LNet Roadmap & Development

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Outline

- LNet Roadmap
- Non-contiguous buffer support
- Map-on-Demand re-work

LNet Roadmap (2.12)

LNet Health

- Increase LNet’s resiliency
- Re-transmit messages on different available local and remote interfaces
- Monitor various LND failures
- Monitor PUT/GET responses, ACK/REPLY respectively, and timeout if not received
- Documentation
  - Scope and Requirements Document: https://wiki.hpdd.intel.com/display/LNet/LNet+Health
  - High-level Design: https://wiki.hpdd.intel.com/display/LNet/LNet+Health+HLD
- Implementation will take place on the Multi-Rail branch

LNet Sysfs Interface (2.12)

- Currently `lnetctl` uses IOCTL to collect statistics and configure the systems
- Move to using sysfs interface for keeping and querying statistics
- Expose more LNet, o2iblnd and socklnd statistics
- Present them in YAML format
- Documentation
  - Scope & Reqs: https://wiki.hpdd.intel.com/pages/viewpage.action?pageId=65700164
  - HLD: https://wiki.hpdd.intel.com/display/LNet/Sysfs+Interface+HLD
  - Test Plan: https://wiki.hpdd.intel.com/display/LNet/Sysfs+Interface+Test+Plan

Multi-Rail User Defined Policies (2.13)

- Fine tune Multi-Rail’s selection algorithm
- Allow specifying preferences of Network and Network Interfaces
- Documentation
  - Scope & Requirements
    - https://wiki.hpdd.intel.com/display/LNet/Multi-Rail+User+Defined+Policies
  - High-level Design
    - https://wiki.hpdd.intel.com/display/LNet/User+Defined+Selection+Policies

Multi-Rail User Defined Policies - Rules

- LNet Network priority rule
  - Assigns a priority to a network
  - During selection the network with the highest priority is preferred
- Local NID rule
  - Assigns a priority to a local NID within an LNet network
  - NID is preferred during selection
- Remote NID rule
  - Assigns a priority to a remote NID within an LNet network
  - NID is preferred during selection
- Peer-to-peer rules
  - Associates local NIs with peer NIs
  - When selecting a peer NI to send to, the one associated with the selected local NI is preferred

LNet Unit Test Framework (2.13)

- Complex LNet features in development need to be unit tested
- These unit tests need to be repeatable for regression
- Use python for writing test scripts
- Interface with `lnetconfig` library to configure and query LNet
- Interface with `lnet_selftest` to perform complex functional tests
- Will be integrated with the current Autotest system
- Documentation
  - Scope & Requirements
    - https://wiki.hpdd.intel.com/display/LNet/LNet+Unit+Test+Infrastructure+%28LUTF%29+Requirements
  - High-level Design
    - https://wiki.hpdd.intel.com/display/LNet/LUTF+High+Level+Design

LNet Documentation

- Create “Scope & Requirements” and “HLD” documents for all new projects
- Need detailed design documentation for LNet
- Makes it easier for new developers to understand the code
- Detailed-level design type documentation is incrementally being added:
  - Connection Management
  - Map-on-demand, etc.
- https://wiki.hpdd.intel.com/display/LNet/LNet+Documentation

Adapt o2iblnd to latest RDMA changes

New Fast Memory Registration API

- https://www.openfabrics.org/images/eventpresos/2016presentations/204KernelVerbs.pdf

CQ Polling API

- https://review.whamcloud.com/#/c/27028/
- Simplify completion queue polling and interrupt handling
- Resolve the error completion unreliability

Draining QP

- Don’t have to wait for WR to complete to destroy a QP
- Current method in o2iblnd risks waiting indefinitely

LNet Router Testing

- Multiple requests received to outline how to test LNet routers
- A test plan has been created

  https://wiki.hpdd.intel.com/display/LNet/LNet+Router+Testing
- Need to translate the test plan into LUTF test scripts

`lnet_selftest` Improvements

- Improve the `lnet_selftest` user interface
  - Provide parameters and results using YAML format
- Allow users to specify different traffic flows
- Better integration with the LUTF for more comprehensive functional testing

Multi-hop route failure detection

- LU-9238 – entered by Cray*
- Current proposal on the ticket
  - Extend LNet ping to include route up/down status
  - Peers get route status from their next hop
  - Percolate to peers that use that route
- Gossip protocol
  - Gossip protocol should be used as a general solution for Network Discovery
    - This should also handle the route health case
  - Look into the potential of integrating it into Lustre

IPv6 Support

- Expand NIDs to support IPv6 addresses
- Will break compatibility with older LNet versions
- Potentially use LNet routers to route between IPv4 and IPv6 networks

Recent Developments

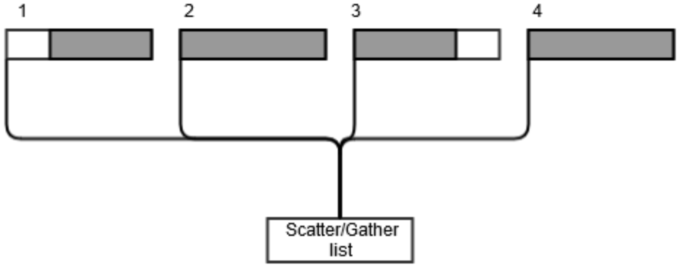
Non-contiguous Buffer Support

Problem Statement

- FMR and FastReg (FRMR) do not support non-contiguous RDMA buffers
- O2iblnd didn’t check if the RDMA buffers were contiguous or not.
- Changes in OSP resulted in non-contiguous buffers being passed to the o2iblnd
- Buffers were not RDMAed properly resulting in corrupted data and operation failure
- Global memory regions usage did not exhibit this problem
- RHEL 7.4+ removed Global memory regions and use FMR/FRMR exclusively

Overview of Memory Mapping

- Scatter/gather list is formed to point to the pages to be RDMAed
- `ib_dma_map_sg()` maps the scatter/gather list in to the DMA memory space
- An RDMA descriptor structure describes each fragment to be RDMAed
- RHEL 7.3 and earlier, global memory regions were supported and used by o2iblnd
- Since the RDMA descriptor described all the fragments correctly there was no problem



The Problem

- Since RHEL 7.4, global memory regions support ceased
  - FMR/FRMR is now the default for `o2iblnd`
- FMR/FRMR pools are used
  - Fragments are mapped into the FMR/FRMR memory region
  - RDMA descriptor describes it as one large fragment
- However, this exposed a problem when the fragments were not contiguous
  - Page 3 had a gap, which resulted in some data from page 4 not being RDMAed

o2iblnd Behavior Changes

- This led to a series of patches which brought behavioral changes to o2iblnd:
  - LU-9983 osp: align the OSP request size by 4k
    - Avoids gaps in the IOV buffer to RDMA
  - LU-9983 ko2iblnd: allow for discontiguous fragments
    - Describe each buffer in the RDMA descriptor
    - Problem with different map_on_demand settings
  - LU-10089 o2iblnd: use IB_MR_TYPE_SG_GAPS
    - MLX5 support
    - Drop in performance
  - LU-10129 lnd: rework map_on_demand behavior

Full Solution

- Do not make map-on-demand configurable
- Set the maximum number of fragments supported on a QP to 256
- Continue negotiation with the peer to handle older versions
  - Could have map-on-demand < 256 and therefore QP's WRQ size could be less
- Detect if fragments passed to o2iblnd are non-contiguous
- FMR requires specifying each non-contiguous fragment in the RDMA descriptor
  - Could fail if the negotiated fragments on the QP is less than the fragments buffer number
  - Early failure with clear message to easily detect the situation
- If FRMR with GAPS then handle non-contiguous fragments, or fail RDMA write as above

Fallout

- Since we use the maximum number of fragments, 256, QP creation could fail
- Reduce the total number of fragments and attempt to recreate the QP
- OPA TID-RDMA uses too much memory.
  - OPA TID-RDMA statically allocates memory based on provided values
  - With conns-per-peer set to 4 memory consumption is multiplied.
    - Servers with many QPs run into OOM errors. We had several bugs related to this issue
- LU-10875 – open to track
  - Devise a method to use fewer WRs
- The map-on-demand rework is available in 2.11

Conclusion

Major LNet projects:

- LNet Health – Lustre 2.12
- LNet Sysfs – Lustre 2.12
- Multi-Rail User Defined Policies – Lustre 2.13
- LNet Unit Test Framework – Lustre 2.13

O2iblnd non-contiguous buffer support

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LU-9983 osp: align the OSP request size by 4k

- The first solution was to simply ensure that you always give 4K aligned buffers to the o2iblnd
- This would hide the problem
- LNet would still not support non-contiguous fragments.
- Any future feature which would make use of non-contiguous fragments would still expose the problem

LU-9983 ko2iblnd: allow for discontiguous fragments

- Instead of collapsing the RDMA fragments into 1 when using FMR/FRMR, continue to describe them fully
- Theoretically, this should avoid the problem described, but it resulted in a different problem
- Map-on-demand value was used to negotiate the maximum number of fragments on the connection. This could be set to a value between 2 and 256
  - Many deployments set it to 32
  - With LU-9983 1M RDMA buffers would get fragmented into 256 which would exceed the negotiated maximum number of fragment on a connection, leading to RDMA failure
- This solution was not enough to fully solve the problem

LU-10089/LU-10394

- For FRMR Mellanox provides a flag, IB_MR_TYPE_SG_GAPS, when creating the memory regions, which would support RDMA fragments with GAPS
- However, according to Cray testing using IB_MR_TYPE_SG_GAPS had a rather significant performance impact; up to 2 GB/s reduction in performance
- Added a flag to turn on FRMR GAPS support:
  - use_fastreg_gaps
  - It’s 0 by default
  - If set to 1 and the HCA supports FRMR then we create the FRMR memory regions using that flag
- Again this does not address FMR and it’s not a sufficient solution for FRMR

LU-10129 lnd: rework map_on_demand behavior

What's the use of map-on-demand?

- Turn on FMR/FRMR usage
- Determine the max size of the send work request queue (WRQ) per Queue Pair (QP)

How did map-on-demand work? (assuming Global Memory Region support)

- If map-on-demand == 0 use Global Memory Region exclusively
- If the RDMA's number of fragments < configured map-on-demand then use Global Memory regions, otherwise use FMR or FRMR (whichever the HW supports)

The Map-on-demand primary benefit is to reduce the max send work request queue size

RDMA mapping in ko2iblnd

- Looking forward, Global Memory Regions are no longer supported in the kernel
- Map-on-demand usage complicates the code
- No major advantage to having the max_send_wrq for the QPs be configurable
- When using FMR/FRMR only 1 WR is used for the RDMA transfer
- Ideally we'd be using the least number of WRs possible