Treating threads as MPI processes thru registration/deregistration

Alexander Supalov
Intel Corporation

June 5, 2009

Contents

- Rationale
- Proposal
- Bindings
- Example
  - Sample code
  - Timeline
  - Notes
- Extensions

Rationale

- Increasing prevalence of multi- and manycore processors calls for extended MPI facilities for dealing with threads as first class MPI entities
- So far the MPI standard treats threads as second-class entities that cannot be directly addressed and whose presence is merely tolerated
- This leads to issues like the Probe/Recv consistency issue described in https://svn.mpi-forum.org/trac/mpi-forum-web/ticket/38 and the partial solution proposed therein
- This proposal seeks to introduce a powerful and convenient way of direct addressing of the threads as MPI processes, thus resolving all related issues

Proposal

- A new collective routine **MPI_Comm_thread_register()** is introduced to create a communicator in which existing threads become MPI “processes” with unique ranks
  - The way in which the existing threads were created or are going to be terminated is out of the scope of this proposal. See Posix threads, OpenMP, etc.
- The existing routines **MPI_Comm_free()** is extended to terminate the resulting communicators
- All power of MPI is retained. For example:
  - All communicator and group manipulation routines can work on the resulting communicators recursively, combining and rearranging processes as needed to the user
  - All communication routines (pt2pt, collectives, 1-sided, file I/O) can work on the new communicators, and may optionally take advantage of the fact that the data should not cross the process boundary
- Prerequisite: MPI_THREAD_MULTIPLE thread support level

MPI_Comm_thread_register Language independent binding

MPI_Comm_thread_register(comm, local_thread_index, local_num_threads, newcomm)

IN comm	original communicator
IN local_thread_index	index of the calling thread (0 to local_num_threads – 1) on the current MPI process in comm
IN local_num_threads	total number of threads issuing this call on the current MPI process in comm
OUT newcomm	new communicator based on threads treated as MPI processes

MPI_Comm_thread_register Basic language bindings

C:

```
int MPI_Comm_thread_register(MPI_Comm comm,
  int local_thread_index, int local_num_threads,
  MPI_Comm *newcomm)
```

Fortran:

```
MPI_COMM_THREAD_REGISTER(COMM,
  LOCAL_THREAD_INDEX, LOCAL_NUM_THREADS,
  NEWCOMM, IERROR)
INTEGER COMM, LOCAL_THREAD_INDEX,
  LOCAL_NUM_THREADS, NEWCOMM, IERROR
```

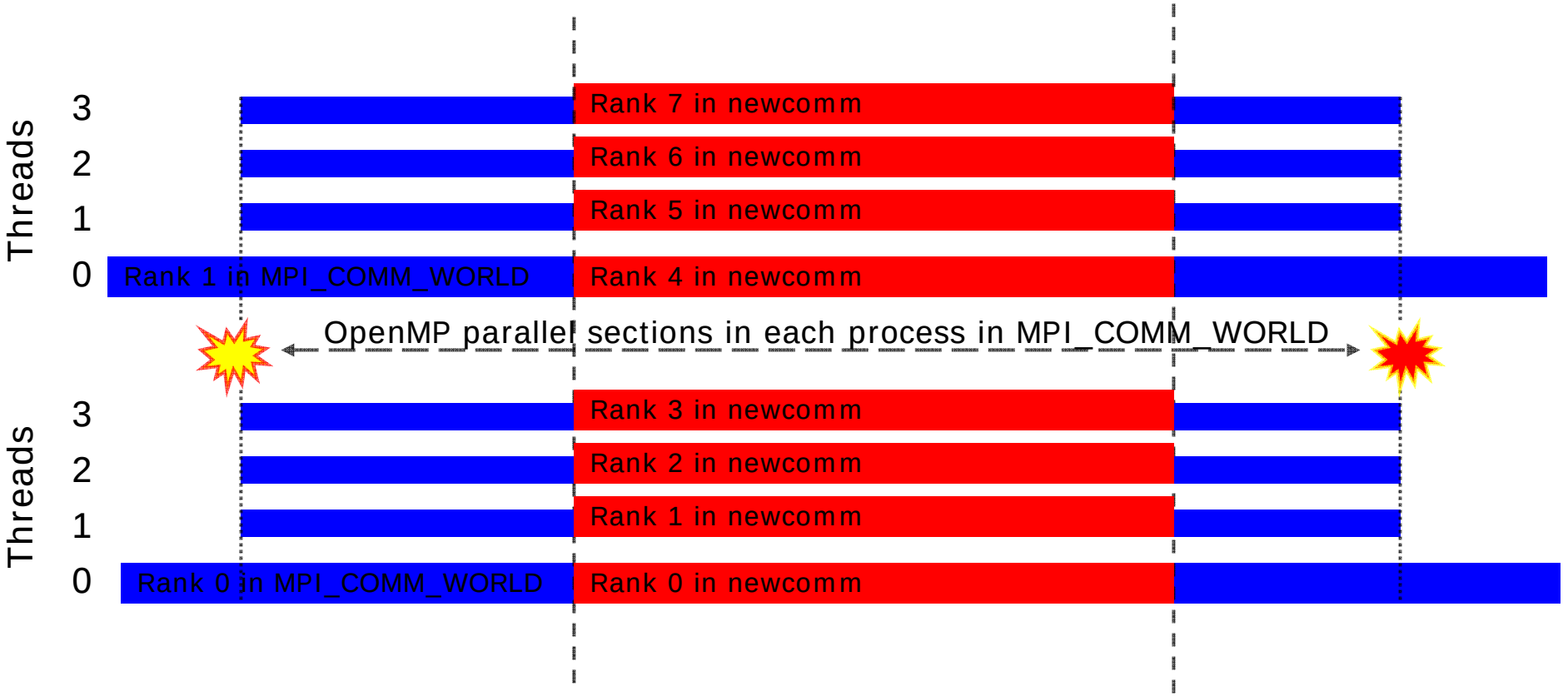
Example: OpenMP parallel section

```
! Any other thread creation method can go here
!$OMP parallel num_threads(4)

call MPI_COMM_THREAD_REGISTER(&
   MPI_COMM_WORLD, OMP_GET_THREAD_NUM(),&
   OMP_GET_NUM_THREADS(), NEWCOMM, IERROR)
!
!        Whatever MPI operations in NEWCOMM
!
call MPI_COMM_FREE(NEWCOMM,IERROR)

! Any suitable thread termination method can go here
!$OMP parallel end
```

Example: Event timeline



MPI_COMM_THREAD_REGISTER(MPI_COMM_WORLD,&
OMP_GET_THREAD_NUM(),
OMP_GET_NUM_THREADS(),&
NEWCOMM)

MPI_COMM_FREE(NEWCOMM)

Example: Notes

- The method of thread creation/termination is out of the scope of this proposal
  - OpenMP is but one possibility
- The number of threads per process can differ from process to process depending on the application logic
  - The value of the local_num_threads argument will facilitate synchronization
- While newcomm exists, both MPI and thread communication and synchronization mechanisms can be used within their respective scopes
  - It is user responsibility to make sure that those mechanisms do not conflict

Extensions

- One can imagine not all threads calling the MPI_Comm_thread_register
  - The minimum of 1 thread per MPI process in the comm is however necessary. Use another comm if you need to skip some processes.
- One can think of using a global_thread_index or color instead of the local_thread_index in the MPI_Comm_thread_register
  - This would allow global thread reordering, resulting in arbitrary newcomm configurations, e.g., all odd threads grouped in round robin fashion across all MPI processes in comm, etc.
  - This is not really necessary as the usual communicator management calls can also be used on the newcomm