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1. Is there a limit on how much parallelism can be exploited using shared-memory architectures using OPENMP? Does programming using MPI solve the problem? Explain.

Shared-memory architecture is limited by the system architecture itself, the main memory and storage disks which are shared by all systems. Therefore, there can only be so much parallelism exploited using shared-memory architecture.

One-sided MPI can solve the problem because it can be used to simulate shared memory and letting a process to get data from another process without the other's process's participation. The calls made by these processes do not make the variation between shared memory and one-sided network access.

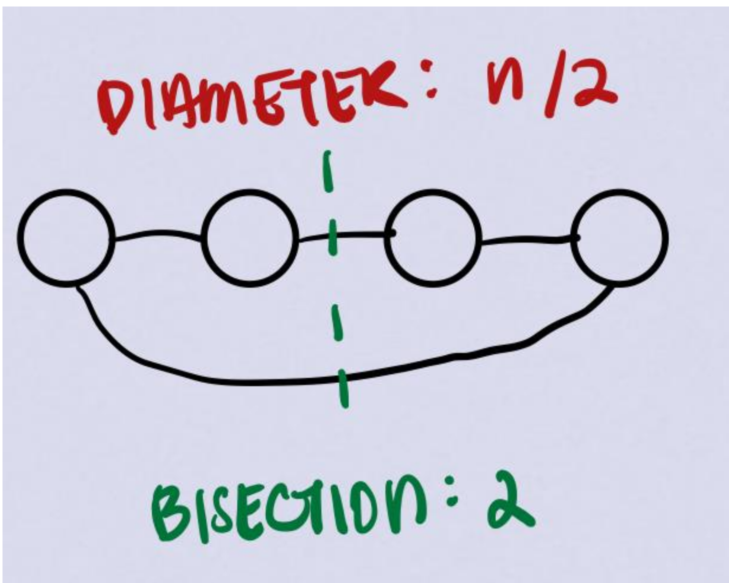
2. Why does synchronization lead to smaller speedup, and less scalable algorithms as compared to if such synchronization is not used? Why?

In distributed computing, synchronizations lead to smaller speedup and less scalable algorithms because synchronization costs resource and time, it will take longer if the entire system synchronizes than to perform just the computation itself. If it takes longer for the system to perform both the synchronization and the computation, then the algorithm becomes less scalable, because if there are more devices in the system, then there are more devices to synchronize. Hence why algorithms without synchronization are favored over algorithms with synchronization, especially in shared-memory architectures, since you are trying to perform high computational tasks as efficiently as possible.

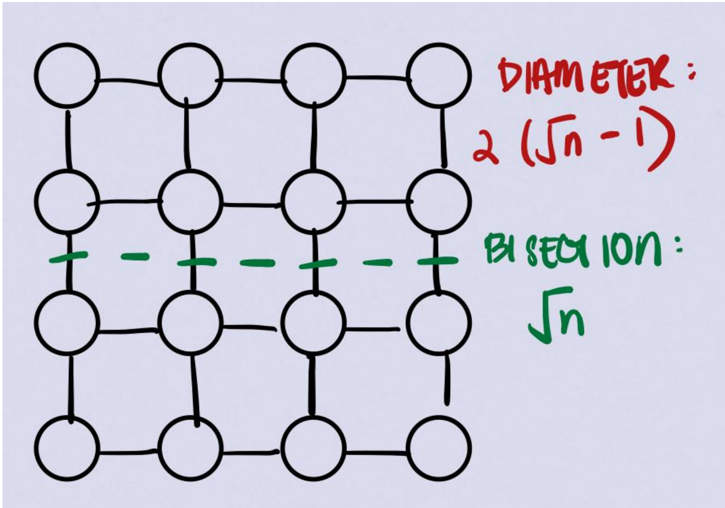
3. What is the difference between bisection width and the diameter of a network topology for a distributed-memory architecture?

Bisection width is the minimum number of links to cut to divide the network into two equal halves. The bisection width gives you the true bandwidth of a network topology. This is important to know because it determines how much data is being moved per unit of time. Along with latency, both properties give you an understanding of how fast the network topology truly is, since Diameter is the shortest path between the two farthest nodes, giving you a scope of how big the network topology is.

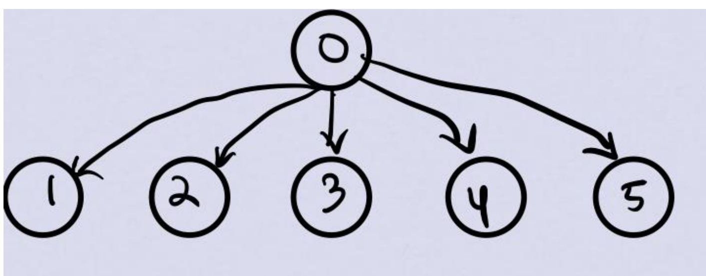
4. **Draw** and write the **bisection width** and **diameter** for the following network topologies:
    a. Ring



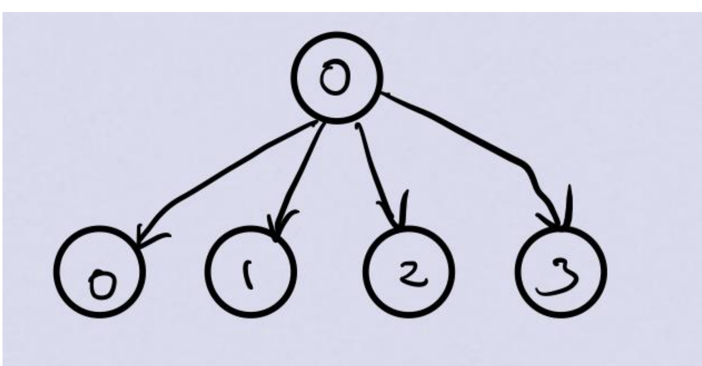
    b. Mesh



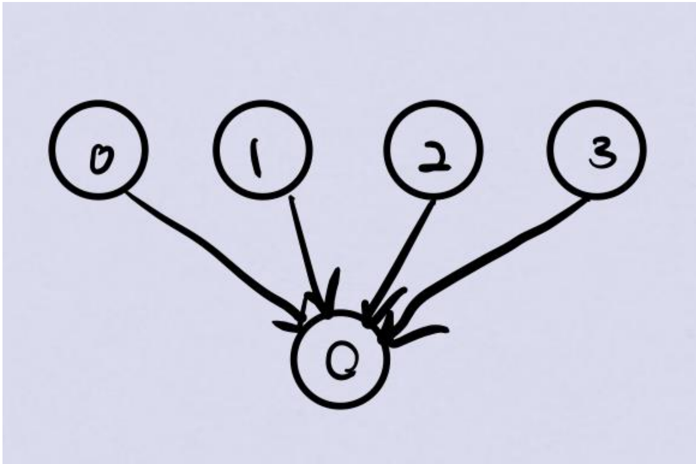
5. With the help of diagrams show the following data movement strategies that can be implemented using MPI:
    a. Broadcast



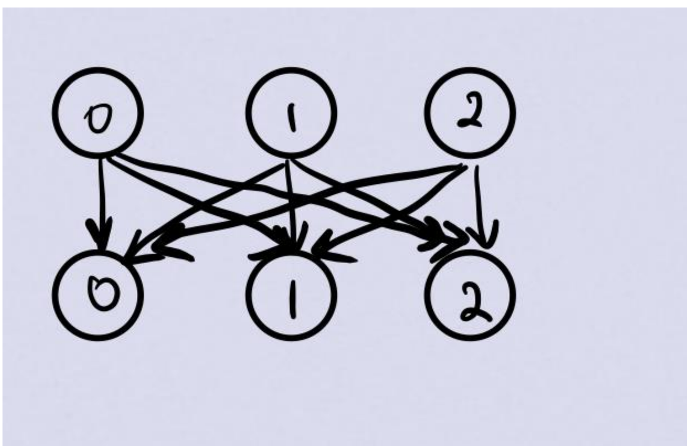
    b. Scatter



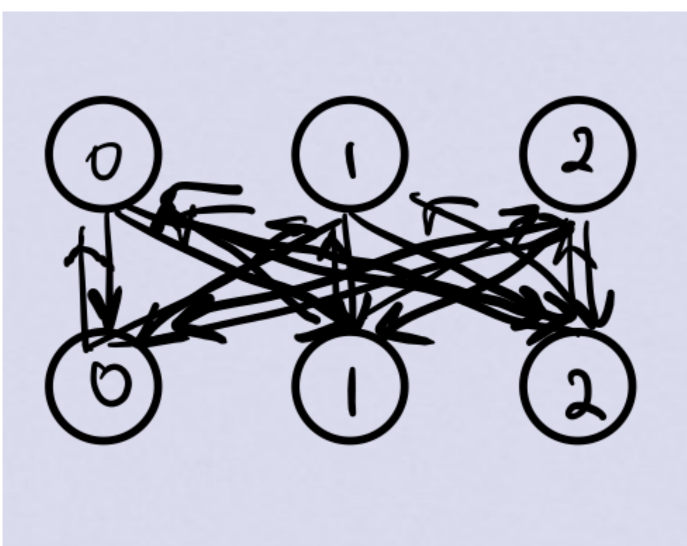
    c. Gather



d. All gather



e. All to all



Citation

Chow, Edmond. *High Performance Computing*, https://faculty.cc.gatech.edu/~echow/ipcc/hpc-course/.

Saeed, Fahad. "Lecture 6 Part 2 PowerPoint (PPT)." Canvas, 2020. PowerPoint Presentation.

Saeed, Fahad. "Lecture 7 PowerPoint (PPT)." Canvas, 2020. PowerPoint Presentation.