

Module 2.5 Homework Exercises

Problem 1: Could simulating the motion of the planets in a solar system be performed well in a shared memory or a distributed memory approach using high-performance computing? For each solar system address the following items and explain your reason why.

1. Can it be executed on a shared memory environment?
2. Will the program run well in a shared memory environment, why or why not? Hint: Think about any bottlenecks that might be encountered.
3. Can it be executed on a distributed memory environment?
4. Will the program run well in a distributed memory environment, why or why not? Hint: Think about any bottlenecks that might be encountered.
5. Would you choose to run this in a shared memory environment or in a distributed memory environment? Explain why.

Solar system A: 9 planets

Solar system B: 1,000 planets

Solar system C: 100,000 planets

Solar system D: 100,000,000 planets

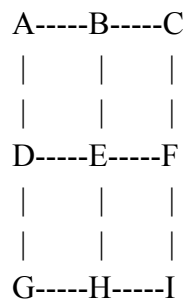
Solar system E: 100,000,000,000 planets

Problem 2: Review Problem 1 and identify how you would combine shared memory and distributed memory approaches to improve performance of the program? Assume that you have a function `PLANET_MODEL(PLANET_NUMBER, PLANET_INFORMATION)` that takes the planet number and planet information as input (i.e., this function is called once for each planet) and returns the position of the planet at the next timestep.

Assume that you have a supercomputer with 1,000,000 physical nodes and each node has one processing element. Explain how you would structure the program and what parts would be shared memory and what would be distributed memory. What language would you use for each part (shared memory and distributed memory)? Perform this for a single timestep.

Problem 3: A planar mesh is a 2D mesh of nodes with each node having a north, south, east, and west link. Traffic is routed from node to node from source to destination and can take any direction. What is the bisection bandwidth of a 3x3 square planar mesh (9 physical nodes)?

Problem 4: A 3x3 planar mesh network is shown below. Determine the number of hops for a message traveling from all nodes other than node F to node F. Use only the shortest path.



Problem 5: Look at the solutions to Problem 4 and the paths that are possible for each message. Identify the bottleneck nodes in the system and make a recommendation to reduce the number of messages traveling through each bottleneck node.