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The Center for High Performance Computing: Support for Research Computing and Data

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www.chpc.utah.edu



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CHPC's Mission

- Innovate, design, engineer, deploy, and operate **cost-effective, functional, high performance, and compliant research computing and data resources** for the university communities we support.
- Continue to innovate, optimize, secure, and embrace the **heterogeneous and rapidly changing IT landscape**.
- Seek out opportunities for **workforce development and continuous learning** for **student employees and staff**.
- Provide a **robust set of service offerings** to support researchers including **user support, facilitation, training, documentation, and collaboration**.



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Who We Are



- Staff of 38 full-time professionals and part-time students
- Backgrounds in a variety of sciences, engineering, management
- Expertise in scientific computing, networking, data storage, software development, system administration, ...



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CHPC can help if:

- You need parallel processing
- You need access to a single high-powered computer
- You need to run many individual jobs simultaneously
- You have a large amount of data to store and/or process
- You need software you don't have on your computer
- Your data is sensitive/restricted:
 - protected health information, IRB-governed, Controlled Unclassified Information, or otherwise sensitive/restricted
- You have other computing needs your local resources cannot meet



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CHPC Resources & Services

- **Computational Clusters** – Notchpeak, Kingspeak, Lonepeak, Ash
- **Storage** – home directory, group spaces, scratch space, archive storage
- **Windows Servers** – windows-only applications (e.g. statistics programs)
- **Virtual Machines** – for needs not met with cluster and windows server
- **Protected Environment** – for sensitive data, includes compute cluster, storage, virtual machines, and Windows Server
- **Networking Support** – supports compute environment; high-speed data transfers, work with researchers on data movement
- **User Support** – assistance with use of resources; installation of applications; training; consultations



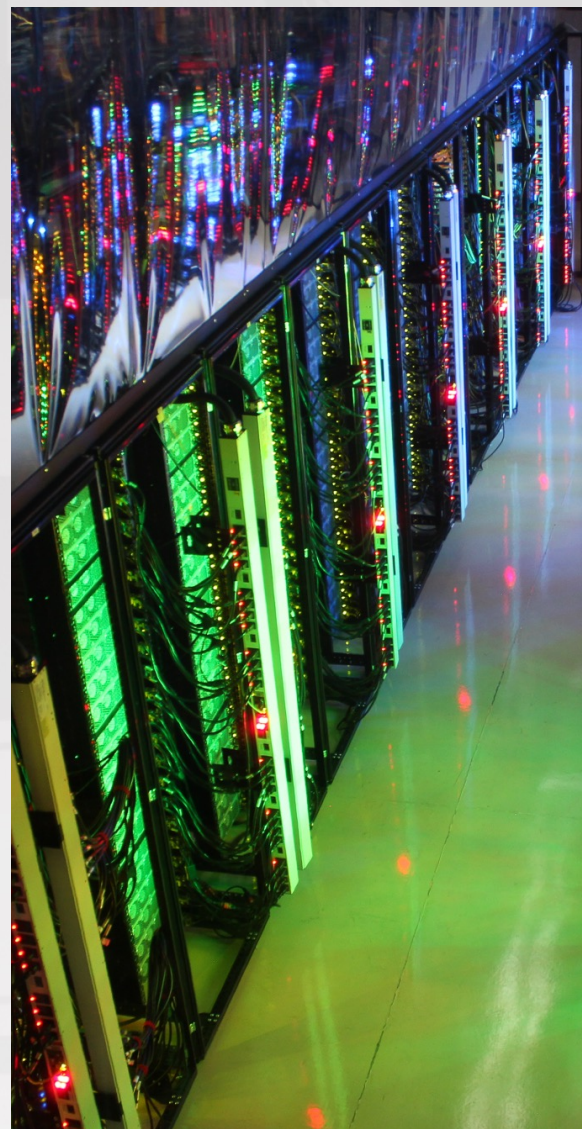
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CHPC Linux Clusters

Environment	Cluster	Compute Nodes	Cores
General	notchpeak	442	20,728
General	kingspeak	309	6,436
General	lonepeak	231	3,540
General	ash	182	3,812
Protected	redwood	214	6,716

- "Condominium" model
 - CHPC-purchased nodes, available to all, priority access with time allocation*
 - Faculty-purchased nodes, priority access to owner, guest access to others
- Interactive, compute, and GPU nodes
- Manage jobs with SLURM system for batch or interactive computing
- Access clusters with ssh, fastx, or OnDemand

* on notchpeak and redwood clusters only





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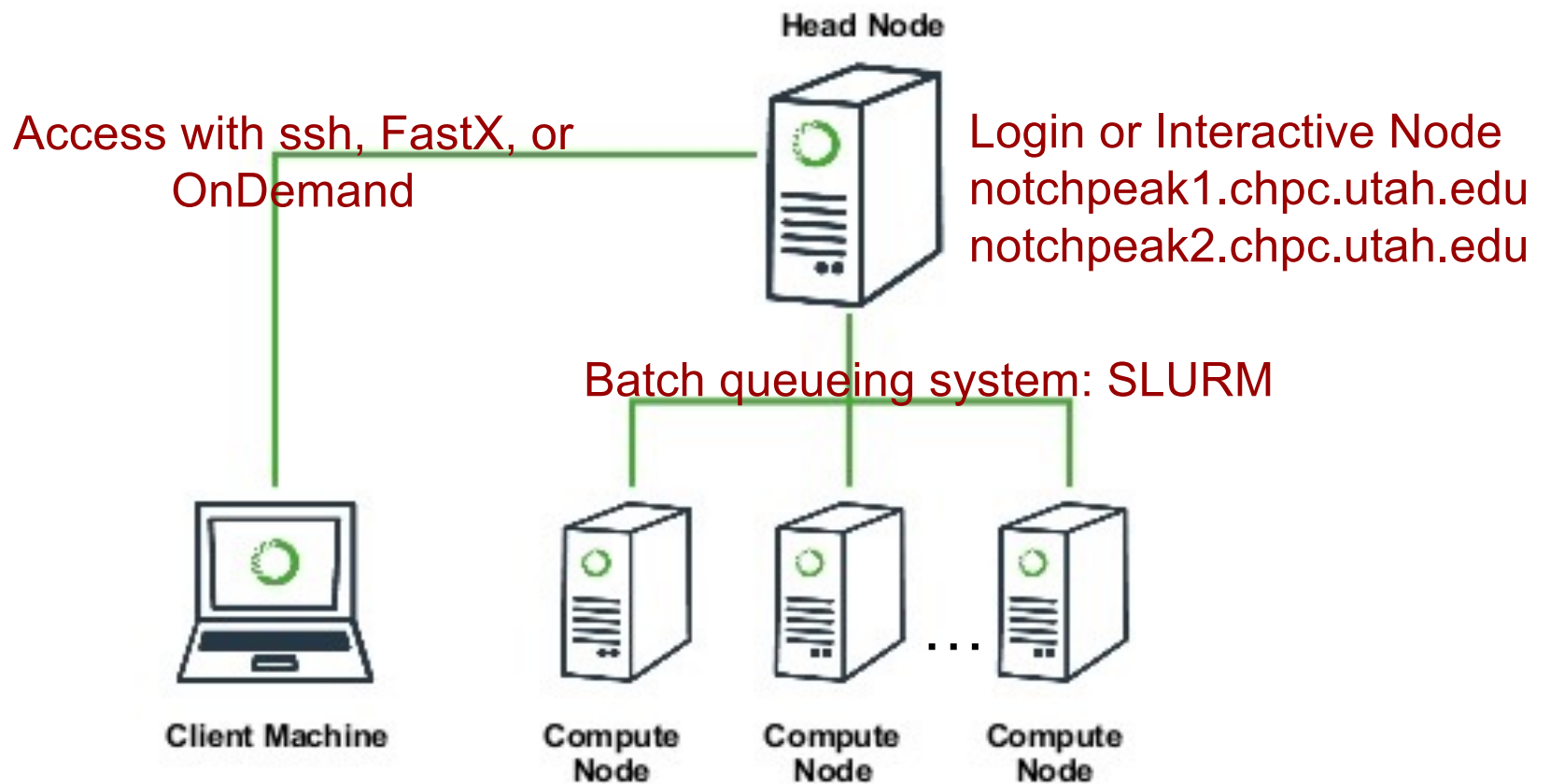
Downtown Data Center

- On-line in Spring 2012, CHPC completed move in Spring 2013
- Shared with enterprise (academic/hospital) groups
- 92 racks and 1.2MW of power, upgrade path to add capacity for research computing
- Fiber optic network connects campus, data center, & internet2
- 24/7/365 facility
- Power, cooling, network connectivity, security





Cluster Architecture Diagram



notch001 notch002 ... notchxxx



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Open OnDemand

- Open OnDemand (OOD) web portal provides access to CHPC resources
- View, edit, upload and download files
- Create, edit, submit and monitor jobs
- Run applications include RStudio and Jupyter Lab
- Connect via a web browser, requires minimal knowledge of Linux and SLURM commands.
- Available in both General and Protected Environments
- Our Presentation Series includes a class on OnDemand

www.chpc.utah.edu/documentation/software/ondemand.php



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SLURM

- SLURM (Simple Linux Utility for Resource Management) controls access and schedules jobs on the cluster
- You request the kinds of resources you need (how much, how long) and SLURM connects you to them, or puts you in the queue to wait for them
- Accessed with a few simple Linux commands:
 - sbatch or salloc - start a job (either batch or interactive)
 - scancel - stop a job
 - squeue - check on jobs
- CHPC provides several easy replacements:
 - myallocation - show my access to computer resources
 - myinfo - show the status of those resources
 - myqueue - show the status of my jobs



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Data Storage

- *Home Directories* -- /uufs/chpc.utah.edu/common/home/<uNID>
 - New solution in place – VAST
 - Home directories 50 GB, not backed up
 - Groups can buy larger home directory space at \$900/TB for 5 years, backed up (nightly incremental, weekly full, 2-week retention)
- *Group Level File Systems*
 - NFS mounted group space: \$450/TB/5 years, backed up, or \$150/TB/5 years not backed up
- *Scratch File Systems*
 - For use by all users; 50 TB quota; files older than 60 days removed
 - 600 TB NFS scratch space (/scratch/general/nfs1)
 - 1.6 PB VAST scratch space (/scratch/general/vast)
 - Local scratch on nodes, up to 1TB (TMPDIR=/scratch/local/\$USER/\$SLURM_JOB_ID)
- *Archive Storage*
 - Archive at \$150/TB/5 years
 - Similar to cloud storage, but on-site



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Windows Servers

- Beehive (general environment) – refreshed 2019
 - 48 physical cores, 512TB memory
- Narwhal (protected environment)
- Presently has the following software installed
 - SAS 9.4 with text miner
 - R
 - STATA
 - Mathematica
 - Matlab
- ***If you need other software, please contact us to discuss***



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Virtual Machines

- For needs and applications that do not fit in compute cluster or Windows server model
- Multiple VM servers with failover – hardware refreshed 2019; expanded 2021, includes data storage
- Community VMs for mysql, mssql, git repositories, web servers, etc, free of charge
- Other VMs (not use of community ones) will have a cost, both for the VM and for any customization needed.

Blocks	RAM (GB)	Cores	Storage (GB)	Price
1	4	2	50	\$425
2	8	2	100	\$615
4	16	4	200	\$990
8	32	8	400	\$1745
16	64	8	800	\$3250

Additional VM storage available, in 100GB increments, at a cost of \$1100/TB.

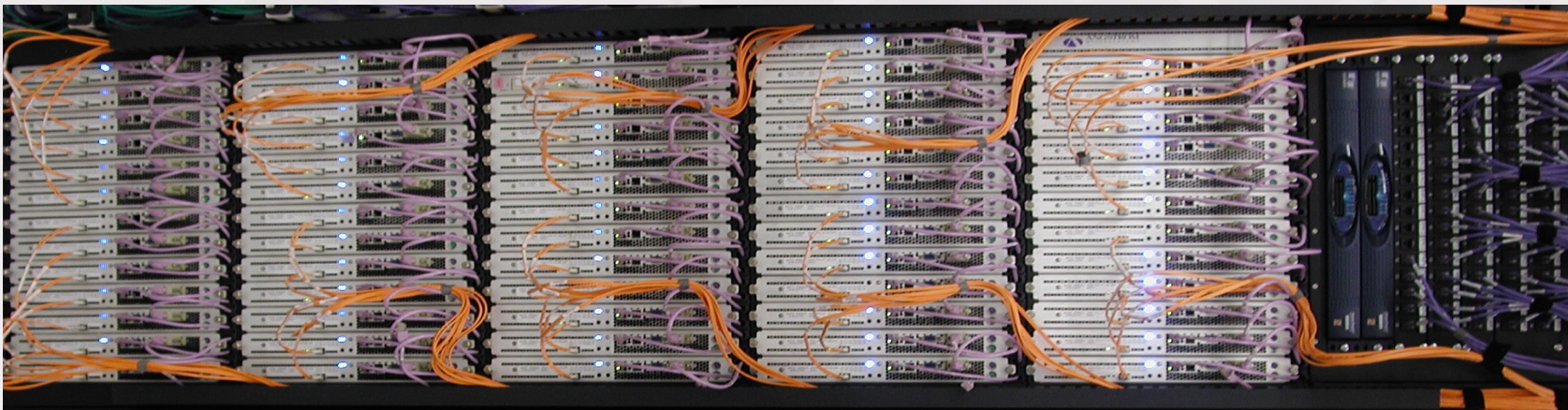
www.chpc.utah.edu/resources/virtualmachines.php



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Networking

- High Speed
- Reliable
- Low Latency
- Enables:
 - Multi-node jobs using Message Passing Interface (MPI) libraries
 - Access to all your files from any node
 - High-speed data transfer nodes
 - Globus, rsync, rclone, sra-toolkit, s3cmd, aspera





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Secure Computing

Protected Environment

- Dedicated secure resources for handling data & projects with protected information
- Currently PHI and projects with other types of sensitive data/restrictions
- Preferred location for human genomic data – meets NIH dbGaP requirements
- Refreshed in 2017 with award of NIH Shared instrumentation grant
- HPC cluster (redwood), VM farm, data storage (home, group space, archive, scratch)
- Windows compute server (narwhal)
- See www.chpc.utah.edu/resources/ProtectedEnvironment.php

CMMC (Cybersecurity Maturity Model Certification) Enclave

- For Controlled Unclassified Information (CUI)



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Software: installed by CHPC

- Over 600 different applications, variety of disciplines, multiple versions of each, most (but not all) open source
- Variety of compilers, debuggers, MPI & math libraries, containers
- Git, gitlab for version control
- CUDA, CuPy for GPU programming
- If you need a package installed - ask us!
- Packages managed with software “modules”
 - “module avail” lists available modules
 - “module spider *keyword*” to search for modules



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Software: installed by you

- anaconda
- pip (python)
- R
- Compilers for numerous languages
- Create your own modules



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Costs

Accounts	Free
Cluster access	Free
Priority cluster access	Free (with time allocation)
50 GB home directory	Free
Scratch space access	Free
Training, Support & Consultation	Free
Group & archive disk space	\$450/TB/5 years (backed up) or \$150/TB/5 years (not backed up)
Virtual Machines	Varies, from \$425 / 5 years
Owner Compute Nodes	Varies, from ~\$7000, email for quote



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Getting an Account

- www.chpc.utah.edu -> Documentation -> Getting Started
 - Requires a U of Utah uNID, uses your campus password
 - All user accounts linked to a Principal Investigator
 - Affiliate accounts (uNIDs) available for other universities, collaborators
 - Automated process, requires PI approval, email confirmation
- Account provides:
 - 50 GB free home directory space
 - Login scripts: `.bashrc` & `.custom.sh` or `.tcshrc` & `.custom.csh`
 - Access to clusters, 50 TB scratch space, windows server, software
 - Subscription to mailing list `chpc-hpc-users@lists.utah.edu`



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Getting an Allocation

- www.chpc.utah.edu -> User Services -> Allocations
 - Provides priority access to notchpeak, redwood clusters
 - Large and Small allocations - applications reviewed each quarter
 - Quick allocations (very small) - reviewed immediately
 - Allocations last up to 1 year (4 quarters)
 - Application requires description of research, estimated usage
 - Allocations managed on per-lab basis, not per-individual or per-project
- View allocation usage: www.chpc.utah.edu/usage
- View allocation and cluster access: myallocation command



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Training, Support and Consultation

- Presentation Series

- www.chpc.utah.edu/presentations
- Fall, Spring, Summer semesters
- Free, open to everyone
- Mix of lectures and hands-on sessions (linux, python, R, git, OnDemand)
- If you have suggestions for other topics contact us
- If you are interested in presentations for classes, research groups contact us

- Documentation

- www.chpc.utah.edu/documentation

- Ticketing System: email helpdesk@chpc.utah.edu

- Consultations: email helpdesk@chpc.utah.edu