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Research Computing Support at the University of Utah: An Overview of CHPC

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CHPC's Mission

In addition to deploying and operating high performance computational resources and providing advanced user support and training, CHPC serves as an expert team to broadly **support** the increasingly **diverse research computing needs** on campus. These needs include support for big data, big data movement, data analytics, security, virtual machines, Windows science application servers, protected environments for data mining and analysis of protected health information, and advanced networking.

- CHPC can help if:
  - You need parallel processing
  - You need access to a single high-powered computer
  - You need the ability to run many individual jobs simultaneously
  - You have a large amount of data to store and/or process
  - You need an application you don't have on your computer
  - Your data is IRB-governed PHI
  - You have other computing needs your local resources cannot meet

Sources of Useful Information

- Getting Started Guide
  - https://www.chpc.utah.edu/documentation/gettingstarted.php
- CHPC policies
  - https://www.chpc.utah.edu/documentation/policies/index.php
- Cluster Usage Guides
  - https://www.chpc.utah.edu/documentation/guides/index.php
- Application Documentation
  - https://www.chpc.utah.edu/documentation/software/index.php
- Programming Guide
  - https://www.chpc.utah.edu/documentation/ProgrammingGuide.php
- How to Videos
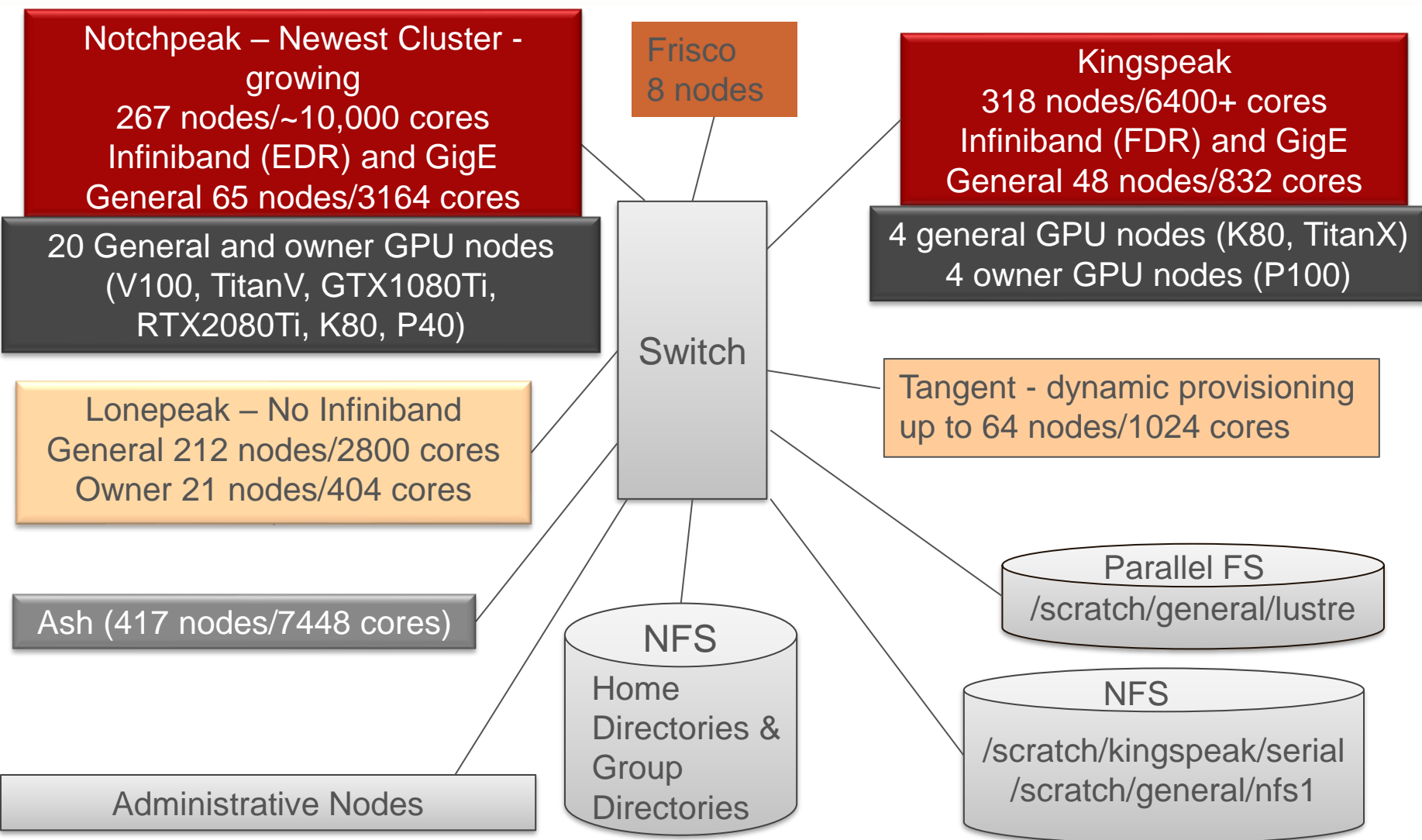 - https://www.chpc.utah.edu/documentation/videos/index.php

Downtown Data Center

- Came online Spring 2012

- CHPC completed move to DDC Spring 2013

- Shared with enterprise (academic/hospital) groups
- 92 racks and 1.2MW of power with upgrade path to add capacity for research computing
- Metro optical ring connecting campus, data center, & internet2
- 24/7/365 facility
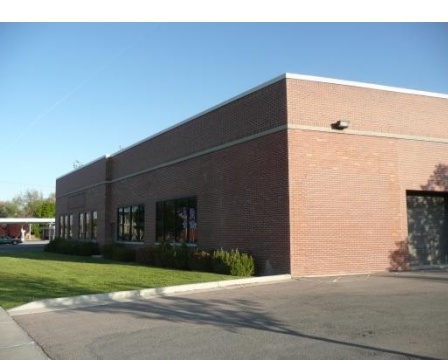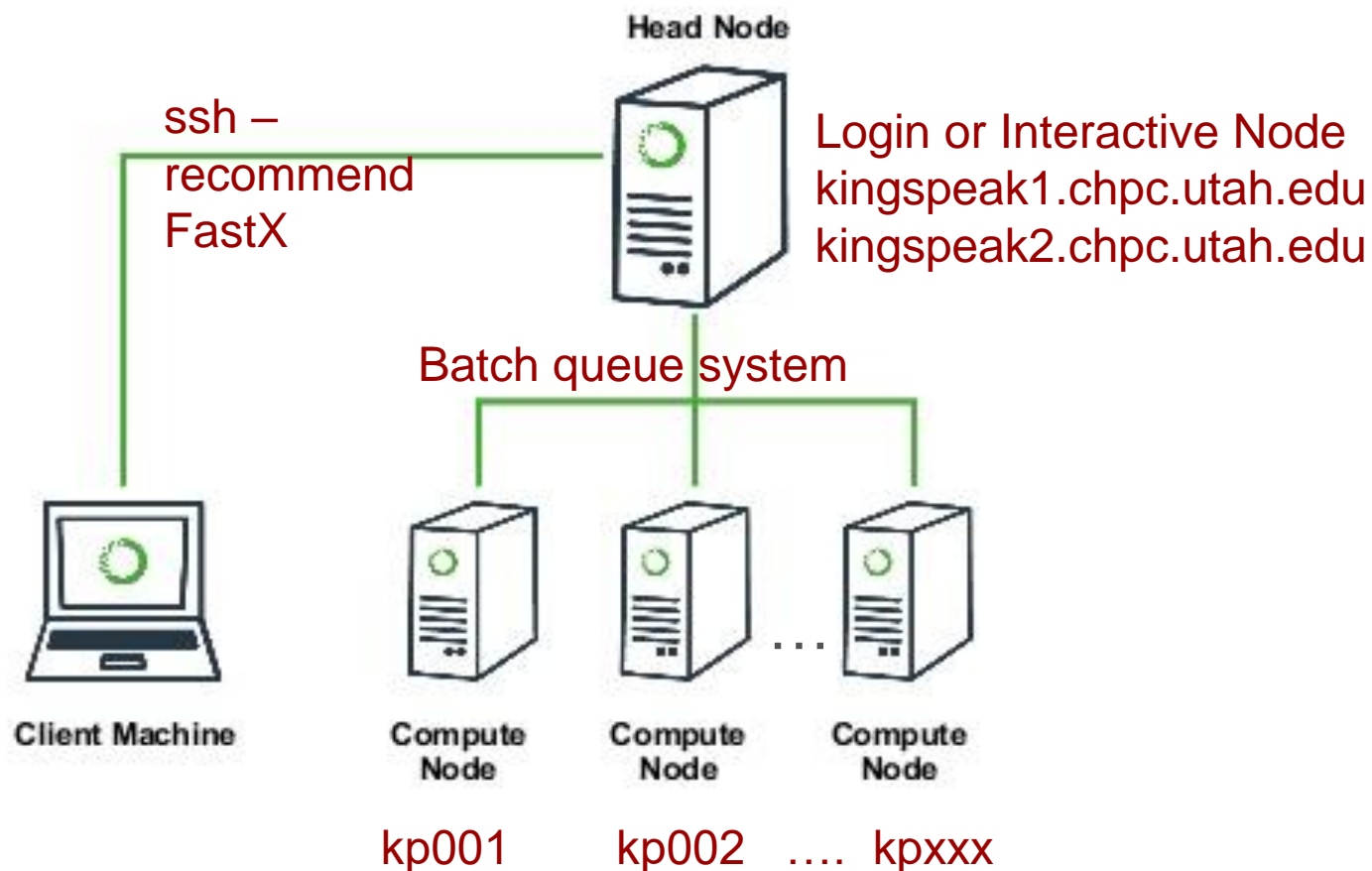
CHPC Resources & Services

- *Computational Clusters* – Notchpeak, Kingspeak, Lonepeak, Ash, Tangent

- *Storage* – home, group, and scratch storage along with archive storage options

- *Windows Servers* – mainly statistics usage and windows only applications

- *Virtual Machines* – for needs not met with cluster and windows server

- *Protected Environment* –computational cluster Redwood, storage, VMs, and Windows Server

- *Networking Support* – support compute environment; work with researchers on data movement

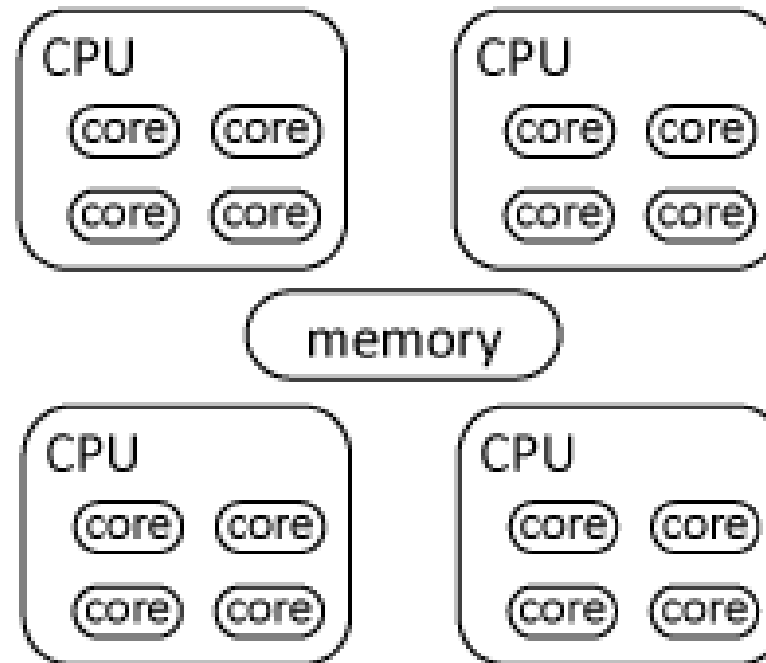- *User Support* – assistance with use of resources; installation of applications; training sessions

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Notchpeak – Newest Cluster - growing
267 nodes/~10,000 cores
Infiniband (EDR) and GigE
General 65 nodes/3164 cores

20 General and owner GPU nodes (V100, TitanV, GTX1080Ti, RTX2080Ti, K80, P40)

Frisco
8 nodes

Kingspeak
318 nodes/6400+ cores
Infiniband (FDR) and GigE
General 48 nodes/832 cores

4 general GPU nodes (K80, TitanX)
4 owner GPU nodes (P100)

Switch

Lonepeak – No Infiniband
General 212 nodes/2800 cores
Owner 21 nodes/404 cores

Tangent - dynamic provisioning up to 64 nodes/1024 cores

Ash (417 nodes/7448 cores)

Parallel FS
/scratch/general/lustre

NFS
Home Directories & Group Directories

NFS
/scratch/kingspeak/serial
/scratch/general/nfs1

Administrative Nodes

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CONTINUUM
ANALYTICS

Cluster Architecture Diagram

Head Node

ssh – recommend FastX

Login or Interactive Node
kingspeak1.chpc.utah.edu
kingspeak2.chpc.utah.edu

Batch queue system

Client Machine

Compute Node ... **Compute Node** **Compute Node**

kp001   kp002   …. kpxxx

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CHPC Clusters - Condominium Model

- Notchpeak (and Redwood in Protected Environment)
  - General resources – Allocation process for cycles
  - Out of allocation – freecycle allowed (with preemption)

- Owner nodes – new purchased added to notchpeak
  - Users from all groups allowed on as owner-guest when not in use (preemption)
  - Found on notchpeak, kingspeak, lonepeak (and redwood in PE)
  - 52 core Intel XeonSP(CascadeLake) @ 2.1GHz cpu speed, 192GB RAM, 2TB local hard drive, 5 year warranty, EDR IB connectivity @ ~$6100/node; with 384GB RAM ~$7770/node
  - 64 core AMD Rome (2.0 GHz base cpu speed), 256 GB memory ~$6150; with 512 GB, ~$8050

- Kingspeak, Lonepeak
  - General nodes no allocation, no preemptions

- Tangent
  - dynamically provisioned cluster resource; no allocation and no preemption

- Ash – Owner cluster
  - All users have guest access as smithp-guest (preemption)

CHPC Provides Core Infrastructure

- Physical needs (racks, power, cooling)

- Core ethernet and IB fabric; IB to ethernet bridging

- Login/head/management nodes

- Scheduling, batch and allocation systems

- HPC scratch space

- Some application and licensing costs

- High speed data transfer nodes (DTNs)

- 'Science DMZ' network

- CHPC Staff

More on Accounts

Allocations and node ownership status	What resource(s) are available
No general allocation, no owner nodes	Unallocated general nodes Allocated general nodes in freecycle mode - not recommended Guest access on owner nodes
General allocation, no owner nodes	Unallocated general nodes Allocated general nodes Guest access on owner nodes
Group owner nodes, no general allocation	Unallocated general nodes Allocated general nodes in freecycle mode - not recommended Group owned nodes Guest access on owner nodes of other groups
Group owner node, general allocation	Unallocated general nodes Allocated general nodes Group owned nodes Guest access on owner nodes of other groups

See https://www.chpc.utah.edu/documentation/guides/index.php#parts

Query your allocation

~]$ myallocation

You have a general allocation on kingspeak. Account: chpc, Partition: kingspeak

You have a general allocation on kingspeak. Account: chpc, Partition: kingspeak-shared

You can use preemptable mode on kingspeak. Account: owner-guest, Partition: kingspeak-guest

You can use preemptable GPU mode on kingspeak. Account: owner-gpu-guest, Partition: kingspeak-gpu-guest

You have a GPU allocation on kingspeak. Account: kingspeak-gpu, Partition: kingspeak-gpu

You have a general allocation on notchpeak. Account: chpc, Partition: notchpeak

You have a general allocation on notchspeak. Account: chpc, Partition: notchpeak-shared

You can use preemptable GPU mode on notchpeak. Account: owner-gpu-guest, Partition: notchpeak-gpu-guest

You have a general allocation on notchpeak. Account: notchpeak-shared-short, Partition: notchpeak-shared-short

You can use preemptable mode on notchpeak. Account: owner-guest, Partition: notchpeak-guest

You have a GPU allocation on notchpeak. Account: notchpeak-gpu, Partition: notchpeak-gpu

You have a general allocation on lonepeak. Account: chpc, Partition: lonepeak

You have a general allocation on lonepeak. Account: chpc, Partition: lonepeak-shared

You can use preemptable mode on lonepeak. Account: owner-guest, Partition: lonepeak-guest

You can use preemptable mode on ash. Account: smithp-guest, Partition: ash-guest

Core Hour Usage

Over 134M core hours provided in 2017; 160M in 2018; 177M in 2019
Since Jan 2017 – over 1600 users from over 435 groups ran more than 13.5 M jobs

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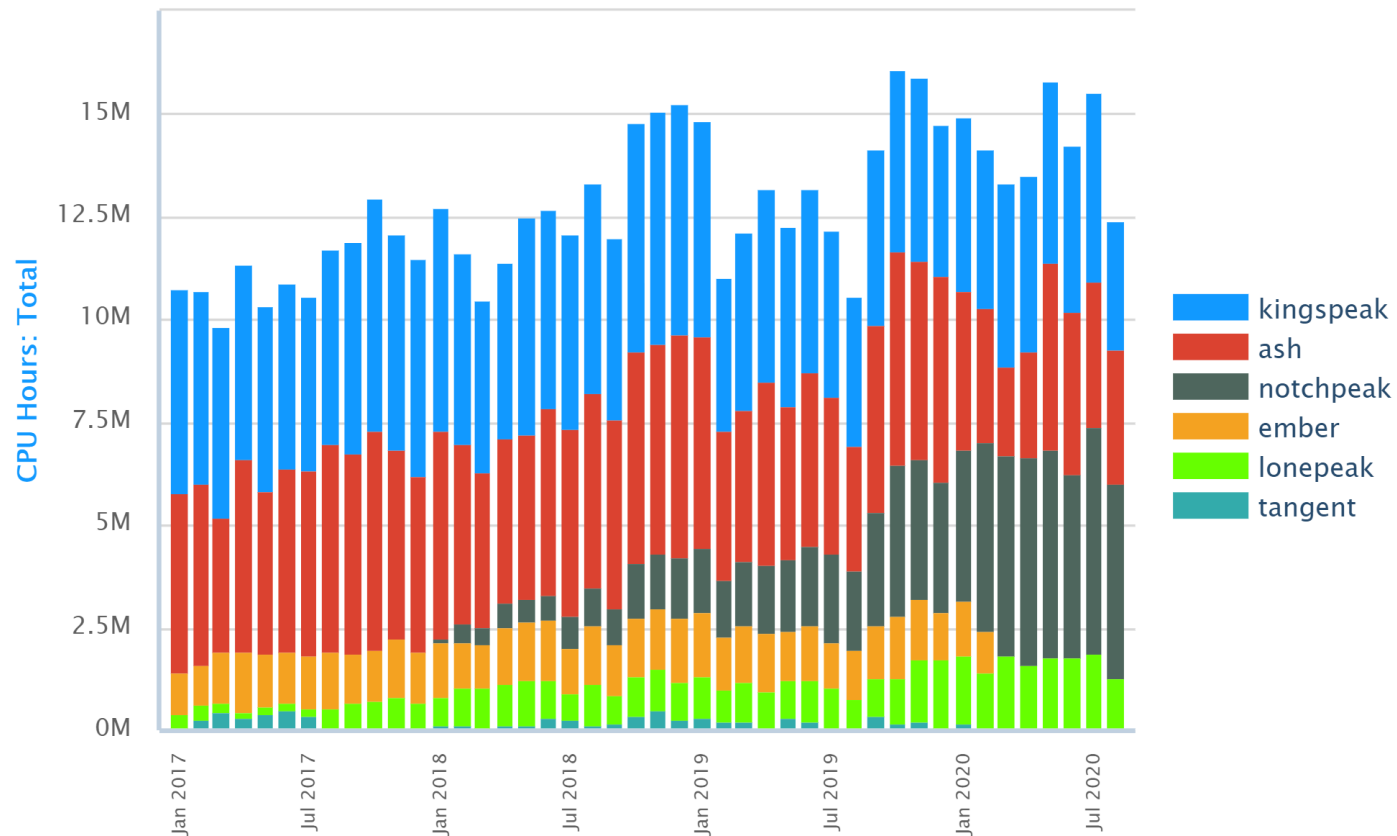
Storage Options

- *Home Directories* -- /uufs/chpc.utah.edu/common/home/<uNID>

    – Home directories 50 GB, not backed up

    – Groups can larger home directory per group at $500/TB for remaining ~2 year warranty; this comes with backup (nightly incremental, weekly full, 2 week retention)

    – Dell Compellent solution - two disk based copies mirrored for HA

- *Group Level File Systems*

    – Group space @$150/TB – no backup included in this price

- *Scratch File Systems*

    – For use by all users; no quotas; scrubbed of files older than 60 days

    – 700 TB Lustre Parallel file system (/scratch/general/lustre)

    – 175 TB NFS mounted file system (/scratch/kingspeak/serial)

    – 600 TB NFS mounted file system (/scratch/general/nfs1)

- *Disk Based Archive Storage*

    – Archive at $150/TB

File Systems

- Access speed based on connectivity
- Local disk fastest – local to each node; varies in size
  - /scratch/local
- Network mounted scratch file systems
  - /scratch/general/lustre
  - /scratch/kingspeak/serial
  - /scratch/general/nfs1
  - home directories and group spaces (***don't use for large i/o!***)

Remember NFS mounted spaces – including file systems for group spaces – are a shared resource!

Protected Environment

- Refreshed in 2017 with award of NIH Shared instrumentation grant
  - HPC cluster – redwood
  - VM farm – prismatic
  - storage – mammoth, both home and project space; elm for archive object storage
  - windows compute – narwhal
- See https://www.chpc.utah.edu/resources/ProtectedEnvironment.php
- Dedicated protected resources for handling of data/projects with protected information
- Currently HIPAA
- Also for projects with other types of sensitive data/restrictions
- Significant area of growth for CHPC
- Preferred location for human genomic – meets NIH dbGaP requirements

Recent Changes

- Changes with /scratch/local directory structure
    - /scratch/local now encrypted
    - /scratch/local no longer writable by user
    - In job prolog (before slurm starts job) a directory /scratch/local/$USER/$SLURM_JOB_ID created
    - If prolog cannot create this directory (/scratch/local has issues) then the job is assigned to a different node
    - Only job owner can write to this directory
    - After job finishes, the job epilog removes this directory
    - New structure will isolate /scratch/local for individual jobs as well as avoid cases where a job starts on a node with a full /scratch/local

Getting a CHPC Account

- CHPC uses campus uNID and password

- PIs must have account and will need to approve accounts for any members of their research group (can delegate)

- Account Application Procedure – Online process

  – Complete CHPC account form at https://www.chpc.utah.edu/role/user/account_request.php

  – For collaborators outside of University of Utah must complete affiliate form with HR to get uNID https://www.hr.utah.edu/forms/affiliate.php and then use account application

Security Policies

- No clear text passwords, use ssh and scp
- You may not share your account under any circumstances
- Don't leave your terminal unattended while logged into your account
- Do not introduce classified or sensitive work onto CHPC systems unless on Protected Environment
- Do not try to break passwords, tamper with files etc.
- Do not distribute or copy privileged data or software
- Report suspicions to CHPC (security@chpc.utah.edu)
- See http://www.chpc.utah.edu/docs/policies/security.html for more details

Accessing Clusters

- Login or interactive nodes with each cluster
  - *cluster*1.chpc.utah.edu or *cluster*2.chpc.utah.edu where *cluster* is notchpeak, kingspeak, ember, tangent, ash-guest, lonepeak (redwood in PE)
  - There are also 8 frisco nodes (frisco1-8) that act as kingspeak interactive nodes
- Interactive nodes only used for short compiles, editing and very short test runs
- ***No more than 15 minutes and no jobs of any length that make heavy use of cpu or memory!***
- Have script (Arbiter) which watches running processes and notifies users when in violation of the acceptable usage policy

Accessing Clusters (2)

- Use FastX from Mac, Windows, or Linux desktops -- preferred

  – https://www.chpc.utah.edu/documentation/software/fastx2.php

- Alternatively:

  – From windows need ssh client

    - PuTTY http://www.chiark.greenend.org.uk/~sgtatham/putty/

    - Xshell http://www.netsarang.com/products/xsh_overview.html

  – For X forwarding applications also need

    - Xming http://www.straightrunning.com/XmingNotes/

      – Look for "mesa" version

  – From mac/linux – use terminal ssh (with –Y for X forwarding)

- Access to protected environment needs Duo two factor authentication (and VPN if off campus)

FastX – Tool for Remote X

- https://www.starnet.com/fastx
- Used to interact with remote linux systems graphically in much more efficient and effective way then simple X forwarding
- Graphical sessions can be detached from without being closed, allowing users to reattach to the session from the same or other systems
- Server on all interactive nodes as well as the frisco nodes; some servers have graphics cards and support OpenGL
- Clients for windows, mac and linux; can be installed on both university and personal desktops.

FastX

- For FastX – see "To Use" section of documentation at https://www.chpc.utah.edu/documentation/software/fastx2.php

- Download client following directions on page

- Do install

- Start program

- Set host to kingspeak1.chpc.utah.edu OR kingspeak2.chpc.utah.edu OR other interactive node OR one of the frisco nodes (frisco1-frisco8.chpc.utah.edu)

OpenOnDemand

- An alternate to open a shell is to use the Open OnDemand (OOD) portal to access CHPC resources

- Allows users to view, edit, upload and download files, create, edit, submit and monitor jobs, run GUI applications, and connect via SSH, all via a web browser and with a minimal knowledge of Linux and scheduler commands.

- Presentation on OOD – Wednesday Sept 23, 2020

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

Login scripts

- CHPC provides login scripts ("dot" files) when creating account for both tcsh and bash shells
- These files set the environment so that applications are found, batch commands work – ***Do not remove***
- Choose shell at account creation – can change at www.chpc.utah.edu (sign in, select edit profile)
- Four files: .bashrc, .tcshrc, .custom.sh, .custom.csh
  - **The first two should not be edited**
  - **The second two is where to add custom module loads**
- Will automatically execute an .aliases file if it exists

CHPC Uses Modules for Setting Environment

- CHPC provides login scripts ("dot" files) when creating account for both tcsh and bash shells
- These files set the environment so that applications are found, batch commands work – ***Do not remove or edit!***
- **https://www.chpc.utah.edu/documentation/software/modules.php** for information
- Presentation on Modules – Friday, September 18

Batch System Information

- Used to access compute nodes which must be used for any extensive use
- Use SLURM – Simple Linux Utility for Resource Management
- https://www.chpc.utah.edu/documentation/software/slurm.php
- Presentation on Slurm – Monday, September 21

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Software on Clusters

- Have a variety of compliers, mpi packages, math libraries and applications installed

- Some licensing restrictions may apply

- If you need a package we do not currently have installed – ask us!

- Currently we place installations at:

    - /uufs/chpc.utah.edu/sys/installdir

- Use 'module spider' to search for applications installed

Allocation

- General Allocation Process Information
  - https://www.chpc.utah.edu/documentation/policies/1.4AllocationPolicies.php
- Regular allocation form
  - https://www.chpc.utah.edu/apps/profile/allocation_form.php
  - Requests due Sept 1, Dec 1, Mar 1, and Jun 1
  - Allocation in core hours
- Quick allocation
  - https://www.chpc.utah.edu/apps/profile/allocation_quick_form.php
- Check usage -- https://www.chpc.utah.edu/usage/cluster/current-project-general.php
- Simplified quick allocation requests & general allocation requests for up to 20,000 core-hours per quarter

Windows Statistics Server

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

Virtual Machine Farm

- For needs and applications that do not fit in compute cluster or Windows server

- Multiple VM servers with failover – hardware refreshed 2019

- VM storage

- Have community mysql/mssql VMs, git repositories, web servers, etc

- New – user 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	$475
2	8	2	100	$705
4	16	4	200	$1175
8	32	8	400	$2115
16	64	8	800	$3995

Additional VM storage available, in 100GB increments, at a cost of $850/TB.

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

Fall 2020 Presentation Series

Only offered remotely via zoom, *1-2pm, **1-3pm, XSEDE 9am-3pm

DATE	PRESENTATION TITLE	PRESENTER
Fri, Aug 28, 2020	Overview of CHPC	Anita Orendt
Tues/Weds, Sept 1-2, 2020	XSEDE HPC Workshop : MPI	XSEDE Webcast
Weds, Sept 9, 2020	Hands on Introduction to Linux, part 1*	Brett Milash &Wim Cardoen
Fri, Sept 11, 2020	Hands on Introduction to Linux, part 2*	Brett Milash &Wim Cardoen
Mon, Sept 14, 2020	Hands on Introduction to Linux, part 3*	Brett Milash &Wim Cardoen
Weds, Sept 16, 2020	Hands on Introduction to Linux, part 4*	Wim Cardoen & Brett Milash
Fri, Sept 18, 2020	Module Basics	Anita Orendt
Mon, Sept 21, 2020	Slurm and Slurm Batch Scripts	Anita Orendt
Weds, Sept 23, 2020	Hands-on Introduction to Open OnDemand*	Martin Cuma
Fri, Sept 25, 2020	Hands-on Introduction to Python, Part 1*	Brett Milash & Wim Cardoen
Mon, Sept 28, 2020	Hands-on Introduction to Python, Part 2*	Brett Milash & Wim Cardoen
Weds, Sept 30, 2020	Hands-on Introduction to Python, Part 3*	Brett Milash & Wim Cardoen

https://www.chpc.utah.edu/presentations/fall2020chpcpresentationschedule.php

DATE	PRESENTATION TITLE	PRESENTER
Fri, Oct 2, 2020	Numpy, part 1 (Hands-on Introduction to Python, Part 4)*	Wim Cardoen & Brett Milash
Mon, Oct 5, 2020	Numpy, part 2 (Hands-on Introduction to Python, Part 5)*	Wim Cardoen & Brett Milash
Tues/Weds, Oct 6-7, 2020	XSEDE HPC Workshop : Big Data and Machine Learning	XSEDE Webcast
Fri, Oct 9, 2020	National and Regional Compute Resources	Anita Orendt
Mon, Oct 12, 2020	OSG (with information about the newchpc osg submit node)	Wim Cardoen
Weds, Oct 14, 2020	Workflows Using Snakemake*	Brett Milash
Fri, Oct 16, 2020	Nextflow* -- *NEW!*	David Chen & Brett Milash
Mon, Oct 19, 2020	Introduction to Parallel Computing*	Martin Cuma
Weds, Oct 21, 2020	Introduction to Programming with MPI	Martin Cuma
Fri, Oct 23, 2020	Introduction to Programming with OpenMP	Martin Cuma
Mon, Oct 26, 2020	Hybrid MPI-OpenMP Programming	Martin Cuma
Weds, Oct 28, 2020	GPU Programming	Wim Cardoen

https://www.chpc.utah.edu/presentations/fall2020chpcpresentationschedule.php

DATE	PRESENTATION TITLE	PRESENTER
Fri, Oct 30, 2020	Introduction to I/O at CHPC	Martin Cuma
Tues, Nov 3, 2020	XSEDE HPC Workshop : OpenMP	XSEDE Webcast
Weds, Nov 4, 2020	Introduction to Profiling	Martin Cuma
Fri, Nov 6, 2020	Introduction to Debugging	Martin Cuma
Mon, Nov 9, 2020	Introduction to Containers*	Martin Cuma
Weds, Nov 11, 2020	Introduction to R*	Wim Cardoen & Brett Milash
Fri, Nov 13, 2020	Data Management Tips	Anita Orendt & Brett Milash
Mon, Nov 23, 2020	Using Git for Version Control*	Martin Cuma
Mon, Nov 30, 2020	Overview of the Protected Environment	Anita Orendt & Wayne Bradford

If you would like training for yourself or your group, CHPC staff would be happy to accommodate your request. Please contact anita.orendt@utah.edu or helpdesk@chpc.utah.edu

https://www.chpc.utah.edu/presentations/fall2020chpcpresentationschedule.php

Getting Help

- CHPC website
  - www.chpc.utah.edu
    - Getting started guide, cluster usage guides, software manual pages, CHPC policies
- Ticketing System
  - Email: helpdesk@chpc.utah.edu
- Mailing Lists:
  chpc-hpc-users@lists.utah.edu used to send messages to users