Lustre Interface Bonding

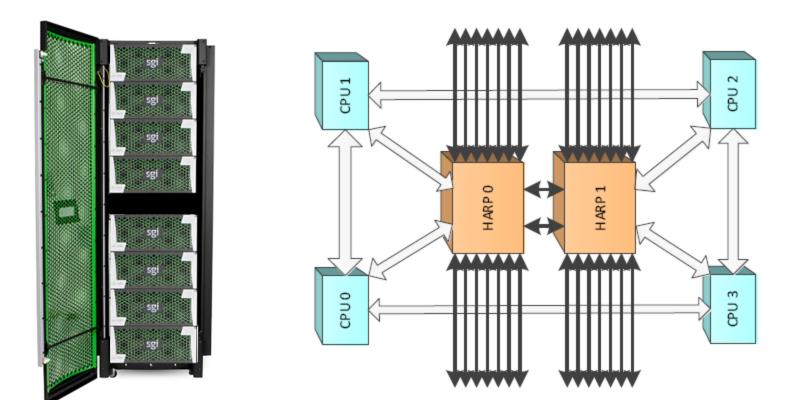
Olaf Weber Sr. Software Engineer



Interface Bonding

- A long-standing wish list item known under a variety of names:
 - Interface bonding
 - Channel bonding
 - Multi-rail
- Fujitsu implemented o2ibInd-level code and made it available to the community
- This proposal is a collaboration between SGI and Intel
- The goal is to land multi-rail support in Lustre

Why Multi-Rail?



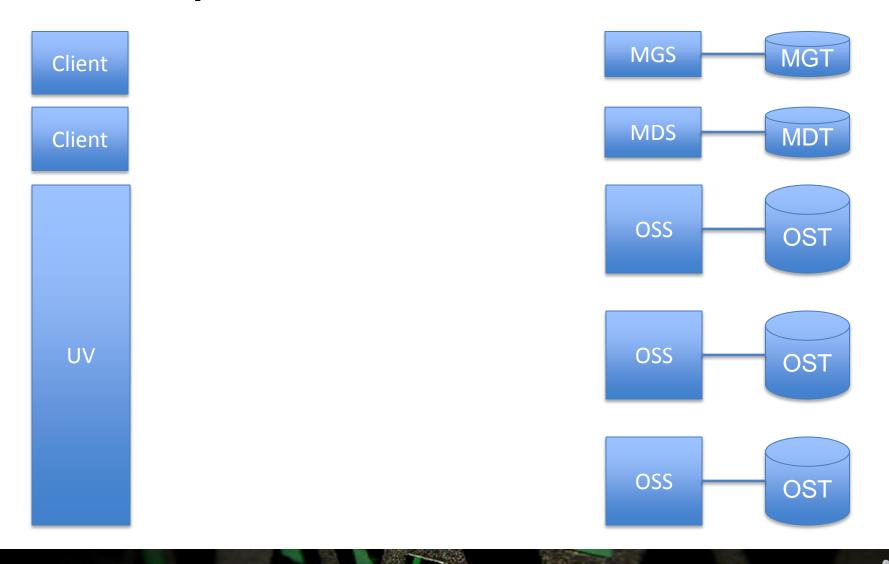
SGI[®] UV[™] 300: 32-socket NUMA System SGI[®] UV[™] 3000: 256-socket NUMA System

Design Constraints

Based on feedback for the Fujitsu code

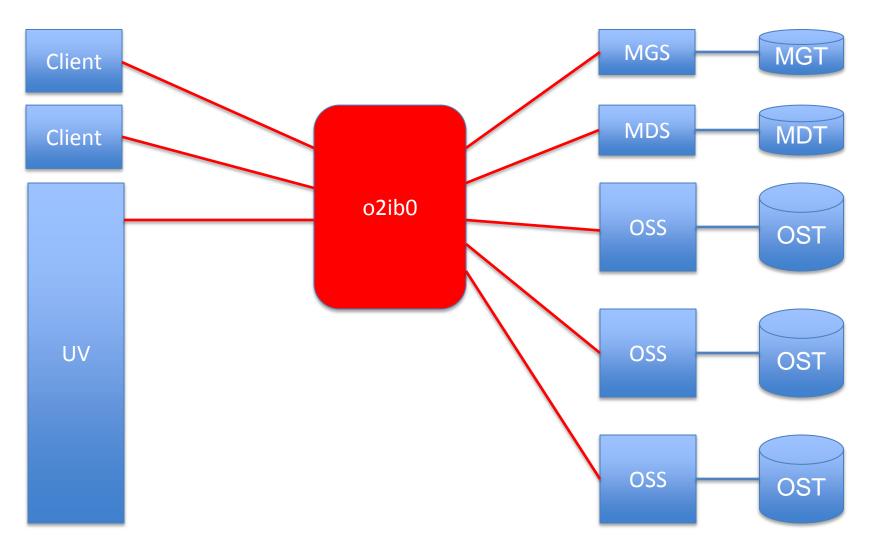
- Mixed-version clusters
- Simple configuration
- Adaptable
- LNet-level implementation

Example Lustre Cluster



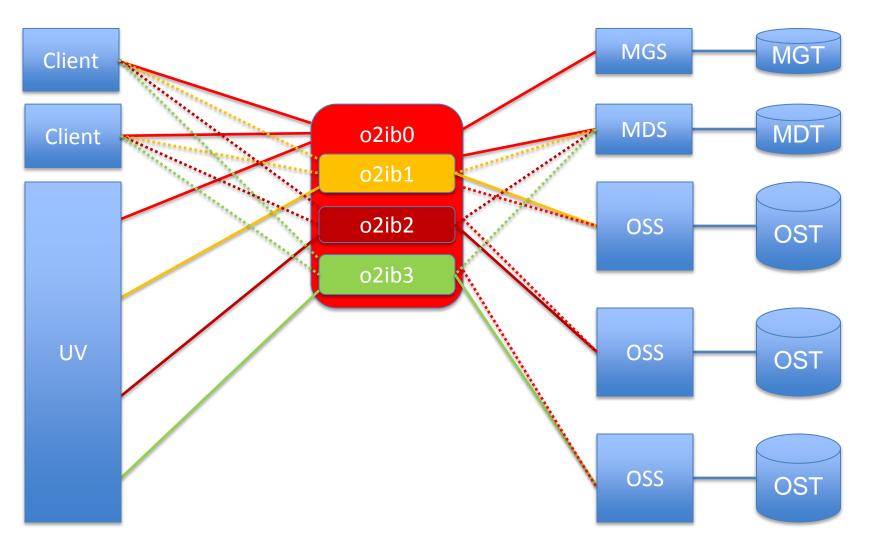
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Mono-rail Single Fabric



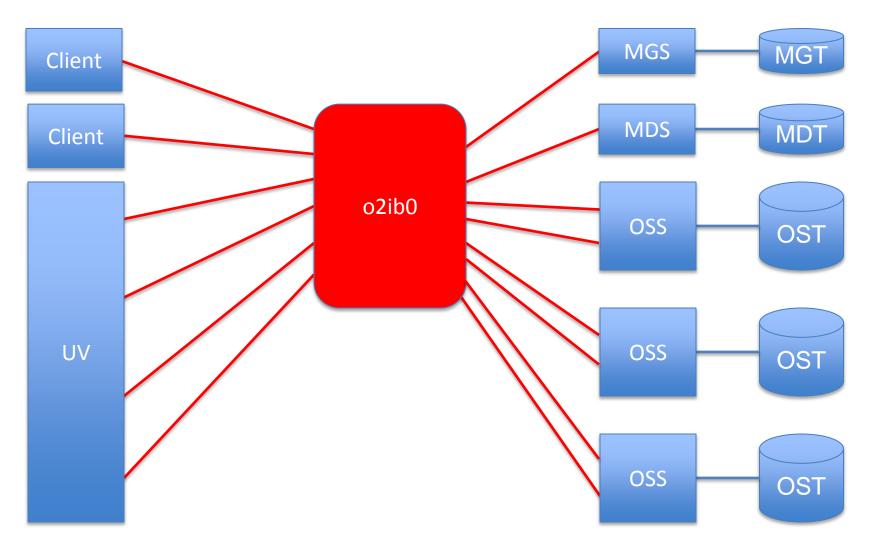
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LNets in a Single Fabric



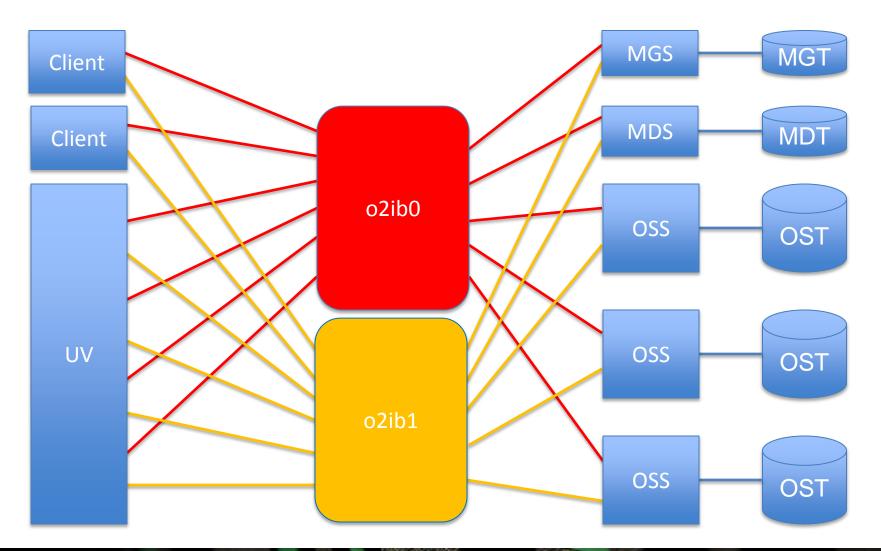
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Multi-rail Single Fabric



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Multi-rail Dual Fabric



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Mixed-Version Clusters

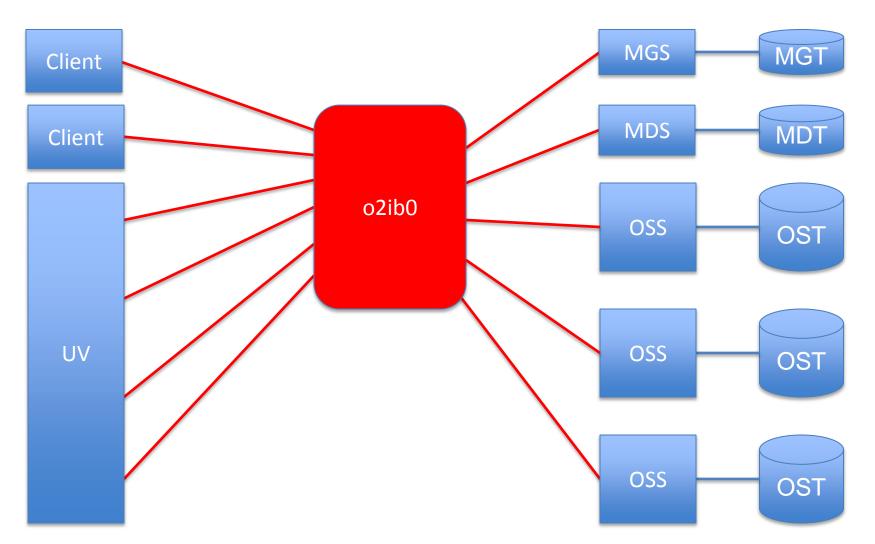
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A Single Multi-Rail Node Peer Version Discovery

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A Single Multi-Rail Node



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Peer Version Discovery

- There is no LNet end-to-end versioning
- LND versioning does not work across LNet routers

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• The LNet ping protocol can be used.

A set bit in *Inet_ping_info_t::pi_features* indicates multi-rail capability.

Peer Version Discovery

A simple version discovery protocol:

- 1. LNet keeps track of all known peers
- 2. On first communication, do an LNet ping
- 3. The node now knows the peer version

The ping reply also contains a list of the interfaces of the peer. Can we use that?

Easy Configuration

Peer Interface Discovery Configuring Interfaces on a Node Dynamic Configuration

Peer Interface Discovery

- Peer Version Discovery gives a node the list of the peer's interfaces.
- For the simple cases, this is all a node needs to know about a peer.
- The peer also needs to know the node's interfaces.

Push the node's interface list to the peer.

Peer Interface Discovery

The push would be like an LNet ping

- Except LNet ping uses LNetGet()
- The push uses LNetPut()

The push should be safe:

• A downrev LNet router can forward a push

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• A downrev peer returns "protocol error"

Configuring Interfaces on a Node

How does a node know its own interfaces? Similar to current methods.

- LNet module options line
 - networks=o2ib(ib0,ib1)
 - networks=o2ib(ib0[2],ib1[6])[2,6]
- DLC uses the same syntax
 It uses the same in-kernel parser

Configuring Interfaces on a Node

What about credits?

- Credits are assigned per interface.
- This applies to both local and peer credits.
- More interfaces more credits.
- The defaults of tunables are unchanged.

Dynamic Configuration

Adding an interface:

- 1. Enable new interface
- 2. Push updated interface list to peers

Removing an interface:

1. Push updated interface list to peers

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2. Disable existing interface

Adaptable

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Interface Selection Extended Routing Additional Considerations

Interface Selection

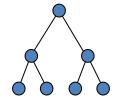
Select a local-peer interface pair to send.

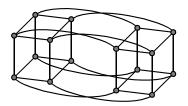
- Direct connection preferred
- LNet network type (anything but TCP)
- NUMA criteria
 - Memory locality
 - Process locality
- Local credits
- Peer credits

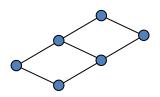
Routing Enhancements

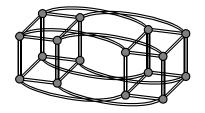
Fabrics can have a complicated topology.

 Preferred point-topoint connections within an LNet









 Prefer an LNet over another (for a subset of its NIDs)

Extra Considerations

Try to be NUMA friendly.

- Nodes do not know each other's topology
- An RPC is a request-response pair.
- Remember origin interface of request
- Prefer origin interface for response

Extra Considerations

On a send failure, a message can be resent on another local-remote interface pair, until all possibilities have been exhausted.

This adds some extra resiliency for network failures to Lustre.

Extra Considerations

Node failure introduces some corner cases.

- Reboot with downrev software

 Upper layers (ptlrpc) do detect node failure
 They can inform LNet so it can reset its state
- NID reuse by a different node
 - Node identity is now separate from NID
 - Special NIDs on the loopback network?

LNet-level Implementation

Implementation Notes

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Datastructure changes

- Split Inet_ni into Inet_Inet and Inet_ni
- Split Inet_peer into Inet_peer and Inet_peerni
- Track preferred routes in Inet_net
- Track preferred *Inet_ni* in *Inet_peerni* (derived from the routes info in Inet_net)

Use LNET_NID_ANY for the self parameter of LNetGet() and LNetPut() when sending an RPC request. This tells LNet to use whichever local-remote interface pair it seems most suitable.

Use the originator NID when sending an RPC response. This tells LNet that this particular local-remote pair is strongly preferred.

The Memory Descriptor can be extended with NUMA hints, to give LNet NUMAspecific information in selecting a suitable local interface.

Then LNet can select a remote interface for the peer that can be reached from the local interface.

- 1. Split *Inet_ni*
- 2. Local interface selection
- 3. Split Inet_peer
- 4. Ping on connect
- 5. Implement push
- 6. Peer interface selection
- 7. Resending on failure
- 8. Routing enhancements

Feedback & Discussion

Q&A

olaf@sgi.com

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