Screencast: OpenFabrics Concepts

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“Verbs” API (VAPI)

- IB/iWARP actions known as “verbs”
  - Send verb, receive verb, etc.
- First IB VAPI was Mellanox VAPI (mVAPI)
  - Now deprecated
- OpenFabrics has different VAPI
  - Similar concepts, but different API

No Unexpected Receives

- All messages *must* be “expected”
- Receiver must pre-allocate resources
  - Pool of buffers to receive messages
  - Pool of buffers as target for RDMA
- Unexpected message triggers an error

Virtual Lanes / Service Levels

- OpenFabrics traffic divided into virtual "lanes"
  - Virtual separation of traffic
  - Analogous to MPI communicators (!)
  - Can be assigned QoS-like attributes
  - Weighting, etc.
- Service levels maps to lanes

Some OpenFabrics Queues

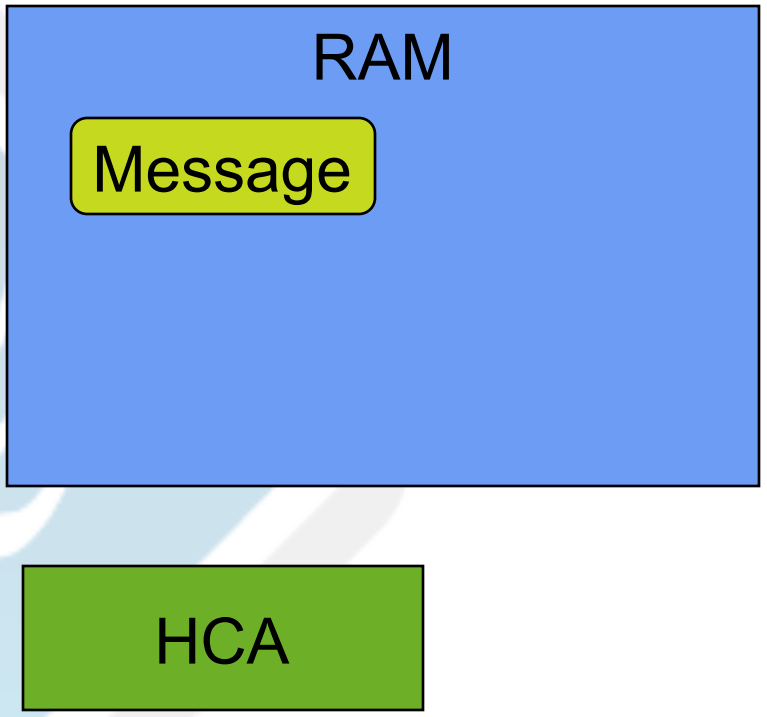
- Queue Pair (QP)
  - Unit of connection in OpenFabrics
  - Think of as “sockets” for OpenFabrics
  - Send queue + receive queue
- Completion queue
  - Most OF verbs are non-blocking
  - OF driver puts events on this queue to signal when a verb has completed

Registered Memory

- InfiniBand/iWARP are RDMA-based networks
  - Directly sends / receives from RAM
  - Without involvement from main CPU
- But…
  - Operating system can change virtual ↔ physical RAM mapping at any time

Race Condition

1. MPI says “IB: send this buffer”
2. HCA obtains physical address
3. HCA starts sending
4. OS changes physical mapping
5. HCA now sending garbage!



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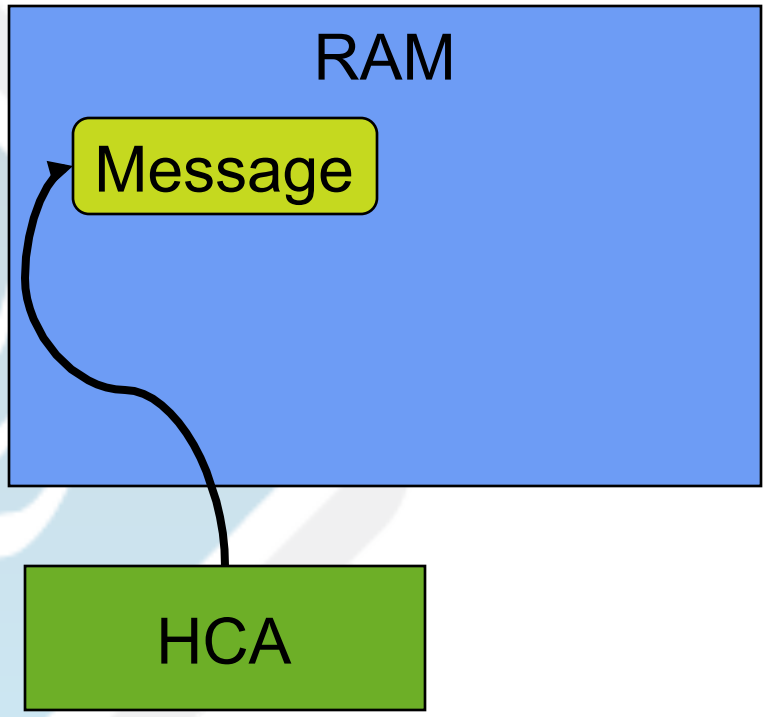

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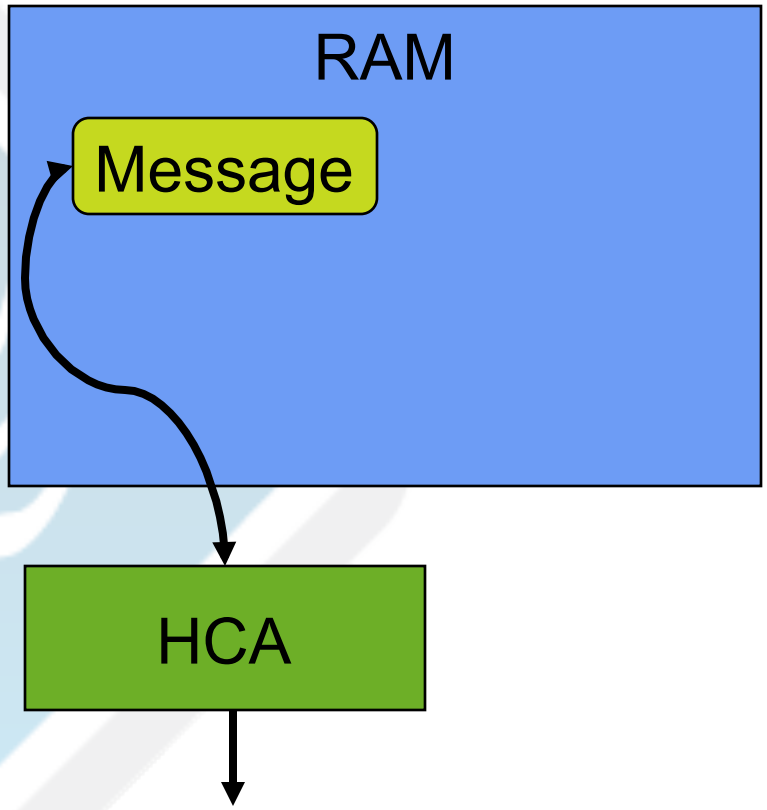

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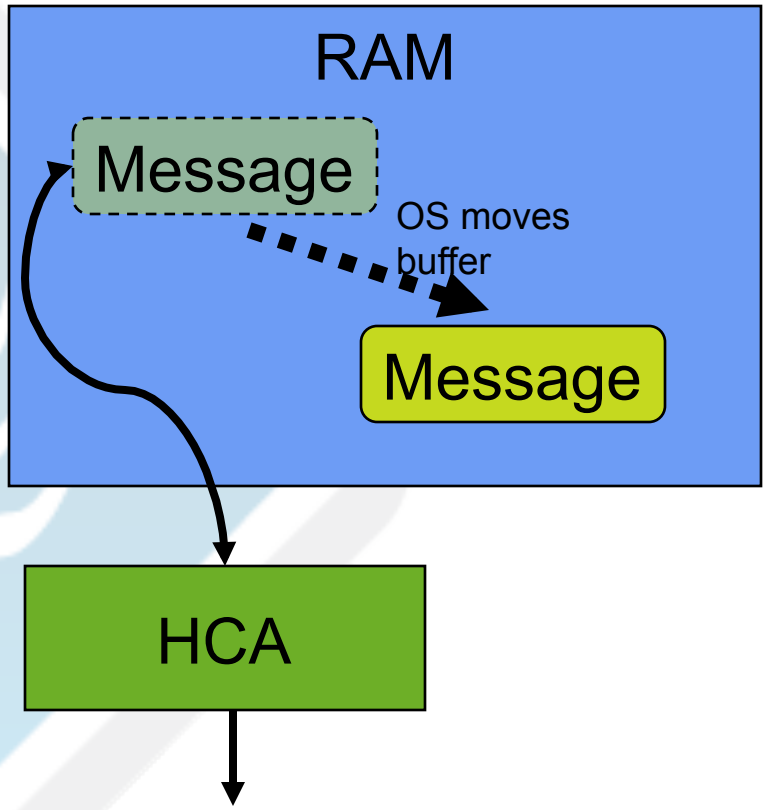

“Registering” Memory

- Solution: tell OS not to change mapping
  - “Pinning” (“locking”) memory
  - Guarantees that the message will stay in the same physical location until HCA is done
- “Registering” memory does two things:
  1. Pinning virtual ↔ physical mapping
  2. Notifying HCA of the mapping

Registered Memory Problems

- Registering and unregistering is slow
- OS can only support so much registered memory at a time
  - Pinned pages are unswappable
- Must be careful to set ulimits properly (OFED)

Registered Memory Footprint

- How much registered memory does Open MPI use?
  - A complicated answer
  - Requires some background information first…
- For reference:
  - Complete answer (for v1.2 and beyond):

http://www.open-mpi.org/faq/?category=openfabrics#limiting-registered-memory-usage

Common MPI Trick

- **`MPI_SEND(buffer, …)`**
  - Register the buffer
  - Do the send
  - Return (leaving the buffer registered)
- Rationale: next time you send from that buffer, do not pay registration cost again
  - Great for benchmarks!
  - Usually not great for real applications
- OMPI does not do this (…by default)

Problems of User Registration

- Can run out of registered memory
  - MPI must implement eviction policies
- Application can free buffer
  - MPI *must* intercept free() or sbrk() to unregister memory before given back to OS
  - Extremely problematic
- So just say "No!"
  - …except for benchmarks ☹

More Information

- Open MPI FAQ
  - General tuning

    http://www.open-mpi.org/faq/?category=tuning
  - InfiniBand / OpenFabrics tuning

    http://www.open-mpi.org/faq/?category=openfabrics


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