Lustre Interface Bonding

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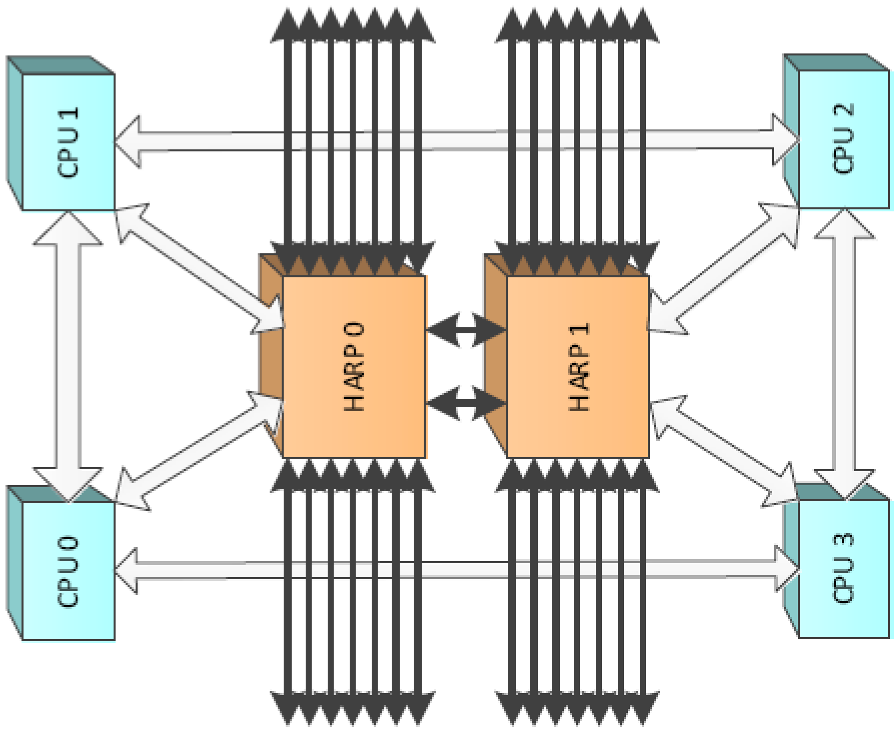
Interface Bonding

- A long-standing wish list item known under a variety of names:
  - Interface bonding
  - Channel bonding
  - Multi-rail
- Fujitsu implemented o2iblnd-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

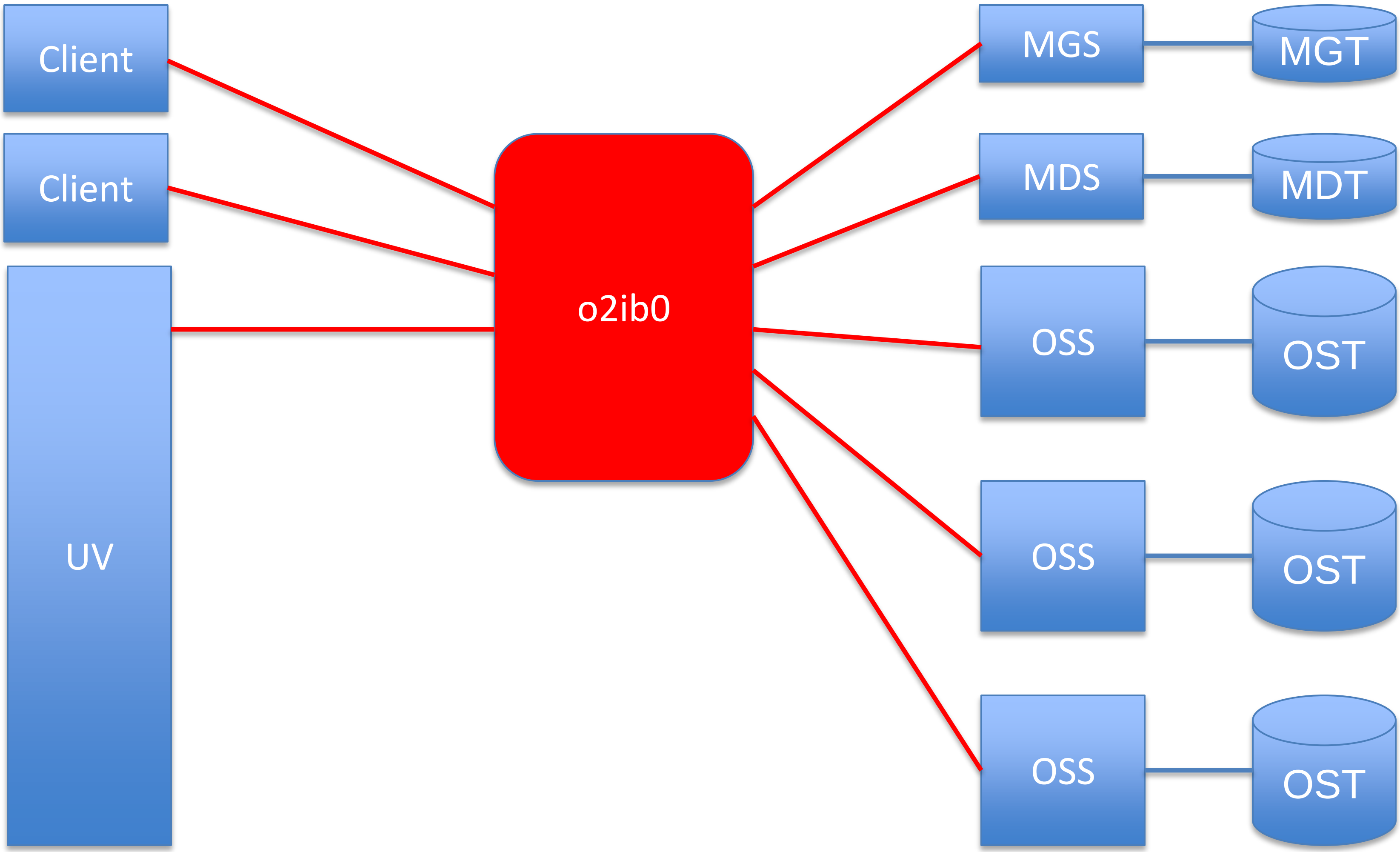
Design Constraints

Based on feedback for the Fujitsu code

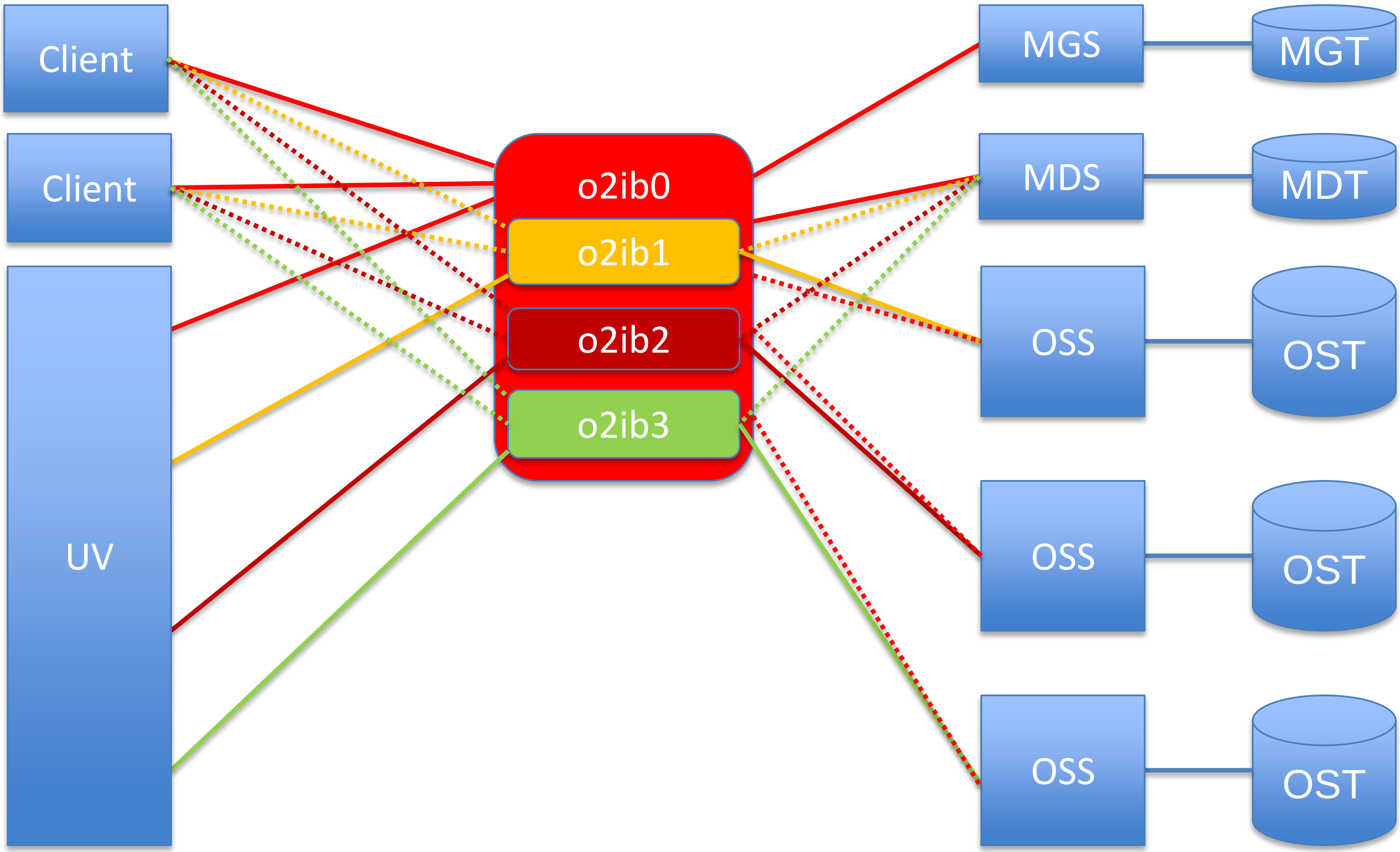
- Mixed-version clusters
- Simple configuration
- Adaptable
- LNet-level implementation

Example Lustre Cluster

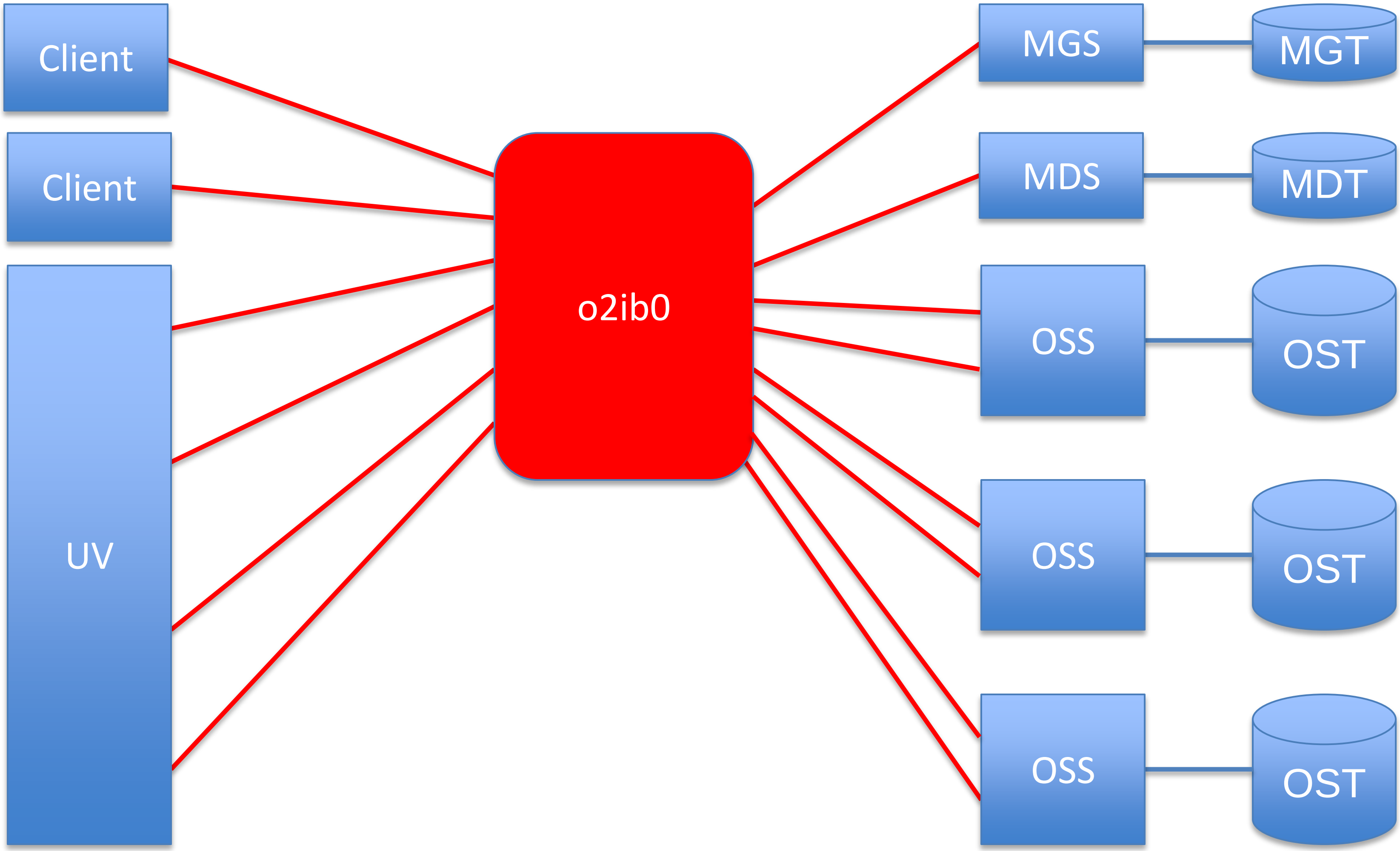
Mono-rail Single Fabric



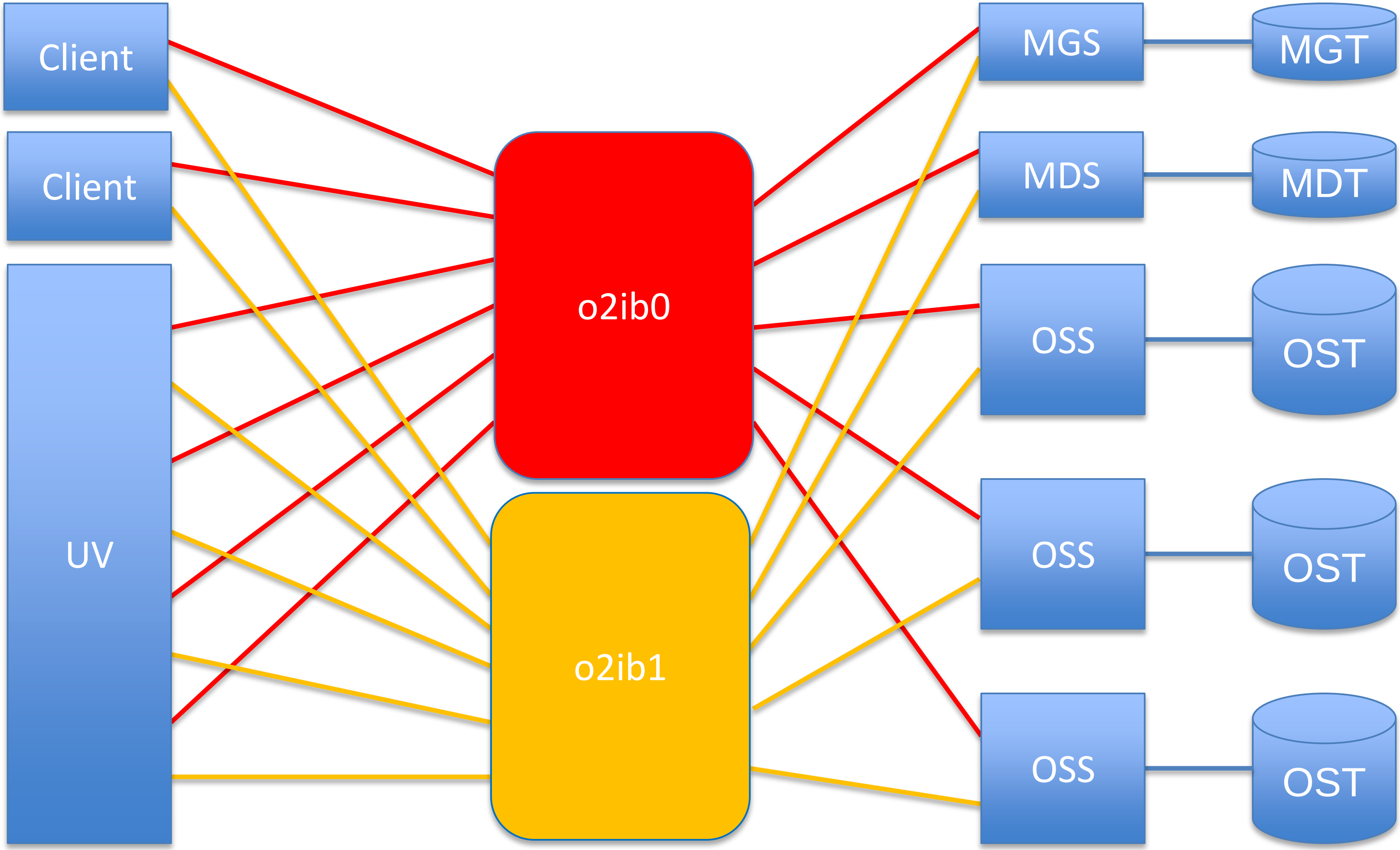
LNets in a Single Fabric



Multi-rail Single Fabric



Multi-rail Dual Fabric

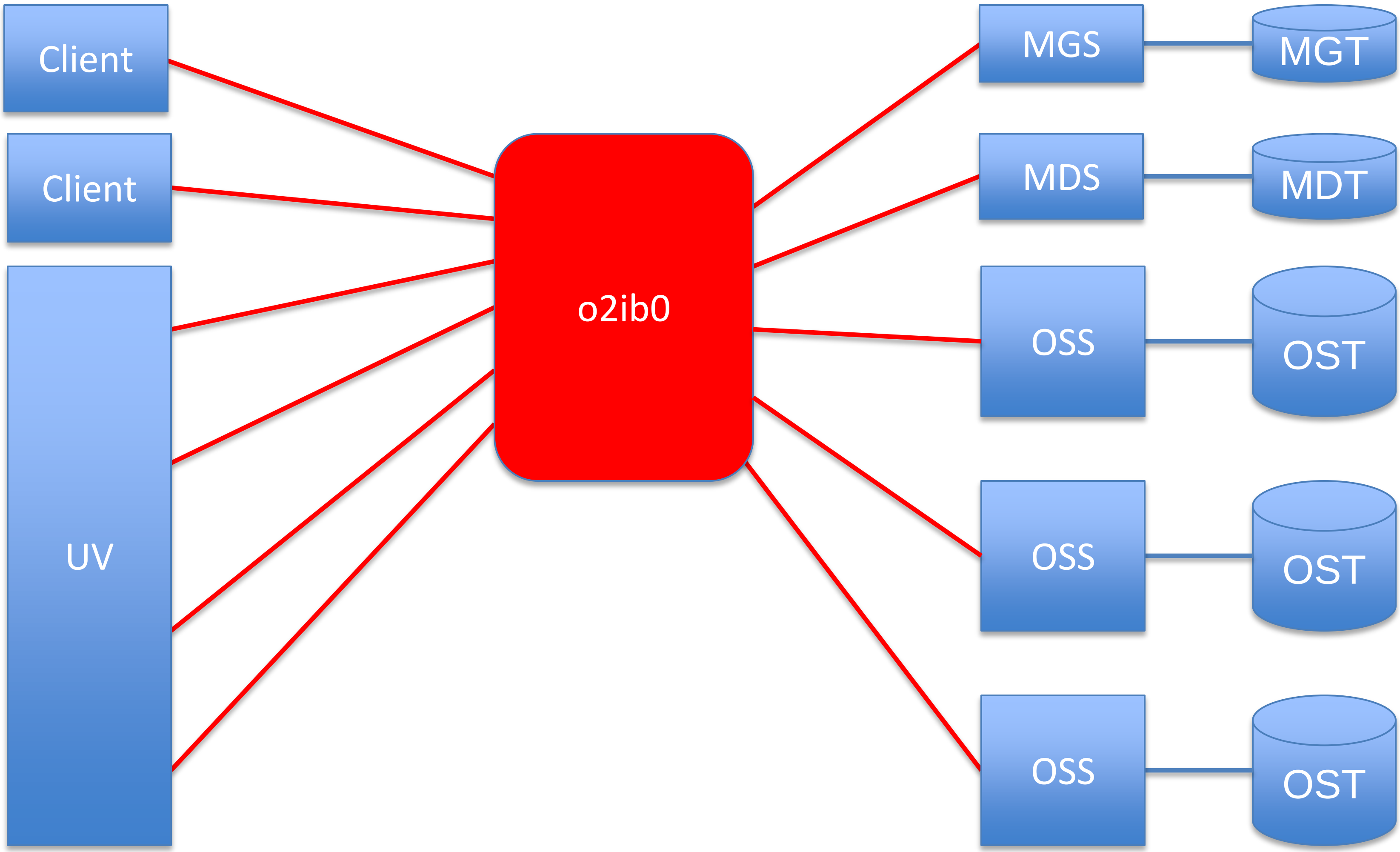


Mixed-Version Clusters

A Single Multi-Rail Node

Peer Version Discovery

A Single Multi-Rail Node



Peer Version Discovery

- There is no LNet end-to-end versioning
- LND versioning does not work across LNet routers
- The LNet ping protocol can be used.

A set bit in *lnet_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

14

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
- 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
2. Disable existing interface

Adaptable

Interface Selection

Extended Routing

Additional Considerations

Interface Selection

Select a local-peer interface pair to send.

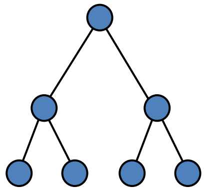
- Direct connection preferred
- LNet network type (anything but TCP)
- NUMA criteria
  - Memory locality
  - Process locality
- Local credits
- Peer credits

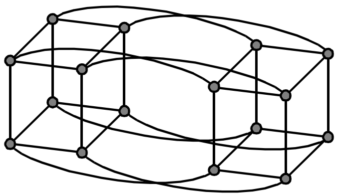
Routing Enhancements

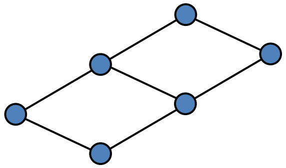
Fabrics can have a complicated topology.

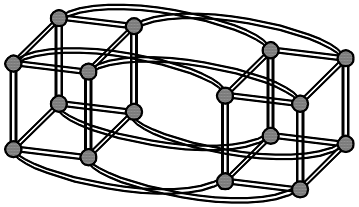
- Preferred point-to-point connections within an LNet

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









22

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

Implementation Notes

Datastructure changes

- Split *lnet_ni* into *lnet_lnet* and *lnet_ni*
- Split *lnet_peer* into *lnet_peer* and *lnet_peerni*
- Track preferred routes in lnet_net
- Track preferred *lnet_ni* in *lnet_peerni* (derived from the routes info in lnet_net)

Implementation Notes

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.

Implementation Notes

The Memory Descriptor can be extended with NUMA hints, to give LNet NUMA-specific 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.

Implementation Notes

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

Feedback & Discussion

Q&A

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31