CS4516: Medical Examiner Client/Server

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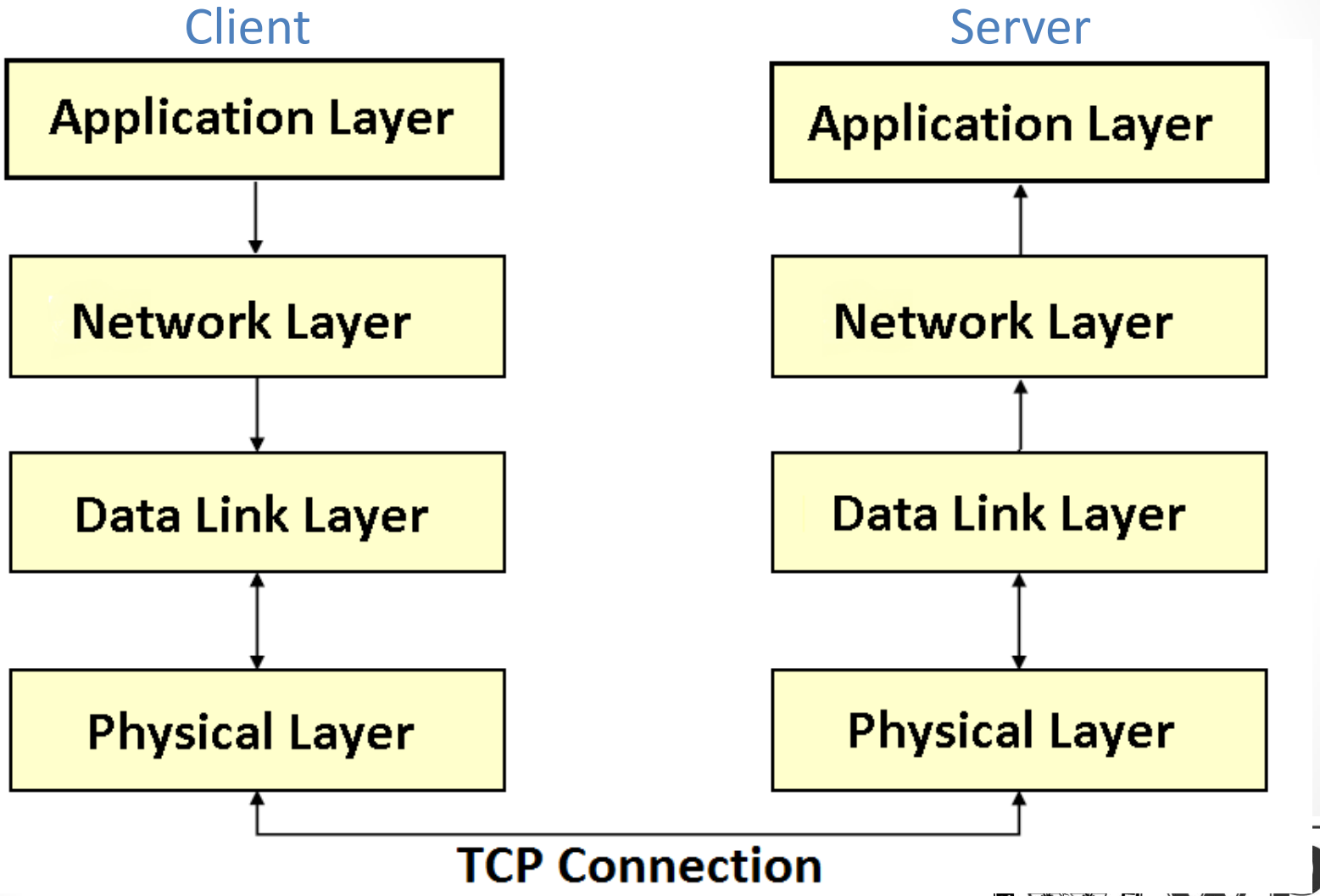
Overview

Objective: Implement both a client and concurrent server with an overlay network emulating four layers of the TCP/IP stack.

- Application Layer: Medical Examiner functionality (Messages)
- Network Layer: Converts messages to packets; Handles sequencing (Packets)
- Data Link Layer: Go Back N sliding window; Error Detection (Frames)
- Physical Layer: Handles sockets and error creation

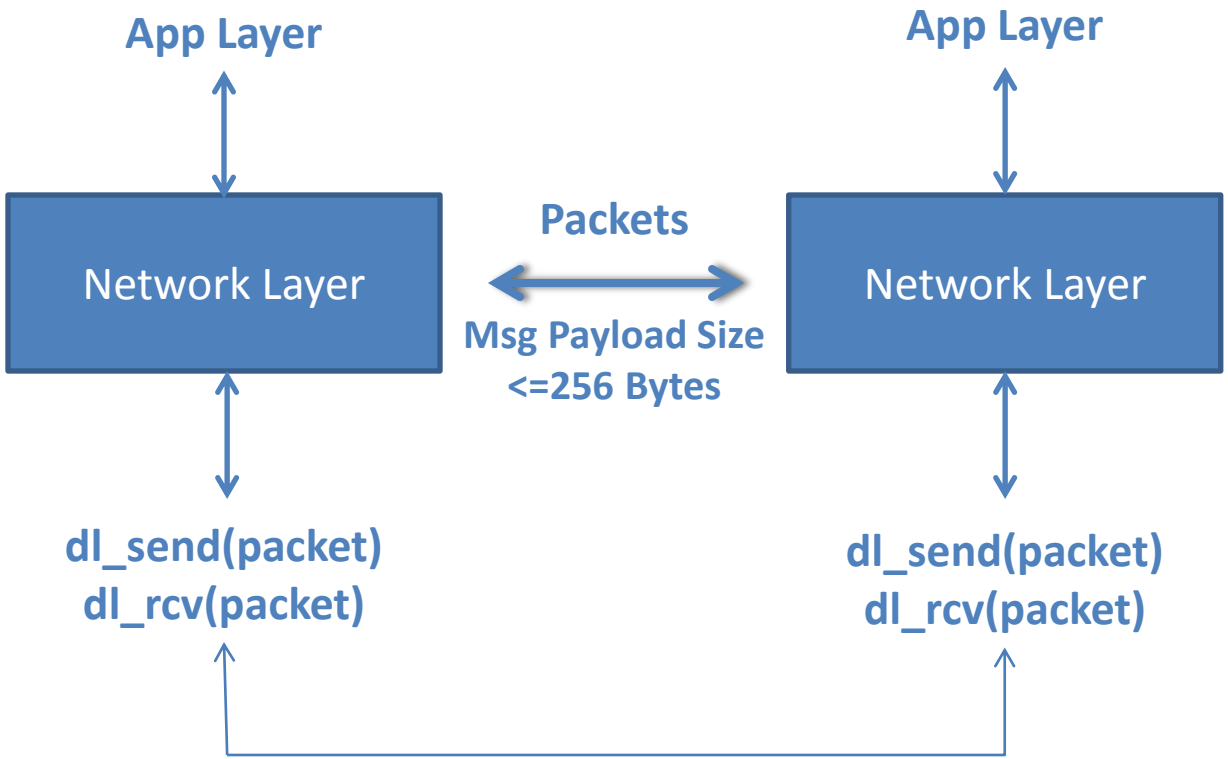
System Structure



Application Layer

- Minimum of **six** client request types. **Must include:** Input of a photo
- Must include message to distinguish user type (authoritative vs. query only)
- It is optional to implement application layer separately or as part of the network layer

Network Layer

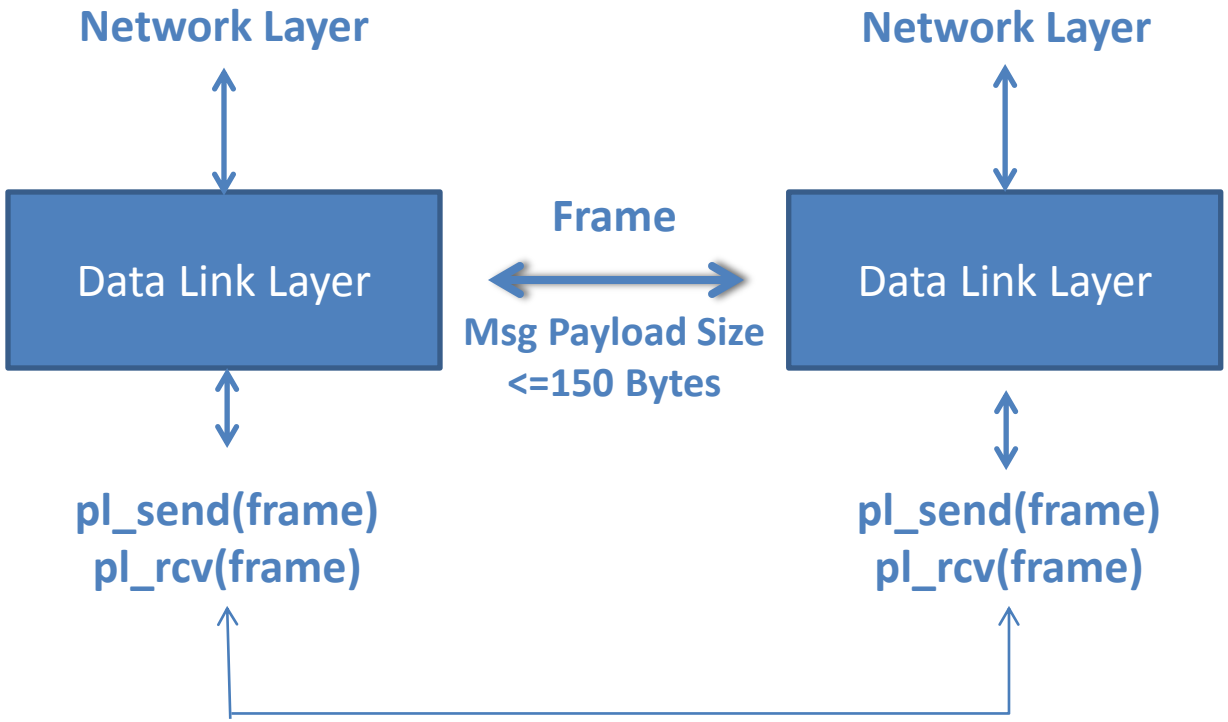


Packet Structure

- 2 Byte Seq #
- Message Payload

Note: The NL may pass packets to the DLL until the sliding window is full

Data Link Layer



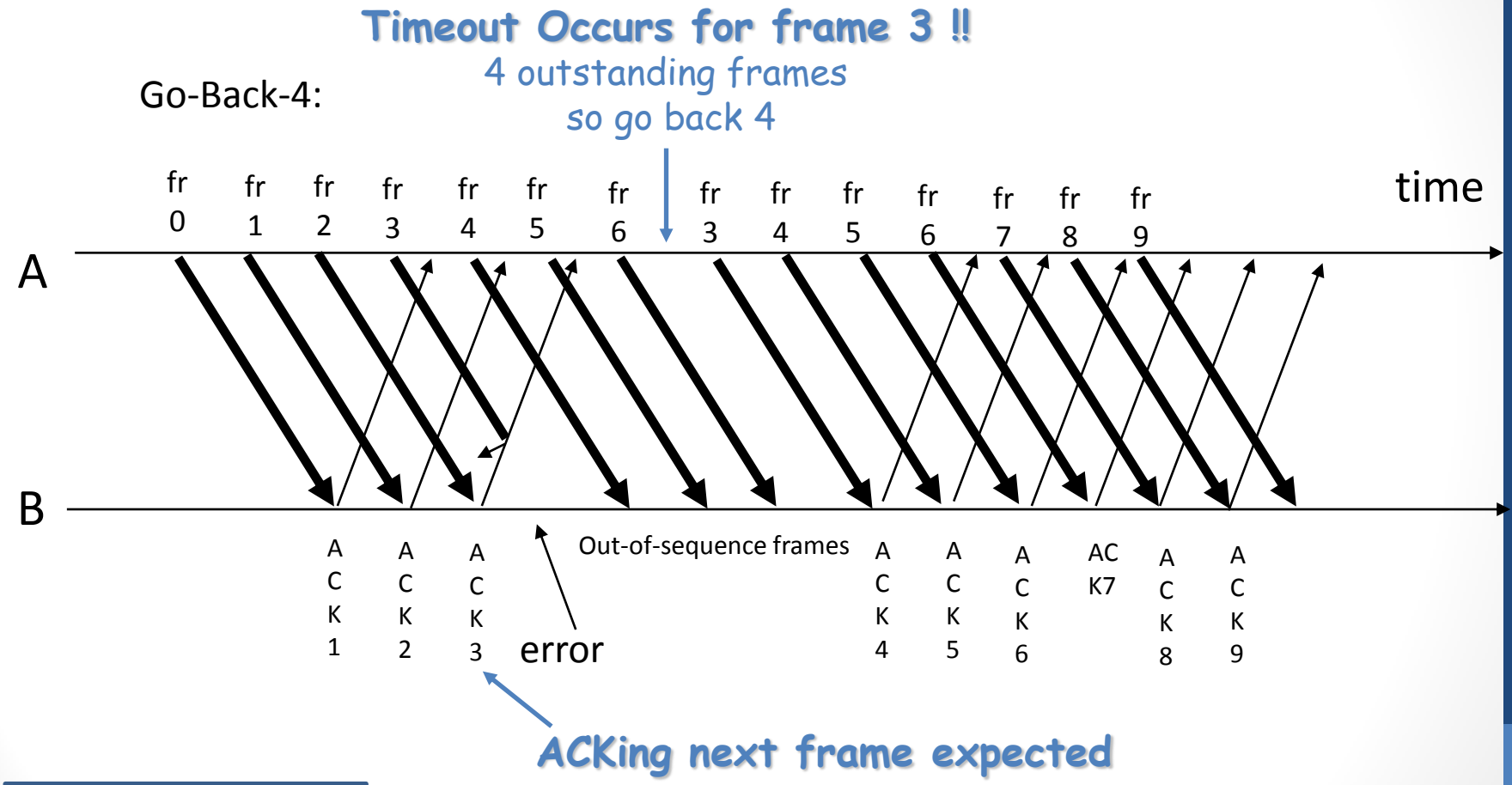
Frame Structure

- Payload
- 2 Bytes Sequence #
- 2 Byte Error Detection
- 1 Byte End-of-Frame
- 1 Byte Frame Type

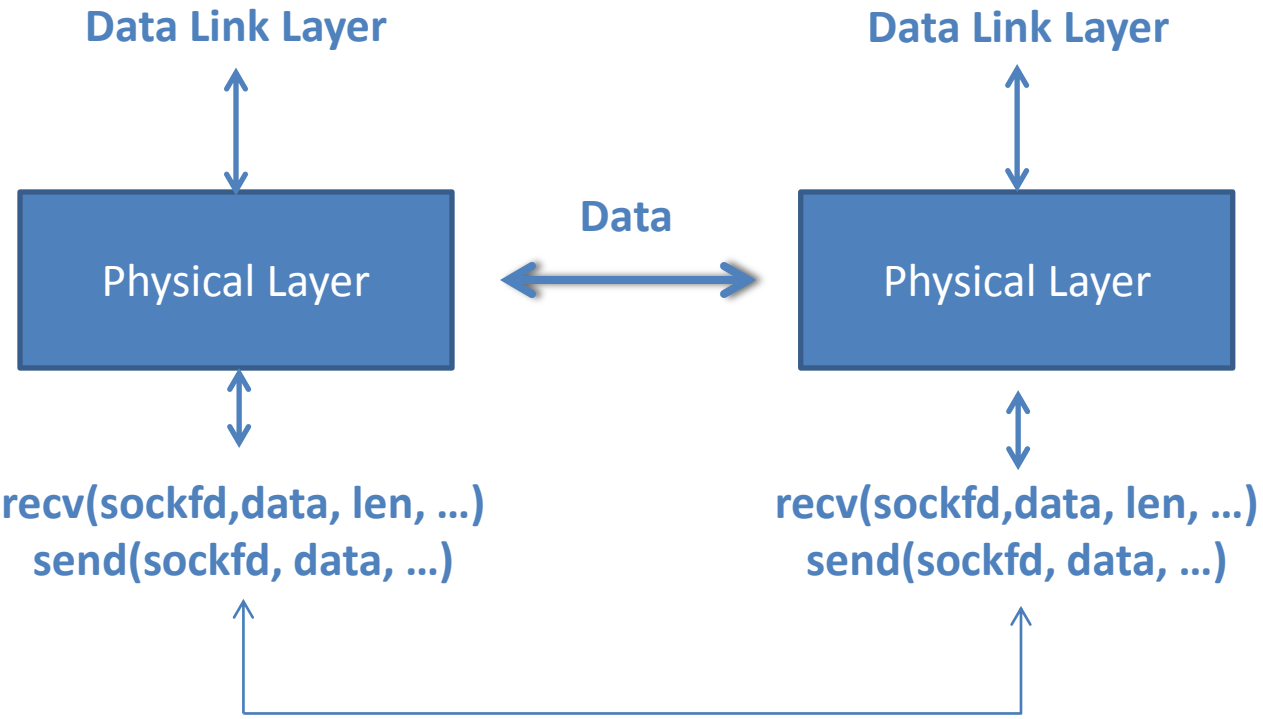
ARQ

- Go-Back N
- ACK or NACK?
- Piggyback the ACK?

Go-Back N ARQ


Timeout Occurs for frame 3 !!
4 outstanding frames
so go back 4
Go-Back-4:
fr 0
fr 1
fr 2
fr 3
fr 4
fr 5
fr 6
fr 3
fr 4
fr 5
fr 6
fr 7
fr 8
fr 9
time
A
B
ACK1
ACK2
ACK3
Out-of-sequence frames
ACK4
ACK5
ACK6
ACK7
ACK8
ACK9
error
ACKing next frame expected

Physical Layer



Forced Single Bit Error

- Every 6th data frame
- Every 8th ACK frame

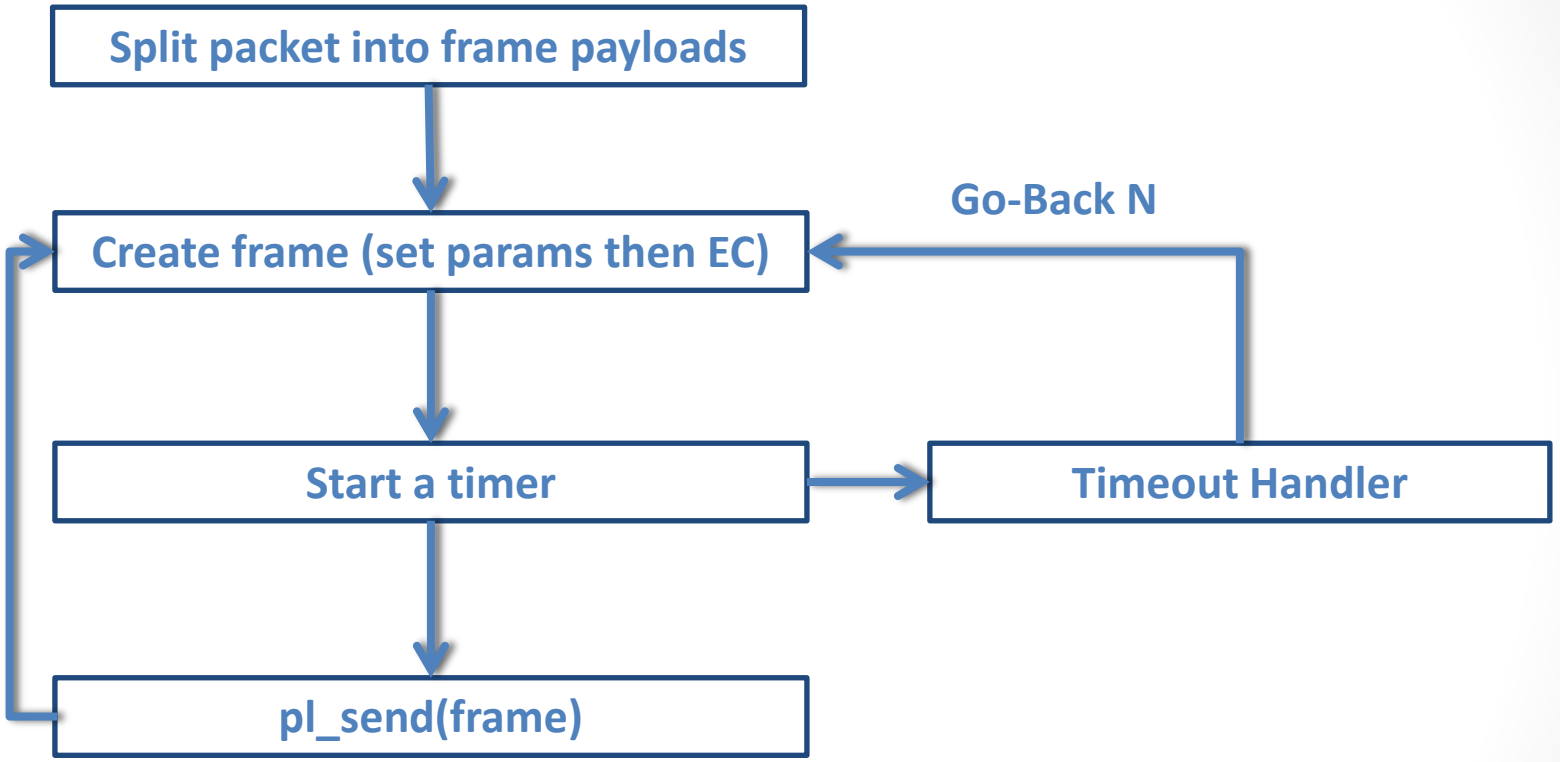
Concurrent Server

- Server must be able to process multiple clients in parallel
- A few ways to achieve concurrency:
  - Use fork() – separate processes, no shared memory
  - Use threads (pthreads)

Concurrent Server (using fork)

```
pid_t pid, id;
int listenfd, connfd;
/* 1. create a socket socket() */
if ((listenfd = socket(AF_INET, SOCK_STREAM, 0)) < 0 ){
        perror("Error creating socket");
        exit(1); }
/* 2. fill in sockaddr_in{ } with server's well-known port */
…
/* 3. bind socket to a sockaddr_in structure bind() */
bind (listenfd, ...);
/* 4. specify the backlog of incoming connection requests listen() */
listen (listenfd, 5);
while(1){
        connfd = accept(listenfd, ... );
        if(( pid = fork()) == 0){
        close(listenfd); /* child closes listening socket */
        doit(connfd); /* process the request. this is where the work is done. */
        close(connfd); /* done with this client */
        exit(0);
}
close(listenfd); /* parent closes the socket */
exit(0);
```

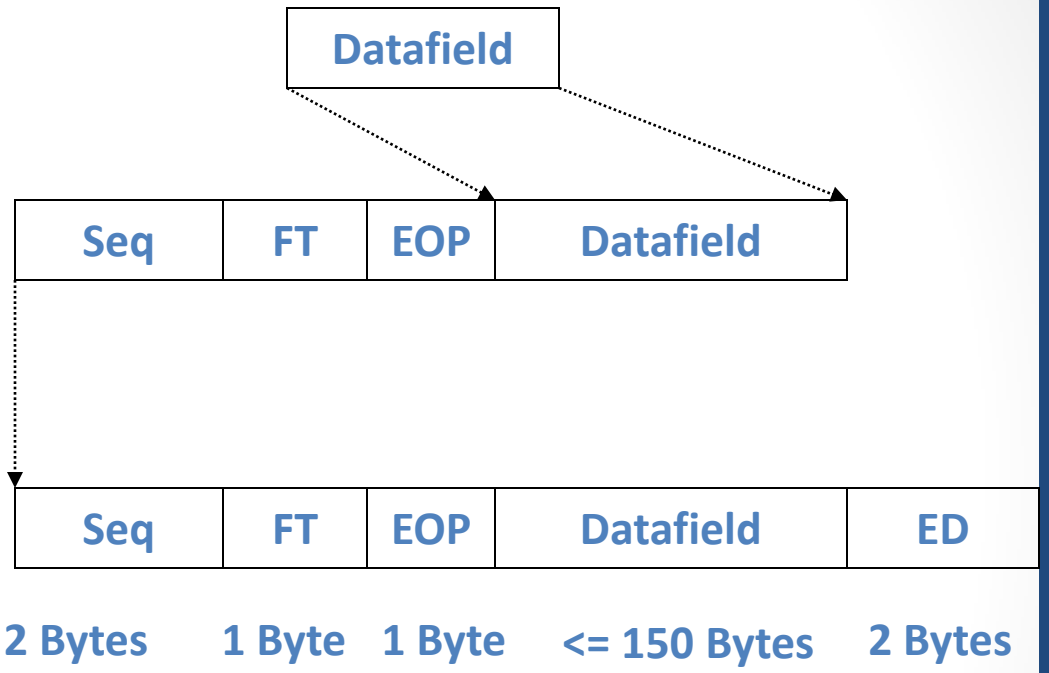
Data Link Layer: dl_send(packet,…)



Frame Structure

1. Compute Seq Number, Frame Type and End-Of-Frame (EOF) bytes

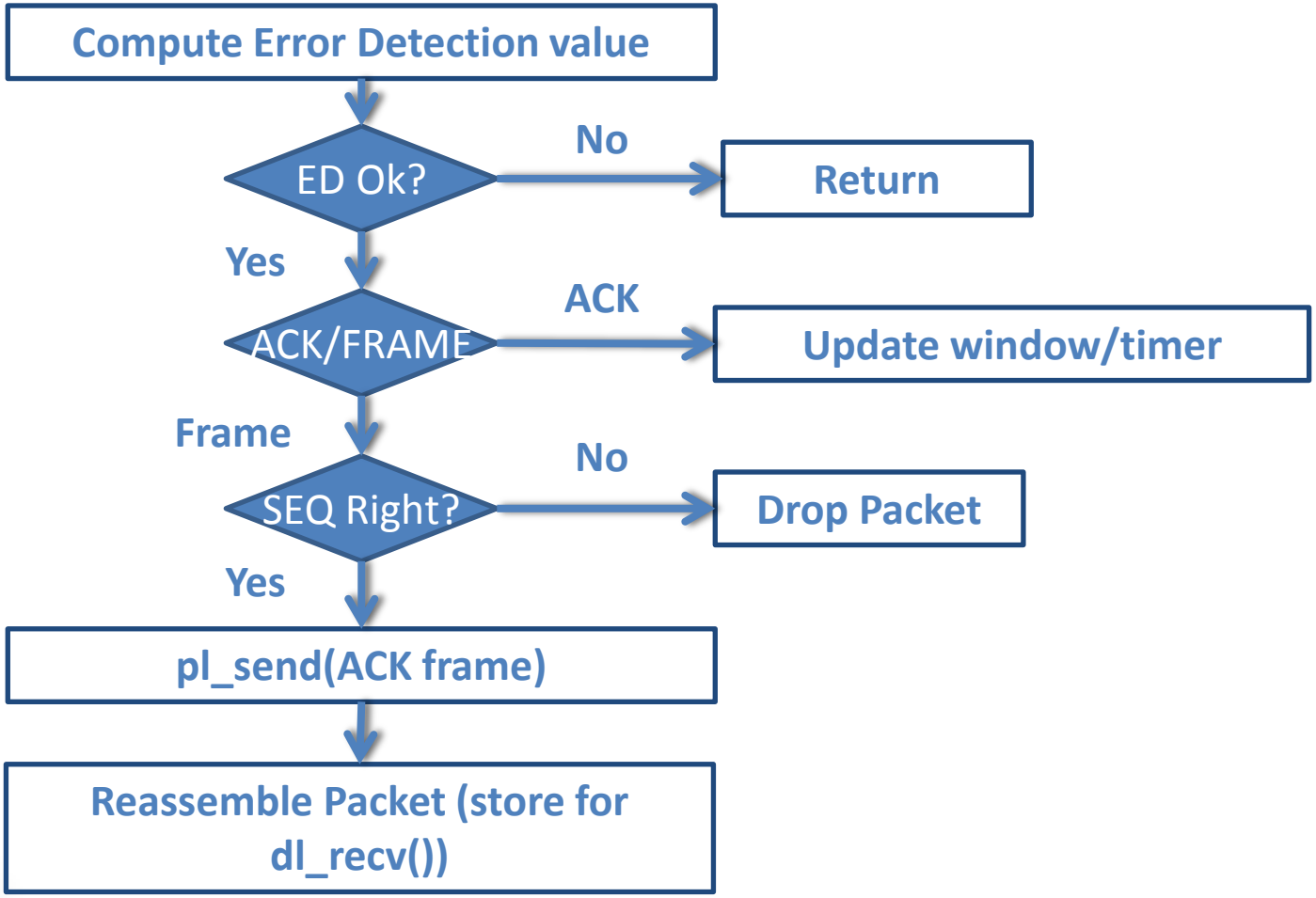
2. Error-Detection (ED) bytes (XOR on Seq + FT + EOF + Data)



EOF: End of Frame
FT: Frame Type

ED: Error Detection
Seq: Sequence Num

Data Link Layer: Frame Reception



Timers

- Timers will be used by the data link layer to detect frame loss.
  - DLL sets a timer when transmitting a frame
  - When the timer expires, DDL handles retransmit of send window up to lost frame
  - With Go Back N, it is possible to use a single timer and keep track of time intervals between transmission of frames.

- Two options for timers:
  - Select
  - Signals and Timers

Example Using select()

- Can be used to both send/recv at same time and/or as a timer for the data link layer

int select(int nfds, fd_set *readfds, fd_set *writefds, fd_set *exceptfds, struct timeval *timeout);

```
int main(void)
{
        fd_set rfds;
        struct timeval tv;
        int retval;
        /* Watch stdin (fd 0) to see
        when it has input. */
        FD_ZERO(&rfds);
        FD_SET(0, &rfds);
        /* Wait up to five seconds. */
        tv.tv_sec = 5;
        tv.tv_usec = 0;

        retval = select(1, &rfds, NULL, NULL, &tv);

        if (retval == -1)
                perror("select()");
        else if (retval)
                printf("Data is available
                now.\n");
        else // retval == 0 here
                printf("No data within five
                seconds.\n");

        exit(EXIT_SUCCESS); }
```

Signal Example

```
#include <signal.h>
#include <time.h>

timer_t timer_id;

void timeout(int signal_number){
        printf("\n SIGNUM: %d\n",
                signal_number);
        exit(0);
}

void start_timer(){
        struct itimerspec time_val;
        signal (SIGALRM, timeout);
        timer_create(
                CLOCK_REALTIME,
                NULL, &timer_id);
```

```
/* set timeout to 1 second */
time_val.it_value.tv_sec = 1;
time_val.it_value.tv_nsec = 0;
time_val.it_interval.tv_sec = 0;
time_val.it_interval.tv_nsec = 0;
timer_settime(timer_id, 0,
        &time_val, NULL);
}

main(){
        start_timer();
        while(1);
}
```

Send/Recv "concurrently"

- One option mention earlier is to use select()
- Another option is to use fcntl() to have the socket not block during recv()
- int fcntl(int s, int cmd, long arg);
  - Example:

```
#include <sys/unistd.h>
#include <sys/fcntl.h>

fctnl(socketFD, F_SETFL, O_NONBLOCK);
```

Questions?