Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

August 10, 2015

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Pleiades Ranks #5 in the World on the HPCG Benchmark

- The Pleiades supercomputer achieved 0.1319 petaflops on the High Performance Conjugate Gradient (HPCG) Benchmark, and ranked 5th in the world on the June 2015 HPCG list.
- HPCG is a relatively new benchmark designed to alleviate limitations of the LINPACK Benchmark used for the TOP500 list.
- Whereas LINPACK emphasizes pure floating-point performance, HPCG provides coverage of the major computation patterns seen in NASA's physics-based simulations, such as:
  - Communications: global and neighborhood collectives.
  - Computation: vector updates, dot products, sparse matrix-vector multiplications, local triangular solves.
- In addition to providing a more accurate performance measurement of real-world scientific and engineering computations on Pleiades, HPCG takes less time to run than LINPACK, making it a good tool for finding problems on Pleiades during maintenance and test time.

Mission Impact: Running the HPCG benchmark across a large portion of the Pleiades supercomputer provides HECC with a good method to identify and address system issues, thereby improving overall reliability for users.

Site	Computer	Cores	HPL Rmax [Pflop/s]	TOP500 Rank	HPCG [Pflop/s]
NSCC / Guangzhou	Tianhe-2 NUDT, Xeon 12C 2.2GHz + Intel Xeon Phi 57C + Custom	3120000	33.863	1	0.5800
RIKEN Advanced Institute for Computational Science	K computer, SPARC64 VIIIfx 2.0GHz, Tofu interconnect	705024	10.510	4	0.4608
DOE/SC/Oak Ridge Nat Lab	Titan - Cray XK7 , Opteron 6274 16C 2.200GHz, Cray Gemini interconnect, NVIDIA K20x	560640	17.590	2	0.3223
DOE/SC/Argonne National Laboratory	Mira - BlueGene/Q, Power BQC 16C 1.60GHz, Custom	786432	8.587	5	0.1670
NASA / Mountain View	Pleiades - SGI ICE X, Intel E5-2680, E5-2680V2, E5-2680V3, Infiniband FDR	186288	4.089	11	0.1319
Swiss National Supercomputing Centre (CSCS)	Piz Daint - Cray XC30, Xeon E5-2670 8C 2.600GHz, Aries interconnect , NVIDIA K20x	115984	6.271	6	0.1246

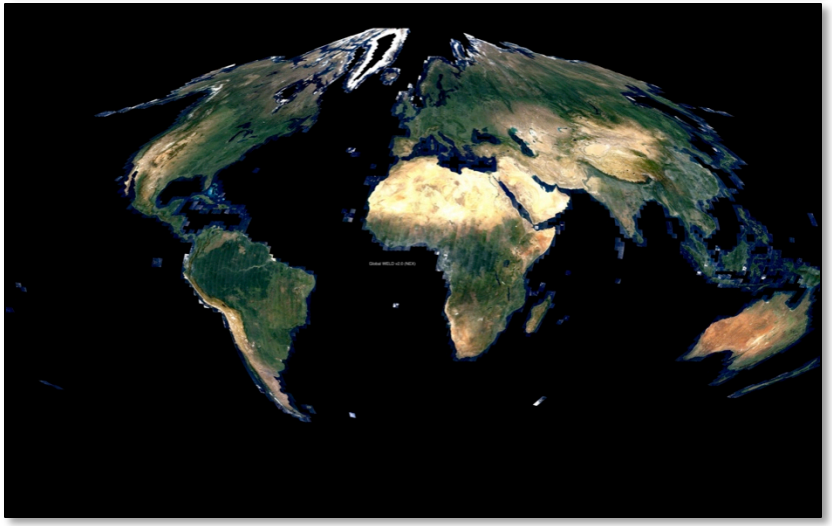
Over 40 high-performance computing sites submitted results for the third HPCG benchmark list, up from 25 submissions at SC14 and 15 submissions at ISC 2014. Pleiades, at #5 on the June 2015 HPCG list, performed better than three machines that are ranked above it on the TOP500 list, which rates performance on the LINPACK benchmark.

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.

NEX Storage Triples in Capacity to Support Landsat Data Products

- HECC engineers tripled the NASA Earth Exchange (NEX) dedicated storage capacity on Pleiades, without impacting NEX users.
- The NEX filesystem grew from 480 terabytes (TB) to 1.5 petabytes (PB) of space, an increase of 220%.
- This increment to the NEX NFS filesystem will enable processing of Landsat data to generate data products for the Earth Observing System Data and Information System (EOSDIS) Global Imagery Browse Service, and continued generation of Web Enabled Landsat Data products.
- Additional Landsat data acquired for this processing will increase the NEX holdings of Landsat 7 and 8 data available to all NEX users by over 300 TB.
- This multi-year processing effort will require almost a PB of input data, produce multiple PB of data products, and manipulation of over 2 million files during processing.

Mission Impact: The enhanced storage infrastructure for the NASA Earth Exchange increases the availability and usability of Landsat data for the scientific community, land use planners, and the public, worldwide.



NASA's Web Enabled Landsat Data (WELD) and Global Imagery Browse Service (GIBS) images provide scientists, land use planners, environmental managers, and the public with access to full resolution, time-sequenced Landsat data.

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HECC Augments Archive Tape Library Capacity

- HECC engineers augmented the Lou archive tape library capacity to meet users' growing storage requirements.
- The tape library capacity increased by 18%, to 134 petabytes of archive storage, with the addition of LTO6 tape drives to the tape subsystem.
- Each LTO6 tape can hold 2.5 terabytes (TB) of uncompressed data, which provides a 66% increase over existing LTO5 tapes.
- This increased capacity enables HECC to wait until the higher capacity LTO7 tape drives are released—anticipated by January 2016. The LTO7 tape technology will provide approximately 6 TB of uncompressed capacity per tape.
- The release of LTO7 would enable the archive system to store approximately half an exabyte of data, with compression.

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

The HECC tape library capacity has grown from 114 petabytes (PB) of data to 134 PB with the recent addition of LTO6 tape drives. This provides the capacity needed until the LTO7 tape technology is available.

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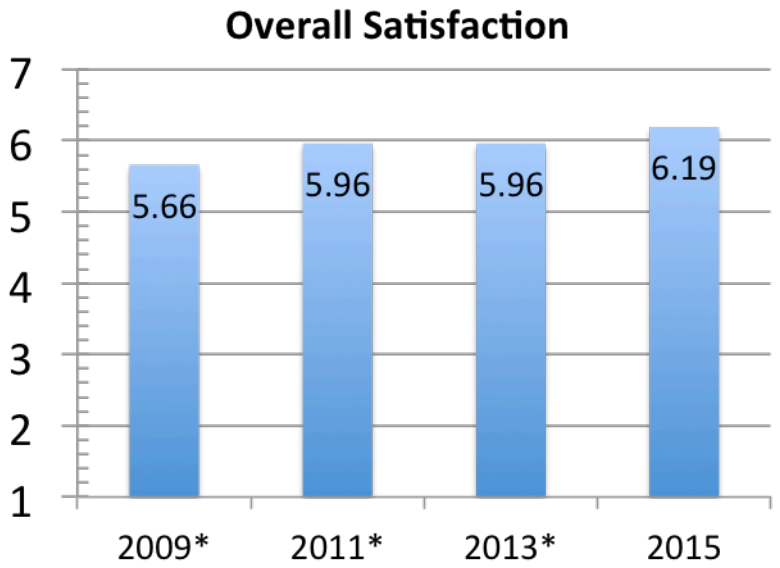
HECC User Survey Results Help Improve Services to our Users

- The HECC User Services and Publications & Media teams completed the 2015 HECC Project user survey.
- Users from all NASA mission directorates, as well as university and industry, participated in the survey.
- A total of 314 users assessed 12 HECC service areas.
- Scores are very similar to past surveys, with Overall Satisfaction scoring 6.19 out of 7.0.
- 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 gain more insight into the nature of users' concerns.
  - Modifying to a 7-point scale to capture more detail in response scores.
  - Adding "importance" question to cross-reference with scores from service areas.
  - Adding logic questions to gain more detail from low scoring responses.
- A representative quote from one of our users: "Really good service overall but system should be larger for faster turnaround."

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 12 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.

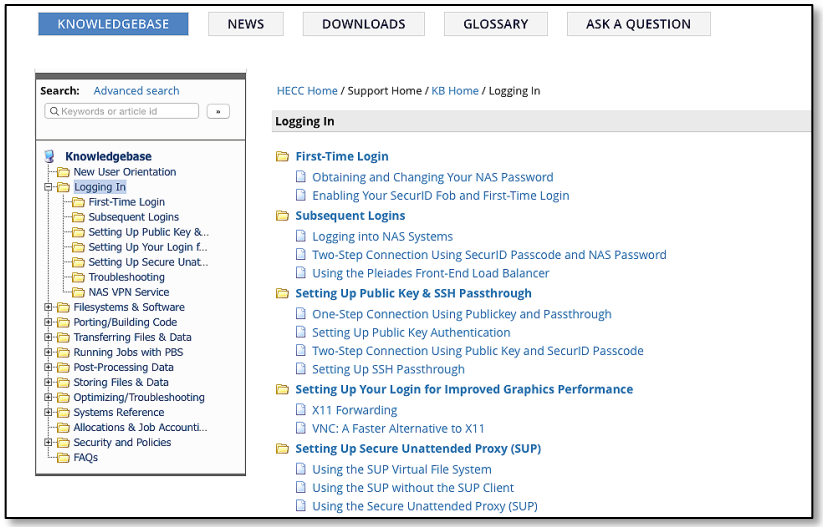
* Calibrated from 5 point scale

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

Knowledge Base Enhanced to Improve Information Access for HECC Users

- The HECC Knowledge Base (KB) provides NASA users with the information they need to access HECC resources, compile code, transfer files, optimize applications, run jobs, post-process their data, and troubleshoot issues.
- Recently, the HECC Publications and Media Team upgraded and enhanced the Knowledge Base, with numerous benefits for users. Work included:
  - Reorganized the approximately 200 articles into a task-based orientation that mirrors the typical user workflow, to help researchers more quickly and easily find the information they need in context.
  - Reformatted article elements such as code boxes and alert boxes, and updated fonts and styles to make information clearer and easier to read.
  - Published a mobile instance of the KB, so users can effectively access articles via their smartphones.
  - Upgraded to the latest version of the KBPublisher, which includes new search capabilities, along with improved editing/review tools and workflows for timely updates.
- The team worked with the Applications team to refine the task-based organization, and with the Engineering Servers and Services team to upgrade the back-end software and move it to a server with CA SiteMinder authentication.

Mission Impact: The HECC Knowledge Base provides the technical documentation NASA researchers and engineers need to effectively use HECC resources, including the agency's flagship Pleiades supercomputer.



The HECC Knowledge Base contains approximately 200 articles that describe how to use the Pleiades, Endeavour, and Merope supercomputers. Structuring documentation by tasks can help HECC users quickly find the information they need to navigate these complex systems.

POCs: John Hardman, john.hardman@nasa.gov, (650) 604-0417, Michelle Moyer, michelle.c.moyer@nasa.gov, (650) 604-2912, NASA Advanced Supercomputing Division, Computer Sciences Corp.

Network Team Tests 'Fair Queuing' to Improve Data Transfer Rates

- HECC network engineers enabled a fair queue (FQ) traffic control packet scheduler in the Linux kernel and tested it to over 200 sites across the country to determine if it provided improvement in data transfer rates.
  - Data was sent from a 10 gigabit-per-second (Gbps) local host that was tuned for cross-country wide area network data transfers. Approximately one-third of the sites saw an overall increase in performance.
  - Tests were run several times to each site, at various hours of the day and on weekends, to get the best sampling of performance data on congested links.
- Sites with more packet loss on the path had the greatest improvements from the FQ scheduler, because FQ reduces the "bursty" nature of 10-Gbps network cards, which are often the cause of data loss. No negative impact was observed; sites with no loss remained at the same performance level.
- These traffic control scheduling capabilities are included in the Linux kernel version 3.11, released by the end of this year. When the new version is installed, system administrators can validate these improvements and put them into production.

Mission Impact: By reducing network packet loss, NASA users can more quickly receive scientific results from large data transfers.

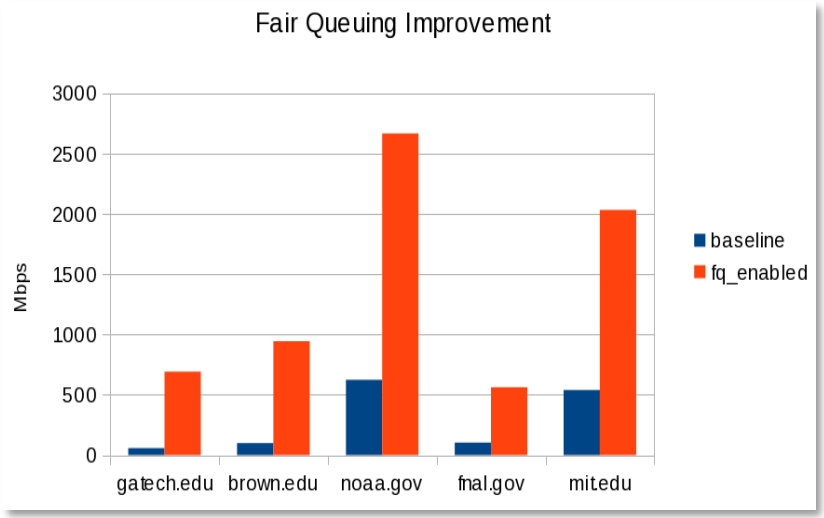


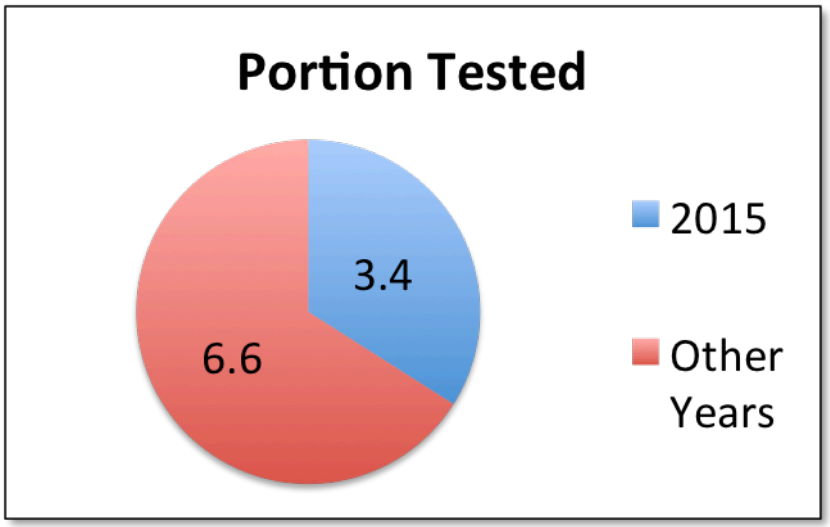
Chart showing the data transfer rate increase to multiple select sites with (red) and without (blue) the fair queuing scheduler.

POCs: Nichole Boscia, nichole.k.boscia@nasa.gov, (650) 604-0891, NASA Advanced Supercomputing Division

Annual Security Tests Preserve HECC Authorization to Operate

- An important compliance requirement associated with all NASA security plans is the testing each year of a significant portion of the National Institute of Standards and Technology (NIST) SP 800-53 Security and Privacy Controls.
- HECC security staff completed three months of testing 100 controls, and all but one were satisfactory.
- The mitigating factors describing the other than satisfied control were prepared and delivered to the Authorizing Official, Dr. Thomas Edwards, with a recommendation to accept this risk to enable mission success.
- All required tasks were performed by the July 30, 2015 deadline, and results were uploaded to the agency repository for security plans and associated documents.

Mission Impact: Successful completion of NASA's annual control tests will help the HECC project maintain its Authorization to Operate.



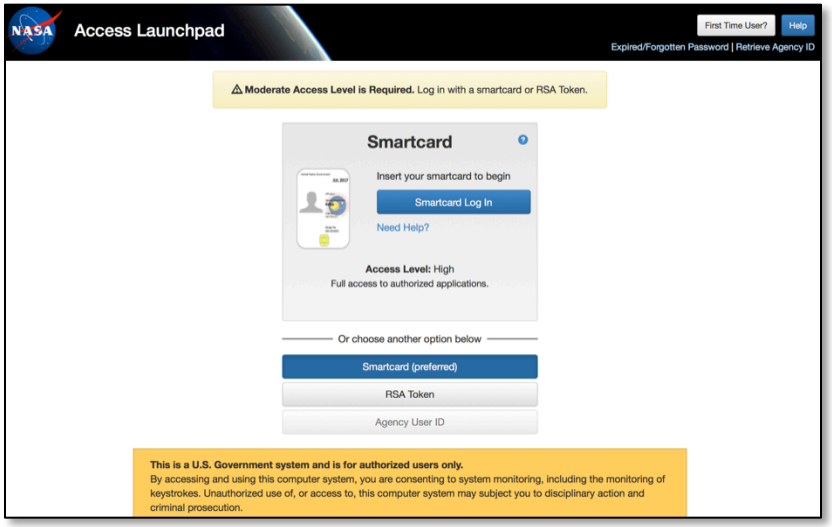
Security experts working under the High-End Computing Capability project successfully completed all of the annual security testing required by the National Institute of Standards and Technology.

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

Multi-Factor Authentication for NAS User Systems

- New NASA requirements call for the use of multi-factor authentication for user system and application access by resident NAS facility users with special roles, such as in Launchpad applications. The HECC Engineering Servers and Services (ESS) team implemented numerous updates to meet the new requirements by the July 15, 2015 deadline.
- The following updates meet these requirements in all areas except for Apple OS X logins, where a solution does not currently exist.
  - Deployed NASA Firefox Configuration Extension (NFCE) on Linux and Mac user systems to provide the capability for users to use smartcards for Launchpad applications.
  - Deployed SecurID dual-factor authentication for user access to Red Hat Linux workstations.
  - Updated X11 settings on OS X to allow smartcard authentication to the Windows Terminal Servers.
- For Mac logins, the ESS team tested ADmitMac as a smartcard solution, but rejected it due to unresolved issues.
- ESS continues to test Centrify as a smartcard solution for Mac logins, and requested inclusion in a pilot test of the next beta-release of Centrify, which NASA's Identity, Credential, and Access Management (ICAM) team believes will allow Centrify to work on Macs in the NASA environment.

Mission Impact: Implementation of multi-factor authentication for Launchpad websites and Linux workstations provides additional security for NAS user systems and applications.



Specific Launchpad sites now require multi-factor authentication via either the Smartcard or RSA Token (SecurID).

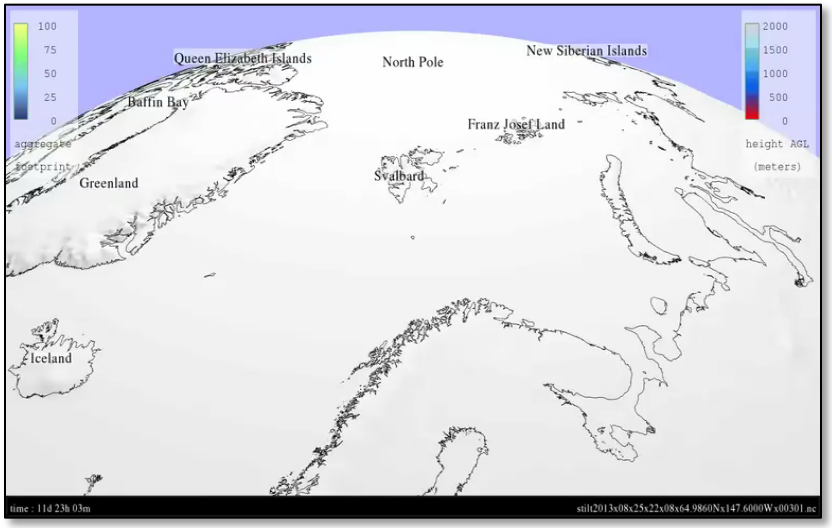
POC: Robert C. Shaw, robert.c.shaw@nasa.gov, (650) 604-4354, NASA Advanced Supercomputing (NAS) Division, Computer Sciences Corp.

Modeling the Carbon Balance in Arctic Ecosystems *

- Meteorologists supporting NASA-sponsored research, including the proposed Arctic Boreal Vulnerability Experiment (ABoVE), ran simulations to improve understanding of the current balance of carbon dioxide (CO_2) and methane (CH_4) in the Arctic. Using Pleiades, the researchers:
  - Generated high-resolution reanalyses of air flow patterns over the Arctic during time periods when CO_2 and CH_4 observations were being made.
  - Computed backward trajectories for hundreds of thousands of air particles to identify the pathways of gases released from the Earth's surface.
  - Computed the potential contribution from these upwind surface-to-air gas fluxes to the concentration measurements at "receptor" locations.
- Pleiades enables modeling of time periods spanning multiple years at a resolution that is an order of magnitude higher than prior studies.
- Researchers will continue to use Pleiades to refine their Weather Research and Forecasting/Stochastic Time-Inverted Lagrangian Transport (WRF-STILT) model, and incorporate current, future and historical observations to provide new insights into the vulnerability and resilience of ecosystems and society to the changing Arctic environment.

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

Mission Impact: HECC resources enable researchers to achieve fine-scale detail in model fields of the Arctic ecosystem at a resolution that is an order of magnitude greater than that of prior research studies.



Visualization of the trajectories of 500 air particles ultimately converging at a receptor (yellow marker) over a 10-day period. Colored line segments denote the positions of particles at high altitudes (white) and low altitudes (red) over 4 hours of that period. Particles passing into the planetary boundary layer contribute to the footprint field (shaded) that accumulates over the 10 days. *Timothy Sandstrom, NASA/Ames; John Henderson, Atmospheric and Environmental Research*

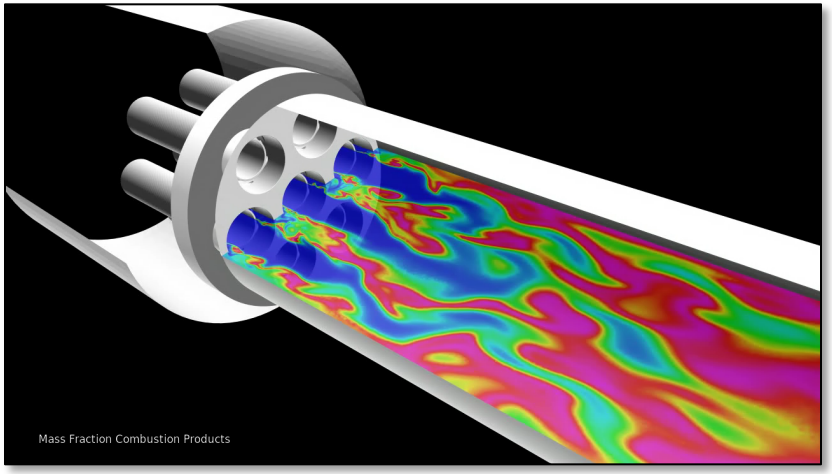
POC: John Henderson, jhenders@aer.com, (781) 761-2240, Atmospheric and Environmental Research

Designing Liquid Rocket Engine Injectors for Performance, Stability, and Cost *

- Advanced booster rocket engine injectors being designed for the next-generation Space Launch System (SLS) will require high performance and stable operation while also meeting aggressive cost reduction goals.
- To investigate the complex injector dynamics that can lead to combustion instability—a critical issue for injector designs—engineers at NASA's Marshall Space Flight Center (MSFC) ran high-fidelity computational fluid dynamics (CFD) simulations on Pleiades.
  - Using the Loci-STREAM CFD code, the engineers ran high-fidelity reacting flow simulations for both single-element and seven-element representations of the full-scale injector design, with robust propellant mixing and combustion in the oxygen/fuel liquid rocket engine.
  - Data from the simulations was then used to significantly augment and improve traditional, empirical design tools, resulting in a stable, high-performance injector design.
  - Further simulations will shed light on the next steps to continue to improve the injector design process for NASA's launch vehicle propulsion systems.
- The simulations required large computational meshes with 100–350 million cells and long run times at time-steps of one microsecond or less. Despite their large size, each run was executed in less than two weeks on Pleiades, using 2,000–4,000 processors.

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

Mission Impact: High-fidelity CFD simulations run on HECC resources help NASA lower the cost of SLS development by reducing reliance on costly full-scale hot-fire testing. Pleiades provides the quick turnaround time needed for results to be used in design cycles where multiple iterations must be completed quickly.



Simulation of an injector design for a Space Launch System liquid rocket engine advanced booster concept, showing the instantaneous contours of mass fraction of combustion products. The magenta color indicates the highest mass fraction of the combustion products that result from the interaction between the inner oxygen stream and the outer fuel stream of each element. *Patrick Moran, NASA/Ames*

POCs: Jeffrey West, jeffrey.s.west@nasa.gov, (256) 544-6309; NASA , Douglas Westra, douglas.g.westra@nasa.gov, (256) 544-3120 Marshall Space Flight Center

HECC Facility Hosts Several Visitors and Tours in July 2015

- HECC hosted 20 tour groups in July; guests learned about the agency-wide missions being supported by HECC assets, and some of the groups also viewed the D-Wave Two quantum computer system. Among the guests this month:
  - NASA Deputy Administrator, Dava Newman, and the U.S. Department of Agriculture Deputy Secretary, Krysta Harden, were at the NAS facility for a media event to sign an interagency agreement establishing a framework for enhanced cooperation in the areas of Earth science research, technology, agricultural management, and the application of science data, models and technology in agricultural decision-making.
  - Her Excellency Dilma Rousseff, President, Federative Republic of Brazil, along with: the Minister of Science Technology and Innovation; the President of the Brazilian Space Agency; the Secretary for Information Technology Policies, Ministry of Science, Technology and Innovation of Brazil; and local media received NASA overviews, and viewed NAS computational fluid dynamic results on the hyperwall.
  - A group of Dartmouth Ivy League alumni.
  - A group of NASA Multidisciplinary Aeronautics Research Team Initiative Program and Space Academy attendees.
  - Attendees of the NASA Space Technology Research Fellows meeting.
  - A large group of summer students from the Stanford Army High Performance Computing Research Center.
  - Attendees of the Enterprise Service Desk Face to Face meeting.
  - Several NASA Ames Summer Intern program groups also visited this month.

NASA Deputy Administrator Dava Newman (third from left, front row) and U.S. Department of Agriculture Deputy Secretary Krysta Harden during a media event held at the NASA Advanced Supercomputing facility to sign an interagency agreement. Both VIPs received NASA overviews and science demonstrations on the HECC hyperwall from NAS Division Chief Piyush Mehrotra.

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

Papers

- "**The Nature of Voids: II. Tracing Underdensities with Biased Galaxies**," S. Nadathur, S. Hotchkiss, arXiv:1507.00197 [astro-ph.CO], July 1, 2015. * *http://arxiv.org/abs/1507.00197*
- "**Quantifying the Difference Between the Flux-Tube Expansion Factor at the Source Surface and the Alfven Surface Using a Global MHD Model for the Solar Wind**," O. Cohen, arXiv:1507.00572 [astro-ph.SR], July 2, 2015. * *http://arxiv.org/abs/1507.00572*
- "**Development of a RANS and LES/RANS Flow Solver for High-Speed Engine Flowpath Simulations**," J. Edwards, J. Fulton, presented at the International Space Planes and Hypersonic Systems and Technologies Conference, Glasgow, Scotland, July 6-9, 2015. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2015-3570*
- "**The Importance of Spatial Detail: Assessing the Utility of Individual Crown Information and Scaling Approaches for Lidar-Based Biomass Density Estimation**," L. Duncanson, R. Dubayah, B. Cook, J. Rosette, G. Parker, Remote Sensing Environment, vol. 168, July 9, 2015. * *http://www.sciencedirect.com/science/article/pii/S0034425715300493?np=y*

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

Papers (cont.)

- "**Magnetized Interstellar Molecular Clouds – I. Comparisons Between Simulations and Zeeman Observations**," P. Li, C. McKee, R. Klein, Monthly Notices of the Royal Astronomical Society, vol. 452, issue 1, July 24, 2015. * *http://mnras.oxfordjournals.org/content/452/3/2500.short*
- "**Comparison of Computational Results with a Low-g, Nitrogen Slosh and Boiling Experiment**," M. Stewart, J. Moder, presented at the Propulsion and Energy Forum, Orlando, Florida, July 27-29, 2015. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2015-3854*
- "**Parametric Study of Pulse-Combustor-Driven Ejectors at High-Pressure**," S. Yungster, E. Paxson, H. Perkins, presented at the Propulsion and Energy Forum, Orlando, Florida, July 27-29, 2015. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2015-4190*

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

Presentations

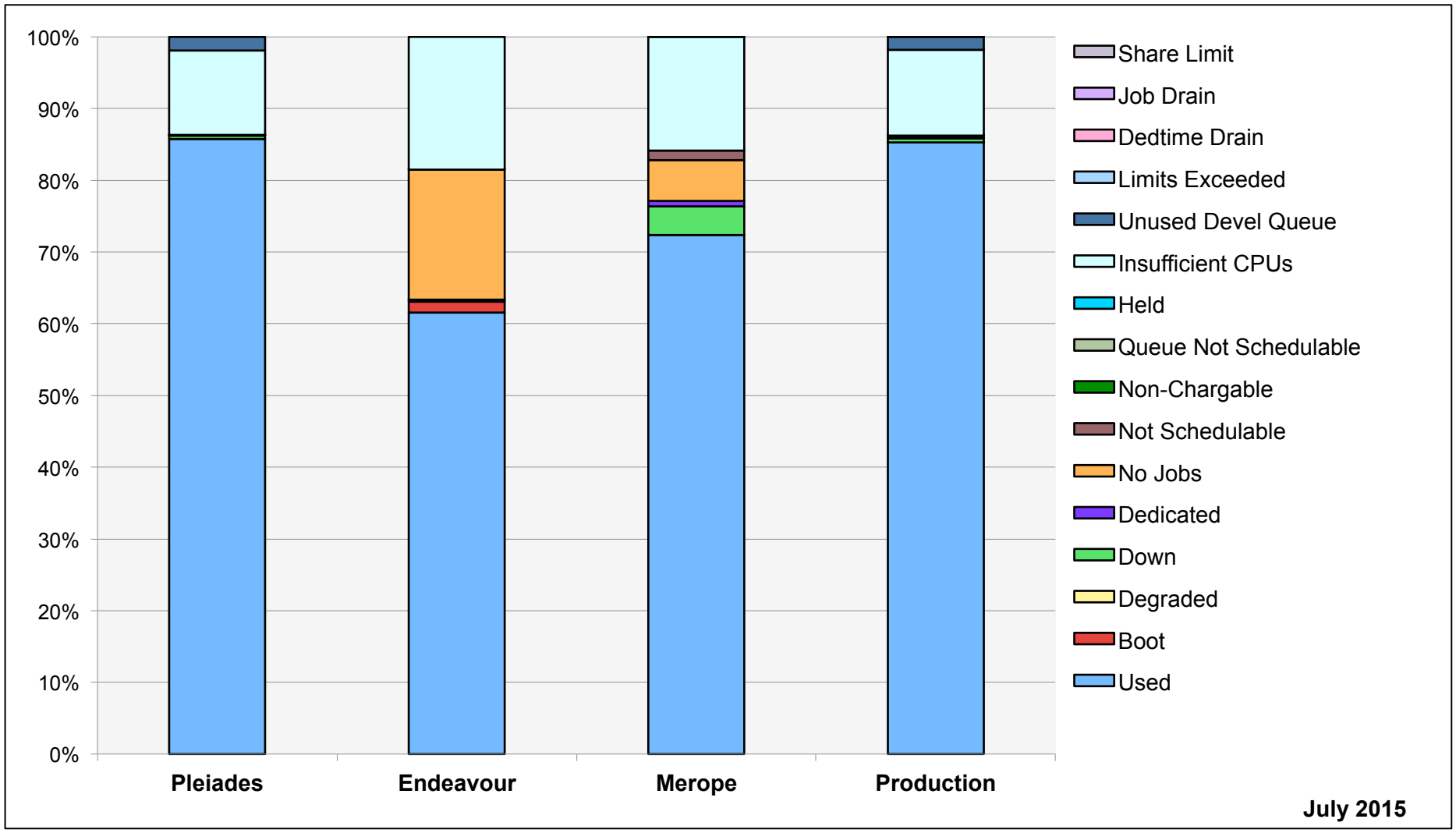
- "**Skylon Aerodynamics and SABRE Plumes**," U. Mehta, M. Aftosmis, J. Bowles, S. Pandya, presented at the International Space Planes and Hypersonic Systems Technologies Conference, Glasgow, Scotland, July 6-9, 2015. * *http://arc.aiaa.org/doi/pdf/10.2514/6.2015-3605*

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

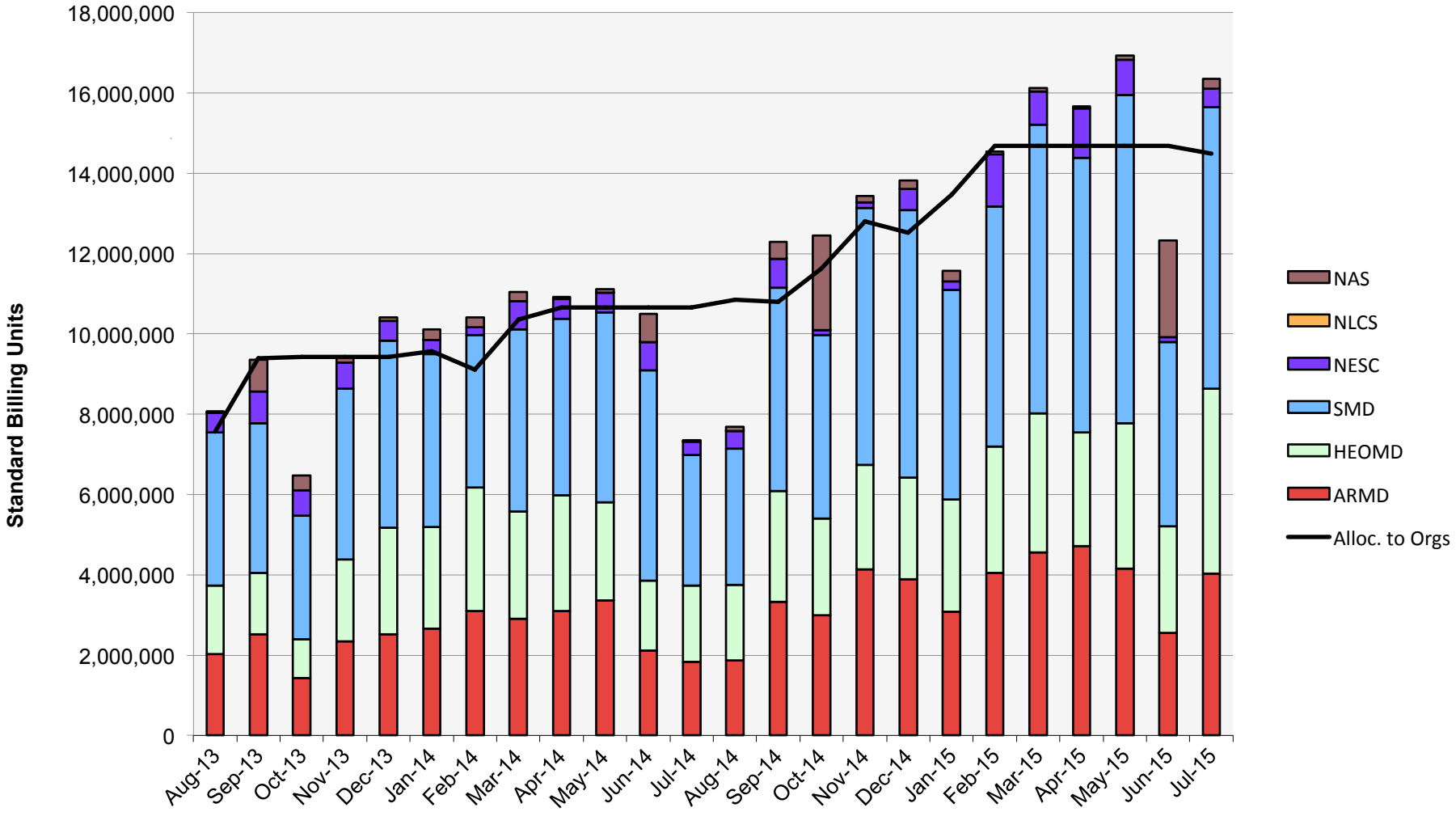
News and Events

- **NASA's Pleiades Continues to Rank Among Most Powerful Supercomputers**, *NASA Ames Press Release*, July 21, 2015—The Pleiades supercomputer at the NASA Advanced Supercomputing (NAS) facility ranks number 11 on the Top500 list announced at the International Supercomputing Conference this month. While the LINPACK computing power of the system jumped nearly 21 percent, its ranking at number 5 on the HPGC benchmark list reflects it's ability to tackle real world applications. (From story featured on NAS website.)
  http://www.nasa.gov/ames/image-feature/nasas-pleiades-continues-to-rank-among-most-powerful-supercomputers
  - **Pleiades Supercomputer Moves Up the Ranks with** Haswell, insideHPC, July 18, 2015. http*://insidehpc.com/2015/07/pleiades-supercomputer-moves-up-the-ranks-with-haswell/*
- **Obama Signs Executive Order to Build First-Ever Exascale Supercomputer**, *Extreme Tech*, July 30, 2015—The President of the United States signs an executive order establishing the National Strategic Computing Initiative (NSCI), which dictates the creation of a coordinated federal strategy for high-performance computing (HPC) research, development, and deployment.
  http://www.extremetech.com/extreme/211247-obama-signs-executive-order-to-build-first-ever-exascale-supercomputer

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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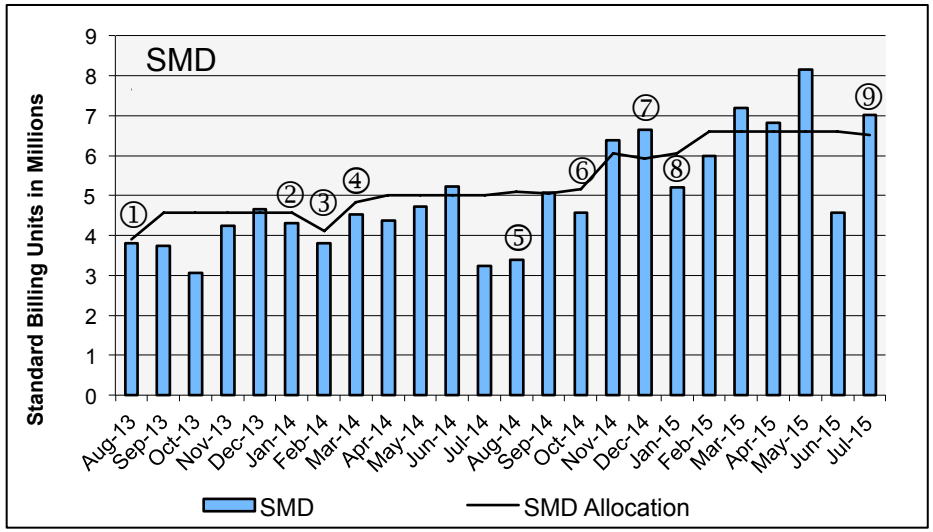
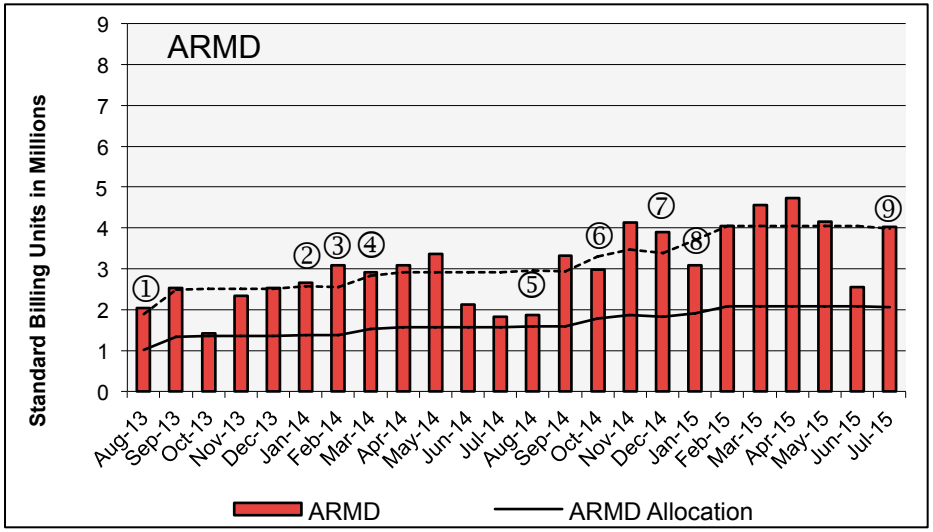
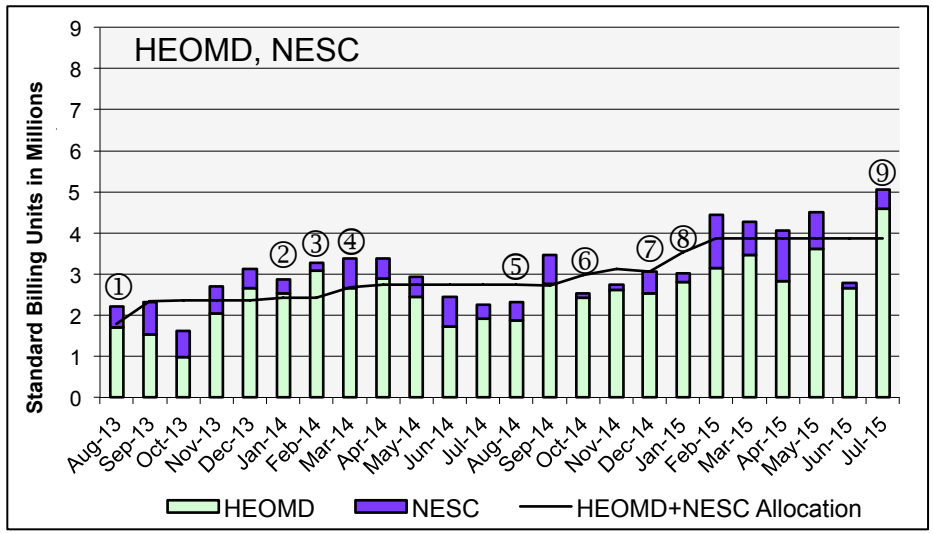






① 32 Harpertown Racks retired; 46 Ivy Bridge Racks added

② 6 Ivy Bridge Racks added; 20 Nehalem, 12 Westmere Racks Retired

③ 8 Ivy Bridge Racks added mid-Feb; 8 Ivy Bridge Racks added late Feb.

④ 4 Ivy Bridge Racks added mid-March

⑤ 6 Westmere Racks added to Merope, Merope Harpertown retired

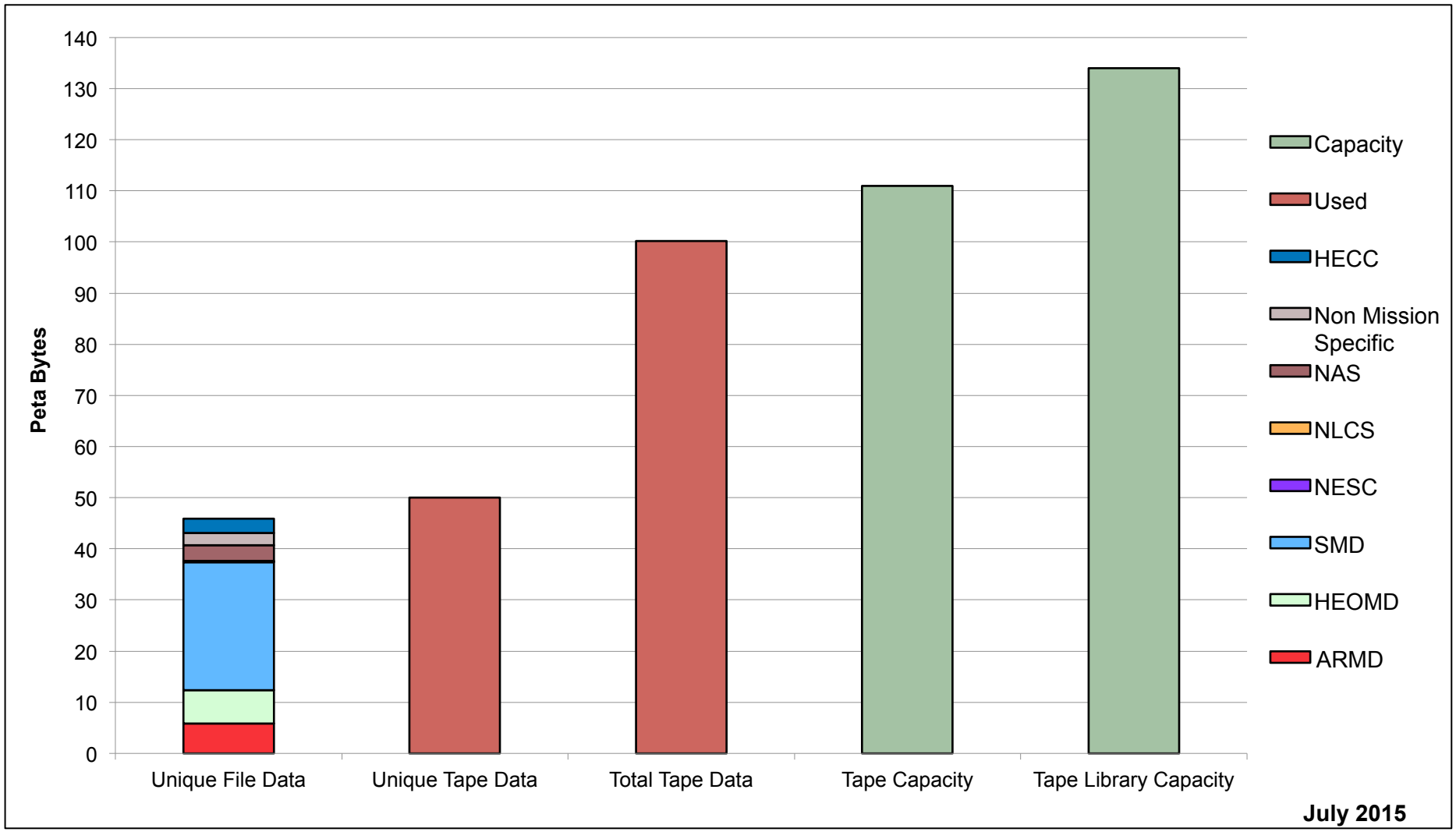
⑥ 16 Westmere Racks retired; 10 Nehalem Racks and 2 Westmere Racks added to Merope; 3 Ivy Bridge Racks added; 15 Haswell Racks added

⑦ 16 Westmere Racks retired

⑧ 14 Haswell racks added

⑨ 7 Merope Nehalem Racks removed

Tape Archive Status



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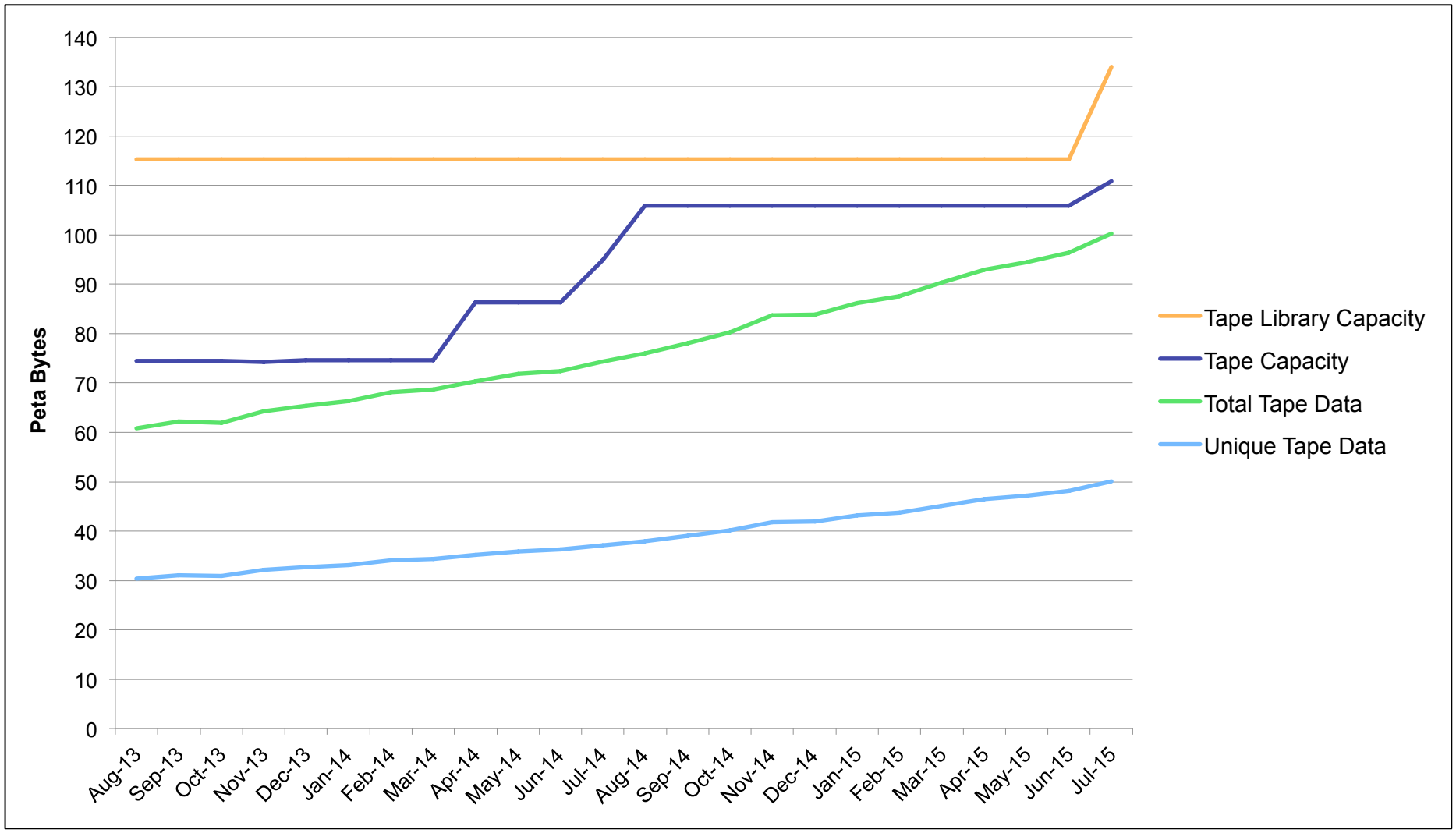
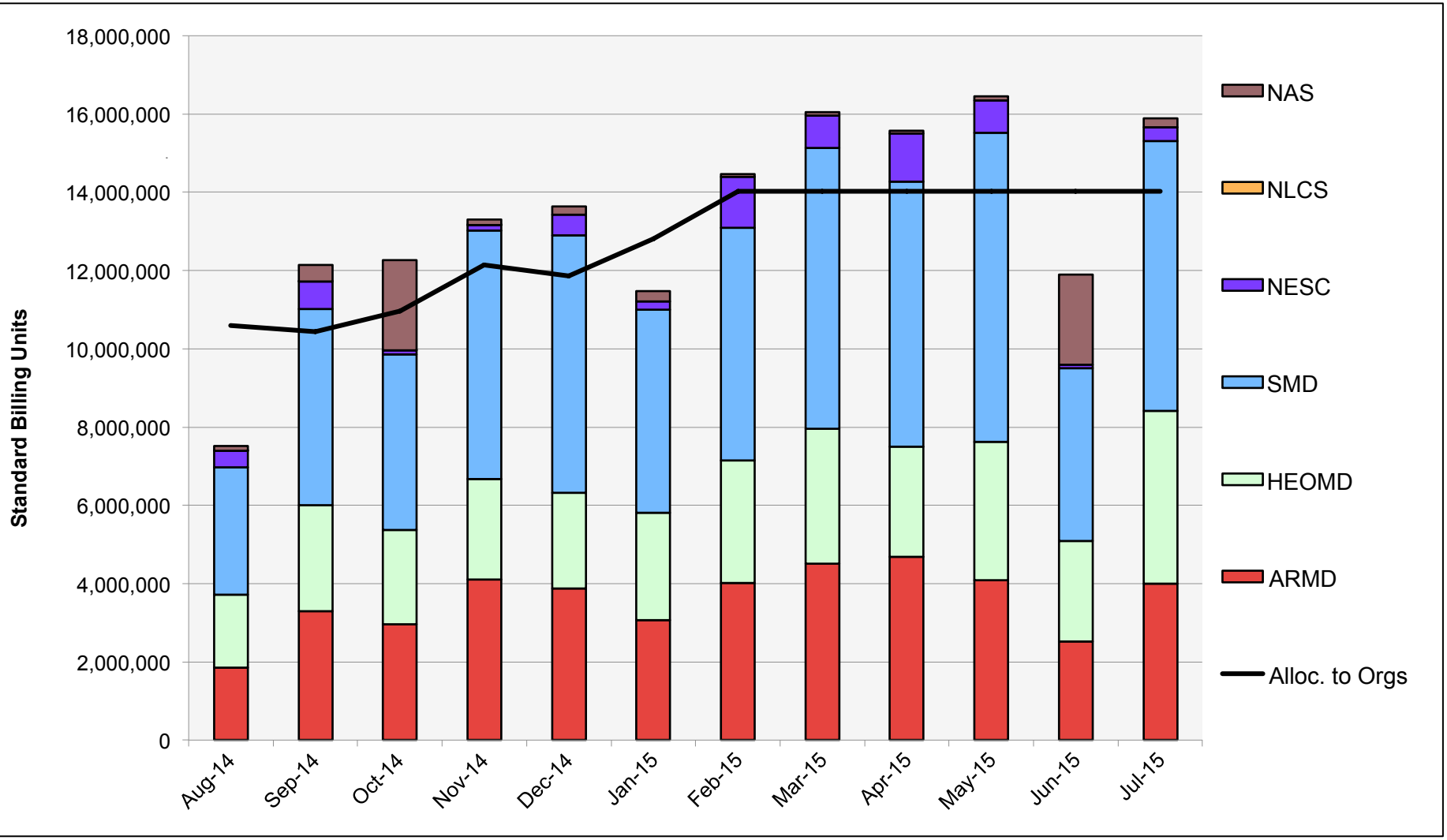
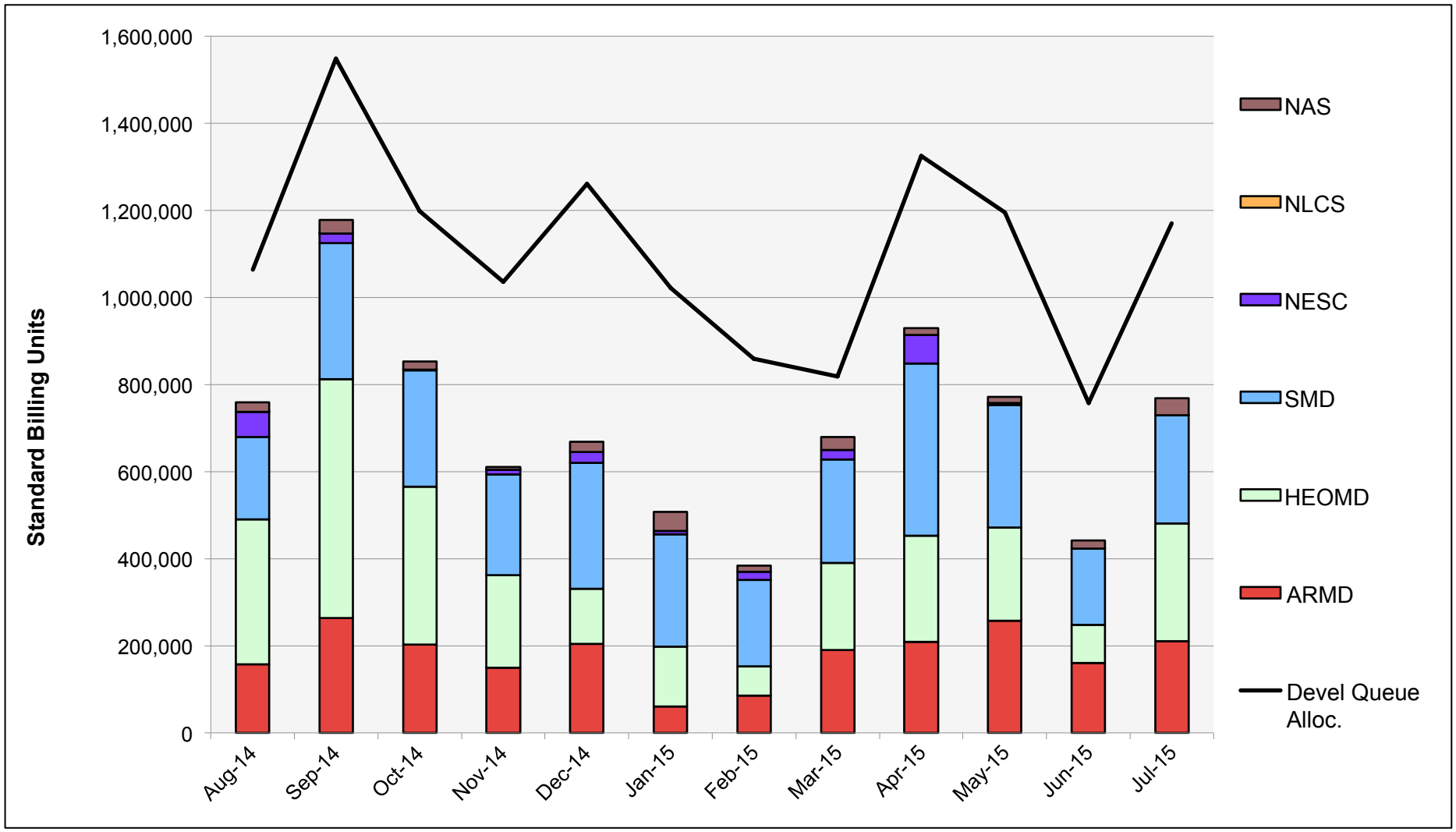


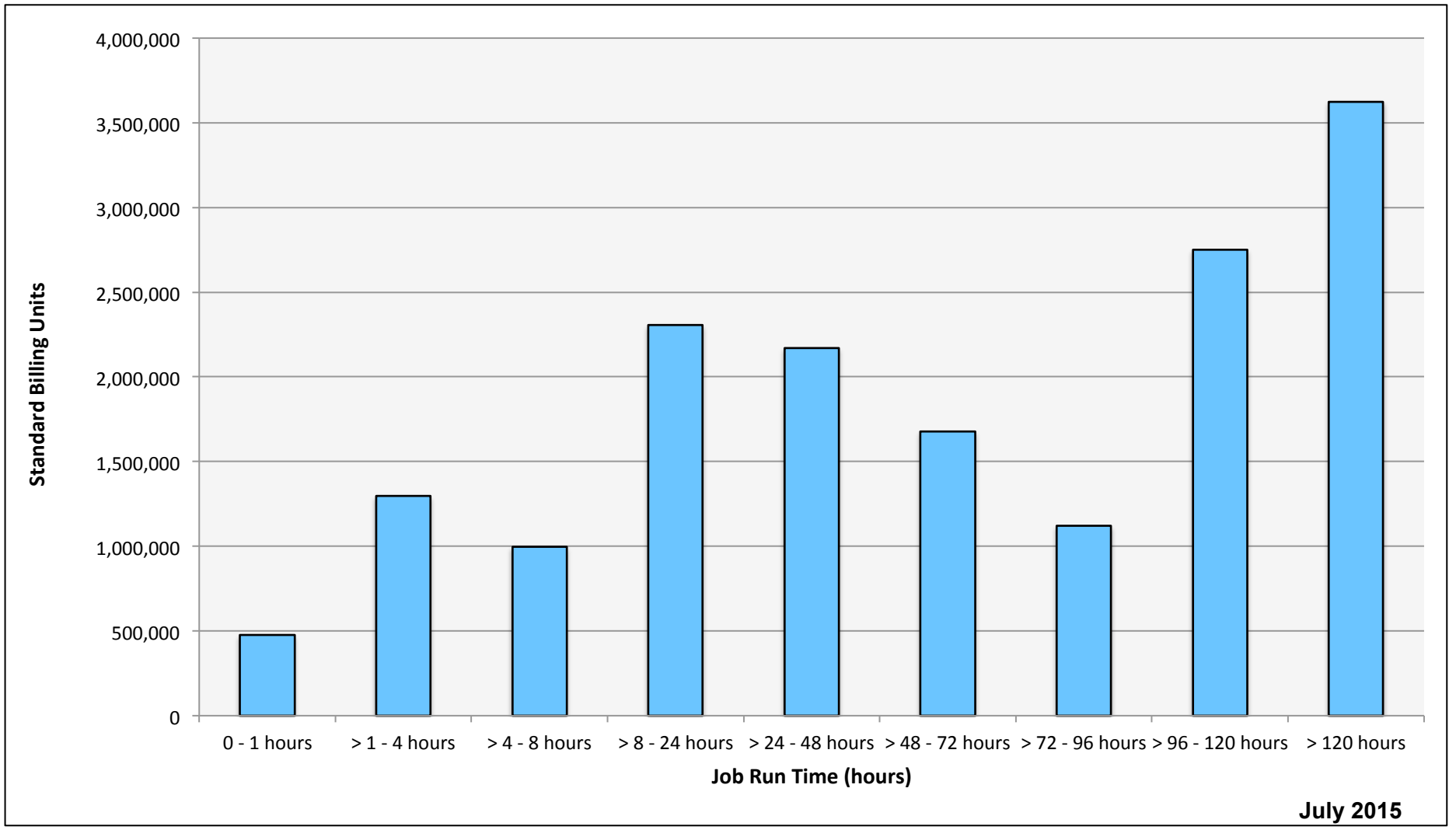
Pleiades:
SBUs Reported, Normalized to 30-Day Month



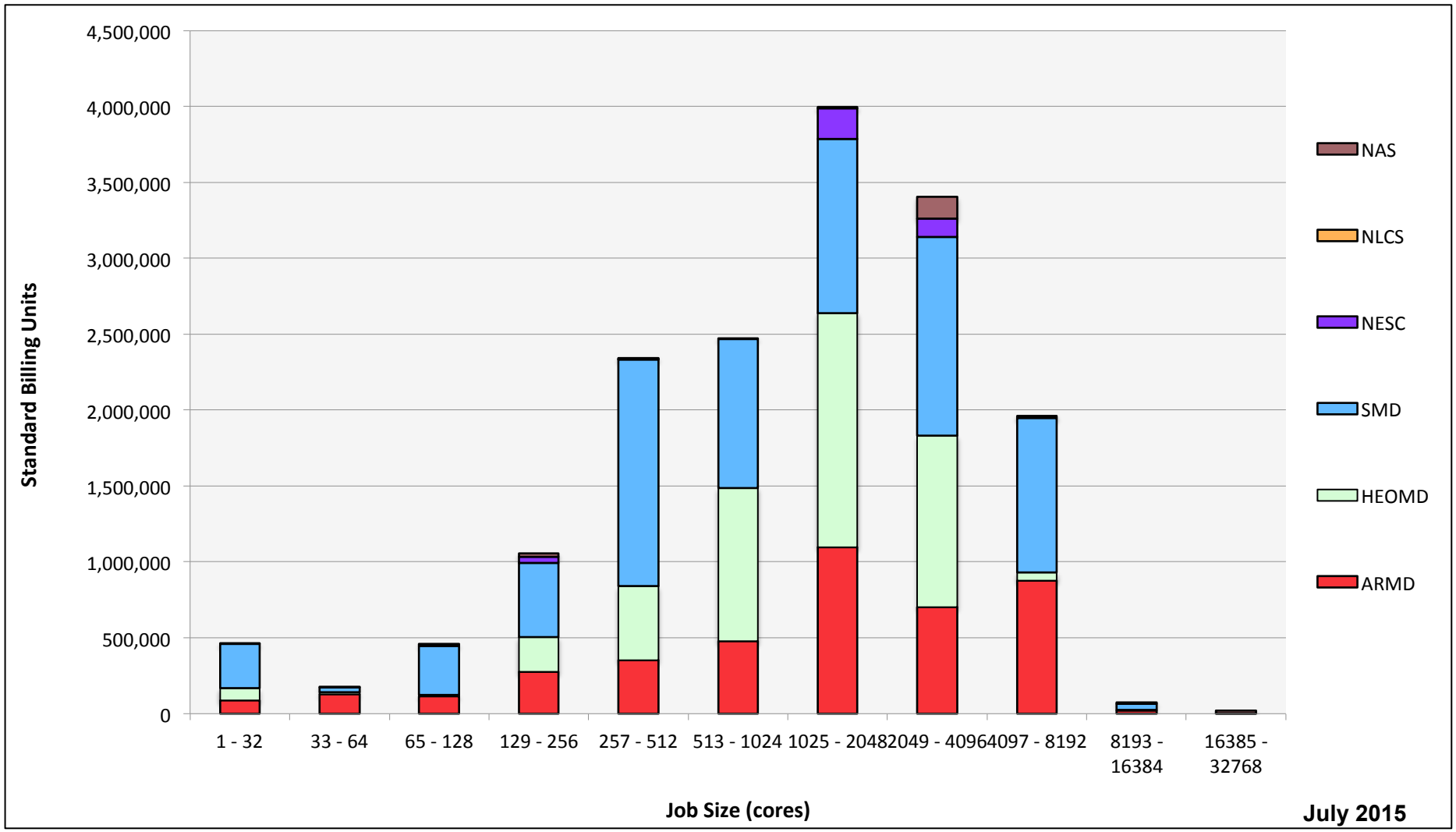
Pleiades:
Devel Queue Utilization



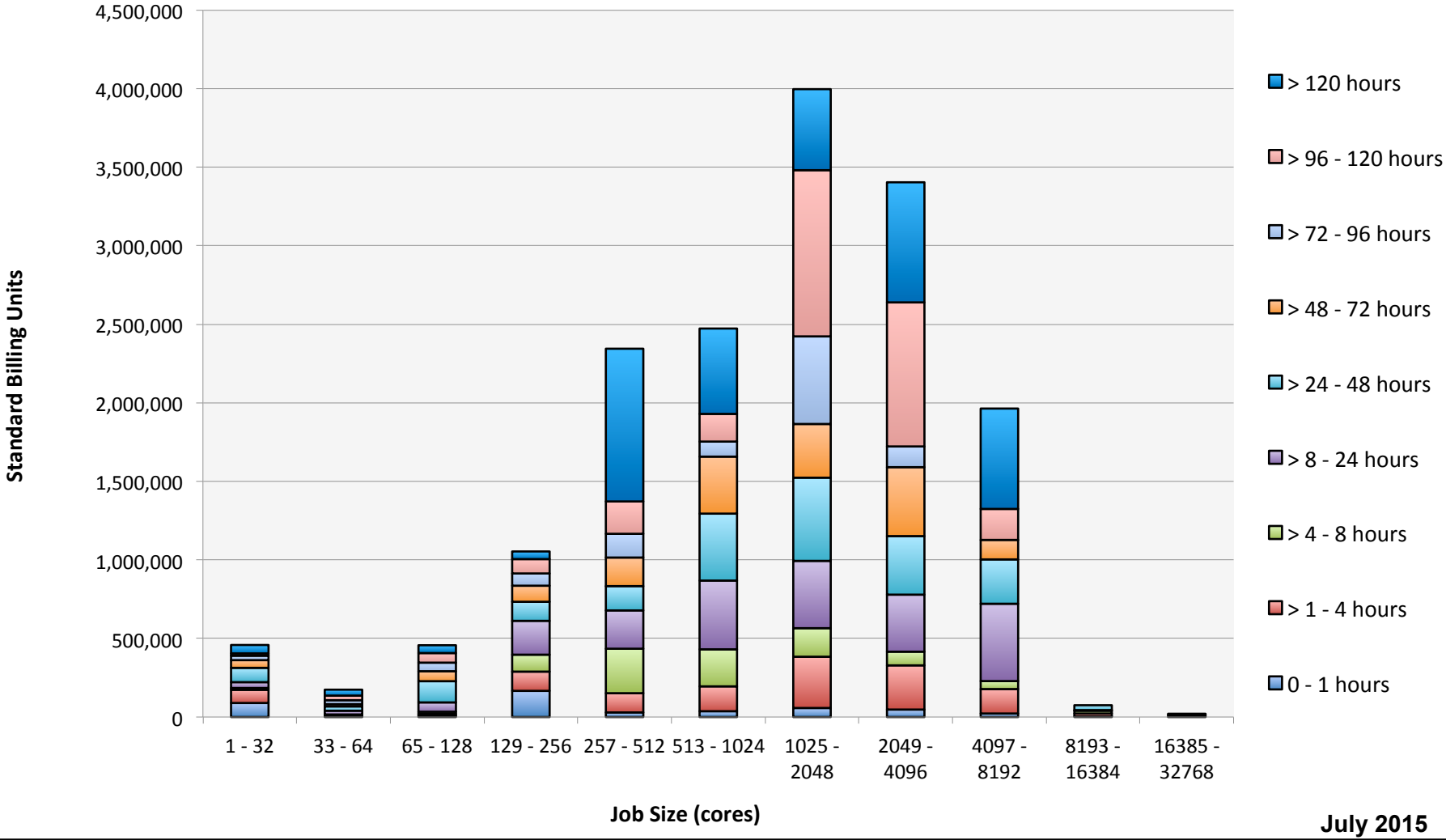
Pleiades:
Monthly Utilization by Job Length



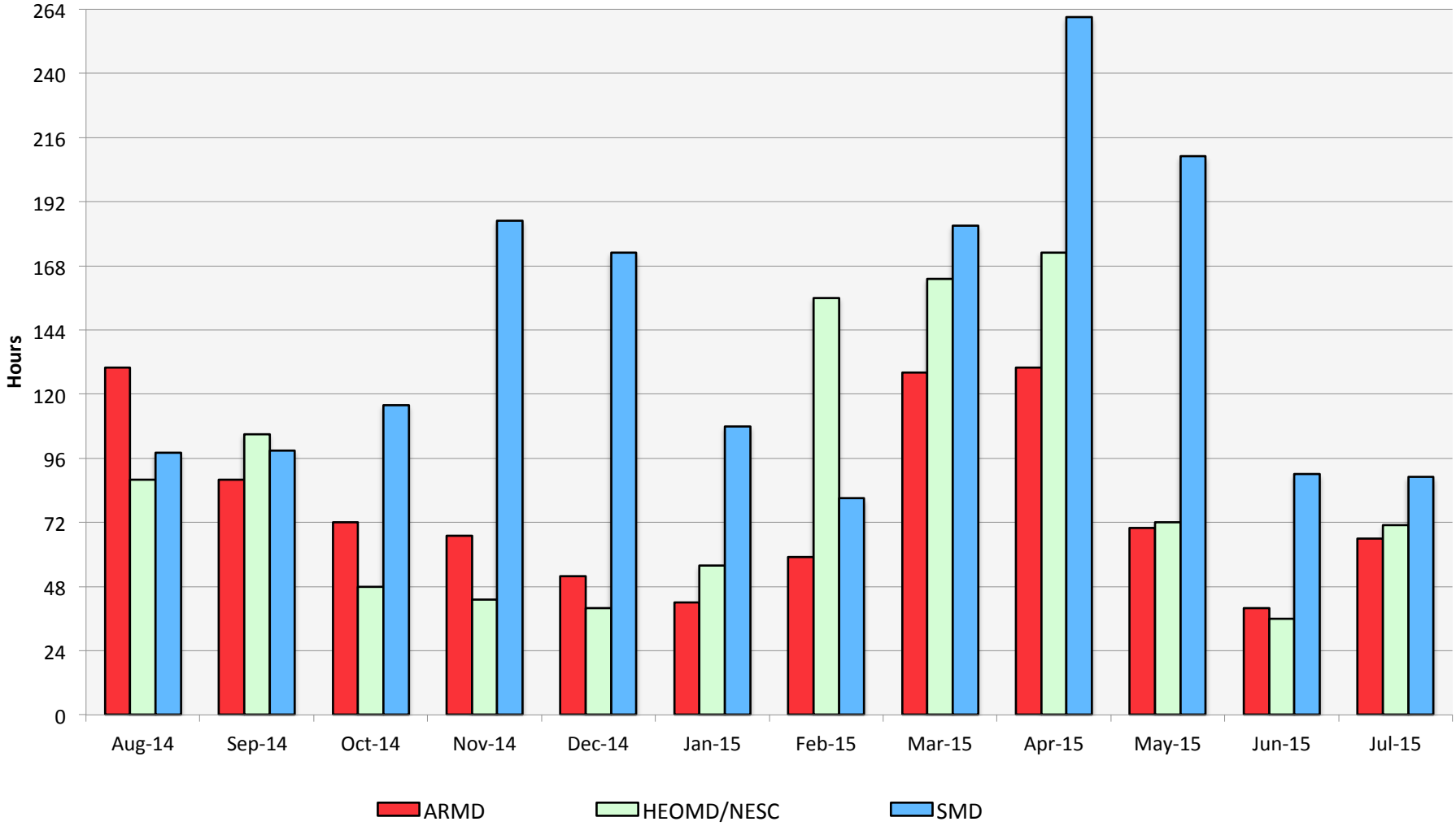
Pleiades:
Monthly Utilization by Size and Mission



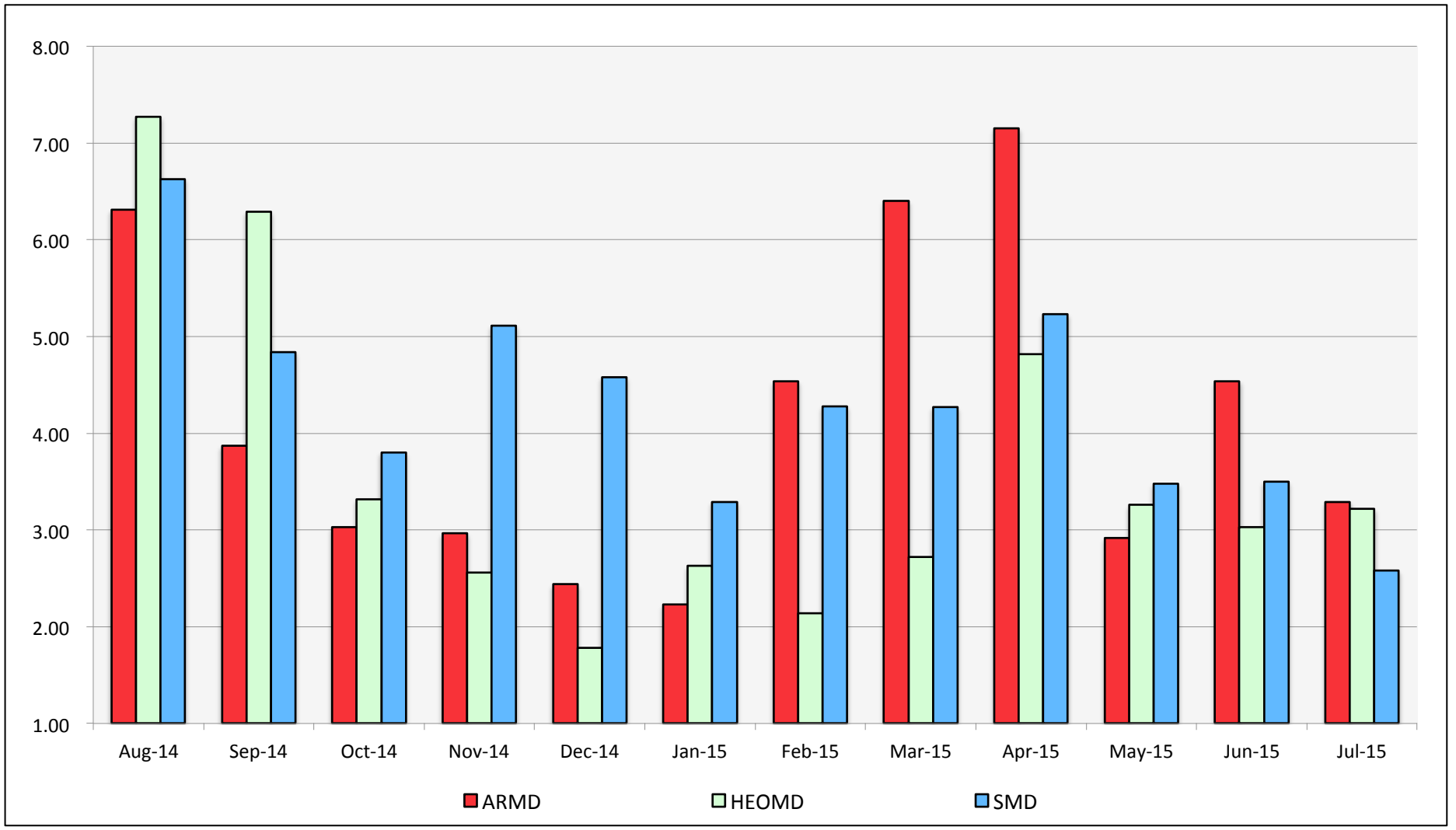
Pleiades:
Monthly Utilization by Size and Length



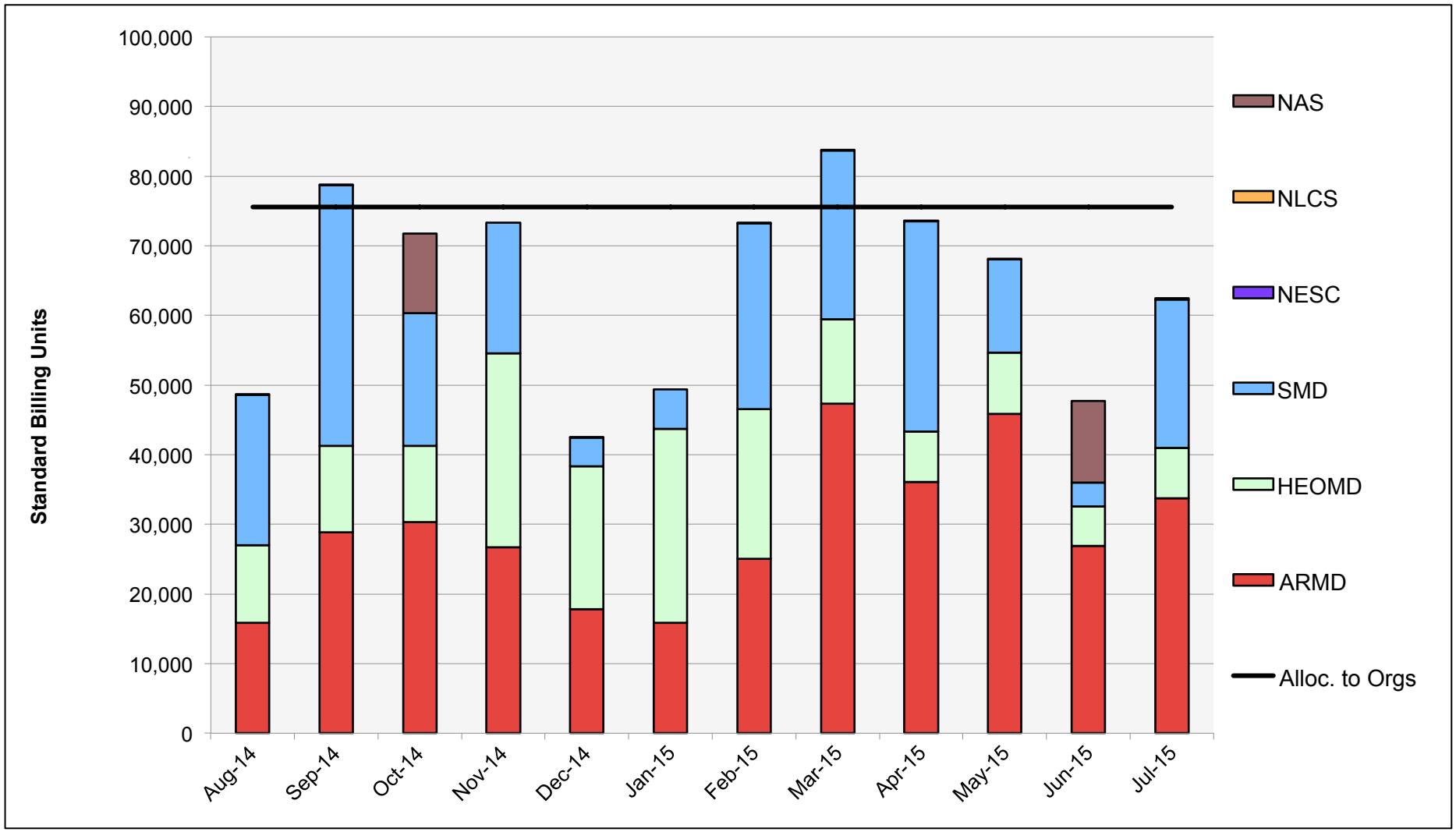
Pleiades:
Average Time to Clear All Jobs



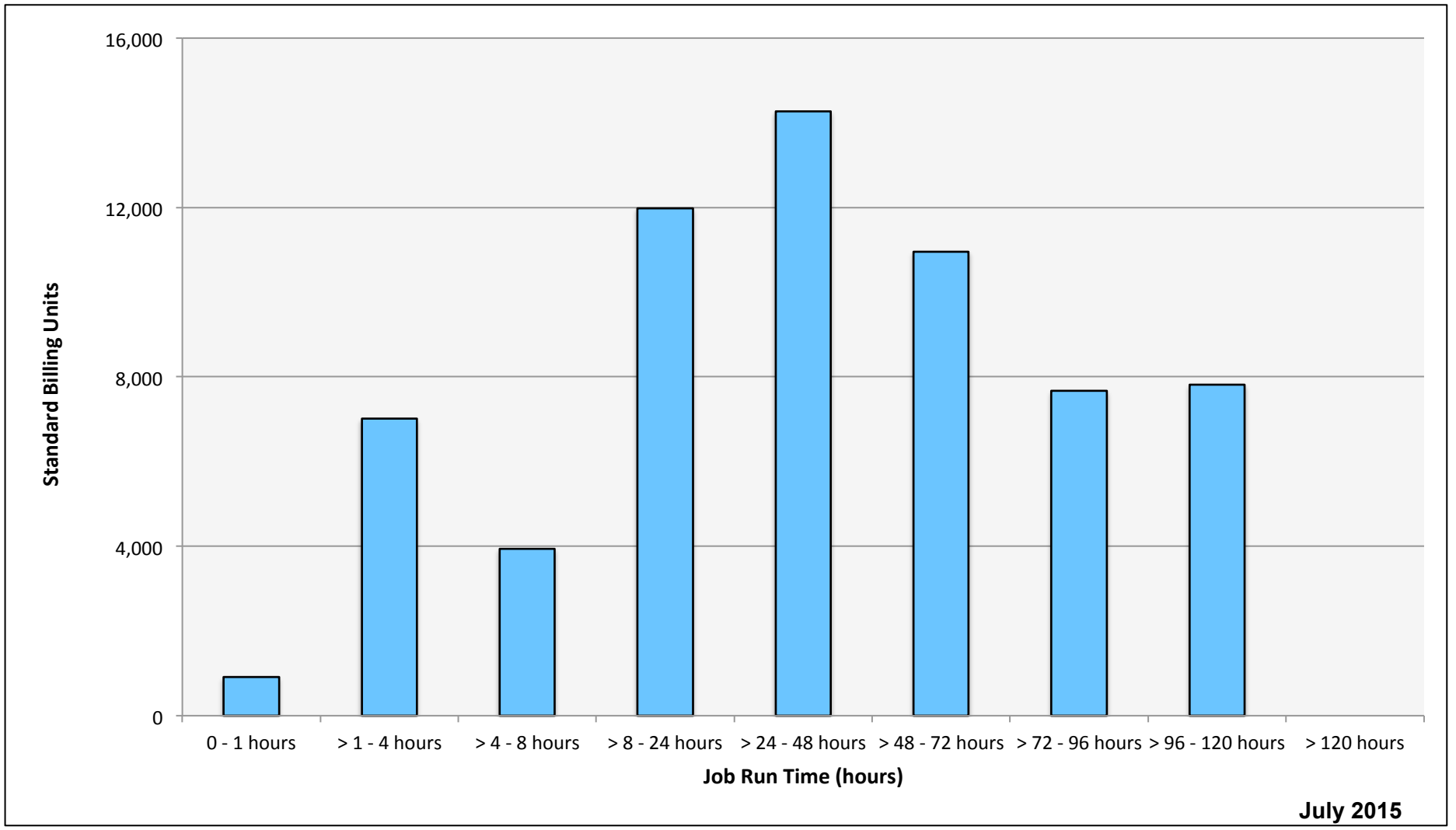
Pleiades:
Average Expansion Factor



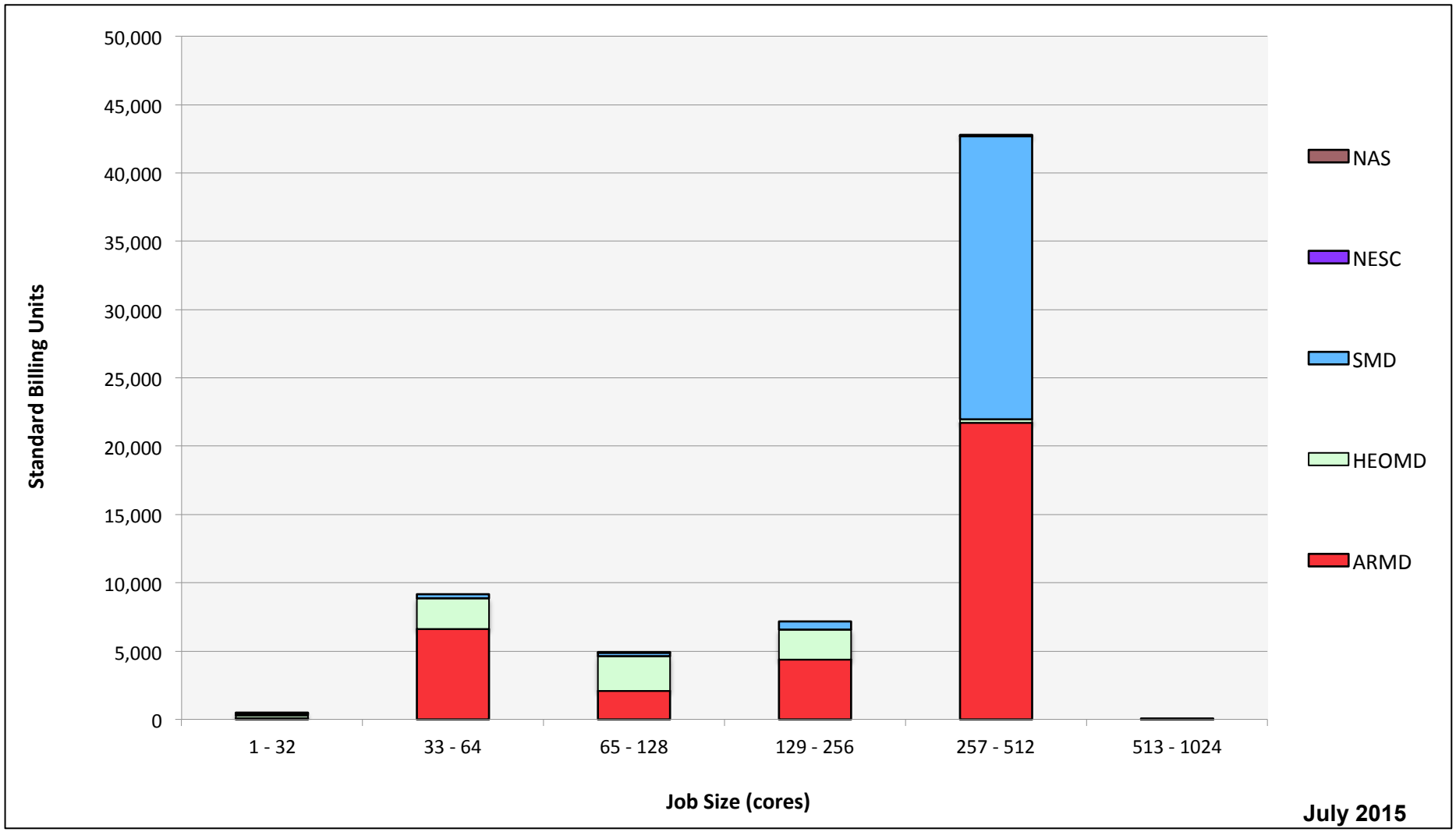
Endeavour:
SBUs Reported, Normalized to 30-Day Month



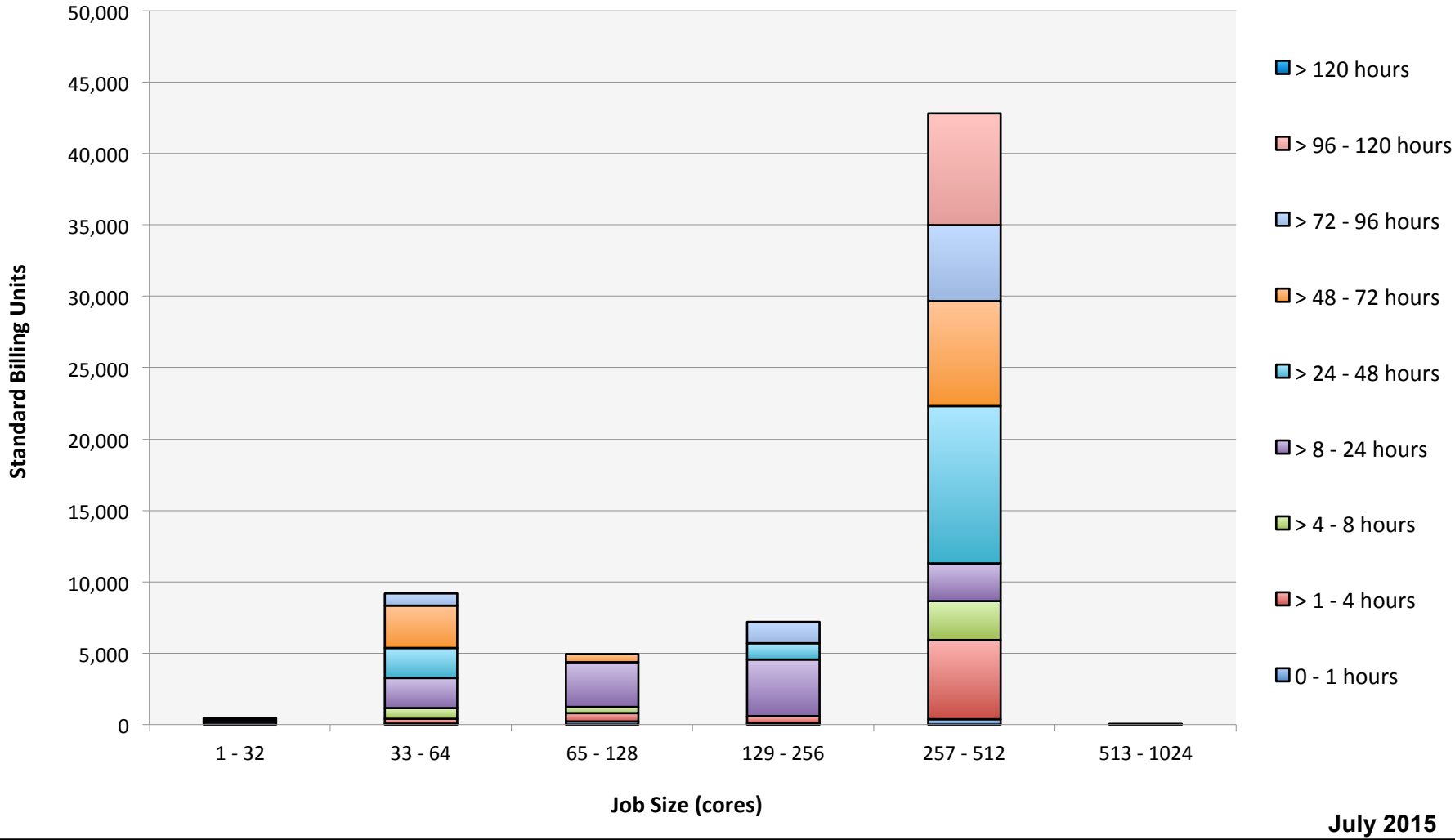
Endeavour:
Monthly Utilization by Job Length



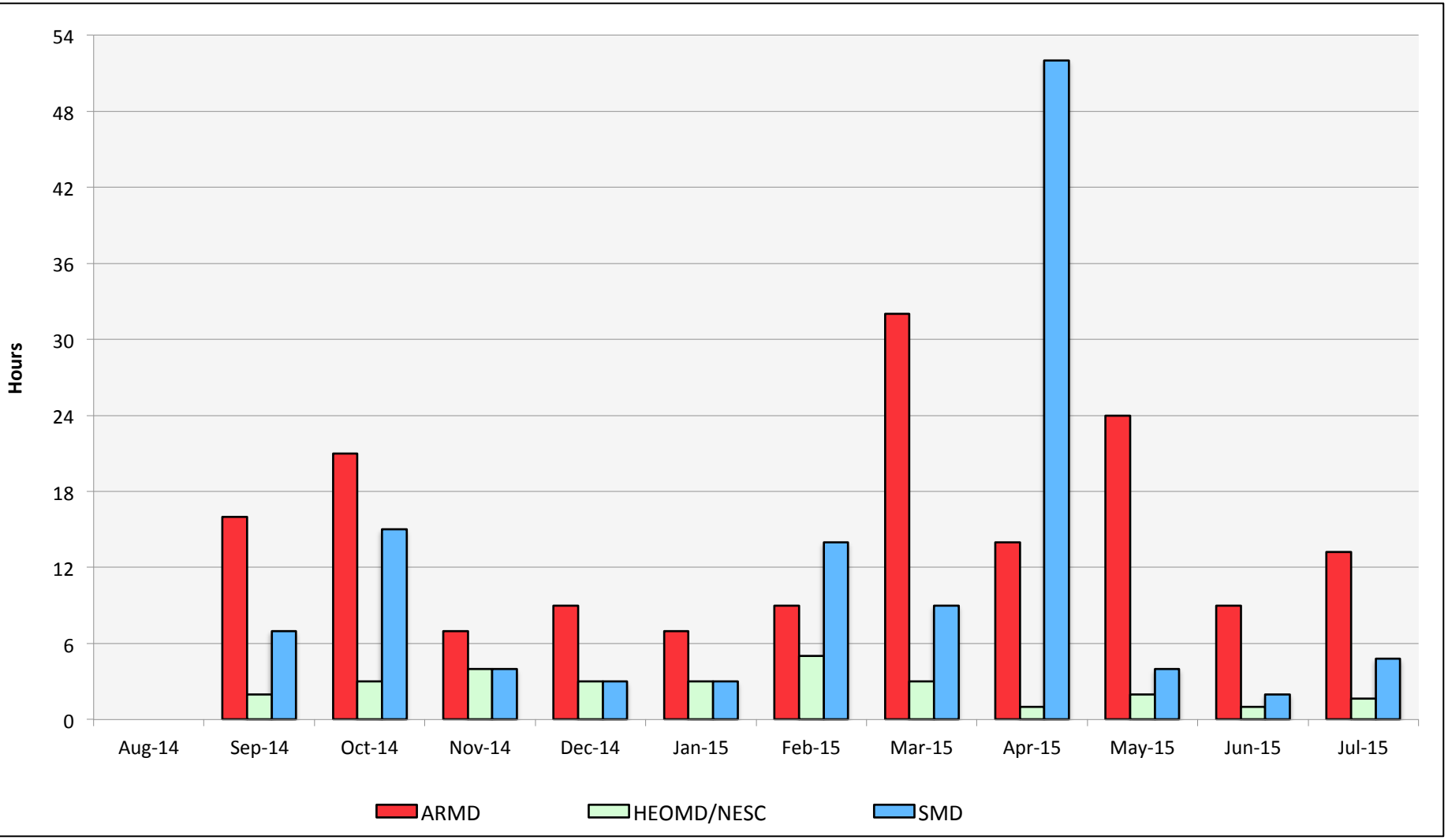
Endeavour:
Monthly Utilization by Size and Mission



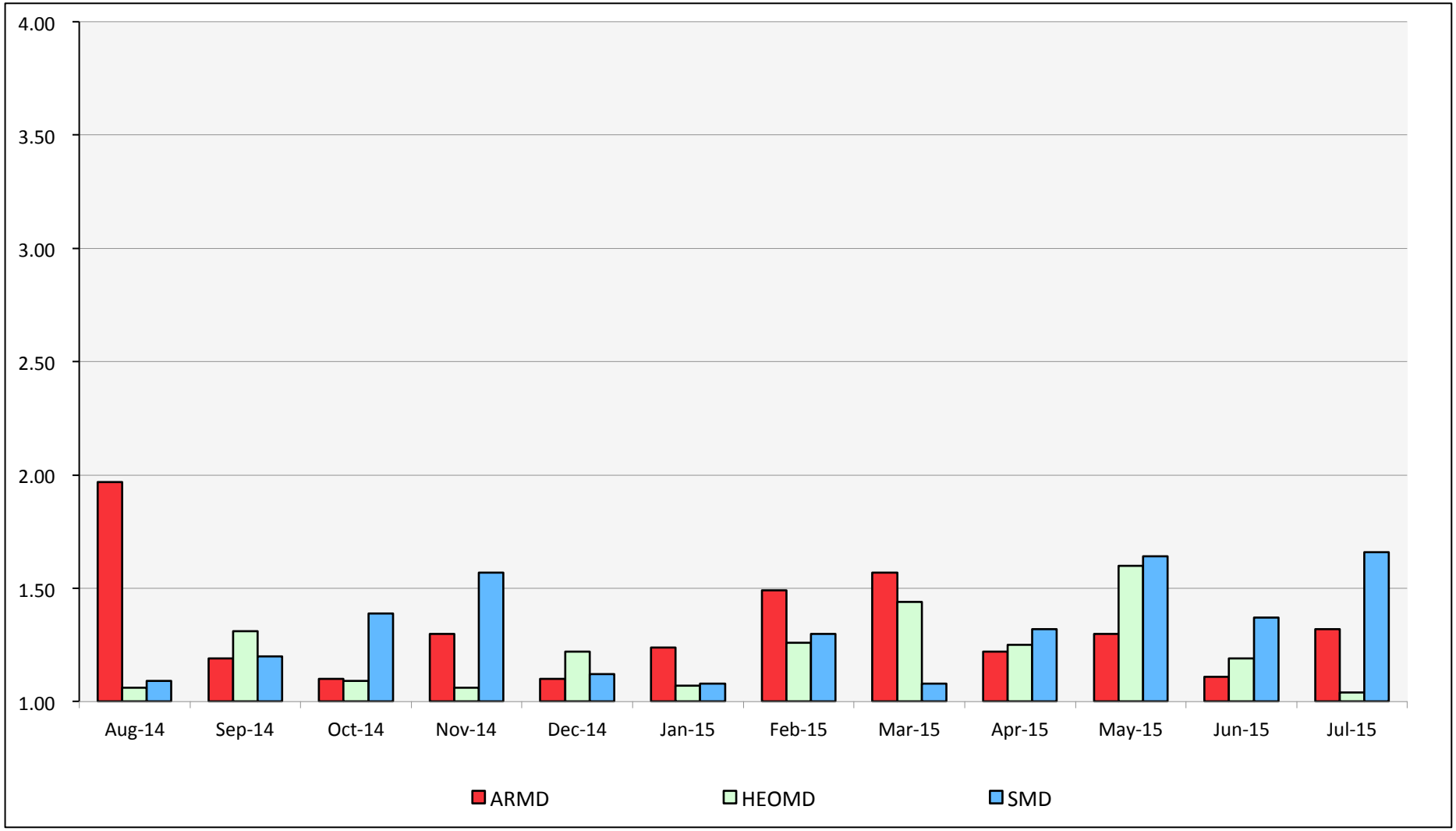
Endeavour:
Monthly Utilization by Size and Length



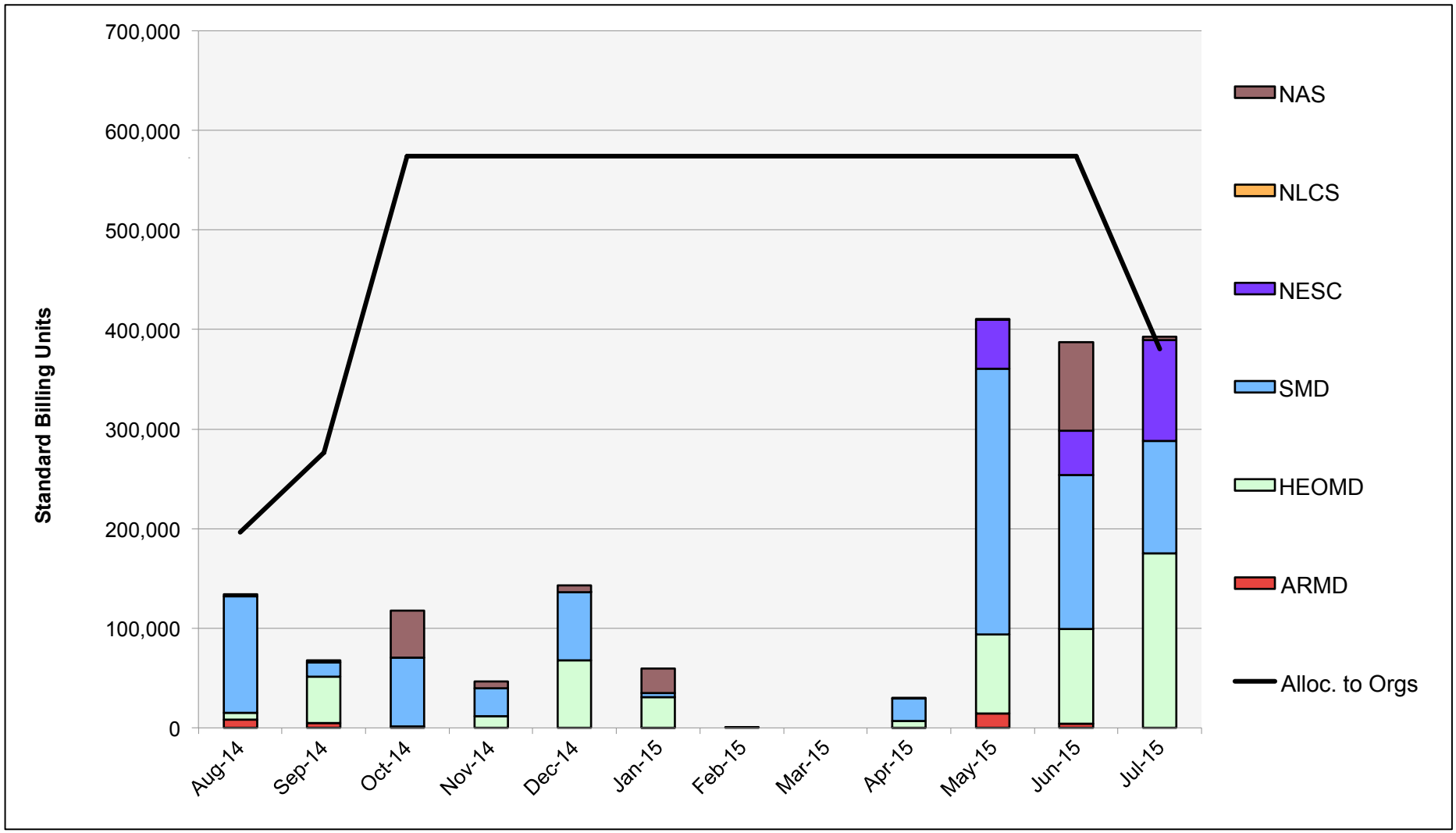
Endeavour:
Average Time to Clear All Jobs



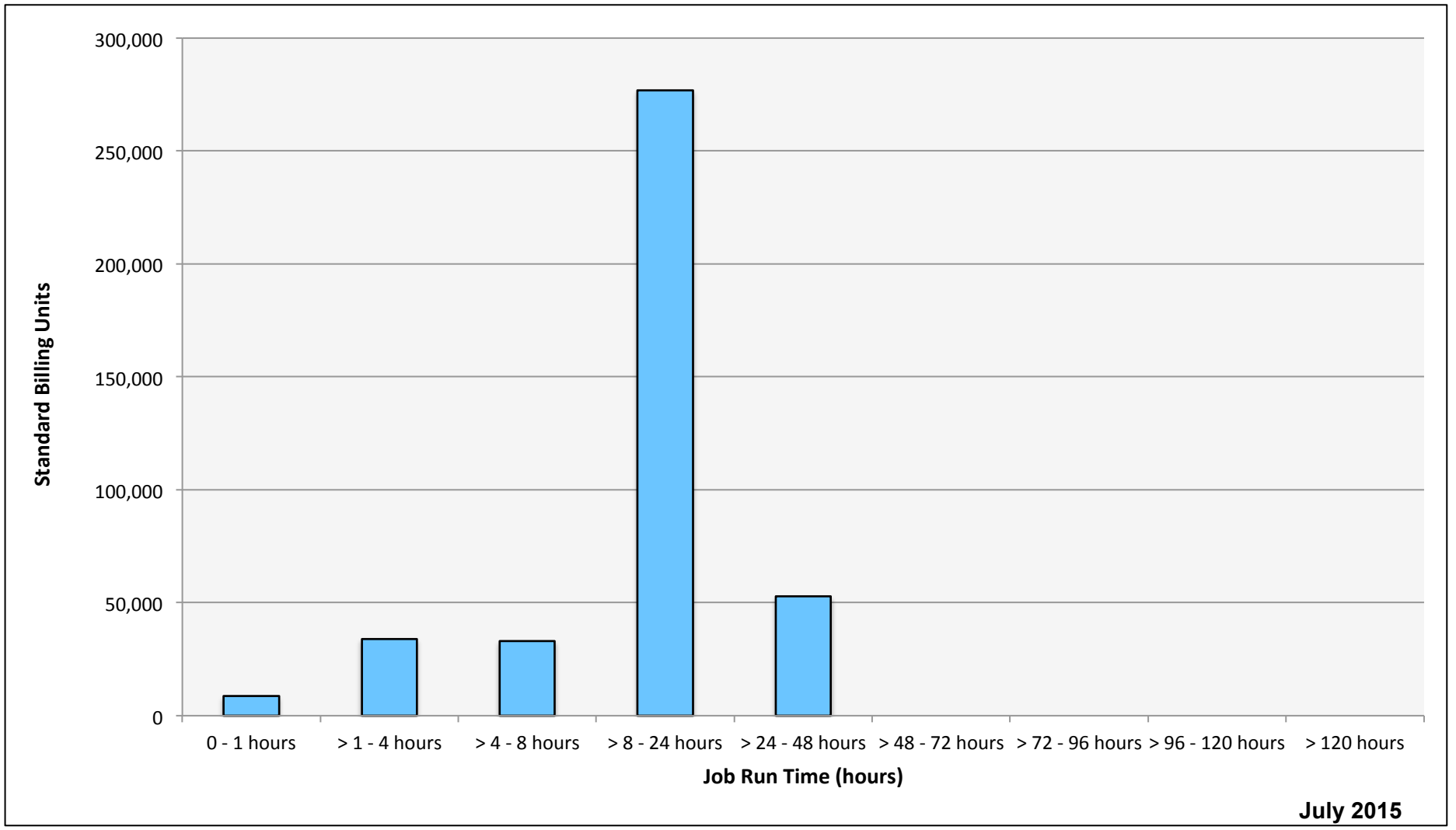
Endeavour:
Average Expansion Factor



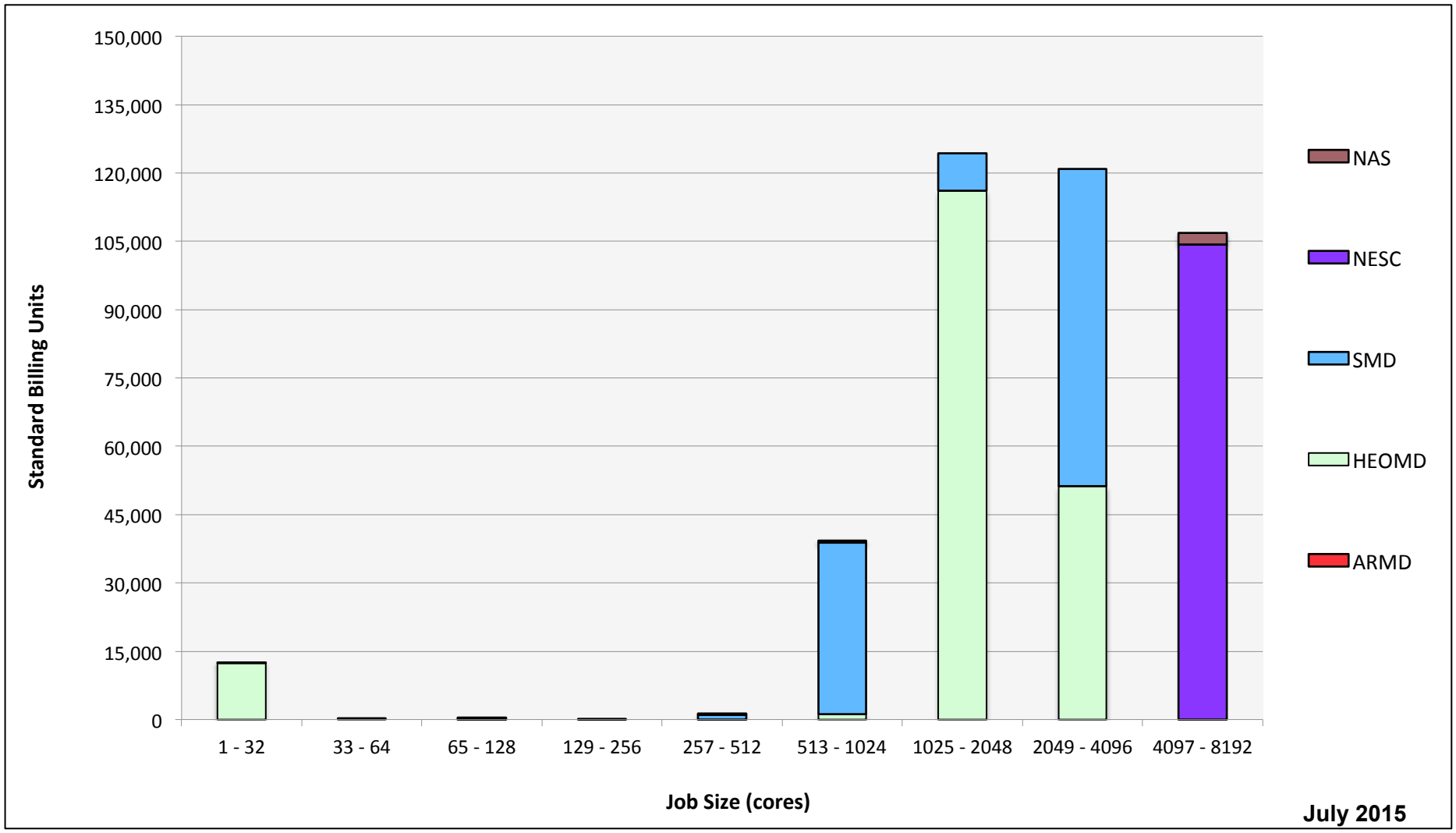
Merope:
SBUs Reported, Normalized to 30-Day Month



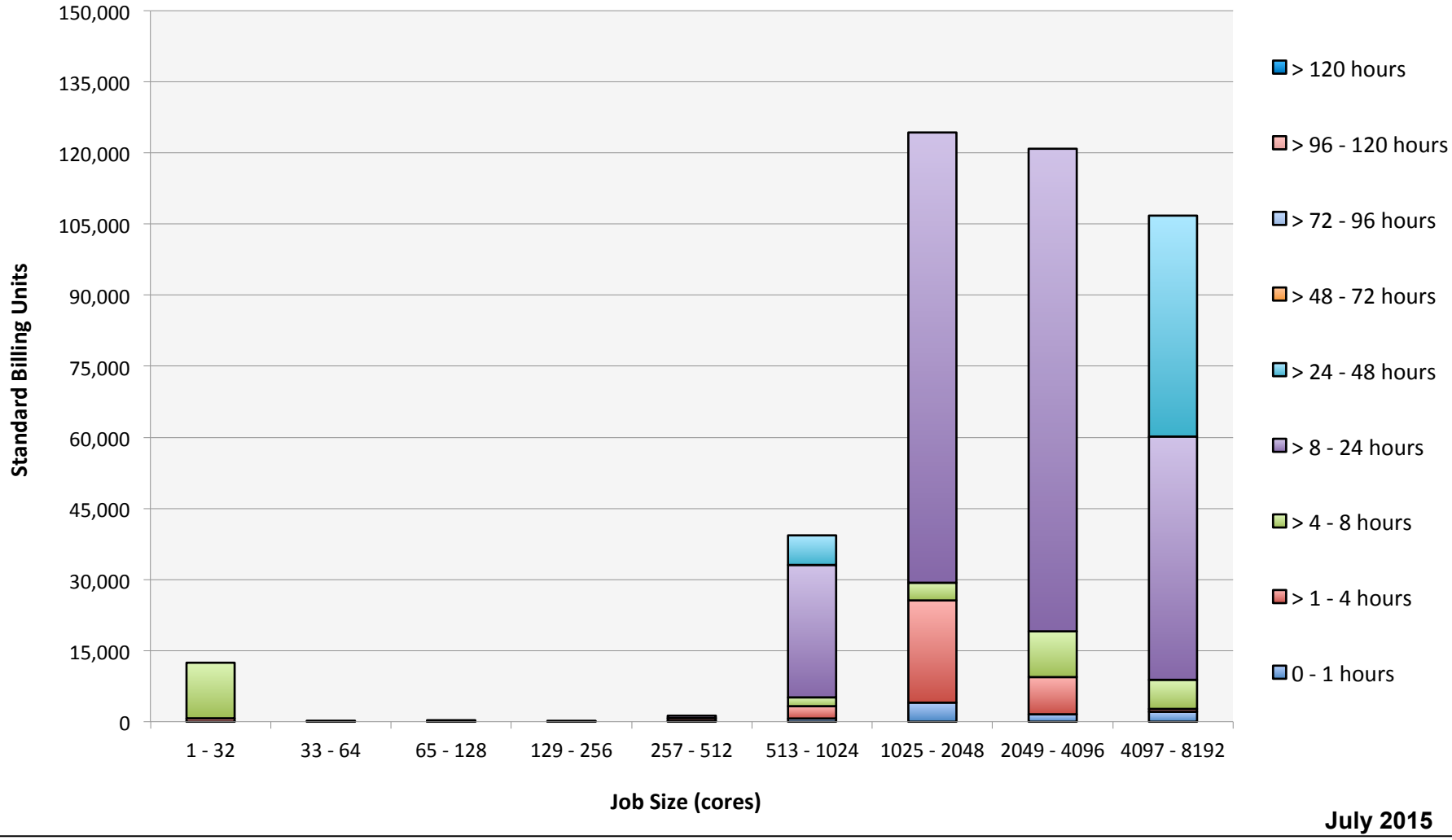
Merope:
Monthly Utilization by Job Length



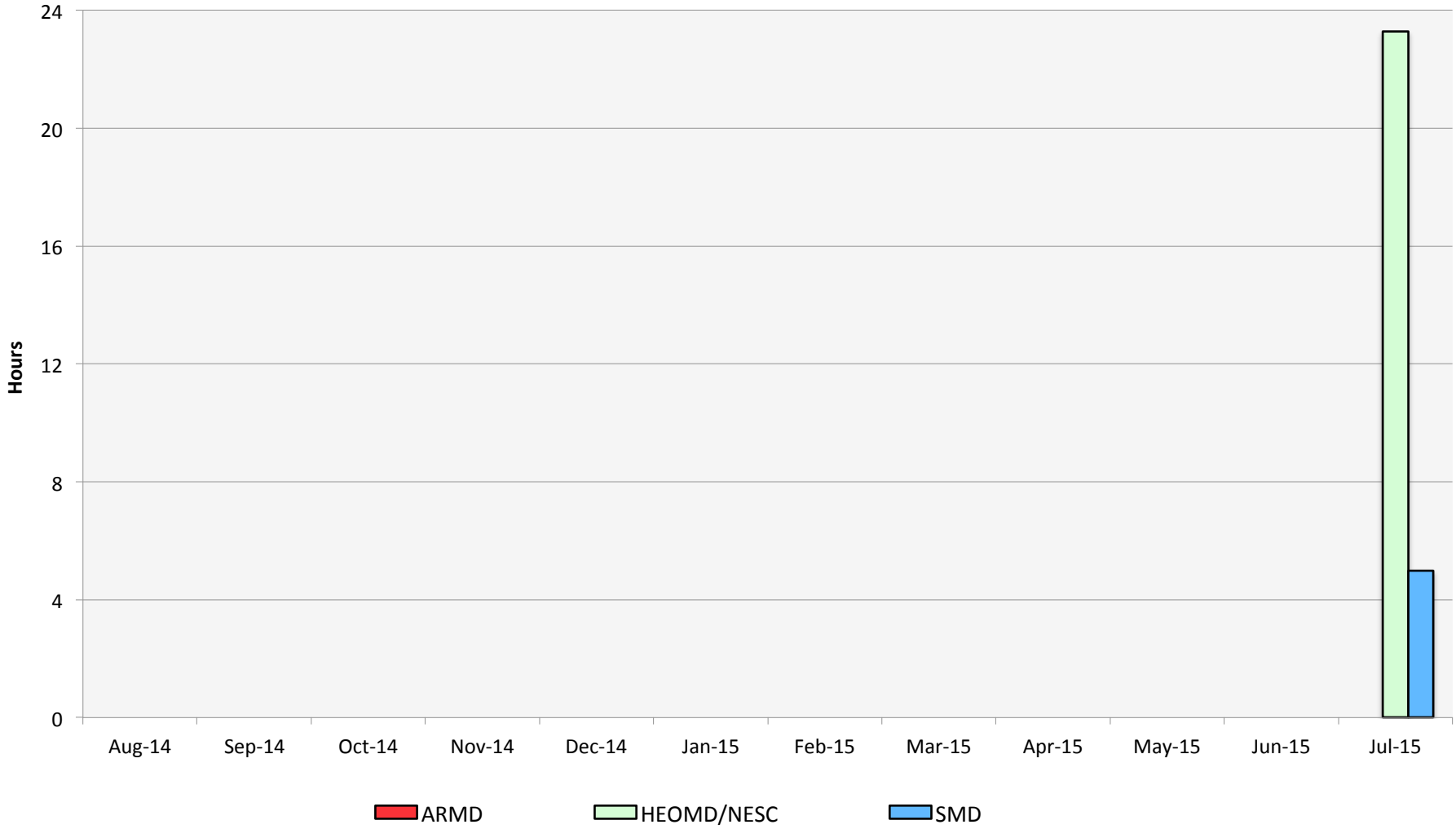
Merope:
Monthly Utilization by Size and Mission



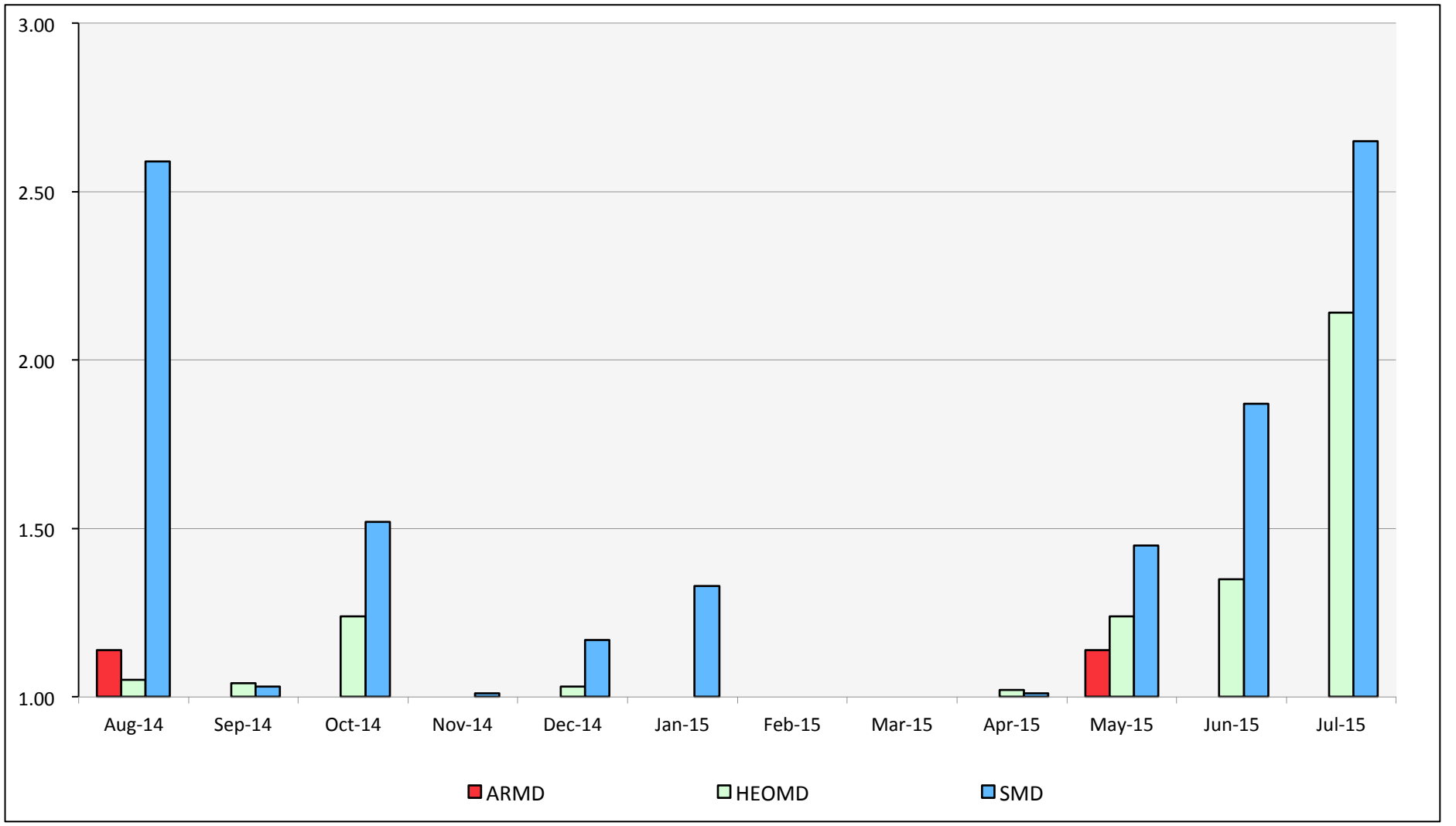
Merope:
Monthly Utilization by Size and Length



Merope:
Average Time to Clear All Jobs



Merope:
Average Expansion Factor



FY15 NAS Storage Expansion

Lustre Upgrade Milestones	Target Due Date	Status
RFQ Released	May 20, 2015	COMPLETED
Vendor Proposals Due	July 1, 2015	COMPLETED
Award	July 17, 2015	In Progress
Installation	August 21, 2015	Pending
Acceptance Testing	August 28, 2015	Pending
Production	September 16, 2015	Pending

Highlights:

- Evaluation of the proposals is taking longer than planned due to the number of proposals (4 vendors, 9 configurations) to review.
- The production date is based on acceptance testing and subject to change.

FY15 NAS Modular Data Center Schedule

MDC Upgrade Milestones	Target Due Date	Status
RFQ Released	June 9, 2015	COMPLETED
Industry Day	June 22, 2015	COMPLETED
Vendor Proposals Due	August 12, 2015	In Progress
Award	August 20, 2015	Pending
Installation	February 5, 2016	Pending
Acceptance Testing	February 26, 2016	Pending
Production	April 4, 2016	Pending

Highlights:

- Revised schedule to provide additional time for vendors to respond per vendor request. Schedule impact +9 days.
- The site preparation was extended affecting all items following reward. The transformer has an 18 week lead time. Schedule impact +115 days
- The production date is based on the acceptance testing and subject to change.