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MPI in Small Bites

HPC.NRW Competence Network

Non-blocking Point-to-Point Communication

HPC.NRW Competence Network

MPI in Small Bites

Non-blocking procedures

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- Return **before** associated operation is complete
- Separate call needed to complete operation
- Track non-blocking operation using a **request handle**:
  - C: **MPI_Request**
  - Fortran: **INTEGER**
  - Fortran 2008: **TYPE(MPI_Request)**

- Operation progress is implementation dependent
  - Within MPI functions (e.g., communication functions or other ‘expensive’ function calls)
  - Progress thread
  - Hardware support
- Used to overlap communication and computation and **to prevent possible deadlocks**

Non-Blocking Send and Receive

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- Non-blocking procedures often have an ‘I’ (capital i) prefix
  - Note: not all non-blocking functions have this prefix, but are non-blocking nonetheless

- Initiation of non-blocking send and receive operations:

```
MPI_Isend (void *data, int count, MPI_Datatype dataType,
      int dest, int tag, MPI_Comm comm, MPI_Request *request)
```

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

  - **request:** on success set to the handle of the non-blocking operation

Waiting for Request Completion

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- Blocking for completion
- Returning status objects (as a blocking receive would)
  - Use **`MPI_STATUS_IGNORE`** to omit return of status object

- Waiting for a single request to complete:

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

- Waiting for any single request out of multiple to complete:

```
MPI_Waitany (int count, MPI_Request array_of_requests[],
             int* index, MPI_Status *status)
```

Waiting for Multiple Request Completion

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– Waiting for a multiple (not necessarily all) requests out of multiple to complete:

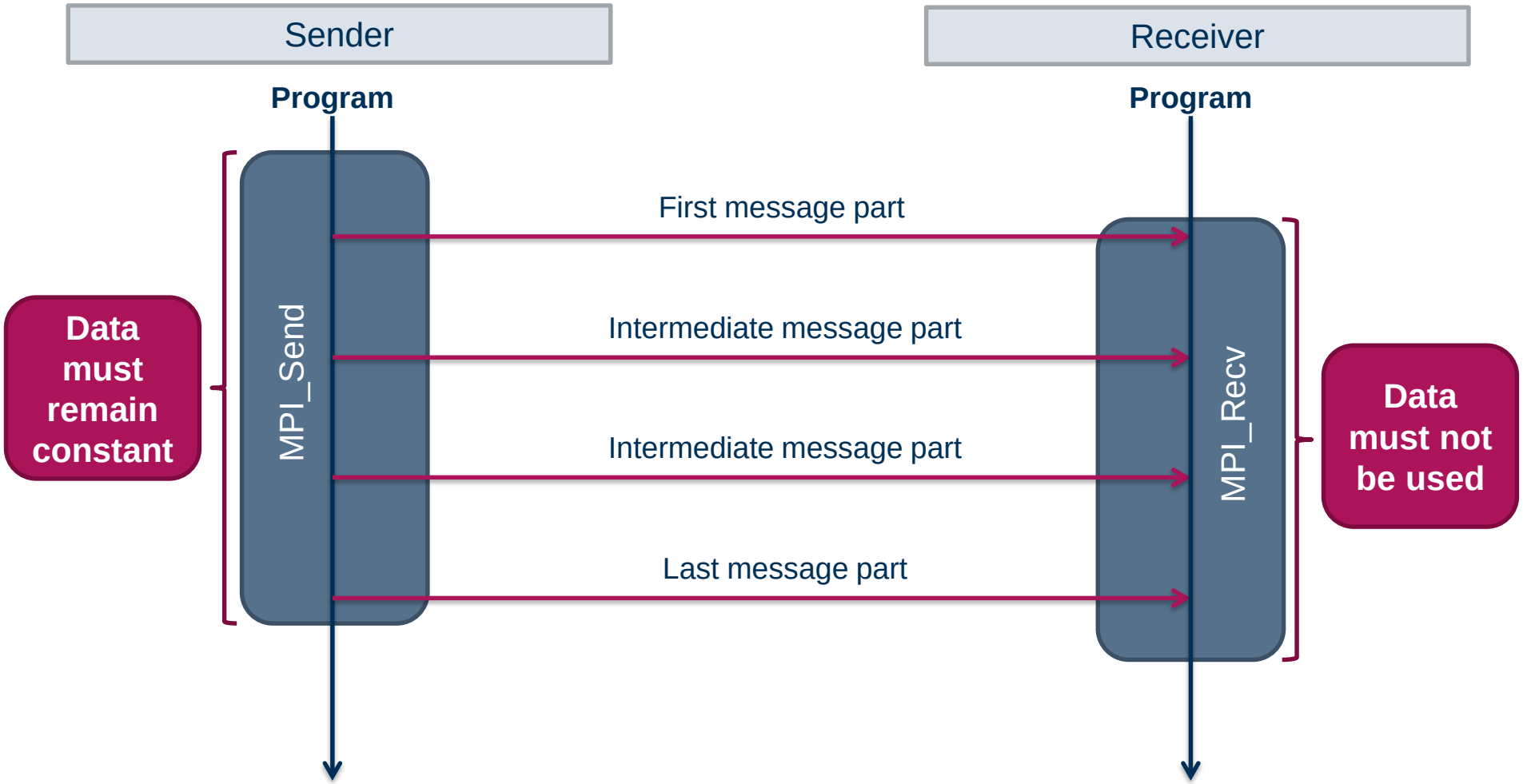
```
MPI_Waitsome (int incount, MPI_Request array_of_requests[],
              int* outcount, int array_of_indices[],
              MPI_Status array_of_status[])
```

  – Use **MPI_STATUSES_IGNORE** to omit return of status objects
  – Returns with `outcount` set to **MPI_UNDEFINED** on no active requests

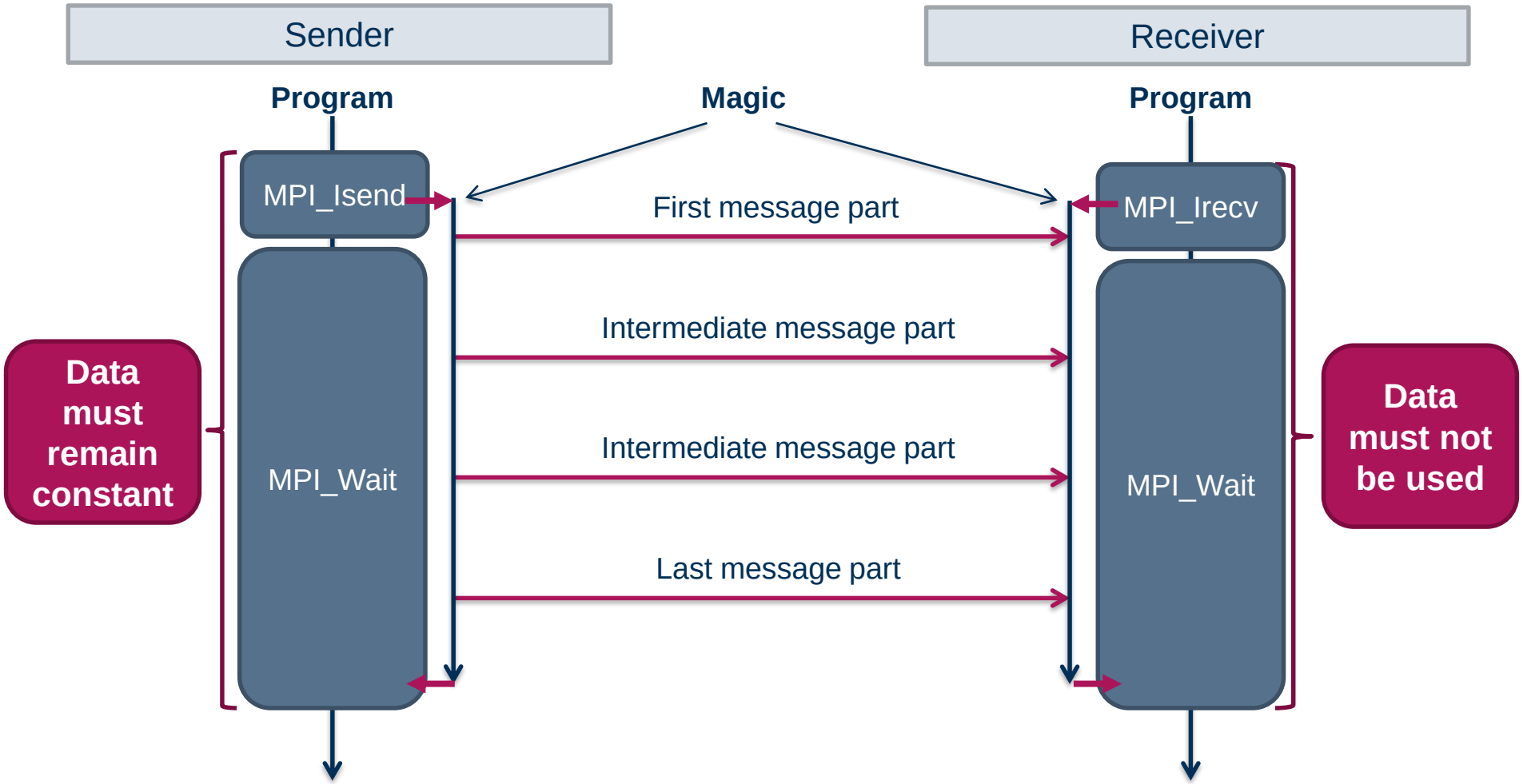
– Waiting for all requests out of multiple to complete:

```
MPI_Waitall (int count, MPI_Request array_of_requests[],
             MPI_Status array_of_statuses[])
```

Communication-Computation Overlap

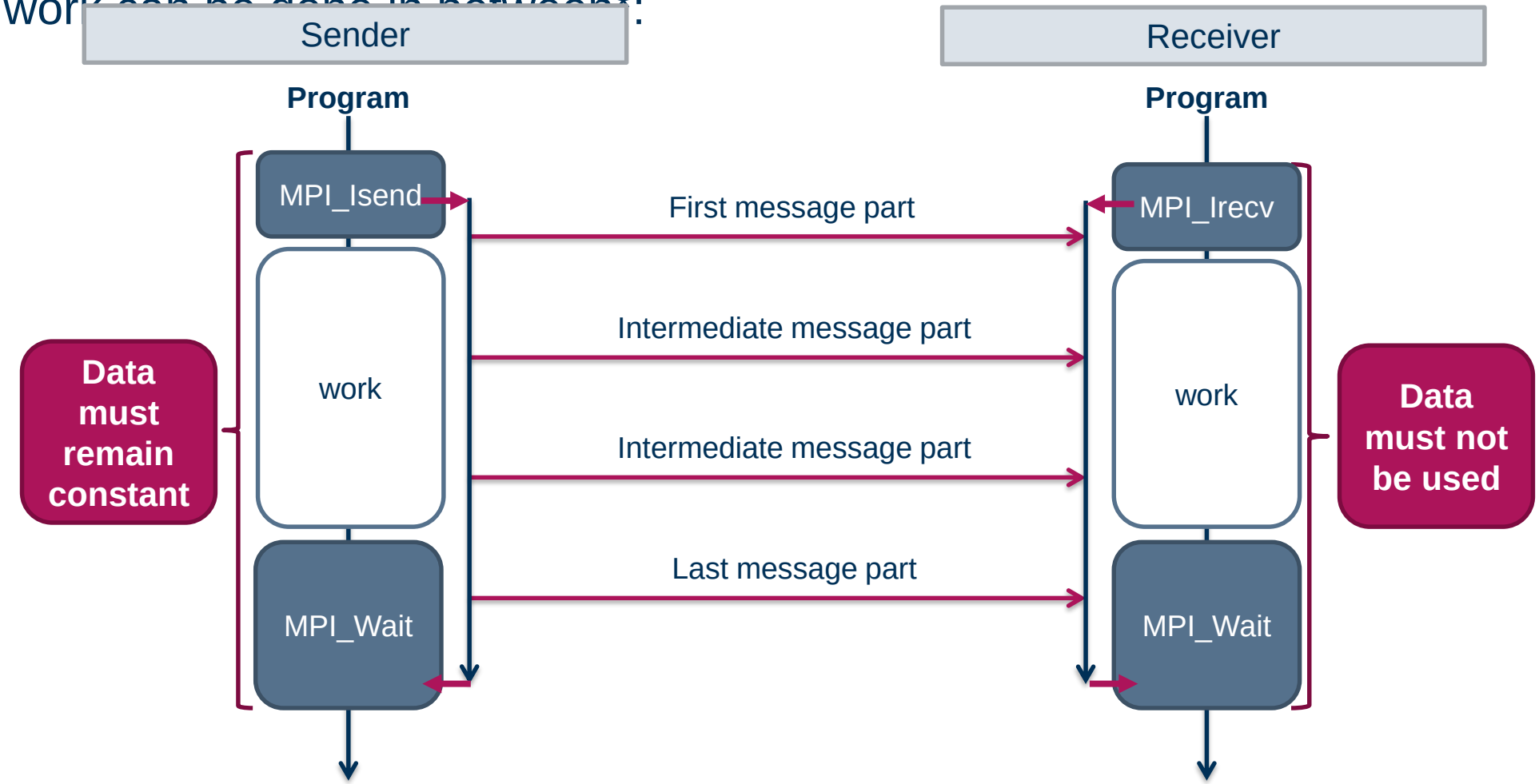


Communication-Computation Overlap



Communication-Computation Overlay

– Other work can be done in between*:



Deadlock Prevention (and Communication-Communication Overlap)

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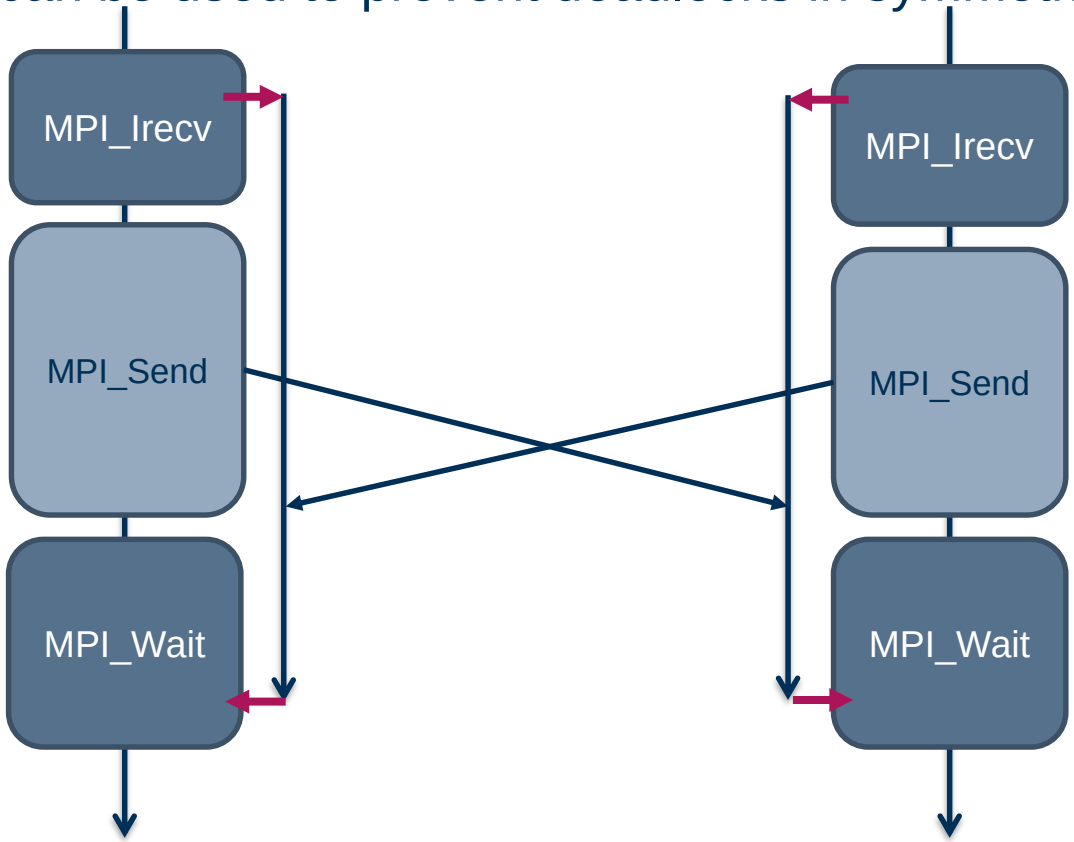
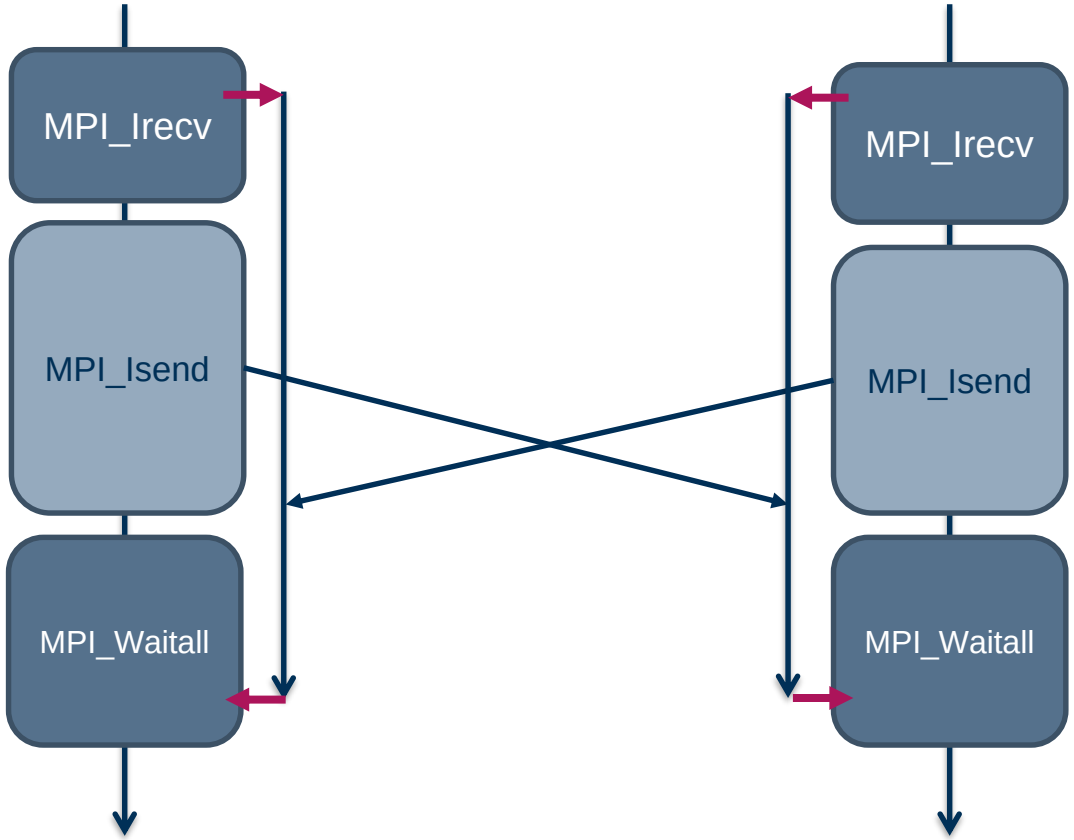
– Non-blocking operations can be used to prevent deadlocks in symmetric code:



– That is how `MPI_Sendrecv` can be implemented

Deadlock Prevention (and Communication-Communication Overlap)



Test for Request Completion

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- Does **NOT** block for completion
  - Indicates whether completion occurred
- Returning status objects (as a blocking receive would)
  - Use **`MPI_STATUS_IGNORE`** to omit return of status object

- Test for completion of a single request:

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

- Test for completion of any single request out of multiple:

```
MPI_Testany (int count, MPI_Request array_of_requests[],
             int* index, int* flag, MPI_Status *status)
```

Test for Multiple Request Completion

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– Test for completion of multiple (not necessarily all) requests out of multiple:

```
MPI_Testsome (int incount, MPI_Request array_of_requests[],
              int* outcount, int array_of_indices[],
              MPI_Status array_of_status[])
```

  – Flag is implicit in **`outcount`**
  – Use **`MPI_STATUSES_IGNORE`** to omit return of status objects

– Test for completion of all requests out of multiple:

```
MPI_Testall (int count, MPI_Request array_of_requests[], int* flag,
             MPI_Status array_of_statuses[])
```

Further Remarks on Request Completion

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- Test or wait for **local** completion
- Successful requests are set to **`MPI_REQUEST_NULL`** on completion

- If called with a null request (**`MPI_REQUEST_NULL`**):
  - **MPI_Wait** returns immediately with an empty **status**
  - **MPI_Test** sets **flag** to **true** and returns an empty **status**
  - Ignored in the presence of other valid requests