CS 425 – MP 2 Report

Alex Huynh (ah10), Kaimeng Zhu (kaimeng2)

Design

The failure detection system is based on the SWIM architecture but without indirect pinging. The general approach is to have each node ping in a sequential round robin with loopback. If a node does not respond to a ping, it is flagged as dead. MP1 was useful to debug this to see if machines were in the network / could receive grep requests.

This design scales to large N. Each node only sends out one ping per interval, so the runtime per interval is O(1), since they run in parallel, with space of O(N) for the cost of each ping.

1. 5-second completeness: because of the round-robin algorithm. Each interval, any given node can detect one failure. The worst case is that there are 3 successive failures. It would take 3 intervals, or 3 seconds because of the 1-second timeout.

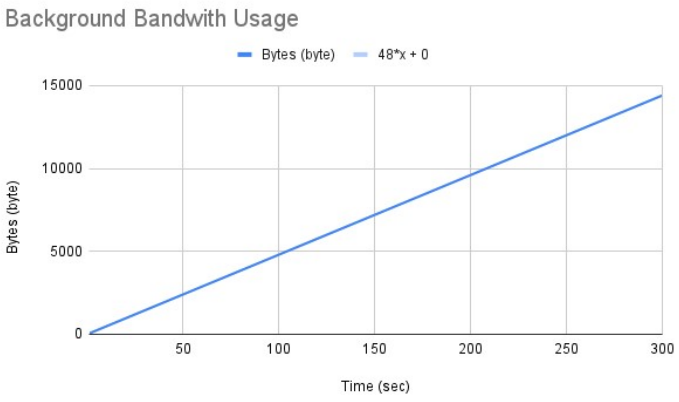
2. Completeness up to 3 failures for similar reasons to (1). In the best case of 3 failures, they are all spread apart. Their predecessor node will detect their failure. In the worst case, 3 successive failures, it will take 3 intervals to detect all the failures.

3. Can be made incomplete with N > 4 if the first four predecessors fail. If those four fail outside the timeout, it can be marked as incomplete.

Measurements

Assuming the case of N=6 machines

Background Bandwidth Usage: Additionally, assuming there are no membership changes. Theoretically, should be bytes of `ping` + `pong` * 6 machines, or 48 bytes total per second.



The data follows the theory exactly. This is likely due to data collection being done locally, so there is no latency.

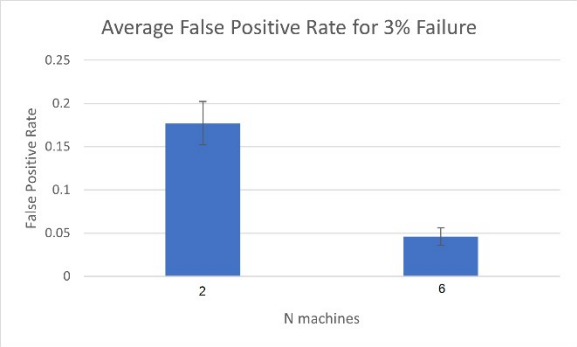
Average Bandwith Usage on Joins, Leaves, and Fails

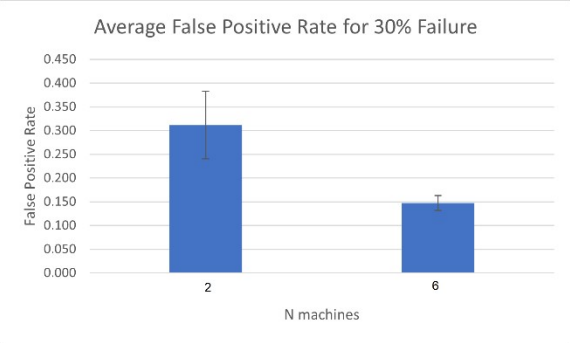
The goal is to reach N=6, so joins start with N=5 while leaves/fails start with N=7. Each data point was calculated using 10 respective joins/leaves/fails and averaged. Note that these numbers include the background bandwith usage.

Operation	Cost (bytes/sec)
Join	261.6
Leave	252.3
Fail	252.3

Leaves/fails are the same because the follow the same protocol. They are less expensive than join because join has the initial call of the `join [myIp]` ping, while a leave/fail simply disconnects itself local to itself.

False Positive Rate





Interestingly, a smaller number of machines leads to a higher false positive rate. Intuition would suggest a higher number of machines leads to a higher number of potential false positives flagged, since they are mutual exclusive events. However, perhaps, due to the round-robin architecture, more nodes are checking the dead node to ensure it is dead in greater N cases.

Also, here are the standard deviations. As expected, smaller N has more variation in data.

N	3%	30%
2	0.0584	0.170
6	0.0480	0.0376