Parallel Computing - MPI

Message Passing Interface

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MPI - Message Passing Interface

MPI is built on 'Routines'

The basic MPI Routines :-

- MPI_Init () ;
- MPI_Comm_rank () ;
- MPI_Comm_size () ;
- MPI_Send () ;
- MPI_Recv () ;
- MPI_Finalize () ;

- - - - - - - - - - - - -

MPI - Communication

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Point to Point Comm^{n}

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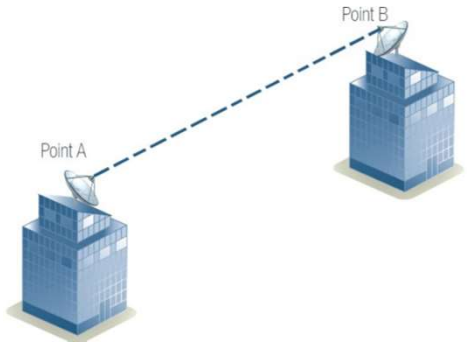

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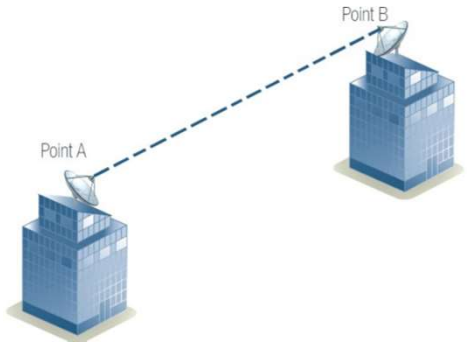

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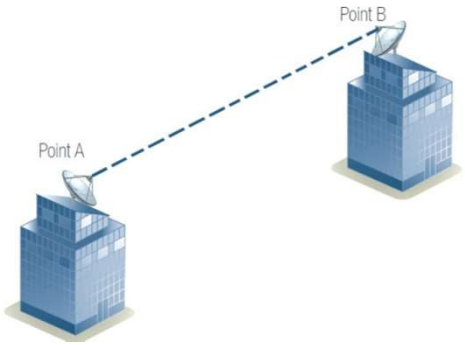

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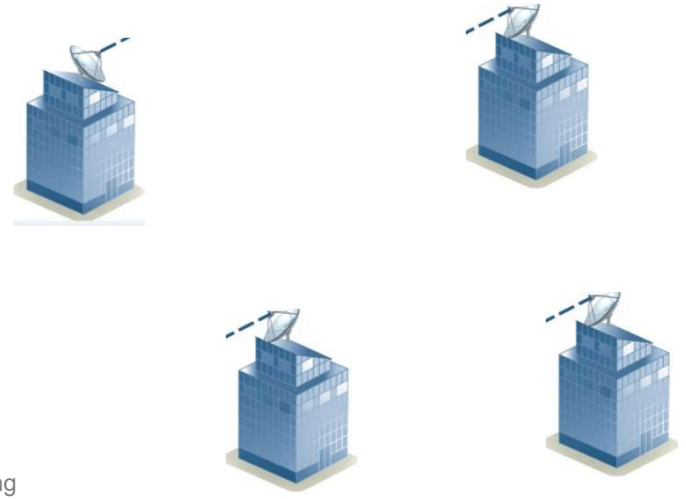

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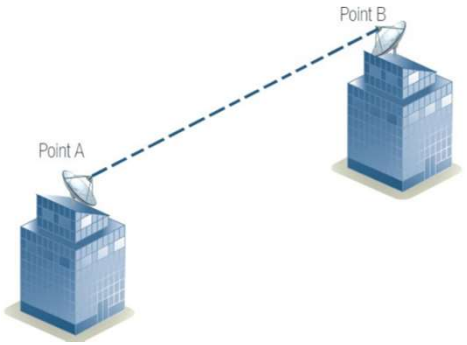

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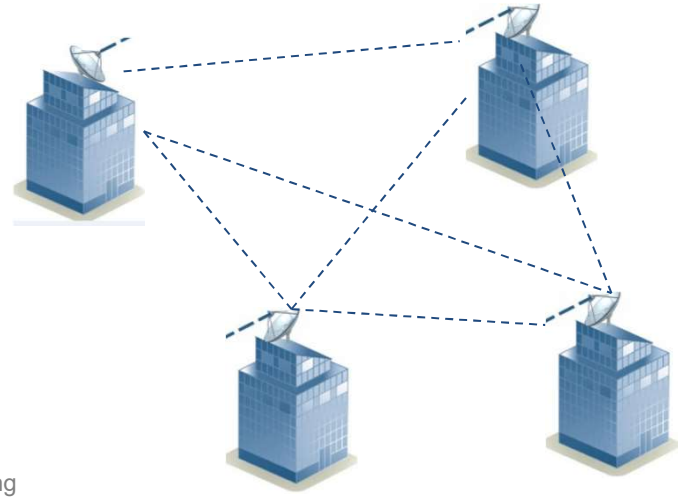
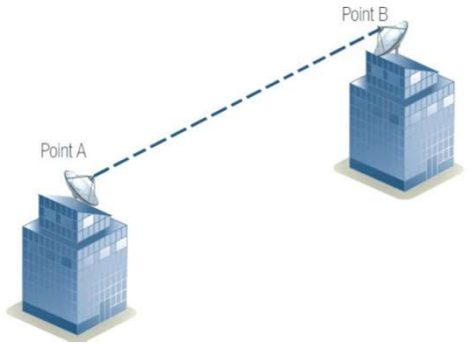
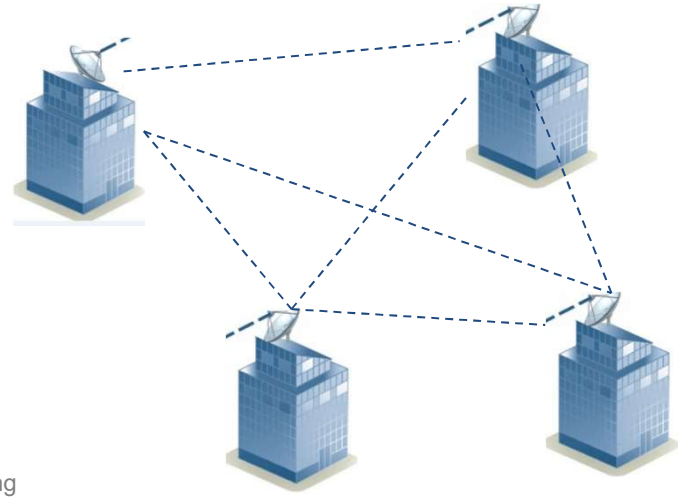


MPI - Communication

Point to Point Comm^{n} → **Collective Comm^{n}**





MPI - Collective Communication

- Collective communication must involve all processes in the scope of a communicator.
- Involve coordinated communication within a group of processes identified by an MPI communicator.

Types of Collective Operations

- Synchronization - Processes wait until all members of the group have reached the synchronization point.
- Data Movement - broadcast, scatter/gather, all to all
- Collective Computation (reductions) - one member of the group collects data from the other members and performs an operation (min,max, add, multiply, etc.) on that data.

Basic Collective Communication Routines

- MPI_Bcast( ) - Broadcast (one to all)
- MPI_Scatter( ) - Scatter (one to all)
- MPI_Gather( ) - Gather (all to one)
- MPI_Reduce( ) - Reduce (all to one)
- MPI_Allgather( ) - (all to all)
- MPI_Allreduce( ) - (all to all)

MPI - Broadcast

Syntax :

MPI_Bcast (void* data , Int count , MPI_Datatype datatype , Int source_process , MPI_Comm comm) ;

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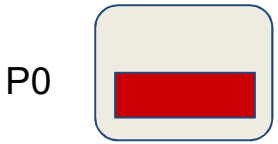

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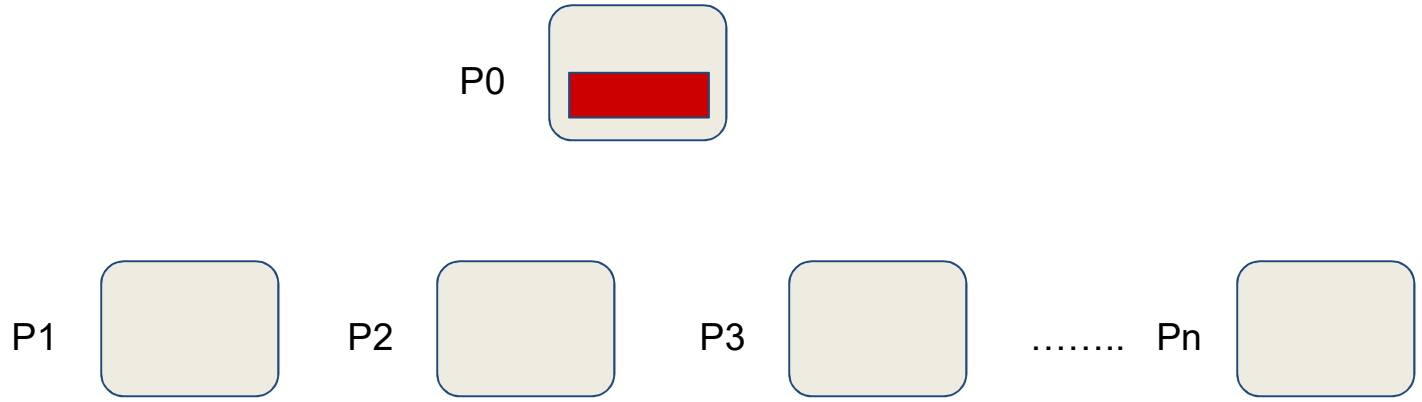

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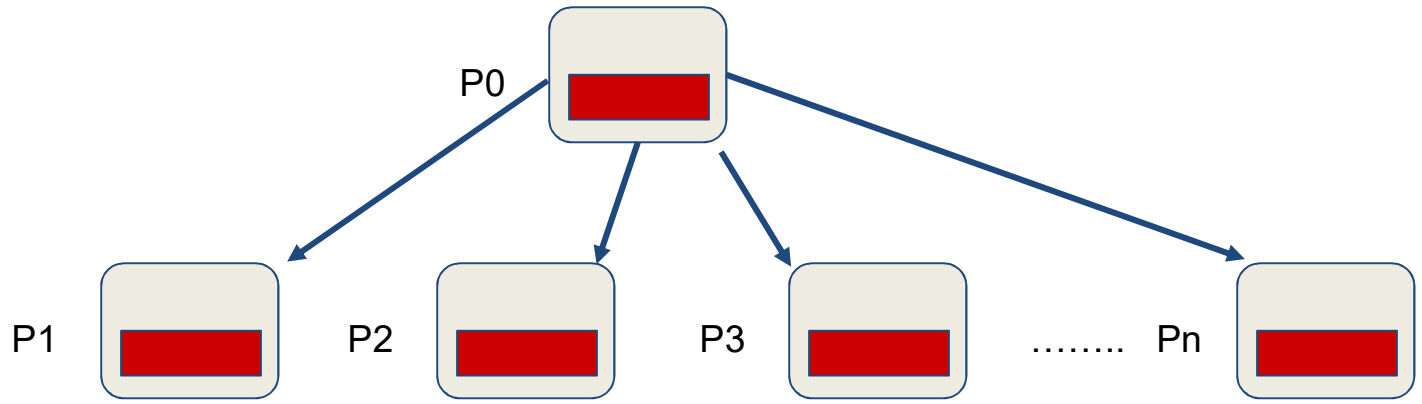

MPI - Broadcast : Example

```
void Get input(int my rank ,Int comm_sz , double a_p , double  b_p , int*  n_p )
        {
                                if (my rank == 0)
                                {
                                        printf("Enter a, b, and n \n");
                                        scanf("%lf %lf %d", a_p, b_p, n_p);
                                }

    MPI Bcast(a_p, 1, MPI_DOUBLE, 0, MPI_COMM_WORLD);

                MPI Bcast(b_p, 1, MPI_DOUBLE, 0, MPI_COMM_WORLD);

                MPI Bcast(n_p, 1, MPI _INT, 0, MPI_COMM_WORLD);
          }
```

MPI - Reduce

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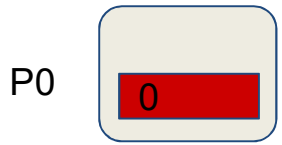

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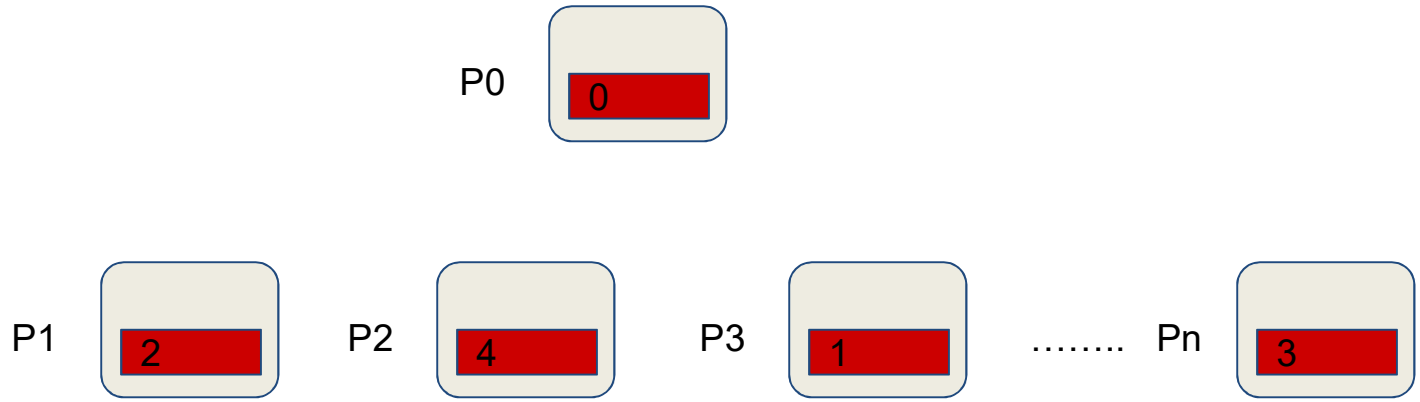

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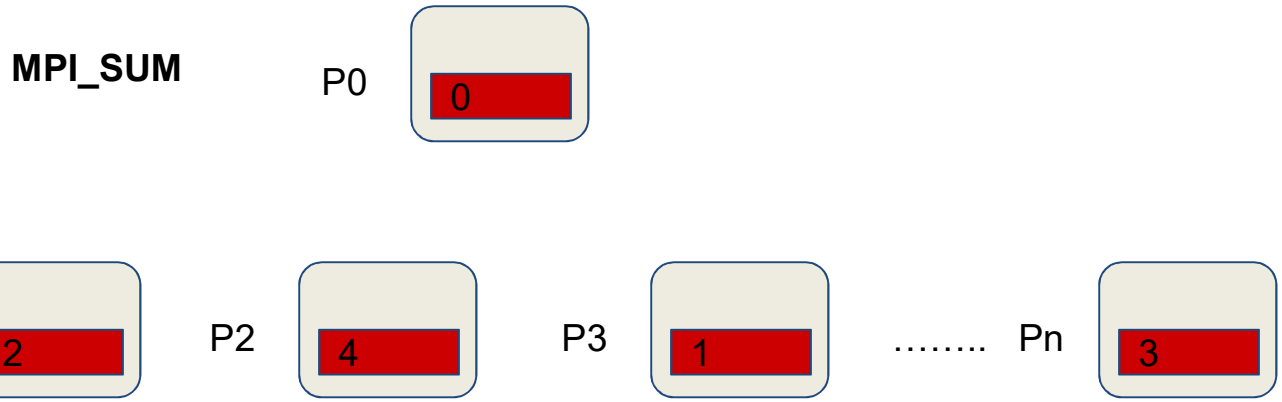

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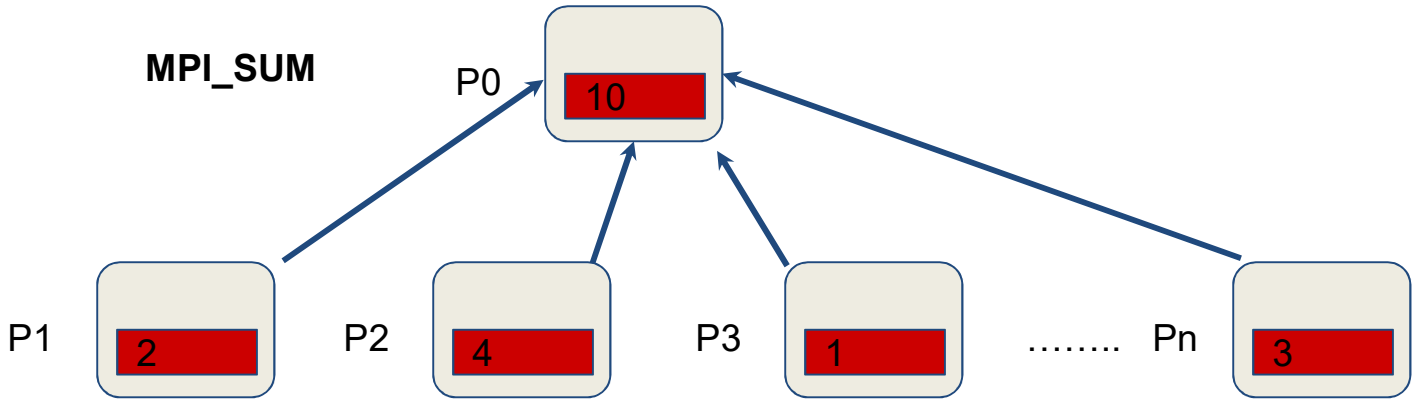

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Example : Many lines in Trap. example programs are replaced by this single line ...

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Example : Many lines in Trap. example programs are replaced by this single line ...

MPI_Reduce(&local_int, &total_int, 1, MPI_DOUBLE, MPI_SUM, 0, MPI_COMM_WORLD) ;

MPI - Allreduce

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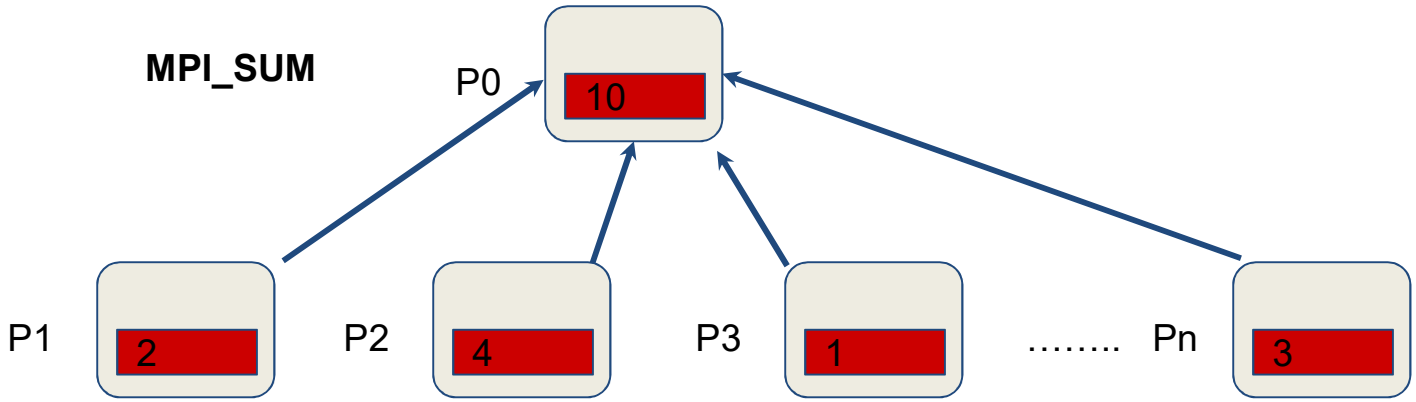
MPI_Reduce (void* input_data , void* output_data , Int count , MPI_Datatype datatype , MPI_Op operator , MPI_Comm comm) ;



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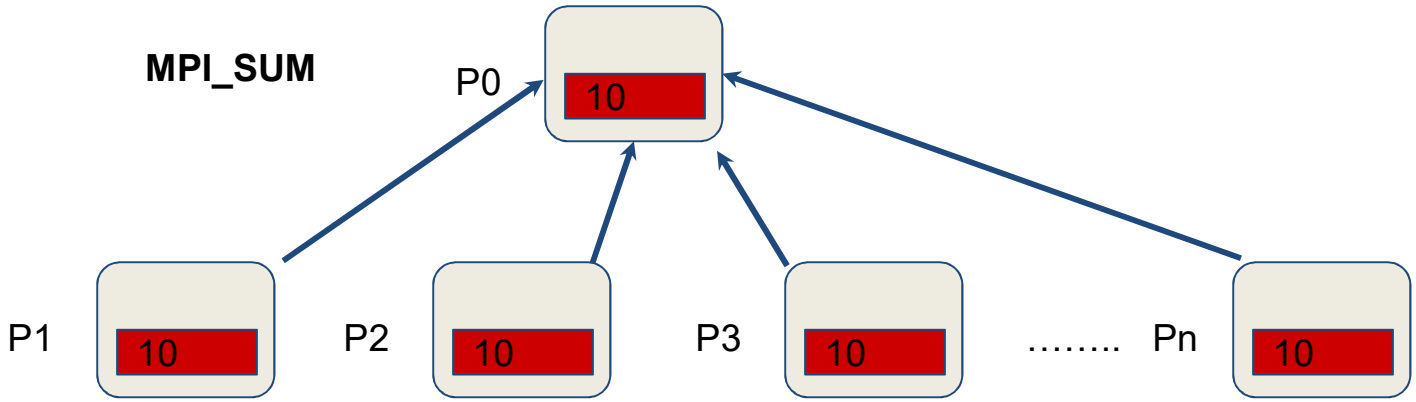
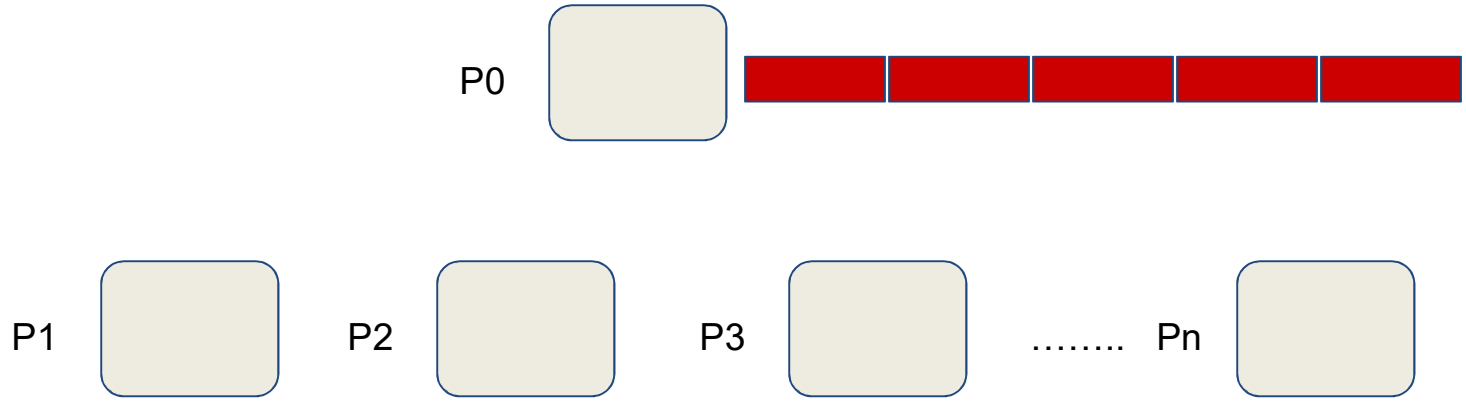


MPI - Scatter

Syntax :

```
MPI_Scatter (void* send_buffer , Int send_count , MPI_Datatype
             send_datatype , void* recv_buffer , Int recv_count ,
             MPI_Datatype recv_datatype , Int source_process ,
             MPI_Comm comm ) ;
```

- MPI_Scatter sends chunks of data to different processes..



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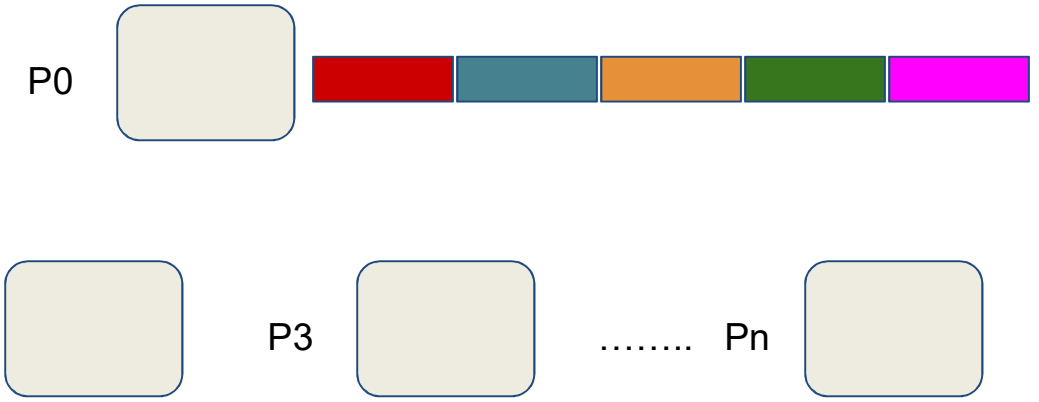

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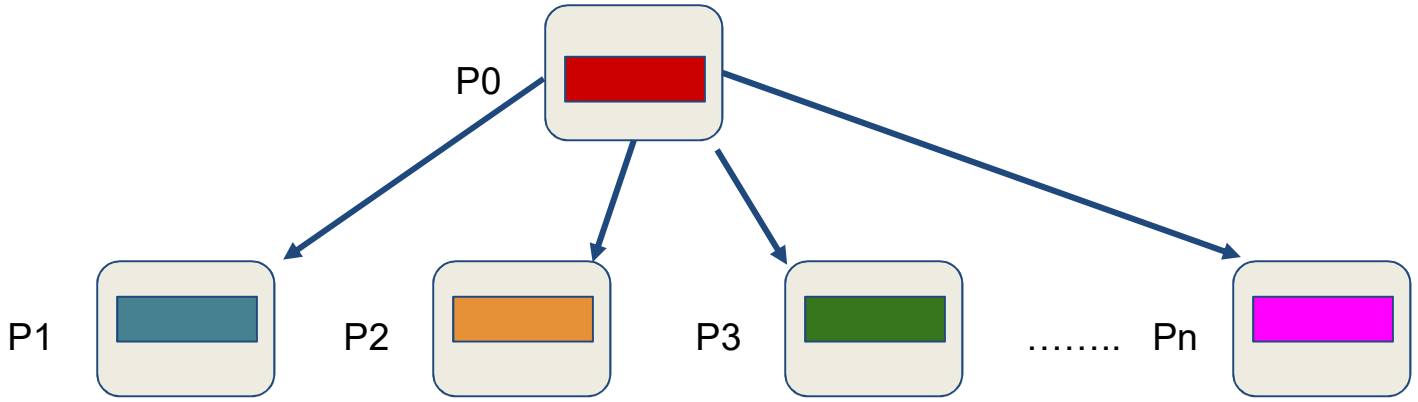

MPI - Gather

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MPI_Gather (void* send_buffer , Int send_count , MPI_Datatype
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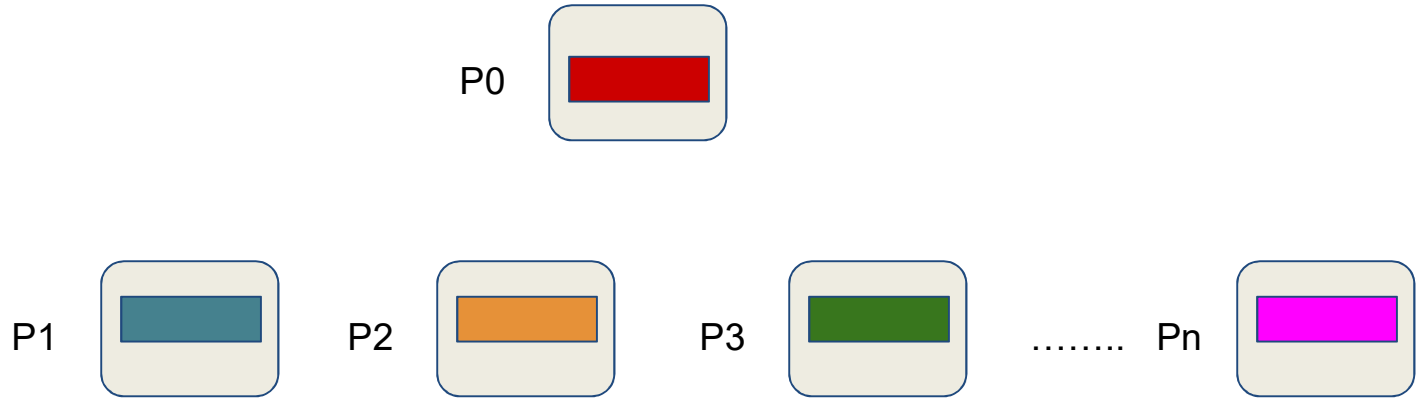
- MPI_Gather collects chunks of data from different processes..



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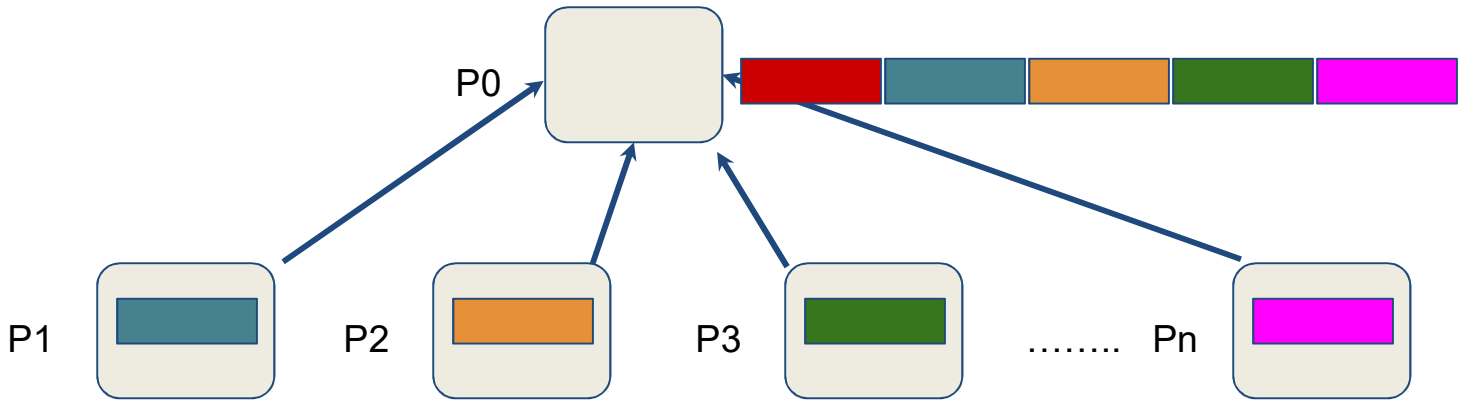

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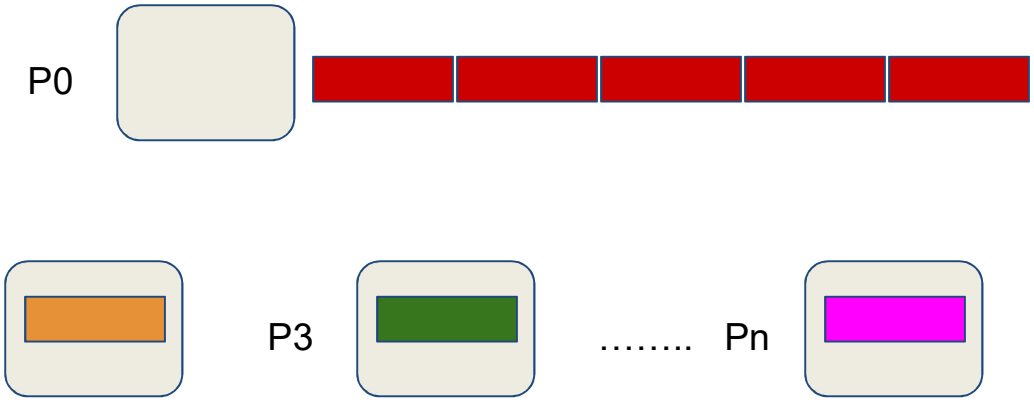

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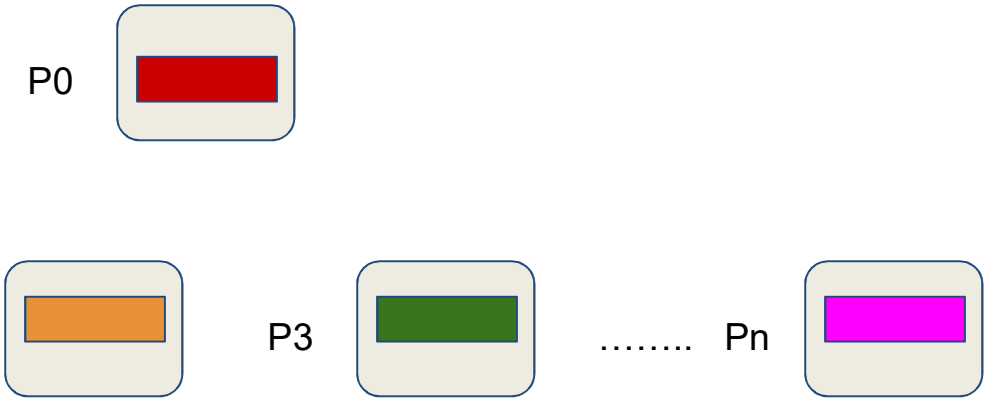

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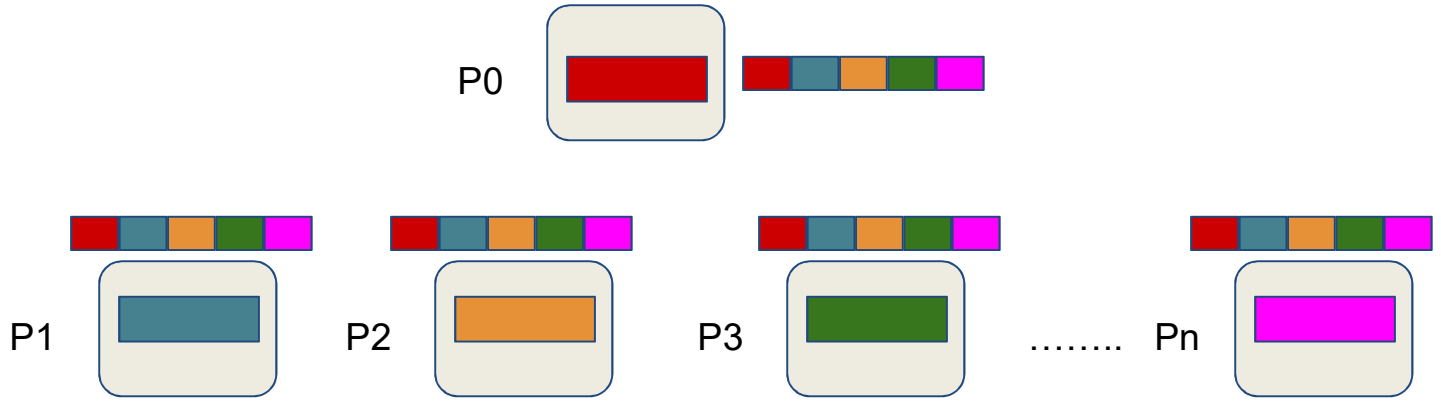

MPI - Synchronization

MPI - Barrier

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- **MPI_Barrier (MPI_Comm communicator) ;**

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- Used to block the calling process until all processes have entered the function. The call will return at any process only after all the processes or group members have entered the call
- The MPI_BARRIER routine blocks the calling process until all group processes have called the function. When MPI_BARRIER returns, all processes are synchronized at the barrier

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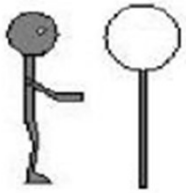

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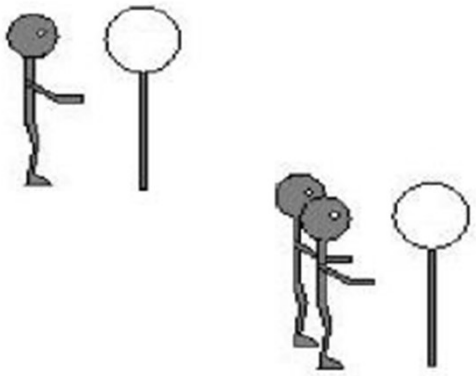

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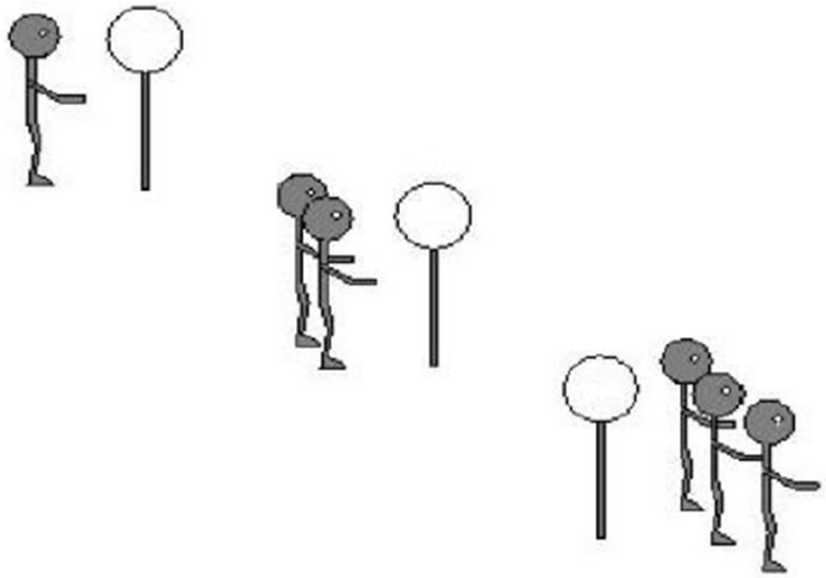

Recap :

- Point to Point Vs Collective communication -
- MPI_Broadcast(...)
- MPI_Scatter(...)
- MPI_Reduce(...)
- MPI_Allreduce(...)
- MPI_Gather(...)
- MPI_Allgather(...)
- Miss MPI routines !
- ....

References :

[1] Barker, Brandon. "Message passing interface (mpi)." *Workshop: High Performance Computing on Stampede*. Vol. 262. 2015.

[2] Yuan, Chung-Tsz, and Shenjian Chen. "Message Passing Interface (MPI)." (1996).

[3] https://computing.llnl.gov/tutorials/mpi/


Thank
You