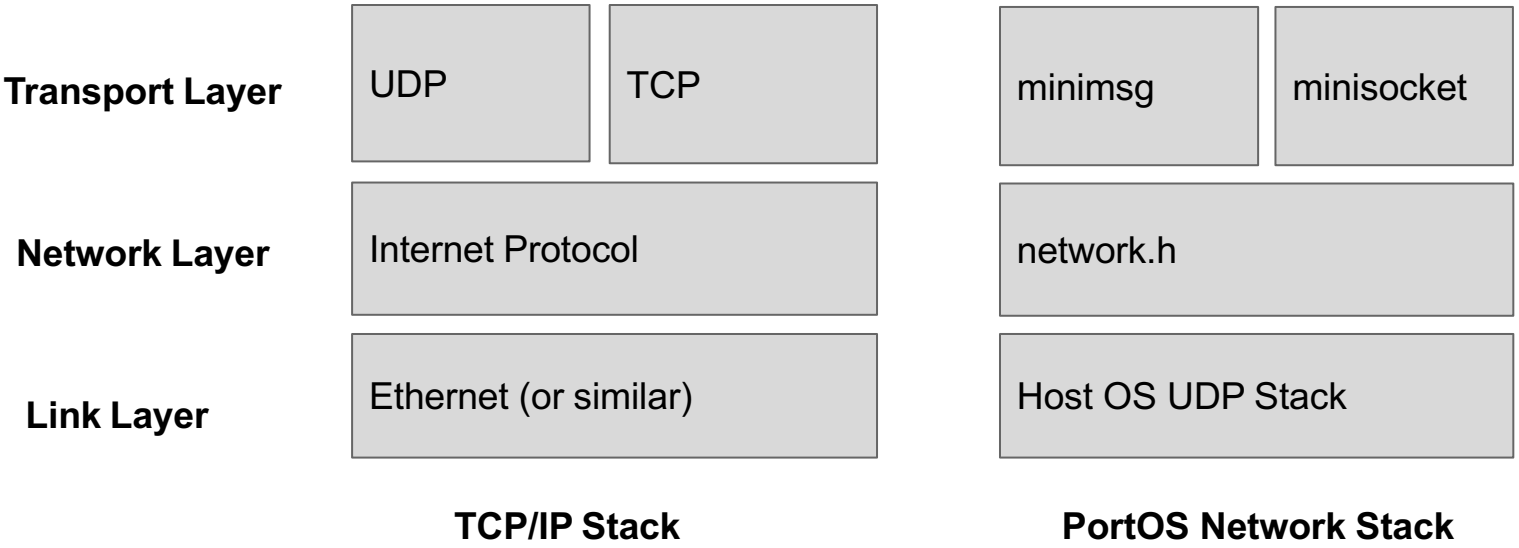
Project 4: Reliable Networking

Slide heritage: Previous TAs

Announcements

- Project 4 has been released
- I assume you've read the project description
- Due Friday, April 14th
- This is a pretty complex project ⇨ Start early!

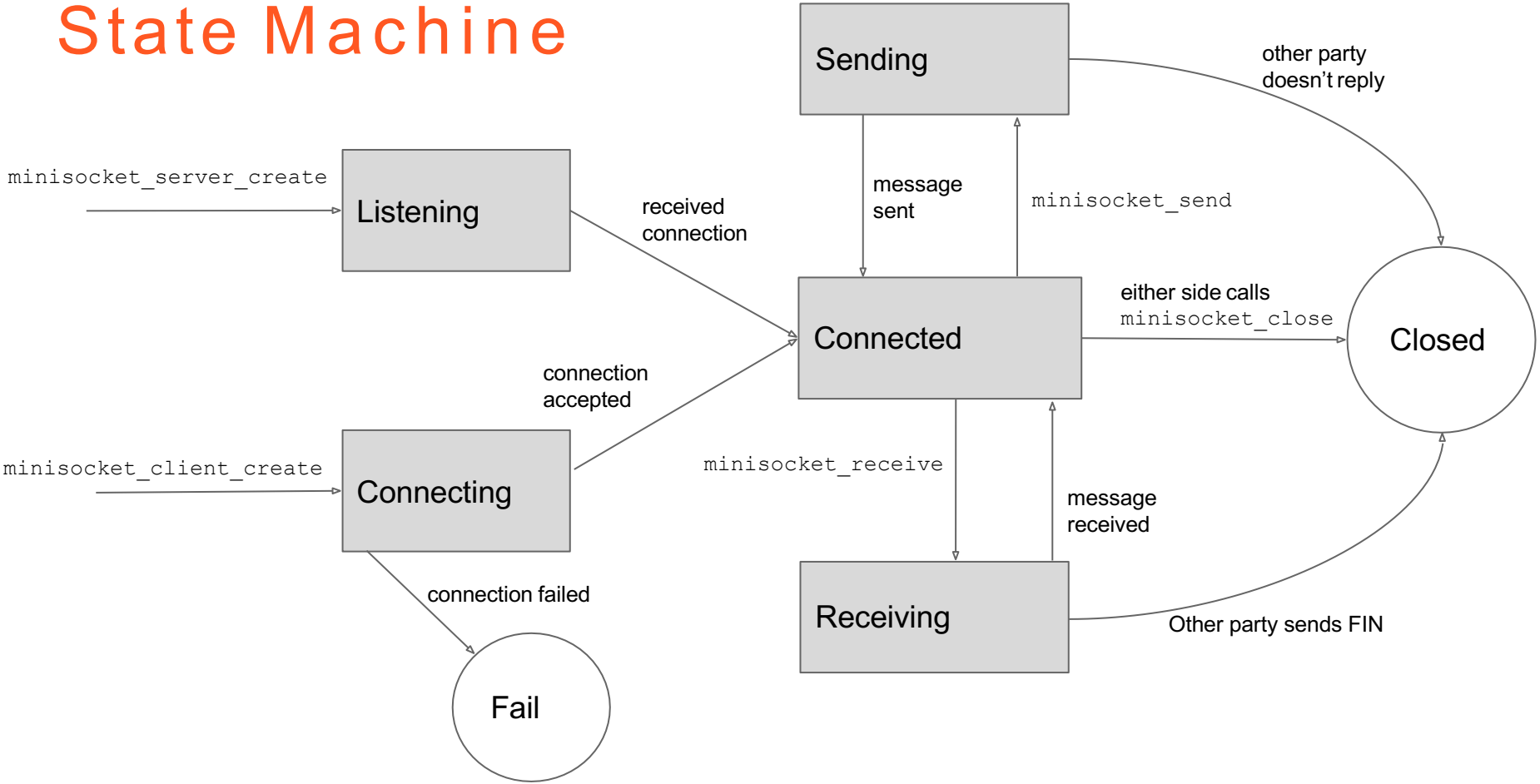
Our network stack vs. the real world



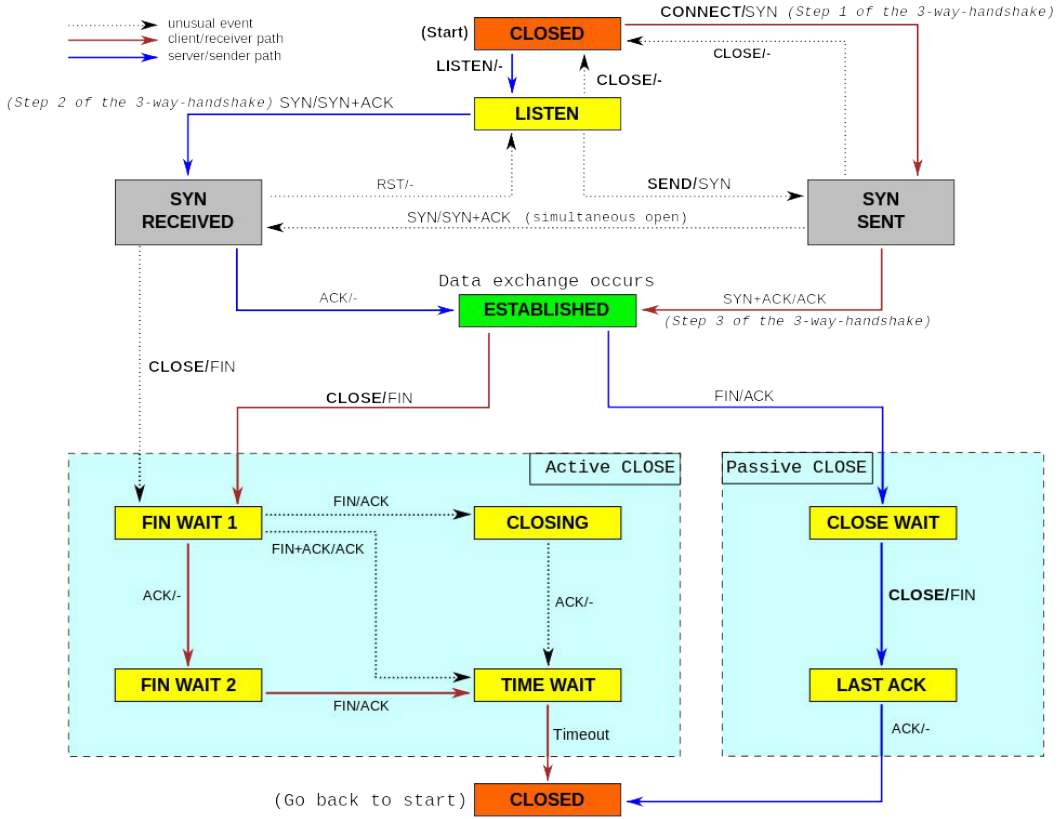
Minisocket is a simplified TCP

- Protocol is connection oriented
  - You must find a way to establish a connection between two endpoints
- Data is sent as a continuous stream of bytes
  - Messages are an application level concept
  - Minisocket must maintain correct ordering
- No limit on message sizes
  - You must fragment and reassemble the data

State Machine



Of course, it's much more complicated...



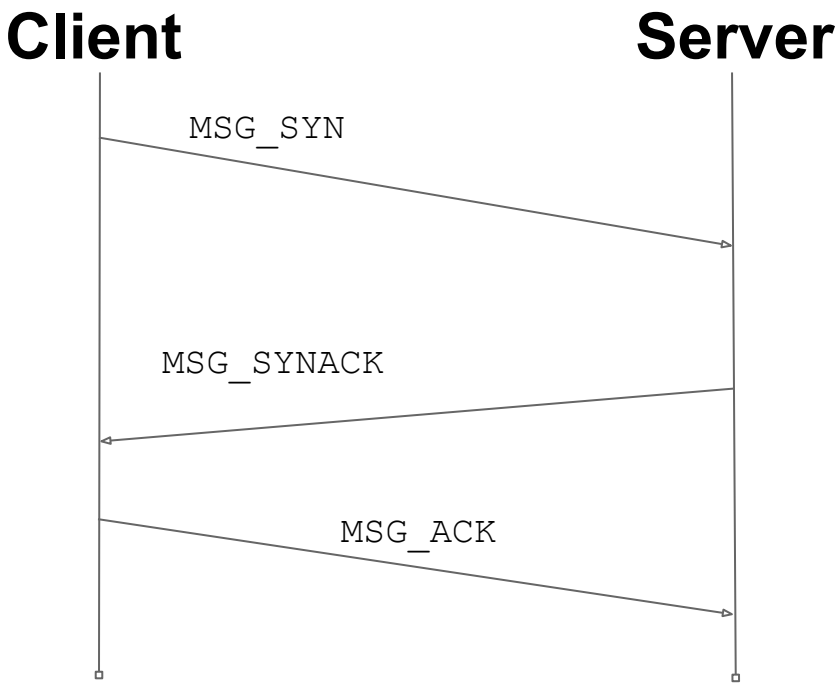
TCP State Machine
Source: Wikipedia/Cube00
License: CC BY-SA 3.0

What can go wrong?

- Any party can die
- Messages can get lost
- Data might be reordered
- Network might be partitioned

Welcome to the fun world of distributed systems!

Connecting: Three-Way Handshake



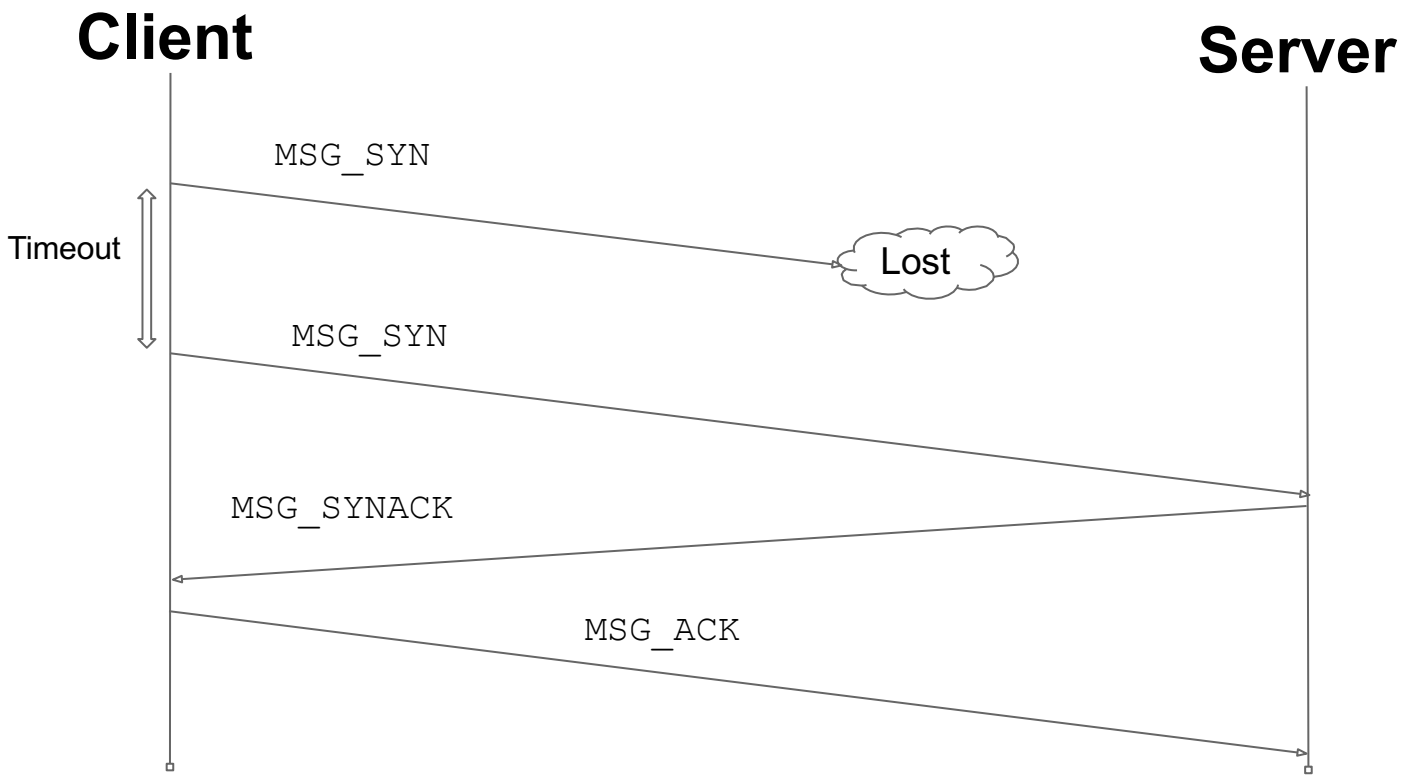
Non-blocking protocol

- Any packet might be lost
- Will be resent up to seven times
- Timeout doubles every time

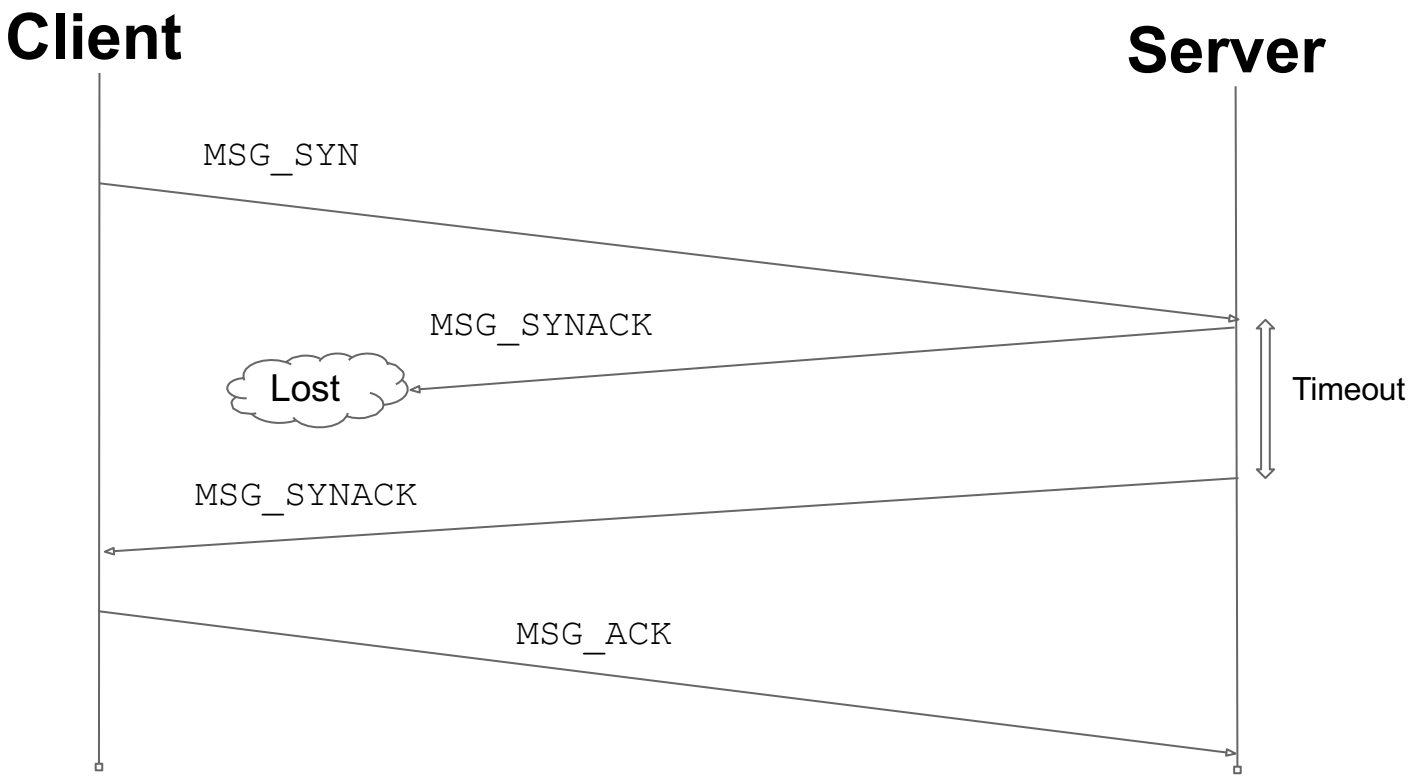
Initial Timeout: 100ms

∗ Give up after 12.7s

Messages can get lost

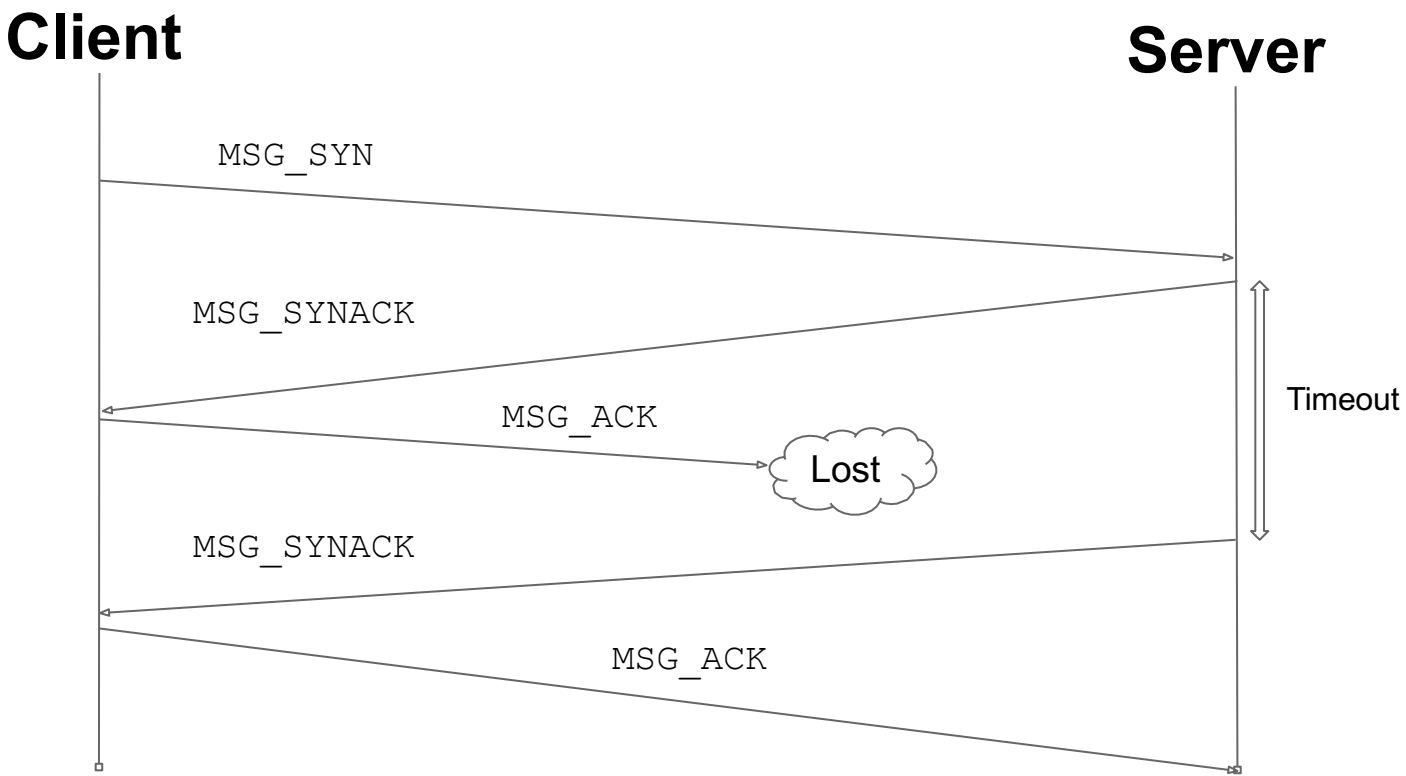


Messages can get lost

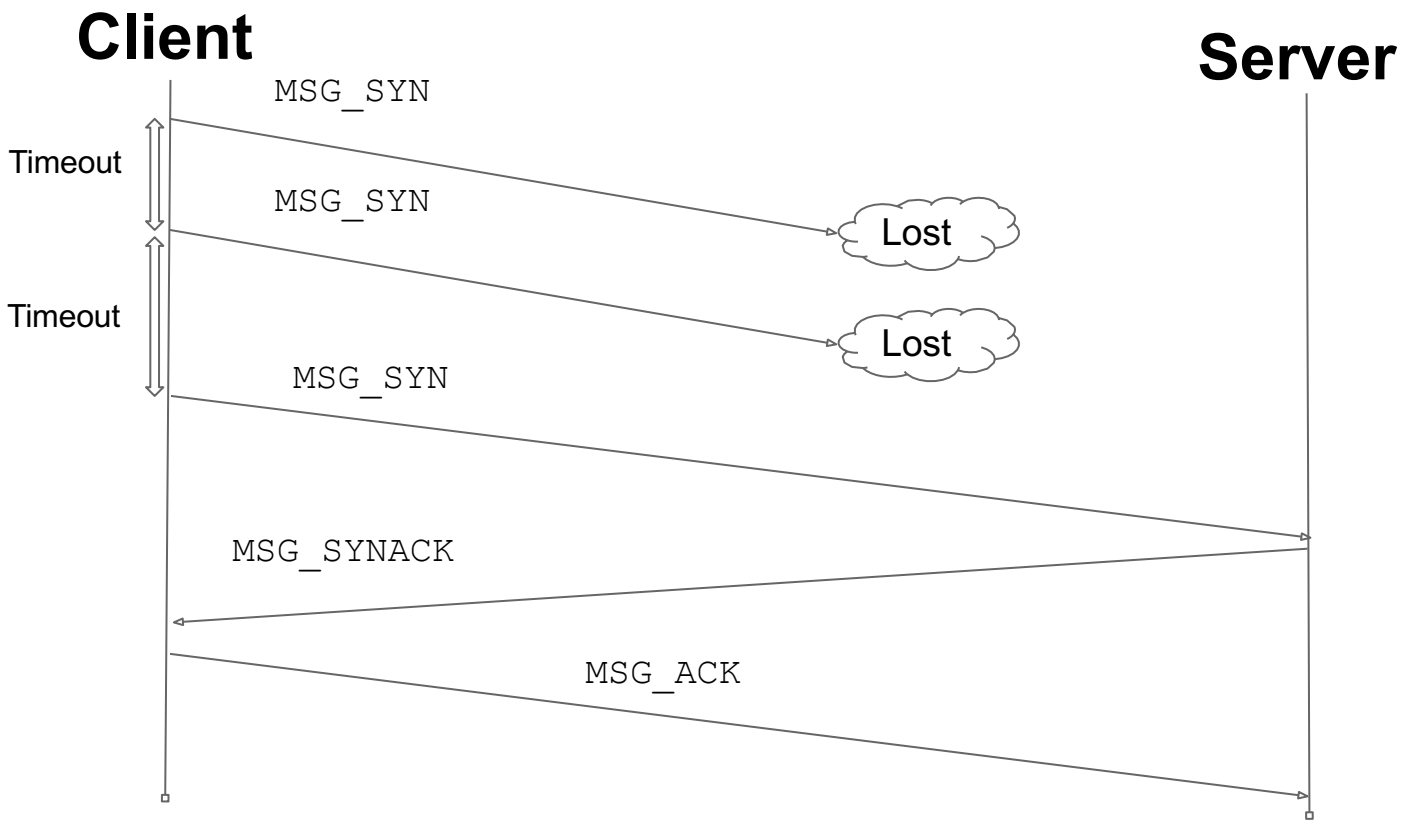


Note: In this case both parties might retransmit

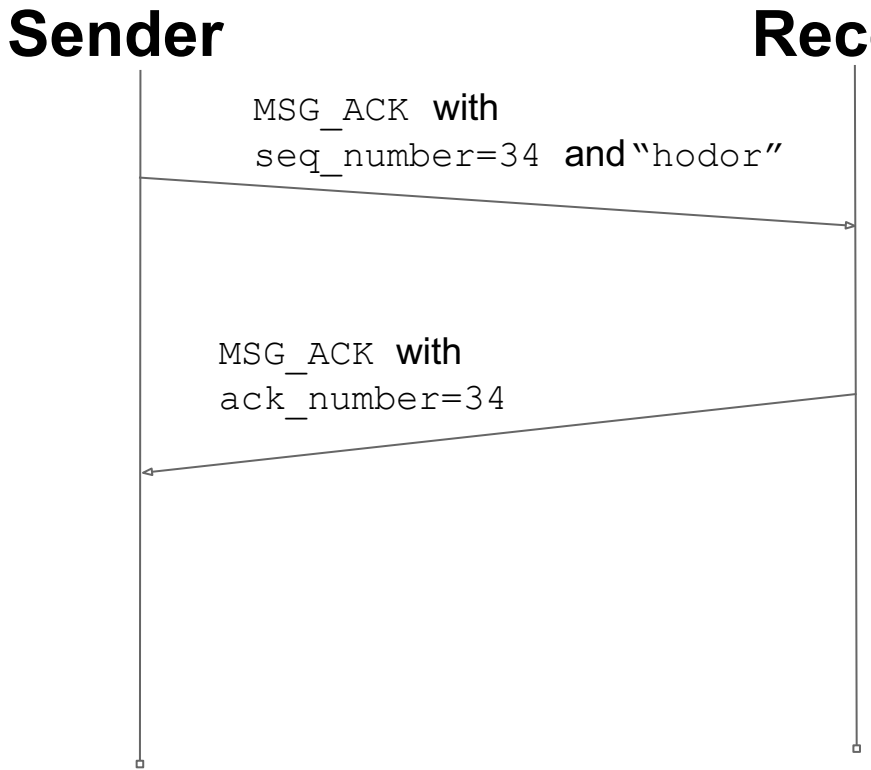
Messages can get lost



Messages can get lost multiple times



Sending Data: SEQ and ACK Numbers

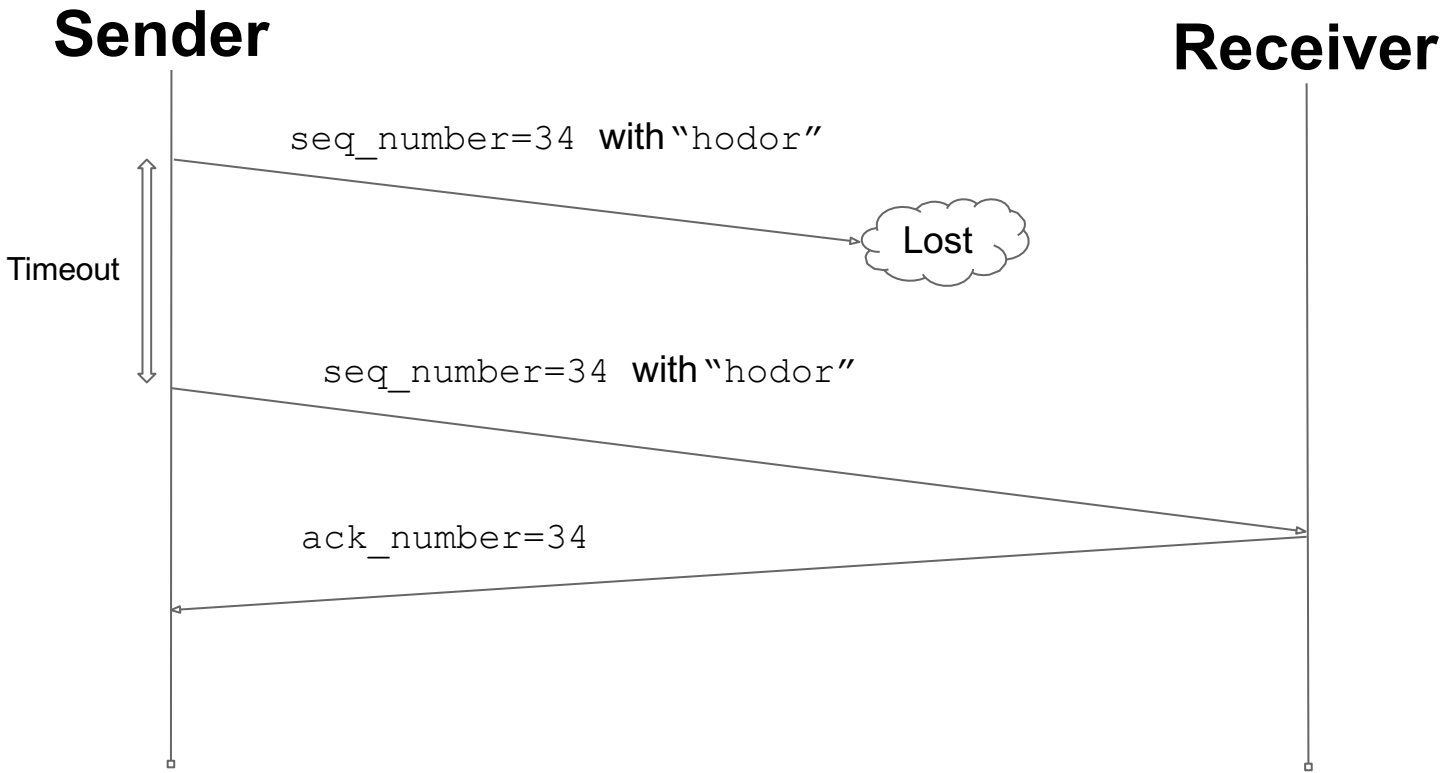


`seq_number` represents how many packets have been sent
⇨ is used to order messages

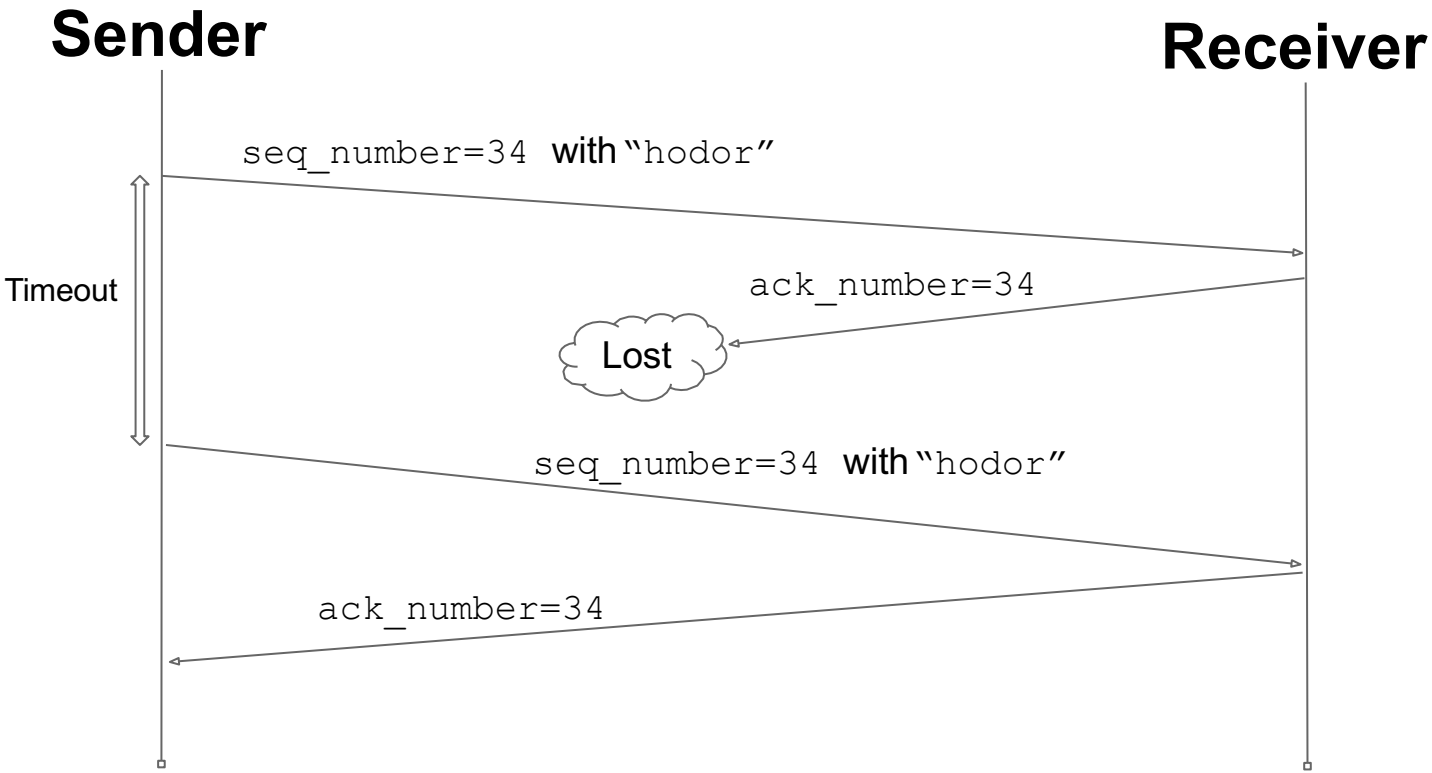
`ack_number` shows total received packets
⇨ is used to resend lost messages

Note: This is a symmetric channel. Both parties can send and receive.

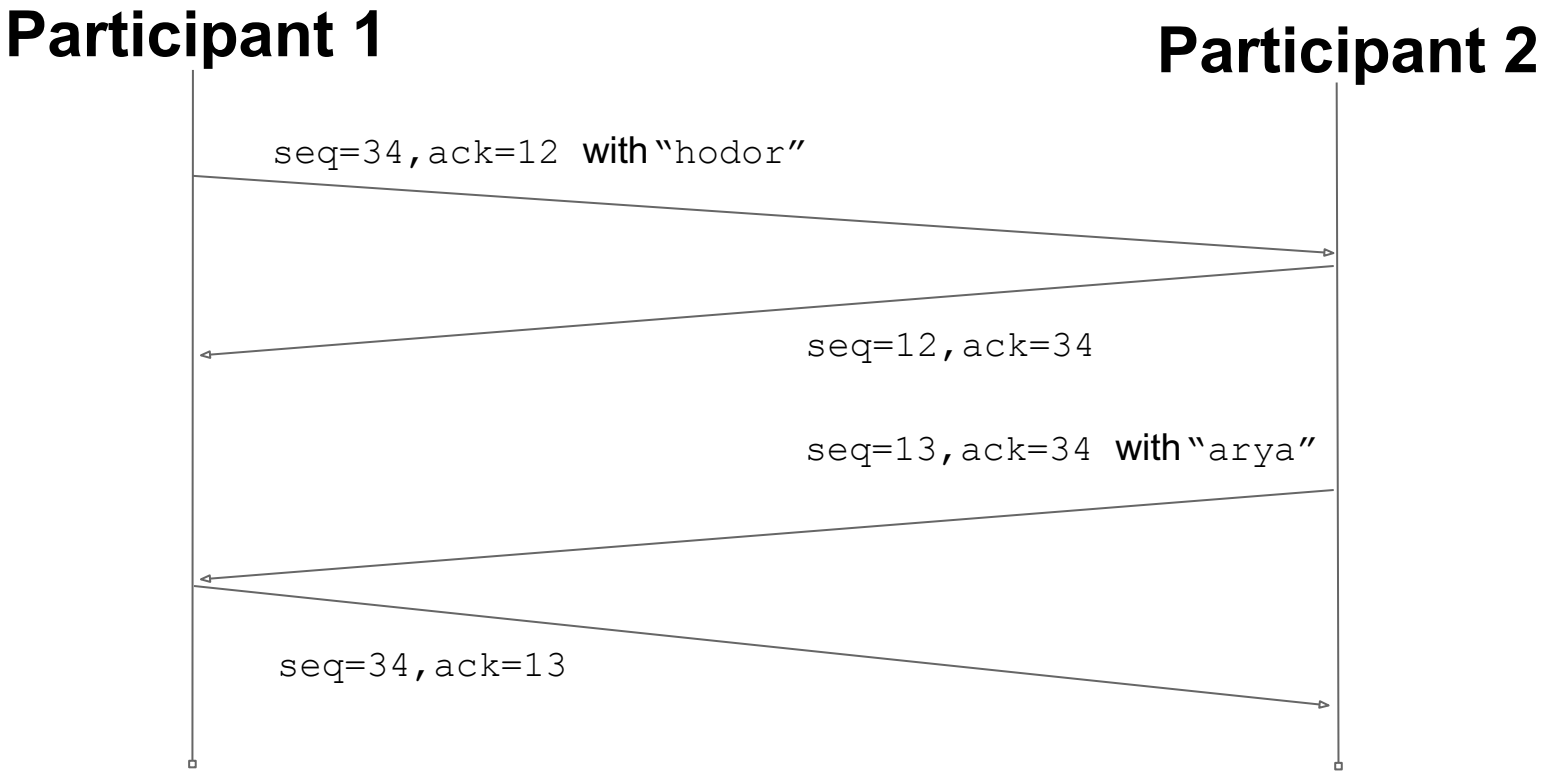
Again, messages can get lost



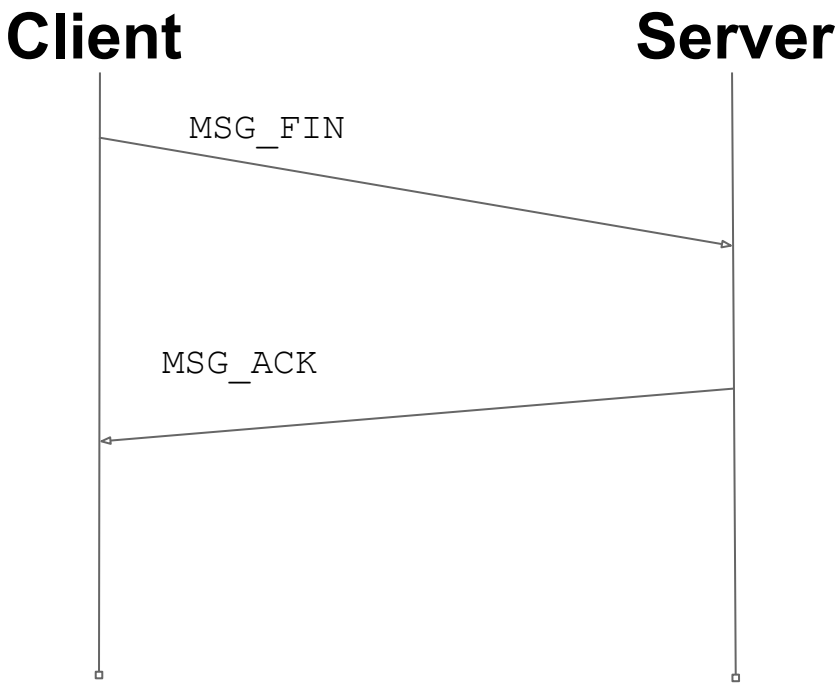
Again, messages can get lost



Either side can send and receive!

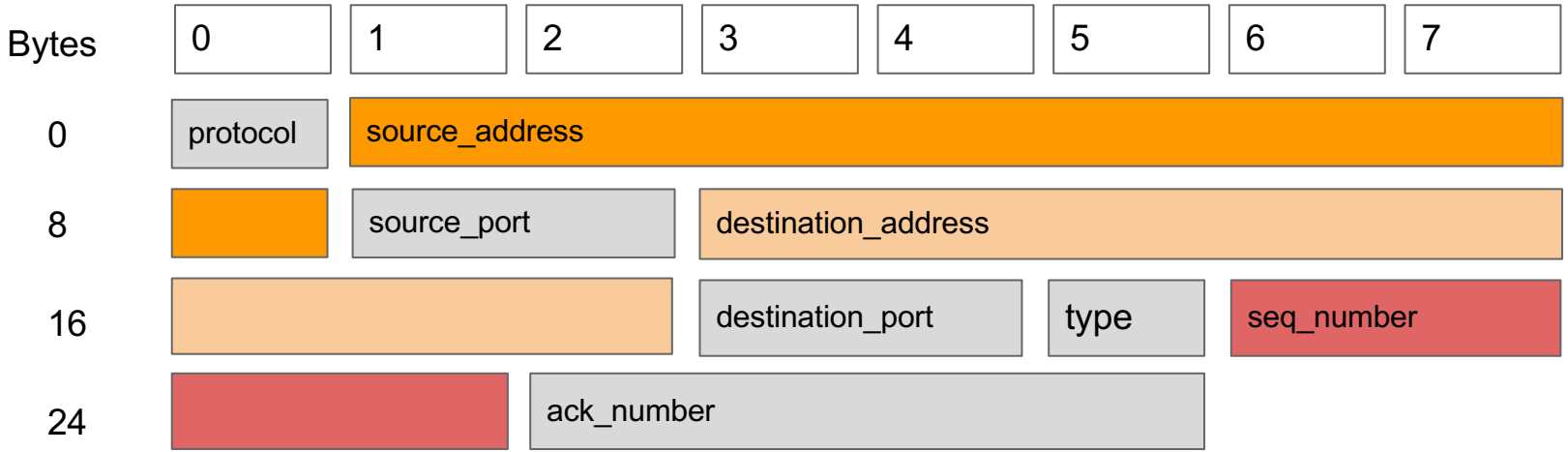


Closing connections



Again, this is a symmetric protocol.
Both sides can close the connection.

Minisocket Header



The first 21 bytes are identical to minimsg_header!

Use protocol field to multiplex protocols.

Tricky Part: How to implement timeout?

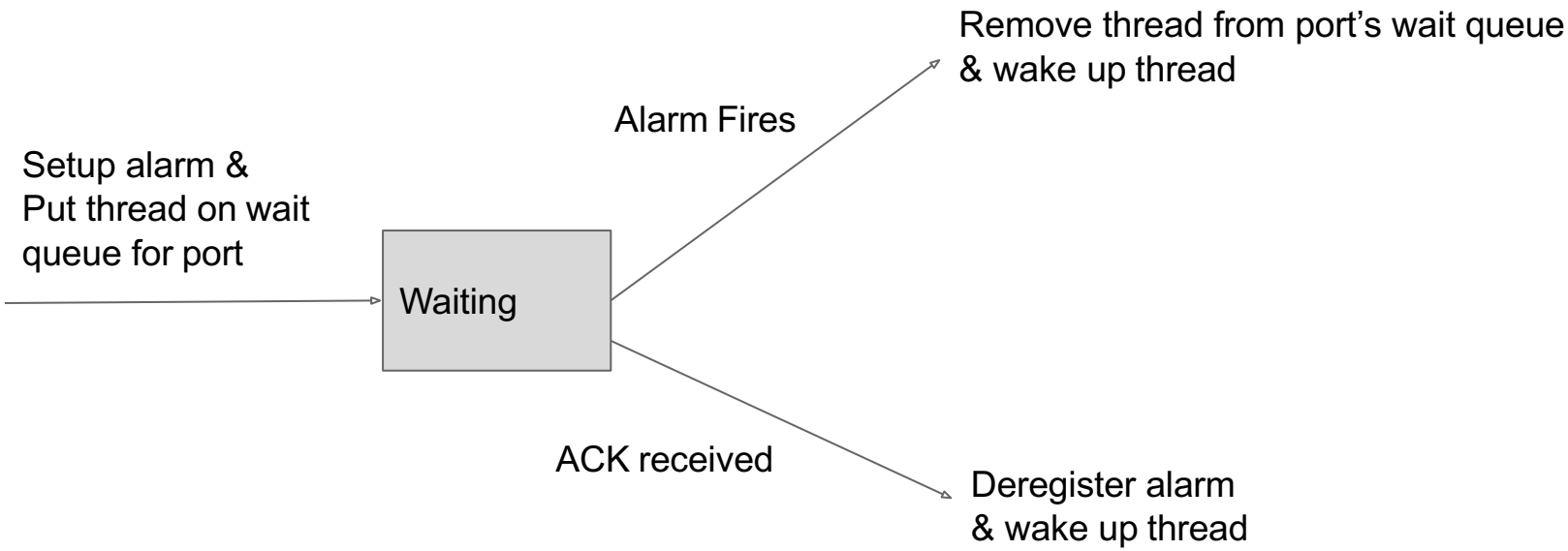
Remember that:

- Parties might never respond
- Multiple threads can call minisocket_receive() on the same port
- At most one thread can call minisocket_send() on a port

Things you must avoid:

- Putting threads on the run queue more than once
- Thread keeps waiting after message is received
- Thread blocks infinitely

Tricky Part: How to implement timeout?



To make it a little easier

- You don’t have to implement congestion control
- Sending one packet at a time is sufficient
- minimsg_send can block until corresponding ACK is received

But you can implement window sizes > 1 if you want to!
(and have the time…)

Where to start

- Think about the state machine from earlier!
- Try to make connection setup and termination work first.
- Test with no loss and single-thread access

Test all the code!

- What happens if you send very large messages?
- Can you handle a lot of messages?
- What if there is loss?
- If one party crashes the other one shouldn't.
- What if multiple threads are sending/receiving from the same port?

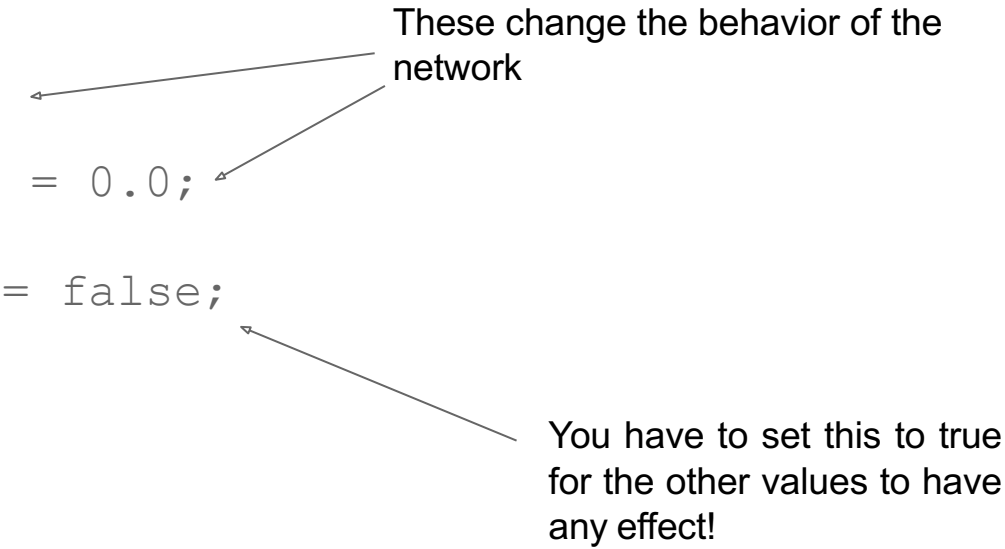
Test all the code!

In network.c:

```
double loss_rate = 0.0;

double duplication_rate = 0.0;

bool synthetic_network = false;
```



Updating your project

Your project has been merged with the latest code. Make sure everything compiles and nothing is missing

New files:

minisocket, conn-network[1-3]

Good Luck

Questions?

As always, if you need help, come to office hours or post your questions on Piazza!