

# 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>

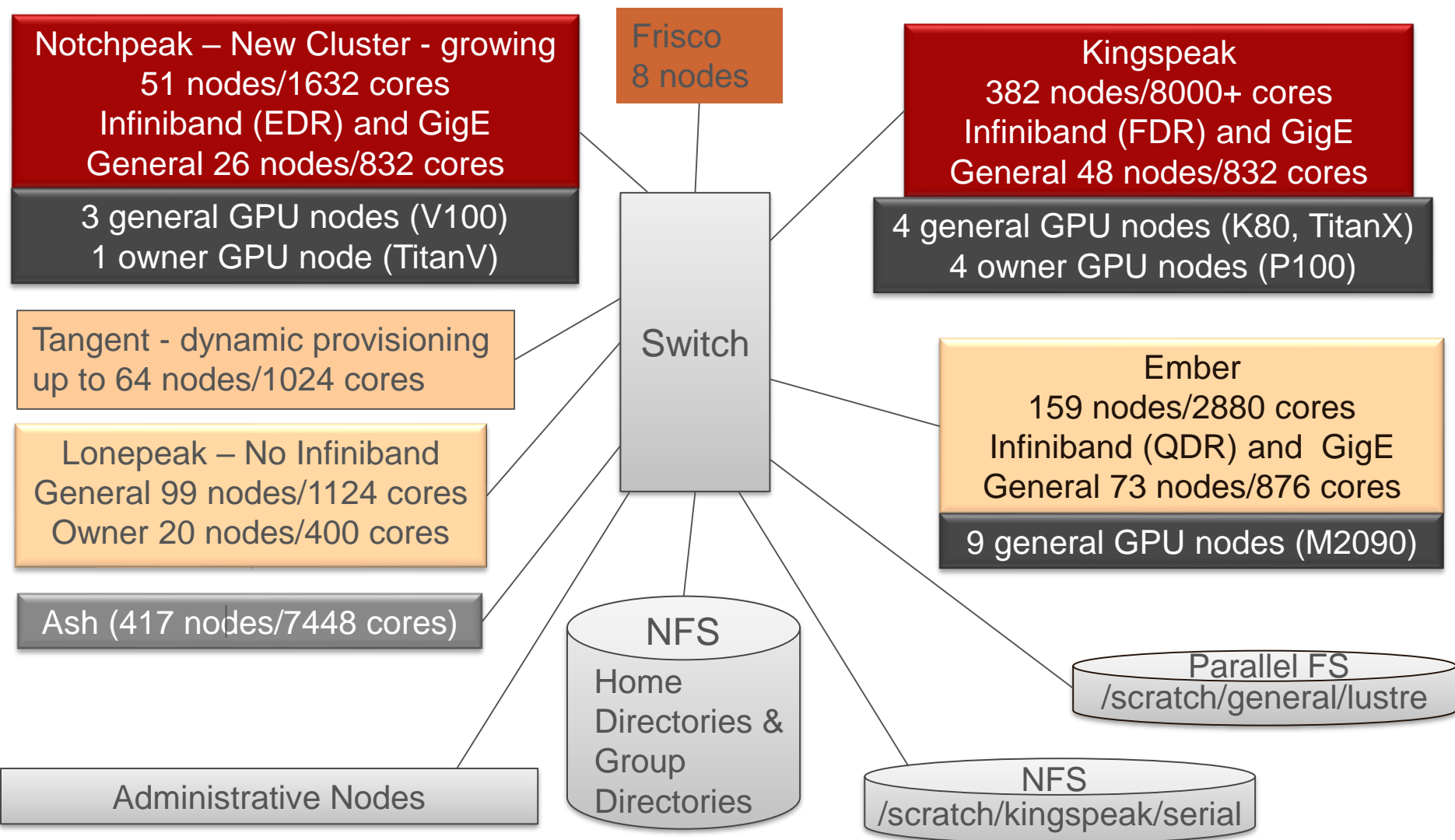
## Downtown Data Center

- 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, Ember, Ash, Tangent
- **Storage** – home, group, and scratch storage along with tape backup and 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 etc
- **User Support** – assistance with use of resources; installation of applications; training sessions



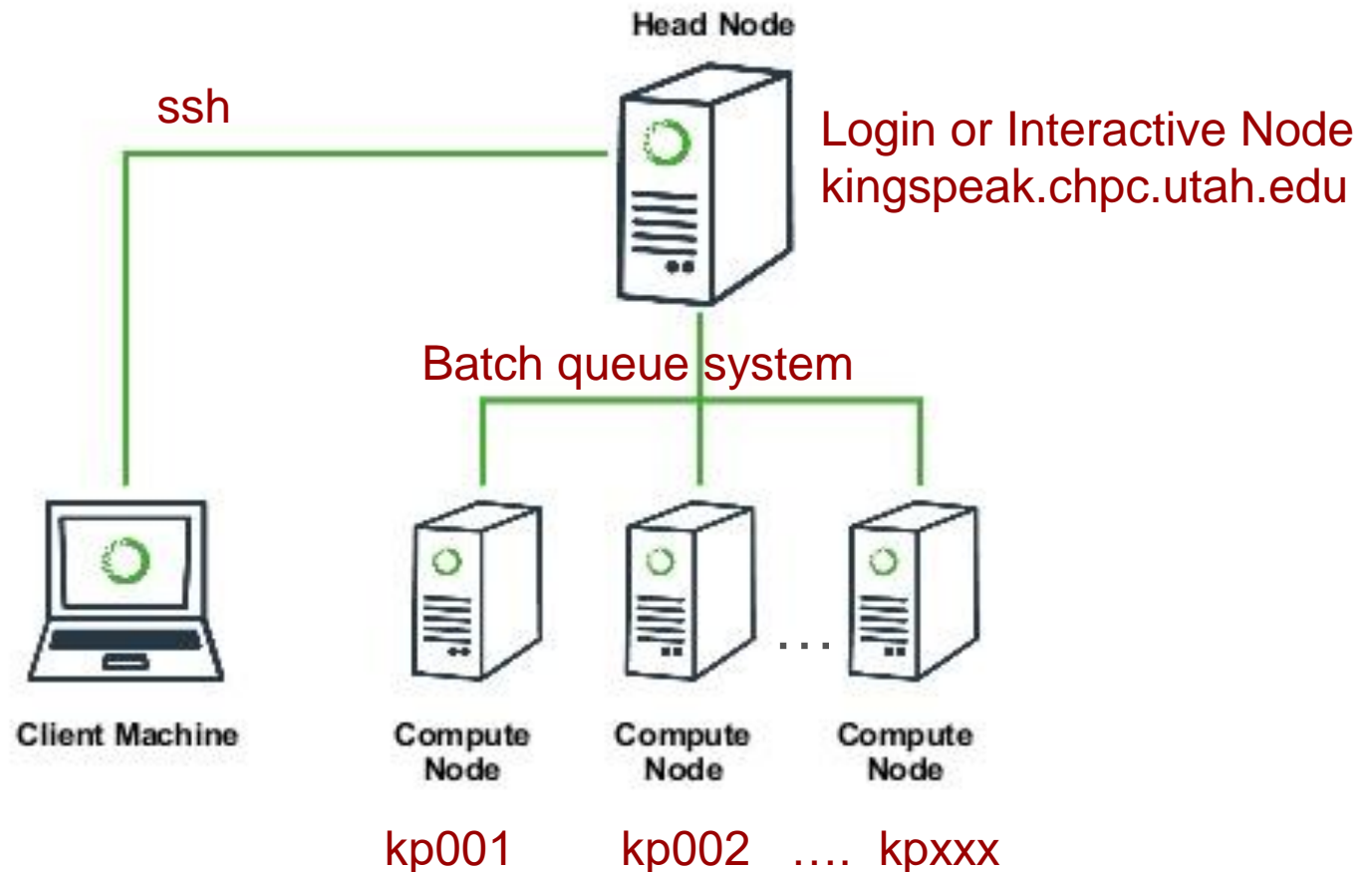


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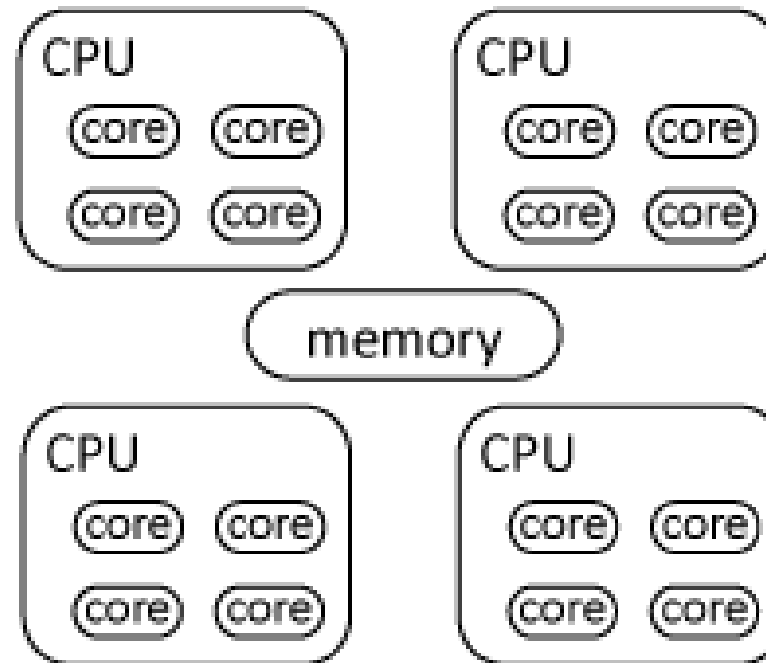




# Cluster Architecture Diagram



## Node

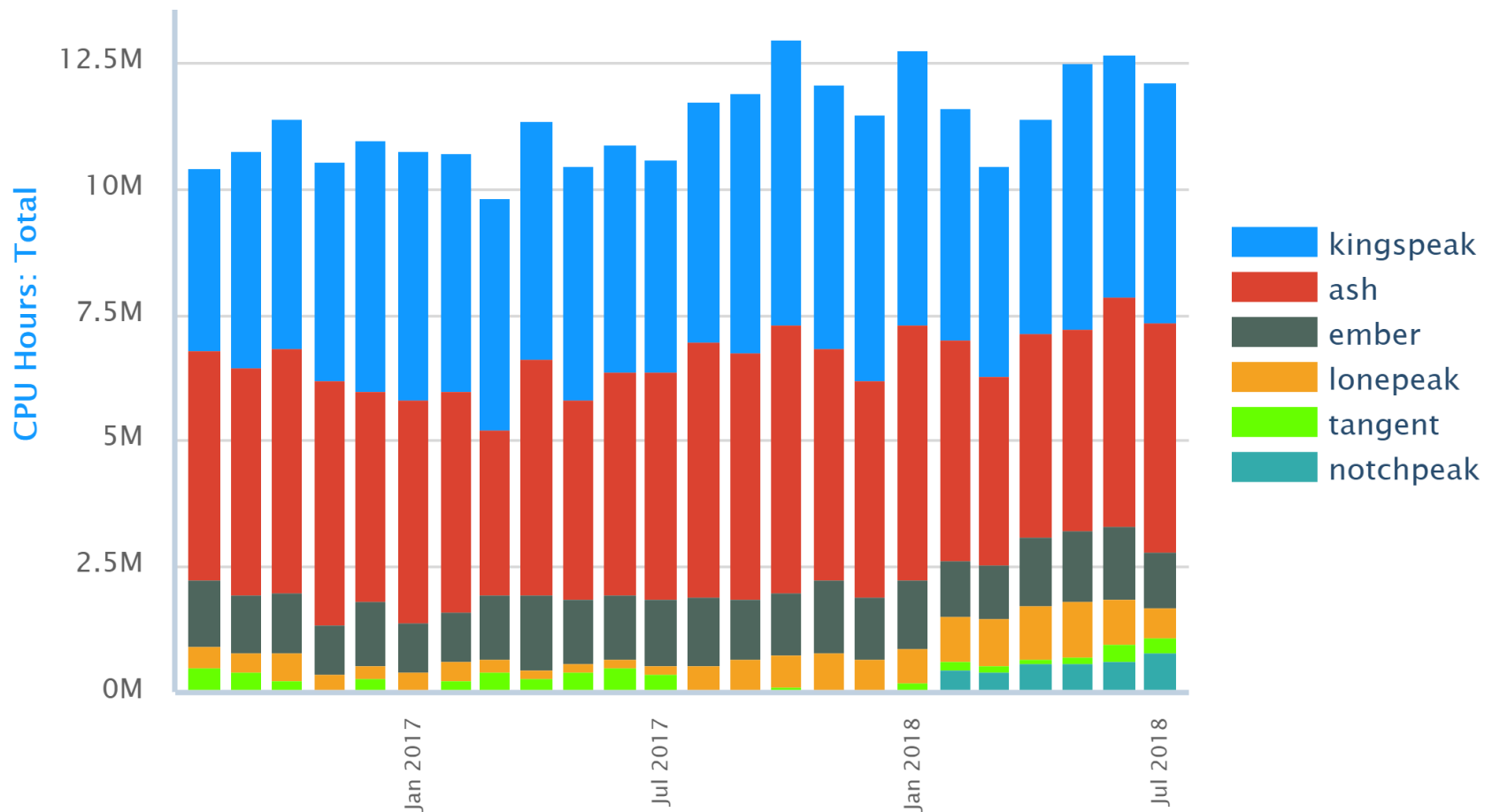


# CHPC Clusters - Condominium Model

- Notchpeak, Kingspeak
  - 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, ember, lonepeak
  - 32 core Intel XeonSP(Skylake) @ 2.1GHz cpu speed, 96GB RAM, 2TB local hard drive, 5 year warranty, EDR IB connectivity @ ~\$8000/node; with 192GB RAM ~\$9200/node
- Ember, Lonepeak
  - no allocation and no preemption
- Tangent
  - dynamically provisioned cluster resource; no allocation and no preemption
- Ash – Owner cluster
  - All users have guest access as smithp-guest (preemption)

# Core Hour Usage

Over 134M core hours provided in 2017; over 71M in first half of 2018



# 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



# Storage Options

- *Home Directories* -- /uufs/chpc.utah.edu/common/home/<uNID>
  - Home directories 50 GB, not backed up
  - Groups can purchase 1 TB max home directory per group at \$1250/TB for hardware lifetime; this comes with backup (nightly incremental, weekly full, 2 week retention)
  - New Compellent solution on-line and all home directories have been migrated
- *Group Level File Systems*
  - Group space @\$150/TB; can get quarterly archives with purchase of tapes\*
- *Scratch File Systems*
  - For use by all users; 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)
- *Disk Based Archive Storage*
- *Tape Backups* – as discussed above

# 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
  - 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

- Just refreshed with award of NIH Shared instrumentation grant
  - New cluster – redwood
  - New VM farm – prismatic
  - New storage – mammoth
  - New windows compute – narwhal
  - New policies
- See <https://www.chpc.utah.edu/resources/ProtectedEnvironment.php>
- Dedicated protected resources for handling of data/projects with protected information
- Currently HIPAA, looking at FISMA & FERPA
- 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

# Upcoming Changes

- Working on new backup solution/strategies
- General Environment Virtual Machine (VM) Farm Refresh
  - VMs will no longer be free of charge

# Getting a CHPC Account

- CHPC uses campus uNID and password
- Pls 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](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](mailto: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
  - ssh -Y **cluster**.chpc.utah.edu where **cluster** is notchpeak, kingspeak, ember, tangent, ash-guest, lonepeak (redwood in PE)
- 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 which watches running processes and notifies users when in violation of the acceptable usage policy

# Accessing Login nodes

- 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](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)



# 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](http://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 – Tuesday, August 28th

# 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> for information
- Presentation on Slurm – Thursday, August 30th

# Software on Clusters

- Have a variety of compilers, 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
- Have a searchable application database
  - <https://www.chpc.utah.edu/software/chpc/>

# 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](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](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

- Kachina/Swasey – each 48 core, 512TB memory
  - In PE – Narwhal
- 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
- 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.
  - Already charging for VMs in protected environment
  - Will start to charge for VMs in general environment later this year
  - Cost depends on size of VM
    - In PE size is multiple of blocks with 1 block = 2 cores, 4GB RAM, 50GB storage, cost is \$350/block for 5 years
    - Price yet to be determined in general



# CHPC Fall 2018 Presentation Series

In INSCC Auditorium at 1-2pm unless otherwise noted – can join remotely via zoom – \*1-3pm; \*\*9am-3pm

DATE	PRESENTATION TITLE	PRESENTER
Thursday August 23rd	<a href="#"><u>Overview of CHPC</u></a>	Anita Orendt
Tuesday August 28th	<a href="#"><u>Module Basics</u></a>	Anita Orendt
Thursday August 30th	<a href="#"><u>Slurm and Slurm Batch Scripts</u></a>	Anita Orendt
Wednesday/Thursday September 5th & 6th	<a href="#"><u>XSEDE HPC Monthly Workshop: Big Data**</u></a>	Wim Cardoen
Tuesday September 11th	<a href="#"><u>Hands on Introduction to Linux, part 1*</u></a>	Brett Milash & Wim Cardoen
Thursday September 13th	<a href="#"><u>Hands on Introduction to Linux, part 2*</u></a>	Brett Milash & Wim Cardoen
Tuesday September 18th	<a href="#"><u>Hands on Introduction to Linux, part 3*</u></a>	Brett Milash & Wim Cardoen
Thursday September 20th	<a href="#"><u>Introduction to Parallel Computing</u></a>	Martin Cuma
Tuesday September 25th	<a href="#"><u>Hands on Introduction to Linux, part 4*</u></a>	Brett Milash & Wim Cardoen
Thursday September 27th	<a href="#"><u>Introduction to Programming with MPI</u></a>	Martin Cuma
Tuesday & Wednesday October 2nd & 3rd	<a href="#"><u>XSEDE HPC Monthly workshop MPI **</u></a>	Martin Cuma
Thursday October 4th	<a href="#"><u>GPU Programming</u></a>	Wim Cardoen
Tuesday October 16th	<a href="#"><u>Hands-on Introduction to Python, Part 1*</u></a>	Brett Milash & Wim Cardoen
Thursday October 18th	<a href="#"><u>Hands-on Introduction to Python, Part 2*</u></a>	Brett Milash & Wim Cardoen

# CENTER FOR HIGH PERFORMANCE COMPUTING

DATE	PRESENTATION TITLE	PRESENTER
Tuesday October 23rd	<a href="#"><u>Numpy, part 1 (Hands-on Introduction to Python, Part 3*)</u></a>	Wim Cardoen & Brett Milash
Thursday October 25th	<a href="#"><u>Numpy, part 2 (Hands-on Introduction to Python, Part 4*)</u></a>	Wim Cardoen & Brett Milash
Tuesday October 30th	<a href="#"><u>Introduction to Programming with OpenMP</u></a>	Martin Cuma
Thursday November 1st	<a href="#"><u>Hybrid MPI-OpenMP Programming</u></a>	Martin Cuma
Tuesday November 6th	<a href="#"><u>XSEDE HPC Monthly Workshop: GPU Programming using OpenACC**</u></a>	Wim Cardoen
Thursday November 8th	<a href="#"><u>Introduction to Debugging</u></a>	Martin Cuma
Tuesday November 13th	<a href="#"><u>Introduction to R*</u></a>	Wim Cardoen & Brett Milash
Tuesday November 20th	<a href="#"><u>Introduction to Profiling</u></a>	Martin Cuma
Tuesday November 27th	<a href="#"><u>National Compute Resources</u></a>	Anita Orendt
Thursday November 29th	<a href="#"><u>Introduction to Containers*</u></a>	Martin Cuma
Tuesday December 4th	<a href="#"><u>Introduction to I/O at CHPC</u></a>	Martin Cuma
Thursday December 6th	<a href="#"><u>Overview of the Protected Environment</u></a>	Anita Orendt

[\*\*https://www.chpc.utah.edu/presentations/Fall2018CHPCPresentationSchedule.php\*\*](https://www.chpc.utah.edu/presentations/Fall2018CHPCPresentationSchedule.php)

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](mailto:anita.orendt@utah.edu) or [helpdesk@chpc.utah.edu](mailto:helpdesk@chpc.utah.edu)

# Getting Help

- CHPC website
  - [www.chpc.utah.edu](http://www.chpc.utah.edu)
    - Getting started guide, cluster usage guides, software manual pages, CHPC policies
- Ticketing System
  - Email: [helpdesk@chpc.utah.edu](mailto:helpdesk@chpc.utah.edu)
- Help Desk: 405 INSCC, 581-6440 (9-5 M-F)
- Mailing Lists:  
[chpc-hpc-users@lists.utah.edu](mailto:chpc-hpc-users@lists.utah.edu) used to send messages to users