Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

August 10, 2013

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Facilities Team Completes Site Preparations for First 32 "Ivy Bridge" Racks

- The HECC Facilities team completed site preparations for the first 32 (of 46) SGI racks containing Intel Xeon E5-2680V2 "Ivy Bridge" processors. The racks were procured via the NAS Technology Refresh (NTR) process.
- By coordinating closely with other HECC staff and SGI engineers, the team completed site prep ahead of schedule, and the first 16 racks of equipment were put in place the same day they arrived. Work included:
  - Storing 32 de-installed Harpertown racks, placing properly cut floor tiles, creating a power plan, relocating power whips, and assisting with unloading crates from delivery trucks;
  - The Facilities team also placed and powered up the racks in record time.
- To prepare for the arrival of the remaining racks, Facilities staff will coordinate the removal of 32 more Harpertown racks, cutting of floor tiles, and power installation.

Mission Impact: Through proper preparation, planning, and execution of facility changes, HECC minimizes the time between delivery and release of new computing systems, ensuring quick delivery of new production capabilities to NASA scientists.

HECC and SGI engineers remove fiber optic cables on the NASA Advanced Supercomputing (NAS) facility's main computer room floor, during early stages of the Ivy Bridge system installation. Such preparations provide engineers with the space and power distribution necessary to quickly install, test, and bring into production new computing capabilities.

POCs: Chris Buchanan, chris.buchanan@nasa.gov, (650) 604-4308, Scott Prevost, scott.prevost@nasa.gov, (650)604-4350, NASA Advanced Supercomputing Division, Computer Sciences Corp.

HECC Deploys "Harpertown" Testbed Cluster

- To provide extra resources to users, the Supercomputing Systems team configured and deployed a 640-node SGI system containing Intel Xeon E5472 ("Harpertown") processors in HECC's auxiliary facility.
- The hardware comprises repurposed Pleiades Harpertown racks removed from production in the primary facility due to power/cooling limitations of the facility. The hardware was configured in 20 half populated racks to meet the auxiliary facility's weight restrictions.
- The system will also be used to test InfiniBand modifications and system configurations, to avoid downtime on Pleiades. When not being used for testing, the system will be available for HECC users to run applications with access to the production NFS and Lustre filesystems over a long distance InfiniBand connection to the HECC's primary facility.
- Currently, the system is being tested by early-access users to validate the usability of CentOS, a freely available operating system for production workloads that could potentially save ~$250K per year in maintenance costs on Pleiades.
- A second 512-node system will be installed in August, increasing the number of nodes available to the user community.

Mission Impact: Repurposing hardware into a dedicated cluster enables HECC to test system changes and enhancements to Pleiades without impacting production jobs, and delivers additional computational cycles to NASA users.

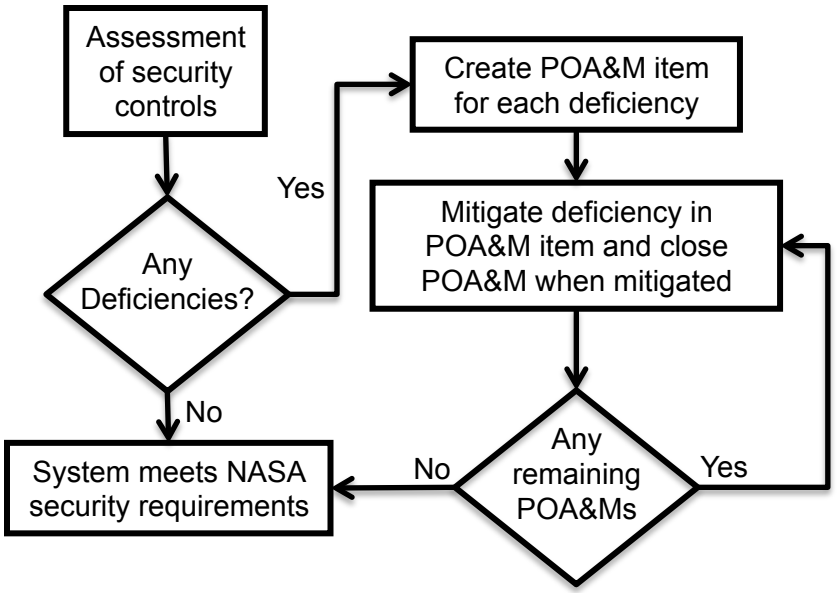
The 640 Harpertown nodes deliver 61 teraflops of theoretical peak performance to users. The cluster comprises 20 half populated racks and is located in Building N233A at NASA Ames.

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

Security Assessment Plan of Action & Milestone Items Completed

- The Security team completed all Plan of Action & Milestone (POA&M) items resulting from a 2012 NASA Ames security assessment to determine if HECC's computer systems met the required National Institute of Standards and Technology (NIST) SP 800-53 Revision 3 controls.
- Each deviation found during these triennial assessments results in a POA&M item to mitigate risks. Last year's appraisal identified just 3 items:
  - First item closed in October 2012 through a software modification applied by HECC's Engineering Servers and Services team;
  - Second item closed in March 2013 through a procedural change with another Ames group;
  - Final item closed in June 2013 when the Authorizing Official accepted the risk of not directly implementing the control (since the vendor was unwilling to make needed changes), and mitigated risk through other means.
- All POA&M work was completed well before the October 2013 deadline.

Mission Impact: Closing out Plan Of Action & Milestone items ensures that HECC computer systems continue to maintain current security and privacy controls required for federal information systems and organizations.



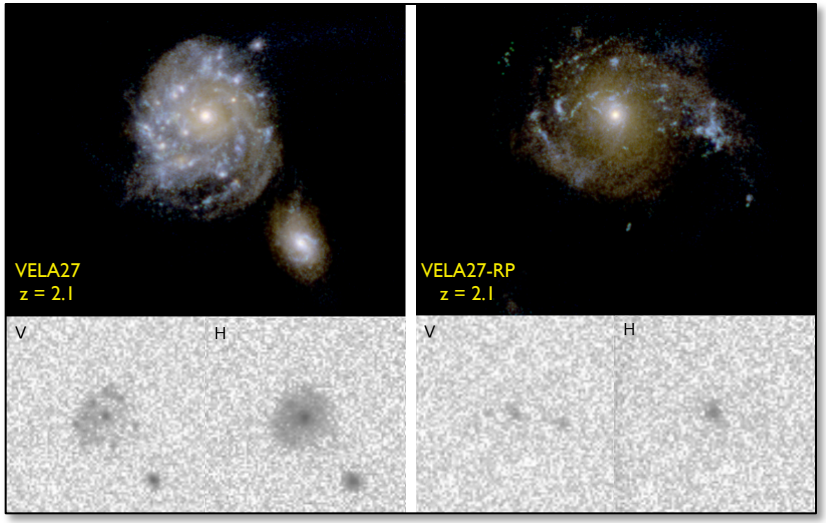
This diagram shows the process by which a Plan of Action and Milestone item is created and closed.

POC: Thomas Hinke, thomas.h.hinke@nasa.gov, (650) 604-3662, NASA Advanced Supercomputing Division

Pleiades Enables Accurate Simulation of the Formation, Evolution of the Universe

- Researchers at the University of California, Santa Cruz (UCSC) are using Pleiades to run Bolshoi-Planck—the most accurate, high-resolution Lambda Cold Dark Matter (ΛCDM) simulation of the large-scale structure of the universe to date.
  - The UCSC team's hydrodynamics plus N-body code, hydroART, simulates scores of cosmological regions at high resolution (15–30 parsecs), each containing a large galaxy and many dwarf and satellite galaxies.
  - Their Monte Carlo radiative-transfer code, Sunrise, creates realistic images of the simulated galaxies in many wavebands at many times during each simulation, and includes the important effects of stellar evolution and dust.
- The team is also directly comparing its "simulated observations" with Hubble Space Telescope observations, to clarify how galaxies form in different environments.

Mission Impact: HECC supercomputing resources enable scientists to reproduce the formation and evolution of the universe with astounding accuracy, and to provide theoretical support for the interpretation of observational data from Hubble and other NASA space-borne observatories.



One of the Pleiades-enabled cosmological galaxy simulations (left) compared with the same simulation run with radiation-pressure feedback (right). Top row: Rest-frame, three-color images produced by the Sunrise code from the galaxy simulations at redshift z =2.1 (about 10 billion years ago). Bottom row: Corresponding images with Hubble Space Telescope resolution in observed v (visual) and H (infrared) wavebands.

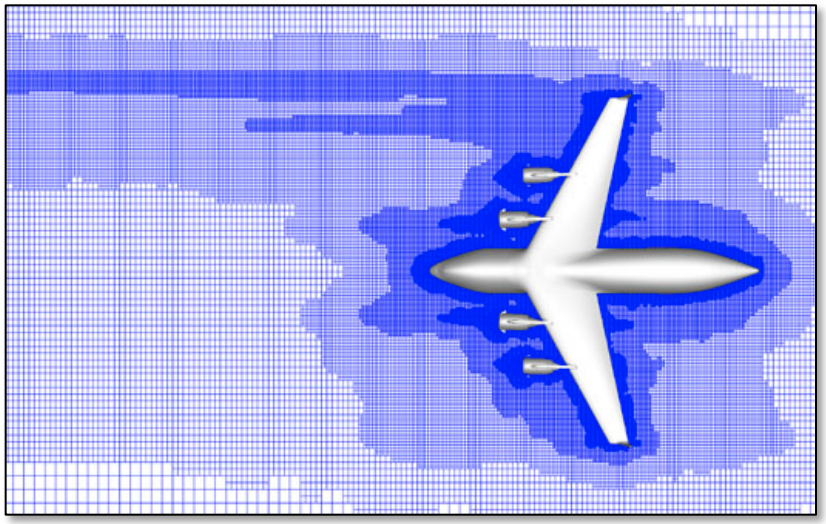
POC: Joel Primack, joel@ucsc.edu, (831) 459-2580, University of California, Santa Cruz

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

HECC Supercomputers Used to Model Extended Flight Formation

- Researchers at NASA Ames are running extremely large simulations on Pleiades to study the potential benefit of formation flight in reducing carbon emissions and gaining fuel economy. Results show that:
  - Benefits of formation flight remain significant when accounting for losses due to transonic compressibility and control surface deflection due to aircraft trim;
  - In trimmed transonic flight, aircraft following 30 spans downstream can still achieve a 35% savings in induced drag;
  - These savings are relatively insensitive to precise positioning of the trailing aircraft.
- With problem sizes that are on the order of a billion degrees of freedom, and hundreds of cases to consider, the availability of Pleiades' massive parallelization capability, along with the new Endeavour system, are key to this research.

Mission Impact: Results from formation flight simulations, enabled by HECC resources, are verified with flight-test data gathered in cooperation with other government agencies. After validation, the data are used in models of the National Airspace System to quantify the potential of formation flight to reduce fuel consumption at a national scale.



The need to resolve many disparate length scales, and to compute small quantities with high accuracy, drives computational requirements for NASA's high-performance computing systems. The mesh shown here has approximately 500 million unknown quantities. *Michael Aftosmis, James Kless, NASA/Ames*

POC: Michael Aftosmis, michael.aftosmis@nasa.gov, (650) 604-4499, NASA Advanced Supercomputing Division

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HECC Facility Hosts Several Visitors and Tours in July 2013

- HECC hosted 13 tour groups in July; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - Alan Littlefield, Chief Engineer at NASA Kennedy Space Center, who visited Ames for informal meetings with HECC staff;
  - International Space Station managers, including Scott Seyl, Deputy Manager, Office of Safety and Mission Assurance; Tony Sang, Mission Evaluation Room Manager; and Patrick Mitchill, Executive Officer. All visited Ames to meet with the Human-Computer Interaction group;
  - Jason Kalirai, Deputy Mission Scientist for the James Webb Space Telescope, who met with HECC visualization experts and the Kepler team;
  - Students from the Naval Post-Graduate School, Monterey, Calif., representing several federal agencies with common interests in the processing and analysis of large-scale image datasets;
  - Students from the 2013 Ames Singularity University, who received a quantum computer overview.
  - 25 high school students from the NASA Opportunities in Visualization, Art, and Science program, associated with the University of California, Berkeley and a NASA Education Grant.

NASA Advanced Supercomputing Division Deputy Chief Bryan Biegel (standing) gives an overview and visualization demonstration to students from the Naval Post-Graduate School, Monterey, Calif.

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

Papers and Presentations

- "**Radiative Feedback and the Low Efficiency of Galaxy Formation in Low-Mass Halos at High Redshift**," D. Cerverino, et al., arXiv:1307.0943 [astro-ph.CO], July 3, 2013. *
  http://arxiv.org/abs/1307.0943
- "**Analytical Hotspot Shapes and Magnetospheric Radius from 3D Simulations of Magnetospheric Accretion**," A. K. Kulkarni, M. M. Romanova, Monthly Notices of the Royal Astronomical Society, July 4, 2013. *
  http://mnras.oxfordjournals.org/content/early/2013/07/04/mnras.stt945.full.pdf
- "**The Same Frequency of Planets Inside and Outside Open Clusters of Stars**," S. Meibom, et al., Nature Letters, issue 449, pp. 55-58, July 4, 2013. *
  http://www.nature.com/nature/journal/v499/n7456/full/nature12279.html
- "**Bi-Directional Energy Cascades and the Origin of Kinetic Alfvenic and Whistler Turbulence in the Solar Wind**," H. Che, M. L. Goldstein, A. F. Vinas, arXiv:1307.2615 [astro-ph.SR], July 9, 2013. *
  http://arxiv.org/abs/1307.2615
- "**Orbital Anisotropy in Cosmological Haloes Revisited**," R. Wojtak, S. Gottlober, A. Klypin, Monthly Notices of the Royal Astronomical Society, July 12, 2013. *
  http://mnras.oxfordjournals.org/content/early/2013/07/12/mnras.stt1113.full

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Papers and Presentations (cont.)

- "**Observable Signatures of Classical T Tauri Stars Accreting in an Unstable Regime**," R. Kurosawa, M. M. Romanova, arXiv:1307.3639 [astro-ph.SR], July 13, 2013. *
  http://arxiv.org/abs/1307.3639
- "**A Global Wave-Driven MHD Solar Model with a Unified Treatment of Open and Closed Magnetic Field Technologies**," R. Oran, B. van der Holst, E. Landi, M. Jin, I. V. Sokolov, T. I. Gombosi, arXiv:1307.4510 [astro-ph.SR], July 17, 2013. *
  http://arxiv.org/abs/1307.4510
- "**No Flares from Gamma-Ray Burst Afterglow Blast Waves Encountering Sudden Circumburst Density Change**," I. Gat, H. van Eerten, A. MacFadyen, The Astrophysical Journal, vol. 773, no. 1, July 18, 2013. *
  http://iopscience.iop.org/0004-637X/773/1/2
- "**Current Sheets Formation in Tangled Coronal Magnetic Fields**," A. F. Rappazzo, E. N. Parker, The Astrophysical Journal, vol. 773, no.1, July 24, 2013. *
  http://iopscience.iop.org/2041-8205/773/1/L2/article
- "**Direct Auroral Precipitation from the Magnetotail During Substorms**," M. Ashour-Abdalla, et al., Geophysical Research Letters (Early Publication), July 30, 2013. *
  http://onlinelibrary.wiley.com/doi/10.1002/grl.50635/full

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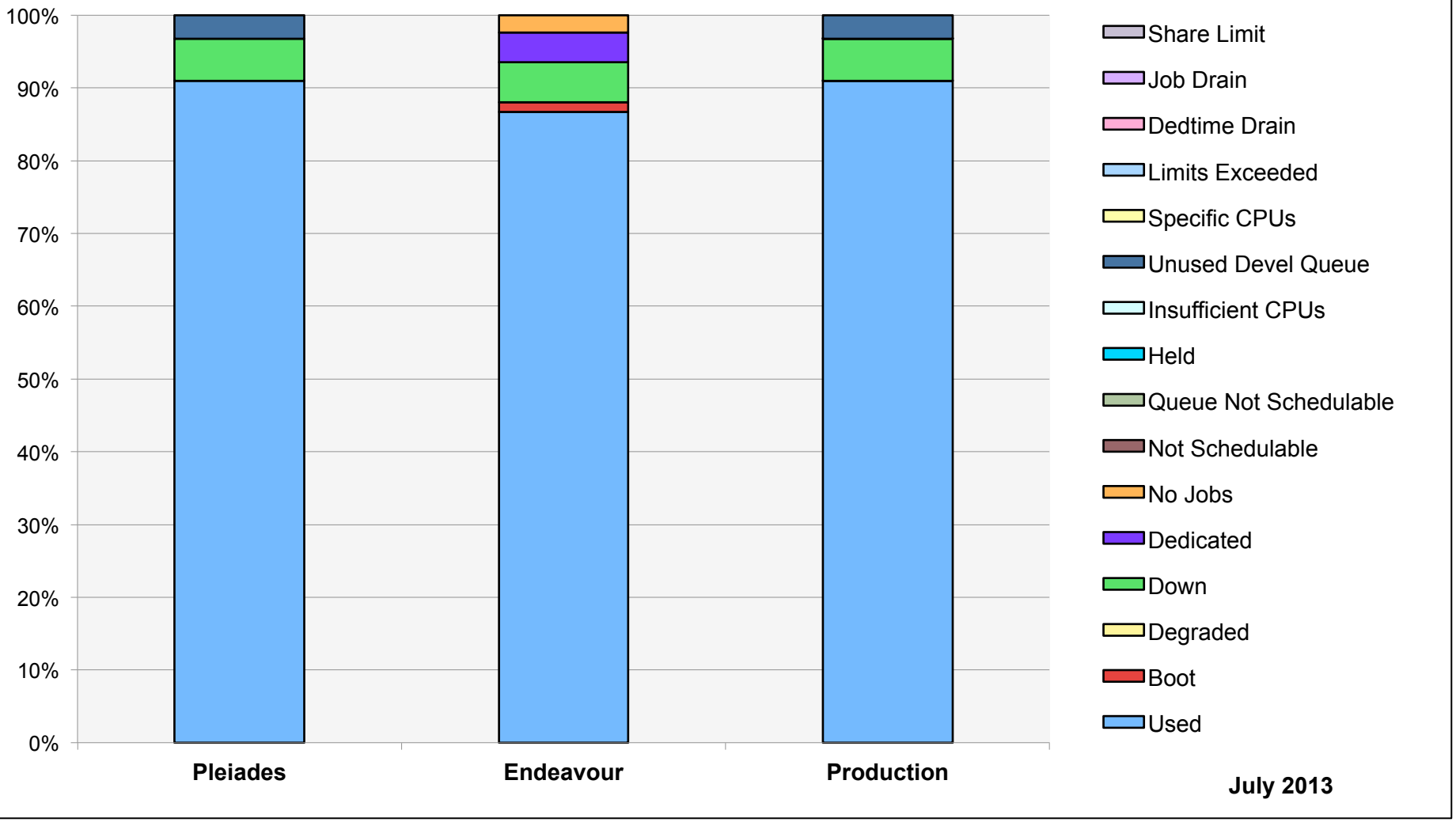
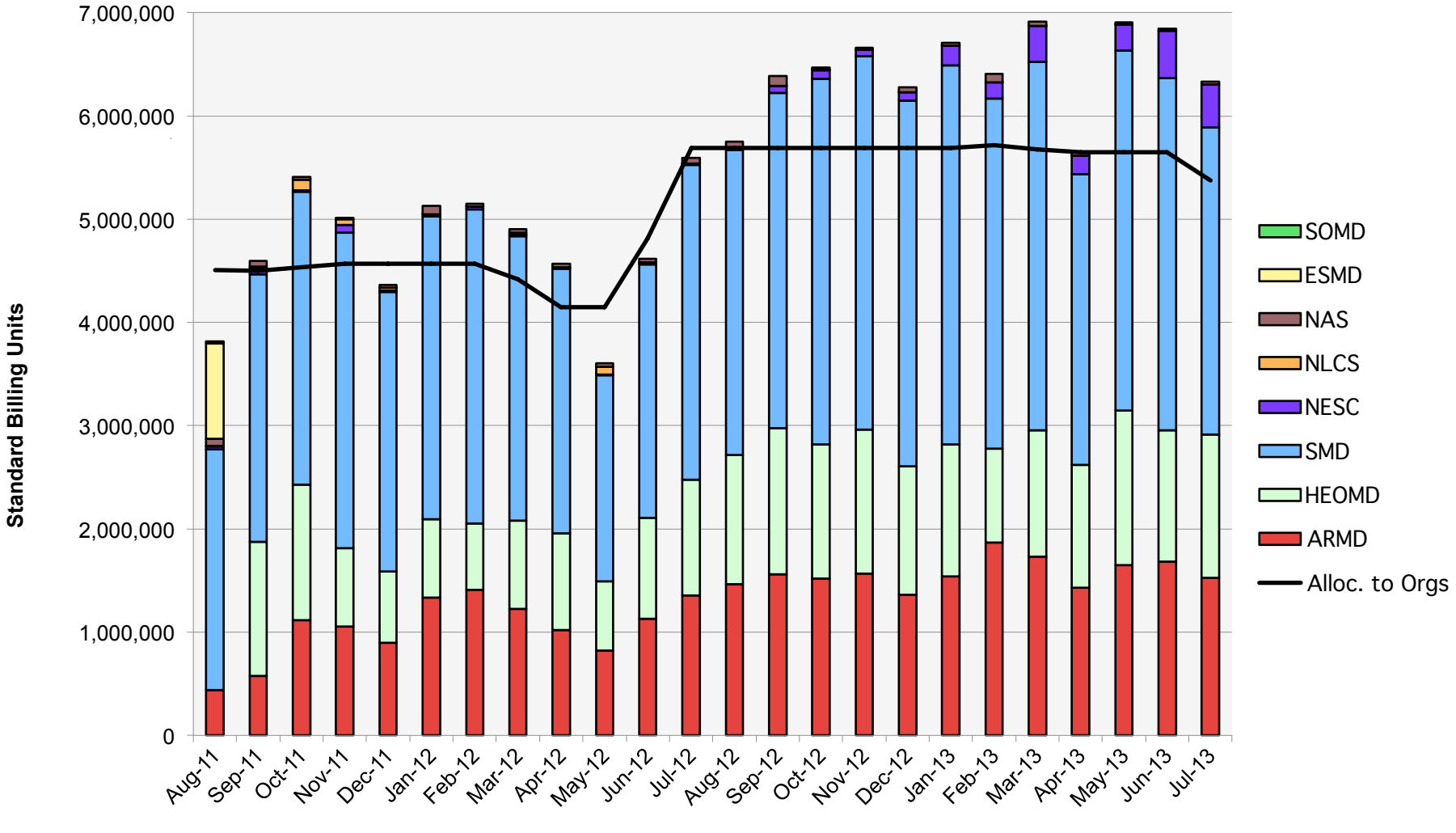
News and Events

- **Pleiades Supercomputer to Upgrade to 2.87 Petaflops**, *insideHPC*, July 6, 2013 – The agency's flagship Pleiades supercomputer will be upgraded with the latest-generation Ivy Bridge processors. Picked up by multiple media sources from an original NAS Division news announcement.
  http://insidehpc.com/2013/07/06/pleiades-supercomputer-to-upgrade-to-2-87-petaflops/
  http://www.nas.nasa.gov/publications/news/2013/07-05-13.html
- **IRIS Mission Gets First Look at Sun's Mysterious Interface Region**, *NASA Ames press release,* July 25, 2013 – NASA's Interface Region Imaging Spectrograph (IRIS) spacecraft has captured its first observations of the lowest layers of the Sun's atmosphere which, in conjunction with modeling and simulations performed on the Pleiades supercomputer, will allow scientists to study these fairly unknown layers in unprecedented detail.
  http://www.nasa.gov/content/iris-mission-gets-first-look-at-suns-mysterious-interface-region/
  - **NASA IRIS Observatory—Designed and Built by Lockheed Martin – Sees First Light**, *Lockheed Martin Press Release,* July 25, 2013.
    http://www.lockheedmartin.com/us/news/press-releases/2013/july/0725-ss-iris.html
- **NASA Extends Contract for Supercomputing Support Services**, *NASA press release,* July 31, 2013 – NASA announces that it will extend its contract with Computer Sciences Corporation for HPC support services at the NASA Advanced Supercomputing Division at NASA Ames Research Center. Picked up by HPCwire and multiple media sources.
  http://www.nasa.gov/press/2013/july/nasa-extends-contract-for-supercomputing-support-services/#.Ufr5EbY7i1Q

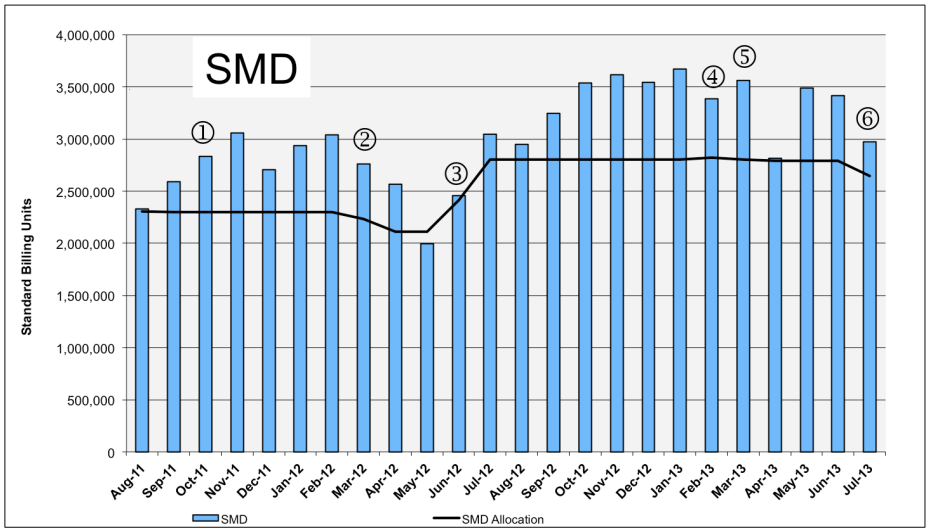
HECC Utilization

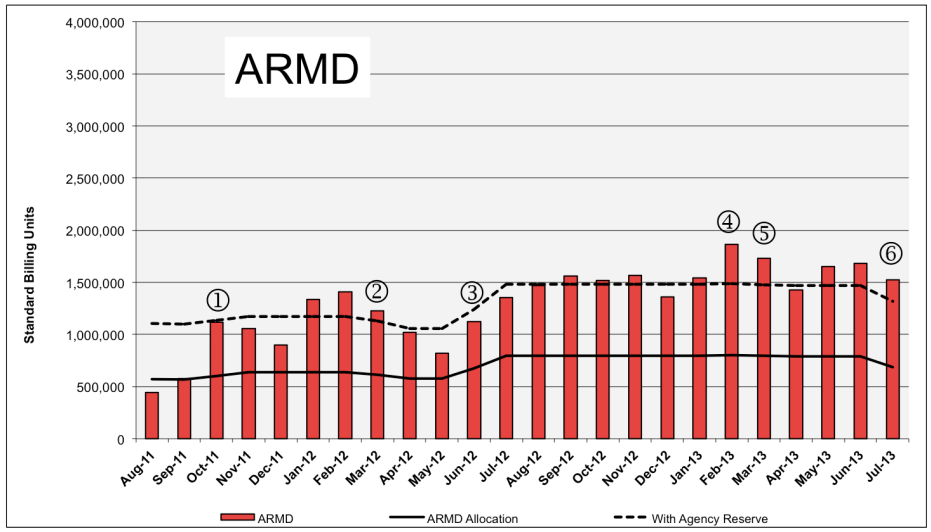


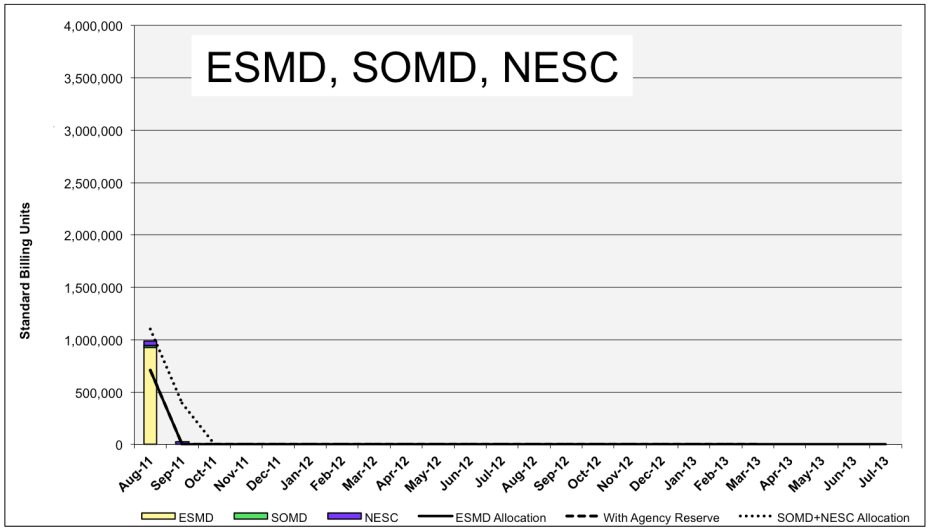
HECC Utilization
(Normalized to 30-Day Months)

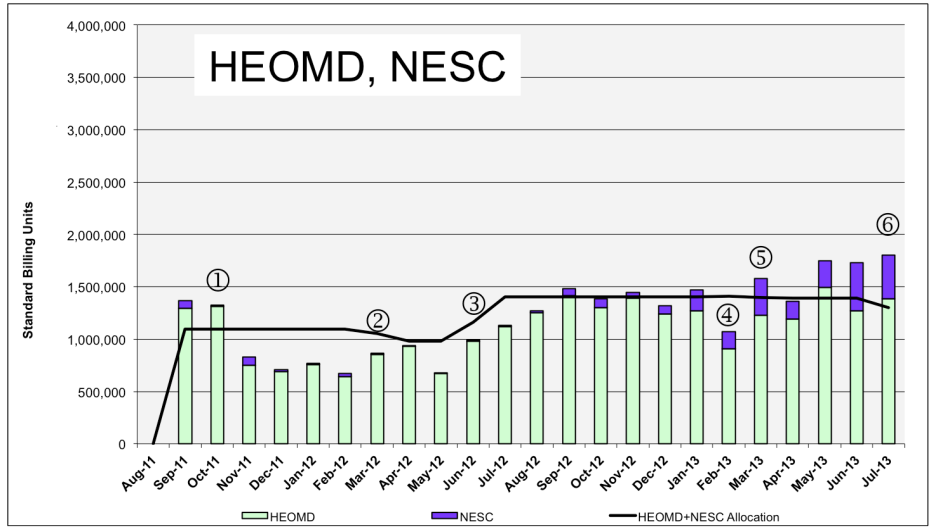


HECC Utilization (By Mission)



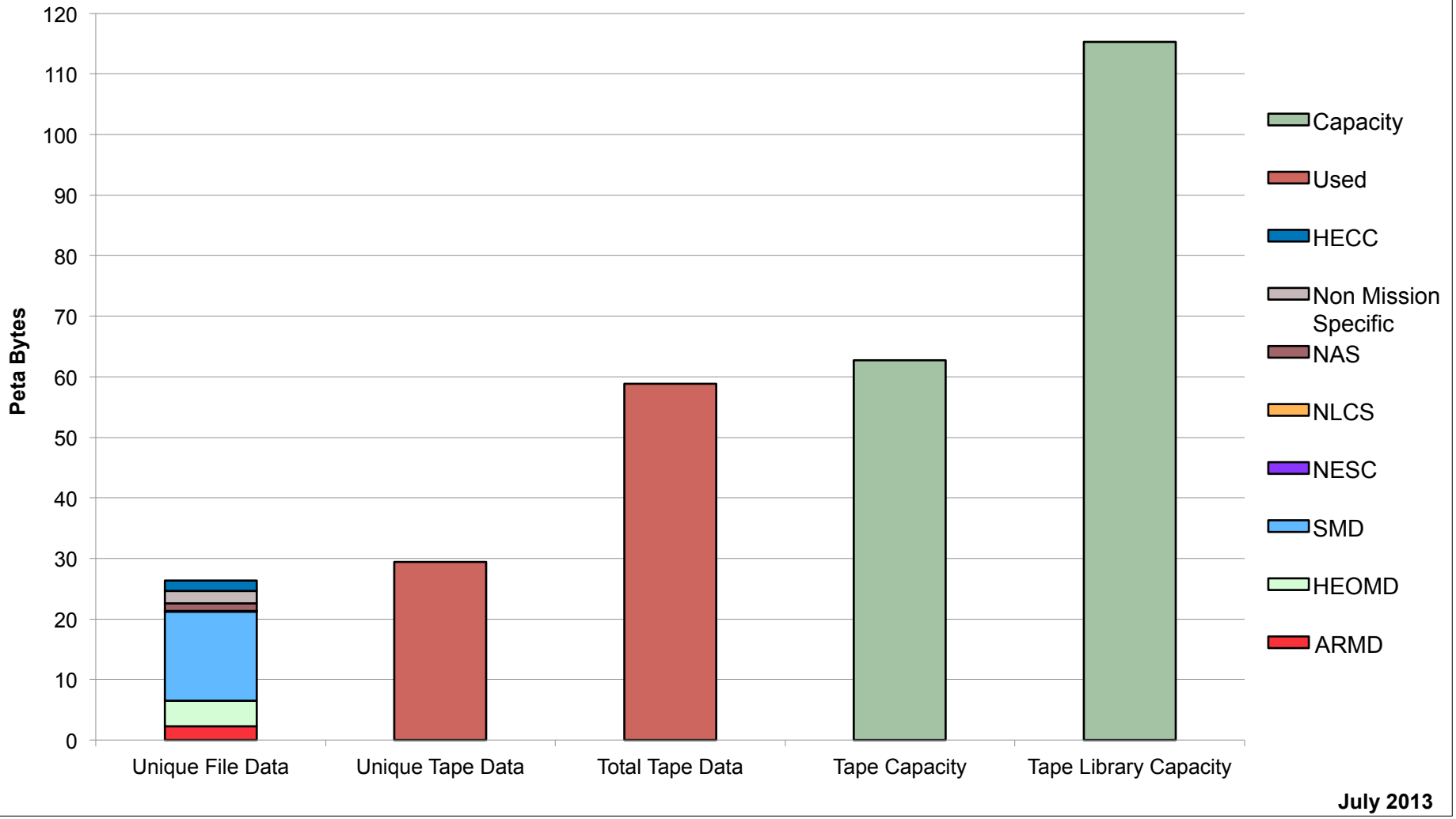




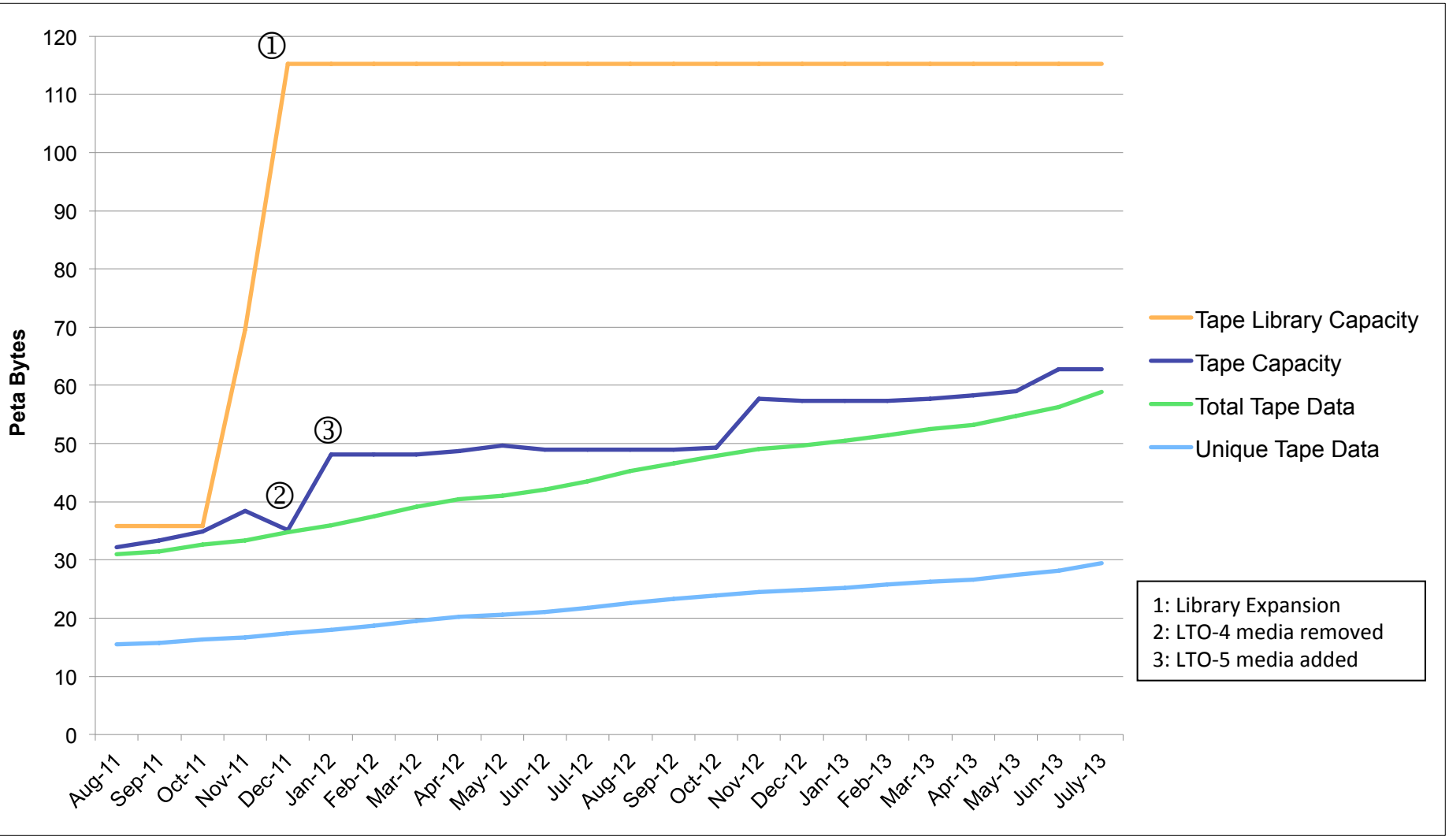


① ARMD Westmere racks added ② 28 Harpertown racks removed ③ 24 Sandy Bridge racks added
④ Columbia 21, 23, and 24 removed; Endeavour 2 added ⑤ Columbia 22 removed, Endeavour 1 added; ⑥ 32 Harpertown racks removed

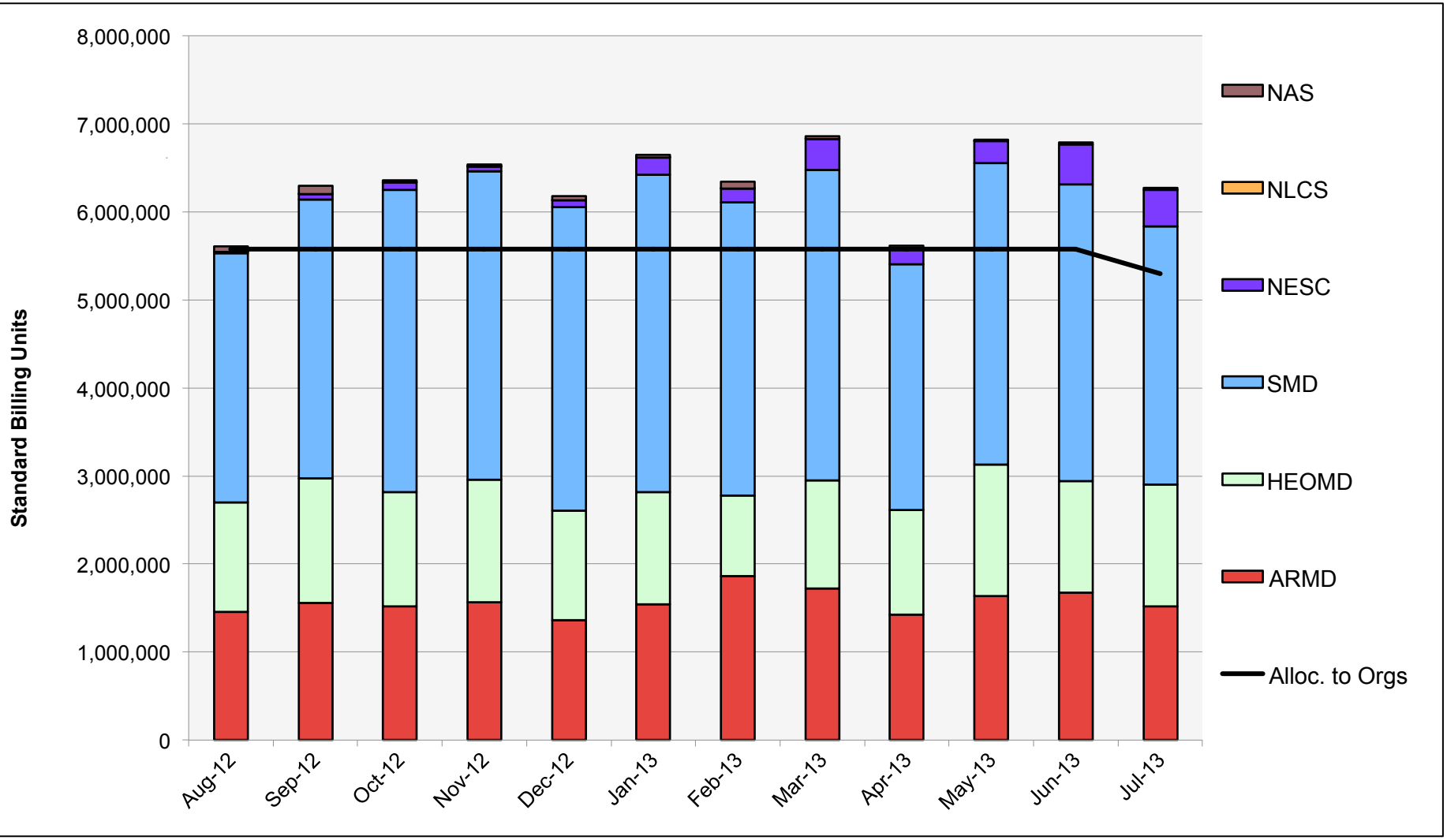
Tape Archive Status (July 2013)



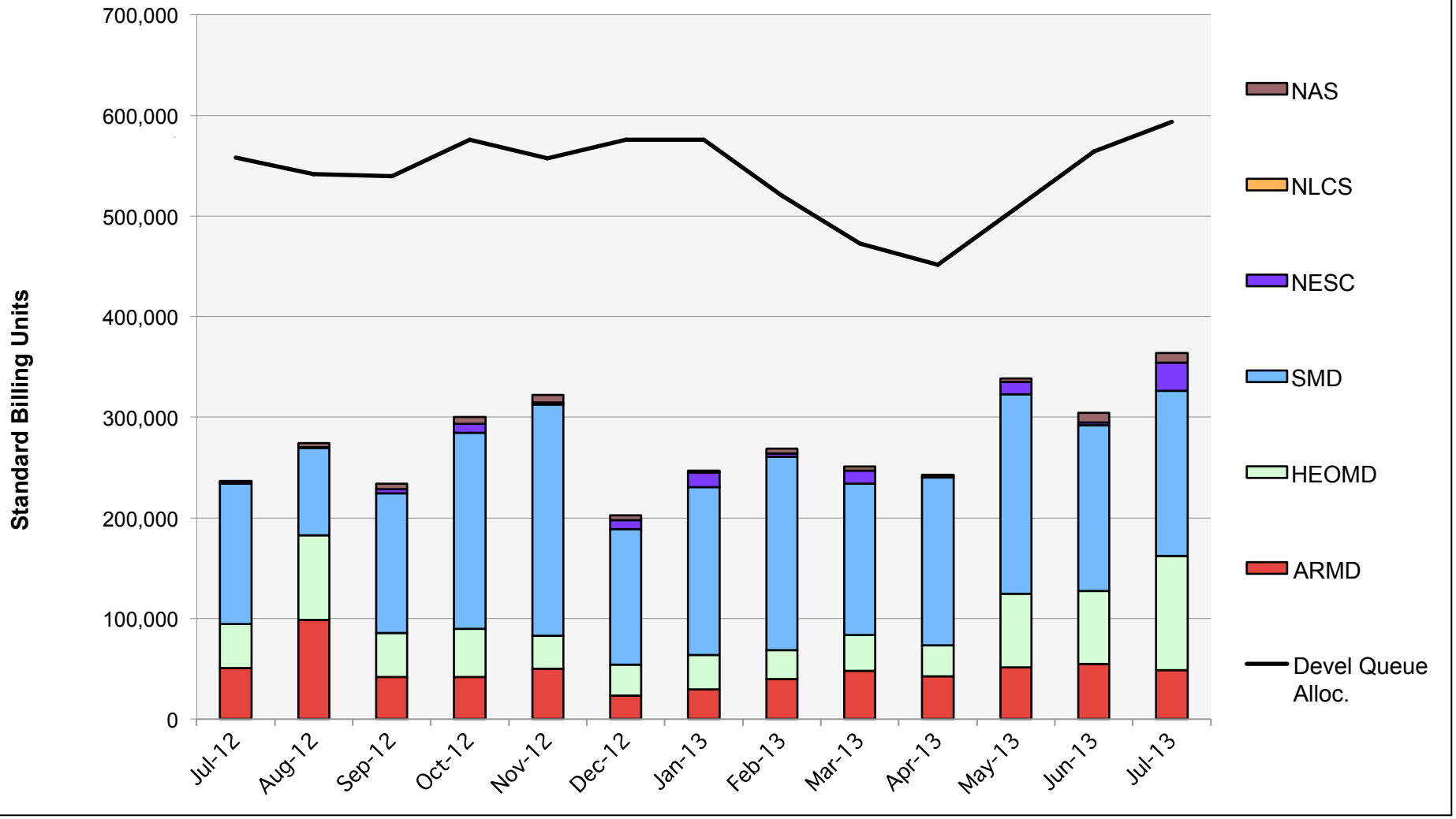
Tape Archive Status



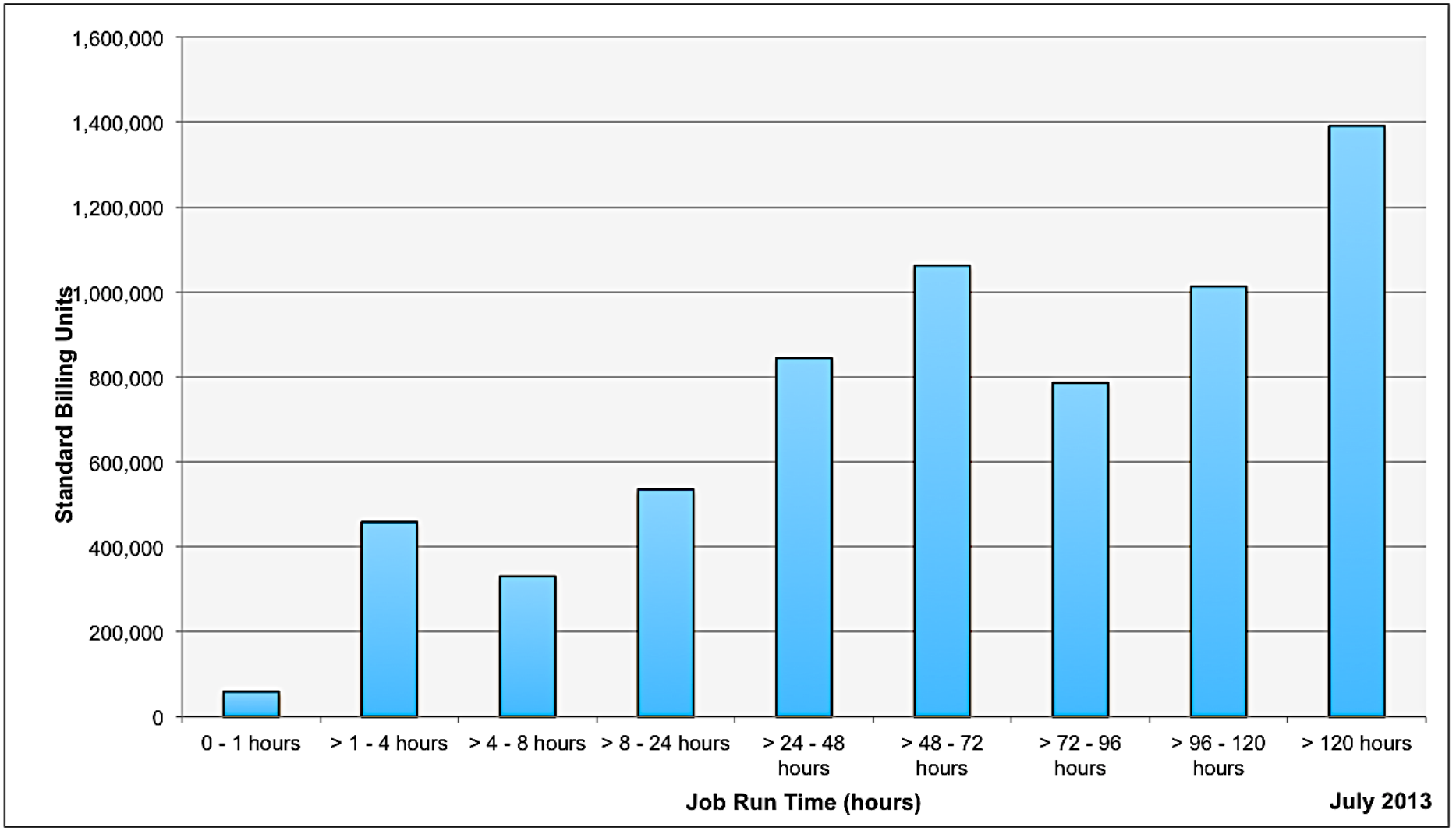
Pleiades:
SBUs Reported, Normalized to 30-Day Month



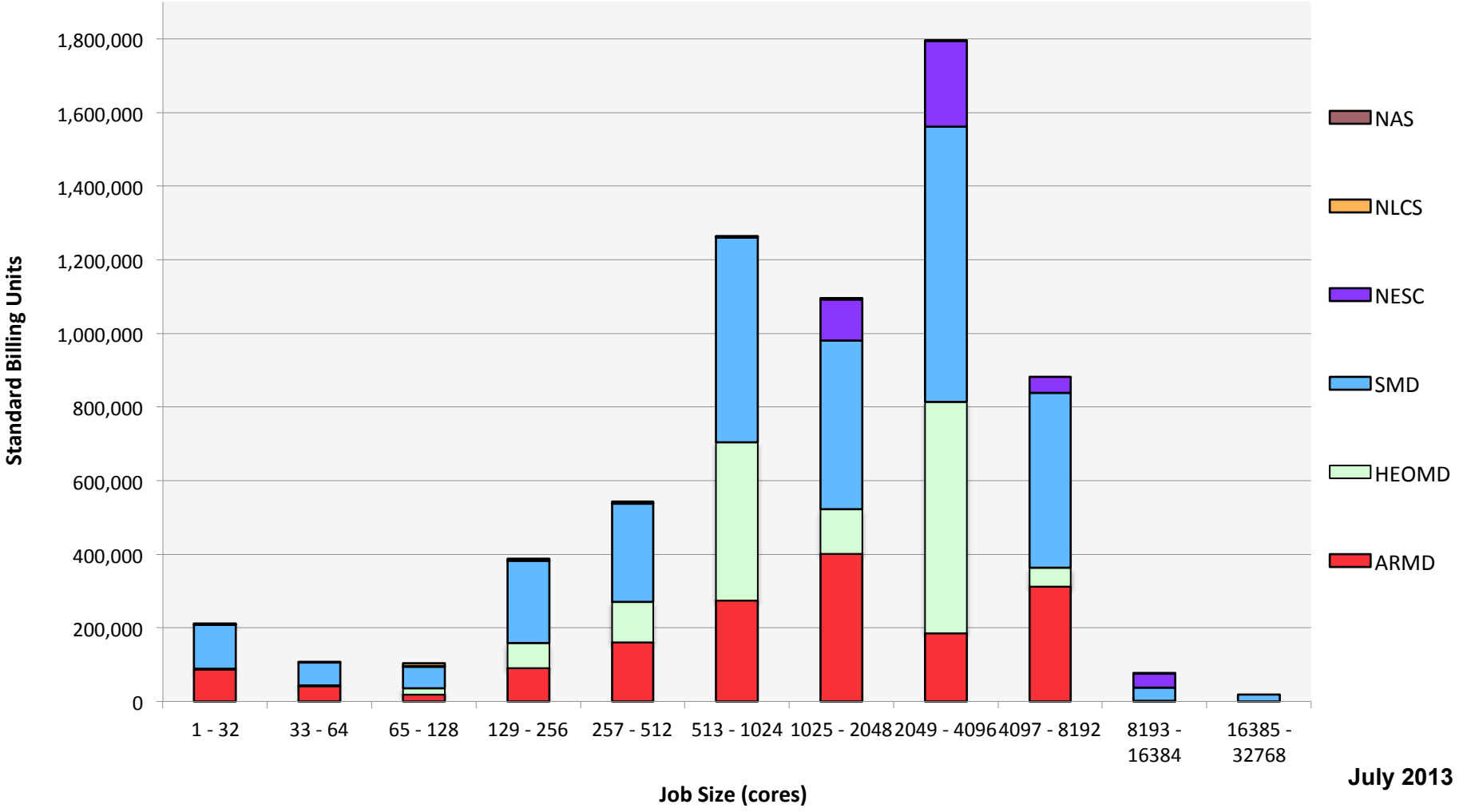
Pleiades:
Devel Queue Utilization



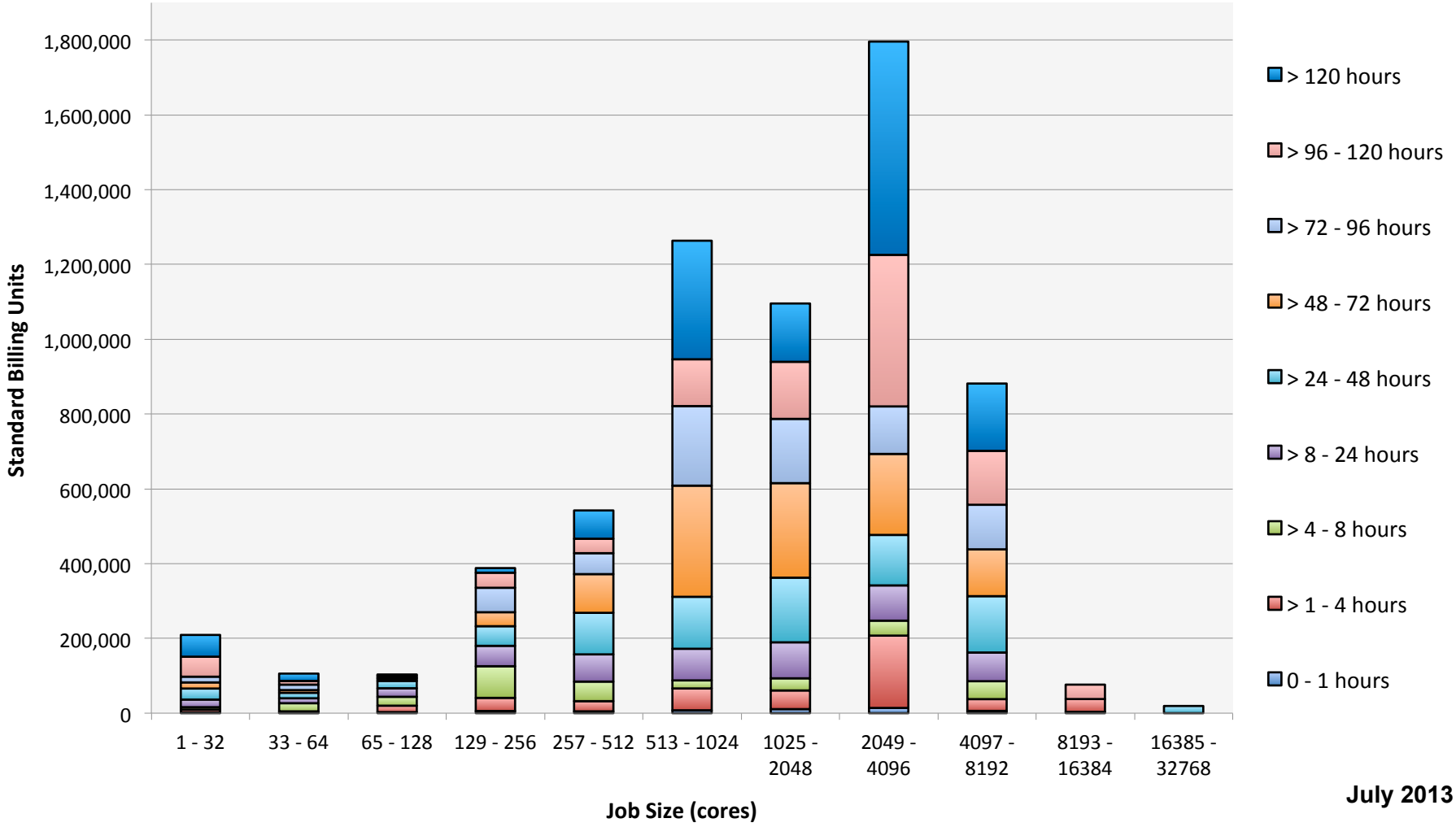
Pleiades:
Monthly Utilization by Job Length



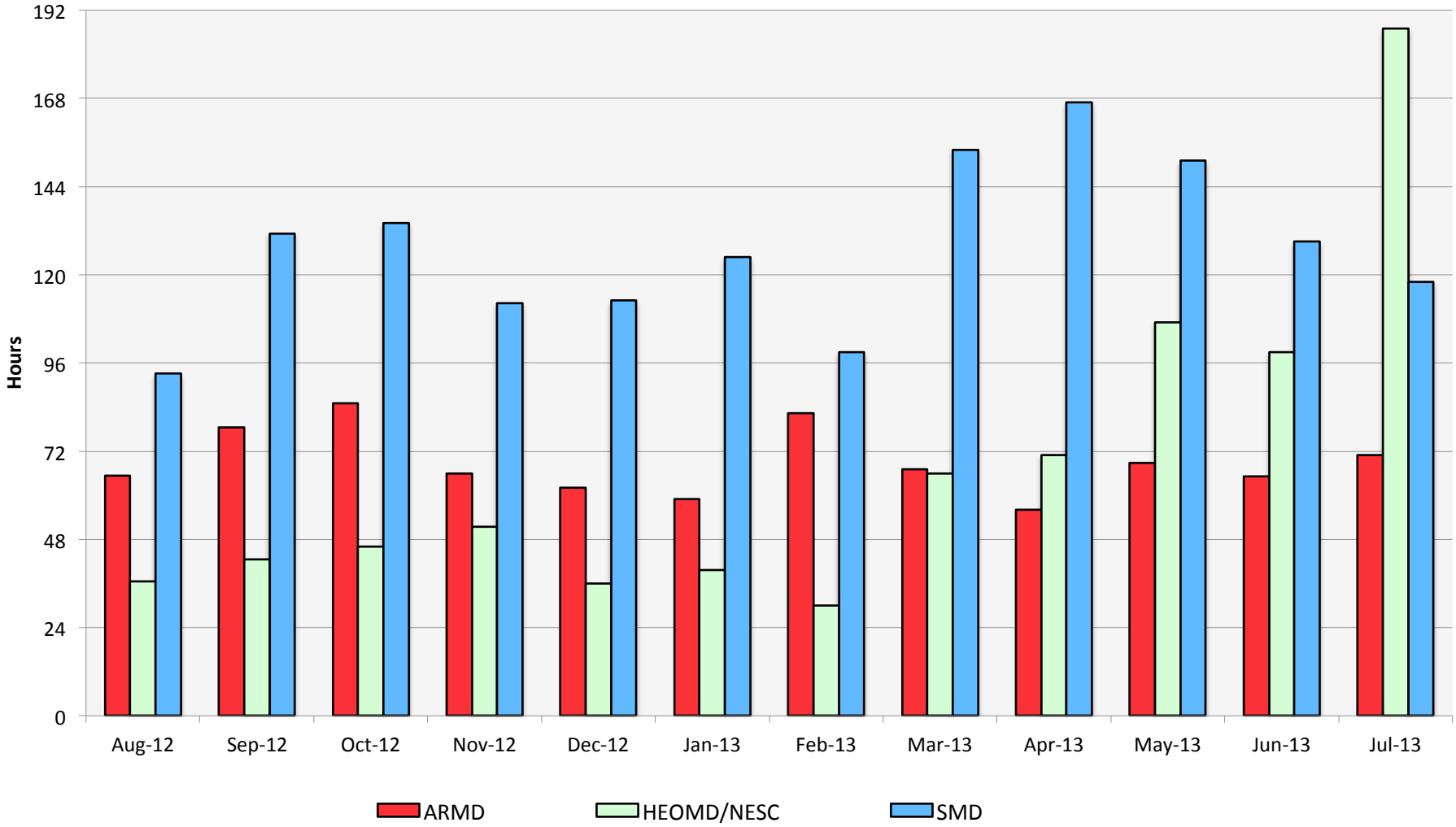
Pleiades:
Monthly Utilization by Size and Mission



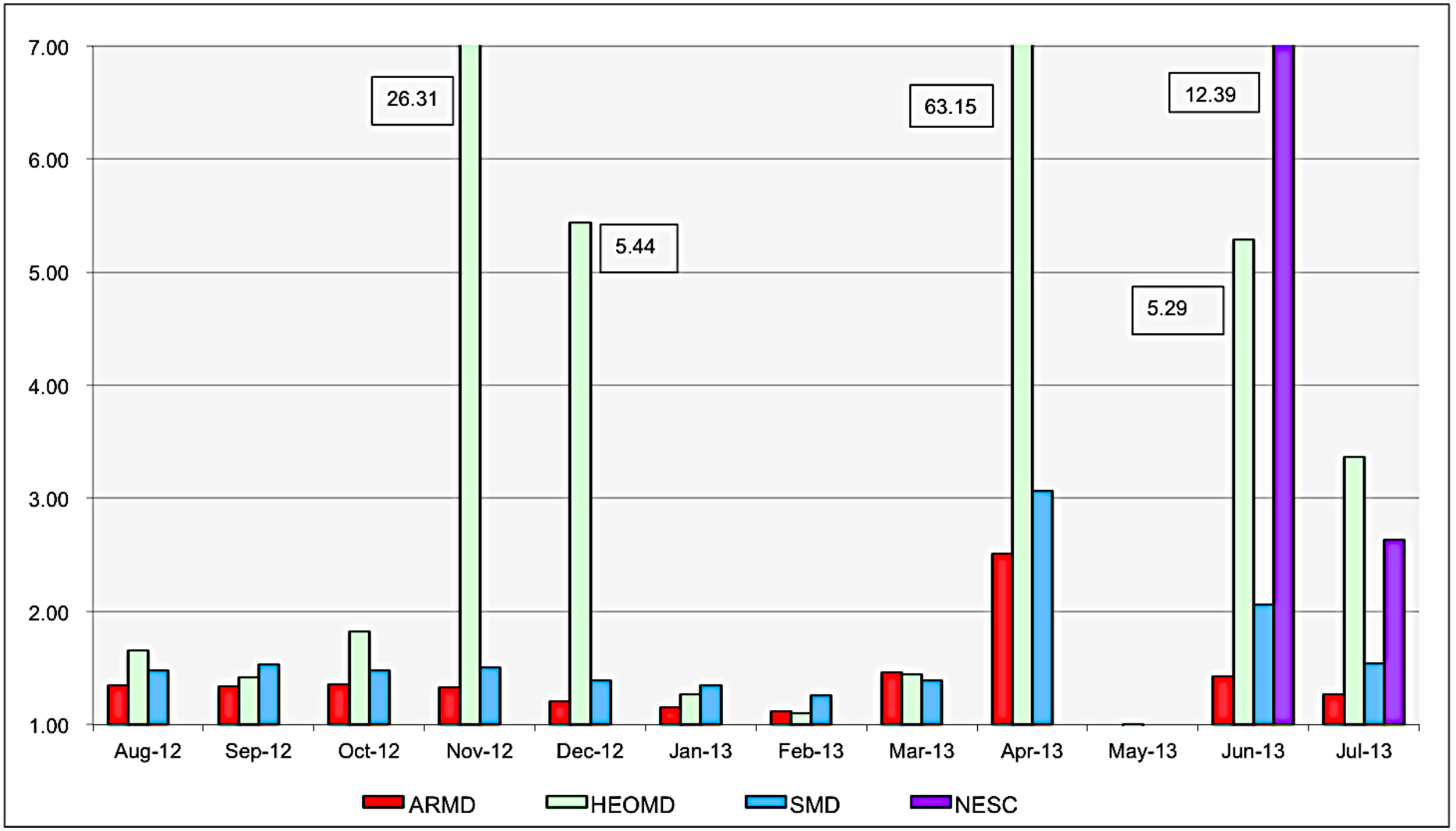
Pleiades:
Monthly Utilization by Size and Length



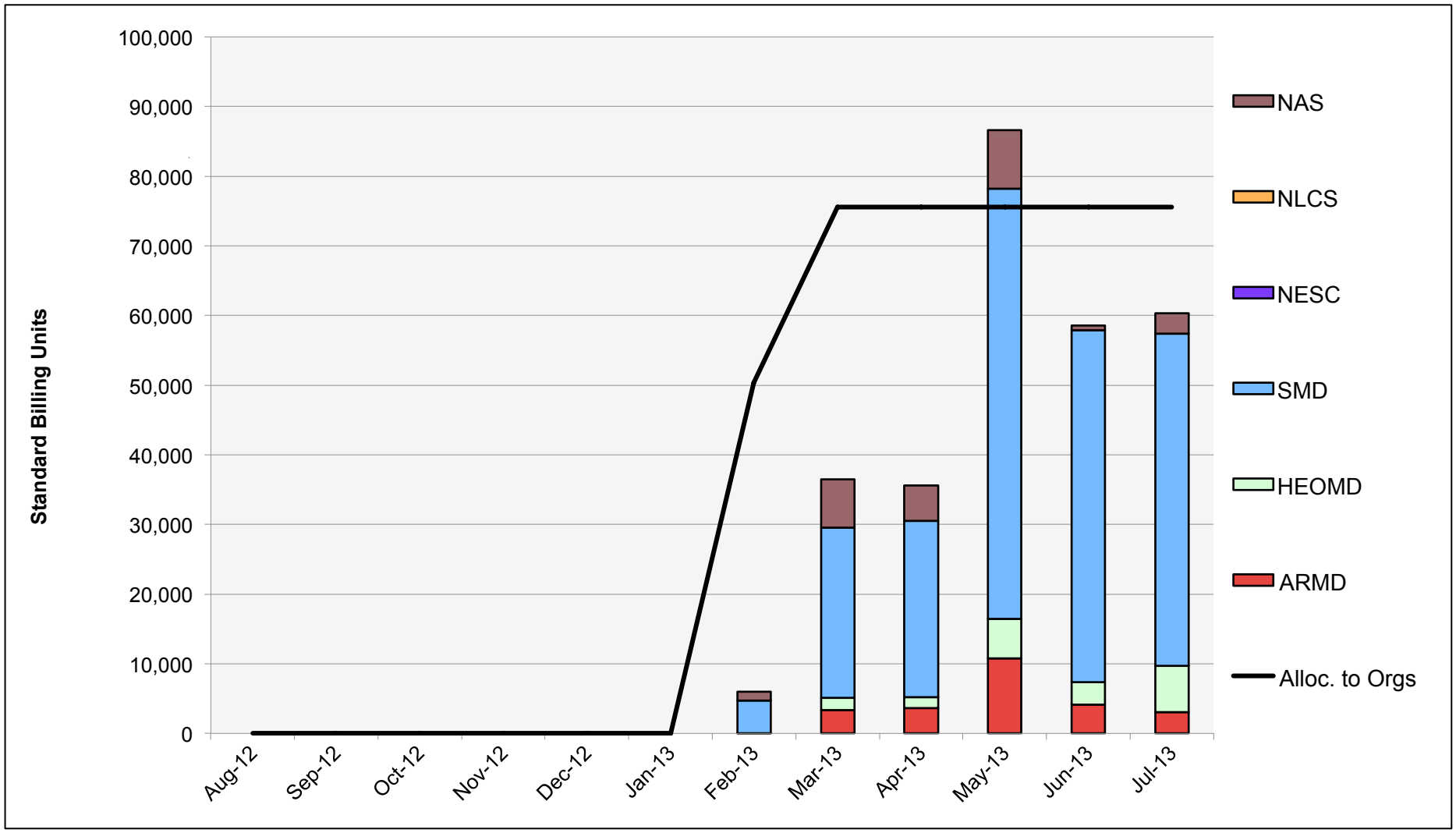
Pleiades:
Average Time to Clear All Jobs



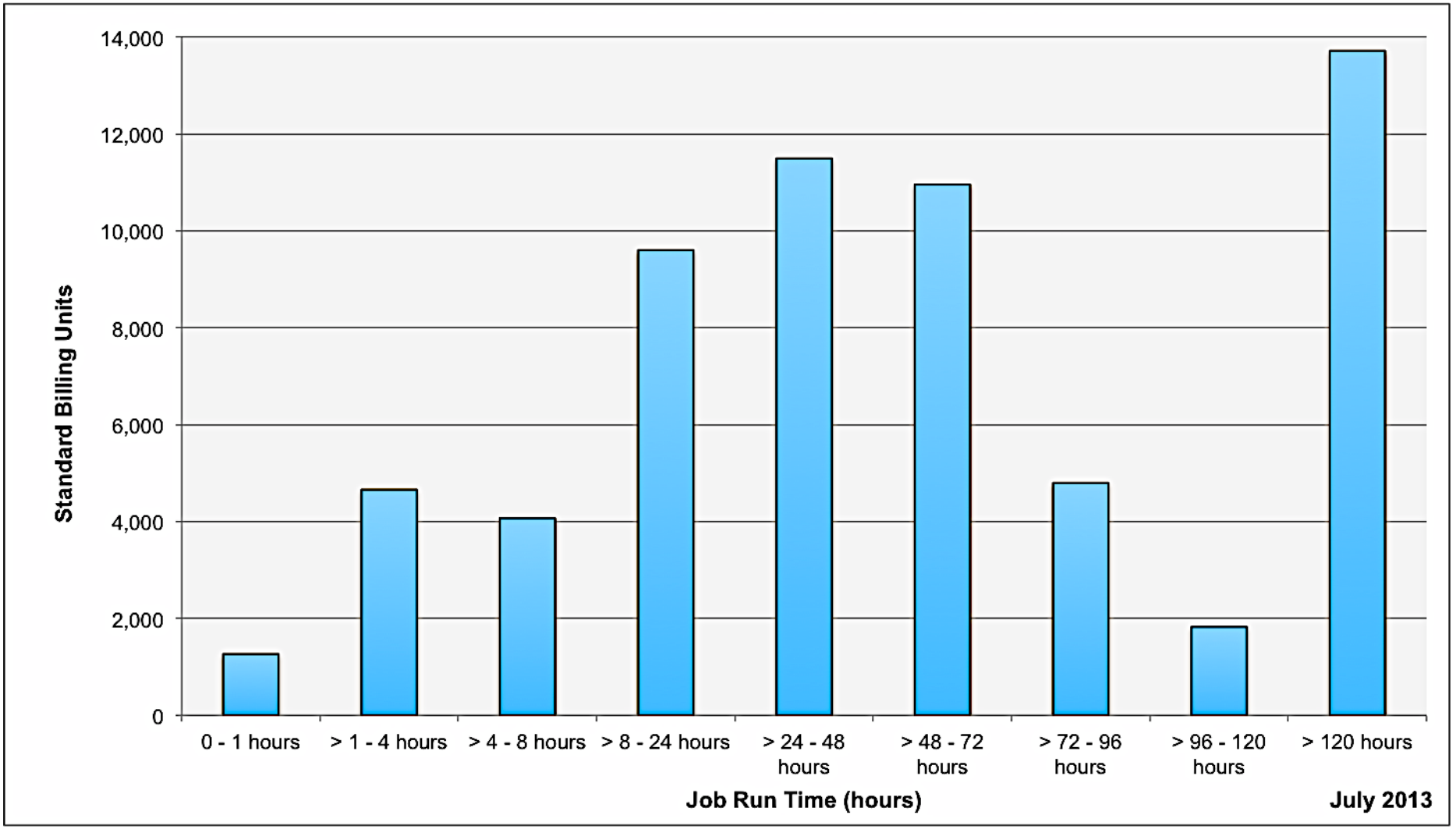
Pleiades:
Average Expansion Factor



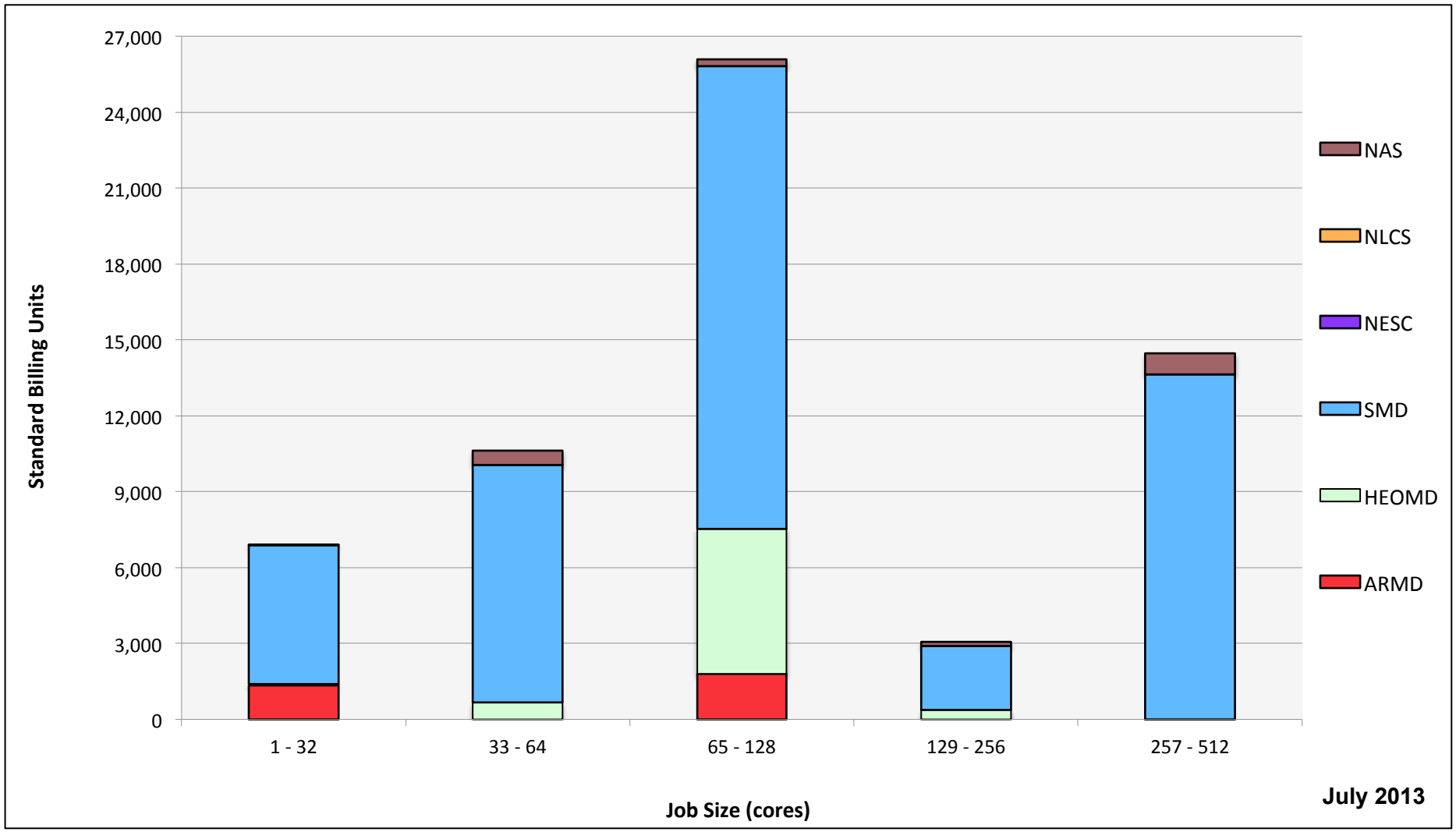
Endeavour:
SBUs Reported, Normalized to 30-Day Month



Endeavour:
Monthly Utilization by Job Length



Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Monthly Utilization by Size and Mission