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USE OF FACSIMILE TECHNOLOGY IN DOCUMENT DELIVERY SYSTEMS

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This report provides the Scientific and Technical Information (STI) manager with a "knowledge transfer" concerning the technical and application aspects of facsimile (fax) within a document delivery infrastructure. The report provides a technical primer on the current and short-term future technological characteristics of the facsimile, points out potential applications of the fax when integrated into a document delivery infrastructure and brings up a number of key considerations and issues that may arise when implementing the fax into the infrastructure.

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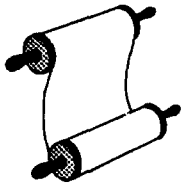

USE OF

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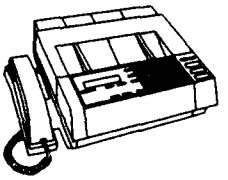

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The intention of this report is to provide the Scientific and Technical Information (STI) manager with a "knowledge transfer" concerning the technical and application aspects of facsimile (fax) within a document delivery infrastructure. The report provides a technical primer on the current and short-term future technological characteristics of the facsimile, points out potential applications of the fax when integrated into a document delivery infrastructure and brings up a number of key considerations and issues that may arise when implementing the fax into the infrastructure.

STI Knowledge Transfer. The mandate for cost-effective and responsive STI knowledge transfer has been exacerbated by the recent technological, economic and geo-political events, which have literally shrunk the physical constraints of time and space in the way we communicate. These global events are also responsible for the burgeoning data explosion that has befallen us over the last twenty-five years. The challenge we face today and into the next century will focus on how to filter, manage and transform this data into meaningful and useful information.

It is widely recognized that STI knowledge transfer can make significant contributions to bolstering U.S. industrial innovation and enhancing its global economic competitiveness. However, some concern has been expressed at the Federal level that the current paper-based STI knowledge transfer cannot adequately handle or expedite the transfer process, particularly in view of the recent maturation of the personal computer (PC) and other computer-related and telecommunications technological innovations. Although a number of STI organizations have or are in the process of developing prototype or small-scale electronic-driven document management systems, a number of economic, technical, organizational and legal issues continue to make paper-based management and delivery the major mode or operation.

Moreover, the anticipated era of the total electronic office, in which information is transferred unencumbered across the globe to both the sophisticated and casual user, will not be a reality until well into the next century. In the context of STI document delivery systems, the technology does exist for developing leading-edge electronic delivery capabilities. However, immature document specification standards, cost-prohibitive hardware for storage and processing and the inability to provide the casual subscriber who does not posses technical capability to receive electronic documents, will cause a paper-based distribution to remain as the dominant delivery medium in the near term. In addition, even if these barriers are succumbed, there would be a major conversion cost from paper and microform to some electronic medium that would tend to make the conversion process time a lengthy one.

Thus, with the continuance of "paper" as the primary vehicle of knowledge transfer, the wide availability and ease-of-use of the facsimile provides the STI manager with a technologically-feasible opportunity to use the fax as a primary document request and send medium. The evolving maturation of facsimile technology, standards and declining cost have made this technology an ideal

candidate for complementing or supplementing current and near-term future STI document delivery systems.

The Fax Appeal. A number of major reasons may be attributed to this broad-based appeal. One is the multifaceted nature of the fax. The hardware platform is a composite technology consisting of an document scanning function (INPUT), a transmission function (PROCESS) and a document receiving or printing function (OUTPUT). Thus, the integration of these three functions makes the fax extremely competitive with other current delivery media such as overnight mail, telex and electronic mail. In some cases, its moderate cost and easy access have made it a more ubiquitous and available delivery vehicle.

A second reason for its appeal is the accelerated rate of innovation on the new units. Once associated with only the "high-end" models and touted as advanced features, laser-driven, plain-paper receiving, document memory, document password security, polling, broadcasting and automatic redial, as examples, are now found on most "mid-end" and many "low-end" units. In addition, fax technological innovations are continuing to integrate other computer technologies to further enhance the unit's capability as a document management system. For example, the recent introduction of the video-fax, which integrates 35mm camera and PC viewing/manipulation capabilities with the fax, provides one way of side-stepping copying document originals to scan the copes into the fax. Another innovation, which integrates a VCR, PC and fax, has the potential of storing documents on tape as still frames. Another innovation integrates voice, phone, fax and on-line computer database for search and retrieval capabilities.

A third reason is the widespread adoption of internationally-driven standards for encoding, transmitting and decoding paper-based documents. The fax is well founded and entrenched in standards for receiving, storing and sending both graphical and textual representations. And although these standards are still evolving to keep abreast with the hardware technological advances in image resolution and digital/multi-media telecommunications, the standards are being written to be "downward" compatible with earlier standards.

A fourth reason for fax appeal is due to the fierce competition among fax vendors vying for the potential huge home and small-office market. The price/performance curves of the facsimile are diverging more rapidly than the PC. The older "high-end" models of the mid-eighties do not contain some of the older advanced features of the current low-end models.

Lastly, the facsimile, as a paper-based medium, will make a virtually transparent transition to this type of document transfer. Moreover, the versatility of emerging fax-server architecture integrated into a local- or wide-area computer network will provide both paper and electronic document sending and receiving capabilities.

In today's fast-track information transfer arena, different technologies deliver documents in various ways. Regular/overnight mail, telex, electronic mail and other electronic sending media are the primary competitors to the facsimile. When comparing the fax against these alternative knowledge transfer media, considerations of cost, delivery speed, volume, format standards, document resolution, type and size fair very favorably against the rest of the pack.

The Fax Bridge. The fax, in and of itself, will not replace traditional and modern state-of-the-art automated document delivery systems. The function of the fax within delivery systems is to provide document transmission, which is a subset component of delivery sys-

tems. However, the facsimile can play an significant role in "bridging" document delivery systems into more leading-edge electronic mechanisms. A number of alternative document delivery architectures can be constructed utilizing the fax that would streamline some of the more labor-intensive operations associated with a paper-based system. If we categorize the delivery process into three phases: (1) receiving requests; (2) processing requests; and (3) sending requests and we further break down the subscriber base according to their technological capacity to interact with the system, a fax configuration matrix can be constructed which provides ways of integrating the technology into the delivery infrastructure to improve performance.

In addition, some of the more significant considerations and issues are brought forth for the STI manager when considering the pros and cons of facsimile integration: *timeliness* -- how much of the subscriber base demands or will demand "immediate" receipt of requests? *subscriber receipt capabilities* -- what are the current and future typical document-receipt facilities of the end-user? *document standards* -- what fax Group 3/4 compatibility may come about with the evolution of American and international image standards on text, graphics and multi media? *material form and format* -- will the increasing use of other multi-media forms and formats overtake the traditional paper-based medium? *staff skills* -- how will the staff respond to radical technology changes that will ultimately be responsible for significant changes in the current paper-based mode of operation?

In addition to the above key points, there are a number of other management decisions that should be made when attempting to integrate facsimile into the longer-term planning of document delivery. The major question is determining the type of facsimile technology that should be infused -- standalone, fax server or some combination thereof. Another matrix is prepared breaking out the major considerations when comparing the two types -- document request, retrieval and receipt. For each of these considerations, three types of issues are examined: *technical* -- the hardware/software that supports each consideration; *cost/performance* -- each technical platform carries with it associated indicators; and *standards* -- each technical platform is also based on a set of standards for receiving, storing and sending documents.

In summary, this report is neither an exhaustive treatise on the technical aspects of the fax nor is it an in-depth discussion on the fax as an integral part of a STI document delivery system. Rather, it is intended to provide a broad-brush view in order for the STI manager to gain an appreciation of the technology and the potential applications, considerations and issues.

CHAPTER 1 INTRODUCTION

1.1 Information Exchange.

To say that the twenty-first century will bring a "global village" reality in our day-to-day lives may be the understatement of the twentieth century. Recent evolving and somewhat dramatic technical, economic and geo-political events have literally shrunk the physical constraints of time and space in the way we communicate with each other. Computer-driven local and wide area networks, real-time satellite and microwave telecommunications on the technology front, liberalized trade restrictions and the recent democratization of eastern Europe and the Soviet Union on the political front have played major roles in orchestrating the virtual instantaneous exchange of ideas and services.

These global events are also contributing to the already burgeoning data explosion that has befallen us over the last twenty-five years. For example, satellite reconnaissance is capturing and transmitting down bits of data at terabyte orders of magnitude. Each year, we generate paper exchanges that would consume some of our largest landfills and there appears to be no end in sight. The exacerbated problem we face today and into the twenty-first century will focus on how to filter, manage and transform this data into meaningful and useful information. This challenge was recognized by the Congress in the passing of the Paperwork Reduction Act of 1980, which mandated that all Federal agencies establish Information Resource Management (IRM) programs. The concept of IRM is that organizations must reorient their business ecume and treat data as an asset in the same lines as their goods and services. Although the ten years since the act have not produced the IRM realization that Congress wished, the concept of treating information as a national and corporate resource has begun to take shape and form.

The last ten years have also brought us two major technological communications media that carry a double-edged sword in the management of responsive and effective information exchange. Since the IBM introduction of its Personal Computer (PC) in 1981, we have witnessed a dramatic metamorphosis in computing and managing data. Many of us can remember the days when data processing was centralized within the monolithic confines of the dungeon-like corporate computer centers. Today, data is managed in a distributed environment with desk-top, lap-top and even hand-held computers. Although the large, mainframe corporate data centers have not gone the way of the dinosaur, a significant amount of data processing has been distributed to the PC and its attendant local and wide area networks. The ramification of the PC, however, has led to a "Tower of Babel" situation in the computer world, in which we now have numerous vendors selling proprietary hardware/software platforms that don't talk to each other's unique, electronic box.

Although invented almost 150 years ago, technological advances in the development of a high-speed, moderate-cost facsimile have paralleled the marketplace acceptance of the PC. The facsimile is currently used primarily as a device to move concepts written on paper around more rapidly. As depicted in

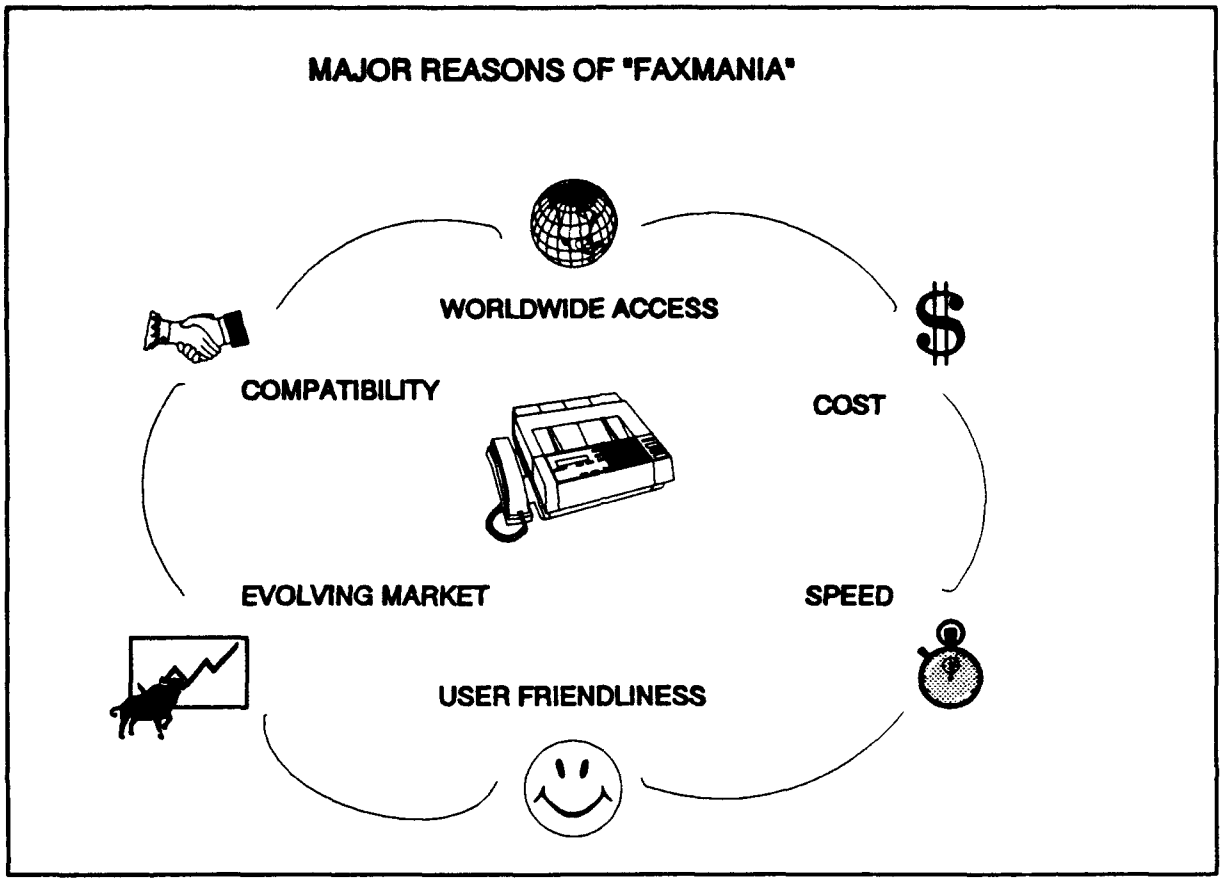


Figure 1-1. Fax Mania

Figure 1-1, there are a myriad of reasons for "faxmania" in this country -- ***Compatibility***: unlike computers, virtually all facsimile equipment today speaks the same electronic language; ***Worldwide Access***: a facsimile permits us to communicate with virtually anyone in the world; ***Cost***: the units are becoming more sophisticated, faster and cheaper. The market is very competitive, thus providing the consumer more latitude in purchasing features, speed, power and price; ***User Friendliness***: within thirty minutes or less, someone can learn to operate a facsimile machine efficiently; ***Speed***: a page can be transmitted within thirty seconds on even the low end models; ***Evolving Market***: the facsimile has reached the acceleration point of the adoption curve with the U.S..

Lastly, and perhaps most important from an STI transfer perspective, is the "content independence" of the fax. The machine can send graphics, charts, type-written text, free form script, signatures, engineering and architectural drawings, Hebrew, Cyrillic, Arabic or Kanji with no special conversion. All of these features have contributed to a faxmania in this country -- we currently use over ten million faxes to send everything from legal documents and emergency medical data to food orders and radio contest replies. In contrast to the hardware/software incompatibilities in the PC world, the virtual ubiquitous compatibility of the facsimile, has caused some negative aspects on the application of the technology. Today we are flooded not only with junk mail but with

"junk fax". In addition, as experienced with the arrival of the overnight letter, the world has been subliminally indoctrinated with the notion that EVERYTHING to be exchanged must happen instantaneously.

This facsimile universality, ease-of-use and moderate cost make it a front-runner candidate for promoting responsible information exchange. PCs, overnight mail and electronic mail, which are other information exchange competitors to the facsimile, do not share these same appealing characteristics. However, the operative word is responsible. The facsimile is not the panacea for effective information dissemination, for it is just a means of information transfer and not a manager or processor of it. In this light, cost effective information dissemination refers to identifying the kinds of applications that deserve or merit (or perhaps more important do not merit) facsimile transmission within one's organization.

1.2 Purpose and Scope.

The purpose of this report is to offer some insight into applying current and future facsimile technology to foster and promote cost-effective information exchange. The report focuses upon the technical characteristics, application potential and management considerations of integrating facsimile technology within document ordering and processing of Scientific and Technical Information (STI) document delivery systems. The report is primarily concerned with the potential of using facsimiles to process and disseminate technical documents when they are requested by government agencies, private organizations or the general public. Although the report is focused upon STI document delivery systems, its principles can be used to apply to the analysis of other types of information management and dissemination centers.

1.3 A Look Ahead.

An examination of current and future aspects and characteristics of STI document delivery systems is addressed in Chapter 2. The chapter highlights the important dual role of STI information exchange with regards the advancement and maintenance of U.S. economic, global competitiveness. A generic model of the life-cycle management of STI documents is presented and glimpses of future ways STI documents may be disseminated are brought forth.

Chapter 3 provides a management overview of the technical features and aspects of the facsimile. A cursory historical perspective on the concept of the devise as a scanning, transmitting and receiving unit is provided. The bulk of the chapter centers upon both current state-of-the-market features and future state-of-the-art technical directions in each of the three facsimile components.

A management perspective of a STI document delivery environment is provided in the final chapter. The first section of the chapter is concerned with comparing utilization of facsimiles for sending requested documents with alternative technologies (e.g., overnight mail, regular mail, e-mail, electronic, etc.). Potential applications are denoted with a STI document delivery setting, and management and consideration issues are discussed.

This report is neither an exhaustive treatise on fax technology nor on STI document delivery. Rather, it is a management overview perspective on the potential advantages and disadvantages of utilizing the facsimile for fostering and promoting responsible information exchange. In addition, it provides a list of some of the important considerations that should be reviewed in making planning decisions of the future of fax in document delivery systems acquisitions.

CHAPTER 2 STI DOCUMENT DELIVERY SYSTEMS

2.1 The Role of STI in the U.S.

The Federal government has been the major participant in the creation, support and dissemination of STI for the past 200 years. Today, it is by far the major producer of sponsored research and development (R&D) -- an estimated $70 billion was funded on Federal R&D in 1991. This mammoth investment generally follows the argument that government-funded research in science and technology serves to support global leading-edge technologies in a wide array of national goals -- national defense, economic growth, improved health, etc. For this investment, the U.S. is the largest source of STI in the world. The results of this funded R&D are considered to be an essential component of the Nation's economic competitiveness.

STI consists of information derived from basic and applied research in a wide range of scientific disciplines -- physical, medical, social, terrestrial and biological. STI is generated by almost all Federal agencies to some degree. However, over 90% of the U.S. R&D is accomplished by five agencies -- Departments of Commerce, Defense, Energy, National Aeronautics and Space Administration and Health and Human Services. Accordingly, these agencies entered into a formal Interagency agreement and chartered CENDI, a group of the five agency STI managers working together to formulate STI standards and solve common problems. Since R&D plays a vital role in each of these agencies, each undertakes a formal role in gathering and processing information from its own R&D and from others, particularly from foreign-based sources through formal international exchange agreements. Each of these agencies maintains STI databases of both ongoing and completed R&D efforts and provides formal outlets for sharing technologies, resources, ideas, information, management activities and standards generated by their constituents within the program.

2.2 Current STI Infrastructure.

The management and processing of STI R&D can be viewed from a life-cycle management perspective. As portrayed in Figure 2-1, just as homo sapiens follow a "womb-to-tomb" life span, STI R&D follows a similar path. At the gestation stage, research is conducted on a particular scientific area. After the observation and analysis phase, the researcher documents his findings in the form of published information such as technical reports, journal articles or books, marking the "birth" of the document. Other forms of a "document" may also include video, audio or other forms of electronic media. Depending upon the type of research report and the source of the work, a STI processing center receives the document for inclusion into its information-center network.

At this point the document traverses two parallel paths. As shown in Figure 2-2, one path is directed at cataloging or putting its contents under intellectual control. It is through this process that the document is entered into the center's bibliographic database. Although the data entry is automated, this process is typically a manual one, in

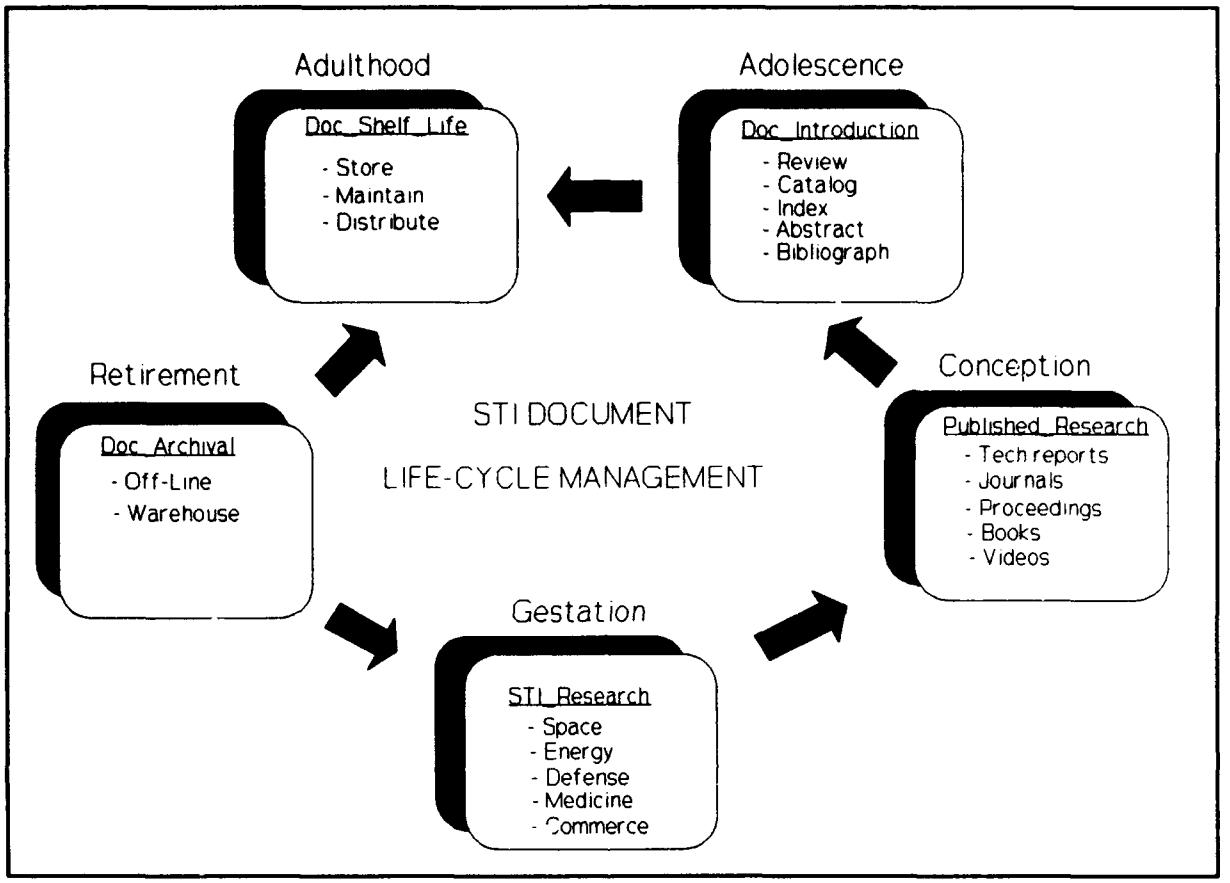


Figure 2-1. The Life-Cycle Model of STI Documents

which a trained cataloger extracts title, author, abstract and appropriate keywords manually from the document and enters them into the center's master citation database. Some computer-assisted techniques are used and these vary by agency. The other path is followed to bring the physical document under some sort of inventory control. A conversion process may then be undertaken to transform the document into either a paper, microfiche or some electronic form for longer storage life and quicker access. Currently, documents are stored primarily in a paper or microfiche form.

During the document's "life span", the knowledge transfer process can be achieved in two modes. Orders for documents can be made either on demand when someone requests a copy of the specific document or on an automatic delivery basis when someone has signed up to receive documents pertaining to pre-selected research areas and the document meets the selection criteria. The automatic delivery process currently notifies an interested party that a document that met the pre-selection criteria has arrived, giving the party an opportunity to request a copy of it.

During the document's life span, it is placed in "active" storage. Typically, the most current and "hot" documents are placed in active storage so that they can be retrieved quickly for dissemination. Older or more esoteric documents are placed in archival

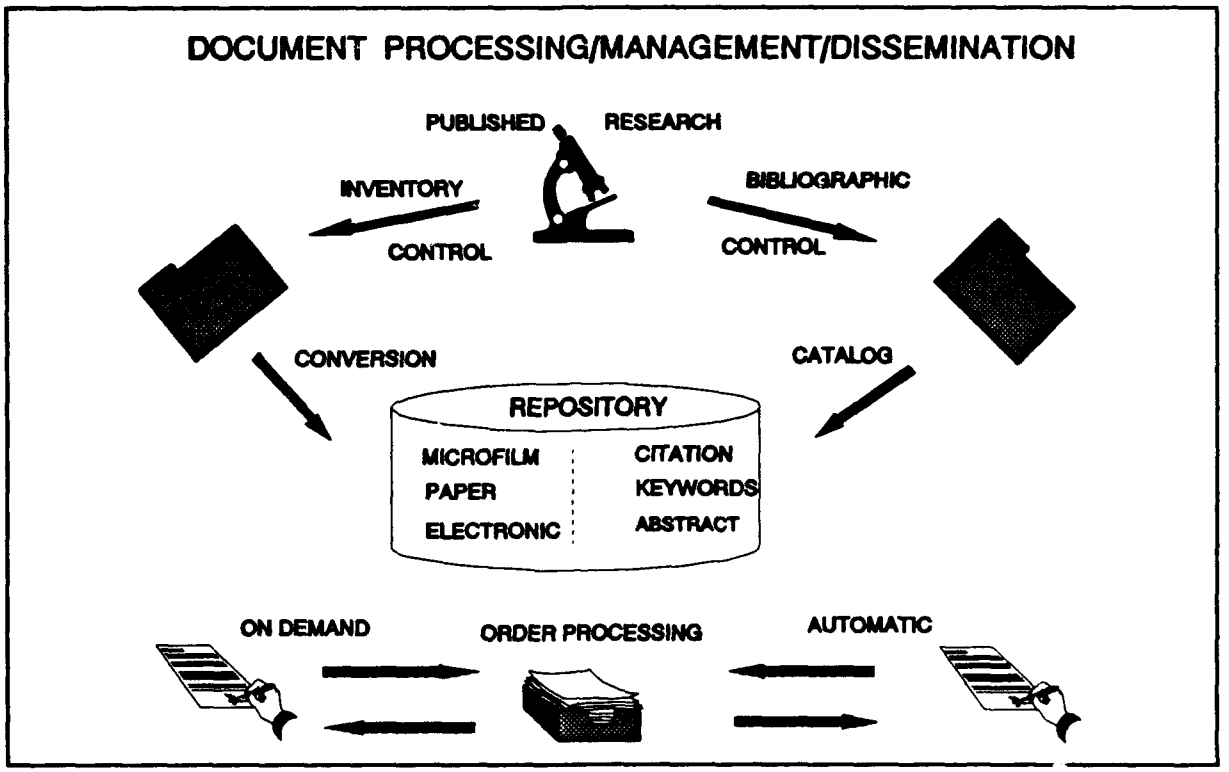


Figure 2-2. Generic Model of STI Knowledge Production and Transfer Process

storage. Archival storage may also be in the form of a variety of media - paper, microfiche, etc.

2.3 Future STI Challenges.

STI can make significant contributions to increasing the country's industrial innovation and productivity and to maximizing its economic competitiveness within a global setting. However, recent innovations with the information technology arena have caused some policy makers to express some concern that there may be a serious void in the transfer process between the producers and users of R&D results and findings. Some contend that the total Federal system of information transfer is passive, fragmented, disjointed and has little means of transferring R&D findings to the appropriate users. Some also fear that we spend the lion's share of taxpayer dollars on knowledge production and a pittance on knowledge transfer.

Efforts at the Federal level are currently underway to address these serious issues. The Office of Science and Technology Policy is currently focusing on four major themes, all of which involve STI dissemination -- education, global change, high-performance computing and economic competitiveness. Congress and Federal agencies are working hard on making a National Research and Education Network (NREN) a reality. A "National Digital Library" plan is also being proposed as an electronic information system comparable to the paper version in the Library of Congress.

Acknowledgement of the gap between knowledge production and knowledge transfer is

placing the U.S. in the right position to obtain its national goals of scientific and economic growth and vitality. STI represents the critical link in the chain between R&D and the achievement of national goals of improving the education of our scientists, strengthening our civilian technology base and fostering international cooperation on global issues and problems.

However, to make matters worse, it has been predicted by Dr. Bromley, director of the Office of Science and Technology Policy (OSTP) that "STI is expected to increase by two orders of magnitude -- a hundredfold -- during the 1990s". Dr. Bromley has called for funded support in research into advanced hardware, software and systems technology and standards to accommodate the impending "flood of STI".

2.4 Technical Opportunities and Risks.

As in many other applications, the recent explosion of computer and telecommunications technologies offers the STI community an arsenal of hardware to combat the impending flood. The maturation of CD-ROM, optical disk, high-performance/moderate-cost intelligent workstations whose CPU throughput power rival some current low-end mainframes, local, metropolitan and wide area gateways and networks provide the STI manager with a technological battery to provide leading-edge electronic document delivery systems. CD-ROMS, which can carry thousands of pages per disk, are currently making their way across libraries carrying bibliographic and cataloging information. Optical disk technology offers even more storage capacity. The technology utilizes a two-sided Write Once Read Many (WORM) cartridge that holds about 40,000 pages per side. These cartridges can now be stored together in a "jukebox" configuration offering a storage capacity of approximately 3.5 million pages per jukebox.

A number of prototype systems have been designed using PCs and optical disks to demonstrate the technical feasibility of producing electronic document management and retrieval systems. The Institute of Electrical and Electronic Engineers (IEEE), in cooperation with the London-based Institution of Electrical Engineers, developed a CD-ROM based prototype for managing their publications, which included journals, conference proceedings, magazines and standards. Each page was entered and stored on the CD-ROM as a "bit-mapped" image (reference Chapter 3). Future prototypes are planned for partitioning the textual pages from pages that contain graphics or picture images -- storing the text in a form that a computer can recognize each character and transform the images to a compressed, bit-mapped, fax-like format similar to a new Group 4 Facsimile standard (reference Chapter 3). The storage requirements will be reduced by a factor of ten and still maintain full text keyword searching and indexing.

As with most opportunities, there are associated risks. The recent computer and telecommunications technological advancements have been evolving rapidly in a number of disparate and incongruent directions with heterogenous hardware and software platforms, and few standards for sharing electronic documents. To the STI manager, this continually dynamic state of flux in the computer/telecommunications industry poses serious risk in investing in proprietary technological solutions. Such marriages will often lead to a system that is accessible by a small fraction of the user community or superseded by later technological developments which render the system obsolete or untransformable due to the introduction of more robust document storage and retrieval standards.

To combat this "Tower of Babel" risk, recent impetus from the Department of Defense (DoD) Computer Aided Acquisition and Logistics Support (CALS) initiative has resulted in the maturation of a number of electronic document standards covering military logistics product data and associated technical publications. Unfortunately for the STI manager, there are two significant problems with CALS and its standards application in STI. The foremost one is the application the standards are being geared to -- product data and technical manuals in support of defense logistics needs. Since STI encompasses as much broader document application range, CALS standards cannot be applied without some adjuncts to the standards.

Fortunately, the facsimile machine is well-founded and entrenched in standards for receiving, storing and sending documents -- both in graphical and textual representations (reference Chapter 3). And although the standards for facsimiles are still changing in order to keep abreast with the hardware technological advances in image resolution and digital multi-media telecommunications, the standards are being written to be compatible with earlier versions in order to keep earlier standard-based facsimiles compatible with the "latest and greatest" version.

The second problem is more of a practical one. The CALS mandate is forcing a total electronic product information exchange between vendor and government. Although the large aerospace and weapon-system manufactures are actively involved in the maturation of CALS and are building computer-based systems to be CALS-compliant, the "mom and pop" spare-parts vendors do not have the financial resources to build or purchase CALS-compliant systems. These vendors will be forced to contract with third party, CALS-generating shops that will convert the required data to compliant electronic form. In a similar vein, some STI users will not possess the required hardware/software media to receive state-of-the-art electronic documents. Thus, although STI centers can begin developing standards and computer platforms for managing documents electronically, they still have to address document conversion to the diverse body of end users.

Because of its "common-language" feature, the proclivity of machines in business today and its spiraling downward cost for home use in the future, the fax can provide the STI manager with a invaluable information exchange medium for the knowledge transfer process. Today, prototypes are being developed to study the feasibility of integrating the facsimile into the mainstream of STI document management and dissemination services. Although many STI agencies have some sort of formal or informal fax delivery service, the day-to-day document management process and dissemination operations are primarily based upon the traditional paper-based mode of operation. Documents are still received, processed, stored, managed and distributed on paper. The only fax feature being capitalized is the "turnaround-time", in which "must have" documents can be retrieved and transmitted in a matter of minutes or hours in lieu of the next fastest overnight medium.

STI centers are beginning to research alternative modes of operation utilizing the facsimile in concert with other hardware/software technologies. One prototype system is being developed by the National Library of Medicine which integrates optical disk storage, facsimiles and PC LAN or WAN technology into a "turnkey" document management system. Documents are converted (the computer nomenclature is scanning) from paper to its digital representation according to the new Group 4 "mixed-mode" standard (reference Chapter 3). The mixed-mode accommodates the management of both text and graphics/pictures on the same page. These "fax-

like" images are then stored, utilizing a digital compression algorithm, onto optical disk. PC software manages the processing and retrieval of the images. When a request comes in for a document that has been captured with the electronic document system and a fax copy is requested, the PC system will flag the document and send it electronically to a fax "server" linked to the network (reference Chapter 3). The fax server will then send the document compatible to the Group designation (i.e., appropriate fax format standard) of the receiving fax.

However, as we will see in Chapter 4, there are other technologies that are vying for the information transfer market. Electronic mail, telex, overnight mail and other purely electronic transfer media can compete with the facsimile. In certain situations and conditions, these alternative technologies may prove to be more effective and responsive to the need in hand. However, as described in detail in the next chapter, these alternatives do not possess the multi-function or composite technology of the facsimile -- preparing the document for sending, transmitting a "facsimile" of the document and receiving the facsimile. Thus, the facsimile can position itself as a extremely versatile technological "bridge" as we progress to more ubiquitous electronic information transfer.

CHAPTER 3 FACSIMILE TECHNOLOGY

3.1 History of Facsimile

It may come as a surprise to learn that facsimile transmission techniques were invented in 1843. The Scots physicist and clock--maker Alexander Bain developed a facsimile system which used a typeset message and a pendulum mounted scanning stylus.

The message was set in metallic printer's type. This flat plate message was then placed on the transmission mechanism. A stylus then swung back and forth across the message, scanning and converting the high points (the letters themselves) of the text into an electrical signal. The telegraph system sent these signals to a receiver at a remote location. A similar pendulum mounted stylus swung back and forth across a wet electrolytic paper.

When the scanning stylus touched the type face, an electric signal was sent through the telegraph lines. That signal then printed chemically on the electrolytic paper. This reproduced a rough image rendition of the original message. This system required typeset messages, a chemist at the receiving end and synchronizing two swinging styli without any electrical or electronic aids. It was a technically advanced attempt at facsimile, but needed much more technology to be practical.

In 1850, Frederick Bakewell invented the copying telegraph. This Englishman started with the ideas of Bain and added cylindrical scanning and recording. Using a rotating cylinder, similar to the original phonographs, the message was etched into tinfoil and wrapped around the scanning drum. The receiving machine used an electrolytic paper wrapped around an identical drum. The drum scanner provided increased reliability and repeatability, when compared to the mechanical flat plate scanner. It suffered from the same lack of synchronization as the original scanner. This system is shown in Figure 3-1.

Early in the twentieth century, several improvements were made which provided the basis for practical facsimile use. The most important developments were made by the German inventor Dr. Albert Korn. Korn added an electrical motor drive to provide a means of synchronizing the sending and receiving units. Korn also provided the first photo-electric scanning mechanism, to make possible the use of normal documents. These machines are among the first to resemble the modern fax in appearance and function.

As early as 1907, a commercial photographic network of Korn's facsimile machines connected Paris, London and Berlin. By 1922, Korn had succeeded in sending photographs from Rome to the United State using radio. More than any other single event, the first picture sent from Rome to the United States forced several large U.S. companies to develop systems for newspaper photograph transmission.

By 1924, AT&T had a network of specially conditioned private-line networks for photo-facsimile. In 1926, the New York Times was granted permission to use the public-

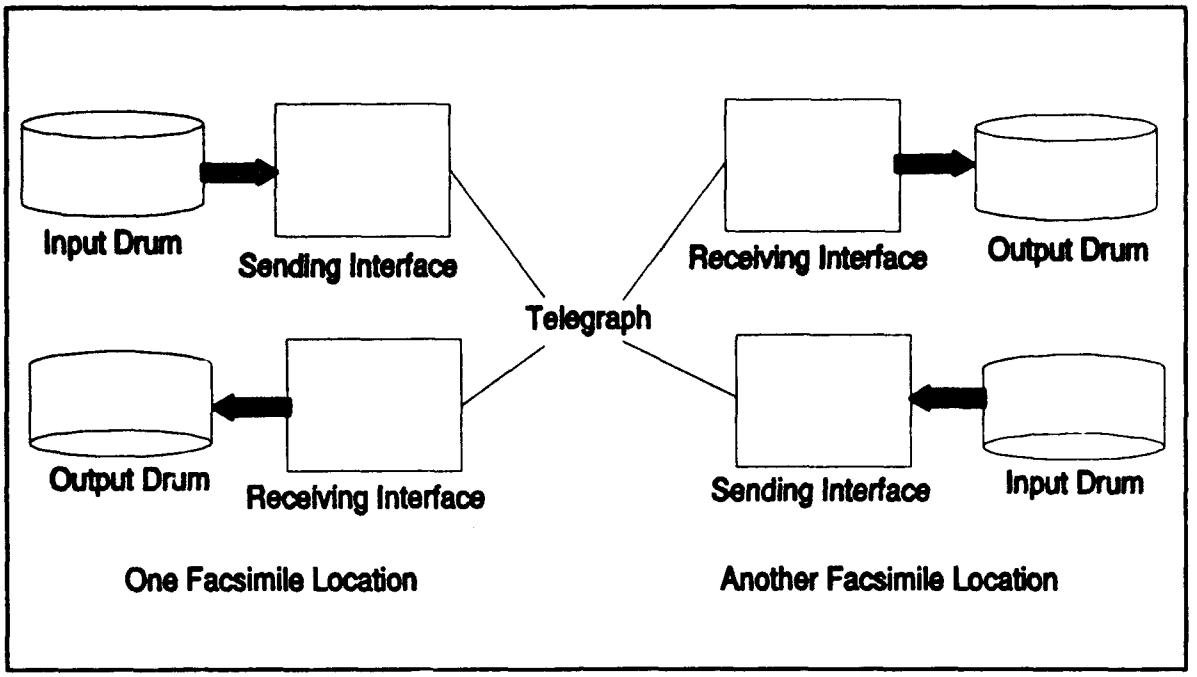


Figure 3-1. Early Facsimile Process

switched telephone network for facsimile transmissions. By 1956, it was possible to send two complete newspaper pages across the continent in four minutes on the dedicated network. Weather information providers also started using facsimile technology to send weather maps to ships at sea by radio and to air transport services by dedicated wired connections.

In 1967, the landmark Carterphone Decision allowed connection of non-AT&T equipment to the AT&T public-switched telephone network. This enabled a revolution in facsimile machines. This revolution allowed many players to enter the marketplace. Unfortunately, each player brought their own incompatible proprietary designs and features to their product line. This made it impossible for machines from one vendor to communicate with any other vendor. It became apparent to users and builders of facsimile machines that some form of international standards were necessary.

The Consultative Committee for International Telegraph and Telephone (CCITT) developed the first facsimile standards in the late 19-60's. Each of the general groups of facsimile standards serves to mark the machines into generations. Each group also yielded revolutionary changes and improvements in capabilities and speed.

The Group 1 machines were based on analog frequency modulation. Unfortunately, the North American frequencies were not those chosen by the CCITT and the rest of the world. Thus, North American Group 1 did communicate outside the U.S.. Group 1 facsimile took four to six minutes to send a single page and often required one to two minutes of operator time per page. The equipment implementing this standard were large, noisy, expensive and unreliable. The printing technology was primitive and often required multiple retransmissions to get a single page of readable copy.

In 1976, the Group 2 standards were approved. This standard was based on analog amplitude modulation. The CCITT standards were followed by virtually all manufacturers, yielding communications compatibility with the entire world. About this time, cut sheet feeders appeared on the machines, allowing pages to be produced rather than scrolled. The transmission time decreased to about three minutes per page, with a resultant decrease in operator time. Flat-bed electromechanical scanners were added to the machines. With increasing capabilities of integrated circuits, such convenience features as automatic answering, unattended operation, automatic dialers and originate/answer identification began to appear.

Group 3 standards were approved in 1980. This standard was based on existing CCITT modem standards, providing 9,600 bits per second data transfers using analog modems. When combined with redundancy reduction and bandwidth compression schemes provided in the standard, the transmission time further decreased to about a minute per page.

Group 4 standards were approved in 1984. These standards were based on three classes of machines. Class 1 is an image mode system. Class 2 provides the capabilities of transmission of image mode documents and reception of image, character and mixed-mode documents. Class 3 provides capabilities for sending and receiving image, character and mixed-mode documents. Mixed-mode documents have both text sections and image mode graphic sections. These machines are based on having very high speed digital transfer between the machines. Until the Integrated Services Digital Network (ISDN) is widely installed in the U.S., these machines are not likely to have great impact on fax transfers.

3.2 Current State-of-the-Market.

As displayed in Figure 3-2, facsimile technology is a composite technology made up of an image scanning function, a transmission function, and a output or printing function. The heart of "facsimile", that which makes it an integrated technology different from the sum of its parts, each of which is a technology with many aspects, is the data format standard that defines and integrates "facsimile" components into an image transmission and delivery system. The facsimile machine hardware and software combines the scanning and printing technology while the transmission uses external communication systems. A comparison of cost and features is contained in Table 3-1.

With the advances in technology the facsimile machine may in fact be reduced to a computer card with data transmission standards while the scanning, output and transmission technology can be a variety of external hardware. Understanding the basic components of "facsimile" is important in order to understand how it will evolved and the potential for applications in information processing.

Basic Features. There are many features that are present in all facsimile machines. These key features provide for the scanning, transmission and printing between facsimile machines. Other common features available on facsimile machines address ergonomics. Any understanding of facsimile should include certain basic features and considerations:

Compatibility. As stated above, CCITT has set up standards that allow facsimile machines to communicate with each other. Most facsimile machines are downward compatible. Over 90% of all facsimile machines used throughout the world are Group 3 machines and many of these machines can communicate with Group 2 machines. There is also a good possibility that the Group 3

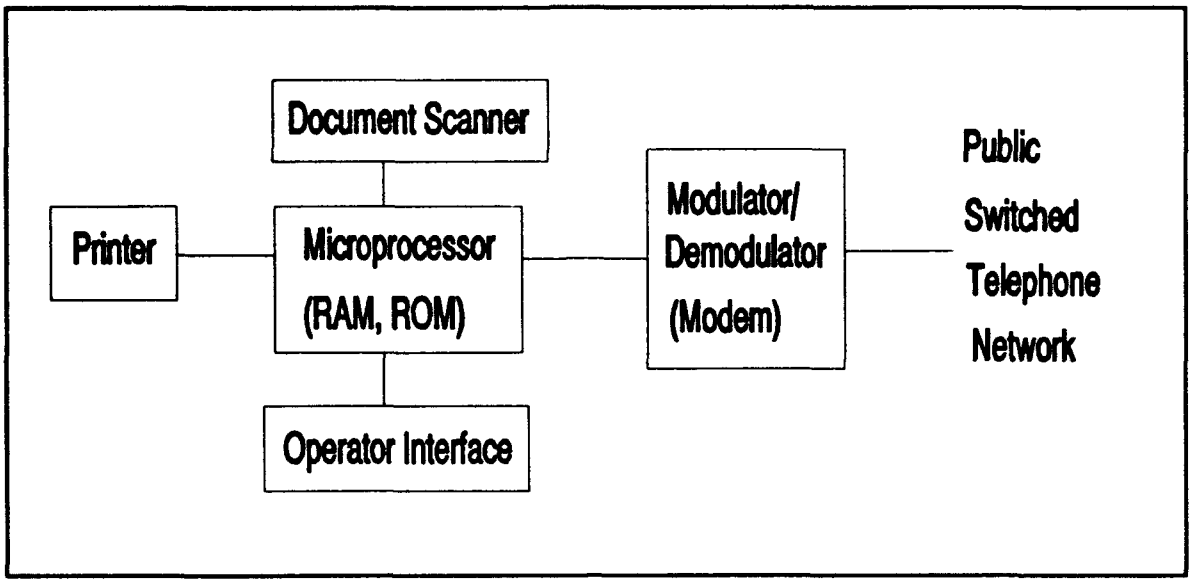


Figure 3-2. Modern Fax Machine

machine will be able to transmit to a Group 1 machine (if you can still find one). It should be noted however, many of the advanced features found in Group 3 machines can not be transmitted to the lower group protocols.

Resolution. CCITT has set Group 3 standard resolution at 200 x 100 Dots Per Inch (DPI), which affords a superior print resolution than an inexpensive dot matrix printer. The committee also agreed to standardize a "fine" resolution mode of 200 x 200 DPI. Most Group 3 machines sold today have the fine resolution mode. It should be noted that this fine mode requires twice as much transmission time as normal mode.

Printing Method. There are four major printing mechanisms employed in fax machines. The oldest method in common use employs a thermal print head to discolor specially treated roll paper. The thermal transfer process uses a thermal print head to fuse pigment from a ribbon onto single sheets of special paper. A few machines use the ink jet technology to print on plain paper. An increasing number of machines use the Xerographic process to deposit and fuse toner onto plain paper. The Xerographic machines may use a laser, an array of light emitting diodes, liquid crystal display shutters and other technology to provide control over the process.

Paper. A decreasing number of facsimile machines use rolls of thermal paper as the output media. Thermal paper is a time-honored and cost effective way to receive documents. A few machines use the thermal transfer method whereby a thermal print head heats a ribbon which fuses a pigment with the paper as it passes by. Another option rapidly gaining popularity is the use of plain-paper facsimile machines. Plain-paper facsimile machines reproduce pages similar to PC laser printers. Plain-paper machines cost more but provide a higher quality original copy. The use of plain-paper machines eliminates the common practice of copying an incoming thermal paper facsimile onto a "better" paper.

Document Size. Most Group 3 machines accept documents 8.5 inches wide. The few

exceptions to this are machines that while adhering to Group 3 standards for transmission, may vary the document size for unique documents. Examples include machines used by law enforcement activities for the smaller fingerprint cards. Larger machines are available that accept documents up to 11.5 inches wide. The length of a document can be unlimited if thermal paper is used. With the use of plain paper, the length of the received document is limited by the length of the plain paper in the paper supply tray. If the transmitted document covers the entire length of the plain paper, the receiving facsimile machine may loose some of the data contained in the top and bottom margin of the transmitted document. The amount of data lost depends on the particular machines, but may be as much as three-quarters of an inch. Typically, the handling of odd size documents requires manual cut-and-paste.

Unattended Operations. Most facsimile machines can automatically answer incoming calls and many machines can automatically dial a phone number at a predetermined time. With an automatic document feeder, this means that the facsimile machine can send documents after business hours. Some facsimile machines can even determine whether or not the incoming caller is another facsimile machine and, if not, can switch the incoming call to a voice telephone.

Advanced Features. Advanced features are not found on all facsimile machines. Many of these features will decrease the amount of time spent "baby-sitting" a facsimile machine and contribute to the ease of transmitting documents. Some of these features can be accomplished at either the originating system end or at the receiving facsimile machine end, and some require participation of both ends. Initial communications handshaking between facsimile machines should establish at call setup which end will provide what features.

Automatic Step-Down and Step-Up. The automatic step-down option detects when errors have occurred in the transmission and will begin to transmit at a slower speed. If the error rate between two facsimile machines is low, the automatic step-up option allows the modem to transmit the document at a faster speed. Both ends must understand when to evoke what speed options.

ECM. ECM is the acronym for Error Correction Mode. This method is used to cut down on transmission errors. ECM was standardized by CCITT as a Group 3 option. In order for ECM to work, both machines must be equipped with this feature. During the transmission of a document, the receiving facsimile machine assembles an error-free document by replacing erroneous sections with retransmitted corrected sections.

White Space Skipping. This is an option that decreases the transmission time for a document by quickly advancing the page past lines that are all white. With this option, horizontal white space such as that found between paragraphs and lines is quickly scanned and bypassed.

Transmit-Terminal Identification. With this feature, the facsimile will stamp a document. This stamp can be as simple as the date and time, or as detailed as the companies name and address. Since facsimile machines stack incoming messages, many document stamps will place the page number at the top of the page. Many people do not want their documents marked up in this fashion and much of the same information such as page counts and sender identity can be provided on a header sheet.

Batch Index. The batch index feature places a black index mark on the top of each page for each incoming facsimile document. Each

Table 3-1. Group 3 Fax Features			
Feature	**Low Cost**	**Mid Cost**	**High End**
Transmission Features			
Alternate number calling	N	M	A
Automatic background control (ABC)	N	F	M
Automatic dialing	F	A	A
Automatic document feeder (ADF)	F (1 - 5)	A (20 - 30)	A (20 & up)
Automatic redial	M	A	A
Automatic retransmission	N	M	A
Book scanning mode	N	N	F
Broadcasting	N	M	A
Copy size reduction	N	M	A
Delayed transmission / polling	N	M	A
Group dialing	N	M	A
Header print	F	A	A
Light / dark / normal control	N	M	A
Page numbering	M	A + Batch	A + Batch
Transmission reservation	N	F	F
User identity cards	N	F	F
Verification stamp	F	M	M
Wide paper scanning	N	F	M
Receiver Features			
Automatic cutter	M	A (Not Applicable)	A (Not Applicable)
Automatic disconnection	M	A	A

Note: "A" = All "M" = Most "F" = Few "N" = None
See Appendix A -- Glossary of Fax Terms for Feature Descriptions

Table 3-1. Group 3 Fax Features			
Feature	**Low Cost**	**Mid Cost**	**High End**
Interpolation	N	F	F
Out of paper reception	N	M	A
Polling	N	M	A
Plain-paper recording	N	F	M
Voice/fax switching	N	M	M
Wide paper recording	N	F	F
Cooperating Features			
Encryption interface	N	F	F
Error correction mode, CCITT	N	M	M
Fine resolution	M	A	A
Group 1 fax compatibility	N	F	F
Group 2 fax compatibility	F	M	M
Group 4 fax compatibility	N	F	F
High modem speed	N	F	F
Step-up modem operation	N	F	F
Voice announcements	N	F	F
General Features			
Copy mode	F	M	M
Indicators for status or errors	M	A	A
Identification of other party	M	A	A
Journal	M	A	A
Memory	N	M	A

Note: "A" = All "M" = Most "F" = Few "N" = None
See Appendix A -- Glossary of Fax Terms for Feature Descriptions

Table 3-1. Group 3 Fax Features			
Feature	**Low Cost**	**Mid Cost**	**High End**
One-touch buttons	M	A	A
Panel display	F	A	A
Telephone built-in	M	M	M
Non-Standard Features			
Automatic resolution control	N	M	A
Confidential reception (or confidential mailbox)	N	F	M
Error-free mode, proprietary	N	F	F
Password operation	N	M	M
Proprietary gray scale	N	F	F
Relay broadcast	N	F	F
Remote diagnostics	N	F	F
RS-232 interface	N	M (option)	M
Super fine	N	F	F
Ultrafine	N	F	F
White Space Skipping	N	F	M

Note: "A" = All "M" = Most "F" = Few "N" = None
See Appendix A -- Glossary of Fax Terms for Feature Descriptions

succeeding page of a particular document has the mark moved a little to the right. At the end of one document, the location of the black mark is reset to the left margin. This allows the handler of the received documents to quickly ascertain the stop and start of individual documents in a single stack.

Polling. A facsimile machine can call another machine and electronically ask if it has any documents queued to be sent to the calling machine. If so, the documents are transmitted from the called machine to the calling machine. This is called polling. Many manufacturers include polling security functions.

Note: "A" = All "M" = Most "F" = Few "N" = None
See Appendix A -- Glossary of Fax Terms for Feature Descriptions

A simple security mode requires that a list of phone numbers be programmed for those facsimile machines you want to have polling privileges. A second type of security not only requires that a list of phone numbers be programmed, but also a terminal identification number as well. The third method requires a phone number, a terminal id number and an encoded password be entered before polling can occur. Polling compatibility will offer significant challenges to Automatic Facsimile Document Delivery systems in that different polling passwords as well as different call back methods may have to be accommodated.

Delayed Transmissions. With this option, a facsimile machine can be set to delay the transmissions of a document in order to take advantage of lower phone rates.

Image Enhancement Systems. This option is used to eliminate the jagged look of lines on facsimile documents. They can work on either the sending or receiving end. When an image is being sent, image enhancement recognizes stray marks and eliminates them.

Contrast. Contrast controls help the machine improve the quality of the copy when the original is either too dark or too light. Contrast controls can be either manual or automatic.

Shading. Halftone transmissions are used to enhance the quality of subtly shaded photographs. Halftone transmission capability is usually rated according to the number of shades of gray it can transmit. The typical capability is 16 shades of gray with some more expensive units capable of 64 or even 256. This increased gray resolution capability increases the transmission times associated with a given document.

Encryption Interface. There are times when sensitive documents could be sent via facsimile machines. It is imperative that these documents are seen only by those who are authorized. Therefore, security measures have been incorporated into many facsimile machines. Some facsimile machines come with features that scramble the transmission while it is going over the phone lines. This option allows sensitive documents from being intercepted by an electronic eavesdropper. If an unauthorized transmission is encountered, all that would be seen on the facsimile is unintelligible markings on the paper.

This encryption can be accomplished in three different methods. The first would be a particular manufacturer's unique, proprietary method of encryption. The second method employs the use of the FIPS Data Encryption Standard (DES). DES is normally acceptable for Privacy Act, personal and For Official Use Only data. The third method would involve the outboard attachment of National Security Agency approved encryption devices such as a KG-84 or STU-III. This third method is the only approved method of handling classified documents.

Color Facsimile Machines. The technology involved in transmitting full color documents has already been developed. These machines are costly, usually over $20,000. The main market is with commercial artist and advertising agencies who typically exchange documents via facsimile machines. Other uses include mapping.

Portable Facsimile. There is already a big push by facsimile manufactures to make facsimile machines portable. The portable facsimile machine is gaining a greater audience with tne increased use of cellular telephones.

Facsimile-Based Audio Conferencing. Telephone conferencing has been around for many years. An enhancement to this idea involves the use of an electronic white board

and a facsimile machine. Images drawn on the white board at one location are sent to the facsimile machine(s) at other location(s). Conferences and educational group meetings could be real-time linked to electronic document archives and on-demand document retrieval could be accomplished by facsimile. As a particular document was needed, it could be ordered and transmitted to the group.

As shown in Figure 3-3, fax machines are increasingly used in communication in the world market. The machines do not respect geo-political boundaries. The machines may also be found as peripherals to many microcomputers, allowing tremendous flexibility in sending documents. The standards currently in place provide capabilities which were not even possible just years ago.

Within the current market, there are several trends which should be recognized. The most important is that capabilities are increasing and costs are decreasing. The current facsimile machine is following the same cost performance curves which have been seen in personal computers. These cost performance curves show doubling in capability at the same price.

Another important trend is the increased capabilities in the machines tend to provide features which are not compatible with those of other manufacturers. Thus, one manufacturer may provide some enhancement, such as encrypted data transfers, which will function only with facsimile machines purchased from the same manufacturer. This rather dangerous trend could lead the industry back to the same confusion prevalent before the CCITT Group 1 standards.

3.3 Future State-of-the-Art

There are a number of advancements that facsimile users can look forward to in the 1990's. There will be a number of powerful options that will increase the efficiency of facsimile communications. Any system planning must address projected changes in facsimile technology as well as advanced document storage and retrieval technologies.

Group 4 Technology. The CCITT decided on the standards for the Group 4 protocol in 1984. This standard was updated in 1988. Within this standard there are three classes of facsimile machines. Class 1 transmits and receives facsimile image documents only. Class 1 have a standard resolution of 200 X 200, and the resolutions can go as high as 400 X 400. Class 2 standards allow transmission of image documents and reception of image only, text only, or mixed-mode text and image. The resolution of class 2 is the same as class 1. Class 3 machines can separate the character portion from the image or graphic portion and transmit the character information more rapidly. Class 3 standards are basically the same as class 2 with enhancements to mixed-mode transmissions.

Currently, only Group 4 Class 1 is in any use in North America. Classes 2 and 3 may never be implemented. This is based on the North American following of the image based Group 3 fax capabilities and abandoning any use of Teletex as an option for any of the machines. This could change, based on the availability of inexpensive ISDN or equivalent digital communications paths.

All three classes of Group 4 machines can transmit at much higher rates. These speeds are due to the dedicated transmission lines that are capable of transmitting information at 64 kilobits per second. However, Group 4 support is expensive in that an ISDN telephone line or dedicated private line currently costs up to $1,000 per month is required. Additionally, the cost of a Group 4 facsimile machine can exceed $8,000.

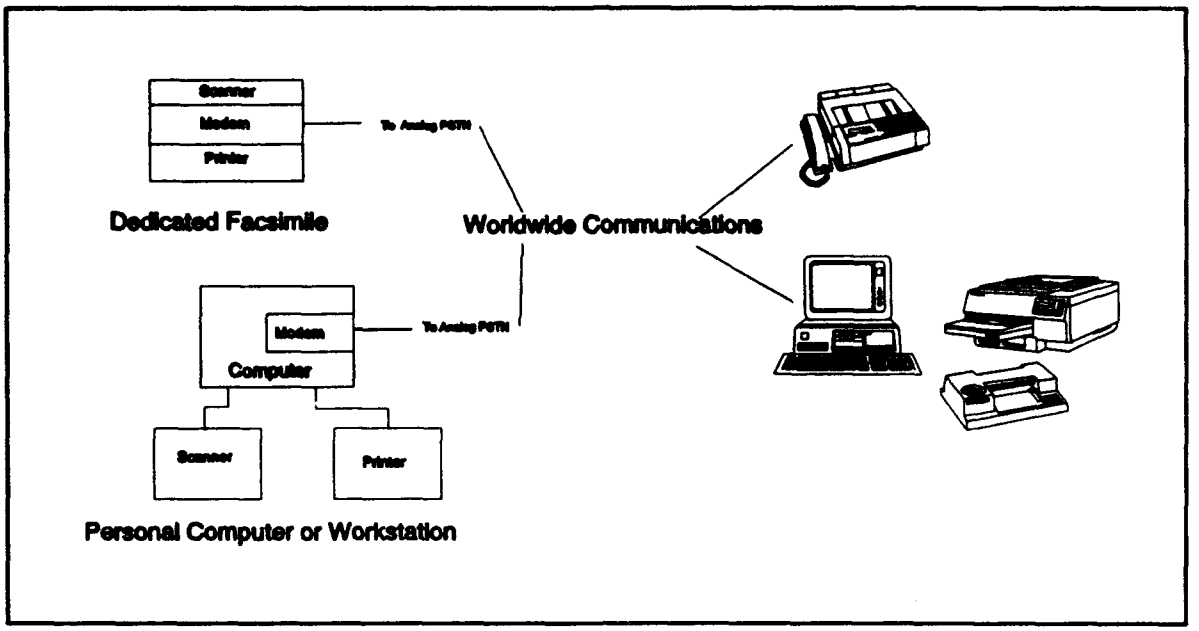


Figure 3-3. Group 3 Facsimile Capabilities

The operation of Group 4 machines on dedicated, high speed lines on the public switched telephone network (PSTN) is currently not defined. There is a major upgrade of telephone service which will supply ISDN capabilities to most of the continental U.S. by the mid-1990's. The published intent of the operating companies is to provide ISDN service to 95% of the East and North West and to the populated areas of the South West by 1995. At that point, overall costs associated with high speed ISDN interconnects should drop.

Group 4 Features. High end Group 3 facsimile machines are now being marketed with Group 4 features such as 400 X 400 DPI resolution. One should not confuse these features with the true Group 4 feature, which require the higher speed transmissions associated with ISDN or equivalent digital telephone lines and special handling of mixed-mode documents.

Group 5 Technology. Group 5 standards are expected to address more of the issues related to mixed-mode electronic document file interchange and less of the facsimile machine mechanics and telecommunications. This standard is in its conceptual stage at this time.

3.4 PC Facsimile Boards and Servers.

With many facsimile machines, a person must spend time feeding the document into the facsimile machine. Furthermore, when a document must be sent to multiple locations, a person may need to feed the document through once for each destination creating a greater demand on human resources. There is another side to facsimile technology: the PC facsimile board. These boards allow automation in the transmission and reception of facsimile documents. It is the reception of facsimiles by way of a facsimile board in the customer's PC that is of most interest to an automated fax document delivery system.

The use of this system is based on the original document being available in electronic form. The document would have to be initially acquired in digital form or digitized into image mode by the STI organization on receipt or digitized and saved on a demand basis. As time progresses and libraries tend to being electronic repositories, paper based archival of documents must become increasingly rare. Systems of this type must become more common.

Typically the facsimile board is installed into an available slot in a PC. The installed board is then connected to a phone line. The next step involves loading software into the PC that will communicate with the facsimile board. This communications software typically runs in what is referred to as either the foreground or background.

Foreground Mode. The foreground mode operation lets the computer user have complete control of the PC facsimile board. By using menus in the software; one can send, receive, print and delete documents. This mode is used when a document needs immediate attention, and will tie up most of the computers resources.

Background mode. When the software is operated in background mode, the PC facsimile board waits for incoming facsimile documents or until a preset time to send out queued documents. While the facsimile board is waiting, a person can use the computer as if the board was not installed. Occasionally, a slow down in the computer system may occur as the PC facsimile board accessed the PC's hard drive and printer to process facsimiles. When this occurs, a message will usually appear on the screen informing the operator of recently transmitted or received facsimile documents. In many cases the PC facsimile software running in the background will send the newly received document directly to the printer.

A PC facsimile board is intended to complement the standard facsimile machine. In those cases where the PC does not have a scanner, documents must be created in word processors and/or graphics programs. The PC facsimile software must convert the text and graphics files into facsimile files before sending it to another facsimile machine. Some of the advantages of PC facsimile boards are:

Paper-less Transmissions. Documents can be transmitted to a facsimile machine without first being printed out and then fed into the facsimile machine. This paper-less process eliminates crooked characters or images (skewing) associated with the scanning process. Using this capability, a plain-paper fax machine can be viewed as a distributed document printer. If the receiving fax machine has 300 or 400 dot per inch resolutions, the output can be as attractive and readable as that produced by any PC laser printer.

Dialing Directory. The facsimile board software usually has a phone directory, and can send the same document to multiple receivers. Most of the software packages have various management features. Whereas facsimile boards use simple English as entered through the PC's keyboard, desk-top facsimile machines typically require the operator to use awkward numeric codes to program dialing directories and other functions.

Electronic Facsimile Queuing. Files can be electronically queued for the facsimile software to send out as time permits or at the preset send time. With a facsimile equipped PC connected to local area network, individuals can electronically send their documents to a central PC to process the facsimile.

Ease of Transmissions. Since a PC facsimile board holds the files on the computers hard

disk drive, documents no longer have to fed into the facsimile machine. A standard facsimile machine makes the telephone connection before it reads the document. Then the facsimile machine scans the document a line at a time. After that the document is converted into a Group 3 image, then transmits. All of these steps add time to the transmission. With the PC facsimile board, the transmission starts when the connection is established. No scanning is involved as the document is already in a Group 3 image format file.

There are problems that can occur when using PC facsimile boards. The following discusses some of the disadvantages of PC facsimile boards:

The Need for Scanners. A disadvantage is that a scanner is needed to handle existing hard copy documents. The solution to this problem is to buy a scanner for the computer using the PC facsimile board. Scanners typically range in price from several hundred dollars for hand held models to several thousand dollars for sheet feeder full page models. At these prices, a desk-top facsimile machine appears to be more economical and easier to operate than a scanner board in a PC. It is only when the multiple use of the scanner for other document management needs such as optical character recognition is considered that a scanner in a facsimile system architecture makes sense.

Reading Documents on the Screen. A receiving PC stores incoming documents on disk. You can view the incoming facsimile on your monitor, but since the screen size is less than an 8.5 by 11 inch facsimile page, a full page on the screen is difficult to read. Therefore, zooming on a portion of the document is the only way to clearly view a document on the PC screen.

Slower Printing Speeds. PC printing the incoming facsimile document is slower than on most facsimile machines because the entire page must be received before the PC can convert it and send it to the printer. Some PC facsimile applications must receive the entire document before printing is started.

Hard Disk Space. Depending on the print density of the page, 10 to 100 kilobytes of disk space is required for a one page document. The operator must manage disk space so as to preclude incoming facsimiles from using up all available disk space. This management usually consists making sure the printer is available, that incoming facsimiles are printed out as they are received, and that facsimile files are purged after they are printed.

3.5 Fax Integration Trends

Several innovative functions have been integrated into the facsimile process. As examples of the innovative ways fax can be put to work, the following examples are offered. These are not the only innovations; rather, they are the innovations which are felt to be useful in the deliberation process for fax integration into document delivery.

One large company has introduced an enhancement to their software for their fax server. This software allows users to preview faxes on a CRT. Users can then choose to print the entire fax, not to print any of the fax, or eliminate pages from printing. Since the user can choose and selectively print only those portions which are needed, the printing of large quantities of paper can be eliminated. With the document in machine-readable form, it is also simple to retain a machine-readable copy, read the portions which were desired, and retain the document on the computer instead of in the book case.

Another company has integrated a video camera with a facsimile. A high resolution gray scale camera and a video screen are incorporated into the unit. The local user can place an object in the camera's view, adjust the lighting and camera to achieve optimal picture quality, see the fax image to be sent, and send the still image to a remote fax machine. The remote machine can be a normal fax machine. The remote machine could also be an integrated facsimile machine with camera and video screen. If it was, then the remote user could see the image on video screen as well. This provides capabilities for sending images from unusual paper sizes, small portions of a single page, three dimensional objects and other unconventional objects to a remote user in an extremely timely manner. At least 10 percent of the overnight courier revenues are estimated to be "show me" packages containing an object which the recipient must see but not necessarily touch.

Another innovative product provides electronic document storage, retrieval and data transmission. The Kirsch Technologies, Inc. InfoStation uses a small computer with attached ordinary videocassette recorders (VCR) to store bit-map images which can be retrieved under computer control. Once the image is in the computer's memory, it can be manipulated and sent to a remote user's Group 3 fax machine. Documents can be scanned into the system using an attached scanner. This capability is not unusual, rather the cost sensitive storage method is the innovation. VCR tapes can store the equivalent of an entire filing cabinet on one tape (roughly six thousand documents). The content of each VCR tape is classified by keywords. These keywords are stored in the computer's database, which allows normal database searching capabilities. The VCR is under computer control for tape positioning and document retrieval. The document can be zoomed, panned and rotated on the screen. Documents can be printed locally or transmitted to a remote fax machine. The capability of transmitting ASCII text documents is also provided. Capabilities are also provided for premastering the content of the VCR to a CD-ROM.

The Communicating Applications Specification (CAS) was jointly developed by Intel Corp. and Digital Communications Associates, Inc. The CAS standard provides an open format for to integrating fax transmissions into standard applications software on PCs. CAS allows users to send a fax from applications such word processing, database query, spreadsheet and desktop publishing, just as easily as sending the information to a printer. CAS thus provides a seamless link between the PC and the fax. This standard provides bit images of the data to the remote user.

In addition to a bit-image fax of the document, it is possible that the user might want the machine-readable version. The Telecommunications Industry Association (TIA) has established a formal standards committee, TR-29.1, to study this problem. This standard would allow an encoded version of a file to be sent between two cooperating Group 3 fax machines, disguised as a fax image. Cooperating processes on each end would send and receive files. The received file would be an electronic, machine-readable copy of the sender's file. The PC fax modems could also be used for normal transmission of fax images. This standard has been sent to CCITT for possible incorporation in 1992. Several PC fax board manufacturers have decided to proceed with the implementation and sale of this standard.

If documents are stored on a computers, in either machine readable or image form, and those computers are linked together on a network, various additional capabilities can be added. One of the most important capa-

bilities would be a fax server or set of fax servers. This would allow users to queue fax requests for documents to the fax board for transmission just as easily as printing the document on a network printer. With fax servers, the user does not have to find paper copies of the document, walk to the fax machine, set documents into the ADF, baby-sit the fax machine through its transmission, retrieve the documents and refile the documents. The fax server allows a user to find the document on the computer and immediately queue it for transmission. The fax server provides a convenient means of gathering machine-readable accounting information for bill back purposes. Obviously, since this is a software driven system, the system must be carefully evaluated to assure capabilities, user friendliness, match to desired functionality and other key issues. With computer stored documents, the idea behind the fax server becomes attractive. The actual implementation must be carefully controlled to assure useful results.

3.6 Fax Cost/Performance Considerations.

As with any hardware investment in major equipment, there are a number of hidden costs that do not necessary surface during the initial procurement. As displayed in Figure 3-4, there can be numerous "extra" costs depending upon the intending utilization of the machine. One obvious non-hidden cost is purchase price and as described earlier, the price depends upon the role of the machine within a document delivery environment. For example, if the machine is only going to be used for receiving requests, a low end fax would suffice since most of the high end feature would not be required (e.g., plain paper, polling, broadcasting, memory, etc.). On the other side, use of the facsimile to send a high number of requests out on a daily basis, requires a high end fax (e.g., large automatic document feeder, large memory capacity, book scanning capability, etc.) that has a heavy duty cycle -- thousands of pages a month. Note that a plain paper is not a requirement for such a transmitting fax machine. Lets examine some of the hidden costs:

Equipment. Maintenance and supplies are the major ones in this category. Service agreements will be a mandatory add-on to the purchase price if the fax is going to be used heavily -- just consider the fax like one of the paper copiers in the office. Even though the office copier may be of the "industrial strength" kind, there will be the inevitable jams and the regular preventive maintenance required to keep the unit in good working condition. Like the copier, toner supplies are required for xerographic plain-paper copiers.

Copying. If the fax is going to serve as a document deliverer and the material is primarily paper based, copies would have to be made to prepare the document for fax transmittal.

Volume. The higher the volume of transmittals or receipts, the more wear-and-tear, potential for jams and preventive maintenance sessions on the unit. The key here is to purchase a fax with a duty cycle that comparable to the project load volume of the unit. Unfortunately, duty cycle data is not well advertized in the fax brochures.

Labor. Like the office copier, someone will have to attend to the unit when sending material and someone will have to process the receiving side of the fax when requests are faxed. High end faxes will large capacity automatic document feeders and memory capacity to "batch" material may cost more up front, but will save in labor "baby-sitting" time when transmitting large amounts of pages.

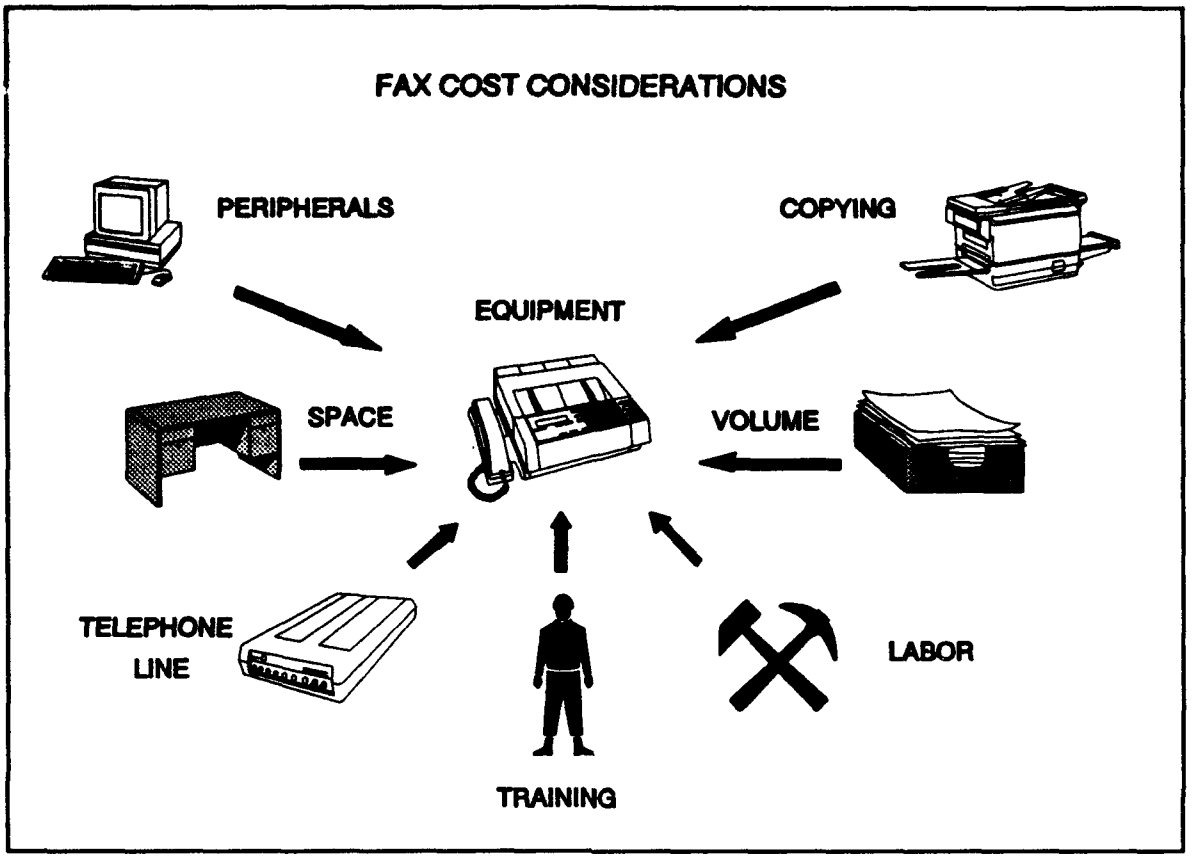


Figure 3-4. Fax Cost Considerations

Training. This cost is fairly insignificant. However, the multi-featured, high end models will require about one hour's worth of training for each intended operator.

Telephone Line. A dedicated telephone line is recommended. Although there are some newer units that are smart enough to share a voice phone line, serious use of the fax would dictate the installation of a dedicated line. If the unit is going to be faxing a large number of documents in a series of batches, some of the newer models have multiple lines for parallel transmitting.

Space. This is an often overlooked cost. The units are not hand-held calculator dimensions and cannot be innocuously hidden on a desk. Indeed, some of the more industrial-type models take on the size of mid-range copiers -- stand-alone units that require floor space and some environmental constraints. If large volumes of data are sent, additional support furnishings will be required to hold the paper documents before and after transmission. Also, working space has to be maintained around the machine itself.

As with any technology based solution to problems, there remain several major and a host of minor concerns to be answered. The questions posed in this section are not the only discriminators. These have been used as a path to starting the thought process required to properly deal with the use of fax in a document delivery system.

CHAPTER 4 POTENTIAL STI APPLICATIONS

4.1 Alternative Technologies.

In today's fast-track information transfer process, different technologies deliver documents in various ways. Regular or overnight mail, telex, electronic mail and other electronic-sending media are the primary competitors to the facsimile in this market. Let's take a look at the pros and cons of each of these media.

Mail and Parcel Services. The cost and area of coverage of mail and parcel services continues to improve. Next-day service with the U.S. is available to Federal agencies and their contractors at $5.00 per one pound package. If the customer can wait 24 hours, this document transfer alternative is hard to beat. Moreover, out-sized documents, in the form of unique paper dimensions (e.g., engineering or architectural drawings) or non-paper forms -- diskettes, magnetic tape and audio/video cassettes, make this transfer medium virtually the only viable one.

At the present time, it is difficult to determine where this service is headed. On the one hand, as increased competition from other transfer media arises and more efficient parcel handling and tracking methods are employed, service should improve and prices should continue to fall. On the other hand, mail and parcel service rely on surface and air transportation, which have cost increases based on the inevitable increases of fuel costs.

Telex. The popularity of the telex has taken a dramatic downturn during the fax mania decade of the eighties. The facsimile has claimed superiority in image resolution, speed, cost of transmission and document preparation, since the document must be re-entered in the telex machine.

However, since a telex is considered a legal instrument whereas there are many unanswered questions concerning the legal validity of a facsimile image, the telex will remain useful in many legal applications. Moreover, some companies have integrated the telex with computer networks to eliminate the re-entering of text to be transmitted. These two features will cause the telex to remain a competitor for the near-term. In the long-term, the eventual acceptance of a facsimile image as a legally binding document and the integration of the fax into computer networks may well render telex as an outdated technology in the information transfer business.

Electronic Mail. Electronic mail, or the use of computers and telecommunications networks for transferring messages in digital form has been available for over twenty years. Commercial vendors like AT&T and MCI-mail, together with the Federal INTERNET e-mail network promote the sending of tens of millions of digital documents across the globe. However, the fax's ease-of-use and universal compatibility have made fax into a major competitor for electronic mail. Facsimile is the communications medium of choice for many organizations. Instead of mastering proprietary communications software and subscribing to numerous mail services to provide wide coverage area, some e-mail users are supplanting their electronic systems with a fax-based network.

To more effectively compete, e-mail vendors have taken steps to make their systems easier to use and more versatile. The recent X.400 communications standards promises to do for e-mail what the CCITT Group 3 standard did for facsimile transmission. X.400 functions like a master interpreter that enables two previously incompatible e-mail systems to communicate with each other. When an e-mail message is transmitted, it is converted into a standard format prescribed by the X.400 protocol. At the receiving end, the message is reconverted to a format that is compatible to the addressee's e-mail protocol.

X.400 compatibility is expected to launch a period of innovation that will revitalize the e-mail business and make it a viable and less expensive communications alternative. For example X.400 will provide LAN interconnections with public data network, enabling LAN users to send and receive e-mail on an intercompany basis for the first time. As mentioned above, X.400 will offer improved and extended service for telex subscribers by eliminating the need for special data-entry terminals and by having the telex forwarded over common carrier lines. In addition, major e-mail vendors are now offering subscribers the option of sending e-mail messages to any Group 3 fax machine in the world -- without using a fax board on the sender's hardware. The e-mail vendor centrally converts the message to the fax-format and sends the message.

One obvious disadvantage of e-mail is the cost of the equipment in terms of computers and telecommunications. Obviously, e-mail is a high end company alternative and not viable for the all users.

Other Electronic Media. The PC revolution has led to an accelerating use of the electronic document as a primary means of transferring information. Text is sent as ASCII (American Standard Code of Information Interchange) codes that are interpreted as characters on the receiving PC. In contrast to the Group 3 fax, which sends bit-mapped images of the characters, ASCII text files reflect orders of magnitude in storage savings since a single ASCII character can be stored in 7 bits as opposed to hundreds to thousands to represent the same character on a Group 3 fax format.

Since the computer can immediately recognize the ASCII codes as characters with no translation overhead, electronic text documents provide numerous advantages over facsimile images. If given facsimile images, the computer must extract the characters from the bit-mapped file using character recognition software. If given electronic text documents, there is no required translation of image back into text.

Graphic images, although not nearly as flexible as text, may also be sent electronically. There are a number of file formats (e.g., TIIF, CGM, HPGL, DXF) that may be used as long as the receiving PC has the software to interpret the graphics format sent.

The maturation of the fax board server technology coupled with the Intel CAS standard (reference Chapter 3), will form a marriage of the information transfer technologies. With the impending widespread use of CAS, the variety of third-party proprietary formats in which documents are currently stored will be immaterial. CAS allows documents to be converted to a fax-format and sent as images.

However, as in the case of pre-X.400 e-mail standards, a "forked-tongue" situation exists for computer electronic file transfer. In addition to ASCII, another major digital representation exists (EBCDIC by IBM). Documents sent in an ASCII format cannot be immediately understood by computers that

are use the other character format. Difference in computer operating systems and disk file formats also provide major electronic transfer barriers. There is much talk about computer vendors developing standard operating systems, file formats, etc., the reality is that the development of X.400-like standards for computers is a long way off in the future.

In an attempt to offer a capsulated view showing cost/performance comparisons of the major information transfer media, the matrix in Table 4-1 is provided. It is clear form the matrix that overnight reflects the most unconstrained or flexible transfer media among the alternatives. The major disadvantage of this medium is time. It is hard to imagine that when someone "positively must have it", the overnight time frame is no longer in vogue.

Let's look at a number of highlights within each of the cost/performance categories:

Cost Element. All exhibit a variable charge based on the volume being sent and all transfer modes carry some document transfer-preparation cost. There is no clear-cut winner in this category since, urgency or need of the document may far outweigh the cost (e.g., medical emergencies).

Delivery Speed. The Group 4 Fax is definitely the best. Although e-mail and other electronic transfer means can compete with this speed, the transmitted document is not actually read until the recipient logs into his/her computer network and "reads" the document.

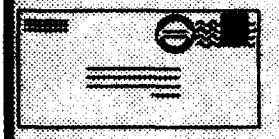
Typical Volume. If the recipient can wait, the overnight medium provides the most flexibility in handling extremely large document volumes. Although the X.400 implementations will be less restrictive, the current maximum e-mail message is less than 50,000 characters. The Group 3 and 4 faxes also have typical volume constraints. Although one is able to theoretically fax an unlimited number of pages, the current Automatic Document Feeders (ADFs) on the high end faxes are currently limited to a maximum of 50 pages. Therefor, if the document is larger than the capacity of the ADF, the sender will have to manually split the document into batches and wait to fill the ADF after each batch is scanned.

Format Standards. Excluding overnight, all other transfer media exhibit page-format constraints. The ability of the Group 4 fax to handle text in ASCII and graphics in compressed bit-map representations makes it the more versatile among the other format standards.

Document Resolution. Excluding overnight, all other transfer media place some restrictions on the amount of "faithful" reproduction of the incoming document. The ability of Group 3 and 4 faxes to "sense" the resolution capabilities of the receiving fax unit and adapt the resolution to the receiving fax makes it the more versatile media.

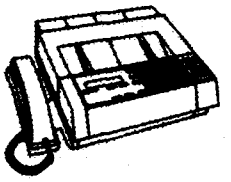
Document Type. Excluding overnight, all other transfer media exhibit some constraints on the type of document that can be received. Group 3 faxes deal with "images" where both text and graphics are identified by digital bit representations. As noted in Chapter 3, Group 4 fax can handle a mixed-mode and differentiate between text and graphics/pictures.

Document Size. Currently facsimile technology is the most constrained medium in this category. Since the CCITT standards are centered upon current U.S. and international printed "page" standards (8.5" by 11", legal, A4), fax units are built to accommodate only these sizes. New high end, special faxes are now being introduced that accommodate engineering and architecture drawings up to



FAX-TO-ALTERNATIVE TRANSFER COMPARISONS

MANAGEMENT COST/PERFORMANCE CONSIDERATIONS



	Cost Element	Delivery Speed	Typical Volume	Format Standards	Document Resolution	Document Type	Document Size
FAX Group 3	Telephone Use + Handling	10 to 30 seconds / page	Max. 5 to 50 based on ADF	CCITT	(100 or 200) by 200 dpi	Image Only	8.5" by (11" or 14")
FAX Group 4	Telephone Use + Handling	3 to 4 seconds / page	Max. 30 to 50 based on ADF	CCITT	400 x 400 dpi	Text and Graphic	8.5" by (11" or 14")
Electronic network / electronic mail	Telephone Use + Computer Use	Based on when User Retrieves	Resource and Disk Constraints	ASCII + X.400	Computer Screen or Printer Dependent	Primarily Text Only	50,000 Character Maximum
Electronic network / electronic file	Telephone Use + Computer Use + Mailing Fee	Overnight	Resource and Disk Constraints	ASCII-Text Graphics	Computer Screen or Printer Dependent	Primarily Text only	Constrained by Deliverer
Overnight	Urgency + Weight + Handling	Overnight	Weight Limit Per Package	None needed	No translation	Unlimited	Original Document

Table 4-1. Alternative Delivery Technologies

the E-size (24" by 36"), but these units are too cost-prohibitive to the average fax user.

Document Format. If the initial format of the document is electronic, then there is certainly no problem using any of the electronic distribution methods. If the document is on paper or microfilm, then any electronic medium will require conversion. If the document is on paper and a typical fax machine is used, there is no real problem. The other electronic media all require some form of translation from paper or microfilm to machine-readable format.

User Capabilities. Finally, it is imperative that the STI manager consider the capabilities of the smaller service user. The small user's acceptance of the various technologies must drive the STI center's choices. If small users

have access to adequate resolution facsimile capabilities, then facsimile may prove to be a useful path. If the small user does not have access to e-mail or facsimile or which ever of the electronic media chosen has little bearing on delivery of STI to that user. It is the general acceptance of the electronic media in the scientific and technical marketplace which will drive its use in document dispersal.

It is important to note that many of the above cost/performance considerations exhibit some sort of interrelationship or dependence upon each other -- in other words, each factor should not be analyzed in isolation from some or all of the others. For example, document resolution, type and size are all closely tied together and should be examined in like manner. Moreover, in some cases there may be more optimal transfer media after taking all the factors into consideration, but one constraint or inhibiting factor may override the optimal choice. For example, the need for a highly detailed engineering drawing or an X-ray may be immediate; however, the only media to effectively handle these types of "documents" is overnight mail.

Within the facsimile technology itself, there are a number of cost/performance considerations that should be taken into account when applying this technology to document delivery. Key issues are described in Chapter 3, to include the four major types of print output media. These and other capabilities generate different cost/performance ratios. Table 4-2 provides some of the more important features that ought to be considered.

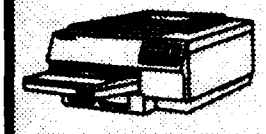
4.2 Potential Applications.

The anticipated and much heralded era of the total electronic office, in which information is transferred unencumbered across political boundaries anywhere on the globe to both the sophisticated and casual user, will not be a reality until well into the twenty-first century. Until more robust and ubiquitous standards are defined for handling both "page" and "pageless" information, common-language computer operating systems and telecommunications networks really do talk to each other, and the technology is cost-effective to even the causal user, the piece-of-paper medium will continue to be the prominent mode of information transmission.

In the context of STI document delivery systems, the technology does exist for developing leading-edge electronic delivery capabilities. However, immature document specification standards, high hardware costs for electronic storing and processing and the inability to provide the causal subscriber who does not posses the requisite electronic platform to receive documents, will cause paper-based distribution to remain the dominant delivery medium in the near term.

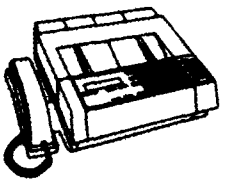
Fortunately, a number of alternative document delivery architectures can be constructed that would streamline some of the more labor-intensive operations associated with a paper-based delivery system and be responsive to the type of subscriber. To this end, if we can assume there may be three types of subscribers: (A) "low-tech" -- one who does not have the facilities to request or receive documents in any other media but their physical representation (i.e., paper, tape, cassette, etc.); (b) "mid-tech" -- one who has a limited capability to request and receive documents in some other form or format from the original document; and (C) "high-tech" -- one who has the ability to request and receive at a comparable technological level as the document delivery service.

Likewise, we can construct these three types of degrees of technologies to the document delivery service in handling requests. Let us



FAX-TO-FAX COMPARISONS

MANAGEMENT COST/PERFORMANCE CONSIDERATIONS



	Purchase Price Range	Cost / Received Page	Expected Volume / Day	Received Page Appearance	Received Page Shelf Life	Color Capability	Document Size Produced
FAX Group 3 Heat/ Thermal Paper	$300 to $4,000	$0.05 to $0.07	Low Hundreds	May be blurred / curled	Short term only, heat sensitive	None	8.5" by roll length
FAX Group 3 Xerographic/ Plain Paper	$2,500 to $14,000	$0.02 to $0.03	Low Thousands	Faithful, based on resolution of engine	Archival	Color possible	8.5" by 11" or 14"
FAX Group 3 Thermal Transfer/ Plain Paper	$1,600 to $4,500	$0.12 to $0.15	Mid Hundreds	Faithful, based on resolution of engine	Archival, not good abrasion resistance	Color possible	8.5" by 11" or 14"
FAX Group 3 Ink Jet/ Plain Paper	$1,500 to $3,000	$0.03 to $0.05	High Hundreds	Faithful, based on resolution of engine	Archival, may have problems with water	Color possible	8.5" by 11" or 14"
FAX Group 4 Xerographic/ Plain Paper	$7,000 to $30,000	$0.02 to $0.02	Mid Thousands	May be improved based on special techniques	Archival, may stick together, solvents or pressure	Color possible	8.5" by 11" or 14"

Table 4-2. Fax Cost/Performance Considerations

also assume that there are three phases of a document delivery service: (1) receiving requests; (2) processing requests; and (3) sending results of requests, we can construct a matrix as shown in Table 4-3, which presents some of the alternative technological interfaces that may result. Let's look at some of these alternatives by phase, type of service and subscriber when orders are placed in an "on-demand" mode.

Phase I: Receiving Requests -- Service Perspective. On the low-tech scale, a low end request-receiving unit(s) can be installed for handling document requests. The unit could be a low end model since all of the high end features would not be required. The manual labor involved would entail someone at designated time intervals monitor the machine checking for errors, paper needs and requests

ALTERNATIVE DOCUMENT DELIVERY VIA FAX POTENTIAL APPLICATIONS BY TYPE TECHNOLOGICAL CAPABILITY			
	REQUEST PHASE	**PROCESS PHASE**	**SEND PHASE**
LOW-TECH Service	Low-end fax to receive free-form requests ... manual processing	Same as in conventional paper-based system	Send material via manually-supervised fax
LOW-TECH Subscriber	Low-end fax to send "free-form" request	Wait for response ... days	
MID-TECH Service	Fax-server on LAN-/WAN to receive free-form or fixed-form request	Process is directed & overseen by computer operator ... limited electronic document storage	Converted material is sent via fax-server ... resolution is determined by receiving fax
MID-TECH Subscriber	Low-end fax but hardware to file fixed-form request	Wait for response ... hours to days	
HIGH-TECH Service	Fax-server on LAN or WAN to receive computer-readable text	All processing is done via LAN/WAN document management network	Material sent in requested format electronically via fax-server
HIGH-TECH Subscriber	Tools to generate electronic, fax-format request and send via fax server	Wait for response ... minutes to hours	

Table 4-3. Potential Fax Applications in Document Delivery Systems

to process. All requests would then be logged in the manual "in-basket".

On the mid-tech scale, a fax server could be configured into a LAN based document processing network. In this manner a request coming in would be filed electronically. This request would also involve human operator interface. The operator would periodically check the electronic fax-basket and process the request on his/her's terminal.

On the high-tech scale, a request would be electronically transmitted in a fax-format, converted to ASCII if the request was from a Group 3 machine and processed automatically without the need for human intervention. Notification of receipt or any errors in the request can also be achieved without manual intervention.

All of the above subscriber-service interfaces are by facsimile. However, a voice-fax architecture could be configured to handle subscribers who would like to conduct literature or keyword searches on the information center's citation database. Here, the user would call a 1-800 or 1-900 number and interact with a synthesized voice directing the caller to possible choices. Through the use of the 12-button touch-tone phone, the caller "converses" with the machine, instructing the unit what to do. The unit is tied to the on-line bibliographic index and begins searching the database, or responds to one of the other "menu" selections. The response to a search or other request can then be faxed to the caller.

Phase I: Receiving Requests -- Subscriber Perspective. Given the proclivity of fax machines in use today and certainly in the near future, all strata of subscribers would have the facility to fax requests. The difference here would pertain to the physical form of the fax request that would differentiate the type of subscriber. The low-tech subscriber request would be either in free-format, in which the request is either typed or written anywhere on the page, or in a fixed format where a copy of a pre-printed request form is used and the subscriber can either type or write in the request.

A more high-tech method would be to have a fixed-format request form and have a subscriber fill in the blanks with a pre-approved typeface. Mid-tech subscribers would have access to this typeface and the facilities with either a conventional typewriter or a PC word processing package and a laser printer to produce the requested output. In this way, the request can be entered into a Optical Character Reader (OCR) image scanner and automatically logged into an electronic in-basket. This method would eliminate the manual request entry.

At the most sophisticated end, a high-tech subscriber would call up the request form on his/her word processing package, enter the request information and electronically fax the request to the LAN fax server of the document service.

Phase II: Processing Requests -- Service Perspective. The document holdings at the service can either be completely in their original physical representation, totally translated into electronic multi-media form or some combination between the two extremes. At the low-tech end, if the location of the original document(s) is physically separate from the request processing location, a facsimile request can be sent to retrieve the material. Once the material is retrieved from "the stacks", it is copied or converted to an appropriate form and faxed to the request unit. The only difference between this procedure and the conventional document delivery service is in the sending medium -- fax in lieu of postal or express mail.

In a mid-tech environment, the incoming fax request is processed by a computer operator. In addition to processing administrative and financial chores, the operator determines the location and storage medium of the requested document(s) and based on the results of the search sends out a request to retrieve the material. Some of the material may be in electronic fax-format and the operator would be able to send the material to the recipient's unit via his/her terminal. If the material is in its physical form, the material would have to

be copied and converted into a fax-format image and forwarded electronically to the fax server for immediate or off-hours transmission.

This environment may also have a video-fax configuration at the document storage facility. A operator would bring a portable unit to the location of the material and then focus the camera on each page to be transmitted. Upon each "shutter click", the viewed page would be transmitted in fax-format to the fax server.

Document processing at the high-tech center would be virtually human free. The electronic image would be located, converted to the electronic format of the recipient and sent for immediate or off-hour transmission.

Phase III: Sending Results of Request -- Service Perspective. At the low-tech end, an operator would use one of the fax units to transmit the document. Once again, the low-end mode of operation basically mimics the conventional paper based, mail processing operations.

At the mid-tech end, "paper-pushing" is still the predominant mode. Most of the material, except for the "hot" material would not be in electronic form. Thus, most material would have to be copied (or videoed) and sent via the fax-format of the recipient.

At the most sophisticated level, the format of the requested material would adhere to the type of form requested by the subscriber -- fax Group 3 or 4, ASCII, particular graphic format, or some other standard.

The above sample alternatives could also be applied to the processing of automatic delivery subscriber service. All of the technological applications of the fax and the process apply. The important point in constructing more leading-edge delivery mechanisms for both kinds of service is the need to build a service that can not only bridge to embrace higher level technologies when needed but can also be "downward compatible" to all lower level subscribers. There is little sense in constructing the state-of-the-market delivery operation if it results in 90% preclusion of its subscriber base.

4.3 Considerations and Issues.

The considerations provided in this document are generic. They are provided as a guide and a starting point for the STI manager to begin the process of evaluating and planning associated with technological solutions to STI dispersal. Detailed numbers for requests, users, pages sent, requests processed and other statistics would need to be developed. A detailed set of scenarios would need to be developed. A study of the document processing technologies being adopted by the majority of STI users would need to be performed. Much more precise analysis will have to be performed to determine exactly what function facsimile will perform in STI dispersal, especially for costs and performance.

Facsimile has a definite place in the document delivery arena. Emergences or "must have now" situations are best suited for the fax. However, to what extent or how much can the facsimile contribute to the mainstream of the document delivery process? To be able to respond to this question, each STI manager should address some key points. Here are a few of the major ones:

Timeliness. How much of the subscriber base demands "immediate" receipt of requests? And how much of the base would be willing to absorb the extra cost of immediate processing? A subscriber base percentage matrix should be developed which contains historical breakdown on customer

demand turnaround time in order to examine the real needs of facsimile. There is little sense in investing in a "fax farm" if only a minute portion of the subscriber base will request immediate shipments of material.

Subscriber Receipt Capabilities. What are the current and future typical document receipt facilities of the end user? Although Group 4 and electronic fax server transfer are technologically superior transmittal mechanisms than stand-alone Group 3 facsimiles, the subscriber base may not be technologically proficient to receive from these transfer media.

Document Standards. What fax Group 3 or 4 compatibility, or more important incompatibility, may come about with the evolution of American and international image standards on text, graphics, video and audio -- will, for example, the page-based fax standard be changed to accommodate the emerging "pageless" document?

Material Form and Format. Although the most prevalent form of STI documents is paper-based and the format is normally compatible with fax paper-dimension limits, will the increasing use of other multi-media forms/formats (e.g, electronic images, video/audio cassette) overtake the traditional paper-based form?

Staff Skills. How will the staff respond to radical technology changes that will ultimately be responsible for significant changes in the current paper-based modus operandi? Higher technology will result in more machine-aided material processing and eventually change the skill-levels of the staff from para-librarian to para-computer.

In addition to the above key points, there are a number of other management decisions that should be made when attempting to integrate facsimile into a document delivery infrastructure. The major question is determining the type of facsimile technology that should be infused -- stand alone, fax server or some combination of the two.

As portrayed in Figure 4-1, the considerations aspect can be applied to the three primary events of the delivery: (1) **request** -- the media the requests are received; (2) **retrieval** -- the way in which the documents are stored and managed; and (3) **receipt** -- the receiving of the material by the subscriber. Intertwined within these components is the aspect of **transmittal**.

Moreover, for each component consideration, there are three types of issues that should be addressed when integrating a facsimile: (A) **technical** -- the hardware/software platforms that support each component; (B) **cost/performance** -- each technical platform carries with it associated cost/performance indicators; and (C) **standards** -- each technical platform is also based on a set of standards for storing and sending documents. For each of these issues, let's examine the three component considerations that should be addressed when building a fax capability into a responsive document delivery infrastructure.

Consideration--Request: Issue--Technical. Although a simple, paper based facsimile request-receiving station(s) would help expedite processing, phone (error prone) and mail requests (time delay) will remain the prominent request media. Offering an alternative mode of request represents the only advantage of installing stand-alone facsimiles at this phase and would do little do alleviate the "paper pushing" attributes of the conventional phone and mail media. An operator would still have to monitor the fax and manually process the incoming requests. A document scanner, PC workstation could be placed next to the fax and then request could be entered via the scanner into the system for further

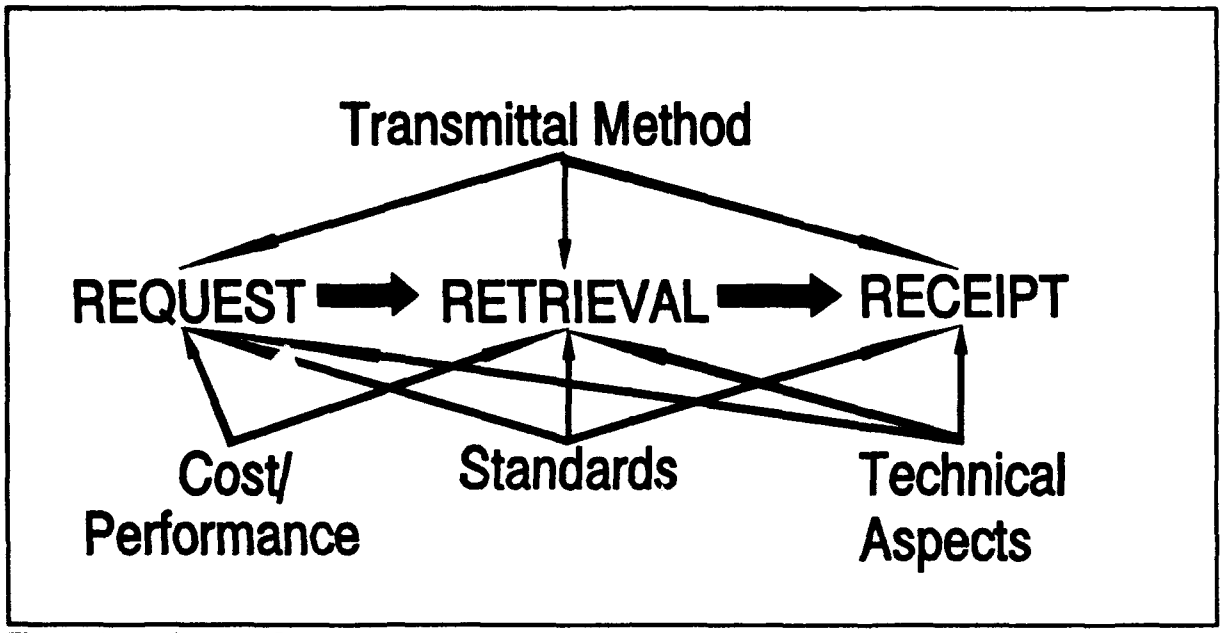


Figure 4-1. Aspect Considerations

electronic processing, but this configuration would add an additional cost (equipment) and labor processing overhead into the equation.

On the other hand, installing a fax server configuration would allow the request to be entered "paperlessly" into the processing system. A computer operator would then process the incoming image or computer-readable form on a computer terminal and direct the order processing electronically.

Consideration--Request: Issue--Cost/Performance. Once again, there is little economic sense in "overkill". If the current or anticipated future subscriber base use of fax is limited, the capital cost and maintenance of a fax server and LAN configuration would certainly outweigh the benefits. However, if the current or intended use is relatively moderate to high, a fax server would make more economic sense, since it would eliminate a number of manual operating steps.

Consideration--Request: Issue--Standards. The format of the request plays an important role. Here, we can consider two type of formats -- free-form, where a written or typed request is placed anywhere on the fax sheet; or fixed-form of which there are two types -- one format that uses a pre-formatted form for writing in or typing the necessary information, and one format that also uses a pre-format form but the information is either typed or PC word processed onto the form that is recognizable by a computer.

Obviously, a stand-alone unit will be able to accommodate any form of legible written or typed request. Regardless of the format of the request, the request would have to be interpreted manually by someone to check that all the correct information is in the request and then transcribed onto a document processing form. In a fax server configuration, the free-form and fixed-form image

formats would still have to be processed by a computer operator, but the preparation of the document processing form would be done electronically. If the request comes in as in readable by the computer, the computer could process the form automatically without operator assistance. A management by exception would result, in which a place would be set aside on the LAN for requests that require manual intervention.

Consideration--Retrieval: Issue--Technical. Regardless of the document storage media, a conversion process would be required for stand-alone fax configurations. Bound paper-based and microform material would have to be copied for the automatic feeder. Documents stored on electronic media (e.g., magnetic, optical, CD-ROM) would have to be printed. These copies could then be faxed -- but what is to be done with the copies once they are faxed? One solution would be to store them so that they could be reused. However, a separate database would have to be created to handle these copies. Also, storage space would have to be created for the copies.

With a fax server configuration, if the documents are stored electronically, there would be no copying step. Depending upon the format of the electronic document, there may be a conversion step to get the material into Group 3 or 4 compatibility. This process would be automated and require no manual "babysitting". This process does not generate extra copies of the document.

Consideration--Retrieval: Issue--Cost/Performance. Cost/performance depends upon the type of storage mechanisms and access paths to the material. Documents stored on the stack or in microform require a labor-intensive "search-and-copy" mission for stand-alone fax configurations. Material stored in electronic form must be copied to printed form. In a fax server environment, a copying process is still inherent in the retrieval operation if the document is not electronic. However, a "electronic as you go" strategy can be implemented in such circumstances. Each time a request is made of a non-electronic copy, the document can be scanned into the fax server network, converted into electronic form. Subsequent requests for the document can then be electronically processed.

Consideration--Retrieval: Issue--Standards. All documents would have to be converted into Group 3 or 4 fax format for subsequent transmittal. If the material is in electronic form and is not in Group 3 or 4 fax format, it would have to be converted. As mentioned in Chapter 2, there are document delivery prototypes that store material in the CCITT standard compressed Group 4 mixed-mode format. Incoming requests with only Group 3 capability will be sent out in a compatible format. Although the electronic storage requirements are much higher than for text, the computer processing time is considerably shortened.

Consideration--Receipt: Issue--Technical. As mentioned earlier, the technical receiving capabilities of the subscriber play a major role in the configuration of the document delivery sending mechanisms. Both the stand-alone fax and server configurations can accommodate stand-alone units at the recipient end. Both Group 3 and 4 faxes can adjust to the receiving capabilities at the other end. In addition, the fax server can send fax-format electronic documents to another fax server configuration. In this manner, the documents may be viewed electronically and only pertinent parts of the material may be printed at the other end. The document can also be electronically archived at the receiving end in lieu of paper storage.

Consideration--Receipt: Issue--Cost/Performance. This consideration/issue

is hard to assess. Once the requested material has been converted or copied, both types of fax configurations exhibit equal capability of sending the material to the recipient, i.e., both send fax-format images and are received as paper facsimiles of the requested material. Cost/performance indicators should be approximately equal for both types of services. One additional benefit to a fax server configuration is the ability to send the fax-format to the receiving end and have it stored electronically.

Consideration--Receipt: Issue--Standards. This consideration/issue depends upon the intended use of the requested material by the recipient. If the subscriber intends to read the material to glean additional knowledge about a subject, both fax considerations can accommodate this "passive" mode of knowledge transfer. However, if the subscriber intends to use portions of the material to conduct additional research or reference actual text in his own research, the ability of the fax server configuration to send the document electronically and have the subscriber electronically "cut and paste" provides distinct advantages. This "active" mode of knowledge transfer would obviate the need to manually reenter or scan the desired material.

The last point concerning active-mode knowledge transfer brings up another important issue that must be addressed -- the rights of intellectual property. The present copyright laws were passed during the age of the paper-based society. As we transcend into the electronic-based society, we will be forced to rethink how we can preserve and maintain the integrity of the knowledge transfer process. With the push of a button, a scientist's life time work can be sent anywhere on the globe. Thus, the electronic era will only exacerbate the need to ensure that knowledge transfer is based on legitimate need. This issue is a research topic in and of itself and will not be taken up in this paper. However, it does have ramifications on how we construct future document delivery systems.

4.4 Conclusion

The ability of the facsimile to complement or supplement STI document delivery systems is a reality today. The technology exists for both the supplier and subscriber to conduct information exchange quickly and at a moderate cost. Its ability as a multifaceted device for receiving, storing and sending paper-based material gives it a decided technological edge over other types of hardware platforms. Although there exists a cornucopia of manufactures vying for the fax market offering more and more advanced features, the CCITT standards have been successful in making the hardware fairly compatible across the globe.

This paper provided the STI manager with a primer on the current and short-term future technological characteristics on the facsimile, pointed out potential applications of the fax when integrated into a document delivery infrastructure and provided a number of considerations and issues that may arise when implementing fax into the infrastructure.

Finally, it is important to note that this paper is neither an exhaustive treatise on the technical aspects of the fax nor is it an in depth discussion on the fax as an integral part of a STI document delivery system. Rather, it provides a broad-brush picture in order for the STI manager to gain an appreciation of the technology and the potential applications considerations and issues. The STI manager now faces the challenge of analyzing his/her own organization to decide what makes sense given his/her mission and goals and objectives.

APPENDIX A GLOSSARY OF FAX TERMS

Activity report - A printed report, generated either automatically or on request, that provides details concerning documents sent to and received from a fax machine. Often used for billing and accounting purposes. See journal.

Alternate number calling - The document may be sent to an alternate fax machine if the fax machine originally called is in use.

AM-PM-VSB - Vestigial sideband amplitude modulation - phase modulation such as used for CCITT Group 2 facsimile.

Analog facsimile - That form of facsimile which uses analog facsimile signals between the facsimile transmitter and the facsimile receiver. Areas of the original with a density between black and white may be recorded as gray shadings.

Automatic background control (ABC) - When sending a page, the same results are obtained for gray or colored backgrounds as for white. The ABC circuit adjusts the background signal level to be the same as white before digitizing it to black/white. This saves the operator from trying to guess the proper setting.

Automatic cutter - This very desirable feature cuts the received pages and stacks them in the receive tray. Without a cutter, a long banner of paper spills on the floor if documents are received while the fax machine is unattended. The time saved can easily pay for the extra cost. If, however, the fax page is torn off for immediate use as received, a cutter is probably not needed.

Automatic dialing - The phone numbers of fax machines frequently called can be stored in memory and used for sending fax transmissions by pressing one or two buttons.

Automatic disconnection - The fax machine automatically disconnects from the phone line after the last page is sent or after a page sent is not received properly. This keeps the fax line open when the fax is not in use.

Automatic document feeder (ADF) - A tray is provided to hold and automatically feed the documents to be sent. It is not necessary to hand feed one page at a time or to wait at the fax machine while the pages are sent. Five page capacity is common on very small fax machines, and 30 pages on full-size fax machines.

Automatic reception - The Group 3 fax machine can be left with power always on, ready to receive documents 24 hours a day.

Automatic redial - If the called fax machine is busy, it is called again in five or ten minutes.

Automatic resolution control - Using nonstandard facilities, a page will be sent with fine resolution where there are fine details and with normal resolution elsewhere. This saves transmission time compared with sending the whole page in high resolution.

Automatic retransmission - Pages not received successfully can be automatically resent from memory.

Bandwidth compression - A technique to reduce the bandwidth needed to transmit a given amount of facsimile information in a given time or to reduce the time needed to transmit a given amount of facsimile information in a given bandwidth.

Baud - The number of changes in signal state per second in a digital signal sent by a modem. A baud may contain only a single bit of digital information. A baud may contain four or more bits as in a CCITT V.29 modem.

Bit - The contraction for binary digit, the smallest amount of information in a binary system, a 0 or 1 condition.

Book scanning mode - This feature allows a book to be placed on the glass plate top of the fax machine and scanned.

Broadcasting - Documents stored in memory can be sent sequentially to many different locations. Delayed sending can be set up to use lower night telephone rates. This is particularly useful for large time zone jumps where no one is at the receiving end during business hours at the sending station. Some fax machines allow documents entered into memory during the day to be automatically sorted for delayed sending of all documents for one destination in one phone call. Different combinations of the same documents can be programmed for different destinations.

CCD - A Charge Coupled Device is a solid state electronic component often used as the primary component in the scanning system.

CCITT - International Telegraph and Telephone Consultative Committee. An intergovernmental advisory organization of the United Nations International Telecommunication Union which recommends worldwide communications standards including facsimile. See Group 1 , 2, 3 and 4.

Codec - A device that allows telephone signals to be converted from analog to digital data.

Color facsimile system - A facsimile system which produces the recorded copy in more than one color. Typically, a full color image is produced by sending images for three primary colors.

Compatibility - Matching facsimile transmitter and facsimile receiver characteristics which permits acceptable facsimile copy to be received.

Compression ratio - In digital facsimile, the ratio of the total bits used to represent the original to the total number of encoded bits.

Confidential reception (or confidential mailbox) - Fax transmissions can be sent directly into memory of the receiving fax unit. A password is needed for retrieval and printout. If this type fax receiver is in the product line, almost all fax machines in that line can send to it.

Continuous tone image (analog gray scale image) - An image in which each resolvable element may be represented by one of a continuous range of tones.

Contouring - Density step lines in recorded copy resulting from quantization of an original image which has observable gray shadings between adjacent quantization intervals.

Copy mode - A document may be copied by pressing the COPY button. The fax machine then sends the information to its own printer.

Copy size reduction - Some fax units have the capability of sending pages 10 to 12

inches wide. Standard 8.5 inch wide pages are also sent without wasting the wider border space. The number of pels per scan line is automatically set as the document feeder guides are adjusted for paper width. When sending wide pages to another fax unit that has 8.5 inch wide paper, the original is reduced in size to fit the narrower recording paper width. The transmitter usually throws away pels from the wider page, causing a reduction in resolution.

Delayed transmission/polling - The fax machine can be programmed to delay calling until the telephone rates are low.

Digital facsimile - That form of facsimile in which densities of the original are sampled and quantized as a digital signal for processing, transmission, or storage.

Direct recording - That type of facsimile in which a visible recorded copy is produced without subsequent processing.

Document - A set of one or more pages which can be transmitted as a set.

Electrolytic recording - Recording with signal--controlled current through an electrolyte in the recording paper, depositing metallic ions to produce a mark.

Electronic handshake - Group 3 units have many different features that must be matched between the transmitter and receiver. The electronic handshake takes care of this automatically and selects the fastest transmission possible between the two units.

Electronic shading - An electronic method of compensating for variations in sensitivity of individual sensors of a sensor array or variation in illumination of copy being scanned. This may be done by correcting the analog signal from each sensor sample under control of stored digital information.

Electrosensitive recording - Recording with an electrical signal which passes directly into the record medium.

Electrostatic recording - Recording by means of a signal controlled electrostatic field. NOTE: A toner is required to make the image visible.

Encryption interface - The facsimile data stream can be encrypted so that it is completely unintelligible to a fax receiver not having the proper code. This prevents the sending of sensitive information to the wrong party and thwarts unauthorized eavesdropping. A set of two RS-232 interfaces is furnished for an external encryption unit and the internal modem is used. The encryption algorithm must be the same and the codes used must match for sending and receiving encryption units.

End-of-line (EOL) - In Group 3 digital facsimile systems, a sequence of digital symbols introduced at the end of a scanning line to establish synchronization of decoding and for error detection.

Error correction mode, CCITT - This standardized option breaks the picture signal into HDLC blocks and automatically retransmits the sections of a page received with errors. The receiving fax unit assembles an error-free page in memory by replacing the error portions with retransmitted sections. Even if there are no errors, this option takes about five percent longer than standard Group 3 transmission time.

Error-free mode, proprietary - This is a NSF option that has more efficient Group 4-like compression and white line skip. The 12--second-or-less per page fax units may use this mode. The initial handshake may also be reduced from 15 to five seconds.

Facsimile copy - A recorded copy of an original produced by a facsimile recorded.

Facsimile transmitter - The apparatus used to translate the original into picture signals suitable for delivery to the communication system.

Facsimile signal - See picture signal.

Facsimile receiver - The apparatus employed to translate picture signals from the communications channel into a facsimile copy of the original.

Facsimile recorder - That part of the facsimile receiver which performs the final conversion of electrical picture signals to an image of the original on the record medium.

Facsimile - The process by which a document is scanned, converted into the electrical signals, transmitted and recorded or displayed as a copy of the original.

Fallback - To decrease the transmission to a slower speed automatically, as dictated by the maximum speed of the receiving machine or by poor telephone lines.

Fax - An abbreviation for facsimile.

Fine resolution - The optional vertical resolution of 193 lines/in. Prints smaller type sizes with good clarity.

Fingerprint facsimile - Facsimile equipment used to transmit fingerprint cards. Note: Existing systems send 8 inch x 8 inch cards at 192 lines per inch.

Ghost - In analog facsimile, a spurious image resulting from echo, envelope delay distortion, or multipath reception.

Group 1 - Analog facsimile equipment per CCITT Recommendation T.2. (Sends an A4 or 8.5 x 11 inch page in six minutes over a voice grade telephone line using frequency modulation with 1,300 Hertz corresponding white and 2,100 hertz to black of the original.) Note: Since North American six minute equipments use 1,500 Hertz white and 2,400 Hertz black, they are not compatible with Group 1 equipments.

Group 1 fax compatibility - Group 1 and North American six-minute fax machines have been obsolete for a number of years, but compatibility with them is still offered on some new fax machines. This feature is useless and may cause problems sending to Group 3 fax machines. After failure to handshake for Group 3 or Group 2, the transmitter may send in six-minute mode even if it is not connected to another fax machine.

Group 2 - Analog facsimile equipment per CCITT Recommendation T.3. (Sends an A4 or 8.5 x 11 inch page in three minutes over a voice grade telephone line using 2,100 Hertz AM-PM-VSB.)

Group 2 fax compatibility - If the fax machine called is a Group 2 fax machine (obsolete design), the page will be sent with Group 2 protocol. This feature becomes less useful each year as the remaining Group 2 units are retired.

Group 3 - Digital facsimile equipment per CCITT Recommendation T.4. (Sends an A4 or 8.5 x 11 inch page typically in a half minute over a voice grade telephone line.)

Group 4 - Digital facsimile equipment per CCITT Recommendations T.5 and T.6. (Uses public data networks and their procedures for essentially error-free reception. May also be used on the public switched telephone network with an appropriate modulation process.)

Group dialing - Groups of fax numbers are programmed on a single key for serial broadcast transmission of documents. A number of groups can be set up on different keys.

Halftone image - An image that has been converted from a continuous tone image into a two tone image while retaining the appearance of a continuous tone image.

Handset - A telephone handpiece is built into some facsimile machines, sometimes containing a dialing keypad in the handle.

Handshaking - An exchange of signals (called control procedures) between the facsimile transmitter and facsimile receiver to verify that facsimile transmission can proceed, to determine which specifications will be used and to verify reception of the documents sent.

Header print - The date, time and phone number of sender is printed at the top of each page received.

High modem speed - The optional 9,600 bits per second V.29 modem provides faster sending speed and thus lower phone line costs.

High capacity ADF - Thirty-page ADF capacity is common. These ADF units are generally more reliable and the range of page thicknesses handled is wider than five page units. Paper jams and multiple page feed errors are less likely.

Horizontal resolution - The number of picture elements per inch (or mm) in the direction of scaling or recording.

Hub - A facsimile used as a central communications device for a group of people. This is typically done for a number of departments in a large company. The hub fax is often directly connected to smaller, special-purpose fax machines in the same office. These are used to send documents to the hub machine for relay to other remote faxes.

Identification of other party - There are various ways of identifying the other party. The other party's fax number may be printed at the top of each fax copy page along with the time, date and page number. The fax number may also show in the front panel character display and the journal.

Indicators for status or errors - Errors in proper performance of the fax machine or telephone line may be indicated by audible alarms, an error lamp, or a character display. The display may also show call progress and other items.

Interpolation - This technique fills in, at the fax receiver, an extra line between scanned lines to make standard resolution recorded copy look almost as good as fine resolution. Some fax units also fill in dots between scanned dots along the scanning line. An algorithm uses adjacent pels to determine whether to make a receiver-added pel black or white.

Jitter (in facsimile) - Irregular error in the position of the recorded spot along the recorded line. NOTE: This is noticeable on the recording of a vertical line.

Journal - A record is made in memory for each document sent or received. This record indicates the date for the journal entry, time of transmission, phone line connection time, identification of the other fax machine, number of pages, identity of other party and confirmation of receipt. Any problem will be noted. The journal may automatically print out each day, when there are 32 entries, or on request. See activity report.

K factor (in modified Reed coding for Group 3 facsimile) - The number of facsimile scan-

ning lines in a set used for coding. At the most, K minus 1 lines are coded two dimensionally to limit the disturbed area in the event of transmission errors. In CCITT Group 3, K = 2 for 3.85 lines/mm and K = 4 for 7.7 lines/mm. In Group 4, K = infinity.

LCD - Liquid Crystal display. A readout panel that is used to provide status and messages to a fax operator.

Light / dark / normal control - This control allows the operator to compensate for light or heavy markings when necessary.

Line-to-line correlation - The correlation of image information from scanning line to scanning line. Useful for two dimensional coding, e.g. modified Reed.

Line monitor - A speaker built into the fax that lets the user listen to the line (dial tone, ringing, answer, modem speed determination, etc.) without using the handset. Typically used to verify operation of the fax machines.

Lines Per Inch (or mm) - The number of scanning or recording lines per unit length measured perpendicular to the direction of scanning.

Maximum keying frequency - The frequency equal to one-half the number of picture elements per second.

Memory - Most memory fax units will store about 30 pages, however, the maximum page memory storage available is about 1,200 pages. The user can quickly scan the documents into memory and return the originals to file.

Mobile facsimile - Facsimile equipment used within vehicles for facsimile.

Modified Huffman (MH) coding- A one-dimensional run length digital scheme of coding white and black runs where the shortest length code words represent the most probable run lengths - Used by Group 3 facsimile.

Modified Reed (MR) coding - A two-dimensional optional digital coding scheme for Group 3 facsimile. NOTE: MR provides an improved transmission speed over modified Huffman coding.

Newsphoto facsimile - Facsimile equipment used to transmit photographs for newspaper or magazine publishing.

One-touch buttons - These allow items associated with each destination, such as telephone number, resolution and transmission time to be stored and recalled by one button. A different set of transmitting conditions can be associated for each number on the list.

Original - A page which is transmitted by facsimile.

Out of paper reception - The fax unit continues to receive pages into memory when the recording paper runs out.

Page numbering - Each page of the received document is automatically numbered. Some fax machines also print "END" on the last page.

Panel display - A display panel with 20 or 40 characters guides the operator in use of the fax machine and reports error messages.

Password operation - Fax units can be set with one or more passwords to prevent the fax from communicating with unauthorized parties. This is particularly useful in polling. For a station communicating only with a given set of fax units, a password will prevent anyone from sending junk fax mail.

Pel - A picture element that contains only black-white information (no gray shading). See pixel.

Photographic recording - Recording by the exposure of a photosensitive surface to a signal-controlled light beam or spot.

Picture transmission (or gray scale) - Pictures are continuous tone and should have five to eight bits of information per picture element, depending on the application. Group 3 fax is a digital system which sends only black or white information for each picture element and the compression coding was selected for black/white information. The Group 3 compromise allows pictures to be sent to any Group 3 fax machine, but the results are poor. The fax transmitter encodes the signal to represent gray scale shades by clumps of pels which imitate the photo screening process used by newspapers. The quality is even poorer than desktop publishing systems which have almost twice as many picture elements per square inch. It also takes much longer to send a photo since many short coding runs are generated. A page may take five minutes or longer to send.

Picture element - The smallest area of the original which is sampled and represented by an electrical signal. See pel and pixel.

Picture signal - A signal resulting from the scanning process or an electronically generated equivalent.

Picture signal processing - The received copy quality can be improved by this enhancement. Isolated specks can be removed from the page being sent and aliasing (edge jitter) can be reduced by signal processing.

Pixel interpolation - Generation of additional unscanned pixels by logical comparison of nearby scanned pixels to simulate increased resolution. Interpolation may be one or two dimensional.

Pixel - A picture element that has more than two levels of gray scale information. See pel.

Plain-paper recording - Thermal transfer is used in some price Class 4 fax units for recording on plain paper. The recorded copy feels and stores somewhat like that made on an office copier. The machine cost is higher than direct thermal recording fax units. Cost of thermal-transfer recording materials varies from somewhat higher to about three times that of direct thermal recording. The size of thermal transfer fax equipments is larger than direct thermal recording fax units. Class 5 units all use laser/xerographic recording on plain copier-type paper. This is the best quality recording, but the machines are the largest.

Polling - This feature allows a called fax machine to transmit documents intended for the caller when the calling machine is not busy. Polling is especially useful when many fax machines must send documents to a single receiving fax in a short period of time. If polling were not used, each sender would be competing with others to access the fax receiver, leading to many busy signals and frustration. Polling is often done at night when all fax machines are unattended. A polling code match between units can be used to prevent sending documents to the wrong calling party. Memory-type fax machines call and poll multiple fax machines in sequence. Turnaround polling is a different feature that allows the calling station to automatically poll the fax machine called after sending documents to it.

Printed call back - A message printed at the end of a transmitted document requesting someone at the receiving station to telephone the transmitting station.

Proprietary gray scale - A nonstandard compression algorithm is used to reduce the transmission time for photographs.

Quantizing levels - In a digital facsimile system the number of different grey steps representing a continuous tone image. See contouring.

Record medium or recording paper - The physical medium on which the facsimile recorder forms an image of the original.

Record sheet - The medium used to produce the recorded copy. The record medium and the record sheet may be identical.

Recorded copy - A hard copy of the original produced by facsimile.

Recording paper length - The length of the roll of paper in a thermal printing fax.

Recording spot - The image area corresponding to a picture element formed at the record medium by the facsimile recorder.

Recording - The process of converting the picture signal in a facsimile receiver to an image on the record medium.

Redundancy reduction - Coding for elimination of redundant information in the picture signal to reduce the amount of information needed for transmission or storage. NOTE: The amount of redundancy reduction will vary with the information content of the original. See compression ratio.

Relay broadcast - This feature uses another fax machine to assist in sending documents to multiple destinations. The relay fax receives documents into memory and then transmits to many other fax units. Sending to many relay fax units makes it possible to broadcast a document to hundreds of other fax machines in a much shorter time than sending from only one fax. Relay broadcast can also save substantial telephone line charges when the relayed fax transmissions are local calls. This is especially so when overseas calls are made. Only the more expensive fax machines have this feature, but even the least expensive units made by the same manufacturer often can relay through the expensive one.

Relay broadcast command - This system programs certain receiving fax units (see relay broadcast) to retransmit received fax messages in its memory to another calling group of fax units. One set of instructions can send the same fax information to as many as 6,400 fax units.

Remote diagnostics - The supplier's diagnostic service center can call a malfunctioning fax unit and read its diagnostic codes to assist the technician in identifying and solving problems quickly.

Resolution - A measure of capability to delineate picture detail. The greater the number of dots per inch, the greater the amount of detail remaining after transmission.

RS-232 interface - This is a digital interface whose use is not defined by the CCITT and therefore nonstandard. It is not needed by most users. Some manufacturers offer it as an extra cost option for connection to computers for fax picture signals or for printing ASCII characters on the fax machine. Make sure both the fax machine and the unit it connects with are coordinated by the manufacturer.

Scanner - That part of the facsimile transmitter which systematically translates the densities of the original into a signal wave form.

Scanning spot - The area on the original viewed instantaneously by the photosensor of the scanner.

Scanning direction - Normal direction is from left to right and top to bottom of the original as when reading a page of print.

Scanning line length - See total line length.

Scanning width - The maximum width of paper the scanning electronics of the transmitting fax can see. Some units are unable to scan the complete width of the input page.

Scanning - The process of analyzing successively the densities of the original according to a predetermined pattern.

Skew - 1 . The deviation of the recorded copy from rectangularity due to asynchronism between scanner and recorder. 2. Angular misalignment of the original from the paper feed direction. 3. Deviation of the angle of the scanning line or recording line from a perpendicular to the paper path.

Soft copy - That form of facsimile which displays the received image on a cathode ray tube or similar display.

Step-down modem - If the modem fails to train at its highest bit rate, it automatically steps down to the next lower bit rate and tries again.

Step-up modem operation - This allows the modem to step up to a higher sending rate between pages if the error rate is low and the modem is running at a slow rate. An isolated noise burst during training signal could have caused this low speed condition.

Store and forward - The use of memory in a fax machine for sequential or relay broadcast.

Subject copy - See original.

Super fine - A NSF optional resolution of 203 x 392 lines/in. gives better results when sending gray scale images such as photographs. It also increases the sharpness of printed text. The 392 lines/in. is achieved by stepping the page through only 1/392 inch per scan line. The size of the pels may still be 1/196 inch high, giving overlap in the paper feed direction, not true 392 lines/in.

Synchronizing - The maintenance of the proper position of the recording spot while it is writing to produce an undistorted recorded copy of the original.

Telephone built-in - A phone as a part of the fax machine is a convenience that takes little extra room. Operation of the fax machine and the phone are almost the same when a separate phone is used.

Thermal recording - That type of recording which is produced principally by signal--controlled thermal action. NOTE : Direct thermal recording involves direct imaging on the record medium. Thermal transfer recording involves heat from a thermal print head transferring marking from a carbon ribbon or overlay sheet to another sheet, forming the recorded copy. Some recorders produce full color recordings by successively overwriting different colors in the same area.

Total line length (TLL) - In digital facsimile, the TLL is equal to the pels per scan line divided by the pels per mm.

Transmission time - The time for sending a single page (elapsed time between the start of picture signals and the detection of end-of--message signal by the facsimile receiver).

Transmission reservation - If the fax unit is receiving when the operator wants to send, the document can be placed in the ADF and handled almost the same as if the fax machine was not being used. After the document is scanned into fax memory, the originals can be put back in the files. When the

fax is no longer busy, it will automatically transmit from memory.

Ultrafine - A few fax units have an optional mode of true higher resolution of about 400 lines / in. both horizontally and vertically with a laser printer at the receiving end.

User identity cards - Credit card size identity cards can restrict use of a fax unit to card holders. They also list the users in the journal and can automatically sort out usage costs by department.

Verification stamp - Each page sent can be automatically stamped on the sending page after the fax receiver handshake confirms that it was received.

Voice/fax switching - A received call rings the telephone if a voice call is received or the fax machine if a fax call is received. Some units have automatic voice answer and record the caller's message if no one answers a voice call.

Voice request - If the sending operator wants to talk after sending, an alarm can be set to ring at the receiving fax machine after transmission is complete. This feature is of no use for normal fax transmission, but might be used by someone who is new to fax. It is seldom needed after users become familiar with fax operation. Alternatively, the receiving station operator can set a calling station alarm for operation at the end of the page being sent. Some fax machines will automatically print out a call back request if the other party fails to answer.

Voice announcements - Both the sender and recipient are notified of the communication status by voice announcement from the fax unit.

White space skipping - This is a method that sends information faster by skipping lines that are all white.

Wide paper sending - This feature, sometimes called size reduction mode, allows pages wider than 8.5 inches to be sent to a standard width recording fax for a reduced-size copy. The automatic document feeder of the transmitter is arranged to send without copy reduction if the ADF paper guides are set for 8.5 inches. Wide paper pages will automatically be sent without reduction when sent to a wide paper recording fax machine.

Wide paper recording - This feature allows the use of wider than 8.5 inch recording paper for receiving full-width copies from wide paper sending fax machines. Often, either of two recording paper widths can be loaded.

Xerographic recording - Recording by action of a light spot on an electrically charged photo-conductive insulating surface where the latent image is subsequently developed with a toner.

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APPENDIX C RELEVANT FAX STANDARDS

CCITT T.2	Standardization of Group 1 Facsimile Apparatus for Document Transmission
CCITT T.3	Standardization of Group 2 Facsimile Apparatus for Document Transmission
CCITT T.4	Standardization of Group 3 Facsimile Apparatus for Document Transmission
CCITT T.5	*Replaced by T.500 Series*
CCITT T.30	Procedures for Document Facsimile Transmissions for the Public Switched Telephone Network
CCITT T.563	Terminal Characteristics for Group 4 Facsimile Apparatus
CCITT T.503	Document Application Profile for Interchange of Group 4 Documents
CCITT T.521	Communication Profile for BTO Bulk Document Transfer Under T.62 Session Service Environment
CCITT T.6	Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Apparatus
CCITT T.62	Control Procedures for Teletex and Group 4 Facsimile Services
CCITT T.70	Network Independent Basic Transport Services for the Telematic Services
CCITT T.72	Terminal Capabilities for Mixed-mode Service
CCITT T.73	*Replaced by the following T.400 Series - Recommendations for Document Transfer, Access, and Manipulation (DTAM), Office Document Architecture (ODA), and Interchange Format*
CCITT T.411	Introduction and General Principles
CCITT T.412	Document Architecture
CCITT T.414	Document Profile
CCITT T.415	Office Document Interchange Format (ODIF)
CCITT T.416	Character Content Architecture

CCITT T.417	Raster Graphics Content Architecture
CCITT V.27ter	Required for modem compatibility for pictures
CCITT V.29	Required for modem operation at 9,600 and 7,200 baud
CCITT V.21	Bit rates for interfaces to the PSTN
ISO / CCITT	Various Open System Interconnect standards for layers 1, 2, and 3
CCITT	Various Integrated Services Digital Network (ISDN) standards, to include those for Signaling System 7 (SS7)
INTEL / Digital Communications Associates, Inc.	Communicating Applications Specification (CAS)
IEEE TIA-578	Asynchronous Facsimile DCE Control Standard
EIA 465	Group 3 Facsimile Apparatus for Document Transmission
EIA 466	Procedures for Document Facsimile Transmission
EIA 536	General Aspects of Group 4 Facsimile Equipment
EIA 537	Control Procedures for Telematic Terminals
EIA 538	Facsimile Coding Schemes and Coding Control Functions for Group 4 Facsimile Equipment
ANSI Z39.18	Information Sciences - Scientific and Technical Reports - Organization , Preparation, and Production