HW3

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PARALLEL PROGRAMMING

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1a.

Computation:
$A*N^2/P$

Communication:
KN

Comm-to-Comp Ratio
K*P/N

Efficiency:
1/(1+(K*P/N))

Isoefficiency:
Let $W = N^2$
We know that N = sqrt(W)
P/sqrt(W) = k; $W = (P/k)^2$

We know that the allgather on a hypercube has a depth of log(p)

Communication Cost:
We start with N/P data and that amount will increase with every level of the gather.
This gives us a sum of (Alpha + Beta * N/P * 2i) for when i = 0 to when i = log(p) – 1

b.

Computation:
A * N / P

Communication:
KN

Comm-to-Comp Ratio
K*P/A

Efficiency:
1/(1+(K*P/A))

Isoefficiency:
Problem size is W

2. a.

i) Diameter = (x-1) + (y-1) + (z-1)
= 29 + 39 + 49
= 117

Degree = [3, 6] (range of 3 to 6, inclusive)
The diameter of this given mesh is 117 and the degree for each node is between 3 and 6.

ii) If we had a 2D mesh of 30x50, the bisection width of this would be 30. If we have a 3D mesh of 30x40x50 we just have the 40 layers of the 30x50 stacked one top of one another. Because of this we have a bisection width of 30 * 40 = 1200. In order to find the bisection bandwidth of the mesh we will need to multiply the bisection by the channel bandwidth. We are given a channel bandwidth as 4 GB/s

bisection bandwidth = channel bandwidth * bisection width
= 4(GB/s) * 1200 = 4800(GB/s)
So we have a resulting bisection bandwidth of the network will be 4800 GB/s

iii) Since we need to minimize bandwidth usage we need to take advantage of all the 2GB/s channel bandwidths. Because of this we need to cut parallels to the x axis apart from the z axis.

Bisection width = 40 * 50
= 2000
This give us 2 GB/s

Bisection bandwidth = channel bandwidth * bisection width
= 2 * 2000
= 4000 GB/s

b.
Assumptions:

1. The original 2D grid of processes are i, j, and k where i = [0,199], j = [0, 299] and k = [0,0]
2. The 3D grid of the processes defined above are labeled with i', j', k' where i' = [0, 29], j' = [0, 39], k' = [0, 49]
3. The total # of nodes in all of the cases are the same:
    a. (200 * 300 => 60000 => 30 * 40 * 50) is true

There are various mappings that can be used in such a situation.
The simplest mapping would take advantage of this:

30 * 10 = 300

40 * 50 / 10 = 200

From this we get the following mapping

f(i', j', k') = (j/10, i/5, k/4)

From this mapping from the y-axis from the original grid to the x-axis of the 3D mesh. This uses the x axis then from the original grid. This finally creates the y and z axes of the 3D meshes.