Parallel Programming Test 4

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(*Please hand in a PDF version.*)

1 How message-passing routines can return before the message transfer has been completed? (Hint: Think about blocking mechanism of MPI data transfer) (no more than 100 words)

Ans:

MPI_Isend(buffer, count, type, dest, tag, comm, request) , using Non-blocking send. The message only be sended out, but you don't need to know whether it is received, you can do next work at once.

2 Can physically separate memories be addressed as one logically shared address space? And if so, how to implement that? (Hint: Think about physical memory address and virtual memory address of computer systems) (no more than 100 words)

Ans:

Can. The CPU gives all memories a specify address to find it.Usually use Distributed shared memory (DSM).

3 What is the diameter and bisection bandwidth of Butterflies? What is the cost of butterflies? What is the motivation and hierarchy of Dragonflies - used in Edison and Cori? How is the Dragonflies combined in hierarchy? (no more than 150 words)

(Source: UC Berkeley CS267 Applications of Parallel Computers (Kathy Yelick et al., Spring 2018) https://www.bilibili.com/video/BV1qV411q7RS?p=10 Lecture 9 Distributed Memory Machines and Programming (0:32:07))

Ans:

Bisection bandwidth is defined as the maximum capacity between any two servers.

4 How to define latency and bandwidth in a network? How can roughly calculate the time to send message of length n? What is often called "$\alpha - \beta$ model" in Latency and Bandwidth Model? (no more than 100 words)

Ans:

Latency is the amount of time it takes for data to travel from one point to another.

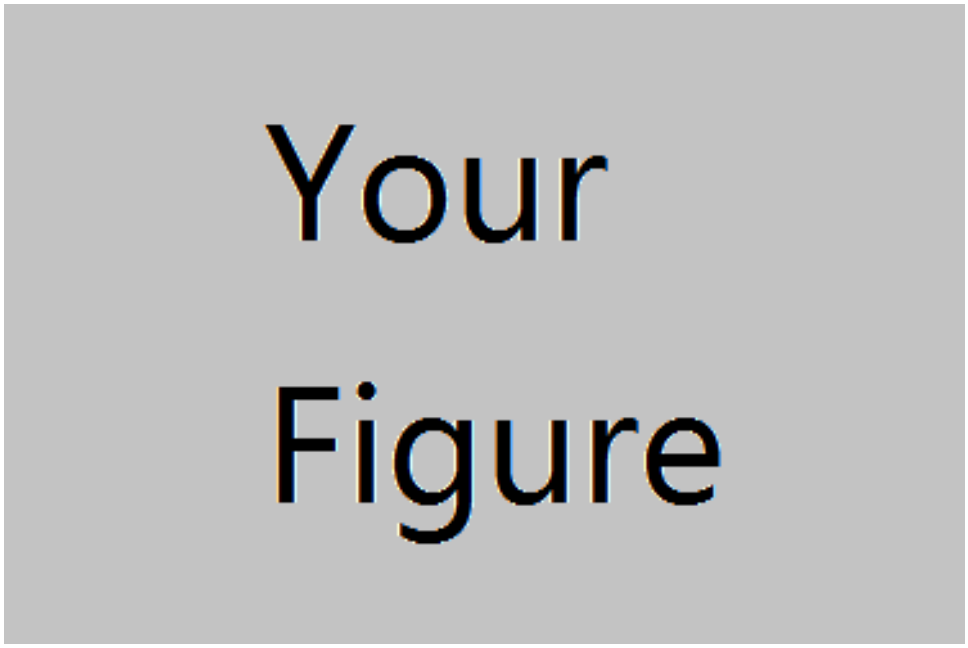
Bandwidth is the rate of data transfer for a fixed period of time.

α –latency/synchronization cost per message β –bandwidth cost

5 Here is the SUMMA code in MPI. Multiply matrix A of size 4*4 with matrix B of size 4*4 using four processes. Draw a figure or a number of figures about how processes communicate with each other? What messages are transferred? and how a process computes local small GEMM? (no more than 100 words)

```
void SUMMA(double *mA, double *mB, double *mc, int p_c)
{
    int row_color = rank / p_c; // p_c = sqrt(p) for simplicity
    MPI_Comm row_comm;
    MPI_Comm_split(MPI_COMM_WORLD, row_color, rank, &row_comm);
    int col_color = rank % p_c;
    MPI_Comm col_comm;
    MPI_Comm_split(MPI_COMM_WORLD, col_color, rank, &col_comm);
    for (int k = 0; k < p; ++k) {
        if (col_color == k)  memcpy(Atemp, mA, size);
        if (row_color == k)  memcpy(Btemp, mB, size);
        MPI_Bcast(Atemp, size, MPI_DOUBLE, k, row_comm);
        MPI_Bcast(Btemp, size, MPI_DOUBLE, k, col_comm);
        SimpleDGEMM(Atemp, Btemp, mc, N/p, N/p, N/p);
    }
}
```

Ans: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Figure