High-Performance Scientific Computing
Lecture 6: MPI

MATH-GA 2011 / CSCI-GA 2945 · October 10, 2012
Today

Tool of the day: gdb

MPI: Point-to-Point
• HW2: ... 
• HW4: due today 
• HW5: out tomorrow 
• On HW5: 5 minute project pitch → due next week! 
• Project: form teams
Atomic: Compare-and-swap

```c
int atomic_cmpxchg (__global int *p, int cmp, int val)
int atomic_cmpxchg (__local int *p, int cmp, int val)
```

Does:

- Read the 32-bit value (referred to as old) stored at location pointed to by p.
- Compute (old == cmp) ? val : old.
- Store result at location pointed to by p.
- Returns old.
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Implement atomic float add?
Outline

Tool of the day: gdb

MPI: Point-to-Point
gdb

Demo time
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MPI: Point-to-Point
Demo time
MPI 3.0, Section 3.4:

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MPI 3.0, Section 3.4, more:

[MPI_Send] uses the standard communication mode. In this mode, it is up to MPI to decide whether outgoing messages will be buffered.

MPI may buffer outgoing messages. In such a case, the send call may complete before a matching receive is invoked. On the other hand, MPI may choose not to buffer outgoing messages.
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What is correct behavior?

Must, should, may (RFC 2119)
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Alternative communication modes:
- Buffered
- Synchronous
- Ready
MPI 3.0, Section 3.4, yet more:

A send in standard mode can be started whether or not a matching receive has been posted.

It may complete before a matching receive is posted.

The standard mode send is non-local: successful completion of the send operation may depend on the occurrence of a matching receive.
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Can learn a lot from *how* something is said.
Lessons

- Blocking ↔ buffers
- Communication modes
- Operation life cycle
- Matching
- Non-locality
Removing the deadlock

Two ways laid out:

• Use buffered send (brittle!)
• Change order (not always easy! Example?)

Would like a middle ground:

"Just keep the buffer I've got right here!"

But when is it safe to reuse that buffer?

Tool of the day: gdb  MPI: Point-to-Point
Removing the deadlock

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Non-blocking

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Nonblocking message-passing operations [...] can be used to avoid the need for buffering outgoing messages.

Additional Advantage: [Sec. 3.7]
One can improve performance on many systems by overlapping communication and computation.
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Nonblocking can be combined with buffered/ready/synchronous.
→ It’s not a “mode”.

Nonblocking sends can be matched with blocking receives, and vice-versa. [3.7]
Nonblocking demo time
Partitioning for neighbor communication

How can I chop up a domain?

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Partitioning for neighbor communication

How can I chop up a domain?

Tool of the day: gdb  MPI: Point-to-Point
Neighbor comm demo time
MPI: Ordering

MPI 3.0, Section 3.5:

**Order** Messages are non-overtaking: If a sender sends two messages in succession to the same destination, and both match the same receive, then this operation cannot receive the second message if the first one is still pending.

If a receiver posts two receives in succession, and both match the same message, then the second receive operation cannot be satisfied by this message, if the first one is still pending.
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MPI: More on Ordering

Possible problem?

```c
if (rank == 0)
{
    MPI_Bsend(buf1, count, MPI_DOUBLE, 1, tag1, comm)
    MPI_Ssend(buf2, count, MPI_DOUBLE, 1, tag2, comm)
}
else if (rank == 1) then
{
    MPI_Recv(buf1, count, MPI_DOUBLE, 0, tag2, comm, status)
    MPI_Recv(buf2, count, MPI_DOUBLE, 0, tag1, comm, status)
}
```
Questions?

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