Parallel Computing - MPI

Message Passing Interface

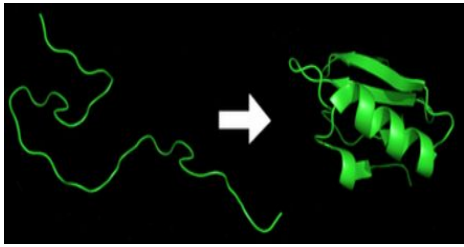
Samir Shaikh
HPC - Tech, CDAC Pune

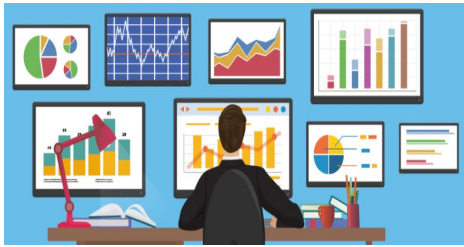
Agenda

- Why Parallel Computing ?
- Why we need ever-increasing Performance ?
- Parallel programing Architectures/Model ..
- MPI - Message Passing Interface
    - What is MPI ?, Need and Evolution of MPI.
    - MPI program - Compile and Execution
    - MPI Program Structure
    - MPI Routines
    - ……

Why we need Ever-Increasing Performance ?

- Accurate medical imaging
- Fast and accurate web searches
- Realistic computer games, Entertainment
- Climate modeling
- Protein folding
- Artificial Intelligence
- Energy research
- Data analysis .....
- .....





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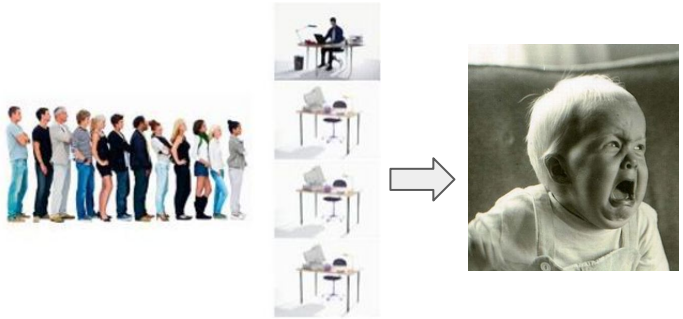

Serial Computing

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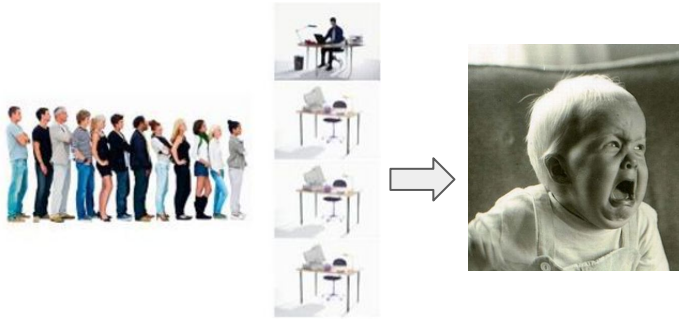
- Why to build parallel systems ? Why build systems with multiple processors ?



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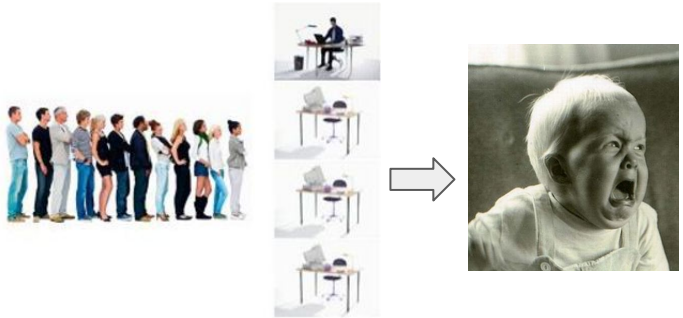

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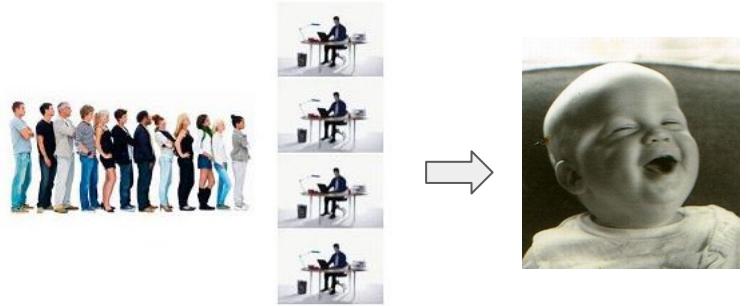
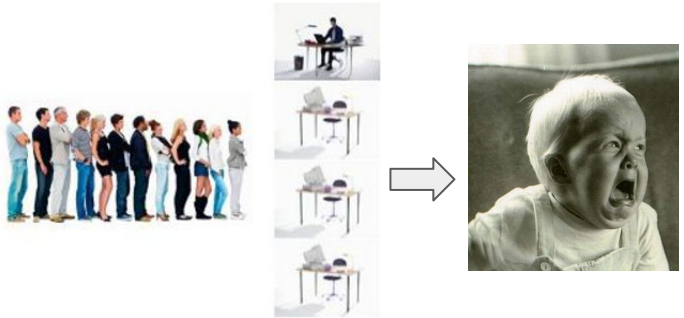


Parallel Computing

Why Parallel Computing ?

- Aren't single processor systems fast enough ?
- Why to build parallel systems ? Why build systems with multiple processors ?
- Why can't we write programs that will automatically convert serial programs to parallel programs ?



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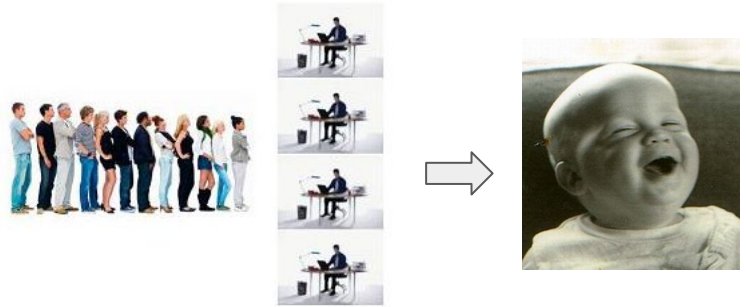

Parallel Computing

What Moore's Law tells.. ?

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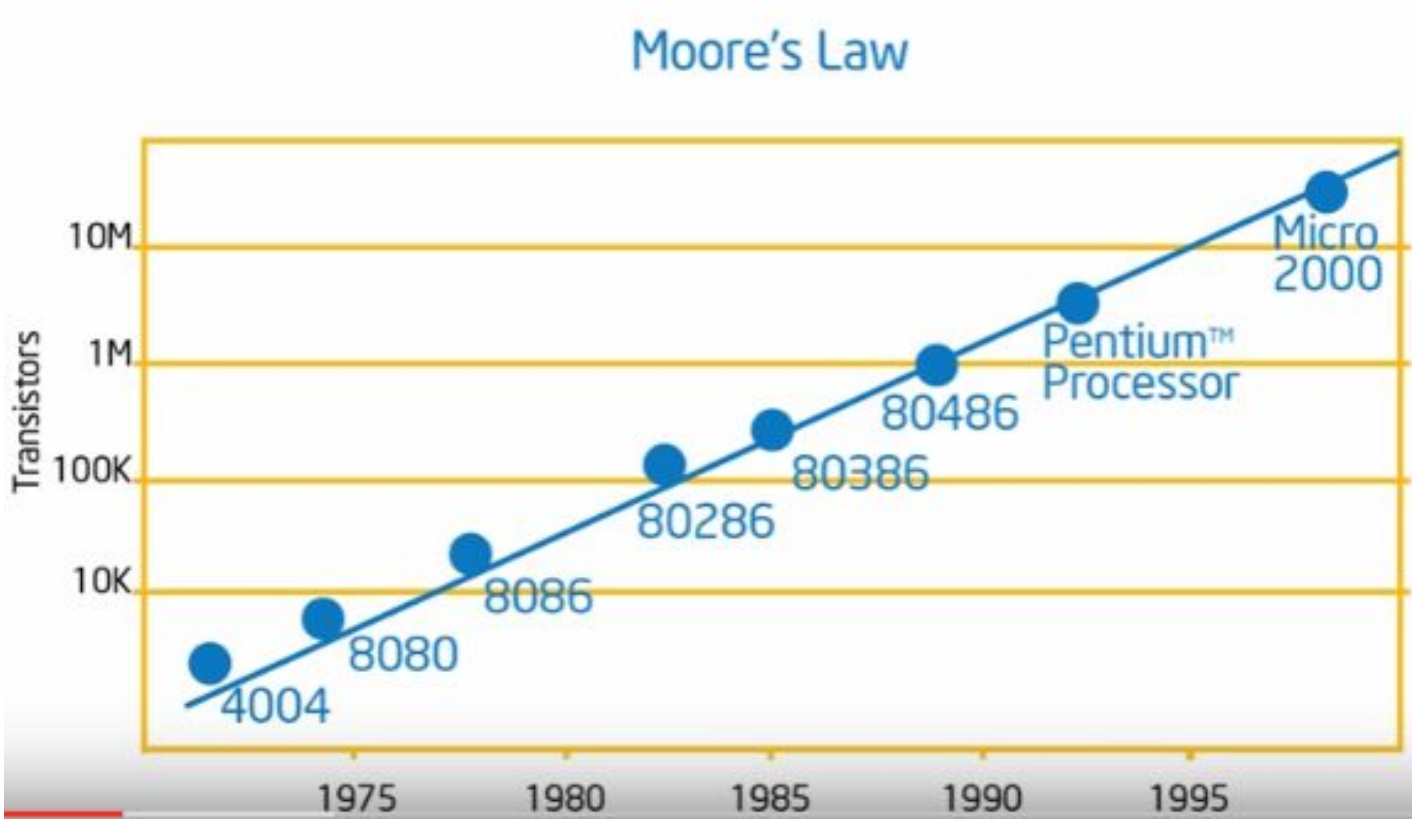

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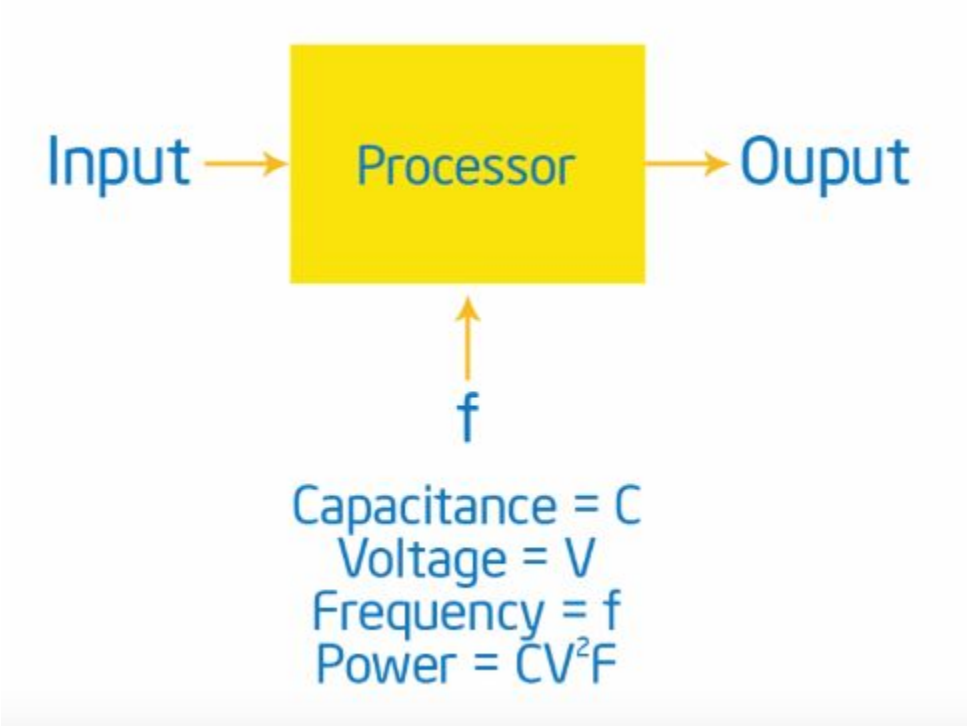

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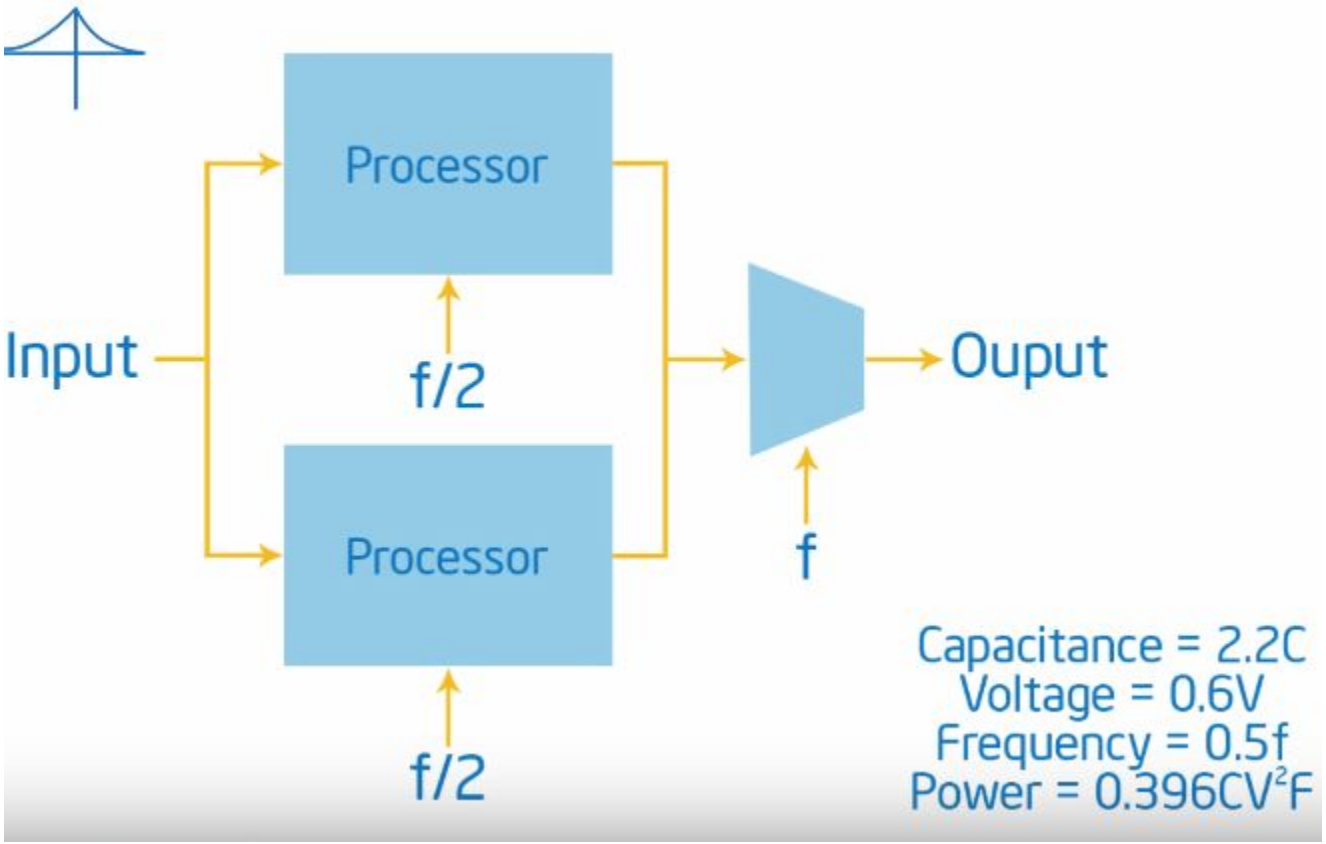

Parallel program

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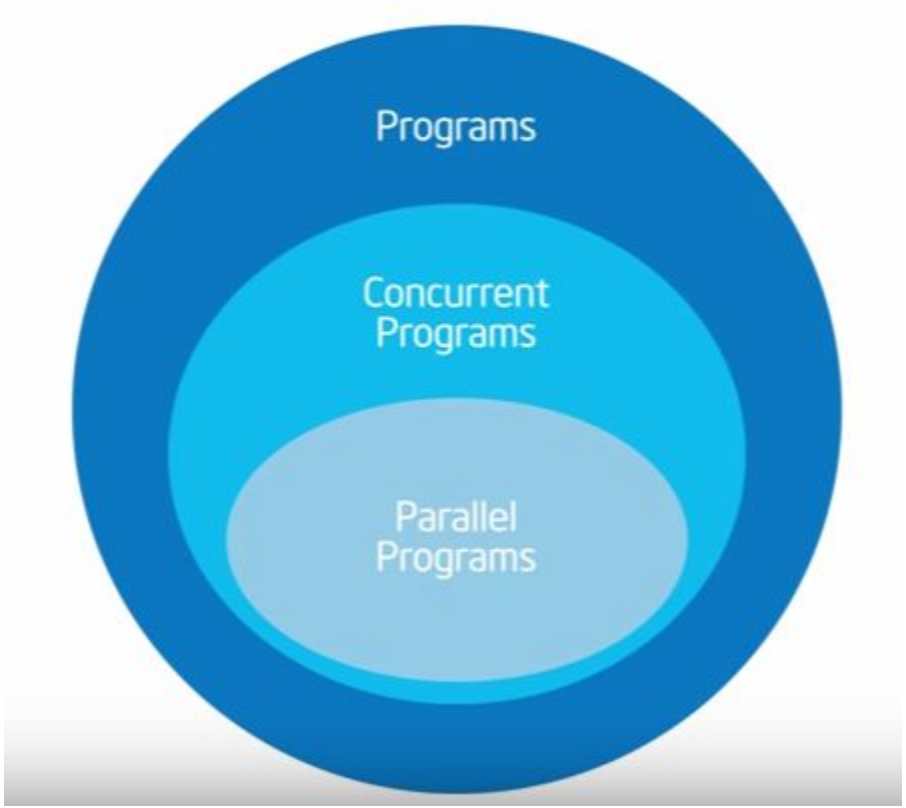
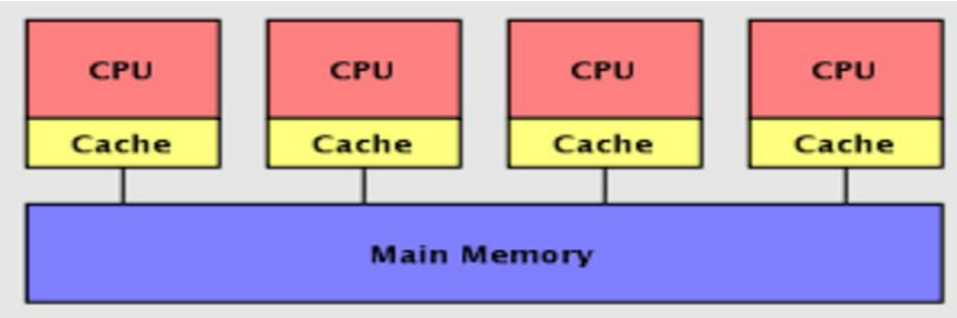


Parallel Programming Models..

❑ Shared-memory Model



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- NUMA - Non-Uniform Memory Access

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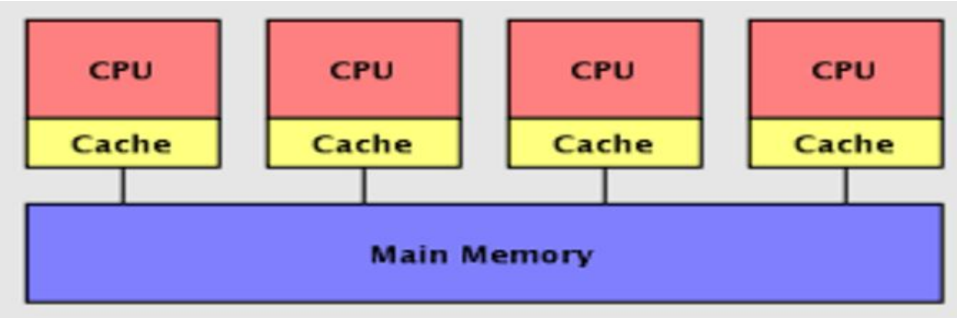

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❖ openMP
❖ Pthreads ...

Parallel Programming Models..

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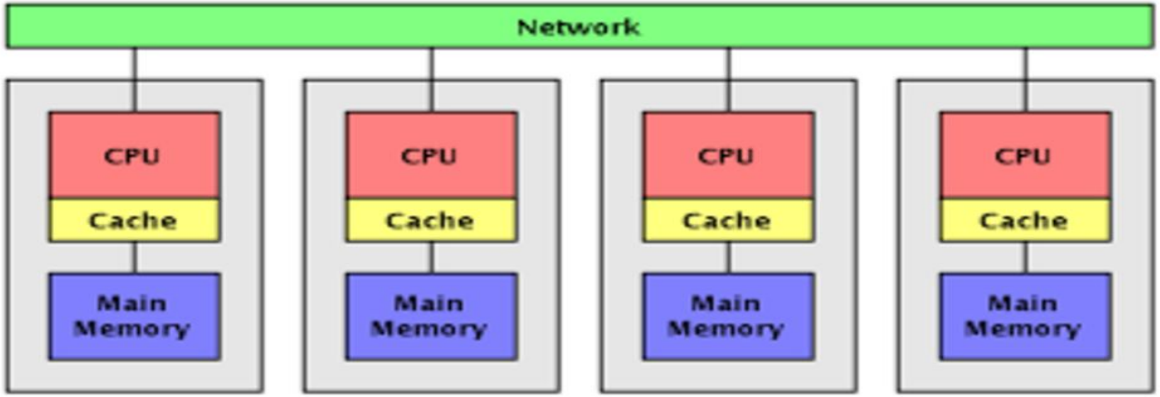

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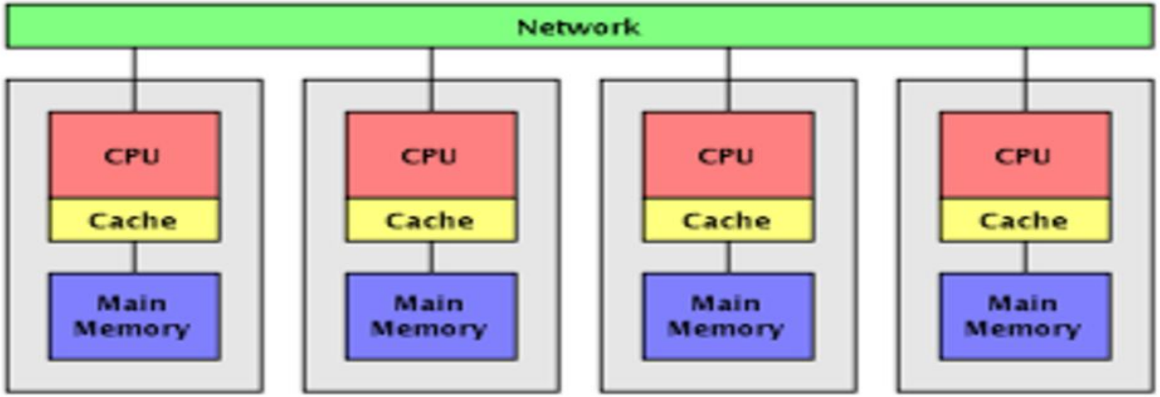

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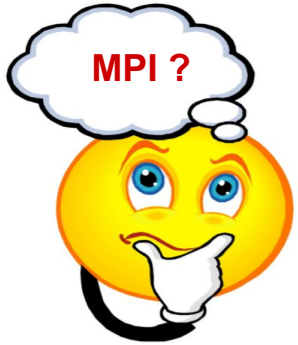

MPI - Message Passing Interface

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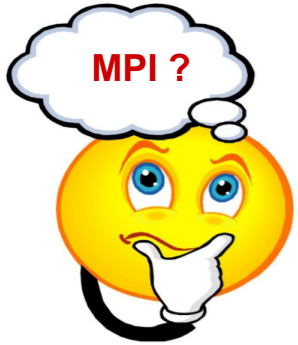

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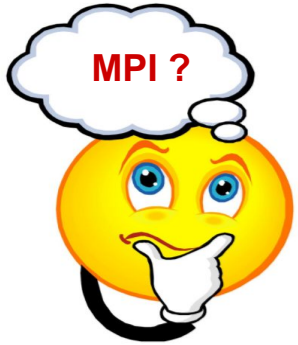

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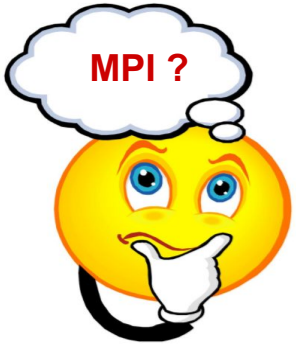

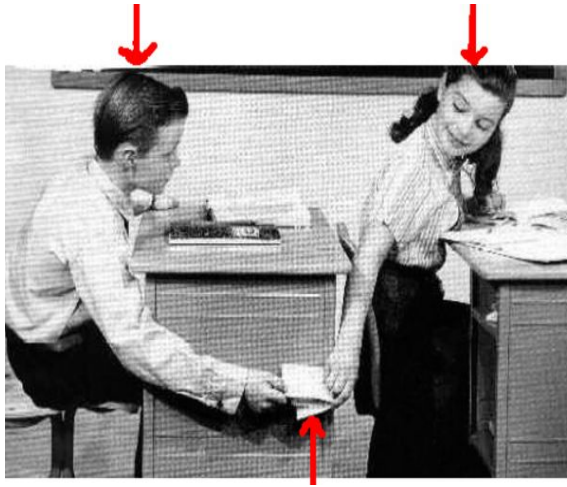

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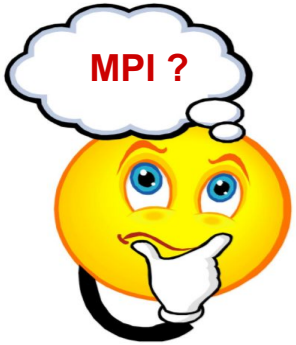

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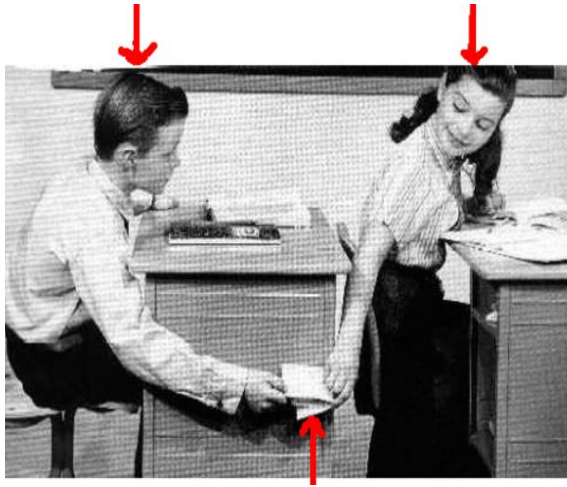

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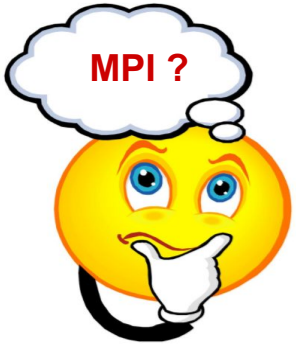

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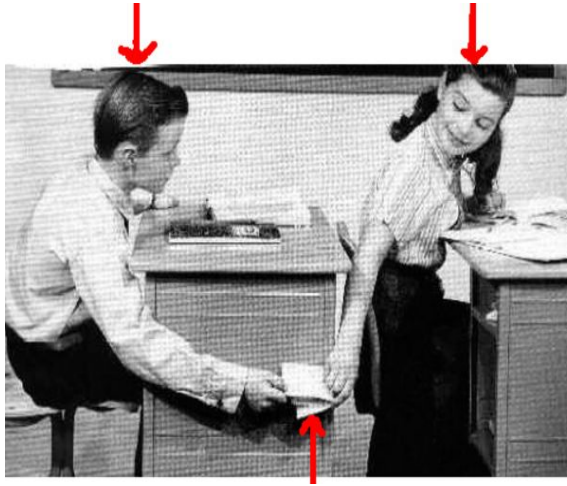
- MPI is not an IEEE or ISO standard, but has in fact, become the "industry standard" for writing message passing programs on HPC platforms.



MPI - Development

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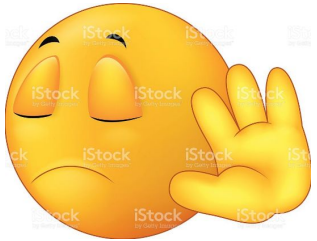
Wait....

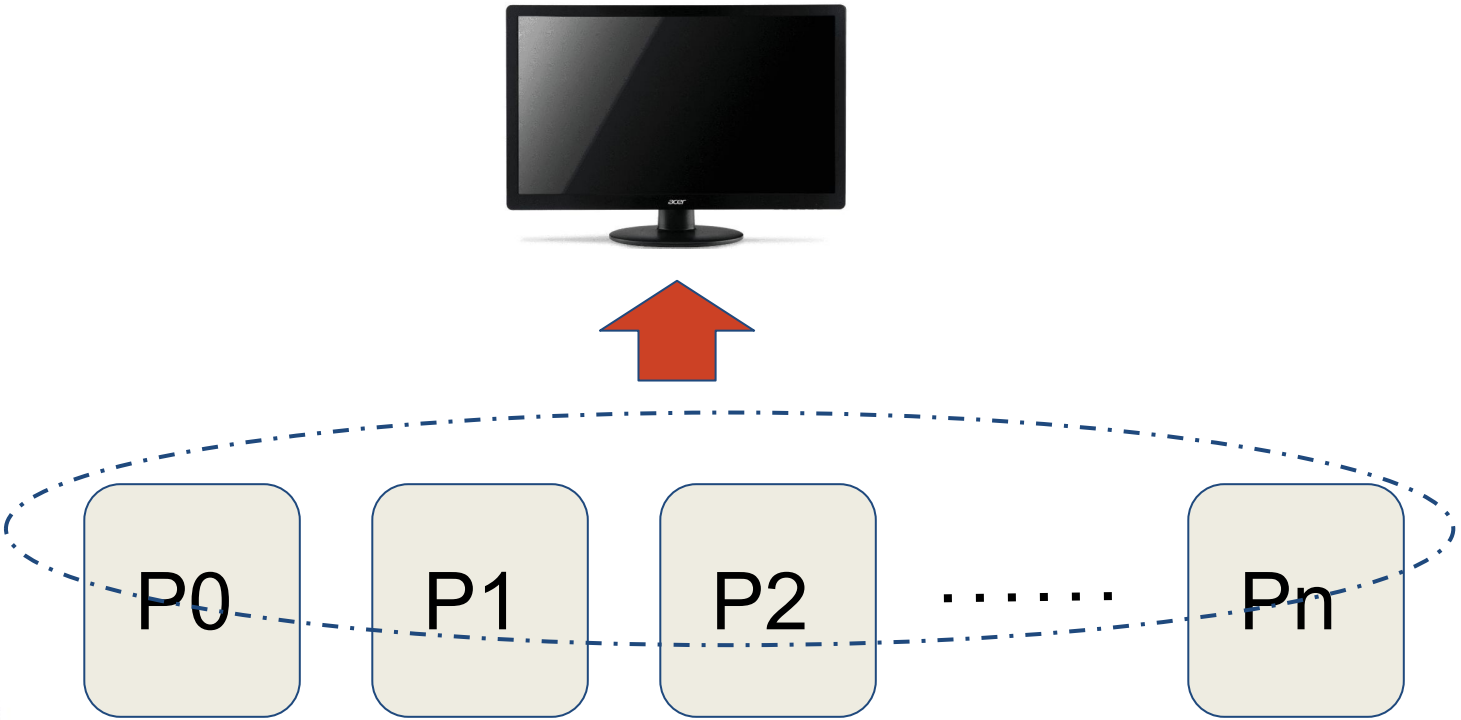
..Answer me first



- What is Process ?

- Is MPI a new programming Language ..?

The Goal ..?



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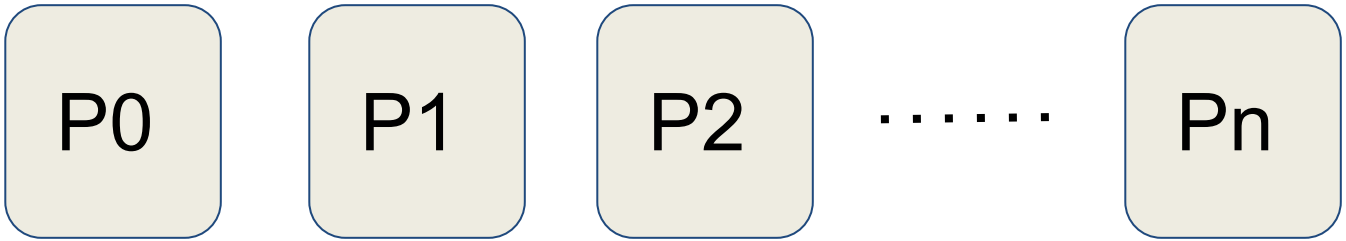

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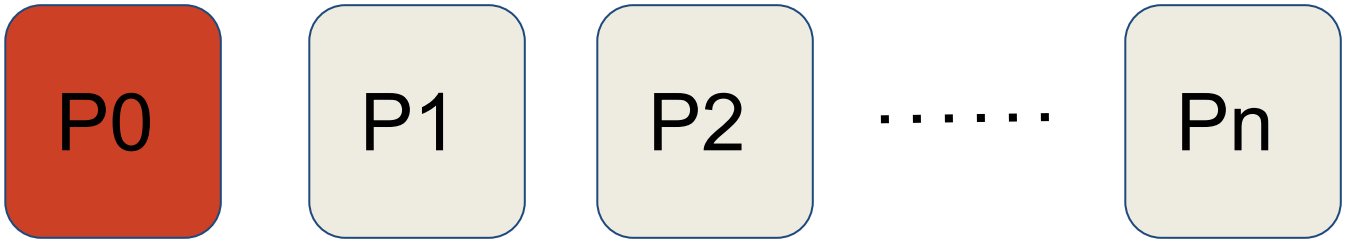

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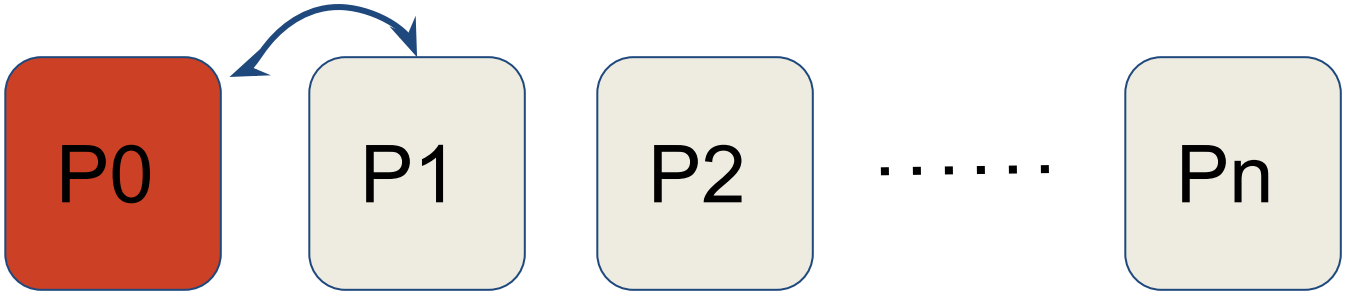

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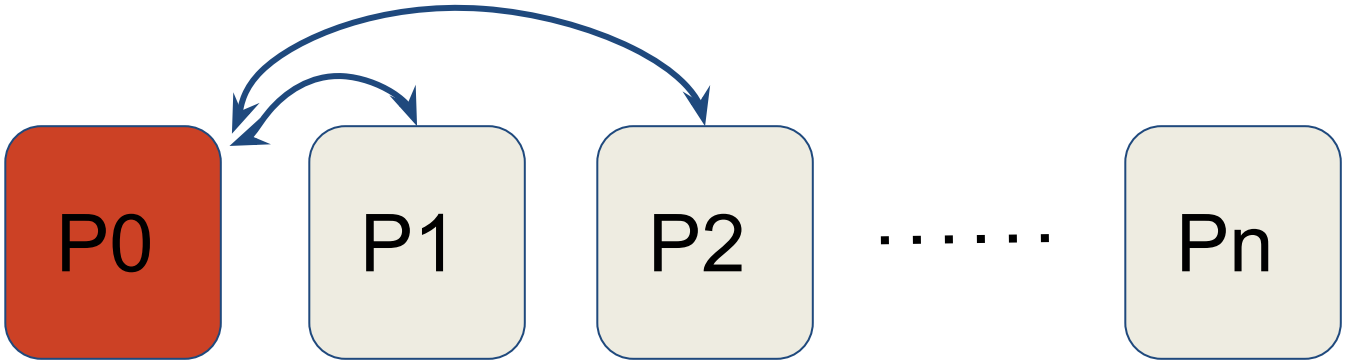

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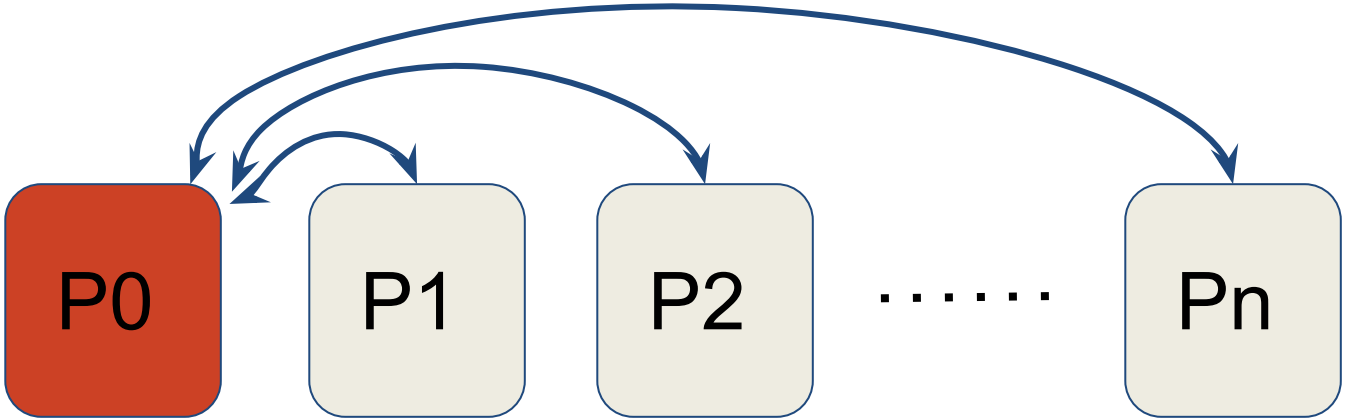

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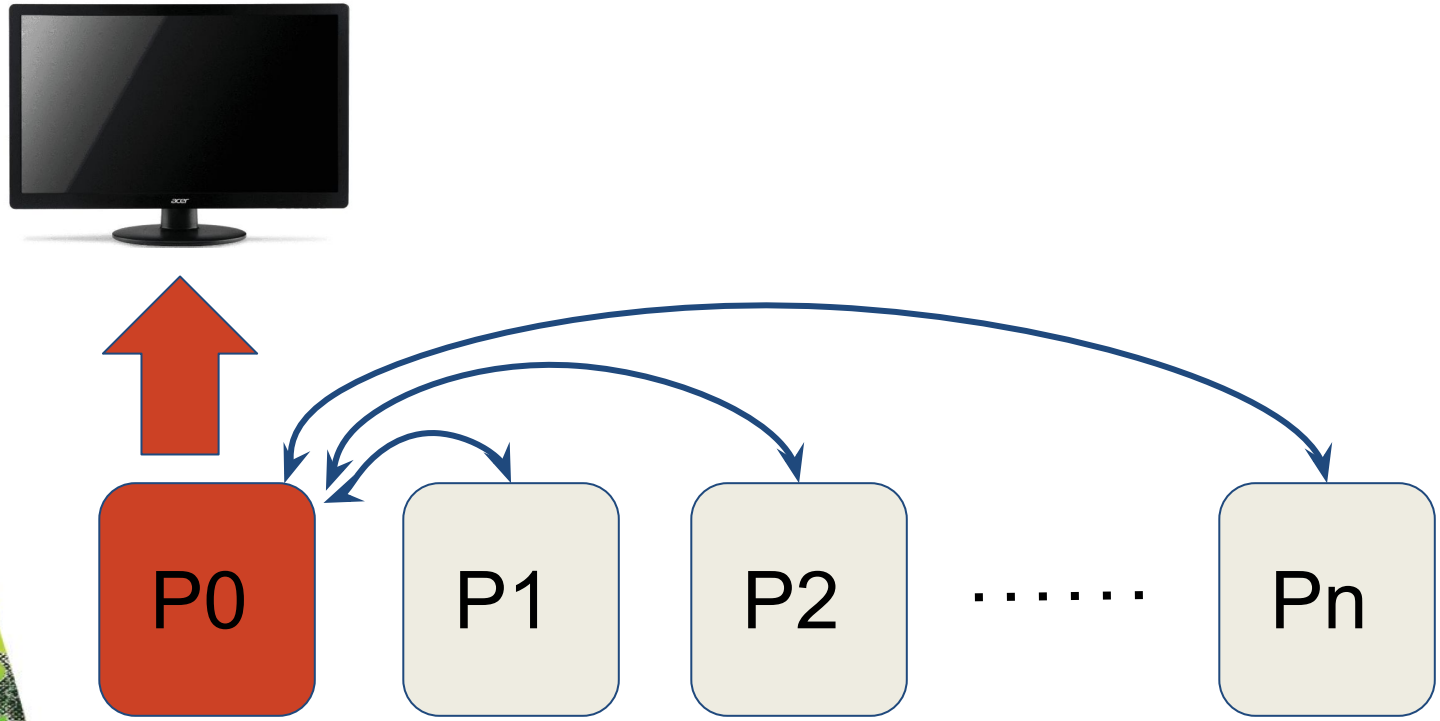

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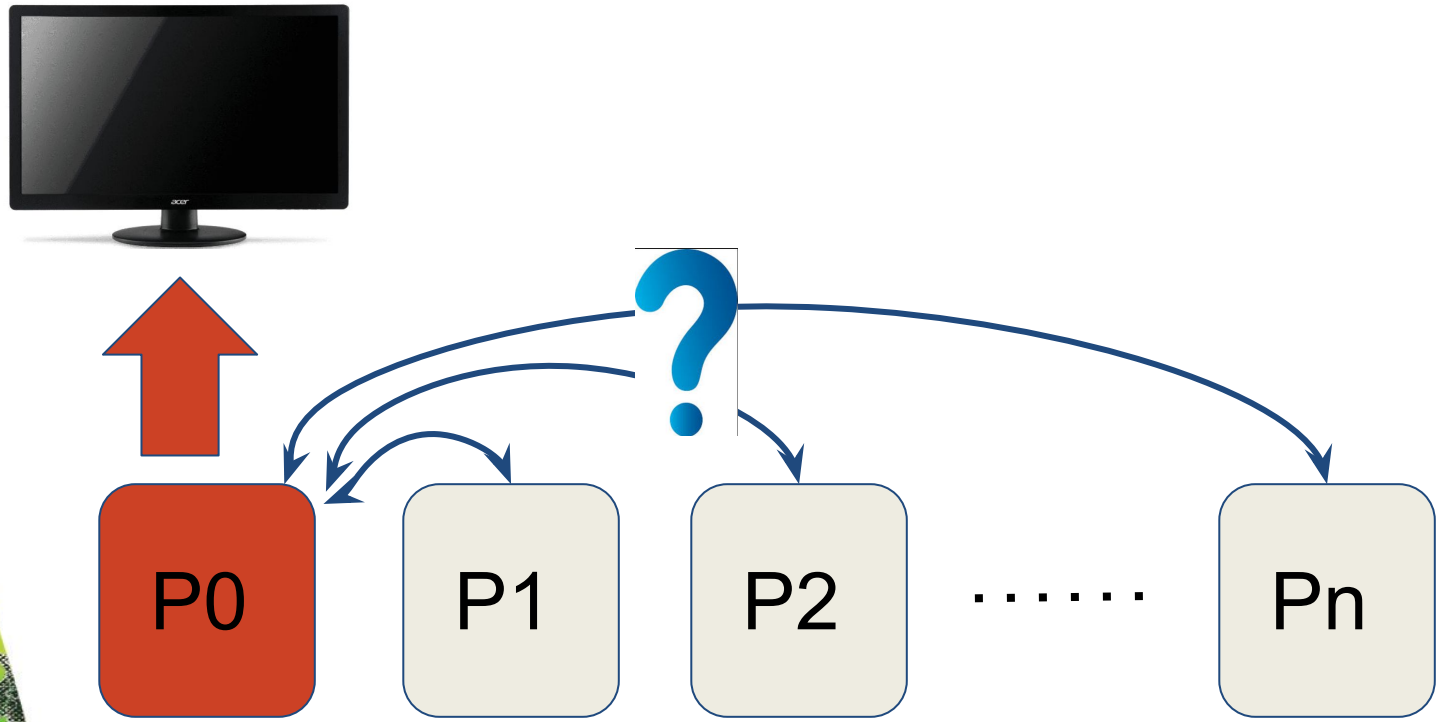

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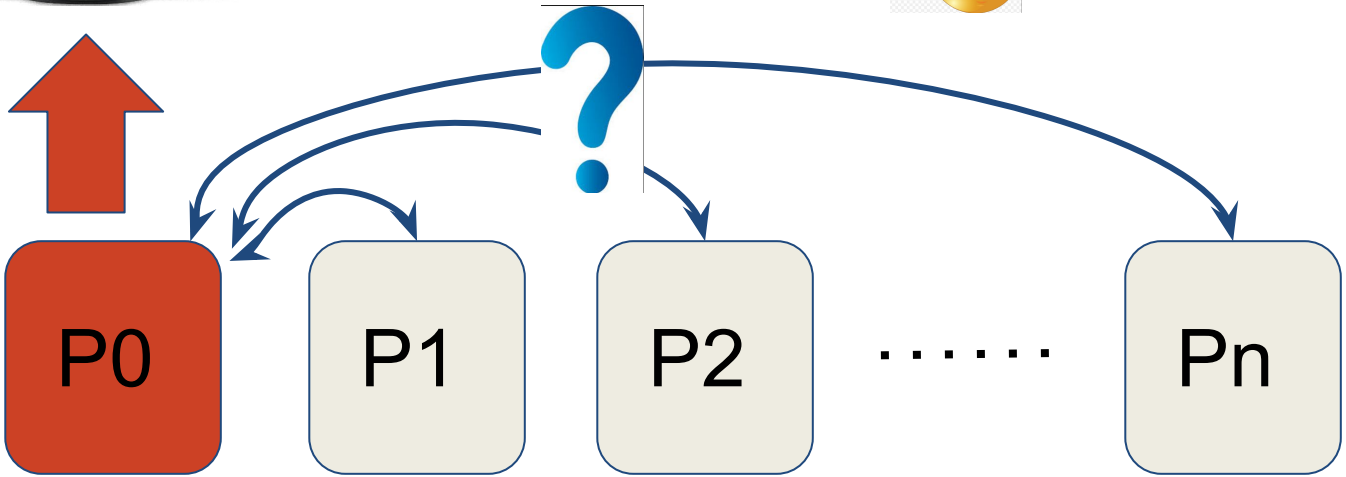
MPI 



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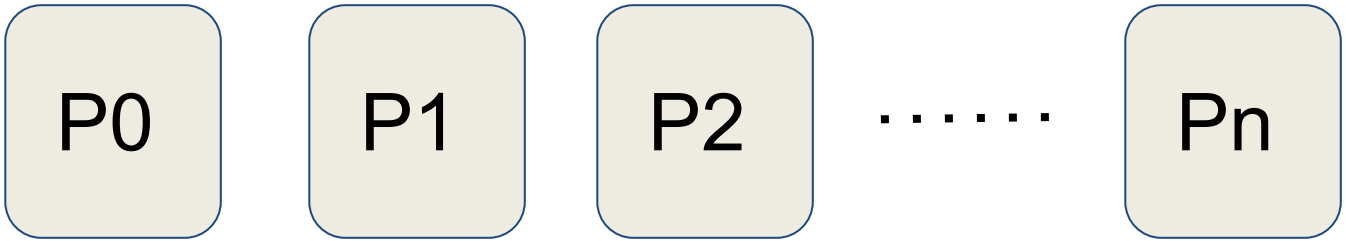

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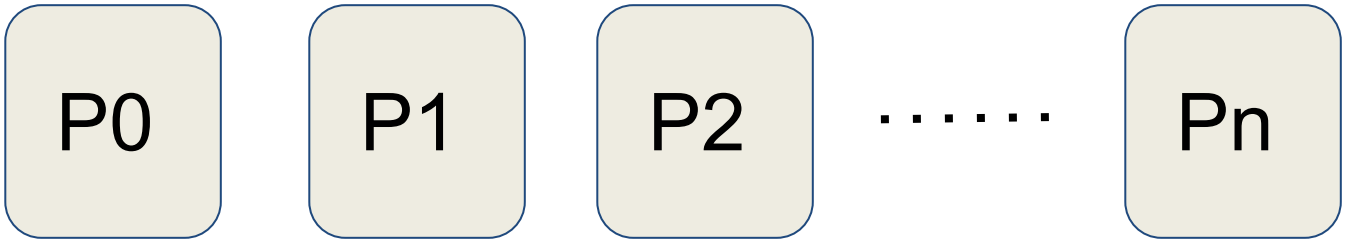

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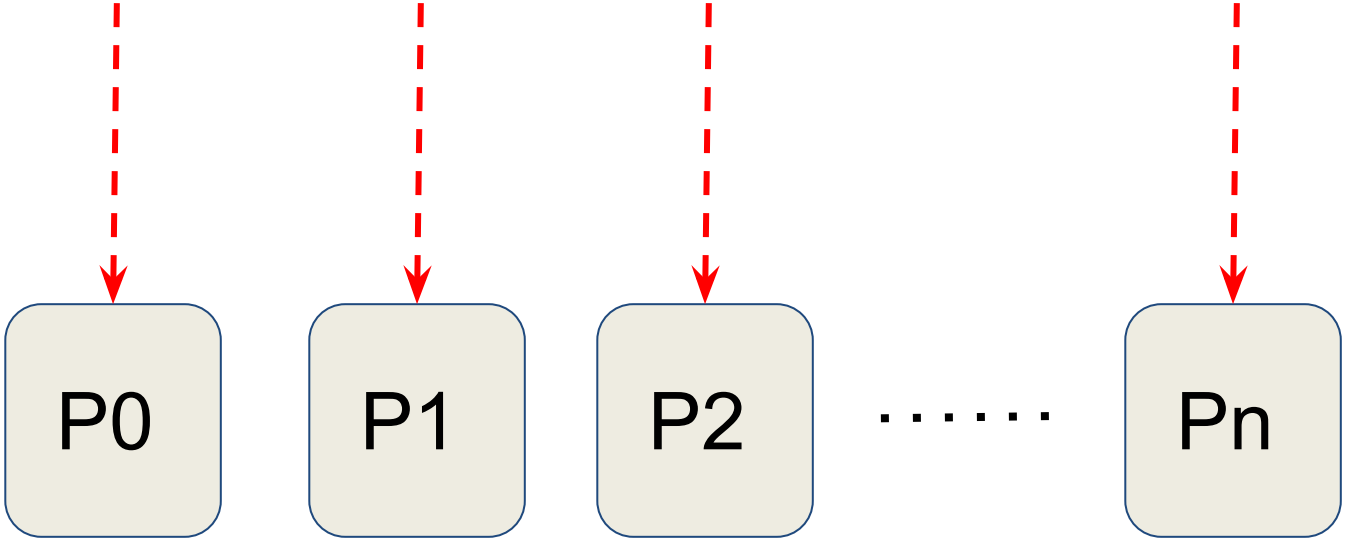

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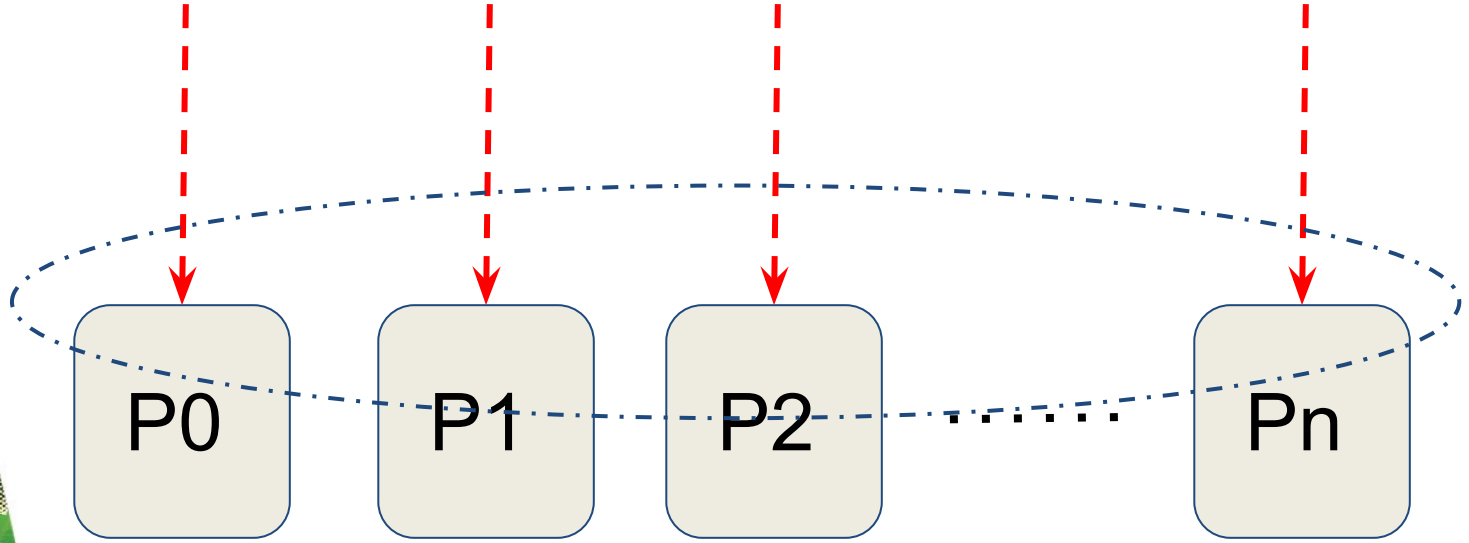

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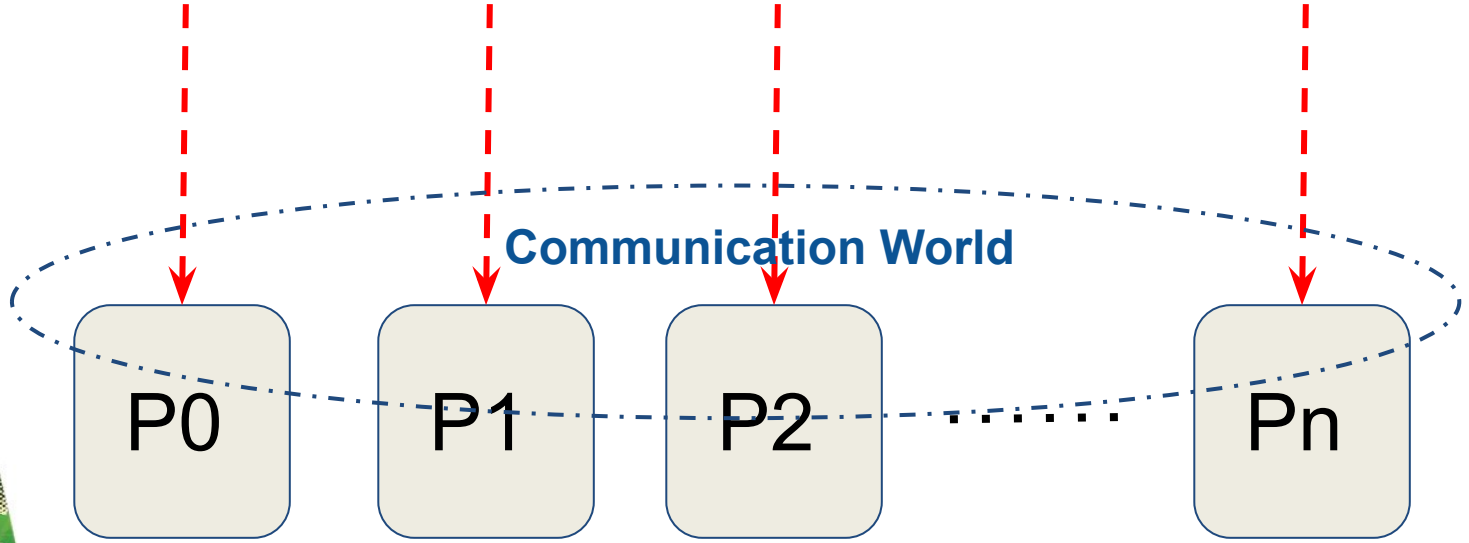

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#include<string.h>
#include<mpi.h>
#define MASTER  0
Int main(void)
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        char  greeting[MAX_STRING];
        int      comm_sz ;
        int      my_rank ;

        MPI_Init(NULL, NULL);
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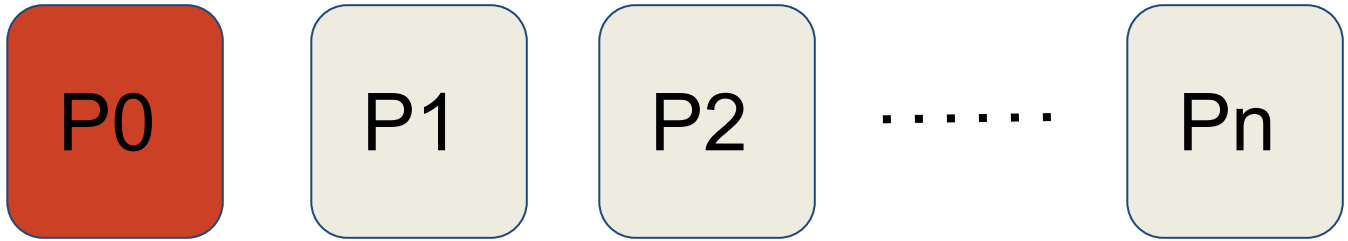

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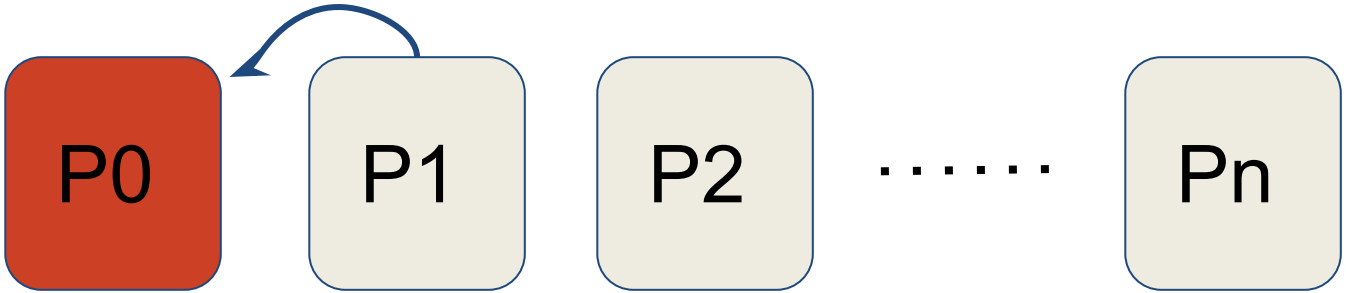

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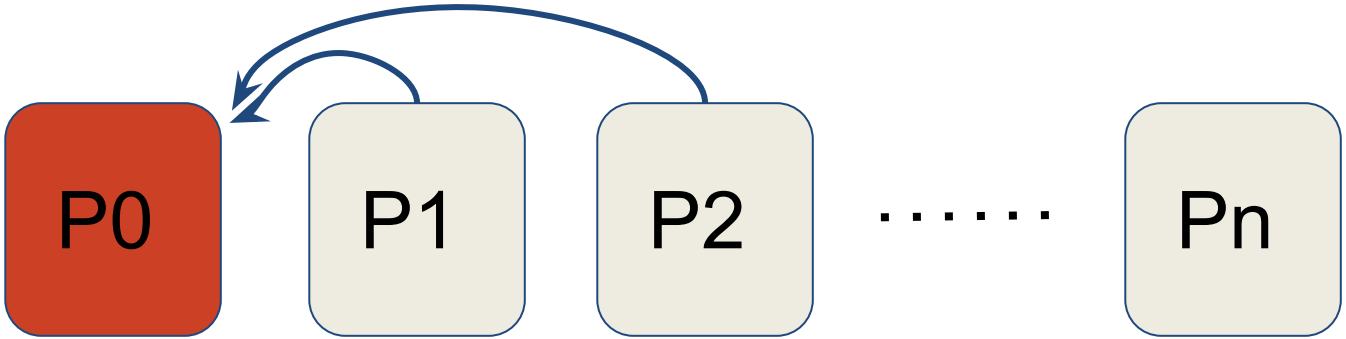

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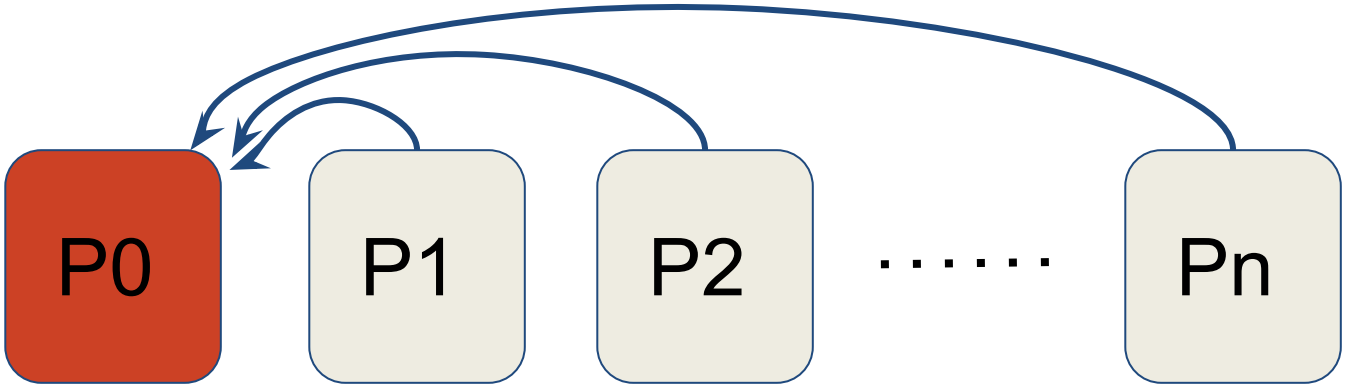
                        ”,  my_rank, comm_sz);
        MPI_Send(greeting, strlen(greeting)+1, MPI_CHAR, 0, 0, MPI_COMM_WORLD) ;
}
```



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        for(int q=1; q < comm_sz; q++)
        {
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 }

   MPI_Finalize();
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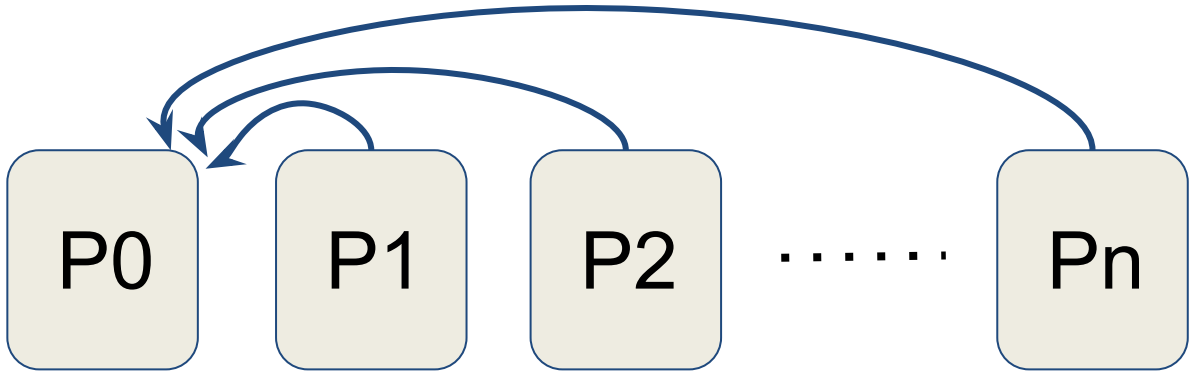

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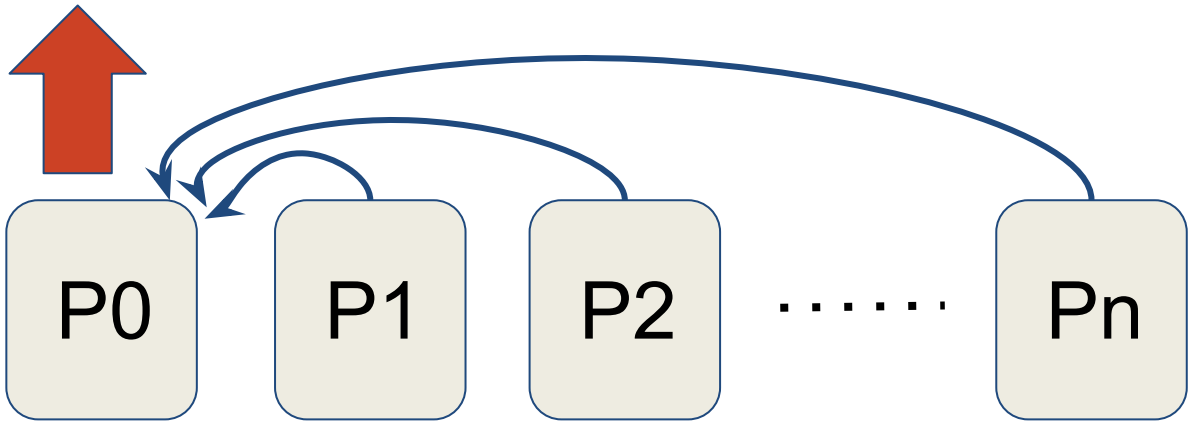

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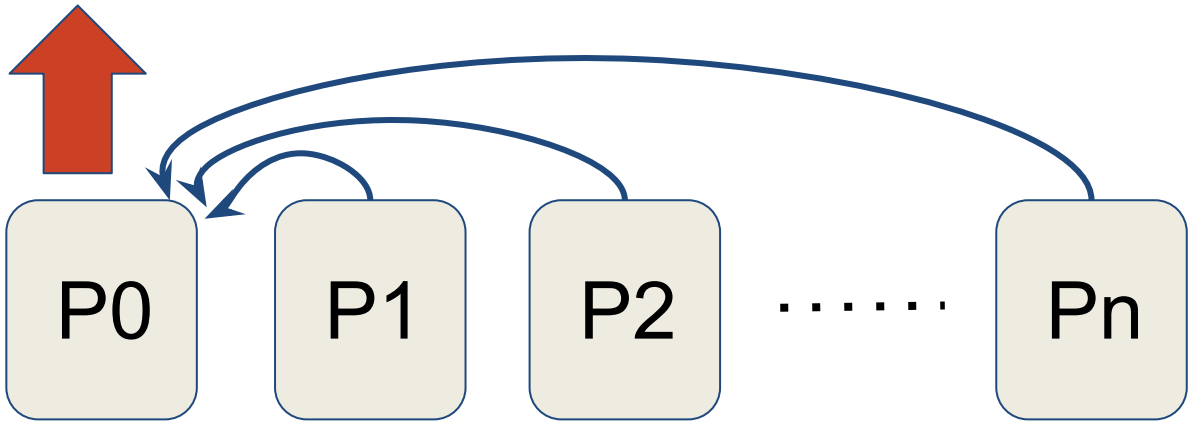

❖ How to compile and run it ?

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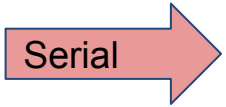

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Serial

- $ gcc -o test test_serial.c
- $ ./test

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Parallel

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Serial

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Parallel

- $ mpicc -o mpi_test mpi_test.c
- $ mpirun -np n ./mpi_test

❖ Output ..

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Welcome to the world of Parallel Computing. I am Process no 0 out of 4
Welcome to the world of Parallel Computing. I am Process no 1 out of 4
Welcome to the world of Parallel Computing. I am Process no 3 out of 4
Welcome to the world of Parallel Computing. I am Process no 2 out of 4

❖ Got it ?

❖ Got it ?

-np 4

❖ Got it ?

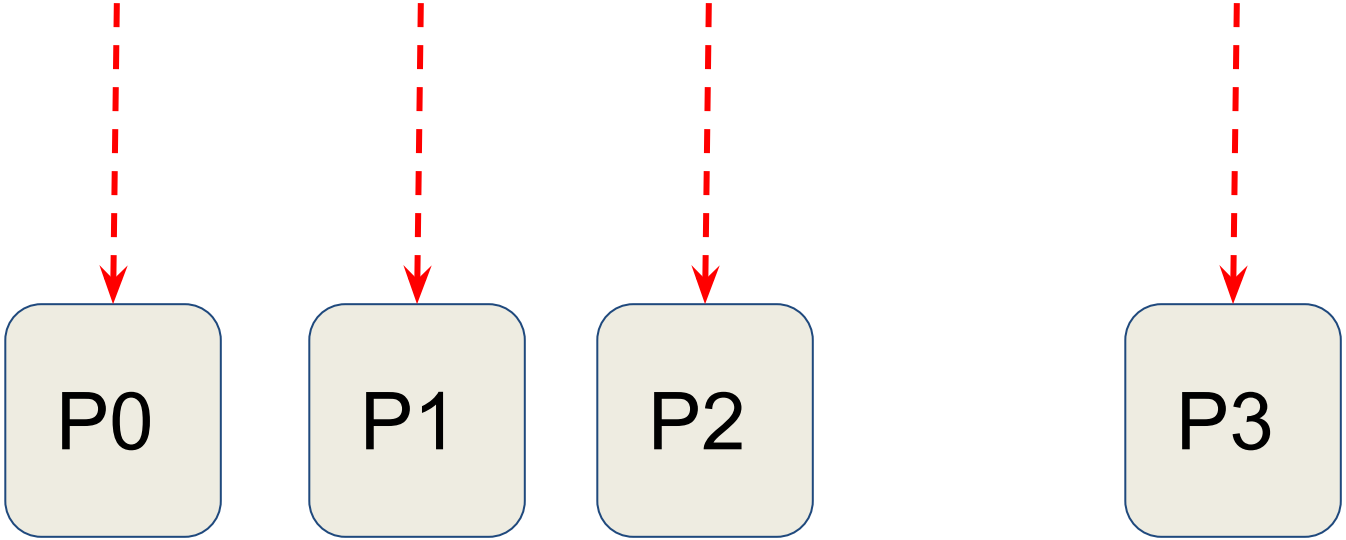
P0

P1

P2

P3

❖ Got it ?



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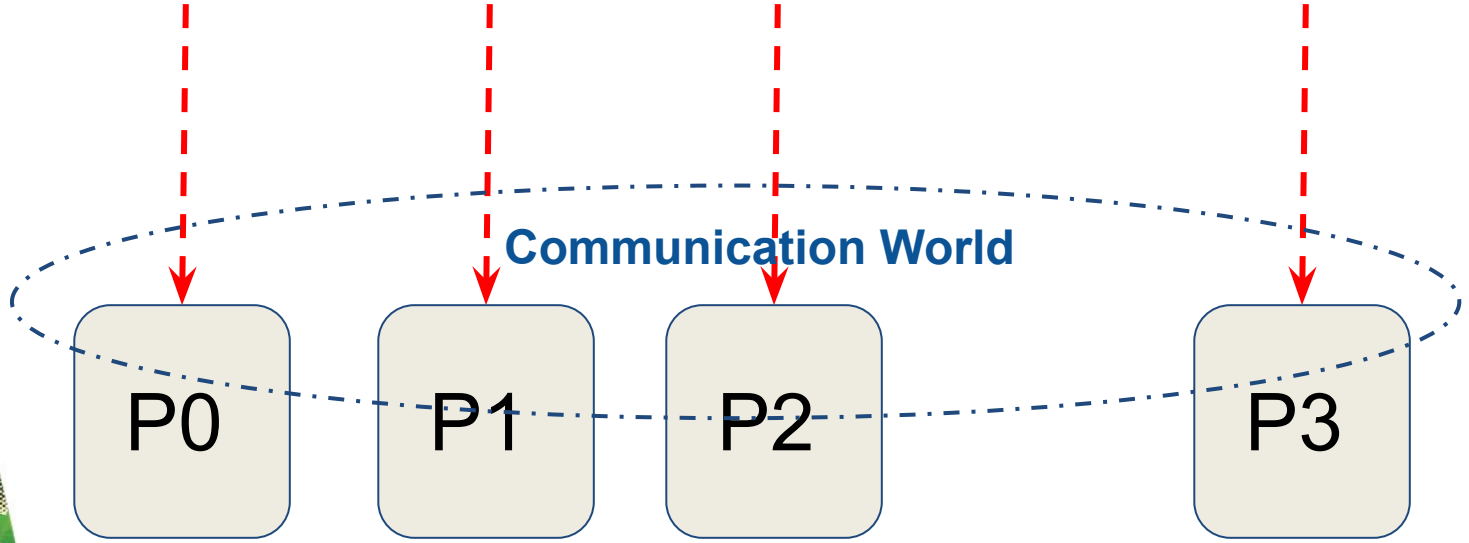

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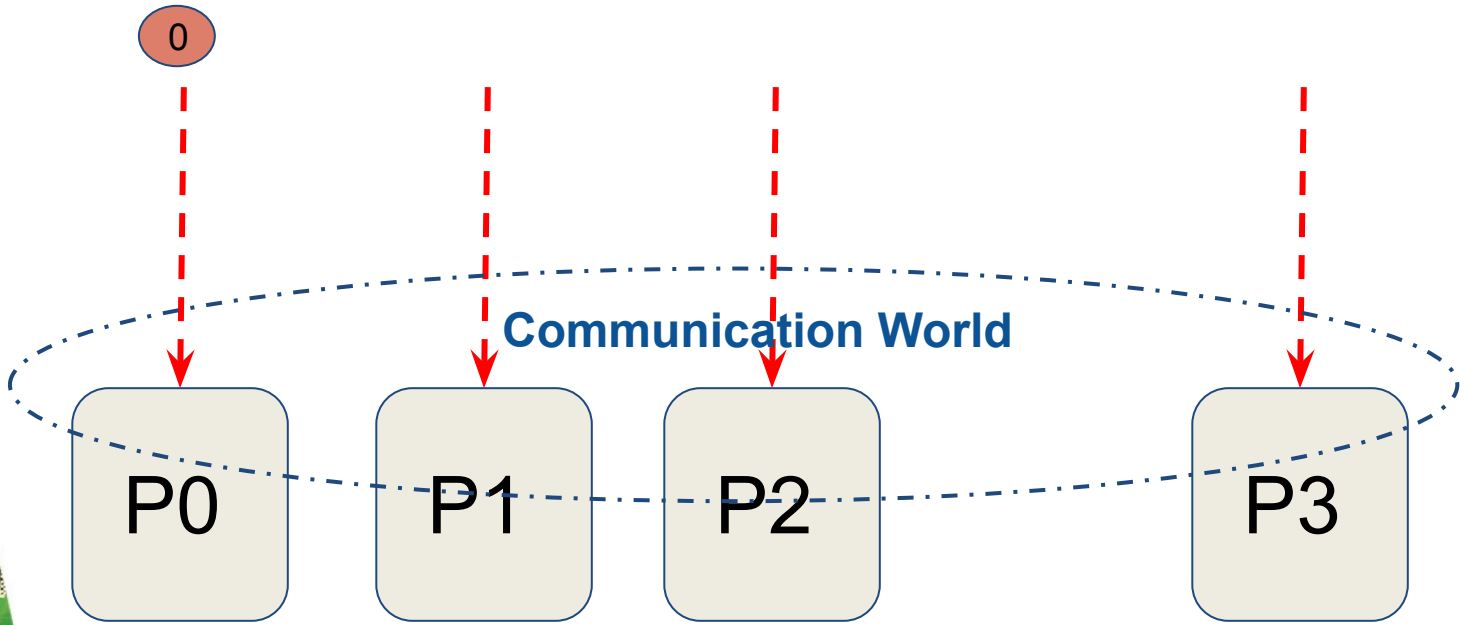

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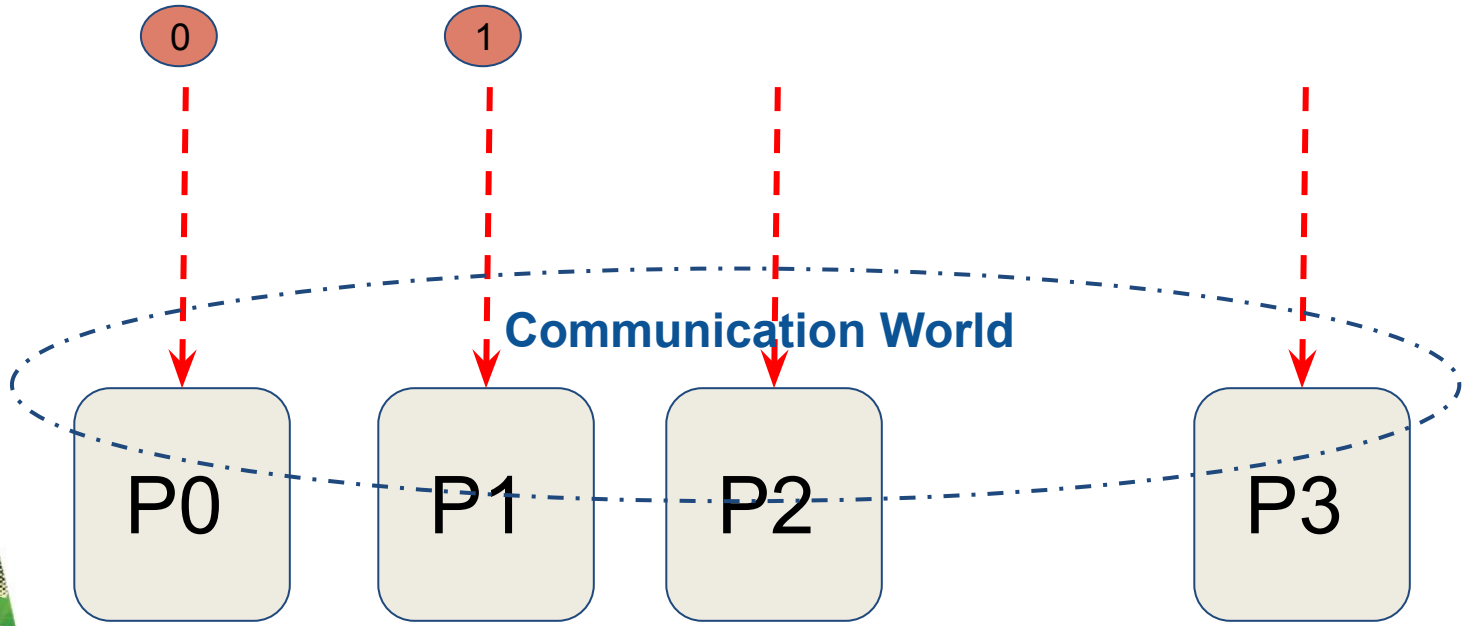

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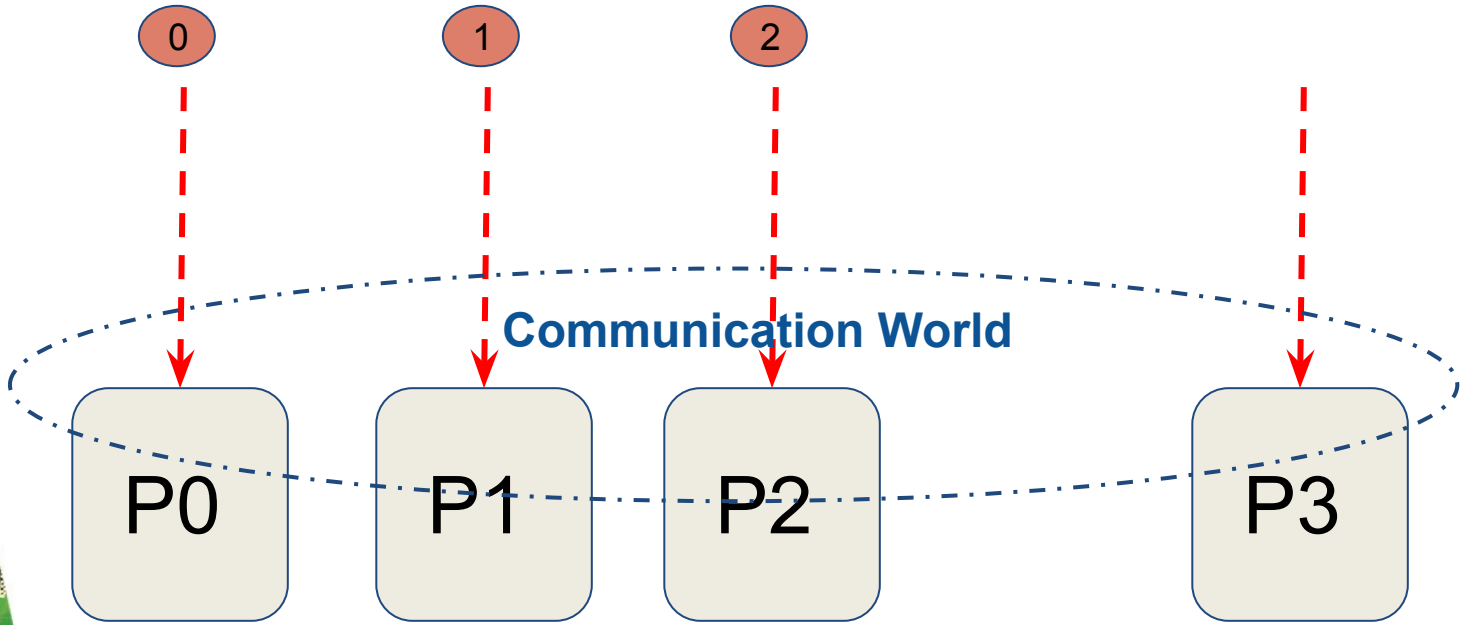

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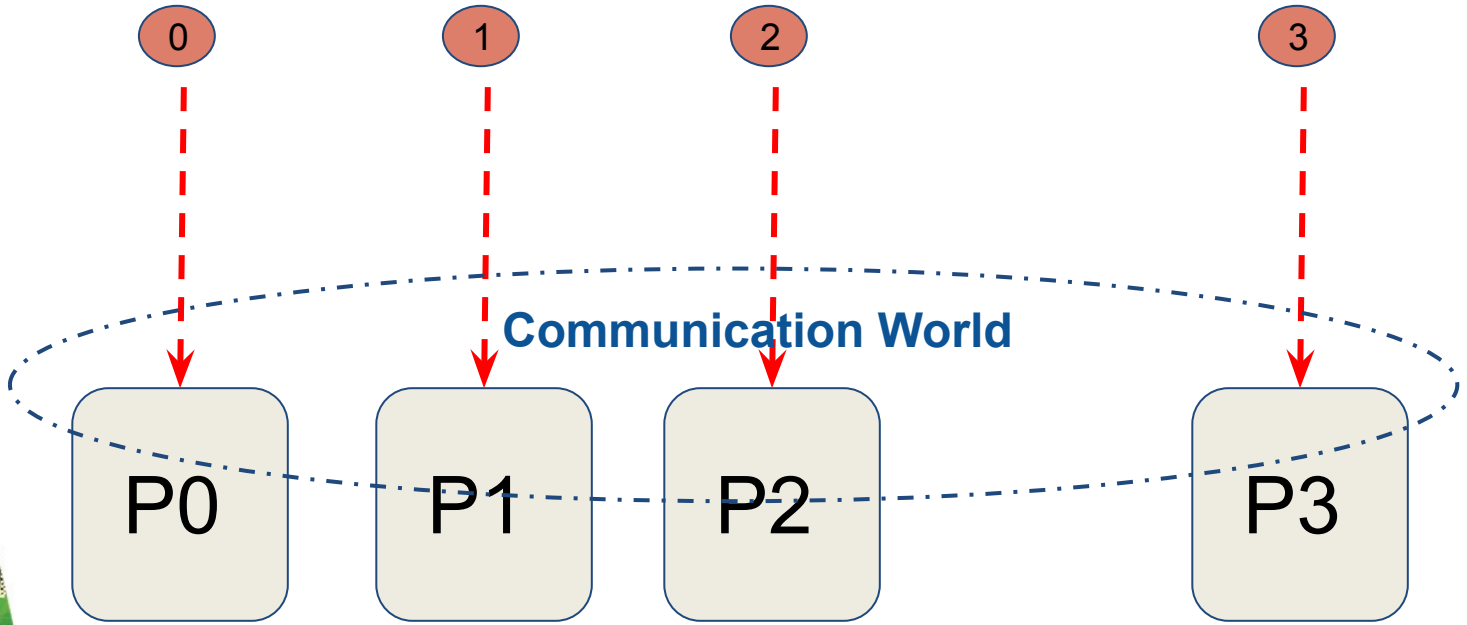

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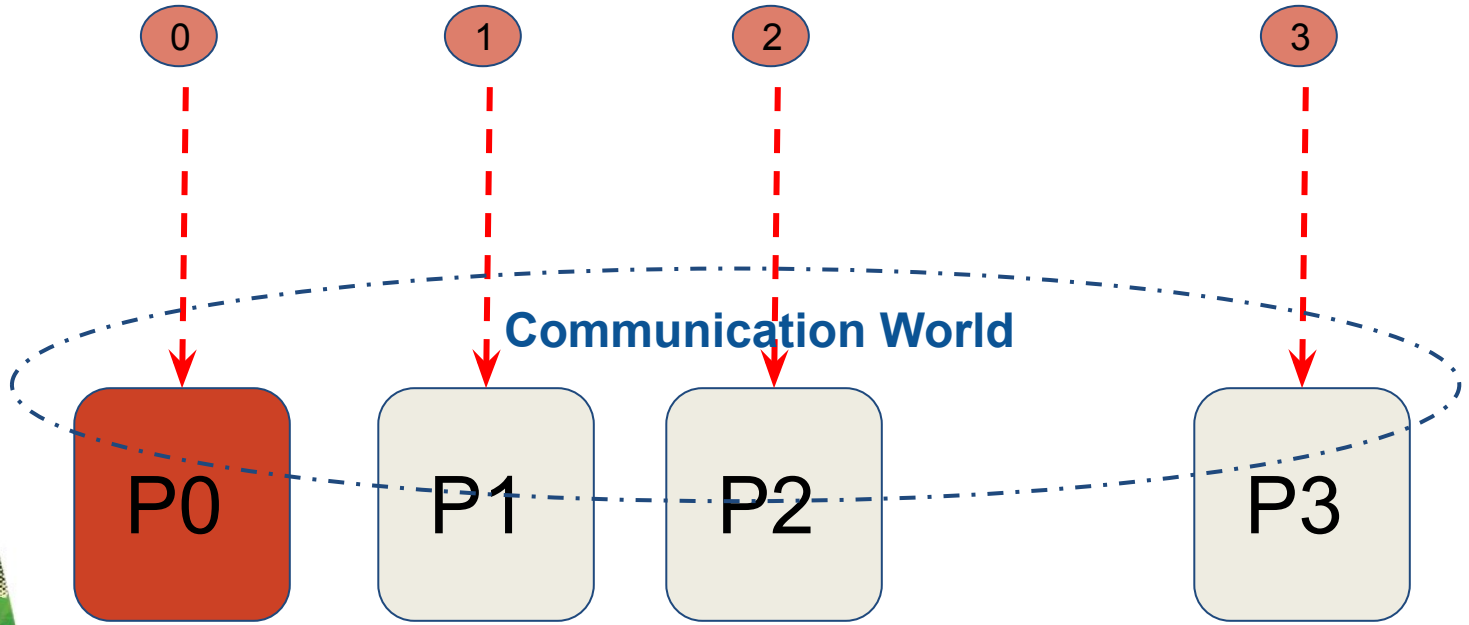
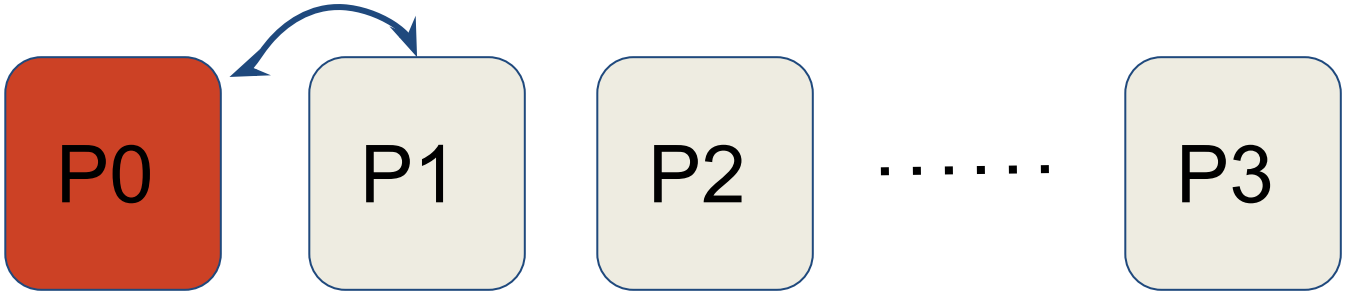


❖ Got it ?

P0 P1 P2 ..... P3

❖ Got it ?



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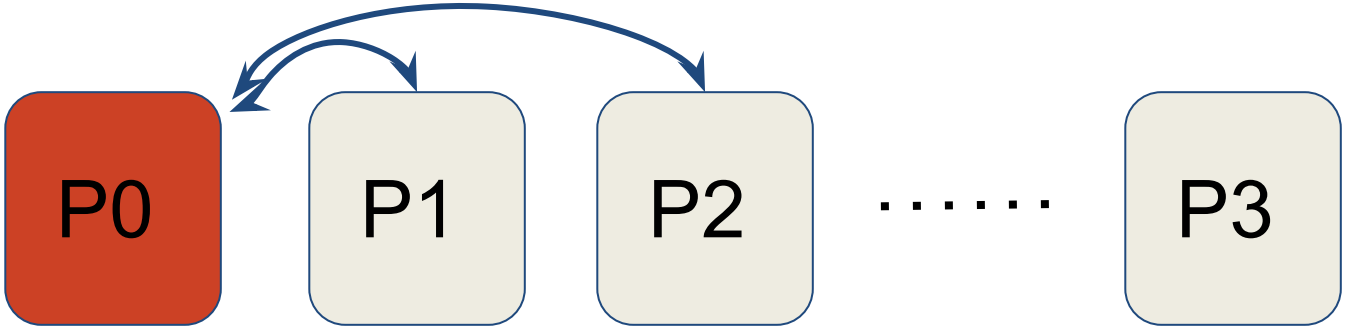

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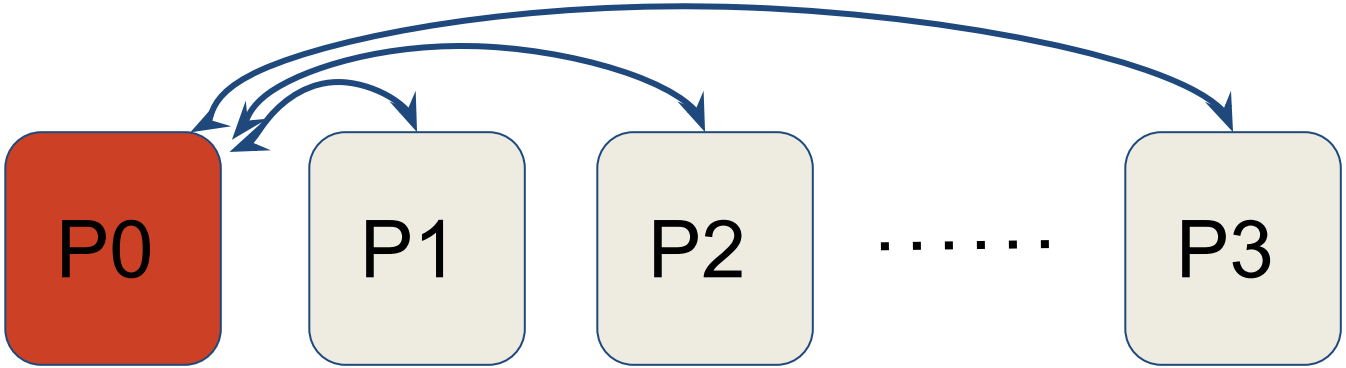

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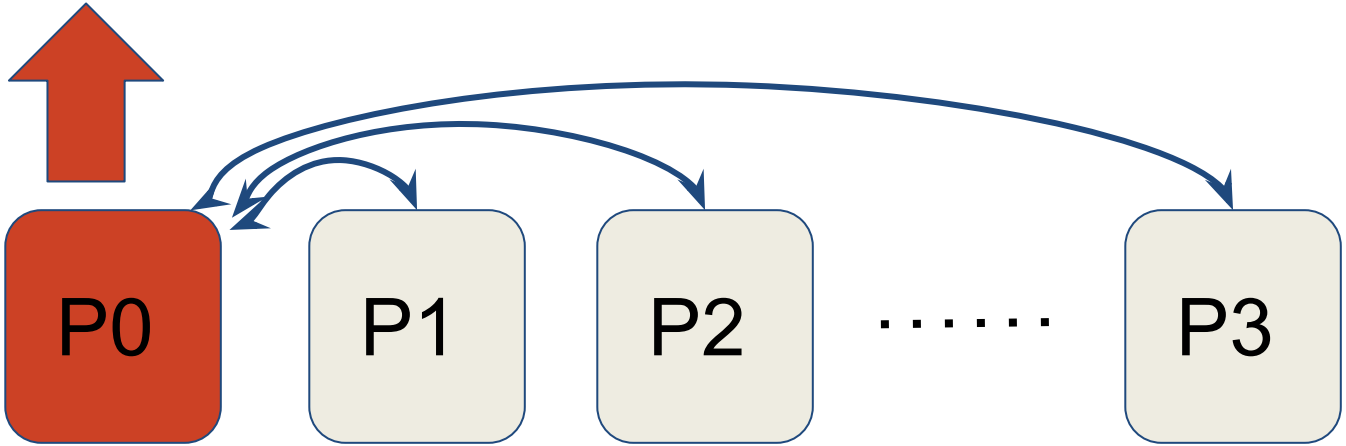

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MPI - Message Passing Interface

MPI is built on ‘Routines’

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The basic MPI Routines :-

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

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

MPI - Program structure

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#include <mpi.h>

main( int argc, char** argv )
{
    MPI_Init( &argc, &argv );

    /* main part of the program */

  /*
    Use MPI function call depend on your data
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Thank
You

Open source Versions of MPI -

- Two popular free versions of MPI are MPICH2 and OpenMPI.

  - MPICH - basis for derivative of MPI implementations to meet special purpose needs.
  - **Network Technology support :** One common complaint about MPICH is that it does not support InfiniBand, However, **MVAPICH** and **Intel MPI** - both of which are MPICH derivatives - support InfiniBand. (Cray Seastar, Gemini, Arise, IBM Blue gene,). *MVAPICH2 - preferred implementation in nearly all cases.
  - **Feature support :** -- ☆☆☆☆☆
  - **Process Management :** --☆☆

  - OpenMPI - targets the common case, both in terms of usage and network conduits.
  - **Network Technology support :** openMPI support InfiniBand. (Cray Gemini, *but not by Cray)
  - **Feature support :** --☆☆
  - **Process Management :** -- ☆☆☆☆☆