

Cray Cluster Supercomputers

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VP of Advanced Technology Solutions
CUG 2013



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Agenda

- **Cray Cluster Supercomputer Presentation**
 - Why Cluster Supercomputer
 - Cray Cluster CS300-AC™, Air-Cooled System
 - CS300™ Cluster Building Block Platforms
 - Networking and Interconnect
 - Cray Cluster Software Stack and ACE™ Management Software

Cray Computing Solutions



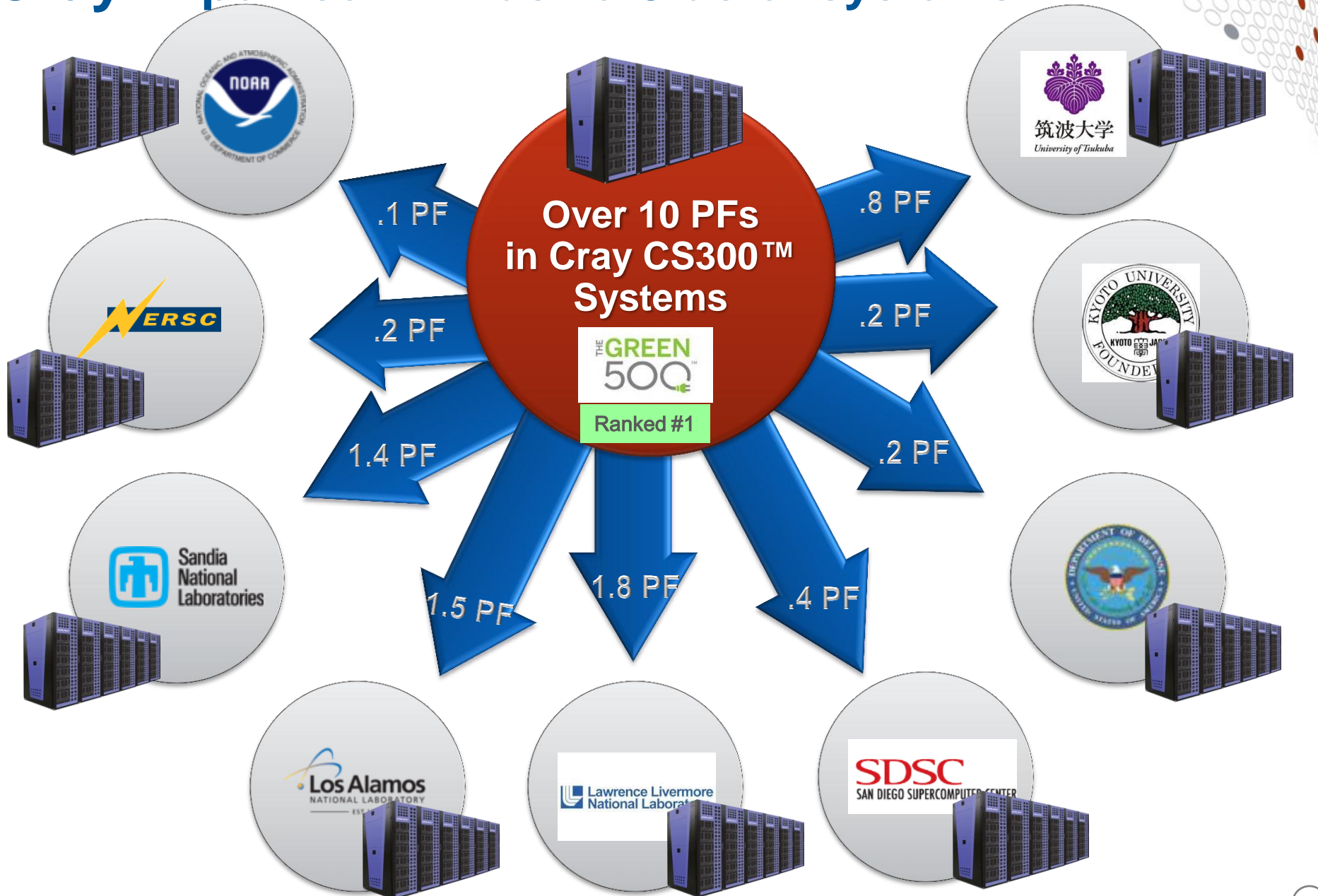
Cray XC30 Series: Scalable Performance



Cray CS300 Series: Flexible Performance

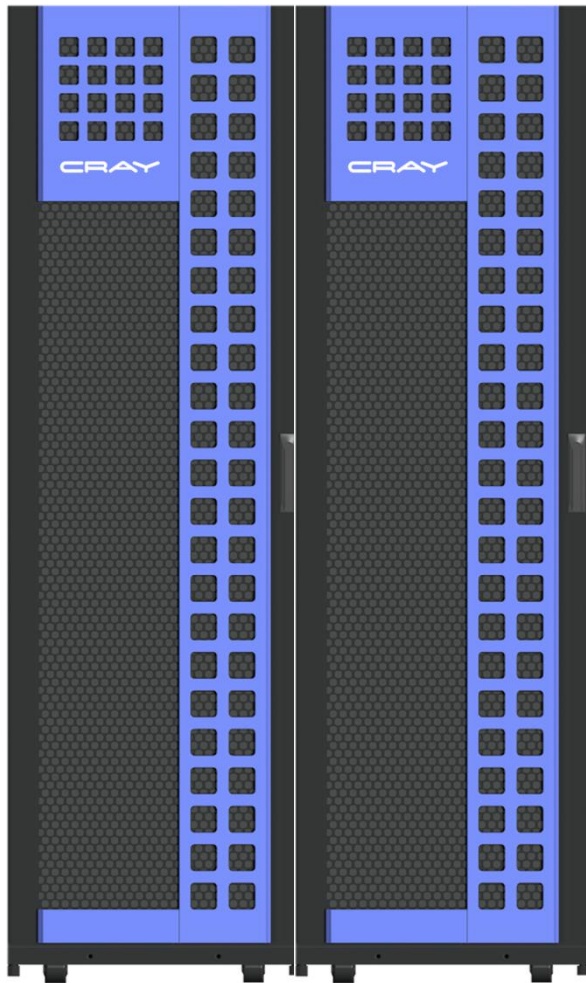
Industry Standards Focus
(Highly Configurable Solutions)

Cray Expertise in midsize Cluster systems



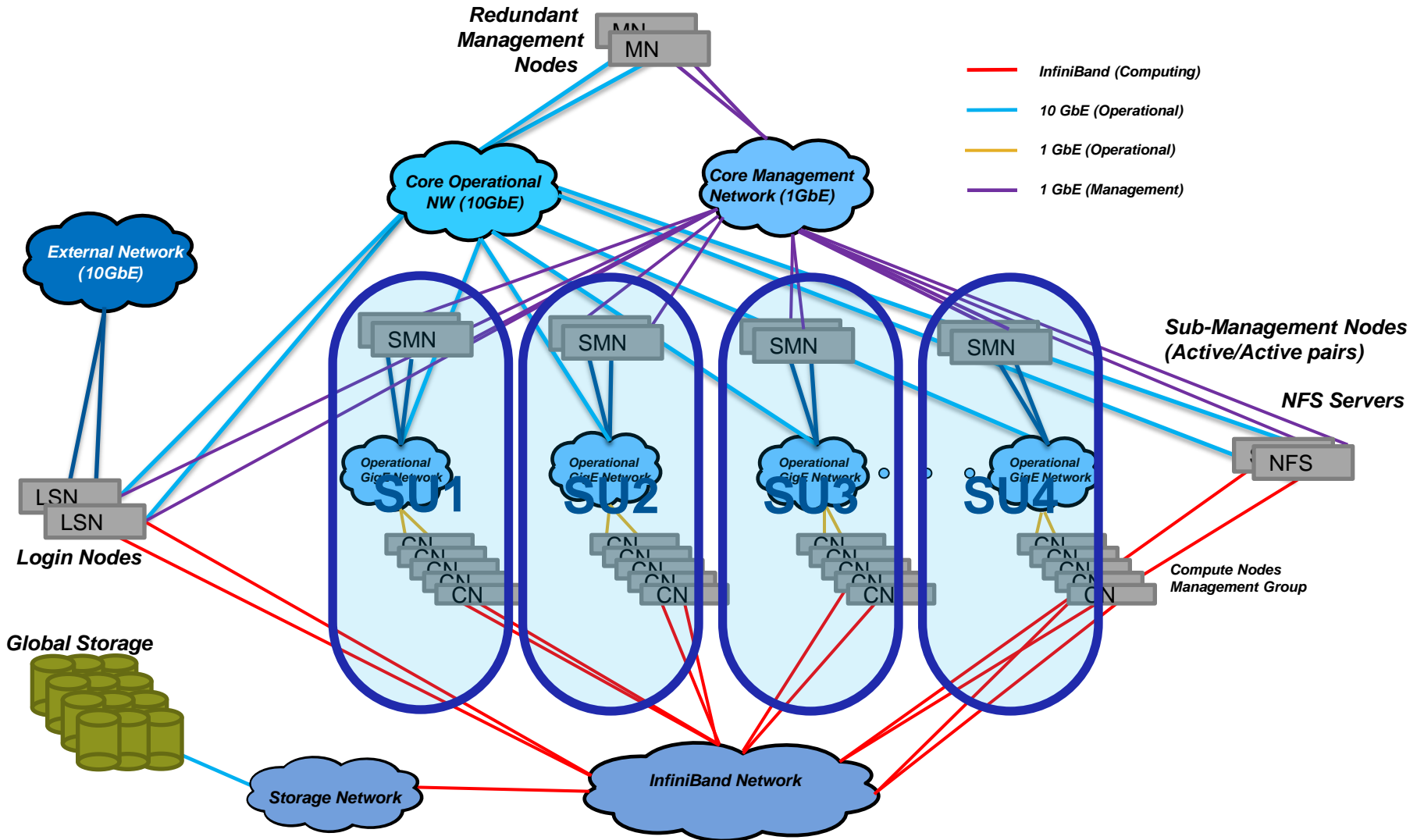
CS300-AC™ Cluster Supercomputer

CRAY

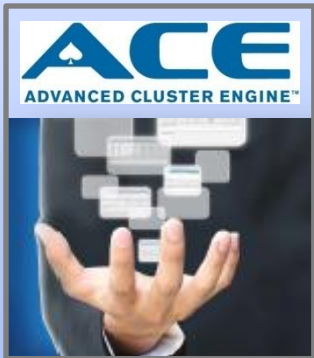


- **Highly Configurable System Architecture**
 - Cray Solutions Architects work with customers to tailor systems to customer's specifications
- **Purpose designed leveraging best-of-breed open standards technologies**
 - Designed from ground up to be a scalable HPC system
- **Air-cooled energy-efficient design**
 - Shared cooling & power infrastructure to save power
- **Complete turn-key system with integrated HPC software stack powered by ACE**
 - Powerful but easy to manage cluster management software suite
- **Reliable and Serviceable**
 - Designed with hot-swappable, redundant FRUs to maintain a low MTBI

Cray CS300-AC™ System Architecture



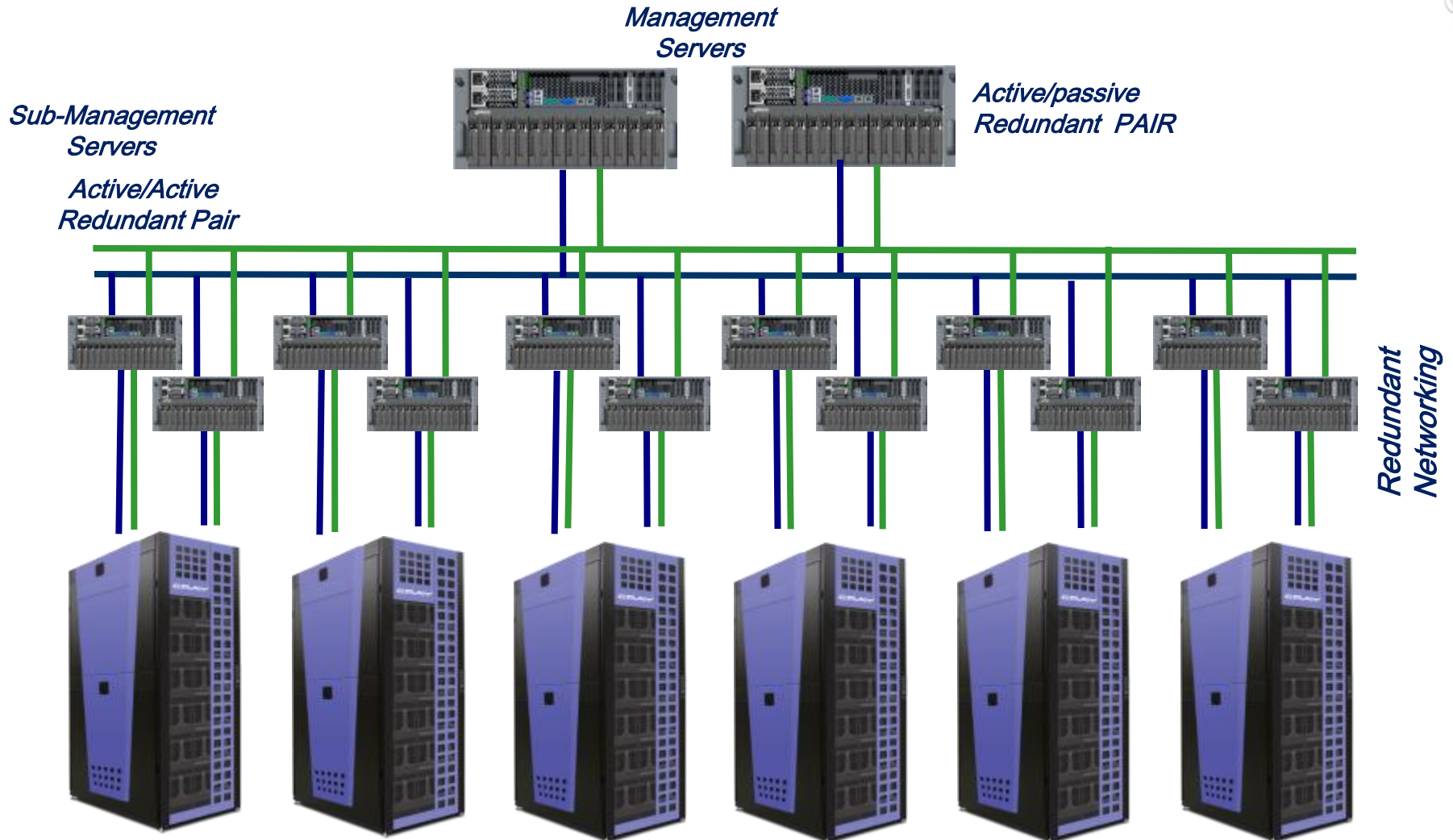
Advanced Cluster Engine™ (ACE) Management Software



- Easy-to-use Remote System Control Manager with CLI and GUI
- Delivers a reliable, highly available architecture supporting multiple network topologies
- Complete SW suite to include Network, Server, Cluster, and Storage Management
 - ✓ Highly scalable, stateless management
 - ✓ No single failure point in the management stack
 - ✓ Can manage heterogeneous nodes with different OS stacks
 - ✓ System power and temperature monitoring
 - ✓ Version control with ability to rollback changes
 - ✓ Ability to export, import system configurations and images
 - ✓ Ability to detect HW, fabric topology configuration errors

Cray CS300-AC™ System Architecture

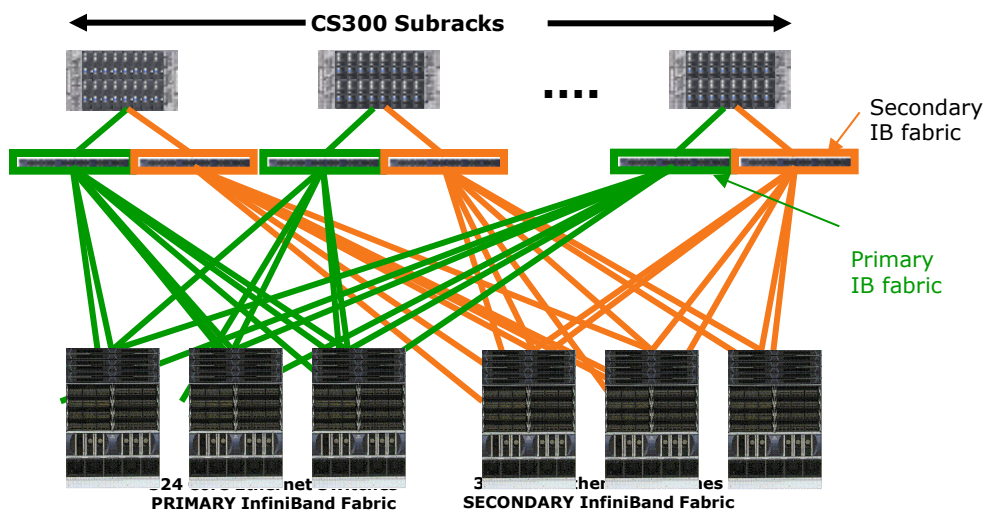
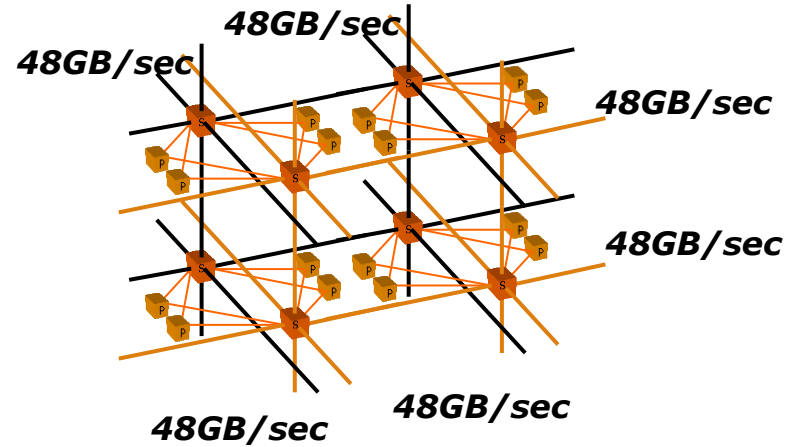
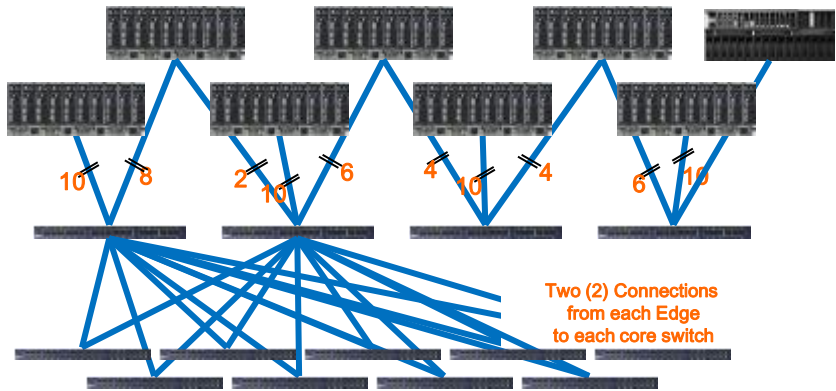
Scalability & Reliability



Cray CS300-AC™ System Architecture

InfiniBand Fabric Management

Support for multiple Topologies



- Scales from hundreds to thousands of nodes
- Single Rail and Dual Rail Fat-Tree
- Distributed Core
- Large Director Class Core
- 2-D and 3-D Torus
- Single and dual rail
- Distributed IO
- Hybrid Topologies
- Large Edge
- Inverted Tree
- 3-D Torus + Tree

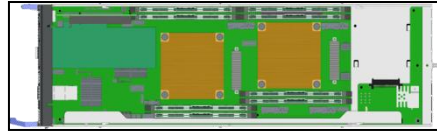
Cray CS300-AC™ Building Block Platform

Next Generation, Cray GreenBlade™



- **Simple.**
 - Singular focus in designing the best HPC-optimized building block
 - Simple and reliable platform-level management appliance (iSCB)
- **Flexible.**
 - Two motherboards & two chassis form factors with modular blade options.
 - Support for multi-vendor accelerators
- **Reliable.**
 - All serviceable FRUs are redundant & hot-swappable
 - High MTBF compute nodes for maximum system reliability

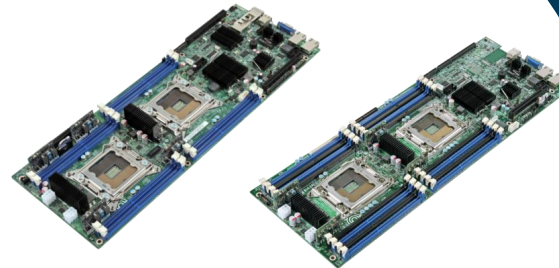
Cray CS300-AC™ Building Block Platform Simple. Flexible. Reliable.



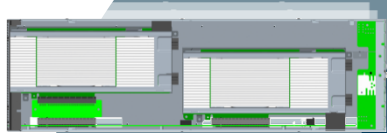
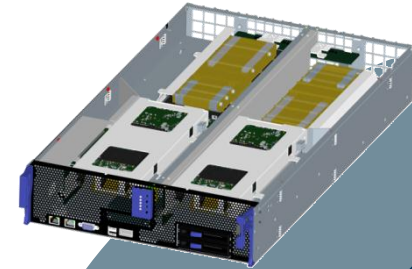
Compute Blades



Service Blades



2x Motherboards



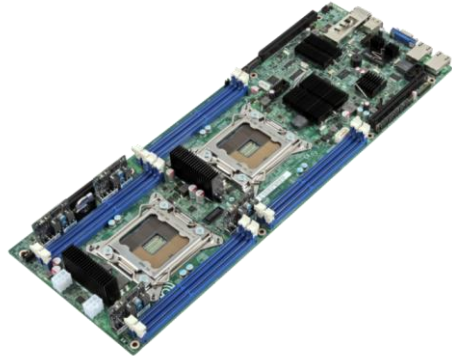
Hybrid Blades



Chassis

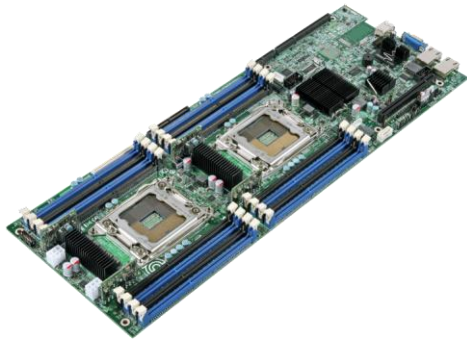


Cray CS300-AC™ Building Block Platform System Boards



Compute Boards

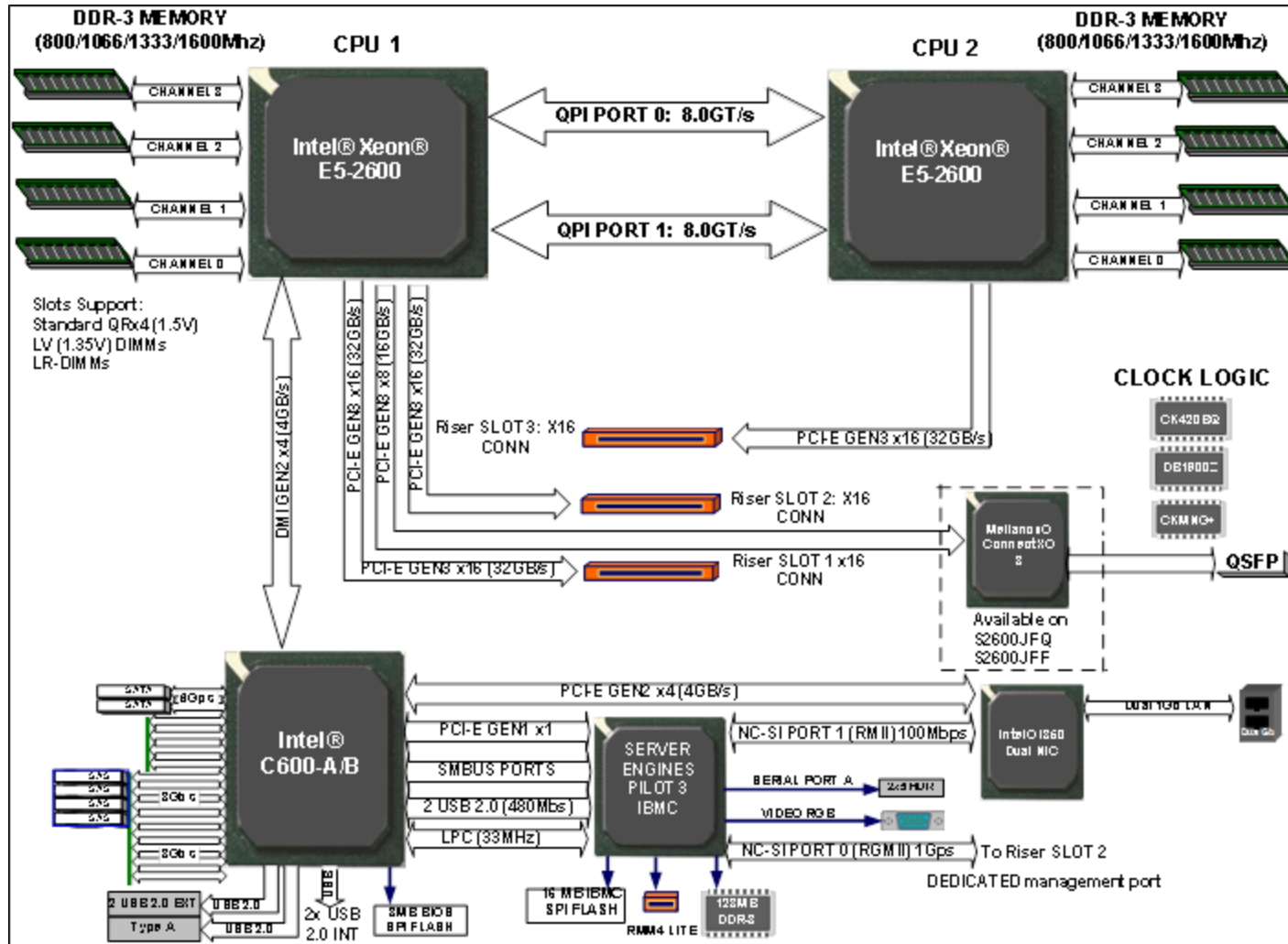
- Design optimized for Compute platform
- Support for 2x Intel Sandy Bridge EP CPUs
- Support for 8x DDR3 1600MHz memory modules
- Access to up to 56 PCIe Gen3 lanes
 - 3x PCIe Gen3 x16 expansion slots
- Option for on-board PCIe Gen3 QDR/FDR IB



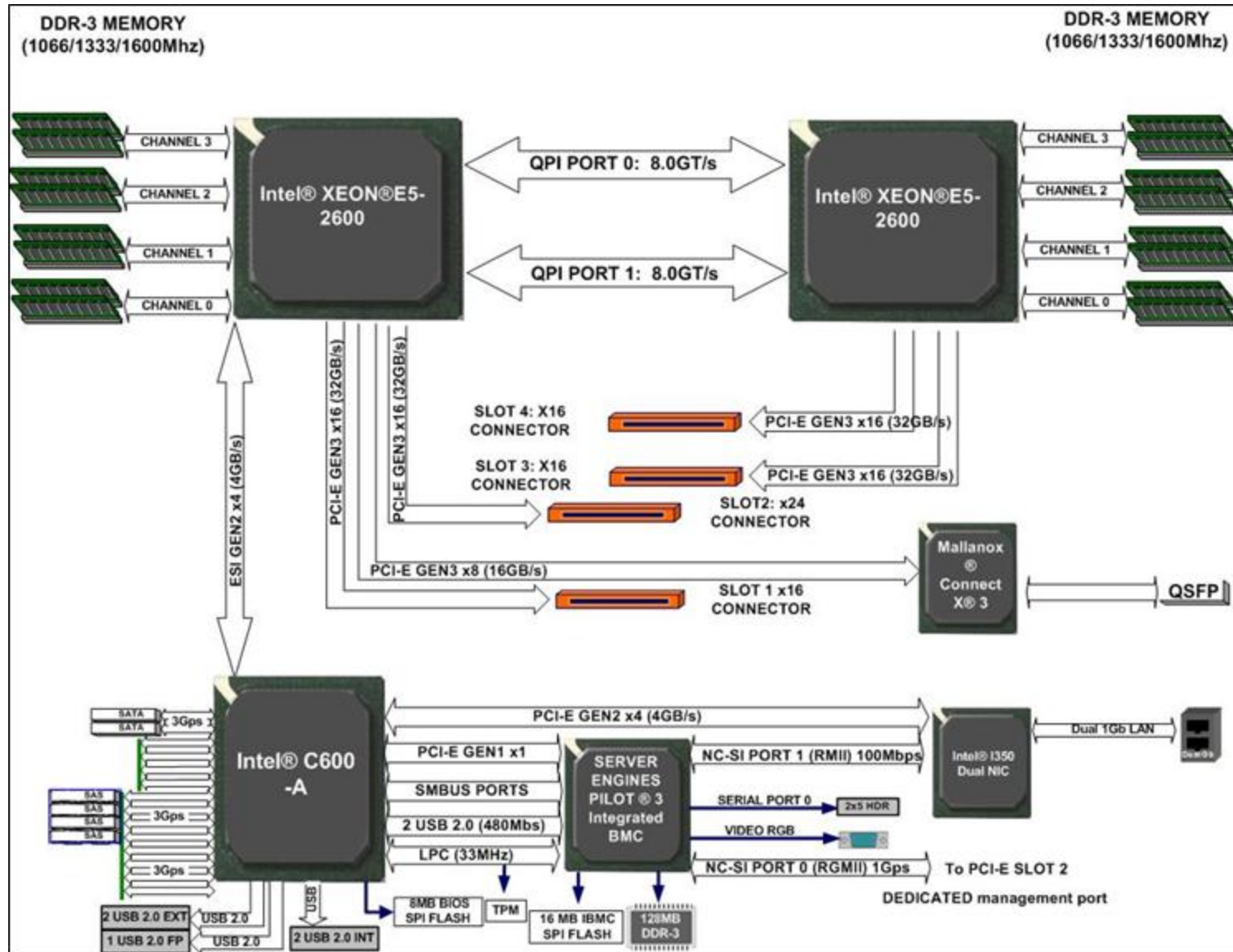
Hybrid Boards

- Design optimized for Hybrid platform
- Support for 2x Intel Sandy Bridge EP CPUs
- Support for 16x DDR3 1600MHz memory modules
- Access to up to 72 PCIe Gen3 lanes
 - 4x PCIe Gen3 x16 expansion slots
- Option for on-board PCIe Gen3 QDR/FDR IB

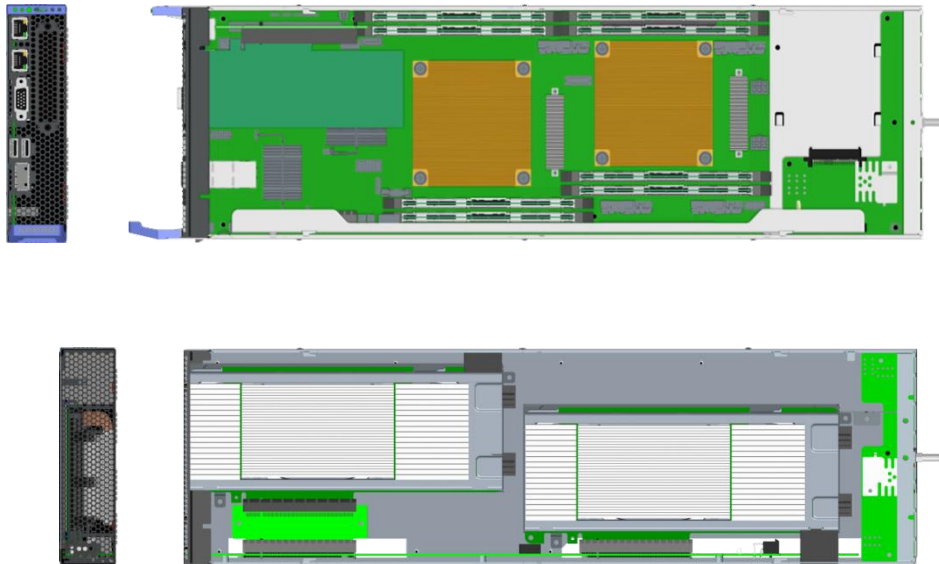
Cray CS300-AC™ Building Block Platform Compute Board Design



Cray CS300-AC™ Building Block Platform Hybrid Board Design

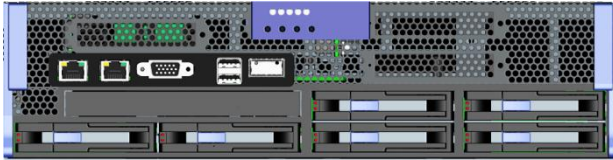
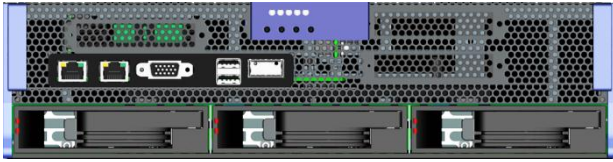


Cray CS300-AC™ Building Block Platform Compute Blade Servers



- **0.5RU effective density Compute Blades**
 - Supports Intel Xeon E5 Sandy Bridge CPUs (Ivy Bridge in 2013)
 - Supports up to 128GB DDR3 1600MHz system memory
 - Integrated PCIe Gen3 QDR/FDR IB (optional)
 - PCIe Gen3 x16 expansion slot
 - Support for one internal 2.5" HDD
- **1RU effective density Hybrid Blades**
 - Host + Expansion Blade
 - Supports 2x nVIDIA Keplers
 - Supports 2x Intel KNCs

Cray CS300-AC™ Building Block Platform Service Hybrid Servers



- **2RU effective density**
- **Service Node w/ expanded IO + 3x 3.5" HDDs**
 - Up to three 3.5" SATA/SAS HDDs
 - Up to four PCIe expansion slots
 - Ideal as a GW/Login Node
- **Service Node w/ expanded IO + 6x 2.5" HDDs**
 - Up to six 2.5" SATA/SAS HDDs
 - One DVD ROM Drive
 - Up to four PCIe expansion slots
 - Ideal as a Management/Boot Node
- **Hybrid Node w/ 4x Accelerators + 2x 2.5" HDDs**
 - Up to two 2.5" SATA/SAS HDDs
 - Up to four nVIDIA Keplers(K10 or K20) or Intel KNCs

Cray CS300-AC™ Building Block Platform

GreenBlade™ Subrack, SR5000 Chassis

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- **SR5000 Chassis supports either:**
 - 10x Compute Blades
 - 5x Hybrid Blades
- Compute Blades are 0.5RU 2P x86 servers
- Hybrid Blades are 1RU 2P x86 combined with either 2x NVIDIA Keplers or 2x Intel KNCs
- Three hot-swappable, redundant Cooling Fan Units
- Up to four hot-swappable, redundant 1630W PS
- Can support one or two redundant iSCB chassis managers

Cray CS300-AC™ Building Block Platform

GreenBlade™ Subrack, SR8000 Chassis

CRAY



- **SR8000 Chassis supports either:**
 - 16x Compute Blades
 - 8x Hybrid Blades
 - 4x double-wide Service Blades
 - 4x double-wide Hybrid Blades
- Compute Blades are 0.5RU 2P x86 servers
- Hybrid Blades are 1RU 2P x86 combined with either 2x nVIDIA Keplers or 2x Intel KNCs
- Double-wide Service Blades are 2RU 2P x86 servers
- Double-wide Hybrid Blades are 2RU 2P x86 servers with either 4x nVIDIA Keplers or 4x Intel KNCs
- Six hot-swappable, redundant Cooling Fan Units
- Up to six hot-swappable, redundant 1630W PS
- Can support one or two redundant iSCB chassis managers

Cray CS300-AC™ Building Block Platform Cooling

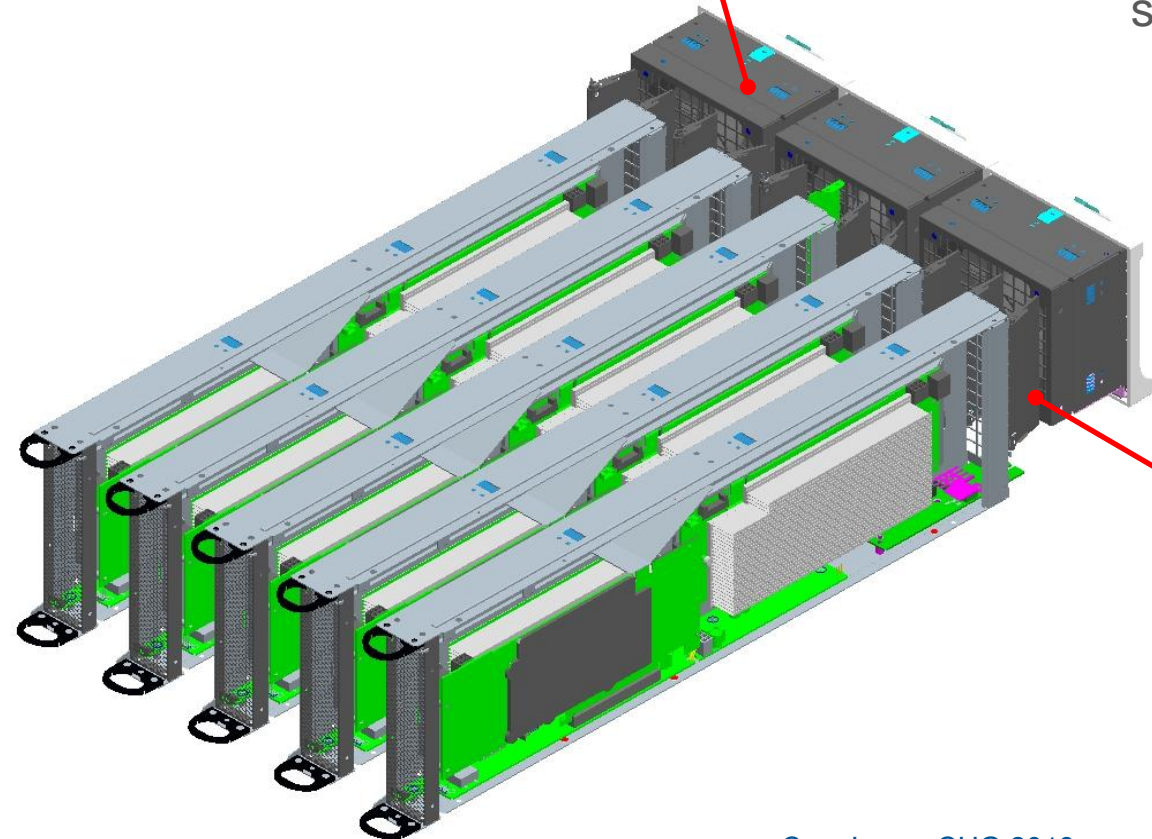


- **Closed-Loop Cooling System**
 - 3x Cooling Fan Unit (CFU)
 - Each CFU has two, redundant 120mm x 120mm x 38mm fans
 - CFU LED: Green for normal and Amber for service
 - iSCB can dynamically control the fan speed or set static speeds
 - iSCB monitors sensors to dynamically change fan speeds to maintain optimal operating temp

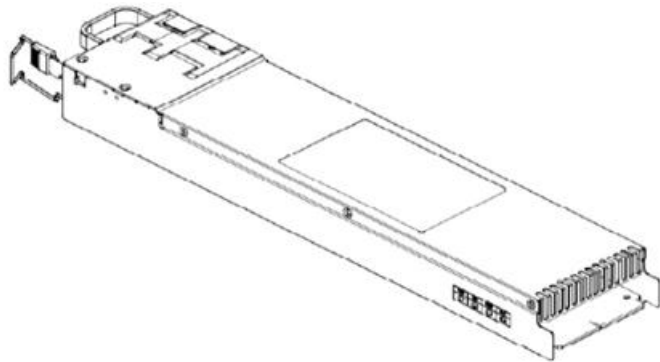
Cray CS300-AC™ Building Block Platform Airflow Management



- Sub-Rack has built-in air shutters that open/close when blades are inserted/removed
- Each CFU cools a zone in the subrack



Cray CS300-AC™ Building Block Platform Power



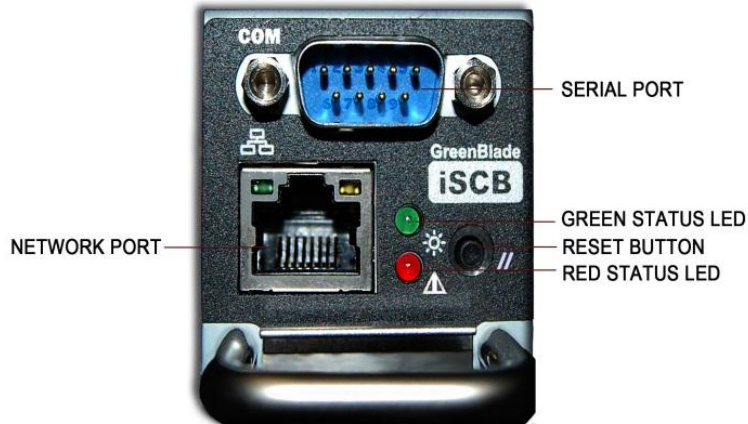
- **Designed specifically for the Cray GreenBlade™ Platform**
 - Designed to support 5+1 load-sharing design
 - Wide 200-277V AC input range
 - 1630W Gold-rated Power Supply
 - Typical efficiency(50% load) of 93%
 - Average efficiency of 92%

- **Designed to meet future RFQ requirements**

- Designed to meet stringent SEMI F47 and CBMEA requirements for power sag/surge

| Certification | Result |
|----------------------------------|------------|
| FCC Part 15 Subpart B, Class A | Compliance |
| CE/EMC Directive: 2004/108/EC | Compliance |
| UL 60950-1 | Recognized |
| IEEE Std. 519-1992 | Pass |
| SEMI F47-0706 | Pass |
| V-3/2012.04 Class A, V-4/2012.04 | Compliance |
| CBEMA | Pass |

Cray CS300-AC™ Building Block Platform Management



- **Designed specifically for the Cray GreenBlade™ Platform**
 - Common interface to all GreenBlade™ product series
- **ARM-based appliance running embedded linux**
 - Node health monitoring
 - Supports concurrent console sessions to each node (terminal concentrator)
 - Reliable power control
 - Active dynamic fan control
 - Power monitoring
 - Dedicated powerman/conman interface
 - GPU/MIC power control
- **Can easily upgrade features**

Cray Focus Areas Supercomputing and Big Data

The Missing Piece is Here!

Supercomputers

Highly Configurable Solutions



Highly Integrated Solutions



Data Analytics



Storage and Data Management



Big Data

Cray Cluster Supercomputers

Thank You
Questions?



Cray Cluster Software Stack

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Software Engineering
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- Cray Cluster Software Stack Components
- ACE Details
 - ✓ What is ACE?
 - ✓ Total Cluster Management Solution
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 - ✓ Architecture
 - ✓ Features, Benefits
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 - ✓ Data and File Systems
 - ✓ Interfaces
 - ✓ ACE-Managed Objects
 - ✓ ACE Clusters
 - ✓ Server, Co-processor, Cluster, System Management
 - ✓ Configuration and Miscellaneous
 - ✓ Network Management
 - ✓ Job Management
 - ✓ Plugins
- ACE Demo System



Cray Cluster Software Stack Components



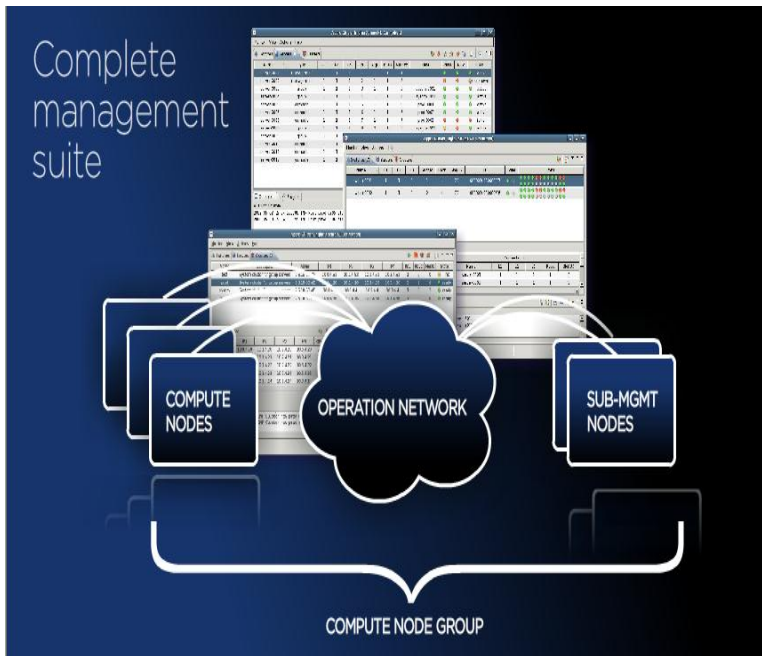
The Essential Software and Management Tools Needed to Build a Powerful, Flexible, and Highly Available Supercomputer.



What is ACE?

Cray Advanced Cluster Engine™ Management Software

ACE stands for Advanced Cluster Engine™, which is a Cray Management Software designed from the ground up to provide a highly-available, scalable, lights-out, remote management system; to obscure the complexity of a large HPC cluster; and to make managing ten thousand nodes as easy as managing one.



- **Performance** - ACE transforms state of the art commodity hardware into a unified complete HPC system.
- **Scalability** – ACE enables simple common management, monitoring, administration, and operation of HPC clusters with 10 to 10,000 nodes.
- **Reliability** – ACE provides a highly-available, scalable HPC cluster. ACE maintains the state of the cluster in a fault tolerant management database.
- **Flexibility** – ACE's Dynamic Cluster Provisioning allows multiple clusters to share the physical resources

Cray Advanced Cluster Engine™ (ACE) Management Software



ACE Devel Cluster

| Name | Type | L1 | N | Grp | Rack | SL...U# | Blade | Host | Net1 | Net2 |
|-------------|------------|----|---|-----|------|---------|-------|-----------|------|------|
| server-0001 | management | 1 | 1 | 1 | 1 | 1 | 1 | phaeton1 | | |
| server-0002 | management | 1 | 2 | 1 | 1 | 1 | 2 | phaeton2 | | |
| server-0003 | compute | 1 | 3 | 1 | 7 | 1 | 1 | prod-0001 | | |
| server-0004 | compute | 1 | 4 | 1 | 7 | 1 | 2 | prod-0002 | | |
| server-0005 | compute | 1 | 5 | 1 | 7 | 2 | 3 | prod-0003 | | |
| server-0006 | compute | 1 | 6 | 1 | 7 | 2 | 4 | prod-0004 | | |
| server-0007 | compute | 1 | 7 | 1 | 7 | 2 | 5 | prod-0005 | | |
| server-0008 | compute | 1 | 8 | 1 | 7 | 1 | | abc-0001 | | |



ACE Devel Cluster

| Name | L1 | Subnet | Rack | SL...U# | GUID | State | Ports |
|-------------|----|--------|------|---------|--------------------|-------|-------|
| switch-0001 | 1 | 1 | 1 | 22 | 0002-c90300656b10 | u... | |
| switch-0002 | 1 | 2 | 1 | 12 | 0002-c90300619-c90 | u... | |

Ports on switch-0001

| Port | Rate (Gb/s) | MRate (Gb/s) | State | Connected To |
|------|-------------|--------------|-------|-------------------|
| 1 | 40 | 40 | up | server-0003 1 7 1 |



ACE Devel Cluster

| Name | Description | Kernel | IP1 | IP2 | IP3 |
|--------|----------------------------------|------------------|------------|------------|------------|
| abc | System cluster for group servers | 2.6.32-...x86_64 | 10.20.3.91 | 10.21.3.91 | 10.22.3.91 |
| prod | System cluster for group servers | 2.6.32-...x86_64 | 10.20.3.47 | 10.21.3.47 | 10.22.3.47 |
| sysarp | System cluster for group servers | 2.6.32-...x86_64 | 10.20.3.3 | 10.21.3.3 | 10.22.3.3 |

Hosts on prod

| Name | IP1 | IP2 | IP3 | Date | R...n | Description |
|-----------|-----|-----|-----|------|-------|-------------|
| prod-0001 | | | | | | |

ACE Devel Cluster

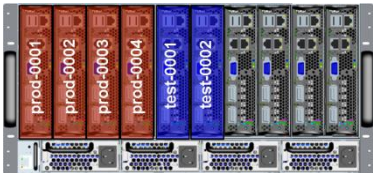
| Job Num | Queue | Host | Owner | Name | State | State | Slots | Submit Tim |
|---------|-------|----------|-------|---------------|-------|---------|-------|------------|
| 198 | all-q | abc-0001 | bench | Run.B...penMP | r | running | 8 | |
| 198 | all-q | abc-0001 | bench | Run.B...penMP | r | running | 8 | |



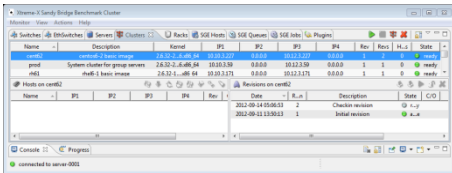
Cray Advanced Cluster Engine™ (ACE)



- **Diskless/Stateless Operation**
 - Simplifies System Administration
 - Improves Performance
 - Multi-Level Cached Root File System
 - Does not require a Light Weight Kernel
 - Local Storage also Supported
 - State maintained in two HA management servers



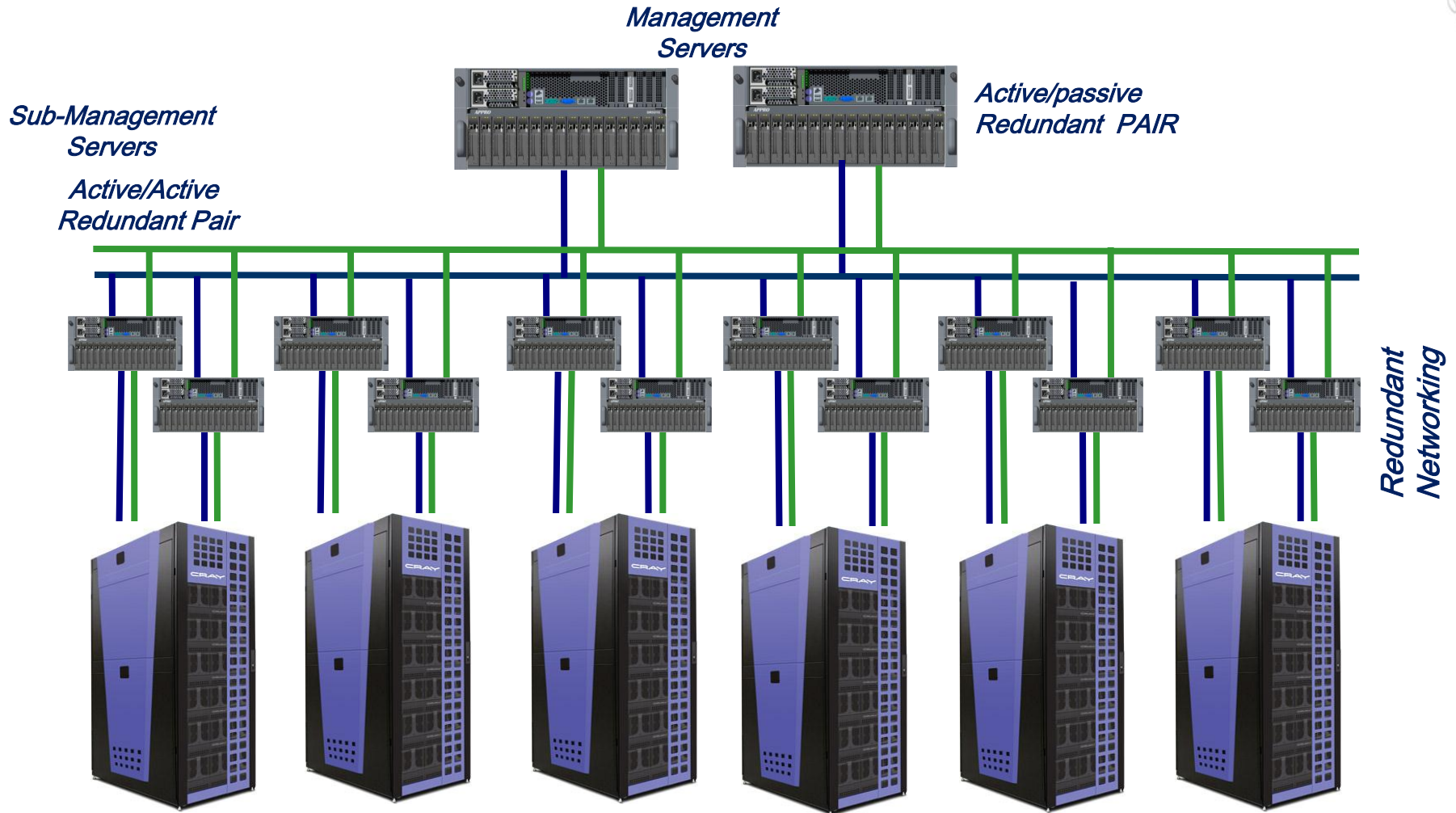
- **“Instant” Provisioning**
 - Multiple Logical Clusters
 - Multiple OS Configurations
 - Provisioning Time = Reboot Time = Less than 10 minutes



- **Configuration Management**
 - Multiple Revisions with Roll-Back Capability
 - Rolling Upgrades on Individual servers between jobs

Cray ACE™ System Architecture

Scalability & Reliability

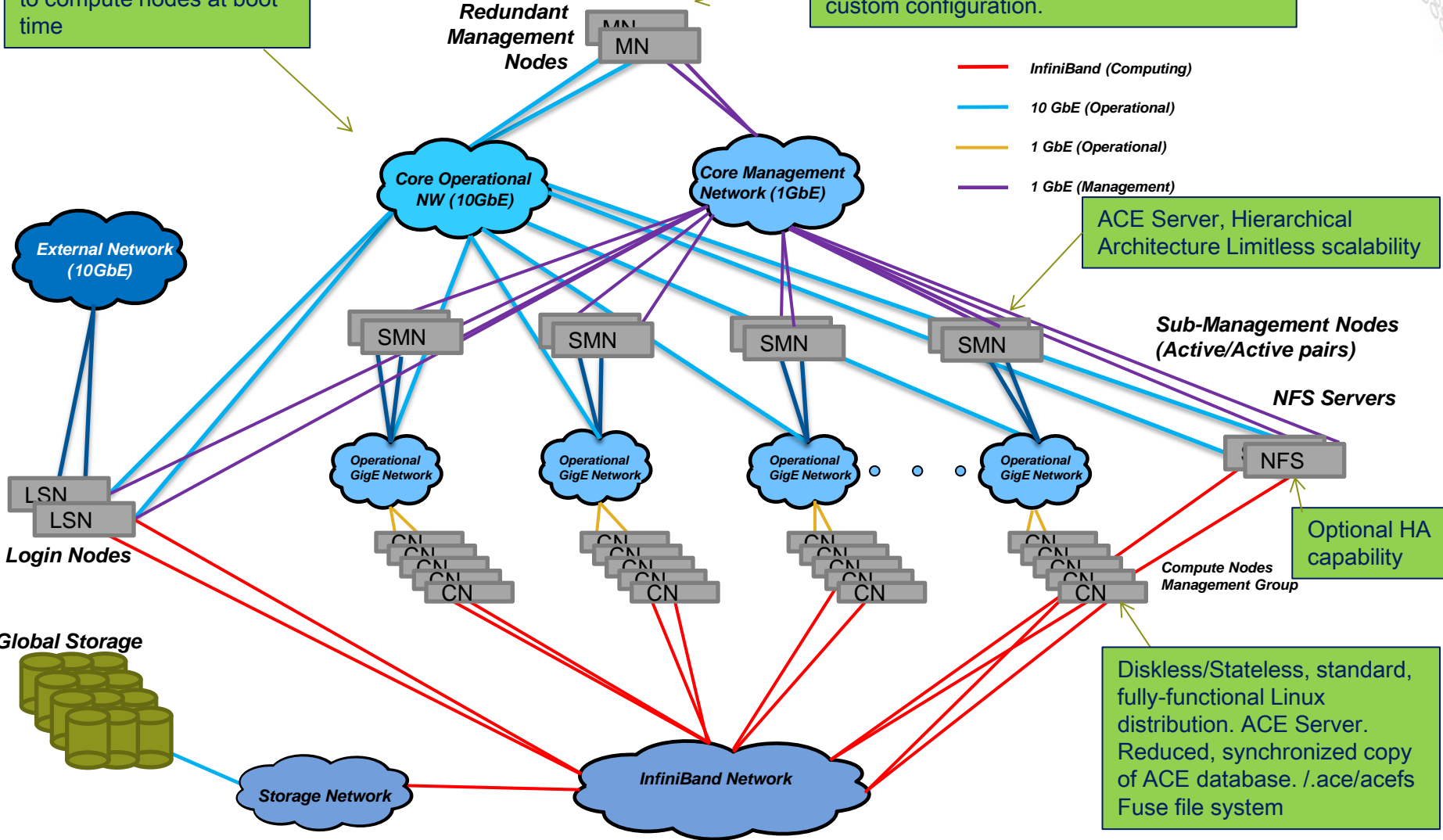


Cray ACE™ System Architecture



Dynamically provision OS to compute nodes at boot time

ACE daemon, ACE database, Fault-Tolerant File System, /acefs Fuse file system for custom configuration.



ACE Server, Hierarchical Architecture Limitless scalability

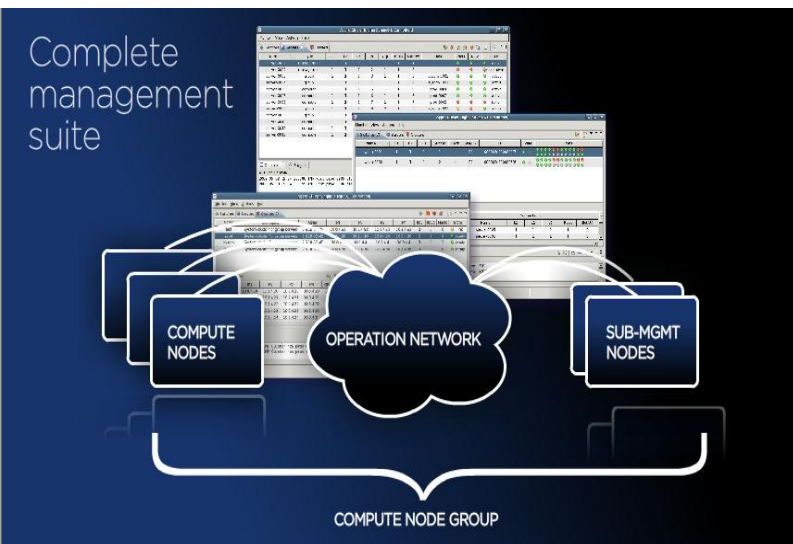
Optional HA capability

Diskless/Stateless, standard, fully-functional Linux distribution. ACE Server. Reduced, synchronized copy of ACE database. /ace/acefs Fuse file system

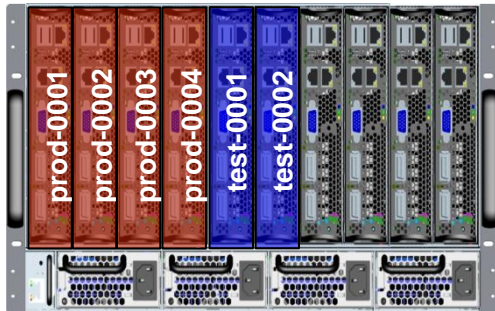
Cray ACE™ Software Management Features

ACE's Scalable Hierarchical Architecture Provides the Following Services:

- Provisioning
- Launching
- Scalable File Services
- System Management
- Server Management
- Network Management
- Cluster Management & Monitoring
- Storage Management



Cray ACE™ Software Management Features

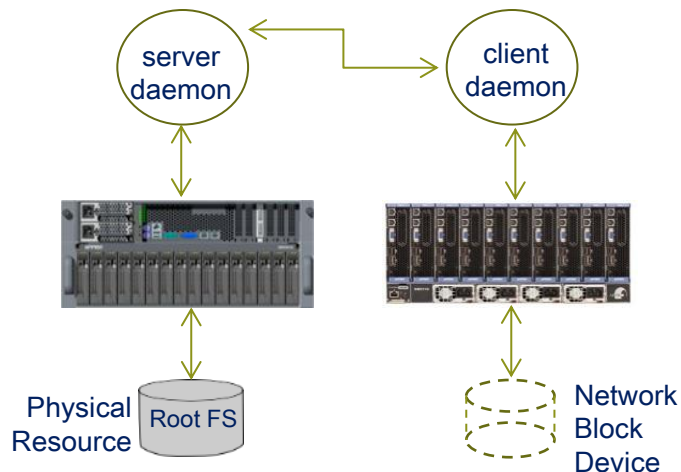


- Provisioning
 - Supports partitioning a Supercomputer into multiple logical computers
 - Maps logical computers (clusters) onto servers (nodes)
 - Supports multiple independent OS configurations, each with up to 10 revisions and rollback capability
 - Manages and monitors logical computer (cluster) status
 - Integrates Supercomputer status into the management system

Cray ACE™ Software Management Features

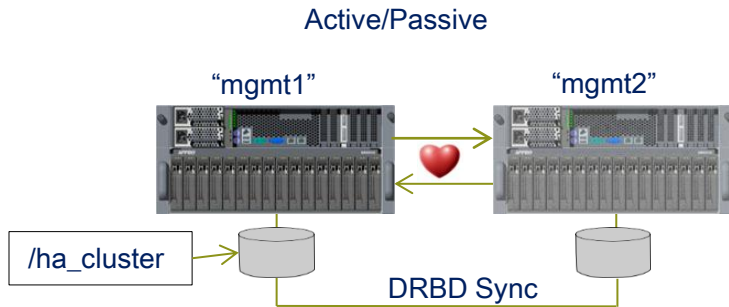


- **Launching**
 - Jobs
 - Job environment configuration
 - Job pre- and post-processing



- **Scalable File Services**
 - Root File System
 - Supports scalable root file systems for diskless nodes
 - Integrates server status into management system

Cray ACE™ Software Management Features



- System Management
 - Management of overall system configuration
 - Redundant Management Servers
 - Automatic failover

Xtreme-X Sandy Bridge Benchmark Cluster

Monitor View Actions Help

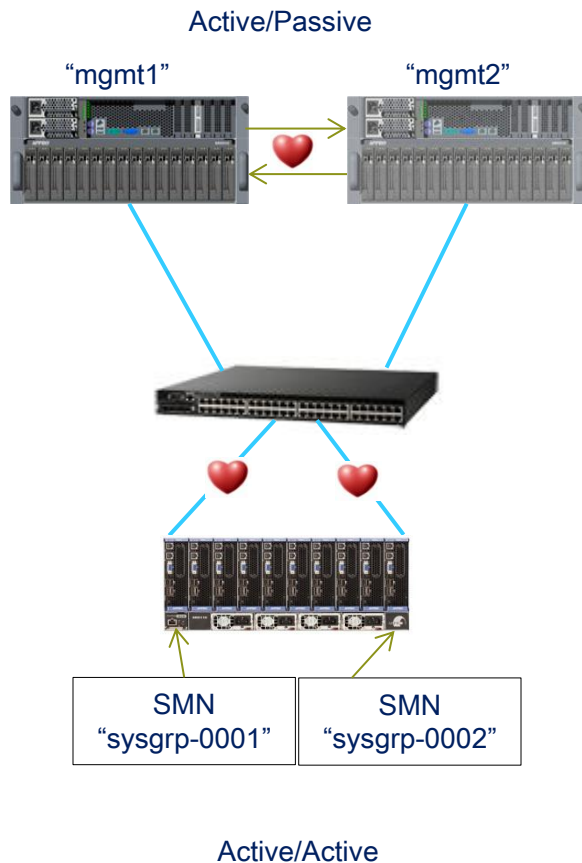
Switches EthSwitches Servers Clusters Racks SGE Hosts SGE Queues SGE Jobs Plugins

| Name | Type | N | Grp | Rack | Sl...U# | Blade | Host | Net1 | Net2 | State | BIOS | HCA |
|-------------|------------|---|-----|------|---------|-------|-----------|------|------|--------------|------------------|----------|
| server-0001 | management | 1 | 1 | 1 | 33 | | osprey1 | ● | ● | ● active | SE5C600.../2011) | 2.9.1000 |
| server-0002 | management | 2 | 1 | 1 | 2 | | osprey2 | ● | ● | ● disc...ted | | |
| server-0003 | compute | 3 | 1 | 1 | 20 | 1 | rh62-0001 | ● | ● | ● active | SE5C600.../2012) | 2.10.700 |
| server-0004 | compute | 4 | 1 | 1 | 20 | 2 | rh62-0002 | ● | ● | ● active | SE5C600.../2012) | 2.10.700 |
| server-0005 | compute | 5 | 1 | 1 | 20 | 3 | rh62-0003 | ● | ● | ● active | SE5C600.../2012) | 2.10.700 |
| server-0006 | compute | 6 | 1 | 1 | 20 | 4 | rh62-0004 | ● | ● | ● active | SE5C600.../2012) | 2.10.700 |
| server-0007 | compute | 7 | 1 | 1 | 20 | 5 | rh62-0005 | ● | ● | ● active | SE5C600.../2012) | 2.10.700 |
| server-0008 | compute | 8 | 1 | 1 | 20 | 6 | rh62-0006 | ● | ● | ● active | SE5C600.../2012) | 2.10.700 |

Console Progress

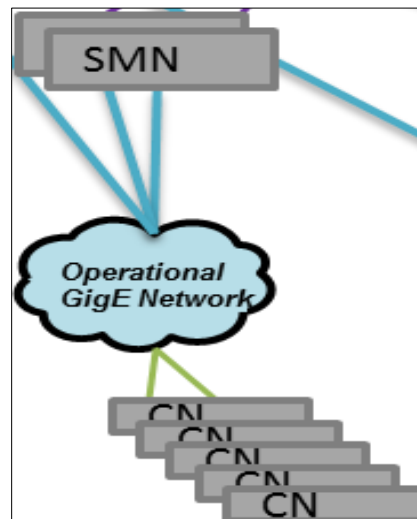
connected to server-0001

Cray ACE™ Software Management Features



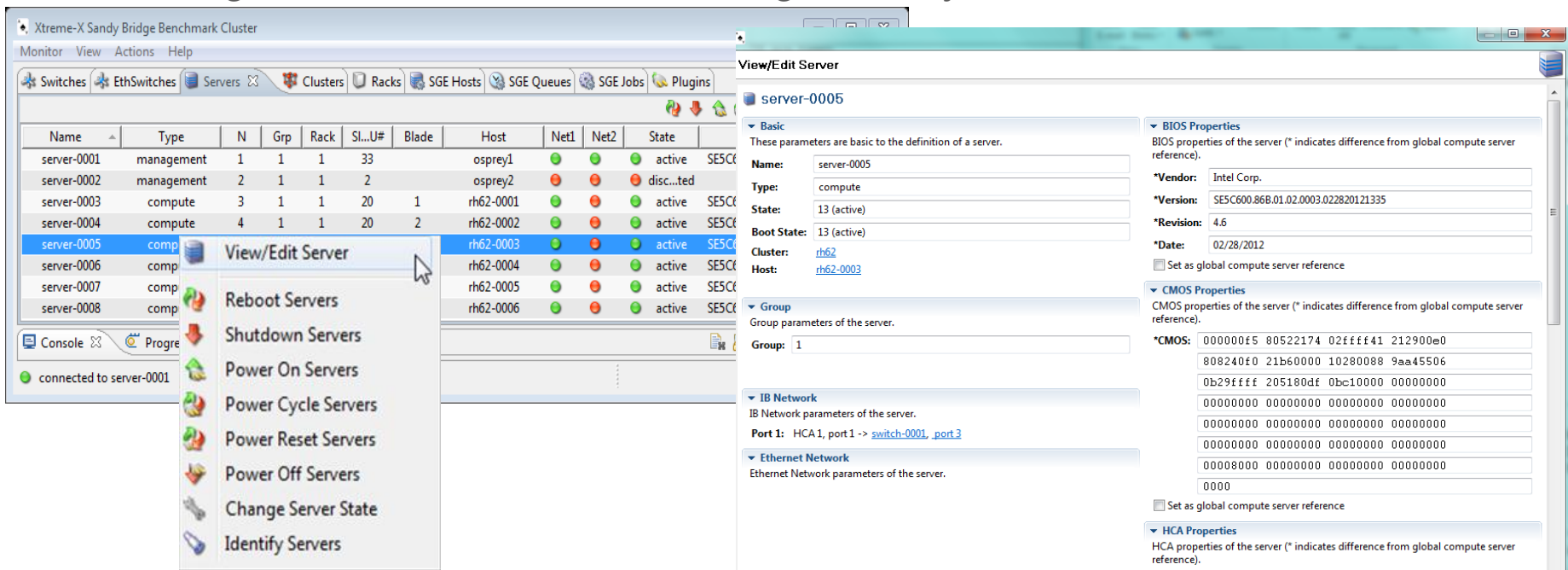
- System Sub-Management

- Management of sub-management groups
- Redundant Sub-Management Servers (standard diskless compute nodes)
- Automatic failover



Cray ACE™ Software Management Features

- Server Management
 - Automatic discovery of server hardware
 - Remote server control (Power On, Off, Cycle)
 - Remote server initialization (Reset, Reboot, Shut Down)
 - Scalable, fast, diskless booting for large node count systems
 - Server redundancy and failover (management & sub-management)
 - Integrates server status into management system



The screenshot displays the Cray ACE software interface for managing a cluster. The main window shows a table of servers with columns for Name, Type, N, Grp, Rack, Sl...U#, Blade, Host, Net1, Net2, State, and SESC. A context menu is open over the 'server-0005' row, listing actions such as 'View/Edit Server', 'Reboot Servers', 'Shutdown Servers', 'Power On Servers', 'Power Cycle Servers', 'Power Reset Servers', 'Power Off Servers', 'Change Server State', and 'Identify Servers'.

The 'View/Edit Server' window for 'server-0005' is also visible, showing configuration details:

- Basic:** Name: server-0005, Type: compute, State: 13 (active), Boot State: 13 (active), Cluster: rh62, Host: rh62-0003.
- BIOS Properties:** Vendor: Intel Corp., Version: SESC600.868.01.02.0003.022820121335, Revision: 4.6, Date: 02/28/2012.
- CMOS Properties:** CMOS: 000000f5 80522174 02ffff41 212900e0, 808240f0 21b60000 10280088 9aa45506, 0b29ffff 205180df 0bc10000 00000000, 00000000 00000000 00000000 00000000, 00000000 00000000 00000000 00000000, 00000000 00000000 00000000 00000000, 00008000 00000000 00000000 00000000, 0000.
- IB Network:** Port 1: HCA 1, port 1 -> switch-0001, port 3.
- Ethernet Network:** Ethernet Network parameters of the server.

Cray ACE™ Software Management Features

- Network Management
 - Validates network topology
 - Monitors switches and cables
 - Notification of mis-connected and slow links
 - Route around network failures on dual-rail management networks

View/Edit Port Parameters

Switch switch-0001, port 33

Basic
 These parameters are basic to the definition of ports on a switch.

Id: 33

Switch: [switch-0001](#)

Connected To: [server-0019](#), HCA 1, port 1

State: 2 (misconnected)

Rate: 40 Gb/s

Measured Rate: 40 Gb/s

All Properties
 All port properties.

```

dest_id = 19
dest_port = 1
id = 33
mrate = 40
rate = 40
slaves = [ ]
state = 2
type = 'server'
  
```

Xtreme-X Sandy Bridge Benchmark Cluster

Monitor View Actions Help

Switches EthSwitches Servers Clusters Racks SGE Hosts SGE Queues SGE Jobs Plugins

| Name | Subnet | Rack | Slot/U# | GUID | State | Ports |
|-------------|--------|------|---------|------------------|-------|-------|
| switch-0001 | 1 | 1 | 40 | 0002c903005b5b80 | up | |
| switch-0002 | 1 | 2 | 25 | 0002c90200430788 | up | |

Ports on switch-0001

| Port | Rate (Gb/s) | MRate (Gb/s) | State | Connected To | | |
|------|-------------|--------------|--------------|--------------|------|---------|
| | | | | Name | Rack | Slot/U# |
| 30 | 40 | 0 | down | server-0032 | 1 | 10 |
| 31 | 40 | 56 | up | server-0033 | 1 | 5 |
| 32 | 40 | 56 | up | server-0034 | 1 | 5 |
| 33 | 40 | 40 | misconnected | server-0019 | 1 | 15 |
| 34 | 40 | 40 | up | switch-0002 | 2 | 25 |
| 35 | 40 | 40 | up | switch-0002 | 2 | 25 |
| 36 | 40 | 40 | up | switch-0002 | 2 | 25 |

Console Progress

connected to server-0001

Cray ACE™ Software Management Features

- Monitoring (Server/Sub-rack)
 - CPU temperatures
 - Power
 - Fan Speeds

“ace temps” command on management node

```
susan.kraus@osprey1:~
File Edit View Options Transfer Script Tools Window Help
Enter host <Alt+R>
susan.kraus@osprey1:~ x
[susan.kraus@osprey1 ~]$ telnet 10.10.0.13 7000
Trying 10.10.0.13...
Connected to 10.10.0.13.
Escape character is '^]'.
1:3:1-iSCB> status
iSCB Status
Node: 01 02 03 04 05 06 07 08 09 10
Power: * * * * *
IDLED:
Console:
BMC: * * * * *
Temp 'C': 48 47 45 43 43 43 43 43 43 48

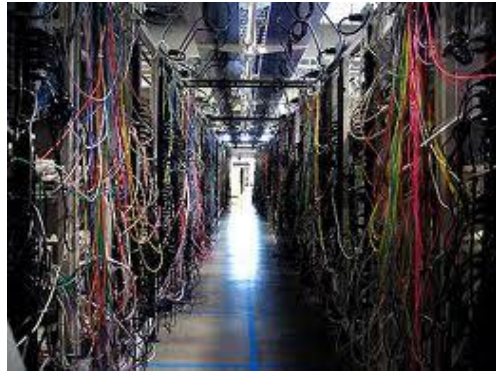
PSU:      01      02      03      04      Total
Power:    on      on      on      off
Status:   ok      ok      ok
Temp:     21'C    21'C    22'C
Fan:      3200,5056 3424,4928 3200,4800
12V:      26A      30A      26A      82A
AC In:    201V    201V    201V
Watt:     348w    388w    352w    1088w

CFU:      01      02      03
Status:   ok      ok      ok
Fan1:     5850rpm 5775rpm 5781rpm
Fan2:     6271rpm 6323rpm 6264rpm
Duty:     100%    100%    100%
ok
1:3:1-iSCB>
```

“status” command on iSCB

```
susan.kraus@osprey1:~
File Edit View Options Transfer Script Tools Window Help
Enter host <Alt+R>
susan.kraus@osprey1:~ x
[susan.kraus@osprey1 ~]$ ace temps
Server Host Temps
server-0003 rh62-0001 30 30 31 26 28 31 27 29 31 31 28 29 35 29 29 25
server-0004 rh62-0002 33 28 30 30 32 28 29 31 33 29 30 30 31 33 29 29
server-0005 rh62-0003 32 27 31 30 28 28 26 36 32 35 26 34 30 33 35 33
server-0006 rh62-0004 29 24 29 35 27 33 28 34 31 33 30 30 25 30 31 29
server-0007 rh62-0005 28 29 25 30 31 25 28 26 36 40 28 33 30 28 26 29
server-0008 rh62-0006 26 33 29 29 26 32 26 35 28 31 30 27 34 21 26 31
server-0009 rh62-0007 32 25 25 28 24 29 27 31 27 30 34 27 28 28 27 26
server-0010 rh62-0008 22 24 27 25 31 26 31 28 28 31 30 27 33 30 29 32
server-0011 rh62-0009 31 33 23 25 28 28 36 31 33 33 36 32 28 30 27 21
server-0012 rh62-0010 35 31 27 28 32 31 29 33 33 34 27 29 28 36 26 29
server-0013 rh62-0011 32 31 26 27 22 31 24 30 30 26 29 30 30 30 32 30
server-0014 rh62-0012 35 25 28 28 31 30 26 31 33 31 26 32 34 27 28 32
server-0015 rh62-0013 33 28 28 26 31 28 30 35 27 33 32 30 32 33 31 28
server-0016 rh62-0014 25 31 33 30 25 27 25 28 26 28 30 30 32 26 31 27
server-0017 rh62-0015 27 21 20 20 22 26 25 30 31 32 26 28 26 29 22 27
server-0018 rh62-0016 33 27 26 29 31 23 28 34 34 28 29 39 34 27 33 30
server-0019 rh62-0017 27 31 35 27 27 23 27 27 26 26 31 31 27 27 28 26
server-0020 rh62-0018 33 29 26 24 28 29 26 28 31 28 32 24 26 27 31 23
server-0021 rh62-0019 33 21 24 26 25 28 30 38 31 32 32 27 28 33 28 21
server-0022 rh62-0020 29 20 27 24 27 28 23 25 26 29 29 26 32 30 31 23
server-0023 rh62-0021 29 30 26 28 28 25 31 31 31 34 33 28 29 30 28 25
server-0024 rh62-0022 37 29 29 30 29 28 32 32 35 33 29 32 38 31 33 28
server-0025 rh62-0023 32 31 27 27 32 30 29 33 32 28 34 33 26 28 29 29
server-0026 rh62-0024 31 28 34 27 28 25 24 31 33 34 37 35 37 33 30 30
server-0027 rh62-0025 27 29 25 32 30 26 26 31 34 29 30 33 28 33 25 31
server-0028 rh62-0026 33 27 28 24 27 21 30 30 27 27 30 32 33 31 29 27
server-0029 rh62-0027 30 28 24 26 24 26 29 33 34 25 26 29 29 30 26 27
server-0030 rh62-0028 27 28 36 27 23 26 30 27 30 29 30 28 32 35 30 29
server-0031 rh62-0029 27 31 19 26 30 31 31 32 30 36 32 25 26 30 19 28
server-0032 rh62-0030 22 23 19 24 23 24 21 21 26 24 34 25 22 26 22 27
```

Cray ACE™ Software Management Features

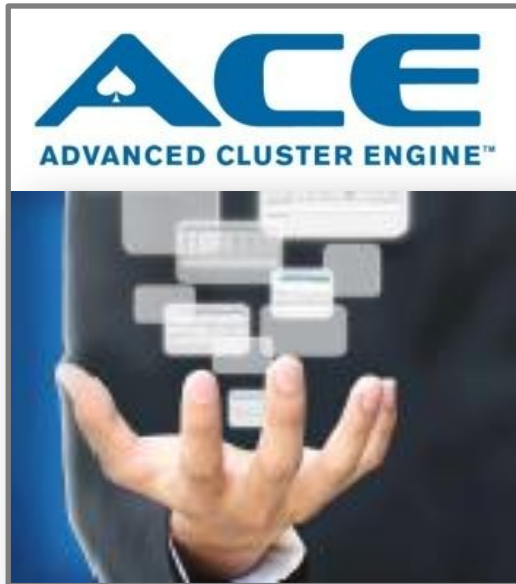


- **Network Management (InfiniBand and Ethernet)**
 - Automatic discovery of interconnect hardware
 - Redundant paths and networks (dual-rail optional)
 - Failover for dual-rail networks
 - Integrates network status into management system



- **Storage**
 - Supports Lustre, NFS, Panasas
 - High bandwidth to secondary storage

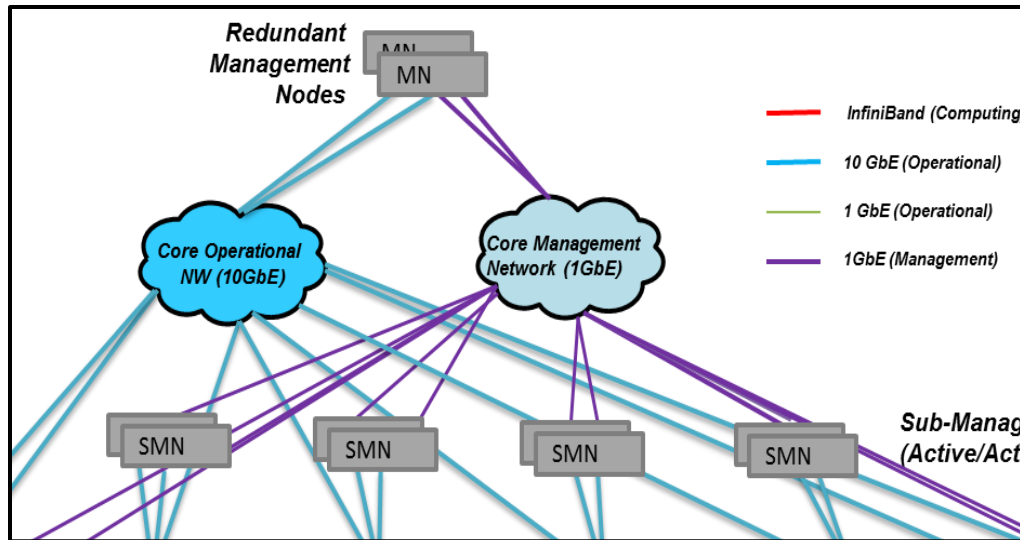
Cray ACE™ Software Management Benefits



- Hierarchical management system
- Diskless/Stateless Computing Environment
- Reduced System Administration

Cray ACE™ Software Management Benefits

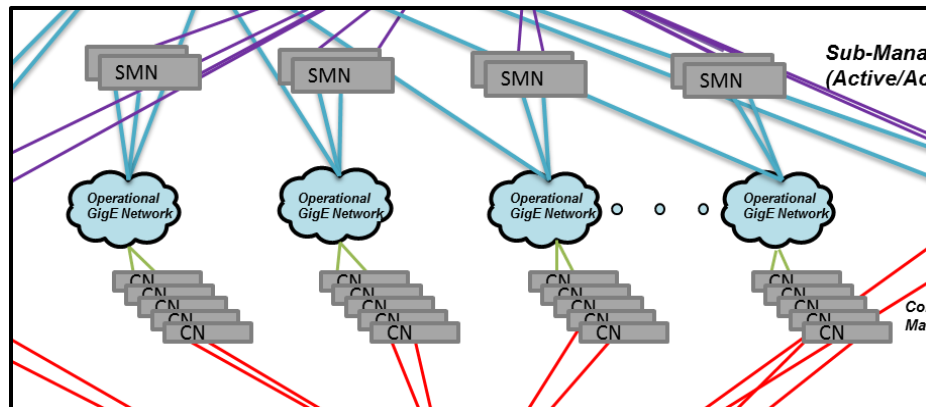
- **Hierarchical Management System**
 - Hardware scalability through the use of sub-management servers
 - Management scalability through dynamic provisioning of cluster images – if you can manage a one-node system, you can manage a 10,000-node system



Cray ACE™ Software Management Benefits

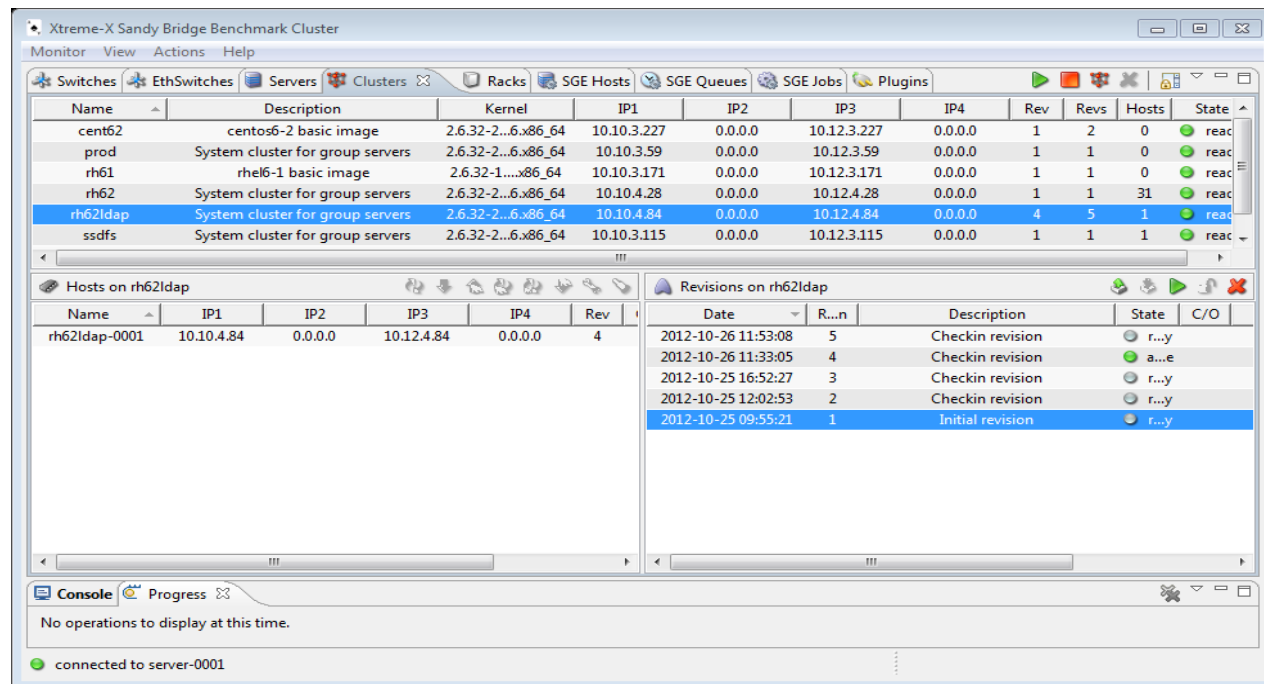
- **Diskless/Stateless Computing Environment**

- Dynamic provisioning of OS and run-time environment
- Scalable network booting
- Ability to use a full kernel and OS without requiring a large amount of memory on each node
- Removes need for local hard drives, reducing MTBI for the compute node
- Reduces complexity of managing and synchronizing thousands of states at the compute node level
- Scalable access to root file system using a network block device
 - Only required files and data are pulled from the management servers, and sub-management servers cache all required data



Cray ACE™ Software Management Benefits

- **Reduced System Administration**
 - OS, run-time, and support programs all stored in one location
 - Streamlines system administration
 - Minimizes security risks
 - System Administration time is not impacted by the number of nodes
 - Revision system allows sys admin to quickly provision nodes with different OS and run-time environment

The screenshot shows the 'Xtreme-X Sandy Bridge Benchmark Cluster' interface. The main table lists various system clusters with their descriptions, kernels, and IP addresses. The 'rh62ldap' cluster is highlighted in blue.

| Name | Description | Kernel | IP1 | IP2 | IP3 | IP4 | Rev | Revs | Hosts | State |
|----------|----------------------------------|---------------------|-------------|---------|-------------|---------|-----|------|-------|----------|
| cent62 | centos6-2 basic image | 2.6.32-2...6.x86_64 | 10.10.3.227 | 0.0.0.0 | 10.12.3.227 | 0.0.0.0 | 1 | 2 | 0 | reactive |
| prod | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.3.59 | 0.0.0.0 | 10.12.3.59 | 0.0.0.0 | 1 | 1 | 0 | reactive |
| rh61 | rhel6-1 basic image | 2.6.32-1...x86_64 | 10.10.3.171 | 0.0.0.0 | 10.12.3.171 | 0.0.0.0 | 1 | 1 | 0 | reactive |
| rh62 | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.4.28 | 0.0.0.0 | 10.12.4.28 | 0.0.0.0 | 1 | 1 | 31 | reactive |
| rh62ldap | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.4.84 | 0.0.0.0 | 10.12.4.84 | 0.0.0.0 | 4 | 5 | 1 | reactive |
| ssdfs | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.3.115 | 0.0.0.0 | 10.12.3.115 | 0.0.0.0 | 1 | 1 | 1 | reactive |

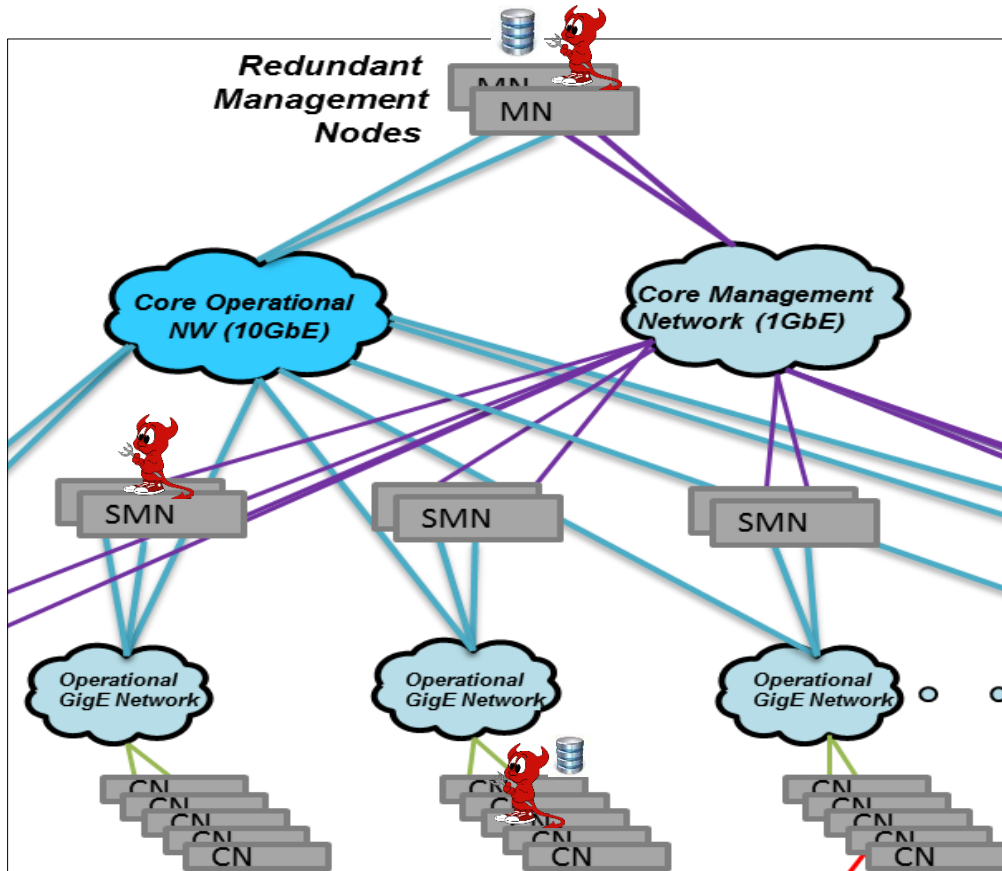
Below the main table, there are two sub-tables for the 'rh62ldap' cluster:

| Hosts on rh62ldap | | | | | |
|-------------------|------------|---------|------------|---------|-----|
| Name | IP1 | IP2 | IP3 | IP4 | Rev |
| rh62ldap-0001 | 10.10.4.84 | 0.0.0.0 | 10.12.4.84 | 0.0.0.0 | 4 |

| Revisions on rh62ldap | | | | |
|-----------------------|-----|------------------|-------|-----|
| Date | Rev | Description | State | C/O |
| 2012-10-26 11:53:08 | 5 | Checkin revision | r...y | |
| 2012-10-26 11:33:05 | 4 | Checkin revision | a...e | |
| 2012-10-25 16:52:27 | 3 | Checkin revision | r...y | |
| 2012-10-25 12:02:53 | 2 | Checkin revision | r...y | |
| 2012-10-25 09:55:21 | 1 | Initial revision | r...y | |

At the bottom, a console window shows the message: 'No operations to display at this time.' and a status indicator 'connected to server-0001'.

Cray ACE™ Software Management Components



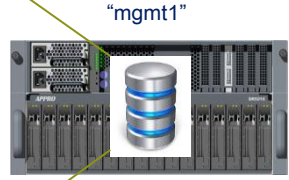
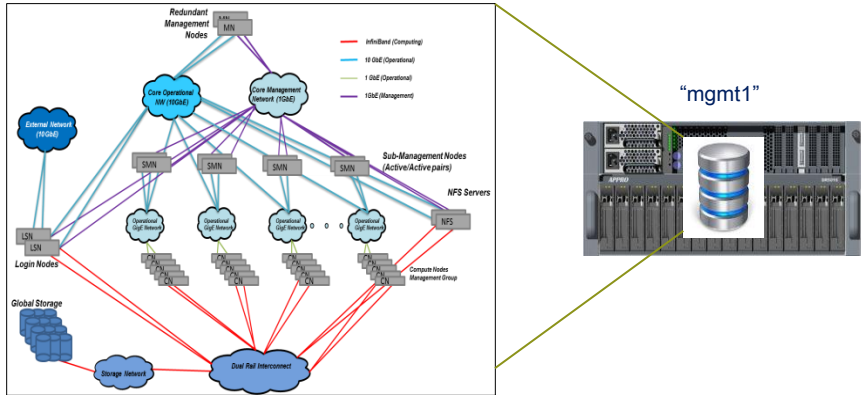
- **Daemons**

- ACE Daemon (aced) runs on Management Server
- ACE Server (ace_server) runs on sub-management and compute servers.

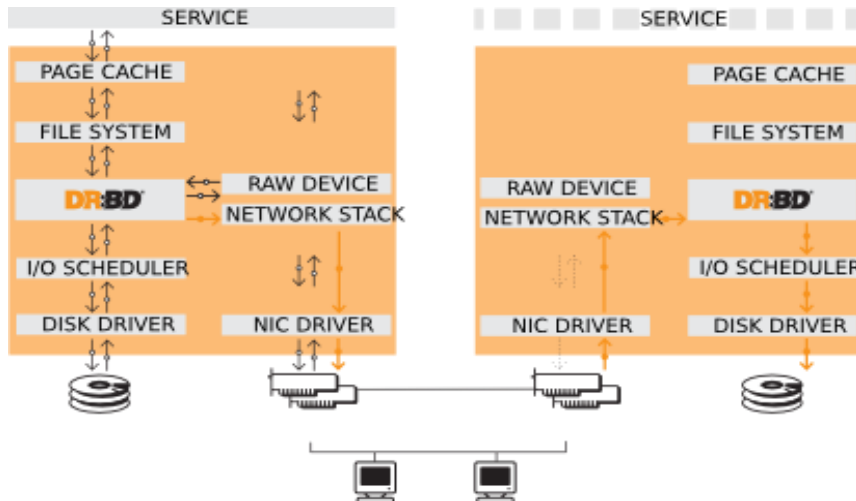
- **Data**

- ACE database and “/ha_cluster” fault-tolerant file system on Management Servers
- ACE database on Compute Server (reduced, synchronized copy)

Cray ACE™ Software Management Data and File Systems

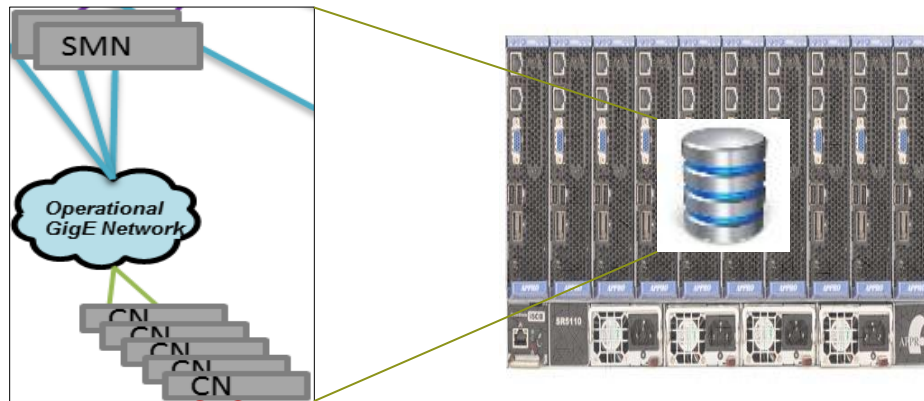


- Management Servers
 - ACE database
 - System Configuration
 - Server Configuration
 - Cluster Configuration
 - Network Connections
 - Status of Servers, Switches, and Ports
 - /ha_cluster file system
 - Fault tolerant with HA configuration
 - DRBD Sync
 - Cluster storage (/home and /global)



Cray ACE™ Software Management Data and File Systems

- Compute Servers – ACE Database
 - ACE Database
 - Reduced synchronized copy
 - A subset related to only that Sub-Management Server's group



Cray ACE™ Software Management Interfaces



ACE™

Command Line Interface

ACE™ GUI

Graphical User Interface

```

susan.kraus@osprey1:~$ ace servers
Name      Type      X Y Z N Grp Rack Slot Blade Host      Net1 Net2 State
server-0001 management 1 1 1 1 1 1 33 - osprey1 up up active
server-0002 management 1 1 1 2 1 1 2 - osprey2 down down disconnect
server-0003 compute 1 1 1 3 1 1 20 1 rh62-0001 up down active
server-0004 compute 1 1 1 4 1 1 20 2 rh62-0002 up down active
server-0005 compute 1 1 1 5 1 1 20 3 rh62-0003 up down active
server-0006 compute 1 1 1 6 1 1 20 4 rh62-0004 up down active
server-0007 compute 1 1 1 7 1 1 20 5 rh62-0005 up down active
server-0008 compute 1 1 1 8 1 1 20 6 rh62-0006 up down active
server-0009 compute 1 1 1 9 1 1 20 7 rh62-0007 up down active
server-0010 compute 1 1 1 10 1 1 20 8 rh62-0008 up down active
server-0011 compute 1 1 1 11 1 1 20 9 rh62-0009 up down active
    
```

The screenshot shows the ACE GUI interface for the 'Xtreme-X Sandy Bridge Benchmark Cluster'. The main window displays a table of server status with columns for Name, Type, N, Grp, Rack, Slot/U#, Blade, Host, Net1, Net2, State, BIOS, and HCA. Below the table is a console window showing log messages.

| Name | Type | N | Grp | Rack | Slot/U# | Blade | Host | Net1 | Net2 | State | BIOS | HCA |
|-------------|------------|----|-----|------|---------|-------|-----------|------|------|------------|-------------------|----------|
| server-0001 | management | 1 | 1 | 1 | 33 | | osprey1 | ● | ● | active | SESC600...2/2011) | 2.9.1000 |
| server-0002 | management | 2 | 1 | 1 | 2 | | osprey2 | ● | ● | disc...ted | | |
| server-0003 | compute | 3 | 1 | 1 | 20 | 1 | rh62-0001 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0004 | compute | 4 | 1 | 1 | 20 | 2 | rh62-0002 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0005 | compute | 5 | 1 | 1 | 20 | 3 | rh62-0003 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0006 | compute | 6 | 1 | 1 | 20 | 4 | rh62-0004 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0007 | compute | 7 | 1 | 1 | 20 | 5 | rh62-0005 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0008 | compute | 8 | 1 | 1 | 20 | 6 | rh62-0006 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0009 | compute | 9 | 1 | 1 | 20 | 7 | rh62-0007 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0010 | compute | 10 | 1 | 1 | 20 | 8 | rh62-0008 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0011 | compute | 11 | 1 | 1 | 20 | 9 | rh62-0009 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0012 | compute | 12 | 1 | 1 | 20 | 10 | rh62-0010 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0013 | compute | 13 | 1 | 1 | 15 | 1 | rh62-0011 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0014 | compute | 14 | 1 | 1 | 15 | 2 | rh62-0012 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0015 | compute | 15 | 1 | 1 | 15 | 3 | rh62-0013 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0016 | compute | 16 | 1 | 1 | 15 | 4 | rh62-0014 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0017 | compute | 17 | 1 | 1 | 15 | 5 | rh62-0015 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0018 | compute | 18 | 1 | 1 | 15 | 6 | rh62-0016 | ● | ● | active | SESC600...8/2012) | 2.10.700 |
| server-0019 | compute | 19 | 1 | 1 | 15 | 7 | rh62-0017 | ● | ● | active | SESC600...8/2012) | 2.10.700 |

ACE Log Console

```

2012-10-24 10:20:13.405 ERR Misconnected port: R02U25-P31 (switch-0002) should be connected to nothing, appears to be
2012-10-24 11:20:34.666 ERR Misconnected port: R01U40-P33 (switch-0001) should be connected to R01U15B07-CA1P1 (serve
2012-10-24 11:20:34.672 ERR Misconnected port: R02U25-P31 (switch-0002) should be connected to nothing, appears to be
2012-10-24 12:20:55.914 ERR Misconnected port: R01U40-P33 (switch-0001) should be connected to R01U15B07-CA1P1 (serve
2012-10-24 12:20:55.920 ERR Misconnected port: R02U25-P31 (switch-0002) should be connected to nothing, appears to be
2012-10-24 12:56:34.039 INF client ID 464 has closed connection
2012-10-24 13:21:17.166 ERR Misconnected port: R01U40-P33 (switch-0001) should be connected to R01U15B07-CA1P1 (serve
    
```

Cray ACE™ Software Management Interfaces - CLI



- ACE Command Line Interface (CLI) invoked using “ace” command

```
[susan.kraus@osprey1 ~]$ ace help
```

The Appro Cluster Engine supports the following commands:

General Commands

| | |
|-----------|-------------------------|
| help | Print this help message |
| ping | Check connectivity |
| date | Show UTC date |
| time | Show time |
| log_flush | Flush logs to disk |
| debug_on | Turn debug logs on |
| debug_off | Turn debug logs off |
| version | Show ACE version |

Status Commands

| | |
|-------------|--|
| switches | Show switch status |
| ports | Show detailed switch port status |
| ethswitches | Show Ethernet switch status |
| servers | Show server status |
| clusters | Show cluster status |
| hosts | Show host status |
| revisions | Show revision status |
| get_logs | Show logs |
| loads | Show load status per server |
| memory | Show memory usage status per server |
| temps | Show CPU temperature status per server |

Server Commands

| | |
|----------|---------------------------------|
| poweron | Power on one or more servers |
| poweroff | Power off one or more servers |
| cycle | Power cycle one or more servers |
| reset | Power reset one or more servers |
| shutdown | Shutdown one or more servers |
| reboot | Reboot one or more servers |
| identify | Identify one or more servers |

Cluster Commands

| | |
|--------------|--------------------------------------|
| clone | Clone a cluster |
| delete | Delete a cluster |
| start | Start hosts on a cluster |
| stop | Stop hosts a cluster |
| update | Update the boot images for a cluster |
| checkin | Check in a cluster revision |
| checkout | Check out a cluster revision |
| release | Release a cluster revision |
| remove | Remove a cluster revision |
| activate | Activate a cluster revision |
| create | Create a cluster |
| export_image | Export cluster image to File |
| import_image | Import File(Cluster Image) to ACE |

Grid Engine Commands

| | |
|--------------------|----------------------------------|
| add_sge_host | Add hosts to Grid Engine |
| delete_sge_host | Delete hosts from Grid Engine |
| add_sge_cluster | Add clusters to Grid Engine |
| delete_sge_cluster | Delete clusters from Grid Engine |
| sge | Show hosts of Grid Engine |

Plugin Commands

| | |
|---------------|------------------|
| plugins | Show the Plugins |
| plugin_add | Add a Plugin |
| plugin_delete | Delete a Plugin |
| run | Run a Plugin |

Database Commands

| | |
|------|---|
| get | Get database information |
| put | Put data in to database |
| sync | Synchronize database with secondary storage |

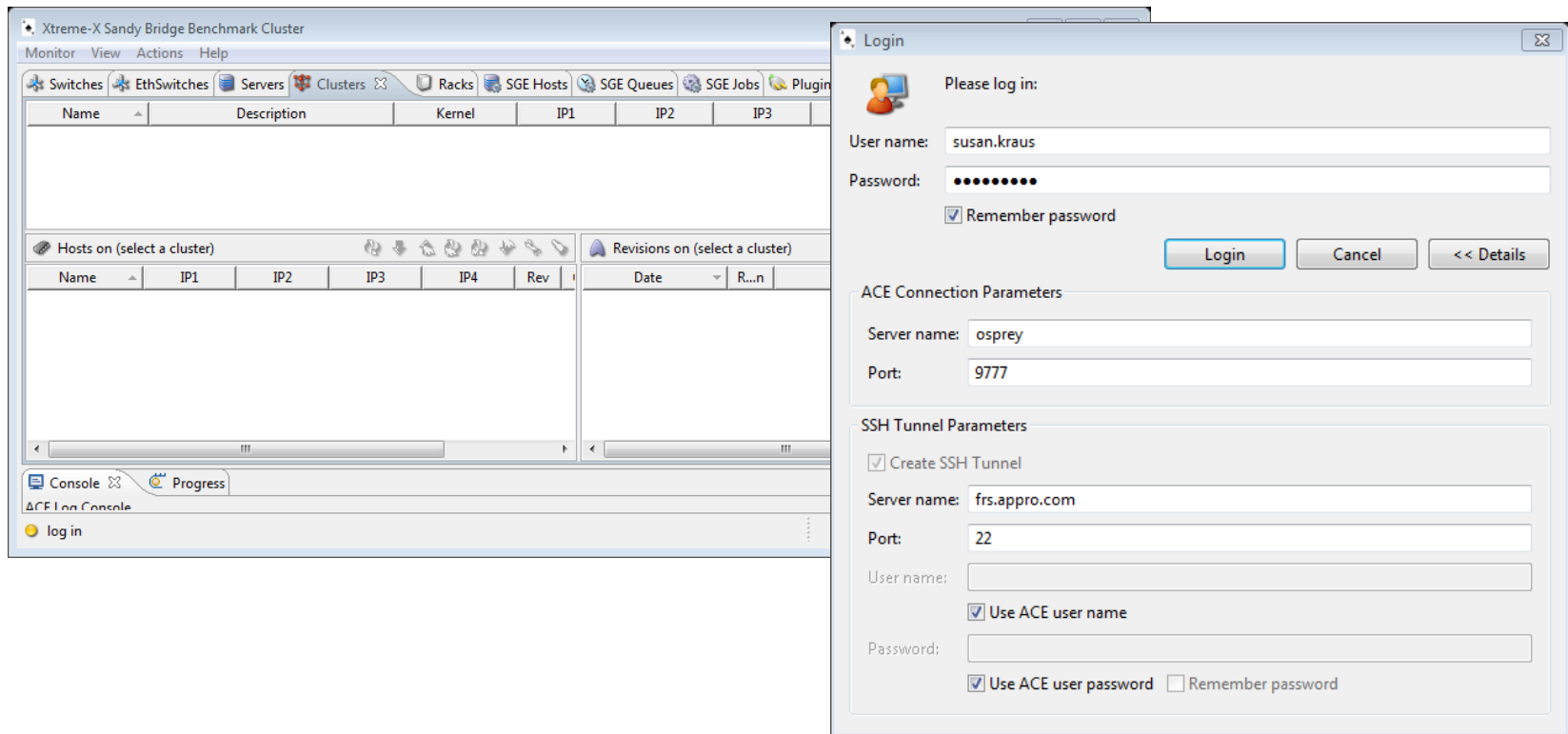
Network Commands

| | |
|----------|-------------------------------|
| restart1 | Restart infiniband network #1 |
| restart2 | Restart infiniband network #2 |

```
[susan.kraus@osprey1 ~]$
```

Cray ACE™ Software Management Interfaces - GUI

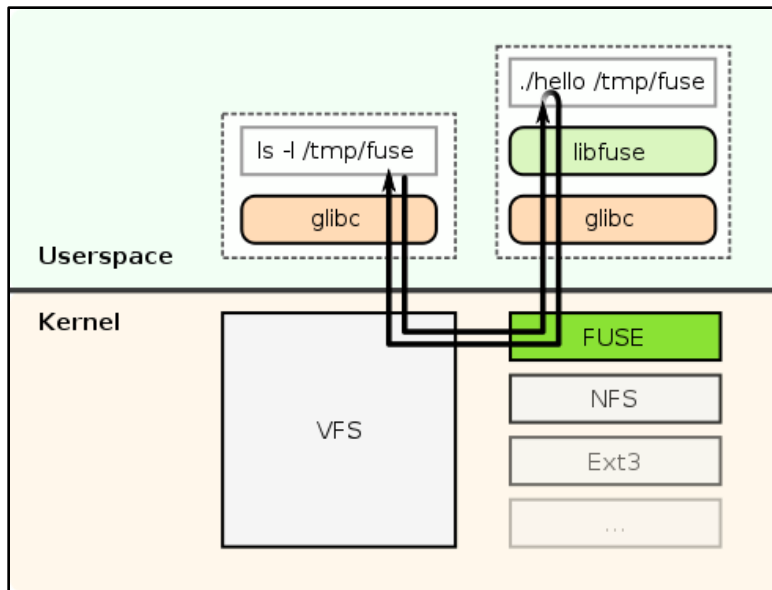
- **ACE Graphical User Interface (GUI)**
 - Efficient, responsive, eclipse-based GUI application
 - Updates automatically sent to GUI
 - Secure access through SSH tunnel
 - Supports Windows, Linux, Mac OS



Cray ACE™ Software Management Interfaces - ACEFS

- **ACEFS – ACE Fuse File System (File System In User Space)**

- A file system interface into the ACE database
- `/acefs` – on management servers
 - `/acefs/global` – globally applied to all clusters
 - `/acefs/clusters` – cluster specific which overrides global configuration
- `/.ace/acefs` – on compute servers
 - Read only file system on the compute servers



Cray ACE™ Software Management Interfaces - ACEFS



```
[susan.kraus@osprey1 ~]$ cd /acefs
[susan.kraus@osprey1 acefs]$ ls -la
total 8
drwxr-xr-x 10 root root 0 Oct 24 16:06 .
dr-xr-xr-x 28 root root 4096 Oct 11 03:06 ..
drwxr-xr-x 8 root root 0 Oct 24 16:06 clusters
drwxr-xr-x 2 root root 0 Oct 24 16:06 ethswitches
drwxr-xr-x 11 root root 0 Oct 24 16:05 global
drwxr-xr-x 12 root root 0 Oct 24 16:06 plugins
drwxr-xr-x 2 root root 0 Oct 24 16:06 self
drwxr-xr-x 42 root root 0 Oct 24 16:06 servers
drwxr-xr-x 5 root root 0 Oct 24 16:06 sgedb
drwxr-xr-x 4 root root 0 Oct 24 16:06 switches
[susan.kraus@osprey1 acefs]$ ls -la clusters
total 0
drwxr-xr-x 8 root root 0 Oct 24 16:06 .
drwxr-xr-x 10 root root 0 Oct 24 16:06 ..
drwxr-xr-x 8 root root 0 Oct 24 16:06 cent62
drwxr-xr-x 8 root root 0 Oct 24 16:06 prod
drwxr-xr-x 8 root root 0 Oct 24 16:06 rh61
drwxr-xr-x 8 root root 0 Oct 24 16:06 rh62
drwxr-xr-x 8 root root 0 Oct 24 16:06 ssdfs
drwxr-xr-x 8 root root 0 Oct 24 16:06 sysgrp
[susan.kraus@osprey1 acefs]$
```

```
[susan.kraus@osprey1 acefs]$ ls -la clusters/rh62
total 0
drwxr-xr-x 8 root root 0 Oct 24 16:07 .
drwxr-xr-x 8 root root 0 Oct 24 16:07 ..
-r--r--r-- 1 root root 2 Oct 24 16:07 clone
drwxr-xr-x 12 root root 0 Oct 24 16:07 control
-r--r--r-- 1 root root 33 Oct 24 16:07 desc
drwxr-xr-x 2 root root 0 Oct 24 16:07 files
-r--r--r-- 1 root root 59 Oct 24 16:07 hostfs_files
drwxr-xr-x 34 root root 0 Oct 24 16:07 hosts
-r--r--r-- 1 root root 2 Oct 24 16:07 id
-r--r--r-- 1 root root 2 Oct 24 16:07 initramfs
-r--r--r-- 1 root root 11 Oct 24 16:07 install
-r--r--r-- 1 root root 11 Oct 24 16:07 ip1
-r--r--r-- 1 root root 8 Oct 24 16:07 ip2
-r--r--r-- 1 root root 11 Oct 24 16:07 ip3
-r--r--r-- 1 root root 8 Oct 24 16:07 ip4
-r--r--r-- 1 root root 22 Oct 24 16:07 kernel
-r--r--r-- 1 root root 34 Oct 24 16:07 kernel_args
-r--r--r-- 1 root root 2 Oct 24 16:07 kickstart
-r--r--r-- 1 root root 0 Oct 24 16:07 ks_eth0
-r--r--r-- 1 root root 0 Oct 24 16:07 ks_eth1
-r--r--r-- 1 root root 0 Oct 24 16:07 ks_netmask
-r--r--r-- 1 root root 2 Oct 24 16:07 localboot
-r--r--r-- 1 root root 3 Oct 24 16:07 max_hosts
drwxr-xr-x 5 root root 0 Oct 24 16:07 mount
-r--r--r-- 1 root root 5 Oct 24 16:07 name
-r--r--r-- 1 root root 3 Oct 24 16:07 num_hosts
-r--r--r-- 1 root root 0 Oct 24 16:07 pxe
-r--r--r-- 1 root root 2 Oct 24 16:07 revision
-r--r--r-- 1 root root 0 Oct 24 16:07 revisions
-r--r--r-- 1 root root 2 Oct 24 16:07 state
-r--r--r-- 1 root root 0 Oct 24 16:07 storage
-r--r--r-- 1 root root 0 Oct 24 16:07 test_dir
-r--r--r-- 1 root root 275 Oct 24 16:07 tmpfs_files
prey1 acefs]$
```

```
[susan.kraus@osprey1 acefs]$ ls -la clusters/rh62/mount
total 0
drwxr-xr-x 5 root root 0 Oct 24 16:08 .
drwxr-xr-x 8 root root 0 Oct 24 16:08 ..
drwxr-xr-x 6 root root 0 Oct 24 16:08 boot_commands.d
drwxr-xr-x 5 root root 0 Oct 24 16:08 etc
drwxr-xr-x 2 root root 0 Oct 24 16:08 root
[susan.kraus@osprey1 acefs]$
```

Cray ACE™ Software Management Managed Objects



Servers

Management

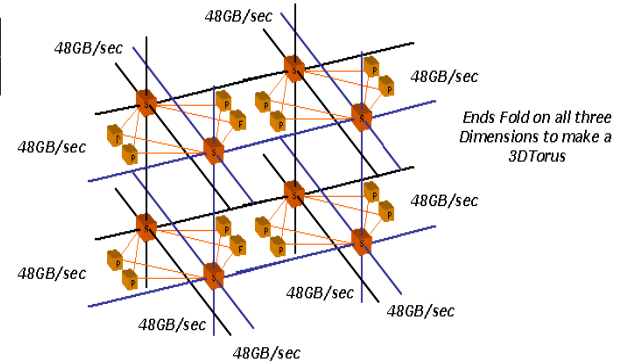


Compute



iSCB

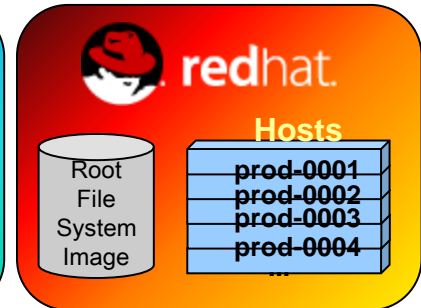
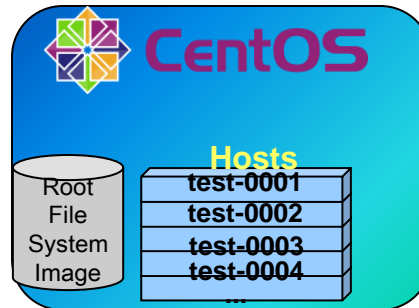
Networks



Storage



Clusters



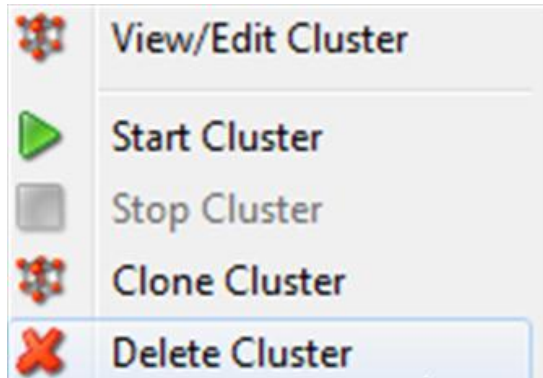
Cray ACE™ Software Management Cluster Operating Systems

ACE Cluster Operating Systems



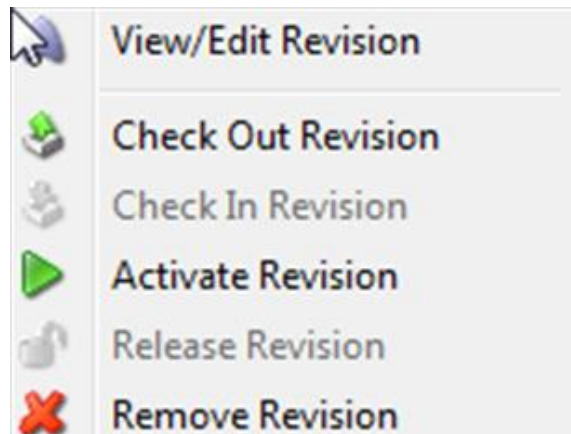
- Full CentOS, Red Hat, or SUSE installation
- Shared read-only root file system image
- Configuration files can be overridden or updated as necessary
- Cluster hosts with automatically configured IP addresses can be started on any compute node

Cray ACE™ Software Management Clusters

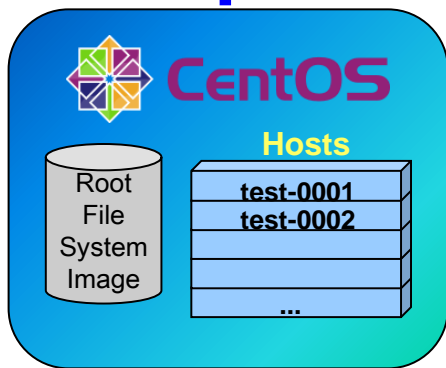
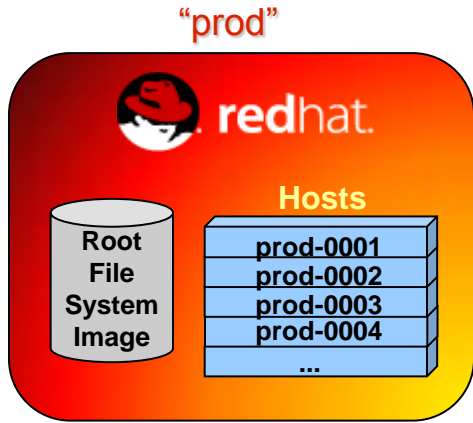


ACE cluster characteristics

- Can be dynamically started on the physical servers with a simple start command specifying the number of hosts
- Root file system can be updated by checking out a “revision host”
- Supports up to 10 revisions of the root file system image
- Can be cloned to create new clusters or exported to be shared with other sites



Cray ACE™ Software Management Cluster Provisioning with Diskless Nodes



"test"

Start Cluster

Start cluster named "test"?

Start how many hosts?

- server-0025
- server-0026
- server-0027
- server-0028
- server-0029

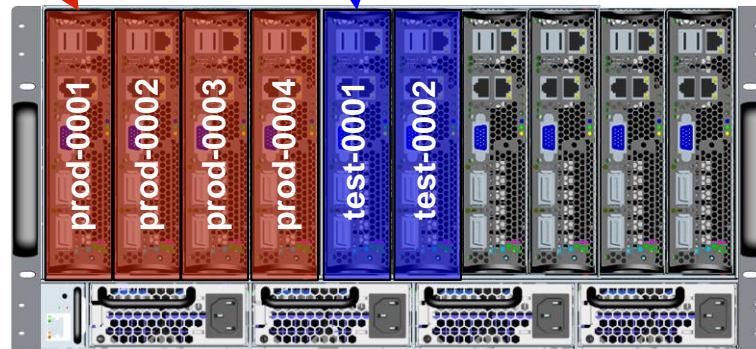
OK Cancel

connected to server-0002

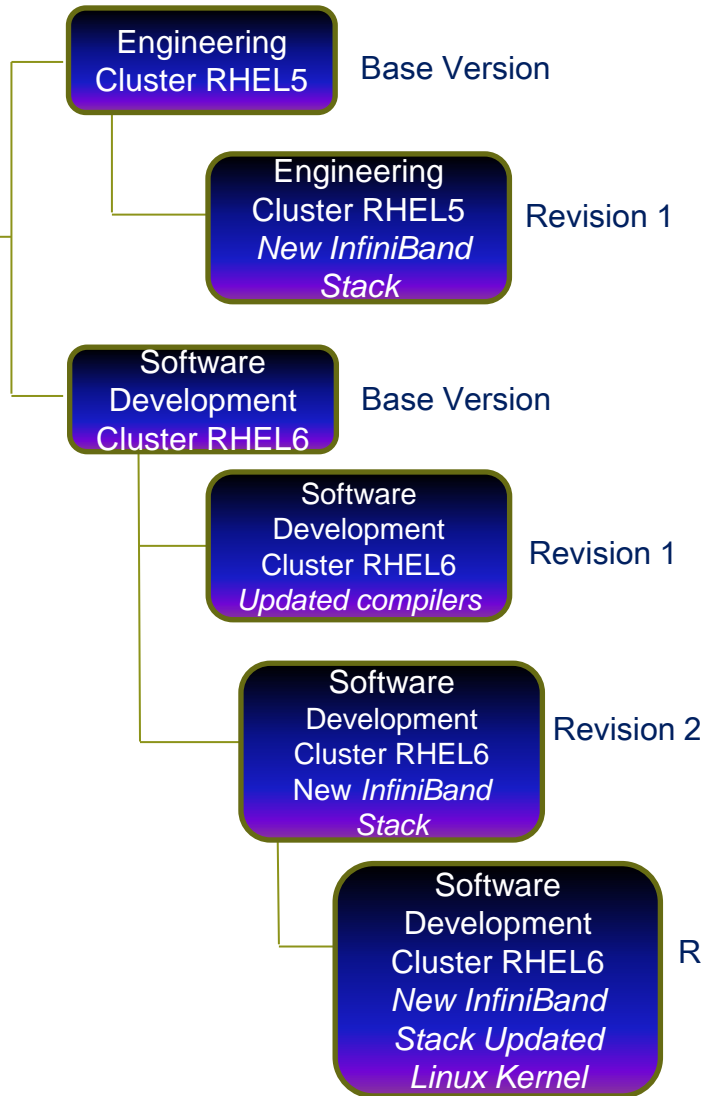
| Name | IP1 |
|-----------|------------|
| prod-0001 | 10.10.3.85 |
| prod-0002 | 10.10.3.86 |
| prod-0003 | 10.10.3.87 |
| prod-0004 | 10.10.3.88 |
| prod-0005 | 10.10.3.89 |
| prod-0006 | 10.10.3.90 |

ACE Log Console

```
2009-11-14 10:15:27.762 INF client ID 23 has closed connection
2009-11-14 10:15:27.762 INF Cluster test revision 1 successfully initialized
```



Cray ACE™ Software Management Cluster Revisions



Cluster Overview Table:

| Name | Description | Kernel | IP1 | IP2 | IP3 | IP4 | Rev | Revs | Hosts | State |
|----------|----------------------------------|--------------------|-------------|---------|-------------|---------|-----|------|-------|-------|
| cent62 | centos6-2 basic image | 2.6.32-2..6.x86_64 | 10.10.3.227 | 0.0.0.0 | 10.12.3.227 | 0.0.0.0 | 1 | 2 | 0 | reac |
| prod | System cluster for group servers | 2.6.32-2..6.x86_64 | 10.10.3.59 | 0.0.0.0 | 10.12.3.59 | 0.0.0.0 | 1 | 1 | 0 | reac |
| rh61 | rhel6-1 basic image | 2.6.32-1...x86_64 | 10.10.3.171 | 0.0.0.0 | 10.12.3.171 | 0.0.0.0 | 1 | 1 | 0 | reac |
| rh62 | System cluster for group servers | 2.6.32-2..6.x86_64 | 10.10.4.28 | 0.0.0.0 | 10.12.4.28 | 0.0.0.0 | 1 | 1 | 31 | reac |
| rh62ldap | System cluster for group servers | 2.6.32-2..6.x86_64 | 10.10.4.84 | 0.0.0.0 | 10.12.4.84 | 0.0.0.0 | 4 | 5 | 1 | reac |
| ssdfs | System cluster for group servers | 2.6.32-2..6.x86_64 | 10.10.3.115 | 0.0.0.0 | 10.12.3.115 | 0.0.0.0 | 1 | 1 | 1 | reac |

Hosts on rh62ldap:

| Name | IP1 | IP2 | IP3 | IP4 | Rev |
|---------------|------------|---------|------------|---------|-----|
| rh62ldap-0001 | 10.10.4.84 | 0.0.0.0 | 10.12.4.84 | 0.0.0.0 | 4 |

Revisions on rh62ldap:

| Date | R..n | Description | State | C/O |
|---------------------|------|------------------|-------|-----|
| 2012-10-26 11:53:08 | 5 | Checkin revision | r...y | |
| 2012-10-26 11:33:05 | 4 | Checkin revision | a...e | |
| 2012-10-25 16:52:27 | 3 | Checkin revision | r...y | |
| 2012-10-25 12:02:53 | 2 | Checkin revision | r...y | |
| 2012-10-25 09:55:21 | 1 | Initial revision | r...y | |

View/Edit Revision Context Menu:

- View/Edit Revision
- Check Out Revision
- Check In Revision
- Activate Revision
- Release Revision
- Remove Revision

Cray ACE™ Software Management Server Management



- Monitoring Servers
- Powering servers on and off via IPMI & iSCB
- Serial Console via SOL & iSCB
- Updating BIOS and system firmware

```

susan.kraus@osprey1:~
File Edit View Options Transfer Script Tools Window Help
Enter host <Alt+R>
susan.kraus@osprey1:~ x
[susan.kraus@osprey1 ~]$ ace servers
Name      Type      X  Y  Z  N  Grp  Rack  Slot  Blade  Host      Net1  Net2  State
server-0001 management 1  1  1  1  1    1    33   -    -    osprey1   up    up    active
server-0002 management 1  1  1  2  1    1    2   -    -    osprey2   down down disconnect
server-0003 compute   1  1  1  3  1    1    20   1    1    rh62-0001 up    down active
server-0004 compute   1  1  1  4  1    1    20   2    2    rh62-0002 up    down active
server-0005 compute   1  1  1  5  1    1    20   3    3    rh62-0003 up    down active
server-0006 compute   1  1  1  6  1    1    20   4    4    rh62-0004 up    down active
server-0007 compute   1  1  1  7  1    1    20   5    5    rh62-0005 up    down active
server-0008 compute   1  1  1  8  1    1    20   6    6    rh62-0006 up    down active
server-0009 compute   1  1  1  9  1    1    20   7    7    rh62-0007 up    down active
server-0010 compute   1  1  1 10  1    1    20   8    8    rh62-0008 up    down active
server-0011 compute   1  1  1 11  1    1    20   9    9    rh62-0009 up    down active
    
```

Xtreme-X Sandy Bridge Benchmark Cluster

Monitor View Actions Help

Switches EthSwitches Servers Clusters Racks SGE Hosts SGE Queues SGE Jobs Plugins

| Name | Type | N | Grp | Rack | Slot/U# | Blade | Host | Net1 | Net2 | State | BIOS | HCA |
|-------------|------------|----|-----|------|---------|-------|-----------|------|------|-------|------------------|----------|
| server-0001 | management | 1 | 1 | 1 | 33 | | osprey1 | ● | ● | ● | SE5C600...2/2011 | 2.9.1000 |
| server-0002 | management | 2 | 1 | 1 | 2 | | osprey2 | ● | ● | ● | disc...ted | |
| server-0003 | compute | 3 | 1 | 1 | 20 | 1 | rh62-0001 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0004 | compute | 4 | 1 | 1 | 20 | 2 | rh62-0002 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0005 | compute | 5 | 1 | 1 | 20 | 3 | rh62-0003 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0006 | compute | 6 | 1 | 1 | 20 | 4 | rh62-0004 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0007 | compute | 7 | 1 | 1 | 20 | 5 | rh62-0005 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0008 | compute | 8 | 1 | 1 | 20 | 6 | rh62-0006 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0009 | compute | 9 | 1 | 1 | 20 | 7 | rh62-0007 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0010 | compute | 10 | 1 | 1 | 20 | 8 | rh62-0008 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0011 | compute | 11 | 1 | 1 | 20 | 9 | rh62-0009 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0012 | compute | 12 | 1 | 1 | 20 | 10 | rh62-0010 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0013 | compute | 13 | 1 | 1 | 15 | 1 | rh62-0011 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0014 | compute | 14 | 1 | 1 | 15 | 2 | rh62-0012 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0015 | compute | 15 | 1 | 1 | 15 | 3 | rh62-0013 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0016 | compute | 16 | 1 | 1 | 15 | 4 | rh62-0014 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0017 | compute | 17 | 1 | 1 | 15 | 5 | rh62-0015 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0018 | compute | 18 | 1 | 1 | 15 | 6 | rh62-0016 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0019 | compute | 19 | 1 | 1 | 15 | 7 | rh62-0017 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |
| server-0020 | compute | 20 | 1 | 1 | 15 | 8 | rh62-0018 | ● | ● | ● | SE5C600...8/2012 | 2.10.700 |

Console Progress

No operations to display at this time.

connected to server-0001

- View/Edit Server
- Reboot Servers
- Shutdown Servers
- Power On Servers
- Power Cycle Servers
- Power Reset Servers
- Power Off Servers
- Change Server State
- Identify Servers

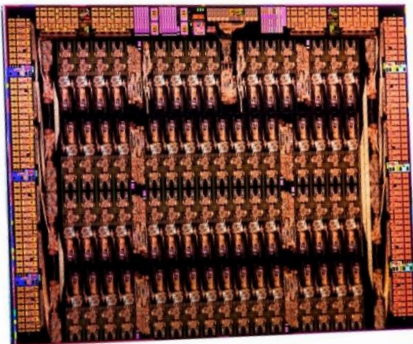
Cray ACE™ Software Management NVIDIA GPU Accelerator Management



- Ability to power on and off GPUs via the iSCB
- Pre-installed, pre-configured, device drivers plus CUDA environment installed in the compute node image

Cray ACE™ Software Management

Intel® Xeon Phi™ Coprocessor Management



- MIC support is automatically installed and configured by ACE
- MPSS software resides on small SSD or disk local to the host node
- Ethernet bridging supported – MICs can be accessed directly from cluster using hostname – “prod-0001-mic0”
- ACE system administrator has full control of the MICs from ACE – MIC status, boot, reboot, reset, and shutdown
- User accounts automatically propagate to MIC
- MIC status available from the ACE CLI and GUI
- ACE plugins will include the MIC tests supplied with the software stack
- Friendly user environment
 - Global file system available from the MIC
 - /opt/intel available from the MIC
 - Avoids having to copy libraries and binaries to the MIC

Cray ACE™ Software Management Cluster Management



- Starting Cluster Hosts
- Stopping Cluster Hosts
- Cloning Clusters
- Updating Clusters
 - Checking out/in
 - Activating

```

[susan.kraus@osprey1 ~]$ ace clusters
Name      Description      Kernel      IP1      IP2      IP3      IP4      Rev Revs Hosts State
cent62    centos6-2 basic image 2.6.32-220.el6.x86_64 10.10.3.227 0.0.0.0 10.12.3.227 0.0.0.0 1 2 0 ready
prod      System cluster for group servers 2.6.32-220.el6.x86_64 10.10.3.59 0.0.0.0 10.12.3.59 0.0.0.0 1 1 0 ready
rh61      rhel6-1 basic image 2.6.32-131.0.15.el6.x86_64 10.10.3.171 0.0.0.0 10.12.3.171 0.0.0.0 1 1 0 ready
rh62      System cluster for group servers 2.6.32-220.el6.x86_64 10.10.4.28 0.0.0.0 10.12.4.28 0.0.0.0 1 1 31 ready
rh62ldap System cluster for group servers 2.6.32-220.el6.x86_64 10.10.4.84 0.0.0.0 10.12.4.84 0.0.0.0 4 5 1 ready
ssdfs     System cluster for group servers 2.6.32-220.el6.x86_64 10.10.3.115 0.0.0.0 10.12.3.115 0.0.0.0 1 1 1 ready
sysgrp    System cluster for group servers 2.6.32-220.el6.x86_64 10.10.3.3 0.0.0.0 10.12.3.3 0.0.0.0 1 1 0 ready
    
```

Cluster Details Table:

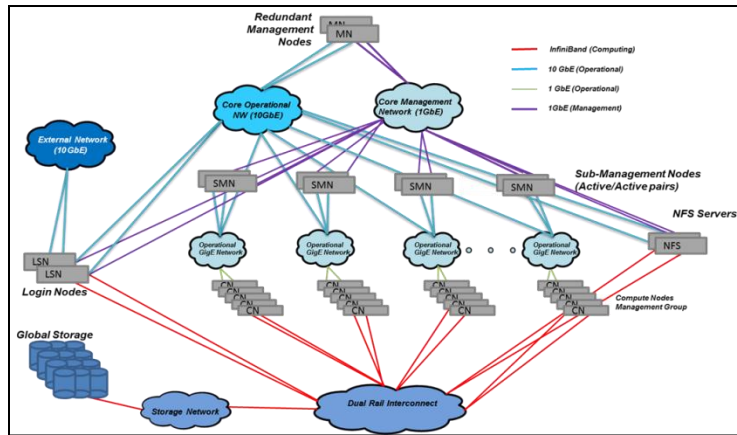
| Name | Description | Kernel | IP1 | IP2 | IP3 | IP4 | Rev | Revs | Hosts | State |
|----------|----------------------------------|---------------------|-------------|---------|-------------|---------|-----|------|-------|-------|
| cent62 | centos6-2 basic image | 2.6.32-2...6.x86_64 | 10.10.3.227 | 0.0.0.0 | 10.12.3.227 | 0.0.0.0 | 1 | 2 | 0 | ready |
| prod | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.3.59 | 0.0.0.0 | 10.12.3.59 | 0.0.0.0 | 1 | 1 | 0 | ready |
| rh61 | rhel6-1 basic image | 2.6.32-1...x86_64 | 10.10.3.171 | 0.0.0.0 | 10.12.3.171 | 0.0.0.0 | 1 | 1 | 0 | ready |
| rh62 | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.4.28 | 0.0.0.0 | 10.12.4.28 | 0.0.0.0 | 1 | 1 | 31 | ready |
| rh62ldap | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.4.84 | 0.0.0.0 | 10.12.4.84 | 0.0.0.0 | 4 | 5 | 1 | ready |
| ssdfs | System cluster for group servers | 2.6.32-2...6.x86_64 | 10.10.3.115 | 0.0.0.0 | 10.12.3.115 | 0.0.0.0 | 1 | 1 | 1 | ready |

Revisions on rh62ldap:

| Date | R...n | Description | State | C/O |
|---------------------|-------|------------------|-------|-----|
| 2012-10-26 11:53:08 | 5 | Checkin revision | r...y | |
| 2012-10-26 11:33:05 | 4 | Checkin revision | a...e | |
| 2012-10-25 16:52:27 | 3 | Checkin revision | r...y | |
| 2012-10-25 12:02:53 | 2 | Checkin revision | r...y | |
| 2012-10-25 09:55:21 | 1 | Initial revision | r...y | |

- View/Edit Cluster
- Start Cluster
- Stop Cluster
- Clone Cluster
- Delete Cluster
- View/Edit Revision
- Check Out Revision
- Check In Revision
- Activate Revision
- Release Revision
- Remove Revision

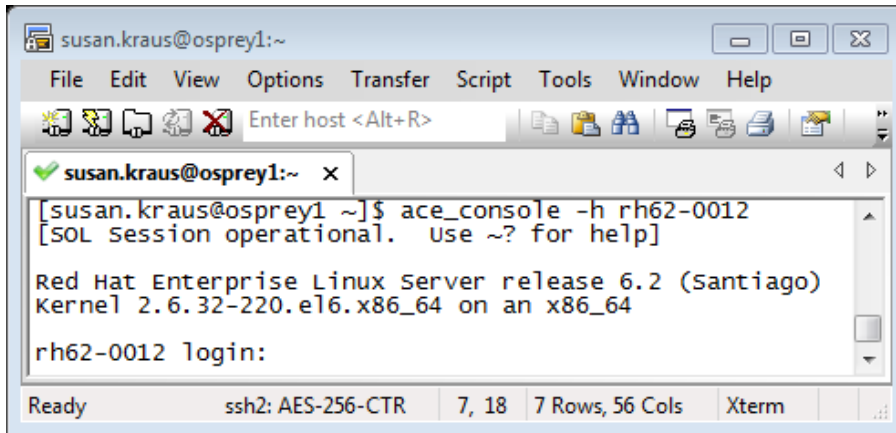
Cray ACE™ Software Management Cluster Management



- Redundant Hierarchical System Management
- Dual networks provide protection from network component failures - switches, cables, NICs
- All system states are managed on the redundant management servers
- All the system configuration data is kept on a fault tolerant data base and file system on the management servers - system configuration files, root file systems
- If the primary management server dies, the secondary management server takes over and the system stays up and running
- Redundant sub-management servers provide scaling of network services and caching of operating system.
- Scalable booting of compute servers - allows thousands of compute nodes to boot quickly and simultaneously

Cray ACE™ Software Management Configurations and Miscellaneous

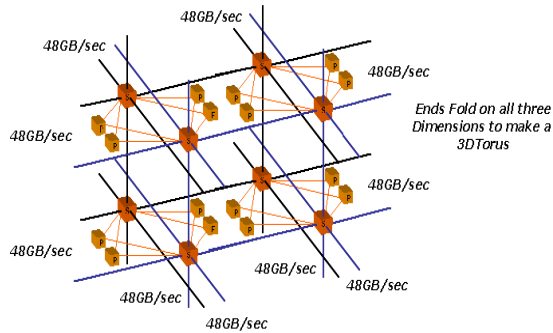
- Hosts management
 - /acefs/global/hosts – user controllable custom hosts
 - /acefs/global/all_hosts – ace controlled master hosts file includes /acefs/global/hosts
- User management – global password, group, shadow files
 - ace_useradd, ace_userdel, etc.
 - Cluster-unique files can be maintained under /acefs
- Serial Console via iSCB



```
susan.kraus@osprey1:~  
File Edit View Options Transfer Script Tools Window Help  
Enter host <Alt+R>  
susan.kraus@osprey1:~ x  
[susan.kraus@osprey1 ~]$ ace_console -h rh62-0012  
[SOL Session operational. Use ~? for help]  
Red Hat Enterprise Linux Server release 6.2 (Santiago)  
Kernel 2.6.32-220.el6.x86_64 on an x86_64  
rh62-0012 login:  
Ready          ssh2: AES-256-CTR    7, 18    7 Rows, 56 Cols    Xterm
```



Cray ACE™ Software Management Network Management



- Monitoring Infiniband Failures
- Monitoring Ethernet Failures
- Running Network Diagnostics

Xtreme-X ETRI Cluster

Switches Servers Clusters Racks SGE Hosts SGE Queues SGE Jobs Plugins

| Name | Subnet | Rack | Slot/U# | GUID | State | Ports |
|-------------|--------|------|---------|------------------|-------|-------|
| switch-0001 | 1 | 1 | 39 | 0002c90200428e48 | up | 15 |
| switch-0002 | 1 | 2 | 39 | 0002c90200425798 | up | 15 |

Ports on switch-0001

| Port | Rate (Gb/s) | MRate (Gb/s) | State | Connected To | | |
|------|-------------|--------------|-------|--------------|------|---------|
| | | | | Name | Rack | Slot/U# |
| 1 | 40 | 40 | up | switch-0002 | 2 | 39 |
| 2 | 40 | 40 | up | switch-0002 | 2 | 39 |
| 3 | 40 | 40 | up | switch-0002 | 2 | 39 |
| 4 | 40 | 40 | up | switch-0002 | 2 | 39 |

Console Progress

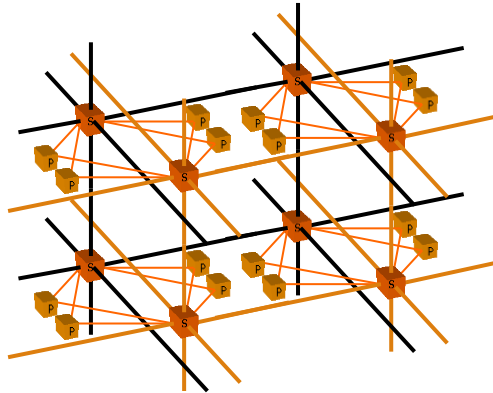
ACE Log Console

```

2011-12-02 07:31:13.024 INF client ID 81888 has closed connection
2011-12-02 07:31:23.104 INF client ID 81889 has closed connection
2011-12-02 07:31:33.178 INF client ID 81890 has closed connection
    
```

connected to server-0001

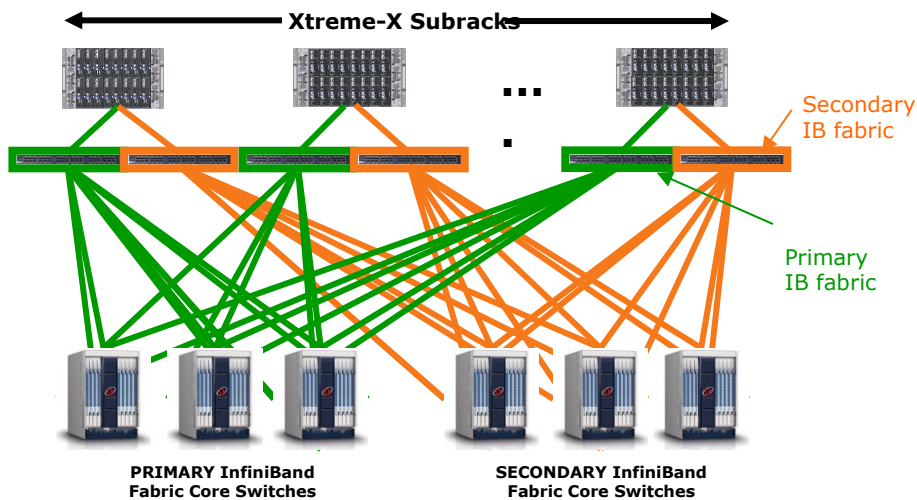
Cray ACE™ Software Management Support for Multiple Topologies



Scales to Thousands of Nodes

Single Rail and Dual Rail Fat-tree

- Distributed Core
- Large Director Class Core



2-D and 3-D Torus

- Single and dual rail
- Distributed IO

Cray ACE™ Software Management Job Management



SLURM

GRID ENGINE

- Queuing System Configuration
- Submitting Jobs
- Monitoring Jobs

Xtreme-X Sandy Bridge Benchmark Cluster

| Name | Arch | Load Avg | Num...es | Num Proc | Num Jobs | Mem Total | Mem Used | Swap Total | Swap Used |
|-------------|------------|----------|----------|----------|----------|-----------|----------|------------|-----------|
| cent62-0001 | lx26-amd64 | 0.14 | 2 | 32 | 0 | 63.0G | 986.3M | 0.0 | 0.0 |
| cent62-0002 | lx26-amd64 | | 2 | 32 | 0 | 63.0G | | 0.0 | |
| cent62-0003 | lx26-amd64 | 0.06 | 2 | 32 | 0 | 63.0G | 989.2M | | |
| cent62-0004 | lx26-amd64 | 0.14 | 2 | 32 | 0 | 63.0G | 987.6M | | |
| cent62-0005 | lx26-amd64 | 0.1 | 2 | 32 | 0 | 63.0G | 983.9M | | |
| cent62-0006 | lx26-amd64 | 0.15 | 2 | 32 | 0 | 63.0G | 985.6M | | |
| cent62-0007 | lx26-amd64 | 0.1 | 2 | 32 | 0 | 63.0G | 987.0M | | |
| cent62-0008 | lx26-amd64 | 0.12 | 2 | 32 | 0 | 63.0G | 984.3M | | |
| cent62-0009 | lx26-amd64 | 0.1 | 2 | 32 | 0 | 63.0G | 989.7M | | |
| cent62-0010 | lx26-amd64 | 0.16 | 2 | 32 | 0 | 63.0G | 988.3M | | |

Xtreme-X Sandy Bridge Benchmark Cluster

| Name | Host | Arch | Num Jobs | Type | Slots Total | Slots Used | State |
|-------|-------------|------------|----------|------|-------------|------------|-------|
| all.q | cent62-0001 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0002 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0003 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0004 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0005 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0006 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0007 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0008 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0009 | lx26-amd64 | 0 | BIP | 1 | 0 | u |
| all.q | cent62-0010 | lx26-amd64 | 0 | BIP | 1 | 0 | u |

Xtreme-X Sandy Bridge Benchmark Cluster

| Job Num | Queue | Host | Owner | Name | State | State | Slots | Submit Time | Urg | Start Time | Prio | Ma |
|---------|-------|---------------|-------------|-----------------|-------|---------|-------|-------------|-----|---------------------|-------|----|
| 589 | all.q | rh621...-0001 | susan.kraus | Run_alltoall.sh | r | running | 32 | | 0 | 2012-10-29 10:29:49 | 0.555 | MA |
| 589 | all.q | rh621...-0001 | susan.kraus | Run_alltoall.sh | r | running | 16 | | 0 | 2012-10-29 10:29:49 | 0.555 | SL |
| 589 | all.q | rh62-0001 | susan.kraus | Run_alltoall.sh | r | running | 16 | | 0 | 2012-10-29 10:29:49 | 0.555 | SL |

Cray ACE™ Software Management Plugins



The screenshot shows the 'Xtreme-X Sandy Bridge Benchmark Cluster' management interface. The 'Plugins' tab is active, displaying a list of plugins and a detailed view of the 'pingpong' plugin.

| Name | Type | Min | Max | User | Ti...ut |
|-------------|------|-----|-----|------|---------|
| hpl | test | 0 | 0 | | 120 |
| pingpong_r2 | test | 0 | 0 | | 3600 |
| updatebmc | tool | 0 | 0 | | 36000 |
| pingpong | test | 0 | 0 | | 3600 |
| setbios | tool | 0 | 0 | | 36000 |
| updatebios | tool | 0 | 0 | | 36000 |
| ctcs | test | 0 | 0 | | 120 |
| netperf_10g | test | 0 | 0 | | 3600 |
| hello | test | 0 | 0 | | 120 |
| panfs_test | test | 0 | 0 | | 3600 |

| Name | IP1 | IP2 | IP3 | IP4 | Rev | C/O | Server |
|-----------|------------|---------|------------|---------|-----|-----|-------------|
| rh62-0017 | 10.10.4.44 | 0.0.0.0 | 10.12.4.44 | 0.0.0.0 | 1 | | server-0019 |
| rh62-0018 | 10.10.4.45 | 0.0.0.0 | 10.12.4.45 | 0.0.0.0 | 1 | | server-0020 |
| rh62-0019 | 10.10.4.46 | 0.0.0.0 | 10.12.4.46 | 0.0.0.0 | 1 | | server-0021 |
| rh62-0020 | 10.10.4.47 | 0.0.0.0 | 10.12.4.47 | 0.0.0.0 | 1 | | server-0022 |
| rh62-0021 | 10.10.4.48 | 0.0.0.0 | 10.12.4.48 | 0.0.0.0 | 1 | | server-0023 |
| rh62-0022 | 10.10.4.49 | 0.0.0.0 | 10.12.4.49 | 0.0.0.0 | 1 | | server-0024 |
| rh62-0023 | 10.10.4.50 | 0.0.0.0 | 10.12.4.50 | 0.0.0.0 | 1 | | server-0025 |
| rh62-0024 | 10.10.4.51 | 0.0.0.0 | 10.12.4.51 | 0.0.0.0 | 1 | | server-0026 |
| rh62-0025 | 10.10.4.52 | 0.0.0.0 | 10.12.4.52 | 0.0.0.0 | 1 | | server-0027 |
| rh62-0026 | 10.10.4.53 | 0.0.0.0 | 10.12.4.53 | 0.0.0.0 | 1 | | server-0028 |


```
n_loops=50 n_bytes=8388608 useClock=1
rh62-0024 <<=====>> rh62-0025           5992 MBS           0.1 Sec.
```

connected to server-0001

Run Plugin

Run Plugin named "pingpong"?

Run how many hosts? 2

- rh62-0024
- rh62-0025

OK Cancel

Cray ACE™ Software Management Demo



An ACE cluster is available for remote or on-site testing at Cray Cluster Solution's Advanced Computing Center in The Woodlands, TX

ACE Dev Cluster

Monitor View Actions Help

Switches EthSwitches Servers Clusters Racks SGE Hosts SGE Queues SGE Jobs Plugins

| Name | Type | L1 | N | Grp | Rack | Slot/U# | Blade | Host | Net1 | Net2 | State | BIOS | HCA | |
|-------------|------------|----|----|-----|------|---------|-------|-----------|------|------|-------|---------|--------------------|----------|
| server-0001 | management | 1 | 1 | 1 | 1 | 1 | 1 | phaeton1 | ● | ● | ● | active | SE5C600....9/2011) | 2.9.1000 |
| server-0002 | management | 1 | 2 | 1 | 1 | 1 | 2 | phaeton2 | ● | ● | ⊗ | unknown | | |
| server-0003 | compute | 1 | 3 | 1 | 7 | 1 | 1 | prod-0001 | ● | ● | ● | active | SE5C600....2/2011) | 2.11.500 |
| server-0004 | compute | 1 | 4 | 1 | 7 | 1 | 2 | prod-0002 | ● | ● | ● | active | SE5C600....2/2011) | 2.11.500 |
| server-0005 | compute | 1 | 5 | 1 | 7 | 2 | 3 | prod-0003 | ● | ● | ● | active | SE5C600....2/2011) | 2.11.500 |
| server-0006 | compute | 1 | 6 | 1 | 7 | 2 | 4 | prod-0004 | ● | ● | ● | active | SE5C600....2/2011) | 2.11.500 |
| server-0007 | compute | 1 | 7 | 1 | 7 | 2 | 5 | prod-0005 | ● | ● | ⊖ | off | SE5C600....8/2012) | |
| server-0008 | compute | 1 | 8 | 1 | 7 | 1 | | abc-0001 | ● | ● | ● | active | SE5C600....1/2012) | 2.11.500 |
| server-0009 | compute | 1 | 9 | 1 | 7 | 3 | | abc-0002 | ● | ● | ● | active | SE5C600....5/2012) | |
| server-0010 | compute | 1 | 10 | 1 | 1 | 2 | 6 | | ● | ● | ⊗ | unknown | | |

Console Progress

● connected to server-0001

Cray Cluster Solutions Division

Advanced Computing Center



The ACC supports compute resources for software development, benchmarking, testing, and training



ACC
The Woodlands, TX



Cray Cluster Software Stack

Thank You
Questions?

