Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

February 10, 2014

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Upgrade to Tape Libraries Paves Way for Growth and Future Improvements

- HECC staff upgraded the tape libraries on the secondary computing floor, in NASA Ames' building N233A, to prepare for future growth.
- Three tape libraries were upgraded with new robotics that will enable HECC to take advantage of future improvements to tape library technology resulting in faster tape media load times and providing a path for further growth of the library infrastructure.
- The staff worked with the vendor (Spectra Logic) upgrading the tape libraries over a three-week period without impact to users. The practice of maintaining two redundant copies of data on our separate computer floors for availability and reliability enabled the transparent upgrade on the archive infrastructure.
- Upgrades to the tape libraries on the primary computer floor in building N258 are in progress and will be completed by early February.

Mission Impact: Enhancing the tape library infrastructure for NASA's largest supercomputing facility enables HECC to keep pace with the ever-increasing data storage requirements of science and engineering users supporting agency missions.

The data archive systems located in HECC's secondary computing facility currently write a total of about 2.3 petabytes of data each month.

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.

HECC Resolves InfiniBand Issues to Improve Large-Scale Simulation Runs on Pleiades

- HECC systems and network engineers, working with SGI and Mellanox counterparts, resolved several InfiniBand (IB) issues that prevented the high-resolution MIT General Circulation Model (MITgcm) code from running at large scales on Pleiades.
  - The HECC team identified and resolved IB fabric cabling issues that were impacting network stability.
  - SGI staff provided an updated version of their MPI library to improve the efficiency of IB packet retransmissions for large-scale jobs.
- These system improvements, combined with modifications to MITgcm (see slide 5) enabled the code to successfully run on 35,000 cores, at an unprecedented global resolution of 1/48°.

Mission Impact: HECC's improvements to the Pleiades InfiniBand network have enabled researchers to run large-scale global Earth science simulations at very high resolutions.

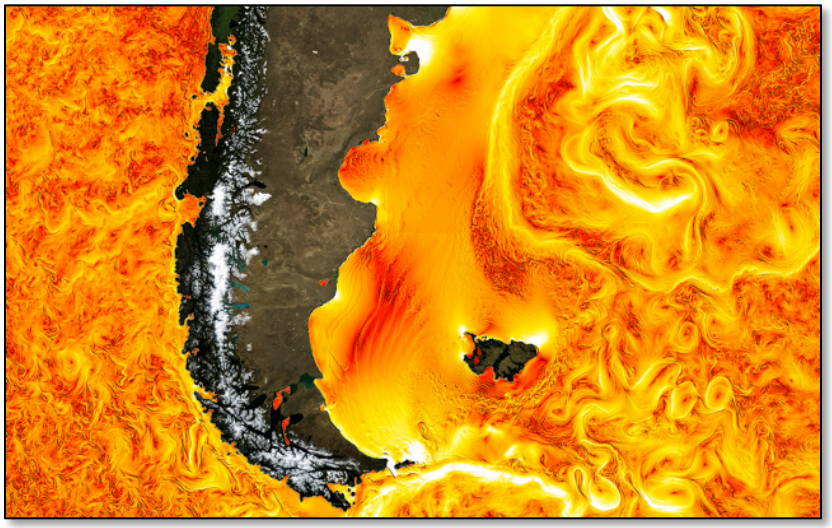
The Pleiades supercomputer is the largest InfiniBand (IB) cluster in the world, with over 65 miles of IB cabling.

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 Sciences Corp.

HECC Teams Optimize Efficiency of High-Resolution Ocean Modeling Code MITgcm

- HECC visualization experts successfully optimized the I/O performance of a widely used ocean modeling code, the Massachusetts Institute of Technology (MIT) General Circulation Model (MITgcm), in response to a request from researchers at the consortium for Estimating the Circulation and Climate of the Ocean (ECCO).
- After analyzing the code's performance, the HECC team identified and implemented a solution that enabled the code to run with unprecedented resolution across 35,000 cores on the Pleiades supercomputer.
  - Extensive code modifications include new I/O processes that reorganize output data into a more streamlined format, and write data to disk while the computational portion of the code continues to run.
  - The modifications improved the code's sustained I/O to more than 10 gigabytes per second, providing the speed needed to achieve the high-resolution simulations.
  - The HECC systems team identified and resolved network and software issues that further enhanced code performance (see slide 4).
- The optimized code enabled the ECCO researchers to run global ocean simulations with a resolution of 1/48° (48 grid points per degree of latitude and longitude)—the highest resolution ever achieved with MITgcm.

Mission Impact: High-resolution global ocean simulations are critical for researchers to understand how ocean, sea-ice, and atmospheric systems interact and evolve. HECC's successful MITgcm efforts lead the way for other codes to achieve similar results.



Snapshot of a global MITgcm simulation run by ECCO researchers, showing a small portion of the ocean's flowfield near the tip of South America. Chris Henze, NASA/Ames

POCs: Chris Henze, chris.henze@nasa.gov, (650) 604-3959, NASA Advanced Supercomputing Division; Bron Nelson, bron.c.nelson@nasa.gov, (650) 604-4329, NASA Advanced Supercomputing Division, Computer Sciences Corp.

"myNAS" iOS Application for Mobile Job Monitoring Released for Beta Testing

- HECC's Application Performance & Productivity, Publications & Media, and Tools teams joined forces to develop the "myNAS" app for iOS devices providing a mobile job monitoring capability for HECC users.
- In addition to showing the status of submitted jobs and computing resources, the app can notify users when jobs change state or produce output. Users can also view output files (text or images) on the device by including a simple command in the job submission script.
- The app provides information to users through three HECC-developed resources: the mobile application, an agent gathering data inside the secure enclave, and a special-purpose web server that processes and sends the data to the app.
- For secure remote access to NASA networks, myNAS uses the Secure Mobile Access Point (SMAP) gateway and framework provided by the NASA Center for Internal Mobile Applications (CIMA). The app works well over either cellular data or Wi-Fi networks.
- The beta version, currently available from the website apps.test.nasa.gov, is being tested by a small group of users. To download and install the application, users must first authenticate using their NASA AUID and LaunchPad password. A production release should be available to all HECC users by the end of March.

Mission Impact: By providing mobile remote access to the supercomputing environment, HECC is improving the productivity of NASA users who want to monitor jobs or availability of resources.

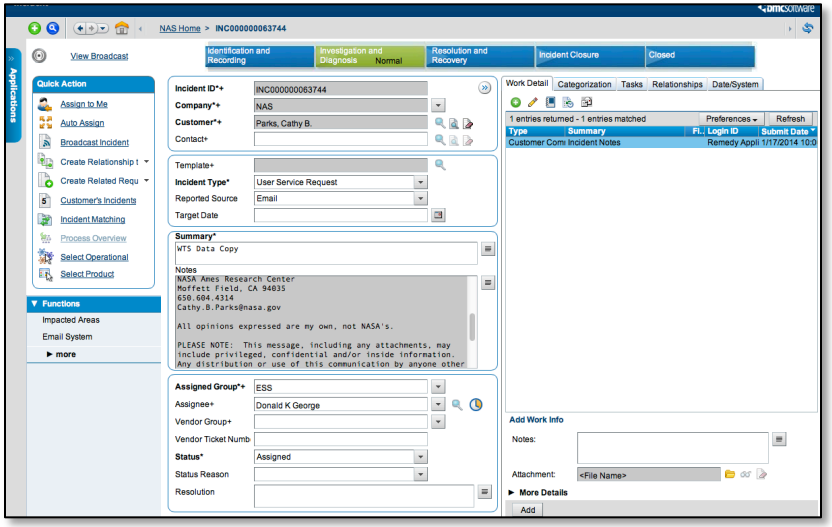
The initial functions of the myNAS app—job monitoring, resource usage, and user news articles—are available via tabs. An additional tab for settings allows customization of app behavior. Future enhancements (based on user feedback) may include such features as file system quota information, allocation information, and help ticket status.

POCs: Robert Hood, robert.hood@nasa.gov, (650) 604-0740; John Hardman, john.hardman@nasa.gov, (650) 604-0417; NASA Advanced Supercomputing Division, Computer Sciences Corp.

Remedy Action Request System Upgraded and Customized for HECC Users

- The Remedy Action Request System used to manage HECC customer calls, system bugs, assets, outages, and Control Room logs, was upgraded to version 8.1, the latest Remedy version. Remedy's Oracle database is integrated into internal HECC/NAS websites to provide status on activities and assets.
- The upgrade, which occurred over several months, also included improvements to HECC customizations; updates to the database tables and the scripts/web sites/tools using these tables; system and user testing; and documentation updates.
- Features associated with the upgrade include:
  - Local customizations moved to overlays, which will improve ease of future upgrades.
  - Support for the Internet Protocol version 6 (IPv6).
  - The ability to schedule and publish reports.
  - Reduced use of floating licenses for the Overview Console (used for monitoring group workload).
  - An improved integration tool for connecting to external data sources.
  - The ability for end users to customize (add/remove) viewable columns in displays.
- The upgrade makes Remedy easier to use, and allows HECC support staff to improve service management for NASA users.

Mission Impact: The Remedy Action Request System, a tool for managing customer calls and providing status of system events and activities, allows HECC to provide improved service quality to NASA's supercomputing users.



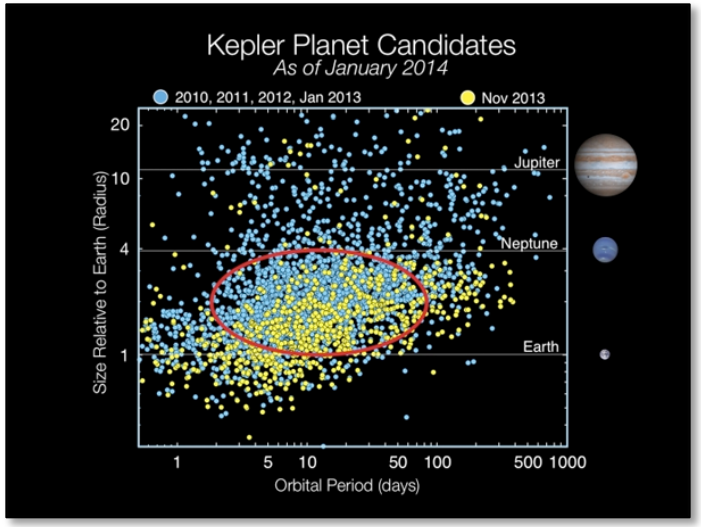
Sample window of a Remedy customer ticket.

POCs: Aqeel Rehman, mohammad.a.rehman@nasa.gov, (650) 604-4566, NASA Advanced Supercomputing (NAS) Division, Intrinsyx; Mi Young Koo, mi.y.koo@nasa.gov, (650) 604-4528, NAS Division, Computer Sciences Corp.

HECC Resources Play Increasingly Critical Role in Kepler's Data-Centric Mission *

- The Kepler spacecraft can no longer attain the pointing precision necessary to search for planets in the star field of the primary mission. Now, a major effort is underway to completely analyze all the data that Kepler has collected, in an effort to shed light on any undiscovered planets still "hiding" in the data.
- Among the important discoveries enabled by Kepler and Pleiades over the past year:
  - The number of Earth-sized planet candidates increased 43%, and the number of super Earth-sized planets increased 21%—with over 1,000 planetary candidates close to the size of Earth.
  - At least one in six stars has an Earth-sized planet.
  - Four planetary candidates in the habitable zone that are less than twice the size of Earth—with one orbiting a Sun-like star.
  - 43% of planet candidates are in multiple-planet systems, some with five or more planets.
- Pleiades enables sophisticated and computationally expensive processes—data calibration, photometric analysis, pre-search data conditioning, transiting planet search, subsequent data validation, and searches for multiple planet systems—to be run in a just a few days.

Mission Impact: NASA's Pleiades supercomputer, along with code optimization services provided through HECC, enable rapid turnaround of both the computationally intensive Kepler planetary transit searches and analysis of planet candidates.



More than three-quarters of the planet candidates discovered by NASA's Kepler spacecraft have sizes ranging between that of Earth and that of Neptune, which is nearly four times as big as Earth. Such planets dominate the galactic census but are not represented in our own solar system.

POCs: Shawn Seader, shawn.seader@nasa.gov, (650) 604-4241, SETI Institute; Todd Klaus, todd.klaus@nasa.gov, (650) 604-2576, Lockheed Martin, NASA Ames Research Center

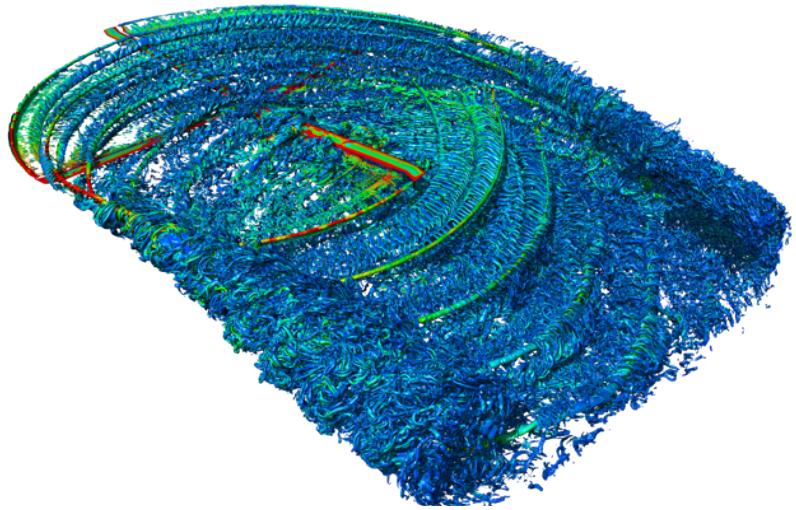
** HECC provided supercomputing resources and services in support of this work*

Pleiades Enables Advanced CFD Simulations for More Accurate Rotorcraft Modeling *

- Performing accurate aerodynamic analyses of rotorcraft is very challenging. Researchers in the NAS Division at NASA Ames are running high-resolution computational fluid dynamics (CFD) simulations on Pleiades to achieve significant improvements in rotorcraft modeling.
- Key accomplishments include:
  - Improved prediction accuracy for the figure of merit (the primary hover performance parameter) from 2% error to 0.2% error, using fifth-order spatial accuracy and detached eddy simulation turbulence modeling.
  - A 50% accuracy improvement (compared to 2007 state-of-the-art models) in predicting the normal force and pitching moment of a Blackhawk helicopter rotor in forward flight.
  - Increased prediction accuracy for vortex core sizes (from 60% error to 4% error) using adaptive mesh refinement.
  - Computed vortex core strengths and locations compared very well with experimental particle image velocimetry measurements.
- These improvements are being applied to develop new rotorcraft concepts, optimize rotor blade shapes, and improve flight performance.

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

Mission Impact: Enabled by HECC supercomputing and storage resources, researchers are improving state-of-the-art simulation capabilities for NASA's Fundamental Aeronautics Program.



Snapshot from a CFD simulation of a Black Hawk helicopter rotor in forward flight. Dynamic adaptive mesh refinements were used to capture the rotor wake with grids four times finer than the baseline resolution. Vortices and turbulent structures are colored by vorticity (red high, blue low). Jasim Ahmad, Neal Chaderjian, NASA/Ames

POC: Neal Chaderjian, neal.chaderjian@nasa.gov, (650) 604-4472, NASA Advanced Supercomputing Division

HECC Facility Hosts Visitors and Tours in January 2014

- HECC hosted three tour groups in January; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors this month included:
  - Brian Mengwasser and Richard Pang from the Society of European Satellites, Luxembourg, who visited Ames to meet with managers and senior staff. The visitors received an overview of large-dataset projects being run on Pleiades, and received a tour of the NAS facility, including the quantum computer room. They also attended mission overviews for Kepler, LADEE, IRIS, and the International Space Station.
  - A group of students participating in the Stanford Student Space Initiative visited the NAS Facility as part of their NASA Ames tour. Some of these students will be part of the Ames summer internship program.
  - Bradley Hill from NASA Kennedy Space Flight Center's Ground Systems Development and Operations group, toured the NAS Facility with members from NASA Ames Space Technology Division.

In January, visitors received a tour of NASA Advanced Supercomputing (NAS) facility, including the room that houses the D-Wave Two quantum computer.

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

Papers and Presentations

- "**Green Leaf Area and Fraction of Photosynthetically Active Radiation Absorbed by Vegetation**," S. Ganguly, R. R. Nemani, et al., Biophysical Applications of Satellite Remote Sensing (Springer), pp. 43-61, January 2014. *
  http://link.springer.com/chapter/10.1007/978-3-642-25047-7_2
- "**Alfven Wave Turbulence as a Coronal Heating Mechanism: Simultaneously Predicting the Heating Rate and the Wave-Induced Emission Line Broadening**," R. Oran, E. Landi, et al., arXiv:1401.0565 [astro-ph.SR], January 2, 2014. *
  http://arxiv.org/abs/1401.0565
- "**Observable Signatures of Classical T Tauri Stars Accreting in an Unstable Regime**," R. Kurosawa, M. M. Romanova, EPJ Web of Conferences, Physics at the Magnetospheric Boundary, vol. 64, January 8, 2014.*
  http://dx.doi.org/10.1051/epjconf/20136404004
- "**Boundary Between Stable and Unstable Regimes of Accretion**," A. A. Blinova, R. V. E. Lovelace, M. M. Romanova, EPJ Web of Conferences, Physics at the Magnetospheric Boundary, vol. 64, January 9, 2014. *
  http://dx.doi.org/10.1051/epjconf/20136405008
- "**The Atmospheric Circulation of the Super Earth GJ 1214b: Dependence on Composition and Metallicity**," T. Kataria, A. P. Showman, J. J. Fortney, M. S. Marley, R. S. Freedman, arXiv:1401.1898 [astro-ph.EP], January 9, 2014. *
  http://arxiv.org/abs/1401.1898

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

Papers and Presentations (cont.)

- **AIAA SciTech 2014**, National Harbor, MD, January 13-17, 2014.
  - "**Computational Assessment of the Boundary Layer Ingesting Nacelle Design of the D8 Aircraft**," S. A. Pandya, A. Uranga, A. Espitia, A. Huang. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-0907
  - "**CRUNCH CFD Calculations for HiLiftPW-2 with Discretization Error Predictions**," P. Cavallo. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-0916
  - "**Direct Numerical Simulations of High-Speed Turbulent Boundary Layers over Riblets**," L. Duan, M. M. Choudhari. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-0934
  - "**Multi-point Adjoint-Based Design of Tilt-Rotors in a Noninertial Reference Frame**," W. Jones, E. J. Nielsen, E. M. Lee-Rausch, C. W. Acree. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-0290
  - "**Evaluation of Mixing-Limited Quasi-Global Wind-US Model for HIFire 2 Flowpath**," M. R. Borghi, W. A. Engblom, N. J. Gerogiadis. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-1160
  - "**Turbulence Model Effects on RANS Simulations of the HIFiRE Flight 2 Ground Test Configurations**," N. J. Georgiadis, M. R. Mankbadi, M. A. Vyas. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-0624
  - "**The LAVA Computational Fluid Dynamics Solver**," C. Kiris, M. F. Barad, J. A. Housman, E. Sozer, C. Brehm, S. Moini-Yekta. *
    http://arc.aiaa.org/doi/abs/10.2514/6.2014-0070

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Papers and Presentations (cont.)

- **AIAA SciTech 2014** (cont.)
  - "**Review of Idealized Aircraft Wake Vortex Models**," N. N. Ahmad, F. Proctor. * *http://arc.aiaa.org/doi/abs/10.2514/6.2014-0927*
  - "**Cart3D Simulations for the First AIAA Sonic Boom Prediction Workshop**," M. Aftosmis, M. Nemec. * *http://arc.aiaa.org/doi/abs/10.2514/6.2014-0558*
  - "**Static Aeroelastic Analysis with an Inviscid Cartesian Method**," D. Rodriguez, M. J. Aftosmis, M. Nemec, S. C. Smith. * *http://arc.aiaa.org/doi/abs/10.2514/6.2014-0836*
  - "**Computational and Experimental Sonic Boom Assessment of Models for the First AIAA Sonic Boom Prediction Workshop**," S. Cliff, D. Durston, W. Chan, A. Elmiligui, S. Moini-Yekta, E. Sozer, J. Jensen. * *http://arc.aiaa.org/doi/abs/10.2514/6.2014-0560*
  - "**Gradient Calculation Methods on Arbitrary Polyhedral Unstructured Meshes for Cell-Centered CFD Solvers**," E. Sozer, C. Brehm, C. Kiris. * *http://arc.aiaa.org/doi/abs/10.2514/6.2014-1440*
  - "**NASA Embarks on the Quantum Computing Path**," R. Biswas (Invited Presentation).
- "**Simulations of Accretion onto Magnetized Stars: Results of 3D MHD Simulations and 3D Radiative Transfer**," M. Romanova, R. Kurosawa, arXiv:1401.4761 [astro-ph.SR], January 20, 2014. * *http://arxiv.org/abs/1401.4761*

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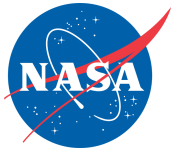
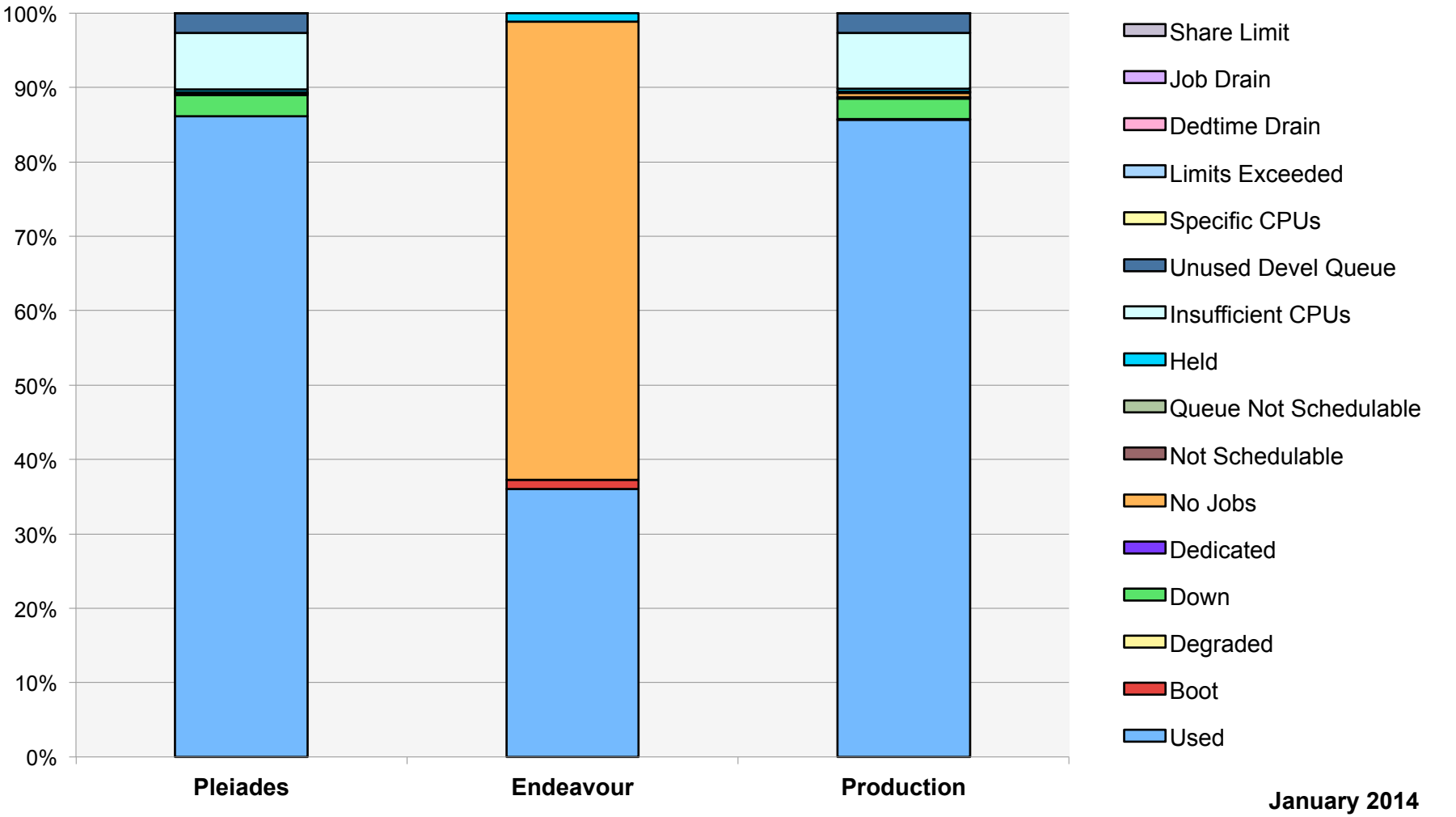
News and Events

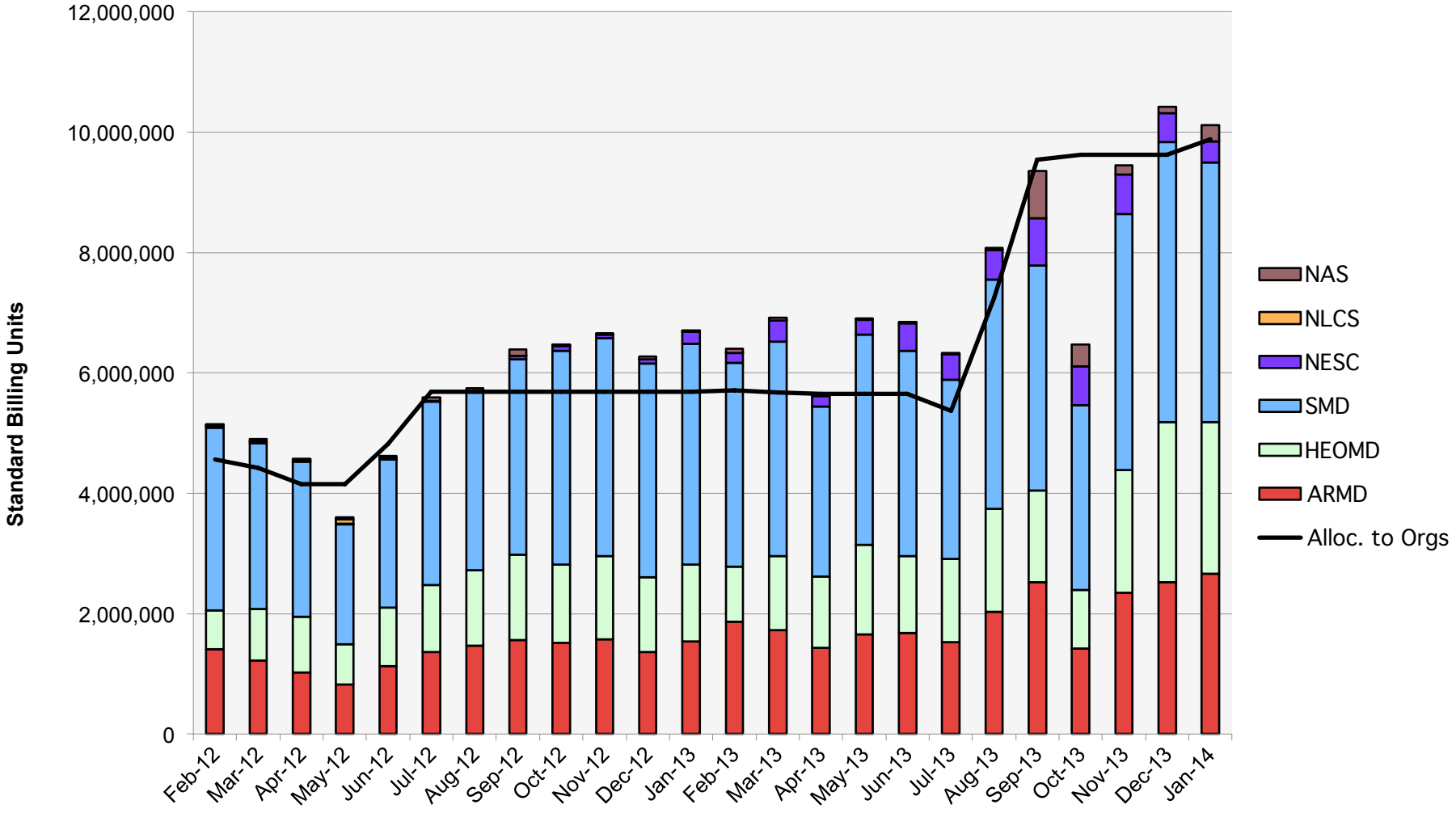


- **Big Data's Next Big Move,** *panel sponsored by Silicon Valley Business Roundtable and the University of California Santa Cruz,* Dr. Piyush Mehrotra, Chief, NAS Division, participated on a panel discussion presenting the big data challenges faced by NASA.
  http://svsbr.org/events/big-datas-next-big-move/
- **Forget 4K TV – Check out the NASA Hyperwall II**, *insideHPC,* January 11, 2014—Showcases the hyperwall-2 in a video demonstration with HECC Visualization Team Lead, Chris Henze.
  http://insidehpc.com/2014/01/11/forget-4k-tv-check-nasa-hyperwall-ii/
- **Quantum Computer Secrets**, *How It Works Daily,* January 19, 2014—Adam Millward talks to HECC Project Manager Rupak Biswas about the "ins and outs" of quantum computing.
  http://www.howitworksdaily.com/technology/quantum-computer-secrets/
- **The holy grail of aircraft noise reduction**, *International Science Grid This Week,* January 22, 2014—iSGTW's Amber Harmon interviews NASA scientist Mehdi Khorrami about work being done on the Pleiades supercomputer to reduce noise caused by aircraft during takeoff and landing.
  http://www.isgtw.org/feature/holy-grail-aircraft-noise-reduction
- **12 Incredible Accomplishments of NASA Ames in 2013**, *NASA Ames Press Release,* January 27, 2014—NASA Ames looks at some of the incredible accomplishments achieved at the center in 2013, including HECC-enabled Kepler planet discoveries and the partnership with USRA and Google to install a D-Wave Two quantum computer at the NASA Advanced Supercomputing facility.
  http://www.nasa.gov/ames/12-incredible-accomplishments-of-nasa-ames-in-2013

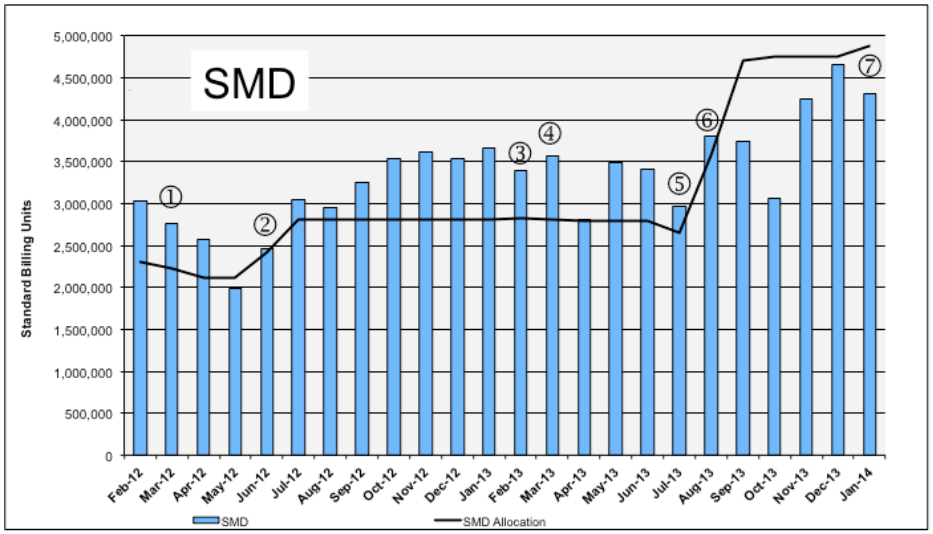
HECC Utilization

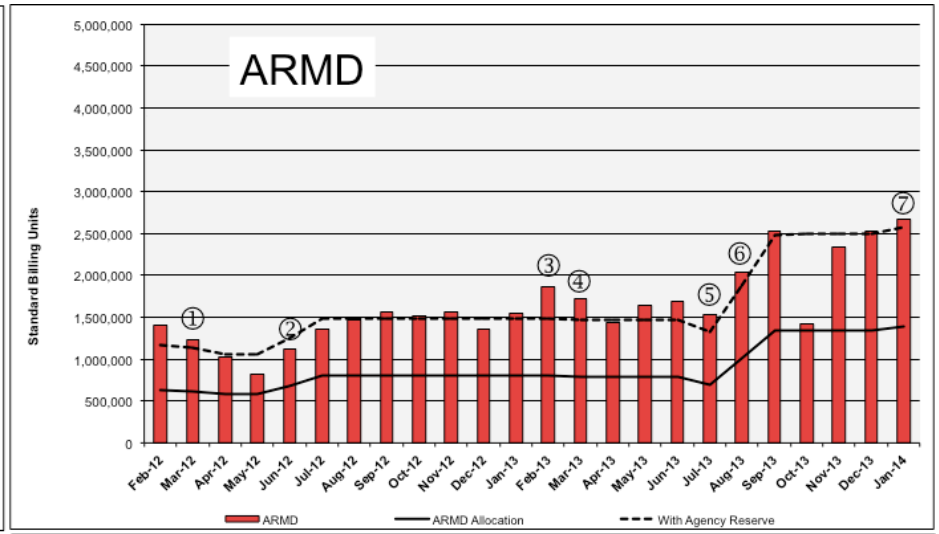


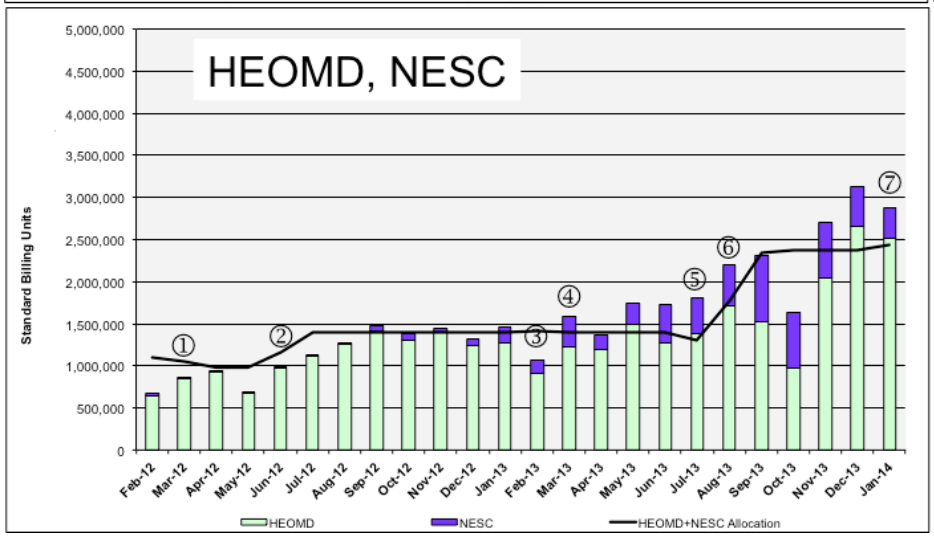
HECC Utilization
(Normalized to 30-Day Months)



HECC Utilization by Mission Directorate (Normalized to 30-Day Months)







① 28 Harpertown Racks retired

② 24 Sandy Bridge Racks added

③ Columbia 21, 23, and 24 retired, Endeavour 2 added

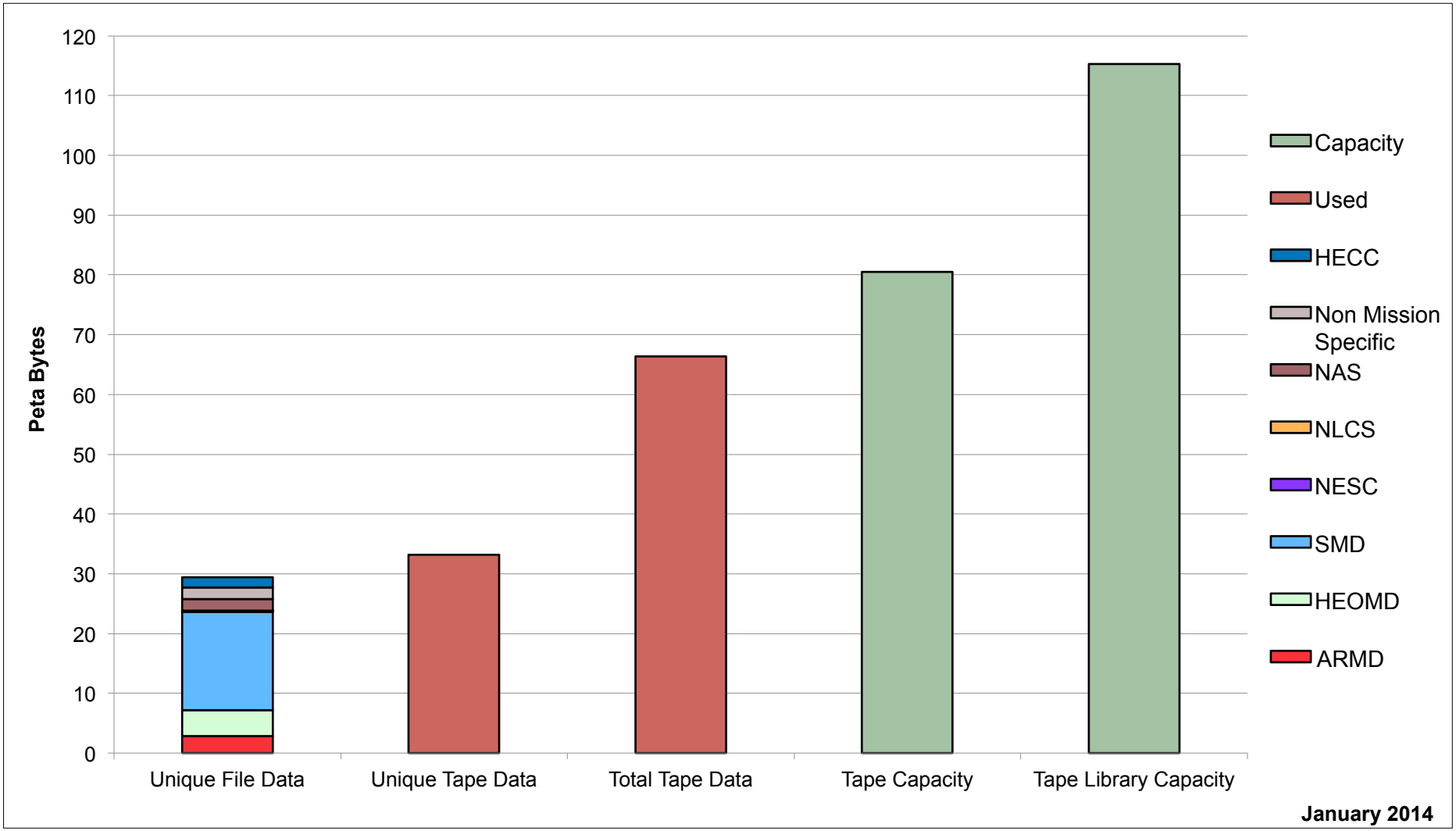
④ Columbia 22 retired; Endeavour 1 added

⑤ 32 Harpertown Racks retired

⑥ 32 Harpertown Racks retired; 46 Ivy Bridge Racks added

⑦ 6 Ivy Bridge Racks added; 20 Nehalem and 12 Westmere Racks Retired

Tape Archive Status



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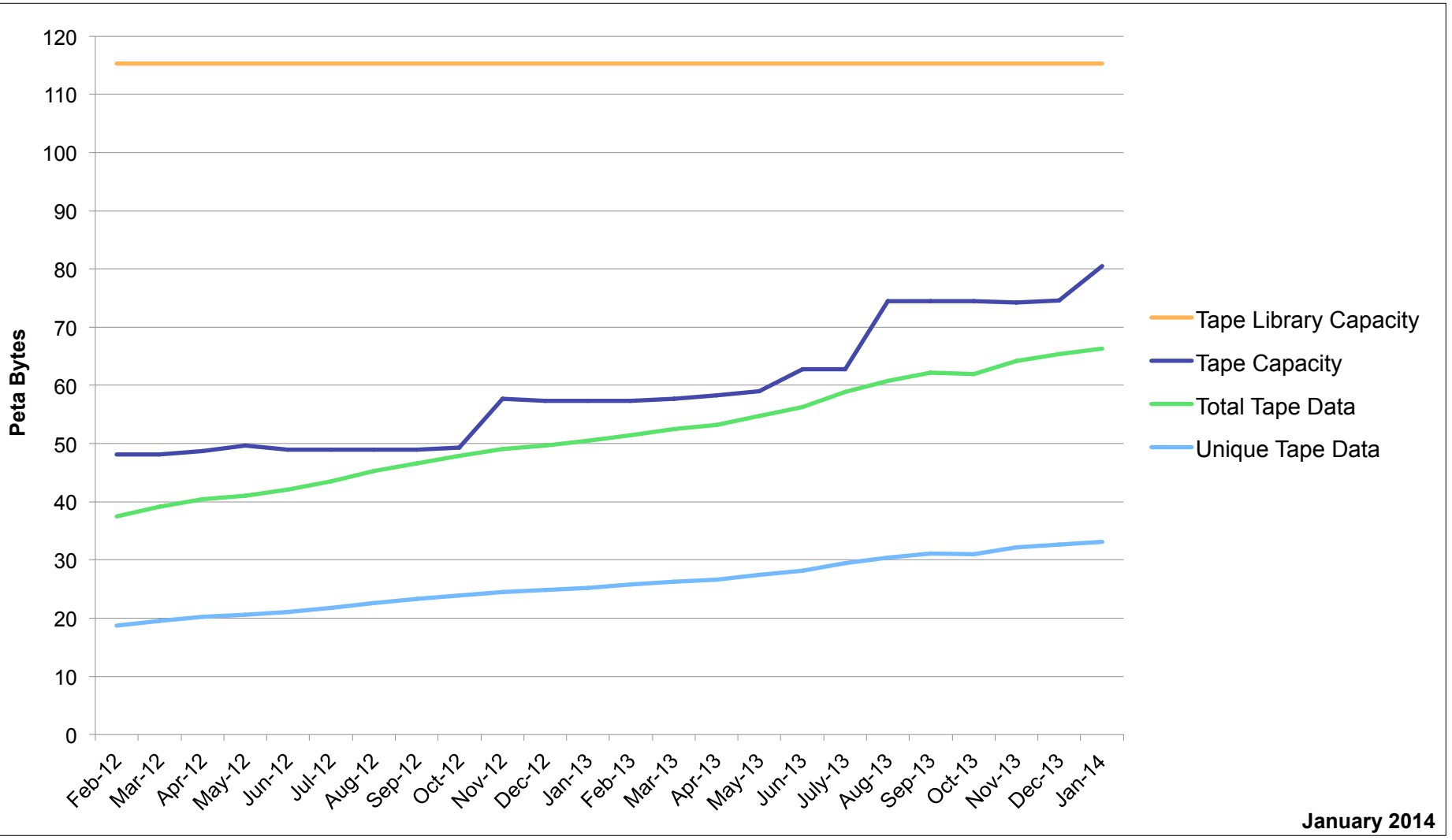
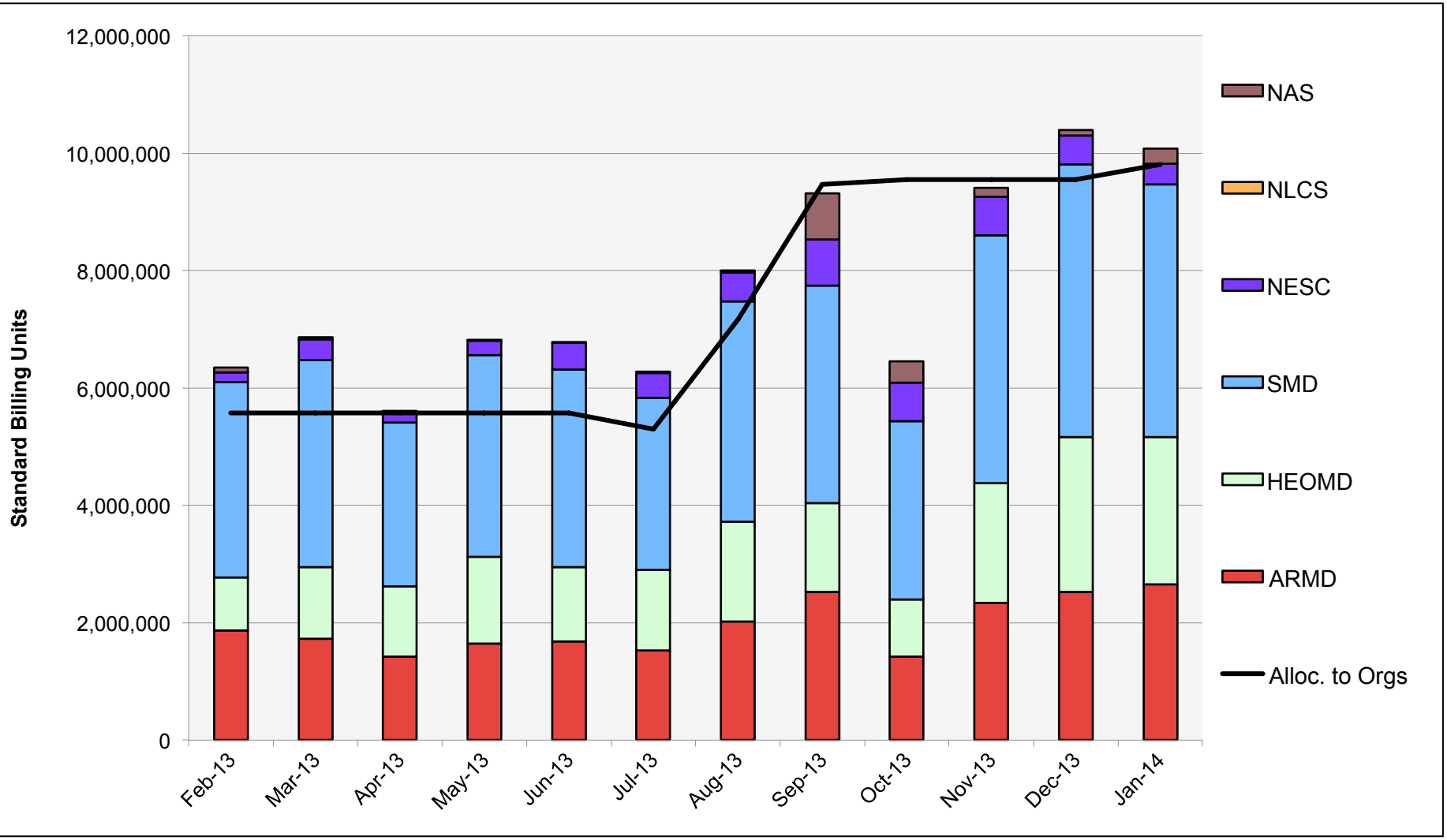
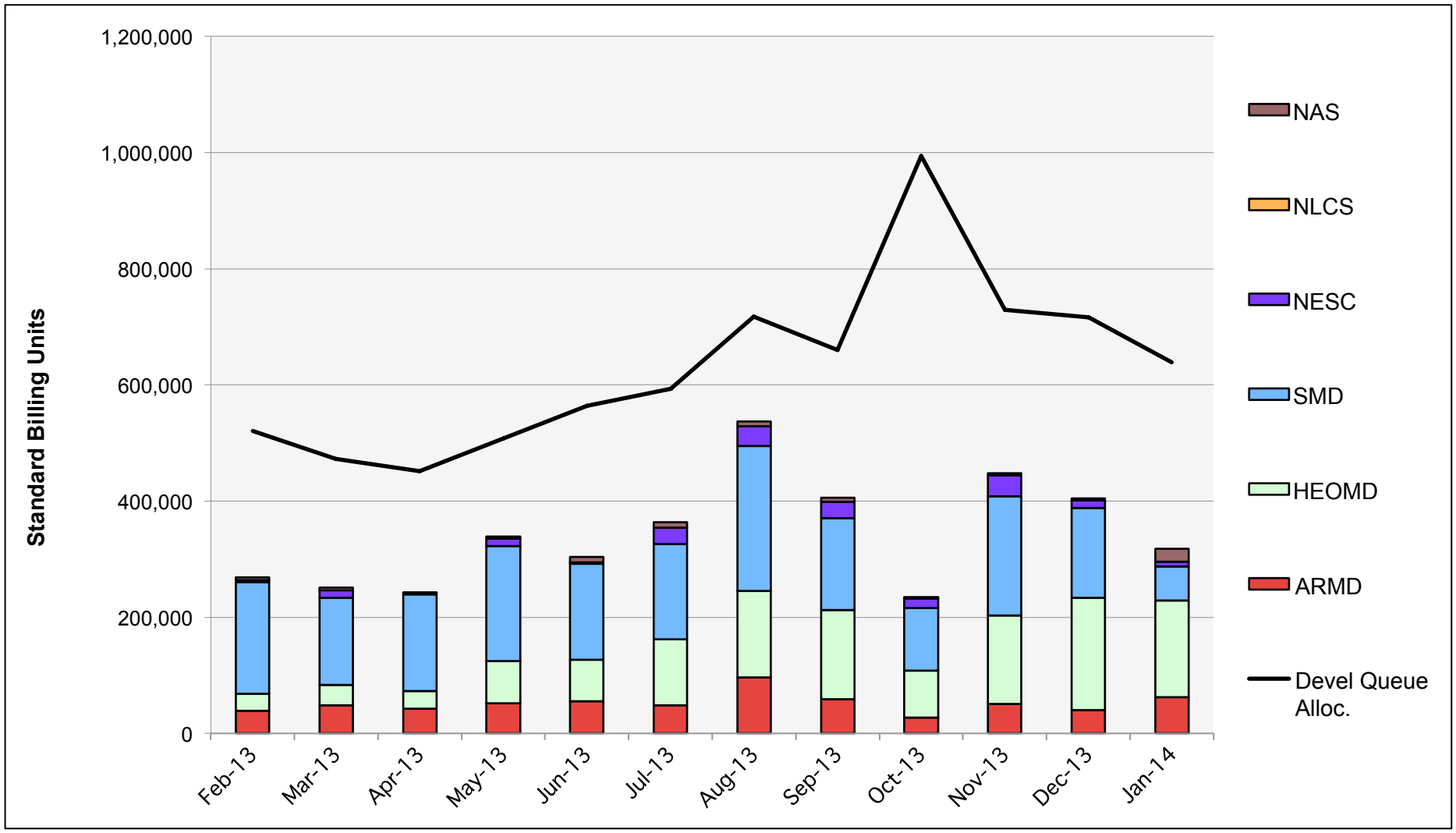


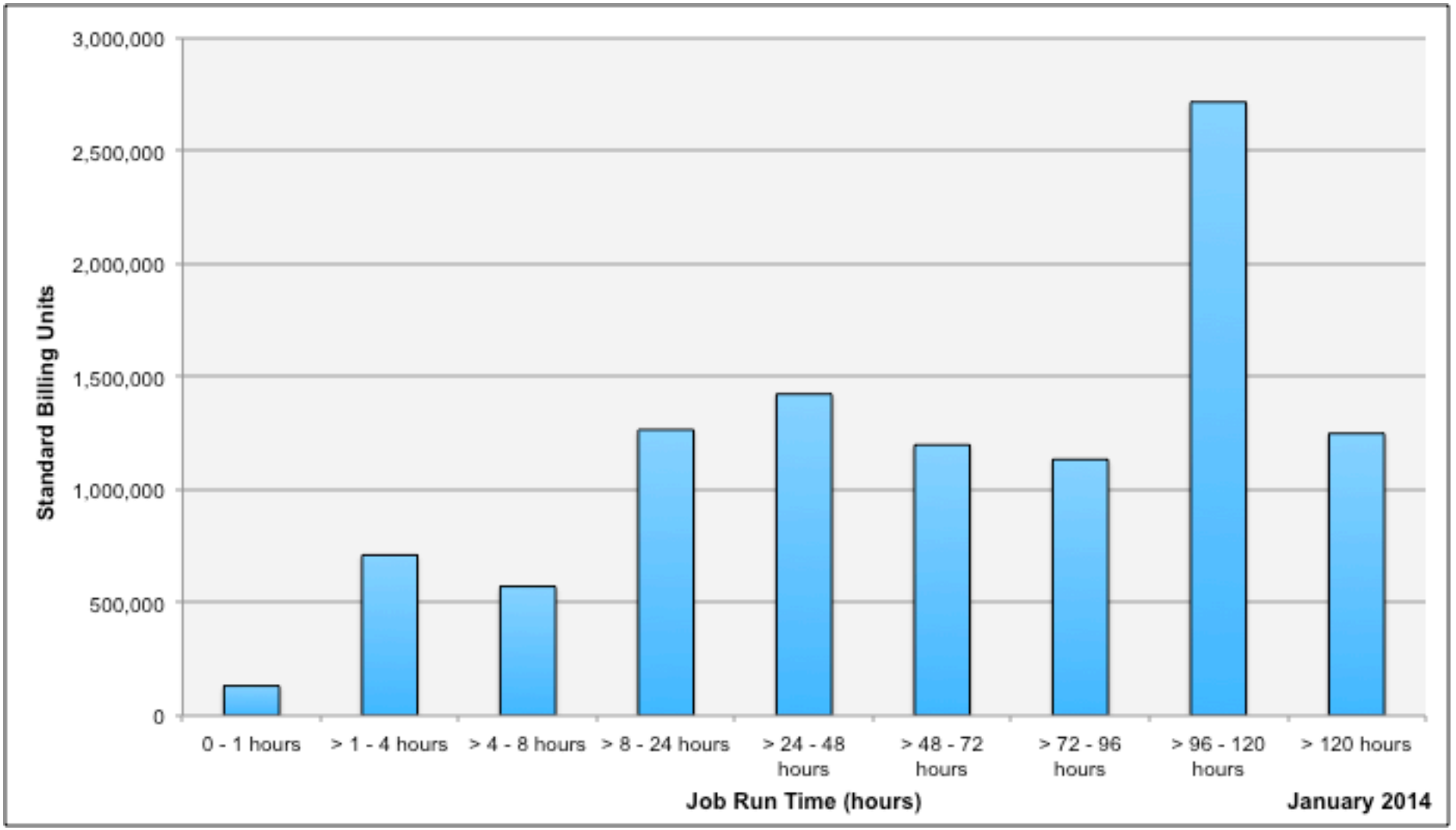
Pleiades:
SBUs Normalized to 30-Day Months



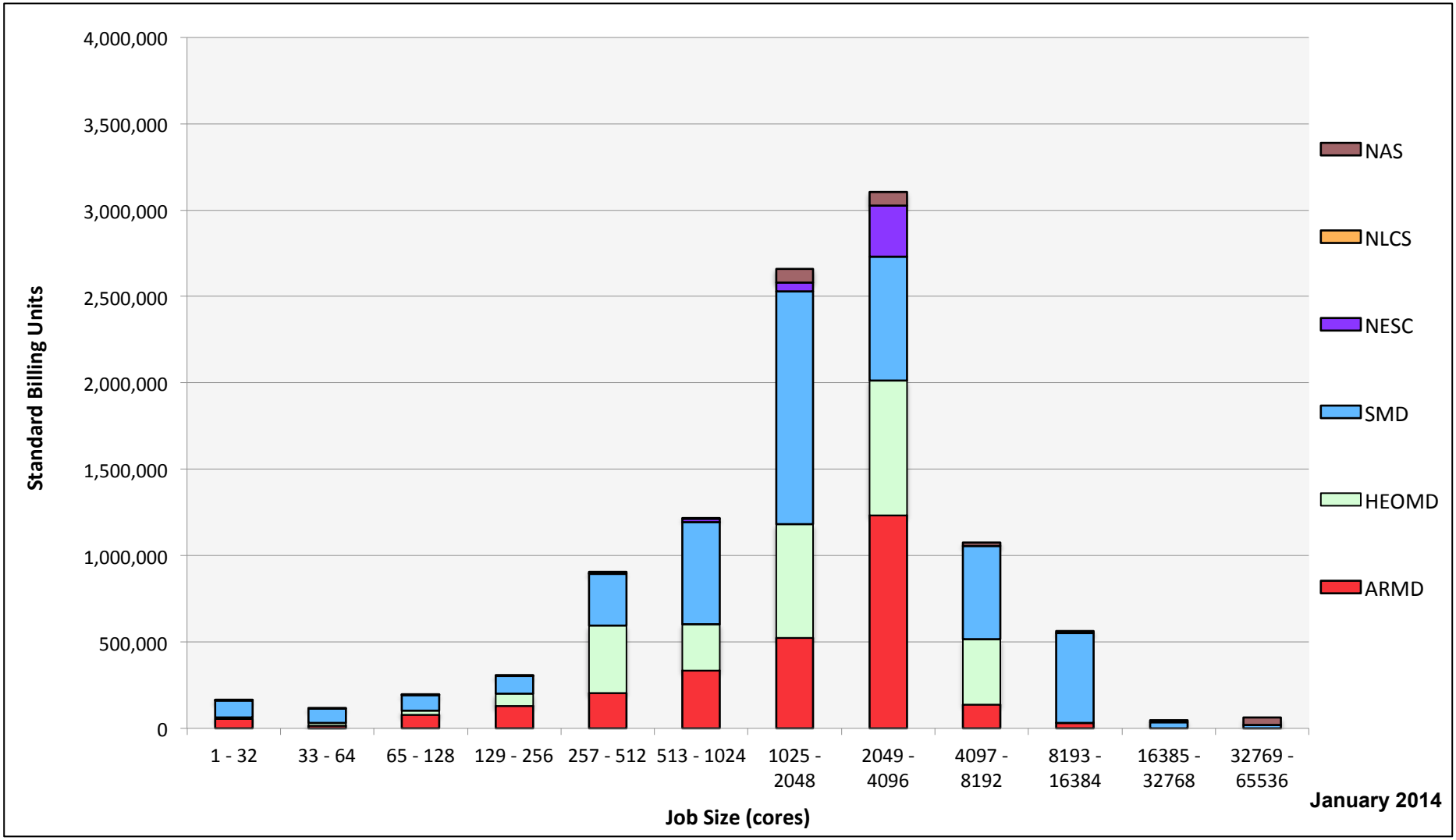
Pleiades:
Devel Queue Utilization



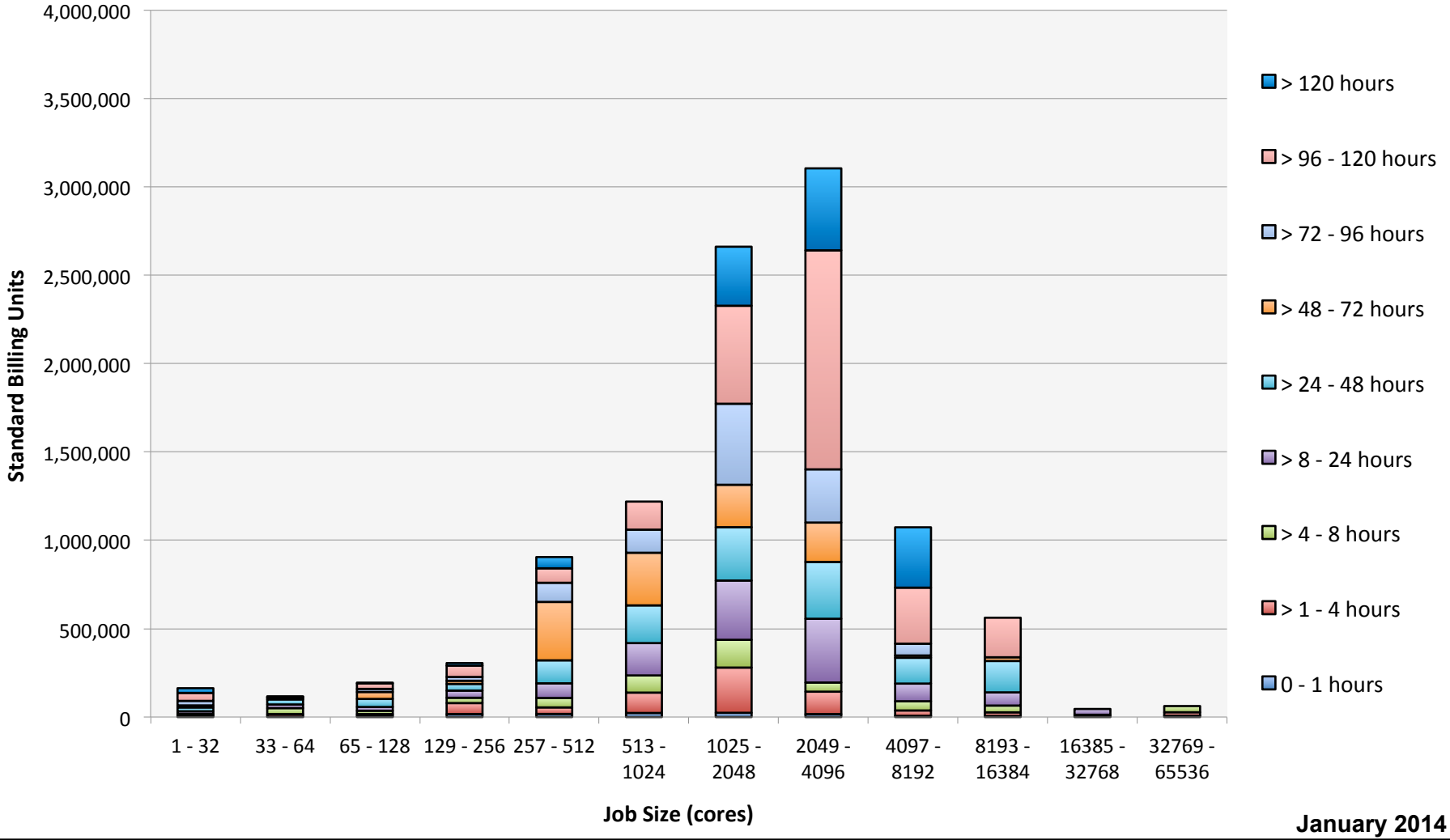
Pleiades:
Monthly Utilization by Job Length



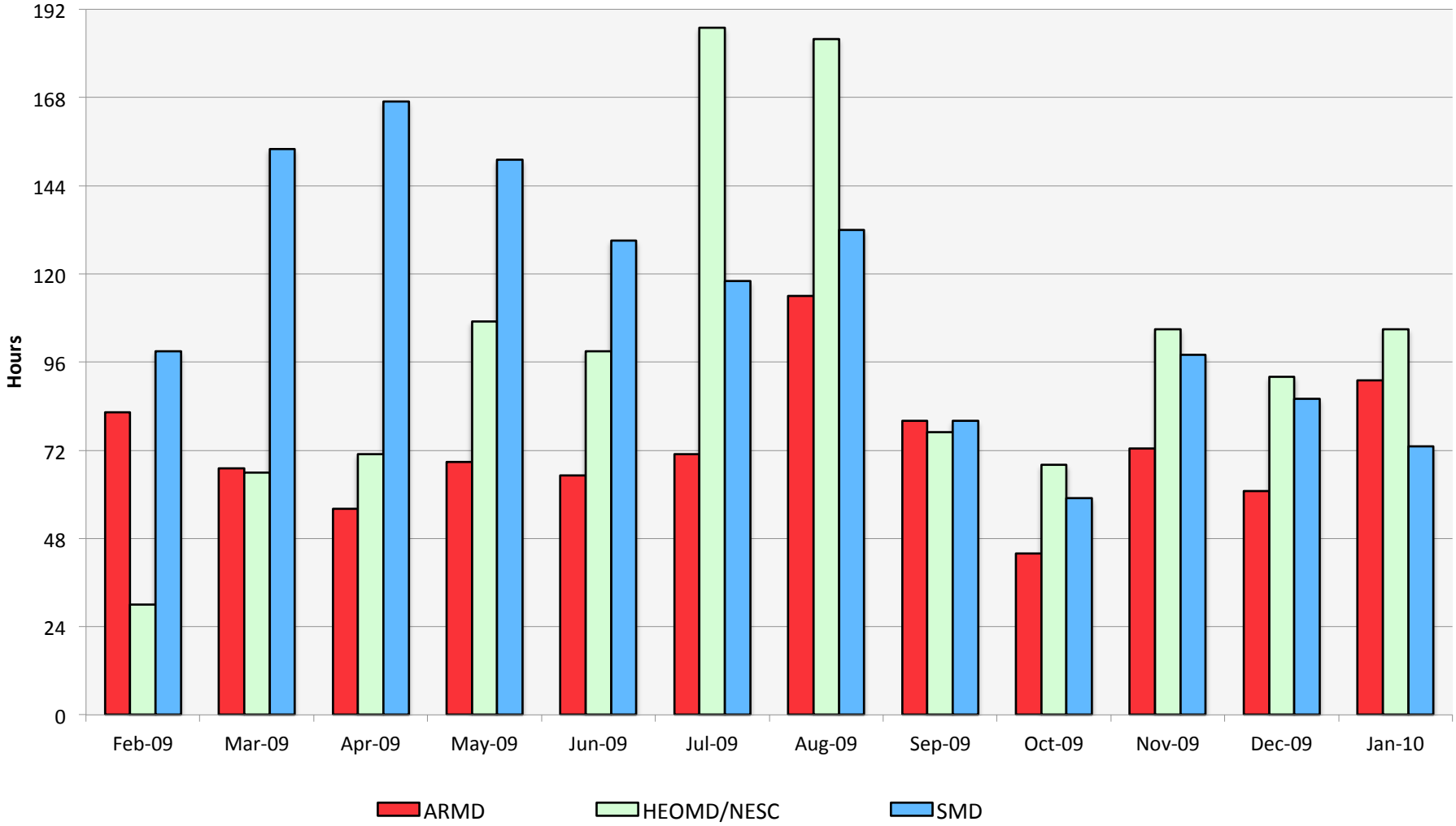
Pleiades:
Monthly Utilization by Size and Mission



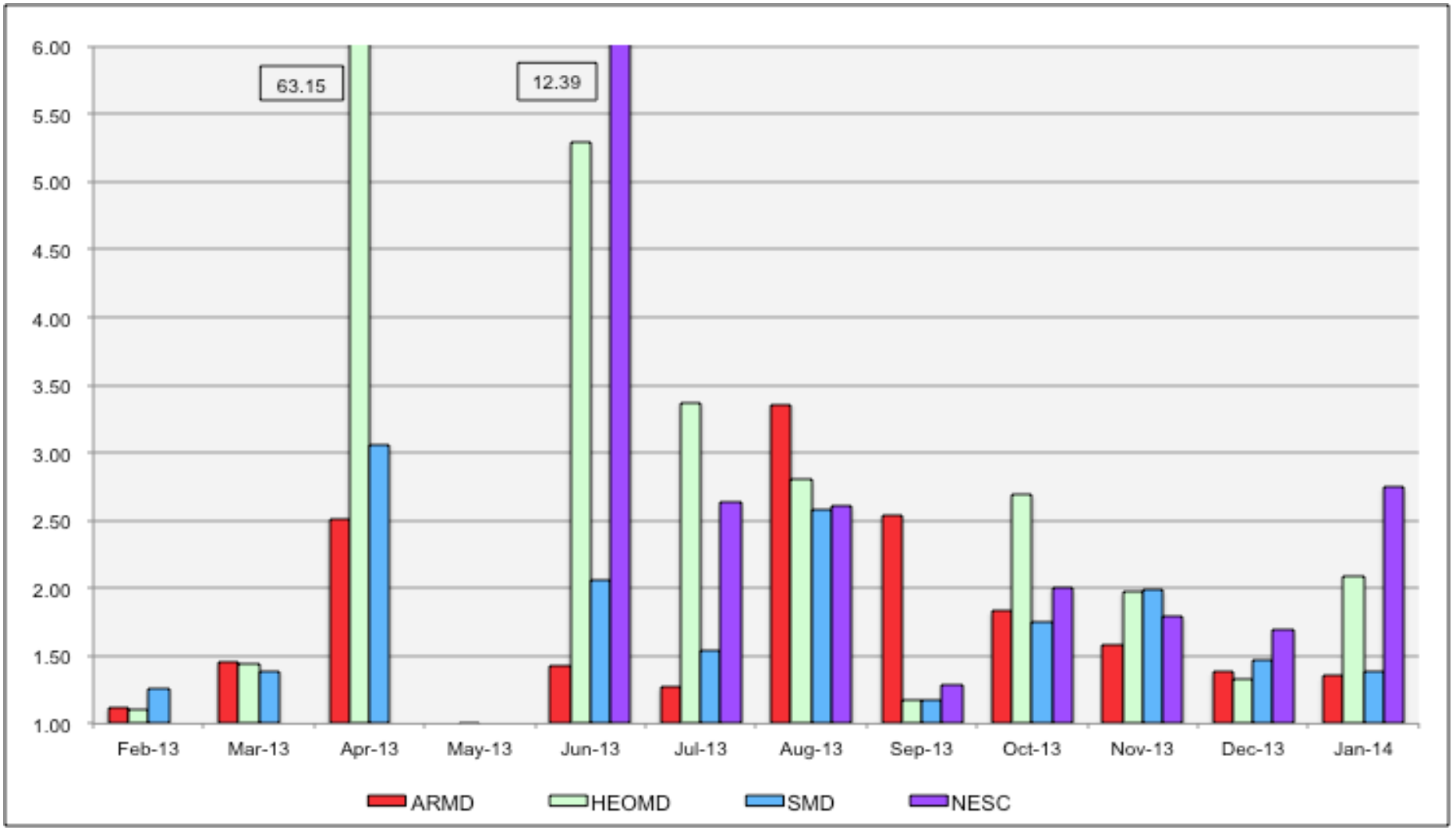
Pleiades:
Monthly Utilization by Size and Length



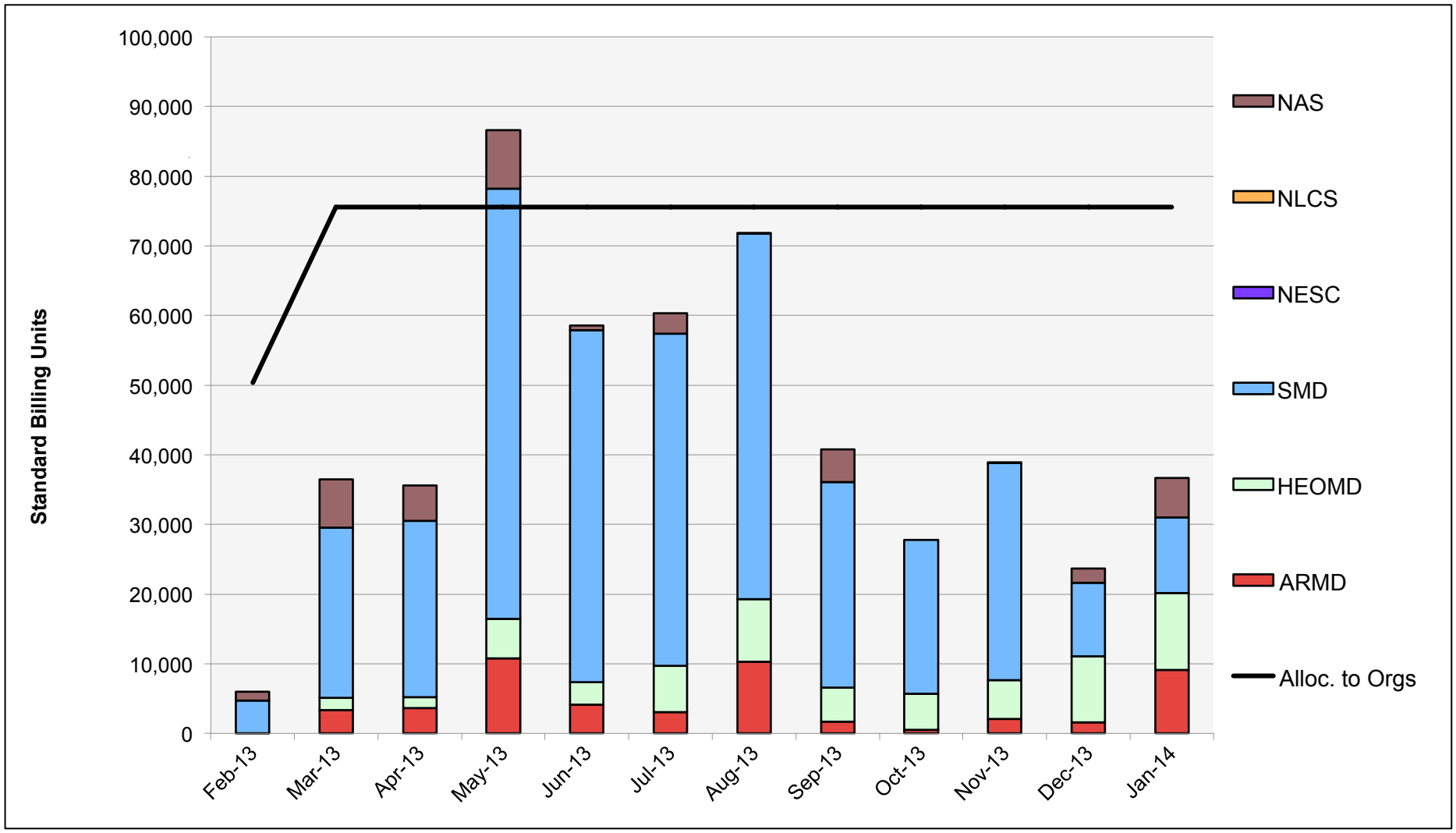
Pleiades:
Average Time to Clear All Jobs



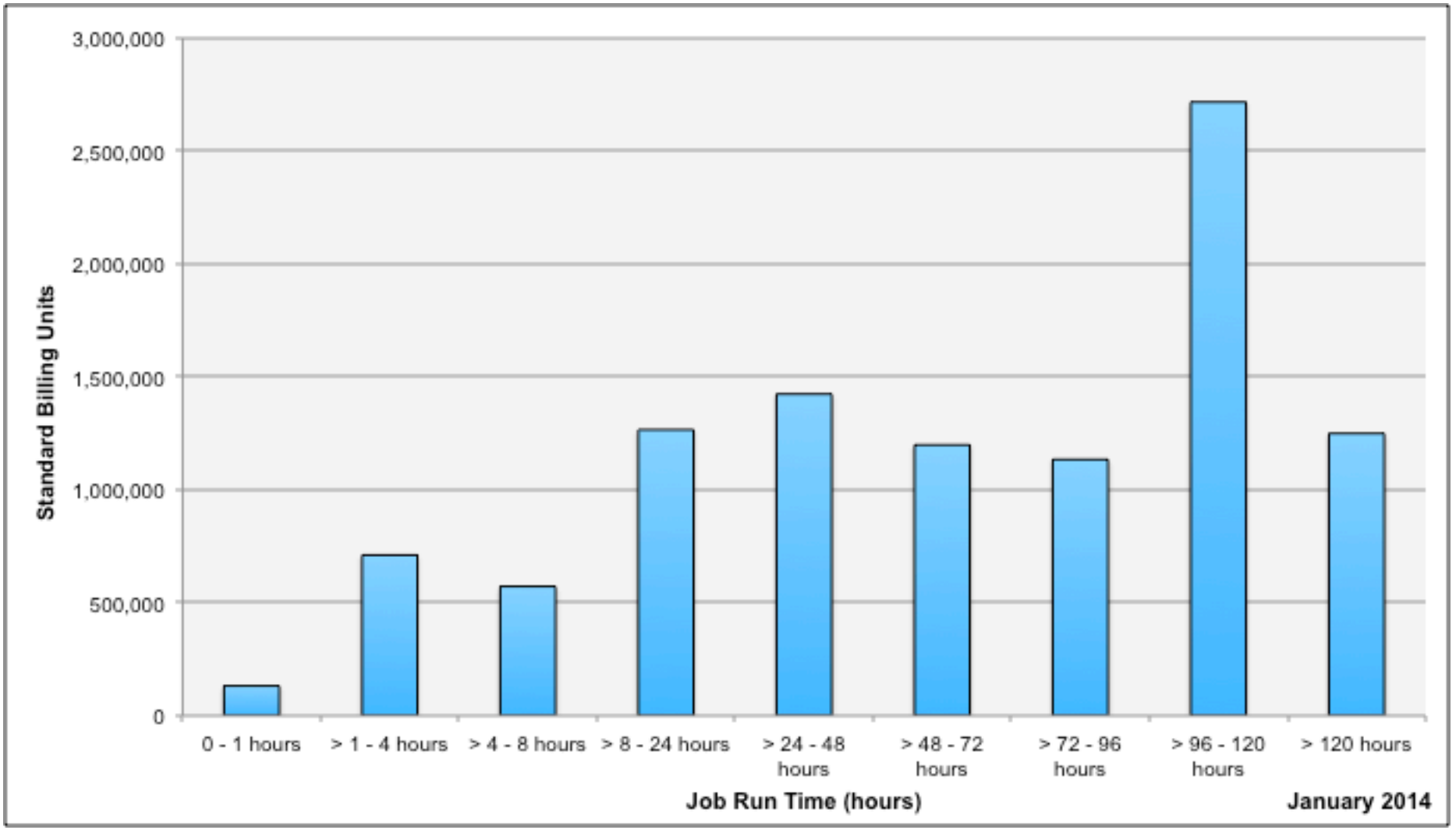
Pleiades:
Average Expansion Factor



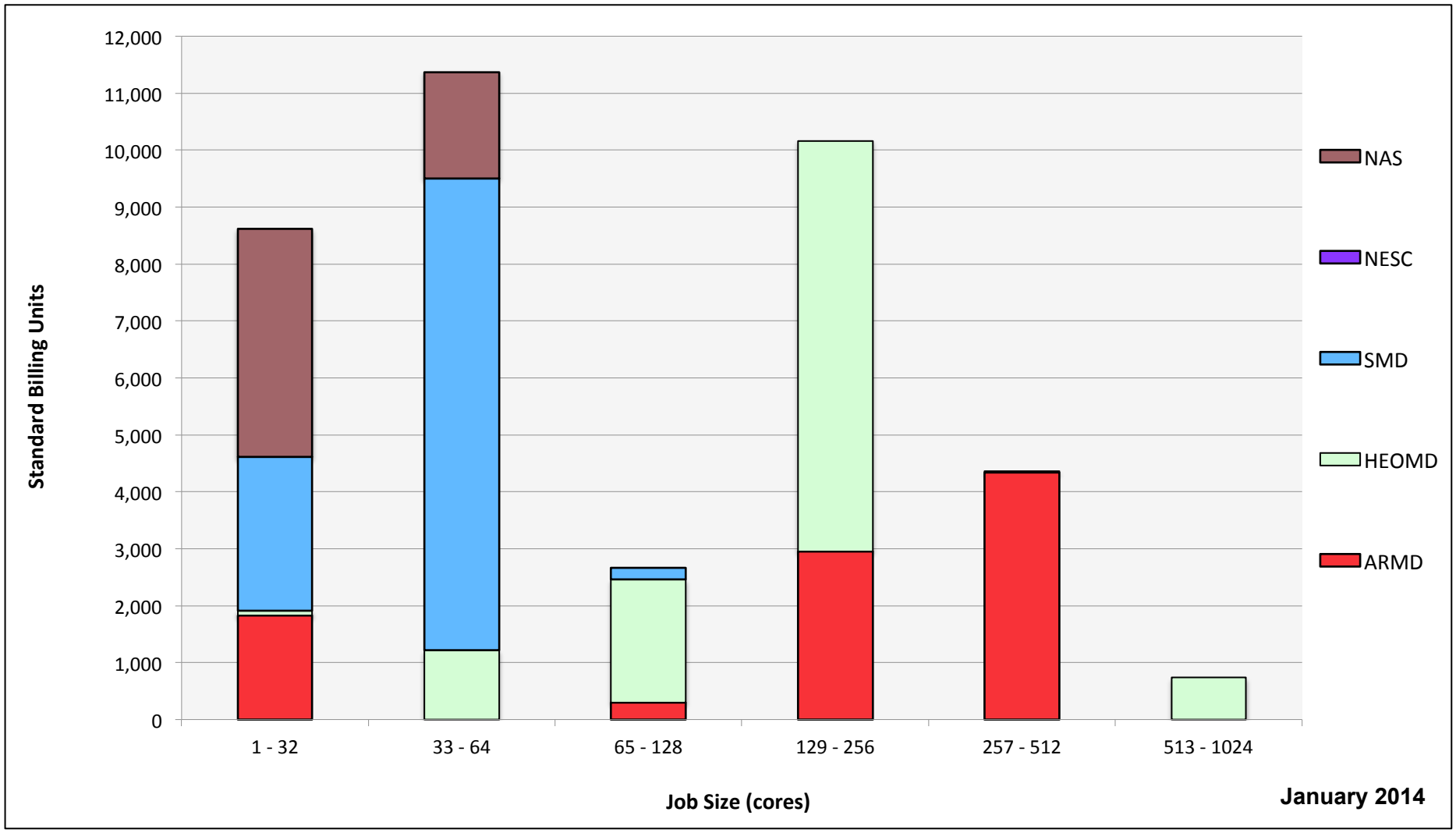
Endeavour:
SBUs Normalized to 30-Day Months



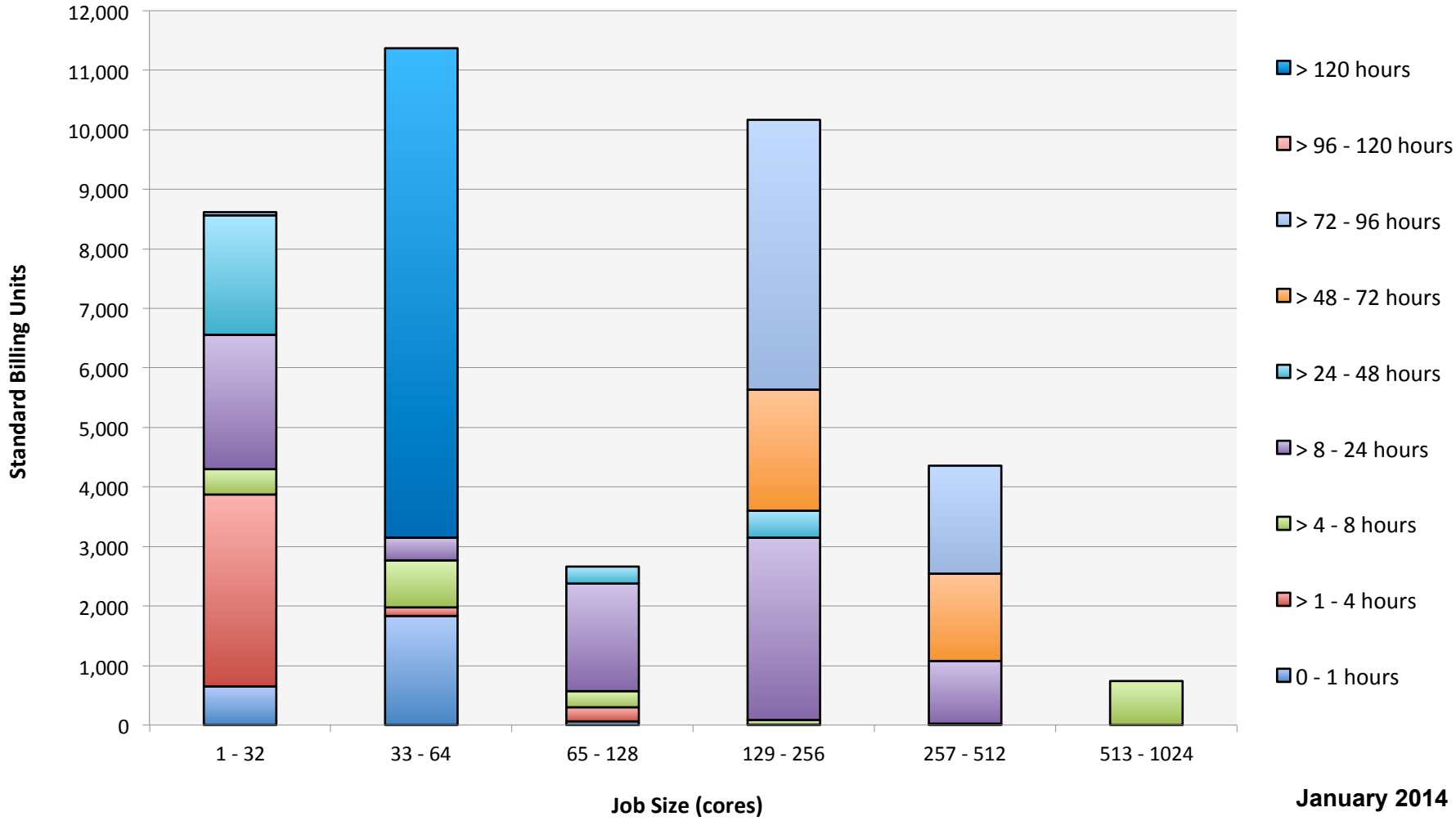
Endeavour:
Monthly Utilization by Job Length



Endeavour:
Monthly Utilization by Size and Mission



Endeavour:
Monthly Utilization by Size and Length



Endeavour:
Average Time to Clear All Jobs