The Hyak HPCDE — Overview

- HPCDE Elements
- Accomplishments
- Mini-History
- MOX.hyak Features
- How To Order
- Useful URLs
The Hyak HPCDE and its Role

- **SoS** – The Speed of Science
  - No proposal writing and hoping for resources
  - Immediate access to resources to try out new ideas, algorithms, etc

- **P4E** – Preparing for Exascale
  - Trying out new algorithms and codes with Exascale type architectures

- **BDP** – Big Data Pipelines
  - Rapid access to large data sets and fast distribution
  - Local experiments, sensors, real-time processing
The Hyak HPCDE — The Elements, Cont...

- **Data Center**
  - 1.8MW Total Capacity
  - 600KW Dedicated to the Hyak HPCDE
  - Sufficient to Support ~1,500 nodes

- **Networks**
  - Internal HPC Interconnects
  - 100Gbs Science DMZ
  - 40Gbs Campus High Speed Research Network (HSRN)
The Hyak HPCDE — The Elements, Cont...

• Engineering Staff
  • 2 x Full Time Senior HPC Engineers (New Hire!)
  • Access to Dozens of UW-IT Engineers
  • Active Participation in the National HPC Scene

• Computational Scientist Support
  • 1 x FTE funded by UW-IT
  • Collaborate with eScience (Rob Fatland)
  • Collaborate with Unit IT Staff

• Lots and Lots More!
  • Inventory, Compliance, Proposal Prep, etc.
The Hyak HPCDE — The Elements

- HPC
  - IKT.hyak
  - MOX.hyak

- Storage
  - Internal Working Storage
  - lolo Archives
  - lolo Collaboration
WIKI for Hyak users

Created by hyaktest, last modified by Stephen Fralich on Feb 03, 2017

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  - 1.1 Mailing List
  - 1.2 Announcements
- 2 System Status
  - 2.1 Current Status
  - 2.2 Monthly Scheduled Maintenance
  - 2.3 Cluster Node Status
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- 11 Feature Requests
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- 13 Help for Hyak Node Sponsors
Hyak HOWTO

Created by hyaktest, last modified by Pramod Gupta on Feb 24, 2017

This page contains a list of HOWTO documents for carrying out specific tasks on hyak.

Hyak_linux_command_line
Using R on hyak
Hyak RStudio
Hyak R ggplot2
Hyak building code
Hyak installing open source software
Hyak installing PETSc
Hyak python programming
Hyak IPython
Hyak mpi4py
Hyak python dask
Hyak spark
Hyak hadoop
Hyak java programming
Hyak R programming

Created by hyaktest, last modified by Pramod Gupta on Dec 08, 2016

Hyak fully supports R, anything that you can do with R on your desktop computer can be done on hyak but on a much larger scale. However, since hyak is a large scale shared resource there are a few steps that you have to take before running R.

Hyak is a Linux supercomputer. If you have not used the linux or UNIX or MacOS X command line before, it is a good idea to get familiar with the command line before running on hyak. Google "linux command line" for useful links. Of course, you should also have experience with R programming and R scripts on your desktop computer before you try running R on a supercomputer like hyak.

Usually, you will be using qsub to submit a PBS script to the hyak scheduler. (See bottom of this page). The PBS script will contain instructions for running your R script. The hyak scheduler takes care of details like finding a suitable node to run your R script etc.

Interactive Session

However, first let us use an interactive qsub session to get familiar with running R on hyak. Issue the command below at the hyak login node, to get a interactive hyak session (the "-l" is an upper case l)

```
qsub -q build -T -l walltime=3:00:00
```

This opens an interactive session on a hyak node.

If we type R at the command line and press enter then we get an error

"R: command not found". What’s wrong? Unlike your desktop computer, hyak supports hundreds of users with different requirements and different versions of the same software. Hence, unlike your desktop computer, not all software executables are put in everyone’s PATH environment variable.

Those fluent with the Linux will want to put the location of R in their own PATH. However, this should be done using module command instead. It essentially performs similar tasks by modifying the PATH, LD_LIBRARY_PATH and other necessary parts of your environment.
What was Accomplished

Data from early 2015
Hyak Supports a BROAD range of Workloads
Hyak Use Statistics

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Campuses</td>
<td>2</td>
</tr>
<tr>
<td>Colleges</td>
<td>6</td>
</tr>
<tr>
<td>Departments</td>
<td>89</td>
</tr>
<tr>
<td>Users</td>
<td>939</td>
</tr>
<tr>
<td>Core Hrs</td>
<td>236,617,278</td>
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</table>
How can Hyak Accomplish this Growth?

- Each Generation of Hyak starts small, then grows in response to user demand.
- Increases in hardware performance over time become increases in Hyak performance.
- Nodes older than four years are retired, making space for newer, faster nodes.
**NextGen Hyak**

Hyak is part of an integrated, scalable, scientific super-computing infrastructure operated by UW-IT. It includes the Iolo Archive and Collaboration File Systems, and a high-performance research network. The network supports fast data transfers among these systems, and between them and the campus and the Internet, as illustrated in the following diagram.

![Data Centers Diagram]

Hyak is made up of two clusters to allow non-disruptive technology refresh. Each Hyak cluster shares:
MOX.hyak — FEATURES

• Intel OmniPath Interconnect
  • > 90% of ideal HPL scaling across 140 nodes — measured
  • 100Gbs Bandwidth / node, 4.5 TBs aggregate
• Fast Processors
  • Intel E5-2680 V4 standard
  • Intel Knight’s Landing Coming in Next Two Months
  • Nvidia GPGPU if Sufficient Demand
• ~1TFlop / node performance
  • ~200 TF aggregate on day 1
  • Scales to > 1PF with todays tech
• Many Data Storage Options Included @ NO COST
  • 500GB Fast Scratch Storage / Node
  • 500GB Iolo Archive Storage / Node
  • 100GB Iolo Collaboration Storage / Node

• New Storage Options for MOX.hyak
  • >= 200TB “scrubbed” Scratch Storage Capacity
  • MOX Head Nodes Connected to IKT.hyak

• Expansion Easy and Inexpensive*
  • Supplemental Shared Scratch @ $10/TB/Month
  • Iolo Archive @$3.45/TB/Month
  • Iolo Collaboration @ $41/TB/Month*
## MOX.hyak — Prices

<table>
<thead>
<tr>
<th>Model</th>
<th>CPU (dual)</th>
<th>Total Cores (14 cores/chip; 2 chips/node)</th>
<th>GB RAM</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lenovo NextScale</td>
<td>E5-2680 v4</td>
<td>28</td>
<td>128</td>
<td>$4,892.00</td>
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<tr>
<td>Lenovo NextScale</td>
<td>E5-2680 v4</td>
<td>28</td>
<td>256</td>
<td>$5,382.00</td>
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<tr>
<td>Lenovo NextScale</td>
<td>E5-2680 v4</td>
<td>28</td>
<td>512</td>
<td>$6,503.00</td>
</tr>
</tbody>
</table>
MOX.hyak — Save $$

• No Overhead
  • Hyak nodes are equipment purchases
  • FA Waiver on All Research Computing Services

• Tax Exempt
  • Pay no tax on Hyak equipment purchases
  • Applies to all of Hyak

• Sponsor Investments Used as Match
  • Grants requiring match can sometimes leverage Hyak
  • Sponsor investments have been used on NSF MRI
  • Details are important
# MOX.hyak — Prices Compared

## Hyak Prices Compared with Some Alternatives

8/1/16

<table>
<thead>
<tr>
<th>CPU</th>
<th>RAM GB</th>
<th>SSD GB</th>
<th># Cores/Chip</th>
<th>Ghz/Core</th>
<th>SpecFP</th>
<th>Ghz/Node</th>
<th>$/Core</th>
<th>$/Ghz</th>
<th>$/SpecFP</th>
<th>$/GB RAM</th>
<th>Hyak Price</th>
<th>Hyak $/SPEC Ratio</th>
<th>Hyak $/GB RAM Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E5-2680 V4</td>
<td>128</td>
<td>120</td>
<td>14</td>
<td>2.40</td>
<td>943</td>
<td>67.2</td>
<td>$174.71</td>
<td>$72.80</td>
<td>$5.19</td>
<td>$38.22</td>
<td>$4,892.00</td>
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<tr>
<td>E5-2680 V4</td>
<td>256</td>
<td>120</td>
<td>14</td>
<td>2.40</td>
<td>943</td>
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<tr>
<td>E5-2680 V4</td>
<td>512</td>
<td>120</td>
<td>14</td>
<td>2.40</td>
<td>943</td>
<td>67.2</td>
<td>$232.25</td>
<td>$96.77</td>
<td>$6.90</td>
<td>$12.70</td>
<td>$6,503.00</td>
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</tr>
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White Box 1U Server from a popular local vendor for comparison. Online pricing from July 2016

<table>
<thead>
<tr>
<th>CPU</th>
<th>RAM GB</th>
<th>Disk GB</th>
<th># Cores/Chip</th>
<th>Ghz/Core</th>
<th>SpecFP</th>
<th>Ghz/Node</th>
<th>$/Core</th>
<th>$/Ghz</th>
<th>$/SpecFP</th>
<th>$/GB RAM</th>
<th>Vendor Price</th>
<th>Hyak $/SPEC Ratio</th>
<th>Hyak $/GB RAM Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>E5-2680 V4</td>
<td>128</td>
<td>500</td>
<td>14</td>
<td>2.40</td>
<td>943</td>
<td>67.2</td>
<td>$284.43</td>
<td>$118.51</td>
<td>$8.45</td>
<td>$62.22</td>
<td>$7,964.00</td>
<td>1.63</td>
<td>1.63</td>
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</table>

Amazon EC2 Pricing for comparison. Online pricing from August 2016

<table>
<thead>
<tr>
<th>CPU</th>
<th>RAM GB</th>
<th>Disk GB</th>
<th># Cores/Chip</th>
<th>Ghz/Core</th>
<th>SpecFP</th>
<th>Ghz/Node</th>
<th>$/Core</th>
<th>$/Ghz</th>
<th>$/SpecFP</th>
<th>$/GB RAM</th>
<th>Vendor Price</th>
<th>Hyak $/SPEC Ratio</th>
<th>Hyak $/GB RAM Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>C3 - 8XL</td>
<td>60.0</td>
<td>640</td>
<td>8</td>
<td>2.80</td>
<td>640</td>
<td>44.8</td>
<td>$1,574.81</td>
<td>$562.43</td>
<td>$39.37</td>
<td>$419.95</td>
<td>$25.197</td>
<td>7.59</td>
<td>10.99</td>
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MOX.hyak — How to Order

• Send Mail to help@uw.edu
  • Describe what you hope to accomplish
  • OR — simply tell us the number and type of nodes
  • Include budget number(s)

• Approach your Sponsor
  • Sponsors invest $$ to support your Hyak nodes
  • Require Sponsor Approval to Proceed

• Other Ways Onto Hyak
  • Evaluation accounts for anyone who asks
  • Student HPC Club — Any student can join
Useful URLs

- [http://hyak.uw.edu](http://hyak.uw.edu)
  - Portal to all UW-IT HPC efforts
- [http://wiki.hyak.uw.edu](http://wiki.hyak.uw.edu)
  - Dozens (hundreds?) of pages of helpful info
- [http://status.hyak.uw.edu](http://status.hyak.uw.edu)
  - Gives many useful statistics related to performance
- [http://itconnect.uw.edu/service/shared-scalable-compute-cluster-for-research-hyak](http://itconnect.uw.edu/service/shared-scalable-compute-cluster-for-research-hyak)
  - UW-IT Service Catalog page
  - Hyak Governance Board