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.
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, …
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, 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
CHPC Linux Clusters

- "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

<table>
<thead>
<tr>
<th>Environment</th>
<th>Cluster</th>
<th>Compute Nodes</th>
<th>Cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>notchpeak</td>
<td>442</td>
<td>20,728</td>
</tr>
<tr>
<td>General</td>
<td>kingspeak</td>
<td>309</td>
<td>6,436</td>
</tr>
<tr>
<td>General</td>
<td>lonepeak</td>
<td>231</td>
<td>3,540</td>
</tr>
<tr>
<td>General</td>
<td>ash</td>
<td>182</td>
<td>3,812</td>
</tr>
<tr>
<td>Protected</td>
<td>redwood</td>
<td>214</td>
<td>6,716</td>
</tr>
</tbody>
</table>
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
Login or Interactive Node
notchpeak1.chpc.utah.edu
notchpeak2.chpc.utah.edu

Access with ssh, FastX, or OnDemand

Batch queueing system: SLURM

notch001 notch002 … notchxxx
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
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
  - `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>
  - 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
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*
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.

### VM Pricing

<table>
<thead>
<tr>
<th>Blocks</th>
<th>RAM (GB)</th>
<th>Cores</th>
<th>Storage (GB)</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>2</td>
<td>50</td>
<td>$425</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>2</td>
<td>100</td>
<td>$615</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>4</td>
<td>200</td>
<td>$990</td>
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<tr>
<td>8</td>
<td>32</td>
<td>8</td>
<td>400</td>
<td>$1745</td>
</tr>
<tr>
<td>16</td>
<td>64</td>
<td>8</td>
<td>800</td>
<td>$3250</td>
</tr>
</tbody>
</table>

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

[www.chpc.utah.edu/resources/virtualmachines.php](http://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

• 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)
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
Software: installed by you

• anaconda
• pip (python)
• R
• Compilers for numerous languages
• Create your own modules
# Costs

<table>
<thead>
<tr>
<th>Service</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accounts</td>
<td>Free</td>
</tr>
<tr>
<td>Cluster access</td>
<td>Free</td>
</tr>
<tr>
<td>Priority cluster access</td>
<td>Free (with time allocation)</td>
</tr>
<tr>
<td>50 GB home directory</td>
<td>Free</td>
</tr>
<tr>
<td>Scratch space access</td>
<td>Free</td>
</tr>
<tr>
<td>Training, Support &amp; Consultation</td>
<td>Free</td>
</tr>
<tr>
<td>Group &amp; archive disk space</td>
<td>$450/TB/5 years (backed up) or $150/TB/5 years (not backed up)</td>
</tr>
<tr>
<td>Virtual Machines</td>
<td>Varies, from $425 / 5 years</td>
</tr>
<tr>
<td>Owner Compute Nodes</td>
<td>Varies, from ~$7000, email for quote</td>
</tr>
</tbody>
</table>
Getting an Account

- [www.chpc.utah.edu](http://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, 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
Training, Support and Consultation

• Presentation Series
  • [www.chpc.utah.edu/presentations](http://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](http://www.chpc.utah.edu/documentation)

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

• Consultations: email helpdesk@chpc.utah.edu