1. A multicomputer with 256 CPUs is organized as a 16 × 16 grid. What is the worst-case delay (in hops) that a message might have to take?

Ans:

We have a 16 x 16 grid, There will be (M - 1) + (N - 1) hops for the M \* N grid. In the given question M = N. # of hops = (M - 1) + (M - 1) = 2 \* (M - 1) = 2 \* (16 - 1) = 2 \* 15 = 30 hops.

1. Consider a 256- CPU hypercube. What is the worst-case delay in terms of hops?

Ans: With a 256-CPU hypercube, each node has a binary address, from 00000000 to 11111111. A hop from one machine to another always involves changing a single bit in the address. Thus from 00000000 to 00000001 is one hop. From there to 00000011 is another hop. In all, eight hops are needed.

1. A multiprocessor ha 4096 50-MIPS CPUs connected to memory by an omega network. How fast do the switches have to be allow a request to go to memory and back in one instruction time?

Ans:

Given:

4096 CPUs, each operating at 50 MIPS.

Omega network connects CPUs to memory.

**CPU Instruction Time:**

**Each CPU operates at 50 MIPS, so the time for one instruction is:**

1/(50 X 106) Seconds = 20 ns

**Round-trip Latency Requirement:**

We want the round-trip time (to memory and back) to be less than or equal to 20 ns (one instruction time).

**Omega Network Latency**:

Omega networks typically consist of multiple stages of switches (routers). The round-trip latency **Tround-trip** through an omega network with k stages is approximately **2k×switching delay**, where switching delay is the time taken by each switch.

**To determine the switching delay required for the switches in the omega network:**

1. Assume a reasonable number of stages k in the omega network.

* A typical assumption for a large-scale omega network might be k=4.

1. Calculate the maximum switching delay that satisfies the round-trip latency requirement:

**Tround-trip < = 20ns**

For k = 4:

2 X 4 X switching delay <= 20 ns

Switching delay <= 2.5 ns

Therefore, to allow a request to go to memory and back within one instruction time (20 ns) for the 4096 CPUs operating at 50 MIPS each, the switches in the omega network should have a maximum switching delay of 2.5 nanoseconds.

4: An experimental file server is up 3/4 of the time and down 1/4 of the time, due to bugs. How many times does this file server have to be replicated to give an availability of at least 99 percent?

Ans:

Server is up = 3/4 = 0.75 and down = 1/4 = 0.25.

a) if there are 2 replications, probability of failing both at same time = .25\*.25 = .0625 =6.25%  
Availiability = 100-6.25=93%

b) if there are 3 replications, probability of failing both at same time = .25\*.25\*.25 = .0156 = 1.56%  
Availiability = 100-1.56=98.44

1. In case of 4 replications probability of failing all at same time =(0.25)4 =0.0039=0.39%  
   Availiability = 100-0.39 ~ 99% //Hence the answer

5: Show the communication path for sending a message from computer 3 to memory 6 in a 8×8 omega network.

6: Explain the principle to avoid any conflict in a 8×8 omega network

7: Construct a 16×16 omega network and explain its connection mechanisms.