MPI Non-blocking Communication

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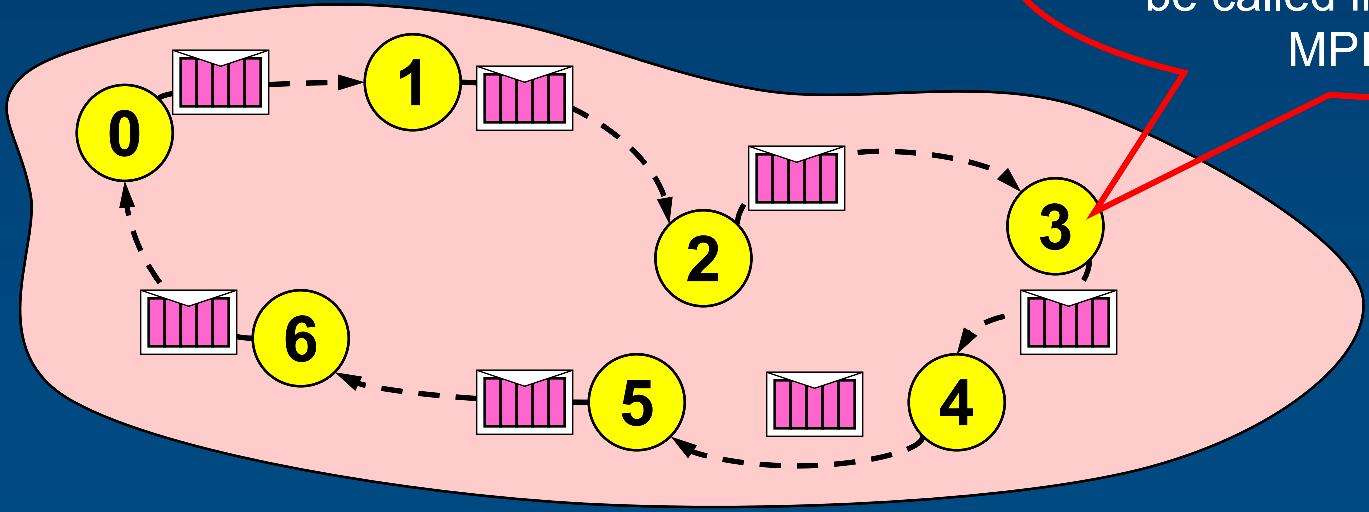
Deadlock

- Code in each MPI process:

  MPI_Ssend(…, right_rank, …)

  MPI_Recv(…, left_rank, …)



Will block and never return, because MPI_Recv cannot be called in the right-hand MPI process

- Same problem with standard send mode (MPI_Send), if MPI implementation chooses synchronous protocol

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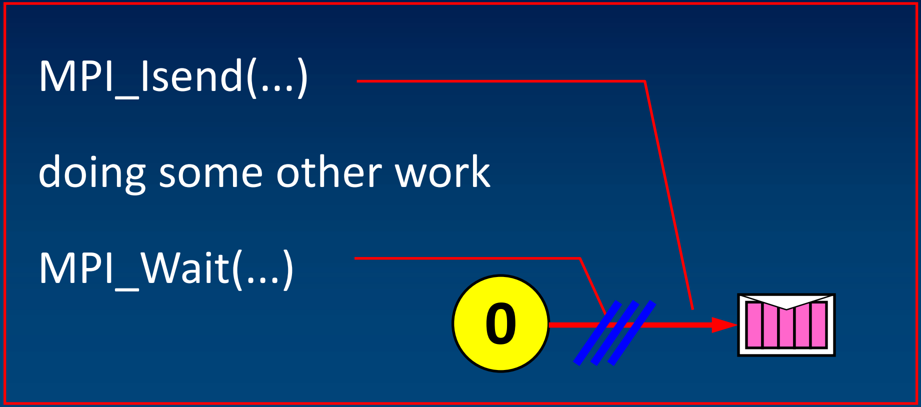
Non-Blocking Communications

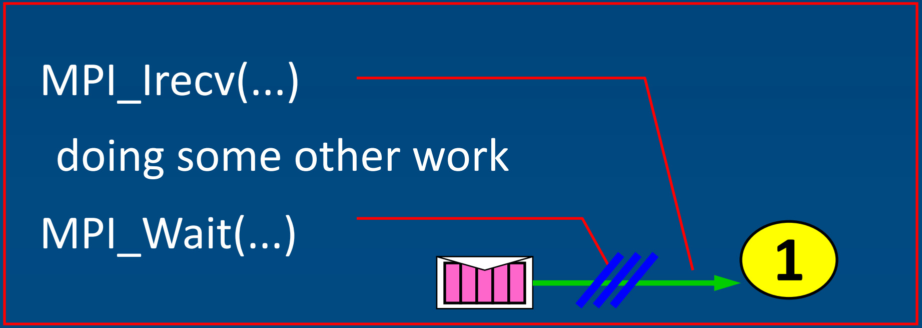
- Separate communication into three phases:
- Initiate non-blocking communication
  - returns **I**mmediately
  - routine name starting with MPI_**I**…
- Do some work
  - "latency hiding"
- Wait for non-blocking communication to complete

Non-Blocking Examples

- Non-blocking **send**



- Non-blocking **receive**



/// = waiting until operation locally completed

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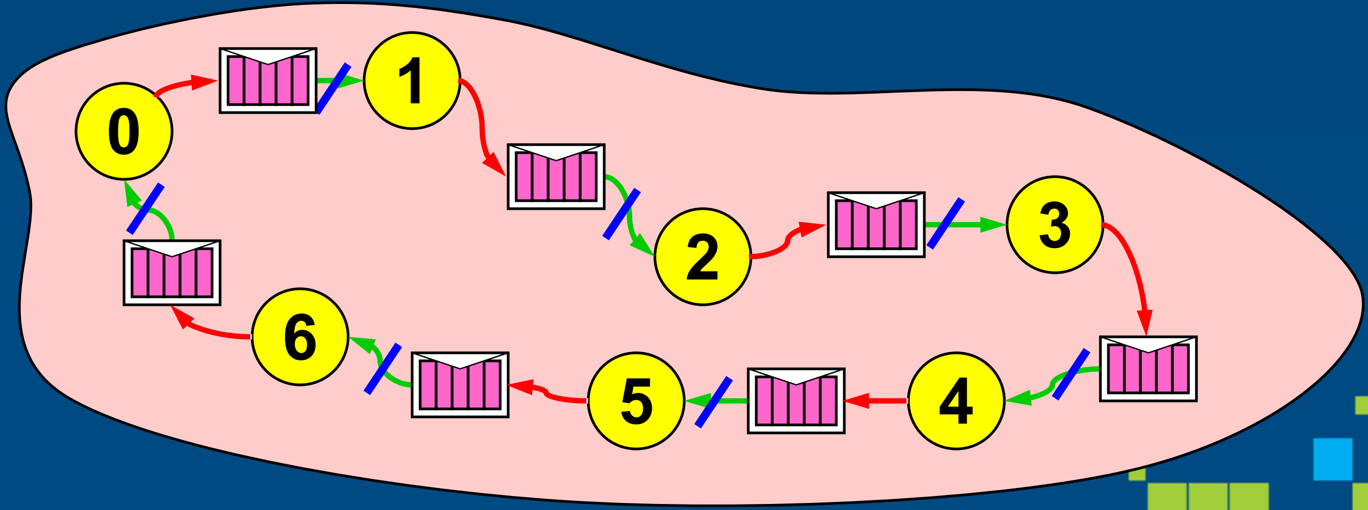
Non-Blocking Send

- Initiate non-blocking send
  - ⟶ in the ring example: Initiate non-blocking send to the right neighbor
- Do some work:
  - ⟶ in the ring example: Receiving the message from left neighbor
- Now, the message transfer can be completed
- Wait for non-blocking send to complete /



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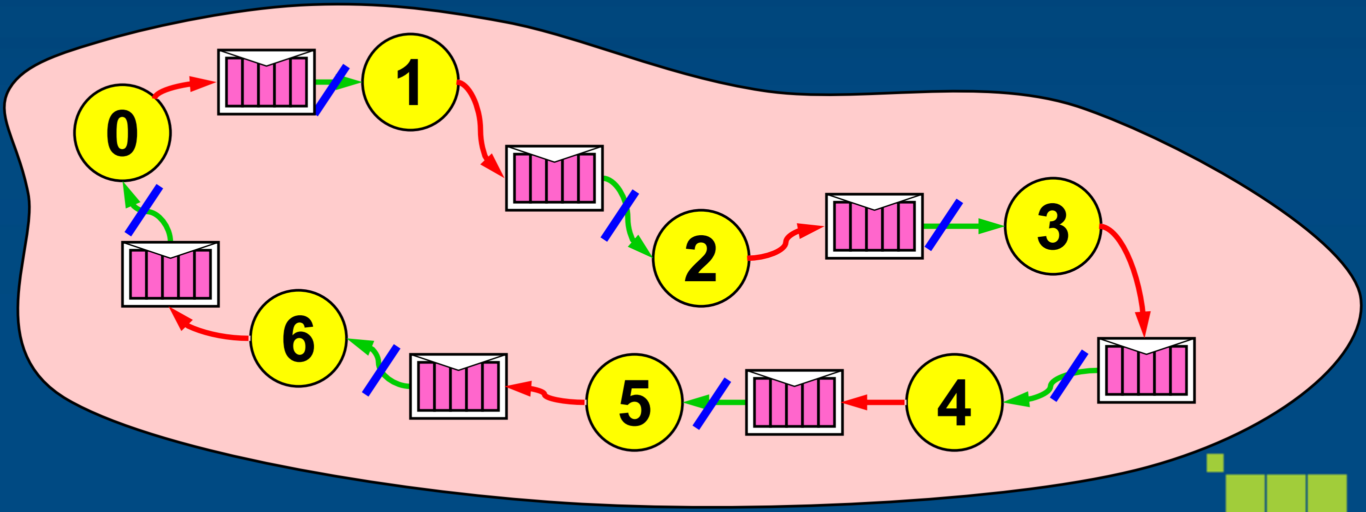
Non-Blocking Receive

- Initiate non-blocking receive
  - $\longrightarrow$ in the ring example: Initiate non-blocking receive from left neighbor
- Do some work:
  - $\longrightarrow$ in the ring example: Sending the message to the right neighbor
- Now, the message transfer can be completed
- Wait for non-blocking receive to complete /



Non-blocking Synchronous Send

- C:
  - MPI_Issend(buf, count, datatypeHandle, dest, tag, comm,
    OUT &requestHandle);
  - MPI_Wait(INOUT &requestHandle, &status);
- Fortran:
  - call MPI_Issend(buf, count, datatypeHnadle, dest, tag, comm,
    OUT requestHandle, ierror)
  - call MPI_Wait(INOUT requestHandle, status, ierror)
- Request handle must be stored in local variables
  - C: MPI_Request
  - Fortran: integer
- buf must not be used between Issend and Wait (in all progr. languages)
- "Issend + Wait directly after Issend" is equivalent to blocking call (Ssend)

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Non-blocking Receive

- C:
  - MPI_Irecv(buf, count, datatypeHandle, source, tag, comm, OUT &requestHandle);
  - MPI_Wait(INOUT &requestHandle, &status);
- Fortran:
  - call MPI_Irecv (buf, count, datatype, source, tag, comm, OUT requestHandle, ierror)
  - call MPI_Wait(INOUT requestHandle, status, ierror)
- buf must not be used between Irecv and Wait (in all progr. languages)

Blocking and Non-Blocking

- Send and receive can be blocking or non-blocking.

Send Mode	Blocking Function	Nonblocking Function
Standard	MPI_Send	MPI_Isend
Synchronous	MPI_Ssend	MPI_Issend
Ready	MPI_Rsend	MPI_Irsend
Buffered	MPI_Bsend	MPI_Ibsend

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Completion

- C:
  - MPI_Wait(&requestHandle, &status);
  - MPI_Test(&requestHandle, &flag, &status);
- Fortran:
  - call MPI_Wait(requestHandle, status, ierror)
  - call MPI_Test(requestHandle, flag, status, ierror)
- one must
  - wait or
  - loop with TEST until request is completed, i.e., flag == 1 or .true.

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Multiple Non-Blocking Communications

- You have several request handles:
- Wait or test for completion of one message
  - MPI_Waitany / MPI_Testany
- Wait or test for completion of all messages
  - MPI_Waitall / MPI_Testall
- Wait or test for completion of as many messages as possible
  - MPI_Waitsome / MPI_Testsome