IRELAND’S ADVANCED COMPUTING CENTRE

MPI Point-to-Point Communication

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An Roinn Post, Fiontar agus Nuálaíochta
Department of Jobs, Enterprise and Innovation

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An Roinn
Oideachais agus Scileanna
Department of
Education and Skills

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Higher Education Authority
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Messages

- A message contains a number of elements of some particular datatype.
- MPI datatypes:
  - Basic datatype.
  - Derived datatypes

- C types are different from Fortran types.
- Datatype handles are used to describe the type of the data in the memory.

Example: message with 5 integers

2345	654	96574	-12	7676

MPI Datatype	C datatype
MPI_CHAR	signed char
MPI_SHORT	signed short int
MPI_INT	signed int
MPI_LONG	signed long int
MPI_UNSIGNED_CHAR	unsigned char
MPI_UNSIGNED_SHORT	unsigned short int
MPI_UNSIGNED	unsigned int
MPI_UNSIGNED_LONG	unsigned long int
MPI_FLOAT	float
MPI_DOUBLE	double
MPI_LONG_DOUBLE	long double
MPI_BYTE	
MPI_PACKED	

int arr[5]
count =5
datatype=MPI_INT

2345	654	96574	-12	7676

MPI Datatype	Fortran datatype
MPI_INTEGER	integer
MPI_INTEGERX	integer*X X=1,2,4,8
MPI_REAL	real
MPI_REALX	real*X
MPI_DOUBLE_PRECISION	double precision
MPI_COMPLEX	complex
MPI_COMPLEXY	complex*Y
MPI_ LOGICAL	logical
MPI_CHARACTER	character(1)
MPI_BYTE	
MPI_PACKED	

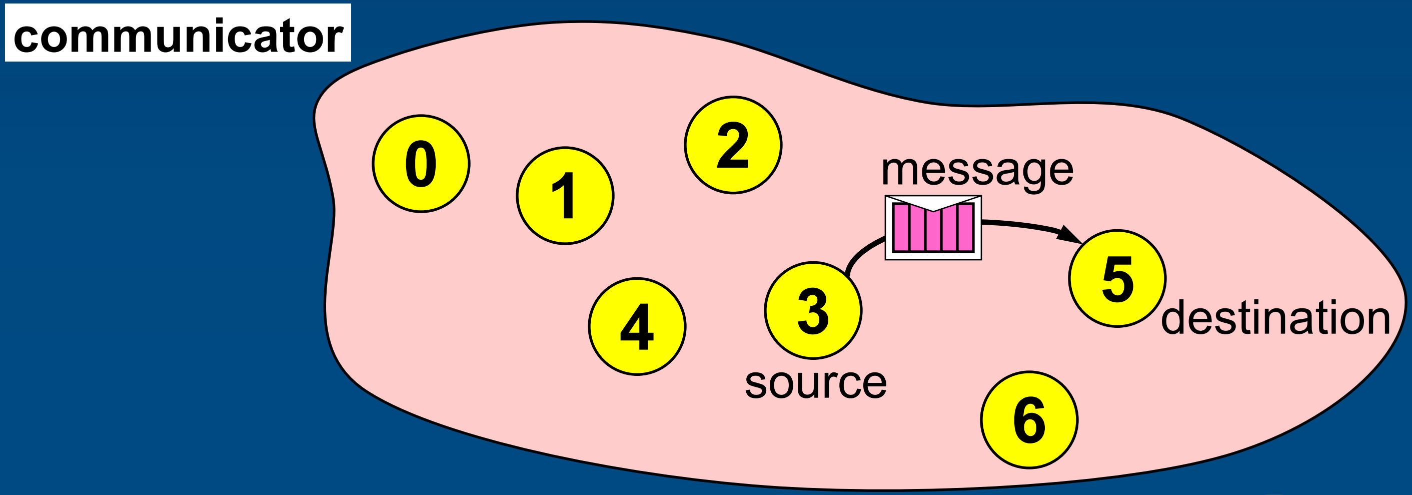
2345	**654**	**96574**	**-12**	**7676**

count=5
datatype=MPI_INTEGER

integer :: arr(5)

Point-to-Point Communication

- Communication between two processes.
- Source process sends message to destination process.
- Communication takes place within a communicator, e.g., MPI_COMM_WORLD.
- Processes are identified by their ranks in the communicator.



Sending a Message

- C: int MPI_Send(void *buf, int count, MPI_Datatype datatypeHandle,
  int dest, int tag, MPI_Comm comm)

- Fortran: MPI_Send(buf, count, datatypeHandle, dest, tag, comm, *ierror*)
  <type> buf(:)
  integer :: count, datatypeHandle, dest, tag, comm, ierror

- buf is the starting point of the message with count elements, each described with datatypeHandle.
- dest is the rank of the destination process within the communicator comm.
- tag is an additional nonnegative integer piggyback information, additionally transferred with the message.
- The tag can be used by the program to distinguish different types of messages.

Receiving a Message

- C: int MPI_Recv(void **buf*, int count, MPI_Datatype datatypeHandle,
  int source, int tag, MPI_Comm comm,
  MPI_Status **status*)

- Fortran: MPI_Recv(*buf*, count,datatypeHandle, source, tag,
  comm, *status*, *ierror*)
  <type> buf(:)
  integer :: count, datatype, source, tag, comm
  integer :: status(MPI_STATUS_SIZE), ierror

- buf/count/datatypeHandle describe the receive buffer.
- Receiving the message sent by process with rank source in comm.
- Envelope information is returned in *status*.
- Output arguments are printed *green-cursive*.
- Only messages with matching tag are received.

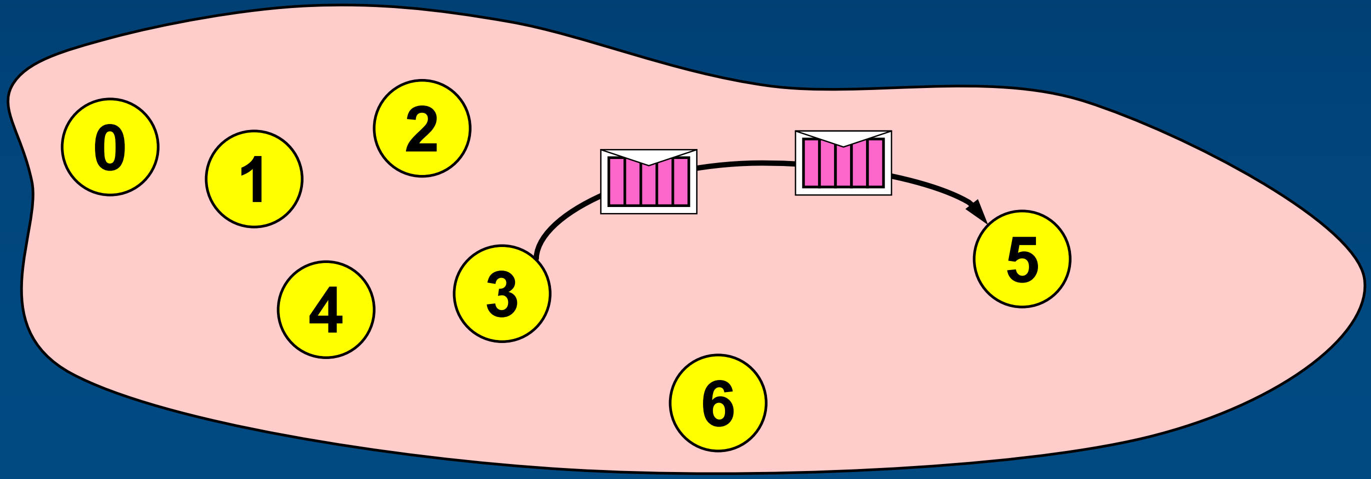
Requirements for Point-to-Point Communications

For a communication to succeed:

- Sender must specify a valid destination rank.
- Receiver must specify a valid source rank.
- The communicator must be the same.
- Tags must match.
- Message datatypes must match.
- Receiver's buffer must be large enough.

Message Order Preservation

- Rule for messages on the same connection,
  i.e., same communicator, source, and destination rank:
- **Messages do not overtake each other.**
- This is true even for non-synchronous sends.



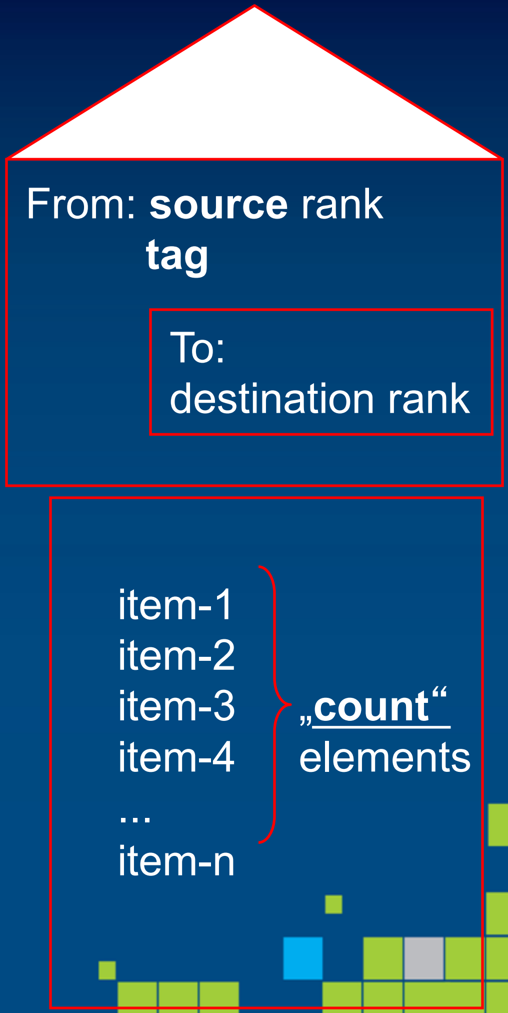
- If both receives match both messages, then the order is preserved.

Communication Envelope

- Envelope information is returned from MPI_RECV in *status*.

- C: status.MPI_SOURCE
  status.MPI_TAG
  count via MPI_Get_count()

- Fortran: status(MPI_SOURCE)
  status(MPI_TAG)
  count via MPI_Get_count()



From: **source** rank
tag

To:
destination rank

item-1
item-2
item-3
item-4
...
item-n

„**count**“
elements

Wildcards

- Receiver can wildcard.
- To receive from any source — source = MPI_ANY_SOURCE
- To receive from any tag — tag = MPI_ANY_TAG
- Actual source and tag are returned in the receiver's *status* parameter.

Communication Modes

- Send communication modes:

○ synchronous send	MPI_**S**send
○ buffered [asynchronous] send	MPI_**B**send
○ standard send	MPI_**Send**
○ Ready send	MPI_**R**send

- Receiving all modes MPI_**Recv**

Communication Modes — Definitions

Sender modes	Definition	Notes
Synchronous send MPI_Ssend	Only completes when the receive has started	risk of deadlock risk of serialization risk of waiting —> idle time
Buffered send MPI_Bsend	Always completes (unless an error occurs), irrespective of receiver	needs application-defined buffer to be declared with MPI_BUFFER_ATTACH/DETACH
Standard send MPI_Send	Standard send. Either synchronous or buffered	
Ready send MPI_Rsend	May be started only if the matching receive is already posted!	highly dangerous!
Receive MPI_Recv	Completes when a the message (data) has arrived	

C

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

int main(int argc, char **argv){
   int myRank, uniSize, ierror, arr[5];
   MPI_Status stat;

   ierror=MPI_Init(&argc,&argv);
   ierror=MPI_Comm_rank(MPI_COMM_WORLD,&myRank);
   ierror=MPI_Comm_Size(MPI_COMM_WORLD,&uniSize);
   if (myRank == 0) {
      arr[0]=2345; arr[1]=654; arr[2]=96574; arr[3]=-12; arr[4]=7676;
      MPI_Send(arr, 5, MPI_INT, 1, 100, MPI_COMM_WORLD);
   } else if (myRank == 1) {
      MPI_Recv(arr, 5, MPI_INT, 0, 100, MPI_COMM_WORLD, &stat);
   }
   ierror=MPI_Finalize();
   return 0;
}
```

Fortran

```
program testMPI
use mpi
implicit none
integer :: myRank,uniSize,ierror
real, dimension(5) :: arr
integer stat(MPI_STATUS_SIZE)

call MPI_Init(ierror)
call MPI_Comm_rank(MPI_COMM_WORLD,myRank,ierror)
call MPI_Comm_Size(MPI_COMM_WORLD,uniSize,ierror)
if (myRank .eq. 0) then
    arr= (/2345, 654, 96574, -12, 7676/)
    call MPI_Send(arr, 5, MPI_INTEGER, 1, 100, MPI_COMM_WORLD,ierror)
else if (myRank .eq. 1) then
    call MPI_Recv(arr, 5, MPI_INTEGER, 0, 100, MPI_COMM_WORLD, stat,ierror)
endif
call MPI_Finalize(ierror)
end program testMPI
```