

Advanced Lecture on Internet Applications

3. File Transfer: TFTP, FTP, Reliable
Multicast

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<ftp://ftp.hpcl.titech.ac.jp/appli3e.ppt>

File Transfer

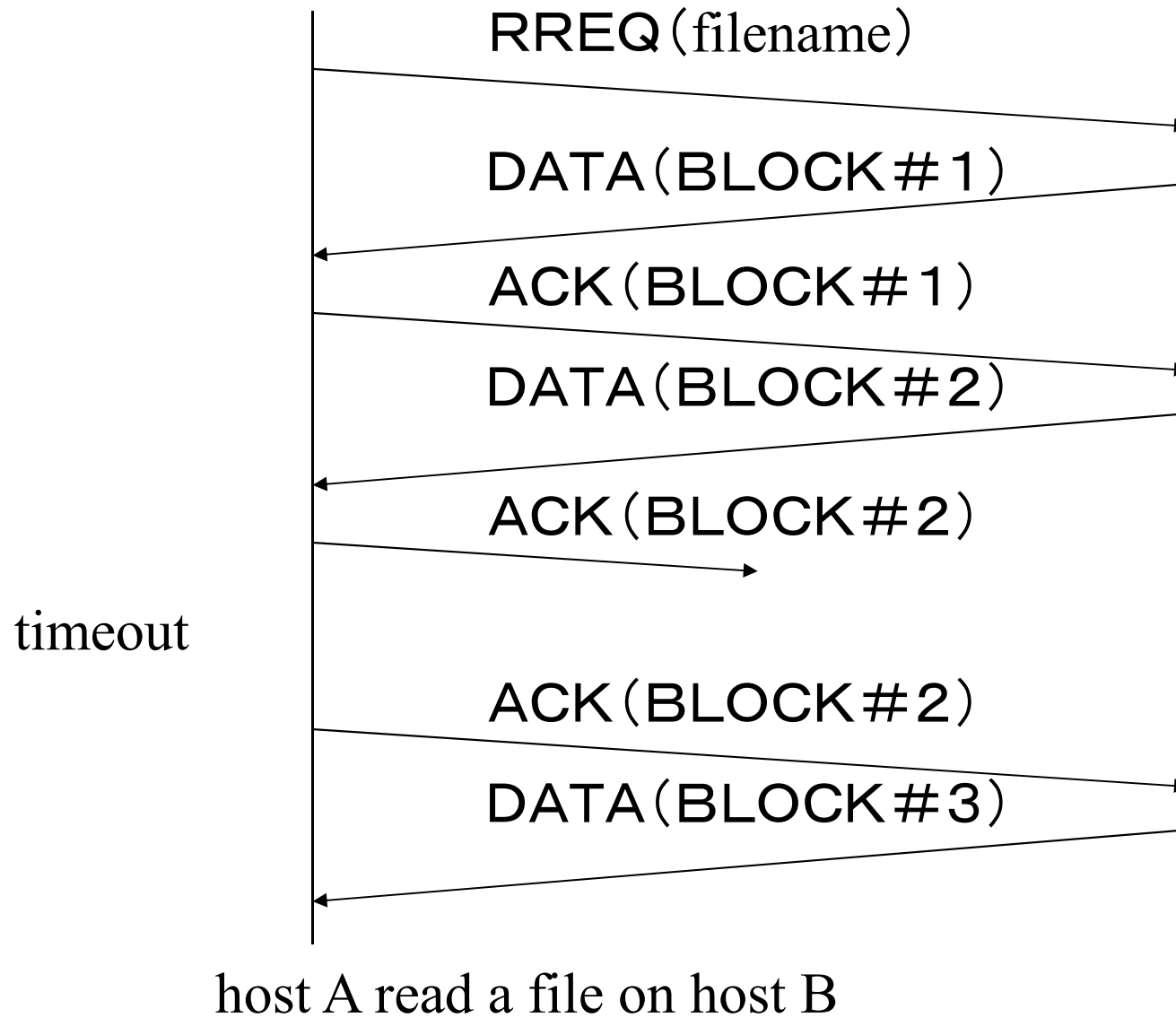
- the most basic application of the Internet
- send all the bits without error
 - retransmission inevitable
 - by application over UDP or by TCP
 - retransmission may be repeated several times
 - certain delay is inevitable
- ACK is useful
 - not usable with multicast

TFTP (Trivial File Transfer Protocol, rfc1350)

- simple file transfer protocol
 - only read/write file
 - no directory listing
 - no user authentication
- constructed over UDP (port 69)
- used for bootstrapping
- 512B fixed (except for the last) data is sent
 - as ACK is received

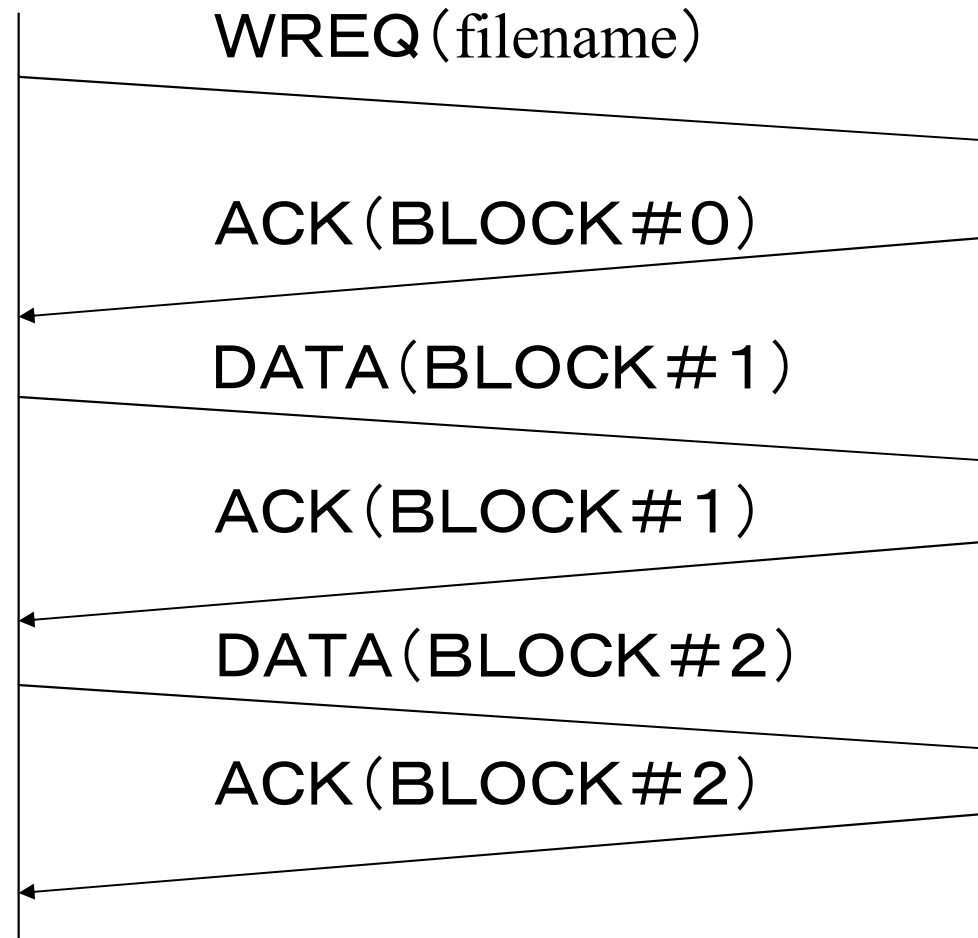
host A (at some UDP port)

host B (at UDP port 69)



host A (at some UDP port)

host B (at UDP port 69)



host A read a file on host B

Packet Format of TFTP (1)

Type	Op #						
	2 bytes	string	1 byte	string	1 byte		
RRQ/ WRQ	01/02	Filename	0	Mode	0		
	2 bytes	2 bytes	n bytes				
DATA	03	Block #	Data				

Packet Format of TFTP (2)

Type	Op #				
		2 bytes	2 bytes		

ACK	04		Block #		

		2 bytes	2 bytes	string	1 byte

ERROR	05		ErrorCode		ErrMsg 0

Errors of TFTP

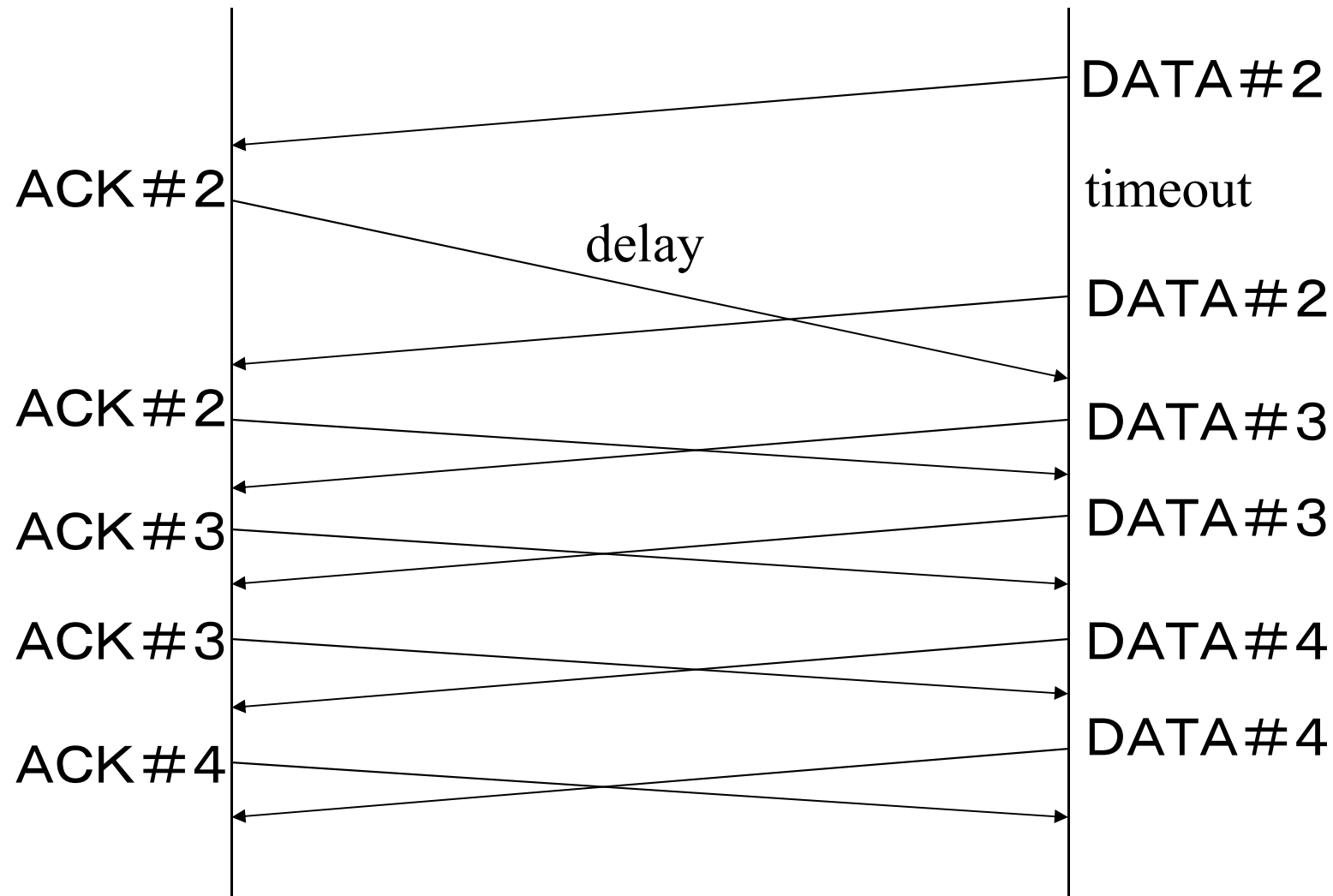
Value	Meaning
0	Not defined, see error message (if any).
1	File not found.
2	Access violation.
3	Disk full or allocation exceeded.
4	Illegal TFTP operation.
5	Unknown transfer ID.
6	File already exists.
7	No such user.

Retransmission of TFTP

- the current specification retransmit ACK upon timeout
 - timeout period should be determined adaptively
- old specification (rfc783) retransmit by both ends upon timeout
 - packet delay causes duplicated transmission to waste bandwidth
 - wasted bandwidth may result in further packet delays

host A (at some UDP port)

host B (at UDP port 69)



problem caused by retransmission by both ends

FTP (rfc959)

- File Transfer Protocol
- protocol to exchange files over the Internet
- port# 21 is used for command and response
- various file formats are supported

TCP and Command

- commands and replies represented in ASCII strings are exchanged over TCP
 - reply often begins with 3 digits followed by a space and text explaining reply **in English**
- line is terminated by CR and LF
- data may be sent over the same TCP connection (SMTP) or other TCP connection (FTP)
 - separator for data is necessary for sending over the same TCP

Meaning of 3 Digit Reply Code (1)

- 1yz Positive Preliminary reply
- 2yz Positive Completion reply
- 3yz Positive Intermediate reply
- 4yz Transient Negative Completion reply
- 5yz Permanent Negative Completion reply

Meaning of 3 Digit Reply Code (2)

- x0z Syntax
- x1z Information
- x2z Connections
- x3z Authentication and accounting
- x5z File system
- “z” gives a finer gradation of meaning in each of the function

Examples of Replies (1)

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.

202 Command not implemented, superfluous at this site.

502 Command not implemented.

503 Bad sequence of commands.

211 System status, or system help reply.

212 Directory status.

213 File status.

214 Help message.

125 Data connection already open; transfer starting.

225 Data connection open; no transfer in progress.

425 Can't open data connection.

226 Closing data connection.

Examples of Replies (2)

425 Can't open data connection.

226 Closing data connection.

426 Connection closed; transfer aborted.

227 Entering Passive Mode (h1, h2, h3, h4, p1, p2).

230 User logged in, proceed.

530 Not logged in.

331 User name okay, need password.

332 Need account for login.

532 Need account for storing files.

Examples of Command Sequences (1)

LOCAL COMMANDS BY USER

ACTION INVOLVED

ftp (host) multics<CR>

Connect to host S, port L,
establishing control connections.
<---- 220 Service ready <CRLF>.

username Doe <CR>

USER Doe<CRLF>---->
<---- 331 User name ok,
need password<CRLF>.

password mumble <CR>

PASS mumble<CRLF>---->
<---- 230 User logged in<CRLF>.

Examples of Command Sequences (2)

LOCAL COMMANDS BY USER

ACTION INVOLVED

retrieve (local type) ASCII<CR>

(local pathname) test 1 <CR>

(for. pathname) test.pl1<CR>

User-FTP opens local file in ASCII.

RETR test.pl1<CRLF> ---->

<---- 150 File status okay;
about to open data
connection<CRLF>.

Server makes data connection
to port U.

<---- 226 Closing data connection,
file transfer successful<CRLF>.

Examples of Command Sequences (3)

LOCAL COMMANDS BY USER

ACTION INVOLVED

type Image<CR>

TYPE I<CRLF> ---->

<----- 200 Command OK<CRLF>

store (local type) image<CR>

(local pathname) file dump<CR> User-FTP opens local file in Image.

(for.pathname) >udd>cn>fd<CR> STOR >udd>cn>fd<CRLF> ---->

<----- 550 Access denied<CRLF>

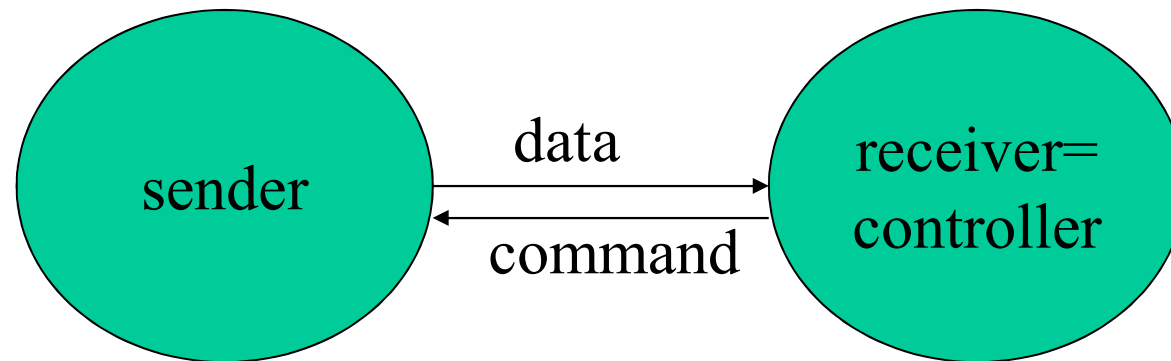
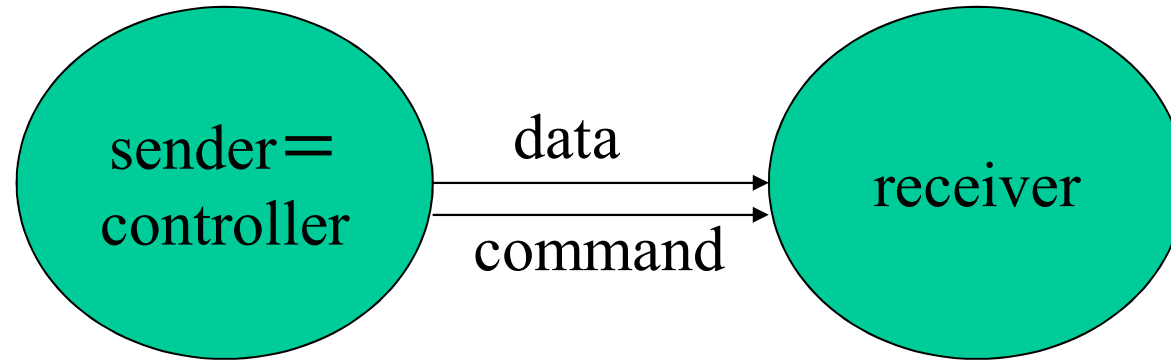
terminate

QUIT <CRLF> ---->

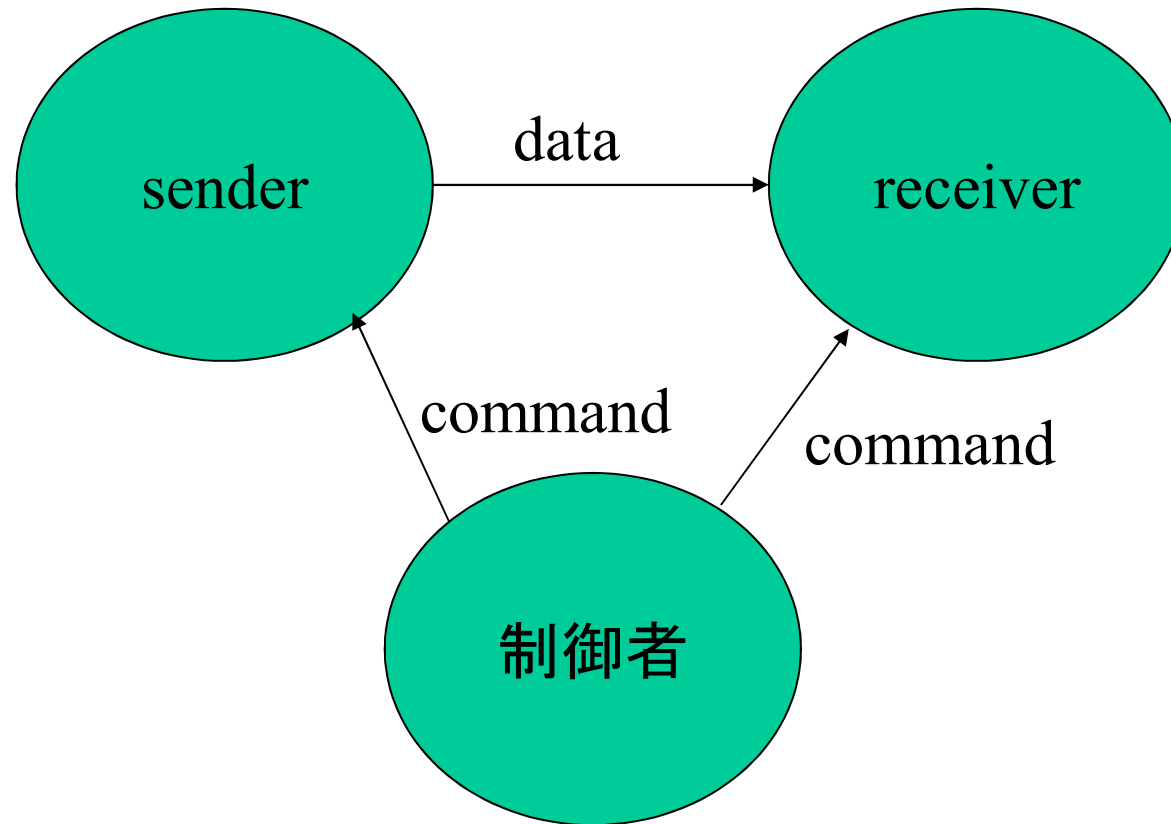
Server closes all
connections.

What are Ends of File Transfer?

- sender
- receiver
- controller!!



usual file transfer



more general form of file transfer

Commands of FTP

- various
 - USER PASS ACCT CWD CDUP SMNT QUIT
REIN PORT PASV TYPE STRU MODE
RETR STOR STOU APPE ALLO REST RNFR
RNT0 ABOR DELE RMD MKD PWD LIST
NLST SITE SYST STAT HELP NOOP

Some Commands of FTP (1)

- USER
 - user name
- PASS
 - password

Some Commands of FTP (2)

- PORT
 - specify IP address and port number to connect
- PASV
 - ask IP address and port number of server waiting for connection
- TYPE STRU MODE
 - file format

Some Commands of FTP (2)

- RETR
 - read from a file
- STOR
 - write to a file

What is Multicast?

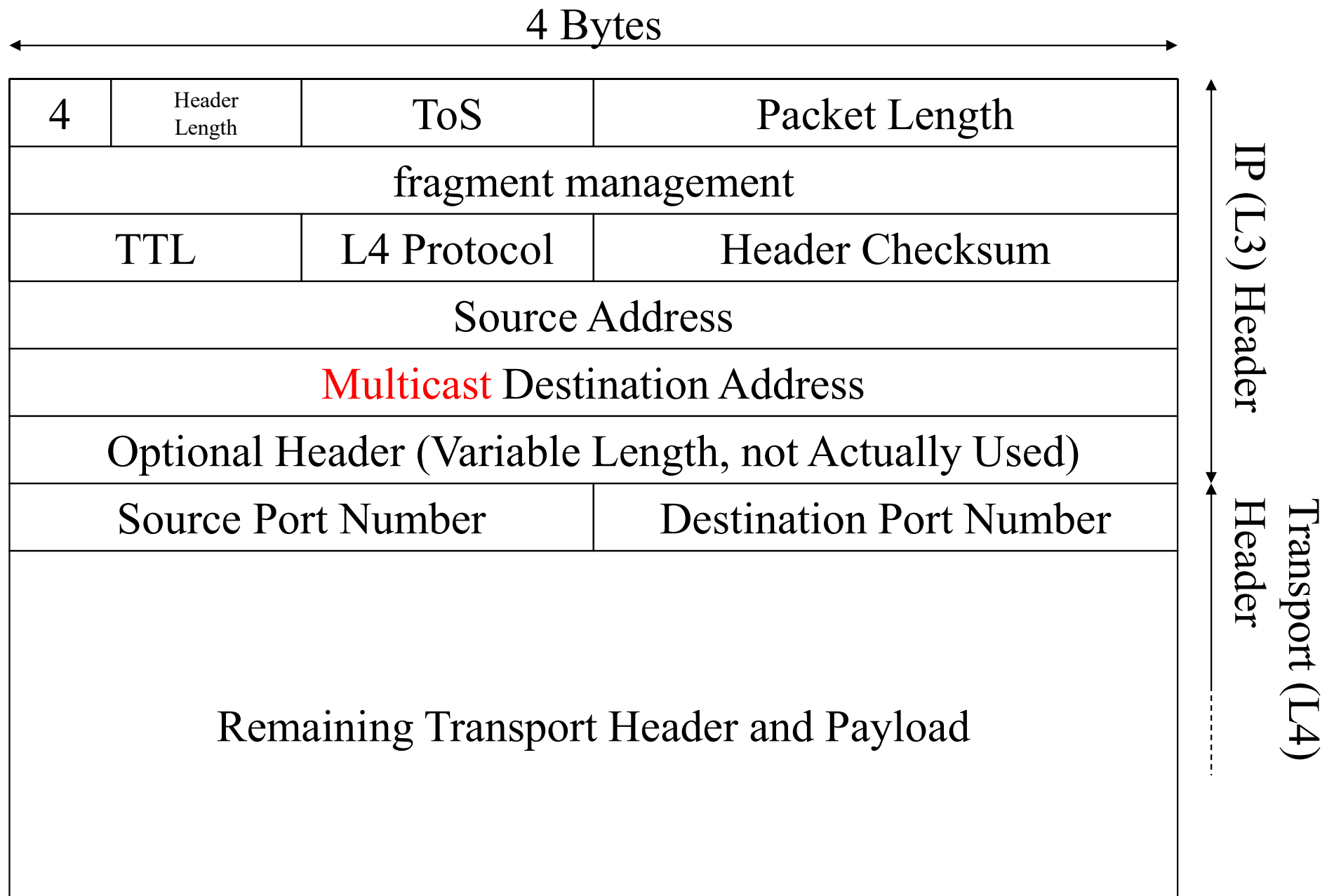
- one to many, many to many communication by copying data **in network**
 - “broadcast” by network
- necessary in network not possible by end
 - copying end is called reflector or, IMHO improperly, application layer multicast
- intimately related to resource reservation
 - cannot adjust BW according to congestion
 - each multicast address consumes routing table entry

Broadcast Network

- Network to Transfer Voice/Image to Many in Realtime
 - Allocate bandwidth for the transfer
 - Minimize delay
- Wide Area One to Many Communication over Radio Waves
 - Broadcast/Multicast
- Protected by Broadcast Act

Multicast and Broadcast

- broadcast
 - send to all the hosts within a region
 - not realistic over the entire internet
- multicast
 - send to all the members of a group
 - # of members can be arbitrary large
 - member management by network impossible
 - members tell network their existence
 - group is identified by multicast address
 - 224.0.0.0~239.255.255.255



Format of IPv4 Packets (rfc791)

Reliable Multicast

- transfer data without error or loss by multicast
 - in a sense, file transfer
 - can not return ACK by so many receivers
- must repeat transmission without ACK
 - no different from transmitting TV program list
- real time reliable multicast is as meaningless as real time TCP
 - retransmission means delay

Wrap Up

- a bit of error or loss is not allowed in file transfer
 - retransmission with ACK (with UDP/TCP)
- TFTP is light weight
- FTP is supports various operations
 - command sequences and replies are sent over TCP
- reliable multicast
 - must repeat transmission of same data