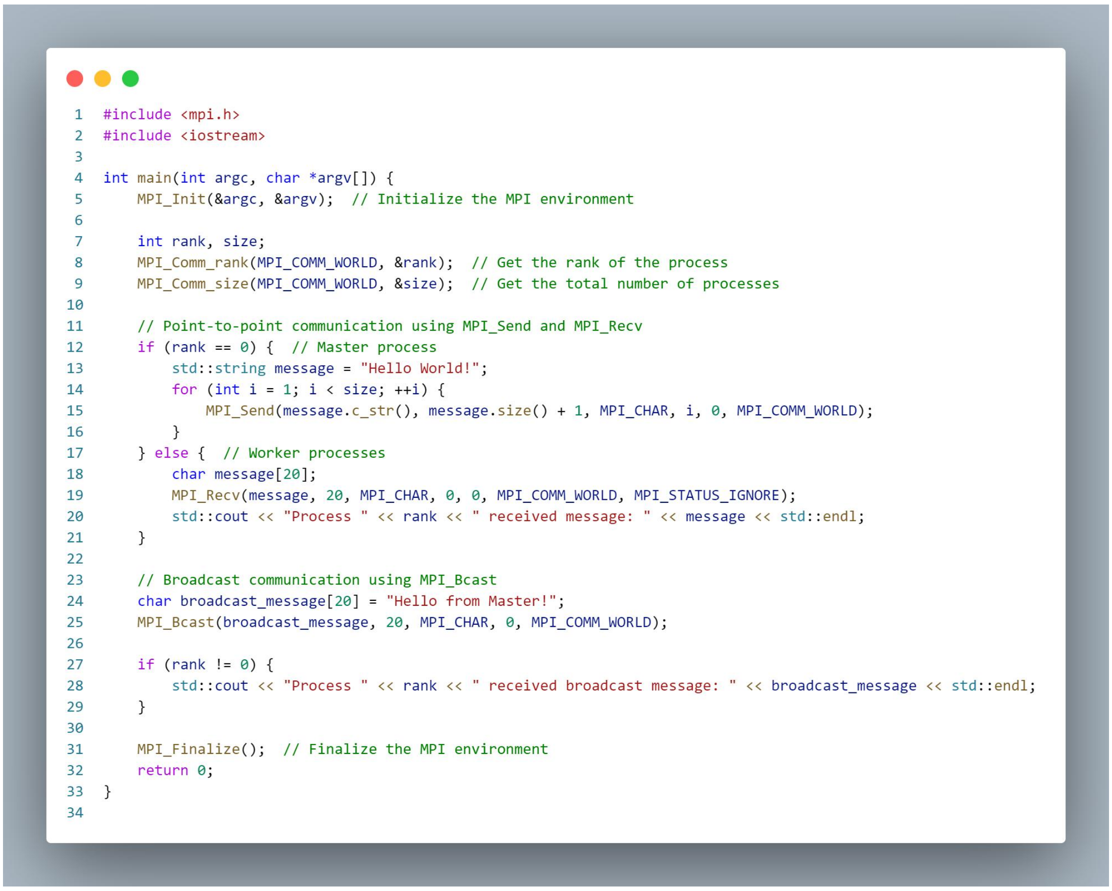
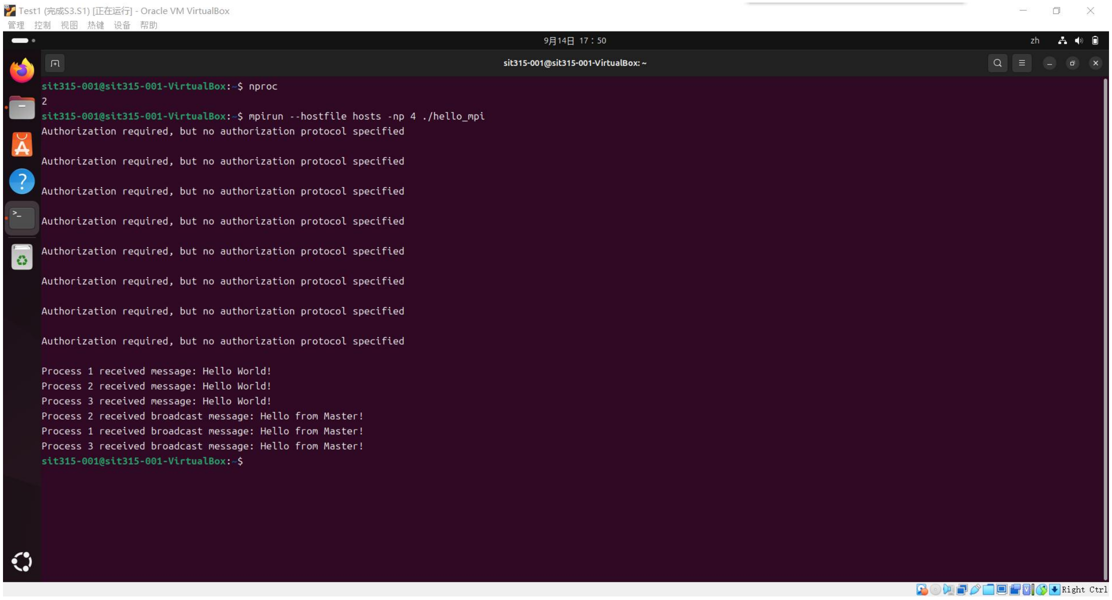
Activity 1

Code Implementation



```cpp
#include <mpi.h>
#include <iostream>

int main(int argc, char *argv[]) {
    MPI_Init(&argc, &argv);  // Initialize the MPI environment

    int rank, size;
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);  // Get the rank of the process
    MPI_Comm_size(MPI_COMM_WORLD, &size);  // Get the total number of processes

    // Point-to-point communication using MPI_Send and MPI_Recv
    if (rank == 0) {  // Master process
        std::string message = "Hello World!";
        for (int i = 1; i < size; ++i) {
            MPI_Send(message.c_str(), message.size() + 1, MPI_CHAR, i, 0, MPI_COMM_WORLD);
        }
    } else {  // Worker processes
        char message[20];
        MPI_Recv(message, 20, MPI_CHAR, 0, 0, MPI_COMM_WORLD, MPI_STATUS_IGNORE);
        std::cout << "Process " << rank << " received message: " << message << std::endl;
    }

    // Broadcast communication using MPI_Bcast
    char broadcast_message[20] = "Hello from Master!";
    MPI_Bcast(broadcast_message, 20, MPI_CHAR, 0, MPI_COMM_WORLD);

    if (rank != 0) {
        std::cout << "Process " << rank << " received broadcast message: " << broadcast_message << std::endl;
    }

    MPI_Finalize();  // Finalize the MPI environment
    return 0;
}
```

Results



Test1 (完成S3.S1) [正在运行] - Oracle VM VirtualBox
管理 控制 视图 热键 设备 帮助
9月14日 17：50
sit315-001@sit315-001-VirtualBox: ~
Right Ctrl

```
sit315-001@sit315-001-VirtualBox:~$ nproc
2
sit315-001@sit315-001-VirtualBox:~$ mpirun --hostfile hosts -np 4 ./hello_mpi
Authorization required, but no authorization protocol specified

Authorization required, but no authorization protocol specified

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Process 1 received message: Hello World!
Process 2 received message: Hello World!
Process 3 received message: Hello World!
Process 2 received broadcast message: Hello from Master!
Process 1 received broadcast message: Hello from Master!
Process 3 received broadcast message: Hello from Master!
sit315-001@sit315-001-VirtualBox:~$
```
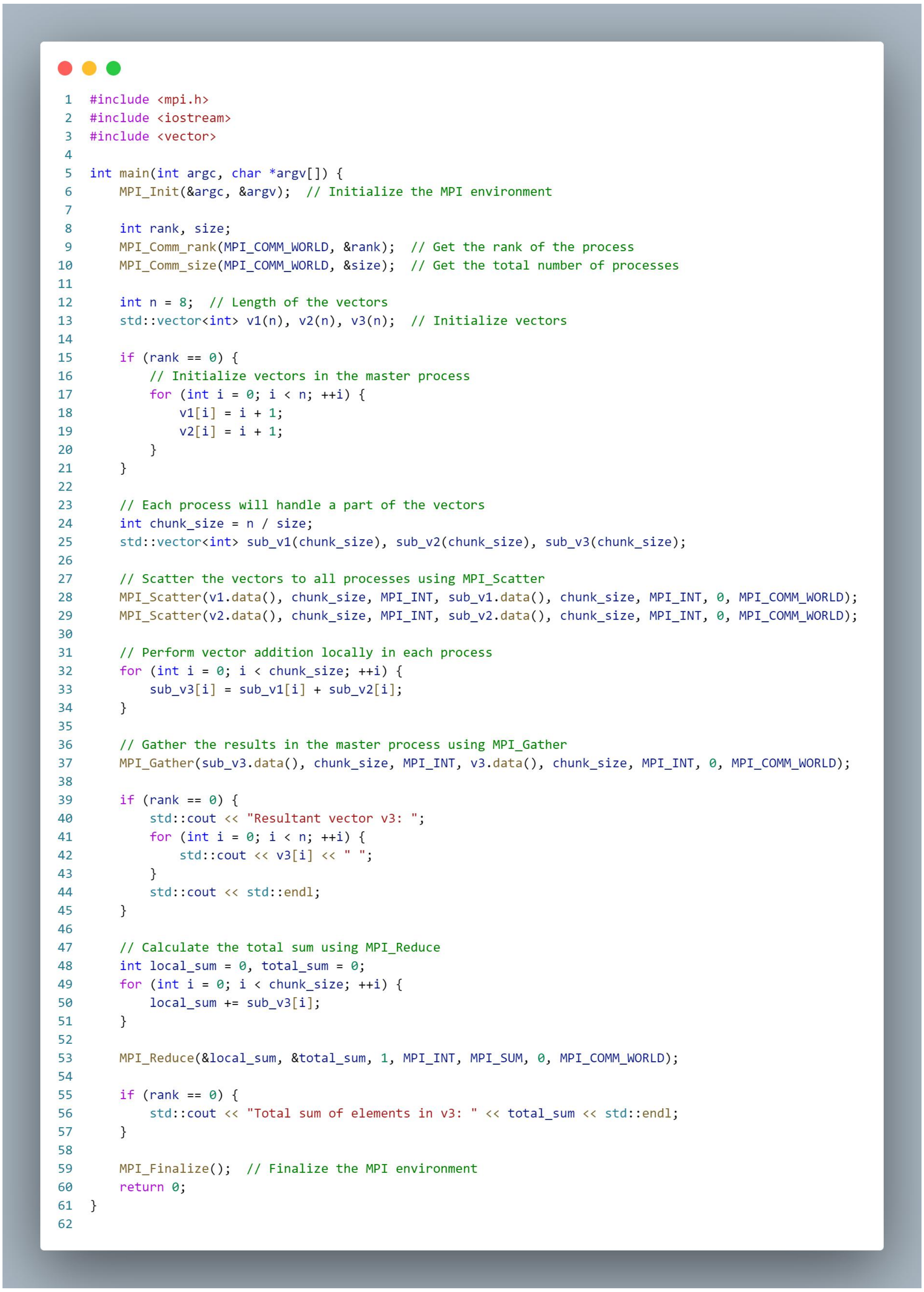

In this activity, I successfully implemented both point-to-point and broadcast communication using MPI. All processes correctly received and printed the messages sent by the master process.

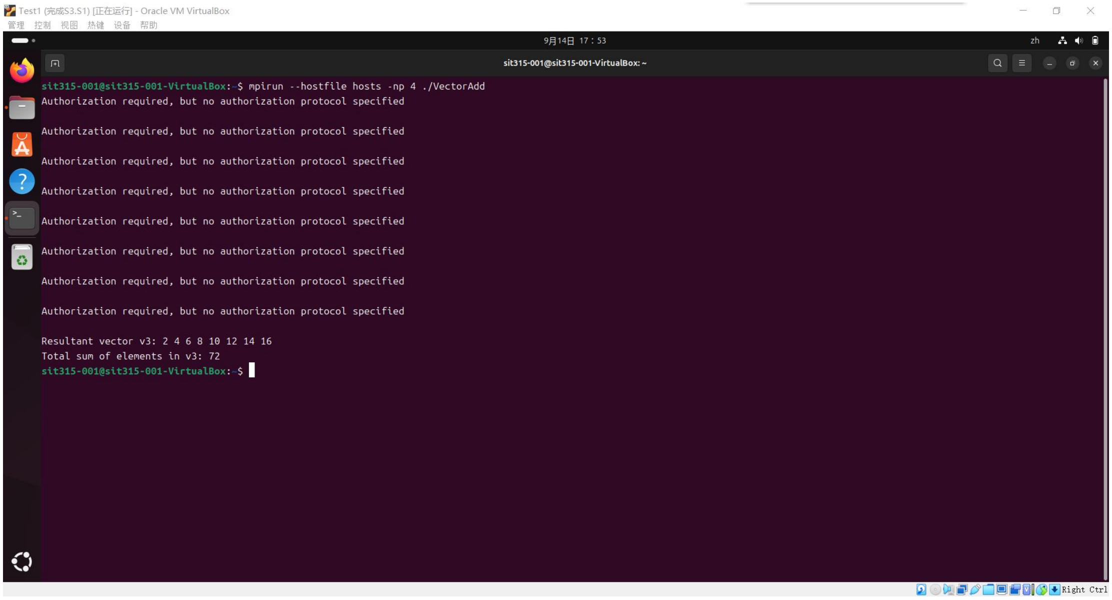
Activity 2

Code Implementation



```cpp
#include <mpi.h>
#include <iostream>
#include <vector>

int main(int argc, char *argv[]) {
    MPI_Init(&argc, &argv);  // Initialize the MPI environment

    int rank, size;
    MPI_Comm_rank(MPI_COMM_WORLD, &rank);  // Get the rank of the process
    MPI_Comm_size(MPI_COMM_WORLD, &size);  // Get the total number of processes

    int n = 8;  // Length of the vectors
    std::vector<int> v1(n), v2(n), v3(n);  // Initialize vectors

    if (rank == 0) {
        // Initialize vectors in the master process
        for (int i = 0; i < n; ++i) {
            v1[i] = i + 1;
            v2[i] = i + 1;
        }
    }

    // Each process will handle a part of the vectors
    int chunk_size = n / size;
    std::vector<int> sub_v1(chunk_size), sub_v2(chunk_size), sub_v3(chunk_size);

    // Scatter the vectors to all processes using MPI_Scatter
    MPI_Scatter(v1.data(), chunk_size, MPI_INT, sub_v1.data(), chunk_size, MPI_INT, 0, MPI_COMM_WORLD);
    MPI_Scatter(v2.data(), chunk_size, MPI_INT, sub_v2.data(), chunk_size, MPI_INT, 0, MPI_COMM_WORLD);

    // Perform vector addition locally in each process
    for (int i = 0; i < chunk_size; ++i) {
        sub_v3[i] = sub_v1[i] + sub_v2[i];
    }

    // Gather the results in the master process using MPI_Gather
    MPI_Gather(sub_v3.data(), chunk_size, MPI_INT, v3.data(), chunk_size, MPI_INT, 0, MPI_COMM_WORLD);

    if (rank == 0) {
        std::cout << "Resultant vector v3: ";
        for (int i = 0; i < n; ++i) {
            std::cout << v3[i] << " ";
        }
        std::cout << std::endl;
    }

    // Calculate the total sum using MPI_Reduce
    int local_sum = 0, total_sum = 0;
    for (int i = 0; i < chunk_size; ++i) {
        local_sum += sub_v3[i];
    }

    MPI_Reduce(&local_sum, &total_sum, 1, MPI_INT, MPI_SUM, 0, MPI_COMM_WORLD);

    if (rank == 0) {
        std::cout << "Total sum of elements in v3: " << total_sum << std::endl;
    }

    MPI_Finalize();  // Finalize the MPI environment
    return 0;
}
```

Results


Test1 (完成S3.S1) [正在运行] - Oracle VM VirtualBox
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9月14日 17：53
zh
sit315-001@sit315-001-VirtualBox: ~
Right Ctrl

```
sit315-001@sit315-001-VirtualBox:~$ mpirun --hostfile hosts -np 4 ./VectorAdd
Authorization required, but no authorization protocol specified

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Authorization required, but no authorization protocol specified

Resultant vector v3: 2 4 6 8 10 12 14 16
Total sum of elements in v3: 72
sit315-001@sit315-001-VirtualBox:~$ 
```

In this activity, I successfully implemented a distributed vector addition program using MPI. The program correctly distributed and computed the vector addition and calculated the total sum of the result vector.