CSE 452 Section 1

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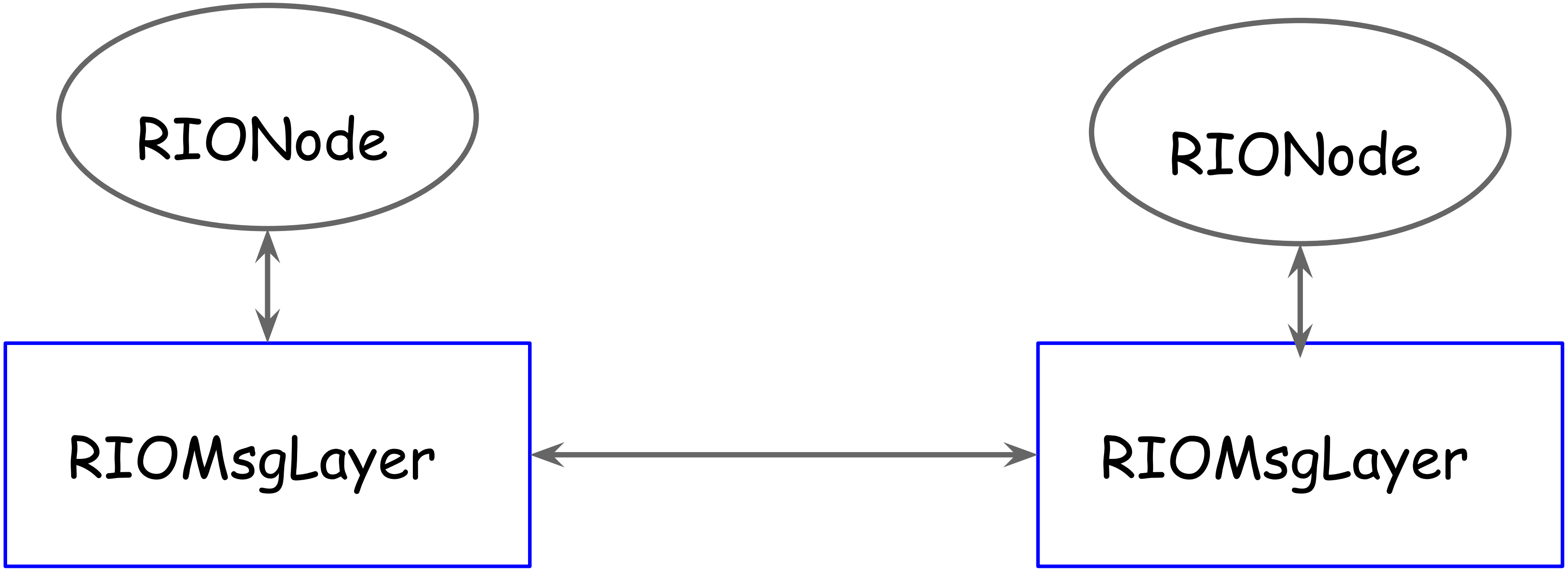
Building Distributed Systems

- distributed components
- have to deal with failures
- Messaging Layer
    - interface with hardware
    - faulty environment
    - debugging
- written in Java

- add/change files in proj/

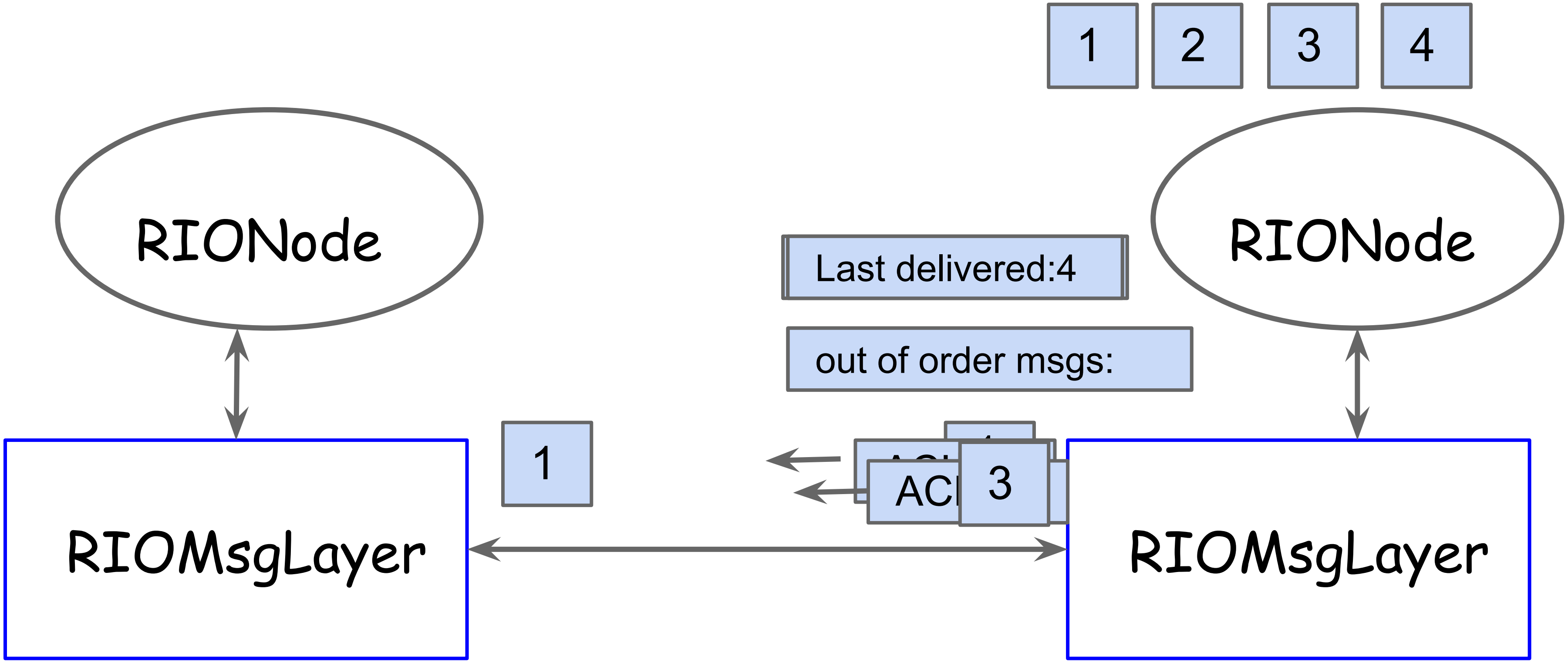
Reliable In-order Message Layer

- ReliableInOrderMsgLayer.java
- Reliable, in-order
  delivery in the absence of failures



In-order Message Delivery

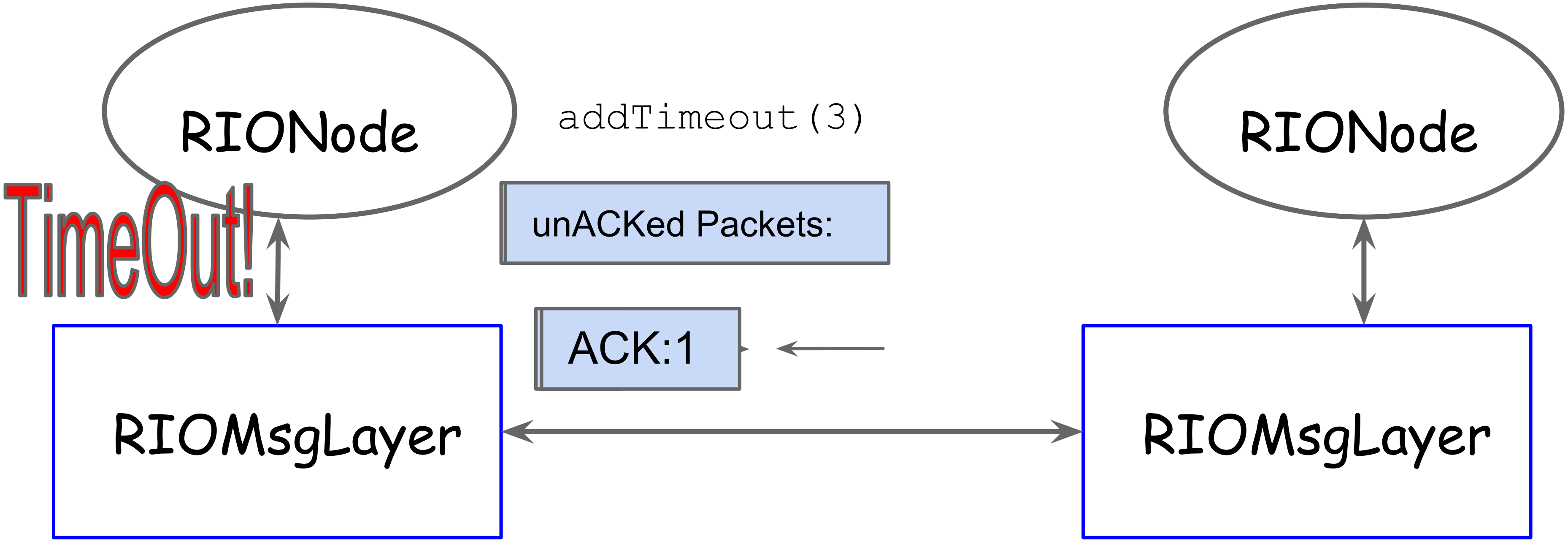
- Sequence Numbers, ACKS
- Time outs, retransmissions (like TCP)
- Packet Receipt: `public void RIODataReceive()`



Packet Sending

- `public void RIOSend(dst,protocol,payload)`
- implementing timeout: register timeout (for each unACK) function as a callback at a certain time

  `Manager.java/Callback.java`



Running the Distributed System

- Environment: simulation/emulation
- Configure Topology/Events
  - configure nodes: `start [n]`
  - event command: `[n] command`
  - `time:` advance by 1 timestep
  - example: scripts/RIOTest

Implementing the Node Interface

- Example: RIOTester (implements RIONode, which derives from Node)
- Node class identified at command line at the start to the manager (sim/emu)
- commands defined in `onCommand()`
  - example: 'begin' in RIOTester
  - send 20 packets to the first 3 nodes
- Packet types: `Protocol.java`

Failure Modes

- Specified by prob in node class
  - `getFailureRate`, `getDropRate`, `getDelayRate` (RIOTester.java)
- ... or by user control (command line)
  - 0: all events controlled by probs
  - 1: crashes controlled explicitly by user
  - 2: drops, 3: delay, controlled by user

Simulator (brief overview)

- Every timestep:
  - process in-flight packets
    - drop, delay, deliver
    - remove dropped pkt from in-flight queue
    - keep delayed pkt in-flight
    - schedule rest as delivery event
    - `checkInTransit(currentRoundEvents)`
  - schedule timeout events
    - `checkTimeouts(currentRoundEvents)`
  - schedule node crash events
    - `checkCrash(currentRoundEvents)`

Project 1: Client Server Filesystem

- 2 nodes in the system: server, client
- Simple RPC protocol
- Set of procedures for file operations (called by client)
- Handle node failures
- commands parsed and executed by `onCommand()` function in node class
    - specified in command file
    - *`0 create 1 foo.txt`*

Simple Filesystem Routines

- flat hierarchy (no directories)
- small files (fit in one pkt, minus header)
- create *server filename*
- read *server filename*
- append *server filename contents*
- checkVersion *server filename*
- Handle incorrect operations:
  - e.g., creating an existing file
  - no file changes, error msg sent back

Handling Failure Events

- Detect crash?
- Client failures
  - crash: server still serves request
  - ignore outstanding responses
- Server failures
  - crash/drop *after* service execution
  - crash/drop *before* service execution
  - client can't know which one

Server Failure Scenarios

1) Lost Request Message

- failure before service execution

2) Lost Response

- failure after service execution

How does the client know this?

- timeouts
- resend request

Server Failure Scenarios

- Side-effects of duplicate requests
  - idempotent (can be repeated harmlessly)
    - reads
  - nonidempotent (side-effects)
    - bank transfers (writes)
- How to deal with nonidempotent duplicate requests?

Server Failure Scenarios

3) Crash

- failure before/after service execution
- semantics for recovery:
  - at least once
    - keep trying until success
    - deal with duplicates (client)
    - idempotent operations
  - at most once
    - only one execution, or give up
    - smart server

Guiding Principles

- Correctness
  - correct action should be performed in the absence of failures
  - if the command executes, result should be correct
- Simplicity
  - corner cases (always)
  - e.g., no need for a 3-way handshake, teardown
- Termination
  - OK to give up after a reasonable # timeouts