eecs 489 COMPUTER NETWORKS

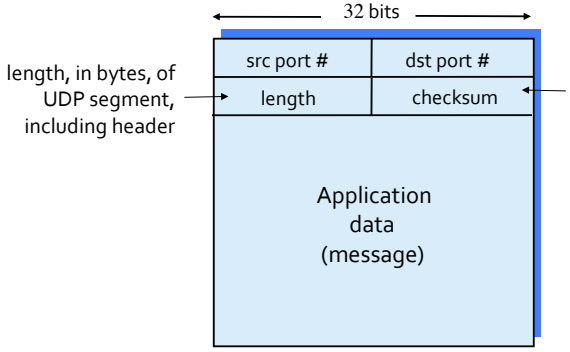
Lecture 25:
UDP Socket

User Datagram Protocol (UDP)

UDP service:

- "no frills," "bare bones" extension of best-effort IP
- "best effort" service, UDP segments may be:
  - lost
  - delivered out of order to app
- connectionless:
  - no handshaking between UDP sender and receiver
  - each UDP segment handled independently of others

UDP [RFC 768]



UDP segment format

Checksum:

- checksum computed including pseudo IP header (containing src and dst IP addresses, protocol, segment length)
- computed with all 0's in the checksum field
- Internet checksum: 1's complement of 1's complement sum

⇒ when checksum is computed at receiver, result is 0

UDP Socket

UDP socket identified by the tuple:

```
<dest IP address, dest port number>
```

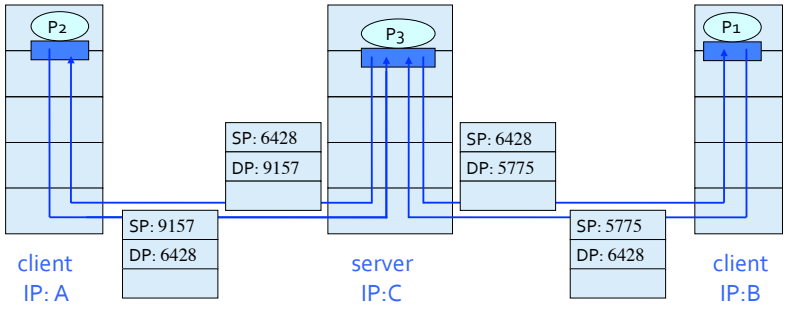
(contrast with TCP's four-tuple!)

When a host receives a UDP segment, it:

- checks the destination port number and
- directs the UDP segment to the socket with that port number

⇒ IP datagrams with different source IP addresses and/or source port numbers are directed to the same socket

Connectionless Demultiplexing



SP provides "return address"

UDP Socket

Similar to TCP's stream sockets, except:

- sockets created using `SOCK_DGRAM` instead of `SOCK_STREAM`
- no need for connection establishment and termination
- no `connect-bind`, `listen`, `accept` handshaking, but server must still always call `bind()`
- client doesn't need to call `connect()` though client may use `connect()` to tell kernel to "remember" the server's address and port#

Data Transmission

No "connection" between sender and receiver

- sender explicitly attaches IP address and port# of destination to each packet, by using `sendto()` instead of `send()`
  - `send()` can still be used if server's address and port# have been "registered" with kernel using `connect()`
- if receiver uses `recvfrom()` it can extract IP address and port# of sender from received packet
  - if these are not needed, `recv()` may be used instead

Transmitted data may be delivered out of order, or not delivered at all

No Connection

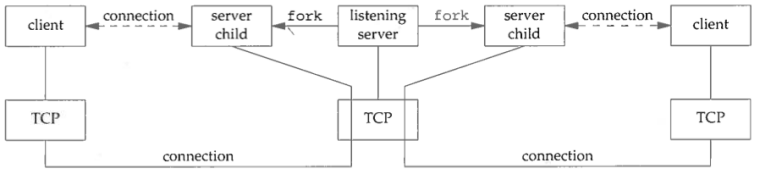


Figure 8.5 Summary of TCP client/server with two clients.

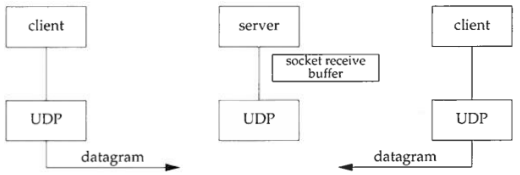


Figure 8.6 Summary of UDP client/server with two clients.

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Socket Addresses

Somewhere in the socket structure:

	IP address	Port#	
bind()			match incoming pkts' destination
connect()			copy to outgoing pkts' destination

TCP Server:

IP address	Port#
INADDR_ANY	well-known
client's address	ephem-eral

UDP Server:

	IP address	Port#	
bind()	239.4.8.9	9489	match incoming pkts' destination
			To be filled in with sender's addr. by kernel

TCP Client:

IP address	Port#
client's address	ephem-eral
server's address	well-known

UDP Client:

	IP address	Port#	
			To be filled in with host's IP addr. and ephemeral port by kernel
connect()	239.4.8.9	9489	copied to outgoing pkts' destination

Data Transmission

UDP packets have boundaries, not forming a byte-stream as in TCP, so `recv()` retrieves one message at a time, i.e., no need to call `recv()` in a loop

- call to `recv()` returns the whole packet
- cannot retrieve only parts of a packet
- to inspect a packet call `recv()` with `flags=MSG_PEEK`
- same for `recvfrom()` and `recvmsg()`

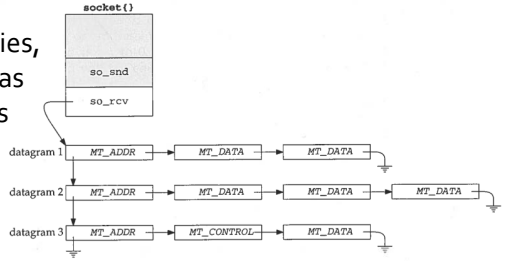

Figure 16.35 UDP receive buffer consisting of three datagrams.

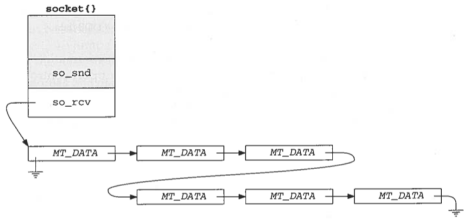

Figure 16.36 so_rcv buffer for TCP.

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Socket Buffers

When receiver's socket receive buffer is full, incoming UDP packets will simply be dropped

If sender's socket send buffer is smaller than the size of UDP data passed to `send()`, `send()` returns `-1` and the system global variable `errno` is set to `EMSGSIZE`

The APIs `getsockopt()` and `setsockopt()` are used to query and set socket options, including the `SO_RCVBUF` and `SO_SNDBUF` options

Lab5 Demo

Best-effort netimg with no flow-control and no error-control

Learn how to set send and receive buffer sizes

Play with different receive buffer sizes and observe effect of lack of flow control

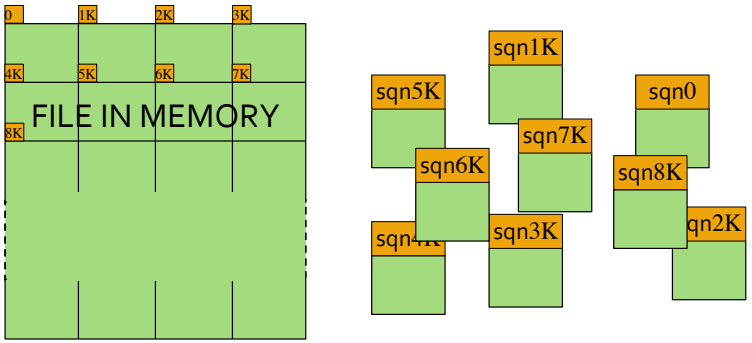
Play with different drop rates and observe effect of lack of error control

Learn how to send and receive large data buffer using gather write (`sendmsg()`) and scatter read (`recvmsg()`)

How to Send a Large File

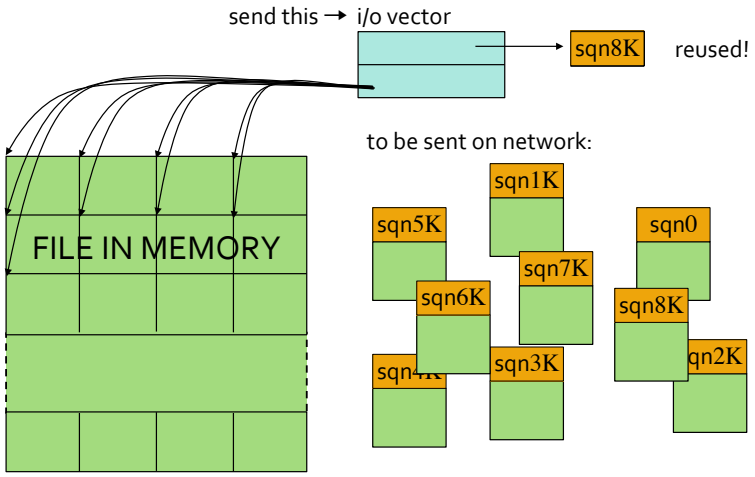
Error recovery and correction both require associating data with sequence number (sqn)

How to attach sequence numbers to chunks of data to be sent (assuming 1K segment)?



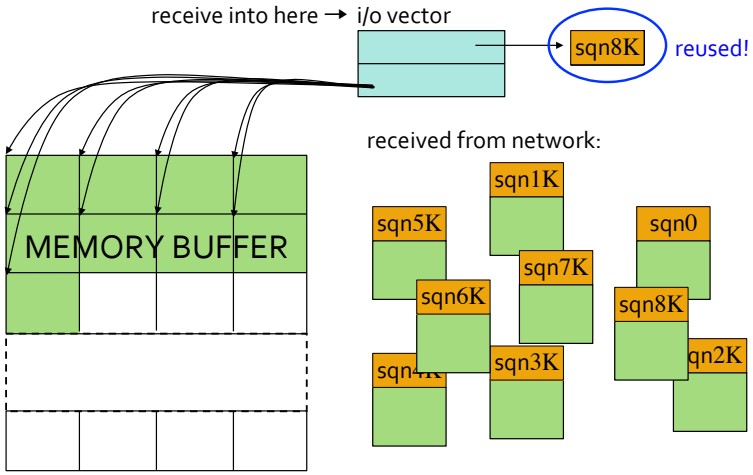
Gather Write

Output data is gathered from multiple buffers

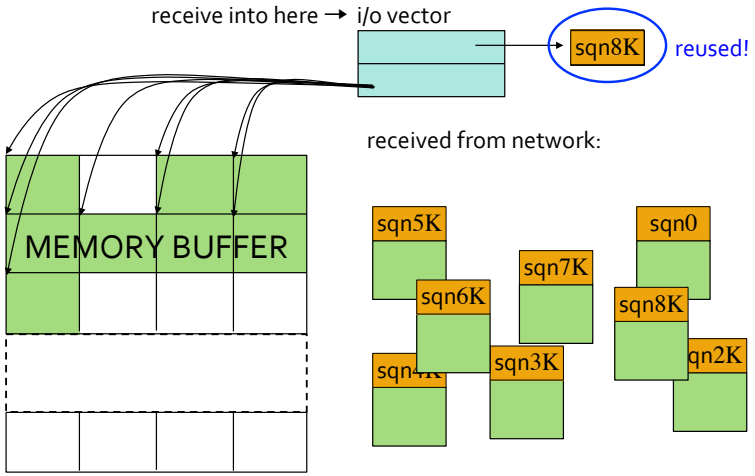


Scatter Read

Input data is scattered into multiple buffers



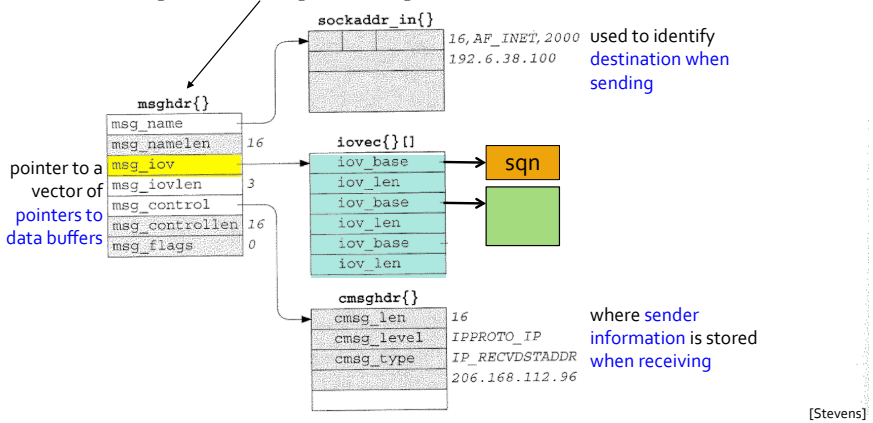
Out-of-Order Packets



Data Scatter/Gather

TCP can also use `sendto()`, `recvfrom()`, `sendmsg()`, and `recvmsg()`

The socket APIs for scatter-gather I/O are `recvmsg(sd, msg, flags)` and `sendmsg(sd, msg, flags)`



[Stevens]

Lab5: Sequence Number

Sequence number is per byte, not per packet

The sequence number attached to a packet is the sequence number of its first byte

The sequence number of a byte is its byte offset from the start of image buffer

This enables out-of-order data to be placed in its right position in the image buffer

Lab5: Interoperability Testing

Home firewall may block UDP packets

Use "`ssh -Y`" to test client on CAEN eecs489 hosts if UDP blocked by home firewall

- on Windows, use *MobaXterm* or similar tools that supports X forwarding

VNC may have OpenGL compatibility issues and is slower