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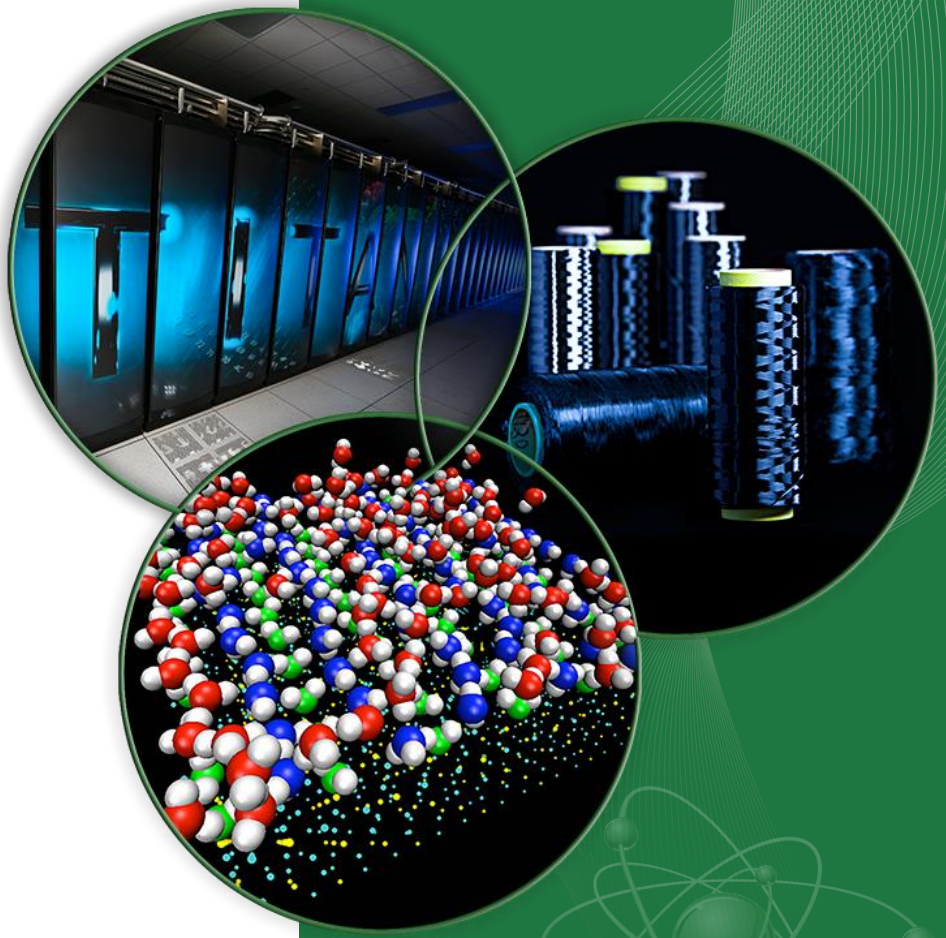
Computing and Computational Sciences Directorate



LNET Bonding

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Network Interface Bonding

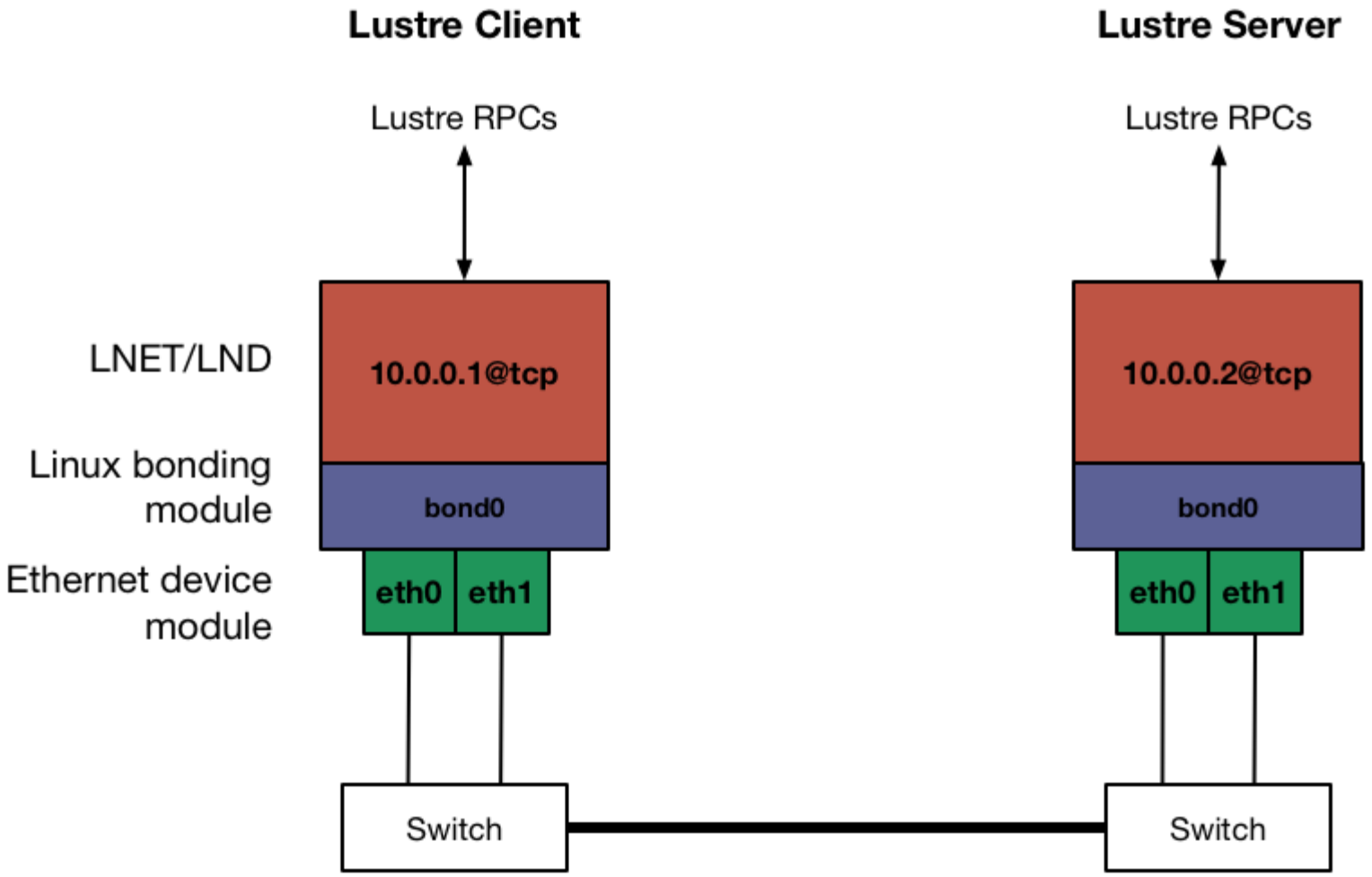
- Combining multiple network interfaces to function as a single logical interface
  - Called channel bonding
  - Dynamic link aggregation (LACP) is a specific type of bonding
  - Network teaming similar, but refers to a new driver and daemon in RHEL 7
- Implemented in Linux by the `bonding` kernel module
- Supported for Ethernet and Infiniband transport mediums

Bonding—what are the benefits?

1. High availability
   - Multiple paths (independent of Spanning Tree Protocol)
2. Increased aggregate throughput
   - Depends on hashing mode

- Can be used for Lustre servers or clients
  - Number of clients >> number of servers

Lustre Networking Layers



Configuring Lustre

- Only need to specify bond interface in lnet.conf

```
options lnet networks="tcp(bond0)"
```

OR

```
options lnet ip2nets="tcp0(bond0) 192.168.1.*"
```

Configuring Interfaces

- Modify slave interface configurations
  `/etc/sysconfig/network-scripts/ifcfg-eth[0-1]`

```
DEVICE=eth0
TYPE=Ethernet
BOOTPROTO=none
ONBOOT=yes
MASTER=bond0
SLAVE=yes
```

- Create bond interface configuration
  `/etc/sysconfig/network-scripts/ifcfg-bond0`

```
DEVICE=bond0
TYPE=Bond
ONBOOT=yes
BOOTPROTO=none
BONDING_MASTER=yes
```

Ethernet Configuration

- Configuration options passed to the bonding module
  - `/etc/modprobe.d/bonding.conf`
  - `/etc/sysconfig/network-scripts/ifcfg-bond0` **`BONDING_OPTS`**
- Example of active/active configuration:

```
options bond0 mode=4 xmit_hash_policy=layer3+4
```

  - mode 4 specifies 802.3ad (LACP) link aggregation
  - mode 0 also supports load-balancing, but uses slave links in a round-robin fashion
  - xmit_hash_policy should be set to layer3+4 so that the hash is over source IP address, destination IP address, source port, destination port
  - default transmit hashing policy is over MAC address + packet type ID, meaning all traffic to a particular host will use the same physical link

Infiniband Configuration

- Bonding in kernel only supports active/passive

```
options bond0 mode=0
```

- Alternative approach combines multi-rail and active/passive bonds for load-balancing Lustre traffic across links

  http://www.opensfs.org/wp-content/uploads/2013/04/LUG13-Presentation-ihara-final-rev4.pdf

  – requires Infiniband partitions configured on subnet manager

  – server-side only

Troubleshooting Tips

- Network verification is tedious

  Break one of the bonded links and test, reactivate link, break the other link, and retest

- Use the distribute option with LNET self-test to fanout connections and check for full utilization of slave links

```
lst add_test --distribute 1:2 --concurrency 2
```

Querying Bond Status

- `cat /proc/net/bonding/bond0`

```
Ethernet Channel Bonding Driver: 2.6.1 (October 29, 2004)
Bonding Mode: load balancing (round-robin)
Currently Active Slave: eth0
MII Status: up
MII Polling Interval (ms): 1000
Up Delay (ms): 0
Down Delay (ms): 0

Slave Interface: eth1
MII Status: up
Link Failure Count: 1

Slave Interface: eth0
MII Status: up
Link Failure Count: 1
```

Tuning

- For Ethernet consider the receive buffer sizes necessary for the bandwidth of multiple links
- If the link bandwidth between Ethernet switches is the same or less than that of the host links, make sure that the switches are also hashing over active/active links
- On server-side it is possible to split the OST threads such that they are local to the NUMA node designated for a particular HCA

Conclusion

- Overview of Linux kernel bonding
- Overview of Lustre networking layers
- Configured Ethernet active/active link aggregation
- Configured Infiniband active/passive bonding
- Troubleshooting/Tuning

Resources

- RHEL 7 documentation: https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/7/html/Networking_Guide/ch-Configure_Network_Bonding.html
- Linux bonding wiki: https://wiki.linuxfoundation.org/networking/bonding
- Linux kernel documentation of bonding module: https://www.kernel.org/doc/Documentation/networking/bonding.txt
- Active/Active Infiniband LNET bonding: http://www.opensfs.org/wp-content/uploads/2013/04/LUG13-Presentation-ihara-final-rev4.pdf
- Infiniband bonding configuration: https://community.mellanox.com/docs/DOC-2160
- Lustre interface bonding proposal: http://wiki.lustre.org/Multi-Rail_LNet/LAD15_Lustre_Interface_Bonding

Acknowledgements

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