Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

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HECC Engineers Resolve Longstanding InfiniBand Network Issue on Pleiades

- The HECC Supercomputing Systems team, working closely with SGI and Mellanox engineers, resolved a longstanding InfiniBand network issue that was causing some user jobs to fail on Pleiades.

- The teams worked with affected users to identify job failures, in order to develop a diagnostic test case. After months of careful detective work, the engineers traced the issue to a bug in an optimization feature that had been part of a Mellanox firmware update.

- Once the problem was identified, the teams quickly provided users with a workaround that enabled their jobs to run—but with lower than normal performance—until a temporary firmware fix was deployed that eliminated the problem.

- Mellanox is developing a complete fix that will re-introduce the optimization feature in a new firmware update, scheduled to be released in December.

Mission Impact: HECC’s collaborative approach to working with industry partners enables thorough diagnosis and timely resolution of problems. This government-industry partnership provides NASA with more reliable, scalable supercomputer systems.

An InfiniBand network (IB) comprised of 65 miles of cables interconnects all of the compute nodes on the Pleiades supercomputer. Systems engineers recently collaborated to fix an IB firmware bug that was causing some user jobs to fail.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, Computer Sciences Corp.
Merope Augmented with Additional Compute Nodes Repurposed from Pleiades

- Merope is periodically upgraded with repurposed compute nodes after they are retired from Pleiades. In August, HECC systems engineers upgraded Merope with 512 Intel Westmere nodes; in September, they incorporated an additional 540 Westmere and Nehalem nodes.
- Merope is now configured with 22 half-populated Westmere racks (704 nodes) and 14 half-populated Nehalem racks (448 nodes), totaling 1,152 nodes with 27.6 terabytes of memory.
- This latest augmentation more than doubles the number of Standard Billing Units (SBUs)* that Merope is able to deliver.
- The compute nodes were removed from Pleiades in order to meet the cooling and power requirements for a new Pleiades upgrade incorporating Intel’s newest-generation Haswell processors.

Mission Impact: Repurposing hardware enables HECC engineers to test system changes and enhancements to the Pleiades supercomputer without impacting production jobs, and delivers additional computational cycles to scientists and engineers.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing (NAS) Division; Davin Chan, davin.chan@nasa.gov, (650) 604-3613, NAS Division, Computer Sciences Corp.

*1 SBU equals 1 hour of a Pleiades Westmere 12-core node
New Parallel Code Developed for Speeding Up Multi-Stage Turbine Simulations

• Experts in the HECC Application Performance and Productivity (APP) group developed a new MPI/OpenMP parallel version of AKIE-MST that significantly speeds up multi-stage turbine simulations.

• The code exploits parallelism at two levels that map well to the Pleiades architecture:
  – Coarse grain among blades in different stages.
  – Fine grain at loops within each blade.

• APP staff achieved a speedup of 43.4 times (over an OpenMP-only code) on 28 Pleiades Ivy Bridge nodes for a four-stage, medium-size test case.

• The new AKIE-MST code enables simulation of much larger configurations that could not be run previously in a realistic timeframe.

• Computational fluid dynamics researcher Chunill Hah, NASA Glenn, has begun using the new code to better understand flow physics and to develop improved flow control strategies in several aeronautics cases.

Pressure field produced from the AKIE-MST code for a high-speed compressor, to investigate the transport of shock-generated vorticity in different stages and the interaction between vortices. Chunill Hah, NASA/ Glenn

**Mission Impact:** The development work by HECC code optimization experts enables much larger turbine simulations, with much faster turnaround time, in support of projects under the Aeronautics Mission Directorate.

**POC:** Henry Jin, haoqiang.jin@nasa.gov, (650) 604-0165, NASA Advanced Supercomputing Division
September Usage on Pleiades Over 12 Million SBUs and Sets New Monthly Record

• NASA’s science and engineering organizations set a new record on the Pleiades supercomputer using 12.15 million Standard Billing Units (SBUs). The SBU is representative of the work accomplished in one hour on a two-socket Westmere node.
• This month followed two months affected by reduced capacity due to a cooling issue and a bug in the InfiniBand software. Both issues have been resolved.
• ARMD continues to significantly exceed their allocation and agency set aside, nearly matching their May 2014 record.
• SMD projects used just over 5 million SBUs
• The upcoming addition of 1,080 nodes based on Intel’s new Haswell processors will significantly increase the available capability for the user community in late October.

Mission Impact: The ability to provide more than 75% of the theoretical peak of the system enables increased productivity of the science and engineering communities

Utilization of the Pleiades Supercomputer bounced back to a new high after facility and system problems were resolved

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division
‘Webpass’ Deployed for Changing HECC/NAS Passwords

- Staff in the HECC Tools group developed and deployed a new external web tool, “webpass,” that allows HECC users to change their NAS passwords online. This eliminates the need for users to go through a more complicated log-in process to make the password change.
- The new tool, served from a NAS public website, allows all HECC users, as well as users of certain non-HECC systems, to easily change their NAS passwords at: https://webpass.nas.nasa.gov
- All users with NAS passwords can take advantage of the new tool. Affected users include:
  - User groups on the NASA Ames local-area network (ARCLAN) who access non-HECC servers supported by the NAS Division. These groups include users of NASA’s Problem Reporting Analysis and Corrective Action (PRACA) system, D-Wave Two System, NX/Docushare, Kepler Mission, and Code I users of Remedy,
  - Remote HECC users.
  - Business staff in the NAS Division accessing infrastructure servers and services.
  - HECC staff supporting HECC and non-HECC servers.
- All security requirements for NASA passwords are enforced by the webpass tool.

Mission Impact: The new “webpass” web tool offers all HECC users and certain non-HECC users an easy, convenient, and secure means to change their passwords.

POC: Ryan Spaulding, ryan.c.spaulding@nasa.gov, (408) 772-6567, NASA Advanced Supercomputing Division, Adnet Systems
HECC Successfully Completes Annual Inventory for 2014

- The HECC Property group successfully completed the 2014 annual equipment inventory of 1,180 pieces of equipment with a value of about $84 million.
- The staff’s active tracking and updating of HECC/NAS property data helped ensure a successful annual inventory. Ongoing tracking and management of equipment during FY14 included:
  - Tagging 135 pieces of new equipment valued at $13 million.
  - Excessing 118 pieces of equipment valued at $23.3 million.
  - Responding to over 800 Remedy tickets, most of which were requests for updates to equipment location and ownership.
- The only items not located were three old displays with a combined value of less than $3,500. To close out the inventory, a Property Survey Report (Form NF598), was completed for each display, removing the items from the NASA property database.

Mission Impact: Accurate tracking of assets through their life cycle at NASA’s largest supercomputing facility, and tracking of data removal during system disposal, ensures good control of government equipment and prevents loss of NASA data.

POC: Judy Kohler, judy.j.kohler@nasa.gov, (650) 604-4303, NASA Advanced Supercomputing Division, Computer Sciences Corp.
Pleiades Enables Realistic Simulations for Interpreting Solar Observations

- Researchers at Big Bear Solar Observatory and NASA’s Ames Research Center ran realistic numerical simulations on Pleiades that are critical to interpreting and understanding phenomena in the convection zone and atmosphere of the Sun.
- In particular, solar simulations provide important insights into:
  - The multi-scale nature of solar convection, in both the quiet areas of the Sun and in magnetic regions.
  - The origin of the solar differential rotation.
  - Properties of the meridional circulation and dynamo mechanism.
  - Formation and dynamics of magnetic flux tubes, and the structure of sunspots.
- The simulations, using up to 8,000 processors each on Pleiades, provide critical data for analyzing and interpreting observations from the Solar & Heliospheric Observatory (SOHO), the Interface Region Imaging Spectrograph (IRIS), the Solar Dynamics Observatory (SDO), and the Hinode Observatory.
- HECC visualization experts created 3D visualizations that contributed to the success of this work.

**POCs:**
- Alexander Kosovichev, sasha@bbso.njit.edu, (909) 866-5791 ext. 244, Big Bear Solar Observatory
- Nagi N. Mansour, nagi.n.mansour@nasa.gov, (650) 604-6420, NASA Advanced Supercomputing Division

*HECC provided supercomputing resources and services in support of this work.*
HECC Facility Hosts Several Visitors and Tours in September 2014

- HECC hosted 10 tour groups in September; guests learned about the agency-wide missions being supported by Pleiades, and viewed the D-Wave Two quantum computer system.
- NOTE: Due to the hyperwall computer system upgrade, many tours were postponed until the hyperwall returns to production.
- Visitors this month included:
  - John Cavolowsky, director of the Airspace Systems Program Office at NASA Headquarters; Peter Dumont, CEO and president of the Air Traffic Controllers Association;
  - Tom McKenna, program manager, Computational Neuroscience and Biorobotics Program, Office of Naval Research;
  - A delegation from Finland’s “Silicon Valley” and other Finnish tech hubs, including experts and executives from the health care, information technology, communications, and mobile sectors, as well as representatives from the Finnish National Technology Agency (Tekes) and the Finnish Innovation Fund (SITRA).
  - Elizabeth Robinson, NASA’s chief financial officer.

POC: Gina Morello, gina.f.morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division
Papers and Presentations

  http://iopscience.iop.org/1742-6596/531/1/012003

  http://arc.aiaa.org/doi/abs/10.2514/1.T4233

  http://www.geosci-model-dev-discuss.net/7/5965/2014/gmdd-7-5965-2014.html

• “Flux Transport Dynamos: From Kinematics to Dynamics,” B. Karak, J. Jiang, M. Miesch, P. Charbonneau, A. Choudhuri, Space Science Reviews, September 2014. *
  http://link.springer.com/article/10.1007/s11214-014-0099-6

  http://arxiv.org/abs/1409.1583

* HECC provided supercomputing resources and services in support of this work
Papers and Presentations (cont.)

  http://arxiv.org/abs/1409.2622

  http://arxiv.org/abs/1409.3866

  http://arxiv.org/abs/1409.4414

  http://arxiv.org/abs/1409.5124

* HECC provided supercomputing resources and services in support of this work
News and Events

- **Aerospace Assessing Potential of Quantum Computing**, *Aviation Week*, August 22, 2014—Aviation Week’s Graham Warwick takes a look at the accessibility of supercomputing resources, such as NASA’s Pleiades supercomputer, for aerospace research and development, and discusses how new capabilities, including quantum computing, may support the aerospace industry.
  

- **Aerospace Explores the Compute Horizon**, *HPCwire*, September 4, 2014.
  
Phi-based Systems

• **Background:**
  *Two Xeon Phi-based systems are being utilized as path-finding resources to determine whether the Many Integrated Core (MIC) Architecture is cost effective for NASA’s computational requirements.*
  - Maia is a 128-node SGI system with two Intel Xeon Phi accelerator cards in each node.
  - Mira is a 64-node Cray system with two Intel Xeon Phi accelerator cards in each node.

• **Status**
  - Interest in this technology is extremely limited. The testing performed has shown that the Phi technology is not ready for production work.
  - No further testing is planned.

• **Upcoming Activities for October**
  - Maia: The Sandy Bridge nodes of the system will be incorporated into Pleiades with the Phi portion disabled. The Phi portions can be enabled for user testing on demand.
  - Mira: Mira will be powered off.
HECC Utilization Normalized to 30-Day Month

**SMD**

0 1 2 3 4 5 6
Standard Billing Units in Millions

**ARMD**

0 1 2 3 4 5 6
Standard Billing Units in Millions

**HEOMD, NESC**

0 1 2 3 4 5 6
Standard Billing Units in Millions

1. Columbia 21, 23, and 24 retired, Endeavour 2 added
2. Columbia 22 retired; Endeavour 1 added
3. 32 Harpertown Racks retired
4. 32 Harpertown Racks retired; 46 Ivy Bridge Racks added
5. 6 Ivy Bridge Racks added; 20 Nehalem and 12 Westmere Racks Retired
6. 8 Ivy Bridge Racks added mid-Feb; 8 additional Ivy Bridge Racks late Feb.
7. 4 Ivy Bridge Racks added mid-March
8. 6 Westmere Racks added to Merope, Merope Harpertown retired
Tape Archive Status

September 2014
Tape Archive Status

![Graph showing Tape Archive Status]

- **Tape Library Capacity**
- **Tape Capacity**
- **Total Tape Data**
- **Unique Tape Data**

The graph illustrates the growth in tape archive status over time, with metrics such as Peta Bytes and months from Oct-12 to Sep-14.
Pleiades:
SBUs Reported, Normalized to 30-Day Month
Pleiades: Devel Queue Utilization

![Diagram showing Pleiades Devel Queue Utilization from Oct-13 to Sep-14. The y-axis represents Standard Billing Units ranging from 0 to 1,700,000, with various categories including NAS, NLCS, NESC, SMD, HEOMD, and ARMD. The x-axis represents the months from Oct-13 to Sep-14. The graph shows the utilization trends and allocations over the period.]
Pleiades:
Monthly Utilization by Job Length

<table>
<thead>
<tr>
<th>Job Run Time (hours)</th>
<th>Standard Billing Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1 hours</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 1 - 4 hours</td>
<td>1,500,000</td>
</tr>
<tr>
<td>&gt; 4 - 8 hours</td>
<td>1,000,000</td>
</tr>
<tr>
<td>&gt; 8 - 24 hours</td>
<td>1,500,000</td>
</tr>
<tr>
<td>&gt; 24 - 48 hours</td>
<td>2,000,000</td>
</tr>
<tr>
<td>&gt; 48 - 72 hours</td>
<td>2,500,000</td>
</tr>
<tr>
<td>&gt; 72 - 96 hours</td>
<td>1,500,000</td>
</tr>
<tr>
<td>&gt; 96 - 120 hours</td>
<td>1,500,000</td>
</tr>
<tr>
<td>&gt; 120 hours</td>
<td>1,500,000</td>
</tr>
</tbody>
</table>

September 2014
Pleiades: Monthly Utilization by Size and Mission

September 2014
Pleiades: Monthly Utilization by Size and Length

September 2014
Pleiades:
Average Time to Clear All Jobs

![Bar chart showing average time to clear all jobs for ARMD, HEOMD/NESC, and SMD from October 2013 to September 2014.](chart.png)
Pleiades: Average Expansion Factor

For the period from October 2013 to September 2014, the average expansion factor for ARMD was 6.63, for HEOMD 15.87, and for SMD 9.06.
Endeavour: SBUs Reported, Normalized to 30-Day Month

Standard Billing Units

Oct-13  Nov-13  Dec-13  Jan-14  Feb-14  Mar-14  Apr-14  May-14  Jun-14  Jul-14  Aug-14  Sep-14

NAS  NLCS  NESC  SMD  HEOMD  ARMD  Alloc. to Orgs
Endeavour: Monthly Utilization by Job Length

September 2014

[Bar chart showing job run times and standard billing units for various job length categories.]
Endeavour:
Monthly Utilization by Size and Mission

September 2014
Endeavour: Monthly Utilization by Size and Length

- > 120 hours
- > 96 - 120 hours
- > 72 - 96 hours
- > 48 - 72 hours
- > 24 - 48 hours
- > 8 - 24 hours
- > 4 - 8 hours
- > 1 - 4 hours
- 0 - 1 hours

Job Size (cores):
- 1 - 32
- 33 - 64
- 65 - 128
- 129 - 256
- 257 - 512

Standard Billing Units:
- 0 - 1 hours
- 4 - 8 hours
- 8 - 24 hours
- > 4 - 8 hours
- > 1 - 4 hours
- > 24 - 48 hours
- > 72 - 96 hours
- > 96 - 120 hours
- > 120 hours
Endeavour: Average Time to Clear All Jobs

[Bar chart showing average time to clear all jobs from Oct-13 to Sep-14 for ARMD, HEOMD/NESC, and SMD.]
Endeavour: Average Expansion Factor

- ARMD
- HEOMD
- SMD
Merope:
SBUs Reported, Normalized to 30-Day Month
Merope: Monthly Utilization by Job Length

September 2014
Merope:
Monthly Utilization by Size and Mission

September 2014
Merope: Average Expansion Factor

Oct-13  Nov-13  Dec-13  Jan-14  Feb-14  Mar-14  Apr-14  May-14  Jun-14  Jul-14  Aug-14  Sep-14

- ARMD
- HEOMD
- SMD
Maia:
SBUs Reported, Normalized to 30-Day Month

[Bar chart showing Standard Billing Units from Oct-13 to Sep-14, with categories for NAS, NLCS, NESC, SMD, HEOMD, and ARMD.]