

## Part 1 Results

A lot of what was asked in the question had already been done.

- a. This was updated to include `MPI_Barrier(MPI_COMM_WORLD)` which can be seen on line 193.
- b. This can be seen on line 123 where `MPI_Bcast` is used to give the partition size to the nodes so memory can be allocated, and on line 128 where `MPI_Send` is used in a for loop to send the partitions to each node.
- c. Created a timer, that times how long the application takes to run. There was no difference in the time it took for the application to run before the changes were made as only adding `MPI_Barrier` was the difference.
- d. As documented in Assignment 1, when the threshold of the array is increased, comparing from 1 node and 4 can be seen in the below:

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 12
Student Name: Sarah Brennan
Student Number: 2962279
Total sum of prime numbers in array is 42
Elapsed time: 0.0015455

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 12
Student Name: Sarah Brennan
Student Number: 2962279
Total sum of prime numbers in array is 42
Elapsed time: 0.0001379
```

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 100
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 684
Elapsed time: 0.0019783

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 100
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 684
Elapsed time: 0.0001374

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 1000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 6077
Elapsed time: 0.0016928

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 1000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 6077
Elapsed time: 0.0002387

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 10000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 65214
Elapsed time: 0.0027585

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 10000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 65214
Elapsed time: 0.0010341

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 100000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 657741
Elapsed time: 0.0043817
```

```

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 100000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 657741
Elapsed time: 0.0059962

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 1000000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 6553641
Elapsed time: 0.0214794

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 1000000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 6553641
Elapsed time: 0.0644561

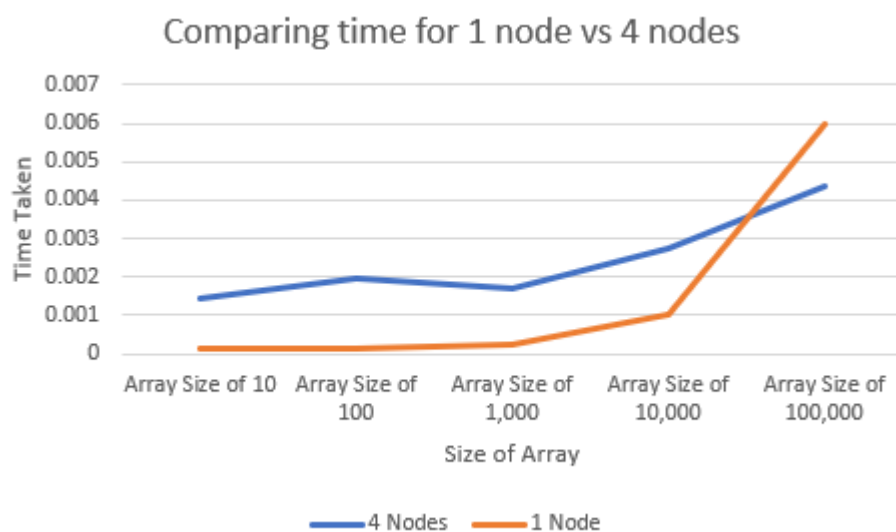
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 10000000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 65633067
Elapsed time: 0.184605

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 10000000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 65633067
Elapsed time: 0.62788

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 4 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 100000000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 655901674
Elapsed time: 1.74608

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Part2\Debug>mpiexec -n 1 Sarah_Brennan_2962279_Part2
Please enter the array size evenly divisible by world size: 100000000
Student Name: Sarah Brennan
Student Number: 2962279
Total sum is 655901674
Elapsed time: 6.45089

```



## Part 2 Results

Created a new project for part 2. Created 5 methods: main, participant, coordinator, median and printArray. The coordinator is used by the first node and the participant by other nodes that may be available. The median method takes in a reference to an array and the size of the array and returns the median number in that array.

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 100
Student Name: Sarah Brennan
Student Number: 2962279
1, 1, 2, 3, 4, 4, 4, 5, 5, 6, 6, 7, 7, 7, 8, 9, 9, 10, 12, 12, 12, 13, 13, 13, 15, 15, 15, 17, 17, 17, 18, 18, 19, 19, 19,
20, 20, 21, 22, 22, 23, 24, 24, 24, 24, 25, 27, 27, 27, 28, 28, 29, 29, 30, 30, 30, 30, 32, 32, 33, 33, 34, 35, 35, 36, 36,
37, 38, 38, 39, 39, 39, 40, 41, 41, 41, 41, 42, 42, 42, 42, 42, 42, 43, 43, 43, 43, 44, 45, 45, 45, 46, 46, 46, 47, 48, 48
, 49, 49, 50
The median of the numbers in array is 28
Elapsed time: 0.0081179
```

Above are the results with an array size of 100. It prints out the numbers within the array and then prints out the median of the numbers. It also has 4 nodes that it works with.

## Comparing 4 nodes with 1

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 100
Student Name: Sarah Brennan
Student Number: 2962279
1, 1, 2, 3, 4, 4, 4, 5, 5, 6, 6, 7, 7, 7, 8, 9, 9, 10, 12, 12, 12, 13, 13, 13, 15, 15, 15, 17, 17, 17, 18, 18, 19, 19, 19,
20, 20, 21, 22, 22, 23, 24, 24, 24, 24, 25, 27, 27, 27, 28, 28, 29, 29, 30, 30, 30, 30, 32, 32, 33, 33, 34, 35, 35, 36, 36,
37, 38, 38, 39, 39, 39, 40, 41, 41, 41, 41, 42, 42, 42, 42, 42, 42, 43, 43, 43, 43, 44, 45, 45, 45, 46, 46, 46, 47, 48, 48
, 49, 49, 50
The median of the numbers in array is 28
Elapsed time: 0.0081179
```

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 1 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 100
Student Name: Sarah Brennan
Student Number: 2962279
1, 1, 2, 3, 4, 4, 4, 5, 5, 6, 6, 7, 7, 7, 8, 9, 9, 10, 12, 12, 12, 13, 13, 13, 15, 15, 15, 17, 17, 17, 18, 18, 19, 19, 19,
20, 20, 21, 22, 22, 23, 24, 24, 24, 24, 25, 27, 27, 27, 28, 28, 29, 29, 30, 30, 30, 30, 32, 32, 33, 33, 34, 35, 35, 36, 36,
37, 38, 38, 39, 39, 39, 40, 41, 41, 41, 41, 42, 42, 42, 42, 42, 42, 43, 43, 43, 43, 44, 45, 45, 45, 46, 46, 46, 47, 48, 48
, 49, 49, 50
The median of the numbers in array is 28
Elapsed time: 0.0006539
```

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 1000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 25
Elapsed time: 0.0032554
```

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 1 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 1000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 25
Elapsed time: 0.0010887
```

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 15000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 26
Elapsed time: 0.007544
```

```
C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 1 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 15000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 26
Elapsed time: 0.0110483
```

```

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 50000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 26
Elapsed time: 0.0124413

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 1 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 50000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 26
Elapsed time: 0.0421051

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 100000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 26
Elapsed time: 0.0237177

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 1 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 100000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 26
Elapsed time: 0.0759785

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 4 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 1000000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 25
Elapsed time: 1.85528

C:\Users\sirla\source\repos\Sarah_Brennan_2962279_Ass2_Part2\Debug>mpiexec -n 1 "Sarah_Brennan_2962279_Ass2_Part2.exe"
Please enter the array size evenly divisible by world size: 1000000
Student Name: Sarah Brennan
Student Number: 2962279
The median of the numbers in array is 25
Elapsed time: 7.06205

```

As can be seen above, the smaller the array is, the better the 1 node works for the application. However, once the array gets huge, the time increases a lot more for 1 node compared to 4. From 100000 onwards, more nodes should be used to help the performance of the application.

Below is a graph of the results from screenshots above:

