

Project structure

- **Raft library** (`/pkg/raft`)
- **URL shortener service** (`/internal/urlShortener`)
 - **HTTP server**
(`/internal/urlShortener/server.go`)
 - **Finite-state machine**
(`/internal/urlShortener/store.go`)
- **Main executable** (`/cmd/joinNode/main.go`)

Load distribution

- only leader accepts write requests

```
// 409 Conflict
type FoundLeader struct {
    Message string `json:"message"`
    LeaderId int    `json:"leaderId"`
}
```

- every replica can answer read requests

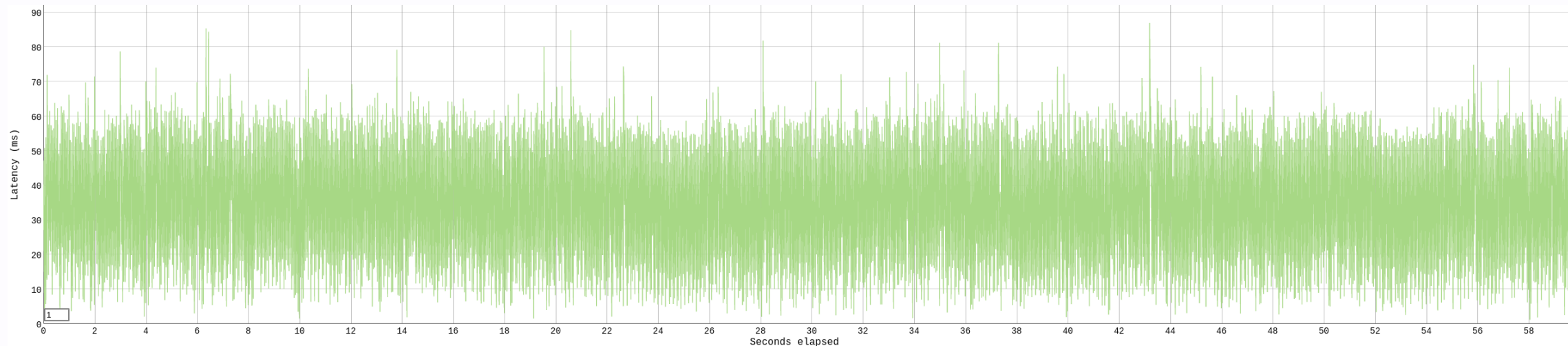
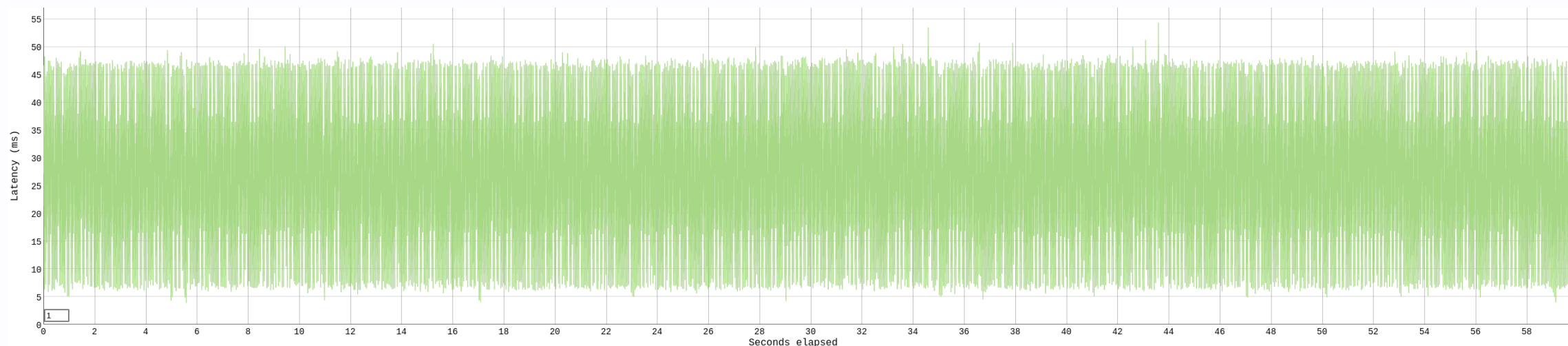
Expected Latency

- for a read request?
- for a write request?

Expected Latency

- $E[r] = \text{processingTime} + \text{networkRoundtrip}$
- $E[w] = (\text{heartbeatInterval} + \text{networkRoundtripQuorum}) / 2 + \text{networkRoundtrip}$

Measured Latency



Measured Latency

Requests	[total, rate, throughput]	6000, 100.02, 100.00
Duration	[total, attack, wait]	59.997s, 59.99s, 6.838ms
Latencies	[min, mean, 50, 90, 95, 99, max]	3.854ms, 26.914ms, 26.886ms, 46.907ms, 47.324ms, 48.299ms, 54.371ms
Bytes In	[total, mean]	606000, 101.00
Bytes Out	[total, mean]	276000, 46.00
Success	[ratio]	100.00%
Status Codes	[code:count]	201:6000

Requests	[total, rate, throughput]	59999, 999.96, 999.20
Duration	[total, attack, wait]	1m0s, 1m0s, 45.637ms
Latencies	[min, mean, 50, 90, 95, 99, max]	1.158ms, 33.349ms, 33.49ms, 52.768ms, 56.23ms, 62.333ms, 87.07ms
Bytes In	[total, mean]	6059899, 101.00
Bytes Out	[total, mean]	2759954, 46.00
Success	[ratio]	100.00%
Status Codes	[code:count]	201:59999

How tf did I debug this?

```
2023-02-08 20:02:03.050 [2] Initializing URLStore
2023-02-08 20:02:03.050 [2] Initializing Raft node
2023-02-08 20:02:03.050 [2] Joining cluster with 3 nodes
2023-02-08 20:02:03.050 [2] RPC: listening on port 9004
2023-02-08 20:02:03.050 [2] RPC: start connecting to node 1
2023-02-08 20:02:03.050 [2] URLStore: start listening to new committed commands
2023-02-08 20:02:03.063 [3] Installing URLStore
2023-02-08 20:02:03.064 [3] Initializing Raft node
2023-02-08 20:02:03.064 [3] Joining cluster with 3 nodes
2023-02-08 20:02:03.064 [3] URLStore: start listening to new committed commands
2023-02-08 20:02:03.064 [3] RPC: listening on port 9005
2023-02-08 20:02:03.064 [3] RPC: start connecting to node 1
2023-02-08 20:02:03.098 [1] Initializing URLStore
2023-02-08 20:02:03.099 [1] Initializing Raft node
2023-02-08 20:02:03.099 [1] Joining cluster with 3 nodes
2023-02-08 20:02:03.099 [1] URLStore: start listening to new committed commands
2023-02-08 20:02:03.099 [1] RPC: listening on port 9003
2023-02-08 20:02:03.099 [1] RPC: start connecting to node 2
2023-02-08 20:02:03.099 [1] RPC: connected to node 2
2023-02-08 20:02:03.099 [1] RPC: start connecting to node 3
2023-02-08 20:02:03.099 [1] RPC: connected to node 3
2023-02-08 20:02:03.099 [1] Starting consensus module
2023-02-08 20:02:03.099 [1] Becoming follower with term 0
2023-02-08 20:02:03.099 [1] Starting HTTP server on port 8000
2023-02-08 20:02:03.099 [1] Resetting election timer, reason: new election timer about to start
2023-02-08 20:02:03.099 [1] Started election timer (0) with timeout of 5.243ms
2023-02-08 20:02:03.152 [2] RPC: connected to node 1
2023-02-08 20:02:03.152 [2] RPC: start connecting to node 3
2023-02-08 20:02:03.152 [2] RPC: connected to node 3
2023-02-08 20:02:03.152 [2] Starting consensus module
2023-02-08 20:02:03.152 [2] Becoming follower with term 0
2023-02-08 20:02:03.153 [2] Starting HTTP server on port 9001
2023-02-08 20:02:03.153 [2] Resetting election timer, reason: new election timer about to start
2023-02-08 20:02:03.153 [2] Started election timer (0) with timeout of 5.273ms
2023-02-08 20:02:03.165 [3] RPC: connected to node 1
2023-02-08 20:02:03.165 [3] RPC: start connecting to node 2
2023-02-08 20:02:03.166 [3] RPC: connected to node 2
2023-02-08 20:02:03.166 [3] Starting consensus module
2023-02-08 20:02:03.166 [3] Becoming follower with term 0
2023-02-08 20:02:03.166 [3] Starting HTTP server on port 9002
2023-02-08 20:02:03.166 [3] Resetting election timer, reason: new election timer about to start
2023-02-08 20:02:03.166 [3] Started election timer (0) with timeout of 5.274ms
2023-02-08 20:02:08.350 [1] Election timer expired
2023-02-08 20:02:08.350 [1] Becoming candidate
2023-02-08 20:02:08.350 [1] Resetting election timer, reason: new election timer about to start
2023-02-08 20:02:08.350 [1] Sending RequestVote to node 2
2023-02-08 20:02:08.350 [1] Sending RequestVote to node 3
2023-02-08 20:02:08.350 [1] Started election timer (1) with timeout of 5.262ms
2023-02-08 20:02:08.352 [2] Received RequestVote from node 1 with term 1
2023-02-08 20:02:08.352 [2] Received RequestVote from node 1 with higher term (1); becoming follower
2023-02-08 20:02:08.352 [2] Becoming follower with term 1
2023-02-08 20:02:08.352 [2] Received RequestVote from node 1, granting vote
2023-02-08 20:02:08.352 [2] Resetting election timer, reason: new election timer about to start
2023-02-08 20:02:08.352 [3] Received RequestVote from node 1 with term 1
2023-02-08 20:02:08.352 [2] Resetting election timer, reason: granted vote
2023-02-08 20:02:08.352 [3] Received RequestVote from node 1 with higher term (1); becoming follower
2023-02-08 20:02:08.353 [3] Becoming follower with term 1
2023-02-08 20:02:08.353 [3] Received RequestVote from node 1, granting vote
2023-02-08 20:02:08.353 [2] Started election timer (1) with timeout of 5.25ms
2023-02-08 20:02:08.353 [3] Resetting election timer, reason: granted vote
2023-02-08 20:02:08.353 [2] Received election timer (0) tick, but term changed in mean time; stopping election timer
2023-02-08 20:02:08.353 [3] Resetting election timer, reason: new election timer about to start
2023-02-08 20:02:08.353 [3] Started election timer (1) with timeout of 5.289ms
2023-02-08 20:02:08.354 [1] Received RequestVote reply from node 2: (Term:1 VoteGranted=true)
2023-02-08 20:02:08.354 [1] Received majority of votes
2023-02-08 20:02:08.354 [1] Becoming leader
2023-02-08 20:02:08.354 [1] Sending AppendEntries to node 3
2023-02-08 20:02:08.355 [1] Received RequestVote reply from node 3: (Term:1 VoteGranted=true)
2023-02-08 20:02:08.355 [1] Received RequestVote reply from node 3, but node is no longer candidate; ignoring reply
2023-02-08 20:02:08.355 [1] Sending AppendEntries to node 2
2023-02-08 20:02:08.356 [3] Received AppendEntries RPC: (Term:1 LeaderId:1 PrevLogIndex:-1 PrevLogTerm:0 Entries:[] CommitIndex:-1)
2023-02-08 20:02:08.356 [3] Resetting election timer, reason: received AppendEntries RPC
2023-02-08 20:02:08.356 [2] Received AppendEntries RPC: (Term:1 LeaderId:1 PrevLogIndex:-1 PrevLogTerm:0 Entries:[] CommitIndex:-1)
2023-02-08 20:02:08.356 [2] Resetting election timer, reason: received AppendEntries RPC
2023-02-08 20:02:08.357 [1] Received AppendEntries reply from node 2: (Term:1 Success=true)
2023-02-08 20:02:08.357 [1] AppendEntries RPC to node 2 was successful: nextIndex=0, matchIndex=-1
2023-02-08 20:02:08.358 [1] Received AppendEntries reply from node 3: (Term:1 Success=true)
2023-02-08 20:02:08.358 [1] AppendEntries RPC to node 3 was successful: nextIndex=0, matchIndex=-1
2023-02-08 20:02:08.361 [1] Received election timer (1) tick, but node won election already; stopping election timer
2023-02-08 20:02:13.400 [1] Sending AppendEntries to node 3
2023-02-08 20:02:13.400 [1] Sending AppendEntries to node 2
2023-02-08 20:02:13.410 [3] Received AppendEntries RPC: (Term:1 LeaderId:1 PrevLogIndex:-1 PrevLogTerm:0 Entries:[] CommitIndex:-1)
2023-02-08 20:02:13.410 [2] Received AppendEntries RPC: (Term:1 LeaderId:1 PrevLogIndex:-1 PrevLogTerm:0 Entries:[] CommitIndex:-1)
2023-02-08 20:02:13.411 [2] Resetting election timer, reason: received AppendEntries RPC
2023-02-08 20:02:13.411 [1] Received AppendEntries reply from node 3: (Term:1 Success=true)
2023-02-08 20:02:13.411 [1] AppendEntries RPC to node 3 was successful: nextIndex=0, matchIndex=-1
2023-02-08 20:02:13.411 [1] Received AppendEntries reply from node 2: (Term:1 Success=true)
2023-02-08 20:02:13.411 [1] AppendEntries RPC to node 2 was successful: nextIndex=0, matchIndex=-1
2023-02-08 20:02:18.458 [1] Sending AppendEntries to node 3
2023-02-08 20:02:18.458 [1] Sending AppendEntries to node 2
2023-02-08 20:02:18.458 [3] Received AppendEntries RPC: (Term:1 LeaderId:1 PrevLogIndex:-1 PrevLogTerm:0 Entries:[] CommitIndex:-1)
2023-02-08 20:02:18.458 [2] Received AppendEntries RPC: (Term:1 LeaderId:1 PrevLogIndex:-1 PrevLogTerm:0 Entries:[] CommitIndex:-1)
2023-02-08 20:02:18.458 [2] Resetting election timer, reason: received AppendEntries RPC
2023-02-08 20:02:18.459 [1] Received AppendEntries reply from node 3: (Term:1 Success=true)
2023-02-08 20:02:18.459 [1] AppendEntries RPC to node 3 was successful: nextIndex=0, matchIndex=-1
2023-02-08 20:02:18.459 [1] Received AppendEntries reply from node 2: (Term:1 Success=true)
2023-02-08 20:02:18.459 [1] AppendEntries RPC to node 2 was successful: nextIndex=0, matchIndex=-1
```

Questions?