2015 CLUSTER PURCHASE: COMMUNITY CLUSTERS TO CLUSTER COMMUNITIES
Since Steele in 2008, Research Computing has deployed many world-class offerings in computation
SIX COMMUNITY CLUSTERS

**STEELE**
- 7,216 cores
- Installed May 2008
- Retired Nov. 2013

**COATES**
- 8,032 cores
- Installed July 2009
- 24 departments
- 61 faculty
- Retired Sep. 2014

**ROSSMANN**
- 11,088 cores
- Installed Sept. 2010
- 17 departments
- 37 faculty

**HANSEN**
- 9,120 cores
- Installed Sept. 2011
- 13 departments
- 26 faculty

**CARTER**
- 10,368 cores
- Installed April 2012
- 26 departments
- 60 faculty
- #175 on June 2013 Top 500

**CONTE**
- 9,280 Xeon cores
- (69,600 Xeon Phi cores)
- Installed August 2013
- 20 departments
- 51 faculty (as of Aug. 2014)
- #39 on June 2014 Top 500
<table>
<thead>
<tr>
<th>U.S. CAMPUS RANKING</th>
<th>UNIVERSITY</th>
<th>NAME</th>
<th>WORLD RANKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PURDUE</td>
<td>CONTE</td>
<td>28</td>
</tr>
<tr>
<td>2</td>
<td>INDIANA UNIVERSITY</td>
<td>BIG RED II</td>
<td>46</td>
</tr>
<tr>
<td>3</td>
<td>USC</td>
<td>HPCC</td>
<td>53</td>
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<tr>
<td>4</td>
<td>RENSSELAER POLYTECHNIC INSTITUTE</td>
<td>BLUE GENE/Q</td>
<td>76</td>
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<tr>
<td>5</td>
<td>CLEMSON UNIVERSITY</td>
<td>PALMETTO 2</td>
<td>115</td>
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<td>6</td>
<td>UNIVERSITY OF ROCHESTER</td>
<td>BLUESTREAK</td>
<td>170</td>
</tr>
<tr>
<td>7</td>
<td>PURDUE</td>
<td>CARTER</td>
<td>175</td>
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<tr>
<td>8</td>
<td>UNIVERSITY OF COLORADO</td>
<td>JANUS</td>
<td>239</td>
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<tr>
<td>9</td>
<td>USC</td>
<td>HPC</td>
<td>242</td>
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<tr>
<td>10</td>
<td>UNIVERSITY OF CHICAGO</td>
<td>MIDWAY</td>
<td>301</td>
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</table>
Open bid process:
- Quantity approx. 700 nodes
- Included various interconnects (10 Gbps Ethernet, FDR/EDR Infiniband)
- 20- and 24-core compute nodes
- Memory sizes from 64 GB to 512 GB
- Conventional disk vs. SSD

Prices ranged from $4400/node to $5400/node for base node (64GB)
Vendors included Dell, HP, IBM, etc.
Base node: HP DL60
- 20-core node, 2.6 GHz Intel “Haswell” processors (E5-2660v3)
  - Larger L3 caches, more cores
  - Double the FLOPS over Carter/Conte processors (FMAC – helps matrix math)
  - Good balance between cost-effectiveness and overall node price
- 64 GB DDR4 memory (minimum)
  - Several memory sizes possible
  - Fastest memory available
- 500 GB local disk
- 10 Gbps Ethernet on all nodes for IP and NFS
- FDR Infiniband interconnect
  - 56 Gbps, 2:1 fat tree – most cost-effective than faster options for most users

Scratch system:
- Approximately 1.4 PB
- 20 GB/sec, IB connectivity to high-performance cluster nodes
General implementation schedule:

- Facilities preparation underway
- Board of Trustees meeting April 9th – pending board approval
- Install day May – may need assistance unboxing & racking
- General availability soon after
25% more cores at 10% more dollars than Conte,

- Better floating point
- Faster memory

<table>
<thead>
<tr>
<th></th>
<th>64G Node</th>
<th>256G Node</th>
<th>512G Node</th>
<th>64G Node + GPU</th>
</tr>
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<tbody>
<tr>
<td>Cost</td>
<td>$4,400.00</td>
<td>$6,500.00</td>
<td>$10,000.00</td>
<td>$11,000.00</td>
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</tbody>
</table>
IN THE PAST

ONE COMMUNITY
NEIGHBORHOODS
Today

Neighborhoods

Purdue University
One System

Many Different (Conflicting) Needs

- Parameter sweeps vs CFD
- Monte Carlo simulation vs climate modeling
- R vs molecular dynamics
Community Clusters to Cluster Communities

*What neighborhoods are in our community?*

**By domain?** Chemistry, mechanical engineering, statistics, structural biology

**By Hardware Configuration?**
Accelerator cluster, big memory cluster, data-intensive cluster

**By Profile of Work:** single core, multi-core, multi-node, inter-node communication needs, I/O characteristics, memory requirements
Community Clusters to Cluster Communities

*What neighborhoods are in our community?*

**HPC (Rice):** Multiple cores or nodes, probably MPI. Benefit from high-performance network and parallel filesystem. The vast majority of campus - 80% of all work!

**HTC (Hammer):** Primarily single core. CPU-bound. No need for high-performance network.

**Life Science (Big memory):** Use entire node to get large amounts of memory. Less need for high-performance network. Needs large, fast storage.
CHALLENGES TO SMALLER COMMUNITIES

- HPC and HTC communities prefer different points to optimize the scheduler.
- Small but key communities (like large memory) lose benefits of standby queues when fewer nodes are spread between several clusters.
- HTC or large memory communities often have little need for HPC-specific optimizations
  - Accelerators
  - High-speed, low-latency networks

Emerging communities often don’t fit in existing model at all!

Big Data Analytics
Graphics Rendering
Nontraditional platforms (Windows, cloud)
Rice: A traditional HPC system just like Carter or Conte

The same, familiar model:
- New cluster acquisition every 12-18 months
- Each a distinct, non-heterogeneous system.

Nothing different for you!
Hammer – HTC
Big Memory

HTC or big memory clusters expanded annually with each purchase.

Better Community Cluster Experience
Pay for resources on-demand!

• Burst capacity for a deadline coming up?
• Access to a different type of node for a short period?

Pay for on-demand node instances in one-month increments.
RESEARCH DATA STORAGE
UPDATES SINCE THE FALL MEETING
At $150/TB per year:

- Storage oriented around your research lab, with
  - Snapshots
  - Multi-site copies of your data
  - Disaster protection
  - A scalable, expandable storage resource optimized for HPC
- Access to Globus data transfer service, and endpoint sharing
New scratch filesystem on order for Carter!

1.5 PB filesystem
Expect Conte-like 100TB, multi-million file user quotas

Existing Carter scratch will remain only on Hansen
Well received!

• Since a fall go-live, over 105 research groups are participating.
  • Many are not HPC users!

• Over .7 PB provisioned to date

• A research group purchasing space has purchased, on average, 8.6TB.
To buy 1 or more TB of space,  
Or to set up a trial for your lab

Order online:  
https://www.rcac.purdue.edu/purchase/depot/
Data moved in 2014:
  13 TB in, 19TB out
  200k files both directions
  55 unique users

Coming soon:
  Globus interface to Fortress

https://transfer.rcac.purdue.edu
• “hathi” Hadoop cluster for prototyping big data applications

• Spark, Hbase, Hive, Pig

36 research groups,
411 users on the system already

https://www.rcac.purdue.edu/compute/hathi/
RESEARCH SERVICES
OTHER SERVICES YOU MIGHT BE INTERESTED IN
Repositories for your lab, managed by your queue management tool.
NEED HELP?

• Hard to solve problems with HPC?
• Need help building your software or optimizing your workflow?
• Need to learn what resources are available?

COFFEE BREAK CONSULTATIONS

Meet up with ITaP research computing staff and other researchers who use or are interested in High Performance Computing at Purdue. Join us for informal discussions of scientific computing along with any other topic that might spring up. We’ll be meeting at different coffee shops around campus each week.

Check the coffee web page to see this week's location and time.
rcac.purdue.edu/coffee
• Need to teach students to use HPC in a course?
• Scholar cluster is available to any instructor at no cost.

Spring 2015:  
EAPS  
CS  
STAT  
CHEM  
AGRY  
ANSC  
ChemE

Just send a CRN
Questions?
EVERYTHING PAST HERE IS SPARE