# MPI Environment (Cray XT Systems)

Customer Documentation and Training

# MPI Message Protocols

- **Message consists of envelope and data**
  - **Envelope contains tag, communicator, length, source information, plus implementation private data**
- **vshort**
  - **Message data is sent with the envelope**
  - **Default is 1024 bytes, max is 16,384 (user tunable)**
- **short (Eager)**
  - **Message is sent, based on the expectation that the destination can store; if no matching receive exists, the receiver must buffer or drop**
  - **Default is 128,000 bytes (user tunable)**
- **Long (Rendezvous)**
  - **Only the envelope is sent (and buffered) immediately**
  - **Message is not sent until the destination posts a receive**
  - **Any message longer than short**

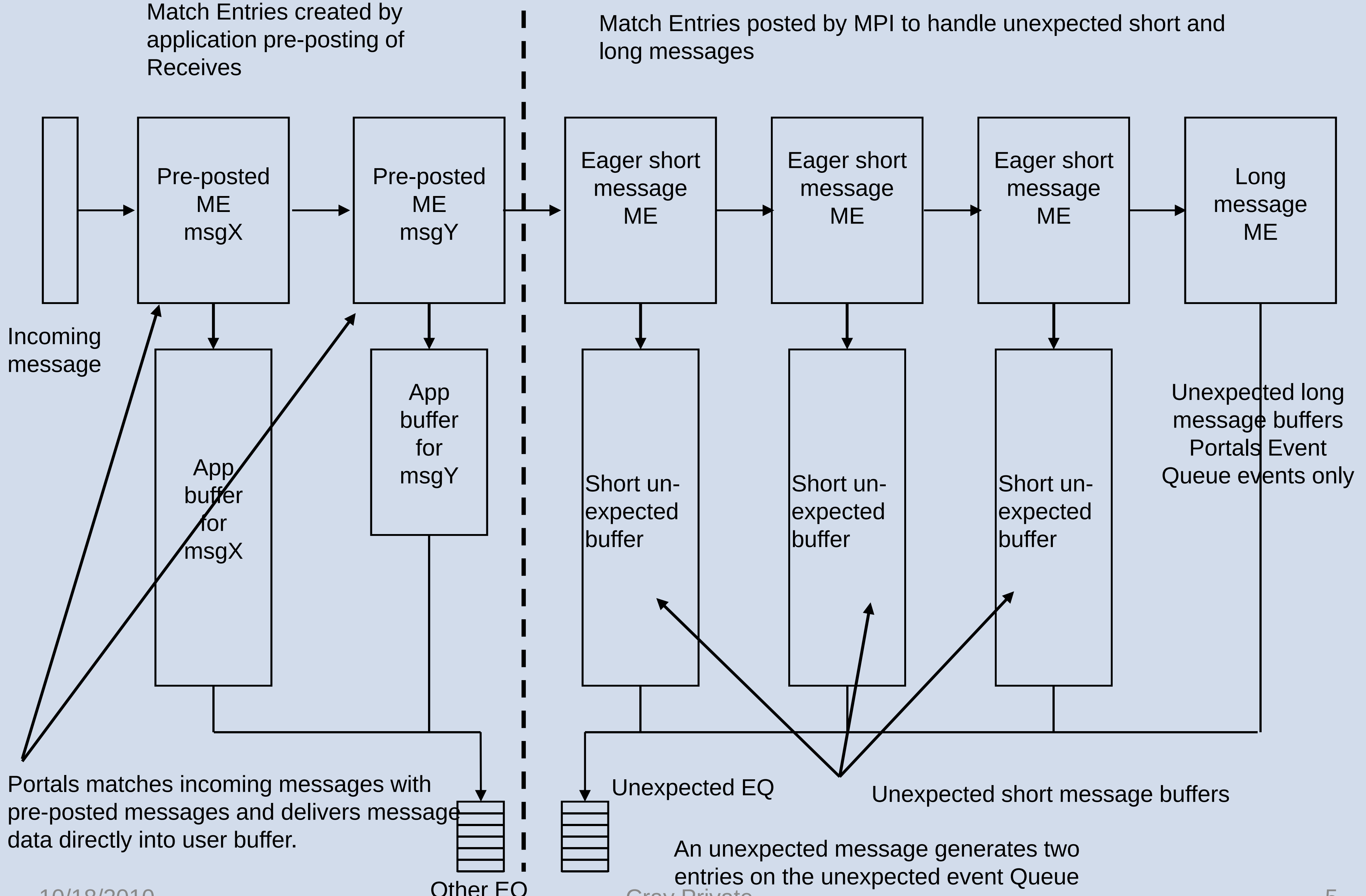
# Messages and the Cray XT System

- All *short* Cray XT messages are *eager*
  - MPICH_MAX_SHORT_MSG_SIZE defines the maximum size of a short message (the default size is 128,000 bytes)
- For long messages, a small 8-byte message is sent to the receiver, which contains sufficient information for the receiver to pull the message data when a matching receive is posted
- However, if the MPICH_PTL_EAGER_LONG environment variable is set, the sender sends long messages via the eager (short) protocol
  - This is good if application logic ensures that matching receives are pre-posted

# Where Do Unexpected Messages Go?

- There are three buffers for unexpected eager messages (20M each by default). Portals delivers unexpected messages (< 128KB) to these buffers.
- Both long and short unexpected messages generate entries in the unexpected event queue (EQ)
- When the process posts a receive, the MPI library checks against unexpected messages and, if it finds a short match, copies data from buffer. If it matches an unexpected long message, it pulls data from the sender.
- Therefore, it is important to prepost receives

# MPI Inside the SeaStar



# Cray XT MPI Tunables

## MPICH_UNEX_BUFFER_SIZE

- **Overrides the size of the buffers that are allocated to the MPI unexpected receive queue; default is 60 MB**
- **If you increase MPICH_MAX_SHORT_MSG_SIZE, increase this one as well; it is the total size of the buffers that hold unexpected short messages**

## MPICH_PTL_UNEX_EVENTS

- **The number of event queue entries for unexpected MPI point-to-point messages. Defaults to 20480**

## MPICH_PTL_OTHER_EVENTS

- **The number of entries in the event queue that is used to receive all other (not unexpected point-to-point) MPI-related Portals events**

# Cray XT MPI Tunables

## `MPICH_ALLTOALLVW_FCSIZE`

- **The algorithm for flow-controlled versions of the `MPICH_ALLTOALLV` and `MPICH_ALLTOALLW` is enabled when the size of the communicator is greater than this variable; default is 120**

## `MPICH_ALLTOALLVW_SENDWIN`, `MPICH_ALLTOALLVW_RECVWIN`

- **When flow control is enabled, send and receive windows are established that can allow maximums of 80 `Isend` operations and 100 `Irecv` operations; use these variables to change these numbers**
- **Also applies to medium-size (256<n<32768 bytes) `MPI_ALLTOALL` operations**

# Cray XT MPI Tunables

**`MPI_COLL_OPT_ON`**

- **Enables collective optimizations that use non default architecture-specific algorithms for some MPI collective operations**

**`MPICH_FAST_MEMCPY`**

- **Enables an optimized `memcpy` routine in MPI**

**`MPICH_MAX_VSHORT_MSG_SIZE`**

- **Specifies in bytes the maximum size of a message to be considered for the `vshort` path; default is 1024**

**`MPICH_VSHORT_BUFFERS`**

- **Specifies the number of 16,384 byte buffers to be preallocated for the sending side buffering of messages for the `vshort` protocol; default is 32**

# MPI Rank Reordering

- The default ordering for multi-core nodes is SMP
- MPICH_RANK_REORDER_METHOD is an environment variable which allows users to select an alternative ordering.
- To display the MPI rank placement and launching information, set PMI_DEBUG to 1.

# MPI Rank Reordering

- **MPICH_RANK_REORDER_METHOD accepts the following values:**

1. **Round-robin**
2. **Specifies SMP-style placement. For a multi-core node, this places sequential MPI ranks on the same node. For example, for an 8-process MPI job on dual-core nodes, the placement would be:**

   | NODE | 0 | 1 | 2 | 3 |
   |---|---|---|---|---|
   | RANK | 0&1 | 2&3 | 4&5 | 6&7 |

3. **Specifies folded-rank placement. Instead of rank placement starting over on the first node when half of the MPI processes have been placed, this option places the N/2 process on the last node, going back to the initial node. For example, for an 8-process job on dual-core nodes, the placement would be:**

   | NODE | 0 | 1 | 2 | 3 |
   |---|---|---|---|---|
   | RANK | 0&7 | 1&6 | 2&5 | 3&4 |

4. **Specifies a custom rank placement defined in the file named MPICH_RANK_ORDER.**

# MPI Reordering - sample program

```
#include <mpi.h>
#include <stdlib.h>
#include <stdio.h>
int main(int ac, char**av) {
  int i, me ,np, nameSize;
  char myProcName[MPI_MAX_PROCESSOR_NAME];
  MPI_Init( &ac, &av );
  MPI_Comm_rank( MPI_COMM_WORLD, &me );
  MPI_Comm_size( MPI_COMM_WORLD, &np );
  MPI_Get_processor_name(myProcName, &nameSize);
  for ( i=0; i<np; ++i ) {
    if ( i==me ) {
      printf("rank = %d processor = %s\n",me,myProcName);
      fflush(stdout);
    }
    MPI_Barrier( MPI_COMM_WORLD );
  }
  MPI_Finalize();
  exit(0);
}
```

# MPI Rank Reordering - SMP rank

```
% export MPICH_RANK_REORDER_METHOD=1
% export PMI_DEBUG=1
% aprun -n 8 ./MPI_where
rank = 0 processor = nid00346
rank = 1 processor = nid00346
rank = 2 processor = nid00347
rank = 3 processor = nid00347
rank = 4 processor = nid00348
rank = 5 processor = nid00348
rank = 6 processor = nid00349
rank = 7 processor = nid00349
```

# MPI Rank Reordering - folded rank

```
% export MPICH_RANK_REORDER_METHOD=2
% aprun -n 8 ./MPI_where
rank = 0 processor = nid00346
rank = 1 processor = nid00347
rank = 2 processor = nid00348
rank = 3 processor = nid00349
rank = 4 processor = nid00349
rank = 5 processor = nid00348
rank = 6 processor = nid00347
rank = 7 processor = nid00346
```

# MPI Rank Reordering - custom rank

```
% cat MPICH_RANK_ORDER
  0,2,1,3,4,6,5,7
% export MPICH_RANK_REORDER_METHOD=3
% aprun -n 8 ./MPI_where
rank = 0 processor = nid00346
rank = 1 processor = nid00347
rank = 2 processor = nid00346
rank = 3 processor = nid00347
rank = 4 processor = nid00348
rank = 5 processor = nid00349
rank = 6 processor = nid00348
rank = 7 processor = nid00349
```

# Timing With MPI_Wtime

- **Using `MPI_WTIME`**
  - **You can compute the elapsed time between two points in an MPI program by using `MPI_Wtime`**
  - **`MPI_Wtime` granularity is 0.000001 sec. (see `MPI_Wtick`). You cannot time any period that is smaller than a microsecond with it.**
  - **The clock in each node is independent of the clocks in other nodes**
  - **`MPI_WTIME_IS_GLOBAL` has value=1 if `MPI_WTIME` is globally synchronized**
    - **Default is 0**