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

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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**.

THE UNIVERSITY OF UTAH

Who We Are

- Staff of 30 full-time professionals and 18 part-time students
- Backgrounds in a variety of sciences, engineering, management
- Expertise in scientific computing, networking, data storage, software development, system administration, …

THE UNIVERSITY OF UTAH

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

CHPC Resources & Services

- *Computational Clusters* – Notchpeak, Kingspeak, Lonepeak, Granite

- *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 software; training; consultations

CHPC Linux Clusters

Environment	Cluster	Compute Nodes	Cores
General	notchpeak	501	27,908
General	kingspeak	268	6,352
General	lonepeak	135	2,748
General	granite	13	1,088
Protected	redwood	228	8,436

- "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, granite, and redwood clusters only

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
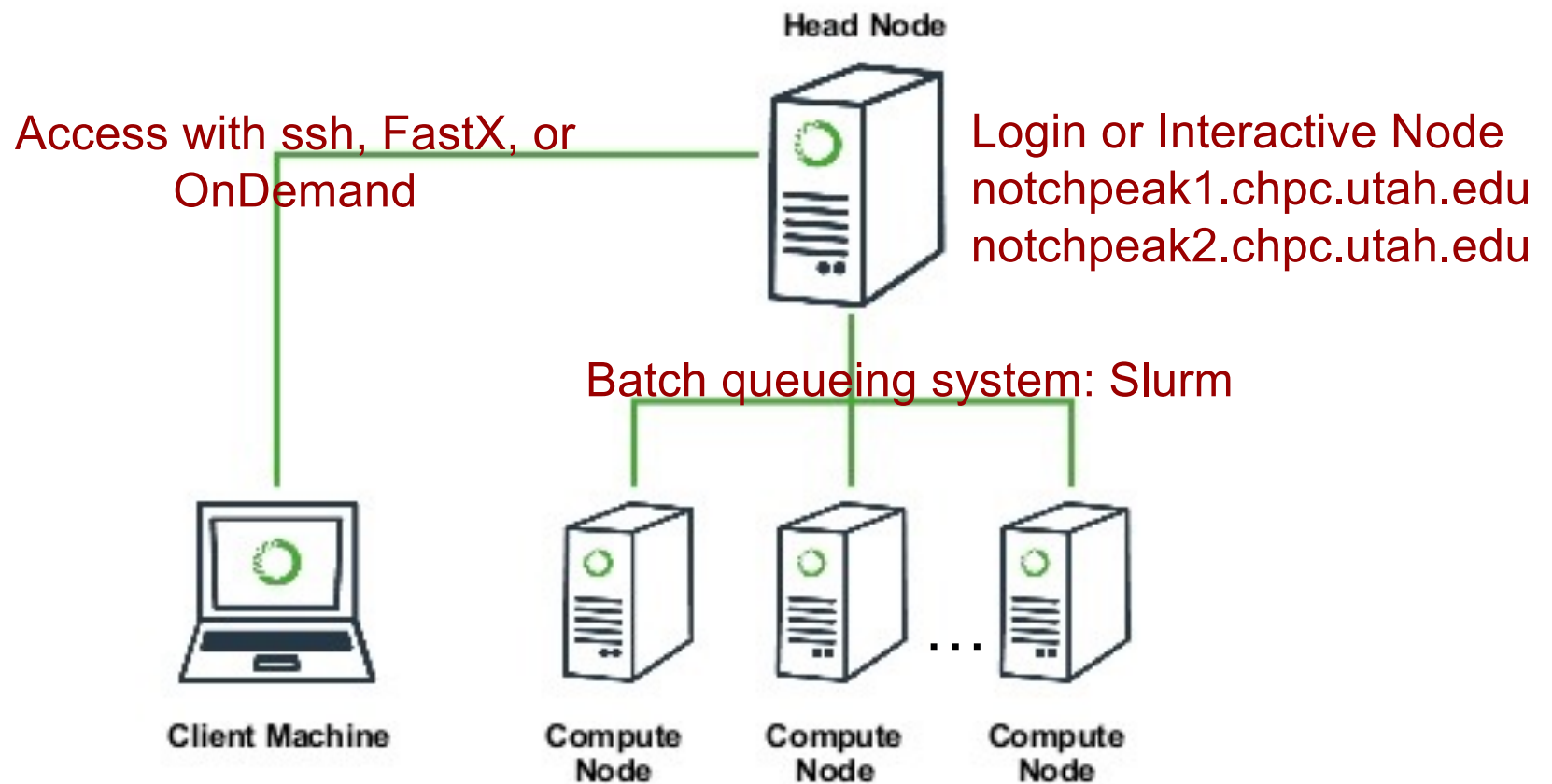
Open OnDemand

- Open OnDemand (OOD) web portal provides access to CHPC resources

- View, edit, upload and download files

- Create, edit, submit and monitor Slurm jobs

- Run applications including RStudio and Jupyter Lab

- Connect via a web browser, requires minimal knowledge of Linux and Slurm commands.

- Available in both General and Protected Environments
  - General environment: https://ondemand.chpc.utah.edu
  - Protected environment: https://pe-ondemand.chpc.utah.edu

- Our Presentation Series includes a class on OnDemand

- Documented here: www.chpc.utah.edu/documentation/software/ondemand.php

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, for 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
  - Also sacct, sinfo, scontrol …

- CHPC provides several easy replacements:
  - mychpc - show my access to computing resources
  - mysinfo - show the status of those resources
  - mysqueue - show the status of my jobs

Data Storage

- *Home Directories -- /uufs/chpc.utah.edu/common/home/<uNID>*
  - Located on a high-performance storage system named VAST
  - Home directories hold up to 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 compute nodes, up to 1TB (TMPDIR=/scratch/local/$USER/$SLURM_JOB_ID)

- *Archive Storage*
  - Archive space costs $150/TB/5 years
  - Similar to cloud storage, but on-site

Windows Servers

- Beehive (general environment) – refreshed 2019
  - 48 physical CPU cores, 2.3 Ghz, 512GB memory

- Narwhal (protected environment)
  - 24 physical CPU cores, 3.0 Ghz, 512GB memory

- Both have the following software installed
  - SAS 9.4 with text miner
  - R
  - STATA
  - Mathematica
  - Matlab

- *If you need other software, please contact us to discuss*

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 the community VMs) will have a cost, both for the VM and for any customization needed.

Blocks	RAM (GB)	Cores	Storage (GB)	Price/5 yrs
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.

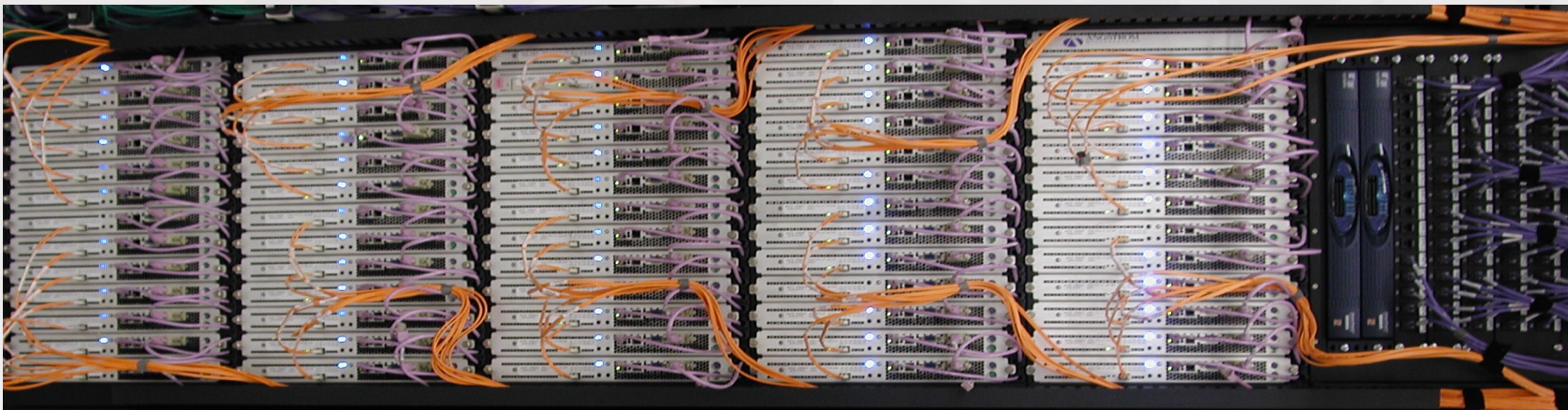www.chpc.utah.edu/resources/virtualmachines.php

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

Secure Computing

Protected Environment (PE)

- 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
  - Security upgrade to meet new NIH requirements for 2025 is in progress - will meet NIST SP 800-171 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

Citadel: Cybersecurity Maturity Model Certification (CMMC) Enclave

- For Controlled Unclassified Information (CUI)

Software: installed by CHPC

- Over 600 different applications, variety of disciplines, multiple versions of each, most (but not all) open source

- Packages managed with software "modules"
    - "module avail" lists available modules
    - "module spider *keyword*" to search for modules

- 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!

Software: installed by you

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

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 CPU Compute Nodes	Varies, from ~$14,000 (as of 1/14/25) 64 cores, 384 GB RAM, 6.2 TB SSD local scratch, email us for quotes
Owner GPU Compute Nodes	Costs vary dramatically depending on number and model of GPU. Email us for quotes

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

Getting an Allocation

- www.chpc.utah.edu -> User Services -> Allocations
  - Provides priority access to notchpeak, granite, redwood clusters
    - GPU nodes on granite also require an allocation as of 1/1/25
  - Regular 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: *mychpc batch* command

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