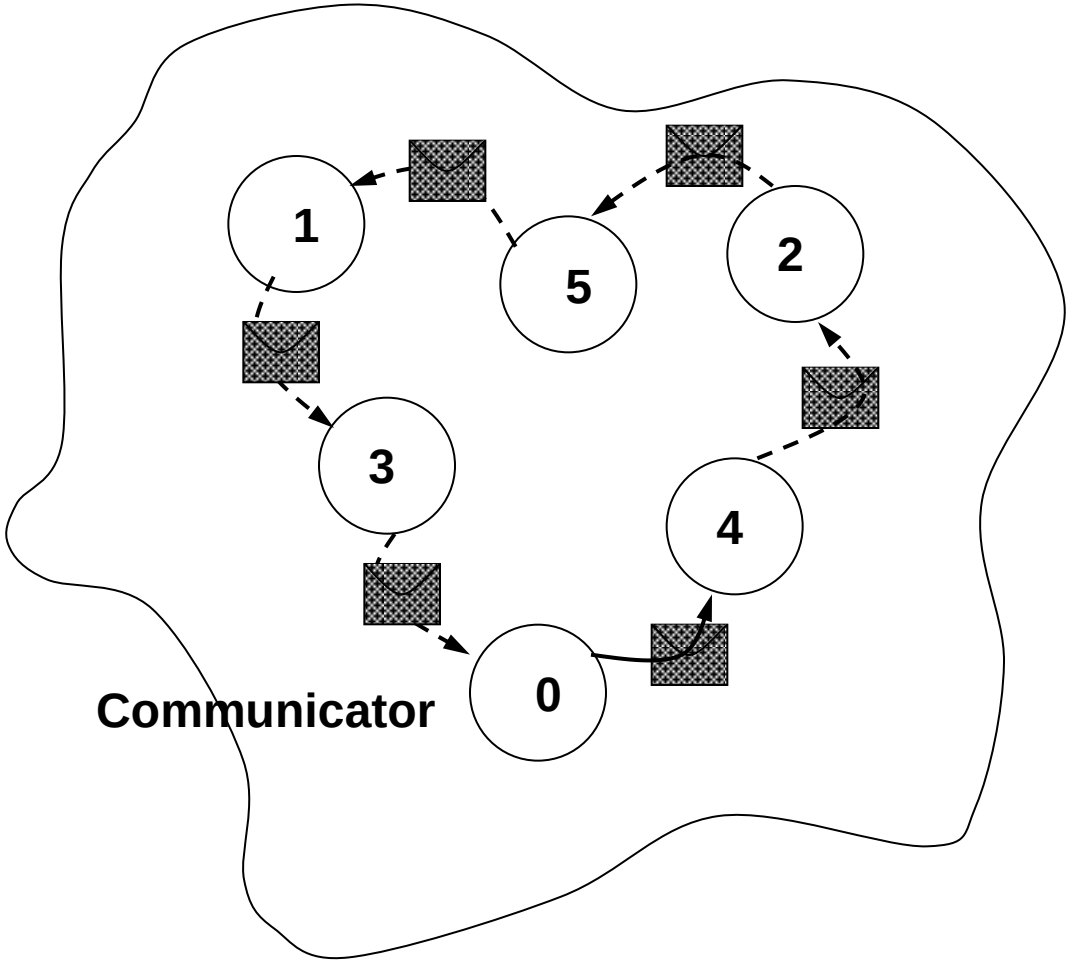
epcc

Non-Blocking Communications

Deadlock

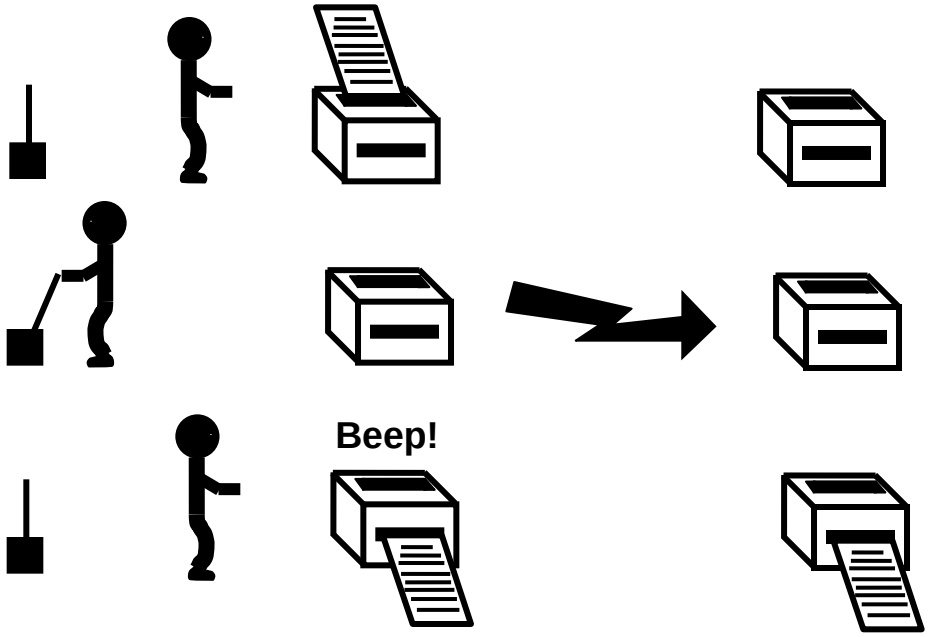


Completion

- The *mode* of a communication determines when its constituent operations complete.
  - i.e. synchronous / asynchronous
- The *form* of an operation determines when the procedure implementing that operation will return
  - i.e. when control is returned to the user program

- Relate to when the operation has completed.
- Only return from the subroutine call when the operation has completed.
- These are the routines you used thus far
  - MPI_Ssend
  - MPI_Recv

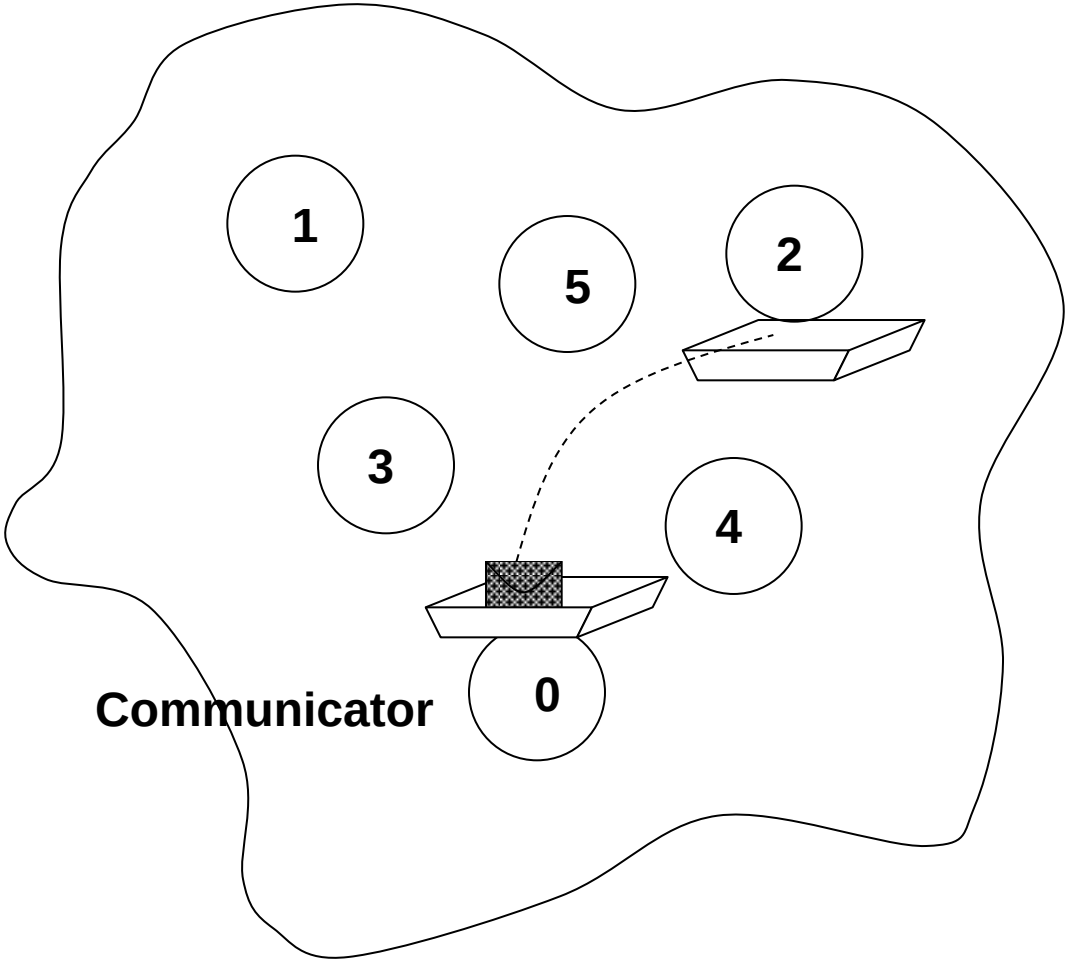
- Return straight away and allow the sub-program to continue to perform other work. At some later time the sub-program can *test* or *wait* for the completion of the non-blocking operation.



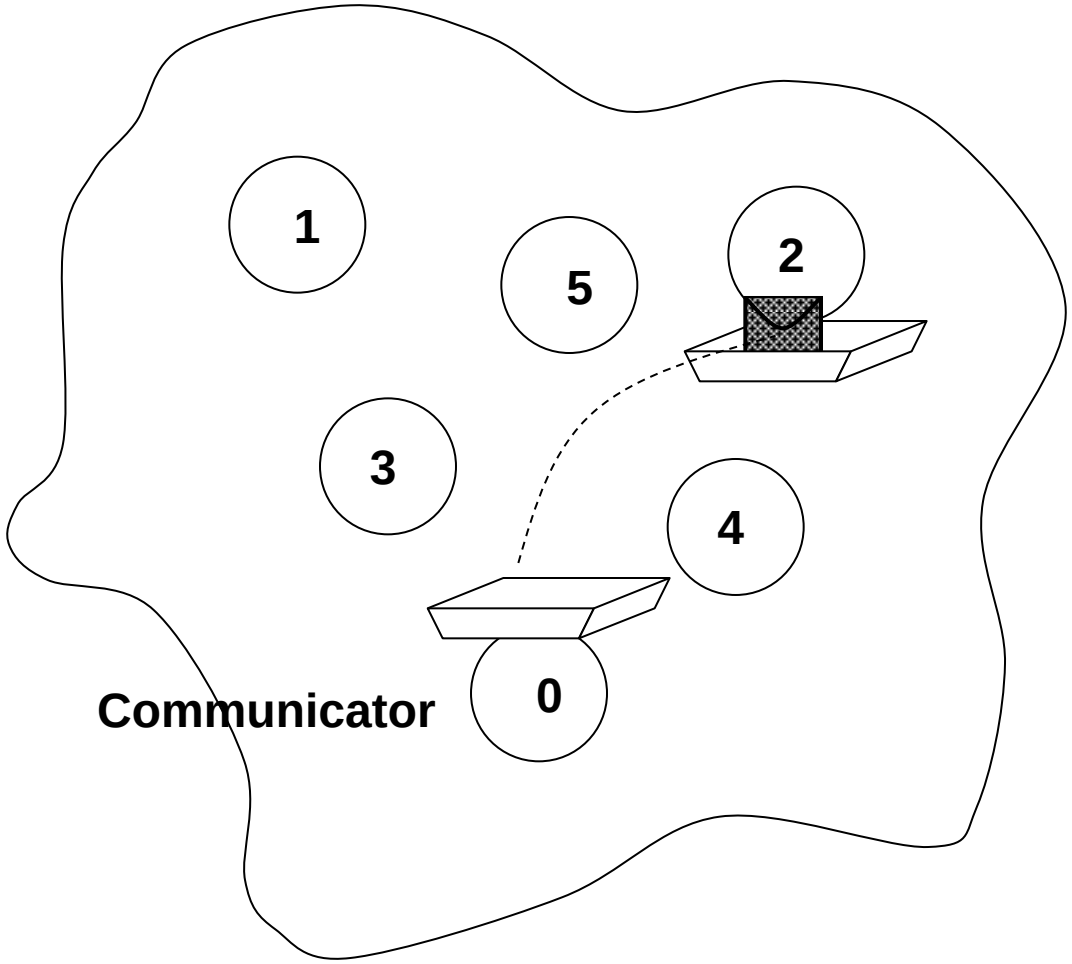
- All non-blocking operations should have matching wait operations. Some systems cannot free resources until wait has been called.
- A non-blocking operation immediately followed by a matching wait is equivalent to a blocking operation.
- Non-blocking operations are not the same as sequential subroutine calls as the operation continues after the call has returned.

- Separate communication into three phases:
- Initiate non-blocking communication.
- Do some work (perhaps involving other communications?)
- Wait for non-blocking communication to complete.

Non-Blocking Send



Non-Blocking Receive



Handles used for Non-blocking Comms

- datatype same as for blocking (`MPI_Datatype` or `INTEGER`).
- communicator same as for blocking (`MPI_Comm` or `INTEGER`).
- request `MPI_Request` or `INTEGER`.
- A *request handle* is allocated when a communication is initiated.

Non-blocking Synchronous Send

- C:

```
int MPI_Issend(void* buf, int count,
               MPI_Datatype datatype, int dest,
               int tag, MPI_Comm comm,
               MPI_Request *request)

int MPI_Wait(MPI_Request *request,
             MPI_Status *status)
```

- Fortran:

```
      MPI_ISSEND(buf, count, datatype, dest,
                 tag, comm, request, ierror)

      MPI_WAIT(request, status, ierror)
```

Non-blocking Receive

- C:

```
int MPI_Irecv(void* buf, int count,
              MPI_Datatype datatype, int src,
              int tag, MPI_Comm comm,
              MPI_Request *request)

int MPI_Wait(MPI_Request *request,
             MPI_Status *status)
```

- Fortran:

```
      MPI_IRECV(buf, count, datatype, src,
                tag, comm, request, ierror)

      MPI_WAIT(request, status, ierror)
```

- Send and receive can be blocking or non-blocking.
- A blocking send can be used with a non-blocking receive, and vice-versa.
- Non-blocking sends can use any mode - synchronous, buffered, standard, or ready.
- Synchronous mode affects completion, not initiation.

Communication Modes

NON-BLOCKING OPERATION	MPI CALL
Standard send	MPI_ISEND
Synchronous send	MPI_ISSEND
Buffered send	MPI_IBSEND
Ready send	MPI_IRSEND
Receive	MPI_IRECV

Completion

- Waiting versus Testing.
- C:

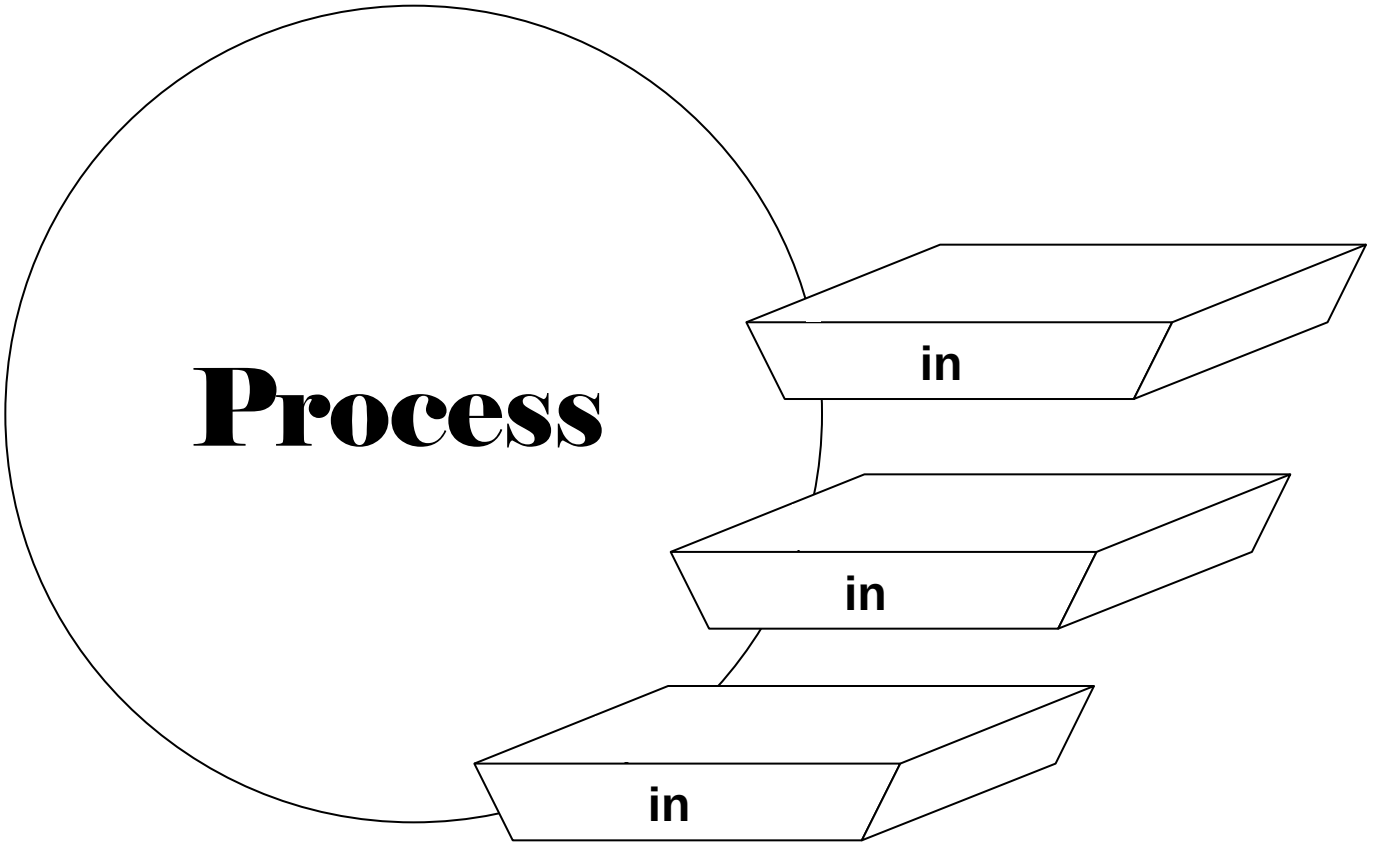
```
int MPI_Wait(MPI_Request *request,
             MPI_Status *status)
int MPI_Test(MPI_Request *request,
             int *flag,
             MPI_Status *status)
```

- Fortran:

```
MPI_WAIT(handle, status, ierror)

MPI_TEST(handle, flag, status, ierror)
```

- Test or wait for completion of one message.
- Test or wait for completion of all messages.
- Test or wait for completion of as many messages as possible.


Process
in
in
in

Combined Send and Receive

- Specify all send / receive arguments in one call
  - MPI implementation avoids deadlock
  - useful in simple pairwise communications patterns, but not as generally applicable as non-blocking

```
int MPI_Sendrecv(void *sendbuf, int sendcount, MPI_Datatype sendtype,
                 int dest, int sendtag,
                 void *recvbuf, int recvcount, MPI_Datatype recvtype,
                 int source, int recvtag,
                 MPI_Comm comm, MPI_Status *status);
```

```
MPI_SENDRECV(sendbuf, sendcount, sendtype, dest,   sendtag,
             recvbuf, recvcount, recvtype, source, recvtag,
             comm, status, ierror)
```

Rotating information around a ring

- See Exercise 4 on the sheet
- Arrange processes to communicate round a ring.
- Each process stores a copy of its rank in an integer variable.
- Each process communicates this value to its right neighbour, and receives a value from its left neighbour.
- Each process computes the sum of all the values received.
- Repeat for the number of processes involved and print out the sum stored at each process.

Possible solutions

- Non-blocking send to forward neighbour
  - blocking receive from backward neighbour
  - wait for forward send to complete
- Non-blocking receive from backward neighbour
  - blocking send to forward neighbour
  - wait for backward receive to complete

- Non-blocking send to forward neighbour
- Non-blocking receive from backward neighbour
  - wait for forward send to complete
  - wait for backward receive to complete

Notes

- Your neighbours *do not change*
  - send to left, receive from right, send to left, receive from right, …
- You *do not alter* the data you receive
  - receive it
  - add it to you running total
  - pass the data *unchanged* along the ring
- You *must not access* send or receive buffers until communications are complete
  - cannot read from a receive buffer until after a wait on irecv
  - cannot overwrite a send buffer until after a wait on issend