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MAIL TRANSFER PROTOCOL

PREFACE

This is a first draft of this protocol and comments are very definitely requested.

INTRODUCTION

The objective of Mail Transfer Protocol (MTP) is to transfer mail reliably and efficiently.

This paper assumes knowledge of the following protocols described in the ARPA Internet Protocol Handbook. The reader will note strong similarities to portions of the File Transfer Protocol; in part, this is due to the original ARPA Network implementation of computer mail as a feature of FTP.

The ARPANET Host-to-Host Protocol [Network Control Protocol] (NCP)

The Transmission Control Protocol (TCP)

The TELNET Protocol (TELNET)

The File Transfer Protocol (FTP)

DISCUSSION

In this section, the terminology and the MTP model are discussed. The terms defined in this section are only those that have special significance in MTP. Some of the terminology is very specific to the MTP model; some readers may wish to turn to the section on the MTP model while reviewing the terminology.

TERMINOLOGY

ASCII

The ASCII character set as defined in the ARPA Internet Protocol Handbook. In MTP, ASCII characters are defined to be the lower half of an eight-bit code set (i.e., the most significant bit is zero) and is called NVT-ASCII.

control connection

The TCP full-duplex communication path or two NCP simplex communication paths between a sender-MTP and a receiver-MTP for the exchange of commands, replies, and mail text. The control connection operates according to the TELNET Protocol.

data mode

The mail is transmitted over the control connection as a stream of octets. (In FTP terminology this is called stream mode.)

data structure

The internal structure of mail is considered to be a continuous sequence of data octets. (In FTP terminology this is called file-structure.)

data representation

The internal representation of all data (i.e., mail) is in NVT-ASCII.

host

A computer in the internetwork environment on which mailboxes reside.

MTP commands

A set of commands which comprise the control information flowing from the sender-MTP to the receiver-MTP.

mail

An ordered set of computer data of arbitrary length, which conforms to the standard set in RFC 733 (Standard for the Format of ARPA Network Text Messages).

mailbox

A character string (address) which identifies a user to whom mail is to be sent. Mailbox normally consists of the host and user specifications. The standard mailbox naming convention is defined to be "user@host". Additionally, the "container" in which mail is stored.

NVT

The Network Virtual Terminal as defined in the TELNET Protocol.

octet

Bytes in MTP are octets (8 bits). This is not necessarily the same byte size in which data is stored in a host.

reply

A reply is an acknowledgment (positive or negative) sent from receiver to sender via the control connection in response to a MTP command. The general form of a reply is a completion code (including error codes) followed by a text string. The codes are for use by programs and the text is usually intended for human users.

receiver-MTP process

A process which transfers mail in cooperation with a sender-MTP process. It "listens" on its port/socket L for a connection from a sender-MTP and establishes a control connection using the TELNET Protocol. It receives MTP commands from the sender-MTP, sends replies, and governs the transfer of mail.

sender-MTP process

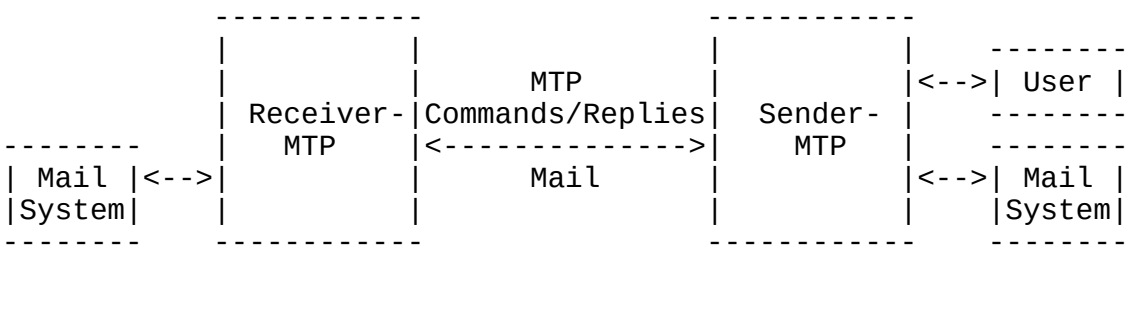
A process which transfers mail in cooperation with a receiver-MTP process. A local language may be used in the user interface command/reply dialogue. The sender-MTP initiates the control connection from its port/socket U to the receiver-MTP process. It initiates MTP commands, receives replies, and governs the transfer of mail.

user

A human being (or a process on behalf of a human being) wishing to obtain mail transfer service. In addition, a recipient of computer mail.

THE MTP MODEL

With the above definitions in mind, the following model (shown in Figure 1) may be diagrammed for an MTP service.



Model for MTP Use

Figure 1

In the model described in Figure 1, the sender-MTP initiates the TCP/NCP control connection which follows the TELNET Protocol. At the initiation of the user, standard MTP commands are generated by the sender-MTP and transmitted to the receiver-MTP via the control connection. Standard replies are sent from the receiver-MTP to the sender-MTP over the control connection in response to the commands. In addition, mail is sent over the control connection.

MAIL TRANSFER FUNCTIONS

The control connection is used for the transfer of commands which describe the functions to be performed, the replies to commands, as well as the actual transfer of mail. Mail is transferred only via the control connection.

The communication channel from the sender-MTP to the receiver-MTP is established by a TCP/NCP control connection from the sender to a standard receiver port/socket. The sender-MTP is responsible for sending MTP commands, interpreting the replies received, and sending the mail; the receiver-MTP interprets commands, sends replies, and receives the mail.

MAIL REPRESENTATION AND STORAGE

Mail is transferred from a storage device in the sending host to a storage device in the receiving host. It may be necessary to perform certain transformations on the mail because data storage representations in the two systems are different. For example, NVT-ASCII has different data storage representations in different systems. PDP-10's generally store NVT-ASCII as five 7-bit ASCII characters, left-justified in a 36-bit word. 360's store NVT-ASCII as four 8-bit EBCDIC codes in a 32-bit word. Multics stores NVT-ASCII as four 9-bit characters in a 36-bit word.

For the sake of simplicity, all data must be represented in MTP as NVT-ASCII. This means that characters must be converted into the standard NVT-ASCII representation when transmitting text, regardless of whether the sending and receiving hosts are dissimilar. The sender converts the data from its internal character representation to the standard 8-bit NVT-ASCII representation (see the TELNET specification). The receiver converts the data from the standard form to its own internal form. In accordance with this standard, the <CRLF> sequence should be used to denote the end of a line of text.

The mail in MTP has no internal structure and is considered to be a continuous sequence of data octets.

ERROR RECOVERY AND RESTART

There is no provision for detecting bits lost or scrambled in data transfer; this level of error control is handled by the TCP/NCP. In addition, there is no restart procedure provided to protect senders from gross system failures (including failures of a host, an MTP-process, or the underlying network).

MTP COMMANDS

COMMAND SEMANTICS

The MTP commands define the mail transfer or the mail system function requested by the user. The syntax of mailboxes must conform to receiver site conventions (with standard defaults applicable). In response to an MTP transfer command, the mail shall always be transferred over the control connection.

The Mail Transfer Protocol follows the specifications of the TELNET Protocol for all communications over the control

connection. Although the language used for TELNET communication can be a negotiated option, the "TELNET language" and the corresponding "TELNET end of line code" are required to be NVT-ASCII and <CRLF> respectively. No other specifications of the TELNET Protocol will be cited.

MTP commands are NVT-ASCII strings terminated by <CRLF>. The command codes themselves are alphabetic characters terminated by the character <SP> (space) if parameters follow and <CRLF> otherwise.

The MTP commands are discussed below. In the description of a few of the commands in this section the possible replies are given explicitly. MTP replies are discussed in the next section.

MAIL (MAIL)

This command allows a sender-MTP to send mail over the control connection. The argument field contains a sender and optional path sequence. If the path sequence is present, it consists of an optional list of hosts and a destination mailbox. When the list of hosts is present, it is source routing information and indicates that the mail must be forwarded to the first host on the list. Following this command line the receiver treats all subsequent characters as mail text from the sender. The mail text is terminated by the character sequence "CRLF.CRLF".

As mail is forwarded along the path sequence, each forwarding host must remove itself from the list. When mail reaches its ultimate destination (the path sequence has only a (possibly empty) destination mailbox), the receiver inserts it into the destination mailbox in accordance with its host mail conventions. If the second argument field is blank (one or more spaces) or empty (<CRLF>), the mail is destined for a printer or other designated place for site general delivery mail. The mail may be marked as sent from the sender as specified by the first argument field.

MAIL RECIPIENT SCHEME QUESTION (MRSQ)

This MTP command is used to select a scheme for the transmission of mail to several users at the same host. The schemes are to list the recipients first, or to send the mail first.

MAIL RECIPIENT (MRCP)

This command is used to identify the individual recipients of the mail in the transmission of mail for multiple users at one host.

HELP (HELP)

This command causes the receiver to send helpful information regarding its implementation status over the control connection to the receiver. The command may take an argument (e.g., any command name) and return more specific information as a response. The reply is type 211 or 214.

QUIT (QUIT)

This command specifies that the receiver must close the control connection.

NOOP (NOOP)

This command does not affect any parameters or previously entered commands. It specifies no action other than that the receiver send an OK reply.

COMMAND SYNTAX

The commands (and their functions and semantics) are TELNET NVT-ASCII strings transmitted over the control connection. The functions and semantics of commands are described in the section on MTP Commands. The reply sequences are discussed in the section on Sequencing of Commands and Replies. Scenarios illustrating the use of commands are provided in the section on Typical MTP Scenarios. The command syntax is specified in this section.

The commands begin with a command code followed by an argument field. The command codes are four alphabetic characters. Upper and lower case alphabetic characters are to be treated identically. Thus any of the following may represent the mail command:

MAIL Mail mail MaIl mAIl

This also applies to any symbols representing parameter values, such as R or r for RECIPIENT first. The command codes and the argument fields are separated by one or more spaces.

The argument field consists of a variable length character string ending with the character sequence <CRLF>. It should be noted that the receiver is to take no action until the end of line code is received.

The syntax is specified below in NVT-ASCII. All characters in the argument field are ASCII characters. Square brackets denote an optional argument field. If the option is not taken, the appropriate default is implied.

The following are the MTP commands:

MAIL <SP> FROM:<sender> [<SP> TO:<path>] <CRLF>

MRSQ [<SP> <scheme>] <CRLF>

MRCP <SP> TO:<path> <CRLF>

HELP [<SP> <string>] <CRLF>

QUIT <CRLF>

NOOP <CRLF>

The syntax of the above argument fields (using BNF notation where applicable) is given below. The "..." notation indicates that a field may be repeated one or more times.

<sender> ::= "<" <mailbox> ">"

<path> ::= "<" ["@" <host> "," ...] <mailbox> ">"

<scheme> ::= "R" | "T" | "?"

<string> ::= <char> | <char><string>

<mailbox> ::= <user> "@" <host>

<host> ::= <string>

<user> ::= <string>

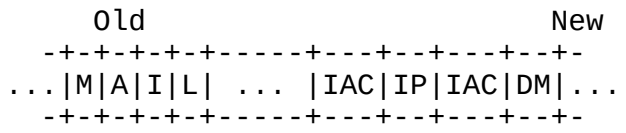
<char> ::= any of the 128 ASCII characters except <CR> and <LF>

CONTROL FUNCTIONS

Most time-sharing systems provide mechanisms to allow a terminal user to regain control of a "runaway" process. When used locally, such systems have access to all user-supplied signals, whether these are normal characters or special "out of band" signals. When terminals are connected to the system through the network, the system does not necessarily have access to all user signals; the network's flow control mechanisms may cause such signals to be buffered elsewhere, for example in the user's host.

To counter this problem, the TELNET "Synch" mechanism is used. A Synch signal consists of a TCP Urgent or an NCP Interrupt notification, coupled with the TELNET command DATA MARK (DM). This notification, which is not subject to the flow control pertaining to the TELNET connection, is used to invoke special handling of the data stream by the process which receives it. In this mode the data stream is immediately scanned for a TELNET Interrupt Process (IP) command. (The rationale for the use of the TELNET IP command is to allow an existing server TELNET module to sit "under" the MTP. If this code were directly implemented in the MTP the IP command would be unnecessary.) The TELNET command DM is the synchronizing mark in the data stream which indicates that any special signal has already occurred and the recipient can return to normal processing of the data stream. For a more complete understanding of this mechanism, see the TELNET Protocol Specification in the Internet Protocol Handbook.

The effect of this mechanism is to to discard all characters (up to the DM) between the sender of the Synch and its recipeint. Thus, all characters in the control connection are ignored until the TELNET command DM is received. The full sequence is illustrated below. Each vertical bar (|) represents the boundary between data octets; IAC refers to the TELNET command code Interpret As Command.



MTP REPLIES

Replies to Mail Transfer Protocol commands are devised to ensure the synchronization of requests and actions in the process of mail transfer, and to guarantee that the sender-MTP always knows the state of the receiver. Every command must generate at least one reply, although there may be more than one. In the latter case, the multiple replies must be easily distinguished. Additionally, some commands must occur sequentially, such as MRSQ T->MAIL->MRCP or MRSQ R->MRCP->MAIL. Replies to these sequences show the existence of an intermediate state if all preceding commands have been successful. A failure at any point in the sequence necessitates the repetition of the entire sequence from the beginning.

The details of the command-reply sequence are made explicit in the section on State Diagrams.

An MTP reply consists of a three digit number (transmitted as three alphanumeric characters) followed by some text. The number is intended for use by automata to determine what state to enter next; the text is meant for the human user. It is intended that the three digits contain enough encoded information that the sender-MTP will not need to examine the text and may either discard it or pass it on to the user, as appropriate. In particular, the text may be receiver-dependent, so there are likely to be varying texts for each reply code.

Formally, a reply is defined to be the sequence: a three-digit code, space <SP>, one line of text (where the maximum line length is 65), and a terminal <CRLF>. Occasionally the text is longer than a single line; in these cases the complete text must be bracketed so the sender-MTP knows when it can stop reading the reply. This requires a special first line format to indicate a multiple line reply, and another on the last line to so designate it. Both lines will contain the appropriate reply code which indicates the transaction state.

Thus the format for multi-line replies is that the first line will begin with the exact required reply code, followed immediately by a Hyphen, "-" (also known as minus), followed by text. The last line will begin with the same code, followed immediately by space <SP>, optionally some text, and <CRLF>.

For example:

```
123-First line
Second line
  234 A line beginning with numbers
123 The last line
```

The sender-MTP then simply needs to search for the second occurrence of the same reply code followed by <SP> (space> at the beginning of a line, and ignore all intermediary lines. If an intermediary line begins with a three-digit number, the receiver must pad the front to avoid confusion.

This scheme allows standard system routines to be used for reply information, with "artificial" first and last lines tacked on. In the rare cases where these routines are able to generate three digits and a space at the beginning of any line, the beginning of each text line should be offset by some neutral text, like space.

This scheme assumes that multi-line replies may not be nested. In general, reply nesting will not occur except for random system messages (also called spontaneous replies) which may interrupt another reply. System messages (i.e., those not processed by the receiver-MTP) will NOT carry reply codes and may occur anywhere in the command-reply sequence. They may be ignored by the sender-MTP as they are only information for the human user.

The three digits of the reply each have a special significance. This is intended to allow a range of very simple to very sophisticated response by the sender-MTP. The first digit denotes whether the response is good, bad or incomplete. (Referring to the state diagram) an unsophisticated sender-MTP will be able to determine its next action (proceed as planned, redo, retrench, etc.) by simply examining this first digit. A sender-MTP that wants to know approximately what kind of error occurred (e.g., mail system error, command syntax error) may examine the second digit, reserving the third digit for the finest gradation of information.

There are five values for the first digit of the reply code:

1yz Positive Preliminary reply

The requested action is being initiated; expect another reply before proceeding with a new command. (The sender-MTP sending another command before the completion reply would be

in violation of protocol. However, receiver-MTP processes should queue any commands that arrive while a preceding command is in progress.)

2yz Positive Completion reply

The requested action has been successfully completed. A new request may be initiated.

3yz Positive Intermediate reply

The command has been accepted, but the requested action is being held in abeyance, pending receipt of further information. The sender-MTP should send another command specifying this information. This reply is used in command sequence groups.

4yz Transient Negative Completion reply

The command was not accepted and the requested action did not occur. However, the error condition is temporary and the action may be requested again. The sender should return to the beginning of the command sequence (if any). It is difficult to assign a meaning to "transient" when two different sites (receiver- and sender- MTPs) must agree on the interpretation. Each reply in this category might have a different time value, but the sender-MTP is encouraged to try again. A rule of thumb to determine if a reply fits into the 4yz or the 5yz category (see below) is that replies are 4yz if they can be repeated without any change in command form or in properties of the sender or receiver. (E.g., the command is repeated identically; the receiver does not put up a new implementation).

5yz Permanent Negative Completion reply

The command was not accepted and the requested action did not occur. The sender-MTP is discouraged from repeating the exact request (in the same sequence). Even some "permanent" error conditions can be corrected, so the human user may want to direct the sender-MTP to reinitiate the command sequence by direct action at some point in the future (e.g., after the spelling has been changed, or the user has altered his/her directory status.)

The second digit encodes responses in specific categories:

x0z Syntax -- These replies refer to syntax errors, syntactically correct commands that don't fit any functional category, and unimplemented or superfluous commands.

x1z Information -- These are replies to requests for information, such as status or help.

x2z Connections -- These are replies referring to the control connection.

x3z Unspecified as yet.

x4z Unspecified as yet.

x5z Mail system -- These replies indicate the status of the receiver mail system vis-a-vis the requested transfer or other mail system action.

The third digit gives a finer gradation of meaning in each category specified by the second digit. The list of replies below will illustrate this. Each reply text is recommended rather than mandatory, and may even change according to the command with which it is associated. On the other hand, the reply codes must strictly follow the specifications in this section. Receiver implementations should not invent new codes for slightly different situations from the ones described here, but rather adapt codes already defined.

A command such as NOOP whose successful execution does not offer the sender-MTP any new information will return a 200 reply. The response is 502 when the command requests an unimplemented non-site-specific action. A refinement of that is the 504 reply for a command that IS implemented, but that requests an unimplemented parameter.

REPLY CODES BY FUNCTION GROUPS

200 Command okay
500 Syntax error, command unrecognized
[This may include errors such as command line too long]
501 Syntax error in parameters or arguments
502 Command not implemented
503 Bad sequence of commands

211 System status, or system help reply
214 Help message
[Information on how to use the receiver or the meaning of a particular non-standard command; this reply is useful only to the human user]
215 <scheme> is the preferred scheme

120 <host> Service ready in nnn minutes
220 <host> Service ready for new user
221 <host> Service closing control connection
421 <host> Service not available, closing control connection
[This may be a reply to any command if the service knows it must shut down]

151 User not local; will forward to <user>@<host>
152 User unknown; mail will be forwarded by the operator
250 Requested mail action okay, completed
450 Requested mail action not taken: mailbox unavailable
[E.g., mailbox busy]
550 Requested action not taken: mailbox unavailable
[E.g., mailbox not found, no access]
451 Requested action aborted: local error in processing
452 Requested action not taken: insufficient system storage space
552 Requested mail action aborted: exceeded storage allocation
[For current mailbox location]
553 Requested action not taken: mailbox name not allowed
354 Start mail input; end with <CR><LF>.<CR><LF>

NUMERIC ORDER LIST OF REPLY CODES

120 <host> Service ready in nnn minutes
151 User not local; will forward to <user>@<host>
152 User unknown; mail will be forwarded by the operator
200 Command okay
211 System status, or system help reply
214 Help message
[Information on how to use the receiver or the meaning of a particular non-standard command; this reply is useful only to the human user]
215 <scheme> is the preferred scheme
220 <host> Service ready for new user
221 <host> Service closing control connection
250 Requested mail action okay, completed
354 Start mail input; end with <CR><LF>.<CR><LF>

421 <host> Service not available, closing control connection
[This may be a reply to any command if the service knows it must shut down]
450 Requested mail action not taken: mailbox unavailable
[E.g., mailbox busy]
451 Requested action aborted: local error in processing
452 Requested action not taken: insufficient system storage space
500 Syntax error, command unrecognized
[This may include errors such as command line too long]
501 Syntax error in parameters or arguments
502 Command not implemented
503 Bad sequence of commands
550 Requested action not taken: mailbox unavailable
[E.g., mailbox not found, no access]
552 Requested mail action aborted: exceeded storage allocation
[For current mailbox location]
553 Requested action not taken: mailbox name not allowed

DISCUSSION OF MAIL TRANSFER

The basic command for transmitting mail is MAIL. This command causes the transmitted data to be entered into the recipient's mailbox.

MAIL <SP> "FROM:" <sender> [<SP> "TO:" <path>] <CRLF>

<sender> is a mailbox and <path> is a source routing list of hosts and destination mailbox. If accepted, it returns a 354 reply and considers all succeeding lines to be the message text. It is terminated by a line containing only a period, upon which a 250 completion reply is returned. Various errors are possible.

There are two possible preliminary replies that a receiver may use to indicate that it is accepting mail for a user whose mailbox is not at that receiver.

151 User not local; will forward to <user>@<host>

This reply indicates that the receiver knows the user's mailbox is on another host and will take responsibility for forwarding the mail to that host. For example, at BBN (or ISI) there are several hosts. Each has a list of many of the users on the hosts. Each host can accept mail for any user on their list and forward it to the correct host.

152 User Unknown; mail will be forwarded by the operator

This reply indicates that the host does not recognize the user name, but that it will accept the mail and have the operator attempt to deliver it. This is useful if the user name is misspelled, but may be a disservice if the mail is really undeliverable.

If forwarding by the operator is unacceptable or if the user would prefer to send the mail directly to the recipient's actual host, the dialogue may be terminated upon receipt of one of these preliminary responses.

There are two MTP commands which allow the text of a message to be mailed to several recipients simultaneously; such message transmission is far more efficient than the practice of sending the text again and again for each additional recipient at a site. In one, all recipients are specified first, and then the text is sent. In the other, the order is reversed and the text is sent first, followed by the recipients. Both schemes are necessary because neither by itself is optimal for all systems, as will be explained later. To select a particular scheme, the MRSQ command is used; to specify recipients after a scheme is chosen, MRCP commands are given; and to furnish text, the MAIL command is used.

SCHEME SELECTION: MRSQ

MRSQ is the means by which a sender-MTP can test for MRSQ/MRCP implementation, select a particular scheme, reset its state, and even do some rudimentary negotiation. Its format is as follows:

MRSQ [<SP> <scheme>] <CRLF>

<scheme> is a single character. The following are defined:
R Recipients first. If this is not implemented, T must be.
T Text first. If this is not implemented, R must be.
? Request for preference. This must always be implemented.

No argument means a "selection" of none of the schemes (the default).

Possible replies are:
200 OK, we'll use specified scheme
215 <scheme> This is the scheme I prefer
501 I understand MRSQ but can't use that scheme
5xx Command unrecognized or unimplemented

There are three aspects of MRSQ. The first is that an MRSQ with no argument must always return a 200 reply and restore the default state of having no scheme selected. Any other reply implies that MRSQ and hence MRCP are not understood or cannot be performed correctly.

The second is that the use of "?" as a <scheme> asks the MTP receiver to return a 215 reply in which the receiver specifies a "preferred" scheme. The format of this reply is simple:

215 <SP> <scheme> [<SP> <arbitrary text>] <CRLF>

Any other reply (e.g., 4xx or 5xx) implies that MRSQ and MRCP are not implemented, because "?" must always be implemented if MRSQ is.

The third important point about MRSQ is that it always has the side effect of resetting all schemes to their initial state. This reset must be done no matter what the reply will be -- 200, 215, or 501. The actions necessary for a reset will be explained when discussing how each scheme actually works.

MESSAGE TEXT SPECIFICATION: MAIL

Regardless of which scheme (if any) has been selected, a MAIL command with a non-null "TO" argument will behave exactly as before; the MRSQ/MRCP commands have no effect on it. However, a normal MAIL command does have the same side effect as MRSQ; it "resets" the current scheme to its initial state.

It is only when the "TO" argument is null (e.g., MAIL FROM:<X@Y> <CRLF>) that the particular scheme chosen is important. Rather than producing an error (as most receivers currently do), the receiver will accept message text for this "null" specification. What it does with it depends on which scheme is in effect, and will be described in the section on Scheme Mechanics.

RECIPIENT SPECIFICATION: MRCP

In order to specify recipient names (i.e., mailboxes) and receive some acknowledgment (or refusal) for each name, the following command is used:

MRCP <SP> TO:<path> <CRLF>

Reply for no scheme:
503 No scheme specified yet; use MRSQ
Replies for scheme T are identical to those for MAIL.
Replies for scheme R (recipients first):
200 OK, name stored
452 Recipient table full, this name not stored
553 Recipient name rejected
4xx Temporary error, try this name again later
5xx Permanent error, report to sender

Note that use of this command is an error if no scheme has been selected yet; an MRSQ <scheme> must have been given if MRCP is to be used.

SCHEME MECHANICS: MRSQ R (RECIPIENTS-FIRST)

In the recipients-first scheme, MRCP is used to specify names which the MTP receiver stores in a list or table. Normally the reply for each MRCP will be either a 200 for acceptance or a 4xx/5xx rejection code. All 5xx codes are permanent rejections (e.g., user not known) which should be reported to the human user, whereas 4xx codes in general connote some temporary error that may be rectified later. None of the 4xx/5xx replies impinge on previous or succeeding MRCP commands, except for 452 which indicates that no further MRCPs will succeed unless a message is sent to the already stored recipients or a reset is done.

Sending message text to stored recipients is done by giving a MAIL command with no "TO" argument; that is, just MAIL <SP> <sender> <CRLF>. Transmission of the message text is exactly the same as for normal MAIL. However, a positive acknowledgment at the end of transmission means the message has been sent to ALL recipients that were remembered with MRCP, and a failure code means that it should be considered to have failed for ALL of these specified recipients. This applies regardless of the actual error code. Regardless of what the reply signifies, all stored recipient names are flushed and forgotten -- in other words, things are reset to their initial state. This purging of the recipient name list must also be done as the reset side effect of any use of MRSQ.

A 452 reply to an MRCP can be handled by using MAIL to specify the message for currently stored recipients, and then sending more MRCPs and another MAIL, as many times as necessary. For example, if a receiver only had room for 10 names this would result in a 50-recipient message being sent 5 times, to 10 different recipients each time.

If a sender attempts to specify message text (MAIL with no "TO" argument) before any successful MRCPs have been given, this should be treated exactly as a "normal" MAIL with a null recipient would be; some receivers return an error, such as "550 Null recipient".

See the example in Appendix A for a mail transfer using MRSQ R.

SCHEME MECHANICS: MRSQ T (TEXT-FIRST)

In the text-first scheme, MAIL with no "TO" argument is used to specify message text, which the receiver stores away. Succeeding MRCPs are then treated as if they were MAIL commands, except that none of the text transfer manipulations are done; the stored message text is sent to the specified recipient, and a reply code is returned identical to that which an actual MAIL would invoke. (Note that ANY 2xx code indicates success.)

The stored message text is not forgotten until the next MAIL or MRSQ, which will either replace it with new text or flush it entirely. Any use of MRSQ will reset this scheme by flushing stored text, as will any use of MAIL with a non-null argument.

If an MRCP is seen before any message text has been stored, the sender in effect is trying to send a null message; some receivers might allow this, others would return an error code.

See the example in Appendix B for a mail transfer using MRSQ T.

WHY TWO SCHEMES ANYWAY?

Because neither by itself is optimal for all systems. MRSQ R allows more of a "bulk" mailing because everything is saved up and then mailed simultaneously. This is very useful for systems such as ITS where the MTP-receiver does not itself write mail directly, but hands it on to a central mailer demon of great power. The more information (e.g., recipients) associated with a single "hand-off", the more efficiently mail can be delivered.

By contrast, MRSQ T is geared to receiver-MTPs which want to deliver mail directly, in one-by-one incremental fashion. For each given recipient this scheme returns an individual success/failure reply code which may depend on variable mail system factors such as exceeding disk allocation, mailbox access conflicts, and so forth. If these receiver-MTPs tried to emulate MRSQ Rs bulk mailing, they would have to ensure that a success reply to the MAIL indeed meant that it had been delivered to ALL recipients specified -- not just some.

NOTES:

* Because these commands are not required in the minimum implementation of MTP, one must be prepared to deal with sites which don't recognize either MRSQ or MRCP. "MRSQ" and "MRSQ ?" are explicitly designed as tests to see whether either scheme is implemented. MRCP is not designed as a test, and a failure return of the "unimplemented" variety could be confused with "No scheme selected yet", or even with "Recipient unknown".

* There is no way to indicate in a positive response to "MRSQ ?" that the preferred "scheme" for a receiver is that of the default state; i.e., none of the multi-recipient schemes. The rationale is that in this case, it would be pointless to implement MRSQ/MRCP at all, and the response would therefore be negative.

* One reason that the use of MAIL is restricted to null "TO" arguments with this multi-recipient extension is the ambiguity that would result if a non-null "TO" argument were allowed. For example, if MRSQ R was in effect and some MRCPs had been given, and a MAIL FROM:<X@Y> TO:<FOO><CRLF> was done, there would be no way to distinguish a failure reply for mailbox "FOO" from a global failure for all recipients specified. A similar situation exists for MRSQ T; it would not be clear whether the text was stored and the mailbox failed, or vice versa, or both.

* "Resets" are done by all MRSQs and "normal" MAILs to avoid confusion and overly complicated implementation. The MRSQ command implies a change or uncertainty of status, and the MAIL command would otherwise have to use some independent mechanisms to avoid clobbering the data bases (e.g., message text storage area) used by the T/R schemes. However, once a scheme is selected, it remains "in effect" just as an FTP "TYPE A" remains selected. The recommended way for doing a reset, without changing the current selection, is with "MRSQ ?". Remember that "MRSQ" alone reverts to the no-scheme state.

* It is permissible to intersperse other MTP commands among the MRSQ/MRCP/MAIL sequences.

DECLARATIVE SPECIFICATIONS

MINIMUM IMPLEMENTATION

In order to make MTP workable without needless error messages, the following minimum implementation is required for all receivers:

```
COMMANDS -- QUIT
            MAIL
            NOOP
```

In terms of FTP, the values of the transfer parameters must be:

```
TYPE -- ASCII
MODE -- STREAM
STRU -- FILE-STRUCTURE
```

All hosts must use the above values for mail transfer.

CONNECTIONS

The receiver-MTP shall "listen" on Port L. The sender-MTP shall initiate the TCP/NCP control connection. The control connection consists of a full-duplex connection under TCP; it is two simplex connections under NCP. Receiver- and sender- MTPs should follow the conventions of the TELNET Protocol as specified in the ARPA Internet Protocol Handbook. Receivers are under no obligation to provide for editing of command lines and may specify that it be done in the sender host. The control connection shall be closed by the receiver at the sender’s request after all transfers and replies are completed.

SEQUENCING OF COMMANDS AND REPLIES

The communication between the sender and receiver is intended to be an alternating dialogue. As such, the sender issues an MTP command and the receiver responds with a prompt primary reply. The sender should wait for this initial primary success or failure response before sending further commands.

Certain commands require a second reply for which the sender should also wait. These replies may, for example, report on the progress or completion of mail transfer. They are secondary replies to mail transfer commands.

One important group of informational replies is the connection

greetings. Under normal circumstances, a receiver will send a 220 reply, "awaiting input", when the connection is completed. The sender should wait for this greeting message before sending any commands. If the receiver is unable to accept input right away, it should send a 120 "expected delay" reply immediately and a 220 reply when ready. The sender will then know not to hang up if there is a delay.

Note: all the greeting type replies have the official name of the server host as the first word following the reply code.

The table below lists alternative success and failure replies for each command. These must be strictly adhered to; a receiver may substitute text in the replies, but the meaning and action implied by the code numbers and by the specific command reply sequence cannot be altered.

COMMAND-REPLY SEQUENCES

In this section, the command-reply sequence is presented. Each command is listed with its possible replies; command groups are listed together. Preliminary replies are listed first (with their succeeding replies indented under them), then positive and negative completion, and finally intermediary replies with the remaining commands from the sequence following. The 421 reply (service not available, closing control connection) may be given at any point if the MTP-receiver knows it must shut down. This listing forms the basis for the state diagrams, which will be presented separately.

```
CONNECTION ESTABLISHMENT
   120
      220
   220
   421
MAIL ACTION COMMANDS
   MAIL
      151, 152
         354
            250
            451, 552
      354
         250
         451, 552
      450, 550, 452, 553
      500, 501, 502, 421
```

```
            MRSQ
               200, 215
               500, 501, 502, 421
            MRCP
               151, 152
                  200
               200
               450, 550, 452, 553
               500, 501, 502, 503, 421
            QUIT
               221
         INFORMATIONAL COMMANDS
            HELP
               211, 214
               500, 501, 502, 421
         MISCELLANEOUS COMMANDS
            NOOP
               200
               500 421
```

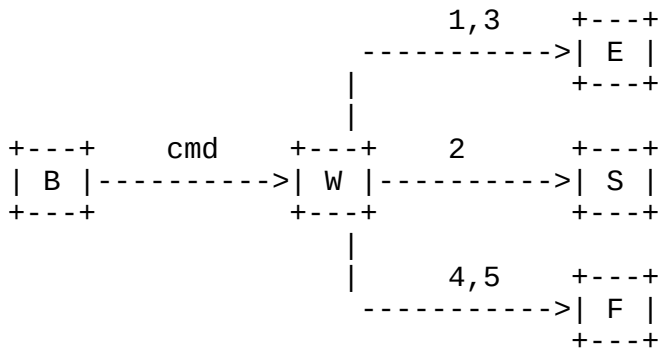
STATE DIAGRAMS

Here we present state diagrams for a very simple minded MTP implementation. Only the first digit of the reply codes is used. There is one state diagram for each group of MTP commands.

The command groupings were determined by constructing a model for each command and then collecting together the commands with structurally identical models.

For each command there are three possible outcomes: "success" (S), "failure" (F), and "error" (E). In the state diagrams below we use the symbol B for "begin", and the symbol W for "wait for reply".

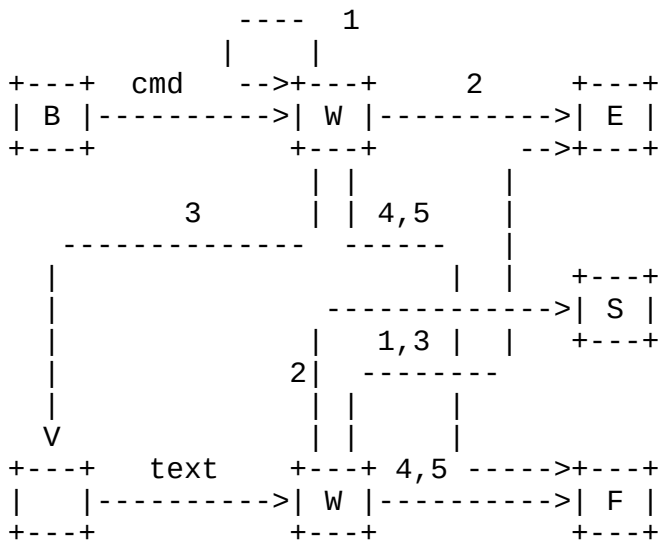
We first present the diagram that represents the most MTP commands:



This diagram models the commands:

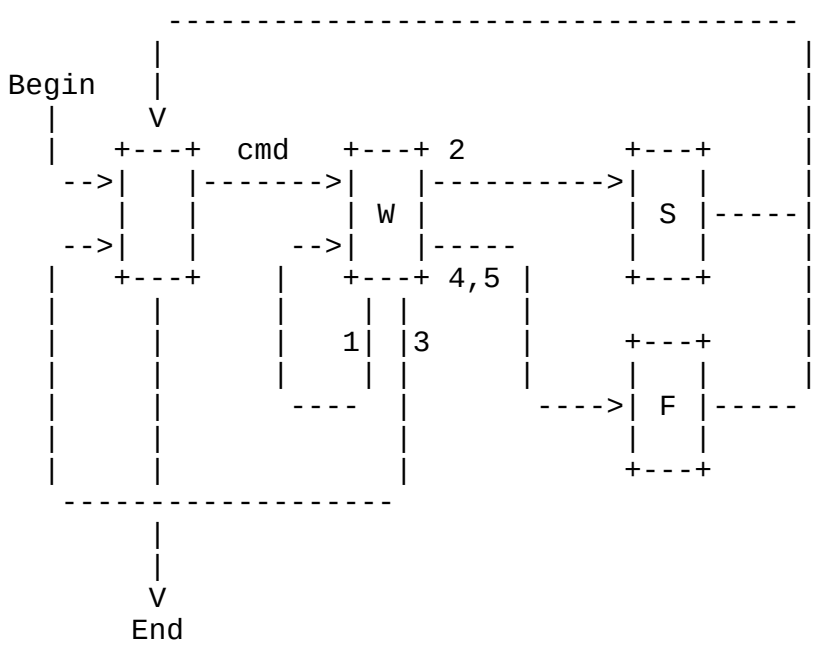
HELP, MRCP, MRSQ, NOOP, QUIT.

A more complex diagram models the MAIL command:



Note that the "text" here is a series of lines sent from the sender to the receiver with no response expected until the last line is sent. (The last line must consist of only a single period.)

Finally we present a generalized diagram that could be used to model the command and reply interchange:



CONNECTION ESTABLISHMENT

The MTP control connection is established via TCP/NCP between the receiver process port/socket L and the sender process port/socket U. This protocol is assigned the service port/socket 57 (71 octal), that is L=57.

APPENDIX A

Example of MRSQ R (Recipients-first)

This is an example of how MRSQ R is used. First the sender must establish that the receiver in fact implements MRSQ.

```
S: MRSQ <CRLF>
R: 200 OK, no scheme selected
```

An MRSQ with a null argument always returns a 200 if implemented, selecting the default "scheme", i.e., none of them. If MRSQ were not implemented, a code of 4xx or 5xx would be returned.

```
S: MRSQ R <CRLF>
R: 200 OK, using that scheme
```

All is well; now the recipients can be specified.

```
S: MRCP TO:<Foo@Y> <CRLF>
R: 200 OK

S: MRCP TO:<Raboof@Y> <CRLF>
R: 553  No such user here

S: MRCP TO:<bar@Y> <CRLF>
R: 200 OK

S: MRCP TO:<@Y,@X,fubar@Z> <CRLF>
R: 200 OK
```

Note that the failure of "Raboof" has no effect on the storage of mail for "Foo", "bar" or the mail to be forwarded to "fubar@Z" through host "X". Now the message text is furnished, by giving a MAIL command with no "TO" argument.

```
S: MAIL FROM:<waldo@A><CRLF>
R: 354 Type mail, ended by <CRLF>.<CRLF>
S: Blah blah blah blah....etc. etc. etc.
S: <CRLF>.<CRLF>
R: 250 Mail sent
```

The mail text has now been sent to "Foo" and "bar" as well as forwarded to "fubar@Z".

APPENDIX B

Example of MRSQ T (Text-first)

Using the same message as the previous example to establish that the receiver implements MRSQ.

```
S: MRSQ ? <CRLF>
R: 215 T Text first, please
```

MRSQ is indeed implemented, and the receiver says that it prefers "T", but that needn't stop the sender from trying something else.

```
S: MRSQ R <CRLF>
R: 501 Sorry, I really can't do that
```

It's possible that it could have understood "R" also, but in general it's best to use the "preferred" scheme, since the receiver knows which is most efficient for its particular site.

```
S: MRSQ T <CRLF>
R: 200 OK, using that scheme
```

Scheme "T" is now selected, and the message text is sent by giving a mail command with no "TO" argument.

```
S: MAIL FROM:<WALDO@A><CRLF>
R: 354 Type mail, ended by <CRLF>.<CRLF>
S: Blah blah blah blah....etc. etc. etc.
S: <CRLF>.<CRLF>
R: 250 Mail stored
```

Now recipients can be specified.

```
S: MRCP TO:<Foo@Y> <CRLF>
R: 250 Stored mail sent

S: MRCP TO:<Raboof@Y> <CRLF>
R: 553  No such user here

S: MRCP TO:<bar@Y> <CRLF>
R: 250 Stored mail sent

S: MRCP TO:<@Y,@X,fubar@Z> <CRLF>
R: 200 OK
```

The text has now been sent to "Foo" and "bar" at host "Y" and will be forwarded to "fubar@Z" through host "X", and still remains stored. A new message can be sent with another MAIL/MRCP ... sequence, but a careful sender would reset the state using the exchange below.

S: MRSQ ? <CRLF>
R: 215 T Text first, please

Which resets the state without altering the scheme in effect.