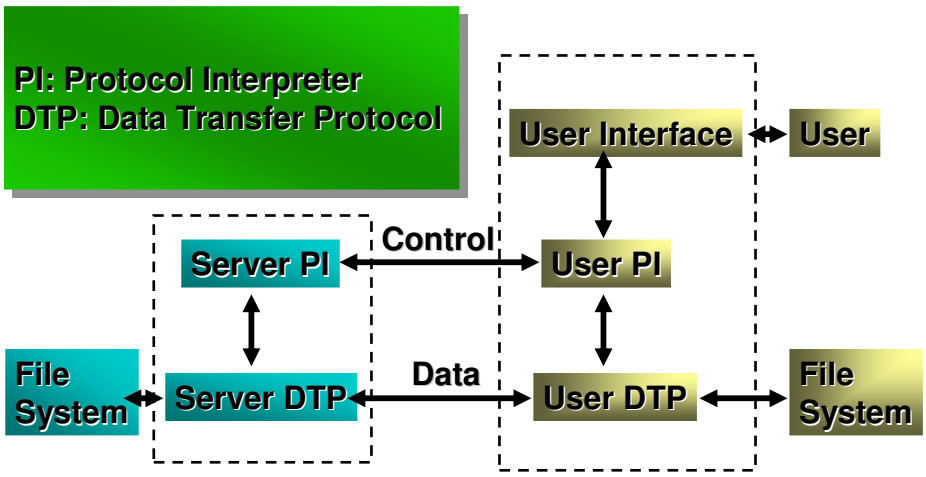
Protocoale de nivel aplicaţie:

FTP, TFTP

FTP

- scop: transfer de fişiere, OS-independent, de pe un server ftp (file server) pe un client
- folosiţi FTP automat în browserul de web, cînd daţi click pe un link cu ftp:// în loc de http://
- RFC 959
- utilizează 2 porturi TCP
  - control
  - transfer de date
- protocol *command-response*
- portul de control port utilizează telnet pentru negocierea conexiunii:
  - comenzi ASCII
  - <crlf>

Modelul FTP

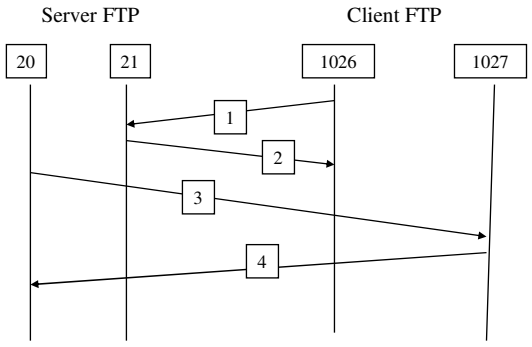


FTP - modul activ

- Clientul FTP se conectează de la un port n > 1024 (neprivilegiat) la portul 21 al serverului FTP
- prin comanda PORT informează serverul asupra portului n
- serverul FTP se conectează de pe portul 20 pe portul n+1 al clientului FTP

  OBS: aceasta face ca, cf. modelul client-server, pentru conex. de date (3-4) serverul FTP este client iar clientul FTP este server (pt. că clientul se conectează la server)

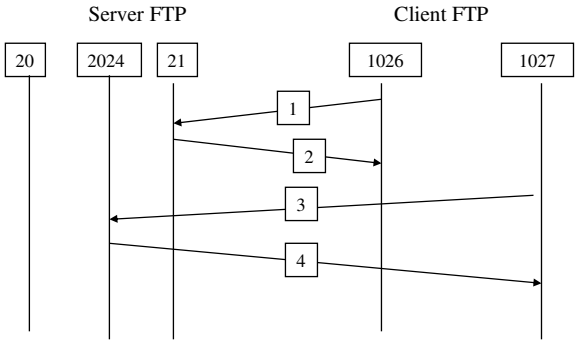
- Exemplu: n=1026



FTP - modul pasiv

- clientul se conectează de la un port n > 1024 la portul 21 (control) al serverului şi trimite comanda PASV
- serverul trimite numărul portului p de folosit pentru transferul de date
- clientul se conectează de la portul n+1 la portul p

- Ex: n=1026, p=2024



Tipuri de date

- FTP = destinat folosirii cross-platform
- se folosesc 4 tipuri de date neutre, OS-independent; se face conversia în tipul local la destinaţie

tip	*abrev.*	*semnificaţie*
– ASCII	A	NVT-ASCII
– EBCDIC	E	EBCDIC Text
– IMAGE	I	Raw binary, series of octets
– LOCAL	L	Raw binary using a variable byte size

- Clientul informează serverul asupra tipului
- tipul implicit este A (ASCII)
- tipul se schimbă cu comanda TYPE

Structura fişierelor

- OS diferite folosesc structuri diferite
- FTP defineşte 3 structuri pentru transport

structură	*abrev.*	*definiţie*
– File	F	Unstructured, sequence of bytes
– Record	R	Series of records
– Page	P	Series of data blocks (pages)

- tipul implicit este File (F)
- structura se schimbă cu comanda STRU

Modul de transfer

- Modul este utilizat pentru a specifica codarea şi/sau modul de secvenţiere al fluxului de date
- independent TYPE şi de STRU

mod	*abvrev.*	*definiţie*
– Stream	S	stream of bytes, if record structure EOF sent as record indication; if file eof indicated by closing stream
– Block	B	file sent as sequence of blocks preceded by header info allows restart of an interruped transfer
– Compressed	C	data compressed using run length encoding (RLE)

- modul se schimbă cu comanda MODE

Comenzi FTP

Comenzile sînt între client şi server

Interfaţa utilizator pune la dispoziţie userului alte comenzi de "nivel înalt" pentru a interacţiona cu serverul FTP, care sînt translatate

userul poate folosi comenzile de nivel înalt (de ex. get, put...) sau direct comenzile de protocol (RETR, STOR...)

- USER — User name, userid for access control
- PASS — Password for access control
- ACCT — Account info
- CWD — Change working directory
- CDUP — Change to parent directory
- RETR — Retrieve, download the file from server
- STOR — Store, upload the specified to server
- STOU — Store unique, same as store but server picks unique file name

Comenzi FTP

- REIN — restarts session at authentication phase
- PORT — Host addr and data port to use
- PASV — Passive mode
- TYPE — Data type, type of subsequent transfers
- STRU — File structure
- MODE — Transfer mode
- SMNT — Structure mount, mount a different file system
- QUIT — informs server that client wants out

Comenzi FTP

- APPE — Append, upload file to server, if file name exists, append the upload
- ALLO — Allocate, sometimes used to preallocate space
- REST — Restart, restart an interrupted transfer
- RNFR — Rename file from filename
- RNTO — Rename file to
- ABOR — Abort, ask server to abort last command
- DELE — Delete specified file
- RMD — Remove directory
- MKD — Make directory

Comenzi FTP

- PWD — Print working directory
- LIST — Request directory listing
- NLST — Request just a file name list
- SITE — Site parameters, allow client to specify site specific options and parameters
- SYST — request server operating system
- STAT — Request server to send status of current xfr
- HELP — general and command specific
- NOOP — ask server to send a positive reply

Comenzile de nivel înalt în interfaţa utilizator → vezi exemplul FTP

Răspunsuri FTP

- Răspunsul e de forma:
- cod de 3 cifre, text, <crlf>
- coduri posibile:

- 1yz - Positive preliminary reply - command is being acted upon; expect a final reply code before sending another command
- 2yz - Positive completion reply - command was successfully executed; new command may be sent
- 3yz - Positive intermediate reply - command was accepted, but the final result is being delayed because other information needs to be supplied from the client; reply is used for sequencing command groups
- 4yz - Transient negative completion reply - command failed, but the condition is temporary
- 5yz - Permanent negative completion reply - command failed and will always fail if given again; the command should not be attempted again

Răspunsuri FTP

- x0z - Refers to command syntax
- x1z - Indicates information returned by commands requesting information such as status or help
- x2z - Refers to the state of the control or data connections
- x3z - The reply is associated with the login process and accounting procedures
- x4z - Reserved for future use
- x5z - Refers to the state of the requested file transfer or other file system command

Exemplu FTP

```
C:\Users\user>ftp ftp.roedu.net
Connected to iota.nren.ro.
220 Welcome to Agency ARNIEC/RoEduNet Online Archive
User (iota.nren.ro:(none)): anonymous
331 Please specify the password.
Password:
230 Login successful.
ftp> help
Commands may be abbreviated.  Commands are:

!               delete          literal         prompt          send
?               debug           ls              put             status
append          dir             mdelete         pwd             trace
ascii           disconnect      mdir            quit            type
bell            get             mget            quote           user
binary          glob            mkdir           recv            verbose
bye             hash            mls             remotehelp
cd              help            mput            rename
close           lcd             open            rmdir
```

```
ftp> ls -la
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
drwxr-xr-x    5 ftp      ftp            91 Nov 26  2010 .
drwxr-xr-x    5 ftp      ftp            91 Nov 26  2010 ..
lrwxrwxrwx    1 ftp      ftp            33 Aug 02  2009 debian ->
  pub/mirrors/ftp.debian.org/debian
lrwxrwxrwx    1 ftp      ftp            37 Aug 02  2009 debian-cd
  -> pub/mirrors/ftp.debian.org/debian-cd/
drwx-wx-wx    3 ftp      ftp          4096 Oct 22 19:11 incoming
drwxr-xr-x    2 ftp      ftp          4096 Apr 22  2010
  lost+found
lrwxrwxrwx    1 ftp      ftp            12 Jul 24  2009 mirrors -
  > pub/mirrors/
drwxr-xr-x    7 ftp      ftp          4096 Jul 24  2009 pub
226 Directory send OK.
ftp: 604 bytes received in 0.01Seconds 54.91Kbytes/sec.
ftp> cd debian
250 Directory successfully changed.
ftp> pwd
257 "/pub/mirrors/ftp.debian.org/debian"
```

```
ftp> ls -la
200 PORT command successful. Consider using PASV.
150 Here comes the directory listing.
drwxr-xr-x    8 ftp      ftp          4096 Oct 26 15:52 .
drwxr-xr-x    5 ftp      ftp            55 Oct 25 22:23 ..
-rw-r--r--    1 ftp      ftp          1064 Oct 08 10:15 README
-rw-r--r--    1 ftp      ftp          1290 Jun 26  2010 README.CD-
   manufacture
-rw-r--r--    1 ftp      ftp          2596 Oct 08 10:14 README.html
-rw-r--r--    1 ftp      ftp        146186 Oct 25 01:52
   README.mirrors.html
-rw-r--r--    1 ftp      ftp         78596 Oct 25 01:52
   README.mirrors.txt
drwxr-xr-x   11 ftp      ftp          4096 Oct 08 10:29 dists
drwxr-xr-x    4 ftp      ftp          4096 Oct 26 13:52 doc
drwxr-xr-x    3 ftp      ftp          4096 Aug 14 10:08 indices
-rw-r--r--    1 ftp      ftp       7093521 Oct 26 14:39 ls-lR.gz
-rw-r--r--    1 ftp      ftp        120526 Oct 26 14:39 ls-lR.patch.gz
drwxr-xr-x    5 ftp      ftp            46 Dec 19  2000 pool
drwxr-xr-x    4 ftp      ftp            51 Nov 17  2008 project
drwxr-xr-x    3 ftp      ftp            61 Jan 25  2011 tools
226 Directory send OK.
ftp: 1001 bytes received in 0.01Seconds 77.00Kbytes/sec.
```

```
ftp> get README
200 PORT command successful. Consider using PASV.
150 Opening BINARY mode data connection for README (1064 bytes).
226 File send OK.
ftp: 1064 bytes received in 0.03Seconds 35.47Kbytes/sec.

ftp> bye
421 Timeout.
```

Exemplu de translaţie comenzi niv. înalt

legenda: `comenzi nivel înalt` / `comenzi de protocol` / `răspunsuri`

```
ftp> get ls-lR.patch.gz.TYPO
> TYPE I
< 200 TYPE set to I
> PORT 128,32,48,169,189,41
```

semnificaţie: IP=128.32.48.168 Port=189*256+41=48421

```
< 200 PORT command successful
> RETR ls-lR.patch.gz.TYPO
< 550 br-0.9a9.tar.gz.TYPO: No such file or directory

ftp> get ls-lR.patch.gz
> PORT 128,32,48,169,189,42
< 200 PORT command successful
> RETR ls-lR.patch.gz
< 150 Opening BINARY mode data connection for ls-lR.patch.gz (120526
   bytes)
```

TFTP

TFTP

- FTP: TCP/20,21
- TFTP: UDP/69

- TFTP= “FTP Light”
- RFC 783, 1350
- TFTP:
  - minimal, pentru a fi simplu şi cît mai mic
  - fără securitate
  - mai rar folosit de către utilizator în mod direct
  - folosit uzual pentru transferul de fişiere de configurare, etc de către echipamente, în mod automat
  - exemplul 1: salvarea/încărcarea fişierelor de configurare şi a sistemului IOS de pe Cisco pe un PC
  - exemplul 2: încărcarea OS pe un PC de tip *diskless workstation*

Exemplul 1 TFTP

```
router#copy tftp flash:
Address or name of remote host []? 192.168.1.2
Source filename []? c1841-ipbasek9-mz.124-12.bin
Destination filename [c1841-ipbasek9-mz.124-12.bin]?
Accessing tftp://192.168.1.2/c1841-ipbasek9-mz.124-
  12.bin....
Loading c1841-ipbasek9-mz.124-12.bin from 192.168.1.2:
  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
  !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
[OK - 16599160 bytes]

16599160 bytes copied in 30.097 secs (123409 bytes/sec)
```

Exemplul 1 TFTP

```
router#dir flash:
Directory of flash:/
1  -rw-   16599160
   c1841-ipbasek9-mz.124-12.bin
```

Se intră în ROMMON cu CTRL-BREAK

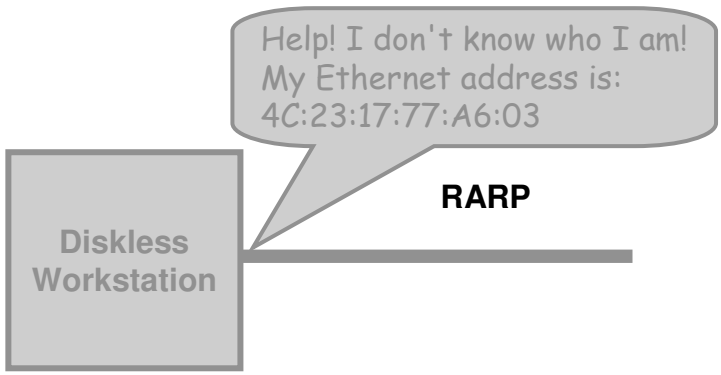
```
rommon 1 > boot flash:c1841-ipbasek9-mz.124-12.bin
```

Exemplul 2 TFTP

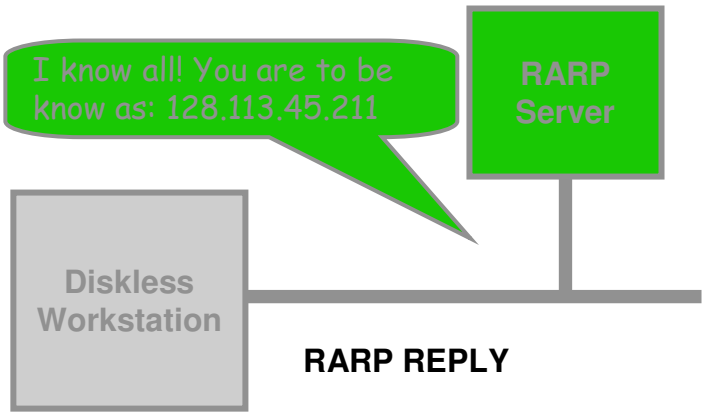
```
router#copy running-config tftp
Address or name of remote host []? 192.168.1.2
Destination filename [router-confg]?
.!!
[OK - 352 bytes]

352 bytes copied in 3.184 secs (0 bytes/sec)
```

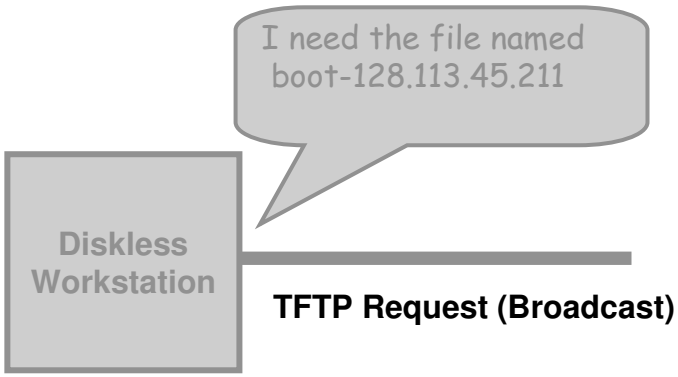
Exemplul 2 TFTP



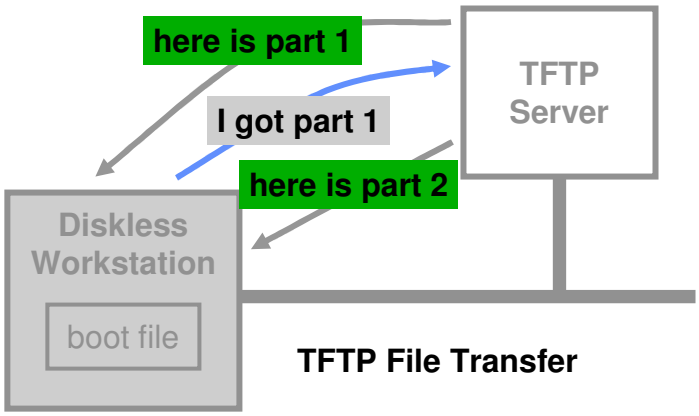
Răspunsul serverului de RARP



Clientul cere fişierul de OS



Serverul TFTP trimite fişierul



Protocolul TFTP

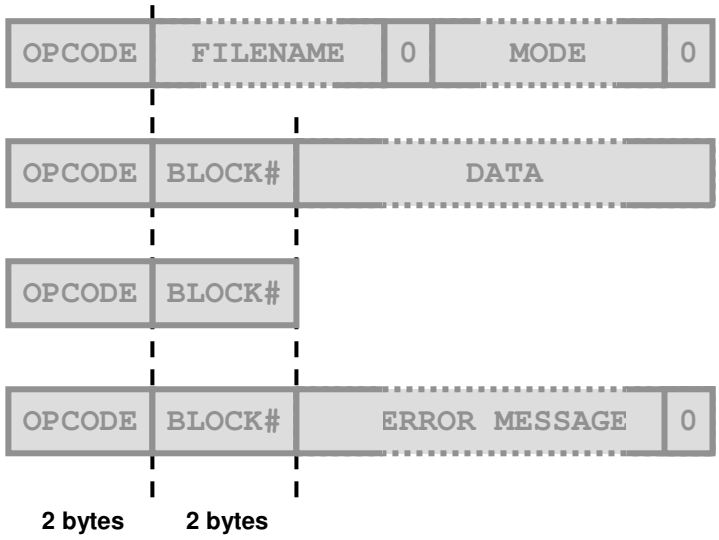
5 tipuri de mesaje:

- Read request RRQ
- Write request WRQ
- Data
- ACK (acknowledgment)
- Error

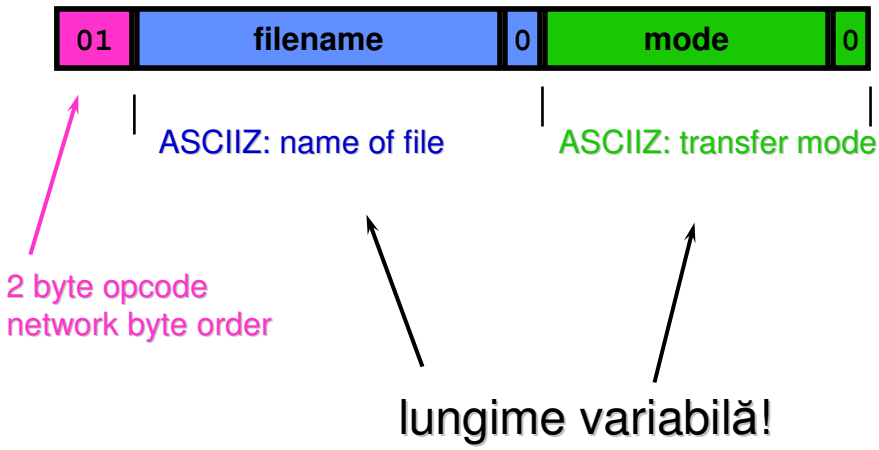
Mesaje

- Fiecare este un pachet (datagramă) UDP
- Primii 2 octeţi: opcode
- Structura restului datagramei depinde de opcode.

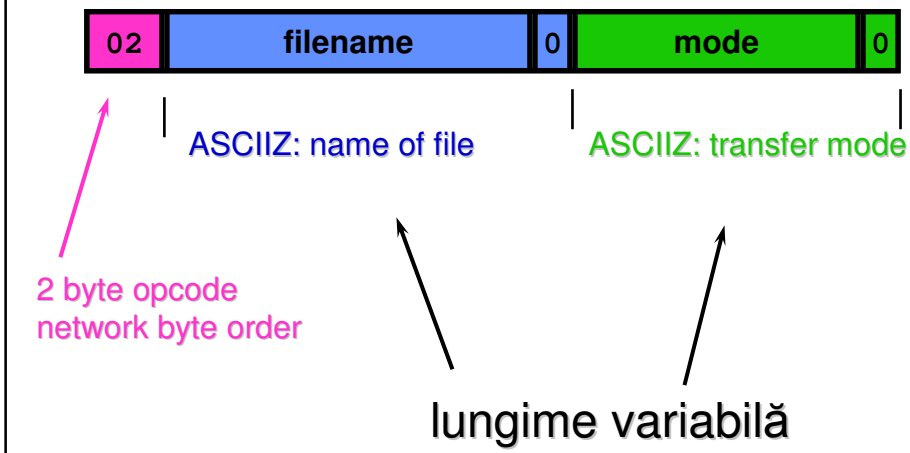
Formatul mesajelor



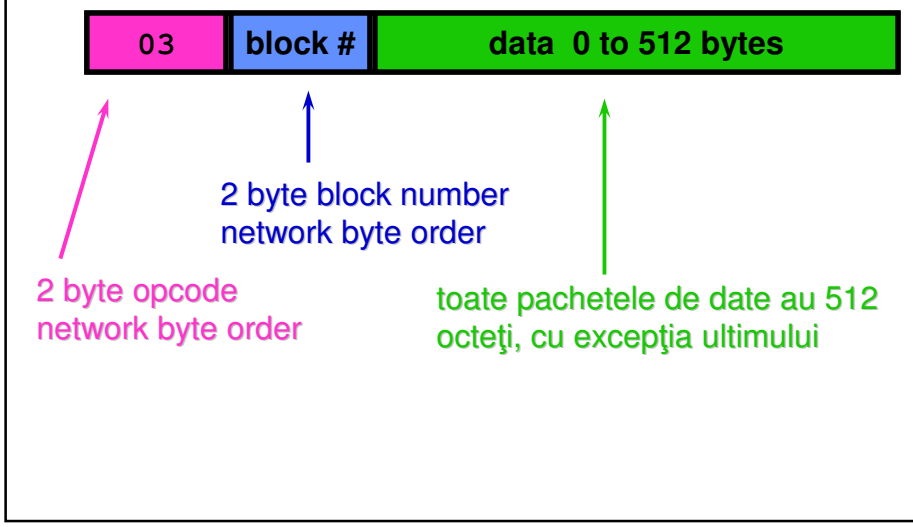
Read Request RRQ



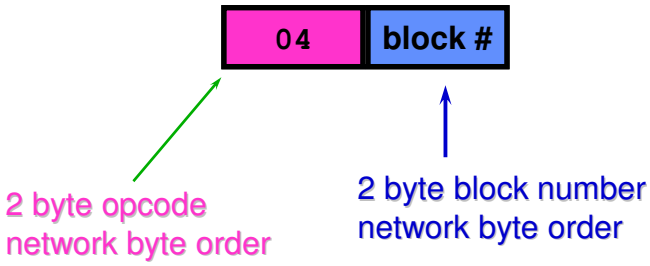
Write Request WRQ



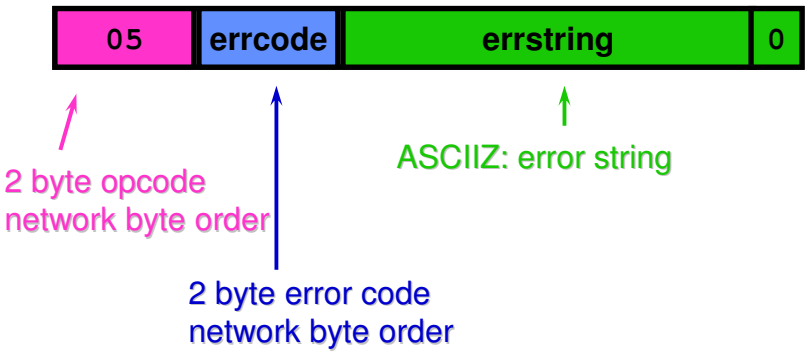
TFTP Data



TFTP Acknowledgment



TFTP Error



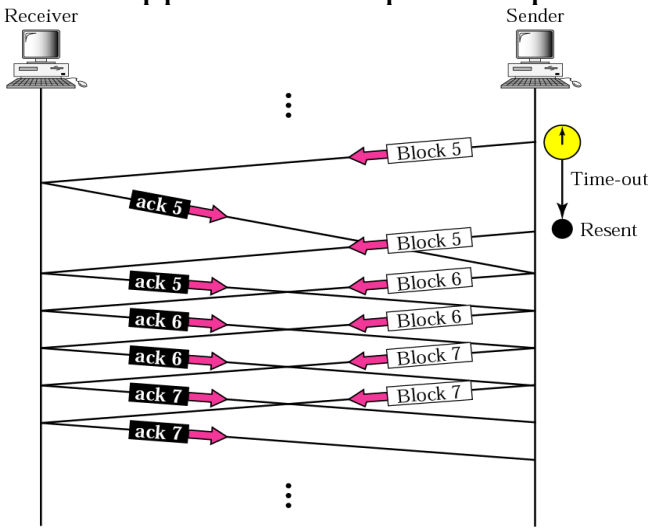
Coduri de eroare TFTP (16 bit int)

0 - not defined
1 - File not found
2 - Access violation
3 - Disk full
4 - Illegal TFTP operation
5 - Unknown port
6 - File already exists
7 - No such user

TFTP: modul de transfer

- "netascii" : pentru fişiere text.
  - toate liniile se termină cu \r\n (CR,LF).
  - format standard, indiferent de OS.
  - clientul/serverul fac conversia de la formatul specific OS la netascii.
  - exemplu: în UNIX, liniile se termină doar cu \n
- "octet" : pentru fişiere binare.
  - nu se face nici o conversie.

“sorcerer’s apprentice”: duplicarea pachetelor



- bug existent în implementarea originală TFTP
- soluţie: recunoaşterea ACK duplicate

Bibliografie

- FTP, *File Transfer Protocol,* CS-328
- TFTP: Netprog