Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

March 10, 2016

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Next-Generation LTO-7 Technology Triples HECC Tape Storage Capacity

- HECC engineers deployed Linear Tape Open (LTO-7), the next-generation tape technology, on the archive system. With this new technology, the tape library tripled in storage capacity.
- LTO-7 is the 7th generation of the LTO tape format and stores 6 terabytes (TB) of uncompressed data per tape. Previously, HECC utilized LTO-5/6 technology that stored 1.5/2.5 TB per tape.
- With this significant increase in tape capacity, the HECC archive systems can store approximately half-an-exabyte of data, with compression.
- Data stored on the existing LTO-5/6 technology will be migrated over time to the LTO-7 media, and the move will be transparent to users.

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

HECC's archived user data grows by an average of 3 petabytes (PB) per month. Currently, the archive system contains approximately 111 PB of dual-copy data.

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, CSC Government Solutions LLC

HECC Completes System Downtime Maintenance Activities

- HECC engineers completed dedicated time activities to deploy patches on Feb 18-19, as part of a patching schedule for HECC systems.
- In addition to the system patches, activities completed during the downtime included:
  - Firmware updates on the storage and InfiniBand subsystems.
  - Lustre filesystem patches and integrity checking.
  - Replacing failing hardware components.
  - System stability and performance testing.
- These maintenance activities were completed ahead of schedule and the systems were released back into production earlier than planned.

Mission Impact: Regular maintenance on the HECC systems provides a stable and well performing system for NASA users.

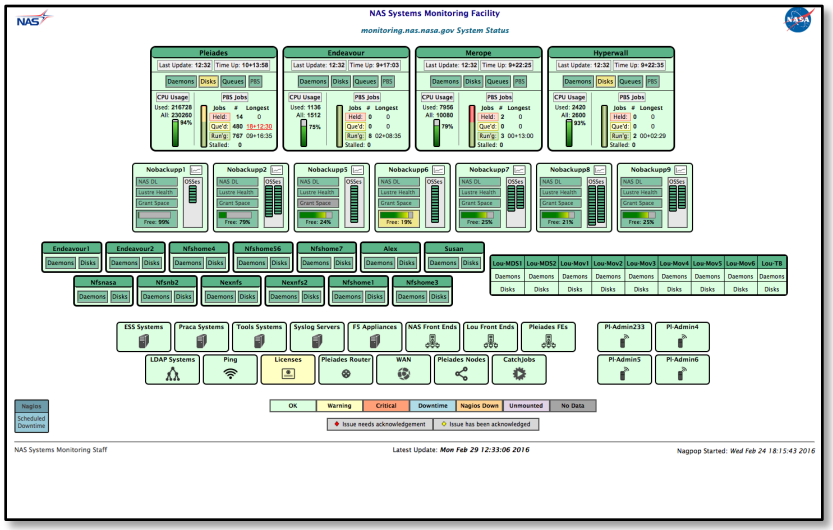
HECC engineers perform as much maintenance as possible without downtime on the Pleiades supercomputer and other resources, but changes that have the potential to be disruptive to users are planned for dedicated times.

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, CSC Government Solutions LLC

New Monitoring Display Means Quicker, More Efficient System Support

- HECC engineers deployed into production a modernized version of the in-house Heads-Up Display (HUD) system that Control Room staff use for system status reporting.
- The original version of the HUD was developed 10 years ago, and it was becoming difficult to add enhancements and maintain the code. A year ago, staff began a project to modernize the code, with the goal to improve maintainability and simplify the configuration.
- The HUD v2 project reduced the size of the codebase by a factor of 3 and significantly improved the maintainability of the code, which takes advantage of modern web technologies to improve the user interface.

Mission Impact: By improving the tools to monitor HECC resources, engineers and support staff can resolve issues more quickly and provide a better computing environment for users.



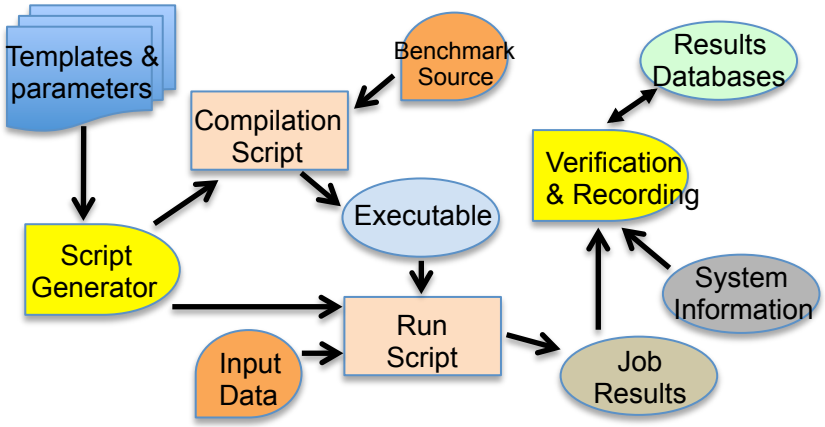
The newly deployed Heads-Up Display (HUD) provides a dashboard status of HECC resources to help staff quickly identify system issues.

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, CSC Government Solutions LLC

APP Team Simplifies Use of Application-Based Tests

- HECC's Applications Performance and Productivity (APP) team developed a set of scripts that allow staff outside the group to initiate application-based tests.
- The scripts run the six applications from the SBU benchmark suite together with the NAS Parallel Benchmarks, and can be used to test proposed system configuration changes.
- In addition to testing the correctness of execution, the scripts also report the duration of each run and compare that to a reference value. This facilitates detection of performance regressions, which sometimes occur after system configuration changes.
- The APP team is extending this work to create a database of performance results that can be used to study system architectures and monitor system performance over an extended period.

Mission Impact: Simplifying the process of application-based testing saves time required to change the system and can result in a more stable environment for the user community.



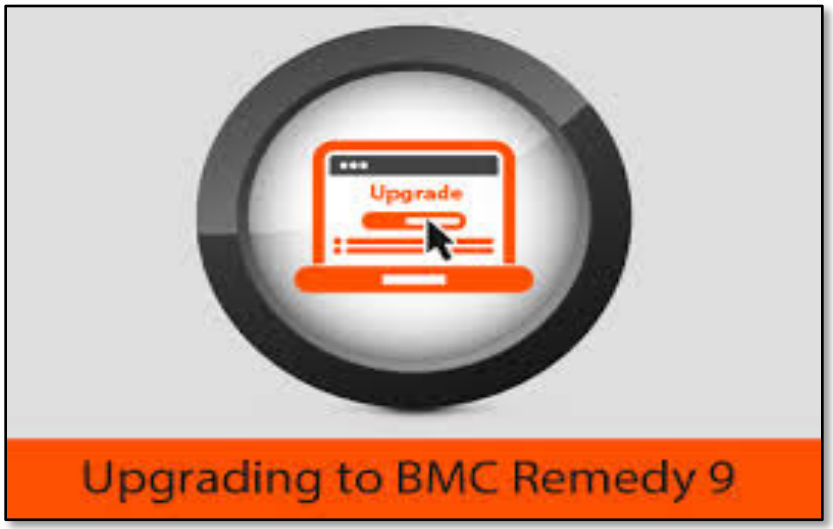
Creation of an automated test application follows the workflow shown in the diagram above. The Script Generator (on the left side in yellow) produces both compilation and run scripts. The Verification and Recording software (on the right side in yellow) validates the results of a test run, compares performance to reference values, and stores results in a database.

POCs: Henry Jin, haoqiang.jin@nasa.gov, NASA Advanced Supercomputing (NAS) Division;
Robert Hood, robert.hood@nasa.gov, NAS Division, CSC Government Solutions LLC

Tools Team Upgrades HECC Incident Management System to BMC Remedy 9.1

- HECC's Tools team upgraded the Remedy incident, problem, and asset management system from version 8.1 to the latest version 9.1.
- Enhancements available with the Remedy 9.1 upgrade include:
  - Full text searches of all attachments and fields.
  - Web-based "smart reporting" service with out-of-the-box dashboard for creating and managing reports.
  - Improvements to the process of reconciling local customizations on upgrades.
  - Enhancements to the integration and application programming interface areas, and for moving code from development to production.
- Team accomplishments during this upgrade included converting and testing Remedy customizations, upgrading to an Oracle 12c database, enabling Oracle case insensitivity on the database, and syncing the data for production cutover.

Mission Impact: The Remedy 9.1 upgrade provides staff at the NAS facility with the most current features available and enhances the ticketing system used to manage HECC assets and user calls.



The BMC Remedy suite is used at the NASA Advanced Supercomputing facility to provide support functionality for incident, user problem, and asset management.

POC: Aqeel Rehman, mohammad.a.rehman@nasa.gov, (650) 604-4566, NASA Advanced Supercomputing Division, Intrinsyx

HECC Tools Team Upgrades Oracle 11g Databases to Oracle 12c

- HECC's Tools team upgraded the databases used for the Remedy incident management system and for HECC usage accounting and reporting from Oracle 11g to Oracle 12c.
- Enhancements in release 12c include:
  - Improved system resource usage and management with a new multi-tenant container.
  - Pluggable databases that provide ease in cloning databases, and container databases that can be more systematically patched.
  - Oracle Enterprise Manager, which provides a single efficient, time-saving management console for backups and restores across all databases.
- Accomplishments during this upgrade included conversion, testing, and transition of major Oracle databases for: Remedy incident and asset management; MicroStrategy HECC accounting reports; and LAMS, the local account management system used to manage accounts on the HECC systems, NAS servers and user systems. The Tools team updated all accesses to these databases to use Oracle 12c wallet credentialed connections.

Mission Impact: The Oracle 12c upgrade of ticketing, account management, and accounting databases provides HECC with the most current features available for Oracle databases and enhances our ability to maintain these databases.

Oracle databases are used for HECC's Pleiades accounting reports, user account management, and the Remedy incident and asset management system.

POC: Mi Young Koo, mi.y.koo@nasa.gov, (650) 604-4528, NASA Advanced Supercomputing Division, CSC Government Solutions LLC

Faster hyperwall Animation Converter Increases Visualization Group Productivity

- The HECC in-house “makegiantmovie” animation converter was recently rewritten so it runs 28 times faster.
- The speedup is due to a new and much faster animation encoder (FFMPEG), and the software no longer writes intermediate files to disk.
- The converter is used to create high-resolution 4K (Ultra-High Definition) and higher animation files that can be played on the hyperwall and mini-hyperwall at the NAS facility.
- Features of the new converter include:
  - Can create animation files directly from a single MPEG animation file input instead of only accepting uncompressed images.
  - New options allow the converter to do some calculations previously done by the user.
- A future enhancement will allow the tool to be used on multiple nodes of a cluster.

Mission Impact: HECC Visualization team members can create new animations faster, and display animations from presenters (for example, for demonstrations or conferences) on the hyperwall more quickly.

Photo of the mini-hyperwall displaying a 4K Ultra-High Definition animation that shows 25 years of data from the North American Forest Dynamics study. The animation was converted using the new converter application.

POC: David Ellsworth, david.ellsworth@nasa.gov, (650) 604-0721, NASA Advanced Supercomputing Division, CSC Government Solutions LLC

ESS Team Develops New Red Hat Enterprise Linux Release 7 Standard for HECC Systems

- The Engineering Servers and Services (ESS) team developed the new OS standard to be used for the infrastructure servers and workstations. This standard, based on Red Hat Enterprise Linux Release 7, is being used for the upgrade of over 250 systems.
- Enhancements offered by the new standard include support for:
  - XFS filesystem, allowing filesystems up to 500 terabytes in size.
  - Linux Unified Key System (LUKS) version 4.10.1 disk encryption, providing faster multi-threaded encryption.
  - Firewalld, enabling the firewall configuration to be updated without stopping/restarting a system.
  - Systemd, allowing applications and services to start at boot time.
  - NAStruck version 2, allowing backups of XFS filesystems at a faster, more efficient rate.
  - CFEngine 3, providing full configuration control for all Red Hat 7 modules.
  - Center for Internet Security (CIS) Benchmark configurations for Red Hat 7.
- The upgrade of the servers and workstations from Red Hat Enterprise Linux Release 6 to the new Red Hat Enterprise Linux Release 7 standard will be systematically completed over the next couple of years.

Mission Impact: The Red Hat Enterprise Linux Release 7 upgrade will provide staff at the NAS facility with the most current features available in Release 7 and access to the latest software applications.

Red Hat Enterprise Linux Release 7, the next generation of Red Hat's comprehensive suite of operating systems, designed for mission-critical enterprise computing.

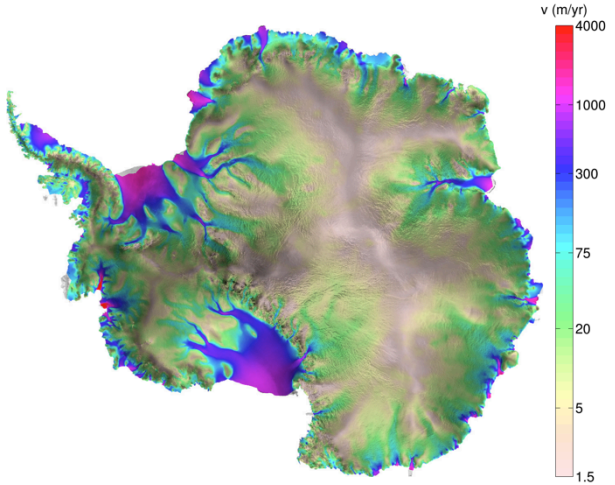
POC: Chris Shaw, robert.c.shaw@nasa.gov, (650) 604-4354, NASA Advanced Supercomputing Division, CSC Government Solutions LLC

Projecting Sea Level Rise by Modeling the Evolution of Ice Sheets *

- A team at NASA's Jet Propulsion Laboratory (JPL) and the University of California at Irvine (UCI) use Pleiades extensively to accurately model the evolution of ice sheets and understand how freshwater fluxes to the ocean will impact sea level rise in the coming decades.
- Using the open-source Ice Sheet System Model (ISSM) software, developed at JPL/UCI, the team's results have had a widespread impact on the cryosphere scientific community. Among their contributions:
  - ISSM's automatic differentiation feature, which enables a new generation of spatiotemporal inversion algorithms that can assimilate NASA remote sensing data into projections of the state of polar ice caps in a changing climate.
  - Optimization of bedrock topography data, and creation of physically consistent bedrock topography for the entire Greenland ice sheet.
  - Improvements in modeled physical processes, for example: calving front dynamics for outlet glaciers in Greenland; ice/ocean interactions for ice streams flowing into the Antarctic Ocean; hydrology for ice/bed conditions under melting glaciers; and paleo reconstructions for model spin-ups over long time periods.
- While ISSM can be deployed in a wide range of HEC environments, the JPL team's reliance on Pleiades is of particular importance—they regularly complete large simulation runs involving thousands of computational nodes on the system.

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

Mission Impact: Understanding and projecting the evolution of polar ice sheets is a priority for the global science community. By leveraging HECC resources, scientists can complete jobs in hours, compared to weeks on conventional computing resources.



This image from the Ice Sheet System Model represents the computed velocities for the entire continent of Antarctica. Brown and green represent relatively slow ice surface velocities (fractions of meters per year to a few meters per year). Blue and purple represent much faster velocities, ranging up to 3,000 meters per year.

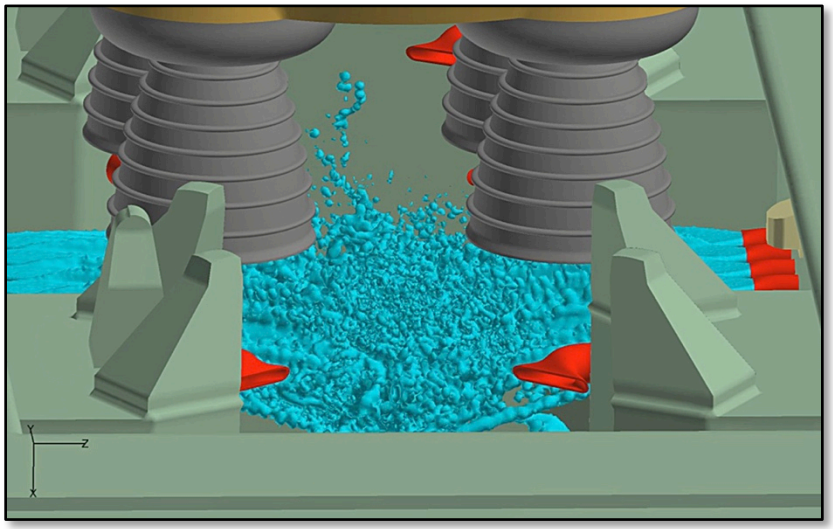
POCs: Gilberto Perez, gilberp@uci.edu, University of California, Irvine; Eric Larour, eric.larour@jpl.nasa.gov, (818) 970.8032, Jet Propulsion Laboratory

SLS Ignition Overpressure/Sound Suppression Water System Simulations *

- Researchers at NASA's Marshall Space Flight Center are running simulations on Pleiades to analyze the Ignition Overpressure/Sound Suppression (IOP/SS) water system for the agency's next-generation heavy-lift launch vehicle, the Space Launch System (SLS).
  - The IOP/SS system will use water spray to mitigate the overpressure and sound waves caused by the ignition of the SLS liquid engine rockets and solid rocket boosters (SRBs), preventing these effects from harming the vehicle.
  - Using a new volume-of-fluid model developed with the Loci-STREAM computational fluid dynamics code, the researchers simulated the SLS launch environment with early IOP/SS system designs to determine optimal placement of the water spray.
  - The simulation results identified water projection patterns that adversely affected both the SRBs and the Hydrogen Burn-off Igniter (HBOI) subsystem, leading to significant improvements in both the IOP/SS and HBOI designs.
- New simulations will quantitatively predict the IOP/SS system's mitigation of the IOP event, providing additional data for SLS design teams.

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

Mission Impact: Simulations run on Pleiades identified problems that led to critical design changes in the SLS Ignition Overpressure/Sound Suppression system, avoiding expensive redesigns and delays that would have occurred if the problems had been detected much later during full-scale testing activities.

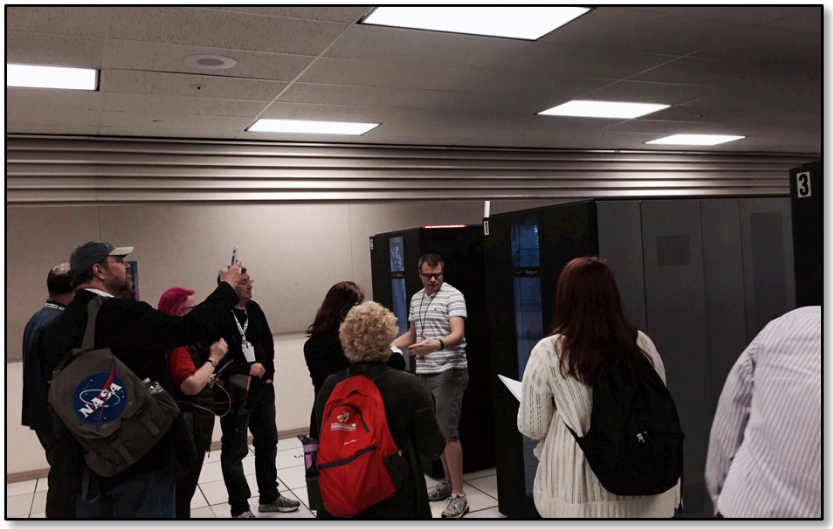


Simulation of the Ignition Overpressure/Sound Suppression (IOP/SS) system projecting water during ignition, depicted by a light blue isosurface under the Space Launch System's RS-25 liquid engines. Note the undesirable water splash upward between the two engine banks.

POC: Jeff West, jeffrey.s.west@nasa.gov, (256) 544-6309, NASA Marshall Space Flight Center

HECC Facility Hosts Several Visitors and Tours in February 2016

- HECC hosted 5 tour groups in February; guests learned about the agency-wide missions being supported by HECC assets, and some groups also viewed the D-Wave 2X quantum computer system. Visitors this month included:
  - Davut Kavranoglu, Chief Science & Technology Advisor to the President of the Republic of Turkey; and other Turkish delegates who were guests of Eugene Tu, NASA Ames Center Director.
  - Traditional media experts and invited social media guests covering the State of NASA/ Budget Rollout media event at Ames; the NAS facility was one of the tour stops.
  - Jerry Davis, Ames' Chief Information Officer, received a HECC project overview and security summary from NAS managers.
  - Students from the Lassen Astrobiology Internship Program (Red Bluff High School, Lassen Volcanic National Park - National Park Service) visited NAS as part of their center tour.



HECC's Nick Bonifas (center right) takes social media guests and members of the press on a tour through the main computer room at the NAS facility as part of the State of NASA/Budget Rollout media event.

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

Papers

- "**Using Gas Clouds to Probe the Accretion Flow Around SgrA*: G2's Delayed Pericenter Passage**," A.-M. Madigan, M. McCourt. R. O'Leary, arXiv:1602.02760 [astro-ph.HE], February 8, 2016. *
  http://arxiv.org/abs/1602.02760
- "**Modelling the Central Constant Emission X-ray Component of η Carinae**," C. Russell, et al., Monthly Notices of the Royal Astronomical Society, vol. 457, issue 2, February 11, 2016. *
  http://mnras.oxfordjournals.org/content/early/2016/02/11/mnras.stw339.abstract
- "**Impact of Uncertainties in Atmospheric Boundary Conditions on Ocean Model Solutions**," A. Chaudhuri, R. Ponte, G. Forget, Ocean Modeling, February 12, 2016. *
  http://www.sciencedirect.com/science/article/pii/S1463500316000226
- "**Halo and Subhalo Demographics with Planck Cosmological Parameters: Bolshoi-Planck and MultiDark-Planck Simulations**," A. Rodriguez-Puebla, et al., arXiv: 1602.04813 [astro-ph.CO], February 15, 2016. *
  http://arxiv.org/abs/1602.04813
- "**Suppression of Collisionless Magnetic Reconnection in Asymmetric Current Sheets**," Y.-H. Liu, M. Hesse, arXiv:1602.05118 [physics.plasm-ph], February 16, 2016. *
  http://arxiv.org/abs/1602.05118

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

Papers (cont.)

- "**Neptune's Orbital Migration Was Grainy, Not Smooth**," D. Nesvorny, D. Vokrouhlicky, arXiv:1602.06988 [astro-ph.EP], February 22, 2016. * *http://arxiv.org/abs/1602.06988*
- "**Skylon Aerospace Plane and Its Aerodynamics and Plumes**," U. Mehta, M. Aftosmis, J. Bowles, S. Pandya, Journal of Spacecraft and Rockets (AIAA), February 26, 2016.* *http://arc.aiaa.org/doi/abs/10.2514/1.A33408*
- "**Dawn-Dusk Asymmetries in Rotating Magnetospheres: Lessons from Modeling Saturn**," X. Jia, M. Kivelson, Journal of Geophysical Research: Space Physics, February 27, 2016. * *http://onlinelibrary.wiley.com/doi/10.1002/2015JA021950/full*

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

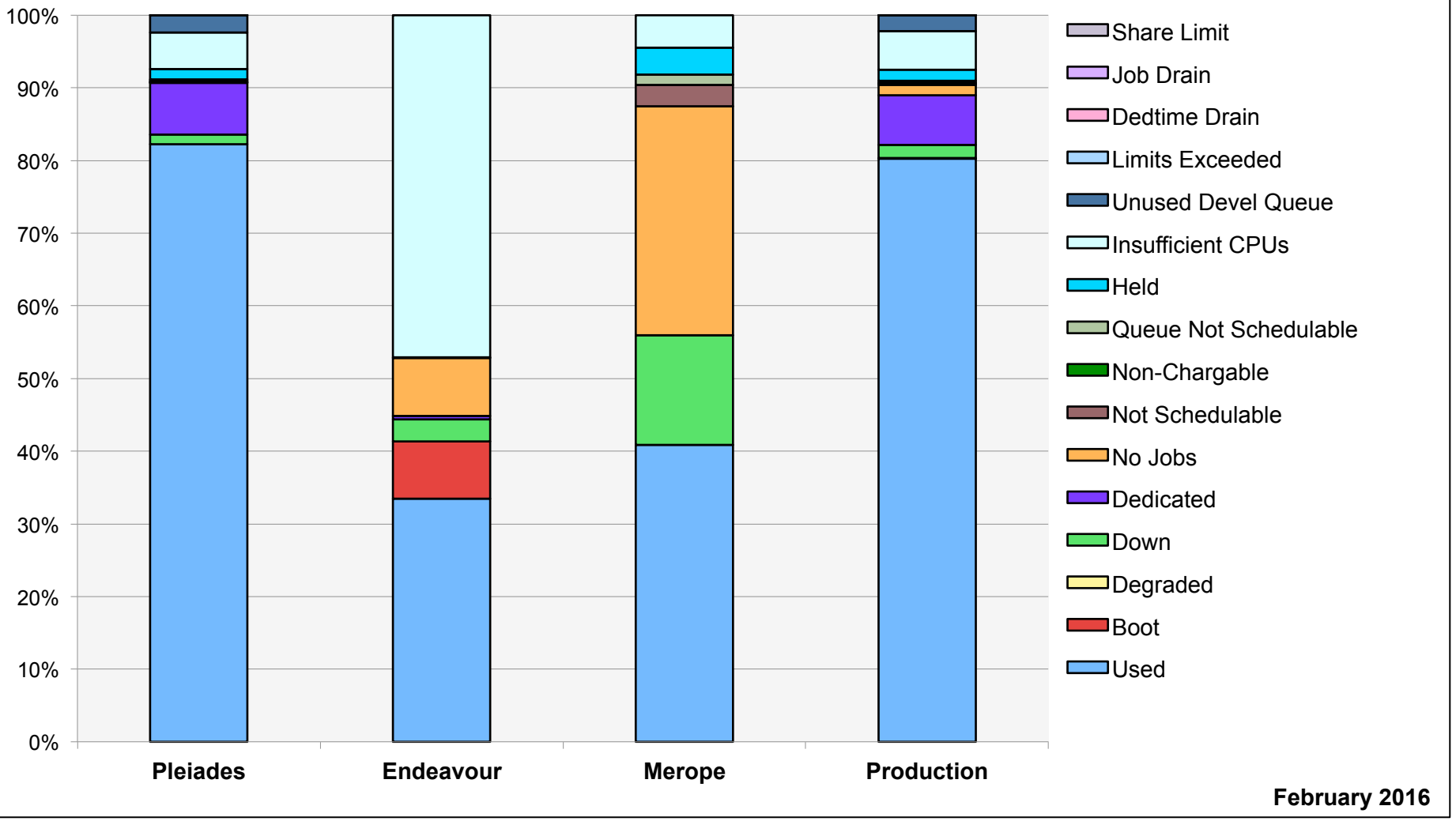
News and Events

- **A Stellar Collaboration: Supercomputing and NASA's IRIS Observatory**, *NAS Image Feature*, January 27, 2016—Using images from NASA's Interface Region Imaging Spectrograph (IRIS) spacecraft and the Pleiades supercomputer, scientists are producing simulations that may help explain how the outer solar atmosphere is shaped and heated. *http://www.nas.nasa.gov/publications/articles/feature_IRIS_Carlsson.html*
  - **Pleiades Supercomputer Simulations Help Explain NASA's IRIS Solar Observatory Findings**, *NASA Ames Image Feature*, February 1, 2016. *http://www.nasa.gov/ames/image-feature/pleiades-supercomputer-simulations-help-explain-nasa-s-iris-solar-observatory-findings*
  - **Pleiades Supercomputer Simulations Help Explain NASA's IRIS Solar Observatory Findings**, *Colorado Space News*, February 3, 2016. *http://www.coloradospacenews.com/pleiades-supercomputer-simulations-help-explain-nasas-iris-solar-observatory-findings/*
- **NASA's Investment in HPC is Supercharging Scientific Research**, *NetApp GovDataDownload Blog*, February 5, 2016—Government and industry partnership has helped develop the high-end computing resources that will take humans to Mars, such as NASA's flag-ship supercomputer, Pleiades, which is helping scientists push our knowledge of the universe further. *http://govdatadownload.com/2016/02/05/nasas-investment-in-hpc-is-supercharging-scientific-research/*

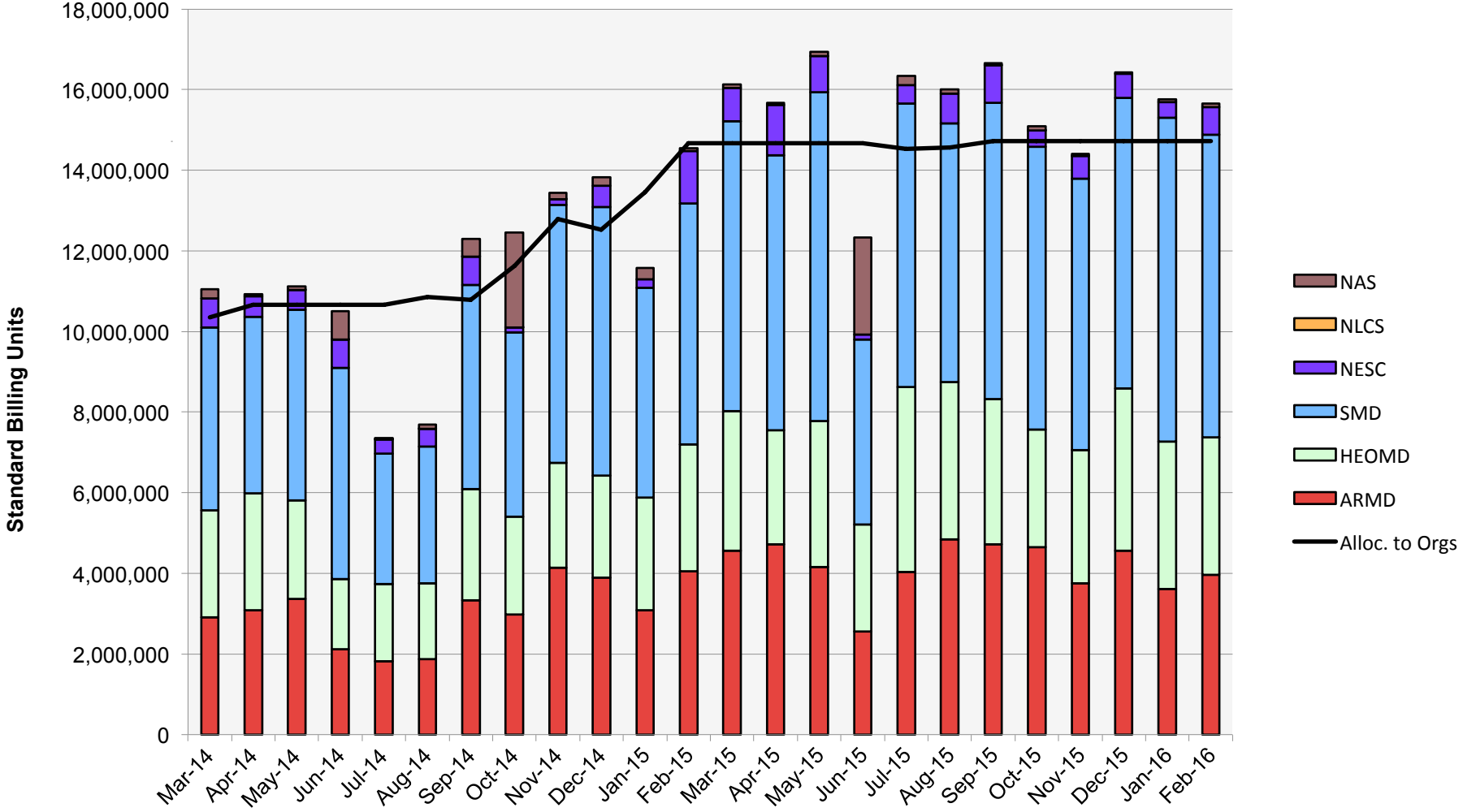
News and Events (cont.)

- **Faster, Quieter, Cleaner: How NASA Imagines the 737 of 2035**, *CNET*, February 24, 2016—CNET talks with NAS Division scientist Nateri Madavan about the future of commercial aircraft, during NASA Administrator Charles Bolden's visit to Ames Research Center. Engineers and researchers across the agency are working together with industry partners to develop cleaner, faster, and quieter planes for more eco-friendly skies. *http://www.cnet.com/news/faster-quieter-cleaner-how-nasa-imagines-the-737-of-2035/*
- **Exomoons in the Hunt for Extraterrestrial Life: NASA Is Looking for a Real-Life Pandora**, *Outer Places*, February 26, 2016—NASA is kicking the search for the first exomoon into gear, and researchers will use Pleiades to simulate billions of star-planet-moon configurations and compare results with Kepler data. *http://www.outerplaces.com/science/item/11368-exomoons-in-the-hunt-for-extraterrestrial-life-astronomers-are-looking-for-a-real-life-pandora*

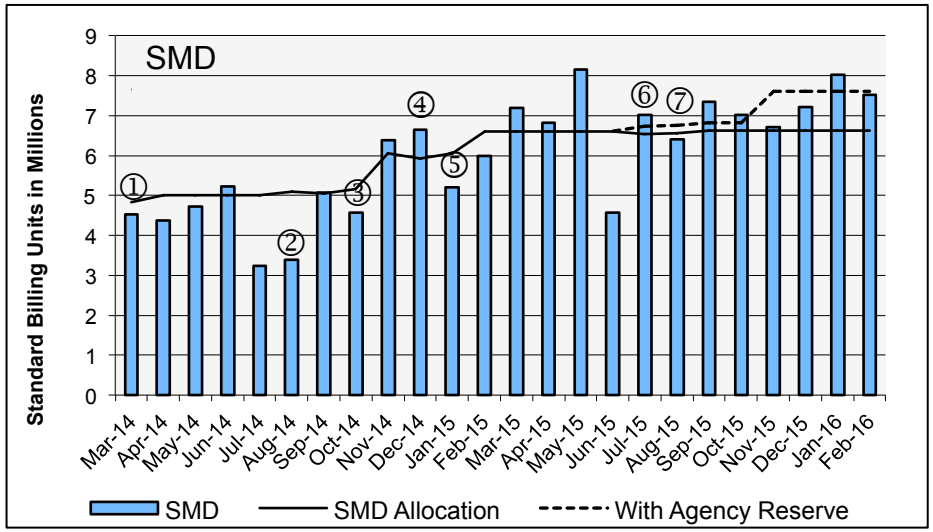
HECC Utilization

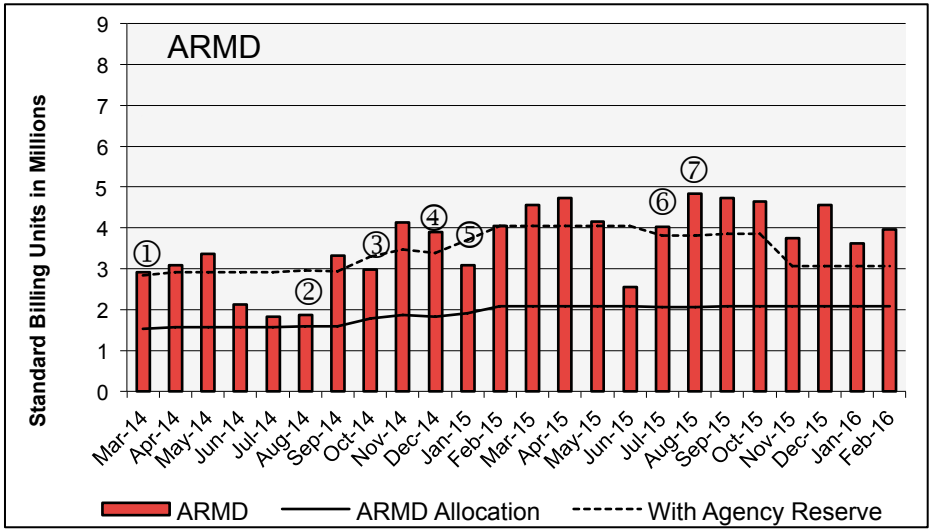


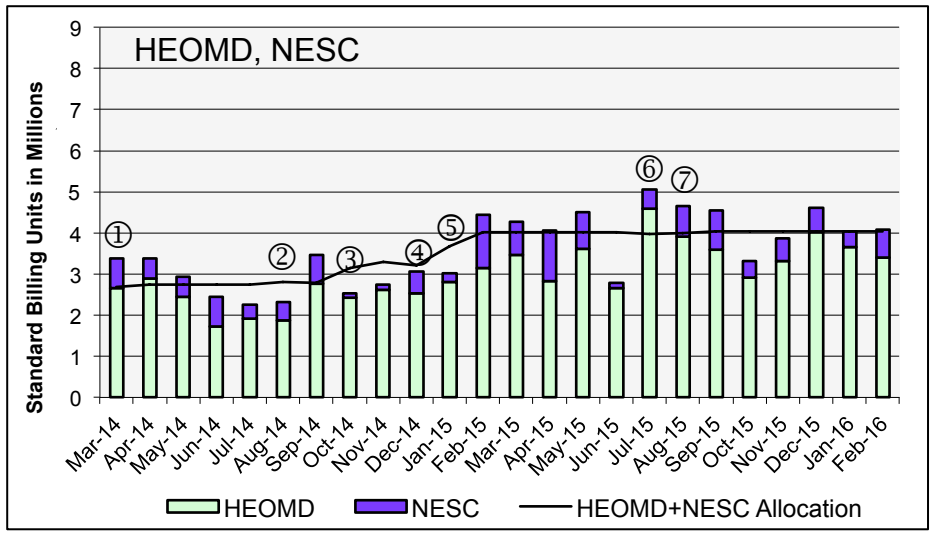
HECC Utilization Normalized to 30-Day Month



HECC Utilization Normalized to 30-Day Month







① 8 Ivy Bridge Racks added mid-Feb; 8 Ivy Bridge Racks added late Feb to Pleiades

② 4 Ivy Bridge Racks added mid-March to Pleaides

③ 6 Westmere Racks added to Merope, Merope Harpertown retired

④ 16 Westmere Racks retired, 3 Ivy Bridge Racks added, 15 Haswell Racks added to Pleiades; 10 Nehalem Racks and 2 Westmere Racks added to Merope

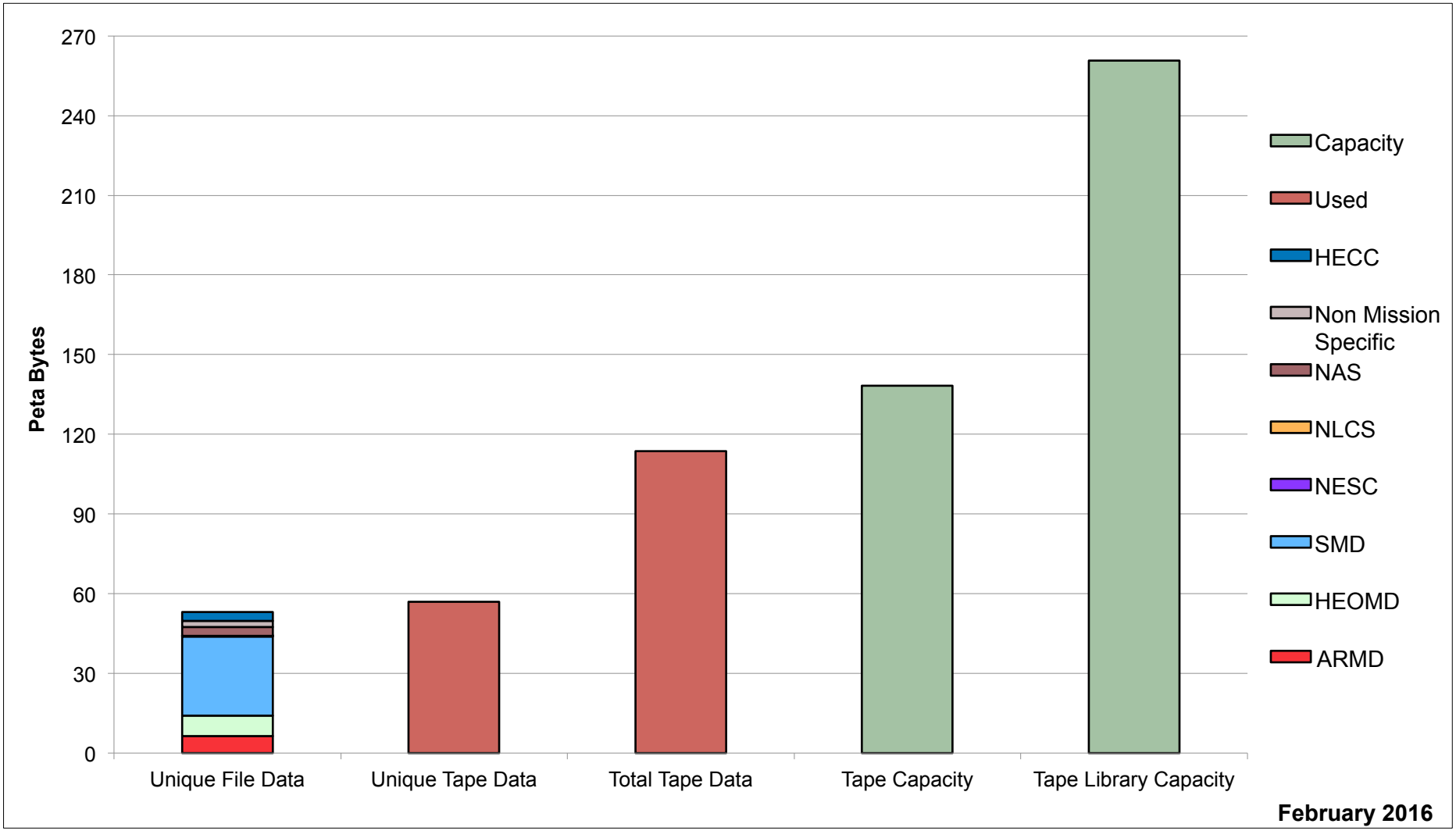
⑤ 16 Westmere Racks retired from Pleiades

⑥ 14 Haswell racks added to Pleiades

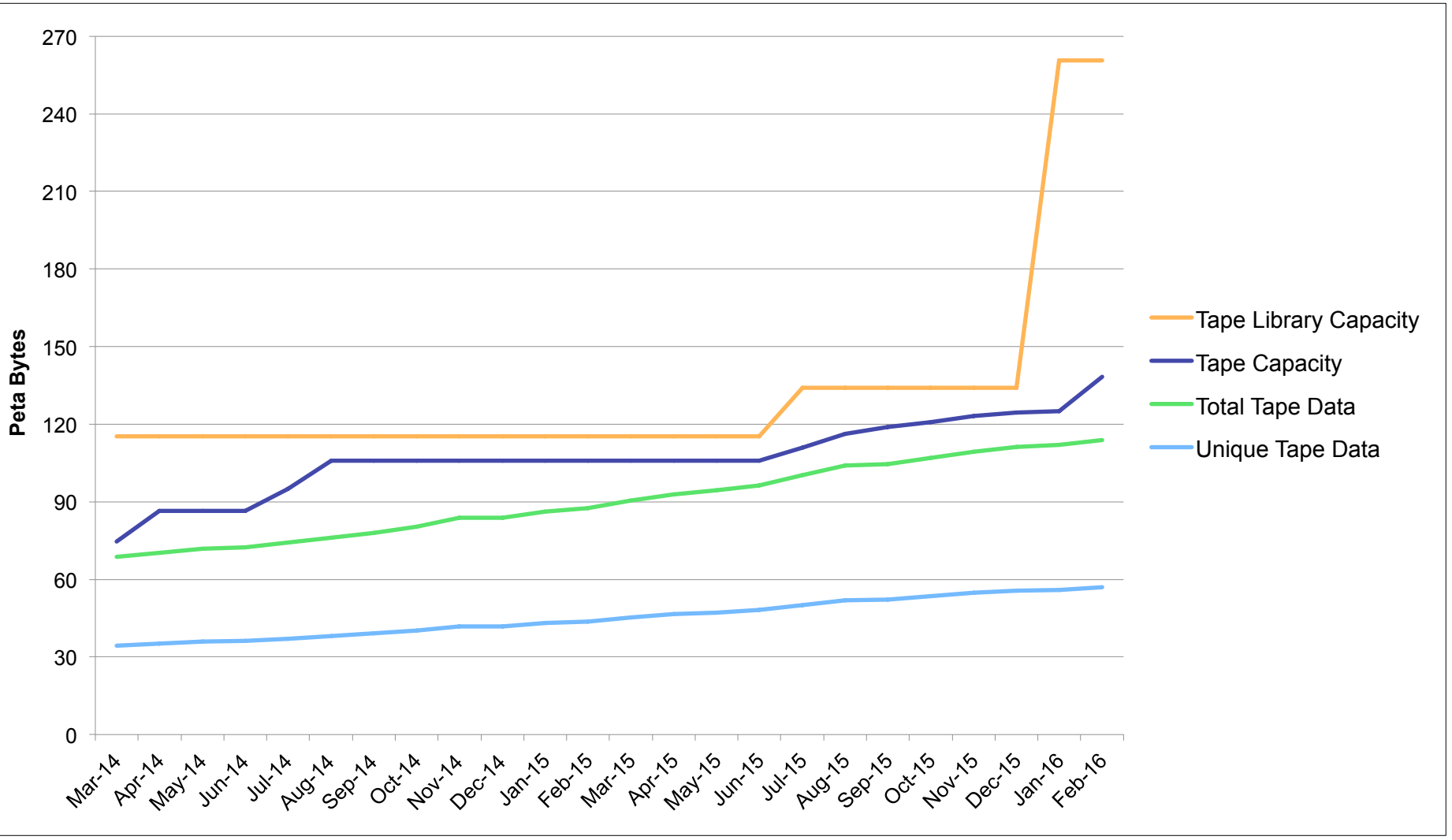
⑦ 7 Merope Nehalem Racks removed from Merope

⑧ 7 Merope Westmere Racks added to Merope

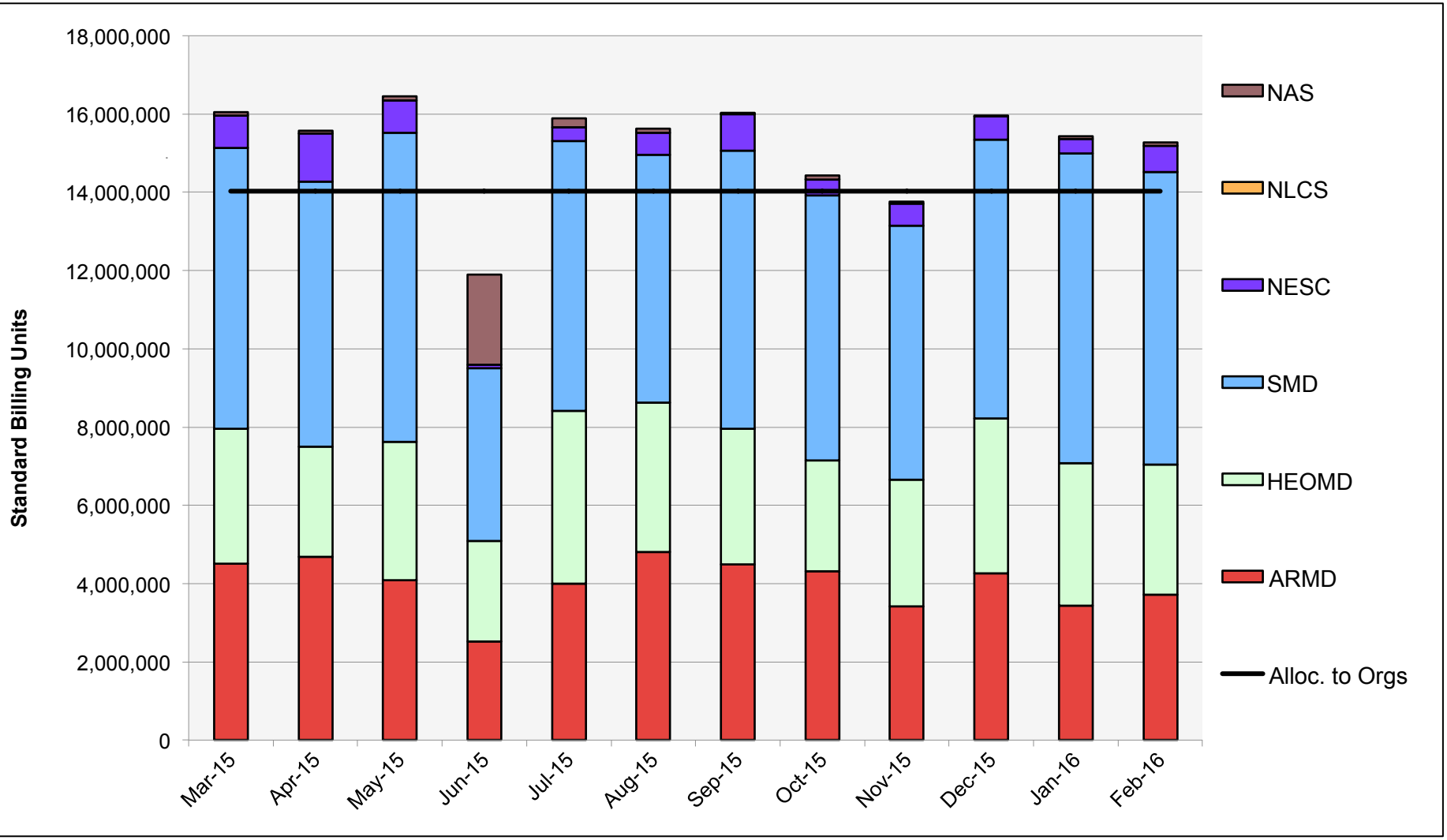
Tape Archive Status



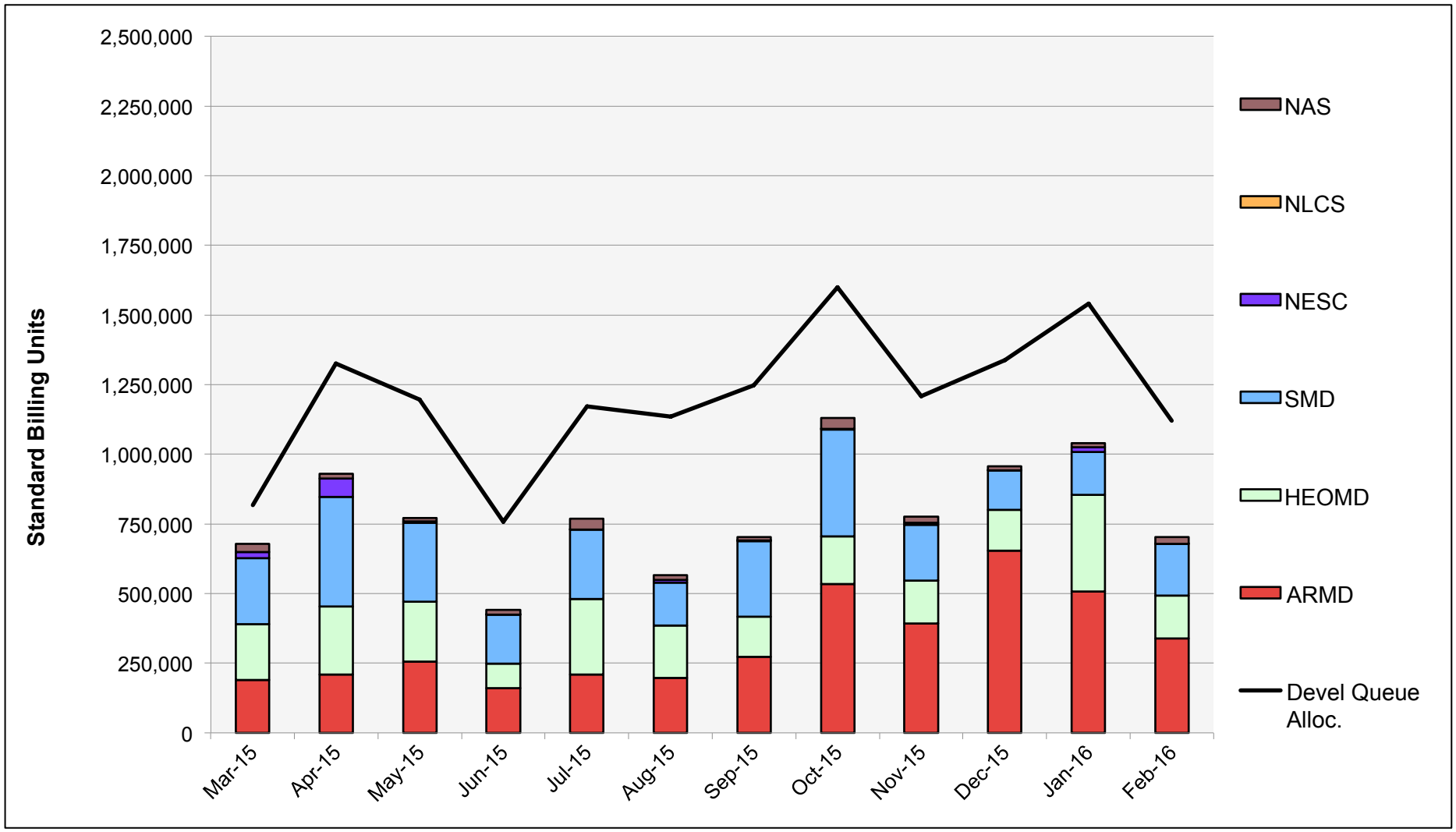
Tape Archive Status



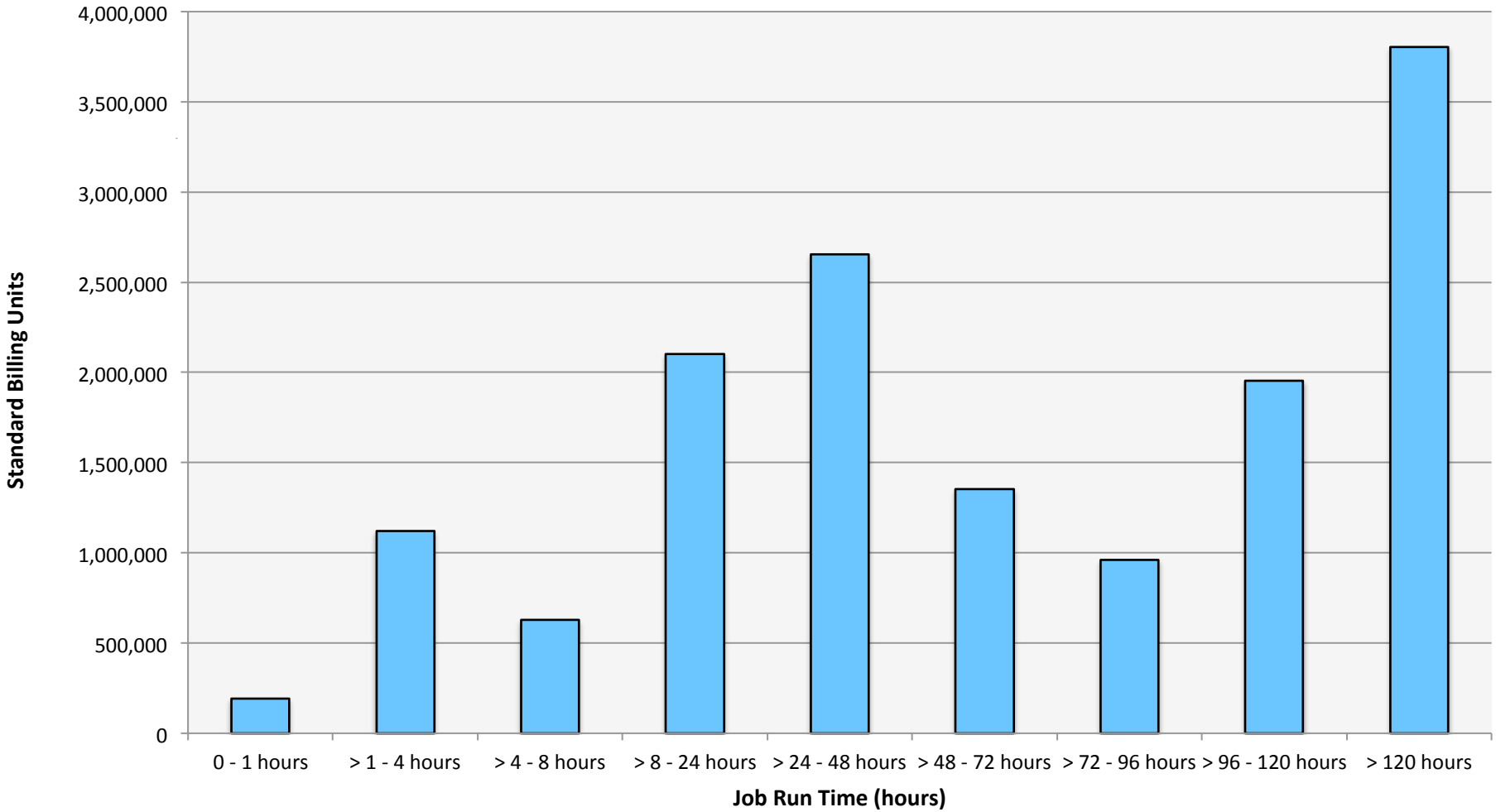
Pleiades:
SBUs Reported, Normalized to 30-Day Month



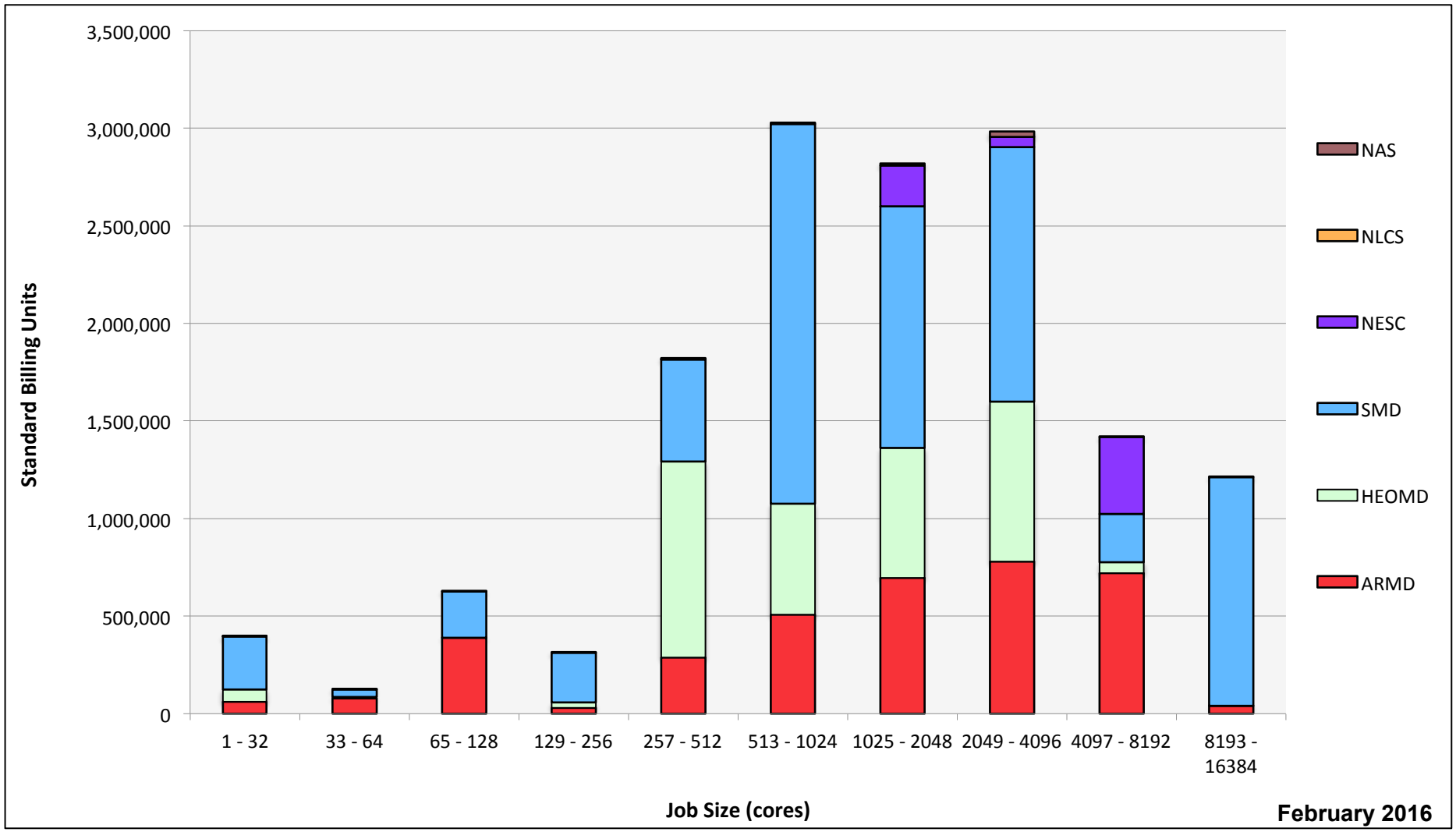
Pleiades:
Devel Queue Utilization



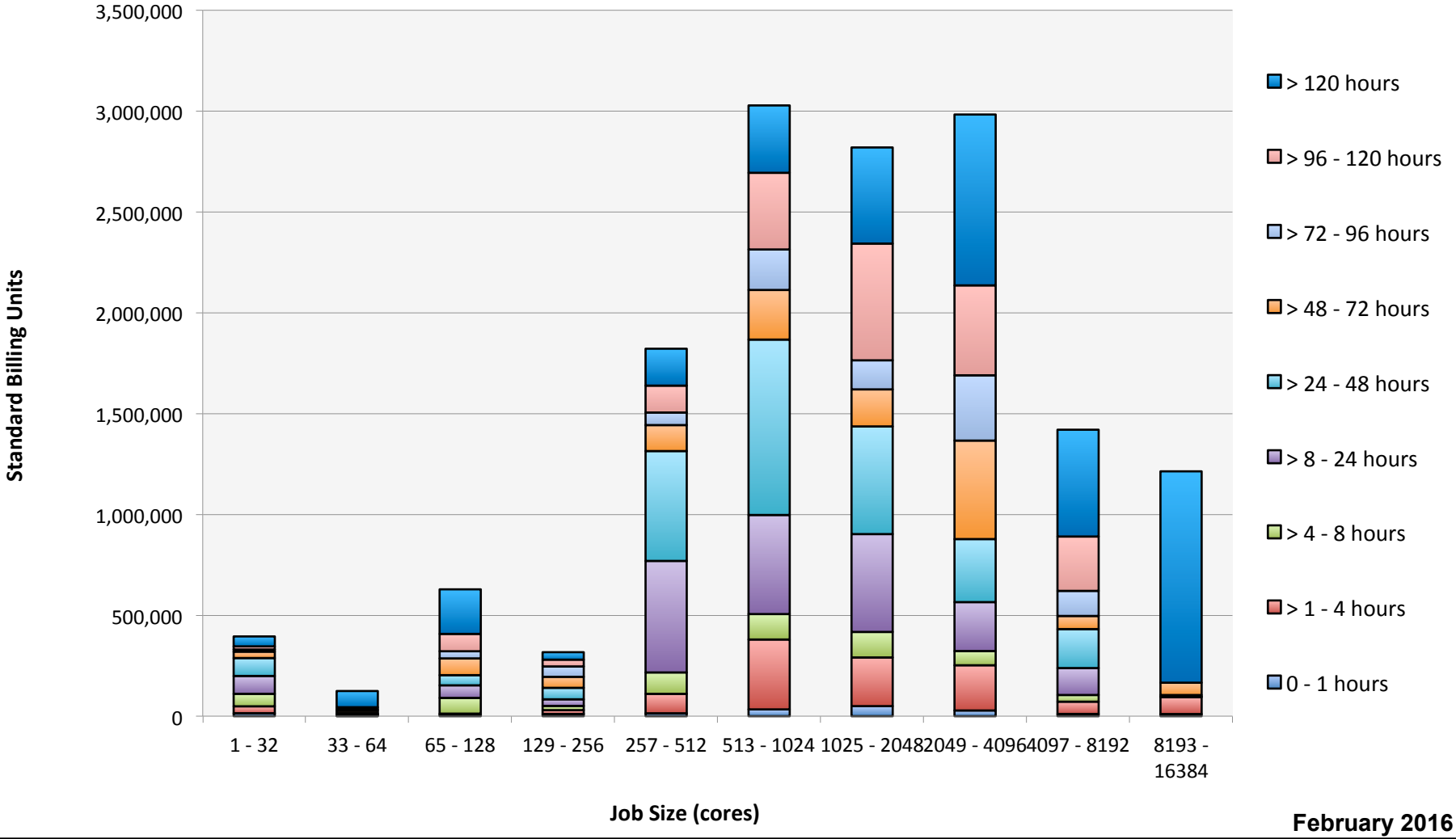
Pleiades:
Monthly Utilization by Job Length



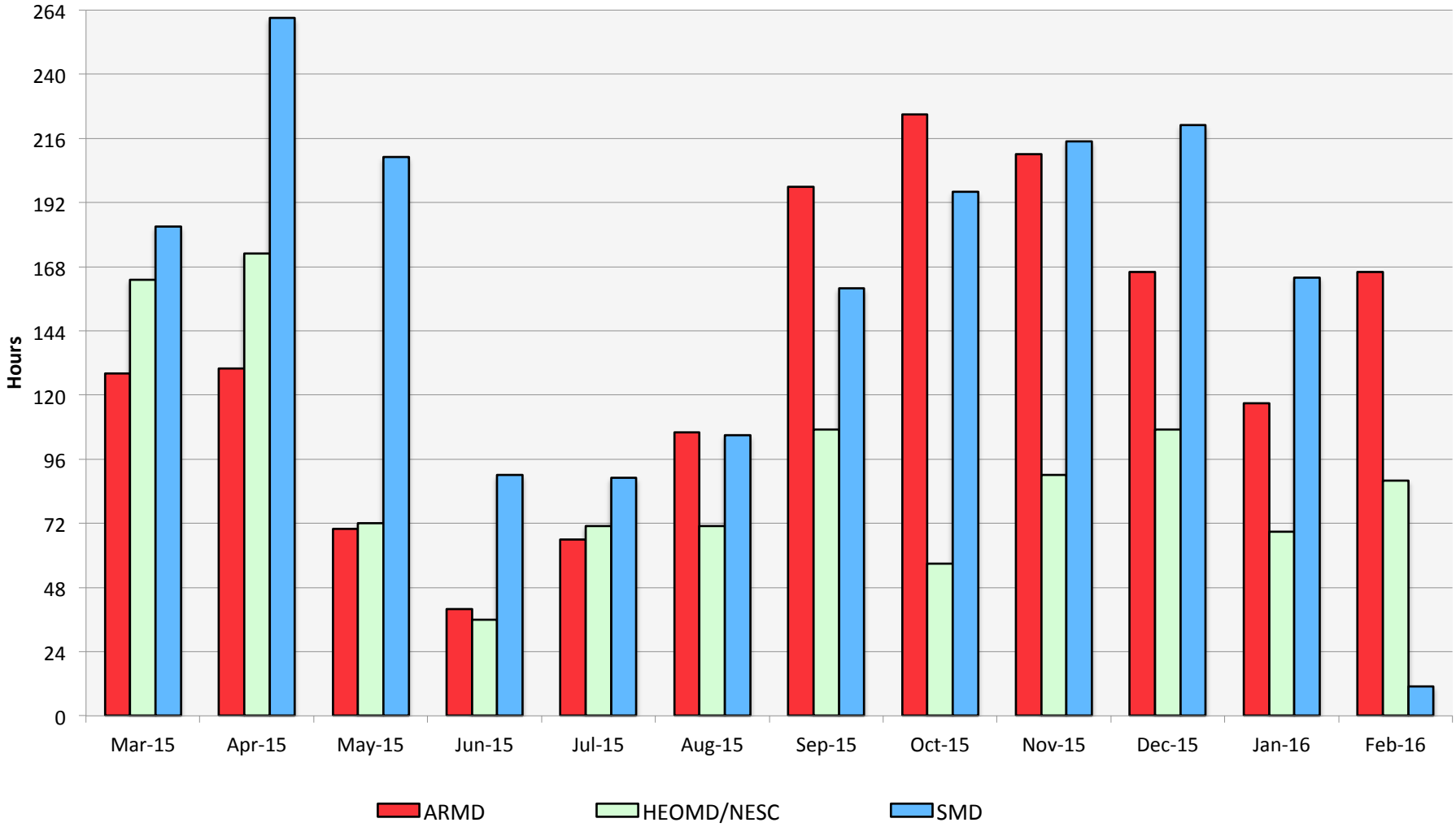
Pleiades:
Monthly Utilization by Size and Mission



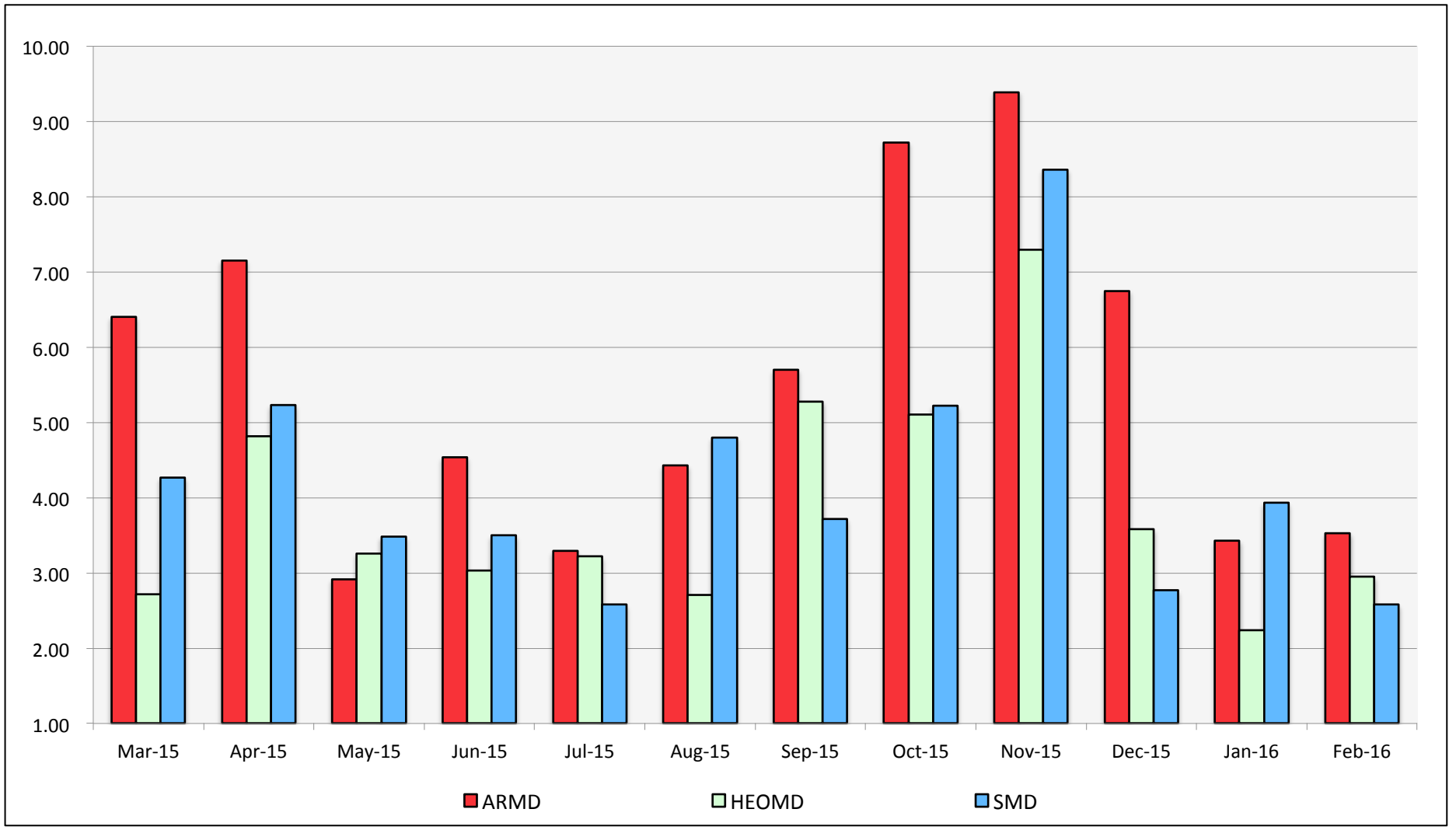
Pleiades:
Monthly Utilization by Size and Length



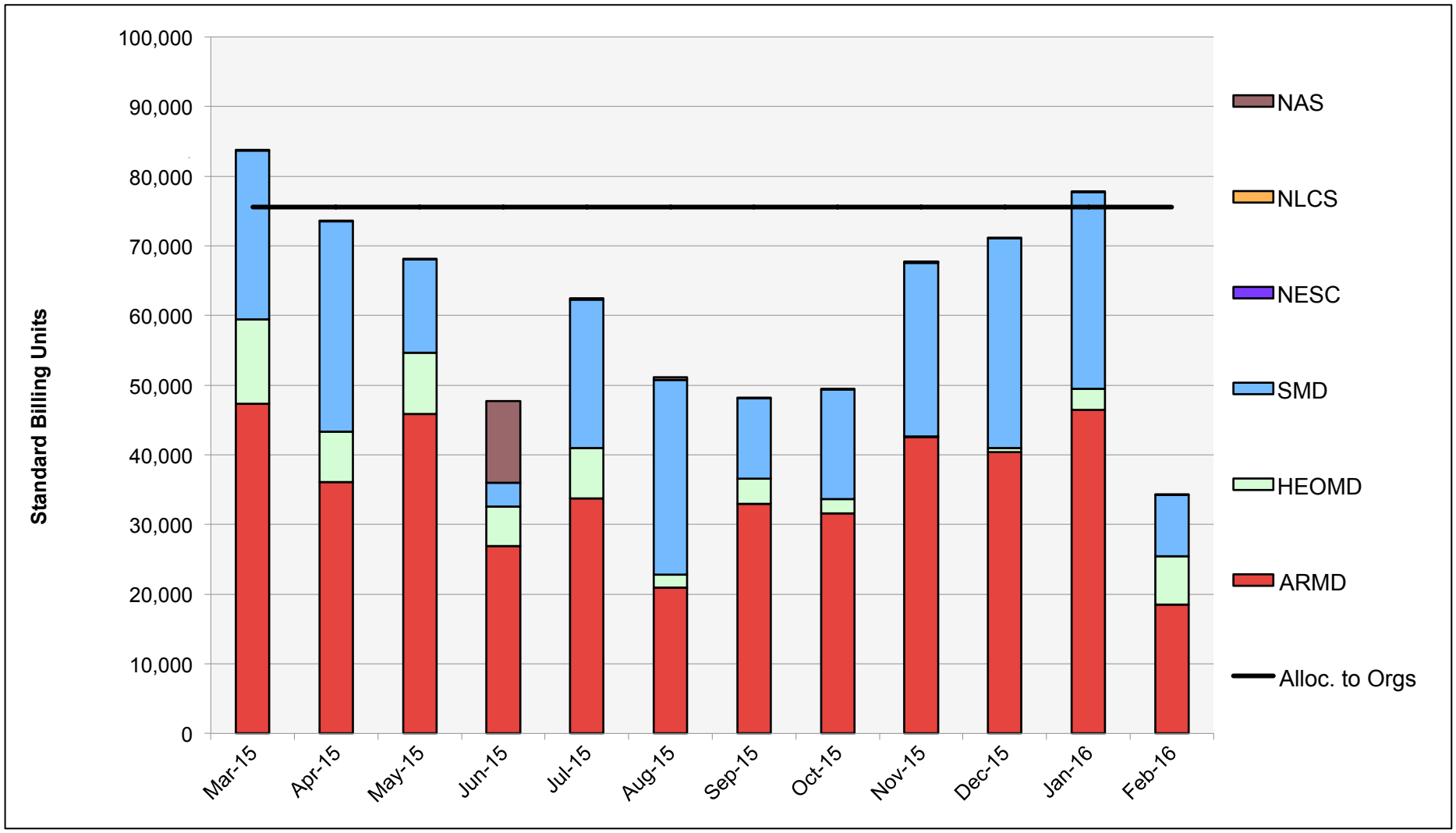
Pleiades:
Average Time to Clear All Jobs



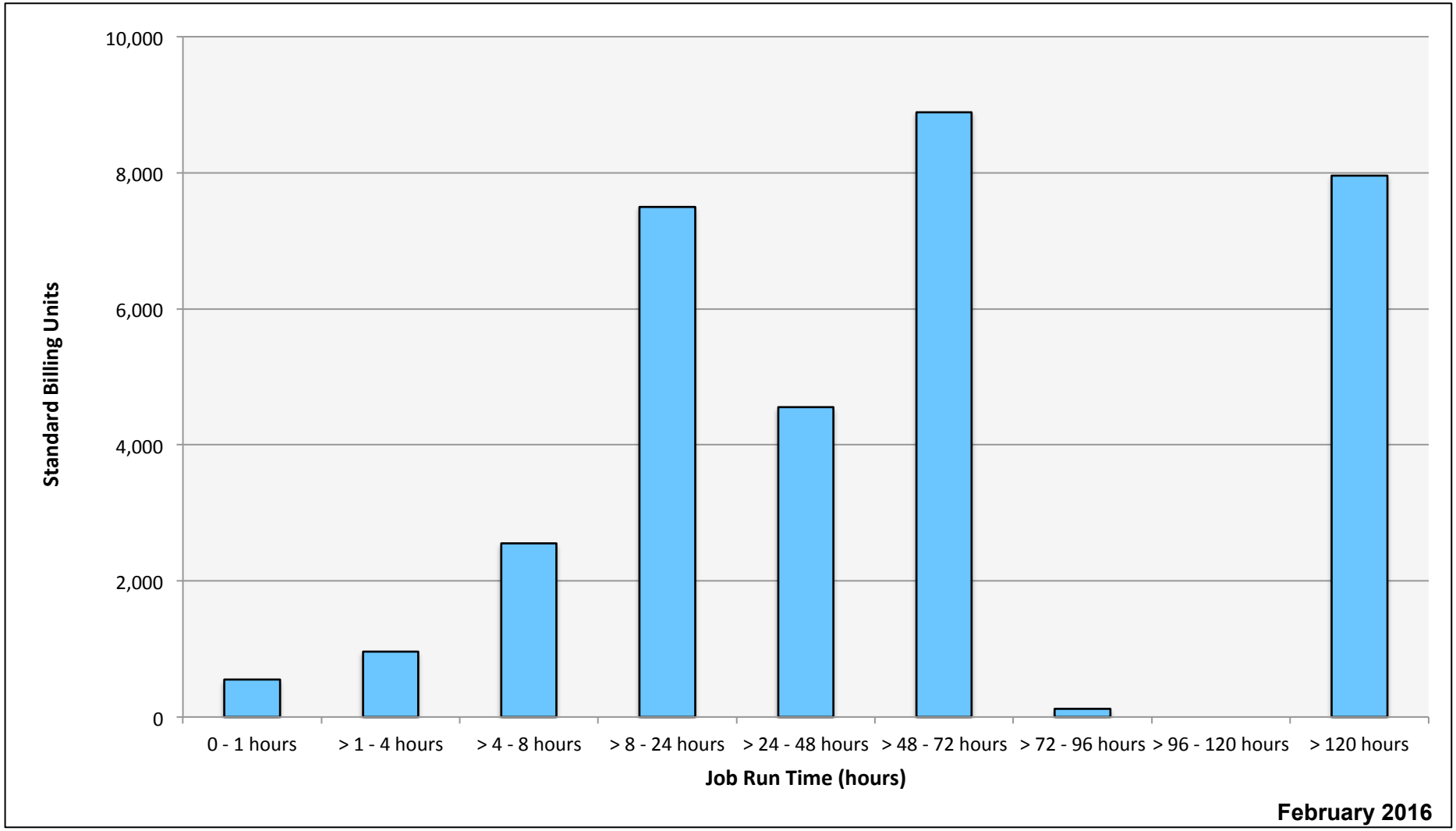
Pleiades:
Average Expansion Factor



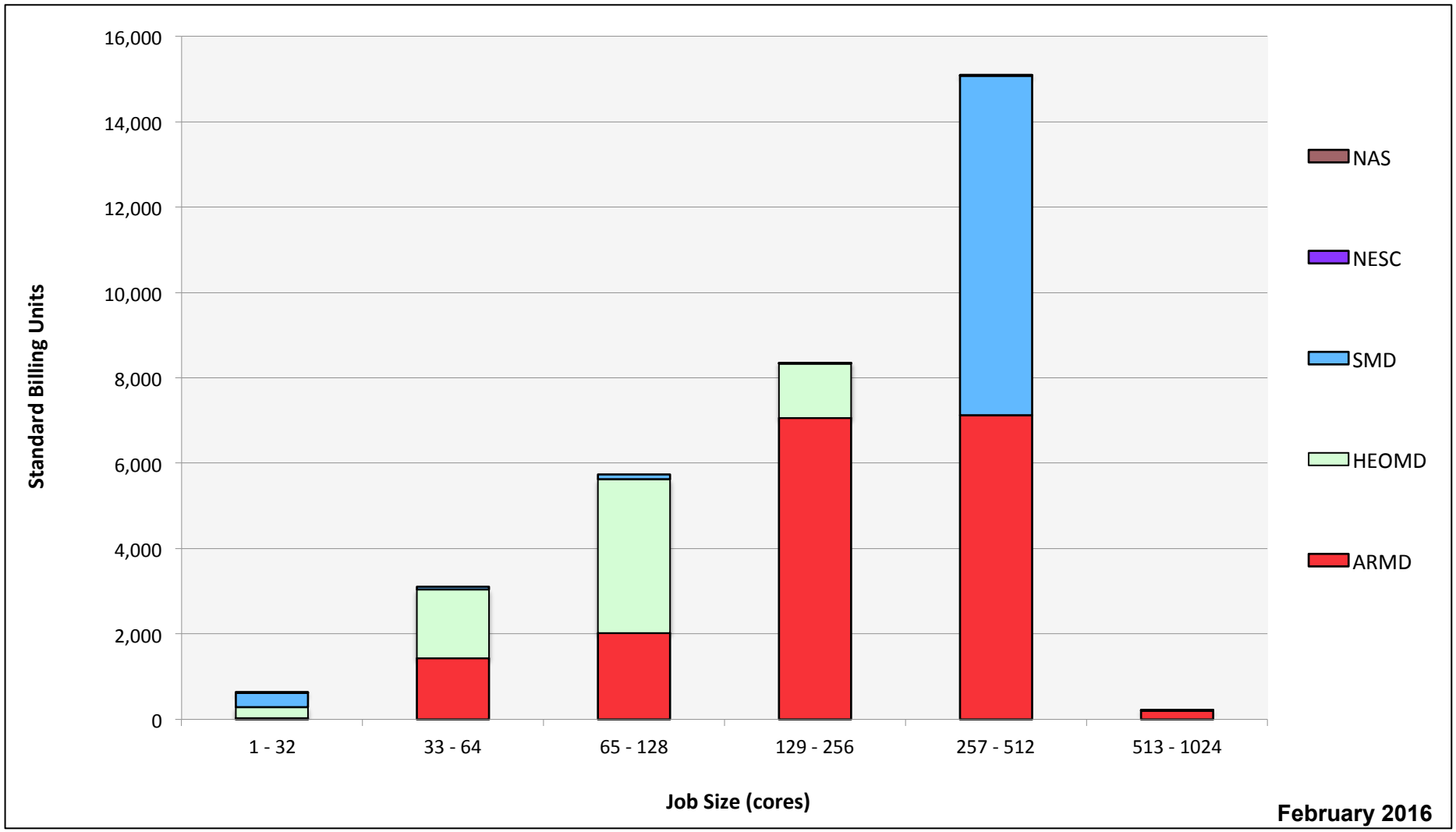
Endeavour:
SBUs Reported, Normalized to 30-Day Month



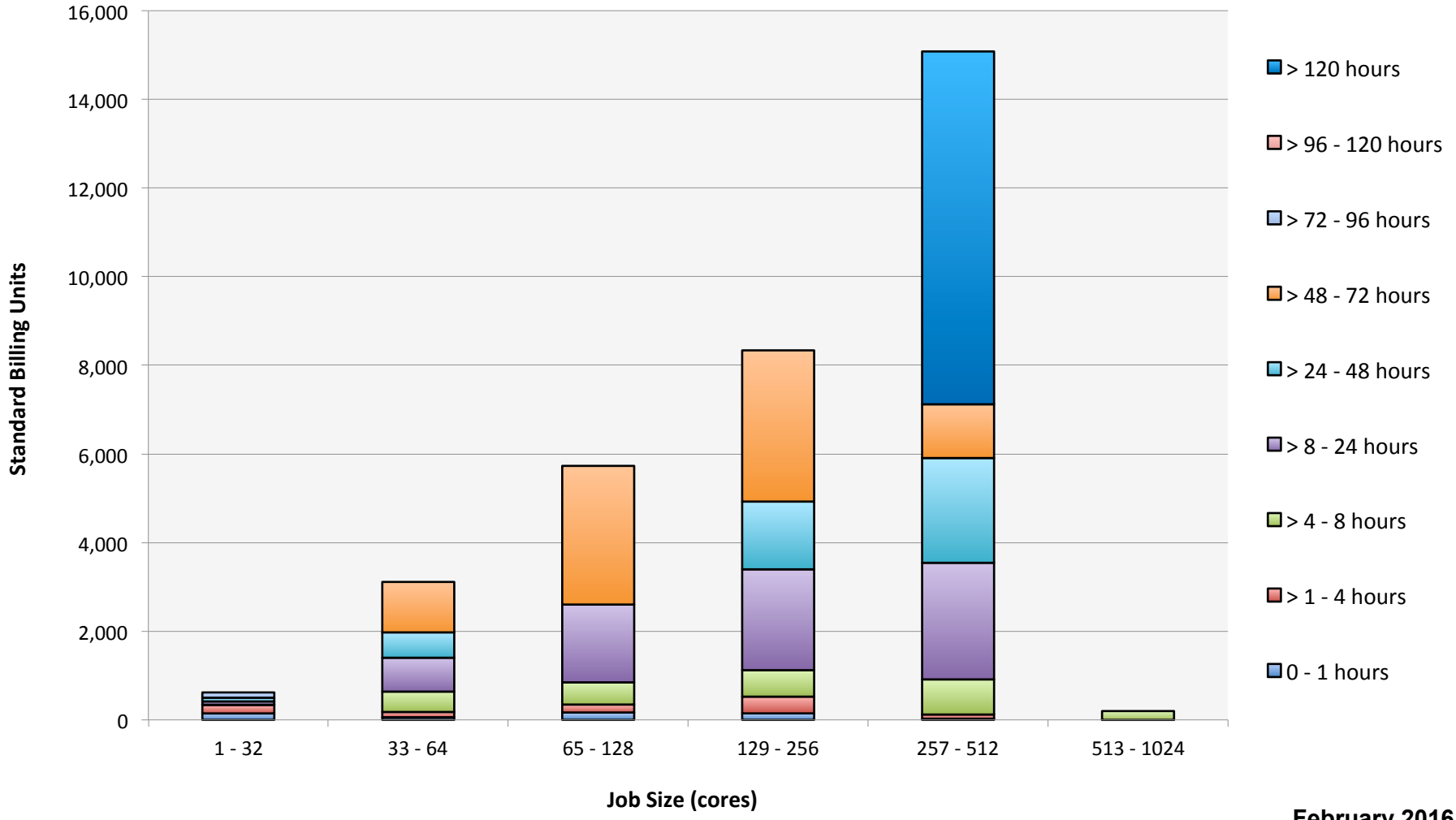
Endeavour:
Monthly Utilization by Job Length



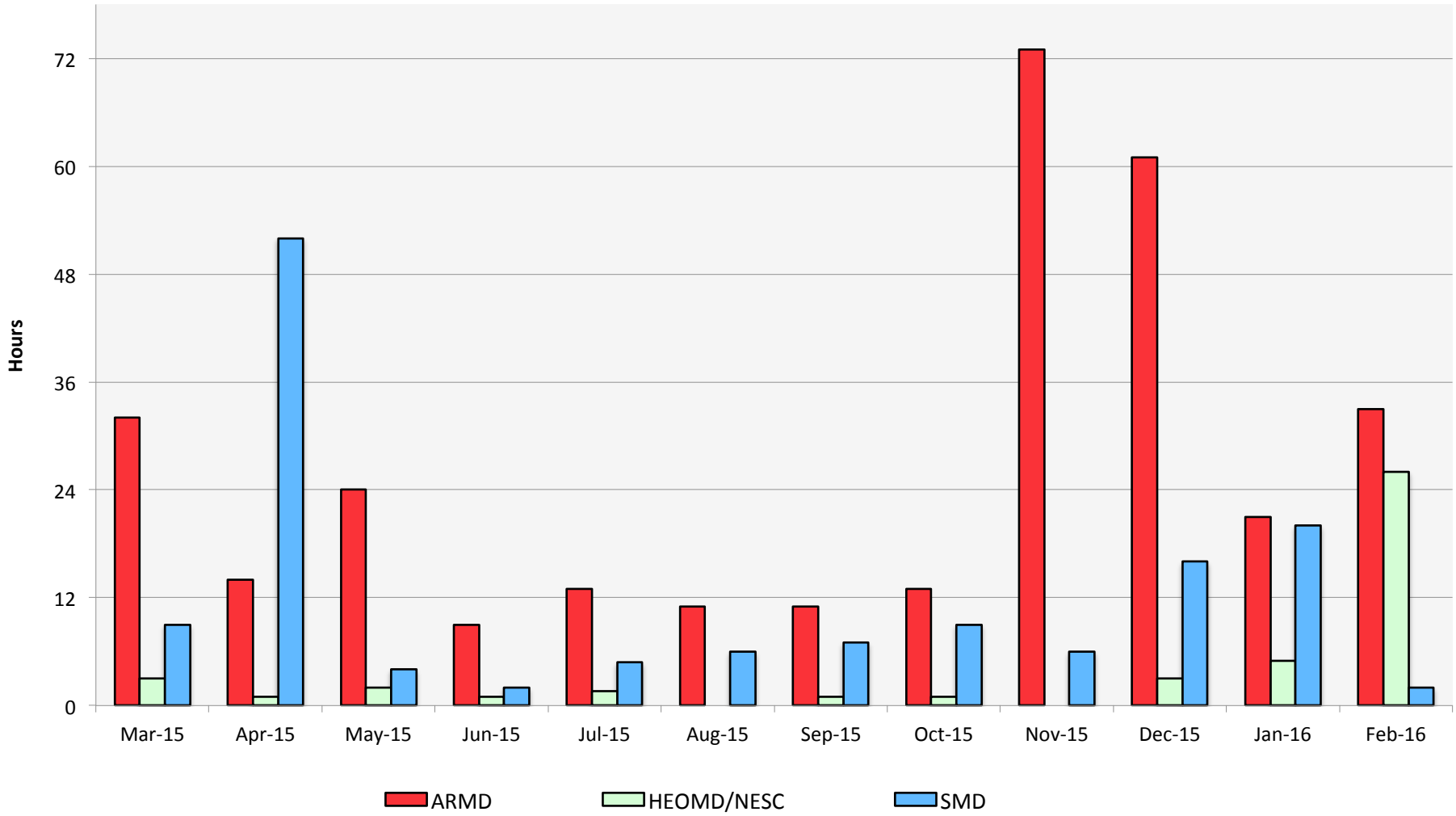
Endeavour:
Monthly Utilization by Size and Mission



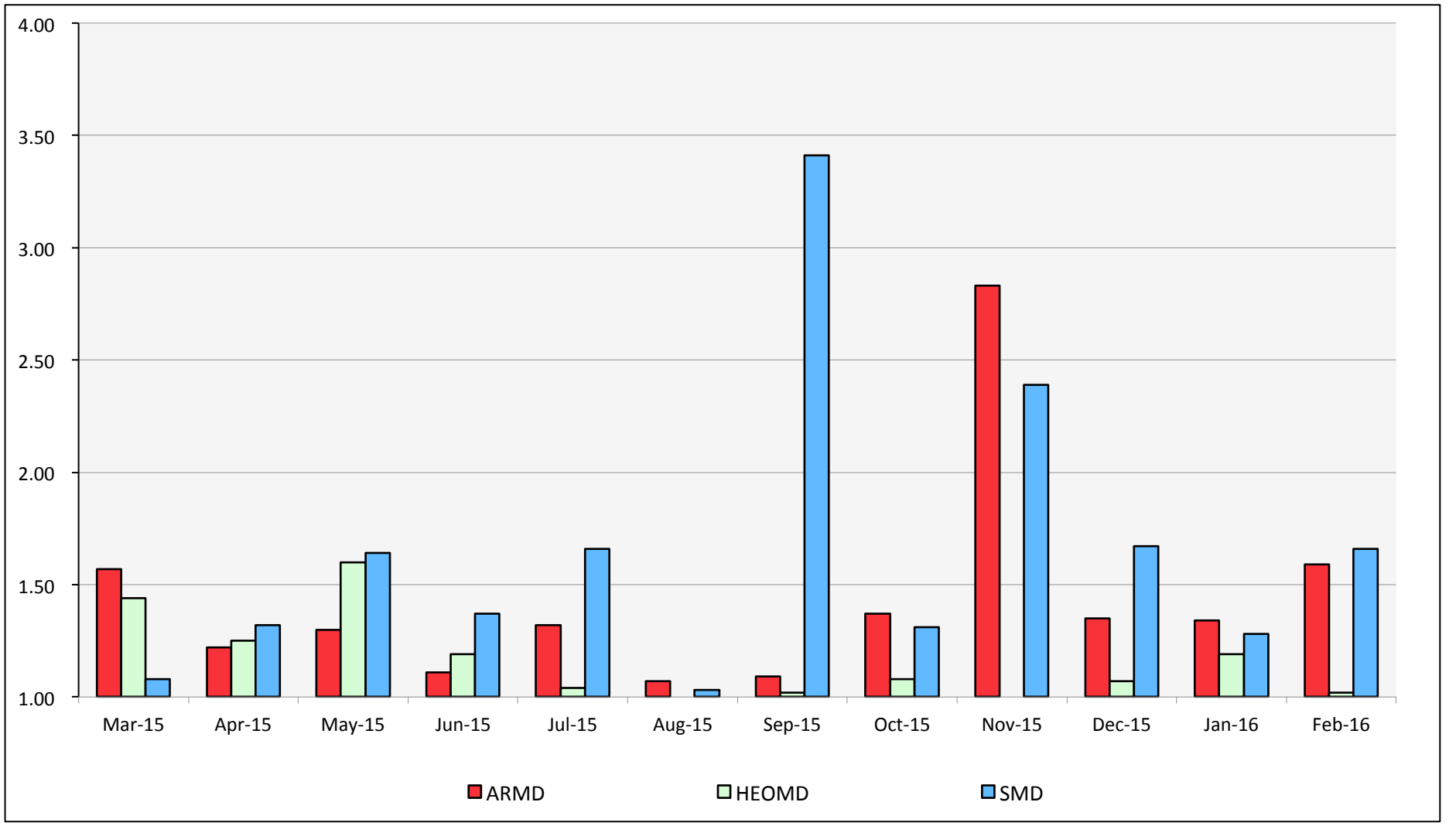
Endeavour:
Monthly Utilization by Size and Length



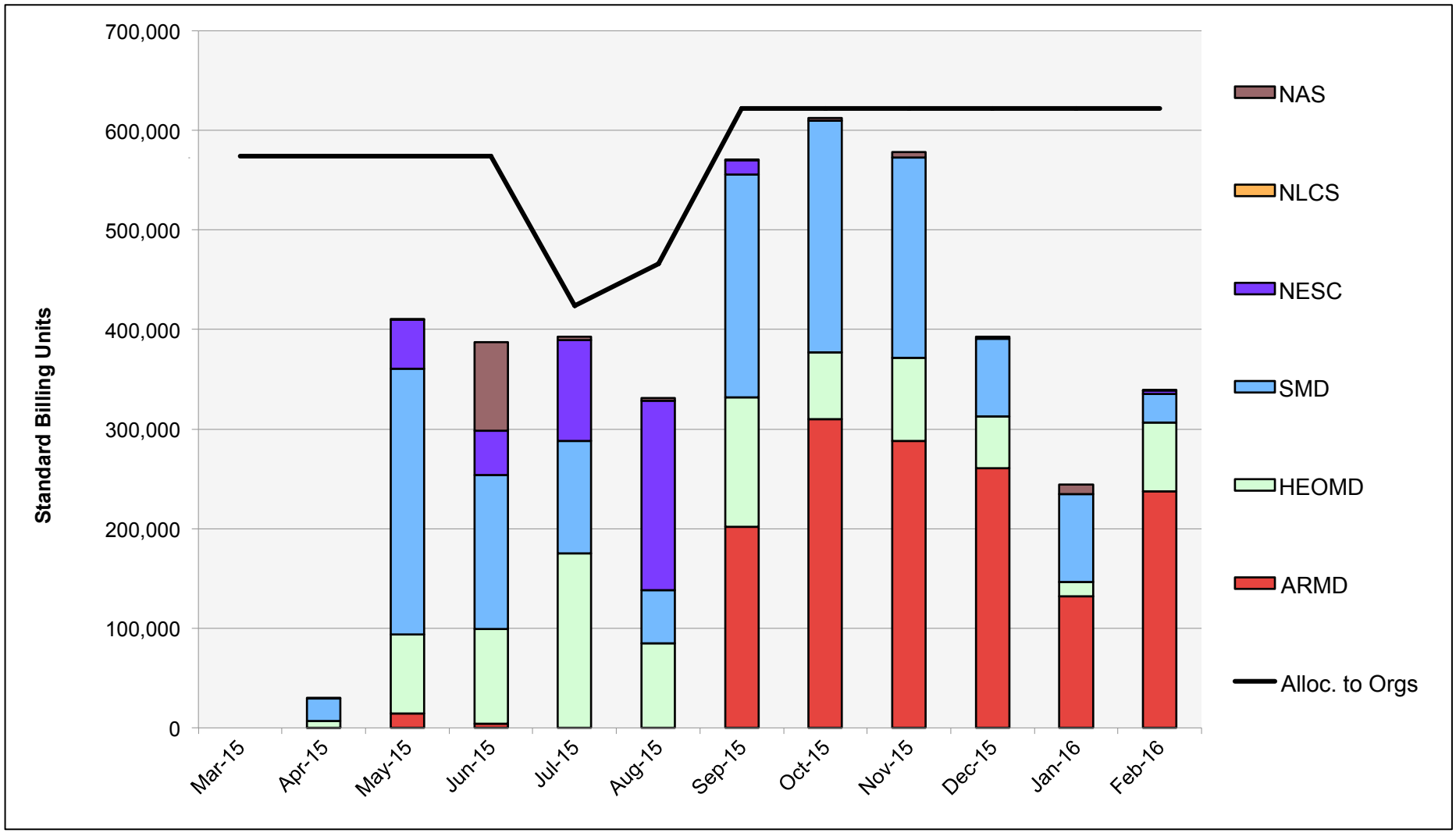
Endeavour:
Average Time to Clear All Jobs



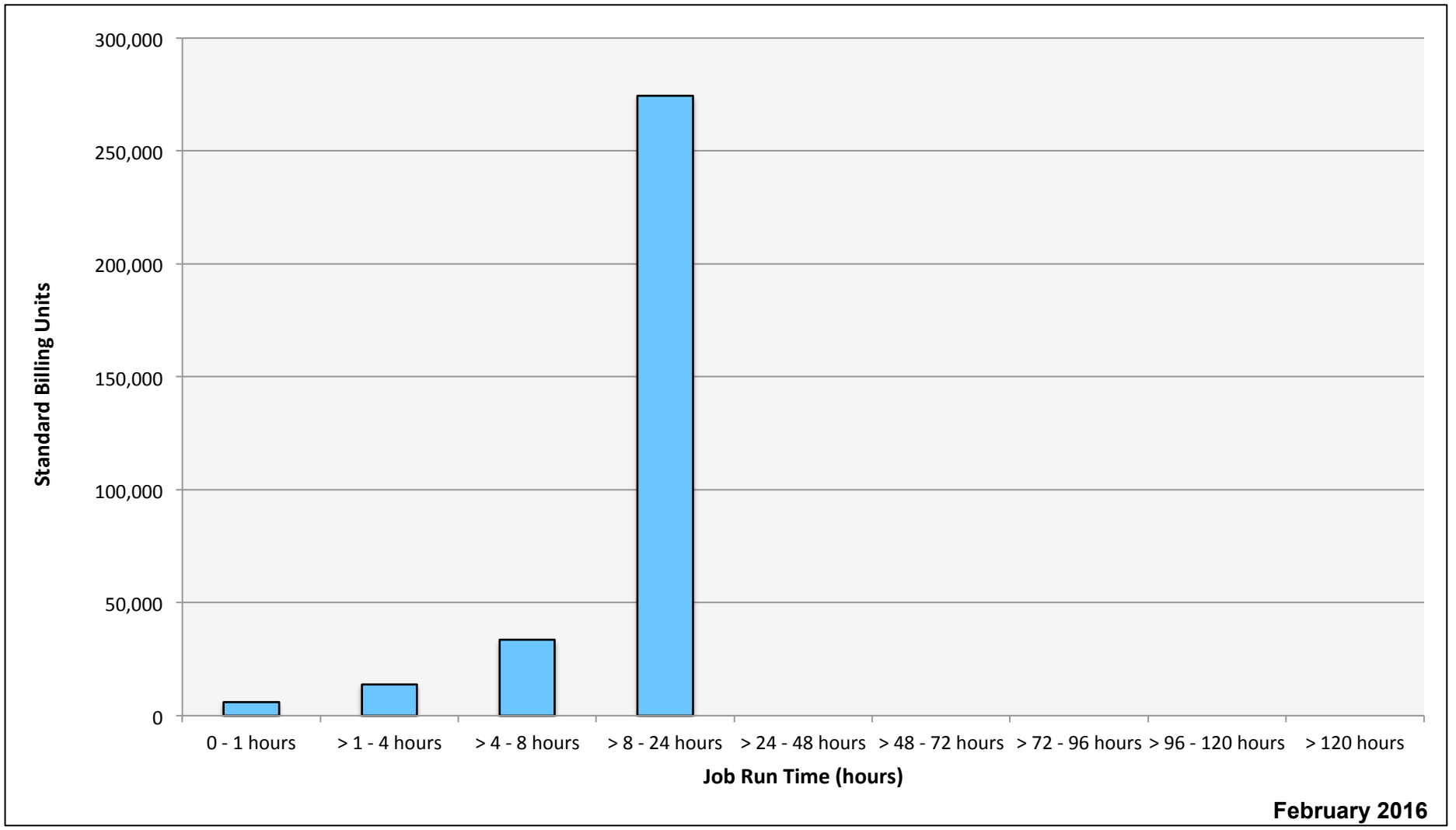
Endeavour:
Average Expansion Factor



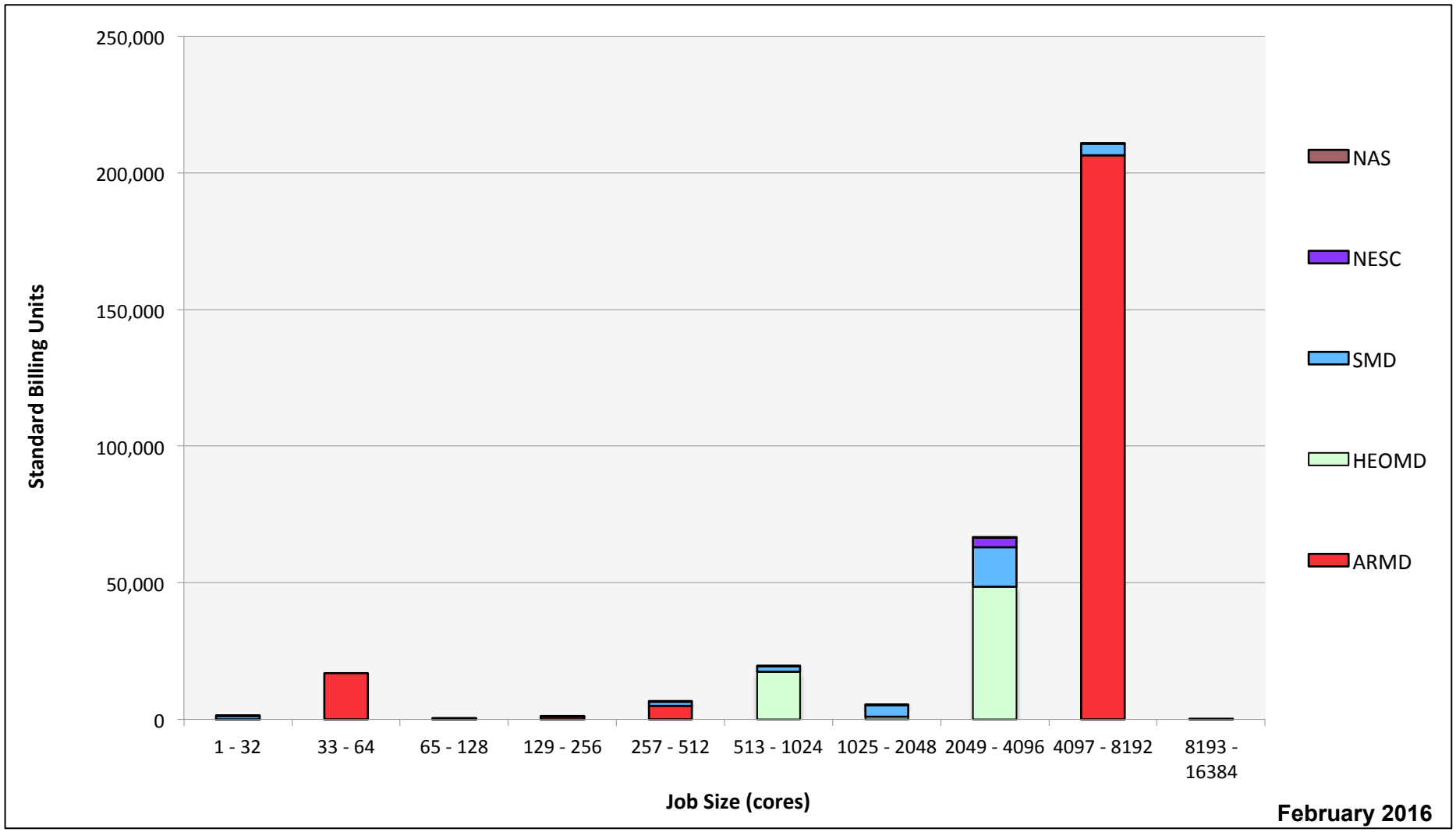
Merope:
SBUs Reported, Normalized to 30-Day Month



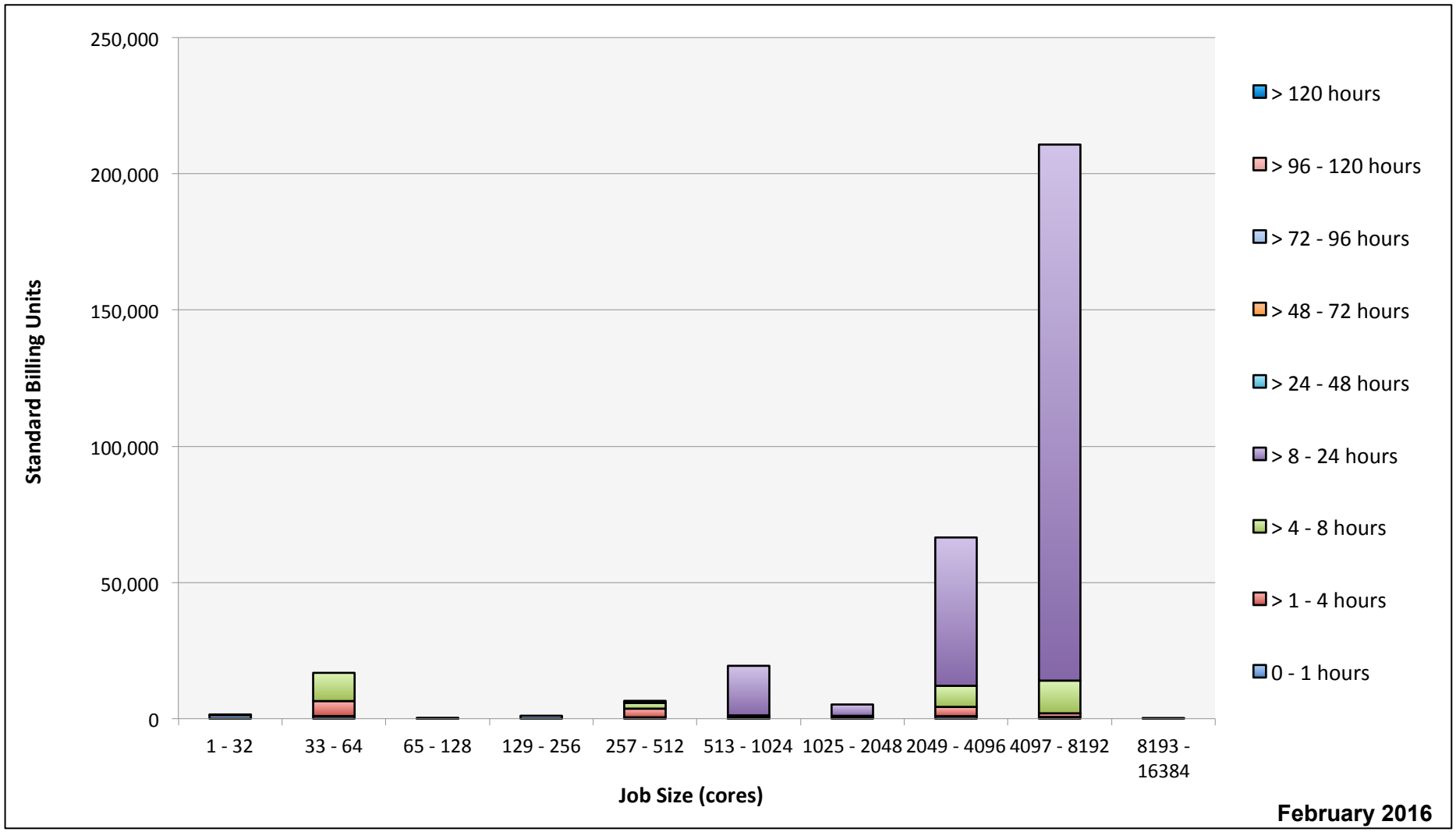
Merope:
Monthly Utilization by Job Length



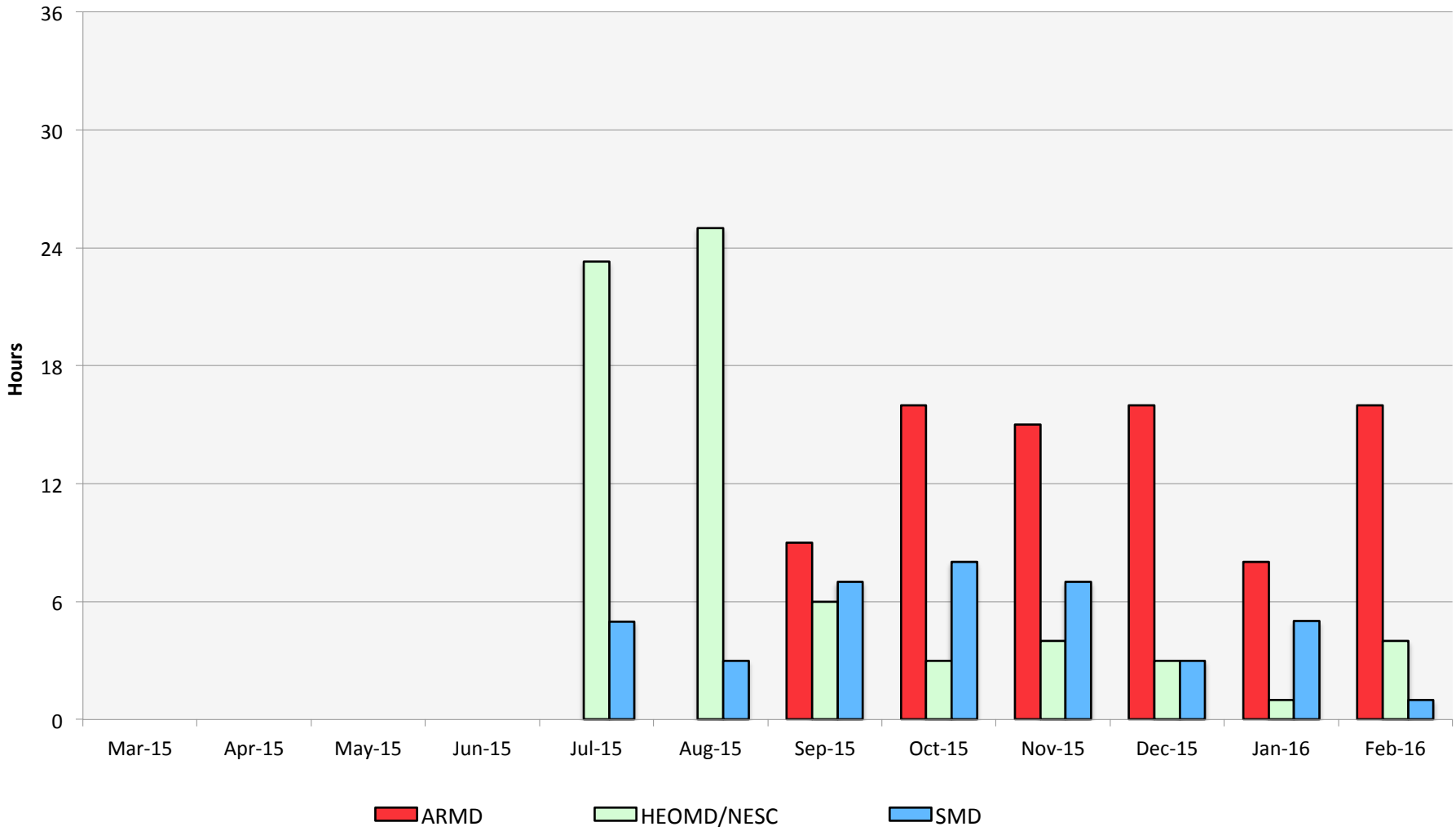
Merope:
Monthly Utilization by Size and Mission



Merope:
Monthly Utilization by Size and Length



Merope:
Average Time to Clear All Jobs



Merope:
Average Expansion Factor