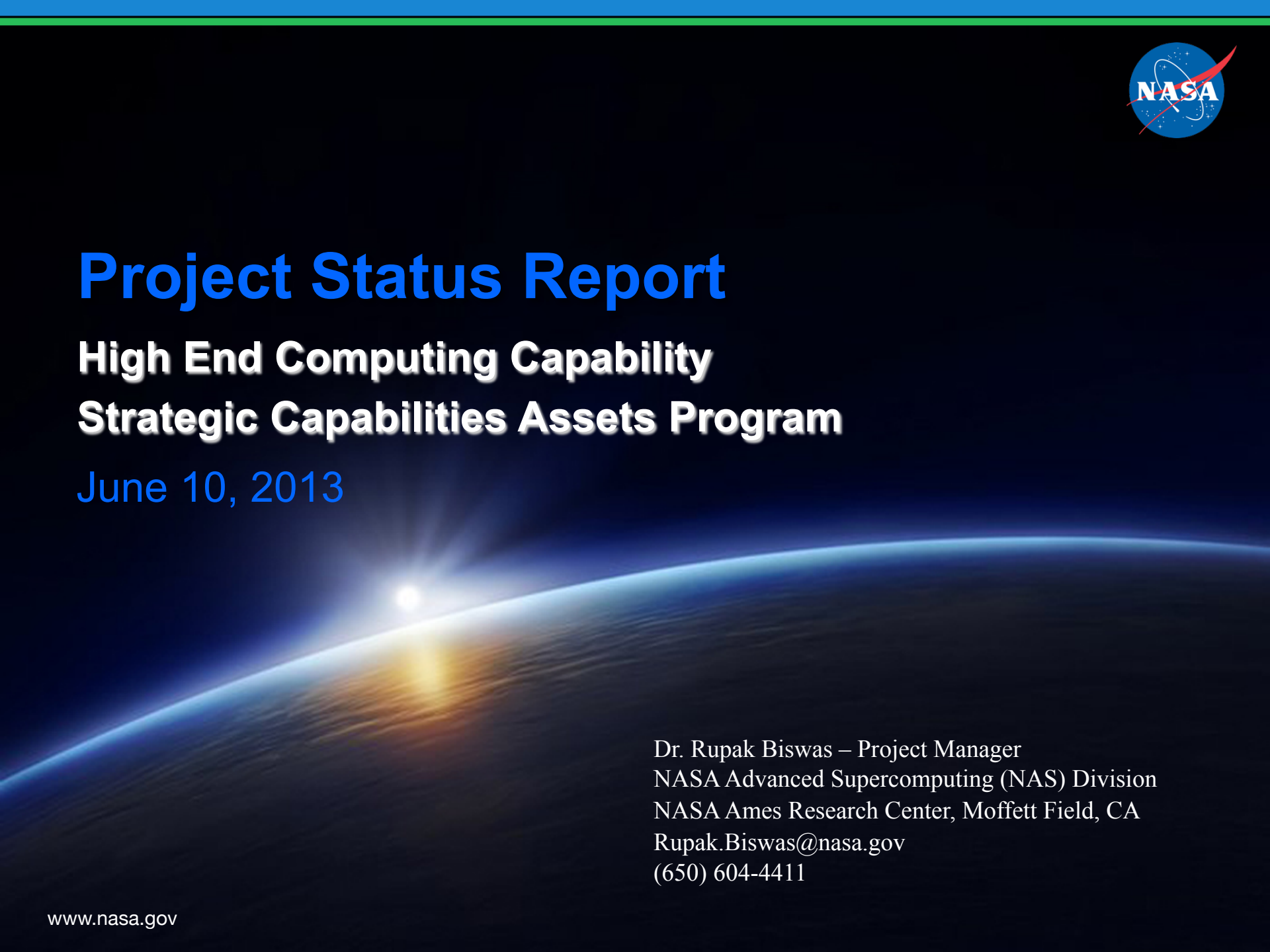


Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

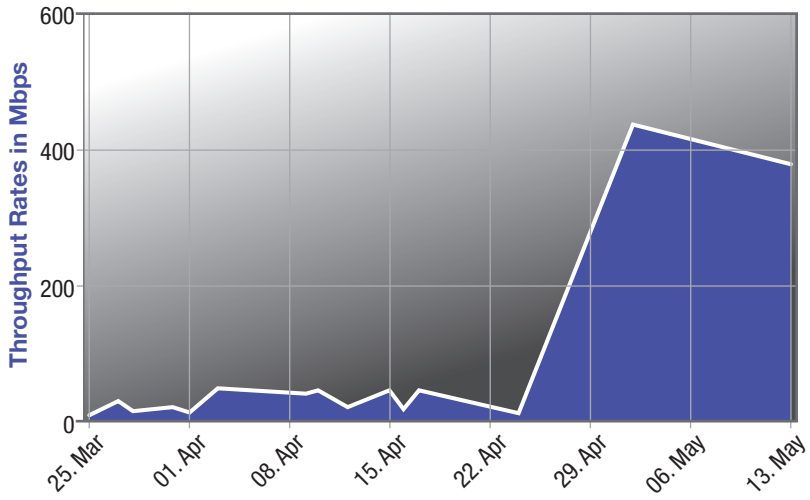
June 10, 2013

Dr. Rupak Biswas – Project Manager
NASA Advanced Supercomputing (NAS) Division
NASA Ames Research Center, Moffett Field, CA
Rupak.Biswas@nasa.gov
(650) 604-4411

Network Team Isolates Problem, Increases Data Transfer Performance up to 50x

- HECC Network engineers identified and corrected a network packet loss issue on the Langley Research Center (LaRC) campus network, resulting in a solution that significantly improved data transfer performance.
- Users transferring files between LaRC and Ames experienced performance increases of up to 50x using the secure copy protocol, SCP.
- In one instance, a 60-gigabyte file that previously took 7 hours to transfer from LaRC to the NAS facility at Ames took only 17 minutes after the fix.
- The HECC network team worked with NASA Services (NICS) and LaRC engineers to isolate and resolve the problem.

Mission Impact: By continuously monitoring network performance and optimizing data transfer rates, HECC experts enable scientists to obtain computational results in minutes rather than waiting hours or days for their results.



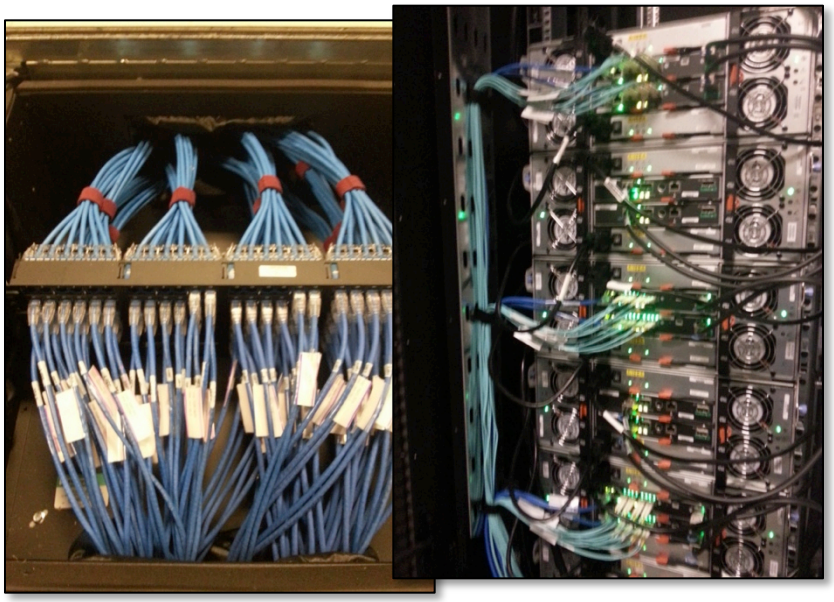
This graph shows the data transfer rate users obtained while moving files from NASA Ames to the NASA Langley campus before and after the fix was implemented on April 24, 2013.

POC: Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Network Engineers Complete Infrastructure To Support New Lustre Hardware

- The HECC Network team successfully expanded the network infrastructure in the main computer room at the NASA Advanced Supercomputing (NAS) facility, to support the installation of the new Lustre filesystem hardware.
- The team installed a new subfloor enclosure that allows engineers to provide a manageable copper Ethernet solution for the Lustre RAID system and associated Meta Data and Object Storage Servers.
- The team also installed 108 copper Ethernet connections and 32 Fourteen Data Rate (FDR) InfiniBand connections. In addition, 184 copper cables, and 248 fiber patch cables were installed to provide network connectivity to the new Lustre hardware.
- The flexibility of the expanded network infrastructure enables faster, more cost-effective augmentations as configuration requirements change.

Mission Impact: Improvements to the HECC network infrastructure enhance user connectivity to the new Lustre filesystem, and provide flexibility for supporting future resource expansion on the computer room floor.



A new network subfloor enclosure box housing the copper Ethernet connections (left) and Fibre Channel connectivity to Lustre hardware (right) located in the main computer room at the NASA Advanced Supercomputing facility.

POC: Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Columbia User Data Archived as Filesystem Hardware is Prepared for Excess

- After the last node of the Columbia supercomputer was retired in March 2013, its filesystems still contained over 155 terabytes of HECC user data.
- HECC support staff alerted users to remove their files from Columbia, providing assistance to those who needed help transferring or deleting their data.
- As requested by users, the support team removed 200 directories from Columbia and transferred the remaining 30 terabytes of data to the archive system at the NASA Advanced Supercomputing facility.
- In archiving the data, HECC staff created a table of contents for each directory and used the checksum utility to verify that every file was transferred properly.
- Columbia's filesystem disks are now being scrubbed and prepared for excess along with the remaining Columbia compute nodes.

Mission Impact: To meet the continuously increasing requirements for high-end computing across all NASA mission directorates, HECC project teams must regularly and significantly upgrade and replace the resources HECC provides to the agency.

The smooth transition from Columbia to the newer systems is the result of a cooperative effort by several HECC teams over the past two years. Columbia user accounts have now been migrated to NASA's flagship Pleiades supercomputer and the new global shared-memory system, Endeavour.

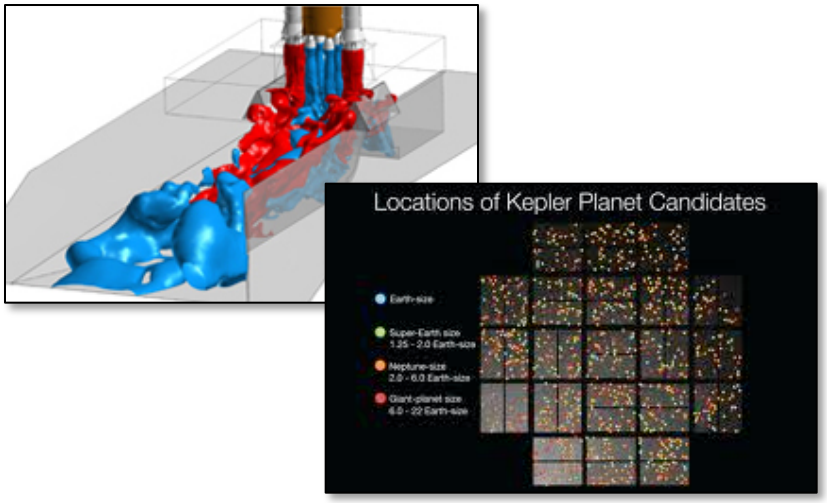
POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

New Allocation Period Begins for NASA Mission Directorates

- May 1, 2013 marked the beginning of a new allocation period for the Human Exploration and Operations Mission Directorate (HEOMD), the NASA Engineering and Safety Center (NESC), and the Science Mission Directorate (SMD).
- These three organizations awarded new allocations of computing time on Pleiades and Endeavour for more than 230 computing projects that support agency science and engineering activities.
  - Combined awards exceeded 56 million Standard Billing Units* (SBUs);
  - SMD requested 3 times their share of the number of hours available on the systems, while HEOMD and NESC requests were in line with the hours available.
- The new allocation period is an opportunity for each organization to assess demands for computing time and to rebalance allocations to meet computing needs for the next year.

*1 SBU equals 1 hour of a Pleiades Westmere 12-core node.

Mission Impact: NASA programs and projects periodically review the distribution of supercomputer time to assess the demand and to assure consistency with mission-specific goals and objectives.



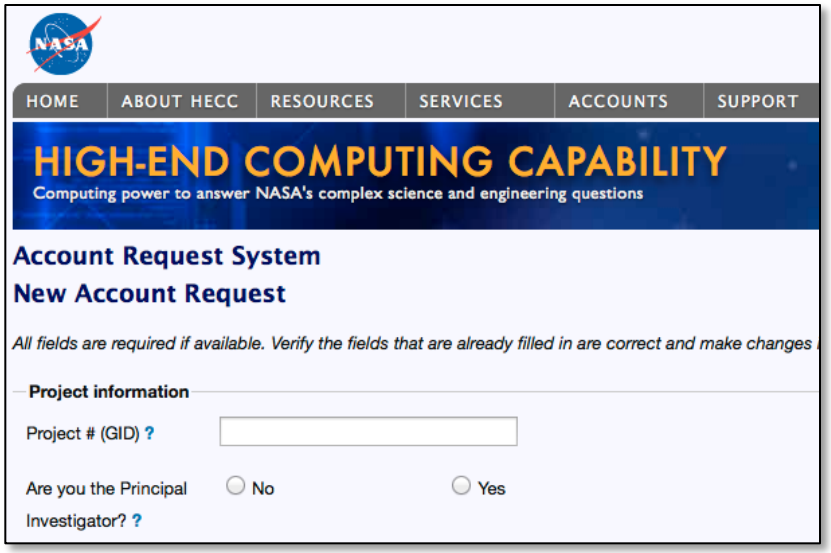
Representative images from HEOMD and SMD projects. Above left: Isosurfaces of core stage engine combustion gas (blue) and solid rocket booster effluent (red) show the evolution and mixing of the plumes. Lower right: Kepler's planet candidates. The relatively small patch of sky observed by Kepler is potentially teeming with planetary systems.

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

New Web-Based Process Enables HECC Users to Request or Renew Accounts Online

- HECC users can now use a simple online tool to request or renew accounts at the NAS facility.
- The online, automated process connects directly with the NAS system that provisions the accounts on HECC supercomputers, which was not possible with the previous paper-based or the NASA Account Management System (NAMS) processes.
- The new process allows users and account administrators to spend significantly less time on this routine administrative task.
- Access to the account request system is controlled by Launchpad authentication. Prospective users without NASA identities can request them directly from the account request system.
- Account administrators can use the web-based tool for notification and tracking of account requests and renewals.

Mission Impact: Automating routine, internal processes enables users to spend less time on administrative tasks and more time on mission-critical projects. In addition, account administrators can focus their expertise on helping users achieve their project goals instead of on routine tasks.



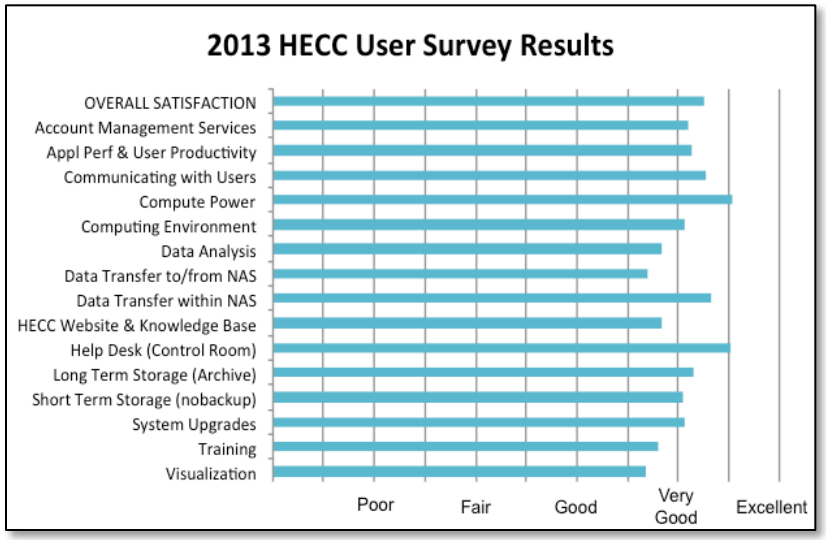
Using the new online tool, users can submit their supercomputer account requests via the HECC website.

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

User Survey Provides Valuable Feedback for HECC Project Services

- The HECC User Services and Publications & Media teams have completed the 2013 HECC Project user survey.
- Users from all NASA Mission Directorates, as well as university and industry users, participated in the survey.
- A total of 279 users assessed 15 HECC service areas.
- Scores are very similar to past surveys, with Overall Satisfaction scoring 4.26 out of 5.0.
  - Help Desk and Compute Power scored the highest ratings (Very Good to Excellent).
  - The greatest improvement was in the Training area; this result is likely due to the many web-based training classes added in the past year.
- In addition to the quantitative results, users provided many comments that the HECC teams will use to help improve services.
- Lessons learned from past surveys led the teams to enhance the survey design, which helped them gain more insight into the nature of users' concerns.

Mission Impact: Periodically surveying users helps HECC support teams understand which services the users consider most important. In addition, the valuable feedback provided by the surveys helps the teams improve services to help HECC users achieve their mission goals.



The HECC survey measured user satisfaction in 15 HECC service areas. These quantitative results, as well as more detailed user feedback, help guide the HECC support teams to focus on service quality improvements.

POC: Catherine Schulbach, catherine.h.schulbach@nasa.gov, (650) 604-3180, NASA Advanced Supercomputing Division

Facilities Team Collaborates with Vendors to Implement Closed-Loop Cooling Solution

- HECC facilities engineers, working with Cray staff members, developed a solution to address an incompatibility between the Cray testbed supercomputer's cooling system and the NAS facility's existing chilled water supercomputer cooling system.
- They determined that three separate Coolcentric Cooling Distribution Units (CDUs) were needed to correct the problem.
- Together, the two teams designed and implemented a closed-loop chilled water system that meets the strict water quality requirements of the testbed system.
- The HECC team successfully integrated the CDUs into the closed-loop cooling system, consisting of a heat-exchange unit, pump, and temperature control unit.

Mission Impact: By developing cooperative working relationships with vendors, HECC team members are able to design and implement solutions to meet stringent government safety and environmental requirements.

The Cray supercomputer was installed at the NASA Advanced Supercomputing facility in February 2013. The system comprises of 64 nodes, each with 2 Intel Xeon "Sandy Bridge" processors and 2 Intel Xeon Phi coprocessors.

POC: Scott Prevost, scott.prevost@nasa.gov, (650) 604-4350, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Process Improvements Result in Sharply Reduced Downtime for Mac OS X Upgrade

- Improvements to the Mac OS X upgrade process resulted in a 50% reduction in downtime for each user, and a 70% reduction in the total time to complete the upgrade. The HECC Engineering Servers and Services (ESS) team achieved this by:
  - Developing and deploying a script that auto-sets the network configuration, reducing the time of each upgrade by 20 minutes;
  - Using the Apple installer to upgrade the OS instead of re-imaging each Mac, reducing the time of each upgrade by 4+ hours;
  - Completing full user data backups the day before each upgrade.
- Comparison of the recent Mountain Lion upgrade with the previous Lion upgrade:
  - Lion: 8+ hours for each upgrade; 8 months to complete the upgrade across the NAS facility.
  - Mountain Lion: 4 hours for each upgrade; 2.5 months to upgrade all 165 NAS facility Macs.
- The new process saved 80+ days of downtime for NAS facility users.

Mission Impact: Improved processes enable support staff to ensure that HECC workstations are optimally maintained and operate within Apple's version support window—a challenging task for enterprise sites, since major OS updates are done annually.

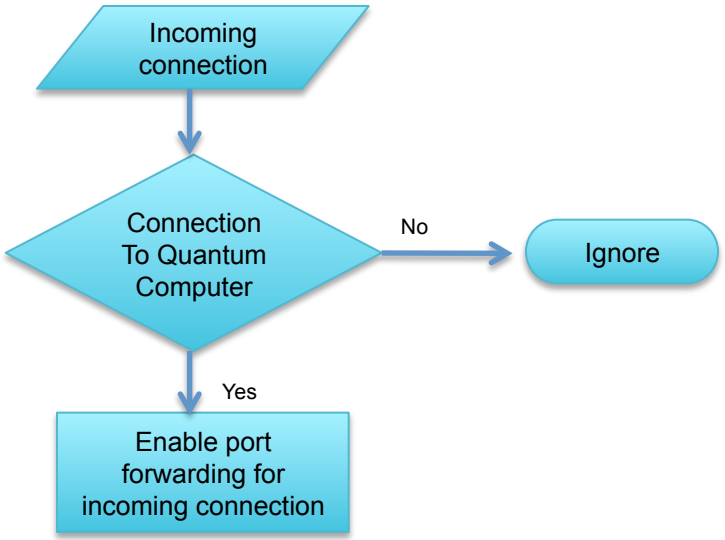
Apple's OS X 10.8 (Mountain Lion) update was released July 2012 and approved by NASA in February 2013.

POCs: Brooks Patton, brooks.patton@nasa.gov, (650) 604-3967; Sam Fike, sam.g.fike@nasa.gov, (650) 604-1338, NASA Advanced Supercomputing Division, Computer Sciences Corporation.

Security and Network Teams Provide Custom Infrastructure for Quantum Computer

- HECC security and network experts collaborated with D-Wave Systems Inc. and Universities Space Research Association engineers to architect and integrate a remote-access solution for a new quantum computer installed at the NAS facility.
- Security staff implemented a Dynamic Port Forwarding method that allows authenticated users to easily and securely access the quantum computer while minimizing risk to NAS's secure environment.
  - New authenticated connections result in the necessary network ports being forwarded from the quantum front-end system (QFE) to the quantum computer;
  - Terminated connections result in the removal of the forwarded network ports from the QFE.
- Network staff implemented critical services (DNS, NTP, VPN, SMTP) to meet operational requirements.
- Both teams worked with D-Wave's onsite engineers to troubleshoot issues and provide prompt support.

Mission Impact: The Dynamic Port Forwarding method will provide users with a standard, easy way to access quantum computing resources while minimizing risk to the NASA Advanced Supercomputing facility and the quantum computer.



This diagram shows the basic process of enabling port forwarding for incoming connections to the quantum computer.

POC: Derek Shaw, derek.g.shaw@nasa.gov, (650) 604-4229, NASA Advanced Supercomputing Division, Computer Sciences Corp.

HECC Supports the 11th Annual SGI User Group Conference

- HECC Supercomputing Systems team members played key roles in the success of the 11th Annual SGI User Group (SGIUG) Conference. The three-day event was held April 30–May 2, in San Diego, CA.
- The SGIUG conference brought together participants from high-end computing sites around the world, providing an opportunity for SGI users to interact and share information, as well as to discuss and influence future products.
- During the conference, Systems staff presented three session talks and led a discussion session (see slide 17).
- In addition, two HECC team members served on the SGIUG board as president, vice-president, and program chair for the 2013 conference.
- The HECC team's Liz Cox was re-elected as SGUIG vice-president.

Mission Impact: HECC supports NASA's outreach and knowledge-sharing goals with other high-performance computing sites through participation at technical conferences such as user group meetings.

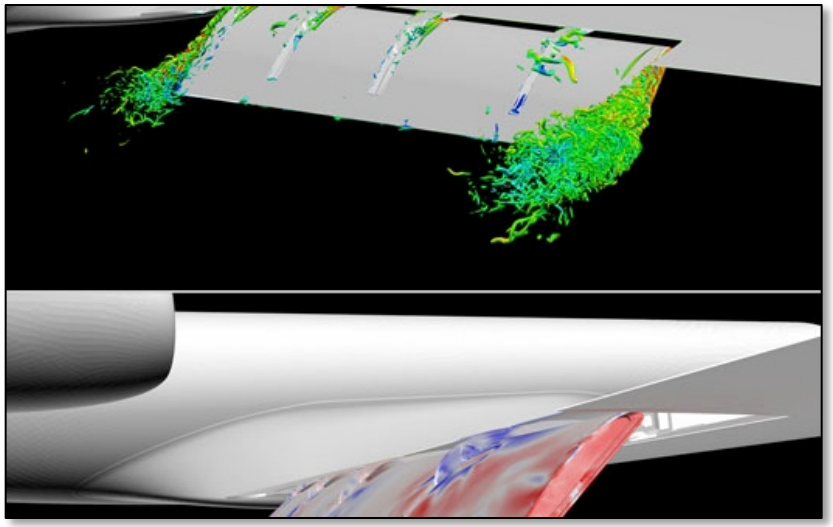
HECC staff presented technical talks on resource management, system installation processes, and data migration at the annual SGI User Group Conference held in May 2013.

POCs: Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division; Davin Chan, davin.s.chan@nasa.gov, (650) 604-4613, NASA Advanced Supercomputing Division, Computer Sciences Corp

Pleiades Enables Large Simulations Aimed at Reducing Aircraft Noise

- As part of NASA's Environmentally Responsible Aviation project to develop aircraft noise reduction technologies, researchers at LaRC used Pleiades to accurately simulate and pinpoint the sources of airframe noise on a Gulfstream aircraft.
- The simulations provided unique insight into the fluid dynamical processes that create noise at aircraft flap tips, and show that:
  - Significant flow unsteadiness at the flap tips is caused by the formation of strong, streamwise vortices;
  - Vortex merging and interaction with solid surfaces produce high-amplitude pressure fluctuations at the flap tips;
  - Portions of the pressure fluctuations are converted into sound waves that radiate toward the ground.
- The research team also ran time-accurate simulations, using LaRC's FUN3D flow solver, to evaluate the effectiveness of a unique noise-reduction concept applied to the flap tips, which proved highly effective.

Mission Impact: HECC supercomputing resources are essential for NASA aeronautics researchers to produce accurate simulations, gain new insight into fluid dynamics processes that create aircraft noise, and contribute to noise-reduction technologies.



Two visualizations of a simulated flowfield for a Gulfstream aircraft high-lift configuration depict the complex, unsteady flow features at both flap tips. Above: The formation of vortex filaments and their roll-up into a single, prominent vortex at each tip. Below: The corresponding surface pressure fluctuation field (noise sources), corroborating wind tunnel measurements that were obtained at NASA Langley Research Center. *Raymond Mineck, NASA/Langley; Patrick Moran, NASA/Ames*

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

POC: Mehdi Khorrami, mehdi.r.khorrami@nasa.gov, (757) 864-3630, NASA Langley Research Center

HECC Facility Hosts Several Visitors and Tours in May 2013

- HECC hosted 10 tour groups in May; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - NASA Administrator Charles Bolden, who was briefed by HECC Project Manager Rupak Biswas and Vadim Smelyanskiy, Quantum Artificial Intelligence Laboratory project lead;
  - California State Assemblyman Rich Gordon and staff members;
  - Joseph McIntyre, Associate Deputy, NASA Chief Financial Office;
  - University Small Spacecraft students, during an educational visit;
  - Students from the German Institute School of Silicon Valley and students from the Gottlieb Daimler School (Stuttgart, Germany), during an educational visit.

Rupak Biswas (second from left) points out components of the newly installed D-Wave quantum computer to NASA Administrator Charles Bolden. The system is located in the Quantum Artificial Intelligence Laboratory at the NASA Advanced Supercomputing facility. Ames Center Director Pete Worden (far left) and Associate Director Steve Zornetzer (not pictured) hosted the administrator's tour of the Ames campus.

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

Papers and Presentations

- "**A Novel Black-Box Simulation Model Methodology for Predicting Performance and Energy Consumption in Commodity Storage Devices**," L. Prada, J. Garcia, A. Calderon, J. D. Garcia, J. Carretero, Simulation Modeling Practice and Theory, vol. 34, pp. 48-63, May 2013. *
  http://www.sciencedirect.com/science/article/pii/S1569190X13000154
- "**The Response of the South Asian Summer Monsoon Circulation to Intensified Irrigation in Global Climate Model Simulations**," S. P. Shukla, M. J. Puma, B. I. Cook, Climate Dynamics, May 2013. *
  http://link.springer.com/article/10.1007/s00382-013-1786-9
- "**Predicting US Summer Precipitation Using NCEP Climate Forecast System Version 2 Initialized by Multiple Ocean Analyses**," J. Zhu, et al., Climate Dynamics, May 2013. *
  http://link.springer.com/article/10.1007/s00382-013-1785-x
- "**Deuterium Burning in Massive Giant Planets and Low-Mass Brown Dwarfs Formed by Core-Nucleated Accretion**," P. Bodenheimer, G. D'Angelo, J. J. Lizzauer, J. J. Fortney, D. Saumon, arXiv:1305.0980 [astro-ph.EP], May 2013. *
  http://arxiv.org/abs/1305.0980
- "**Kepler-62: A Five-Planet System with Planets of 1.4 and 1.6 Earth Radii in the Habitable Zone**," W. J. Borucki, …, C. Henze, et al., Science Magazine (Special Edition), May 3, 2013.
  http://www.sciencemag.org/content/340/6132/587.full

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

Papers and Presentations (cont.)

- "**Performance Evaluation of Amazon Elastic Compute Cloud for NASA High-Performance Computing Applications**," P. Mehrotra, J. Djomehri, S. Heistand, R. Hood, H. Jin, A. Lazanoff, S. Saini, R. Biswas, Concurrency and Computation: Practice and Experience, May 14, 2013. *http://onlinelibrary.wiley.com/doi/10.1002/cpe.3029/full*
- "**Dwarf Galaxy Formation with H_2-Regulated Star Formation: II. Gas-Rich Dark Galaxies at Redshift 2.5**," M. Kuhlen, P. Madau, M. Krumholz, UCO/Lick Observatory Papers, May 23, 2013. * *http://www.ucolick.org/~krumholz/papers/kuhlen13a.pdf*
- "**Transparent Optimization of Parallel File System I/O via Standard System Tool Enhancement**," P. Z. Kolano, presented at the 2nd International Workshop on High Performance Data Intensive Computing, Boston, MA, May 24, 2013. *http://people.nas.nasa.gov/~kolano/papers/hpdic13.pdf*
- "**Angular Momentum Transport by Acoustic Modes Generated in the Boundary Layer. II. Magnetohydrodynamic Simulations**," M. A. Belyaev, R. R. Rafikov, J. M. Stone, The Astrophysical Journal, vol. 770, no. 1, May 24, 2013. * *http://iopscience.iop.org/0004-637X/770/1/68*

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

News and Events

- **NASA Ames Selects SGI UV, the Big Brain Computer, for a Wide Range of Research,** *SGI Press Release,* May 23, 2013—SGI CEO Jorge Titinger, Intel Vice President Raj Hazra, and HECC Deputy Project Manager William Thigpen talk about the new Endeavour supercomputer installed earlier this year at the NAS facility. *http://www.sgi.com/company_info/newsroom/press_releases/2013/may/nasa.html*

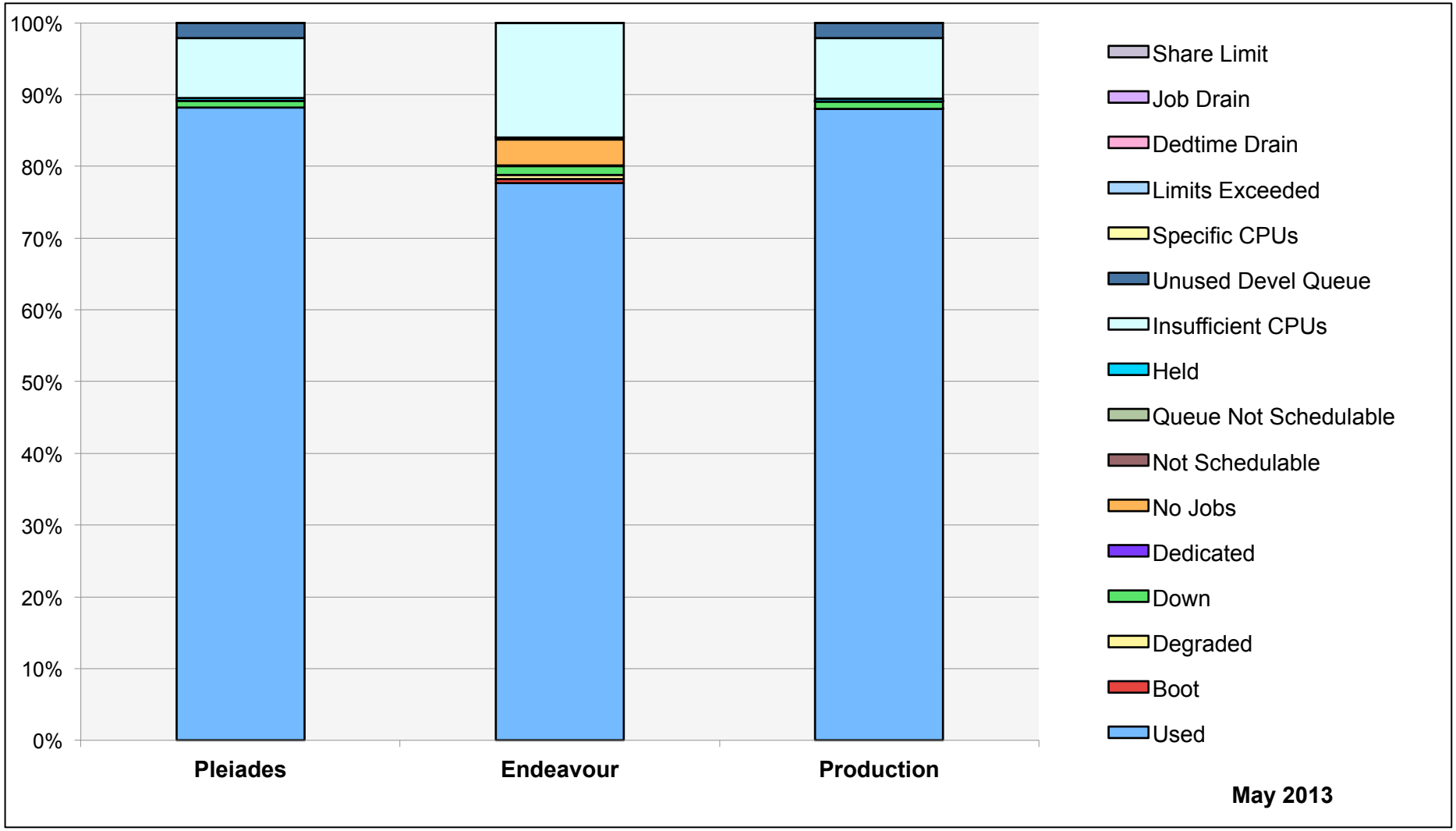
- **SGIUG Conference 2013,** San Diego, CA, April 30-May 2, 2013—HECC staff played key roles in the 11th Annual SGI User Group (SGIUG) Conference. This year's meeting focused on emerging trends in HPC, and featured talks from scientists around the world, including HECC staff:
  - "Resource Matching for Combining Quick-turnaround and Batch Workloads in PBSPro," G. Matthews
  - "Setting Up the UV2000 at NASA Ames," H. Yeung
  - "pDMF at the NASA Advanced Supercomputing Facility," M. Cary

News and Events (cont.)

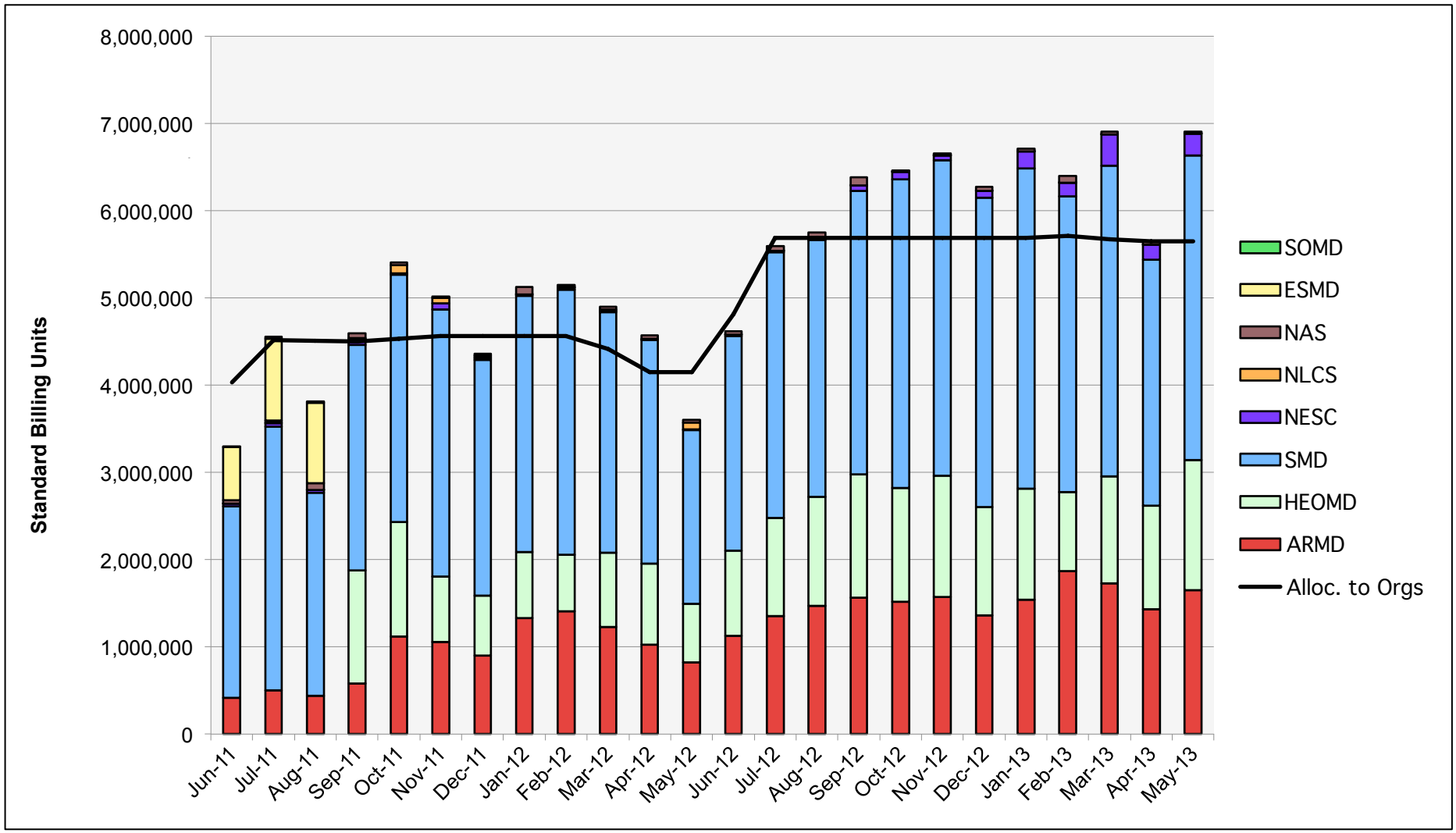
- **D-Wave Two Quantum Computer Selected for New Quantum Artificial Intelligence Initiative, System to be Installed at NASA's Ames Research Center, and Operational in Q3**, *D-Wave Systems press release,* May 16, 2013—D-Wave Systems announced a new Quantum Artificial Intelligence Laboratory collaboration with Google, NASA, and Universities Space Research Association (USRA).
  http://www.dwavesys.com/en/pressreleases.html#dwaveus_Google_NASA

  See also:
  - **Quantum Computing Collaboration Announced**, *NASA Ames/NAS Division web post,* May 16, 2013.
    http://www.nas.nasa.gov/publications/news/2013/05-17-13.html
  - **Launching the Quantum Artificial Intelligence Lab**, *Google Research Blog post,* May 16, 2013.
    http://googleresearch.blogspot.com/2013/05/launching-quantum-artificial.html
  - **NASA, Google and USRA Establish Quantum Computing Research Collaboration**, *USRA announcement*, May 16, 2013.
    http://www.usra.edu/quantum/
  - **Google and NASA Launch Quantum Computing AI Lab**, *MIT Technology Review,* May 16, 2013.
    http://www.technologyreview.com/news/514846/google-and-nasa-launch-quantum-computing-ai-lab/
  - **Quantum Computer Lab to Study Artificial Intelligence**, *CNET,* May 16, 2013.
    http://news.cnet.com/8301-1023_3-57584839-93/google-quantum-computer-lab-to-study-artificial-intelligence/
  - **Google, NASA Open New Lab to Kick Tires on Quantum Computer**, *Wired.com,* May 16, 2013.
    http://www.wired.com/wiredenterprise/2013/05/google-dwave/

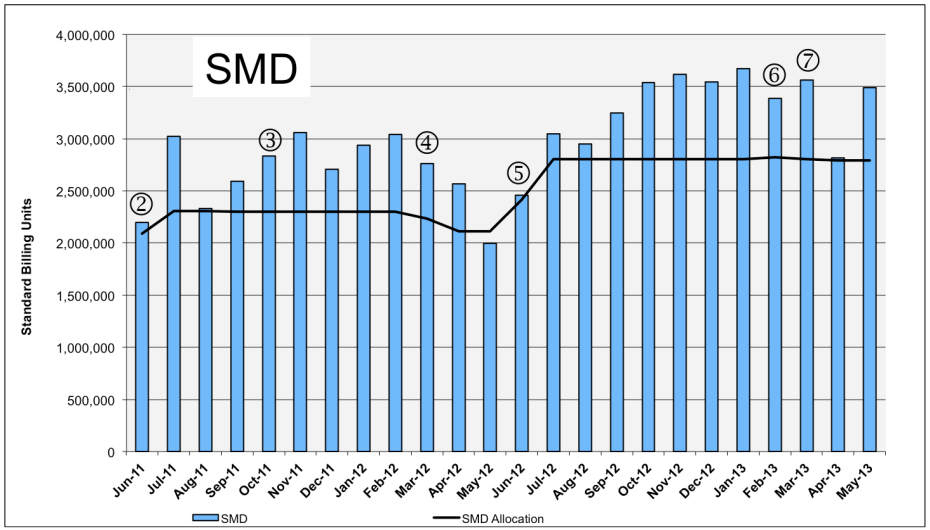
HECC Utilization

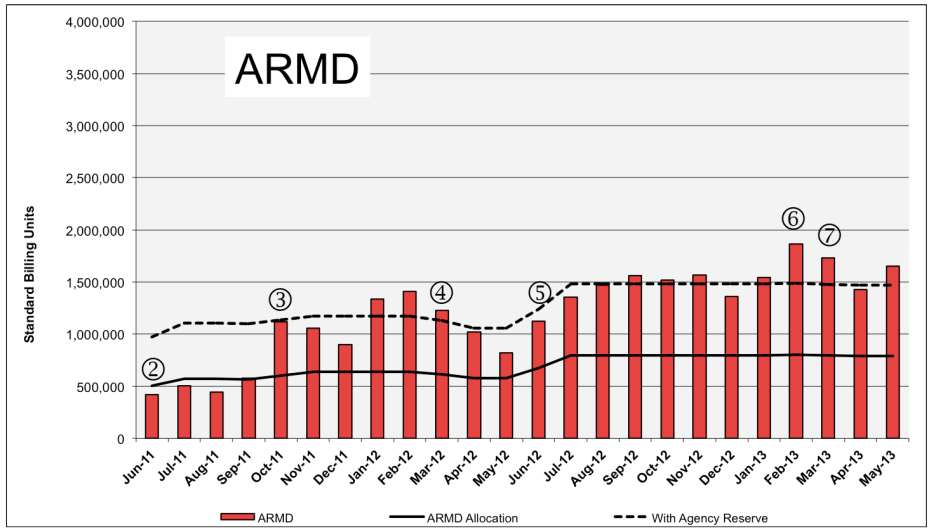


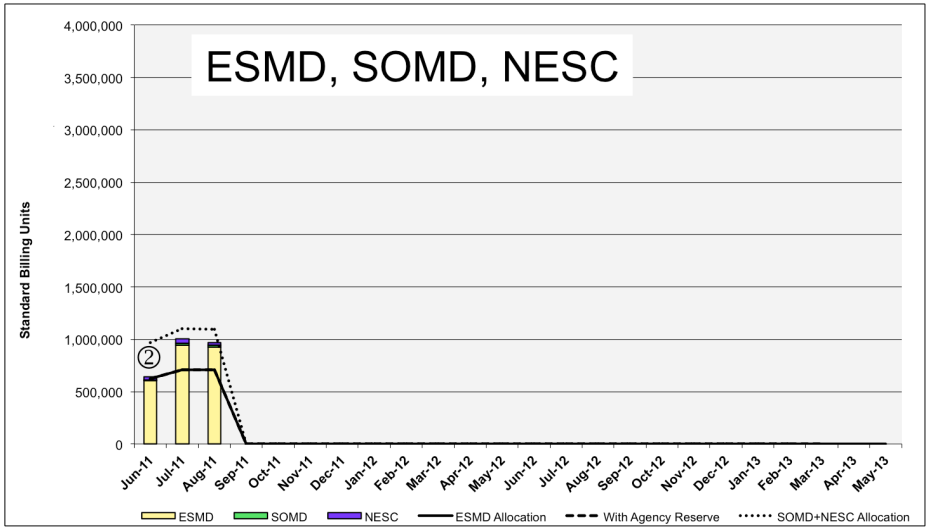
HECC Utilization Normalized to 30-Day Month

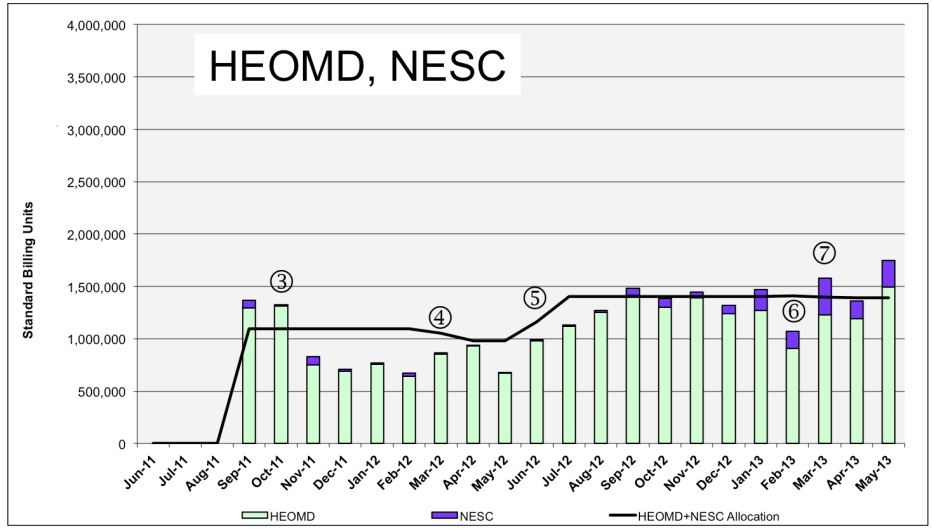


HECC Utilization Normalized to 30-Day Month



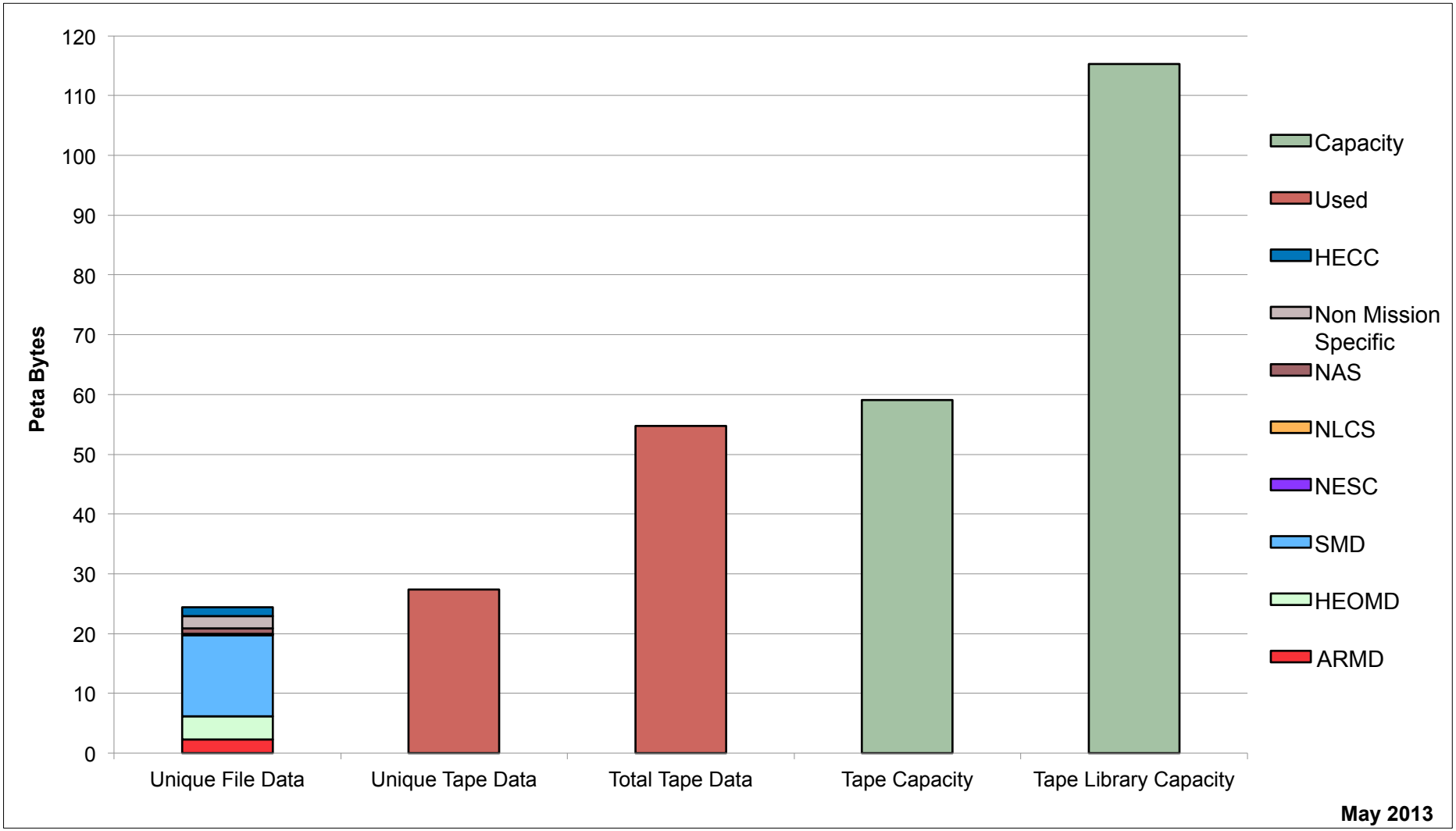




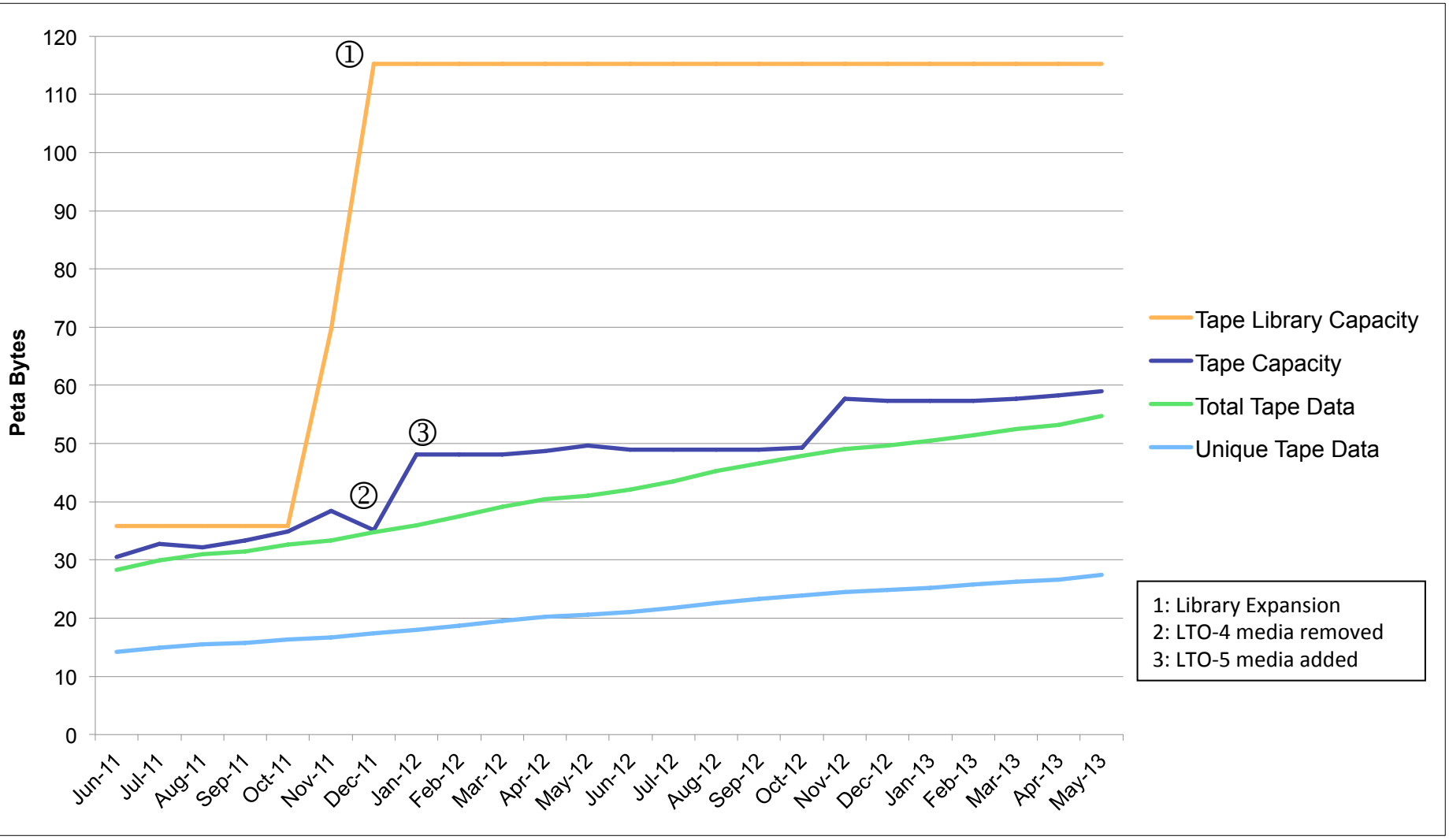


② 14 Westmere racks added ③ 2 ARMD Westmere racks added ④ 28 Harpertown racks removed ⑤ 24 Sandy Bridge racks added
⑥ Columbia 21, 23, and 24 removed; Endeavour 2 added ⑦ Columbia 22 removed, Endeavour 1 added

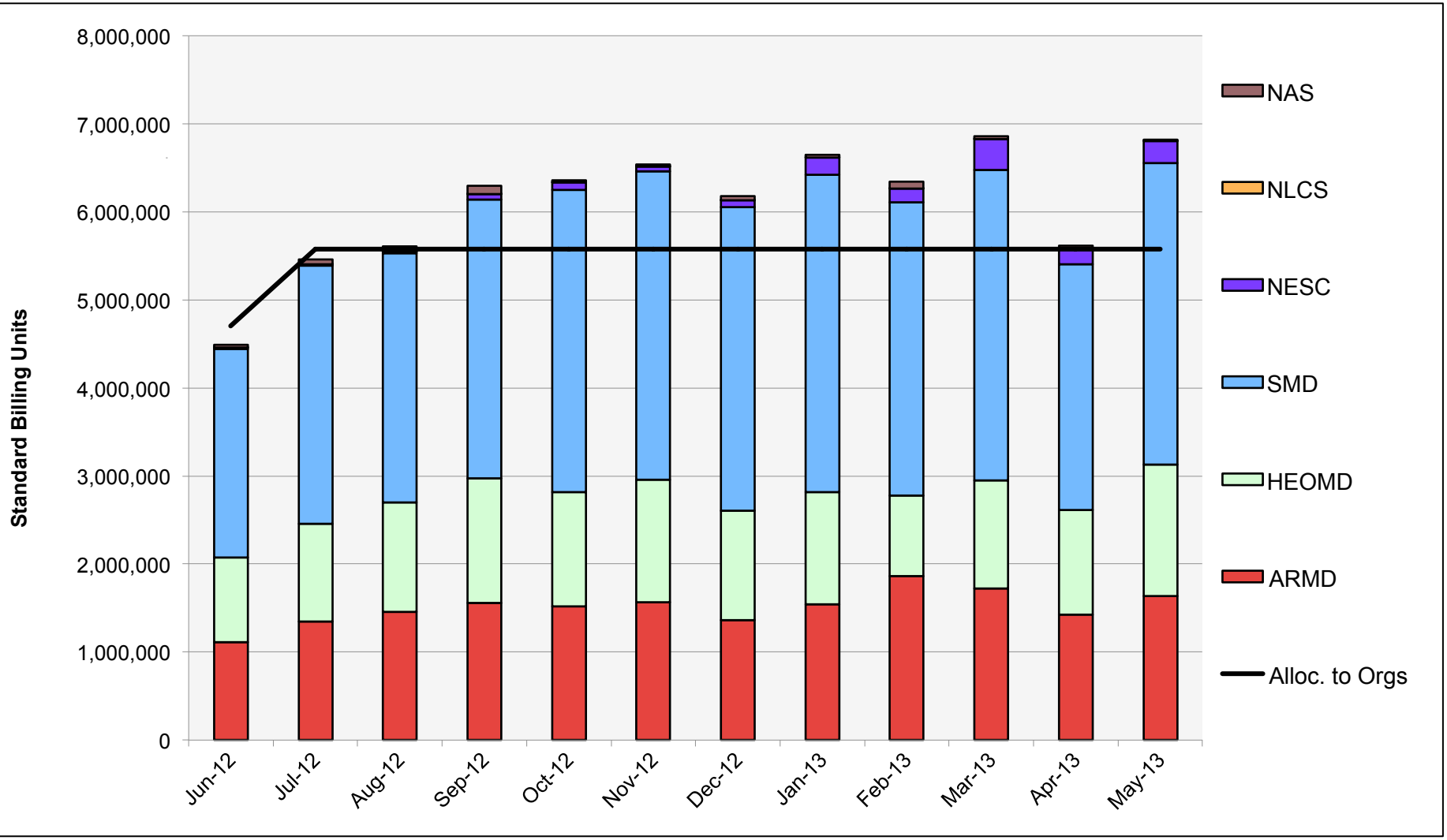
Tape Archive Status



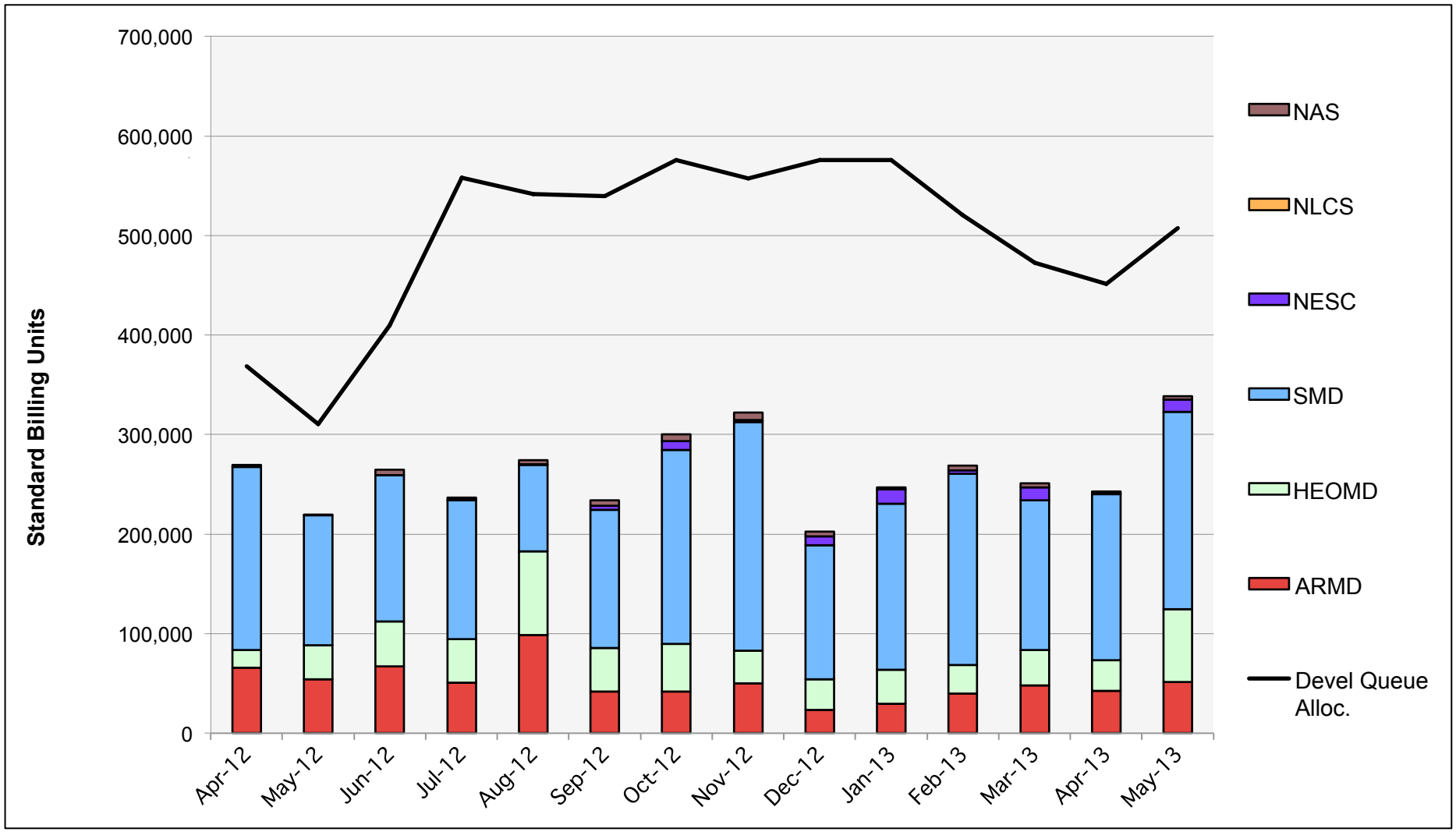
Tape Archive Status



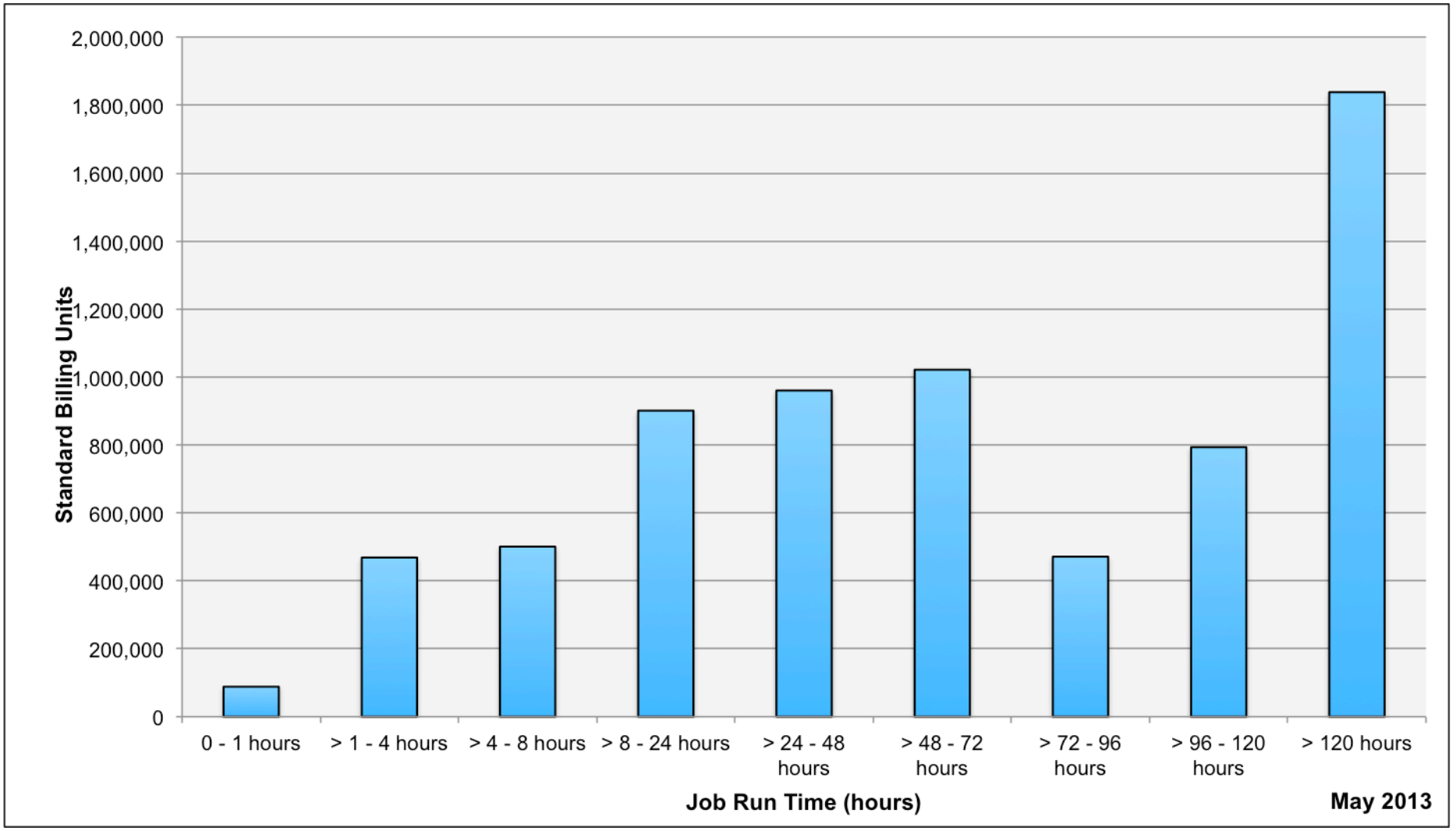
Pleiades:
SBUs Reported, Normalized to 30-Day Month



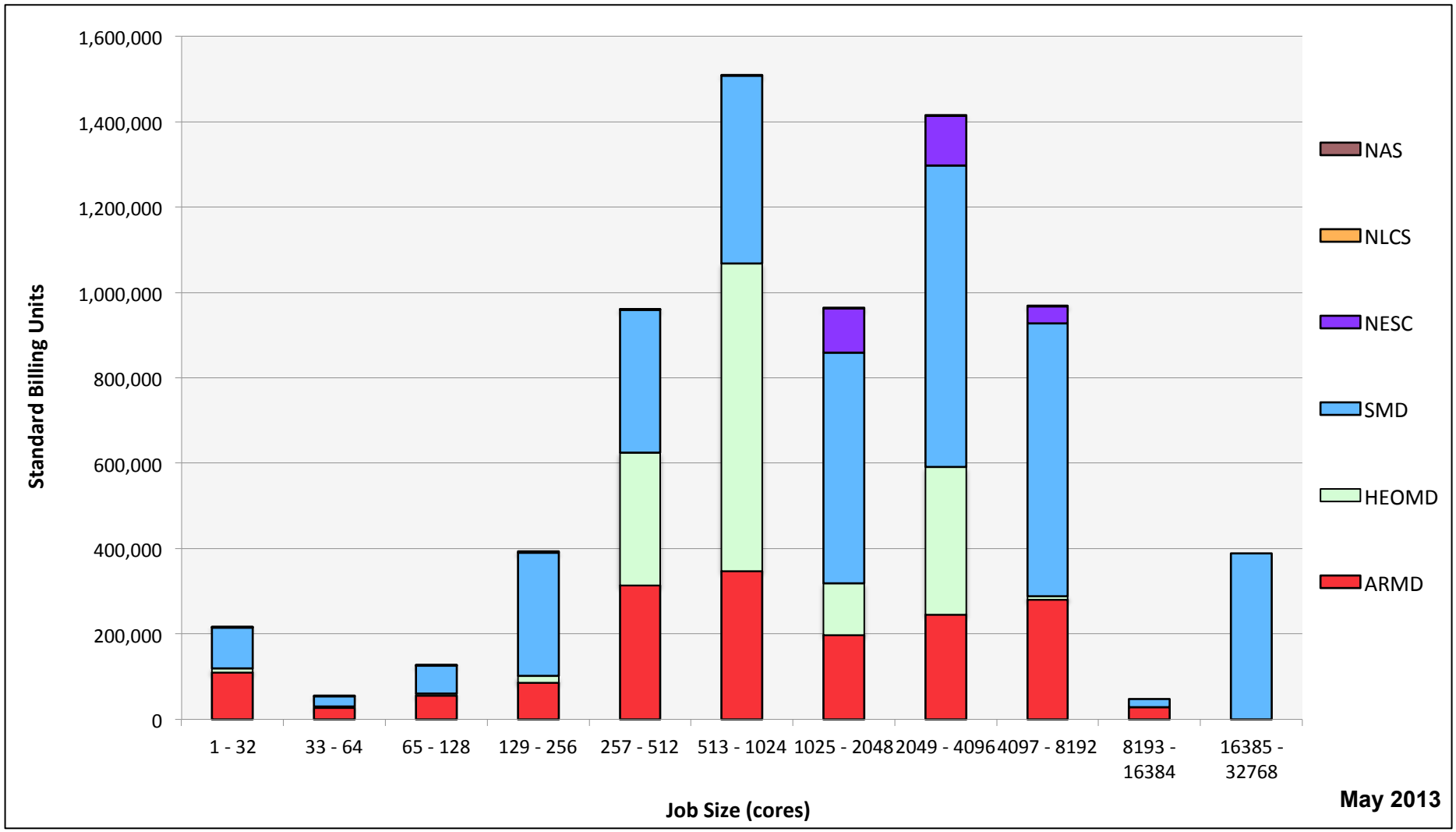
Pleiades:
Devel Queue Utilization



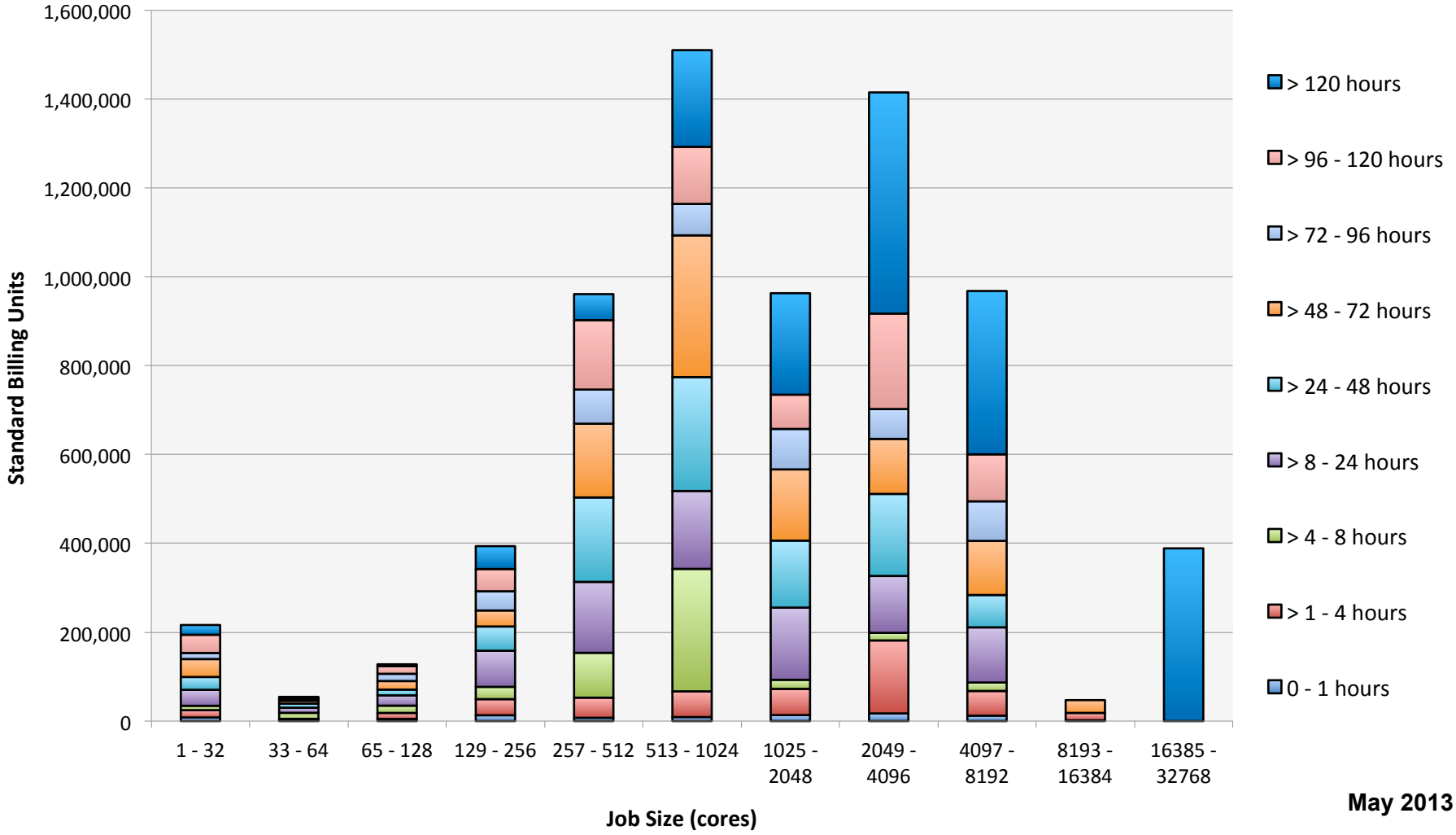
Pleiades:
Monthly Utilization by Job Length



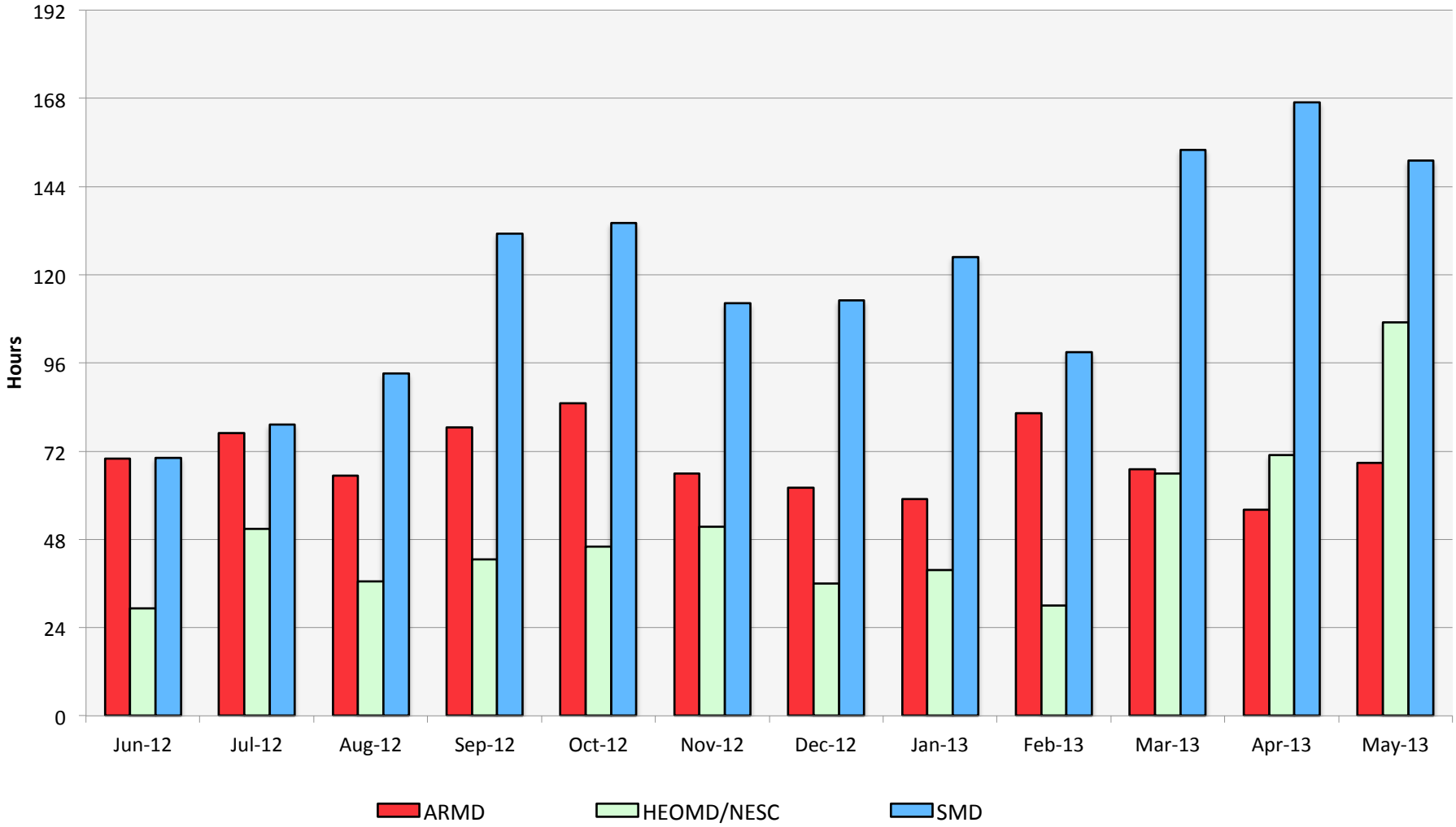
Pleiades:
Monthly Utilization by Size and Mission



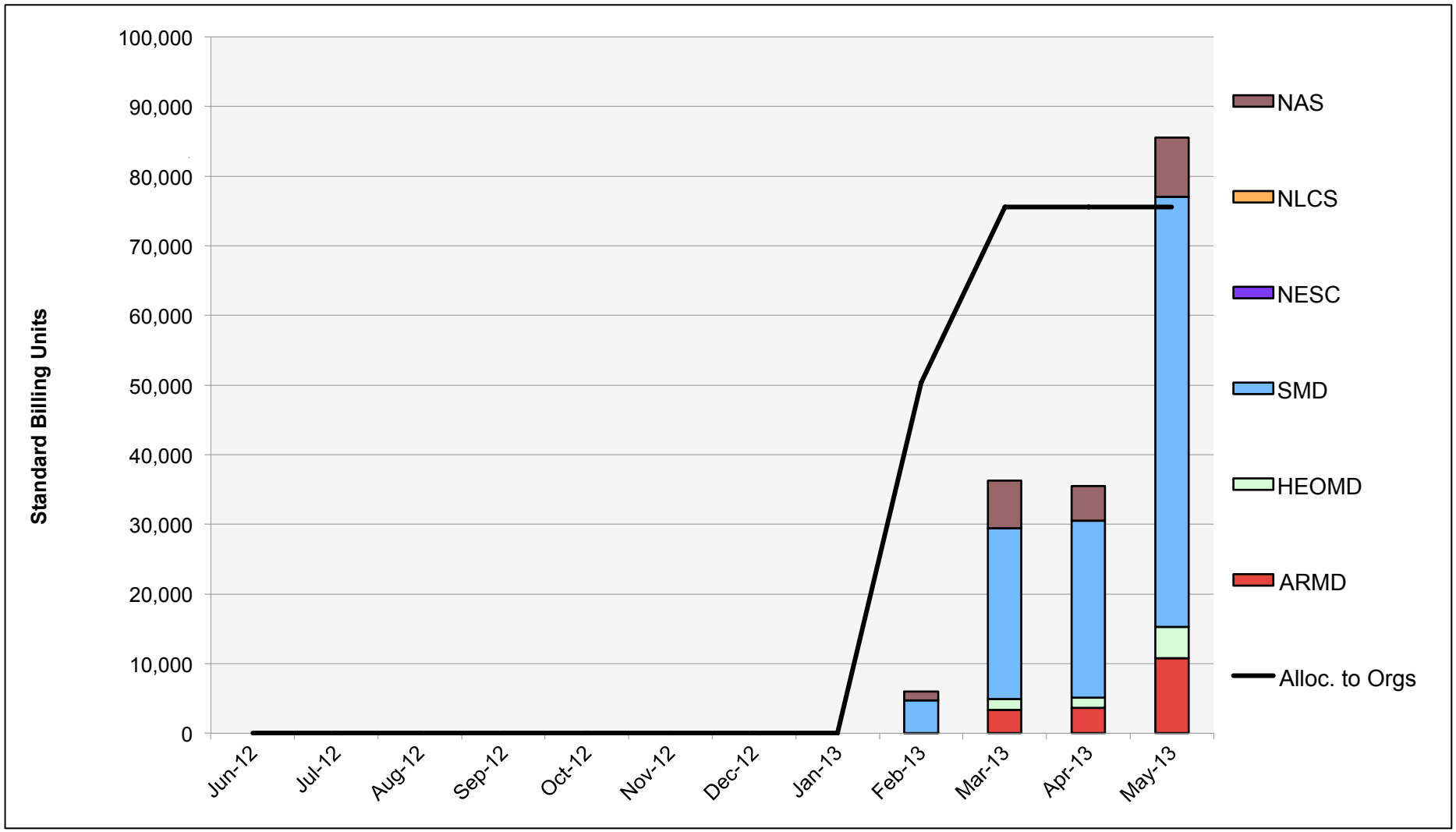
Pleiades:
Monthly Utilization by Size and Length



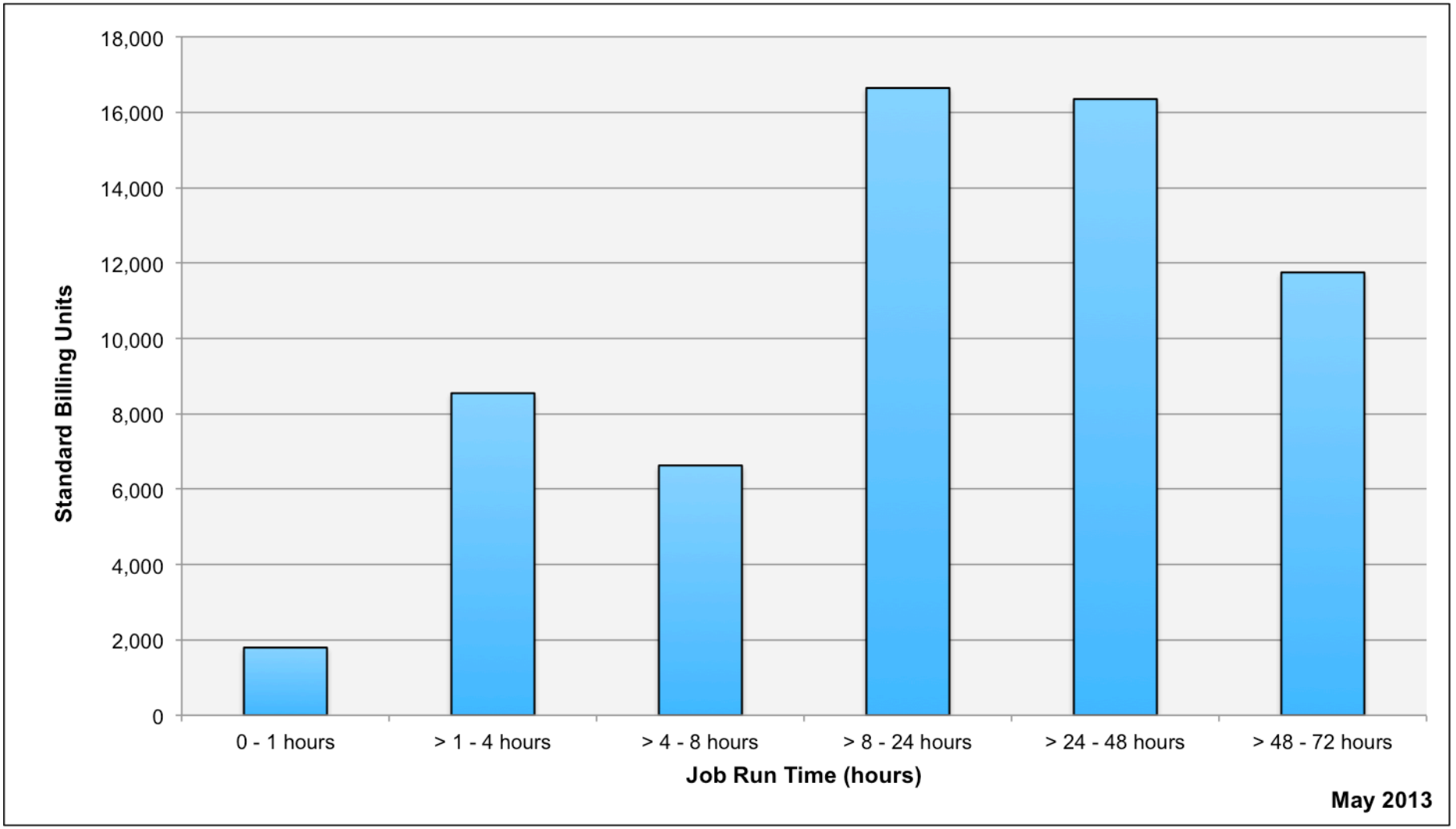
Pleiades:
Average Time to Clear All Jobs



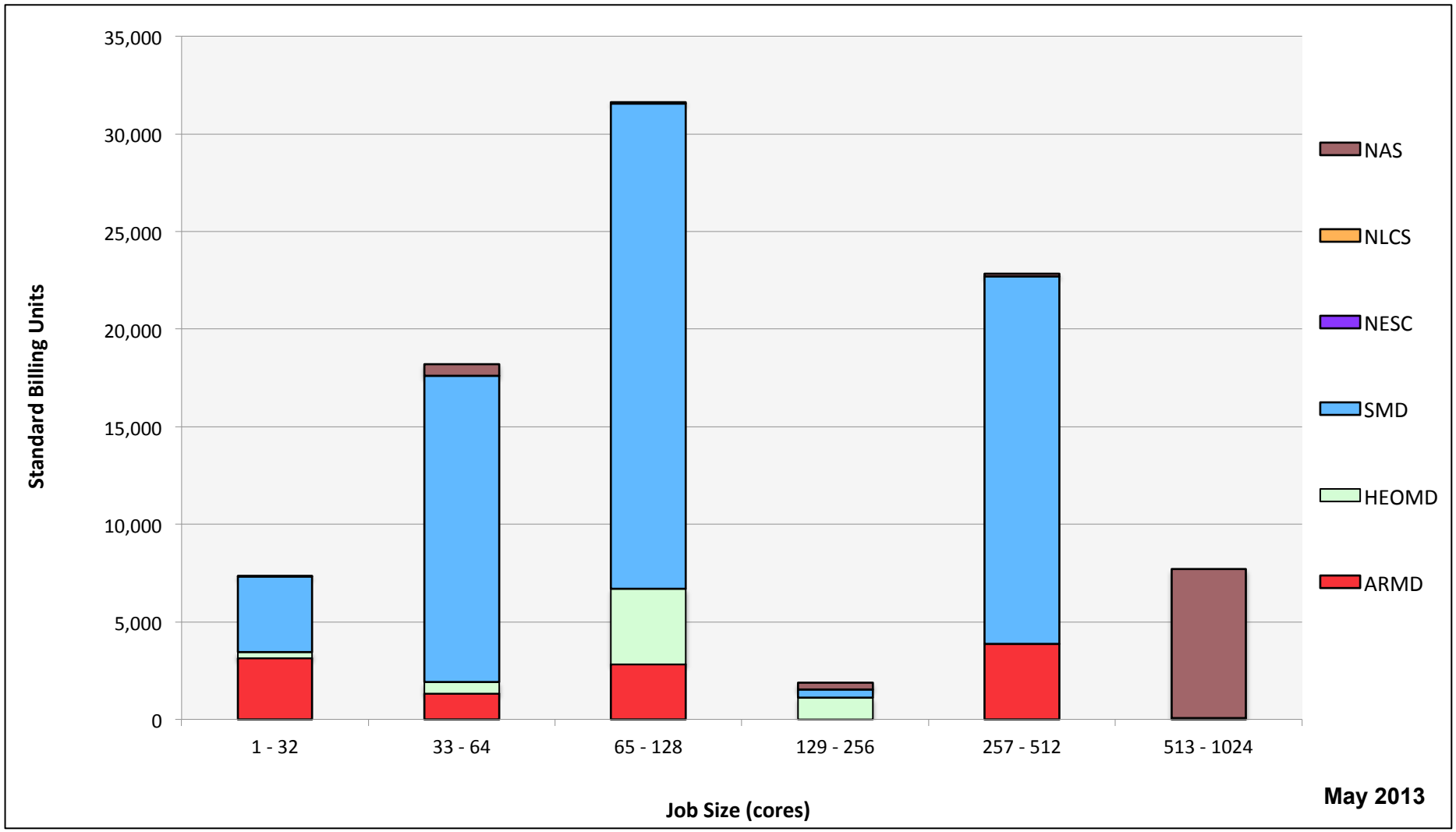
Endeavour:
SBUs Reported, Normalized to 30-Day Month



Endeavour:
Monthly Utilization by Job Length



Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Monthly Utilization by Size and Mission