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19 JUN 75

Revised FTP Reply Codes

This document describes a revised set of reply codes for the File Transfer Protocol.

The aim of this revision is to satisfy the goal of using reply codes to enable the command issuing process to easily determine the outcome of each command. The user protocol interpreter should be able to determine the success or failure of a command by examining the first digit of the reply code.

An important change in the sequencing of commands and replies which may not be obvious in the following documents concerns the establishment of the data connection.

> In the previous FTP specifications when an actual transfer command (STOR, RETR, APPE, LIST, NLIST, MLFL) was issued the preliminary reply was sent after the data connection was established. This presented a problem for some user protocol interpreters which had difficulty monitoring two connections asynchronously.
>
> The current specification is that the preliminary reply to the actual transfer commands indicates that the file can be transferred and either the connection was previously established or an attempt is about to be made to establish the data connection.

This reply code revision is a modification of the protocol in described in RFC 542, that is to say that the protocol implementation associated with socket number 21 (decimal) is the protocol specified by the combination of RFC 542 and this RFC.

A note of thanks to those who contributed to this work: Ken Pogran, Mark Krilanovich, Wayne Hathway, and especially Nancy Neigus.

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19 JUN 75

A New Schema for FTP Reply Codes

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Replies to File Transfer Protocol commands were devised to ensure the synchronization of requests and actions in the process of file transfer, and to guarantee that the user process always knows the state of the Server. 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. In addition, some commands occur in sequential groups, such as USER, PASS and ACCT, or RNFR and RNTO. The replies 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.

8

Details of the command-reply sequence will be made explicit in a state diagram.

8a

An FTP 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 intended for the human user. It is intended that the three digits contain enough encoded information that the user-process (the User-PI described in RFC 542) 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 server-dependent, so there are likely to be varying texts for each reply code.

9

Formally, a reply is defined to contain the 3-digit code, followed by Space <SP>, followed by one line of text (where some maximum line length has been specified), and terminated by the TELNET end-of-line code. There will be cases, however, where the text is longer than a single line. In these cases the complete text must be bracketed so the User-process knows when it may stop reading the reply (i.e. stop processing input on the TELNET connection) and go do other things. This requires a special format on the first line to indicate that more than one line is coming, and another on the last line to designate it as the last. At least one of these must contain the appropriate reply code to

indicate the state of the transaction. To satisfy all factions it was decided that both the first and last line codes should be the same. 10

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 TELNET <eol>. 10a

For example:

```
123-First line
Second line
  234 A line beginning with numbers
123 The last line
```
10a1

The user-process 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 3-digit number, the Server must pad the front to avoid confusion. 10b

This scheme allows standard system routines to be used for reply information (such as for the STAT reply), 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. 10b1

This scheme assumes that multi-line replies may not be nested. We have found that, in general, nesting of replies will not occur, except for random system messages (called spontaneous replies in the previous FTP incarnations) which may interrupt another reply. Spontaneous replies are no longer defined; system messages (i.e. those not processed by the FTP server) will NOT carry reply codes and may occur anywhere in the command-reply sequence. They may be ignored by the User-process as they are only information for the human user. 10c

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 user-process. The first digit denotes whether the response is good, bad or incomplete. (Referring to the state diagram) an unsophisticated user-process will be able to determine its next action (proceed as planned, redo, retrench, etc.) by simply examining this first digit. A user-process that wants to know approximately what kind of error

occurred (e.g. file system error, command syntax error) may examine the second digit, reserving the third digit for the finest gradation of information (e.g. RNTO command without a preceding RNFR.) 11

There are four values for the first digit of the reply code: 11a

1yz Positive Preliminary reply 11b

The requested action is being initiated; expect another reply before proceeding with a new command. (The user-process sending another command before the completion reply would be in violation of protocol; but server-FTP processes should queue any commands that arrive while a preceeding command is in progress.) This type of reply can be used to indicate that the command was accepted and the user-process may now pay attention to the data connections, for implementations where simultaneous monitoring is difficult. 11b1

2yz Positive Completion reply 11c

The requested action has been successfully completed. A new request may be initiated. 11c1

3yz Positive Intermediate reply 11d

The command has been accepted, but the requested action is being held in abeyance, pending receipt of further information. The user should send another command specifying this information. This reply is used in command sequence groups. 11d1

4yz Transient Negative Completion reply 11e

The command was not accepted and the requested action did not take place, but the error condition is temporary and the action may be requested again. The user should return to the beginning of the command sequence, if any. It is difficult to assign a meaning to "transient", particularly when two distinct sites (Server and User-processes) have to agree on the interpretation. Each reply in the 4yz category might have a slightly different time value, but the intent is that the user-process is encouraged to try again. A rule of thumb in determining if a reply fits into the 4yz or the 5yz (Permanent Negative) category is that replies are 4yz if the commands can be repeated without any change in command form or in properties of the User or Server (e.g. the command is spelled the same with the same

arguments used; the user does not change his file access or user name; the server does not put up a new implementation.) 11e1

5yz Permanent Negative Completion reply 11f

The command was not accepted and the requested action did not take place. The User-process 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 his User-process 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 directory status.) 11f1

The following function groupings are encoded in the second digit: 11g

x0z Syntax - These replies refer to syntax errors, syntactically correct commands that don't fit any functional category, unimplemented or superfluous commands. 11g1

x1z Information - These are replies to requests for information, such as status or help. 11g2

x2z Connections - Replies referring to the TELNET and data connections. 11g3

x3z Authentication and accounting - Replies for the logon process and accounting procedures. 11g4

x4z Unspecified as yet 11g5

x5z File system - These replies indicate the status of the Server file system vis-a-vis the requested transfer or other file system action. 11g6

The third digit gives a finer gradation of meaning in each of the function categories, specified by the second digit. The list of replies below will illustrate this. Note that the text associated with each reply is suggestive, rather than mandatory, and may even change according to the command with which it is associated. The reply codes, on the other hand, should strictly follow the specifications in the last section; that is, Server implementations should not invent new codes for situations that are only slightly different from the ones described here, but rather should adapt codes already defined.

If additional codes are found to be necessary, the details should be submitted to the FTP committee, through Jon Postel. 11h

A command such as TYPE or ALLO whose successful execution does not offer the user-process any new information will cause a 200 reply to be returned. If the command is not implemented by a particular Server-FTP process because it has no relevance to that computer system, for example ALLO at a TENEX site, a Positive Completion reply is still desired so that the simple User-process knows it can proceed with its course of action. A 202 reply is used in this case with, for example, the reply text: "No storage allocation necessary." If, on the other hand, the command requests a non-site-specific action and is unimplemented, the response is 502. A refinement of that is the 504 reply for a command that IS implemented, but that requests an unimplemented parameter. 11h1

11i

200 Command okay 11i1

500 Syntax error, command unrecognized
[This may include errors such as command line too long.] 11i2

501 Syntax error in parameters or arguments 11i3

202 Command not imlemented, superfluous at this site. 11i4

502 Command not implemented 11i5

503 Bad sequence of commands 11i6

504 Command not implemented for that parameter 11i7

11j

110 Restart marker reply.
In this case the text is exact and not left to the particular implementation; it must read:
MARK yyyy = mmmm
where yyyy is User-process data stream marker, and mmmm is Server's equivalent marker. (note the spaces between the markers and "=".) 11j1

211 System status, or system help reply 11j2

212 Directory status 11j3

213 File status 11j4

214 Help message (on how to use the server or the meaning of a particular non-standard command. This reply is useful only to the human user.) 11j5

11k

120 Service ready in nnn minutes 11k1

220 Service ready for new user 11k2

221 Service closing TELNET connection (logged off if appropriate) 11k3

421 Service not available, closing TELNET connection.
[This may be a reply to any command if the service knows it must shut down.] 11k4

125 Data connection already open; transfer starting 11k5
225 Data connection open; no transfer in progress 11k6
425 Can't open data connection 11k7
226 Closing data connection; requested file action successful (for example, file transfer or file abort.) 11k8
426 Connection trouble, closed; transfer aborted. 11k9
227 Entering [passive, active] mode 11k10
11l
230 User logged on, proceed 11l1
530 Not logged in 11l2
331 User name okay, need password 11l3
332 Need account for login 11l4
532 Need account for storing files 11l5
11m
150 File status okay; about to open data connection. 11m1
250 Requested file action okay, completed. 11m2
350 Requested file action pending further information 11m3
450 Requested file action not taken: file unavailable (e.g. file not found, no access) 11m4
550 Requested action not taken: file unavailable (e.g. file busy) 11m5
451 Requested action aborted: local error in processing 11m6
452 Requested action not taken: insufficient storage space in system 11m7
552 Requested file action aborted: exceeded storage allocation (for current directory or dataset) 11m8
553 Requested action not taken: file name not allowed 11m9
354 Start mail input; end with <CR><LF>.<CR><LF> 11m10

Command-Reply Sequences 12

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 under them), then positive and negative completion, and finally intermediary replies with the remaining commands from the sequence following. This listing forms the basis for the state diagrams, which will be presented separately. 13

ICP 13a
120 13a1
220 13a1a
220 13a2
421 13a3

Logon 13b

USER 13b1
230 13b1a
530 13b1b
500, 501, 421 13b1c
331, 332 13b1d
PASS 13b2
230 13b2a
202 13b2b
530 13b2c
500, 501, 503, 421 13b2d
332 13b2e
ACCT 13b3
230 13b3a
202 13b3b
530 13b3c
500, 501, 503, 421 13b3d

Logoff 13c

QUIT 13c1
221 13c1a
500 13c1b
REIN 13c2
120 13c2a
220 13c2a1
220 13c2b
421 13c2c
500, 502 13c2d

Transfer parameters 13d

SOCK 13d1
200 13d1a
500, 501, 421, 530 13d1b
PASV 13d2
227 13d2a
500, 501, 502, 421, 530 13d2b
ACTV 13d3
227 13d3a
202 13d3b
500, 501, 421, 530 13d3c
BYTE, MODE, TYPE, STRU 13d4
200 13d4a
500, 501, 504, 421, 530 13d4b

File action commands 13e

ALLO 13e1
200 13e1a
202 13e1b
500, 501, 504, 421, 530 13e1c
REST 13e2
500, 501, 502, 421, 530 13e2a
350 13e2b
STOR 13e3
125, 150 13e3a
(110) 13e3a1
226, 250 13e3a2
425, 426, 451, 552 13e3a3
532, 450, 452, 553 13e3b
500, 501, 421, 530 13e3c
RETR 13e4
125, 150 13e4a
(110) 13e4a1
226, 250 13e4a2
425, 426, 451 13e4a3
450, 550 13e4b
500, 501, 421, 530 13e4c
LIST, NLST 13e5
125, 150 13e5a
226, 250 13e5a1
425, 426, 451 13e5a2
450 13e5b
500, 501, 502, 421, 530 13e5c
APPE 13e6
125, 150 13e6a
(110) 13e6a1
226, 250 13e6a2
425, 426, 451, 552 13e6a3
532, 450, 550, 452, 553 13e6b
500, 501, 502, 421, 530 13e6c
MLFL 13e7
125, 150 13e7a
226, 250 13e7a1
425, 426, 451, 552 13e7a2
532, 450, 550, 452, 553 13e7b
500, 501, 502, 421, 530 13e7c
RNFR 13e8
450, 550 13e8a
500, 501, 502, 421, 530 13e8b
350 13e8c
RNTO 13e9
250 13e9a
532, 553 13e9b

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         500, 501, 502, 503, 421, 530                          13e9c
      DELE                                                     13e10
         250                                                  13e10a
         450, 550                                             13e10b
         500, 501, 502, 421, 530                              13e10c
      ABOR                                                     13e11
         225, 226                                             13e11a
         500, 501, 502, 421                                   13e11b
      MAIL                                                     13e12
         354                                                  13e12a
            250                                              13e12a1
            451, 552                                         13e12a2
         450, 550, 452, 553                                   13e12b
         500, 501, 502, 421, 530                              13e12c

   Informational commands                                       13f

      STAT                                                     13f1
         211, 212, 213                                        13f1a
         450                                                  13f1b
         500, 501, 502, 421, 530                              13f1c
      HELP                                                     13f2
         211, 214                                             13f2a
         500, 501, 502, 421                                   13f2b

   Miscellaneous commands                                       13g

      SITE                                                     13g1
         200                                                  13g1a
         202                                                  13g1b
         500, 501, 530                                        13g1c
      NOOP                                                     13g2
         200                                                  13g2a
         500                                                  13g2b
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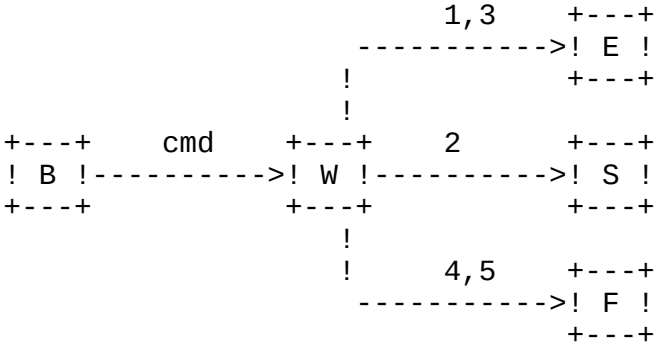
FTP State Diagrams 14

Here we present state diagrams for a very simple minded FTP implementation. Only the first digit of the reply codes is used. There is one state diagram for each group of FTP commands or command sequences. 15

The command groupings were determined by constructing a model for each command then collecting together the commands with structurally identical models. 16

For each command or command sequence 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". 17

We first present the diagram that represents the largest group of FTP commands: 18

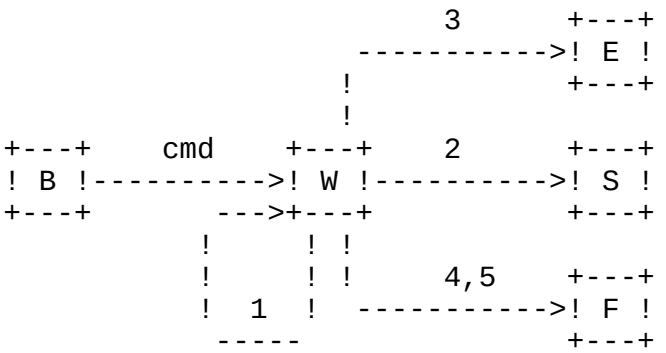


18a

This diagram models the commands: 18b

ABOR, ACTV, ALLO, BYTE, DELE, HELP, MODE, NOOP, PASV, QUIT, SITE, SOCK, STAT, STRU, TYPE. 18b1

The other large group of commands is represented by a very similar diagram: 19



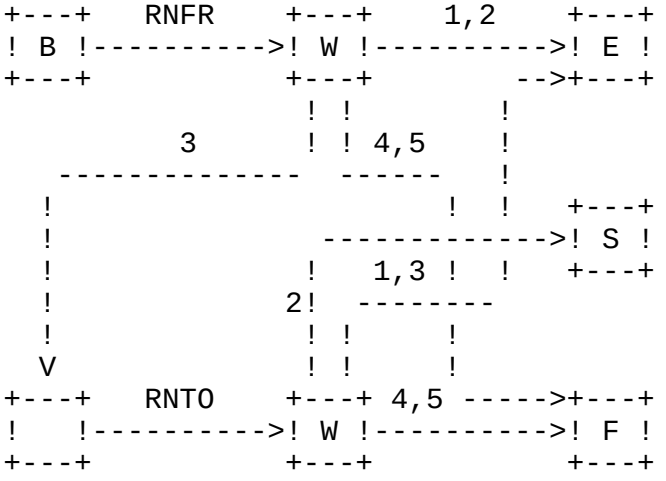
19a

This diagram models the commands: 19b

APPE, (ICP), LIST, MLFL, NLST, REIN, RETR, STOR. 19b1

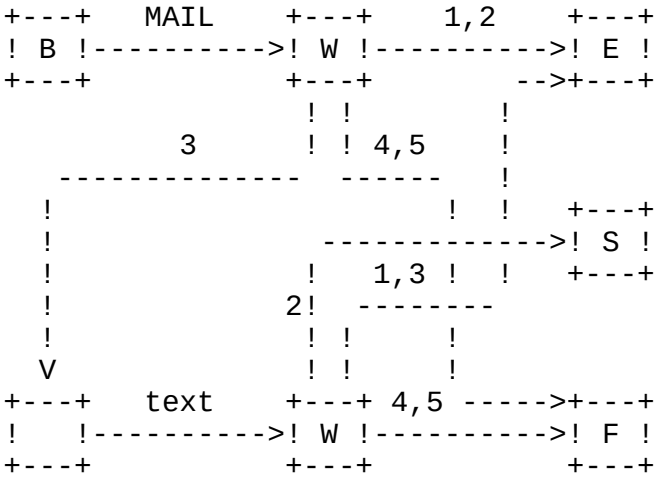
Note that this second model could also be used to represent the first group of commands, the only difference being that in the first group the 100 series replies are unexpected and therefore treated as error, while the second group expects (some may require) 100 series replies. 20

The remaining diagrams model command sequences, perhaps the simplest of these is the rename sequence: 21



21a

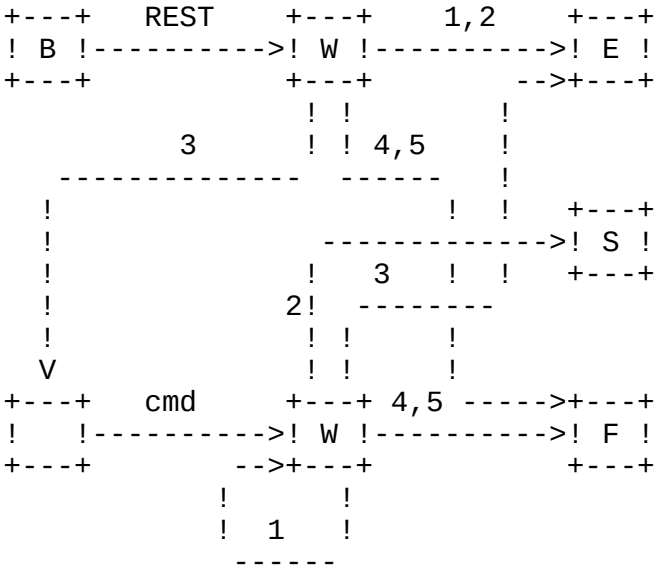
A very similar diagram models the Mail command: 22



22a

Note that the "text" here is a series of lines sent from the user to the server with no response expected until the last line is sent, recall that the last line must consist only of a single period. 22b

The next diagram is a simple model of the Restart command: 23

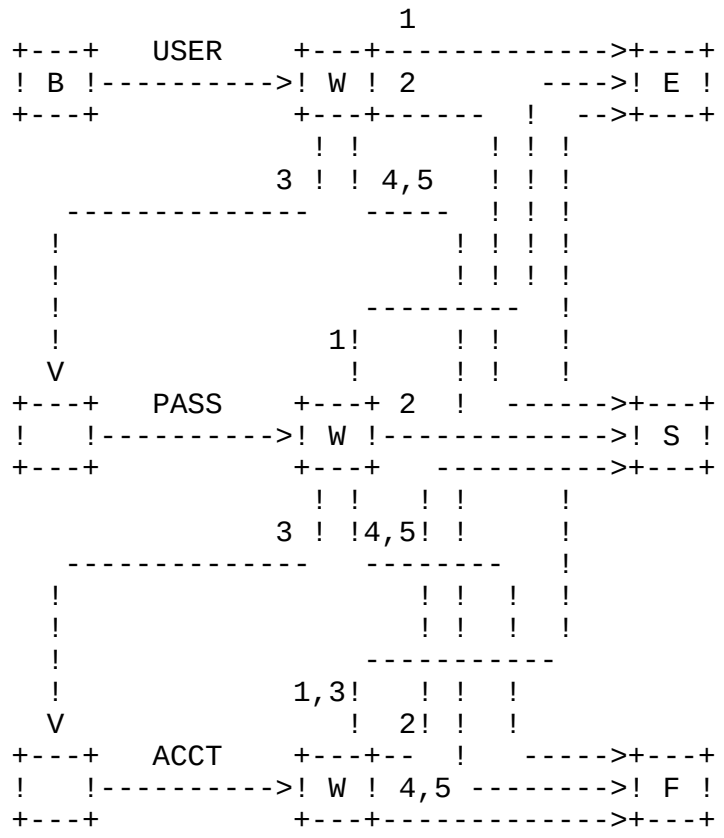


23a

Where "cmd" is APPE, STOR, RETR, or MLFL. 23a1

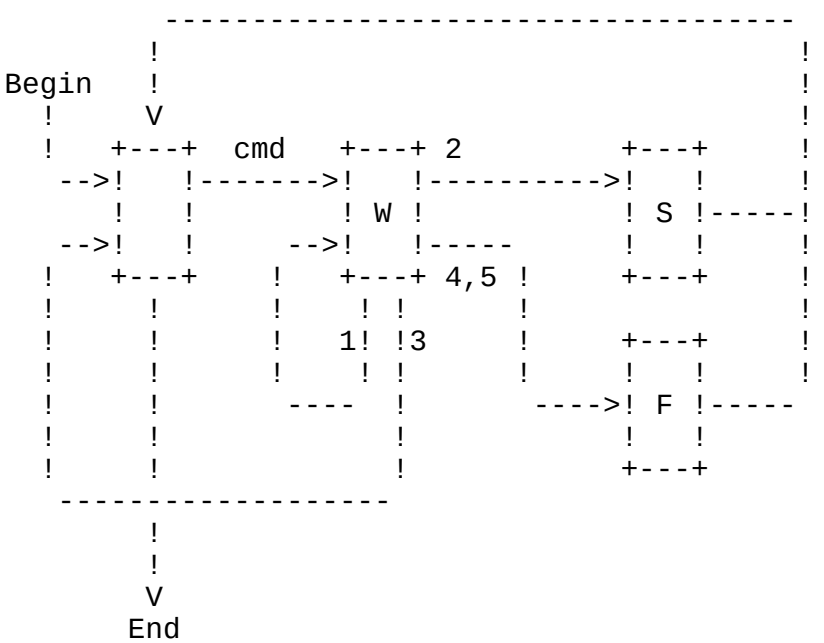
We note that the above three models are similar, in fact the Mail diagram and the Rename diagram are structurally identical. The Restart differs from the other two only in the treatment of 100 series replies at the second stage. 24

The most complicated diagram is for the Logon sequence: 25



25a

Finally we present a generalized diagram that could be used to model the command and reply interchange: 26



26a