

# **PROJECT REPORT**

## **Group Members:**

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## **Topologies implemented are:**

- Line Topology : Actors are arranged in a line. Each actor has only 2 neighbors. (one left and one right, unless you are first or last actor).
- Full topology : Each actor is connected to every other actor. A node sends message to any of its neighbor randomly.
- Imperfect Line : Same as Line but one other random neighbor is selected from other actors.
- Torus Topology : Each actor has 4 neighbors (similar to the 2D grid) but both directions are closed to form circles.
- Random 2D Topology : Actors are randomly position at x,y coordinates on a  $[0-1.0] \times [0-1.0]$  square. Two actors are connected if they are within 0.1 distance to other actors.
- 3D Topology : Actors arranged in a 3D grid. Actors can only talk to the grid neighbors.

## **Algorithms Implemented are:**

- Gossip Protocol
- Push-Sum Algorithm

## **Convergence Criteria:**

In our implementation, when a particular node receives a rumor 10 times, it stops transmitting the rumor. The point of convergence is reached when each actor receives the rumor 10 times. We terminate the algorithm after convergence and measure the time taken to run the algorithm.

Push-Sum algorithm works by sending messages in form of (S,W) pair, where S is the value of actor and  $W=1$  for each actor. For Push-Sum algorithm, we define that the convergence of a node happens when its average estimate (S/W value) does not change more than  $10^{-10}$  in three consecutive message receive rounds. We terminate the algorithm after all the nodes in the network achieve convergence.

## **Time measurement:**

Before calling Gossip or Push-Sum protocols, we noted the current CPU time in “st\_time” variable, and at the end, after the convergence is reached we subtracted “st\_time” from the time at that point.

## RESULTS:

*Graphs for No. of Nodes vs Time required to converge in milliseconds:*

### For Gossip Algorithm

#### FULL

No. of Nodes	Time for Convergence (milliseconds)
50	2185
200	2304
400	2409
600	2616
800	2750

#### 3D

No. of Nodes	Time for Convergence (milliseconds)
50	2420
200	3167
400	3282
600	3618
800	3863

#### TORUS

No. of Nodes	Time for Convergence (milliseconds)
50	2079
200	2630
400	2731
600	2959
800	3274

#### IMPERFECT LINE

No. of Nodes	Time for Convergence (milliseconds)
50	2619
200	3616
400	3502
600	3825
800	4581

#### LINE

No. of Nodes	Time for Convergence (milliseconds)
50	6791
200	12588
400	34788
600	43929
800	84011

#### RANDOM-2D

No. of Nodes	Time for Convergence (milliseconds)
50	7407
200	7532
400	7855
600	8059
800	8128

### For Push-Sum Algorithm

#### FULL

No. of Nodes	Time for Convergence (milliseconds)
50	785
200	946
400	1028
600	1221
800	1332

#### 3D

No. of Nodes	Time for Convergence (milliseconds)
50	8320
200	10187
400	14148
600	15900
800	17371

#### TORUS

No. of Nodes	Time for Convergence (milliseconds)
50	1240
200	2078
400	4240
600	7158
800	8646

### IMPERFECT LINE

No. of Nodes	Time for Convergence (milliseconds)
50	1354
200	2047
400	4876
600	5240
800	6386

### LINE

No. of Nodes	Time for Convergence (milliseconds)
50	2420
200	2479
400	3264
600	3687
800	4313

### RANDOM-2D

No. of Nodes	Time for Convergence (milliseconds)
50	5997
200	6189
400	6278
600	6166
800	6816

We have drawn 3 graphs :

1. For Gossip Algorithm: Full, 3D, Torus, Imperfect Line, Random 2D
2. For Gossip Algorithm: Line
3. For Push-Sum Algorithm: Full, 3D, Torus, Imperfect Line, Random 2D, Line

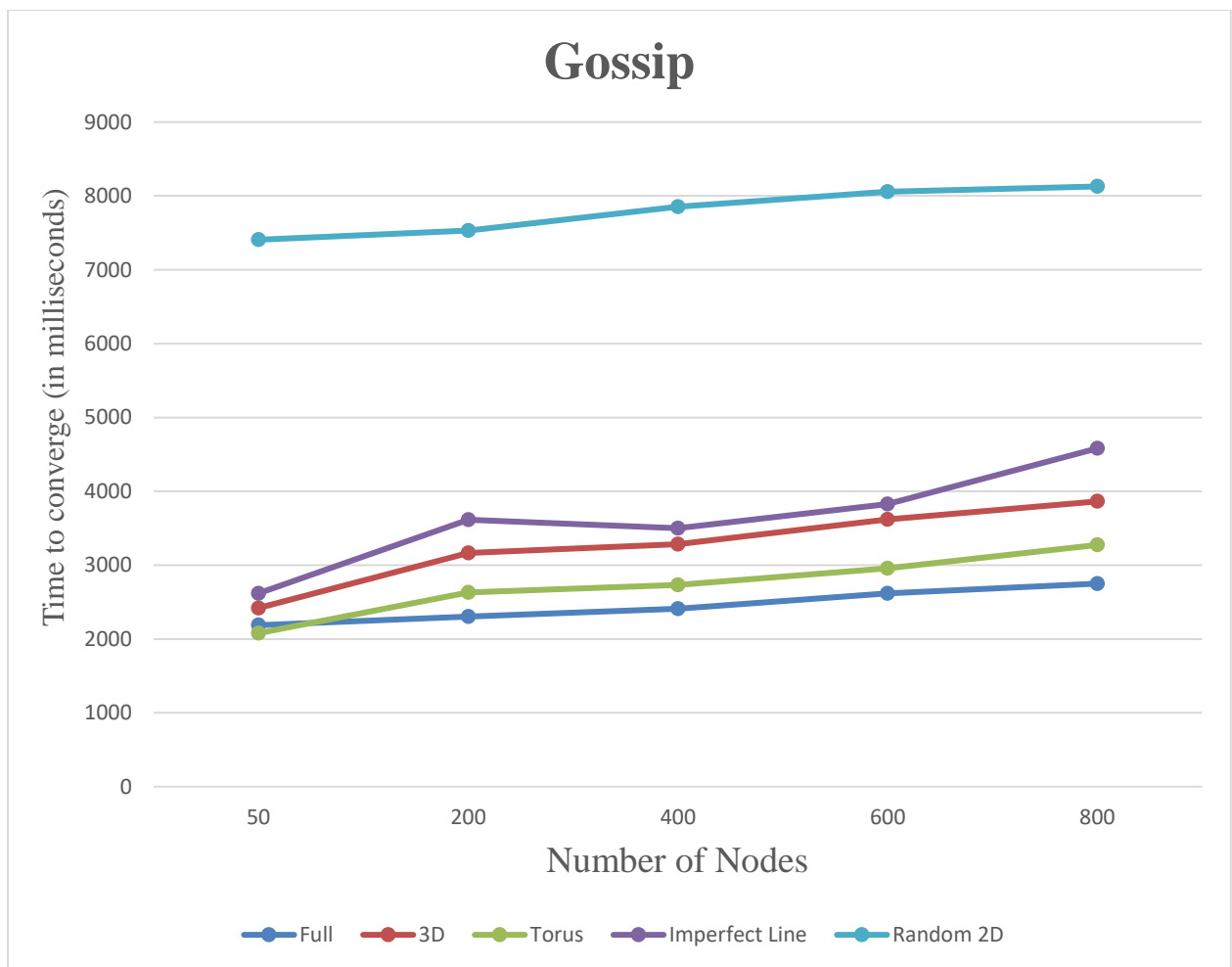


Fig 1. Convergence times for different topologies for gossip algorithm

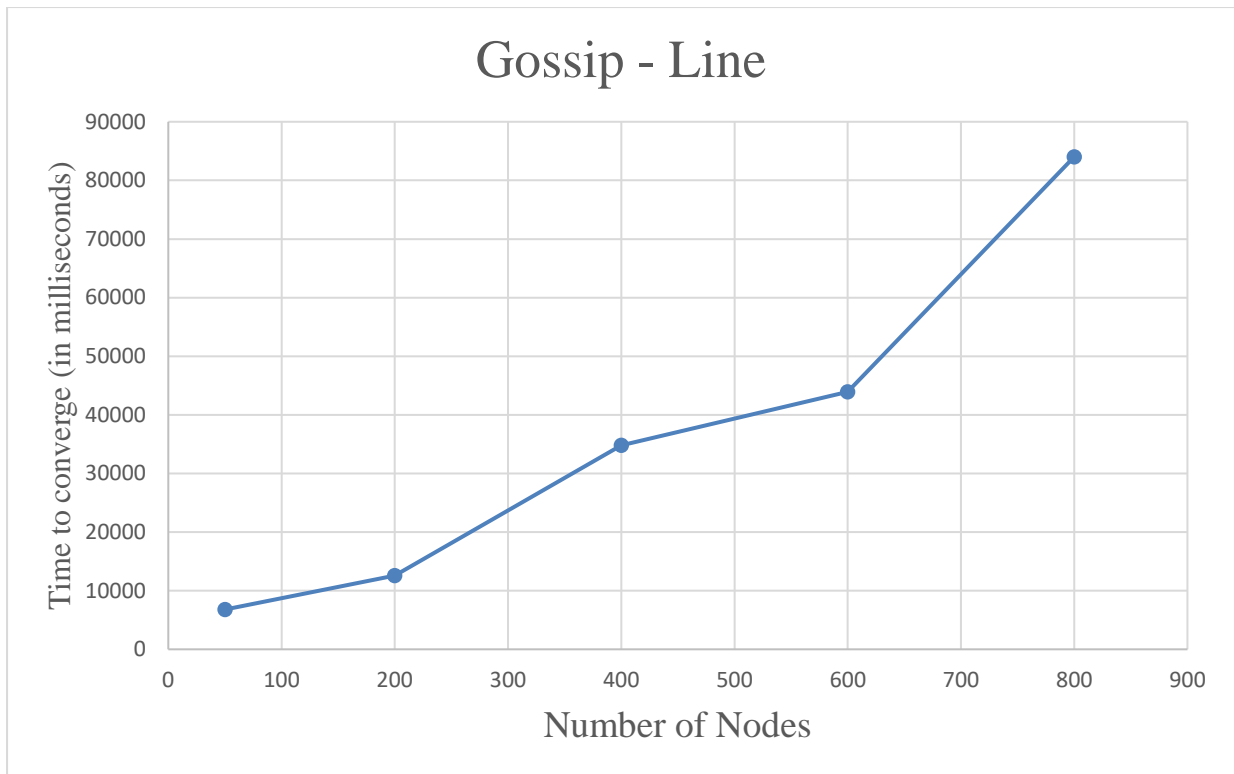


Fig 2. Convergence times for Line topology for gossip algorithm

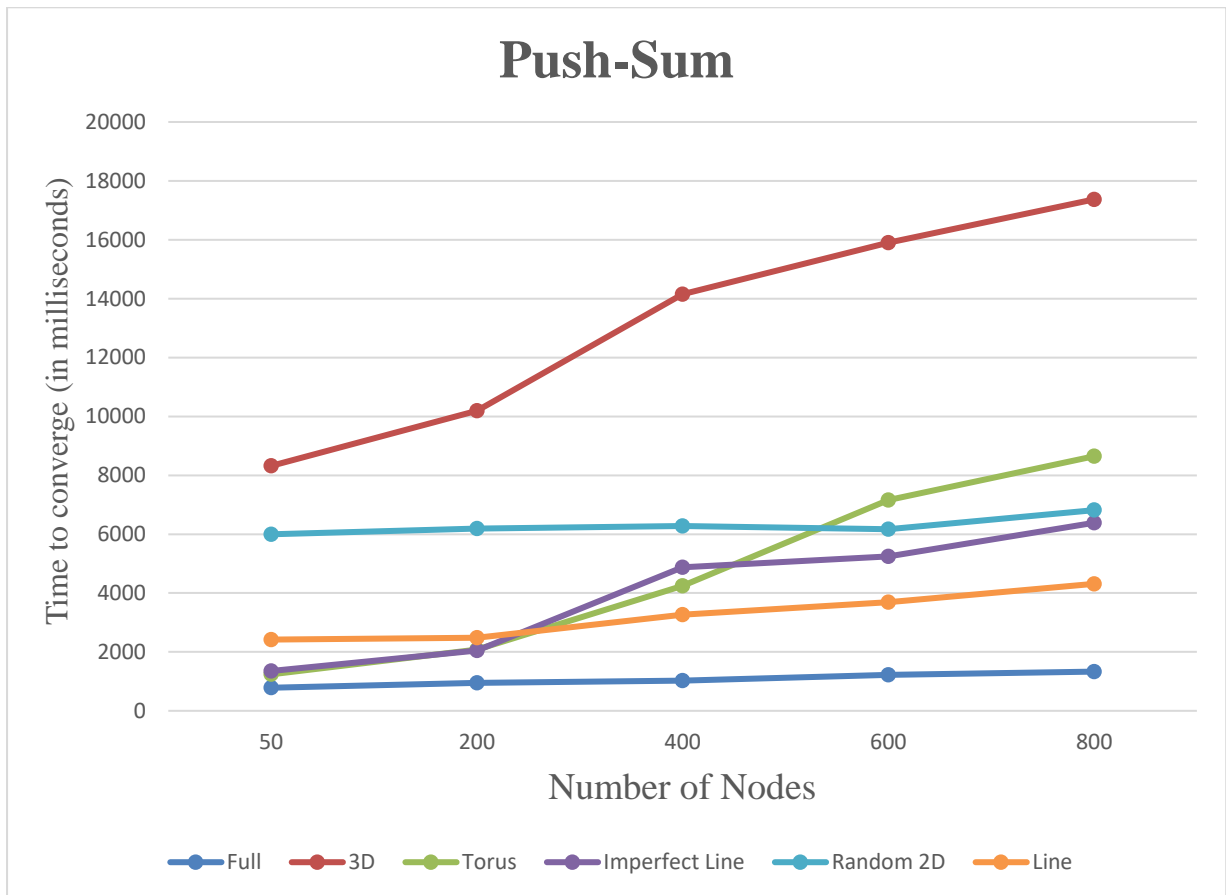


Fig 3. Convergence times for different topologies for push-sum algorithm

**Interesting Observations :**

1. Line topology and Random 2D topology took maximum time for convergence. This must be due to less number of neighbors.
2. Imperfect Line topology takes less time for convergence, this must be due to that one random neighbor of each node.
3. In Push-Sum Algorithm, after 200 nodes, there is a sharp increase in time to converge for 3D and imperfect Line.
4. For Line topology in Gossip Algorithm, the time to converge becomes almost double from 40000 ms to 80000 ms for 600 nodes to 800 nodes.