The ORNL Cluster Computing Experience…

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Scalable Systems Software

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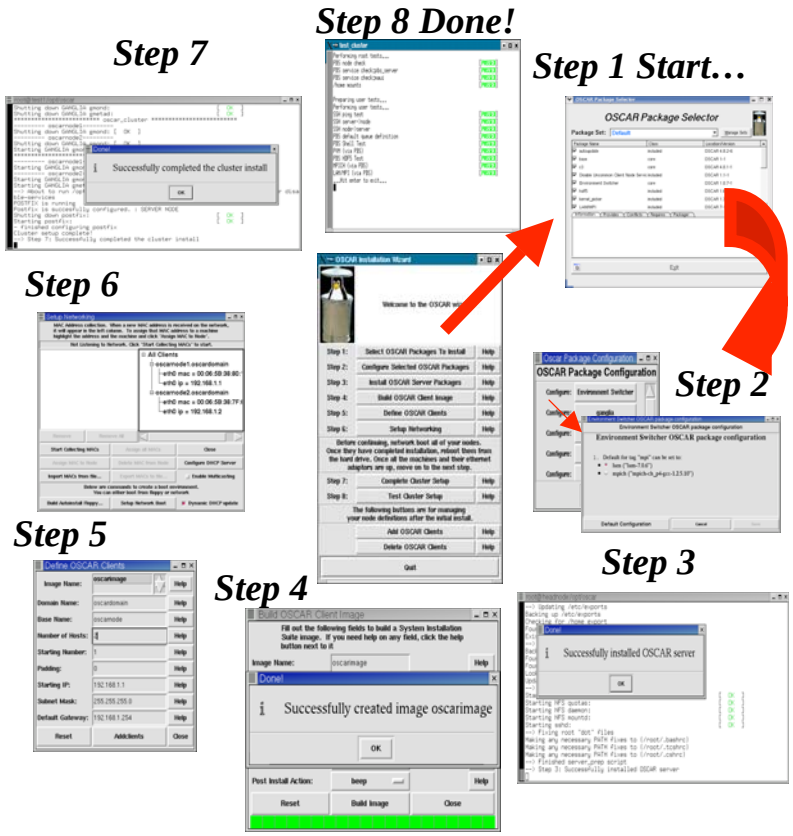
Open Source Cluster Application Resources

What is OSCAR?

- OSCAR Framework (cluster installation configuration and management)
  - Remote installation facility
  - Small set of “core” components
  - Modular package & test facility
  - Package repositories
- Use “best known methods”
  - Leverage existing technology where possible
- Wizard based cluster software installation
  - Operating system
  - Cluster environment
    - Administration
    - Operation
- Automatically configures cluster components
- Increases consistency among cluster builds
- Reduces time to build / install a cluster
- Reduces need for expertise



OSCAR Components

- Administration/Configuration
  - SIS, C3, OPIUM, Kernel-Picker, NTPconfig cluster services (dhcp, nfs, ...)
  - Security: Pfilter, OpenSSH

- HPC Services/Tools
  - Parallel Libs: MPICH, LAM/MPI, PVM
  - Torque, Maui, OpenPBS
  - HDF5
  - Ganglia, Clumon, … [monitoring systems]
  - *Other 3rd party OSCAR Packages*

- Core Infrastructure/Management
  - System Installation Suite (SIS), Cluster Command & Control (C3), Env-Switcher,
  - OSCAR DAtabase (ODA), OSCAR Package Downloader (OPD)

OSCAR Background

- Concept first discussed in January 2000
- First organizational meeting in April 2000
  - Cluster assembly is time consuming & repetitive
  - Nice to offer a toolkit to automate
- First public review at SC 2000
- First public release in April 2001
- Use “best practices” for HPC clusters
  - Leverage wealth of open source components
  - Targeted modest size cluster (single network switch)
- Form umbrella organization to oversee cluster efforts
  - Open Cluster Group (OCG)

Open Source Community Development Effort

- Open Cluster Group (OCG)
  - Informal group formed to make cluster computing more practical for HPC research and development
  - Membership is open, direct by steering committee

- OCG working groups
  - OSCAR (core group)
  - HA-OSCAR (High Availability)
  - SSS-OSCAR (Scalable Systems Software)
  - SSI-OSCAR (Single System Image)

OSCAR Core Participants

- Intel
- Bald Guy Software
- Revolution Linux
- INRIA
- EDF
- Canada's Michael Smith Genome Sciences Center
- Indiana University
- Oak Ridge National Laboratory
- Louisiana Tech Univ.
- NEC HPC Europe

SSI-OSCAR

Single System Image Open Source Application Resources

- Easy use thanks to SSI systems
  - SMP illusion
  - High Performance
  - Fault Tolerance
- Easy management thanks to OSCAR
  - Automatic cluster install / update

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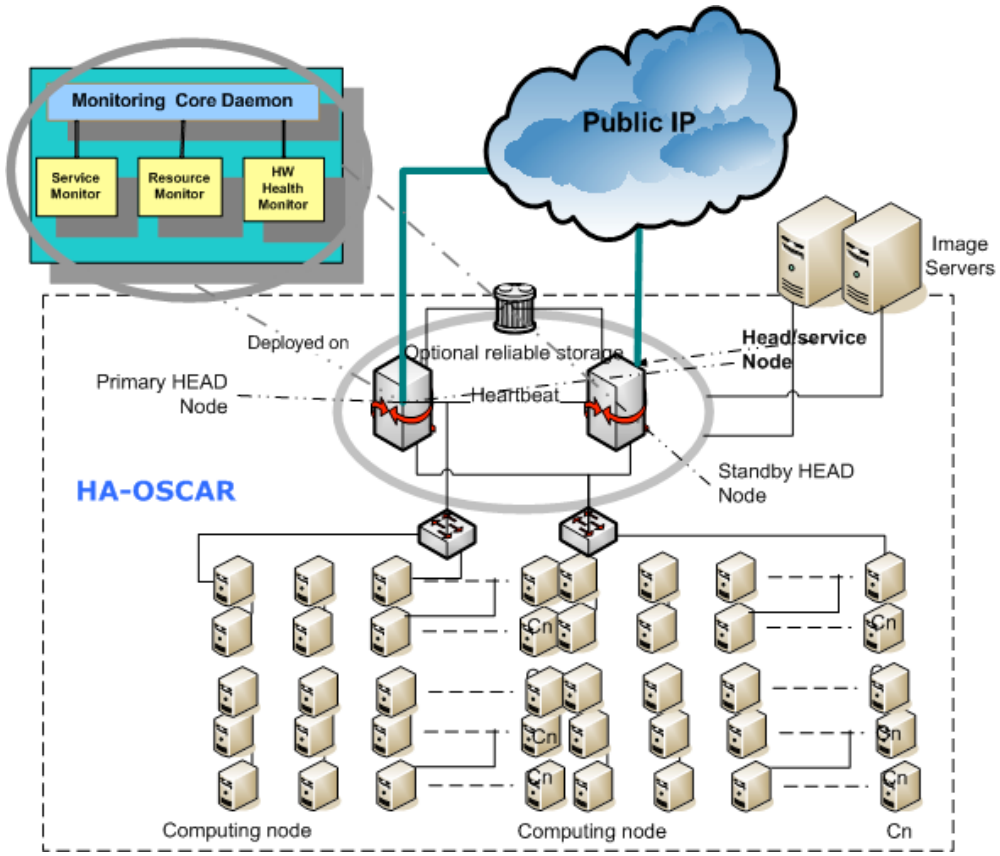
HA-OSCAR:

RAS Management for HPC cluster



- The first known field-grade open source HA Beowulf cluster release
- Self-configuration Multi-head Beowulf system
- HA and HPC clustering techniques to enable critical HPC infrastructure
- Active/Hot Standby
- Self-healing with 3-5 sec automatic failover time

SSS-OSCAR

Scalable System Software

Leverage OSCAR framework to package and distribute the Scalable System Software (SSS) suite, *sss-oscar*.

sss-oscar – A release of OSCAR containing all SSS software in single downloadable bundle.

SSS project developing standard interface for scalable tools

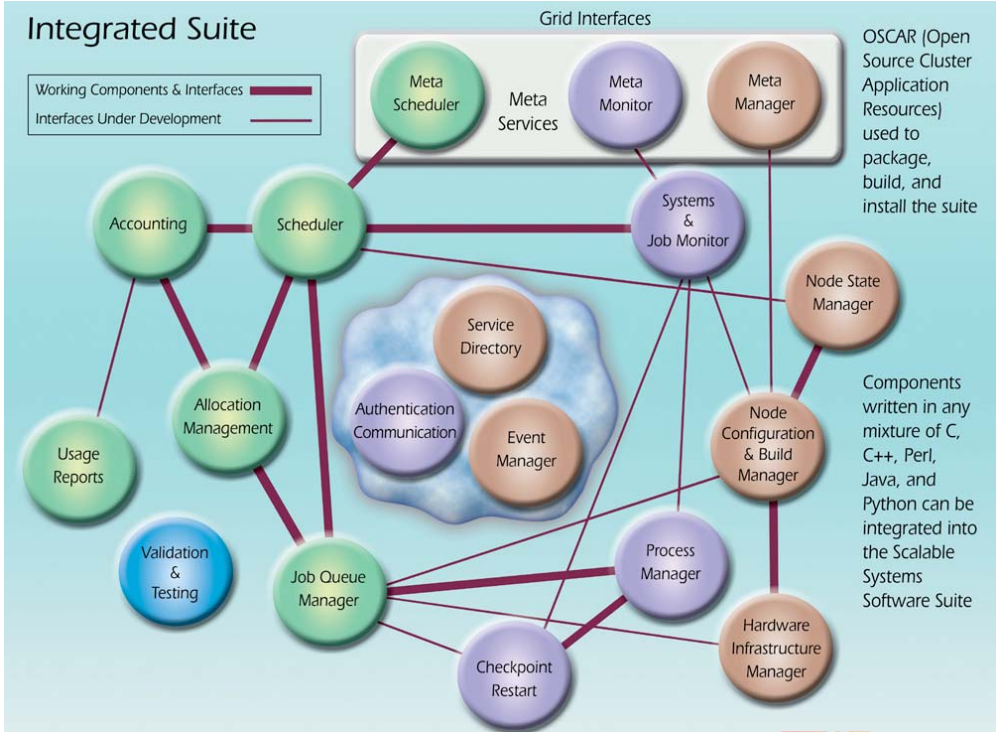
- Improve interoperability
- Improve long-term usability & manageability
- Reduce costs for supercomputing centers

Map out functional areas

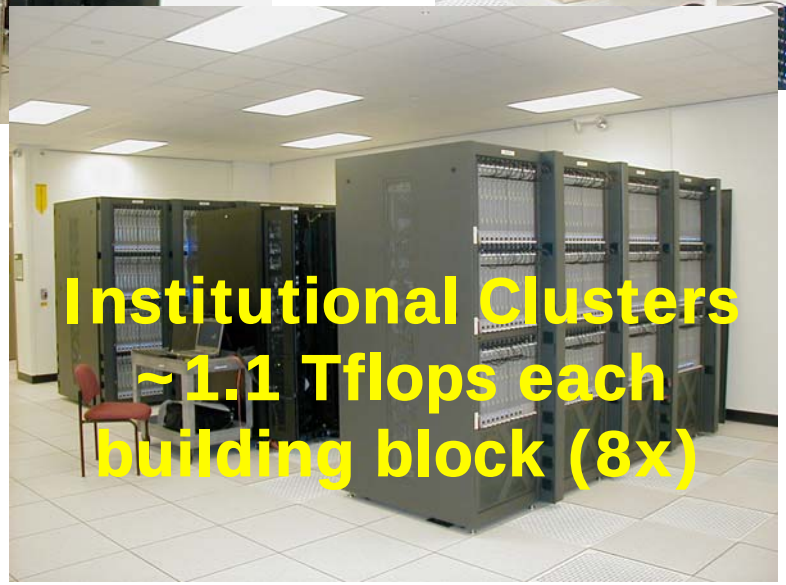
- Schedulers, Job Mangers
- System Monitors
- Accounting & User management
- Checkpoint/Restart
- Build & Configuration systems

Standardize the system interfaces

- Open forum of universities, labs, industry reps
- Define component interfaces in XML
- Develop communication infrastructure



Powered by OSCAR



C3 Power Tools

- Command-line interface for cluster system administration and parallel user tools.
- Parallel execution **`cexec`**
  - Execute across a single cluster or multiple clusters at same time
- Scatter/gather operations **`cpush/cget`**
  - Distribute or fetch files for all node(s)/cluster(s)
- Used throughout OSCAR and as underlying mechanism for tools like OPIUM's *useradd* enhancements.

C3 Building Blocks

- System administration
  - cpushimage - “push” image across cluster
  - cshutdown - Remote shutdown to reboot or halt cluster

- User & system tools
  - cpush - push single file -to- directory
  - crm - delete single file -to- directory
  - cget - retrieve files from each node
  - ckill - kill a process on each node
  - cexec - execute arbitrary command on each node
    - cexecs – serial mode, useful for debugging
  - clist – list each cluster available and it’s type
  - cname – returns a node name from a given node position
  - cnum – returns a node position from a given node name

What do I look for in students?

Attributes Leading to Success!

Personality & Attitude

- Adventurous
- Self starter
- Self learner
- Dedication
- Willing to work long hours
- Able to manage time
- Willing to fail (what!?)
- Work experience
- Responsible
- Mature personal and professional behavior

Academic

- Minimum of Sophomore standing
- CS major
- Above average GPA
- Extremely high faculty recommendations
- Good communication skills
- Two or more programming languages
- Data structures
- Software engineering

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