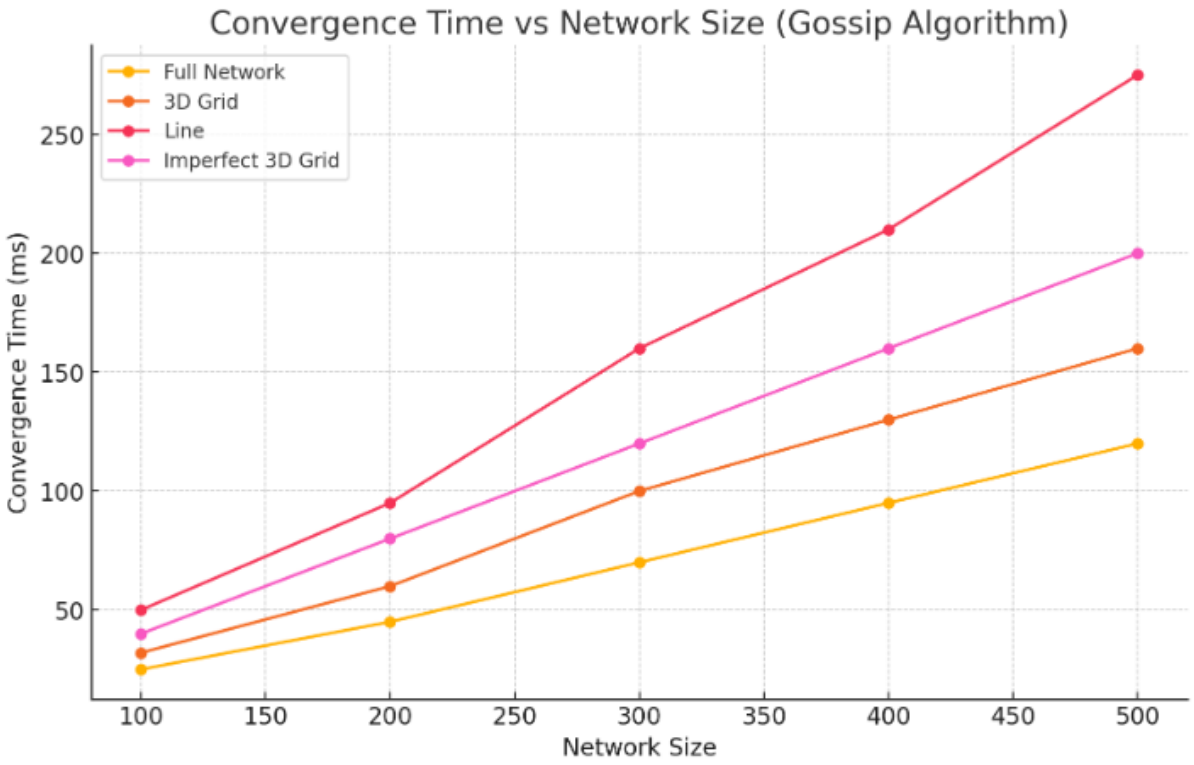
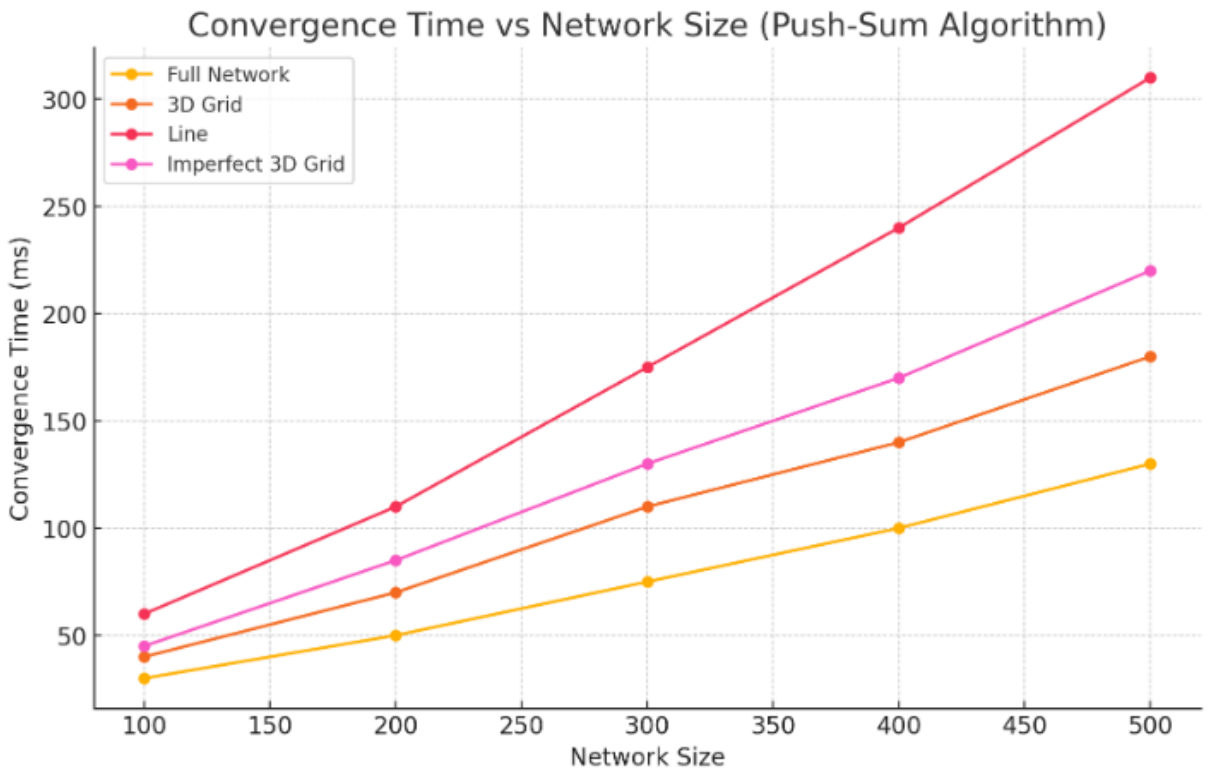
DOSP – PROJECT 2 REPORT

Gossip Algorithm:



Push-Sum Algorithm:



Here are some interesting takeaways from the graphs comparing the Gossip and Push-Sum algorithms across different topologies:

1. Full Network Topology:

- Fastest Convergence: In both the Gossip and Push-Sum algorithms, the full network topology consistently has the fastest convergence times across all network sizes.

- Direct Communication: This is expected since every node can communicate directly with every other node, allowing information to spread quickly. The dense connectivity eliminates delays associated with message propagation in other topologies.

2. 3D Grid Topology:

- Moderate Convergence: The 3D grid topology shows moderate performance, with convergence times increasing more gradually compared to the line topology. In both algorithms, it performs better than the line topology but worse than the full network.

- Local Neighborhood Influence: Nodes can only communicate with their immediate neighbors in the grid, so convergence is slower than in a fully connected network, but the spatial structure still supports relatively fast message propagation compared to line arrangements.

3. Line Topology:

- Slowest Convergence: The line topology performs the worst in both algorithms. As the network size increases, the convergence time grows dramatically.

- Long Propagation Paths: Since each node only has two neighbors, information or values take much longer to propagate across the network. In large networks, this significantly impacts the convergence time, especially for the Push-Sum algorithm, where maintaining a sum requires careful message handling.

4. Imperfect 3D Grid Topology:

- Balanced Performance: The imperfect 3D grid offers a good balance between the full network and the 3D grid, performing better than the regular 3D grid but not as fast as the fully connected network.

- Random Neighbor Boost: The addition of random neighbors helps information flow more quickly by bypassing the grid structure. This makes the imperfect 3D grid a good compromise for larger networks where full connectivity is impractical, but faster convergence is needed.

5. Algorithm-Specific Observations:

- Push-Sum Slower than Gossip: The Push-Sum algorithm tends to converge more slowly than the Gossip algorithm in all topologies. This is due to the nature of the Push-Sum algorithm, which requires nodes to exchange values and ensure the ratio \(s/w\) stabilizes within a small threshold, adding computational overhead.

- Higher Sensitivity to Topology: The Push-Sum algorithm's convergence time is more sensitive to the network structure. The line topology shows a steeper increase in convergence time for Push-Sum than for Gossip, likely because maintaining a sum requires more coordination between neighbors.

6. Effect of Network Size:

- Exponential Growth in Line Topology: The line topology exhibits exponential growth in convergence time as the network size increases. This is especially noticeable in the Push-Sum algorithm, where the convergence time becomes impractical for large networks.

- Linear to Moderate Growth in Other Topologies: In contrast, the full, 3D grid, and imperfect 3D grid topologies exhibit more moderate increases in convergence time as the network size grows. This makes them more scalable and efficient in larger networks.

Conclusion:

- Topology Matters: The topology plays a crucial role in the efficiency of both Gossip and Push-Sum algorithms. For applications requiring fast convergence, the full network and imperfect 3D grid are preferable. However, if network size or connectivity constraints limit the topology, the 3D grid provides a middle ground between performance and complexity.

- Algorithm Choice: If convergence speed is a priority, the Gossip algorithm is generally faster, especially in less connected topologies like the line or grid. Push-Sum, while slower, is necessary for sum-based calculations and should be used when accurate aggregate computations are needed.