

Distributed Operating System Principles – Fall' 20

Project 2 – Gossip Simulator

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Project Description:

The aim of the problem is implementing the Gossip and Push-Sum algorithms for group communication and aggregation. The algorithms are built and implemented using four significant topologies namely full, 2d-grid, imperfect-2d-grid, and line.

- The Gossip starts by initiating the main process of a single actor that propagates the message to its neighbors based on the topology. The algorithm converges when each actor receives the message 10 times.
- The Push-Sum starts by transmitting pair (s, w) messages where s is an actor index or actor number, and w is set to 1. The algorithm converges when the difference ratio (s / w) of previous and current state is less than 10^{-10} for three consecutive times on each actor.

Network Topologies:

- In Full network, every actor is a neighbor of any other actor and messages propagates randomly.
- In 2D Grid network, the actors are viewed in a two-dimensional matrix and messages are sent to its adjacent neighbors.
- Imperfect 2D Grid network is like 2D Grid network, alongside it sends messages to a random neighbor.
- In Line network, the actors are represented as a list, and messages are sent back and forth adjacent neighbors.

Implementation:

Project2.fsx:

Initially the program takes three command line arguments *NumofNodes* (number of actors), *Topology* (name of the network topology), and *Algorithm* (gossip or pushsum) in the same order.

The program contains four actor methods, two for Gossip, and two for Pushsum. The boss actor method controls maintain the worker actors and terminates the actor system when actors converge based on the condition of the algorithm. The worker actor propagates the messages to the neighboring actors based upon the topology built.

Along with these, there are few helper methods to build topologies and generate random nodes.

Observations:

The order of convergence of the network topologies from the results of gossip and pushsum are roughly is $T(\text{full}) < T(\text{imperfect 2D}) < T(2D) < T(\text{line})$. The line topology was hard to converge because of limited neighbors for each actor and propagation is restricted compared to other topologies. Imperfect 2D and 2D Grid converges at almost times.

Largest number of actors managed to solve for Gossip on full topology is 50000 nodes with convergence time of 134300 milliseconds, 2d topology is 50000 nodes with convergence time of 148560 milliseconds, imperfect 2d topology is 50000 nodes with convergence time of 146722 milliseconds, and line topology is 50000 nodes with convergence time of 200908 milliseconds.

Largest number of actors managed to solve for PushSum on all topologies is 3000 nodes with varying times.

Commands to Run:

GOSSIP:

- *dotnet fsi --langversion:preview project2.fsx numNodes full gossip*
- *dotnet fsi --langversion:preview project2.fsx numNodes 2d gossip*
- *dotnet fsi --langversion:preview project2.fsx numNodes 2dimp gossip*
- *dotnet fsi --langversion:preview project2.fsx numNodes line gossip*

PUSHSUM:

- *dotnet fsi --langversion:preview project2.fsx numNodes full pushsum*
- *dotnet fsi --langversion:preview project2.fsx numNodes 2d pushsum*
- *dotnet fsi --langversion:preview project2.fsx numNodes 2dimp pushsum*
- *dotnet fsi --langversion:preview project2.fsx numNodes line pushsum*

Note: *numNodes* is an integer number (10, 50, 100, etc.) to be updated before running.

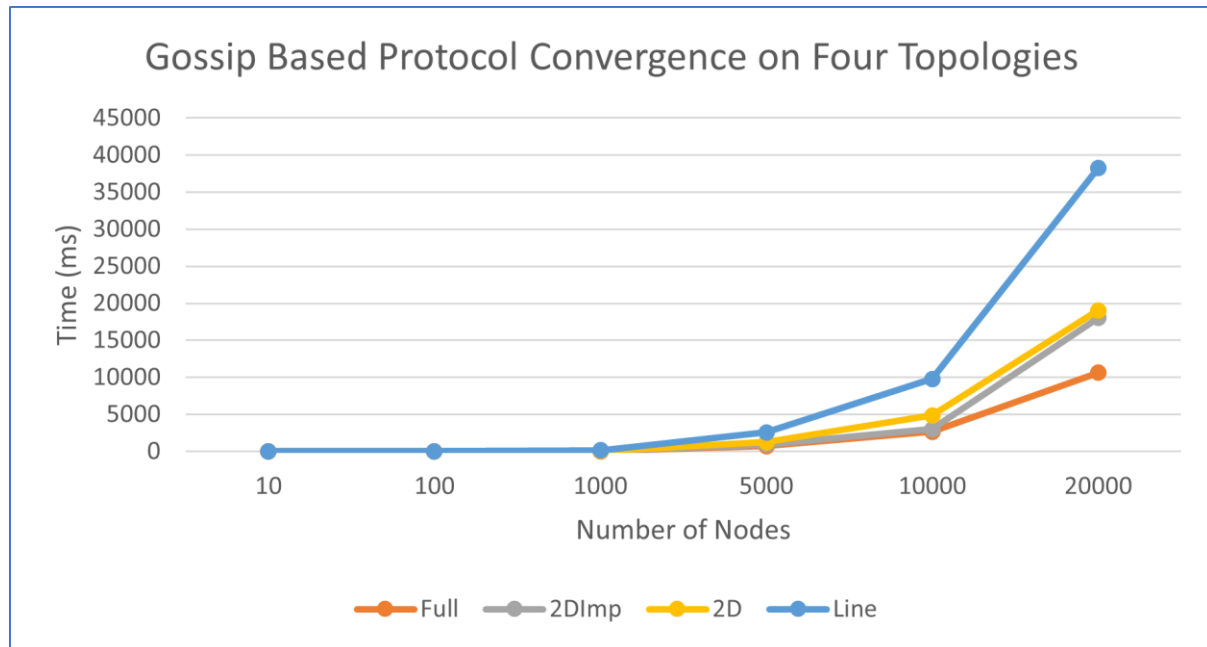
Results:

The dependency curves of convergence time as a function of the size of the network.

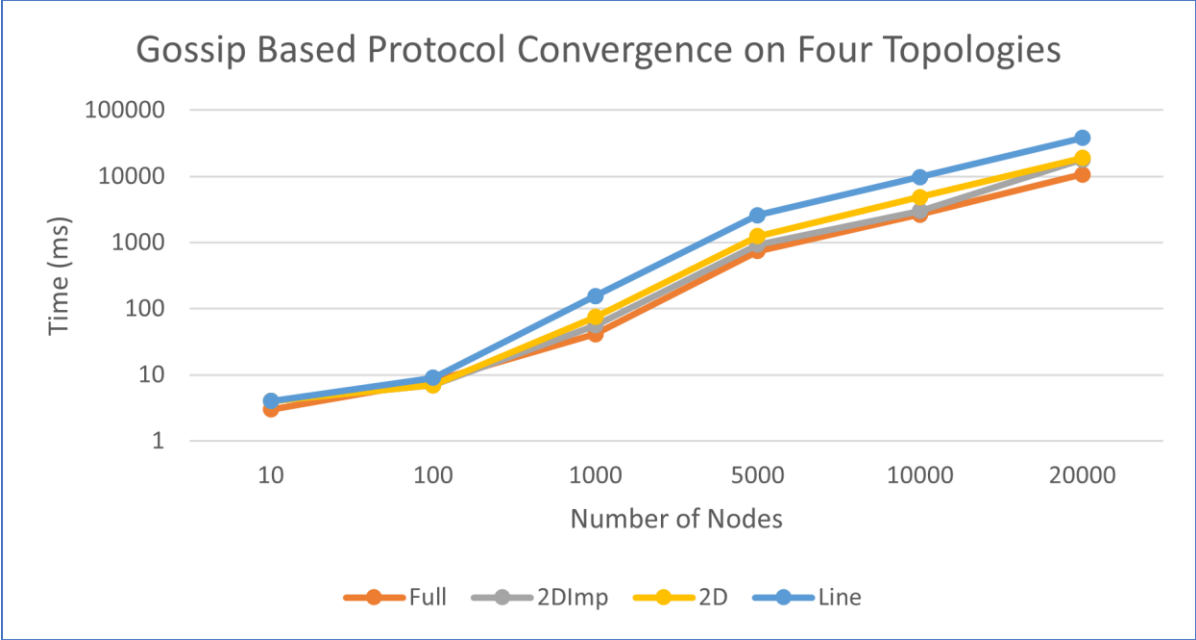
GOSSIP:

On normal scale –

| Number of Nodes | Full | 2DImp | 2D | Line |
|-----------------|-------|-------|-------|-------|
| 10 | 3 | 4 | 4 | 4 |
| 100 | 8 | 7 | 7 | 9 |
| 1000 | 41 | 56 | 75 | 156 |
| 5000 | 745 | 932 | 1241 | 2591 |
| 10000 | 2660 | 3001 | 4832 | 9759 |
| 20000 | 10628 | 17996 | 19032 | 38229 |



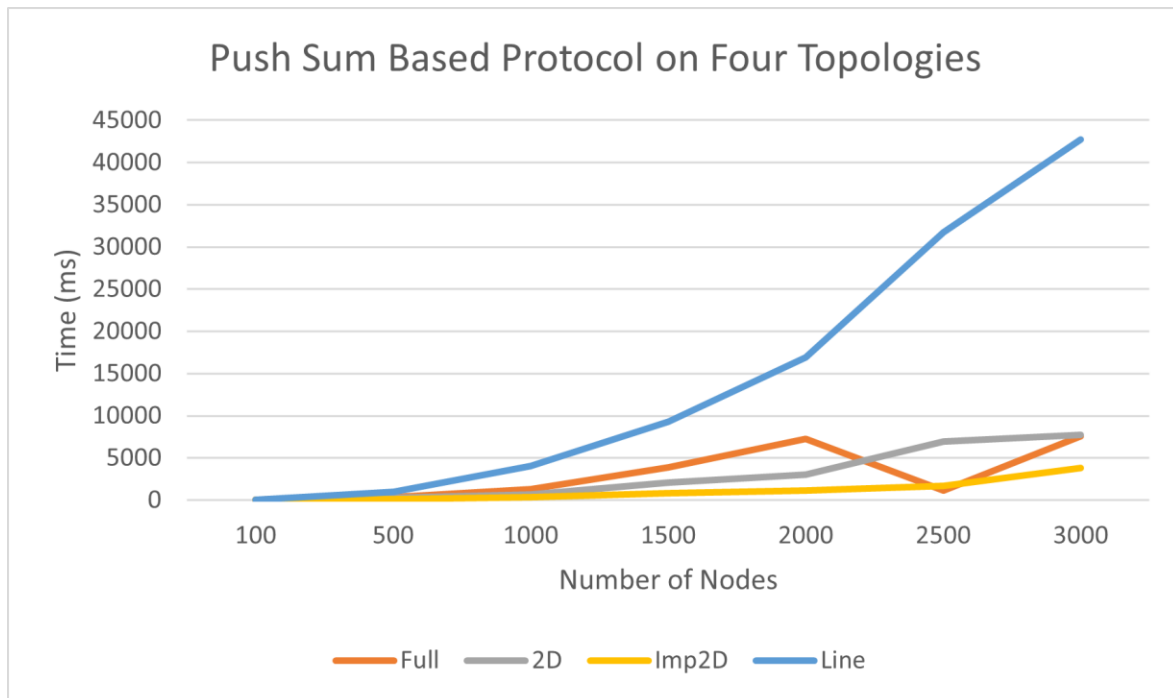
On Logarithmic Scale—



PUSH SUM:

| PushSum | | | | |
|-----------------|------|------|-------|-------|
| Number of Nodes | Full | 2D | Imp2D | Line |
| 100 | 40 | 33 | 33 | 45 |
| 500 | 331 | 240 | 124 | 957 |
| 1000 | 1312 | 639 | 342 | 4001 |
| 1500 | 3856 | 2062 | 789 | 9287 |
| 2000 | 7231 | 2999 | 1174 | 16938 |
| 2500 | 1144 | 6948 | 1719 | 31764 |
| 3000 | 7583 | 7698 | 3772 | 42709 |

On normal scale—



On Logarithmic Scale—

