NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA SURATHKAL

DEPARTMENT OF INFORMATION TECHNOLOGY

IT 301 Parallel Computing LAB 9

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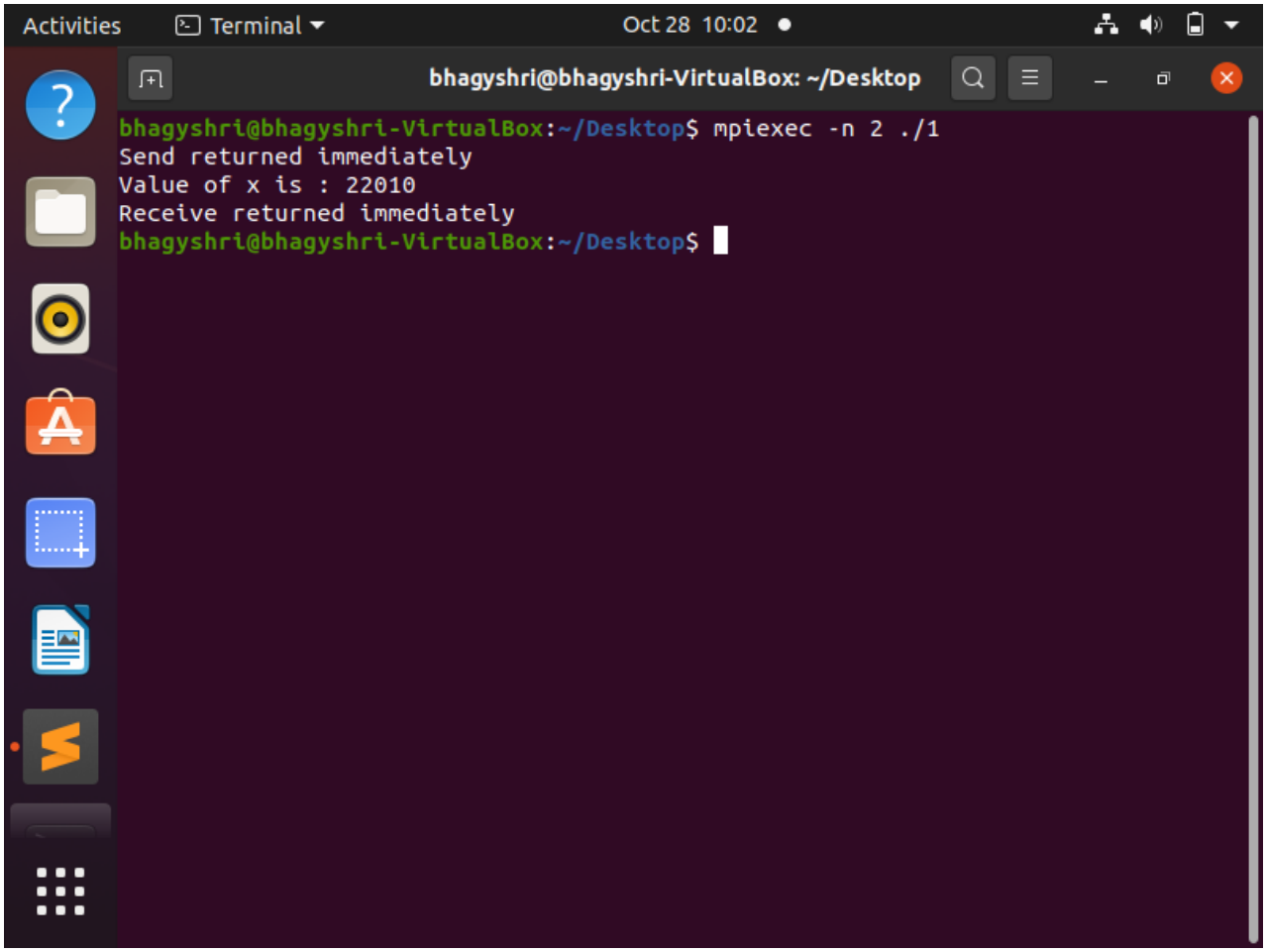
1. Non-Blocking Send and Receive.

```
#include<mpi.h> #include<stdio.h> int main(intargc,char *argv[ ])

{

int size,myrank,x,i; MPI_Status

status;

MPI_Request request;

MPI_Init(&argc,&argv);

MPI_Comm_size(MPI_COMM_WORLD,&size); MPI_Comm_rank(MPI_COMM_WORLD,&myrank);

if(myrank==0)

{ x=10;

MPI_Isend(&x,1,MPI_INT,1,20,MPI_COMM_WORLD,&request); // Tag is different at receiver.

printf(“Send returned immediately\n”);

} else

if(myrank==1)

{

printf("Value of x is : %d\n",x);

MPI_Irecv(&x,1,MPI_INT,0,25,MPI_COMM_WORLD,&request);

printf(“Receive returned immediately\n”);
}

MPI_Finalize(); return

0;
```

}

Observation:

a) Note the difference between standard mode send and non blocking send.

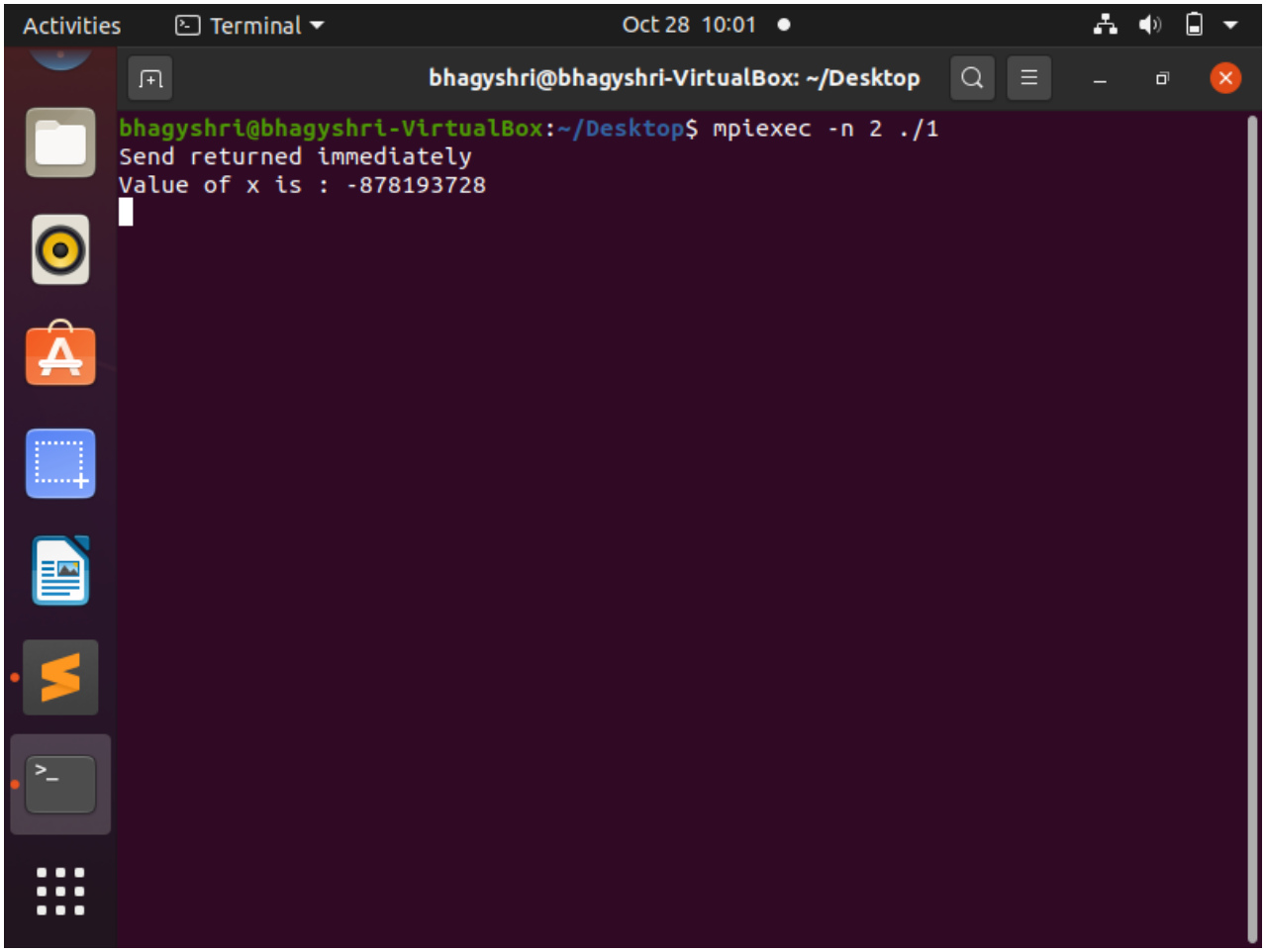


Standard mode send returns only after the value is copied out of send buffer but here at non blocking send, without waiting for that the next print statement is executed

b) Note the observation by placing MPI_Wait() routine after MPI_Isend() and MPI_Irecv().

```
#include<mpi.h>
#include<stdio.h>
int main(int argc,char *argv[ ])
{
int size,myrank,x,i;
MPI_Status status;
MPI_Request request;
MPI_Init(&argc,&argv);
MPI_Comm_size(MPI_COMM_WORLD,&size);
MPI_Comm_rank(MPI_COMM_WORLD,&myrank);
if(myrank==0)
{
```

```
x=10;
MPI_Isend(&x,1,MPI_INT,1,20,MPI_COMM_WORLD,&request);
MPI_Wait(&request,&status);
printf("Send returned immediately \n");
}
else if(myrank==1)
{
printf("Value of x is : %d \n",x);
MPI_Irecv(&x,1,MPI_INT,0,25,MPI_COMM_WORLD,&request);
MPI_Wait(&request,&status);
printf("Receive returned immediately \n");}
MPI_Finalize();
return 0;
}
```

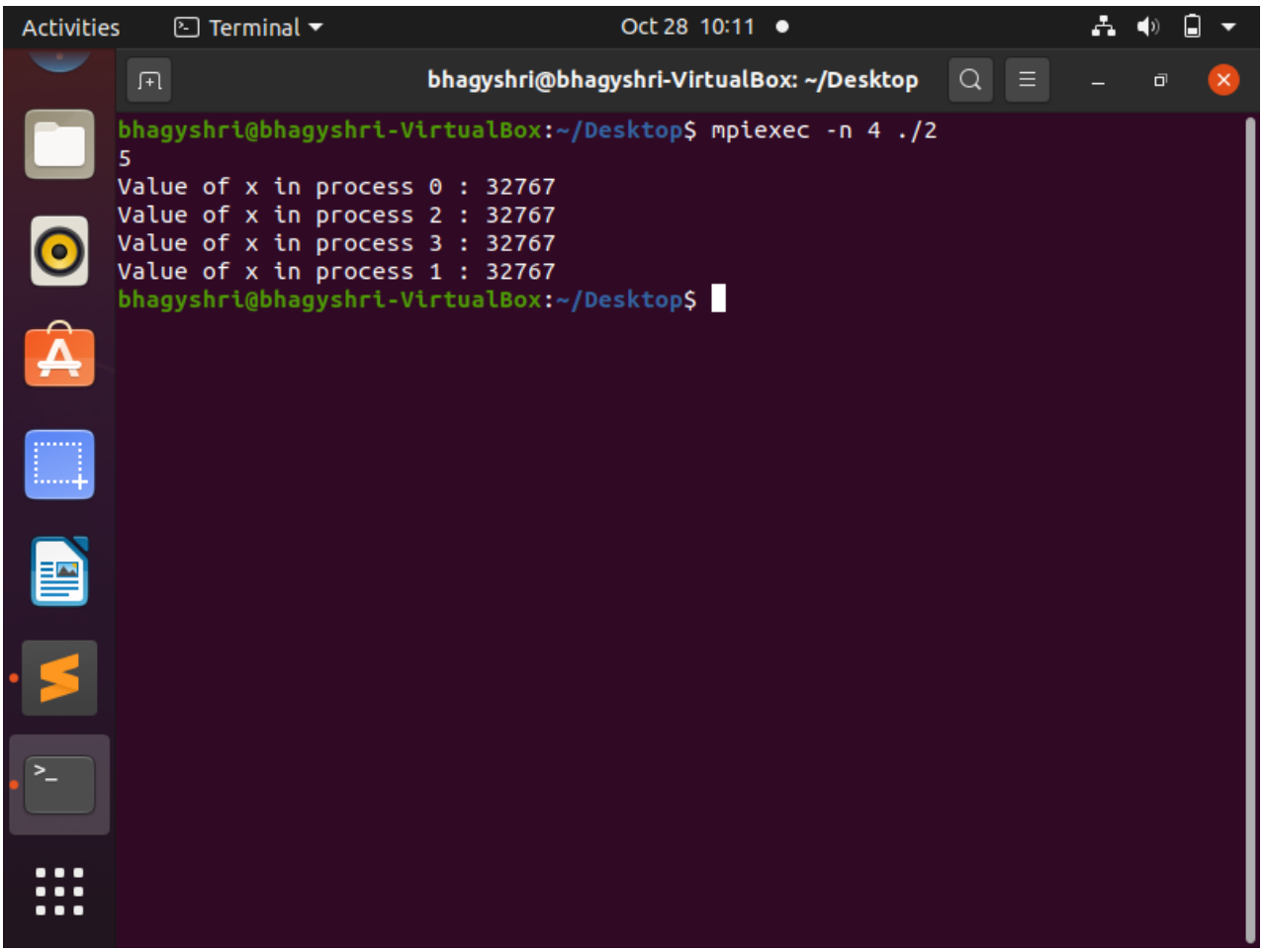


Observation-Once MPI_Wait() is placed for MPI_Isend(), it will return only when the value is copied out of send buffer,for MPI_Irecv(), it will return only when some value is copied to receiving buffer. Therefore here after executing MPI_Wait() of MPI_Send(), the next print statement is also executed. But it will wait indefinitely at MPI_Wait() of MPI_Irecv() till a send with matching tag is made without executing the next print statement.

2. Demonstration of Broadcast operation : MPI_Bcast().

```
#include<mpi.h>

#include<stdio.h> int main(int

argc,char *argv[ ])

{ int

size,myrank,x;

MPI_Init(&argc,&argv);

MPI_Comm_size(MPI_COMM_WORLD,&size); MPI_Comm_rank(MPI_COMM_WORLD,&myrank);

if(myrank==0)

{ scanf("%d",&x);

}

MPI_Bcast(&x,1,MPI_INT,1,MPI_COMM_WORLD);

printf("Value of x in process %d : %d\n",myrank,x);

MPI_Finalize(); return 0;

}
```

Output-



Here process with id 0, reads in value of x as 5 and broadcasts it into every process in MPI_COMM_WORLD.

3. Demonstration of MPI_Reduce with Sum Operation

You may use MPI_PROD to get product of elements in each process.

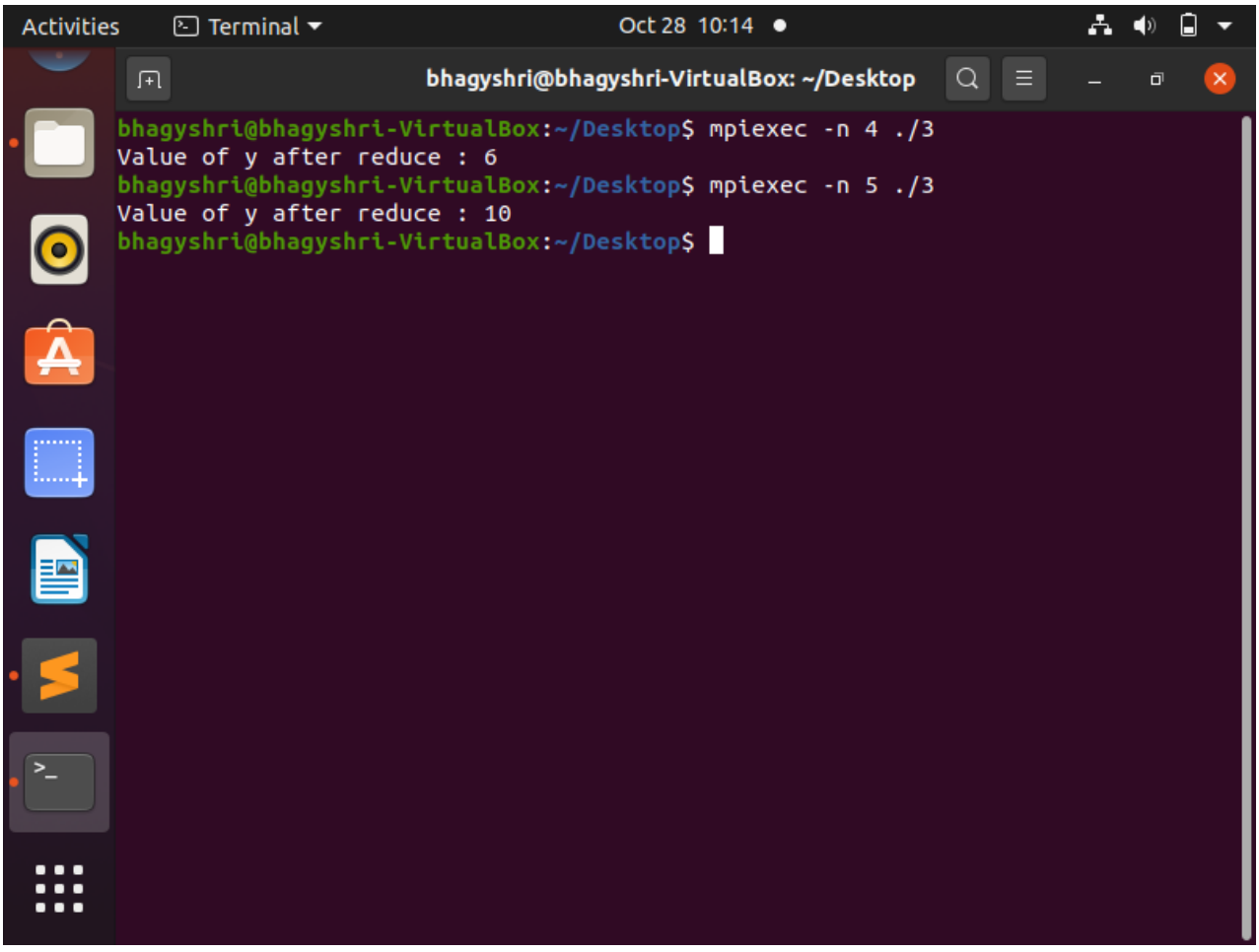
You may also try using array of elements instead of single element x.

Try to understand the working of Reduce.

```
#include<mpi.h>

#include<stdio.h> int main(int

argc,char *argv[ ])

{

int size,myrank,i,x,y;

MPI_Init(&argc,&argv);
```

```
MPI_Comm_size(MPI_COMM_WORLD,&size); MPI_Comm_rank(MPI_COMM_WORLD,&myrank);

x=myrank; // Note the value of x in each process.

MPI_Reduce(&x,&y,1,MPI_INT,MPI_SUM,0,MPI_COMM_WORLD);

if(myrank==0) {

printf("Value of y after reduce : %d\n",y);

} MPI_Finalize();

return 0;

}
```

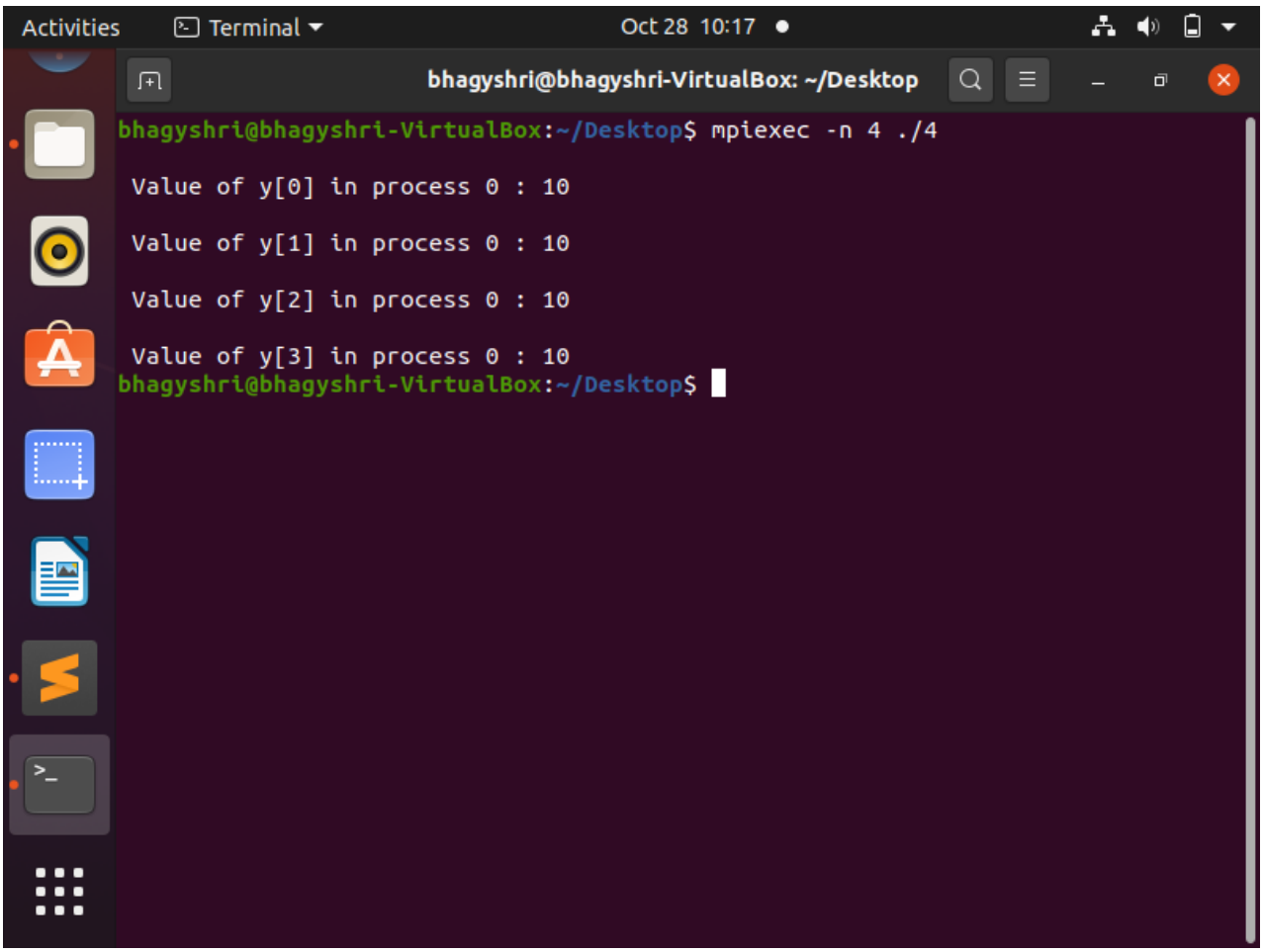
Output-



Here in every process x value is the respective process id. All this values are added using reduce and stored in y buffer of 0 th process For total 4 no of process, y= 0+1+2+3=6 For total 5 no of process,y=0+1+2+3+4=10

4. Demonstration of MPI_Gather():

```
#include<mpi.h>
#include<stdio.h> int main(int
argc,char *argv[ ])
{
int size,myrank,x=10,y[5],i;
MPI_Init(&argc,&argv);
MPI_Comm_size(MPI_COMM_WORLD,&size);
MPI_Comm_rank(MPI_COMM_WORLD,&myrank);
MPI_Gather(&x,1,MPI_INT,y,1,MPI_INT,0,MPI_COMM_WORLD); // Value of x at each process is
copied to array y in Process 0 if(myrank==0)
{
for(i=0;i<size;i++) printf("\nValue of y[%d] in process %d :
%d\n",i,myrank,y[i]);
}
MPI_Finalize();
return 0;

}
```



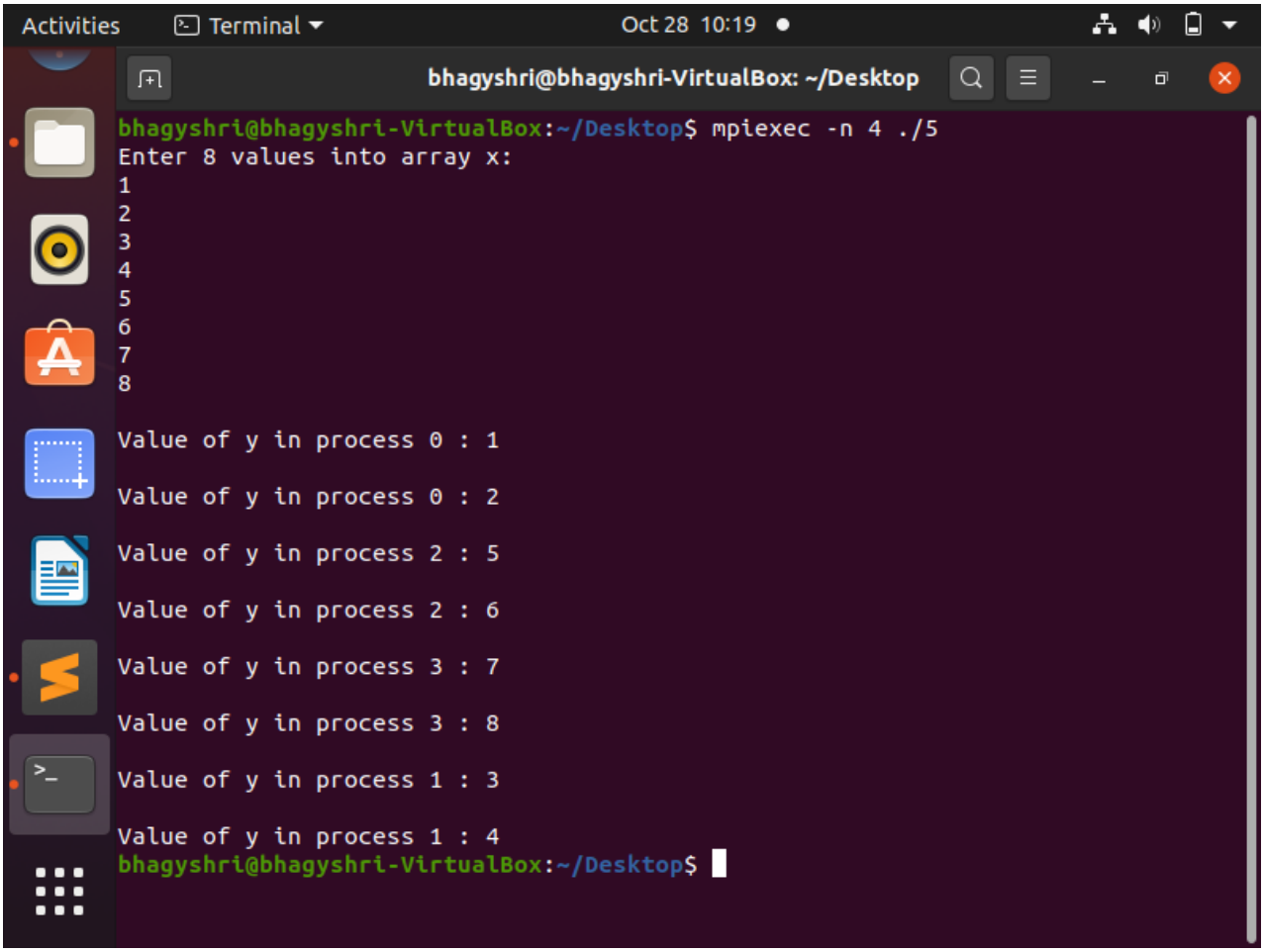
Observation -Process 0 gathers the value stored in the buffer from all other processes and stores in y

5. Demonstration of MPI_Scatter()

- **Note that the program is hard coded to work with 4 processes receiving two chunks from the array.**
- **You may change according to what you want to explore.**

```
#include<mpi.h>
#include<stdio.h> int main(int
argc,char *argv[ ])
{
int size,myrank,x[8],y[2],i;
MPI_Init(&argc,&argv);
```

```
MPI_Comm_size(MPI_COMM_WORLD,&size);
MPI_Comm_rank(MPI_COMM_WORLD,&myrank); if(myrank==0)
{
printf("Enter 8 values into array x:\n");
for(i=0;i<8;i++) scanf("%d",&x[i]);
}
MPI_Scatter(x,2,MPI_INT,y,2,MPI_INT,0,MPI_COMM_WORLD);
for(i=0;i<2;i++)
printf("\nValue of y in process %d : %d\n",myrank,y[i]);
MPI_Finalize(); return 0; }
```



Process 0 reads 8 values and is scattered among the 4

processes. Each process prints the 2 values it received

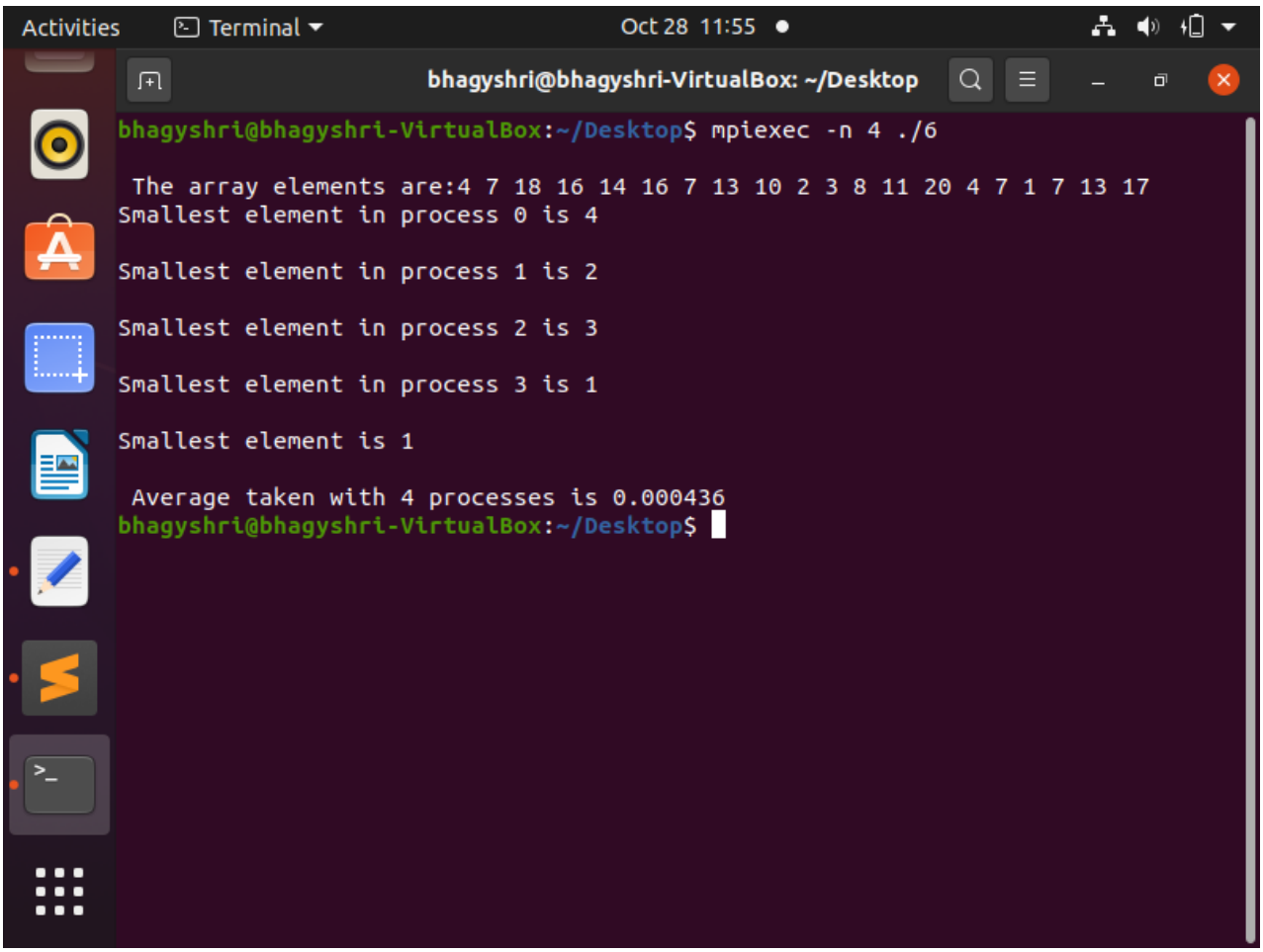
6. Write an MPI program to find the smallest element in a given array of size N.

- Try to find out how many processes you may need for parallel computation based on N.

- Use MPI_Reduce routine. Identify which routine you would use to find the minimum number in a given array.

```
#include<mpi.h>
#include<stdio.h>
int main(int argc,char *argv[ ])
{
int size,myrank;
int n=20;
int x[20],y[20];
int Min=n+1;
int GlobalMin;
int indSize;
double s;
int sendcount[20],displacement[20];
double start,end,time,avgtime;
MPI_Init(&argc,&argv);
start = MPI_Wtime();
MPI_Comm_size(MPI_COMM_WORLD,&size);
MPI_Comm_rank(MPI_COMM_WORLD,&myrank);
indSize=n/size;
s=size;
if(myrank==0)
{
printf("\n The array elements are:");
for(int i=0;i<n;i++)
{
x[i] =1+ rand()%n;
printf("%d ",x[i]);
}
}
displacement[0]=0;
for(int i=0;i<size-1;i++)
{
```

```
sendcount[i]=indSize;
displacement[i+1]+=indSize;
}
sendcount[size-1]=n-(size-1)*indSize;
MPI_Scatterv(&x,sendcount,displacement,MPI_INT,&y,5,MPI_INT,0,MPI_COMM_WORLD
);
for(int i=0;i<sendcount[myrank];i++)
{
if(y[i]<Min)
Min=y[i];
}
printf("\nSmallest element in process %d is %d\n",myrank,Min);
MPI_Reduce(&Min,&GlobalMin,1,MPI_INT,MPI_MIN,0,MPI_COMM_WORLD);
if(myrank ==0)
{
printf("\nSmallest element is %d\n",GlobalMin );
}
MPI_Barrier(MPI_COMM_WORLD);
end=MPI_Wtime();
time=end-start;
MPI_Reduce(&time,&avgtime,1,MPI_DOUBLE,MPI_SUM,0,MPI_COMM_WORLD);
avgtime= avgtime/s;
if(myrank==0)
printf("\n Average taken with %d processes is %f\n",size,avgtime);
MPI_Finalize();
return 0;
}
```



Process 0 assigns random values to the array elements, and scatter the array to different processes. Each process finds the local minimum and the minimum is found using reduce

MPI_Scatter() and MPI_Reduce() routines are used here

No of processes	Time taken
1	0.000038
2	0.000070
3	0.000196
4	0.000236
5	0.035423
6	0.042532