MPI-2

Sathish Vadhiyar

- http://www-unix.mcs.anl.gov/mpi/mpi-standard/mpi-report-2.0/mpi2-report.htm
- Using MPI2: Advanced Features of the Message-Passing Interface. http://www-unix.mcs.anl.gov/mpi/usingmpi2/

One Sided communications

Motivation

- Remote memory access (RMA)
- All communication parameters on one side (sender/receiver)
- For applications that have dynamic data access patterns
- For using hardware provided features
- Consists of communication (put, get, update) and synchronization functions

Allowing memory accesses

- MPI provides controls
  - Which parts of memory can be accessed by remote memory
  - During what time (synchronization – more later)
- Which parts of memory? – MPI helps creates window of memory access
- MPI_WIN_CREATE(base, size, disp_unit, info, comm, win)

Communication Calls

- 3 non-blocking calls:
- MPI_PUT(origin_addr, origin_count, origin_datatype, target_rank, target_disp, target_count, target_datatype, win) for writing to remote memory
- MPI_GET(origin_addr, origin_count, origin_datatype, target_rank, target_disp, target_count, target_datatype, win) for reading from remote memory
- MPI_ACCUMULATE(origin_addr, origin_count, origin_datatype, target_rank, target_disp, target_count, target_datatype, op, win) for updating remote memory

Example - Get

- To compute A = B(map)

```
SUBROUTINE MAPVALS(A, B, map, m, comm, p)
USE MPI INTEGER m, map(m), comm, p
REAL A(m), B(m)
INTEGER sizeofreal, win, ierr

CALL MPI_TYPE_EXTENT(MPI_REAL, sizeofreal, ierr)
CALL MPI_WIN_CREATE(B, m*sizeofreal, sizeofreal, MPI_INFO_NULL, & comm,
        win, ierr)

CALL MPI_WIN_FENCE(0, win, ierr)
DO i=1,m
  j = map(i)/p
  k = MOD(map(i),p)
  CALL MPI_GET(A(i), 1, MPI_REAL, j, k, 1, MPI_REAL, win, ierr)
END DO CALL
MPI_WIN_FENCE(0, win, ierr)

CALL MPI_WIN_FREE(win, ierr)
RETURN END
```

Example - Accumulate

- To update B(j) = $\Sigma_{map(i)=j}$ A(i)

```
SUBROUTINE SUM(A, B, map, m, comm, p)
  CALL MPI_TYPE_EXTENT(MPI_REAL, sizeofreal, ierr)
  CALL MPI_WIN_CREATE(B, m*sizeofreal, sizeofreal, MPI_INFO_NULL,
      & comm, win, ierr)
  CALL MPI_WIN_FENCE(0, win, ierr)

  DO i=1,m
    j = map(i)/p
    k = MOD(map(i),p)
    CALL MPI_ACCUMULATE(A(i), 1, MPI_REAL, j, k, 1, MPI_REAL, &
      MPI_SUM, win, ierr)
  END DO
  CALL MPI_WIN_FENCE(0, win, ierr)
  CALL MPI_WIN_FREE(win, ierr)
  RETURN END
```

Synchronization

- Active target communication - Both processes are explicitly involved in communication
- Passive target communication - Only origin process is involved
- Access epoch - Contains RMA calls in the origin. Starts and ends with synchronization calls.
- Exposure epoch – contains RMA calls in the active target

Synchronization

- 3 synchronization mechanisms:

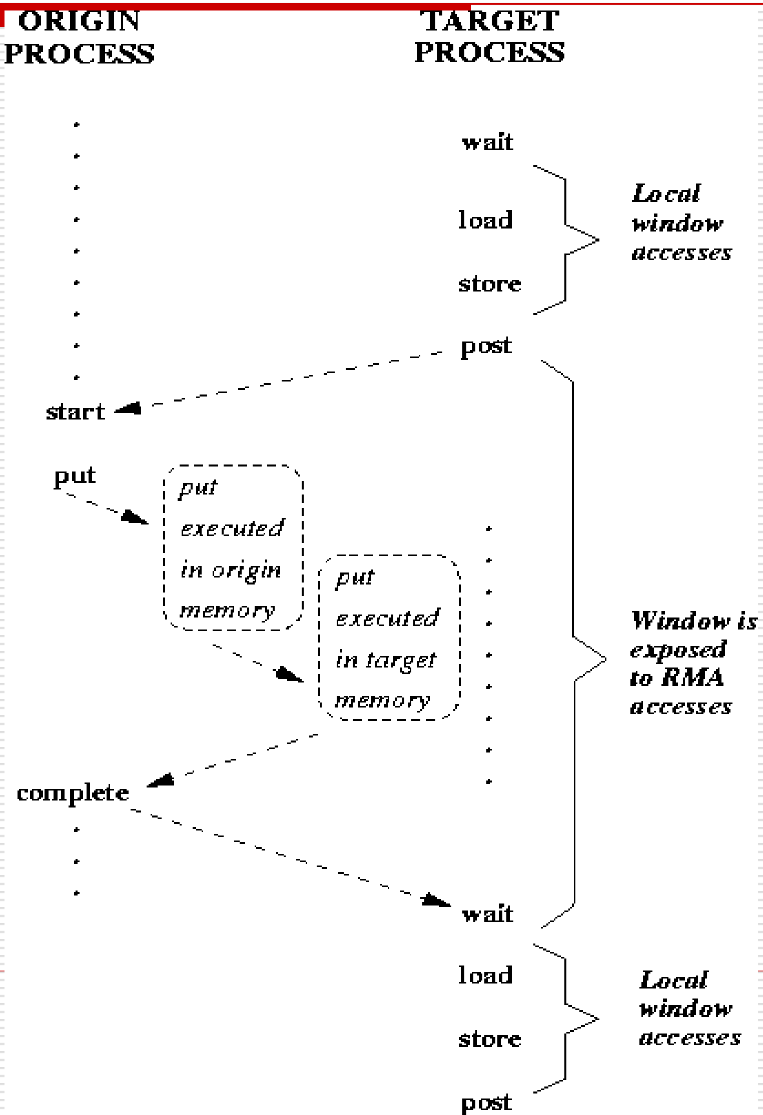
  - MPI_WIN_FENCE (at origin and target) (for active target)

  - MPI_WIN_START, MPI_WIN_COMPLETE (origin)

  MPI_WIN_POST, MPI_WIN_WAIT (target) (for active target)

  - MPI_WIN_LOCK, MPI_WIN_UNLOCK (only at origin) (passive target)

Active synchronization



Passive synchronization

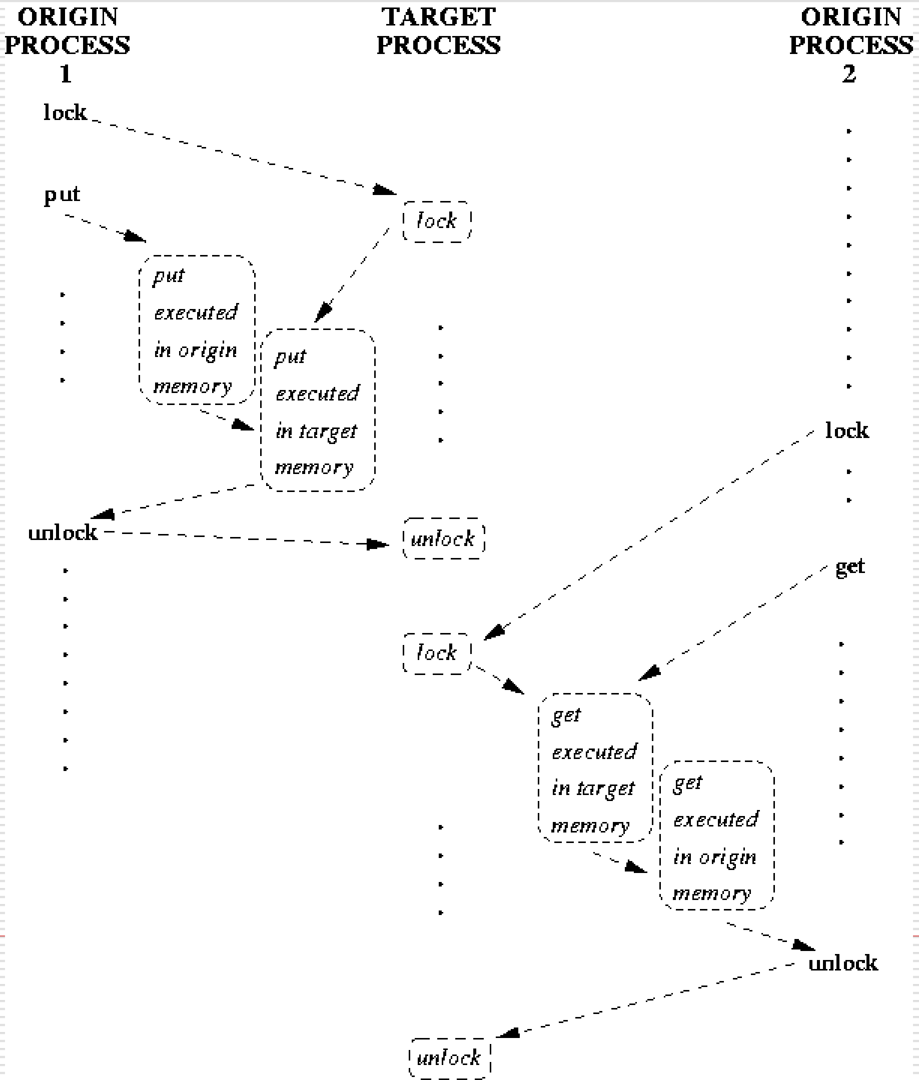
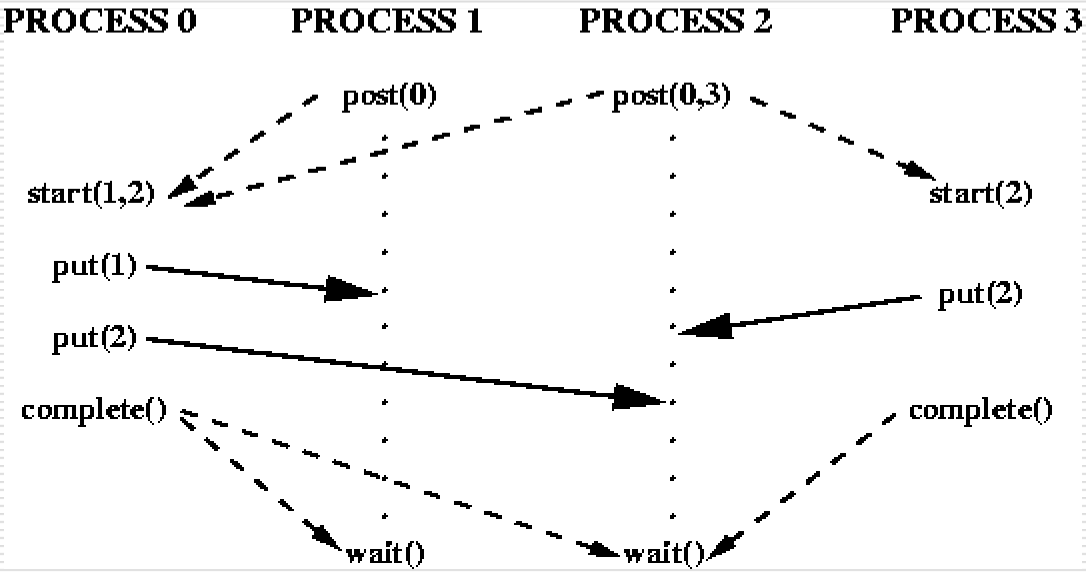

ORIGIN PROCESS 1
TARGET PROCESS
ORIGIN PROCESS 2
lock
lock
put
put executed in origin memory
put executed in target memory
unlock
unlock
lock
get
lock
get executed in target memory
get executed in origin memory
unlock
unlock

Illustration – start, complete, post, wait



Extended Collectives

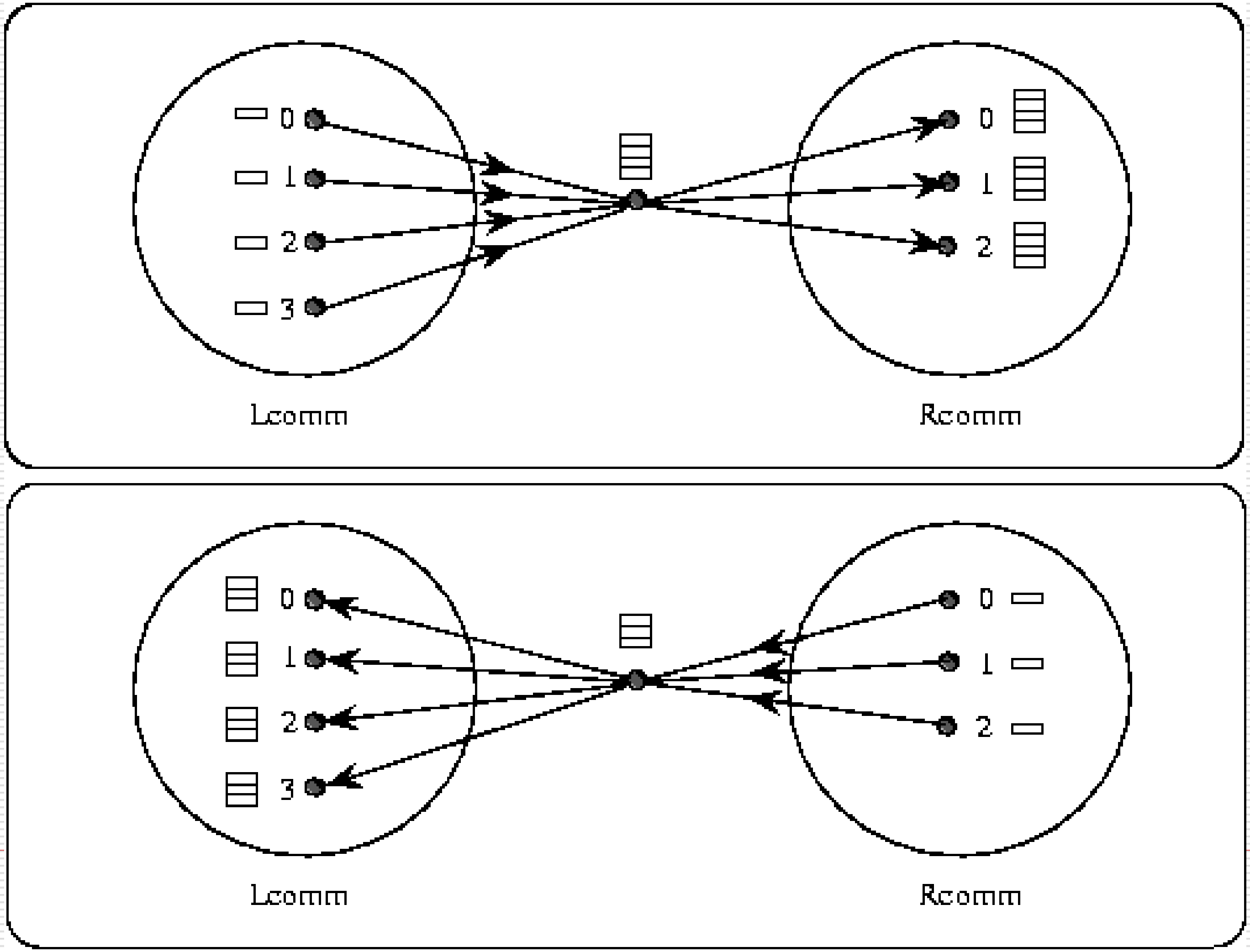
Collective communications with inter-communicators

Intercommunicator Collectives

- Result of Collective operations on one group is seen on the other group
- Applies to following:

1. MPI_BCAST,
2. MPI_GATHER, MPI_GATHERV,
3. MPI_SCATTER, MPI_SCATTERV,
4. MPI_ALLGATHER, MPI_ALLGATHERV,
5. MPI_ALLTOALL, MPI_ALLTOALLV, MPI_ALLTOALLW
6. MPI_REDUCE, MPI_ALLREDUCE,
7. MPI_REDUCE_SCATTER,
8. MPI_BARRIER.

Illustration – Intercommunicator all-gather


0
1
2
3
Lcomm
0
1
2
Rcomm
0
1
2
3
Lcomm
0
1
2
Rcomm