**Question 4:**

For question 2 (1 d distribution):

(Source: introduction\_to\_parallel\_computing\_second\_edition-ananth\_grama.)

The communication command is used in the code is: MPI\_Alltoall.

Now in case of a ring or linear array all to all broadcast involves (p-1) steps of communication between nearest neighbors. Each step, involving a message of size m, takes time

Here

Network Latency (setup time)

= 1/bandwidth (time per each data)

Here m= (matrix dimension/ number of processors)

Now this all to all happens “blockdim” times where,

blockdim=(matrix dimension/ number of processors)

For question 3 (2 d distribution):

The communication command is used in the code is: MPI\_Sendrecv\_replace.

(I did not find any source explicitly discussing on this. So, I tried intuitively to find the timing)

is time for MPI\_SEND so for MPI\_Sendrecv\_replace it will be:

(neglecting the replacement time)

Here k= chunk of data that is send at once.

m= data size= (Blockdim\*Blockdim)

Lets consider k=1;

So the eqn becomes:

Network Latency (setup time)

= 1/bandwidth (time per each data)