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Multimedia Fax-MIME Interworking

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A thesis submitted to the
School of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

MASTER OF APPLIED SCIENCE
in
Electrical Engineering

Ottawa-Carleton Institute of Electrical Engineering

**Department of Electrical Engineering
Faculty of Engineering
University of Ottawa**

July, 1994

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to my family

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Abstract

In this thesis, the architecture of an application-level Internet-fax gateway to facilitate multimedia messaging and to extend Internet services to the home or office is presented. We propose the use of the latest developments in the facsimile and Internet worlds, notably BFT support for Group3 protocols and MIME, for the exchange of multimedia messages (documents) between both environments as well as providing Internet e-mail, file transfer and Internet news services to fax users. Such services would be of most benefit to Internet novices and those users who do not have access to Internet via dialup/SLIP or Freenet facilities. The gateway services would allow a smooth transition into the widespread proliferation of multimedia communications. Implementation of such a gateway would make multimedia at home a very practical reality.

A remote printer server, whose functionality is a subset of the proposed multimedia fax-Internet gateway was configured and setup at the MCRLab. This server became operational on February 3, 1994 and covers the local calling areas of the Ottawa/Hull region. This exercise gave us better insight into the practical aspects of the Internet Remote Printing Experiment. Further, a demo for inbound multimedia messaging was developed using the Binary File Transfer extensions to CCITT Group3 facsimile. This prototype serves as a proof of concept for the proposed gateway services.

ACRONYMS

ASCII	American Standard Code for Information Interchange
BFT	Binary File Transfer
BNF	Backus Naur Form
CCD	Charged Couple Device
CCITT	International Telegraph and Telephone Consultative Committee
DNS	Domain Name System
ECM	Error Correction Mode
EIA	Electronics Industry Association
FTP	File Transfer Protocol
IANA	Internet Assigned Numbers Authority
IETF	Internet Engineering Task Force
ISDN	Integrated Services Digital Network
ISO	International Standards Organisation
JPEG	Joint Photographic Experts Group
LAN	Local Area Network
MCRLab	Multimedia Communications Research Laboratory
MIME	Multipurpose Internet Mail Extensions
MPEG	Motion Pictures Expert Group
MH	Modified Huffman
MMR	Modified Modified Read
MR	Modified Read
MTA	Message Transfer Agent

MTS	Message Transfer System
NNTP	Network News Transport Protocol
OCR	Optical Character Recognition
PC	Personal Computer
PSTN	Public Switched Telephone Network
RFC	Request For Comments
SMTP	Simple Mail Transfer Protocol
TIA	Telecommunications Industry Association
TIFF	Tagged Image File Format
UA	User Agent

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Chapter 1

Introduction

1.1 The Multimedia Revolution

In recent years, multimedia has become the buzzword for the research community as well as the commercial world, with projects and products announced which claim to provide multimedia information and capabilities. Multimedia communications has become a major area of research and development at Universities and Research laboratories around the world. So what is multimedia ? Multimedia refers to the representation and use of information in various media. These media can be text in different languages, audio, images, graphics, video, etc. Computers of today are able to create, reproduce and render these media in various forms with varying amounts of storage requirements. With the large number of computer networks that are already in place, and many more with higher bandwidth being installed, there is a big thrust to

have a common platform or standard technique to represent and encode these various media. Major new standards like MPEG [ISO11172] for video and JPEG [ISO10918-1] [WAL91] for images have been formulated to achieve this goal. Efforts are being made to use multimedia for applications such as messaging, conferencing, publishing, interpersonal communications and telepresence. We have concentrated our effort on multimedia messaging in this thesis.

1.2 Electronic Mail

We start this description with the definition of Internet. Throughout the thesis we refer to the Internet as the vast network of computers across the world that communicate with each other using the protocols of the TCP-IP (Transport Control Protocol - Internet Protocol) suite. Electronic mail is the exchange of data (mainly ASCII text, until recently) between users on the same or different computers through the use of a common protocol. Electronic mail has been so pervasive that by now its use has spread to almost the whole of the world [PER92-1]. Electronic mail is used for research, collaborative work, information exchange, business, or just plain correspondence between users, in a domain free of distance, time and geographical boundaries. It provides flexibility, accessibility and prompt communications to its users. The implications of e-mail on the modern work place is discussed in [PER92-2]. E-mail has gained high popularity in research, commerce, education and engineering development in the past decade. The number of e-mail users in the U.S. alone, is estimated to be 9.4 million in 1992, and is predicted to increase up to 38 million by 1995 [REI93].

Electronic mail is conceptually analogous to traditional means of correspondence. An electronic message consists of an envelope and the body. The envelope carries the address of the originator and recipient of the message, while the body is the

information that is to be delivered. The e-mail message is posted by the originator to the underlying messaging system, which delivers it to the recipient. [ROS93] presents a model for the messaging handling system that describes the structure of the various mechanisms that facilitate the delivery of a message from the originator to the recipient. We present here this model, illustrated in Fig.1.1 in the context of the Internet world.

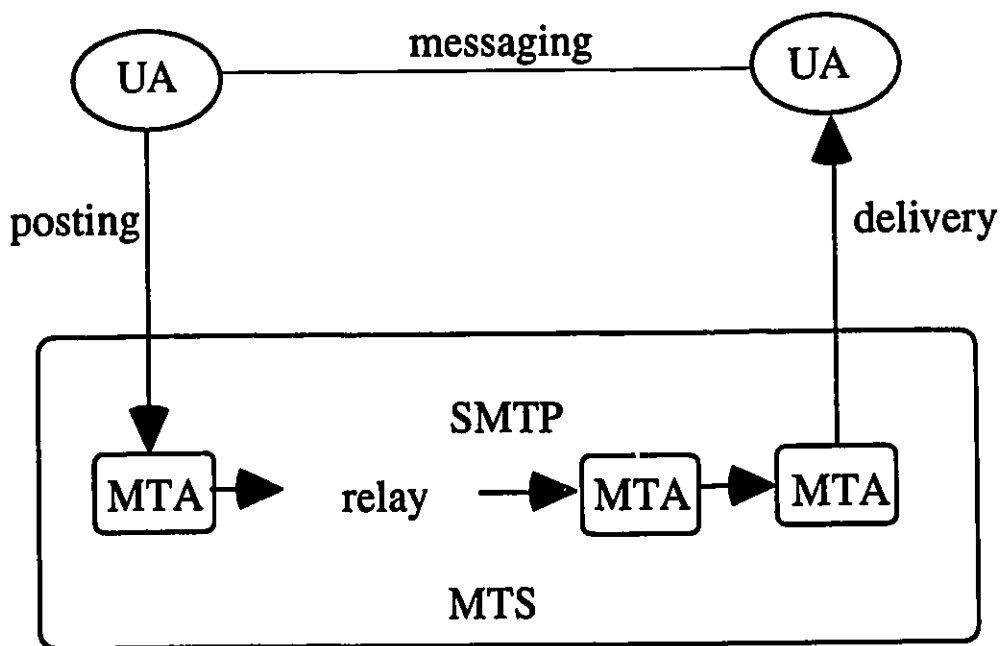


Fig.1.1
The electronic mail model for Internet

The user agent (UA) is the entity that acts on behalf of the user for posting or receiving messages. The Message Transfer Agent (MTA) entity on the user machine accepts messages from the user agent and relays it across various other MTAs to the MTA on the destination machine. This MTA then delivers the message to the user agent which displays it to the recipient. On the Internet, MTAs use the Simple Mail Transfer Protocol (SMTP) [RFC821] to route electronic mail messages to their appropriate destinations. The collection of MTAs responsible for the proper transfer of

messages across the network is termed the Message Transfer System (MTS). The primary goal here is messaging between the originator and the recipient. Traditionally electronic mail has been in use for exchanging information in textual form, but over the last decade it has grown to incorporate various other medias like audio, images, postscript, graphics, etc. This exchange of multiple media through electronic mail is termed multimedia mail, which is discussed later in this chapter.

1.3 Multimedia Messaging

As discussed earlier in the previous subsection electronic mail is increasingly being used as a means of communications by a large number of users. With the advent of the multimedia era in the 90's, there is an increasing interest and need among e-mail users to exchange multimedia mail. According to [HUI89] a multimedia mail message would include the following :

- text, with "composition effects" like the use of several fonts or the highlighting of important sentences,
- graphics, in most cases two-dimensional,
- images,
- voice parts, mostly used as annotations within complex messages,
- animations, i.e. moving pictures, either silent or coupled with voice and sounds,
- structured data, e.g. produced by spreadsheet programs.

We define Multimedia mail as the exchange of messages that contain over and above text, other medias like images, graphics, audio, video and applications. The factors which are crucial for the feasibility of multimedia mail are multimedia document standards, workstations with multimedia capabilities and high speed transport networks. Various efforts have been made in the past [NAF86] and are being made in the present [YAM90], [HOF93], [BAV93], [CAR94] with focus on different aspects

of multimedia mail messaging using different standards for various computer networks. The new standard for multimedia mail over the Internet, Multipurpose Internet Mail Extensions (MIME) [RFC1521], has gained wide acceptance from the user community and seems to be the solution for the present situation. We have used MIME as the multimedia mail document standard for our research. A detailed discussion of this standard follows in chapter 2.

1.4 Investigated Approach

The main focus of our research was multimedia messaging for Internet as well as users who did not have Internet access. We studied the recent developments over the Internet notably Multipurpose Internet Mail Extensions (MIME) and the Remote Printing Experiment and Binary File Transfer (BFT) extensions for Group3 facsimile. The next step was the design of a multimedia fax-Internet gateway that would provide bi-directional multimedia services as well as other Internet services to facsimile users.

1.5 Thesis Organization

The outline of the thesis follows more or less the course of the research effort. We have made an effort to guide the reader in an effortless manner to our research accomplishments.

Chapter 2 describes Facsimile developments, MIME and the Remote Printing Experiment, which are the basic building blocks of our endeavor. The section on facsimile briefly describes Group3 facsimile and Binary file Transfer (BFT), the new development that we use to provide Internet services to facsimile users. In the next section the various functionalities and schemes for multimedia mail over the Internet

used by MIME are explained. Finally we describe the Remote Printing Experiment that facilitates e-mail to fax service for the Internet community.

In chapter 3, we describe the proposed multimedia fax-Internet gateway. Here we explain how the recent developments discussed in chapter 2 can be used to facilitate messaging, file transfer and Internet news services. A description of the architecture and functionalities of the multimedia fax-Internet gateway concludes this chapter.

The practical experiences that we gained during the setup and configuration of an actual Remote Printer server for a subset of the 1-613 and 1-819 area codes of the capital region are stated in chapter 4. A statistical survey from the data accumulated during the operation of the Remote Printer server is also presented in this chapter.

Chapter 5 is the description of a basic prototype implementation. It deals with a proof of concept of inbound multimedia messaging using commercial BFT implementations.

Lastly chapter 6 summarizes the accomplishments and conclusions reached as a result of this research project. Also in this chapter we state possible future avenues of research.

1.6 Main Contributions

The main contributions of this thesis are as follows:

- Design of an application level multimedia fax-Internet gateway.
- Specification of new mechanisms to provide new services for the Internet and facsimile communities.

- Implementation of a basic prototype for inbound multimedia messaging using CCITT's Binary File Transfer extensions to Group3 facsimile.

1.7 Publications

The whole research effort resulted in the following publications.

1. S. P. Patel, G. Henderson & N. D. Georganas, "Multimedia Fax-MIME Interworking", Proceedings of the IEEE International Conference on Multimedia Computing and Systems, Boston, U.S.A., pp. 325-330, May 14-19, 1994.
2. S. P. Patel, G. Henderson & N. D. Georganas, "Multimedia Fax-MIME Interworking", to be published in the IEEE Multimedia Magazine.

Chapter 2

Developments in Internet and Facsimile Standards

This chapter describes the various developments in the Internet and facsimile world that constitute the foundation of this research and lead to the conceptualization of the proposed multimedia fax-Internet gateway.

2.1 Facsimile Developments

2.1.1 Introduction

In the past decade fax machines have become a very important aspect of interpersonal communications today. A large number of people all over the world use fax machines

to exchange documents for business, research and personal reasons. It is predicted [Van91] that by the year 2000, in the United States alone, there will be about a 100 million fax machines and fax boards in use. According the New Webster Dictionary, facsimile is defined as 'an exact copy' of the original. This is exactly what a facsimile machine (fax machine) does, i.e., it prints a copy of the original document at a remote location over telephone lines. Fax machines have been in use since the beginning of the century, however their use in the last two decades has increased considerably. The primary reason for this is the standardization of the equipment, procedures and protocols used for this mode of communication by the International Telegraph and Telephone Consultative Committee (CCITT). A brief overview of a subset of the protocols (Group3 facsimile [CIT T30]) used for facsimile transmissions and a new development in this field (Binary file transfer [CIT T434]), which is of particular interest for our research, follow in the subsequent sub sections. The book " FAX : Facsimile Technology and Applications Handbook" [McC92] is a good source for further information on various issues of fax technology.

2.1.2 Traditional Group3 Facsimile

Early facsimile standardization was initiated by the CCITT Group1 facsimile (now obsolete), where a page was transmitted in about six minutes with a resolution of 98 scan lines per inch. For its successor, Group2 facsimile it took about three minutes to transmit a page at a resolution of 100 scan lines per inch. Present day fax machines use the CCITT Group3 protocols for facsimile transmission of documents over telephone lines. A fax machine takes in a page of document and scans it to produce analog signals according to the contents of the page. These analog signals are converted into digital data and then compressed. A modem modulates this digital data into analog signals which are then transmitted over telephone lines to the destination

fax machine. At the receiving fax machine a modem receives the analog data, converts and decompresses the digital data. The printer then prints out the document which is an exact copy of the original. Various components that constitute a fax machine, facilitate the proper transmission of facsimile across the public switched telephone network. Fig 2.1 illustrates the various functional blocks of a typical facsimile transceiver (fax machine).

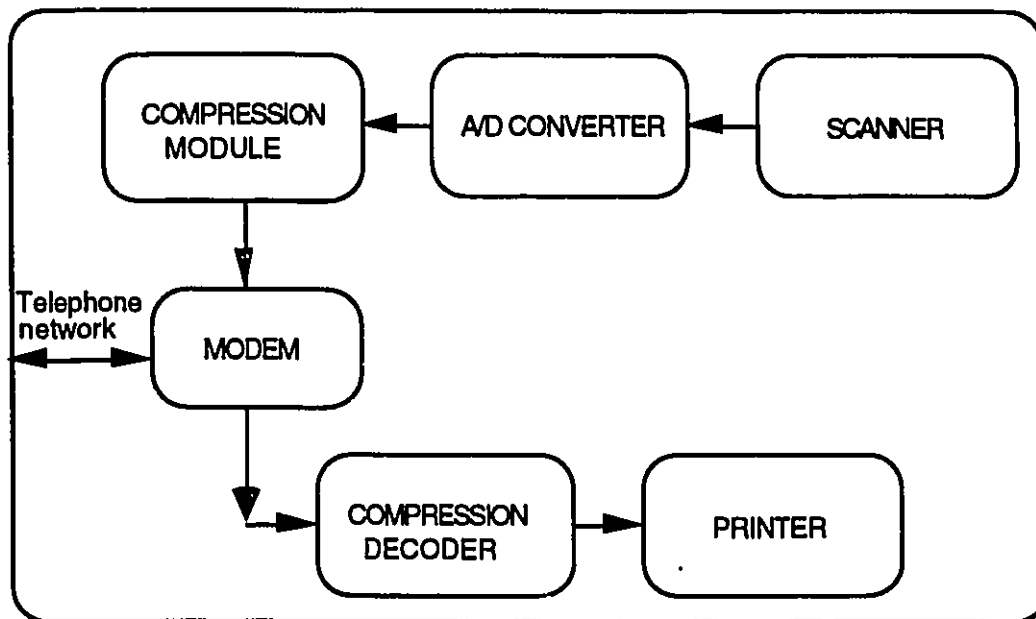


Fig. 2.1
Block diagram of a fax machine

A brief description of the specific functions of each block follows:

(i) *Scanner*

This block performs the function of producing analog electrical signals according to the content of document being scanned. Basically, each page to be scanned is divided into a number of rows with each row divided into 1728 spots (more for higher resolution) or pixels. The number of rows per page may vary according to the resolution, and is typically 2200 rows for 'fine' resolution. The scanner consists of a row of 1728 photo sensors which read (scan) each pixel per line from the topmost row and continues

vertically down the page. Each photo sensor produces a pulse for each spot, so 1728 pulses are produced per line scanned. The amplitude of the pulse varies according to the darkness of the spot (with black and white being the extreme points) The most common scanning technology used in most of today's fax machines is the Charge Coupled Device (CCD) photo sensor .

(ii) A/D converter

As the name suggests this block performs the analog to digital conversion of the output of the scanner module. Here the amplitude of the pulse for each spot is converted to digital data and passed on to the compression module.

(iii) Compression Module

Here the digital output from the A/D converter is compressed to remove redundancy and effectively reduce the size of the data to be transmitted. The various coding schemes which are used for data compression in most facsimile units are Modified Huffman (MH), Modified Read (MR) and Modified Modified Read (MMR). MR and MMR provide higher compression than the MH coding scheme.

(iv) Modem

A modem is an electrical device which modulates digital signals to analog and demodulates analog signals to convert the into digital form. The modem module accepts digital data from the compression module, converts it to an analog signal, and transmits it over the telephone lines using Pulse Amplitude Modulation (PAM) to the receiving fax machine. When data is ready to be transmitted the modem calls up the destination phone number and goes through the initial handshake and negotiations with the receiving fax machine before sending the actual document. The elaborate set of signals, exchanged between fax machines during a facsimile transmission is defined in the Group3 Recommendations. At the receiving fax machine, the modem carries out

the function of accepting facsimile transmissions, demodulating the data and passing on the coded digital stream to the compression decoder. The modem is an integral part of most fax machines. External modems which are units by themselves are also available.

PC Fax Modems: The dramatic growth of fax has also manifested itself in the form of cards for personal computers. Using these cards PCs emulate the Group3 fax machine. Further the availability of a variety of facsimile software in the market have increased their popularity. [ARN93] states that by the year 2000, over 2/3 of all fax installations will be PC fax cards. The advantages of PC fax over traditional facsimile according to [McC92] are as follows :

- The ability to print received fax on regular white paper than thermal paper used in many of the fax machines.
- the user can view the facsimile and then decide on whether to print it or discard it.
- Computer generated documents can be sent directly from the computer without first printing them and then scanning them.
- Better security ; printouts exist for only those authorized to see them.

Moreover facsimile software packages available currently provide enhance functionalities such as allowing users to broadcast faxes to many recipients, automatic generation of cover pages, sending faxes at a predetermined future time and incorporation of faxes into other electronic documents.

There are two basic types of external modems : the fax modem and the data modem. Nowadays cards and units which have both the functionalities in one are available. Only fax modems are discussed here.

Facsimile modems are used with personal computers and workstations, where the facsimile software takes over the work of image coding and compression. A set of rules have been defined for communications between the fax software and the computer fax modem. Based on this, computer modems are categorized in different

service classes according to the level of functionality that they offer. The two service classes of computer fax modems are Class 1 and Class 2. The service Class 1 standard for communications between the fax modem and the fax software has been defined by the technical committee TR29.2 of the CCITT in 1988. The service Class 2 specification has not yet reached a standardization state, but modems for this class (based on draft recommendations of the TR29.2 committee) are widely available in the market and are being extensively used.

Service Class 1 specifies that the computer perform the functions of data encoding, compression and protocol exchange, while the modem only carries out the function of modulation/demodulation and digital<->analog conversion. The Class 2 service specifies that the computer (facsimile software) carry out the function of data encoding and compression, while the fax modem takes care of the protocol exchange function over and above modulation/demodulation and digital<->analog conversion. Here the facsimile software hands over the compressed data page by page to the modem. With more and more personal computers making their way into homes, service Class 2 modems have become more popular.

The following table 2.1 lists the various types of modems, their transmission rates, baud rate and bits/sample:

Type of Modem	Bits per second	Baud Rate	Bits/sample
V.17	14400	2400	6
V.17	12000	2400	5
V.29	9600	2400	4
V.29	7200	2400	3

V.27 _{ter}	4800	1600	3
V.27 _{ter}	2400	1200	2

Table 2.1
Various types of modems specified by the CCITT, source: [McC 92]

The CCITT Recommendation T.4 [CIT T4] defines the specification of equipment for Group3 facsimile transmissions and image coding/compression and data formatting techniques. Recommendation T.30 describes the standard procedures for Group3 facsimile transmission over the public switched telephone network. The document EIA/TIA-578 describes the host to modem protocol specification for Class 1 service and the draft standard SP-2388-A describes the Class 2 service specification for host to modem communications.

(v) Decompression Module

This block receives the compressed image data from the receiving modem. It then decompresses the data into its original digital form and passes it on as a stream to the printer module which prints out the copy of the original document.

(vi) Printer

This module is responsible for reproducing an exact copy of the original document at the receiving fax machine. It accepts as input a stream of digital data and prints the contents on paper. The various types of printers in use in fax machines are thermal printers (which are the most common), plain paper printers, laser printers and ink-jet printers. Thermal printers are the most common ones in use today.

The Group3 facsimile Recommendations describe in detail the procedures required to be carried out during a facsimile transmission in all combinations between manual and automatic facsimile units. The standard defines an automatic unit as one which

performs all the procedures listed in the standard automatically, and a manual unit as one where operator assistance is required for any of the procedures like station identification. As most of the facsimile units in use today are automatic, we shall discuss the Group3 protocol only for the case where the transmitting and receiving units are both automatic. A brief discussion of the protocol for this case follows.

The Group3 facsimile standard defines a communications protocol which involves procedures like dialing the destination, mutual identification between the calling and called units, declaration and negotiation of the capabilities and features of each other and the actual image transmission. The whole procedure of facsimile transmission consists of five phases, with distinct actions being carried out in each phase as specified in the CCITT Recommendation T.30. These phases are

- (i) Phase A (Call setup phase)
- (ii) Phase B (Pre-message procedure)
- (iii) Phase C (Message transmission)
- (iv) Phase D (Post-message procedure)
- (v) Phase E (Call release phase)

The transmitting and receiving fax machines carry out the handshake and negotiation signaling at a 300 b/s low carrier. A high speed carrier (according to the negotiated speed) is used to transfer the actual document image. The activities stipulated for each of these phases are described below for a case when both the transmitting and receiving facsimile machines are automatic.

Phase A Call Setup :

In this phase, the transmitting facsimile unit goes 'off-hook' and dials the phone number of the recipient fax machine. The recipient fax machine answers the ring by going 'off-hook'. The calling unit then transmits a Call tone (CNG) signal. This signal

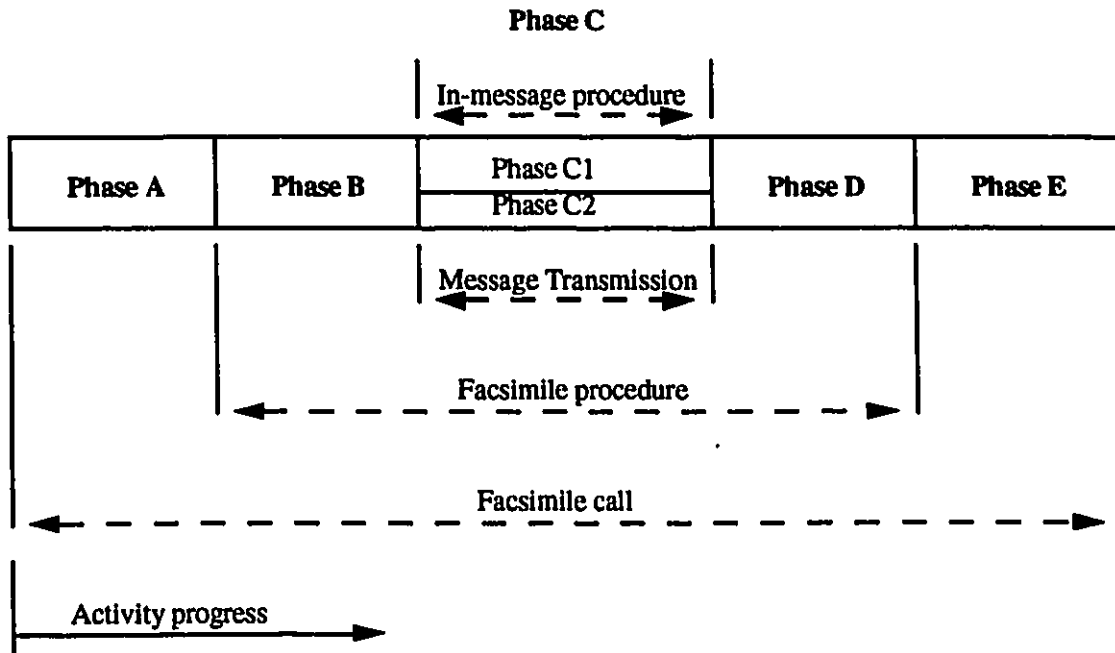


Fig. 2.2
Various phases of a facsimile call

enables the recipient fax machine to distinguish whether the call was a facsimile call (fax modem), data call (data modem) or a voice call. The Class 2 document describes this feature as adaptive answering. The called unit then identifies itself by sending the Called station identification (CED) tone. This ends the Call setup phase of the facsimile call.

Phase B Pre-message procedure :

Here, the called fax machine transmits its Digital Identification Signal (DIS) which contains information regarding capabilities and features like data signaling rate, the resolution of image data that it supports, size of the document. As an optional signal many units send the Called Subscriber Identification (CSI) signal. In response the calling fax machine transmits the Digital Command Signal (DCS) which specifies the set of capabilities to use for the image data exchange. Most fax machines transmit the optional Transmitting Subscriber Identification (TSI) signal (sender's phone number). The sender then transmits a training signal which is a high speed burst of data along

with the Training check frame (TCF) signal which the receiving station uses to evaluate the signal quality and level of line distortion. If the receiving unit is satisfied with the quality of the signal, it sends back a Confirmation to Receive (CFR) signal, otherwise it sends the Failure To Train (FTT) signal to the sender, who will either repeat the training procedure or abort the call. This marks the end of the Pre-message procedures.

Phase C Message Transmission :

The actual transmission of the compressed image data takes place in this phase. Here the sender transmits a short training signal before sending the T.4 encoded compressed image data. This action constitutes Phase C1. The document transfer takes place page by page which is Phase C2. After the transmission of one page, the sender sends the Return To Control (RTC) signal to the receiver marking the end of phase C .

Phase D Post-Message Procedure :

Here the sender transmits a low speed signal, which could be either the End Of Procedure (EOP) signal, if no other pages are to be transmitted, or a Multi Page Signal (MPS), if more pages of data are to follow, or End Of Message (EOM) signal for more pages to be followed in a new document. The receiver then responds with a Message Confirmation (MCF) signal which lets the sender know that the transmission was received properly. Consequently, if the sender sends a EOP signal, phase E will commence or both the receiver and sender will go back into Phase C in case of an EOM or MPS signal.

Phase E Call Release :

In Phase E (Call Release), the facsimile call is formally completed. The sender transmits a disconnect (DCN) signal to the receiver and consequently, both the units disconnect the call and go 'on hook'.

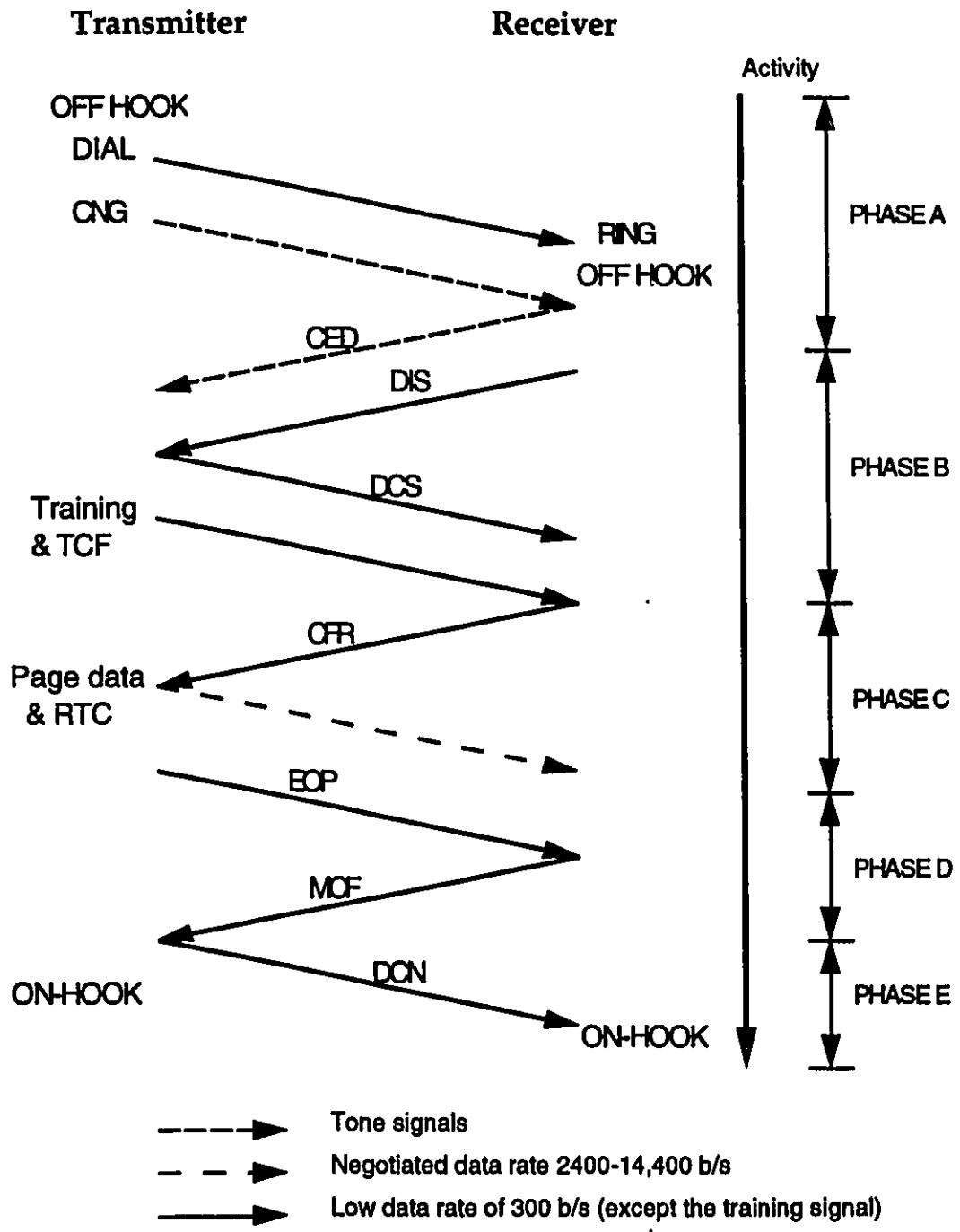


Fig. 2.3
Signal exchanges during a facsimile call

The figure Fig. 2.3 illustrates the line diagram of a typical Group3 protocol and data exchange for a single page message between two automatic facsimile units.

The following table is a glossary of the terms and abbreviations used in Fig. 2.3.

Signal	Function
CNG	Analog tone for distinguishing between a fax call and a voice call.
CED	Called station identification
DIS	Digital identification signal
DCS	Digital command signal
TCF	Training check frame
CFR	Confirmation to receive
RTC	Return to Control
EOP	End of procedure
MCF	Message confirmation
DCN	Disconnect

Table 2.2
Different signals used during a facsimile transmission.

2.1.3 Binary File Transfer

Introduction

The CCITT Recommendations for Group3 protocols have been extensively deployed all over the world and a plethora of commercial products are available based on this standard. Group3 fax machines have been very popular for paper documents, due to the ease of use and minimal human intervention required. Lately, the growth in fax usage has been more in fax cards for domestic personal computers and this will grow in the future as suggested by [ARN93]. Recently major extensions to the CCITT T.30 standard have been approved in the T.430 series of Recommendations (Document transfer and Manipulation (DTAM)) of which Recommendation T.434 (Binary File

Transfer format for the telematic services) [CIT T434] is of particular interest to us. Other sources of information for this standard are the Study Group VIII, report R39 [CIT R39] and the standards proposal made by the Telecommunications Industry association (TIA) SP-2225 [TIA92].

Traditional Group3 facsimile has a limitation in that the information exchange is facilitated through the transmission of an image of a page rather than the text itself which incurs a large amount of redundancy in terms of the content. For example if we were required to fax 0.632 KBytes of ASCII text, the size of the data that would be transmitted in the facsimile format would be 29.453 KBytes. Also the media type that you can transfer is in paper document format for a traditional fax machine, i.e. at the receiving end the document cannot be edited or changed like other computer files. Whereas in case of PC fax , it can be either ASCII, postscript, images or TIFF (Tagged Image File Format) in binary form. Binary File Transfer for Group3 facsimile allows for the transfer of any form of binary data by using the protocols of Group3 facsimile. In effect it allows personal computer users equipped with fax modems to transfer computer files over high speed modems. The standard defines the syntax and semantics required to represent a data file for transmission over the public switched telephone network through fax modems using the protocols of Group3 facsimile.

The protocols of Group3 are extended to allow for the transfer of binary data files. The initial handshake between the fax machines is the same, except that during phase B (Pre-message procedure), the sender and the receiver mutually declare support for BFT through the DIS and DCS signals and that during the actual transmission in phase C (Message Transmission) the data transmitted is a binary data file instead of a compressed rasterized image of a document. The 51st bit (capability to emit data file) in the DIS frame is set by the called fax unit to let the sender know that it is capable of transmitting and receiving data files. Similarly the 53rd bit (Binary File

Transfer) in the DCS frame is set by the sender to declare that it is sending a data file using BFT. Error Correction Mode (ECM) which is an optional feature for traditional Group3 facsimile is mandatory for BFT. ECM is a feature for recovery of data lost during a facsimile transmission. Here, the file to be transferred is divided into fixed blocks of data and the sender retransmits those blocks which are erroneously received at the receiver.

Binary File Transfer Attributes

The Binary File Transfer standard provides a model similar to the interpersonal messaging model of content encapsulated in an envelope as illustrated in Fig.2.4. The envelope contains a list of "attributes" or headers describing the content which is the "binary file" itself. An "attribute" is defined as information indicating the property of something, taking one of a defined set of values. A "binary file" is defined as a sequence of octets, representing a binary file and optional attributes.

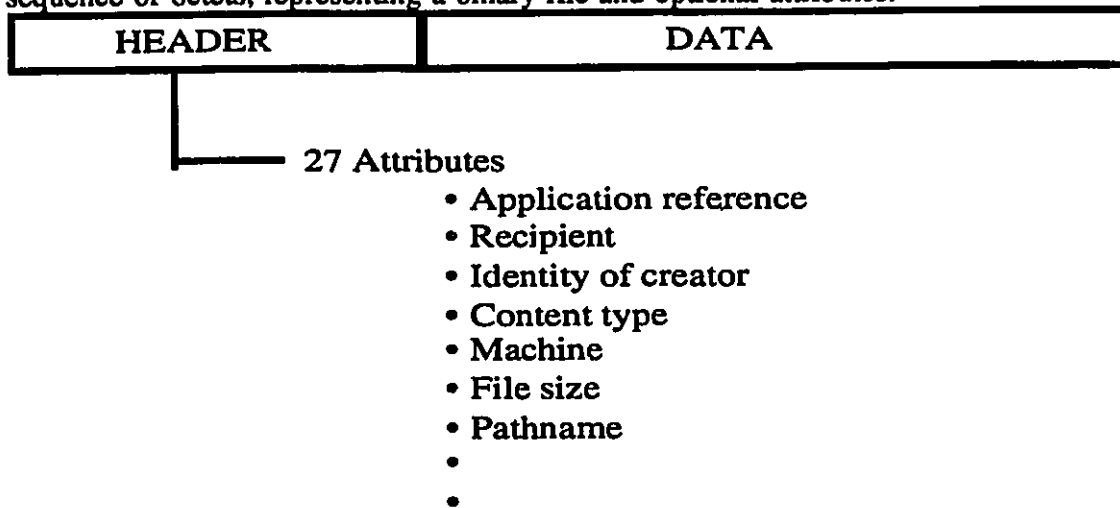


Fig. 2.4
Structure of a BFT message

These twenty seven attributes available in a BFT header are based on many of the attributes defined in the File Transfer Access and Management (FTAM) standard [ISO8571-2] [ISO8571-4].

The various file attributes stipulated in the standard are listed below. It should be noted that all of these attributes are optional.

- access control
- application reference
- character set
- compression
- contents type
- data file content
- date and time of creation
- date and time of last modification
- date and time of last read access
- environment
- file name
- filesize
- future filesize
- identity of creator
- identity of last modifier
- identity of last reader
- legal qualifications
- machine
- operating system
- pathname
- permitted actions
- private use
- protocol version
- recipient

storage account

structure

user visible string

data file content

- (i) **File name** This attribute indicates the name of the data file that is being transferred.
- (ii) **Permitted actions** Here a set of actions that can be performed upon the file are declared. These actions could be any combination of the actions read, insert, replace, extend and erase.
- (iii) **Contents type** The Contents type attribute describes the type of data that is contained in the file. Possible values could be 'unstructured text' or 'unstructured binary'.
- (iv) **Storage account** The accounting authority responsible for the accumulated file storage charges is stipulated in this attribute value.
- (v) **Date and Time** The date and time of creation attribute specifies the time (in the generalized time format) when the file was created. Similarly, the date and time of modification and date and time of last read attributes indicate when the file was last modified or last read, respectively.
- (vi) **Identity of Creator** This attribute specifies the name of the creator or the last modifier of the file.
- (vii) **File characteristics** The File size attribute describes the size of the data file, while the Future filesize attribute contains the nominal size that the file can take after any modification.
- (viii) **Legal qualification** The indication of the legal status data file in question and its use is stipulated in the Legal qualification attribute.

- (ix) Private use The private use attribute as the name suggests can be used for defining and using any proprietary or private property or information regarding the file.
- (x) Environment The various attributes like application reference, machine, operating system, environment, pathname, user-visible-string fall under this category. They provide information regarding the environment under which the file is created or modified.
- (xi) Structure Here the format of the data in the file is declared.
- (xii) Recipient The Recipient attributes provides information regarding the user at the destination who will receive the file after the BFT transfer.
- (xiii) Character Set This attribute indicate the particular character set that has been used in representing the text in the file.
- (xiv) Compression If the data file in question is in a compressed format, this attribute is used to specify the particular data compression technique used.
- (xv) Data Format Here the format of the data file being transferred can be specified.
- (xvi) Access Control This attribute is actually a set of attributes, where each set describes one condition for access to the file being valid. The file can be accessed if any one of these attributes is satisfied and not for a union of these conditions.

Implementations of BFT

As BFT is a relatively new standard, not many implementations are available. Presently the following implementations that support BFT are available.

- Kalman Technologies The Hydraworks software package of this firm provides support for BFT compliant to CCITT T.434.

•Microsoft The Microsoft At Work package has a proprietary implementation of BFT, and is in many ways different than the CCITT specification as pointed out in [ALL94].

•Delrina Delrina's WinfaxPro 4.0, has support for both CCITT T.434 and the Microsoft version of BFT.

No public domain implementation of BFT is available yet, probably because it entails for the introduction of ECM.

2.2 Multi-purpose Internet Mail Extensions (MIME)

2.2.1 Introduction

As mentioned earlier in section 1.2 electronic mail is the most prevalent service in use in modern day computer networks. Back in 1982, the proposed Internet standards for simple mail transfer [RFC821] and for format of textual messages [RFC822] along with others, paved the way for uniformly exchanging electronic mail across heterogeneous computer systems and networks. Message transfer agent and user agent implementations conformant to these Internet protocols have been widely deployed across the Internet and are being used extensively for efficient transfer and display of textual messages. Electronic mail systems based on these standards faced some significant limitations which are as follows:

- Only ASCII characters could be used to formulate a message.
- No uniform support for multiple media mail.
- The length of a message was restricted.
- Each line in the message could contain at the most 1000 characters.

These limitations are felt more with the advent of the multimedia communications era in the 90's. Now, it is possible to represent, encode and display various media other than plain text like audio, video, graphics and images in digital form on personal computers. As discussed previously in section 1.3 various schemes, architectures and systems have been proposed, developed and implemented for multimedia messaging but most of them are either proprietary, complex or incomplete. The requirements of a scheme for exchange of multimedia messages is that it be simple, pervasive, interoperable, robust and above all standardized implying wide acceptability. The X.400 standard [CIT X400] for multimedia mail was one approach towards this end but it still does not achieve its goal. As pointed out in [CAR94] X.400, has no specification for music, images and video bodyparts. Also, the specification for voice is incomplete as it does not describe how to encode this bodypart. In June, 1992 a new standard MIME (Multipurpose Internet Mail Extensions [RFC1341] was defined by an Internet Engineering Task Force (IETF) working group on E-mail Extensions for multimedia electronic mail over the Internet. MIME has been built from previous work in [RFC1049] which proposes a content-type header field for Internet messages and [RFC1154] which describes the use of encoding header field for Internet messages. It is Internet's answer for the above need, which has by now been widely accepted and deployed by the Internet community and beyond. [RFC 1341] has been revised in [RFC1521] and [RFC1522]. A brief overview of MIME is provided in [BOR92], [BOR93] and a review of it is presented in [ROS93].

2.2.2 Multimedia Standardization

MIME specifies the representation and encoding format of various media like text, multilingual text, audio, video, images, embedded messages and applications for the exchange of multimedia mail over the Internet. As stated in the standard [RFC 1521], "it redefines the format of message bodies to be represented and exchanged without

loss of information and is largely orthogonal to [RFC 822], rather than being an extension to it". This is because RFC 822 defines the various headers for electronic mail and leaves the content to be only US ASCII text, whereas MIME redefines the format of e-mail to contain various other body parts other than plain text. The mechanism that MIME provides is independent of the rendering scheme for the various multimedia content types, which allows for better inter-operability and compatibility between different computer systems. Moreover it extends the existing mailing systems to facilitate multimedia messaging without causing them to break, thus paving the way for a smooth transition. Some of the capabilities of MIME enumerated in [ROS93] are as follows:

- It allows for an electronic mail message to have nested body parts.
- It allows for user agents (mail readers) to select among alternative representation of contents.
- It allows for a content to be a pointer to data stored somewhere other than the user's machine.
- Each content can contain arbitrary data, which can be binary or textual.

MIME formulates seven basic Content-Types which can be encapsulated in a multimedia message. These Content-Types are as follows : "text", "multi-part", "application", "message", "image", "audio" and "video", all of which are explained in detail in the following section.

RFC 822 defines an electronic message to contain a header and a body part. The header contains a series of field names and field values, followed by a blank line which marks the end of the header and then the body all of which are in plain text. A typical message would be as illustrated below :

From : Sanjiv Patel < patel@trix.genie.uottawa.ca >
To : < grant@shamin.genie.uottawa.ca >
Subject : Test message

Hi Grant,

This message is to check whether your mailbox on trix is corrupted or not.

- sanjiv

The "From", "To" and "Subject" header bodies have the originator's e-mail address, the recipient's e-mail address and the subject of the message, respectively, as their field bodies. This is followed by the delimiting blank line and the message itself. MIME defines a new header field "Content-Type" which lets the mail reader know the type of data contained in a particular body part and accordingly use an appropriate agent or mechanism to render it to the user or deal with it in an appropriate manner. Also with each Content-Type is associated a subtype identifier, which provides the specific format used to represent that data type. The subtype specification is mandatory for any MIME compliant message. As mentioned earlier initially seven Content-Types have been defined and some subtype formats for all of these Content-Types have been defined. Any addition to the seven primary Content-Types would have to be done by another formal RFC or if for some reason it is required to add one, it should be named starting with an "X-", standing for experimental. MIME is extensible in the sense that new subtypes for the seven basic Content-Types can be registered with the Internet Assigned Numbers Authority (IANA). A current list of these formats can be obtained from [RFC1340]. Moreover to promote and specify interoperability and compatibility the RFC also provides a basic applicability statement that defines a minimal level of conformance with the standard, for an implementation to be called MIME compliant.

2.2.3 Header Fields and Encoding Issues

Over and above specifying a standard format for multiple media mail over the Internet, MIME has also formalized issues for encoding of the data being exchanged as well as defining new header fields to promote interoperability and compatibility. MIME defines a new header field "MIME-version" which is used to declare the version number of the message format standard that the message is compliant with. The version number "1.0" has been specified for the current standard. To take into account future versions or extensions to MIME, it has been formally defined as follows in BNF grammar :

```
version := "MIME-Version" ":" 1*DIGIT "." 1*DIGIT
```

Also, MIME extends the concept of a "Content-Type" header field, originally introduced in [RFC1049] to fully describe the data in the body in order that the user agent can either choose a proper mechanism or application to render the data or act upon it in an appropriate manner. The "type" and "subtype" declarations specify the a general category of the data followed by more information in the form of parameters, expressed in the 'attribute=value' format. A more detailed description of this header field follows in the next subsection.

Another header field that MIME defines is the "Content-Transfer-Encoding" header field which declares the type of scheme used to encode a particular body part. It indicates the type of transformation that the enclosed data has undergone. This transformation is essential in cases where the data in its inherent form is either 8-bit character or binary data, which would restrict their proper delivery over some transport protocols (e.g. simple mail transport protocol RFC821). RFC822 imposes a restriction that the mail messages be 7-bit ASCII and that the lines be only 1000 character long. The various mechanisms which can be used for such transfer encoding

are "7bit" (which is the default), "quoted-printable", "base64", "8bit", "binary" and "x-token". The 7bit, 8bit and binary values do not indicate any encoding on the data but are rather useful in selecting the encoding scheme. The "7bit" data means that it is represented as US-ASCII data. Data that might contain non ASCII characters and/or might have lines with length more than a 1000 characters is termed "binary". The "quoted-printable" encoding scheme, represents nearly all 7-bit characters as themselves and encodes only the remaining characters. It is more efficient and suitable for the text media type. The "base64" encoding technique encodes three octets of a binary stream as four 7-bit characters, using base 64 alphabets. The "x-token" mechanism indicates that an arbitrary encoding scheme can be used between originator and recipient but by naming it as "X-..name". The formal BNF declaration of this field is illustrated below:

```

encoding :=      "Content-Transfer-Encoding" ":" mechanism

mechanism :=    "7bit"          ; case-insensitive
                / "quoted-printable"
                / "base64"
                / "8bit"
                / "binary"
                / x-token

```

MIME allows for two more content header fields, which are optional. The "Content-ID" header field can be used to label individual body parts. This can be useful when internal referencing of various body parts is required. The other header field is "Content-Description", where a brief description of the Content-Type can be inserted for providing additional information to the recipient. In BNF syntax both these header fields can be shown as follows:

```

id :=           "Content-ID" ":" msg-id

description :=  "Content-Description" ":" *text

```

2.2.4 Content-Types

The seven basic Content-Type header fields specified in MIME are defined as follows in the Augmented BNF notation [RFC 1521] :

```
content :=      "Content-Type" ":" type "/" subtype * ( ";" parameter )
                ; case-insensitive matching of type and subtype

type :=        "application"      / "audio"
                / "image"          / "message"
                / "multipart"      / "text"
                / "video"          / extension-token
                ; All values case-insensitive

extension-token := x-token / iana-token

iana-token :=  <a publicly-defined extension token, registered with
                IANA, as specified in appendix E [RFC 1521]>

x-token :=    <The two characters "X-" or "x-" followed, with no
                intervening white space, by any token>

subtype :=    token                ; case-insensitive

parameter :=  attribute "=" value

attribute :=  token                ; case-insensitive

value :=     token / quoted-string

token :=     1*<any (ASCII) CHAR except SPACE, CTLs, or tspecials>

tspecials :=  "(" / ")" / "<" / ">" / "@" / "," / ";" / ":" /
                "\" / <"> / "/" / "[" / "]" / "?" / "="
                ; Must be in quoted-string,
                ; to use within parameter values
```

In order that the Content-Type subtype names do not conflict, two alternatives have been specified for using (declaring) valid content subtypes. The first alternative specifies that new standard values must be documented, registered and approved by the Internet Assigned Numbers Authority (IANA) and when intended for public use, the formats they refer to must also be defined by a published specification. Alternatively, private values (starting with "X-") may be defined bilaterally between cooperating agents without outside registration or standardization. The seven primary Content-Types formulated by MIME are as follows.

a) Text Content-Type

This Content-Type is used to represent information in textual form. It is the default Content-Type and its default subtype is plain text. So, a default header field for a MIME mail message would have the following syntax:

```
Content-type: text/plain; charset=us-ASCII
```

As depicted above it is also possible to specify a 'charset' parameter to declare the character set used for the textual message. RFC 1341 defined a subtype `text/richtext` which uses markup commands enclosed in angle brackets. This scheme offers simple text markup, without making the text unreadable to someone without a the software to interpret it. The `text/richtext` subtype is now obsolete and superseded by the `text/enriched` subtype.

b) Image Content Type

The "image" Content-Type is used to include images (still pictures) in an e-mail message. The sub type header field specifies the format in which the image has been represented and is case insensitive. The two initial sub types stipulated in the

standard are JPEG [ISO 10918-1] and "gif" [GIF90] which are the most commonly used image formats by the Internet community. The formal syntax for an image Content-Type is as follows:

```
image-type := "image" "/" ("gif" / "jpeg" / extension-token)
```

c) Audio Content-Type

The Content-Type "audio" indicates that audio or voice data is being transmitted in an e-mail message. For audio initially the subtype "basic" was accepted, which is 8-bit ISDN μ -law [PCM72] with 8000 Hz sampling frequency. It is expected that other formats for higher quality or lower bandwidth audio will be registered with the IANA. For audio the formal grammar representation for its Content-Type header field is as follows:

```
audio-type := "audio" "/" ("basic" / extension-token)
```

d) Video Content-Type

The "video" Content-Type can be used to transmit a body consisting of video or moving image data, possibly with color and accompanying sound. Though MIME discourages the mixing of different media in a single body part, as an exception it has been explicitly allowed to include audio within the video body part as many of the video representation schemes include intervened audio with the coded moving pictures. MPEG [ISO11172] [LEG91] was the initial subtype specified for the "image" Content-Type. The formal syntax for the Content-Type header field for video data is given by:

```
video-type := "video" "/" ("mpeg" / extension-token)
```

e) Multipart Content-Type

This Content-Type can be used when a user wants to include several body parts of different Content-Types and subtypes in a single body or message. The main body has to have a "multipart" Content-Type header field, followed by a global boundary declaration for the whole body. After this comes one or more body parts, each with its own Content-Type/subtype header and boundary declaration, then the data encapsulated in the boundary. The boundary has to be unique and cannot appear inside any of the encapsulated parts. The encapsulating boundary is defined as a line starting with two hyphen characters ("-") followed by the boundary parameter value. Also, the encapsulation boundary following the last body part has a special delimiter which indicates that no further body parts will follow. This delimiter is the addition of two more hyphen characters after the boundary string. If no Content-Type is declared for a constituent body part, it is assumed to be of type text/plain. Additional information can be included prior to the global encapsulation boundary and following the final boundary. Here is an example of a multipart message :

```
From: Sanjiv Patel <sanjiv@shamin.genie.uottawa.ca>  
To: Grant Henderson <grant@slowpoke.genie.uottawa.ca>  
Subject: Sample message  
MIME-Version: 1.0  
Content-type: multipart/mixed;  
        boundary="Omnamahganeshaynamah"
```

This is the preamble. I hope by now slowpoke has xv installed otherwise you won't be able to view the gif image that I am sending for you.

--Omnamahganeshaynamah

Hi Grant,

I hope you had a nice time in Boston. I am sending you this MIME file which you wanted for Monday's demo.

-sanjiv

--Omnamahganeshaynamah

Content-type: multipart/parallel;
boundary="jaigayatrimajaigayatrima"

and of course you will also need an audio player to hear the accompanying music.

--jaigayatrimajaigayatrima
Content-Type: audio/basic
Content-Transfer-Encoding : base64

.....audio data

--jaigayatrimajaigayatrima
Content-Type: image/gif
Content-Transfer-Encoding : base64

.....gif image data.....

--jaigayatrimajaigayatrima--
--Omnamahganeshtaynamah
Content-Type: text/plain; charset=us-ascii

I hope this message is appropriate for your need

--Omnamahganeshtaynamah--
This is the epilogue. It is also to be ignored.

The above example clearly depicts the syntax of a multipart message, specially its boundary declaration and syntax. The initial subtypes specified for the multipart Content-Type are

- (i) mixed,
- (ii) alternative,
- (iii) digest,
- (iv) parallel.

A brief overview of these subtypes follows.

(i) *Multipart/mixed subtype*

It is the primary subtype for the multipart Content-Type and is to be used for including several independent body parts in a particular order in an e-mail message.

(ii) *Multipart/alternative subtype*

This subtype is syntactically similar to the mixed subtype, but the content of each of its body parts is the same. Here each of the body parts is the same information but in different format or versions, with an increasing order of preference i.e. the most preferred alternative being the last one. The mail reader should perform in such way that the user is either shown the last version or should be given a choice of the version that he wants to see.

(iii) *Multipart/digest subtype*

The digest subtype is syntactically identical to the mixed subtype, but the default Content-Type value (when there is no explicit declaration of the content type) has to be "message/rfc822" instead of "text/plain".

(iv) *Multipart/parallel subtype*

This subtype of the multipart Content-Type is used when the mail message composer wishes that the body parts included in this body be simultaneously rendered (displayed) on the recipient machine.

The formal syntax representation of the multipart subtype is depicted in the following illustration :

```
multipart-subtype :=      "mixed" / "parallel" / "digest"  
                        "alternative" / extension-token
```

f) Message Content Type

When it is required to encapsulate a message within a message, this Content-Type can be used. The initial subtypes defined for this Content-Type are "rfc822", "partial" and "external-body", where rfc822 is the primary subtype. A brief description of these subtypes is given below.

(i) Message/rfc822 subtype

This subtype is used when the body part is an encapsulated message with the syntax of an rfc822 message or even a MIME message. It is not strictly required that the message header has at least the "From", "Subject" and "To" headers, which is the minimal requirement of an rfc822 header.

(ii) Message/partial subtype

The message/partial subtype is used when a message is required to be fragmented due to its large size. This mechanism is specially useful when message transfer agents impose a maximum limit on the size of a message. Here several fragments of a large message are delivered to the recipient and they are automatically pieced together by the user agent. Three parameters are to be specified with each fragment in the Content-Type field, the first being the "id", which is a unique identifier to be used to reassemble all the fragments. The second parameter is "number", an integer, which is the part number of the fragment and the last one "total", the total number of fragments. The "id" and "number" parameters are mandatory for all the fragments where as the "total" parameter is mandatory only for the last fragment. The numbering of the "number" parameter starts from 1 and not 0.

(iii) Message/external-body subtype

The presence of this subtype indicates that the body part included is a pointer to the actual body data. Following the message/external-body are the parameters that describe the mechanism for accessing the referenced data. The parameter "access-type" describes the method for retrieval of the referenced content type and is accompanied by other parameters according to its type. The values of the access-type can be any one of the following.

(a) *ftp* This indicates that File Transfer Protocol (FTP) [RFC959] is to be used to retrieve the body. The parameters 'name', name of the file which contains

the data and the "site", the ftp site address are mandatory for this access mechanism. The user will also be asked to provide his 'login-id' and 'password' for the host specified in the "site" parameter.

(b) *tftp* This access method uses the Trivial File Transfer Protocol (TFTP) [RFC1350] to access the actual body data. This method is similar to FTP (it does not use authentication for file transfer).

(c) *anon-ftp* Here anonymous ftp is used for data retrieval. The user agent will use 'anonymous' login id and supply the user's e-mail address as the password at the site where the data resides.

(d) *local-file* The "local-file" access method is used when the data is accessible as a file on the local machine. The "name" and "site" parameters indicate the name of the file and the domain specification of the machine that holds the data file.

(e) *afs* This access type is similar to local-file except that the file is accessible via the global Andrew File System (AFS). The parameters "name" and "site" with the same semantics as the previous access-type are used here.

(f) *mail-server* This method indicates that the data can be retrieved from a mail server, by sending an electronic mail message to the mail server specified in the "server" parameter. The content of this body part is copied into the mail message sent to the server, which provides a facility to send the server commands in the required format.

The following parameters are optional with all the above access types.

(i) *expiration* This parameter specifies the date after which the existence of the data referenced is not guaranteed.

(ii) *size* This is the size of the actual data, which allows the recipient to decide on whether to access that particular data or refrain from doing so.

(iii) *permission* This lets the user know the level of access that he has, which is either 'read' or 'read-write'.

The overall formal syntactic representation of the Content-Type message is as follows.

```
message-type := "message" "/" subtype
```

```
message-subtype := "rfc822"  
/ "partial" partial-param  
/ "external-body" 1*external-param  
/ extension-token
```

```
partial-param := (";" "id" "=" value)  
/ (";" "number" "=" 1*DIGIT)  
/ (";" "total" "=" 1*DIGIT)  
; id & number required  
; total required for last part
```

```
external-param := (";" "access-type" "=" atype)  
/ (";" "expiration" "=" date-time)  
; Note that date-time is quoted  
/ (";" "size" "=" 1*DIGIT)  
/ (";" "permission" "=" ("read" / "read-write"))  
; Permission is case-insensitive  
/ (";" "name" "=" value)  
/ (";" "site" "=" value)  
/ (";" "dir" "=" value)  
/ (";" "mode" "=" value)  
/ (";" "server" "=" value)  
/ (";" "subject" "=" value)  
; access-type required  
; others required based on access-type
```

```
atype := "ftp" / "tftp" / "anon-ftp" / "local-file"  
/ "afs" / "mail-server" / extension-token  
; Case-insensitive
```

g) Application Content-Type

This Content-Type is used for data which does not belong to any of the above described content types, specially for data which the user will be able to see or render only after an application program has acted upon it. It is very well suited for mail enabled applications such as mail based file transfer, spreadsheets and data transmission for mail scheduling systems. Initially two subtypes have been defined for the application Content-Type, which are :

(i) *Application/octet-stream subtype*

The octet-stream subtype is used to transfer an arbitrary binary data. Possible parameters for this subtype are "type" declaring the type of the binary data (specially for human recipients) and "padding" the number of bits of padding that was appended to the actual bit stream to form a byte oriented stream.

(ii) *Application/postscript subtype*

The application/postscript Content-Type indicates that a postscript program is included within that body part. This subtype could be potentially used for mischief and pose security problems, so the standard [RFC1521] clearly outlines those weaknesses.

The BNF syntax for Content-Type application is illustrated below:

```
application-type :=      "application" "/" application-subtype

application-subtype :=  ("octet-stream" *stream-param)
                        / "postscript" / extension-token

stream-param :=         (";" "type" "=" value)
                        / (";" "padding" "=" padding)

padding :=              "0" / "1" / "2" / "3" / "4" / "5" / "6" / "7"
```

2.3 The Remote Printing Experiment

This section describes the various technical, administrative and operative policies of a new service made available over the Internet under the auspices of the Remote Printing experiment. The basic aim of this service is to facilitate electronic mail to fax service on a global scale.

2.3.1 Introduction

The Internet Community has a very versatile tool in the form of electronic mail, which allows its user to exchange information in the form of text, audio, images and video data. Unfortunately, not everyone has Internet access or can use this facility for inter-personal communications. On the other hand, using a fax machine or receiving a fax is routine and is accessible to the common man. The Remote Printing experiment bridges the Internet and facsimile devices interconnected through the public switched telephone network. In July 1993, this experiment was formally defined in [RFC1486] and more recently described in three Internet RFCs : [RFC1528] describes the technical procedures involved under this experiment, [RFC1529] and [RFC1530] which are purely informational, describe the 'administrative policies' and 'general principles and policies' respectively. Remote Printing allows for unidirectional electronic mail to fax service (only for those area codes covered under this experiment) in a transparent manner for the Internet user. Various electronic mail to fax gateways for computer networks (usually private ones) are available [BRI94] that provide remote facsimile service across the Local Area Network (LAN), that they support. The Remote Printing experiment is unique and innovative in the sense that it encompasses the global telephone network for this service and is accessible to any Internet user. The tpc.int domain defined under this project allows for the addressing

of all Group3 facsimile devices connected to the international telephone network as an integral part of the recipient e-mail address. Since its initiation in July 1993, Remote Printer servers have been set up around the world to cover a large proportion of the international telephone network namespace. The following subsections cover the technical procedures involved in this experiment, the guidelines for its administrative and operational policies and finally a brief report of its practical proliferation.

2.3.2 Technical Overview

The 'technical procedures' formulated for the Remote Printing experiment outlined in [RFC1528], are explained in this subsection. The scheme used for Remote Printing is explained by a simple example illustrated in Fig 2.5.

REMOTE PRINTING EXPERIMENT

RFC 1528, 1529, 1530

e-mail -> fax

Content Types :

- text
- postscript
- TIFF



remote-printer.Joe_Smith@2.8.8.6.4.6.5.3.1.6.1.tpc.int

Fig. 2.5
The Remote Printing experiment

For a hypothetical situation, let us say Mr. John Doe, an Internet user in Australia, wishes to fax a letter to Mr. Joe Smith residing in Ottawa, Canada. Joe Smith, works

for a company which does not have Internet access, but has a telephone and a fax machine whose number is 1-(613)-564 6882. So Mr. John Doe types the following electronic message to be sent as facsimile to Mr. Joe Smiths (with the Internet address as shown in Fig. 2.5).

From: John Doe <doej@dolphin.qld.ts.au>
To: remote-printer.Joe_Smith@2.8.8.6.4.6.5.3.1.6.1.tpc.int
Subject: Reminder for tomorrow's meeting

Hi Joe,

I hope you are having a nice time in Ottawa. I am sending you these notes with reference to your letter dated

.....all the best.

-John Doe

He sends this e-mail from his desk in his office. In the above example we see that the "From" address is in accordance to the RFC822 style addressing, but the recipient address is quite strange. On observing more carefully we can see that the fax number of Mr. Joe Smiths has been inverted, with each digit separated by period in the @.... part of the address as a prefix to the .tpc.int domain string. This e-mail address allows the Internet mail infrastructure to properly route the mail message to a Remote Printer gateway for this local calling zone (with reference to the telephone network), which happens to be at the Multimedia Communications Research Laboratory at the University of Ottawa. This message is then transmitted across the telephone network as facsimile with a proper cover page to the recipient facsimile device. An actual sample of such a transmission is included in Appendix A1. A close examination of the sample transmission shows that the recipient name and the e-mail headers form the cover page whose bottom third portion is an advertisement and the actual message follows in the next page.

Addressing and Routing

The address of a group-3 facsimile device is specified in the following manner.

1 613 564 6882

where the "1" corresponds to the international calling code for a country (which is 1 for Canada and U.S.A.) and the following string "613 564 6882" is the telephone number within the country. So, any facsimile device which is connected to the international telephone network could be addressed using the above format. To allow for subnetwork addressing the telephone number (address of the facsimile device) is used in the domain part of the recipient address. Also a separate "tpc.int" domain has been created specially for this experiment. The Internet e-mail address can be basically divided into two parts.

"local-part"@domain-part" e.g. sanjiv@shamin.genie.uottawa.ca

The local part is the login-id of the user and the domain part is the Internet address of the host. So, to address a facsimile device the local part of the e-mail address has to be at least a string "remote-printer" which can be optionally followed by ".recipient". Then comes the "@" character followed by the reversed telephone number where each digit is separated by a period "." and lastly the .tpc.int domain. So, to address a recipient 'Amit Jain' at a facsimile device with number 1 (613) 564 6882, the following electronic mail address would be formulated.

remote-printer.Amit_Jain/Room_B-415@2.8.8.6.4.6.5.3.1.6.1.tpc.int

As space characters are not allowed in the address string, the underscore "_" character is used to specify a blank space and the slash "/" character for a new line. So the above address would result into the following output on the facsimile cover sheet:

FACSIMILE TRANSMISSION

Please deliver this facsimile to:

AMIT JAIN
ROOM B-415

Care should be taken not to exceed the character limit for Internet e-mail headers. Under this experiment remote servers are setup across the world to provide this e-mail to fax service. The remote servers are hosts with Internet connectivity and which are connected to the telephone network through a fax card or a fax modem. Each Remote Printer server serves a "cell", which is a portion of the international telephone number space that it agrees to support when it registers itself. The routing of messages for Remote Printing is done in a way similar to the electronic mail environment over the Internet (which uses the MX algorithm [RFC974]). If a Remote Printer server (multimedia.genie.uottawa.ca) agrees to serve all the facsimile devices falling under the +1613 564 namespace, then a resource record of the following type would be present:

```
*.4.6.5.3.1.6.1.tpc.int.  IN  MX  10  multimedia.genie.uottawa.ca.
```

When an electronic message with the address in the4.6.5.3.1.6.1.tpc.int subdomain is to be mailed across the Internet, the Domain Name Server would return the above resource record to the originator message transfer agent. This would direct all messages destined for facsimile devices connected to telephone numbers in this namespace to the host multimedia.genie.uottawa.ca, which would in turn deliver these messages via a facsimile transmission. If there is more than one host serving the

same number space, then there would exist multiple MX records for the same number space.

Under this experiment a user on the Internet could either send a plain electronic mail message or a MIME [RFC1521] compliant message for transmission as a facsimile. The case for plain text e-mail has been explained in the preceding illustrations. A description of how this experiment can provide e-mail to fax service by using the MIME format for messages is explained below.

MIME Content-Types : To exercise remote printing, a MIME message has to be of type "multipart/mixed", where the first body part has to be "application/remote-printing" which is used to create a pseudo fax cover page and the second body part can be any Content-Type. The content types "audio" and "video" can obviously not be printed on a Group3 fax machine so they cannot be transmitted under this experiment. The standard [RFC1528] lists the following notes for various MIME content types that are valid in the context of the Remote Printing experiment. They are text/plain, message/rfc822, application/postscript, image/tiff and any multipart:

- All the character sets of the "text/plain" content type are not supported.
- The subordinate body parts of the "message" and "multipart" content type are processed recursively.
- The Remote Printer server processes the "application/postscript" in a safe execution environment.
- For the "multipart/mixed" and "multipart/digest" content types, each subsequent body part is started on a new page in the facsimile transmission. For the "multipart/alternative" content type only one subordinate content is printed.

The Remote Printer server keeps a copy of the message in Group3 format and attempts to send the fax. After it has processed each message it sends an e-mail

receipt to the originator of the message and informs him or her of the success or failure of the message transmission.

2.3.3 Administrative and Operation Policies

In order to clearly outline the guidelines for the operation and administration of Remote Printer servers under the tpc.int subdomain, the initiators of this experiment have defined them in two informational RFCs [RFC1529] and [RFC1530]. This subsection gives a description of these documents.

Administrative Policies

RFC 1529 deals with the administrative policies for the various Remote Printer sites serving the Internet community. It also specifies the different ways in which Remote Printer server operators can recover the cost of their resources and also deals with their auditing, security and access restrictions policies. This document defines various "models" for the recovery of the resources used in providing the Remote Printing service. These resources would typically be the cost of the host, of Internet connectivity and of a fax modem or a fax card. The three models are the "Community Library Model", the "Neighbourhood Model" and the "Local Newspaper Model".

(i) Community Library Model

The basic aim of this model is to run a Remote Printer server as a community service. Here neither the originator of the message nor the recipient of the resulting service are charged for the use of the Remote Printing service. This model could be applied to an organization which is ready to cover all the facsimile devices that are within its telephone system e.g. a university or a local corporation. On the other hand, in the context of this model, a university or a government body might agree to cover not only its own internal telephone number space but a part or the whole of its local calling

number space. The Remote Printer cell setup at the Multimedia Communications Research Laboratory, Department of Electrical Engineering at the University of Ottawa, is a server of the latter type and covers most of the local calling areas of the +1-613 and +1-819 number space.

(ii) Neighbourhood Grocery Model

Here a commercial organization would run a cell and serve the facsimile numbers of only those end users who registered with them. The commercial organization could then run the cell by either charging the end user or not charging.

(iii) Local Newspaper Model

The idea here is that the cost of the resources for running a Remote Printer gateway is sponsored by a third party other than the originator or the recipient of the message or the cell operator. In return for this, the cell operator could acknowledge the sponsorship in the cover page of the resulting facsimile or/and in the acknowledgment being sent to the message initiator. The cell operator is allowed to use the bottom one third of the cover page for this acknowledgment and upto 250 bytes of ASCII text in the notification message. The syntax, format and content of these acknowledgments are subject to the applicable rules governing the form and content of sponsorship acknowledgments. It is required to prominently display the phrase "paid advertisement" in the message area if money has been paid for any part of this message delivery.

A Remote Printer server is allowed to keep a log which might contain at the most the following data for each message delivery that it makes:

- (i) The date of the receipt of the message.
- (ii) The "From" and "Message-Id" header fields of the message.
- (iii) The size of the body of the message.

- (iv) The phone number of the recipient's facsimile machine.
- (v) Any telephony-related data, e.g. call duration, number of retries.
- (vi) Any group 3 related data, e.g. recipient ID.

Though this is the maximum list of the amount of information that a server operator can maintain, it can be further limited by the local legal authorities. Also, this log serves the purpose of accountability in case of resource abuse. These logs are to be kept confidential as their release would incur the violation of the privacy of the originator and recipient of the message and to be released only if required by the legal authorities. The use of these logs for commercial gains, e.g. marketing, is also prohibited. The cell operator is allowed to release the log for statistical analysis or studies of this service or a particular remote server gateway. The content of the messages being processed is not to be monitored or disclosed unless required for technical or legal reasons. The last point discussed is the denial of access to this service. As the RFC [RFC1529] states "the denial of access should be based on the source but not the destination of the message". So a site can deny access to a particular source in case of abuse or in case of legal requirement. In all cases the source is to be informed of the reason (the policy violated) for denial of access. Denial of access should not be mistaken for inability to provide access for any technical reason. If a Remote Printer cell finds that it cannot serve any particular part of the telephone number space that it previously did cover, then it can do so by re-registering itself with the Domain Name System (DNS). A denial of access to a particular source could be caused by a single message or a series of messages or consistent long term abuse. A Remote Printer cell may also impose a limit on the number of messages that it processes, if it considers it necessary. The authority to define their own specific policies for denial of access has been left to the individual Remote Printer server operators for now.

General Principles

The general principles and policy for the operation of the tpc.int subdomain have been stated in [RFC1530]. All the sites which are ready to provide the Remote Printing service are a part of a cooperative which falls under the tpc.int subdomain in the Internet world. The policies of this cooperative are formulated and governed by a Board of Arbitration and Conciliation which is responsible for its smooth operation and control. [RFC1530] states the main purpose of this experiment is " to provide transparent mapping between general-purpose computers on the Internet and special purpose devices connected to the telephone network". This makes the Internet a more versatile and flexible communications network to its vast number of users all over the world. As the Remote Printing service is based upon the existing electronic mail infrastructure of the Internet world, any host which has e-mail connectivity to the Internet can access this service. On the whole it broadens the messaging capability of the Internet to a further boundary. Here all the sites that wish to be a part of this cooperative have to be registered under the .tpc.int subdomain without bias. For multiple servers serving the same number space the authoritative name server alternates the ordering of the list of hosts covering that space frequently so that the load of processing is evenly shared by all the sites.

As the tpc.int subdomain is organized as a cooperative so its Board of Arbitration and Conciliation also functions on the same lines. The boards members are members of the tpc.int subdomain cooperative who are appointed to hear and resolve all the questions and problems that might arise from the operation of the Remote Printing experiment. The names and contact addresses of the initial members of the Board of Arbitration and Conciliation can be obtained from [RFC1530]. The board members serve for a period of two years, with fifty percent or more of the initial members serving for a year. The board deals with issues regarding the definition of service or operation of the

service under this experiment. The secretarial services of the tpc.int subdomain are being provided by the Internet Multicasting Service, Washington D.C., a non-profit organization.

A listing of the global telephone numberspace currently being covered under this experiment is included in Appendix A2.

Information sources on the Internet :

- To receive a FAQ (frequently asked questions) on the Remote Printer experiment send e-mail to tpc-faq@town.hall.org
- To obtain a list of the area codes covered under this experiment send e-mail to tpc-coverage@town.hall.org
- To take part in discussions and debates on issues pertaining to the Remote Printing experiment subscribe to the mailing list tpc-rp-request@aarnet.edu.au

2.4 Summary

To summarize, in this chapter, we have presented an overview of new developments in standards of facsimile and the Internet. These development are Binary File Transfer, Multipurpose Internet Mail Extensions and the Remote Printing Experiment. The study of these standards was vital for our research endeavor. We have used different facets of these standards to achieve our goal of multimedia messaging across the Internet and the facsimile network.

Chapter 3

Fax-MIME Interworking

3.1 Introduction

The Internet is the fastest growing wide area network in the world, whose rapid growth surpasses that of any other communications network. Electronic mail standards developed by the Internet community since 1982 allow users worldwide to exchange information over the Internet. These e-mail standards which are very effective for textual e-mail have begun to show their age with the emergence of multimedia communications. Some key limitations as described in chapter 2 include no support for multimedia messaging, multilingual text and message length and line length restrictions. The new Internet standard Multipurpose Internet Mail Extensions (MIME), overcomes these limitations and also provides enhanced capabilities for e-

mail. MIME allows users to exchange multiple media mail messages over the Internet.

Another communications tool which has become pervasive over the last decade is the fax machine. The growth of fax usage in the 80's and the 90's has been dramatic and now there are over 15 million facsimile units in use throughout North America [PUG91]. The growth in fax usage is likely to continue with the recent adoption of an enhanced CCITT fax standard, Binary File Transfer (BFT) for Group3 facsimile protocols. Binary File Transfer allows users to transfer different media in binary form over the public switched telephone network.

There exist various commercial solutions for providing facsimile access over Local Area Networks (LANs). Many facsimile mailing systems [ASA88], [ARI89], [ISY91] have been developed which provide various levels of interconnection between mailing systems and facsimile systems. While these solutions offer enhanced reachability, their scope is limited to the local area network that they support or cover and are not capable of handling multimedia content.

At the Multimedia Communications Research Laboratory (MCRLab), we have been pursuing the integration of the e-mail and the facsimile worlds for bi-directional multimedia messaging. In this approach towards seamless global communications, we envisioned an environment where traditional fax machines, multimedia fax machines (fax card enabled computers with BFT support) and computers/workstations on the Internet would communicate with each other using the protocols of facsimile and the Internet. The fundamental goal of our research was to focus on bi-directional multimedia messaging across two heterogeneous environments (i.e. the Internet and the public switched telephone network). The bridge between fax users and the Internet would be the multimedia fax-Internet gateway, an application level gateway

which is described in the subsequent sections. This work has been inspired by a previous paper [ARN93] and the tpc.int Remote Printing Experiment [RFC1528]. Presently the Internet community is able to seamlessly communicate to traditional fax machines with the use of the Remote Printing Experiment, which routes RFC822 e-mail and MIME messages through the Internet to remote printer servers or 'cells'. These cells then automatically transmit the e-mail as local facsimile to the recipient. Our fax-Internet gateway would extend this work and allow Internet users to connect to the vast number of facsimile machines and fax enabled personal computers in a consistent manner to exchange multimedia messages. It would also make available Internet services to fax enabled personal computers with BFT support. These services which include messaging, Internet FTP (File Transfer Protocol) and Internet news service are discussed further in the following sections.

3.2 General overview

We have provided a discussion of the three key developments which allow for the design of a bi-directional fax-Internet gateway earlier in chapter 2. These developments include the Remote Printing Experiment, MIME and Binary File Transfer. Here we state what functionalities and aspects of these developments we intend to use for this unique multimedia gateway design.

Remote Printing Experiment

First and foremost is the Remote Printing Experiment, which we will use and enhance, to provide multimedia messaging capabilities across the facsimile and Internet environments. The Remote Printing Experiment strives to bring together the e-mail and facsimile communities on a global scale through unidirectional (e-mail to fax) services. The subnetwork addressing scheme and the routing mechanism for delivery of messages to appropriate "cells" that the Remote Printing experiment provides is

vital for the working of the multimedia gateway. Moreover, it also provides a good framework for multimedia messaging and for the other services that we wish to provide to multimedia fax users.

Multipurpose Internet Mail Extensions (MIME)

MIME provides for the exchange of various media such as multilingual text, images, audio, video, applications and embedded message through e-mail over the Internet. It provides for a common platform for the exchange of multiple media messages across the Internet and also allows for different arbitrary mechanisms to be used for the rendering and display of such messages. MIME has been designed to provide robust performance over different variations of mail transport protocols in use today. In this way MIME facilitates the representation and encoding of various media in a uniform manner. As mentioned earlier, the Remote Printing Experiment supports MIME, however support is limited to a few restricted content types. Our aim is to facilitate support for all the major media such as text, images, audio, video, application, etc. and in the process use MIME as a universal messaging platform.

Binary File Transfer (BFT)

Lastly, we consider the BFT enhancement for Group3 facsimile protocols. The limitation of traditional Group3 facsimile is that only a rasterized image of the document (which can be either plain text or image) can be transmitted, even to fax card enabled personal computers which are capable of rendering all types of media like text, audio, image, video, etc. On the other hand, BFT can be used to transfer documents and data in binary form through high speed modems. The BFT standard describes the semantics and syntax necessary to represent a data file in order to transfer it through the protocols of the Group3 facsimile. It also defines the various attributes which can be used to describe the data that is to be transferred. The use of

these attributes allows for sub-network addressing, specification of service request and other properties which are essential to building a bi-directional gateway. BFT provides reliable transmission of multiple files in a session. Thus, multimedia fax machines can use this enhancement to exchange multipart, multiple media messages across the telephone network. We intend to use this development in facsimile technology to marry the fax and Internet communities to provide bi-directional multimedia messaging and Internet services.

3.3 General description

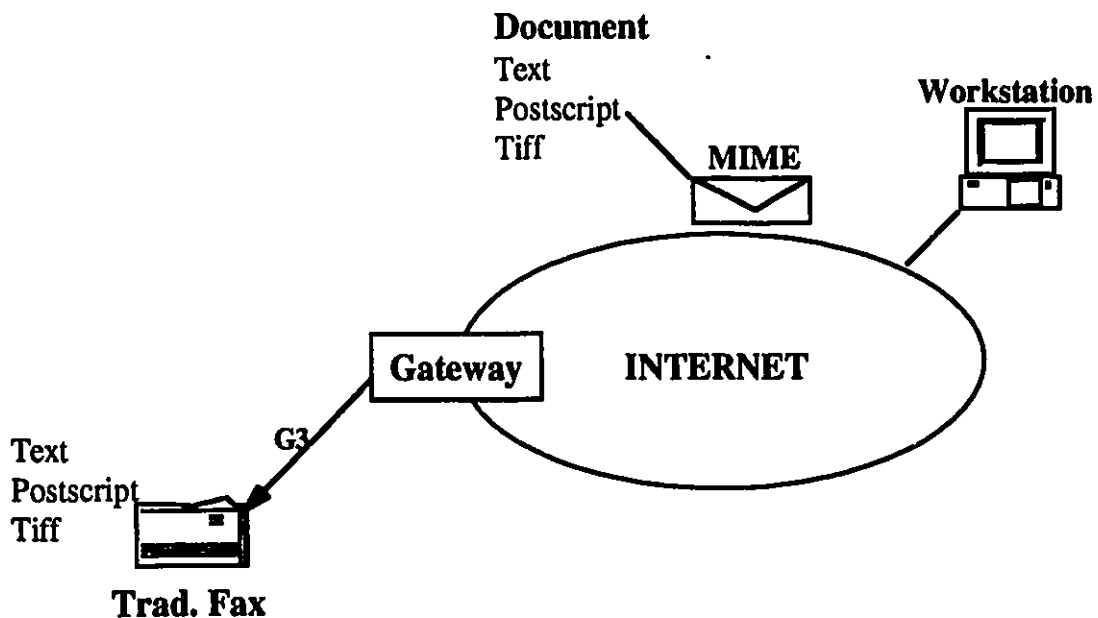


Fig.3.1
Scenario of the service provided by the Remote Printing Experiment

Our goal is to build on the infrastructure laid out by the Remote Printing Experiment to provide bi-directional multimedia messaging between two distinct communities. Further, we wish to make available Internet services like FTP and Internet news to users who do not have Internet access. With the Remote Printing Experiment in

place, MIME or plain e-mail messages can be routed across the Internet to local remote printer gateways as shown in Fig.3.1, which in turn will locally fax them to the appropriate facsimile user. As noted earlier, the limitations here are that messaging is unidirectional from the Internet to the facsimile community and only a limited type of media like ASCII text, postscript and TIFF (Tag Image File Format) images can be delivered.

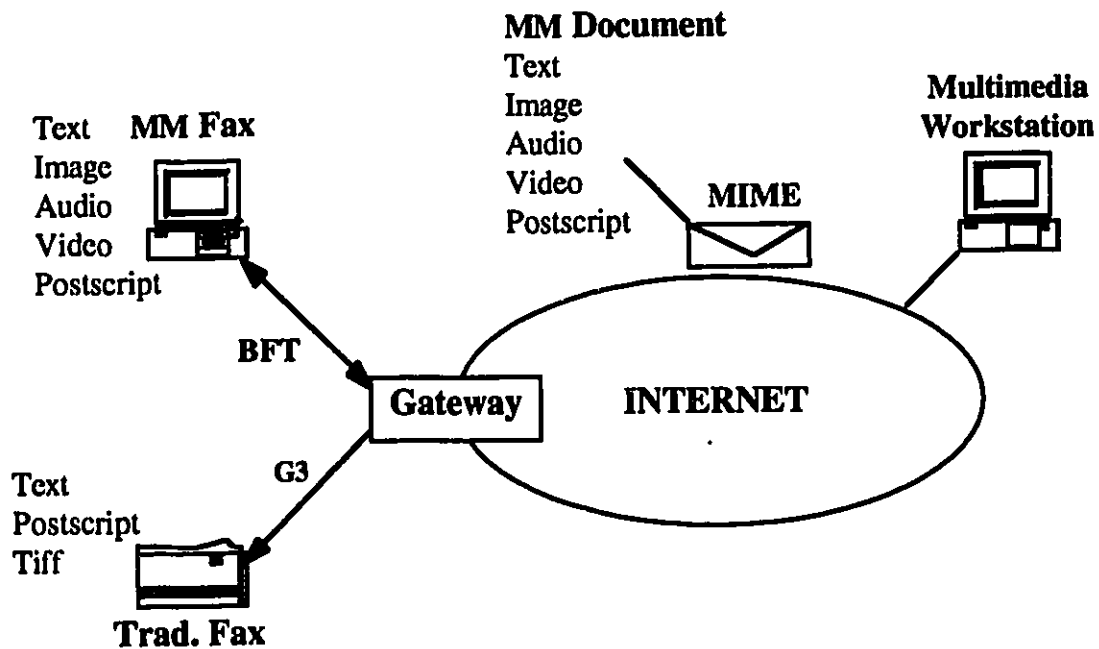


Fig 3.2
Scenario of the service provided by the multimedia fax-Internet gateway

However, as shown in Fig.3.2, we can have bi-directional multimedia messaging through the proposed fax-Internet gateway. Here MIME messages (text, images, audio, video, application, etc.) can be routed across the Internet to a local fax-Internet gateway, using an extension of the Remote Printing Experiment mechanism. Over the telephone network the fax-Internet gateway would use BFT as a tunneling mechanism to deliver the MIME message to multimedia fax machine or use Group3 for transfer of regular fax messages (plain text, tiff, postscript) to traditional fax machines. For fax to Internet traffic the multimedia fax machine would use BFT to ship

MIME encoded messages to the fax-Internet gateway. The gateway would strip off the BFT header and mail the message to the destination e-mail address. Thus using MIME and BFT we can facilitate bi-directional multimedia messaging through the use of the fax-Internet gateway. In a similar way, the BFT header can be used to send requests to the gateway for FTP or news services. It should be noted though that traditional fax machines would not be able to send messages to the Internet.

This endeavor of ours provides the following advantages over the Remote Printing Experiment for both the Internet and facsimile communities :

- Multimedia messaging services in a uniform manner (MIME) for both the communities.
- Extension of the Remote Printing Experiment to support all media types supported by MIME.
- Bi-directional messaging as opposed to unidirectional one provided by the Remote Printing Experiment.
- Allows multimedia fax users to have access to Internet resources.
- Simplified connection/setup model, as compared to SLIP (Serial Line Internet Protocol) [RFC1055] /PPP (Point to Point Protocol) connections.

3.4 Gateway services

3.4.1 Introduction

The application level gateway that we propose here provides services both for a user on the Internet and a multimedia fax user who does have Internet access. The gateway can provide the following services:

- Messaging (e-mail, fax) services.

- Internet file transfer services (FTP).
- Internet news services.

Each of the services listed above is discussed in detail in the following subsections.

3.4.2 Messaging service

For this service, we are assuming that Internet and multimedia fax users have MIME compliant user agents which allows them to create, manipulate, render and display

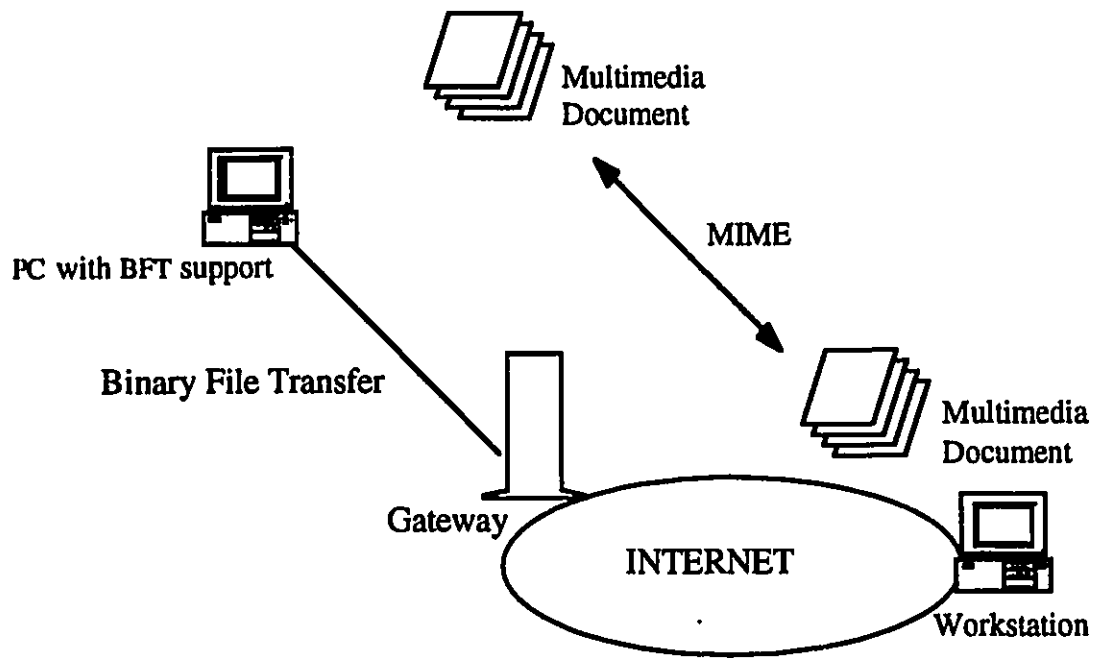


Fig.3.3

Multimedia messaging service between multimedia fax machine and Internet

multimedia messages. Fig.3.3 portrays the scenario that we envision for multimedia messaging for Internet and facsimile users with BFT support.

For Internet users, the gateway would provide access to traditional fax machines as well as to multimedia fax machines which are not connected to the Internet. In a typical scenario this would allow a user on the Internet to send plain text or multimedia documents to a personal computer with BFT support at home. The Internet

Message encapsulation for BFT transfer

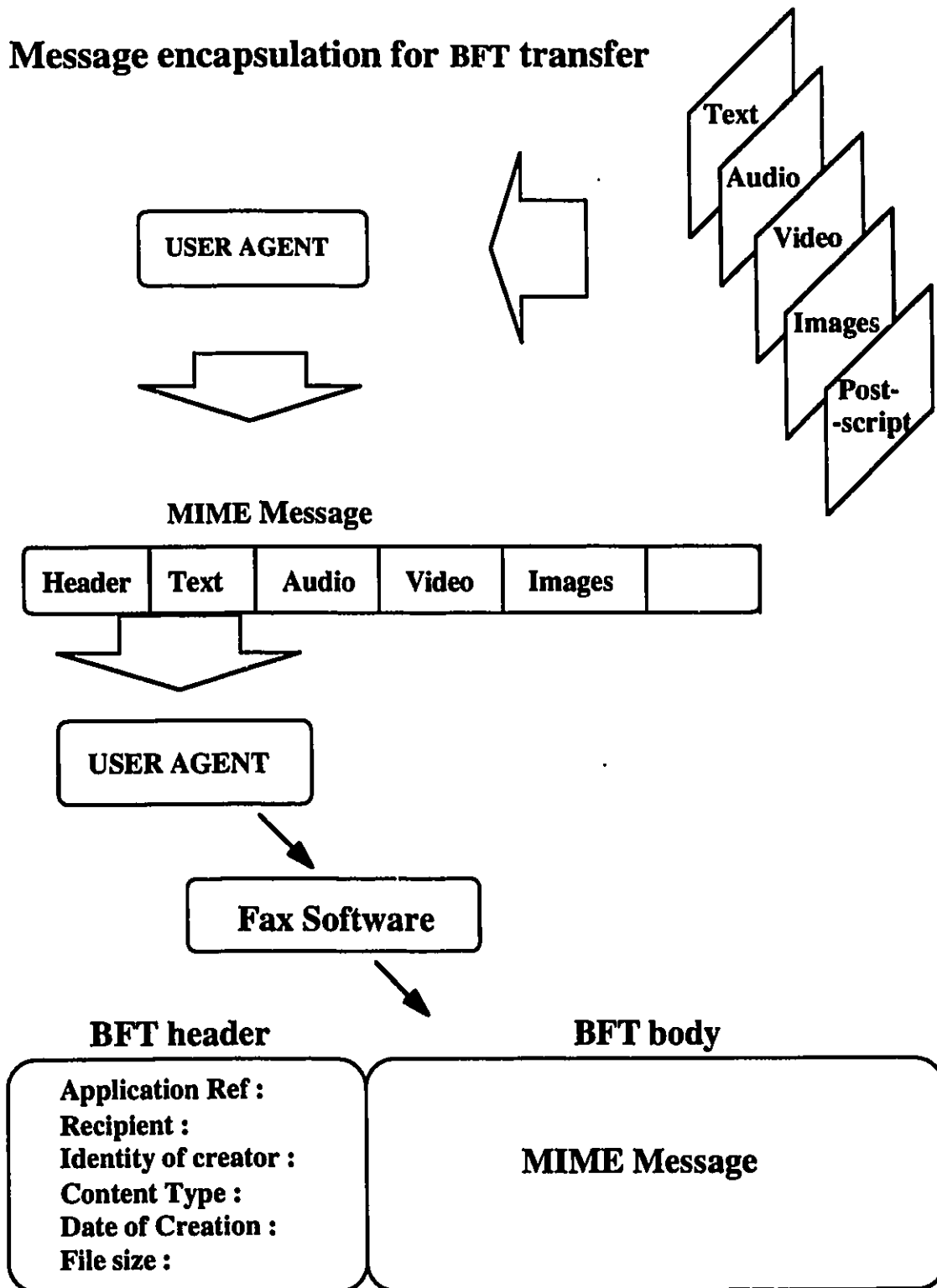


Fig. 3.4

Multimedia message encapsulation for a BFT transfer

user can create a MIME document and send it by e-mail to the fax-Internet gateway (as the gateway would be a superset of the remote printer the user could specify the destination phone number in the e-mail address itself). The aforementioned gateway would then encapsulate this MIME message into a BFT body with appropriate headers and fax it to the local multimedia fax machine. If the gateway finds that the destination fax number does not support BFT, it sends only those content types that are supported by plain fax to the recipient, and also a message informing him or her about the receipt of a multimedia message and the other media (audio, video) which it was unable to fax. These content types would then be either mailed back to the originator or discarded according to an option which could be specified by the originator of the message. Also e-mail distribution lists could be used to send fax to fax users on a regular basis.

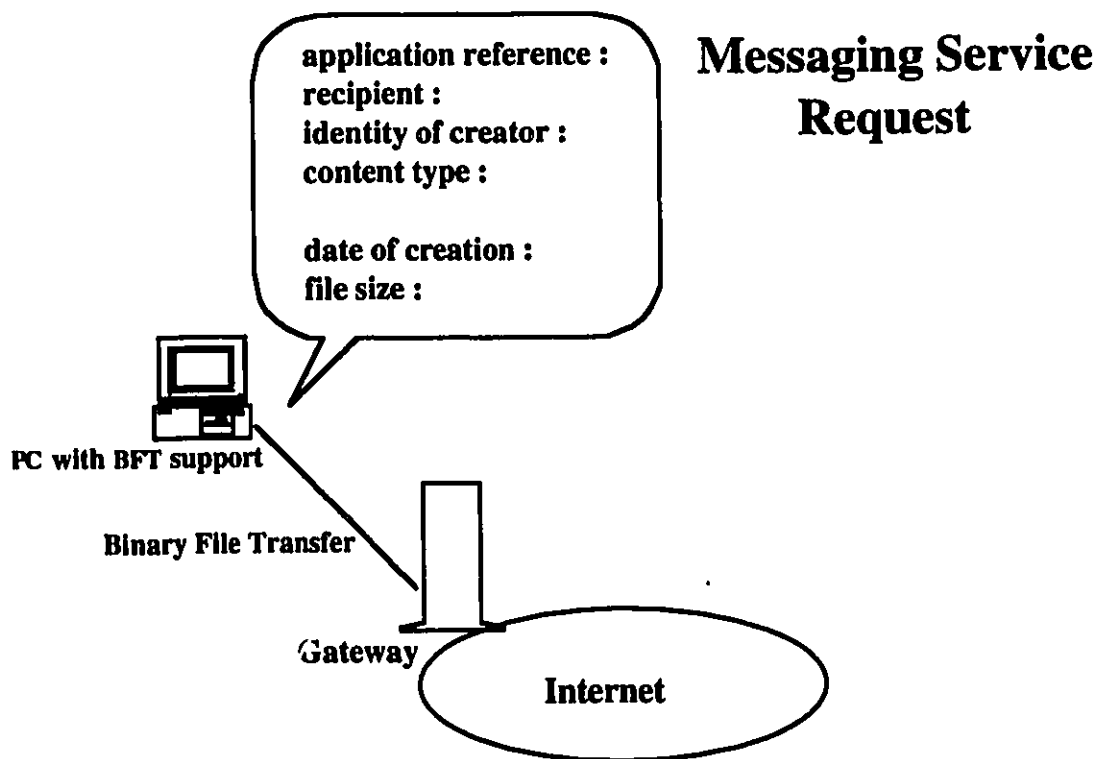


Fig. 3.5
Attributes used for the messaging service

For fax to Internet messaging (inbound messaging), the user agent (which is MIME compliant) on a multimedia fax machine would encapsulate the multimedia MIME message in a BFT body and use the BFT header to specify the recipient address (Internet) and other attributes of the messages as shown in Fig.3.4. The fax MIME gateway would decapsulate the BFT message and use the e-mail address in the BFT header to mail the MIME message to the recipient or to another fax-Internet gateway. Traditional fax machines would not be able to automatically send messages to different users on the Internet.

Fig.3.5 illustrates the various attributes in BFT header that we intend to use to facilitate the messaging service. The following depicts a typical messaging BFT header used by a multimedia fax user to transfer a MIME message to the fax-Internet gateway.

Minimal attributes

application reference : messaging
recipient : patel@trix.genie.uottawa.ca
identity of creator : 16135649911
content type : MIME 1.0

Optional attributes

date of creation : 4 Nov. 1993
file size : 567K

The minimal attributes are ones which are mandatory, while the optional ones can be used for extra information. The application reference attribute tells the gateway which service is requested. Other mandatory attributes include the recipient, which is a valid Internet e-mail address, originator address which is the senders fax number, content type which could be either the MIME version number or RFC822 mail. The optional

attributes date of creation and file size can be used to provide additional information to the gateway.

3.4.3 Internet file transfer service

As the name suggests, this service facilitates File Transfer Protocol (FTP) services for multimedia fax users. This service can be used to retrieve files from ftp sites on the Internet or from user accounts to the multimedia fax machine. Here the user specifies the Internet address of the host machine (site), the directory in which the file lies and the name of the file itself which is to be retrieved, in the request for FTP service.

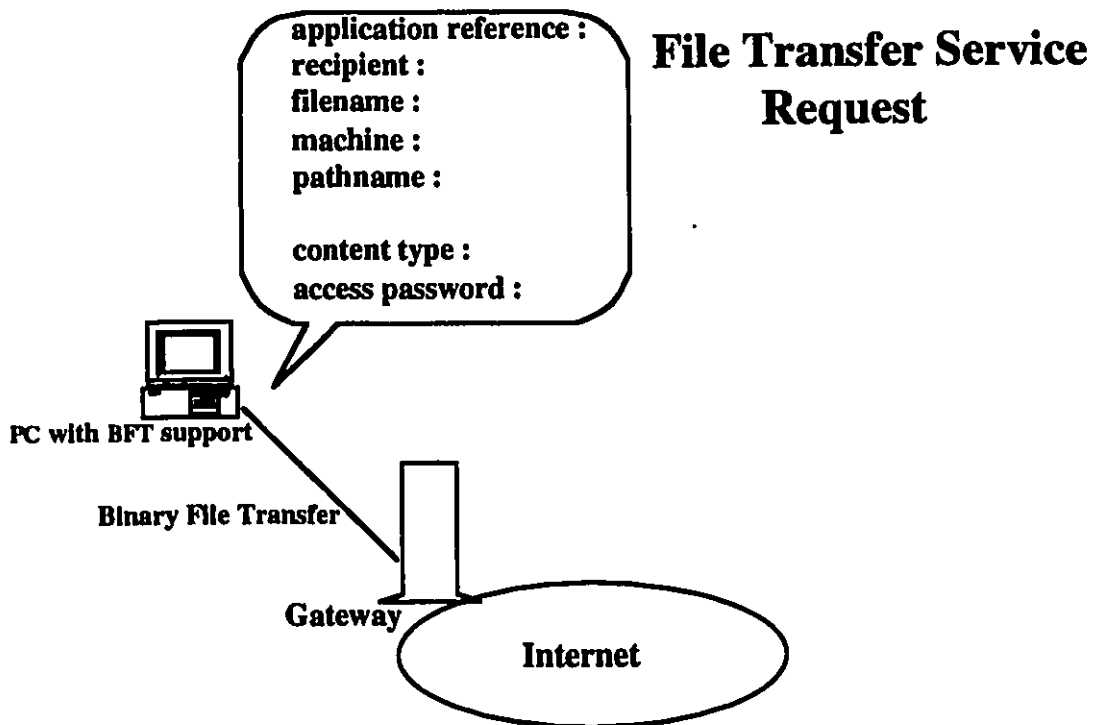


Fig. 3.6
Attributes used for the File Transfer service

The user agent uses this information to form the BFT header for FTP service. When the gateway receives this fax (request), it uses this information to login anonymously to the host and retrieve the required file. It then transfers the file back to the

multimedia fax user through a BFT transmission. In case of failure to retrieve the file, the gateway will send back a message to the user informing him about the reason for failure. The attributes that are to be used by the multimedia fax user for this service are shown in Fig.3.6.

A typical FTP request to retrieve a file is shown below.

Minimal attributes

application reference : get file
filename : make.tar.Z
machine : sunsite.unc.edu
pathname : pub/linux/SLS/X11/devel/
recipient : 16135649911

Optional attributes

content type : binary
access-password :

The application reference attribute and the other minimal attributes inform the gateway to anonymously FTP the file imake.tar.Z from the FTP site sunsite.unc.edu from the directory /pub/linux/SLS/X11/devel/ and fax it to +1-613-564-9911. By default, the gateway assumes the file transfer to be of type anonymous. The optional attribute access password can be used to FTP files from a particular user account. The BFT body here would be a null body. Similarly a 'put file' value for the attribute application reference can be used to put files on FTP sites or user accounts.

3.4.4 Internet news services

This service, like the FTP service, can be provided to multimedia fax users by the gateway to get news articles from various news groups on the Internet. Based on

information like the news server name, the news group, the number of the last article read, number of articles the user wants retrieved, recipient fax number, etc. The gateway would retrieve the news article over the Internet and bundle it up as a BFT message and fax it to the recipient. In this way the user would be able to have news on his desktop at home everyday or whenever he wishes to get them. As the Internet news service begins to incorporate MIME messages, these would immediately be available to the multimedia fax user. The retrieval request can be stored by the user agent for future use. Fig.3.7 depicts the various attributes in a BFT header that are to be used for this service.

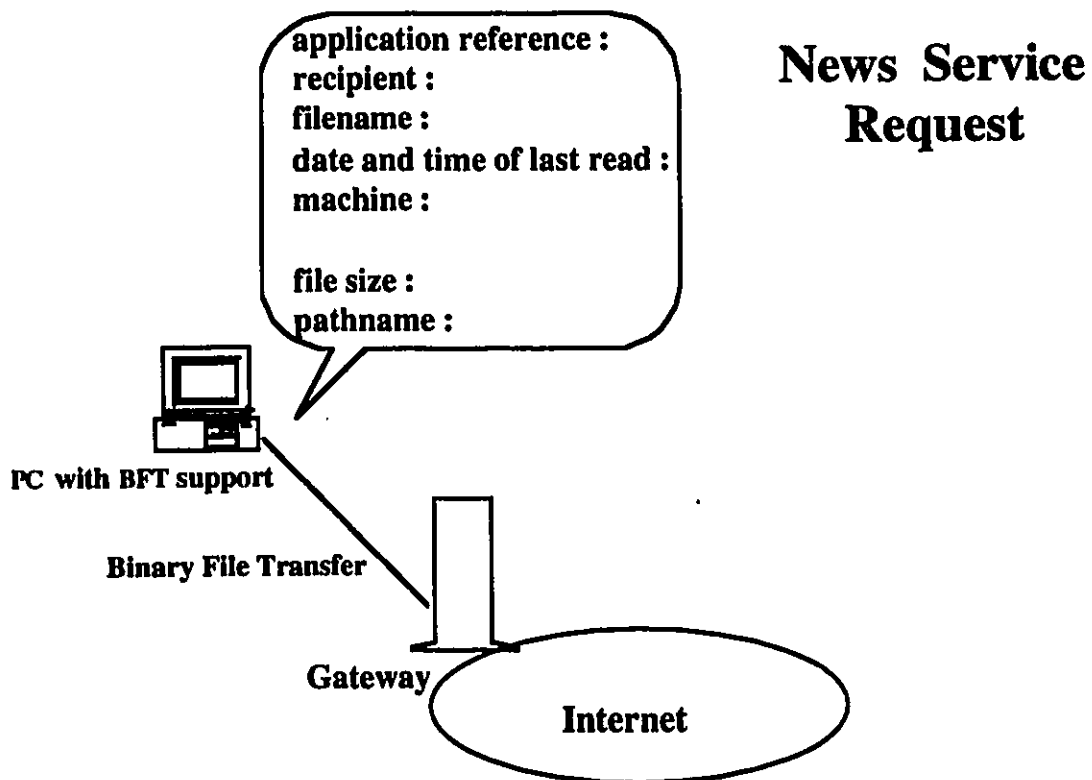


Fig. 3.7
BFT attributes used for the News service

The various minimal and optional attributes required for this service are as follows.

Minimal attributes

application reference : Internet news

filename : comp.mail.multimedia
date and time of last read : 4 Nov. 1993, 08:00:00.
machine : panda.genie.uottawa.ca
recipient : 16135643998

Optional Attributes

file size :

pathname :

The application reference for this service would be Internet news. The filename attribute specifies the news group, the date and time of last read allows the gateway to know the next news article to be retrieved from the specified news server. The gateway would then fax these articles as a BFT document to the recipient phone number. The file size and pathname attributes are the optional attributes which can provide extra information. Here again like the file transfer request a null body would be transmitted in the service request.

3.5 Architectural and functional description

For interoperability between the facsimile and the Internet environments, we had a choice of either mapping the various MIME body parts to separate BFT files or plain encapsulation of the MIME message in a single BFT file. The mapping option allows for full conversion of various body parts with no redundant data in the message, but would make the processing of messages slower and increase the implementation complexity. On the other hand encapsulation offers robust processing of messages, and simpler implementation but with an overhead of redundant information contained in the MIME header as well as the BFT header. After carefully weighing the pros and cons of both the options, we chose encapsulation. The architecture of the fax-Internet

gateway is depicted in Fig.3.8. The fax interface and Internet interface connect the gateway to the telephone network and Internet respectively.

Gateway Architecture

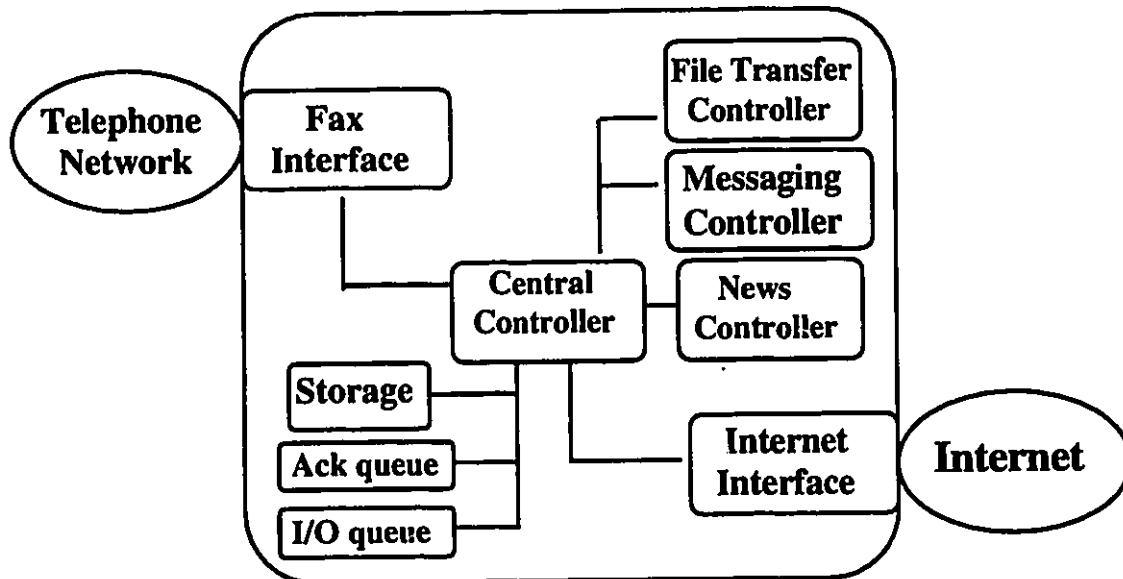


Fig.3.8
Architecture of the multimedia fax-Internet gateway

The fax interface receives and transmits fax messages using the Group3 fax protocol. Physically a modem (or a fax card) and fax software with BFT support constitute this block. The Internet interface receives and mails MIME or RFC 822 conformant e-mail messages. Physically, a network card with the TCP-IP stack and Internet messaging infrastructure constitute this block. The Messaging controller would have the functionality of a remote printer server and also to accept multimedia messaging requests. It would extract the destination address of the recipient and the originator address from the BFT header and mail the multimedia message using the Internet interface. The File Transfer controller accepts ftp requests and retrieves files from the Internet according to the information provided in the BFT headers and transmits them as BFT transmissions to the recipient. Similarly, the News controller makes available

Internet news articles from NNTP (Network News Transport Protocol) [RFC977] servers according to the information in the news service request. There are separate input and output queues for the fax interface and the Internet interface. The central controller picks up requests from each input queue and the various controllers place the processed messages or facsimiles in the appropriate output queues. The storage module is used for temporarily keeping large messages which can not be transmitted to their destination. Separate ACK. queues contain acknowledgment messages or error reports for Internet and facsimile users.

When the gateway receives either a fax or an e-mail, it is transferred to the input queue. The central dispatcher takes each fax (uses BFT header to determine service) or e-mail message from the input queues and invokes either of the three controllers for further processing. All e-mail messages from the Internet are processed by the messaging controller and transferred to the output queue for local facsimile transmission. The messaging controller also maintains a database of previously dialed phone numbers with their capabilities for use during future message transfers, especially to determine whether the destination fax machine is a multimedia fax machine or a traditional fax machine. The central dispatcher then sends these messages to the fax interface for transmission. The fax interface will abort the transmissions of MIME messages if it detects that the destination fax machine does not support BFT, and stores the message in the storage queue. Then only those content types which can be printed on plain fax machines will be sent to the recipient while the remaining content types will be either discarded or mailed back to the originator.

When requests for messaging, file transfer or Internet news come as BFT transmissions to the fax interface, they are initially stored in the input queue. The central dispatcher will then transfer it to the appropriate controller by parsing the

application reference attribute. For a messaging request, the messaging controller will remove the BFT header and e-mail the MIME message to the specified Internet address via the output queue and Internet interface. If it is a file transfer request, the file transfer controller retrieves the requested file by anonymous FTP from the specified site and forms a BFT message for the requested destination. This BFT message would then be faxed by the fax interface from the output queue. The news controller retrieves the requested number of articles from the specified NNTP server to form a BFT document and deposits it in the output queue for transmission. The positive acknowledgment mechanism used in the Remote Printing Experiment would also be incorporated in the gateway functionality through the ACK. queue. The modular architecture of the gateway would make it easy to extend its functionality for other services.

3.6 Summary

In this chapter, we have described the concept of using the Remote Printing Experiment, MIME and Binary File Transfer to facilitate bi-directional multimedia messaging across the Internet and the facsimile network. Subsequently we have described the services that can be provided through the multimedia fax-Internet gateway. Finally, we describe the architecture and the functionalities of the multimedia gateway for the various services that it provides. The above work is also described in brief in [PAT94].

Chapter 4

Remote Printer Gateway: Practical Experiences

4.1 Introduction

Early in the summer of 1993, when we embarked upon the Multimedia Fax project, we were considering various schemes for subnetwork addressing, fax to e-mail and e-mail to fax messaging between the Internet and the public switched telephone network . Around that time the Remote Printing experiment was announced on the Internet and our hopes and spirits ebbed seeing actual implementation along our lines of thought. But, eventually the Remote Printing experiment turned out to be a stepping stone for our research and in a way cleared the path towards bi-directional multimedia messaging. In order to get better acquainted to the concepts and techniques used in the Remote Printing experiment, later we embarked upon the project of setting up a

Remote Printer server for the Ottawa/Hull region. This chapter describes the various stages of setting up a Remote Printer server at the Multimedia Communications Research Laboratory. The setting up of the gateway was not necessarily pure research or development, but rather a successful effort to interwork different software entities to achieve the goal of e-mail to fax service. Also in the process the author was exposed to the various aspects, modules and modes of electronic mail systems for the Internet and learned to cope with practical problems of system integration. Finally, while the Remote Printer servers where fully developed on commercial platforms, the author successfully ported it to a new host platform, namely Linux [WIE93].

4.2 System description

The task of setting up a Remote Printer server was divided into several stages according to the system requirement. The various functional units which constitute a remote-printer server are depicted in Fig. 4.1 below :

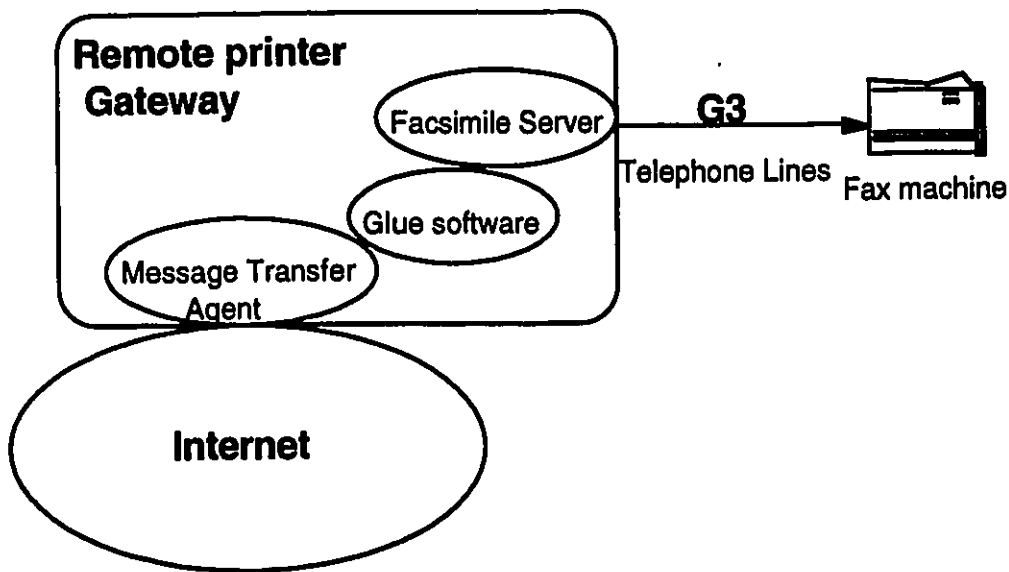


Fig. 4.1
Functional units of a Remote Printer server gateway

A brief description of these units with their functions and the exact software packages used follow. (It should be noted that though various other alternatives for the choice of the different modules involved is possible, the ongoing discussion describes only those software packages and programs that were actually used to set up a Remote Printer server at MCRLab).

Message Transfer Agent :

In traditional electronic mail systems, the message transfer agent performs the function of sending, relaying and receiving electronic mail using the Simple Mail Transfer Protocol [RFC821] in the Internet world. In the context of the Remote Printing Experiment, the message transfer agent (residing on the Remote Printer gateway host) is required to recognize electronic mail messages which are of the syntax remote-printer.user@x.x....x.x.tpc.int as explained in sect. 2.4. It has to be configured in such a way that it will accept only those e-mail messages which match the subset of the telephone name space that the Remote Printer server has agreed to cover. Prior to this it is required to register with the zone administrator of the particular domain (which is tpcadmin.trystero.radio.com for Canada and the U.S.A) so that all queries to the Domain Name System will direct the matching (address) e-mail messages to the appropriate Remote Printer server. The glue software which is available has directions of use for Sendmail [ALM93], which is a widely used message transfer agent on UNIX hosts over the Internet. Sendmail is reconfigured so that it accepts e-mail messages in the tpc domain syntax and passes it on to the glue software.

Glue Software :

This component is actually a set of shell scripts, which perform the function of accepting e-mail messages, forming the cover page for facsimile transmission and

making an appropriate request for facsimile transmission to the facsimile server. This program is invoked by the message transfer agent and passed on the e-mail address (message recipient), message originator and the message itself. The glue software performs the following functions upon receipt of an electronic mail message for facsimile transmission.

- extracts the telephone number of the destination fax machine from the e-mail address header.
- checks the e-mail message for discrepancies like no message-id, no sender information, etc.
- If the message is a MIME message with the 'application/remote-printing' content type, it forms a cover page according to the information provided. Alternatively for a RFC822 message it will use the e-mail address and message headers to form a cover page. Here the bottom third of the cover page is used to display an advertisement.
- If a MIME message contains portions which are not either plain text, postscript, tiff or forwarded message, it removes them and appends a note to the facsimile transmission, informing the recipient about the action taken.
- If the e-mail message contains an empty body, it sends a mail message to the originator letting him know of the above fact and inability to process the request.
- Finally it invokes the facsimile server while passing on the telephone number of the fax machine, originator, message-id, the formulated cover page and the message itself.
- Then it sends an e-mail message to the administrator of the fax gateway, informing him or her of the queuing of the message for facsimile transmission along with the identification number returned by the facsimile server.

Facsimile server :

The facsimile server is a daemon process which waits for requests for facsimile transmission, and transmits the messages received over the telephone lines after converting them to the Group3 facsimile image format. It accepts documents in either text, postscript or tiff format for transmission. Parameters like telephone number, originator, message-id, default cover page generation, time for transmission, number of retries, etc. can be specified when a request for fax transmission is made to the server. The Remote Printer gateway package has support for two facsimile server software packages available on the Internet. They are Bristol Group's IsoFax and Samuel Leffler's Flexfax package. A fax modem, connected to the telephone network, has to be configured to work with the fax server. The facsimile server transmits the messages from the send queue one by one, and in case the recipient fax machine is busy, it reschedules the fax transmission for a later time. Ultimately it notifies the originator of the success or failure of the facsimile transmission and in case of failure sends a log report of the communication exchange.

4.3 Practical Configuration

The preceding subsection gave a brief system description of a Remote Printer server gateway. In this subsection, we describe the actual stages undergone during the configuration of the Remote Printer gateway at the Multimedia Communications Research Laboratory, University of Ottawa. Also for each stage we state the problems faced, with the solutions or work-arounds that we devised to overcome them.

The first step was choosing the platform (operating system) and the facsimile package for this project. While the majority of the tpc.int sites in the world run on sun workstations, with SunOS 4.13, the success of a widely distributed service like remote printing depends on low cost solutions. Our goal was to explore the operation

of a Remote Printer gateway, using surplus equipment and freely available software. Linux, a freely available UNIX for IBM PC's was selected for this purpose. Among Linux's strong points were that it was a full featured free UNIX which offered a POSIX compliant interface. We began with a 386/20 MHz computer with a surplus monitor, a small 120 MB harddisk and a SupraFax modem.

Flexfax 2.2.2:

Next, the Flexfax package (source code) was ftp'd from the Internet to the host machine. The Flexfax software is written by Sam Leffler of Silicon Graphics and made available to the general public in the public domain. It is structured on the client server model and coded in C++. A facsimile server process ("faxd" fax daemon) runs for each modem, and client modules ("sendfax") can send requests for facsimile transmissions from across the network. The facsimile server holds facsimile that have been received (in tiff format) and those awaiting transmission in predefined directories. A log of all the transmissions and receipts with their result is kept in a file (xferlog) for accounting and tracking purpose. A shell script (notify) performs the function of informing the user about the result of the facsimile transaction.

Software components listed below were obtained and installed for the proper compilation of the source code :

- The latest version of the GNU c++ compiler *gcc2.4.5*.
- The *libg++2.4*, libraries for c++.
- A software interpreter for postscript files *Ghostsript 2.6.2* .
- *afm* font metric library.
- A program *ps2fax* to convert postscript to fax (TIFF F) format.

While Flexfax did not support Linux, a minimal amount of hacking allowed us to run it on our host. The next step after compilation was to configure the modem (a SupraFax modem V32.bis) to work with the facsimile server. This part required a considerable

amount of time and effort as the modem would some how not work in class 2 mode. With help from the "Flexfax mailing list", a work around was used by using the modem in Class 1 mode. The actual configuration parameters (config.cua0) used in for this modem is listed in Appendix A3.

Remote Printer Glue software:

The first step was to replace Smail (mail router) with Sendmail 5.65 (as the Remote Printer software supports only Sendmail presently). Next it was required to configure this MTA (Message Transfer Agent). Sendmail had to be configured to recognize and accept e-mail messages with recipient addresses of the form 'remote-printer@*.tpc.int' and then hand it over to the tpcmailer.sh shell script. To accomplish this a file is created which contains the domain name (partial string of the tpc e-mail address to be matched for local facsimile transmission. For example, if the server wanted to cover all the phone numbers under +1-(613) and +1-(819), the file (tpcmailer.cT) would contain

3.1.6.1.tpc.int

9.1.8.1.tpc.int

This file provides a definition of a new class "T" for Sendmail, and is declared using the 'FT' directive in the sendmail.cf file (the configuration file for Sendmail). Also a change is made to the rule set 0 in the sendmail.cf file so that not only will it recognize tpc conformant addresses, but also accept only those messages whose recipient address matches one of the entries of the 'Class T'.

The problem we faced here was that Sendmail would not read the file specified in the FT directive and consequently would not accept tpc style recipients. So we used the Cv directive in Sendmail to declare the class, which required the whole file to be included in the sendmail.cf itself.

Next a proper `tpcmailer.sh` script was produced by specifying the environment variables on the host multimedia, like the facsimile package used, location of e-mail user agent, `ghostscript`, etc. This process automatically rewrites the Flexfax notify script so that it can prepare and mail log reports for the Remote Printing service. Also a separate directory tree is created to store the `tpcmailer.sh`, shell scripts for automated denial of service to particular users at source, accounts directory, advertisement directory to place the advertisements on the cover page, etc. The faxd server can be configured to accept requests for transmission from only hosts in stipulated domains. This parameter was changed to accept requests from all domains over the Internet.

Next an exchange file was formed of the format

```
Ottawa-Hull!613!564 763
```

where the string Ottawa-Hull represents the exchange name, with the number within !'s is the area code and the remaining three digit arrays separated by spaces are the first three numbers of a telephone number. The above illustration represents a case where the server is ready to cover all facsimile devices with phone numbers starting with +1-(613) 564 xxxx and +1-(613) 763 xxxx. The actual exchange file for the Ottawa/Hull server is listed in Appendix A4 .

This exchange file was sent to the zone administrator for the `tpc.int` domain and trials were run to check the proper working of the Remote Printer gateway. Here again a problem arose, when although Sendmail, the MTA on the host multimedia, accepted messages for the `tpc.int` domain and passed over to the `tpcmailer.sh` script, the messages never got through to the facsimile server. With a considerable effort and help from various sources across the Internet and the campus, we were able to ascertain the root of the problem. According to the way the system was then configured, Sendmail invoked the `tpcmailer.sh` as "bin" and it used this id to send a

request to the Flexfax server through the client "sendfax", on behalf of the originator of the e-mail message. The Flexfax client does not allow this switch or discrepancy in id and dies immediately after it is invoked. However the client will allow 'root' id to supposedly masquerade as the originator of the message. To allow for this, the declaration of the tpcmailer.sh in sendmail.cf was changed so that Sendmail would invoke tpcmailer.sh as 'root', and thus allow for proper submission of facsimile transmission requests. Eventually the MCRLab Remote Printer server was officially announced (Appendix A5) to be operational on February 3, 1994 to the mailing list for the Remote Printing experiment (tpc-rp mailing list). This server was the first one of it's kind in Canada (Appendix A6) and the only one running Linux on a 386/20 machine, as opposed to most of the other servers running on high end workstations and commercial operating systems.

4.4 Statistical Survey

Based on the statistical data available from logs of the server, the following characteristics were observed as regard to the usage of the Remote Printer server. The bar graph in Fig.4.2, shows the total numbers of successful facsimile transmissions made by the Remote Printer server at MCRLab on a monthly basis in the first half of 1994. As this service gets more known over the Internet it is estimated that this figure will rise.

The causes of failure of facsimile transmissions (which was quite high during the initial weeks of the gateway operation), were found to be the following.

- No carrier detected. This failure report suggests that a facsimile device was not found at the destination. This was the most common failure reason found.

- Repeated busy signal detected for the maximum limit of attempts (three for this case) made by the fax server for a request.
- No response to repeated MPS (Multi Page Signal), which causes the session to end midway.

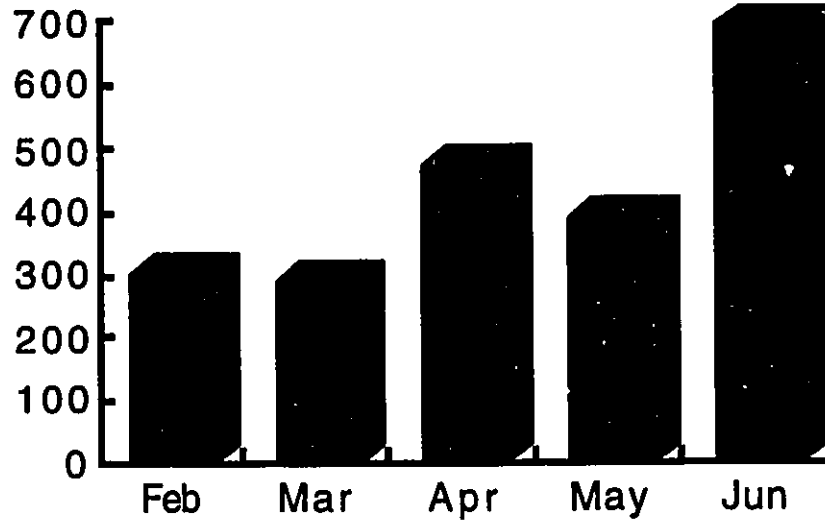


Fig. 4.2

Successful facsimile transmissions made by the Ottawa server on a monthly basis:

- Communications error during phase B/C.
- Inability to get remote capabilities or remote not being T.4 compatible.

Month	Pages/fax
February	2.8
March	3.05
April	2.5
May	2.4
June	2.7

Table 4.1
Average pages/fax.

Table 4.1 lists the average number of pages sent per transmission on a monthly basis. It should be noted here that this includes the cover page created by the tpcmailer.

The Remote Printer gateway at MCRLab is used regularly by a large number of users on the Ottawa Freenet, Universities all over Canada, commercial organizations and firms, a few Universities from the U.S.A. Also on some occasions users from countries like United Kingdom, Israel and Italy have availed the services of this gateway.

All the above statistics have been computed from the xferlog file records of the fax daemon on the Remote Printer gateway.

4.5 Summary

In this chapter, we described the course that we took to setup a Remote Printer gateway at the MCRLab. This exercise gave us a thorough hands on experience of the procedures specified for the Remote Printing experiment. The Remote Printer server, as the statistics suggest, is being extensively used by the Internet community, since its establishment.

From this exercise we also came up with an initial list of features and functionalities that would be required to have a multimedia gateway based on the current Remote Printer gateway:

- The facsimile server software would need to have BFT support.
- The glue software, which at present performs the functions of the central controller and messaging controller, would have to be radically extended to provide the features of the messaging controller alone and a new central controller module would have to be developed.
- A ftp controller and a news controller would also have to be developed.

Chapter 5

Inbound Multimedia Messaging

5.1 Introduction

After defining the architecture and services of a multimedia fax MIME gateway and setting up a Remote Printer server at the Multimedia Communications Research Laboratory, it was felt that the concepts developed so far result into an actual implementation. On the other hand, there were quite a few constraints to do so in the limited time frame of the thesis period. Some of these constraints were

- (i) The entire gateway implementation as a whole was too large a project to be accomplished by the author alone.
- (ii) As the multimedia gateway would also require the functionality of the Remote Printing Experiment, it is a requirement that it be implemented on a UNIX platform. Moreover, Binary File Transfer is a relatively new standard, so applications for UNIX

platforms are not yet available nor are there any public domain implementations available.

(iii) The project would entail modification of the BFT implementation on the client as well as the server so as to accommodate the use of the BFT header fields suggested in the proposed multimedia gateway architecture.

(iv) Two BFT implementations with the accompanying hardware, were made available by commercial vendors on a loan basis. Both of these were for the DOS platform and the application software source code was not available. Going into a collaboration agreement could incur bureaucratic delays.

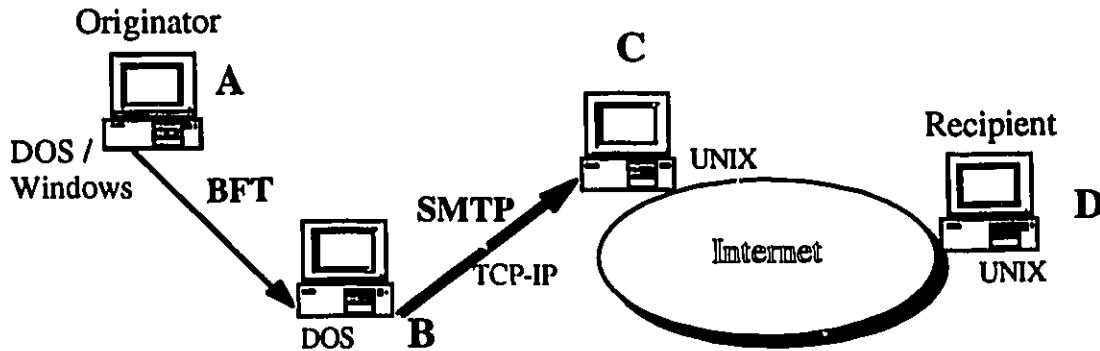
So instead a compromise was made, where we implemented a basic prototype for inbound multimedia messaging. The prototype is far from the proposed architecture, but rather a proof of concept for the overall goal of inbound multimedia messaging using BFT. This section gives a description of the prototype, which involved an implementation of a basic Simple Mail Transfer Protocol (SMTP) client for the DOS platform.

5.2 The demo (setup description)

The setup for the inbound multimedia messaging demonstration is depicted in Fig. 5. The aim here was to deliver a multimedia message (MIME compliant) from a multimedia fax machine which does not have Internet connectivity, to a user on the Internet and thus demonstrate inbound multimedia faxing (messaging). Binary File Transfer is used to transport a MIME message to the multimedia gateway, which in turn would deliver it to the recipient on the Internet.

The flow of the MIME message, across the various hosts from originator to the recipient along with the software entities involved on each host is illustrated in Fig. 5.2. A description of the events that occur on each host during the transfer of the

multimedia message follows. For our experiment the originator is on host A, while the recipient is on host D and both of them have MIME compliant user agents.



Inbound Multimedia Messaging

Fig.5.1
Setup for the experiment

Host A

Host A, running the DOS operating system is our multimedia fax machine (PC with BFT support). Here the originator creates a multimedia message with a MIME compliant user agent and passes it on to the BFT software (WinfaxPro 4.0 supplied by Delrina Corporation). The user on A uses WinfaxPro to send a MIME message as a BFT transmission to the gateway machine Host B.

Host B

Host B with DOS platform, has another BFT implementation in the form of HydraWorks from Kalman Technologies Inc.. HydraWorks is a communications management system for fax, voice and data. The HydraWorks package provides support for BFT exchange and also an option to write application specific programs in a special language (media script) to configure the BFT software to carry out predefined functions. A small program was developed to configure HydraWork for the required task. This program performs the task of polling for a BFT/Fax call. When it

receives a BFT transmission it first unpacks the BFT transmission and writes the data to a predefined file. After successful receipt of a BFT file, it invokes the 'SMTPmailer' and passes on the received BFT filename as an argument. The SMTPmailer [Appendix B] is a program developed to have a minimal implementation of a SMTP client over a DOS platform. The program is based on the popdump client provided by

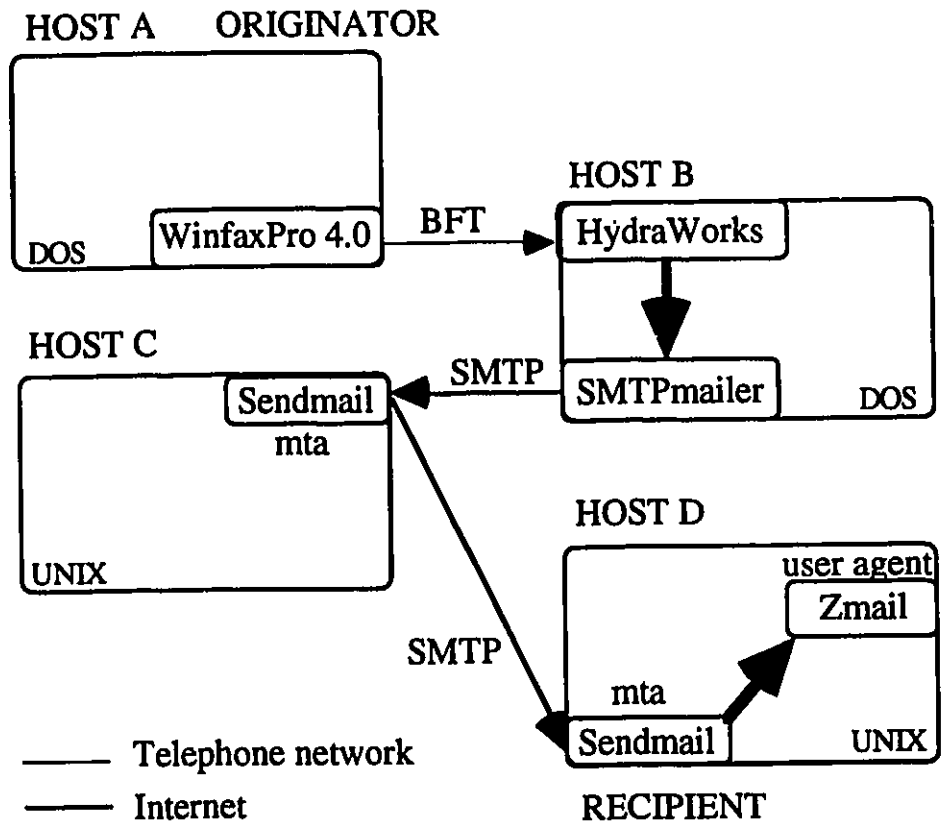


Fig.5.2
Inbound multimedia messaging

Waterloo University's Watter package. The Watter package provides TCP-IP based implementations for the DOS platform. SMTPmailer accepts a file name as an argument, parses the named file to get the originator (From : header) and recipient (To:) address for the message. Next it uses this information to open a SMTP session

with a predefined MTA on a host on the Internet and hands over the file (message) for further relay.

In our case the SMTPmailer program parses the BFT file, which is actually a MIME message and extracts the originator address and the recipient address. Then it opens up a TCP-IP connection with Sendmail on host C (multimedia.genie.uottawa.ca) and initiates a SMTP session on behalf of the originator. During this session it passes on the MIME message to host C to be relayed on the Internet to the actual recipient on Host D.

Host C

This is the host multimedia, which is the remote printer gateway under UNIX. The MTA Sendmail merely acts as a relay agent for messages from host C. In our case it accepts the multimedia message from the SMTPmailer and delivers it to Sendmail on host D through a SMTP session. The reason for introducing Host C into the picture was that SMTPmailer is not a fullfledged SMTP implementation and it performs the function of only relaying the MIME message to a real Message Transfer Agent in the form of Sendmail which handles the actual routing and mailing function.

Host D

Host D is a UNIX machine with a MIME capable user agent (ZMail). The MTA here receives the MIME message from host C and delivers it to the recipient mailbox. The recipient would then be able to view the multimedia message with a MIME capable user agent (Zmail). The recipient on host D could then optionally send a reply to host A using the tpc.int gateway.

Thus through this exercise, inbound multimedia messaging is achieved or in other words a multimedia fax is sent to the Internet.

5.3 Summary

With the above described prototype demonstration, we have proven the feasibility of the gateway and its services proposed in chapter 4. Also we had a chance to interwork various communications protocols and software packages in a successful manner.

Chapter 6

Summary and Future Extensions

6.1 Summary

In this thesis we have studied three recent developments for the Internet and the facsimile worlds. Based upon this research, we have designed an application level gateway between the Internet and the public switched telephone network. Also we have defined various services for the multimedia fax user as well as the Internet user. The exercise of setup and configuration of a remote printer server for the Ottawa/Hull region, the first one of it's kind in Canada, helped to provide a hands on experience of the underlying infrastructure. The experiment for inbound multimedia messaging using Binary File Transfer demonstrates the feasibility of the concept and further lays the foundation for future complete implementation of the multimedia fax-MIME gateway.

MIME with its uniform mechanism for representation and encoding scheme for various media, is a major step in the multimedia standardization process for multimedia e-mail. BFT will prove to be an appropriate vehicle for a smooth transition in bringing multimedia messaging to the home or office. The fax-MIME gateway paves a way for enhanced communications between two large communications environments, the Internet and the facsimile network and over and above facilitates bi-directional multimedia messaging.

6.2 Future extensions

The multimedia fax Internet gateway provides a smooth transition into the multimedia communications era and interconnects two communications networks. As an extension to this effort, more Internet services/resources can be made available to standalone personal computers with BFT support. With the use of OCR (Optical Character Recognition) software or hardware, fax messages from traditional fax machines could also be delivered to an Internet user or routed through another Remote Printer server to a fax machine. Also rather than interconnecting just two networks (i.e., the facsimile network and Internet), an application level gateway encompassing other heterogeneous networks (e.g., X.25 networks) can be devised for further interoperability.

Appendix

A.1- Remote Printing fax transmission

FACSIMILE TRANSMISSION

Please deliver this facsimile to:

JOE SMITH

From: doej@dolphin.qld.ts.au
Date: Tue, 05 Jul 1994 13:52:20 GMT
Subject: Reminder for tomorrow's meeting

Message-Id: <199407051352.AA32538@multimedia.genie.uottawa.ca>
Apparently-To: <remote-printer.Joe_Smith@2.8.8.6.4.6.5.3.1.6.1.tpc.int>

.....
PUBLIC SERVICE ANNOUNCEMENT

THINK GLOBALLY.



ACT LOCALLY.

Hi Joe,

I hope you are having a nice time in Ottawa. I am sending you these notes with reference to your letter dated

.....all the best

-John Doe

A.2- Global Coverage area of the Remote Printing Experiment

From: tpc-admin@dbc.mtview.ca.us
To: "Sanjiv P. Patel" <sanjiv@pixie.genie.uottawa.ca>
Subject: Re: send list (success)
Comments: generated by mailback.tcl - Enabled Mail (EM) environment for UNIX
Mime-Version: 1.0
Content-Type: text/plain; charset=us-ascii
Content-Id: <3840.768148731.1@dbc.mtview.ca.us>
Status: RO

Australia (+61)
 Sydney (+61-2)
 Wollongong (+61-42)
 Canberra (+61-62)
Canada and the United States (+1)
 +1-301
 +1-313
 +1-317
 Battle Ground
 Brookston
 Buck Creek
 Clarks Hill
 Lafayette/West Lafayette (Purdue University)
 Mulberry
 Otterbein
 Romney
 West Point
 +1-408
 Aptos
 Ben Lomond
 Boulder Creek
 Campbell
 Felton
 Los Gatos
 San Jose 1
 San Jose 2
 San Jose 3
 Santa Cruz 1
 Santa Cruz 2
 Saratoga
 Sunnyvale
 +1-410

+1-412
Carnegie Mellon University
Pittsburgh

+1-415
Belvedere
La Honda
Los Altos
Mountain View
Pacifica
Palo Alto
Redwood City
San Carlos-Belmont
San Francisco 1
San Francisco 2
San Francisco 3
Sausalito
South San Francisco-San Bruno
Woodside

+1-508
Acton
Andover
Beverly
Billerica
Concord
Danvers
Dover
Framingham
Littleton
Lowell
Maynard
Medfield
Natick
North Reading
Peabody
Salem
Topsfield
Westford
Wilmington

+1-510
Antioch
Clayton
Concord 1
Danville
East Bay 1
East Bay 2
East Bay 3
East Bay 4
Fremont-Newark 1
Fremont-Newark 2

Fremont-Newark 3
Hayward
Lafayette
Martinez
Moraga
Orinda
Pittsburg
Pittsburg West
Richmond
Walnut Creek
+1-608
University of Wisconsin, Madison (+1-608-26)
+1-613
Almonte
Alymer
Bourget
Buckingham
Carlton Place
Carp
Casselman
Chelsea
Clarence Creek
Constance Bay
Crysler
Cumberland
Embrun
Gatineau
Gloucester
Jockvale
Kanata Stittsville
Kemptville
Low
Luskville
Manotick
Merrickville
Metcalf
Navan
North Gower
Orleans
Osgoode
Ottawa Hull
Pakenham
Perkins
Plantagenet
Quyong
Richmond
Rockland
Russel
St. Pierre de Wakefield

Thurso
Wakefield
+1-617
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Bedford
Belmont
Boston Central
Brighton
Brookline
Burlington
Cambridge
Charlestown
Chelsea
Dedham
Dorchester
East Boston
Everett
Hingham
Hull
Hyde Park
Lexington
Lincoln
Lynn
Lynnfield
Malden
Marblehead
Medford
Melrose
Milton
Needham
Newton
Norwood
Quincy
Randolph
Reading
Revere
Roxbury
Saugus
Somerville
South Boston
Stoneham
Wakefield
Walpole
Waltham
Watertown
Wayland
Wellesley
West Roxbury
Weymouth

Winchester
Winthrop
Woburn
O'Reilly & Associates, Inc., MA
Cambridge Computer Associates, Inc., MA
+1-703
Alexandria-Arlington
Braddock
Department of Defense
Dulles-Metro
Engleside
Fairfax-Vienna
Falls Church-McLean
Herndon
Lorton
Pay Per View
Repair Service
+1-718
Cambridge Computer Associates, Inc., NY
Queens, Brooklyn, and the Bronx, NY
Tinkelman Enterprises, Inc.
+1-800
+1-810
+1-813
Tampa
+1-818
Azusa
Covina 1
Covina 2
San Gabriel Canyon
+1-909
Chino
Claremont
Diamond Bar
Ontario
Pomona
Upland 1
Upland 2
+1-919
Chapel and Carrboro
Mebane
Hillsborough
Pittsboro
RTP
RDU Airport
Manhattan and Staten Island, NY (+1-212)
New York City (misc), NY (+1-917)
Temporary +1-301-981 (+1-301)
Washington, DC (+1-202)

all areas except the US Congress
Denmark (+45)
 Copenhagen (+45-3)
 Greater Copenhagen (+45-4)
Germany (+49)
 Universitaet Dortmund (+49-231-755)
 FernUniversitaet Hagen (+49-233-1987)
Japan (+81)
 Kawasaki (+81-44)
 Fujisawa (+81-466)
 Tokyo (+81-3)
Korea (+82)
 Seoul (+82-2)
 Taejon (+82-42)
New Zealand (+64)
Portugal (+351)
 Lisbon (+351-1)
United Kingdom (+44)
 University of Oxford (+44-8652)
 Loughborough University (+44-509-265393)

A.3- Flexfax: Modem Configuration

```
# $Header: /usr/people/sam/fax/etc/RCS/config.rockwell,v 1.18 93/09/27 11:12:01 sam
Rel $
#
# Configuration for a Rockwell-based Class 2 modem.
# Boca M1440E          firmware V1.270 or newer
# Dallas Fax          (throw it away!)
# Hayes Optima 24+Fax96  firmware TR00-J260-001 XXX or newer
# SupraFAX v.32bis    firmware V1.200-C or newer
# Twincom 144/DF      firmware revision V1.200 or newer
# (and others)
#
# This configuration file sets up the modem to run at 19.2 for
# sending and for receiving. XON/XOFF flow control is used on
# the tty port. RTS/CTS can be used by switching the flow control
# setup, but beware of modems that do not support it during
# facsimile operations. Also beware that the adaptive-answer
# facility, when supported, is usually unreliable.
#
# CONFIG: CLASS2: ROCKWELL*
#
CountryCode:          1          # CANADA/USA
LongDistancePrefix:  1
InternationalPrefix: 011
AreaCode:             613
DialStringRules:     etc/dialrules
FAXNumber:            +1.613.564.9940
ServerTracing:       1
SessionTracing:      11
RecvFileMode:        0600
LogFileMode:         0600      # private log files
DeviceMode:          0600      # device is accessible only to uucp/fax
SpeakerVolume:       off
RingsBeforeAnswer:   1          # answer on first ring
#
ModemType:           Class2     # use class 2 interface
ModemRate:           19200      # fax send is locked at 19.2
ModemResetCmds:      &F2       # what you want for a Supra
# NB: enable this only if you're setup for dialins
#GettyArgs:          "-h %l dx_%s" # locked at receive rate (for SGI)
#GettyArgs:          "std.%s -"   # locked at receive rate (for SunOS)
ModemFlowControl:    xonxoff
ModemFlowControlCmd: &K4        # software flow control
```

ModemSetupDTRCmd:	&D3	# DTR off causes modem to reset
ModemSetupDCDCmd:	&C1	# DCD follows carrier
ModemSetupAACmd:	+FAA=1	# enable in current class
#		
ModemSendFillOrder:	LSB2MSB	# as expected
ModemRecvFillOrder:	MSB2LSB	# opposite of what makes sense
#		
ModemDialCmd:	+FAA=0;DT%s	# T for tone dialing, @ for silence

A.4- Coverage area of the MCRLab Remote Printer Server

!
!"Sanjiv Patel" (+1-613-564-9911) <sanjiv@shamin.genie.uottawa.ca>
!"Grant Henderson" (+1-613-564-9247) <grant@shamin.genie.uottawa.ca>
!
! Geographical Site
!
Ottawa Hull-1!613!224 225 226 228 23* 241 244 245 247 274 350 521 523 526
Ottawa Hull-2!613!580 593 594 596 598 72* 730 731 733 734 736 737
Ottawa Hull-3!613!738 739 741 744 745 746 747 748 749 750 755 761 762 763
Ottawa Hull-4!613!765 769 780 781 782 783
Ottawa Hull-5!613!785 786 787 789 794 797 798 820 828 829 844 941 943
Ottawa Hull-6!613!944 945 946 947 951 952 954 957 990 991 992 993
Ottawa Hull-7!613!995 996 998 529 556 558 599 660 742 788
Ottawa Hull-8!613!791 799 860 560 562 563 564 565 566 567 569
Ottawa Hull-9!819!243 246 561 568 595 770 771 772 773 775 776 777 778 779
Ottawa Hull-9!613!243 246 561 568 595 770 771 772 773 775 776 777 778 779
Ottawa Hull-10!819!790 920 953 956 994 997
Ottawa Hull-10!613!790 920 953 956 994 997
Carlton Place!613!253 257
Almonte!613!256
Kemptville!613!258
Merrickville!613!269
Buckingham!819!281 986
Buckingham!613!281 986
Low!819!422
Low!613!422
Embrun!613!443
Russel!613!445
Rockland!613!446
Luskville!819!455
Luskville!613!455
Wakefield!819!456 459
Wakefield!613!456 459
St. Pierre de Wakefield!819!457
St. Pierre de Wakefield!613!457
Quyong!819!458
Quyong!613!458
Bourget!613!487
Clarence Creek!613!488
North Gower!613!489

Kanata Stittsville!613!590 591 592 599 831 836
Pakenham!613!624
Gatineau!819!643 663 669
Gatineau!613!643 663 669
Perkins!819!671
Perkins!613!671
Plantagenet!613!673
Alymer!819!682 684 685
Alymer!613!682 684 685
Manotick!613!692
Casselman!613!764
Metcalf!613!821
Gloucester!613!822
Jockvale!613!823 825
Orleans!613!824 830 834 837 841
Osgoode!613!826
Chelsea!819!827
Chelsea!613!827
Constance Bay!613!832
Cumberland!613!833
Navan!613!835
Richmond!613!838
Carp!613!839
Thurso!819!985
Thurso!613!985
Crysler!613!987

A.5- Ottawa Server Announcement

Received: from dbc.mtview.ca.us (ppp.dbc.mtview.ca.us [192.103.140.254]) by nico.aarnet.edu.au (8.6.5.Beta11/8.6.4) with ESMTP id CAA10187 for <tpc-rp@aarnet.edu.au>; Fri, 4 Feb 1994 02:38:33 +1100

Received: from localhost by dbc.mtview.ca.us (5.65/3.1.090690) id AA23612; Thu, 3 Feb 94 07:37:12 -0800

To: tpc-rp@aarnet.edu.au

From: Arlington Hewes <tpcadmin@dbc.mtview.ca.us>

Subject: Ottawa, CA (+1-613) now online

Reply-To: tpc-rp@aarnet.edu.au

Mime-Version: 1.0

Content-Type: text/plain; charset="us-ascii"

Content-Id: <23603.760289822.1@dbc.mtview.ca.us>

Date: Thu, 03 Feb 1994 07:37:03 -0800

Message-Id: <23606.760289823@dbc.mtview.ca.us>

Sender: mrose@dbc.mtview.ca.us

Status: RO

Hi. The University of Ottawa is now running a cell providing access to these localities in +1-613

Almonte, Alymer, Bourget, Buckingham, Carlton Place, Carp, Casselman, Chelsea, Clarence Creek, Constance Bay, Crysler, Cumberland, Embrun, Gatineau, Gloucester, Jockvale, Kanata Stittsville, Kemptville, Low, Luskville, Manotick, Merrickville, Metcalfe, Navan, North Gower, Orleans, Osgoode, Ottawa/Hull, Perkins, Plantagenet, Quyon, Richmond, Rockland, Russel, St. Pierre de Wakefield, Thurso, Wakefield

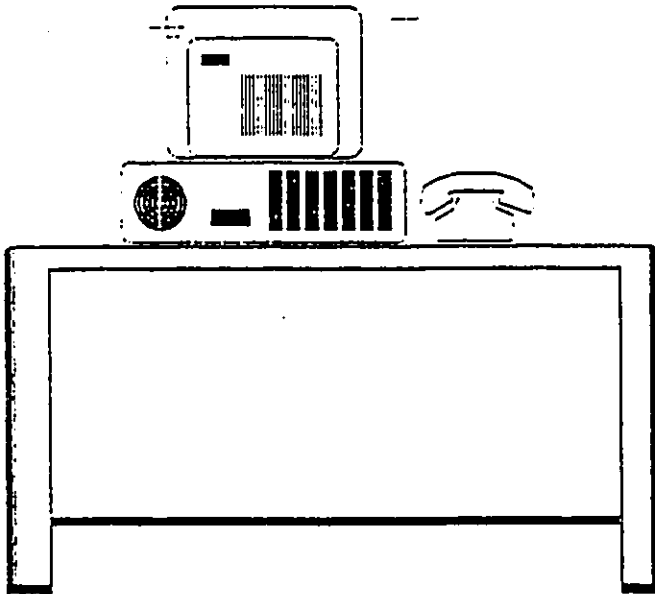
Great!

/mtr

A.6- First Remote Printer server in Canada



13-294 Albert St, Ottawa K1P 6E6 Tel: (613) 567-2000 Fax: (613) 567-4730



From the desk of...
Bill St. Arnaud

Voice: +1 613 567-2000
FAX: +1 613 567-4730
E-mail: bstarn@ccs.carleton.ca

To: Grant Henderson Total Pages 2
Fax No: 564-7681

It has been a couple of months see I have sent out my last broadcast on new and exciting developments in "Future FAX."

As most of you have already heard, the boards of VISION 2000 and CANARIE, have agreed in principle to merge the two organizations. I myself, have decided to pursue other alternatives, and have accepted the position of Director of Ontario Region for NSTN. NSTN is Canada's largest commercial Internet provider, currently based in Nova Scotia and now expanding westwards.

We plan to do some exciting things with FAX and Internet at NSTN. I will keep you posted as to developments. However, I plan to still remain active in the Future FAX with VISION 2000 in its new guise of CANARIE. So please feel free to contact me, if you require any assistance or information with regards to our technology focus.

My new number will be V: +1 613 831-0888
F: + 613 831-1836

e-mail: starnaudGrantox.nstn.ns.ca

I have enjoyed working with the many people who are members of VISION 2000 and those others in the industry who are on this list. Future FAX will be an exciting technology and I look forward to continuing to being a part of its exciting future development.



TPC.INT wins prestigious EMMSy award

EMMS (Electronic Mail and Messaging System) recently awarded its prestigious EMMSy Service Event of the Year to the Internet TPC.INT e-mail to FAX service.

This service, also known as Remote Printing, was started by Carl Malamud of the Internet Multicasting Service and Marshall Rose of Dover Beach Consulting. It allows Internet e-mail users to send e-mail to FAX machines at a variety of participating TPC.INT sites scattered around the world. There is no additional cost or premium to use this service. Large parts of the United States, Japan, England, Germany, Portugal, Denmark, Australia, New Zealand and other countries are currently providing coverage for this service. Other countries and domains are being added regularly. For more information please send an e-mail tpc-faq@town.hall.org.

Ottawa University is Canada's first TPC.INT site

Ottawa University's Multimedia Research Laboratory has setup Canada's first TPC.INT domain to serve the greater Ottawa-Hull area. The system developed by Sanjiv Patel and Grant Henderson is the first phase of a project to develop a multimedia FAX-Internet gateway using the new FAX BFT (Binary File Transfer) technology.

With this service, anybody who has Internet access can send e-mail messages to any FAX machine in the Ottawa-Hull area.

BYTE magazine feature article on FAX BFT

In the March issue of BYTE magazine there is an excellent article on the FAX standard for Binary File Transfer and Microsoft's implementation of that standard called "Microsoft At Work".

VISION 2000 to merge with CANARIE

The boards of VISION 2000 and CANARIE have agreed in principle to merge the two organizations. CANARIE is the Canadian Network for the Advancement of Research Industry and Education and are the people responsible for heading up the development of the "Information Highway" in Canada. Both organizations share many of the same goals and objectives and it was felt that there would be many advantages to merge and coordinate the activities of the two organizations.

B- SMTPmailer

```
/* -----  
-----  
**           SMTP.C  
**  
** Purpose:   sends a mail message to an smtp relay host  
**  
** Author:    Sanjiv Patel - Multimedia Communications Research Lab.  
**  
** History:   April 94 - Code based on Erick Engelke's popdump program  
**            distributed with the University of Waterloo's  
**            WATTCP stack for IBM PC's.  
**  
** -----  
----- */  
  
#include <stdio.h>  
#include <string.h>  
#include <dos.h>  
#include <tcp.h>  
  
#define FALSE    0  
#define TRUE     1  
  
#define DEBUG     FALSE    /* Flag to turn on/off debugging */  
#define SMTP_PORT 25      /* SMTP port definition for a TCP connec. */  
#define BUFFER_SIZE 513  /* Size of the buffer used for sender and */  
                          /* recipient addresses */  
  
#define FILENAME 128  
#define EXIT_SUCCESS 1  
#define EXIT_FAILURE 2  
  
void smtp(char *bftfile)  
{  
    tcp_Socket *s;          /* Pointer to the socket to be used for mail relay */  
    tcp_Socket smtpsock;   /* Declaration of a tcp-ip socket for smtp comm. */  
    int status;           /* Variable to store status of the socket connec. */  
    int i;                /* Counter for internal loops */  
    char *g, *h;          /* Pointers for sender and recipient names */  
    char sender[100], recipient[100];  
                          /* Arrays to store sender & recipient addresses */  
    FILE *f;              /* Pointer to the bftfile that is to be mailed */  
    char buffer[BUFFER_SIZE]; /* Array to store lines parsed in the bftfile */  
}
```

```

int found_to = 0, found_from = 0; /* Flags to mark end of parsing */
longword host; /* variable to store the host address */

#ifdef DEBUG
    printf ("Inside smtp\n");
#endif

/* Resolves the gateway machine name and uses the ip address to
   open a tcp-ip connection on that machine at port 25 */

s = &smtpsock;
host = resolve("multimedia.genie.uottawa.ca");
if (!tcp_open( s, 0, host, SMTP_PORT, NULL )) else {
    puts("Sorry, unable to connect to that machine right now!");
    goto quit;
}

#ifdef DEBUG
    printf("waiting...\r");
#endif

/* Opens up an SMTP session with the gateway machine and
   declares it's hostname */

sock_mode( s, TCP_MODE_ASCII );
sock_wait_established(s, sock_delay, NULL, &status);
sock_wait_input( s, sock_delay, NULL, &status );
sock_gets( s, buffer, sizeof( buffer ));
puts(buffer);
if ( *buffer != '2' ) else {
    puts("Sorry, host not accepting SMTP session initialization");
    goto quit;
}

/* Extracts the sender address from the bft file by looking
   for the From: string in each line */

if (( f=fopen( bftfile, "r" )) != NULL )
{
    while ((fgets (buffer, FILENAME, f) != NULL) && !found_from)
    {
        if (( h = strstr(buffer,"From:")) != NULL)

```

```

    {
        found_from = 1;
        i=0; h+=6;
        while ( *h == ' ') h++;
        while ( *h != ' ' && *h != '\n')
            {
                sender[i++] = *h;
                h++;
            }
        sender[i] = '\0';
    } else {
        puts("Unable to get sender address from BFT file");
        goto fquit;
    }
} else {
    puts("Unable to open BFT file!");
    goto fquit;
}
fclose (f);

```

/ Sends the MAIL FROM: command with the sender address to the gateway MTA for relaying a mail message */*

```

sock_printf( s, "MAIL FROM:<%s>", sender);
sock_wait_input( s, sock_delay, NULL, &status );
sock_gets( s, buffer, sizeof( buffer ));
puts(buffer);
if ( *buffer != '2' ) else {
    puts("Sorry, host not accepting mail from this sender");
    goto quit;
}

```

/ Extracts the recipient address from the bft file by looking for the To: string in each line */*

```

if (( f=fopen( bftfile, "r")) != NULL )
{
    while ((fgets (buffer, FILENAME, f) != NULL) && !found_to)
    {
        if (( g = strstr(buffer,"To:")) != NULL)
        {
            found_to = 1;
            i=0; g+=4;
            while ( *g == ' ') g++;

```

```

        while ( *g != ' ' && *g != '\n')
            {
                recipient[i++] = *g;
                g++;
            }
        recipient[i] = '\0';
    } else {
        puts("Unable to get recipient address from BFT file");
        goto fquit;
    }
} else {
    puts("Unable to open BFT file!");
    goto fquit;
}
fclose (f);

```

/* Sends the RCPT TO: command with the recipient address to the gateway MTA for relaying the mail message */

```

sock_printf( s, "RCPT TO:<@multimedia.genie.uottawa.ca:%s>", recipient);
sock_wait_input( s, sock_delay, NULL, &status );
sock_gets( s, buffer, sizeof( buffer ));
puts(buffer);
if ( *buffer != '2' ) else {
    puts("Sorry, host not accepting mail for this recipient");
    goto quit;
}

```

/* Lets the MTA know that, what follows is the mail message */

```

sock_printf(s, "DATA");
sock_wait_input( s, sock_delay, NULL, &status );
sock_gets( s, buffer, sizeof( buffer ));
puts(buffer);
if ( *buffer != '3' ) else {
    puts("Sorry, host not accepting mail");
    goto quit;
}

```

/* Opens the bftfile and prints the whole file line by line onto the SMTP port which is relayed on to the actual recipient by the gateway MTA */

```

if (( f=fopen( bftfile, "r")) != NULL )
{
    while (fgets (buffer, FILENAME, f) != NULL)
    {
        buffer[strlen(buffer)-1]='\0' ;
        sock_printf(s, "%s", buffer);
    }
} else {
    puts("Unable to open BFT file!");
    goto fquit;
}
fclose(f);
sock_printf(s, ".\n");
sock_wait_input( s, sock_delay, NULL, &status );
sock_gets( s, buffer, sizeof( buffer ));
puts(buffer);
if ( *buffer != '2' ) else {
    puts("Sorry, host did not receive end of message properly");
    goto quit;
}

/* Closes the SMTP connection with the QUIT command */

sock_printf( s, "QUIT");
sock_wait_input( s, sock_delay, NULL, &status );
sock_gets( s, buffer, sizeof( buffer ));
puts(buffer);
if ( *buffer != '2' ) else {
    puts("Sorry, host did not close SMTP session properly");
    goto quit;
}

/* Close the socket and then quit when there are breaks
in SMTP communications */

quit:
    sock_puts(s,"QUIT");
    sock_close( s );
    sock_wait_closed( s, sock_delay, NULL, &status );

/* Close the file, close the socket and then quit,
when there are problems in file operations */

fquit:
    fclose (f);
    sock_puts(s,"QUIT");

```

```

sock_close( s );
sock_wait_closed( s, sock_delay, NULL, &status );
exit (EXIT_FAILURE);

/* Print the status of the socket errors */

sock_err:
switch (status) {
    case 1 : /* foreign host closed */
        break;
    case -1: /* timeout */
        printf("ERROR: %s\n", sockerr(s));
        break;
}
printf("\n");
}

int main(int argc, char **argv)
{
    if (argc < 2)
    {
        puts("usage: smtp filename");      /* error message for wrong usage */
        exit(EXIT_FAILURE);
    }

    sock_init();                          /* Call for initialization of a socket */
    smtp(argv[1]);                         /* Call to the smtp function with bft file as argument */
    exit(EXIT_SUCCESS);
}

```

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