HPC_HW_Chap2_PartB
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Problem 2.10
According to the given assumptions, the total time to complete the work:
$T = (10^{12}/p / 10^6) + (\text{number of messages} * \text{time per message})$
$p = 1000$
number of messages = $10^9(p-1)$
a)
time per message = 10^{-9} seconds
$T = (10^{12}/1000/ 10^6) + (10^9(1000-1) * 10^{-9}) = 1000+999 = 1999$ seconds
b)
time per message = 10^{-3} seconds
$T = (10^{12}/1000/ 10^6) + (10^9(1000-1) * 10^{-3}) = 1000+999000000 = 999001000$ seconds

Problem 2.11
Ring (link number = 2p)
Each node establishes two links: one connects to a core, the other connects to the next node.

Toroidal mesh (link number = 3p)
Like a ring, in each dimension each node establishes two links. With two dimensions, the number counts to 4p. However, the number of cores is recomputed in each dimension. So the number of links equals 4p-p=3p.

Fully connected network (link number = $p^2/2+p/2$)
Each node connects to a core, and connects to the rest (p-1) cores. The latter is computed twice. So the link number equal p+p*(p-1)/2.

Hypercube (link number = $2^d*(2+d)/2$)
A hypercube has 2^d nodes, hence 2^d cores. Each node has d connections to other nodes, while each connection is computed twice.

Problem 2.12
a)
Assume there are p and q nodes on the edges of the planar mesh, respectively. The minimum number of links that can be removed to split the planar mesh is min{p, q}, which equals the bisection width.
b)

For a three-dimensional mesh, assuming the number of nodes on the third edge is r. Then its bisection width equals min{pq, pr, qr}.

Problem 2.15

a) Despite the x in core 0's cache is changed to 5, the x in memory is not updated accordingly due to write-back caches. When core 1 figures out it doesn't have x in its cache, it tries to fetch x from memory. With snooping cache coherence, the x in memory is broadcasted to core 1 with value of 0 rather than 5.
b) When core 0 updates x in its cache, the corresponding entry in the directory is updated as well. When core 1 tries to fetch x from primary memory, it consults the directory first and knows x has been updated. So the updated value, 5, will be read and assigned to y.
c) Snooping is fast but is not scalable. Directory saves bandwidth but is slow. Each has its advantages and drawbacks. The best solution is to apply the proper method in different scenarios.