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IOC/I~~OE-XIV~~/INF-910
Paris, 27 October 1992
English only

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION
(of UNESCO)

Fourteenth Session of the IOC Committee on
International Oceanographic Data and Information Exchange
Paris, 30 November - 9 December 1992

DOCUMENT DELIVERY VIA THE INTERNET

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Document Delivery via the INTERNET

Telecommunications Networks:

The 1980's saw the full advent of electronic telecommunications within the international scientific research community.

In general, the major uses of this medium have been computer mediated communications (electronic mail, conferencing, bulletin boards) and resource sharing (access to remote computers and high speed transfer of files).

The commercially-based OMNET/ScienceNet system established itself as the network of choice for most of the U.S. and international marine sciences community. In the 1990's, with strong support from the US National Science Foundation, the Internet (using the name in its broadest connotation to describe all networks which are TCP/IP compatible and which cooperate in the Internet-standard addressing conventions -- in the US, "NREN" or National Research and Education Network has become synonymous with the "Internet") has become the telecommunications network of choice for the international education and research community.

Within the marine science community, the Internet has come to rival OMNET as the medium of choice. The Internet-standard TCP/IP suite of protocols (SMTP, TELNET,FTP) supports a broad range of computer mediated communications and resource sharing services .

Document Delivery:

In the 1980's, distributed responsibility for resources and "access not acquisition" have increasingly become imperatives for traditional acquisitions-based information systems. Hence, within the Internet matrix, document delivery, as a form of resource sharing, has been of key interest to the research community. Source documents which are already in the form of machine readable files are easily transportable across the networks but traditional, paper-based source documents present a more difficult problem.

Historically, document delivery was accomplished by physical delivery of the original source document to a user (as for example by interlibrary loan). The development of facsimile media such as microfilm, microcards, and microfiche made possible the wider distribution of documents without actual movement of original source document. Photocopying has resulted in a quantum increase in the distribution of facsimile documents. However with respect to scientific documents, the major limitation of all these media has been poor image quality, particularly when dealing with micrographs or other images which require high resolution.

Telefacsimile:

Taking advantage of great improvements in both optical scanning and laser printing, telefacsimile or "fax" technology has resulted in the delivery of high resolution images together with near-original-quality facsimile documents over conventional telephone lines.

In the late 1980's "fax" experienced a tremendous expansion in use (SEE for example Abelson, 1989) nevertheless, there remain some obvious constraints imposed by conventional fax technology:

-- fax generally requires that long distance phone lines must be used for connection to remote machines;

-- most fax systems do not incorporate the "store-and-forward" capabilities of electronic communications (i.e. it is required that both sender and receiver be simultaneously open and functional);

-- despite greatly improved scanning and printing capabilities the average quality of fax copies can still be highly uneven (dependent on a number of contingent variables: resolution/scan quality, transmission problems, line problems, receipt quality);

--the technology does not generally support filing, archiving and retrieval of previously sent fax "messages".

Document Delivery over the Internet:

Pulled by the convenient availability of hundreds of catalogs of bibliographic data on the Internet, and pushed by the problems related to conventional fax services, several projects have explored use of the Internet as a matrix for a unified system which would allow for the searching, identification and delivery of documents within a single convenient, cost-effective, computer-based telecommunications environment.

Such projects typically incorporate common design elements:

use of modular components (including scanners, printers and network hardware);

use of high compression software to gain maximal efficiency in transmission of documents (achieving at least 80-90% compression of textual material thus reducing average file sizes from 8-12 MB to 800-1200 KB)

achievement of higher transmission speeds by virtue of higher image compression ratios.

At least, three (U.S.) national level projects have undertaken to test the Internet as a medium for document delivery. These three are the Research Libraries Group's ARIEL project, the Digitized Document Transmission Project (developed by the U.S. National Agricultural Library and North Carolina State University together with eleven U.S. landgrant universities), and the Committee on Institutional Cooperation (the "Big Ten" plus the University of Chicago) Network's Internet/fax project. Brief descriptions follow:

Research Libraries Group's "ARIEL":

The US-based Research Libraries Group (RLG) of Mountain View, California has developed and marketed a document transmission system (called ARIEL) which uses custom RLG software and modular non-dedicated configurations of component hardware to move documents across the Internet. (Appended to this report are RLG documents which describe the software and various hardware components which configure the "ARIEL" system and a list of sites, worldwide, which have currently implemented ARIEL).

ARIEL incorporates standard components:

Computer components:
- 8 MHz 80286 minimum required / (20 MHz 32-bit 80386' preferred)
- 640 KB standard RAM
- 80 MB hard drive (30 MB minimum)
- DOS 3.0 or later (DOS 4.01 for 32+MB drives)

Communications components:
- LAN adapter
- Ethernet transceiver
- standard Ethernet transceiver cable

Scanner (several are acceptable).

Laser Printer (several are acceptable) w. accelerator card.

Custom ARIEL software (As of 7/1/92 $479 (US) for single copy).

(SEE ALSO Appendix 1)

U.S. National Agricultural Library / North Carolina State University: Digitized Document transmission Project("DDTP")

DDTP was supported by the US National Agricultural Library and administered by North Carolina State University in cooperation with eleven landgrant universities.
As opposed to ARIEL's library-to-library approach, DDTP undertook to provide networked delivery of documents directly to researchers' workstations. The basic system runs on a Macintosh platform and also requires designation of a "host" computer at all recipient sites to act as server for store-and-forward distribution of documents across campus networks to individual workstations.

DDTP was designed on a Macintosh platform and incorporates the following standard components:

Computer components:

Macintosh IIsi (or higher)
8 MB of RAM
80 MB storage

Telecommunications components:
Ethernet card
Etherprint device

Scanner: Abaton Scanner

Printer: Apple NT PostScript laser printer

Software: the original DDTP prototype use unmodified Macintosh applications programs for scanning, transmission, receipt, printing and/or viewing. These were:

Scanning:	Abaton scanner desk accessory
Compression:	Stuffit Deluxe
Transmission/Receipt:	NCSA Telnet
Printing:	SuperPaint 2.0

During the project's second phase, a Hypercard application was designed and implemented to streamline and simplify these processes.

(SEE ALSO Appendix 2)

CICNet/OARnet Networked Fax Project:

This project was supported by CICNet (the Committee on Institutional Cooperation (of the "Big Ten" plus the University of Chicago) Network and OARNet (Ohio Academic Resources Network) and is administered by the University of Ohio's Academic Computing Services. The basic strategy of this project was to use Group 3 fax machines to scan images, transmit the images for storage on a DOS-based personal computer equipped with fax and ethernet interface cards and then to transmit the image over an ethernet [the Internet] to a similarly equipped personal computer for capture and local transmission to a fax machine.

Computer components:

H-P Vectra PC/XT clone OR AST 286-18 PC/AT clone
Hayes/Quadrum fax cards (with associated fax software)

Communications components:

commercially available "null telephone company" adapter
KA9Q (TCP/IP) software

(SEE ALSO Appendix 3)

Evaluation:

All three projects are in some sense "preliminary" efforts to take full advantage of the emergent international Internet as an alternative to conventional fax services.

Despite ARIELS's relatively wide acceptance (SEE Appendix 1), it has not yet achieved a "critical mass" of participating libraries which will give it a broad enough resource base to fully satisfy document delivery requests from throughout the scientific research community. It has also not taken the direction of the DDTP project by providing for direct transmission to individual scholar's workstations although such service does not seem precluded by it's current configuration.

Nevertheless, the ARIEL project, at this point, would seem to be the preferred model. It is most broadly implemented (SEE appended list of active sites), operates on a DOS-based platform and accepts several hardware options for it's key component elements, it also has an established marketing and support network.

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The user's directory of computer networks. Tracy LaQuey (Ed.) Bedford, MA., Digital Press, 1990

------- ARIEL (tm) EQUIPMENT REQUIREMENTS AND APPLICATION NOTES --------

Last updated 7/10/92

ARIEL - RLG's Document Transmission Software

Ariel is an innovative new document transmission system from the Research Libraries Group. Using commercially available hardware and RLG's Ariel software, users can scan articles, photos, and similar documents, transmit the resulting electronic images through their Ethernet LAN over the Internet to each other's Ariel workstations, and print them on a laser printer.

The system, which is optimized for Internet transmission, is faster, more reliable, and less expensive to use than fax and produces images of greater resolution and quality.

Basic Ariel PC/Communications Equipment:

20 MHz 32-bit 80386 PC recommended
(minimum requirement: 8 MHz 80286)
640 KB standard RAM
80 MB hard disk drive recommended
(minimum requirement: 30 MB)
5-1/4" or 3-1/2" floppy disk drive
4 expansion slots
MS-DOS 3.0 or later (4.01 or later for disks above 32 MB)
3Com 3C503 EtherLink II LAN adapter
Standard Ethernet transceiver cable*
Ethernet transceiver (MAU)*
*Required only for Standard Ethernet (10BASE5),
not for Thin Ethernet (10BASE2)

NOTE: RLG recommends a 386 or better PC to provide the robustness necessary for sending/receiving large volumes of documents. While 286 PCs and other PC ATs, will run Ariel, throughput will be slower. For small volume operations, or for those running Ariel printing at night unmanned, this drawback may be minimal.

Scanners

HP ScanJet Plus with scanner interface
(scans 8-1/2" x 11" page)
or
HP ScanJet IIp with scanner interface
(scans 8-1/2" x 11" page)
or
HP ScanJet IIc with scanner interface
(scans up to 8-1/2" x 14" page)
or
Panasonic FS-RS506 image scanner
(scans up to 8-1/2" x 14" page)

Note: The HP ScanJet Plus is no longer manufactured by Hewlett-Packard, and is replaced by the ScanJet IIp. But it is compatible with Ariel, and can be used if you have this model of scanner available. The Hewlett-Packard

ScanJet IIc is the fastest (and most expensive) scanner on the supported list. Although the IIc is color-capable, Ariel will not produce image files that can be printed in color ... the files scanned by Ariel with the IIc will print as gray-scale images. The HP scanners can be supplemented with an HP "ADF" automatic document feeder, to speed up scanning (and to allow scanning of legal size originals on the HP ScanJet Plus and ScanJet IIp models.

Printers

Hewlett-Packard LaserJet II
Hewlett-Packard LaserJet III

Note: Ariel supports the HP LaserJet II and III printers, but does not explicitly support other HP models (e.g., the HP LaserJet IIIp is not supported). Printers having the same Canon SX engine may also work with Ariel, but your institution must provide the support for these other printers.

JLASER Printer Accelerator Card

Although a JLASER printer accelerator card is not required, most sites that use Ariel with regularity will find that it provides a real advantage. Documents that would take 1-2 minutes to print on a LaserJet III without this card can print in 10-15 seconds with the card. The JLASER card is installed in one of the available added card slots in the Ariel PC. It connects to the printer via a special cable provided by Tall Tree systems, connecting to a "JSX adapter", also supplied by Tall Tree Systems, which plugs into the additional I/O slot on the printer. The printer has a second connection to the PC, via a centronix parallel cable, to one of the parallel ports (LPT1, etc.).

If a JLASER card is not used, the LaserJet printer must include 2 MB of memory on the printer, to handle the large files created and transmitted with Ariel. If a JLASER card is used, no additional printer memory is required but 2 MB of expanded memory is required, either on the JLASER card or elsewhere on the PC system.

For more JLaser information or to place an order, contact:

Tall Tree Systems	Phone: 415 493-1980
2585 E. Bayshore Road	Fax: 415 493-7639
Palo Alto, CA 94303	

Note: JLASER Ariel adapter does not work in Zenith Z248 or Wyse PCs. Contact Tall Tree to determine the appropriate board to use.

Alternative LAN Adapters

Note: RLG recommends only the 3Com 3C503 EtherLink II LAN adapter. The adapters listed below may also work with the Ariel software, but RLG has not tested them and cannot offer support for them.

3Com 3C501 EtherLink I
3Com 3C523 EtherLink II/MC
3Com 3C505 EtherLink Plus
3Com 3C507 EtherLink
AT&T Ethernet & Starlan

BICC Isolan 4110
Interlan NI5010
MICOM-Interlan NI5210
MICOM-Interlan NI9210
Racal/Interlan NI6510
Tiara LANcard/E
Ungermann-Bass NIC-PS/2
Ungermann-Bass PC/NIC
Western Digital WD-8003e

Note: Clarkson packet drivers are included with Ariel for all of the LAN cards listed above with the exception of the 3C507 driver. This driver is available via anonymous FTP from lyra.stanford.edu, in the pub/ directory, if it is not supplied with your LAN card.

Fax as Alternative to Printer Equipment

A fax machine can be used in place of the LaserJet printer. The following fax hardware and phone lines are required, in place of the LaserJet printer:

Zoltrix ZoFax Standard 96/24 fax/modem card (or other card that fully supports the Class 2 DCE-DTE Fax/Modem Interface standard)
Separate stand-alone fax machine for printing
Two telephone lines

ARIEL Software Prices

Ariel can be purchased for both scanning and printing ("Full System") or for use on a PC without an attached scanner, for receiving and printing only ("Print Module").

	Full System	Print Module Only
1-4 copies	$479 per copy	$249 per copy
5-9 copies	$399 per copy	$199 per copy
10-24 copies	$299 per copy	$149 per copy
25 + copies	$199 per copy	$99 per copy

Note: All prices are per order. These prices are current as of 7/1/92, and are subject to change without notice. For an Ariel product order form, contact the Distribution Services Center, The Research Libraries Group, Inc., 1200 Villa Street, Mountain View, CA 94041-1100, email: bl.dsc@rlg.bitnet or bl.dsc@rlg.stanford.edu, fax: 415.964.0943.

Ariel vs Fax over Internet

The only feature that is similar between FAX projects and Ariel is use of the Internet as the transportation medium.

The differences include:

1. Ariel uses modular, non-dedicated components that can be used for other PC applications.

2. Ariel compresses the image data by a factor of 1 to 15, making the image files 1/15th the size. This saves disk storage space and

reduces significantly the size of the electronic package sent on the Internet.

3. Ariel retains all scanned images until successful transmission has occurred. This means that the receiving PC is not only up and running Ariel, but that the entire image file has arrived intact. A checksum agreement between the sending PC count and the receiving PC count must occur or the receiving PC will ask for retransmission. Error-free transmission results.

4. In addition to the features in 3., Ariel gives you the ability to scan and store temporarily, scan and store permanently, and scan and send immediately to single or multiple receiving sites.

5. Ariel gives you access to the "held" files, so that you can select any one of the stored documents for transmission to another site.

6. Resolution is very high quality. The 300 dpi HP printer produces output that resembles 600 dpi quality of other printers. Fax output, even from the expensive Canon and Fujitsu Group 4 Fax machines is much poorer than that produced by Ariel.

7. The Ariel software integrates the hardware; that is, the HP scanner operating under the control of the HP scanner software scans more slowly than under the Ariel software. The printer likewise. So, the scan time is under 10 seconds (using a 386 PC) and the print time is under 20 seconds per page.

8. Ariel has a compression algorithm even for photographs. Under most compression schemes, photographs produce a larger file when compressed, and hence, are usually left uncompressed.

9. Travel on the Internet is much faster with Ariel because of the significantly reduced file size.

10. In addition to all of the above, Ariel can use a fax machine as a printer as an interim step for institutions having an abundance of fax machines and no budget for printers, as yet. Even in this scenario, Ariel performs better, because the transmitted image is subject to the error-free transmission checking routine. Thus, you do not get the distortions or missing lines that often occur with fax transmissions. This is because the Ariel-produced image travels the Internet, arriving at the receiving PC error-free. THEN, it is transferred to the fax machine for printing.

Ariel has other features that separate it from other low budget image transmission systems, including image reduction to permit pages with narrow margins to be scanned completely. Also, no photocopying of books or journals is necessary. Scan directly from the original source. And so on.....

Ariel Hardware and Software Costs

General prices for Ariel hardware and for the Ariel software are given below. For complete and accurate prices for hardware components, refer to your PC and peripheral hardware vendors. The Ariel software prices shown below are correct as of 7/1/92, but are subject to change.

Basic PC/Communications Equipment:	
***PRICE RANGE (80386).....	$1,500 - 2,000
***ADDED PRICE FOR ETHERNET CARD...	100 - 250
Scanner:	
***PRICE RANGE (HP SJ IIp).....	520 - 600
Printer:	
***PRICE RANGE (HP LJ III).....	1,200 - 1,200
Optional JLASER Printer Accelerator card:	
***PRICE RANGE.....	249 - 399
SUB-TOTAL, HARDWARE.....	$3,569 -$4,449

ARIEL Software (all prices are per order)

	Full System	Print Module Only
1-4 copies	$479 per copy	$249 per copy
5-9 copies	$399 per copy	$199 per copy
10-24 copies	$299 per copy	$149 per copy
25 + copies	$199 per copy	$99 per copy

Bruce Washburn
Research Libraries Group, Inc., Technical Support
1200 Villa St., Mountain View, CA 94041-1100 USA
bl.btw@rlg.bitnet or bl.btw@rlg.stanford.edu
Phone: (800) 537-7546 (US & Canada) or 415-691-2272 --------- Fax: 415.964.0943

Installed Ariel sites, as of 8/26/92

Arizona State Univ.
Australian National University
Ball State University
Boise State University
Brigham Young Univ.
California State Univ., Long Beach (print-only)
College of Physicians of Phil.
Colorado State Univ.
Cornell Univ.
Dartmouth - Baker Library
Dartmouth - Dana Biomedical
Dartmouth - Feldberg Library
Dartmouth - Kresge Business
Duke Univ., Perkins Library
Duke Univ. - School of Law Library
East. Pennsylvania Psychiatric Institute
Emory University
Engineering Information, Inc.
Hahnemann University
Harvard University - Law
Health Sciences Libraries Consortium Office
ITESM-Campus, Monterrey Tech School Library, Mexico
ITESM-Campus, Biblioteca-Centro de Informacion, Mexico
Johns Hopkins
Lehigh Univ.
Macquarie Univ. (Australia)
Medical College of Pennsylvania
New York Univ.
Oregon Health Sciences University Library
Oregon State University
Oulu University Library (Finland)
Penn State - Hershey Med Ctr
Philadelphia College of Osteopathic Medicine
Philadelphia College of Pharmacy & Science
Queen's Univ.- Douglas Library
Queen's Univ.- Law
Rutgers Univ. - Alexander Library
Rutgers Univ. - Library of Science and Medicine
Rutgers Univ. - Robeson Library
St. Cloud State University
SUNY Binghamton
Syracuse Univ.
Technical Research Center of Finland
Temple Univ.
Temple Univ. Health Sciences Lib.
Texas Christian University
Thomas Jefferson University
Univ. of Alberta
Univ. of Arkansas
Univ. of California, San Francisco
Univ. of Delaware, Newark DE
Univ. of Guelph
Univ. of Kansas
Univ. of Kentucky
Univ. of Maryland, Baltimore
Univ. of Maryland at Baltimore, Health Sciences
Univ. of Michigan

Univ. of Minnesota - Medical
Univ. of Minnesota - Duluth
Univ. of Minnesota - Minitex
Univ. of New Brunswick
Univ. of Oklahoma
Univ. of Pennsylvania
Univ. of Pennsylvania - Biomedical Library
Univ. of Pennsylvania - Law Library
Univ. of Pittsburgh
Univ. of Rochester
Univ. of Tennessee
Univ. of Texas
Univ. of Texas - Tarlton Law
Univ. of Utah - Health Sciences
Univ. of Utah - Marriott Library
Univ. of Utah - Law Lib
Univ. of Virginia
Univ. of Western Australia
Univ. of Wisconsin - Stevens Pt.
Univ. of Wisconsin - Whitewater
Univ. of Wollongong (Australia)
Villanova University
Welch Medical Library
Yale Univ.

North Carolina State University

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North Carolina State University Libraries
Digitized Document Transmission Project

ABSTRACT

The NCSU Digitized Document Transmission Project is a collaborative project between North Carolina State University Libraries, the National Agricultural Library and eleven landgrant university libraries. The aim of the project is to explore the basic issues and questions involved in developing network-based document delivery systems for library materials.

NCSU Libraries, in partnership with the National Agricultural Library (NAL), is leading the research and demonstration project that is investigating the technical, procedural, and administrative issues related to the electronic delivery of digitized research materials via the NSFnet/Internet and campus telecommunications networks. Commercially available graphics-capable, networked desktop computers, scanners, and laser printers have been installed in participating institutions' interlibrary loan departments for the direct transmission and receipt of digitized materials. The system allows the digitized research materials to be transmitted directly to the researcher's workstation whereupon the image can be readily imported into a graphics or wordprocessing program or an ASCI file can be used to created using an OCR program. Printed images are markedly superior to telefacsimile transmissions. A distinguishing feature of the system is its ability to import and deliver materials originating in electronic form such as electronic journal articles or multimedia works.

INTRODUCTION

North Carolina State University (NCSU) Libraries, the National Agricultural Library (NAL) and the NCSU Computing Center are collaborators in a research project exploring techniques for electronic receipt, display, distribution, and output of digitized library research materials.

The project includes thirteen land grant libraries representing most of the regional networks in the Internet. Universities taking part in the project, in addition to NAL, are Clemson, Iowa State, Michigan State, NCSU, Ohio State, Pennsylvania State, Utah State, Virginia Polytechnic, Washington State, and the Universities of Delaware, Maryland at College Park and Minnesota at St. Paul.

The initiative, under the auspices of the National Agricultural Text Digitizing Project (NATDP), began with a pilot demonstration study on the transmission of digitized images conducted from April 1989 through September 1990 funded in part by a grant from the USDA (1). The pilot study conducted by NCSU and the NAL established proof of concept i.e. that it is possible to successfully capture, transmit, receive, and output digitized image files via the Internet. The project represents the beginning of the third phase of the three-phase NATDP initiative launched by the NAL in 1987. The first two phases of the NATDP consisted of a cooperative project involving the NAL and forty-two landgrant libraries to test scanning hardware and indexing/search software systems for capturing full text and images in digital format for publication via media such as CD-ROM discs, optical discs, or digital video discs (2).

Building on the findings of the pilot study, an expanded study was initiated in 1990 to identify and investigate both the technical and administrative issues involved in local, regional, and national network-based electronic document delivery. The expanded study is a two year, two stage research and demonstration project funded in part by a Title II-D grant from the U.S. Department of Education, an equipment grant from Apple Computer,Inc. and resources from the participating institutions.

PROJECT OBJECTIVES

The project objectives are fourfold:

- to explore and evaluate technical, procedural, administrative, and user response issues involved in bringing digitized document delivery to a substantial community of researchers

- establish libraries as stakeholders in developing the national research and education network

- examine issues related to selecting hardware platforms for delivering documents using network technologies

- carry out a comprehensive publication and conference program to widely disseminate the project results

Stage One: Interlibrary Loan

In stage one, the project is investigating the transmission of library materials between libraries. Fourteen landgrant libraries, representing most of the regional networks in the NSFnet/Internet, have installed the project platform in the libraries' interlibrary loan processing area and have been successfully transmitting actual document requests since July 1991. The project team recognized early on the need for a user interface to streamline the system. A hypercard prototype was released in October 1991. The system interface is currently being refined and the project team is investigating both hardware and software upgrades to further streamline the system.

Stage Two: Campus Document Delivery

In stage two, NCSU is testing an enduser electronic document delivery system that allows faculty, students, and staff to receive library materials at their personal workstations (Macintosh, DOS and/or UNIX). The Electronic Document Delivery Service (EDDS) is a two part model using email and FTP. Using the EDD Service, researchers submit their document requests via the campus electronic mail system to the Libraries' interlibrary loan department. Requests are filled, through the Digitized Document Transmission Project sites, by obtaining scanned electronic versions of the in-house articles or an original electronic document/file. Filled requests are received and held by a central computer, which automatically notifies the researcherthat the digitized article is available and provides retrieval instructions for electronic pickup by the researcher(3).

TECHNICAL DESIGN

The technical design specifies the use of nonproprietary, widely available technologies and widely supported standards, as well as established national and local networking infrastructures. It included five components:

1) Hardware: A desktop computer, scanner, and Postscript-compatible printer located in the ILL processing area at each site. Specifically, the workstation uses the following hardware: a Macintosh IIsi or above with a minimum 80 MB, 8 MB of RAM, Ethernet card, Etherprint device, an Abaton scanner, and an Apple NT PostScript laser printer.

2) Standard image format: Tagged Image File Format (TIFF) as the file format standard. TIFF is widely supported by scanning, digitizing, and image editing software, as well as optical character recognition software.

3) High-speed data communications link: Ethernet bandwidth connectivity from the interlibrary loan area where the workstation resides, and T-1 links from the campus to the Internet. For the purposes of the project, a direct connection to the Internet was defined as the ability to perform Telnet/FTP operations directly from the desktop computer used for the project.

4) A host computer at the recipient site: To ensure round-the-clock availability, sufficient disk storage, and access from all sites on campus. (For example at NCSU, the NCSU Computing Center established one of its VAX computers, running under Ultrix, as the receiving node for images from NAL. From that node, computers in the NCSU Libraries can pick up the images at any time, from any location on the campus internet.)

5) Compression: Since each journal article consisted on average of 8-12 megabytes of scanned data, even high-speed transmission of the files take an unacceptable length of time. Because of the large amount of white space in textual materials, archiving and compression commonly achieved 80 - 90% compression; on average, compressed journals articles require about 800-1200k of storage.

The design permits two configurations for receipt of images. Participants could specify a host computer, usually a Unix or IBM mainframe machine on the Internet, as the machine for receiving transmitted images, or they could use the Macintosh itself. The preferred configuration is to establish a single central computer as a server host for the campus. This computer receives and holds images transmitted to the participating library for later retrieval by library staff.

During the initial phases of the project, participants used existing, unmodified applications programs for Macintosh computers to scan images, compress them, transmit and receive them, then print or view them. These programs were:

Scanning: Abaton scanner desk accessory
Compression: StuffIt Deluxe
Transmission/Receipt: NCSA Telnet
Printing: SuperPaint 2.0

The use of independent software components permitted participants to carry out project operations, but required great care and an unacceptable amount of time. The time required to simply start up each program for each step of scanning, compressing, transmitting, receiving, uncompressing, and printing compromised productivity levels. During the second phase of the project, the project team

designed and implemented a Hypercard application that streamlined and simplified the entire process. The application's first release allowed users to perform most operations with a single click of the mouse button and is currently being upgraded. (See the upcoming issue of Macintoshed Libraries for a description of the project's HyperCard application.4)

Other Transmission Systems

The technical design of the NCSU R&D project differs from the other regional/national systems which are using production-oriented systems using proprietary hardware and software designs (specifically, the Committee on Institutional Cooperation Network's (CICnet) fax over the Internet system and the Research Libraries Group's (RLG) ARIEL system). Although all three transmission systems use digitization technology and the Internet as the primary means of delivery, their technical designs differ significantly.

The current CICnet and RLG systems can be understood as point-to-point, platform dependent, print-over-the-Internet systems. They rely on transmitting to identical platforms and have a single input device, a scanner, and a single output device, a printer, both directly attached to the workstation. The NCSU DDTP's system design differs in three key areas from the design approach taken by CICnet and RLG.

1) The NCSU system uses an off-the-shelf workstation configuration, with no customization of hardware.

2) By adhering to widely supported data format and transmission standards, the NCSU system is designed to be used in a networked, heterogenous computing environment. The Macintosh platform used by DDTP is readily integrated into a heterogeneous computing environment, and (unlike the CICnet and RLG systems) allows materials to be transmitted via campus networks directly to the researcher's workstation whereupon the researcher takes ownership of the electronic file.

3) The NCSU system provides an "import" function which allows the system to fill document delivery requests for materials regardless of their input source or original format. Print materials can be converted into a digitized form using a scanner, or materials already in machine readable form, such as electronic documents, digital sound and video, or multimedia materials can be imported into the system and transmitted. Conversely, the DDTP system can output to any network device, including printers, slide projectors, color printers or any other network accessible device.

All three transmission systems represent but the first steps towards meeting the requirement for prompt delivery of library materials to the researcher and making library services an integral and seamless function accessible from the researcher's workstation.

Conclusion

Preliminary findings of the NCSU Libraries initiative indicate that the research library community is not as well prepared to investigate networking issues as one might expect and that Internet reliability is questionable. The Internet, as it is presently constructed, may not be suitable for production work. (The other transmission systems are likely to report similar findings once significant user bases become operational.) The Project will conclude on 30 September 1992 and a final report will be published in late Fall.

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Manuscript accepted for publication: Please do not cite without permission.

THE OHIO STATE UNIVERSITY

Network Fax Project

Initiative

Academic Computing Services (ACS) of The Ohio State University has an ongoing research and development initiative to explore issues in the transmission of facsimile (fax) images over Internet facilities. The initiative includes both research work and a project to develop an Internet/fax gateway for use as a library document delivery mechanism. The project is supported by grants from CICNet and OARnet and by ACS. CICNet is the midwestern regional NSFNet affiliate network formed by CIC, a consortium of the Big Ten universities and the University of Chicago. OARnet is the statewide Ohio Academic Resources Network.

Overview

In early research, ACS personnel examined the feasibility of transmitting fax images at group 3 and group 4 standards over TCP/IP networks. The results of this work indicated that there were no technical impediments and that a functional Internet/fax gateway could be built from currently available hardware and software. The basic approach was to scan an image with a fax machine and transmit the image to an IBM-compatible PC equipped with fax and Ethernet interface cards. The image was then stored as a file on the PC's disk. File Transfer Protocol (FTP) software was used to transmit the image file over an Ethernet to a similarly equipped distant PC for storage on disk. Finally, the image was transmitted from the fax interface card of the second PC to a nearby fax machine. The fax machines were connected to the PC's fax interface cards though a commercially available "null telephone company" adaptor, which dealt with line power and signaling concerns for the telephone equipment. A test system was assembled to demonstrate the concept.

The CICNet project grew out of an earlier CIC Interlibrary Loan pilot project which placed group 3 fax machines at CIC libraries to deliver documents over long-distance telephone lines. After a demonstration of the Internet/fax image transmission process, CICNet awarded ACS a grant to develop a low-cost gateway to enable the libraries' existing

group 3 fax machines to transmit documents over CICNet facilities rather than telephone lines. The OARNet grant supported extending the project to explore fax-over-Internet document delivery for Ohio academic libraries using OARnet facilities and included the University of Cincinnati as a test site.

The goal of this project has been to integrate inexpensive off-the-shelf microcomputer and fax components with public domain TCP/IP software for use with any group 3 fax machine. The result is a low-cost, easily procurable Internet/fax document transmission workstation operable by nontechnical personnel. ACS selected the hardware, built prototype workstations, and developed control software to integrate the components. ACS also developed a user interface in consultation with CIC universities' library personnel. After extensive beta testing at libraries in several states, production units were assembled and delivered to all CIC libraries.

Hardware and software

The prototype units were built using inexpensive PC/XT clones, Hayes/Quadram fax cards and associated fax software, and KA9Q TCP/IP software. The PCs were selected for their reliability, low cost, and compatibility. The Hayes/Quadram fax card was selected because of its reliability and its publicly available programmers' toolkit for use in developing the custom control software. The KA9Q TCP/IP software was selected because it is a well-established, reliable and publicly available TCP/IP networking base; supports extensions in the C language; and provides limited multitasking capabilities even with inexpensive Intel-based PCs. ACS staff also has extensive experience using the KA9Q software in development projects. The approximate cost of the prototypes, not including the existing fax machines, was $2,000 each. Since reliable and widely repairable XT clone PCs are no longer available, production units are based in AST 286-16 PC/AT clones. These systems also were chosen for cost, reliability, and compatibility. The prototypes were used for demonstrations at several conferences and to develop both user documentation and a windowed user interface with onscreen user help.

The process

Fax software is loaded with DOS when the workstation boots. This software operates as a DOS Terminate-and-Stay-Resident (TSR) program. It receives any incoming fax image from the fax interface card and stores it as a file on disk. It also transmits a disk file through the fax interface card on command from other software. KA9Q TCP/IP software, invoked after the boot is complete, manages the workstation and

runs FTP server, fax management, and user interface processes. The KA9Q software has been modified to add the fax management and user interface modules. The fax management module includes an FTP client component.

To simplify disk management and delivery concerns, a "notify and retrieve" operational model was developed. In this model, the local unit notifies the remote unit that an image is available. The remote unit determines if it can accept the image at that point and either retrieves it or schedules later retrieval.

Operational mode

In operation, a document is fed into the local fax machine and transmitted to the local PC's fax interface card. The fax TSR then stores the image as a disk file. The user interface software determines that a fax image has arrived and obtains remote destination and delivery information from the operator via the menu interface. The fax management software then makes a TCP connection to the remote PC using ACS's defined port 192. The fax management software notifies the remote unit that a fax image is available and passes delivery information. The remote unit schedules the transfer for immediate or deferred action. When ready to transfer, the fax management software on the remote unit uses FTP client software to retrieve the disk file from the FTP server on the original unit. It then issues a command to the fax TSR on its unit to transmit the image through the fax interface card to its nearby fax machine (see illustration attached).

The fax machine can be connected to the fax interface card through a "null telephone company" adapter. Both machines also can be connected to normal telephone lines. With normal telephone lines, the fax machine can be used for regular telephone fax transfers as well as Internet fax transfers.

The speed of the network fax workstation is limited by the speed of the fax machine and the telephone connection to the PC fax interface card. The actual fax transfer across Internet facilities is nearly instantaneous, typically running less than two seconds per page. User workflow is enhanced because the fax machine can scan and print documents continuously without regard for busy remote machines. Network transfer is handled as a background task, freeing the fax machine for input and output.

Project status

Beta test units were deployed at The Ohio State University Libraries, the University of Cincinnati Library, and the University of Indiana Library by early 1991. These units were in active service delivering Interlibrary Loan documents for more than six months. Documents also were routed to nonaffiliated libraries within local telephone call range of the beta test libraries. During the beta test, ACS selected and prepared production units for CIC libraries. The production units were delivered to the CIC university libraries by late 1991. These units were centrally configured and monitored from Ohio State and formed a unified document delivery system. ACS is using another unit to provide a general Internet to fax electronic mail gateway for public campus service.

Future plans...

Future development will include support for 386- and 486-based PCs; a UNIX base for true multitasking; Group 4 fax standards; alternate fax interface cards; support for flexible delivery options using file delivery over local LANs, local fax delivery over telephone lines and LANs to the scholar's fax machine and desk, and local hard copy delivery; alternate data compression algorithms; development of local configuration and monitoring options; support for scanners as input devices; and support for laser printers as output devices. ACS staff has attended meetings of the new IETF (Internet Engineering Task Force) Network Fax Working Group. This group has explored Internet/fax issues and has developed a standard for fax transmission over Internet facilities. ACS supports this work and intends to evolve toward these standards as well as new standards.

Scanners and printers

While adding support for scanners and laser printers changes the focus of the original application from supporting existing fax machines to one of more general image transmission, there appears to be no disadvantages to providing this capability. Moving ahead in this area requires that ACS seek additional funding and deal with a few technical problems.

The level of scanning technology in current hardware and software is inadequate. Scanners presently available are unreliable and labor-intensive, requiring too many post-scanning adjustments of the image. Development work is needed to provide an interface between a scanner and the fax management module and to convert a scanned image to the standard fax format. Printers available to group 3 fax machines, which this project currently addresses, are capable of only 200 dpi. Development work also will be needed to take advantage of

the better resolution available on laser printers. Additional development work is needed to provide a printer interface to replace the fax interface card for laser printer output. ACS concludes that support of scanning and laser printing would enhance the original fax project, and it plans to begin an investigation of this possibility.

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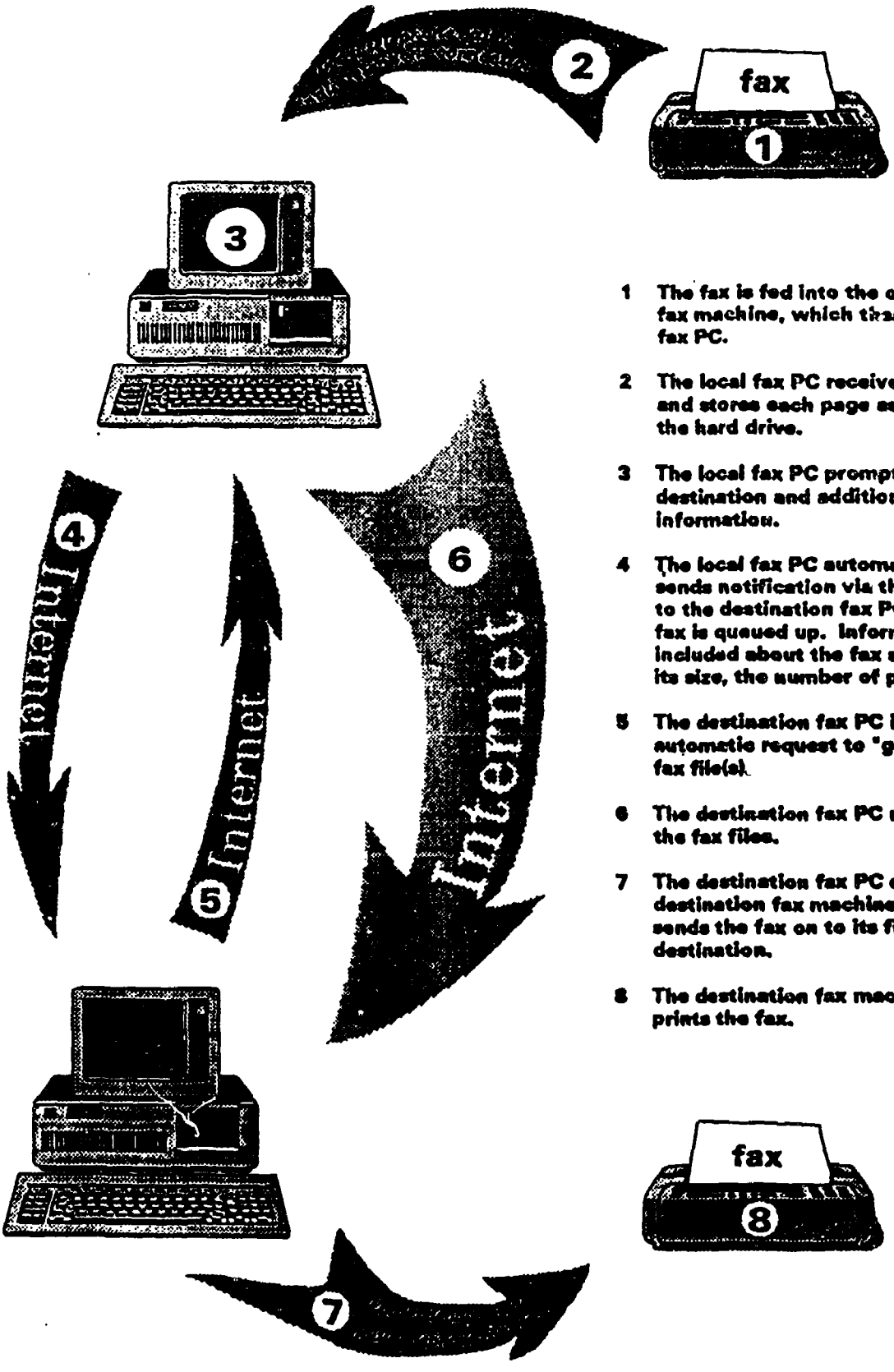

1 The fax is fed into the originating fax machine, which then calls the fax PC.

2 The local fax PC receives the fax and stores each page as a file on the hard drive.

3 The local fax PC prompts for destination and additional information.

4 The local fax PC automatically sends notification via the Internet to the destination fax PC that a fax is queued up. Information is included about the fax such as its size, the number of pages, etc.

5 The destination fax PC issues an automatic request to "get" the fax file(s).

6 The destination fax PC receives the fax files.

7 The destination fax PC dials the destination fax machine and sends the fax on to its final destination.

8 The destination fax machine prints the fax.