CS425 MP2 REPORT

Yixuan Li, Netid: yixuan19; Tong Wei, Netid: twei11

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1. Design

In our MP2 implementation, we mainly drew inspiration from the SWIM protocol's dissemination mechanism, specifically the PING-ACK node information exchange process. In the design, each node periodically pings a random set of K nodes (from the full membership list) and expects an ACK in return to check if the node has left or failed. If there are updates to a node's status, instead of immediately sending extra update messages, the node waits until the next ping cycle to attach the update information to the PING/ACK message.

In our implementation, we attached the updated membership list to the outgoing messages. This approach prevents the network from being overloaded, ensures that the load is balanced across all nodes, and provides an efficient mechanism for failure detection and information dissemination.

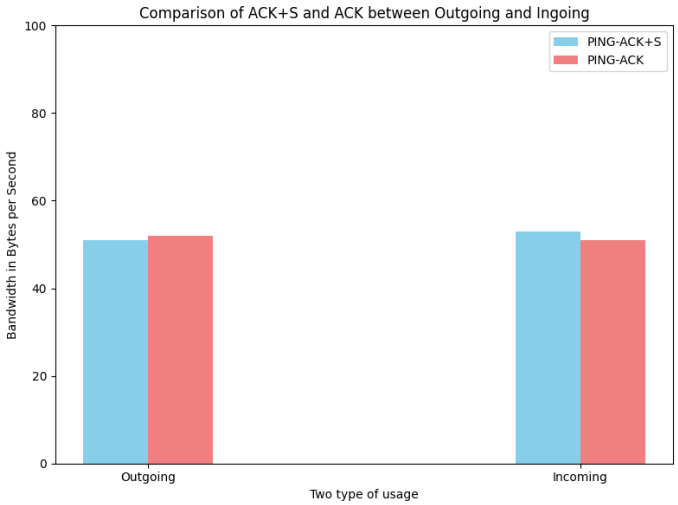
As for suspection mode, we use two tic-tok to measure the time it takes to receive a feedback from a specific node. If a node is labelled as a suspected node, it will be added into a pending list and wait for timer to clear them if no further update arrives.

2. Experiments Results

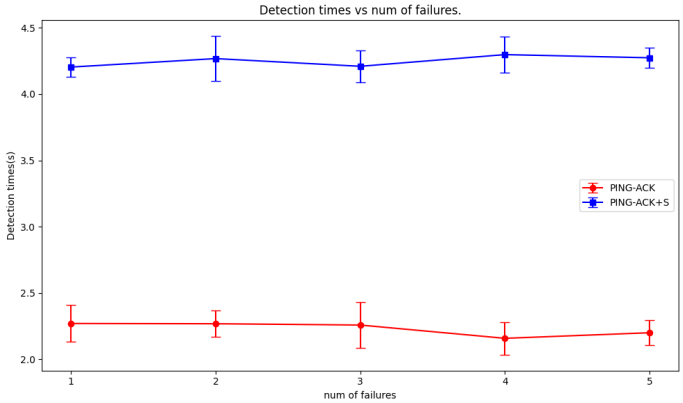
Experiment 1: Time-Bound

Through the first measurement of bandwidth usage (using the socket tool `psutil`), we separately measured the incoming and outgoing bandwidth of both PING-ACK and PING-ACK-Suspect in a stable state (in bytes/second). We observed no significant difference between the two. We hypothesize that this is because all additional information is attached to the periodic PING-ACK messages and sent together without requiring additional transmissions, hence no extra bandwidth is consumed.

For varying numbers of server failures, we measured the corresponding failure detection time. Our design setup includes a failure tolerance time of 2 seconds and a suspect time of 2 seconds. The results show that in PING-ACK mode, the failure detection time remains constant at around 2.3 seconds, regardless of the number of failures. Similarly, in PING-ACK-Suspect mode, the detection time remains stable at around 4.2 seconds.



(a) Time Bound - bandwidth usage of two mode



(b) Time Bound - detectTime vs Number of Failures

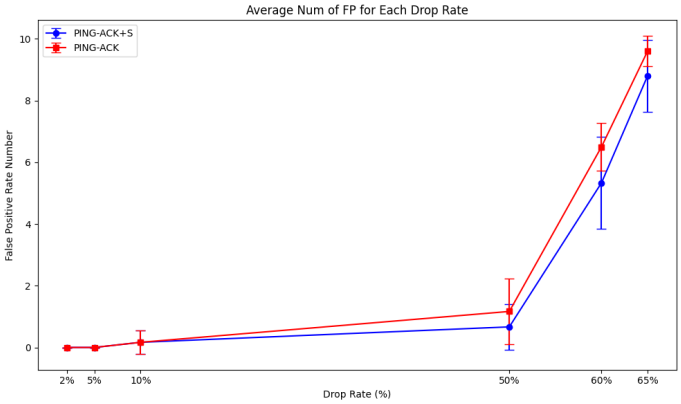
In the measurement of false positives, we conducted a more ambitious test by experimenting with a drop rate from 0% to 65%. We found that both modes exhibited a slow increase in false positives in the 0-50%

range, with a sharp rise after 50%. We hypothesize that the turning point, which is around 50% as shown in the figure, is determined by the combined effect of the number of ping messages spreading and the ping frequency.

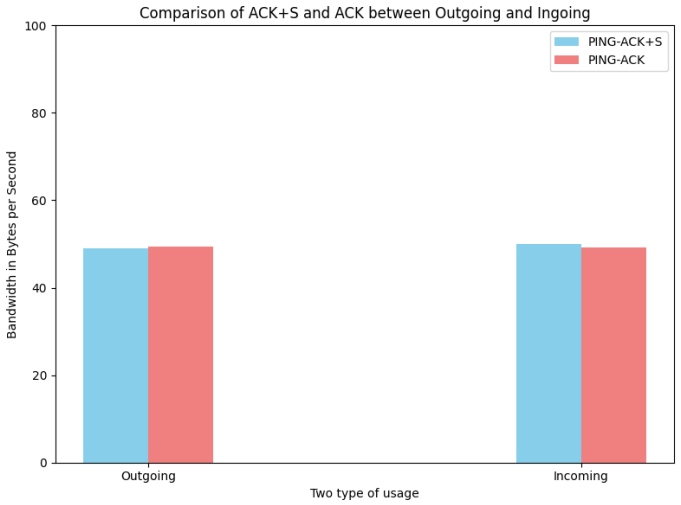
Experiment 2: Bandwidth Cap

The last three figures are from the second experiment, where we set a bandwidth cap on both modes and measured their performance under simultaneous failure scenarios.

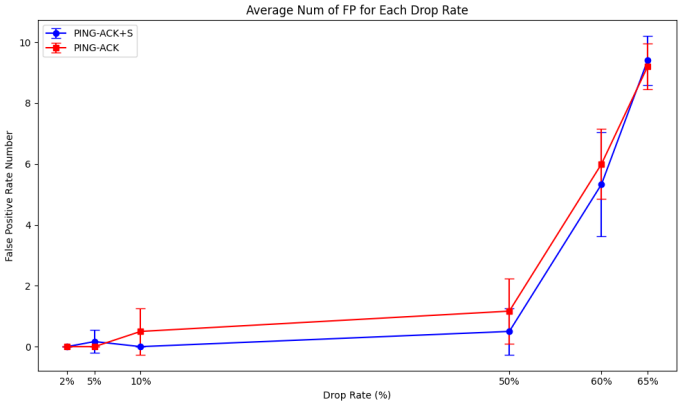
First, we measured the bandwidth usage under different modes. The overall trend remains consistent with previous observations. Due to the SWIM-like nature of our implementation, the difference between the two modes is minimal. Additionally, because of the bandwidth cap, neither mode exceeds the cap limit.



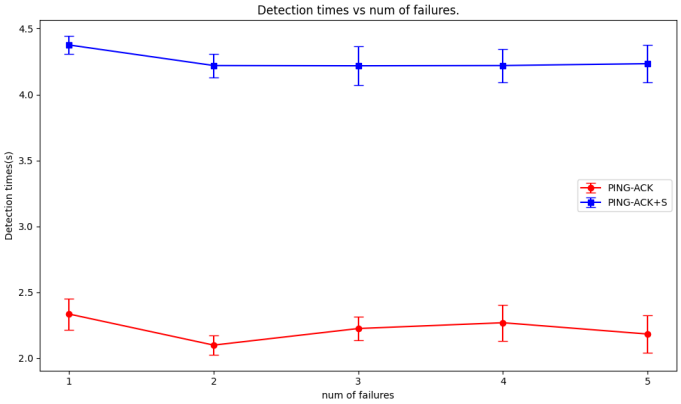
(a) Time Bound - False Positive Rate



(b) Bandwidth Cap - bandwidth usage of two mode



(a) Bandwidth Cap - False Positive Rate



(b) Bandwidth Cap - detectTime vs Number of Failures

Next, we measured the false positive (FP) rate under the bandwidth cap. We still did not observe any significant changes, and the turning point remained around 50%, as we expected.

Finally, we measured the detection time in failure cases. We observed that the overall detection time did not significantly change with the number of failures. Therefore, we believe that the bandwidth used in failure cases is not substantially different from the bandwidth in non-failure cases. We attribute this to the inherent characteristics of the SWIM protocol.