Class: Final Year (Computer Science and Engineering)

Year: 2022-23 **Semester:** 1

Course: High Performance Computing Lab

Practical No. 11

Exam Seat No: 2019BTECS00070

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Q1. Execute the all-to-all broadcast operation (Program C) with varying message sizes.
Plot the performance of the operation with varying message sizes from 1K to 10K (with constant number of processes, 8). Explain the performance observed.

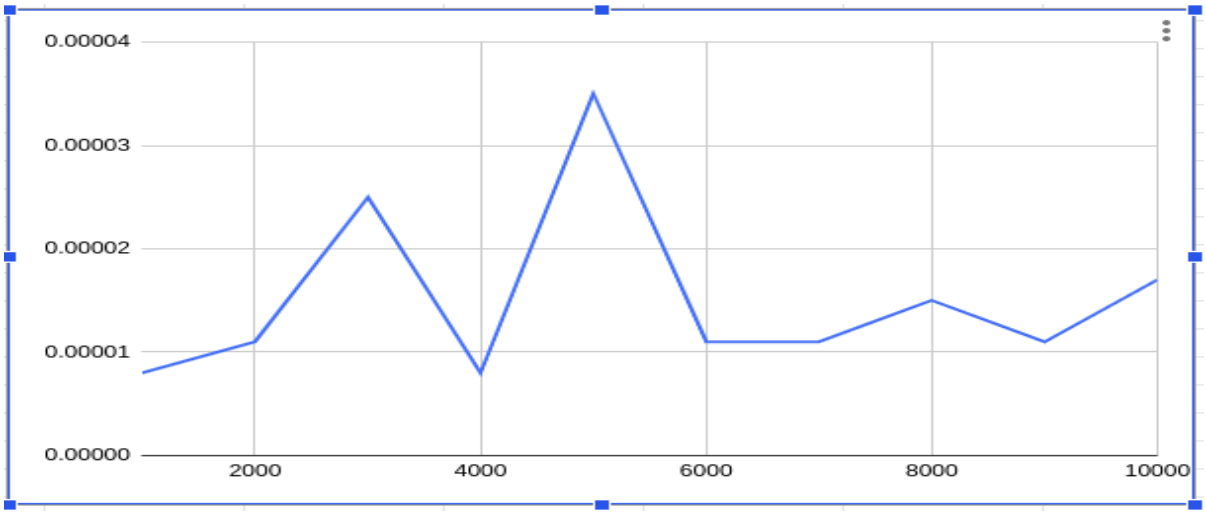
Code:

```
#include <stdio.h>

#include <stdlib.h>

#include <time.h>

#include <mpi.h>

int main(int argc, char *argv[]) {

 if (argc != 2) {

 printf("Usage : alltoall message_size\n");

 return 1;

 }

 int rank;

 int num_procs;

 int size = atoi(argv[1]);

 MPI_Init(&argc, &argv);

 MPI_Comm_size(MPI_COMM_WORLD, &num_procs);

 MPI_Comm_rank(MPI_COMM_WORLD, &rank);

 int i;

 char input_buffer[size*num_procs];

 char recv_buffer[size*num_procs];

 srand(time(NULL));

 for (i = 0; i < size; i++)

 input_buffer[i] = rand() % 256;

 int j;
```

```
for (j = 1; j < num_procs; j++) {

int k = 0;

for (i = j*size; i < j*size + size; i++) {

input_buffer[i] = input_buffer[k];

k++;

}

}

double total_time = 0.0;

double start_time = 0.0;

for (i = 0; i < 100; i++) {

MPI_Barrier(MPI_COMM_WORLD);

start_time = MPI_Wtime();


MPI_Alltoall(input_buffer,size,MPI_CHAR,recv_buffer,size,MPI_CHAR,MPI_COMM_WORLD);

MPI_Barrier(MPI_COMM_WORLD);

total_time += (MPI_Wtime() - start_time);

}

if (rank == 0) {

printf("Average time for alltoall : %f secs\n", total_time/100);

}

MPI_Finalize();

}
```

Output:

```
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 1000
Average time for alltoall : 0.000008 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 2000
Average time for alltoall : 0.000011 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 3000
Average time for alltoall : 0.000025 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 4000
Average time for alltoall : 0.000008 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 5000
Average time for alltoall : 0.000035 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 6000
Average time for alltoall : 0.000011 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 7000
Average time for alltoall : 0.000011 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 8000
Average time for alltoall : 0.000015 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 9000
Average time for alltoall : 0.000011 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./codec.exe 10000
Average time for alltoall : 0.000017 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$
```



Q2. Execute the all-reduce operation (Program D) with varying number of processes (1 to 16) and fixed message size of 10K words. Plot the performance of the operation with varying number of processes (with constant message size). Explain the performance observed.

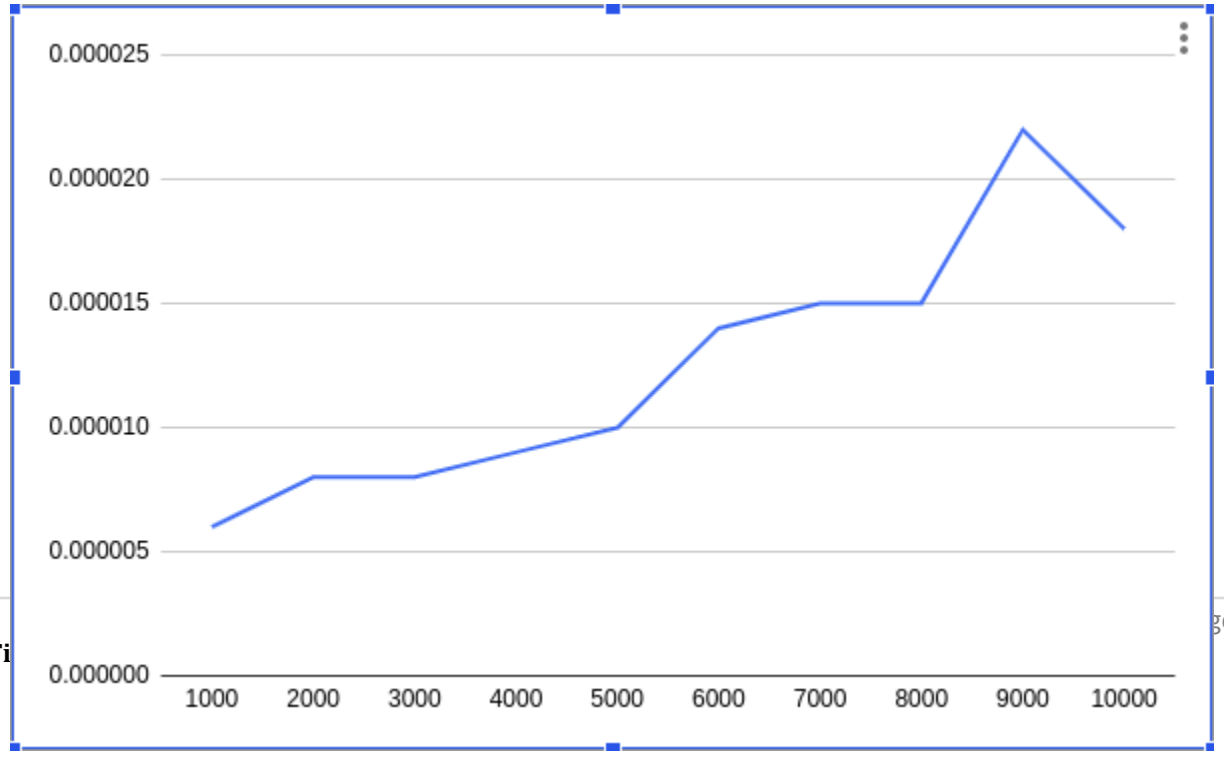
Code:

```
#include <stdio.h>
#include <stdlib.h>
#include <time.h>
#include <mpi.h>
int main(int argc, char *argv[]) {
   if (argc != 2) {
      printf("Usage : allreduce message_size\n");
      return 1;
   }
   int rank;
   int size = atoi(argv[1]);
   char input_buffer[size];
   char recv_buffer[size];
   MPI_Init(&argc, &argv);
   MPI_Comm_rank(MPI_COMM_WORLD, &rank);
   int i;
   srand(time(NULL));
   for (i = 0; i < size; i++)
      input_buffer[i] = rand() % 256;
   double total_time = 0.0;
   double start_time = 0.0;
   for (i = 0; i < 100; i++) {
      MPI_Barrier(MPI_COMM_WORLD);
      start_time = MPI_Wtime();
      MPI_Allreduce(input_buffer,recv_buffer,size,MPI_BYTE,MPI_BOR,MPI_COMM_WORLD);
```

```
        MPI_Barrier(MPI_COMM_WORLD);
        total_time += (MPI_Wtime() - start_time);
    }
    if (rank == 0) {
        printf("Average time for allreduce : %f secs\n", total_time/100);
    }
    MPI_Finalize();
}
```

Output:

```
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpic++ coded.cpp -o ./coded.exe
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 10000
Average time for allreduce : 0.000036 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 1000
Average time for allreduce : 0.000006 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 2000
Average time for allreduce : 0.000008 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 3000
Average time for allreduce : 0.000008 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 4000
Average time for allreduce : 0.000009 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 5000
Average time for allreduce : 0.000010 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 6000
Average time for allreduce : 0.000014 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 7000
Average time for allreduce : 0.000015 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 8000
Average time for allreduce : 0.000015 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 9000
Average time for allreduce : 0.000022 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$ mpirun -n 4 ./coded.exe 10000
Average time for allreduce : 0.000018 secs
prathmesh@prathmesh-G3-3500:/media/prathmesh/DATA/sem7/HPC assignment/assignment11$
```



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Github Link:

https://github.com/killedar27/HPC-assignments/tree/main/assignment11