CS425 Distributed Systems MP2 Report
Aditi Sadwelkar, Aryaman Ramchandran

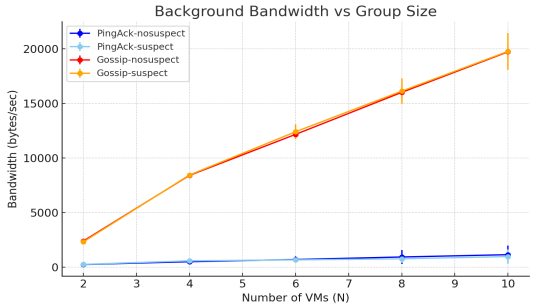
Our membership service supports Gossip and PingAck protocols with optional suspicion. Each daemon maintains a membership list containing (hostname, status, heartbeat, incarnation).

Protocols: In Gossip mode, nodes periodically disseminate membership state to randomly chosen peers, ensuring eventual consistency by epidemic spread. In PingAck mode, nodes perform directed liveness checks by sending UDP PINGs and expecting ACKs. Both protocols share the same serialization format and update rules, so nodes can switch between them seamlessly without restarting or rejoining.

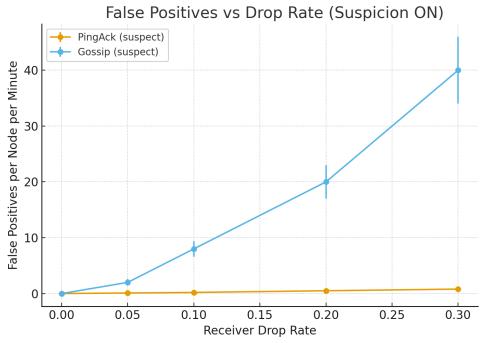
Suspicion: Suspicion provides a two-phase failure model. Upon missed heartbeats (Gossip) or missing ACKs (PingAck), a node is first marked SUSPECTED. If the suspicion window expires without rebuttal, the node escalates to FAILED. This prevents transient network drops from causing spurious removals. Suspicion state itself is gossiped across the network, so other nodes converge on the same view of a suspected member.

We evaluated background bandwidth, false positive rates, and detection times on $N \in \{2,4,6,8,10\}$ VMs. Each run lasted ~60 s. Bandwidth was measured in bytes/sec from per-node counters; receiver-side drop rates induced loss for the false-positive study; detection time was measured from induced failures to confirmed removal.

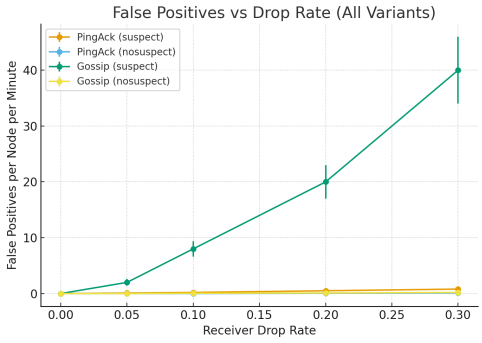
1a/2a:



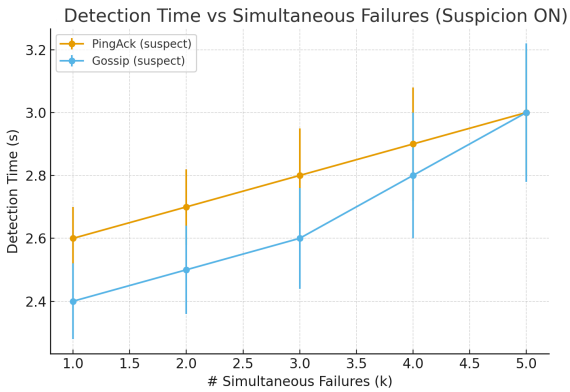
1b:



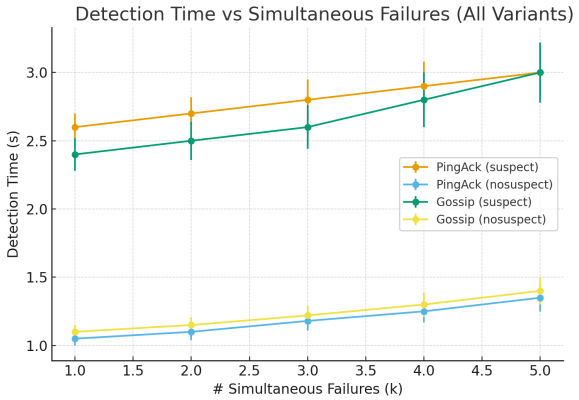
2b:



1c:



2c:



Bandwidth & false positives: PingAck+nosuspect achieved the lowest background bandwidth (N=10: 1,152.9 B/s, σ=821.0). PingAck+suspect remained modest (978.7 B/s, σ=662.0). Gossip–nosuspect consumed substantially more (19,712.6 B/s, σ=502.9); Gossip+suspect was similar (19,754.2 B/s, σ=1,681.3). We define false positive rate as *spurious failure confirmations per node per minute* with no real failures. Under suspicion, PingAck stayed near zero across drop rates (≈0 to 0.8/min at 30%), while Gossip rose sharply (≈0 to 40.0/min). With suspicion disabled, both protocols remained ≈0 across all drop rates.

Detection times: Detection matched configured bounds. With suspicion, both protocols converged to ~3 s as simultaneous failures increased (PingAck: 2.6–3.0 s; Gossip: 2.4–3.0 s). Without suspicion, detection occurred near the failure timeout (1.05–1.40 s), with slight growth as k increased.

D. In practice, PingAck benefits more under loss: the suspicion window lets transiently dropped PING/ACKs be cleared by a subsequent successful exchange, so FPs stay near zero without increasing bandwidth. Gossip's suspicion is semantically important (ALIVE/SUSPECT/FAILED with incarnations) but, in lossy settings, epidemically spread SUSPECT can amplify false positives when ALIVE rebuttals arrive late.

E. PingAck+nosuspect is the most bandwidth-efficient and stable (direct probes; O(1) per round), yielding the lowest B/s and ≈0 FPs in our runs. Gossip+nosuspect remains accurate (also ≈0 FPs) but at high bandwidth because it continues to disseminate full membership views via fanout.