Network Programming

Simulating Flow Control using Socket Programming

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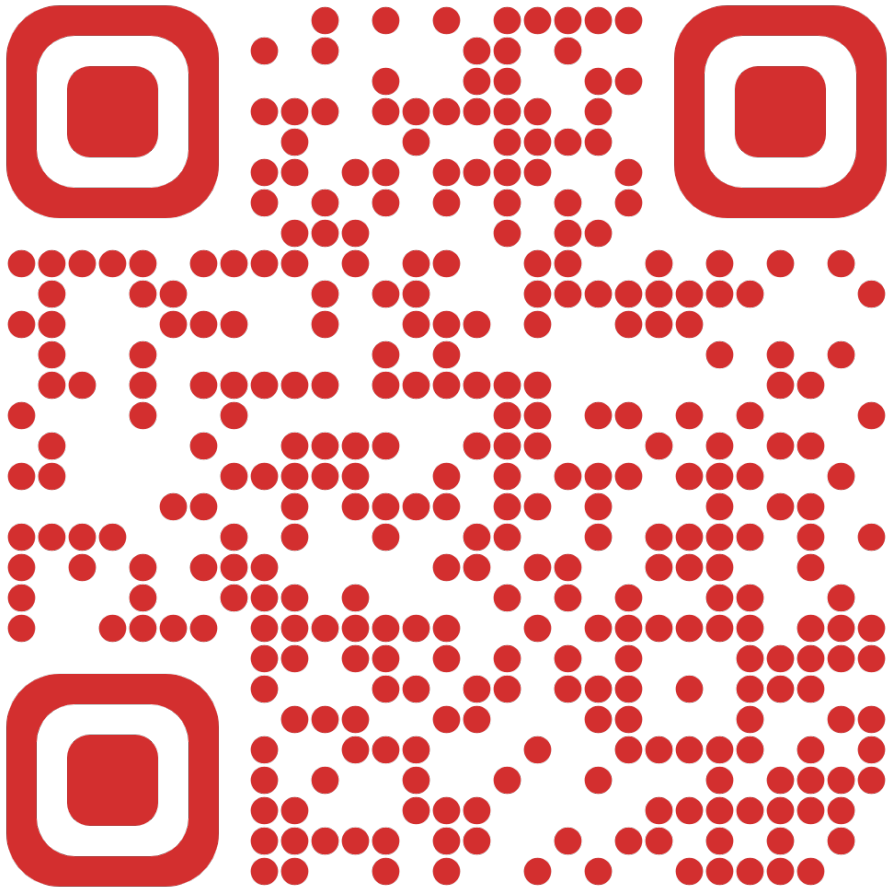
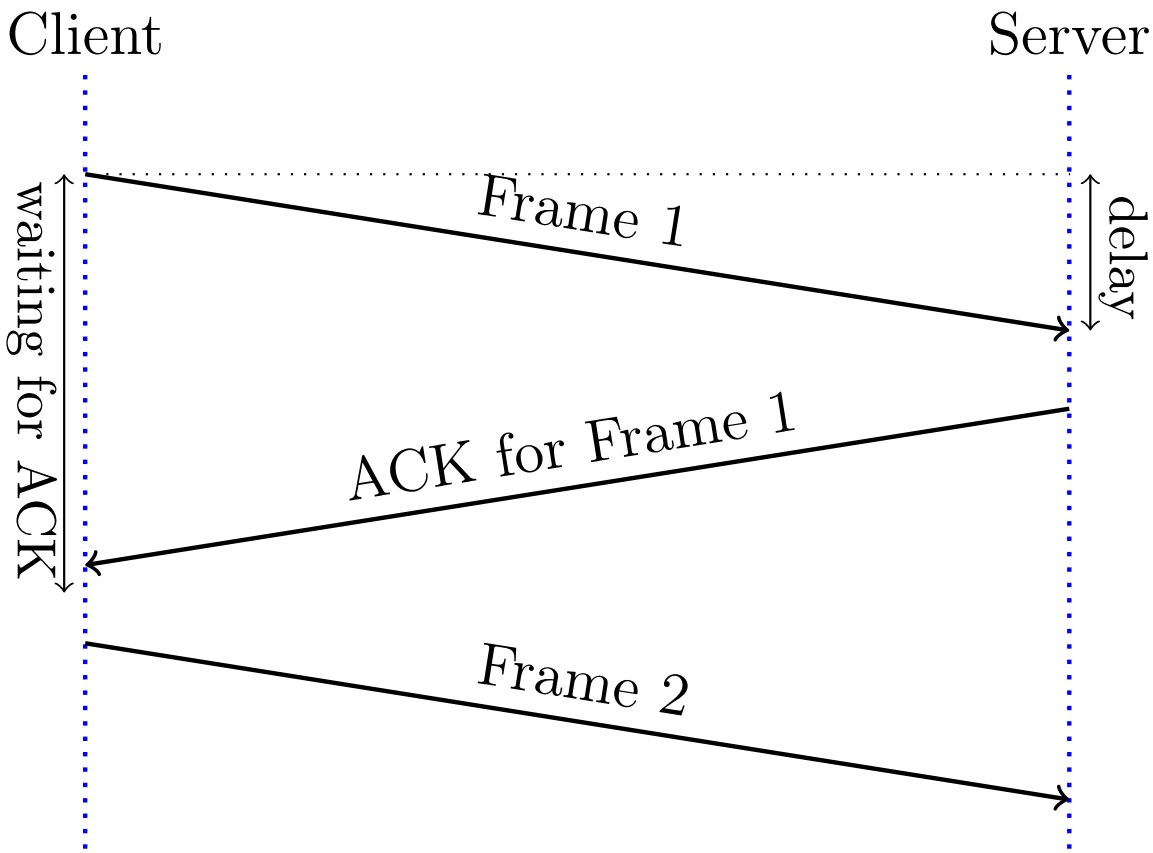
https://www.isical.ac.in/~rathin_r/uploads/CN/



WEB PAGE

Stop-and-Wait Protocol

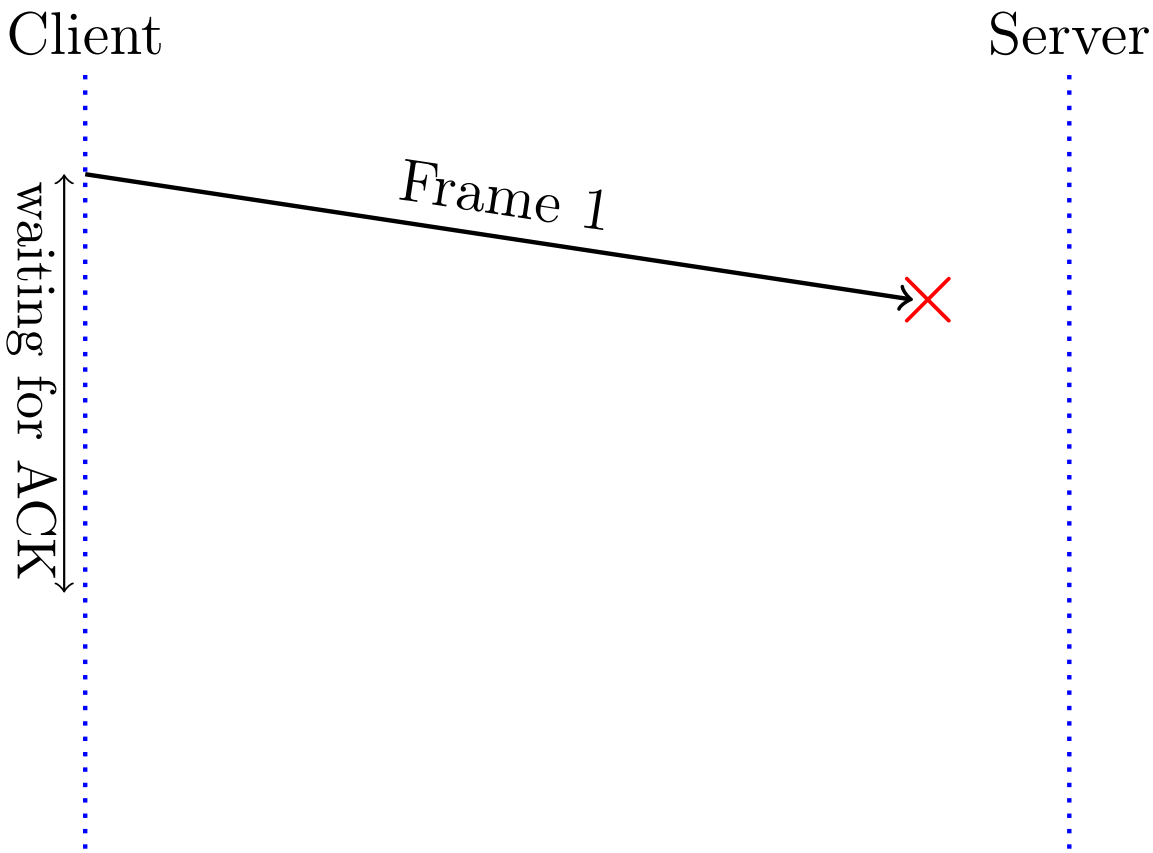
Simplest case of sliding window protocols



Normal operation

Stop-and-Wait Protocol

Simplest case of sliding window protocols



Dealing with lost frames

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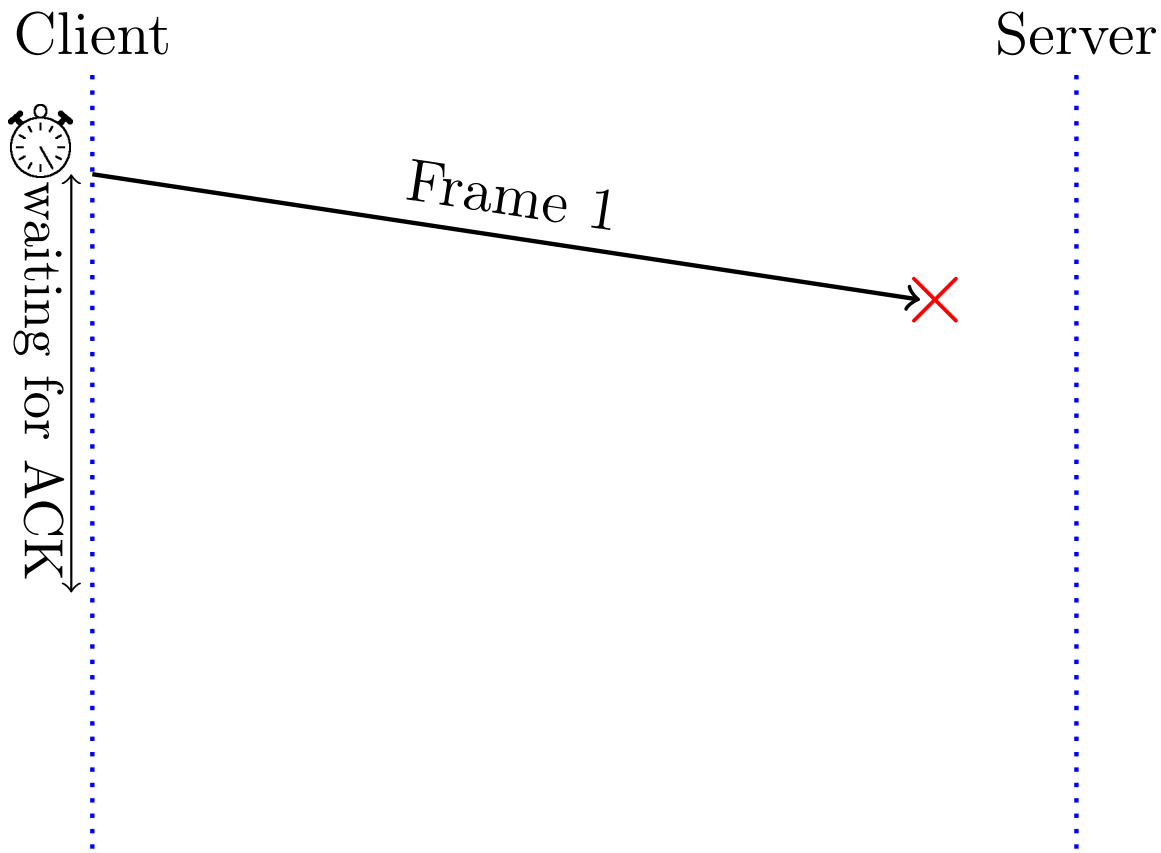

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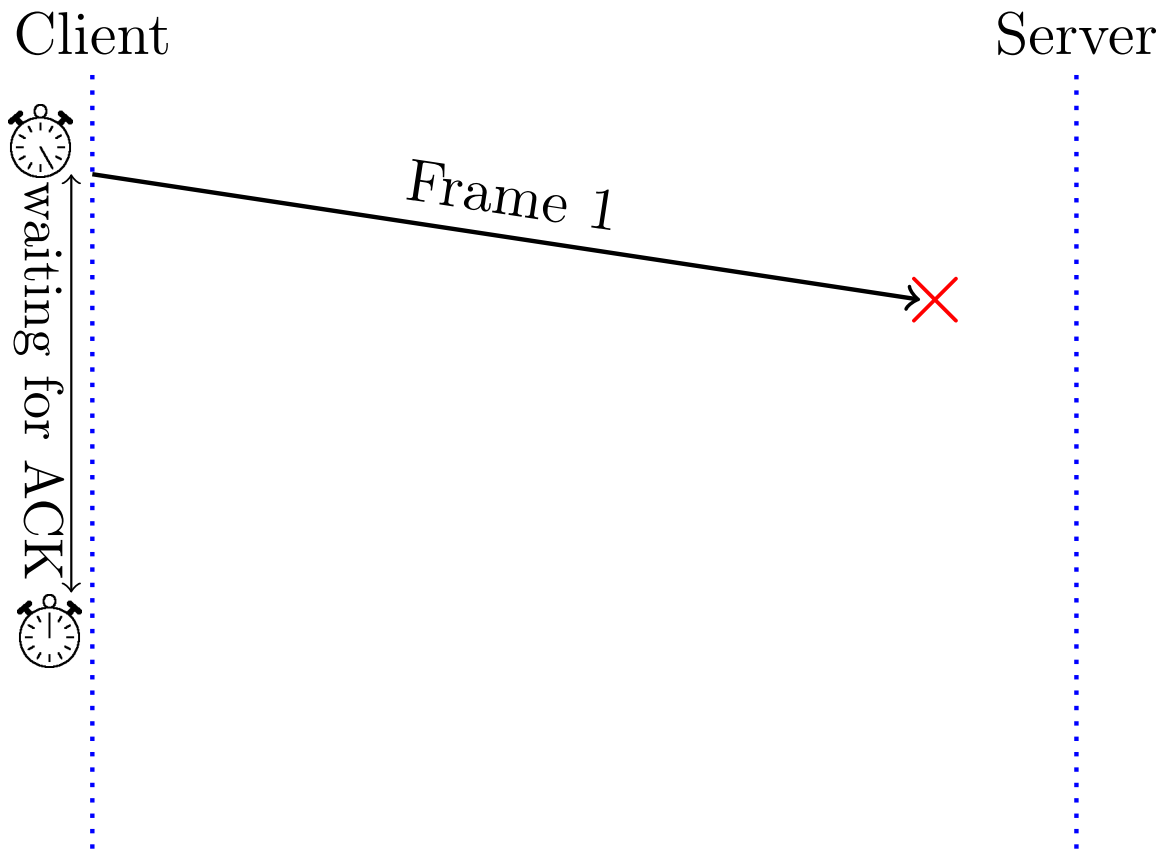

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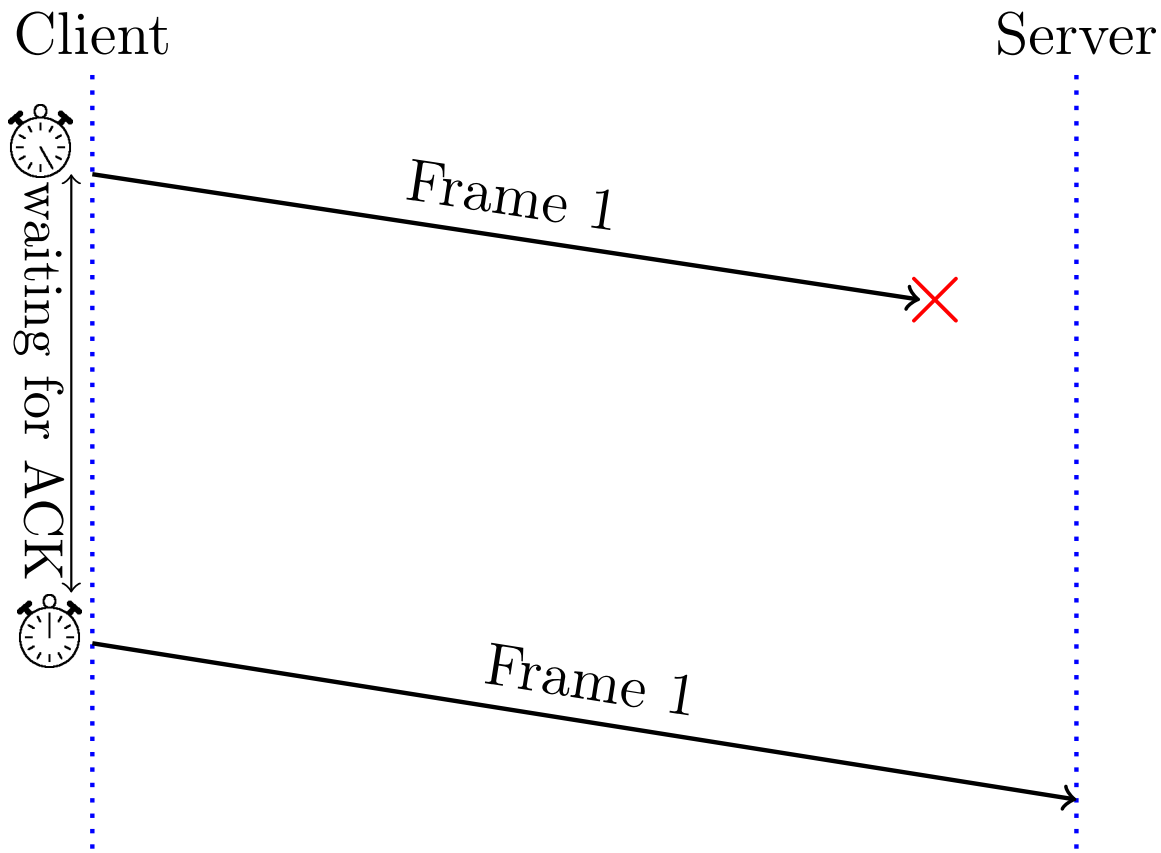

Dealing with lost frames

Prerequisite

- Some mechanism for simulating network delays

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  – making a process wait
- Some mechanism to detect a timeout
  – monitoring fds using `select()`
- Some mechanism for simulating packet loss
  – deterministic/random

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- How to wait for some 'exact' amount of time

  – utilize the system clock[1]

```
time_t before = time(NULL);
while(time(NULL) - before < 10); // wait 10 seconds
```

[1] See man page for `time()`: https://man7.org/linux/man-pages/man2/time.2.html

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```
sleep(10); // wait 10 seconds
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Take a look at `waiting.c`

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Monitoring File Descriptors

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- Recall that invoking a `read()` call indefinitely blocks the current process until some input arrives, or some error occurs

- To avoid this indefinite wait we can monitor a file descriptor for some desired I/O event
- And only invoke `read()` when some input arrives

- For this monitoring we will use the `select()` API[1]

[1] See man page: https://man7.org/linux/man-pages/man2/select.2.html

The `select()` API

```
#include <sys/select.h>
int select(int nfds, fd_set *readfds, fd_set *writefds,
           fd_set *exceptfds, struct timeval *timeout);
```

Return value: Returns the total number of fds are that ready.
On timeout, zero is returned. On error, -1 is returned.

Parameters:
`nfds`: set to the highest-numbered file descriptor in any of the three sets, plus 1
`readfds`: set of fds that are watched to see if they are ready for reading
`writefds`: set of fds that are watched to see if they are ready for writing
`exceptfds`: set of fds that are watched for 'exceptional conditions'
`timeout`: specifies the interval that `select()` should block waiting for a file descriptor to become ready

[1] `fd_set` is a special type that can represent a set of file descriptors

The `select()` API (contd.)

```
struct timeval {
    time_t      tv_sec;  /* seconds */
    suseconds_t tv_usec; /* microseconds */
};
```

The select() API (contd.)

```
struct timeval {
    time_t      tv_sec;  /* seconds */
    suseconds_t tv_usec; /* microseconds */
};
void FD_ZERO(fd_set *set);
// removes all file descriptors from the set

void FD_SET(int fd, fd_set *set);
// adds the file descriptor fd to the set

void FD_CLR(int fd, fd_set *set);
// removes the file descriptor fd from the set

int  FD_ISSET(int fd, fd_set *set);
// test if a file descriptor is still present in a set
```

All the three fd sets supplied to the `select()` call are updated
They must be reinitialized before making successive `select()` call

Timed Input

Take a look at `timeout.c`

Stop-and-Wait (without any packet loss)

Take a look at `stop_wait_server.c` and `stop_wait_client.c`

Simulating Frame Loss

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- The condition can be *randomized*

```
if( rand()  <  0.5 * RAND_MAX ) { // some threshold
    /* send the frame */
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```

- The condition can be *deterministic* as well

```
int counter = 0; // global scope or value-result argument
...
if( counter % 3 == 0 ) { // some condition
    /* do not send every third frame*/
} else { /* send the frame */ }
counter = (counter + 1) % 3 // update counter
```

Practice Problems

- Modify `stop_wait_client.c` to incorporate frame loss
  Assume no ACK is lost

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- Extend these ideas to simulate Go-Back-N Protocol for flow control