# Non-Blocking Communication

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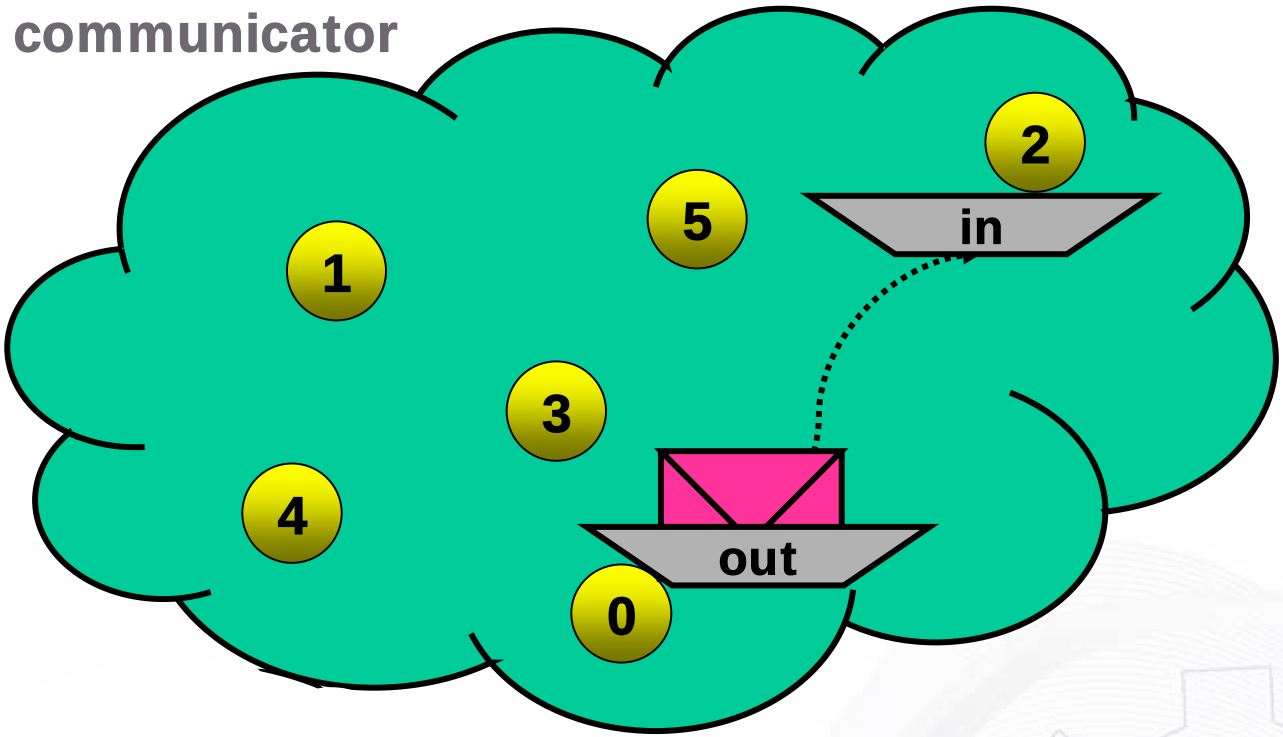
# Non-Blocking communications

Separate communication into three phases:

1. Initiate non-blocking communication ("post" a send or receive)
2. Do some other work not involving the data in transfer
   - Overlap calculation and communication
   - Latency hiding
3. Wait for non-blocking communication to complete

# Non-Blocking send



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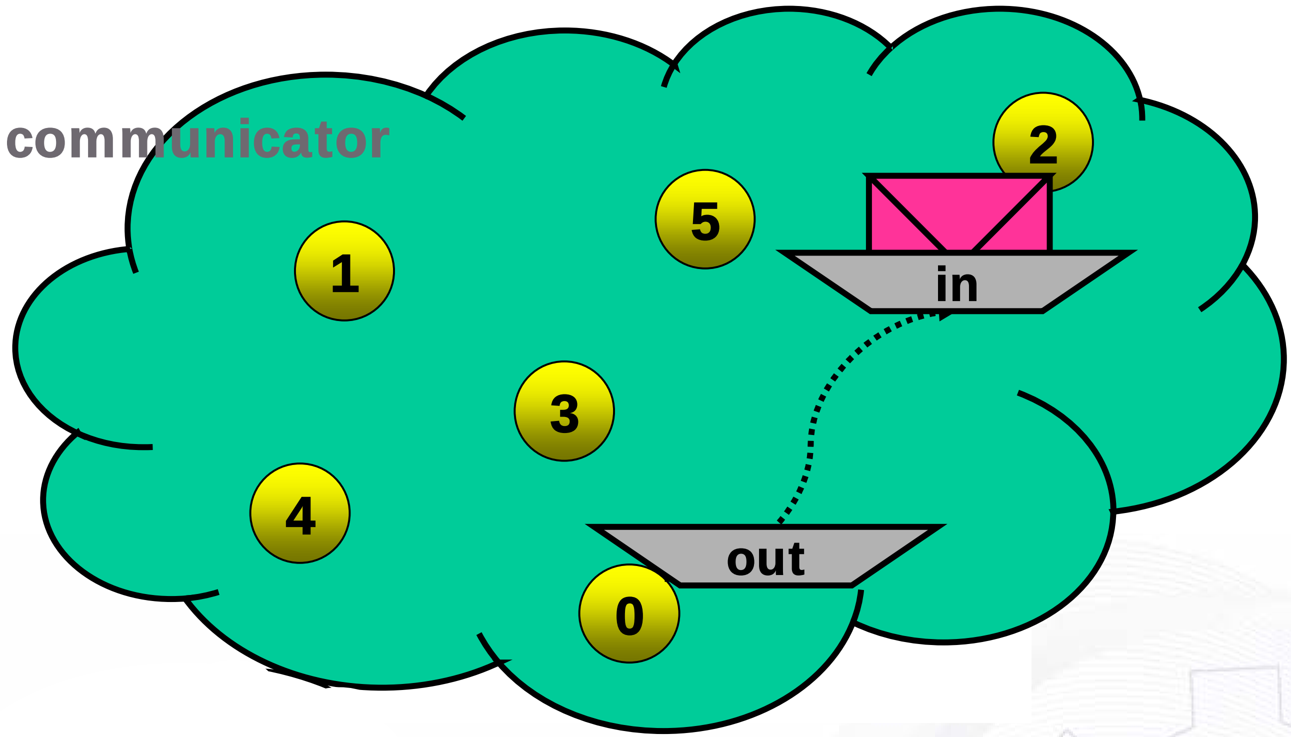
# Non-Blocking receive



# Handles used for non-blocking communication

| | |
|---|---|
| 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 non-blocking communication is initiated
- The request handle is used for testing if a specific communication has completed

# 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)
```

## Fortran:

```
CALL
  MPI_ISSEND(BUF,COUNT,DATATYPE,DEST,TAG,COMM,REQUEST,IERROR)

<type>  BUF(*)
INTEGER COUNT,DATATYPE,DEST,TAG,COMM
INTEGER REQUEST,IERROR
```

"**_I**" for "Immediate" because they return more or less immediately

# Non-Blocking receive

## C:

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

## Fortran:

```
CALL
  MPI_IRECV(BUF,COUNT,DATATYPE,SOURCE,TAG,COMM,REQUEST,IER
  ROR)

<type> BUF(*)
INTEGER COUNT,DATATYPE,SOURCE,TAG,COMM
INTEGER REQUEST,IERROR
```

**system-defined, not directly accessible by programmer**

Note: no STATUS argument

# Blocking and non-blocking

- Send and receive can be blocking or non-blocking
- A blocking send can be used with a non-blocking receive, and vice-versa, e.g.,

  `MPI_Isend` → `MPI_Recv`

- Non-blocking sends can use any mode - synchronous, buffered, standard or ready

  Note: there is no advantage for buffered or ready modes

# Routine names

| Non-Blocking Operation | MPI Call |
| --- | --- |
| Standard send | MPI_ISEND |
| Synchronous send | MPI_ISSEND |
| Buffered send | MPI_IBSEND |
| Ready send | MPI_IRSEND |
| Receive | MPI_IRECV |

"I" : Immediate

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# Completion tests

- Waiting vs. Testing

- **Wait:** routine does not return until completion finished

- **Test:** routine returns a TRUE or FALSE (`0`) value depending on whether the communication has completed

# Wait/Test routines

## C:

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

## Fortran:

```
CALL MPI_WAIT(REQUEST,STATUS,IERR)
INTEGER REQUEST,STATUS(MPI_STATUS_SIZE),IERR

CALL MPI_TEST(REQUEST,FLAG,STATUS,IERR)
LOGICAL FLAG
INTEGER REQUEST,STATUS(MPI_STATUS_SIZE),IERR
```

Here is where `STATUS` appears. It is a three-element structure in C and an integer array of size `MPI_STATUS_SIZE` (defined in `mpif.h`) in Fortran.

# Multiple communications

- Test or wait for completion of one (and only one) message:
  - `int MPI_Waitany(...)`
  - `int MPI_Testany(...)`
- Test or wait for completion of all messages:
  - `int MPI_Waitall(...)`
  - `int MPI_Testall(...)`
- Test or wait for completion of as many messages as possible:
  - `int MPI_Waitsome(...)`
  - `int MPI_Testsome(...)`

# Class Exercise: Calculating Ring

- Repeat the Processor Ring exercise, this time using non-blocking communication routines

- In addition, each processor should calculate the sum of all the ranks as it receives them