Message Passing Programming

Introduction to MPI





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What is MPI?





MPI Forum

- First message-passing interface standard.
- Sixty people from forty different organisations.
- Users and vendors represented, from the US and Europe.
- Two-year process of proposals, meetings and review.
- Message Passing Interface document produced in 1993





Implementation

- MPI is a *library* of function/subroutine calls
- MPI is not a language
- There is no such thing as an MPI compiler
- The C or Fortran compiler you invoke knows nothing about what MPI actually does
 - only knows prototype/interface of the function/subroutine calls





Goals and Scope of MPI

- MPI's prime goals are:
 - To provide source-code portability.
 - To allow efficient implementation.
- It also offers:
 - A great deal of functionality.
 - Support for heterogeneous parallel architectures.





Header files

```
• C/C++:
```

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

Fortran 77.

include 'mpif.h'

very outdated!

• Fortran 90:

use mpi

• Fortran 2008:





MPI Function Format

```
• C:
    error = MPI_Xxxxx(parameter, ...);

MPI_Xxxxx(parameter, ...);
```

Fortran:

```
CALL MPI_XXXXX (parameter, ..., IERROR)
```

- IERROR optional in 2008 version only, otherwise essential





Handles

- MPI controls its own internal data structures.
- MPI releases `handles' to allow programmers to refer to these.
- C handles are of defined typedefs.
- Fortran 90 handles are INTEGERS.
- Fortran 2008 handles are user-defined types as for C
 - will present Fortran 90 interface here
 - still the most commonly used





Initialising MPI

• C:

```
int MPI_Init(int *argc, char ***argv)
```

Fortran:

```
MPI_INIT(IERROR)
INTEGER IERROR
```

- Must be the first MPI procedure called.
 - but multiple processes are already running before MPI_Init



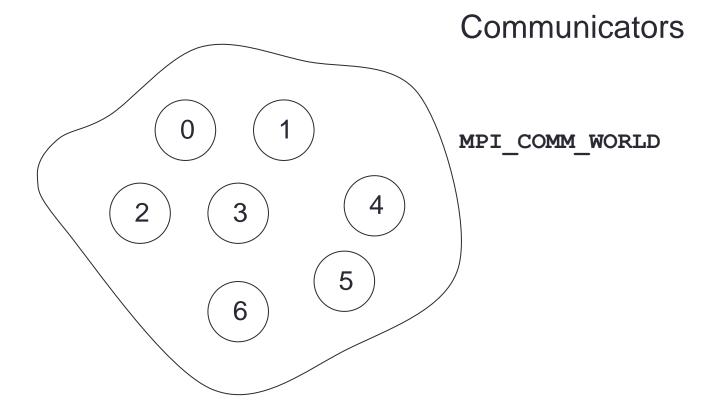


MPI_Init

```
int main(int argc, char *argv[])
  MPI Init(&argc, &argv);
int main(void)
  MPI Init(NULL, NULL);
program my mpi program
  integer :: ierror
  CALL MPI INIT (IERROR)
```



MPI_COMM_WORLD







Rank

 How do you identify different processes in a communicator?

```
MPI_Comm_rank(MPI_Comm comm, int *rank)
MPI_COMM_RANK(COMM, RANK, IERROR)
INTEGER COMM, RANK, IERROR
```

- The rank is not the physical processor number.
 - numbering is always 0, 1, 2,, N-1





MPI_Comm_rank

```
int rank;
MPI Comm rank(MPI COMM WORLD, &rank);
printf("Hello from rank %d\n", rank);
integer :: ierror
integer :: rank
CALL MPI COMM RANK (MPI COMM WORLD, rank, ierror)
write(*,*) "Hello from rank ", rank
```





Size

 How many processes are contained within a communicator?





Exiting MPI

▶ C:

```
int MPI_Finalize()
```

Fortran:

```
MPI_FINALIZE(IERROR)
INTEGER IERROR
```

Must be the last MPI procedure called.





What machine am I on?

- Can be useful on a cluster
 - e.g. to confirm mapping of processes to nodes/processors/core

```
int namelen;
char procname[MPI MAX PROCESSOR NAME];
MPI Get processor name (procname, &namelen);
printf("rank %d is on machine %s\n", rank, procname);
integer :: namelen
character* (MPI MAX PROCESSOR NAME) :: procname
call MPI GET PROCESSOR NAME (procname, namelen, ierror)
write(*,*) "rank ", rank, " is on machine ", procname(1:namelen)
```





Summary

- Have covered some basic MPI calls
 - but no explicit message-passing yet
- Can still write useful programs
 - e.g. a task farm of independent jobs
- Need to compile and launch parallel jobs
 - procedure is not specified by MPI
 - next lecture gives machine-specific details



