

Ohio Supercomputer Center

An **OH·TECH** Consortium Member

Introduction to High Performance Computing at the Ohio Supercomputer Center

Dr. Judy Gardiner

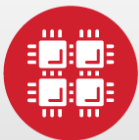
Spring 2014



Outline

- Overview
 - What is OSC?
 - HPC Concepts
 - Hardware Overview
 - Resource Grants and Accounts at OSC
- How to use our systems
 - User Environment
 - Batch Processing
 - Storage
 - Third-Party Software Applications
 - Policies





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What is the Ohio Supercomputer Center?

The OH-TECH Consortium



Ohio Supercomputer Center provides high performance computing, software, storage and support services for Ohio's scientists, faculty, students, businesses and their research partners.



OARnet connects Ohio's universities, colleges, K-12, health care and state and local governments to its high-speed fiber optic network backbone. OARnet services include co-location, support desk, federated identity and virtualization.



OhioLINK serves nearly 600,000 higher education students and faculty by providing a statewide system for sharing 50 million books and library materials, while aggregating costs among its 90 member institutions.



eStudent Services provides students increased access to higher education through e-learning and technology-enhanced educational opportunities, including virtual tutoring.



Research & Innovation Center will operate, when opened, as the proving grounds for next-generation technology infrastructure innovations and a catalyst for cutting-edge research and collaboration.



Ohio Innovates with the World



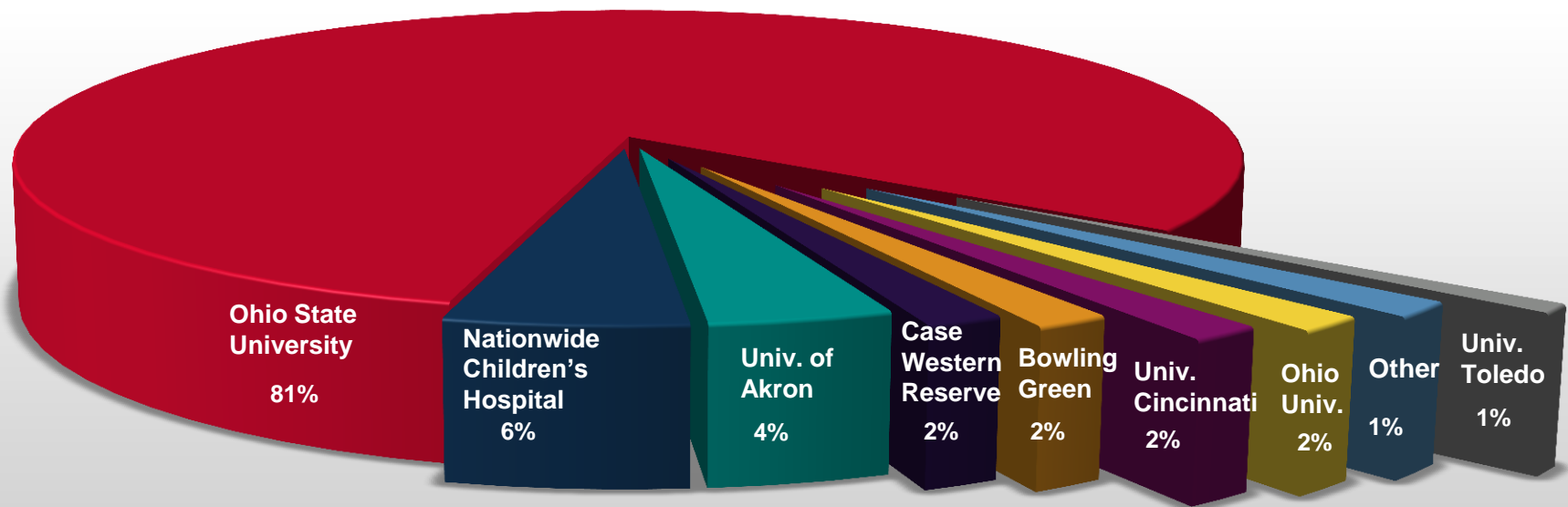


About OSC

- Founded in 1987
- Statewide resource for all universities in Ohio
 - high performance computing services
 - computational science expertise
 - “ ... propel Ohio's research universities and private industry to the forefront of computational based research.”
- Funded through the Ohio Board of Regents
- Reports to the Chancellor
- Located on OSU's west campus
- Fiscal agent is OSU



OSC 2012 Usage Data: Hours Used, By Institution





Science and Technology Support Group (STS)

- OSC Help
 - Help desk and basic consulting
 - Contact by phone or email (oschelp@osc.edu)
- Training
 - Usually three workshops per semester on a variety of topics
- Website
 - www.osc.edu/supercomputing
- Advanced consulting
 - Code parallelization & optimization
 - Software development, algorithm research



What can OSC provide you?

- “Capability computing”
 - Computation too large to run on laptop/desktop
- “Capacity computing”
 - Takes too long on laptop, need to make many runs
- Access to licensed software
 - Have academic licenses for many commercial packages
- Expertise, collaboration
 - Parallel computing, algorithms, web portals, etc.





Statewide Licensed Software

- Use the software in your lab or office
 - Connect to license server at OSC
- Software available
 - Altair Hyperworks
 - Totalview Debugger
 - Intel Compilers, Tools, Libraries
 - Portland Group Compilers
- Contact OSC Help
 - Provide your IP address





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HPC Concepts

Big Numbers

Prefix

- K
 - kilo, 10^3 , thousand
- M
 - mega, 10^6 , million
- G
 - giga, 10^9 , billion
- T
 - tera, 10^{12} , trillion
- P
 - peta, 10^{15} , quadrillion
- E
 - exa, 10^{18} , quintillion

Example: bytes

- 1KB – very small
- 12MB L2 cache per core
- 48GB memory per node
- .5 TB disk space per user
- 4 PB aggregate storage
- Exascale systems – current research area

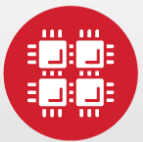




HPC Terminology

- Cluster
 - A group of computers (nodes) connected by a high-speed network, forming a supercomputer
- Node
 - Equivalent to a high-end workstation, part of a cluster
- Core
 - A processor (CPU), multiple cores per processor chip
- FLOPS
 - “FLoating-point Operations (calculations) Per Second”





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Hardware Overview



Supercomputers at OSC

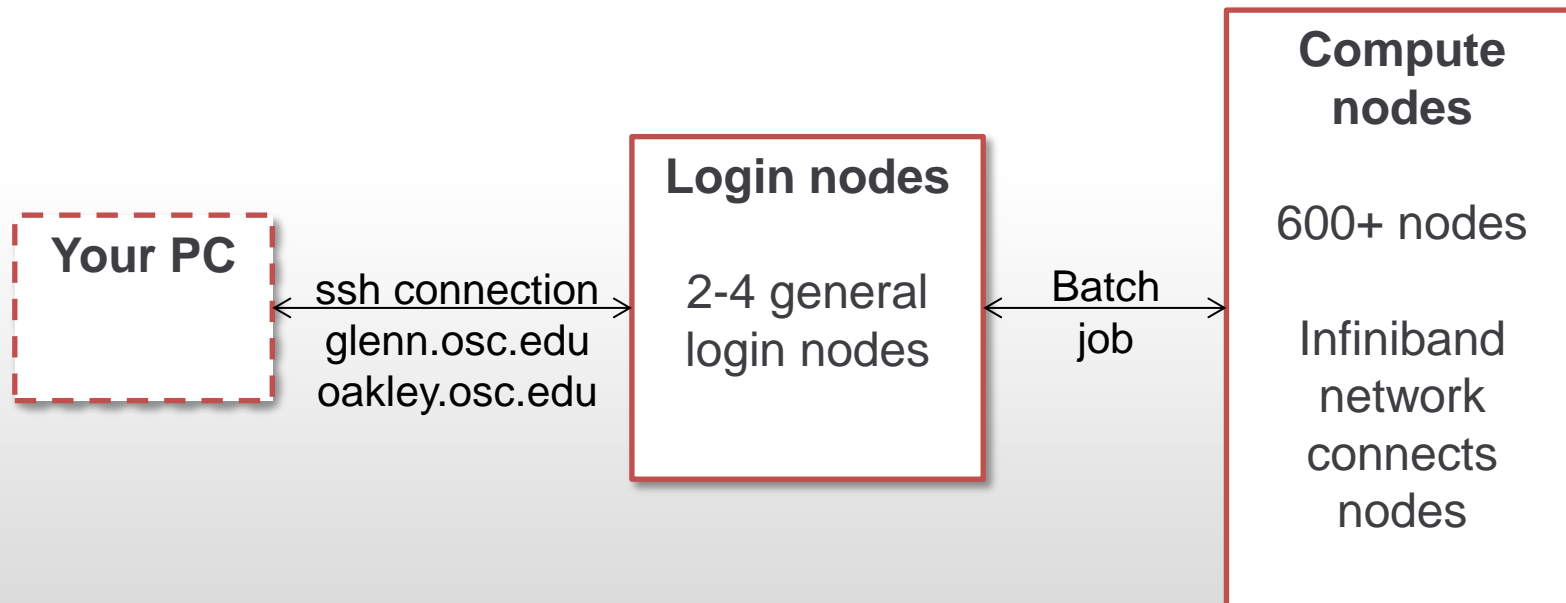
- Oakley cluster
 - Online March 2012
 - Named for Annie Oakley, famous Ohio sharpshooter
 - HP system, Intel Xeon processors, 8280 cores
- Glenn cluster
 - “Glenn phase II” online July 2009
 - Named for John Glenn, Ohio astronaut and senator
 - IBM 1350, AMD Opteron processors, 5200 cores



OSC's Newest HPC System: Oakley Cluster



Organization of an OSC Cluster



Shared file systems

Visible from all nodes of Oakley, Glenn, & other OSC systems





Login Nodes – Configuration

- Oakley
 - 2 general-purpose login nodes
 - 12 cores, 124 GB memory each
 - Connect to oakley.osc.edu
- Glenn
 - 4 general-purpose login nodes
 - 8 cores, 32 GB memory each
 - Connect to glenn.osc.edu





Login Nodes – Usage

- Purpose
 - Submit jobs to batch system
 - Edit files
 - Manage your files
 - Interactive work – small scale
- Limits
 - 20 minutes CPU time
 - 1GB memory
- Use the batch system for serious computing!



Compute Nodes – Oakley

- 684 standard nodes
 - 12 cores per node
 - 48 GB memory (4GB/core)
 - 812 GB local disk space
- 8 large memory nodes
 - 12 cores per node
 - 192 GB memory (16GB/core)
 - 812 GB local disk space
- Network
 - Nodes connected by 40Gbit/sec Infiniband network (QDR)



Special Resources – Oakley

- GPU computing
 - 128 NVIDIA Tesla M2070 GPUs
 - 64 of the standard nodes have 2 GPUs each
- 1 huge memory node
 - 32 cores
 - 1 TB memory
- Intel Xeon Phi accelerators (Ruby cluster)
 - 8 nodes, each with one Phi card
 - limited-access test cluster



Compute Nodes – Glenn

- 634 standard nodes
 - 8 cores per node
 - 24 GB memory (3GB/core)
 - 393 GB local disk space
- 8 large memory nodes
 - 16 cores per node
 - 64 GB memory (4GB/core)
 - 188 GB local disk space
- Network
 - Nodes connected by 20Gbit/sec Infiniband network (DDR)





Special Resources – Glenn

- GPU computing
 - 18 NVIDIA Quadro Plex S4 systems
 - Each Quadro Plex S4 has 4 Quadro FX GPUs
 - 36 of the standard nodes have 2 GPUs each





Hardware Performance – Oakley

- CPU performance
 - 88 trillion floating point operations per second (TFLOPS) peak performance
 - 79 TFLOPS sustained performance
- GPU acceleration
 - 66 TFLOPS peak performance
- Total peak performance
 - 154 TFLOPS



Specs: Oakley Cluster vs. Top 500 Systems in the World



Metric	June 2012	June 2012	November 2012	November 2012	June 2013
	Performance Ranking	Efficiency Ranking	Performance Ranking	Efficiency Ranking	Ranking
Overall Ranking in the World	180 th	37 th	460 th	30 th	Not Listed
Overall Ranking in US	89 th	8 th	235 th	8 th	Not Listed
Overall Academic Ranking in the World	40 th	9 th	91 st	13 th	Not Listed
Overall Academic Ranking in US	11 th	2 nd	23 rd	2 nd	Not Listed



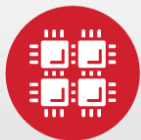
OSC File Space Information

- Lustre – Parallel File System (Temporary Space)
 - ~570 TBs (all disk)
- Project Space and GPFS
 - ~1000 TBs total usable (Disk)
 - Hierarchical storage capable to tape subsystem
 - Allocated to projects in TBs, for limited time periods
- Home Directory Space / NFS
 - ~295 TBs usable (Disk)
 - Allocated to each user, 500 GB quota limit

Mass Storage Overview

- 2 Petabytes (PBs) of usable disk
- ~1 PB NFS storage
- 370 TBs GPFS storage
- 570 TBs Lustre storage
- 1.8 PBs tape





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Resource Grants and Accounts at OSC



Who can get an account?

- Academic accounts
 - Principal investigator (PI) must be a full-time faculty member or research scientist at an Ohio academic institution
 - PI may authorize accounts for students, post-docs, collaborators, etc.
 - Classroom accounts are also available
 - No cost to Ohio academic users
- Commercial accounts
 - Commercial organizations may purchase time on OSC systems





Accounts and Projects at OSC

- Project
 - Headed by a PI
 - May include other users
 - Basis for accounting at OSC
 - Submit proposal for computing resources for a project
- Account
 - Username and password to access HPC systems
 - Each account associated with one project
 - Each account used by one person (please!)
 - If you work on multiple projects, you will have multiple accounts.





Allocations and Charges

- Charges are in terms of resource units
- Resource units
 - 1 resource unit (RU) = 10 CPU hours
 - CPU hour = walltime x (total # of cores requested)
- Project receives an allocation of RUs
- Jobs are charged to a project





Getting an Account

- Startup grant
 - One per PI per lifetime
 - Provide contact info, institution, department
 - 5000 RUs
- Additional allocations for a project
 - Submit a proposal for more RUs
 - Standard: 10,000
 - Major: 30,000
 - Discovery: >30,000
 - Peer-reviewed
 - Grants awarded by Statewide Users Group (SUG)





Acknowledging OSC

- Please acknowledge OSC in your publications:
 - **"This work was supported in part by an allocation of computing time from the Ohio Supercomputer Center."**
- These publications should be reported to OSC through the *ARMSTRONG* portal.



ARMSTRONG Researcher Portal

- <https://armstrong.osc.edu>
- Manage your project and accounts
 - Change password and shell
 - Monitor resource utilization on all your projects
 - Add authorized users (request accounts) – PIs only
- View current information
 - OSC system notices
 - Training opportunities and other events
 - Research opportunities
- Post publications



ARMSTRONG Researcher Portal

<https://armstrong.osc.edu>

The screenshot shows a web browser window displaying the profile page for Ian MacConnell on the Ohio Supercomputer Center (OSC) Ning network. The browser's address bar shows the URL <http://ohiosuperusers.ning.com/profile/ianMacConnell>. The page header includes the OSC logo and navigation tabs for Main, Invite, My Page, Members, Forum, Events, Groups, Blogs, Notes, FAQ, Chat, My Storage, and Manage. The main content area features a welcome message, a search bar, and a bar chart titled "Resource Unit Utilization over the last 30 Days". The chart shows daily resource unit usage, with a total of 0.0000 over the period. Below the chart, there is a "My Publications" section listing two articles. The left sidebar contains a profile picture of Ian MacConnell, his name, and various management options like "Manage My Profile" and "Request Resource Units". The right sidebar includes a "Sign Out" button, a list of notifications (Inbox, Alerts, Friends - Invite, Settings), and a section for "OSC News & Info" with a link to "The X10 Language and Tools for Advanced HPC Programming Workshop".

Ohio Supercomputer Center
Empowering Ohio's Research Community

Ohio Supercomputer Center

Main Invite My Page Members Forum Events Groups Blogs Notes FAQ Chat My Storage Manage

Welcome, Ian MacConnell!

What brings you here? Update

Project 937438

Resource Unit Utilization over the last 30 Days [View Detailed Usage](#)

Minimum/day: 0.0000, Average/day: 0.0000, Maximum/day: 0.0000
Total RUs over time period: 0.0000

My Publications [Add Publications](#)

1. Kelley, H, MacConnell, I, and Abel: "An Analysis of Identity Links on the ARMSTRONG Portal". Next Steps, Wood, D, Decker, S, and MacConnell, I (Eds.), Columbus, OH (2010). [An online version is also available for download.](#)
2. Berrueta, D, Labra, JE, and MacConnell, I: "XSLT+SPARQL : Scripting the ARMSTRONG Portal with SPARQL embedded into XSLT stylesheets". In: 4th Workshop on Scripting for the ARMSTRONG Portal, Bizer, C, Auer, S, Grimmes, GA, and Heath, T (Eds.). Tenerife (2008). [An online version is also available for download.](#)

ian MacConnell
Manage My Page or Photo
[Manage My Profile](#)
Select A Project
[Request Resource Units](#)
[Manage OSC Accounts](#)
1357/5000 Units Remaining
Blog Posts
Discussions
Events (1)
Groups
Videos
Admin Options
★ Feature
[Reset Profile Photo](#)
My Events [Edit](#)
The X10 Language and Tools for Advanced HPC Programming Workshop
August 10, 2010 from 9:15am to 5pm - Ohio

Ian MacConnell
Sign Out
Inbox
Alerts
Friends - Invite
Settings
Quick Add...
Events
The X10 Language and Tools for Advanced HPC Programming Workshop
August 10, 2010 from 9:15am to 5pm - Ohio Supercomputer Center - BALE Theater
[+ Add an Event](#) [View All](#)
OSC News & Info
OSC Supercomputing System Notices
Information on system downtimes, upcoming workshops and software installations.
OSC's Calendar of Events
Here you can see a listing of all our upcoming events, workshops and training sessions.
Ohio Supercomputer Center deploys IBM system expansion to boost research into biosciences, other areas of focus
The Ohio Supercomputer Center today deploys a much anticipated \$4 million expansion to its flagship system, providing further computational support to the state's economic development aspirations in research and innovation.
[More...](#)
Research Grant Opportunities
Research Grant Opportunity - Early





Your Contact Info

- Keep your contact information current
 - Send email to oschelp@osc.edu to update email address
- If you're at OSU, monitor your name.#@osu.edu
- If your student continues to use OSC after graduation, make sure email address is updated
 - Acceptable if still collaborating with you
- May need to contact you about problems
- You can opt out of routine notifications





Statewide Users Group (SUG)

- The Statewide Users Group (SUG) is made up of OSC users
 - Provides program and policy advice to OSC
 - Meets every four months
 - Headed by a chairperson elected yearly
- Standing committees
 - Allocations
 - Software and Activities
 - Hardware and Operations
- Get involved!



System Status

- Check system status on:
 - <https://www.osc.edu/supercomputing> (bottom of page)
 - <https://armstrong.osc.edu/systemnotices/index.php>
 - Message of the day (/etc/motd) – displayed at login
 - Twitter: @HPCnotices
 - Email for major outages or problems
- Scheduled downtimes
 - Quarterly maintenance – one day outage
 - Jobs held for up to two weeks prior





Demo

- Website tour: www.osc.edu
- ARMSTRONG: <https://armstrong.osc.edu>





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User Environment



Linux Operating System

- “UNIX-like”
- Widely used in HPC
- Mostly command-line
- Choice of shells (bash is default)
- Freely distributable, open-source software
- Tutorials available
- www.linux.org



Connecting to the Oakley or Glenn Cluster

- Connect to OSC machines using **ssh** (secure shell)
 - From a Linux/UNIX machine : At prompt, enter
`ssh userid@oakley.osc.edu`
`ssh userid@glenn.osc.edu`
 - From a Mac: Enter **ssh** command in TERMINAL window
 - From Windows: **ssh** client software needed
 - Both commercial and free versions are available
- New: Connect using OnDemand portal (web-based)



OSC OnDemand

- 1: User Interface
 - Web based
 - Usable from computers, tablets, smartphones
 - Zero installation
 - Single point of entry
 - User needs three things
 - ondemand.osc.edu
 - OSC Username
 - OSC Password
 - Connected to all resources at OSC
- 2: Interactive Services
 - File Access
 - Job Management
 - Visualization Apps
 - Desktop access
 - Single-click apps (Abaqus, Ansys, Comsol, Paraview)
 - Terminal Access



Connecting to an OSC Cluster with Graphics

- Programs on the cluster can have an X-based GUI
 - Display graphics on your computer
- Linux/UNIX and Mac: Use `-x` flag
 - `ssh -X userid@oakley.osc.edu`**
- Windows: Need extra software
 - Both commercial and free versions are available
 - Configure your ssh client to tunnel or forward X11
- Primarily used with programs on login node
 - Can also use with interactive batch jobs

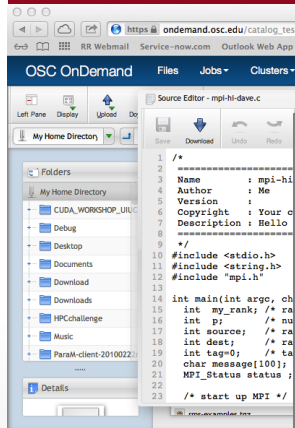


Transferring Files to and from the Cluster

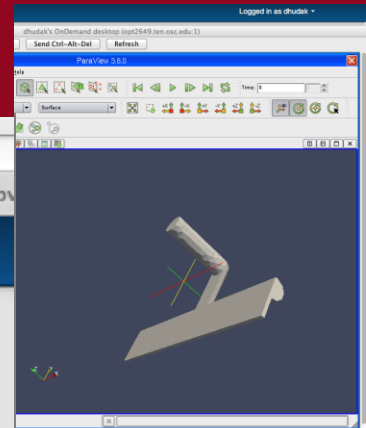
- Most file transfers to and from OSC machines use **sftp** or **scp**
 - Linux and Mac have them built in
 - Windows needs extra software
- For small files, connect to login node
`oakley.osc.edu`
`glenn.osc.edu`
- For large files, transfer may fail due to shell limits
 - Connect to `gridftp01.osc.edu` (file transfer only)



File Transfer & Editing



Visualization

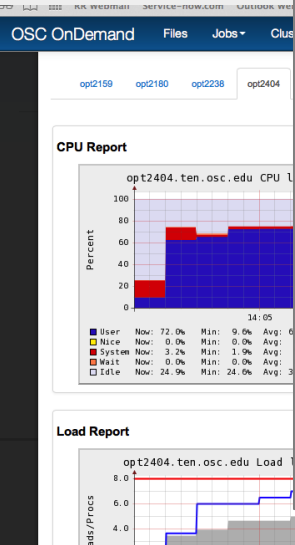


Common Catalog

OSC OnDemand

where you go to do everything at OSC

OnDemand provides an integrated, single access point for all of your resources on Glenn and Oakley.



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```
Anyterm
Web OnDemand [param] OSC Subversion Ganglia CWeb Sysdoc csd - Trac
Anyterm
background :
*****
User has
cy 26th From
Oakley
and access
algorithm for
2013.
a higher
arges are in
change, and
/osc.edu/n or
jobs (jobs
> Glenn
formation
ent
*****
of quota 500GB and 20 files of quota 1000000 files
38 of quota 500GB and 557205 files of quota 1000000 files
01 used 1cm of quota 0GB and 104389 files of quota 0 files
02 used 1GB of quota 200GB and 8 files of quota 1000000 files
09 used 468GB of quota 2861GB and 878266 files of quota 200000
11 used 110GB of quota 2861GB and 88414 files of quota 200000
```

Job Submission & Monitoring

Command Line



Text editing

- Traditional Unix editors
 - `vi`
 - `emacs`
 - Many books and web pages about `vi` and `emacs`
- GUI editor
 - `gedit`
- Simple editor
 - `nano`
- Can also edit on your computer and transfer files back and forth
 - `dos2unix`, `unix2dos`, `mac2unix`





Demo

- OSC OnDemand
- ssh
- sftp
- Linux
- Home directory tree
- Text editor: nano



Modules

- Add or remove software from your environment, e.g.,
 - `module load comsol`
- Allow multiple versions of software to coexist on our system
- Allow us to make changes without affecting you
 - PLEASE DON'T HARDCODE PATHS!
- Can load modules at command prompt or in your `.bash_profile` or `.bashrc` file
- Also load modules in your job (batch) scripts



Modules and your shell environment

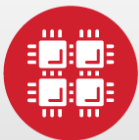
- How modules work
 - Modify environment variables like `$PATH` and `$MANPATH` within your shell
- Default set of modules loaded at login
 - module system, batch system (do not unload)
 - default compiler and MPI modules
- Do NOT completely replace `$PATH` in your `.bash_profile` or `.bashrc`
- DO prepend directories to the existing `$PATH`
 - Type: `export PATH=$HOME/bin:$PATH`



Module Commands (Oak/Glenn not the same!)

- What modules do you have loaded?
 - `module list`
- What modules are available?
 - `module spider` or `module avail`
- Multiple versions of the same software
 - `module avail intel`
- Add a software module to your environment
 - `module load cuda`
- Remove a software package from your environment
 - `module unload intel`
- Load a different software version
 - `module swap intel intel/13.1.3.192`



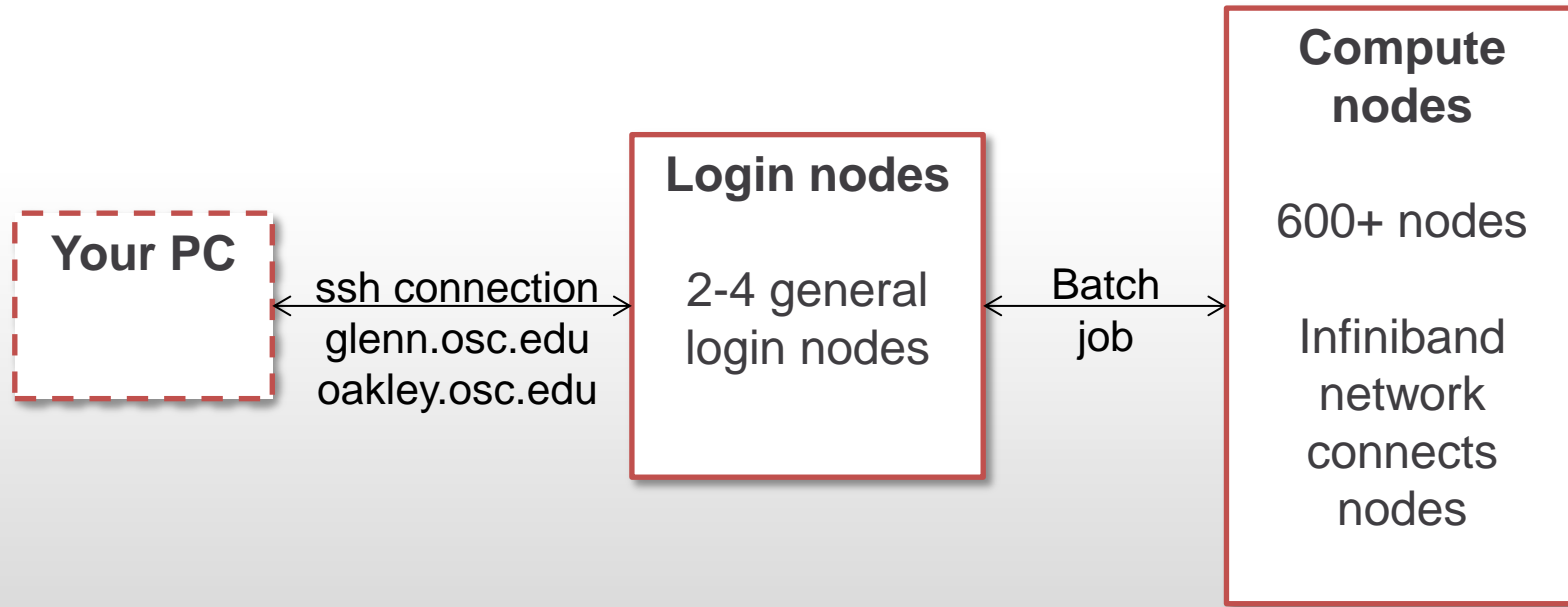


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Batch Processing

Organization of an OSC Cluster



Shared file systems

Visible from all nodes of Oakley, Glenn, & other OSC systems



Batch System at OSC

- Compute nodes are allocated through the batch system
 - PBS – Portable Batch System
 - Torque – resource manager
 - Moab – scheduler
- Documentation at www.osc.edu/supercomputing/batch-processing-at-osc





Idea Behind Batch Processing

- Whatever you would normally type at the command prompt goes into your batch script
- Output that would normally go to the screen goes into a log file (or files)
- The system runs your job when resources become available
- Very efficient in terms of resource utilization





Running a Job on the Compute Nodes

- Create a batch script for a job
- Submit the job
- Job gets queued
- Job runs when resources become available
- Get your results when the job finishes



Sample Batch Script

```
#PBS -N serial_fluent
#PBS -l walltime=1:00:00
#PBS -l nodes=1:ppn=1
#PBS -j oe
#PBS -l software=fluent+1
```

Job setup information
for PBS

This is a comment

```
# Set up the FLUENT environment
module load fluent
```

```
# Move to directory job was submitted from
cd $PBS_O_WORKDIR
```

Commands
to be run

```
# Run fluent
fluent 3d -g < run.input
```

Put all this into a text file!



Submitting a Job and Checking Status

- Command to submit a job
 - `qsub script_file`
- Response from PBS (example)
 - `123456.oak-batch.osc.edu`
- Show status of batch jobs
 - `qstat -a jobid`
 - `qstat -u username`
 - `qstat -f jobid`





Scheduling Policies and Limits

- Walltime limit
 - 168 hours for serial jobs (single node)
 - 96 hours for parallel jobs (multiple nodes)
- Per-user limits
 - 128 concurrently running jobs
 - 2040 processor cores in use
 - 1000 jobs in the batch system, running or queued
- Per-group limits
 - 192 concurrently running jobs
 - 2040 processor cores in use



Waiting for Your Job To Run

- Queue wait time depends on many factors
 - System load
 - Resources requested
 - nodes, cores, large memory, gpus, software licenses
 - Fair share limits (if load is high)
 - reduced priority for users or groups using a lot of resources
- To see **estimated** start time for job
 - `showstart jobid`
 - Very unreliable



Job Output

- Screen output ends up in file *job_name.ojobid*
 - Copied to your working directory when job ends
 - Example: `testjob.o1234567`
- To see screen output while job is running
 - `qpeek jobid`
 - Example: `qpeek 1234567`



Interactive Batch Jobs

- Interactive, but handled through batch system
 - Resource limits same as standard batch limits
- Useful for tasks forbidden on login nodes
 - Debug parallel programs
 - Run a GUI program that's too large for login node
- May not be practical when system load is high
 - Long wait, same as standard batch job
- To submit an interactive batch job (example)
 - `qsub -I -X -l nodes=2:ppn=12 -l walltime=1:00:00`





Batch Queues

- Oakley and Glenn have separate batch systems
 - Submit job and check status on the same cluster
- Debug reservation
 - A few nodes on each system are reserved for short jobs (≤ 1 hour)



Glenn or Oakley – Which should I choose?

- Some software installed only on one system
 - See software page for your application
- Oakley is newer and faster, with more memory
- Glenn often has shorter queue waits
- Can switch between them
 - Most sequential code will run on either system
 - Performance may be better on system code was built on
 - Keep separate executables in different subdirectories





Parallel Computing

- Each processor is fast, but real speed comes from using multiple processors
- Multithreading
 - Use multiple cores on a single node
 - Shared memory
- Message passing (MPI)
 - Use one or multiple nodes
 - Distributed memory





To Take Advantage of Parallel Computing

- Program must be written to take advantage of multiple cores and/or multiple nodes
- Many commercial applications have multithreaded or parallel versions
- Must use `mpirexec` for multiple nodes
- **Can't just request more nodes or cores and expect your job to run faster**

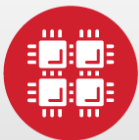




Specifying Resources in a Job Script

- Nodes and cores (processors) per node
- Memory
- GPUs
 - See “Batch Processing at OSC” on OSC website
- Walltime
 - Overestimate slightly – job will be deleted if it hits limit
 - Shorter job may start sooner due to backfill
- Software licenses
 - See specific software page on OSC website





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Storage



Home Directories

- Each user has a home directory
- Visible from all OSC systems
- Backed up daily – “permanent storage”
- Quotas
 - 500GB of storage per user account
 - 1,000,000 files maximum
 - Cannot create new files if over quota
 - Quota and usage info displayed at login



Project Directories

- PI may request project directory if more space needed
 - Send request to OSC Help
 - Large requests are reviewed by SUG Allocations Committee
 - Shared by all users in the project
- Backed up daily
- Visible from all OSC systems
- Project quota is separate from the home directory quota



Sample Quota Display

Quota display at login (information collected nightly):

```
As of 2010 Jul 15 04:02 userid usr1234 on /nfs/06 used 28GB of
quota 500GB and 41374 files of quota 1000000 files
As of 2010 Jul 16 04:02 project/group PRJ0321 on /nfs/proj01
used 27GB of quota 5000GB and 573105 files of quota 1000000
files
```

Output from `quota` command (run manually):

```
Disk quotas for user usr1234 (uid 11059):
Filesystem
  blocks  quota  limit  grace  files  quota  limit  grace
fs06-oak.ten.osc.edu:/nfs/06/osc
  201698292  450000000  524288000  631137  950000  1000000
```





File Management

- Compress large, rarely used files
 - Use `gzip` or `bzip2` commands
- Combine large numbers of small files into an archive
 - Use `tar` command





Parallel File System – Lustre

- Designed to handle heavy parallel I/O load
- Faster access than home and project directories
- NOT good for small files
- Visible from all cluster nodes (shared)
- Suitable for short-term storage (up to 6 months) of large amounts of data
- Also useful as batch-managed temporary storage
- **NOT backed up**



Local Disk – \$TMPDIR

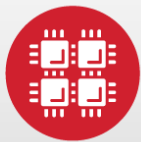
- Local file system on each compute node
 - 812 GB on each Oakley node
 - 393 GB on each Glenn node
- Fast – use for intermediate or scratch files
- Not shared between nodes
- Not backed up
- Managed by the batch system
- Data removed when job exits



Overloading the File Servers

- “*A supercomputer is a device for turning compute-bound problems into I/O-bound problems.*” --Ken Batcher (parallel computing pioneer)
- One user’s heavy I/O load can affect responsiveness for all users on that file system
- **Never** do heavy I/O in your home or project directory!
- Use \$TMPDIR, copying files in and out as necessary
- Don’t let large numbers of jobs run in lockstep.





Ohio Supercomputer Center

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Third-Party Software Applications



Access to Licensed Software

- Most software licenses for academic use only
- Some software requires signed license agreement
 - Check website
 - Contact OSC Help



Third party applications

- **Chemistry** (*license agreement required)
 - *AMBER
 - ChemTools
 - COLUMBUS
 - *CSD (Cambridge Structural Database)
 - ESPRESSO
 - GAMESS
 - *Gaussian
 - GROMACS
 - LAMMPS
 - MacroModel®
 - MEAD
 - NAMD
 - NWChem
 - Open Babel
 - *Turbomole



Third party applications

- **Bioinformatics**

- Bioperl
- BLAST
- BLAT
- Bowtie
- Clustal W
- EMBOSS
- Fitmodel
- HMMER
- MrBayes
- NAMD
- PAML
- PAUP
- RAxML
- RepeatMasker
- TreeBeST



Third party applications

- **Structural Mechanics** (*license agreement required;
¢ statewide licensed)
 - *ABAQUS
 - ¢ Altair HyperWorks
 - *ANSYS
 - COMSOL Multiphysics
 - *LSDYNA
 - LS-PREPOST





Third party applications

- **Fluid Dynamics** (*license agreement required)
 - *Fluent
 - OpenFOAM



Third party applications

- Mathematics/Statistics (⌘ statewide licensed)
 - MATLAB (special licensing restrictions)
 - Octave
 - R
 - Stata
 - FFTW
 - ScaLAPACK
 - MINPACK
 - sprng2
 - ⌘ Intel MKL
 - ACML (Glenn only)



Third party applications

- **General programming software** (⌘ statewide licensed)
 - gnu compilers and debugger
 - ⌘ Intel compilers
 - ⌘ Totalview debugger
 - ⌘ PGI compilers
 - MPI library
 - HDF5
 - NetCDF
 - Java, Java Virtual Machine
 - Python





Third party applications

- **Parallel programming software** (⌘ statewide licensed)
 - MPI library (mvapich, mvapich2)
 - OpenMP
 - CUDA
 - OpenACC





Third party applications

- **Visualization software**

- GNUplot
- Jmol
- VTK

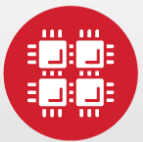
- More applications can be found at Software page:
<http://www.osc.edu/supercomputing/software/>



OSC doesn't have the software you need?

- Commercial software
 - Fill out a request form (see our FAQ)
 - SUG will consider it
- Open-source software
 - You can install it yourself in your home directory
 - If there's enough demand, we can install it for shared use
- Have your own license?
 - Contact OSC Help





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OSC Policies

Firefox

Supercomputing | Ohio Supercomputer ...

https://www.osc.edu/supercomputing

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Home

Supercomputing

As a leader in high performance computing and networking, the Ohio Supercomputer Center (OSC) is a vital resource for Ohio's scientists and engineers. OSC is a fully-scalable center with mid-range machines to match those found at National Science Foundation centers and other national labs. The Center's flagship supercomputing system is the Oakley Cluster, an 8,300+ core HP Intel Xeon machine.

OSC also is home to the Ohio Interface Labratory, which provides state-of-the-art graphics equipment and output services for computer graphics and animation. Members of the Science and Technology Support Group provide much of the information for this server.



Oakley HP Intel Xeon Cluster (8,328 Cores)

Getting Started

Welcome to OSC! If you are new to supercomputing, new to OSC, or simply interested in getting an account (if you don't already have one), we have some resources to help you.

- Read about the [basics of High Performance Computing](#) (highly recommended for new users).
- Learn more about [our account allocation process](#), and [how to get started](#).
- Apply for [expanded resources](#) beyond those for a start-up project.
- Get help [connecting to our resources](#).
- Read our [policies](#), [FAQ](#), [code of ethics](#) for users, and [glossary](#).

OSC Policies

Supercomputing

- Getting Started
- HPC Environments
- Available Software
- Portals
- Tutorials & Training
- Support Services
- Search Documentation

Upcoming Events

August 8, 2013 - [Statewide User Group \(SUG\) General Meeting](#) (Columbus, OH)

August 23, 2013 - [Your Plan For Health Biometric Screenings](#) (Columbus, OH)

September 3, 2013 - [Intro to OSC](#) (Columbus, OH)

[More](#)

Recent News

Columbus, Ohio (July 23, 2013) - [OSC OnDemand gives computational](#)





OSC Policies

- OSC-1, OSC Data Lifecycle Management Policy
 - Use of home directory, project directory and **\$TMPDIR**
 - Storage and file quotas
 - Backup and recovery





OSC Policies

- OSC-11, OSC User Management Policy
 - Who can get an account
 - Charges for accounts
 - Types of accounts
 - Account restrictions
 - Account resource units
 - Inappropriate system use



For More Information

- Visit our documentation website
www.osc.edu/supercomputing
- Contact the help desk (OSC Help) M-F 9-5
oschelp@osc.edu
614-292-1800
1-800-686-6472





Questions

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