Communication with MPI

Collective Communication

broadcast
Communication with MPI

Collective Communication

broadcast

scatter
Communication with MPI

Collective Communication

broadcast

scatter

gather
Communication with MPI

Collective Communication

broadcast

gather

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reduction
Communication with MPI

Point-to-Point Communication

Example 1: Hello world

```c
char msg[20];
int myrank;
int tag = 99;
MPI_Status status;

MPI_Comm_rank( MPI_COMM_WORLD, &myrank);

if (myrank == 0) {
    strcpy( msg, "Hello world!");
    MPI_Send( msg, strlen( msg) + 1, MPI_CHAR, 1, tag, MPI_COMM_WORLD);
}
else if (myrank == 1) {
    MPI_Recv( msg, 20, MPI_CHAR, 0, tag, MPI_COMM_WORLD, &status);
    printf( "%s\n", msg);
}
```
Communication with MPI

Nonbuffered Communication

1. P1 has to wait till P2 is ready, if there is no/not enough buffer.
2. P1 will not continue, P1 is blocked.
Communication with MPI

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Buffered Communication

1. P1 copies data to buffer.
2. P1 continues.
3. P2 will continue work after receiving data.
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Why do messages need to be buffered?

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- Still, user buffer may be reclaimed, modified, etc.
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  - architecture,
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Problem: How large is the system buffer?

- Programs may fail due to system buffer exhaustion.
- Too bad: system buffer size depends on
  - architecture,
  - operating system,
  - MPI implementation.
- Portability of code restricted.
Communication with MPI

What makes a Message?

- **Message Envelope**
  - Data

- **Source**
  - Destination
  - Tag
  - Communicator

- **Data**
Communication with MPI

MPI_Send

```c
int MPI_Send( void *buffer, /* address of send buffer */
              int count, /* number of entries in buffer */
              MPI_Datatype datatype, /* datatype of entry */
              int destination /* rank of destination */
              int tag, /* message tag */
              MPI_Comm communicator /* communicator */ )
```

- ▶ Standard **blocking** send operation.
- ▶ Assembles message envelope.
- ▶ Sends message to destination.
- ▶ May return as soon as message is handed over to 'system' (buffered communication).
- ▶ May wait for corresponding receive operation (unbuffered communication).
- ▶ Buffering behaviour is implementation-dependent.
- ▶ No synchronization with receiver (guaranteed).
Communication with MPI

MPI_Assrecv

```c
int MPI_Recv(void *buffer, /* OUT : address of receive buffer */
              int count,    /* IN : maximum number of entries */
              MPI_Datatype datatype, /* IN : datatype of entry */
              int source    /* IN : rank of source */
              int tag,      /* IN : message tag */
              MPI_Comm communicator, /* IN : communicator */
              MPI_Status *status /* OUT : return status */
)
```

- Standard blocking receive operation.
- Receives message from source with tag.
- Disassembles message envelope.
- Stores message data in buffer.
- Returns not before message is received.
- Returns additional status data structure.
Communication with MPI

- Receiving messages from any source?
  Use wildcard source specification MPI_ANY_SOURCE.
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- Message buffer larger than message?
  Don’t worry, superfluous buffer fields remain untouched.
Communication with MPI

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  Use wildcard tag specification MPI_ANY_TAG

- Message buffer larger than message?
  Don’t worry, superfluous buffer fields remain untouched.

- Message buffer smaller than message?
  Message is truncated, no buffer overflow.
  MPI_Recv returns error code MPI_ERR_TRUNCATE.
### Communication with MPI

#### Deadlock I

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The program will deadlock, if system provides no buffer.

Process A is not able to send message with tag=0.

Process B is not able to receive message with tag=1.
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The program will deadlock, if system provides no buffer. Process A and Process B are not able to send messages. Order communications in the right way!
Communication with MPI

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▶ Process A and Process B are not able to send messages.
▶ Order communications in the right way!
Communication with MPI

Example: Exchange of messages

```c
if (myrank == 0) {
    MPI_Send( sendbuf, 20, MPI_INT, 1, tag, communicator);
    MPI_Recv( recvbuf, 20, MPI_INT, 1, tag, communicator, &status);
}
else if (myrank == 1) {
    MPI_Recv( recvbuf, 20, MPI_INT, 0, tag, communicator, &status);
    MPI_Send( sendbuf, 20, MPI_INT, 0, tag, communicator);
}
```

- This code succeeds even with no buffer space at all !!!

- Important note: Code which relies on buffering is considered unsafe !!!
How to solve a tridiagonal system?

Algorithm (Tridiagonal system)
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1. Eliminate in each diagonal block subdiagonal elements.
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If data are stored rowwise only one communication to neighbouring processor necessary.