Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

10 September 2012

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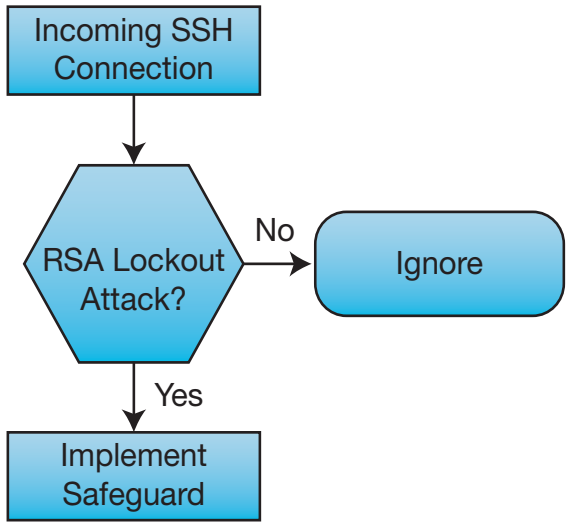
HECC Teams Implement Safeguards to Reduce RSA SecurID Lockouts

- RSA SecurID lockouts are a source of user-level denial-of-service attacks across NASA triggered by failed login attempts by malicious outside attackers over the Internet
- HECC's Networking and Security teams developed and deployed an approach to automatically block the IP address source of a sequence of failed login attempts
  - If block is triggered by the attacker using a user identifier that is not a legitimate NAS user ID, the IP address will be blocked before it can impact any legitimate users.
  - If the block is triggered by the attacker guessing and using a legitimate NAS user ID, then the block will be imposed before any other users are affected.
- Future work includes:
  - Extending safeguards to detect and prevent other network-level attacks.
  - Sharing attack information with the NASA Security Operations Center.

Mission Impact: Reducing the number of RSA SecurID lockouts ensures that HECC resources are available to authorized NASA users.



Basic diagram of RSA SecurID lockout safeguard process.

POCs: *Nichole Boscia, nichole.k.boscia@nasa.gov, (650) 604-0891; Derek Shaw, derek.g.shaw@nasa.gov, (650) 604-4229, NASA Advanced Supercomputing Division, Computer Sciences Corp.*

HECC Re-architects Networks to Meet TIC 2.0 Federal Mandate

- HECC networking staff completed a long-term project to create a clear boundary between internal and external networks to meet the federally mandated Trusted Internet Connections (TIC) 2.0 architecture.
- The staff identified servers that required moving based on their function and access, for desktop-support servers, LDAP servers, RAID devices, web servers, and HEC front-end systems, minimizing the outward facing devices.
- They worked with the desktop support, supercomputer systems, and security staff to create change control procedures and schedule a seamless method for re-architecting the location or appropriate network for each affected server.
- Almost 50 servers, spanning five different subnets, were moved over the five-month period.

Mission Impact: HECC's timely compliance with federal mandates ensures that no disruption in service occurs for NASA users and that security of the agency networks and data is maintained.

Some of the 50 servers that were required to move in order to adhere to the new Trusted Internet Connections 2.0 architecture.

POCs: *Nichole Boscia, nichole.k.boscia@nasa.gov, (650) 604-0891; Derek Shaw, derek.g.shaw@nasa.gov, (650) 604-4229, NASA Advanced Supercomputing Division, Computer Sciences Corp.*

ISS Team Verifies Flight Control Software Update to Resolve Space Station Anomaly

- The ISS Loads & Dynamics team ran extensive analyses—requiring over 357,000 SBUs on Pleiades—to complete the Verification Analysis Cycle for the Service Module (SM) 8.05 pulse train software update.
- Analyses verified that using the updated pulse train to improve thruster control on the ISS Motion Control System resulted in acceptable peak on-orbit loads.
  - SM 8.05 is the first of two pulse train updates planned to mitigate a thruster firing/structural resonance anomaly that was observed on the Russian Segment in 2011.
  - Solar array keep-out zone matrices were also developed for post-processing and delivery.
  - Results will be further verified by the Guidance, Navigation, and Control team at Johnson Space Center, and the Russian Federal Space Agency.
- Access to HECC supercomputing resources allowed timely verification of the loads impact of the software update, enabling the team to submit the update in time to meet the SM 8.05 patch schedule.

Mission Impact: Enabled by HECC computing resources, fast verification analyses ensure timely on-orbit implementation of critical ISS software updates.

The International Space Station (ISS) in orbit. Each blue dot represents a sensor location for on-orbit measurements. In 2011, sensors detected a structural resonance anomaly that led the ISS team to update flight control software, in order to prevent recurrence of the anomaly by improving control of the thruster firings used to maneuver the ISS.

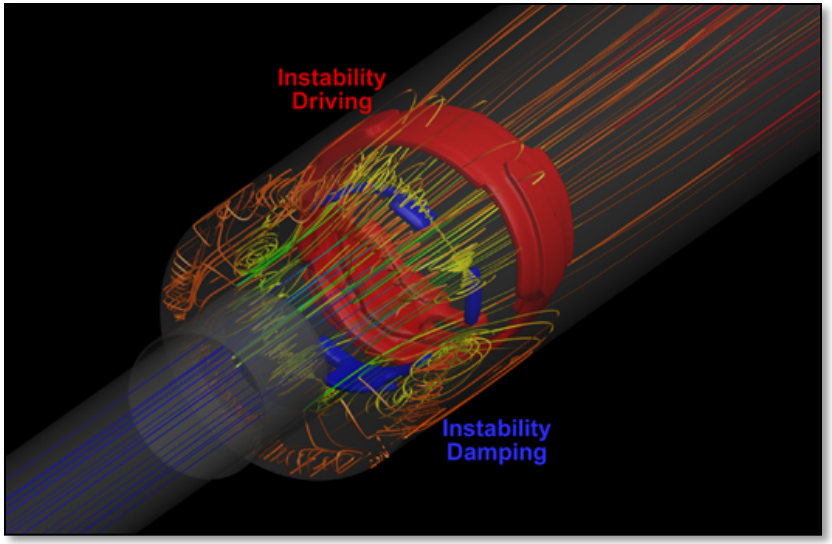
POC: *Quyen T. Jones, quyen.t.jones@nasa.gov, (281) 483-0564, Loads and Structural Dynamics Branch, NASA Johnson Space Center*

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

HECC Resources Speed Up Simulations for Validating Combustion Instabilities Model

- Researchers at Purdue University are running 3D computational fluid dynamics (CFD) simulations on Pleiades to advance understanding of how combustion instabilities in rocket engines occur.
- Simulations of an unstable, model combustor are done in parallel with experiments to validate computational models and to better define test geometries and operating conditions.
- Once validated, the 3D CFD models can provide an abundance of data that would not be available from experiments; key results include:
  - Analysis of the transition from stable to unstable behavior allows detailed examination of the underlying processes causing instability.
  - Instability damping and driving sources are located in the shear layer separating the bulk axial flow from the recirculation region of the combustor.
  - Pressure signal results better match experimental data with significant improvement over 2D results.
- NASA supercomputing resources enable these detailed simulations to run for extended durations.

Mission Impact: Understanding the fundamental causes of combustion instabilities can drastically reduce time and cost in developing new rocket engines. HECC resources are essential for capturing the complete physics of this challenging problem.



Instantaneous flowfield inside a model combustor. Areas driving combustion instability are indicated by the red isosurface. Instability damping is indicated by the blue isosurface. Time-averaged streamlines are colored with the C02 mass fraction, a product of combustion. Matthew Harvazinski, Purdue University

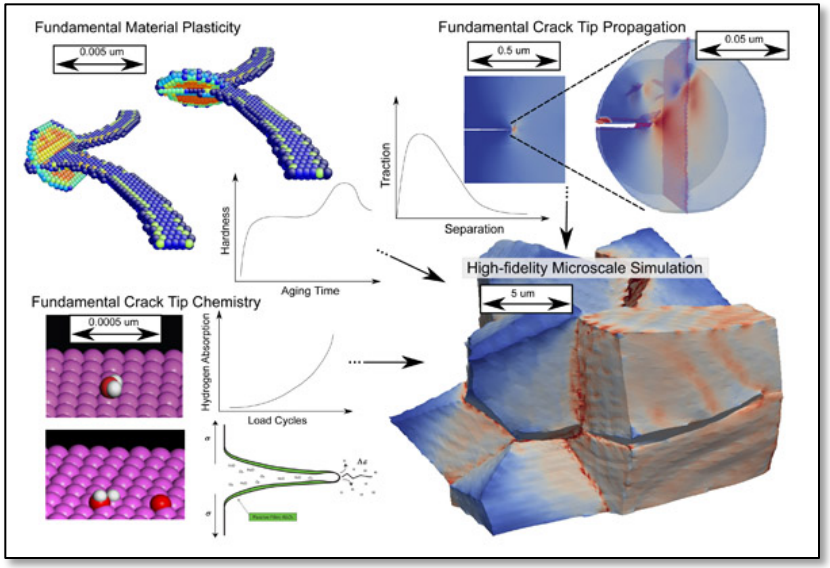
POC: *William Anderson, wanderso@purdue.edu, (765) 496-2658, Purdue University*

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

Simulations Run on Pleiades Enable Design of Ultra-Durable Materials for Future Aero Vehicles

- Researchers at NASA Langley are performing a series of simulations on Pleiades to support requirements for developing new, ultra-durable materials for future aerospace vehicles.
- Simulation results are used to deduce key aspects of material response to loads and environments, including:
  - Microstructural mechanics that govern metal fatigue crack initiation and growth.
  - The variety and complexity of the dislocation-precipitate interactions that underpin plastic behavior and damage evolution.
  - Energetic principles that govern the interaction of water with crack surfaces within a structural component.
- The intensive, high-fidelity simulations required for this work would be impossible to obtain without the use of Pleiades.

Mission Impact: These simulations, enabled by HECC resources, will be used to guide the design of new structural materials with exceptional properties, and to develop new methodologies for model-based material certification and sustainment.



Crack tip chemistry simulations predict the dissociation of water on crack surfaces. The multiple simulations, at various time and length scales, inform micro-scale simulations for improved fidelity in engineering applications. Rob Kelly, University of Virginia; Anthony Ingraffea, Derek Warner, Cornell University

POCs: *Jacob Hochhalter, jacob.d.hochhalter@nasa.gov, (757) 864-3094; Edward Glaessgen, e.h.glaessgen@nasa.gov, (757) 864-8947, NASA Langley Research Center*

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Role of Supercomputing in Mars Missions Highlighted at Ames MSL Event

- Volunteers from the NAS facility were on hand at the August 5th Mars Science Laboratory (MSL) event held for 7000-plus visitors at NASA Ames.
- The staff explained the role of HECC resources in the MSL and other missions, answered questions, and gave out materials on HECC capabilities.
- Eye-catching posters in the Supercomputing booth featured several MSL-related projects run on Pleiades over the last four years, including simulations used to analyze and predict the effects of shock waves and heat on the MSL Thermal Protection System.
- Guests also enjoyed using interactive touch-screens to take a quiz designed by HECC Publications and Media staff to connect with students and the public.

Mission Impact: Engaging the public about the role of NASA supercomputing resources and capabilities in solving science and engineering challenges across the agency can inspire future generations of U.S scientists and engineers.

Enthusiastic visitors of all ages posed questions and took an interactive quiz related to supercomputing resources at the Mars Science Laboratory event held at NASA Ames on August 5, 2012.

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

HECC Facility Hosts Several Visitors and Tours in August 2012

•HECC hosted 9 tour groups in August; guests learned about the agency-wide missions being supported by Pleiades, and viewed scientific results on the hyperwall system. Visitors included:

- Dr. Thomas Hussey, Chief Scientist, Air Force Office of Scientific Research.
- Brooke Owens, an Office of Management and Budget program examiner.
- Congressional staffer Dr. Ben Gutman, who works for Congresswoman Zoe Lofgren on science, space, and technology issues.
- Space Launch Systems researchers from Headquarters, MSFC, and KSC.
- 25 Singularity University students.
- 25 ASPIRE Project high school students attending a summer internship with University of California, Berkeley's Space Sciences Laboratory.

Visualization team lead Chris Henze presents data from simulations for NASA missions to ASPIRE Project students, demonstrating use of the hyperwall-2 system.

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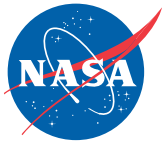
Papers and Presentations



- "**There and Back Again – An Unexpected Journey in Rotorcraft CFD**," Neal Chaderjian, Aeronautics Technical Seminar, presented at NASA Ames Research Center, August 30, 2012.*
- "**Numerical Dissipation and Wrong Propagation Speed of Discontinuities For Stiff Source Terms**," Helen Yee, paper presented at ISIS20 Stockholm Sweden, August 20–24, 2012.*
- "**MESSENGER Detection of Electron-Induced X-Ray Fluorescence from Mercury's Surface**," Richard D. Starr et al**,** Journal of Geophysical Research, Vol. 117, August 16 2012.*
  http://www.agu.org/pubs/crossref/2012/2012JE004118.shtml
- "**2011 NAS User Survey Results**," announced on the HECC website, August 23, 2012.
  http://www.nas.nasa.gov/assets/pdf/papers/2011_NAS_User_Survey_Results.pdf
- "**Shared-Memory Parallelism and OpenMP**," Henry Jin, HECC user webinar presented at the NAS facility on August 22, 2012.
  http://www.nas.nasa.gov/hecc/support/past_webinars.html
- "**Scalability Improvement of the NASA Multiscale Modeling Framework for Tropical Cyclone Climate Study**," Bron Nelson, Samson Cheung, Wei-Kuo Tao, Computing in Science and Engineering, IEEE Computer Society, August 10, 2012.*
  http://doi.ieeecomputersociety.org/10.1109/MCSE.2012.90
- "**NAS Engineers Improve Efficiency of the National Combustion Code on Pleiades**," Technical Highlight, NASA Advanced Supercomputing Division website, July 31, 2012.*
  http://www.nas.nasa.gov/publications/news/2012/07-31-12.html

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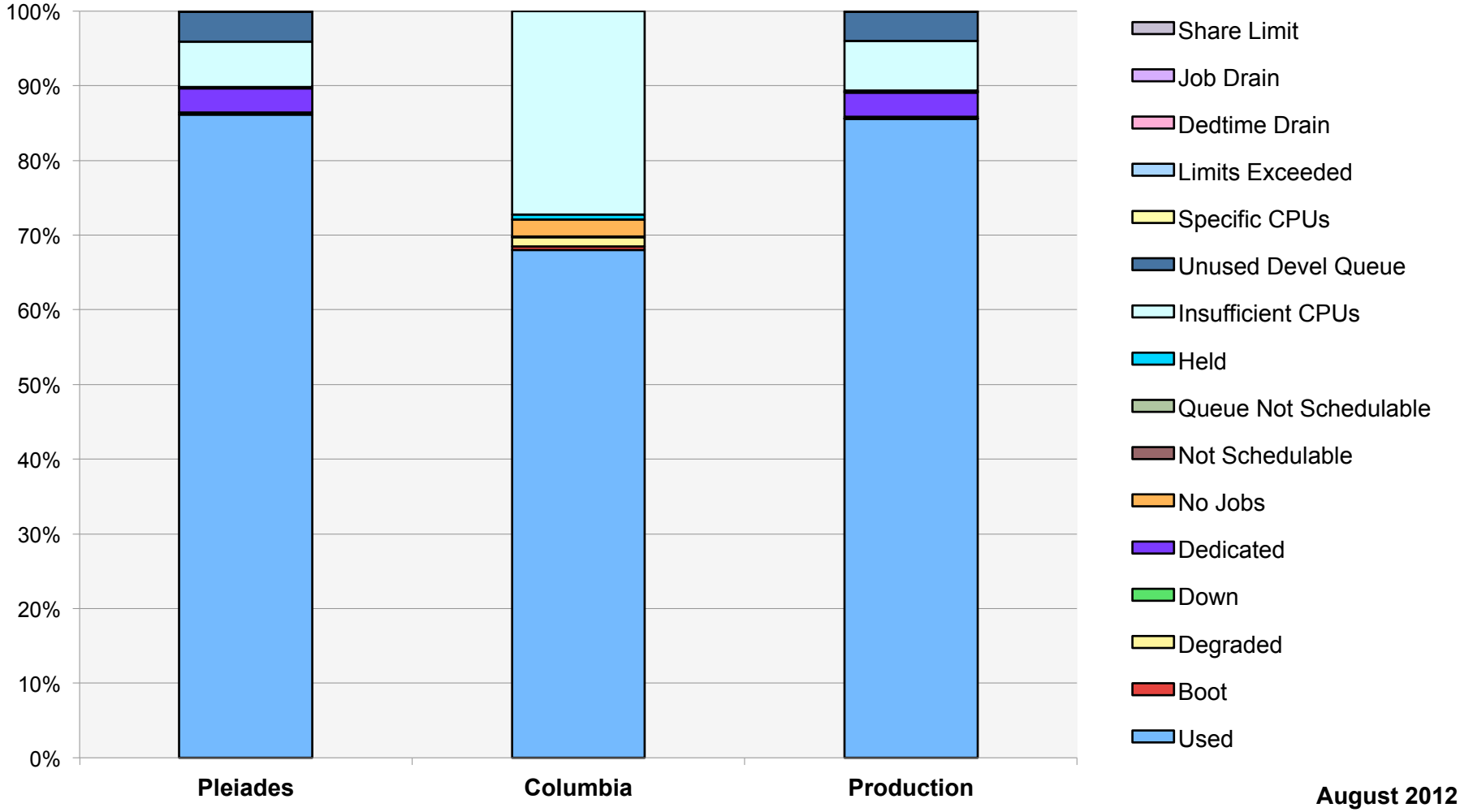
News and Events

•**In the Land of the Computer, Pleiades is King**, *NBC TV Bay Area,* August 3 – In this 3-minute video special, reporter Garvin Thomas interviews HECC Deputy Project Manager Bill Thigpen, and takes viewers behind the scenes to highlight the Pleiades supercomputer.
http://www.nbcbayarea.com/video/#!/news/local/In-The-Land-Of-The-Computer--Pleiades-Is-King/164932296

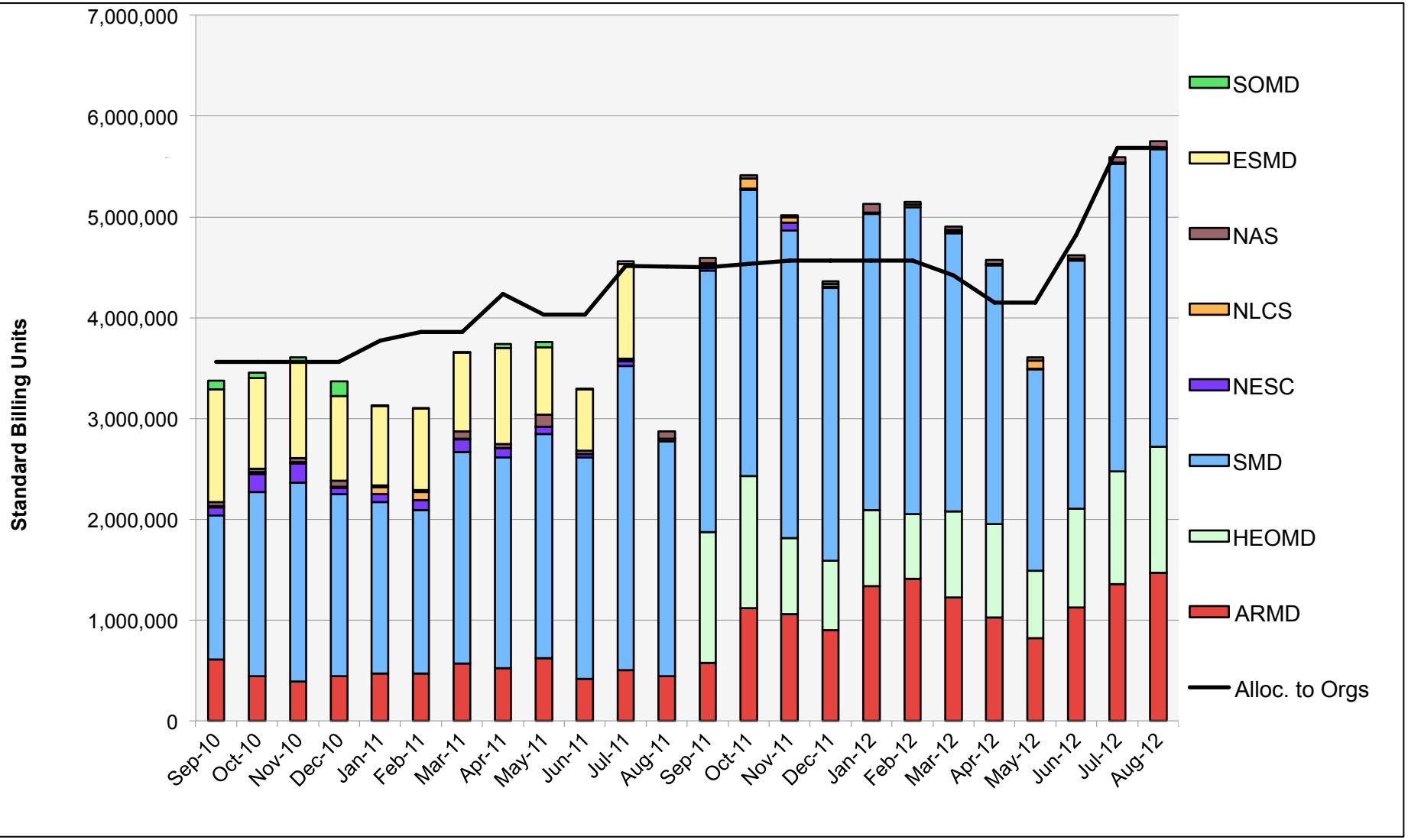
•**2012 NASA Honor Awards Ceremony**, Ames Research Center, August 22 – Seven individuals and nine teams performing work under or with the support of the HECC Project were recognized.

- Exceptional Achievement Medal – Neal Chaderjian, Goetz Kloepfer
- Exceptional Engineering Achievement Medal – Robert Ciotti
- Exceptional Public Service Medal – Lorien Wheeler
- Exceptional Service Medal – Henry Jin, Marian Nemec, Helen Yee
- Outstanding Leadership Medal – Ramakrishna Nemani
- Ames Sonic Boom Team
- Cart3D Development Team
- High End Computing Storage Team
- HyperRad Modeling and Software Development Team
- NAS Tours Team
- SDO Science Investigation Team (nominated by GSFC)
- Nebula Test Team (nominated by HQ)
- Science Mission Directorate Presentation Hyperwall Team(nominated by HQ)
- Ares I Aerodynamic/Aeroelastic Archival Team (nominated by LaRC)

HECC Utilization



HECC Utilization Normalized to 30-Day Month



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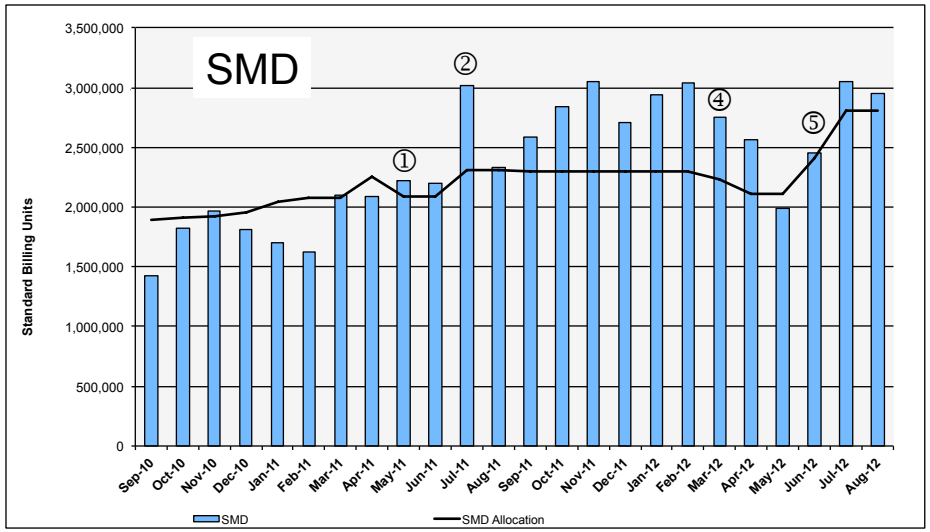
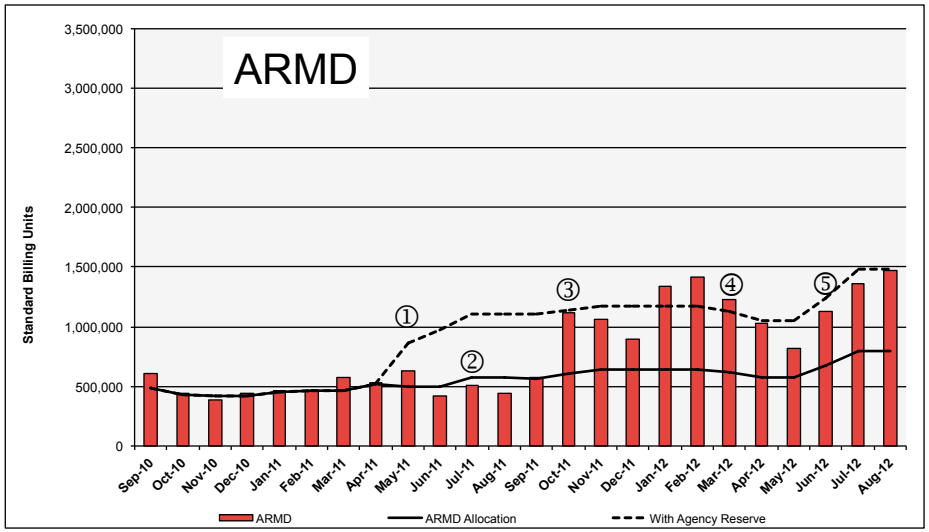
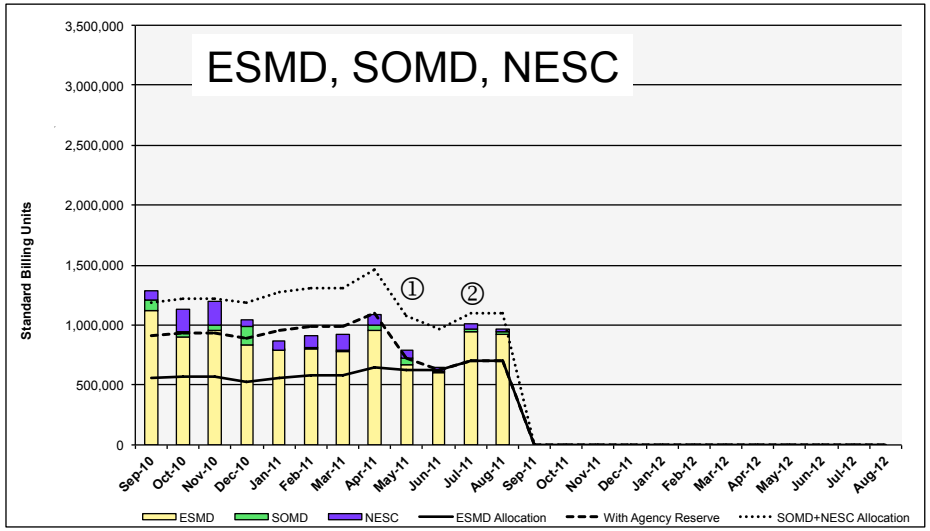
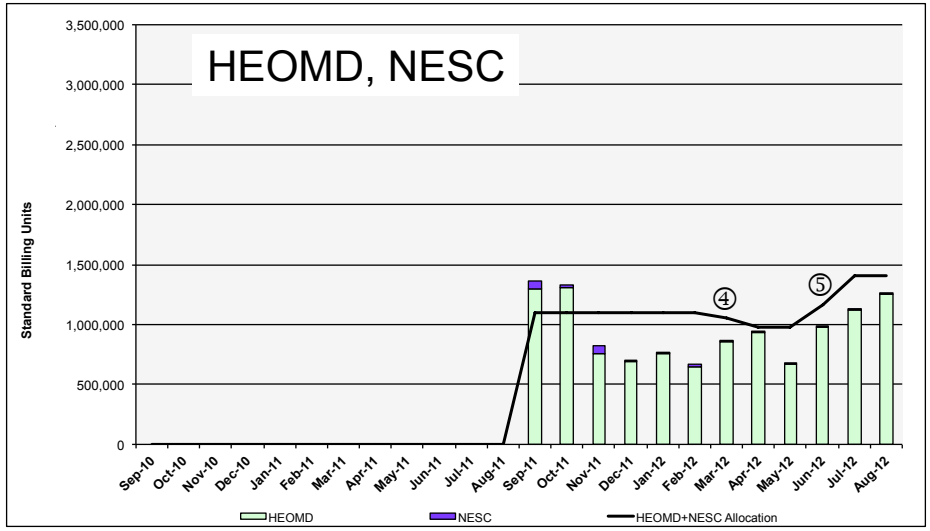
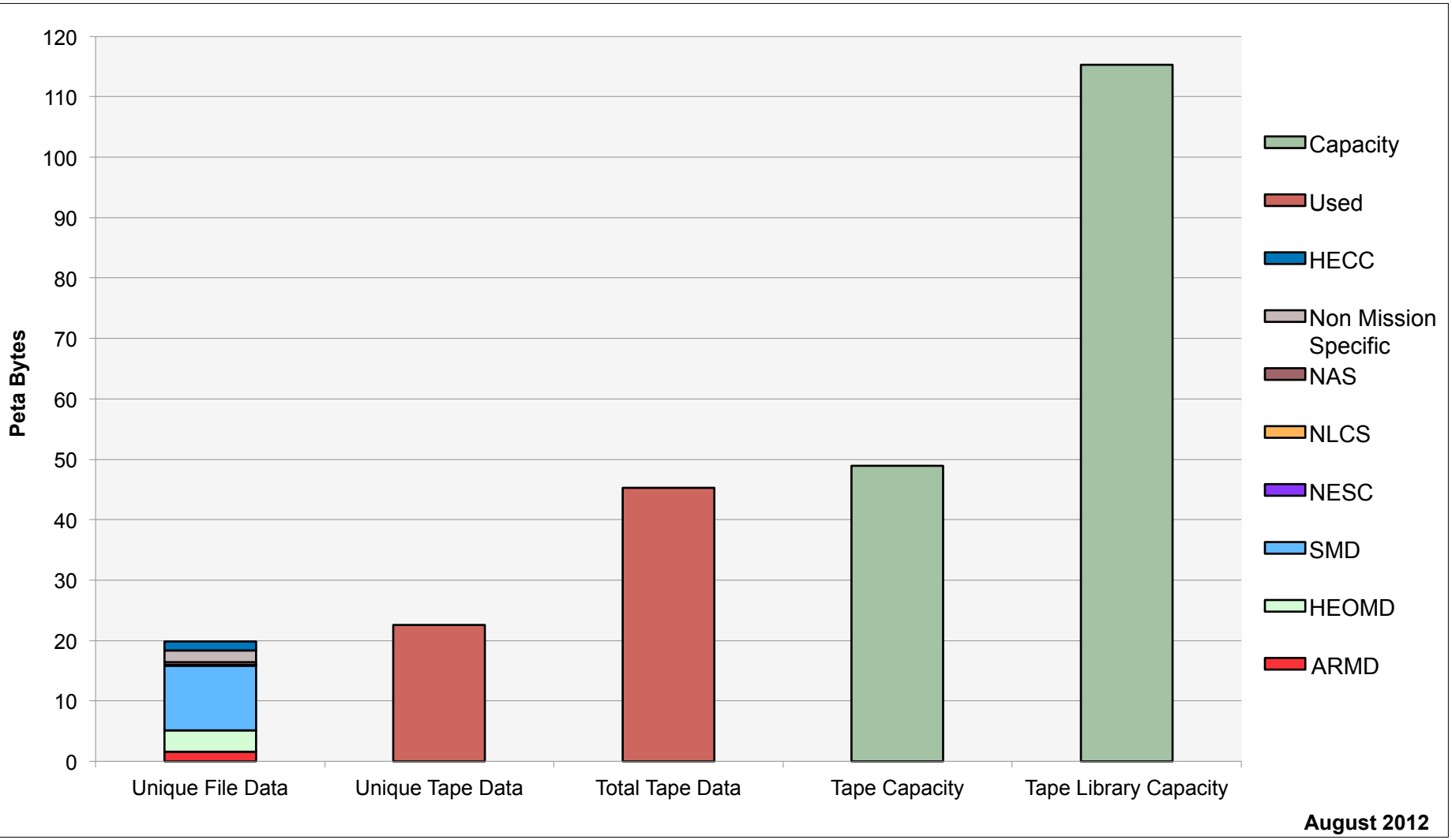








Tape Archive Status



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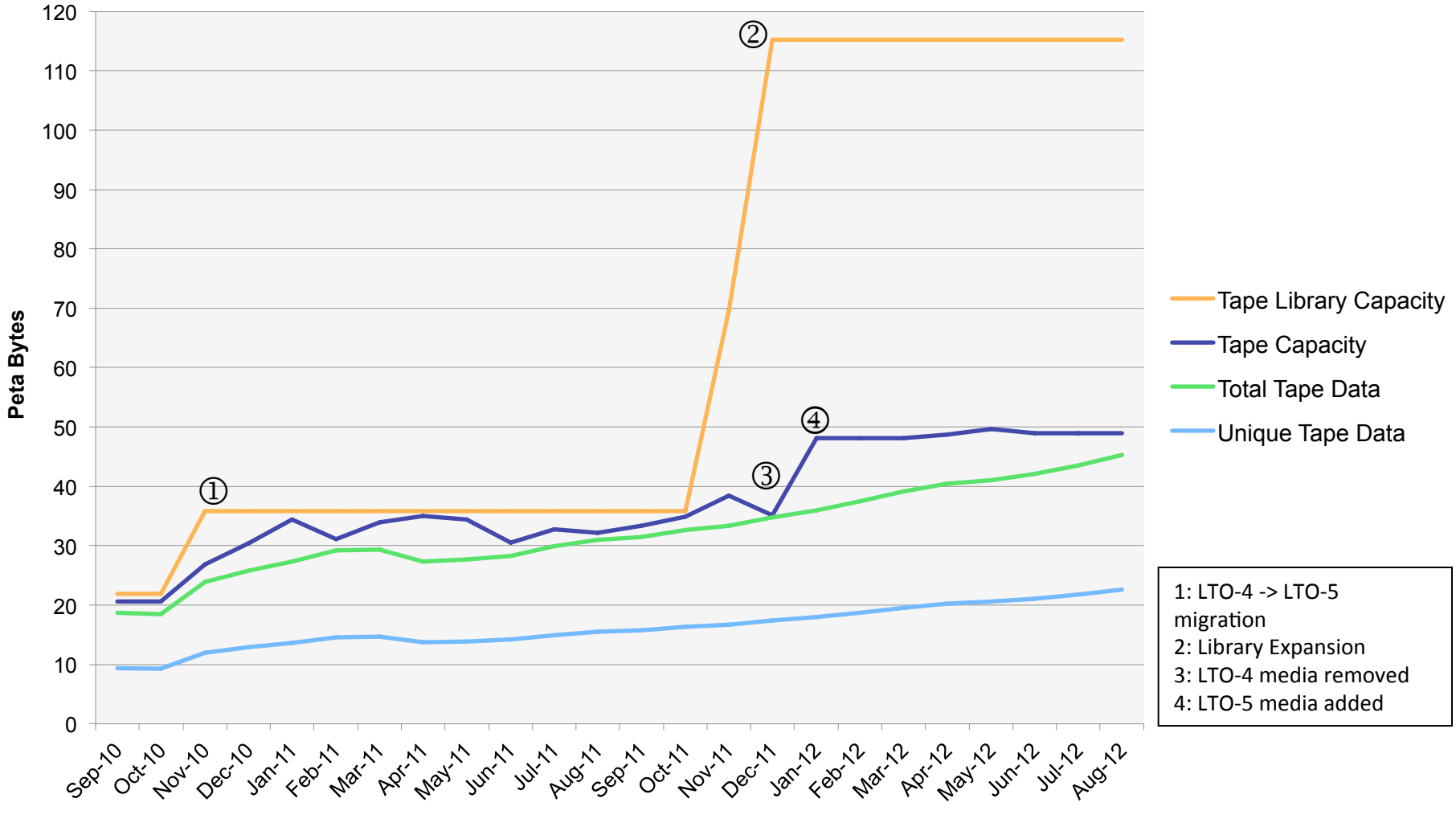
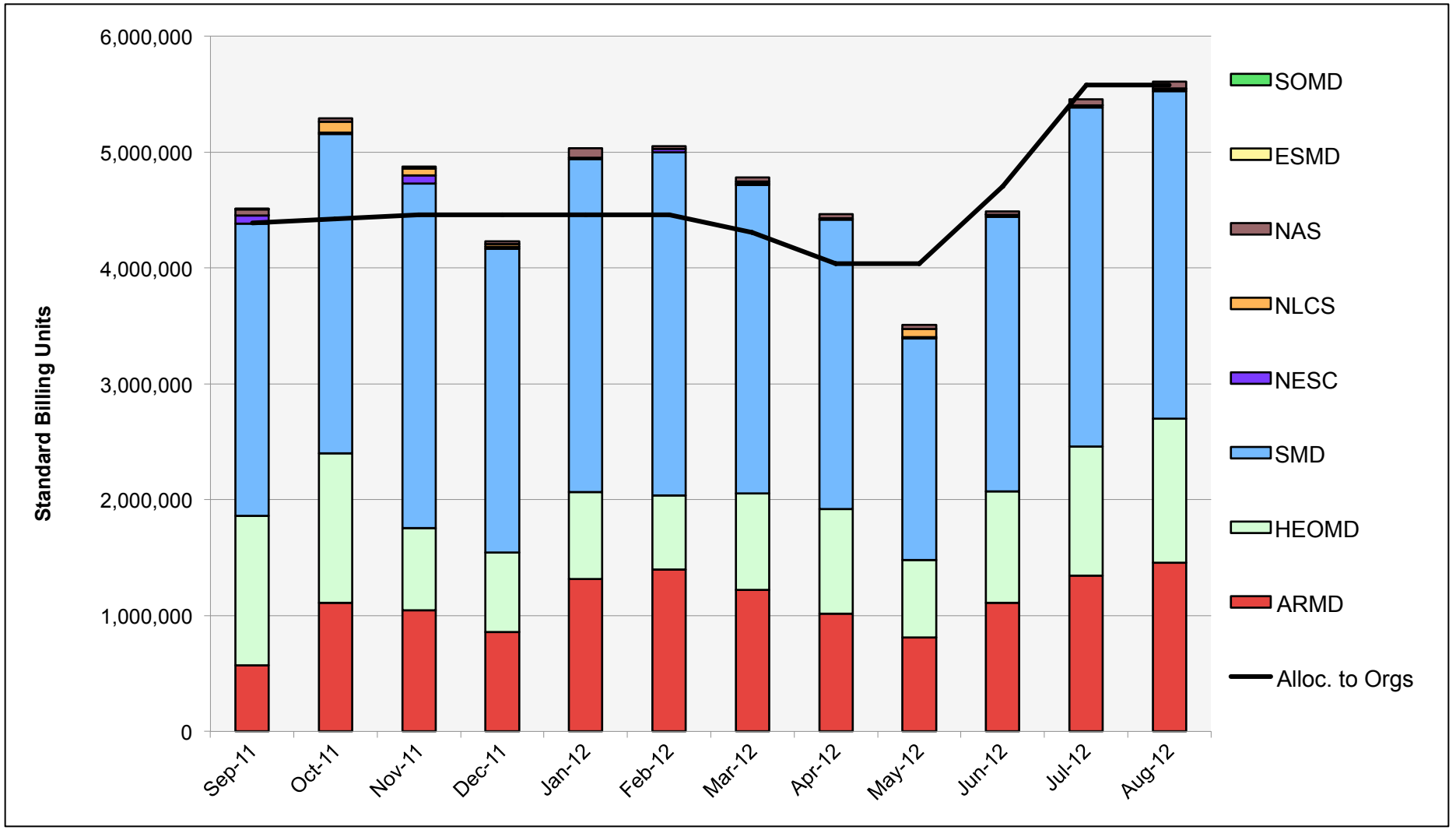
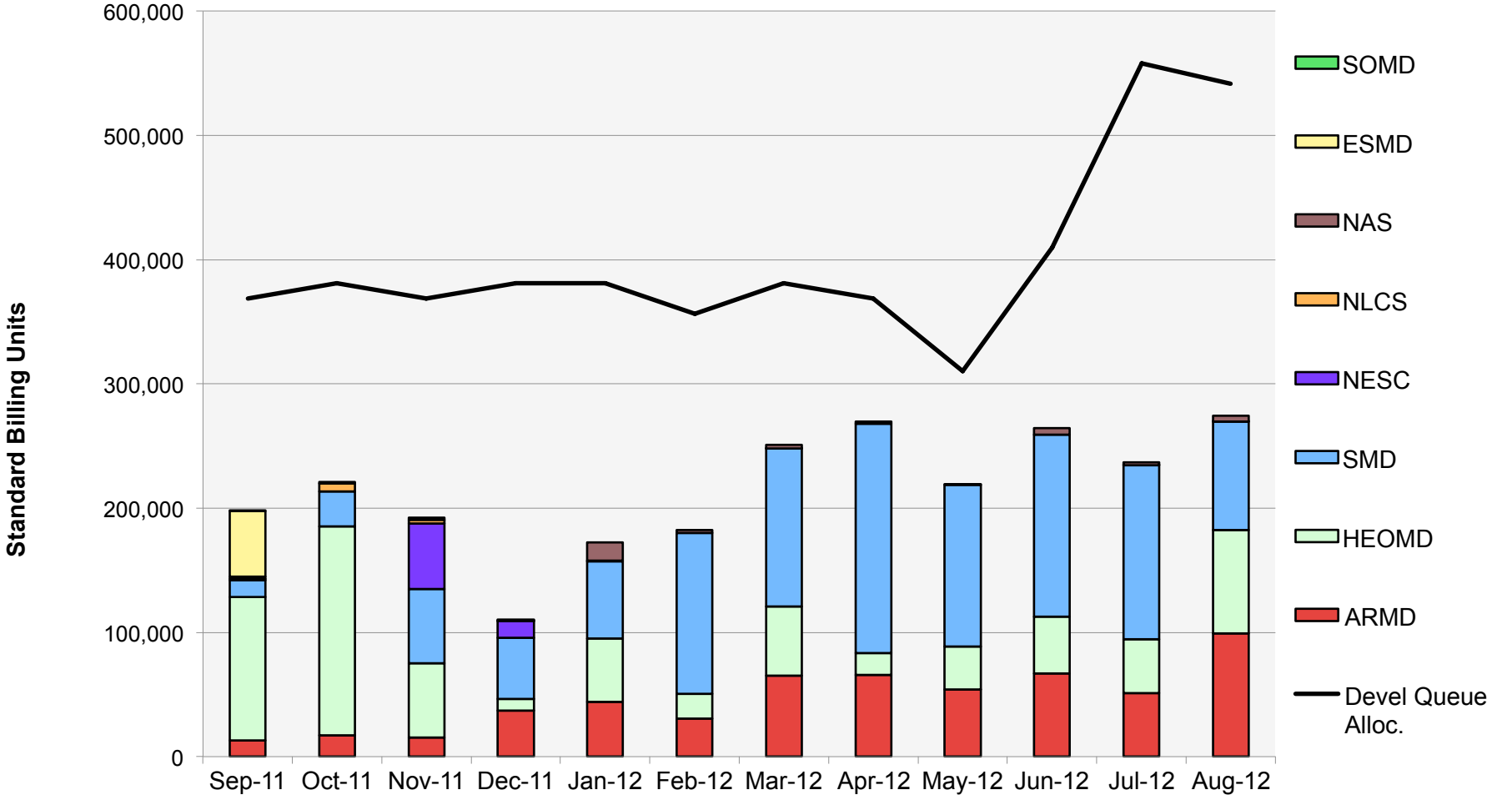


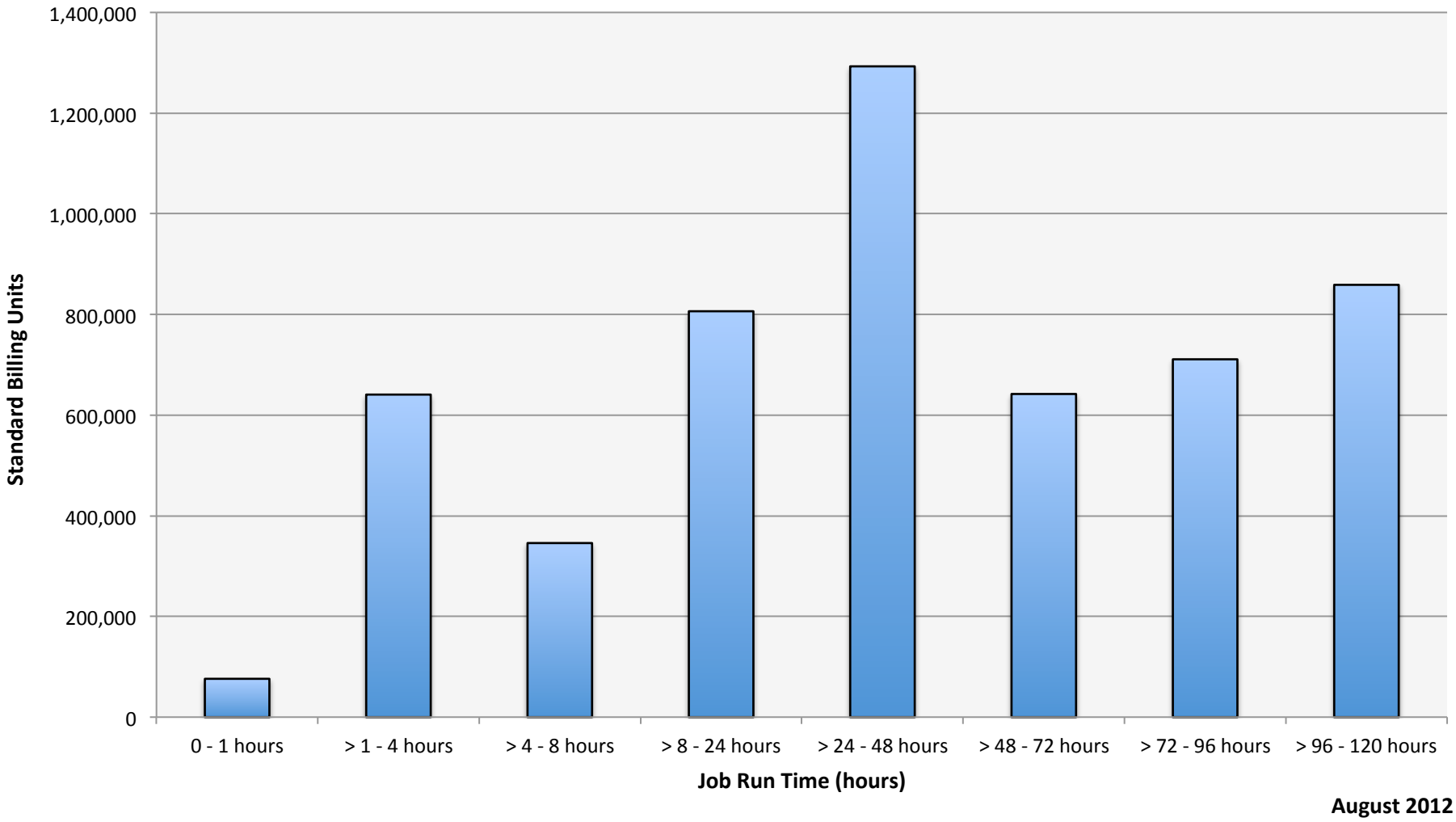
Pleiades:
SBUs Reported, Normalized to 30-Day Month



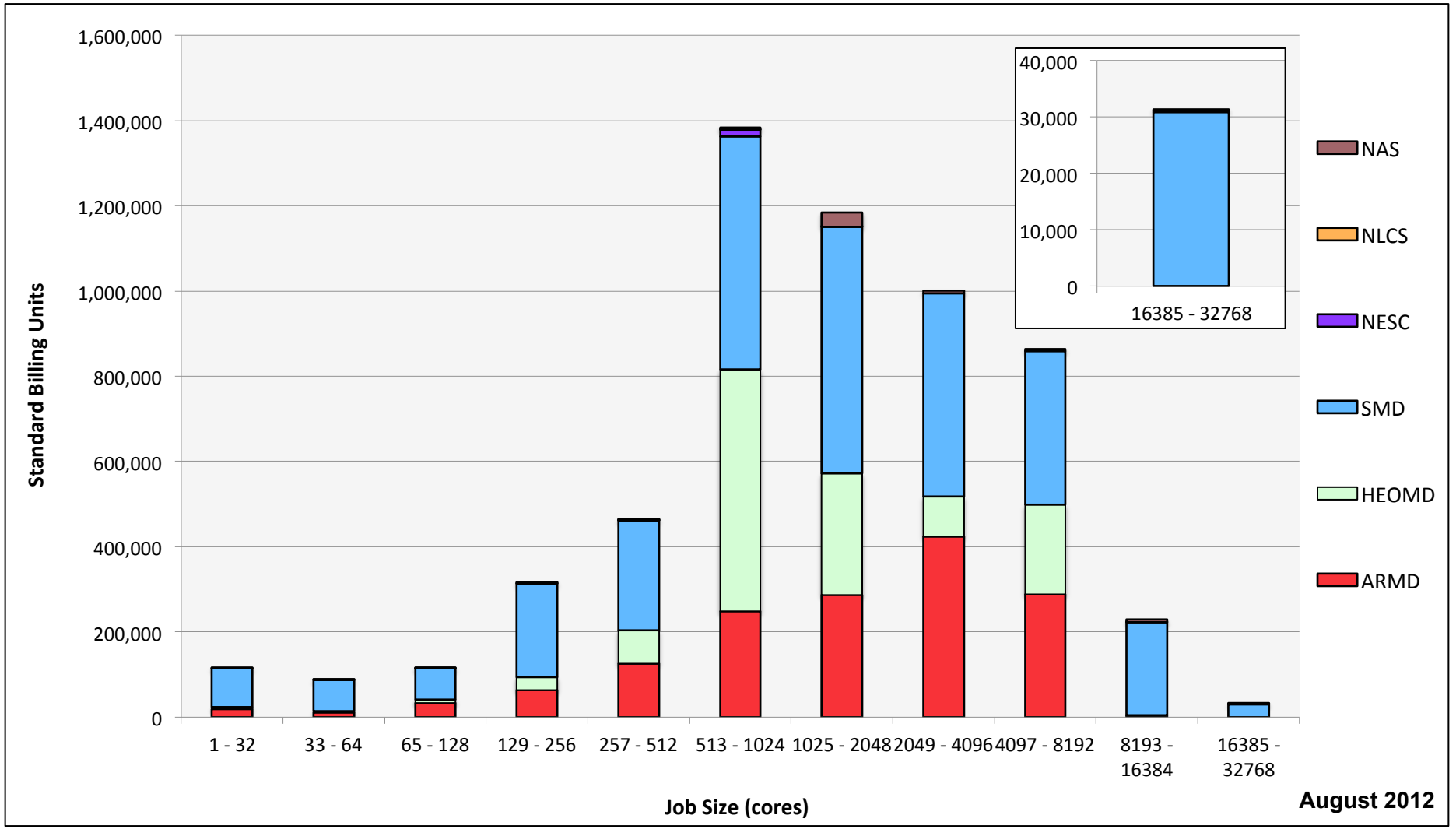
Pleiades:
Devel Queue Utilization



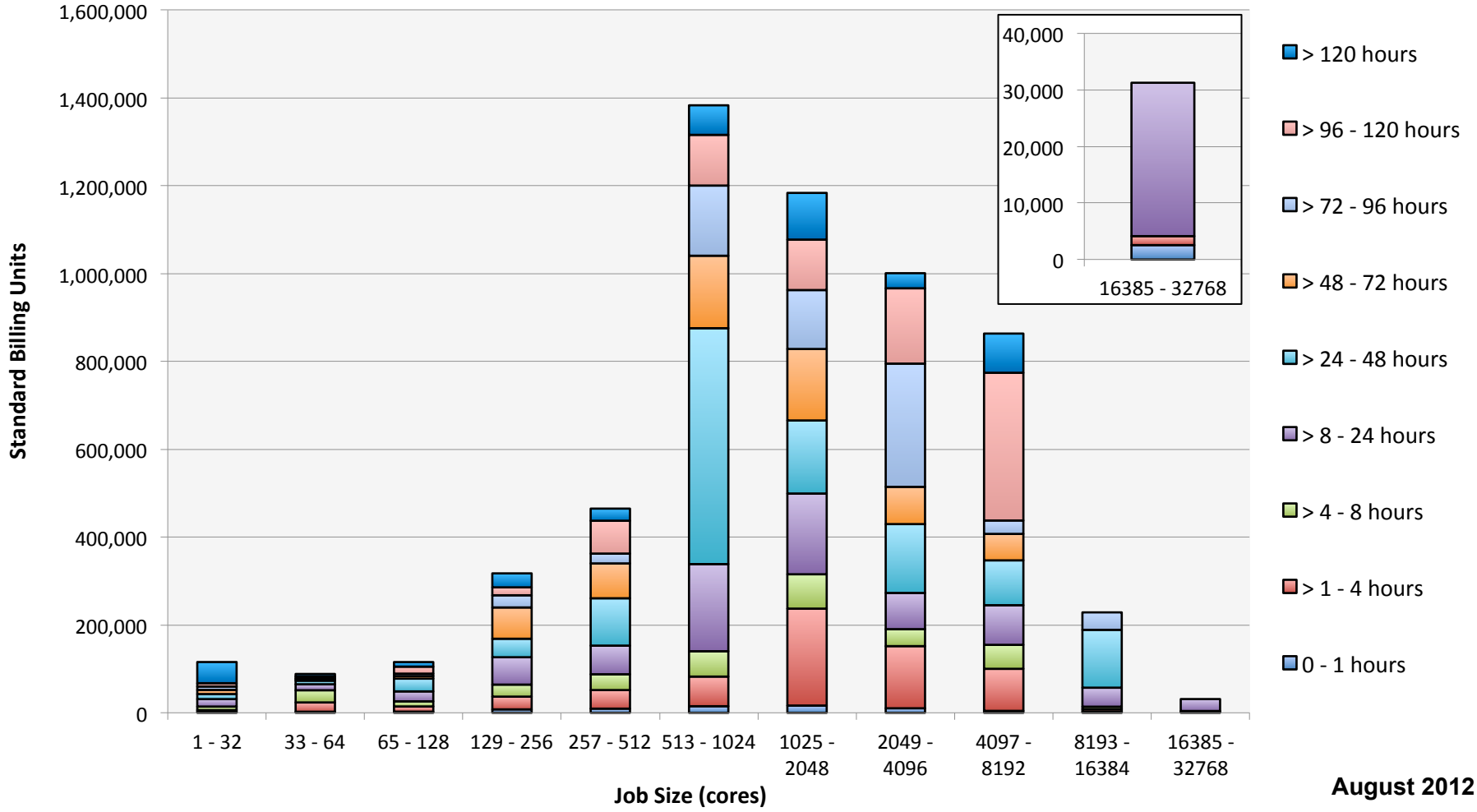
Pleiades:
SBUs Reported, Normalized to 30-Day Month



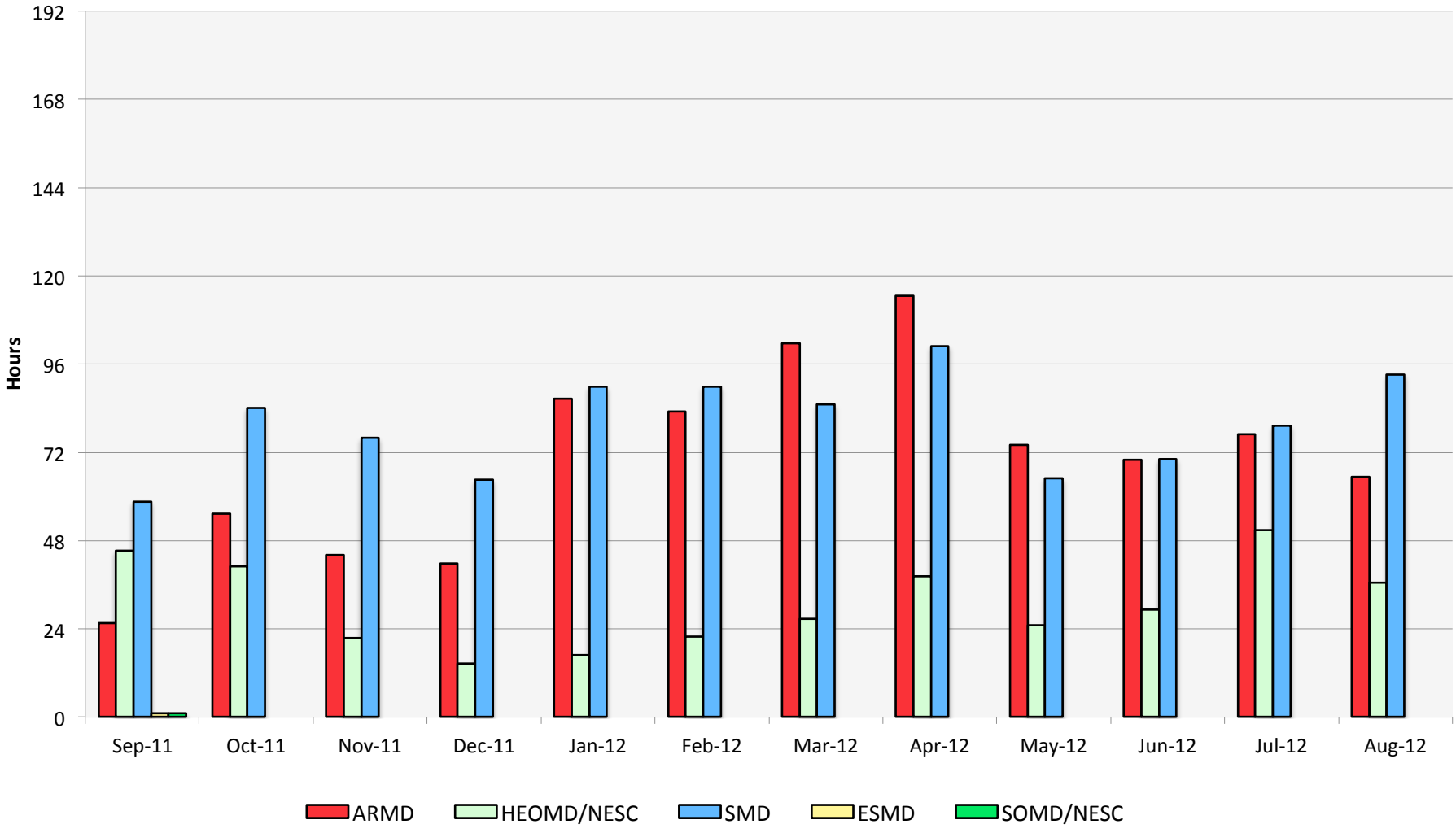
Pleiades:
Monthly Utilization by Size and Mission



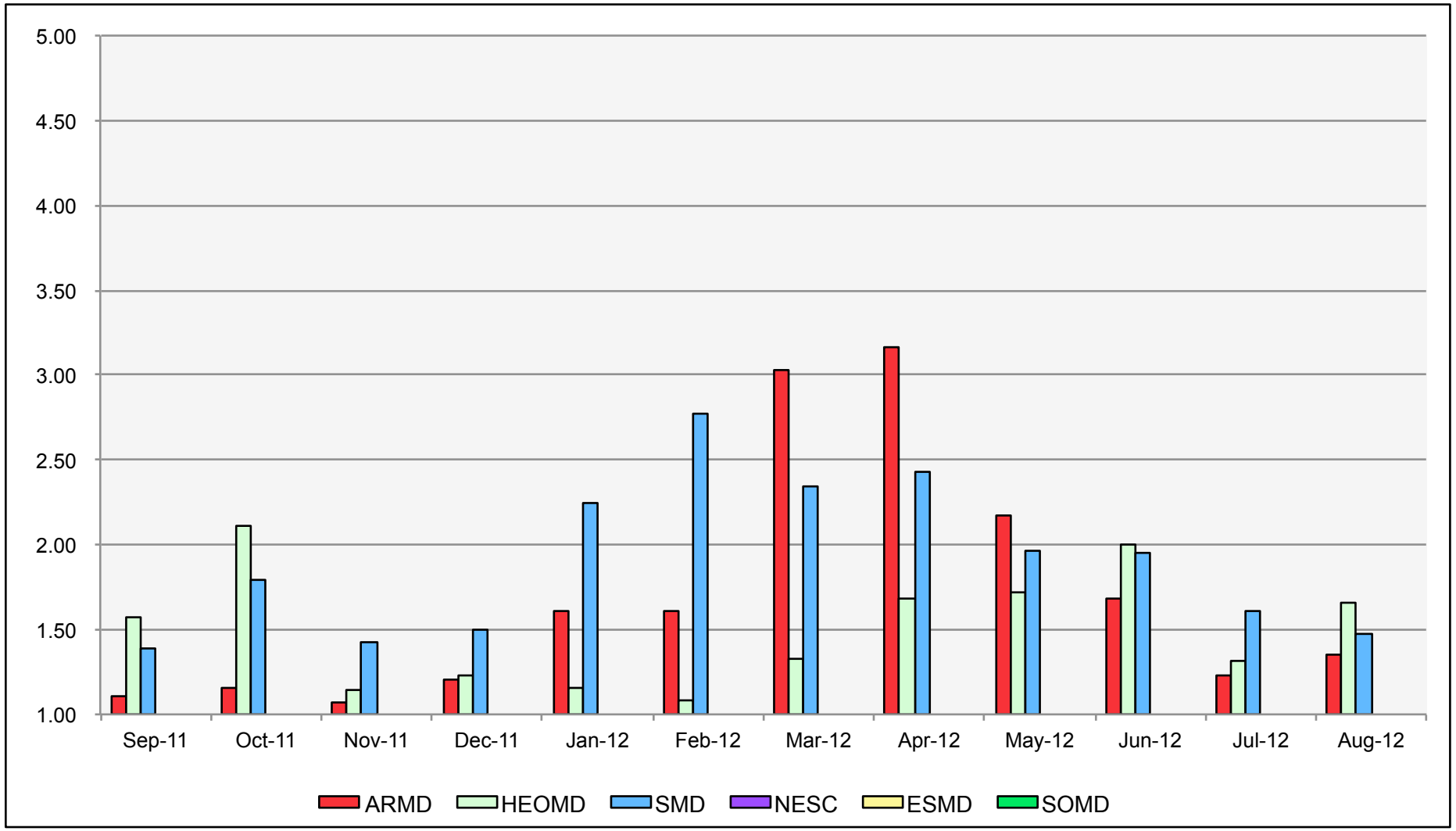
Pleiades:
Monthly Utilization by Size and Length



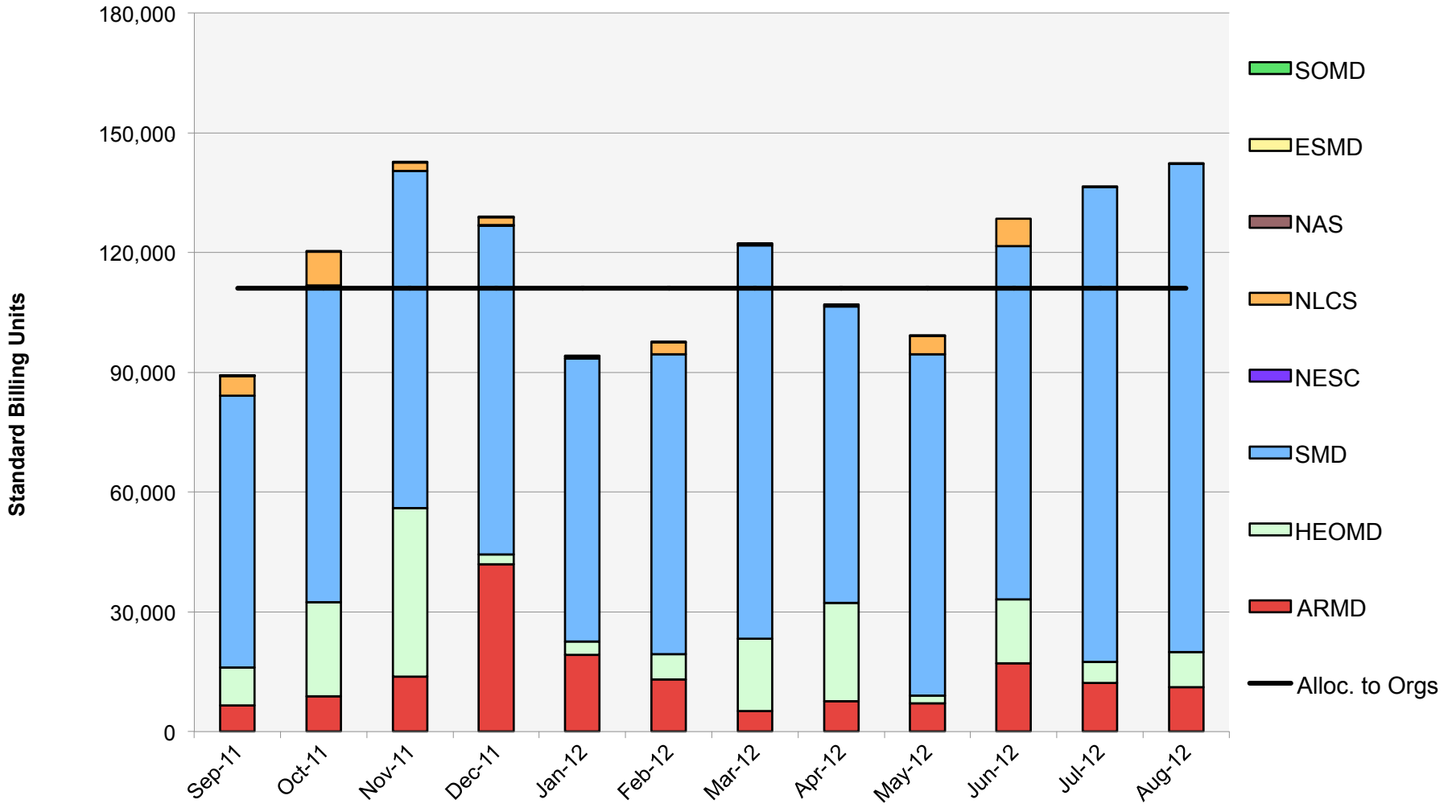
Pleiades:
Average Time to Clear All Jobs



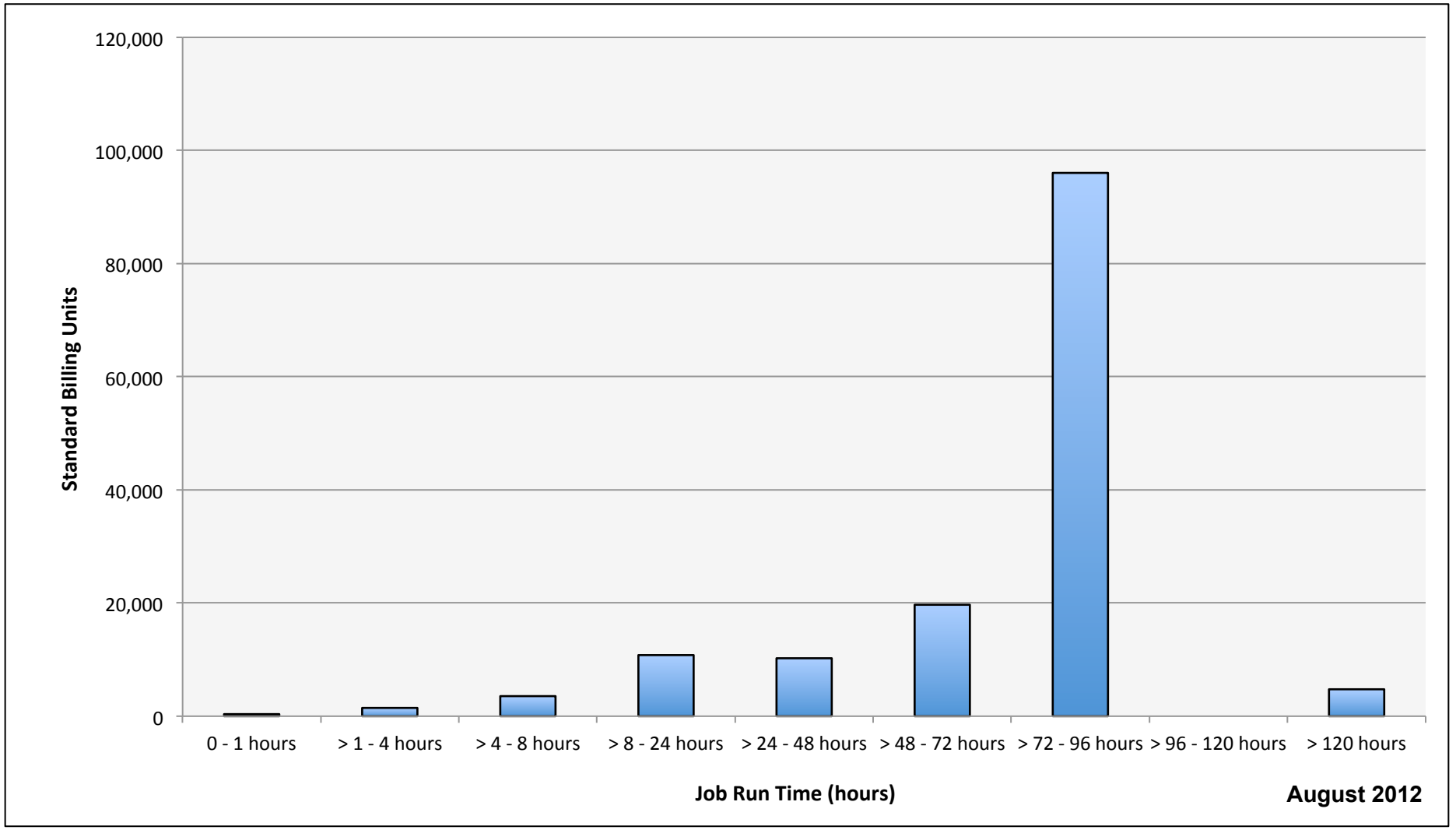
Pleiades:
Average Expansion Factor



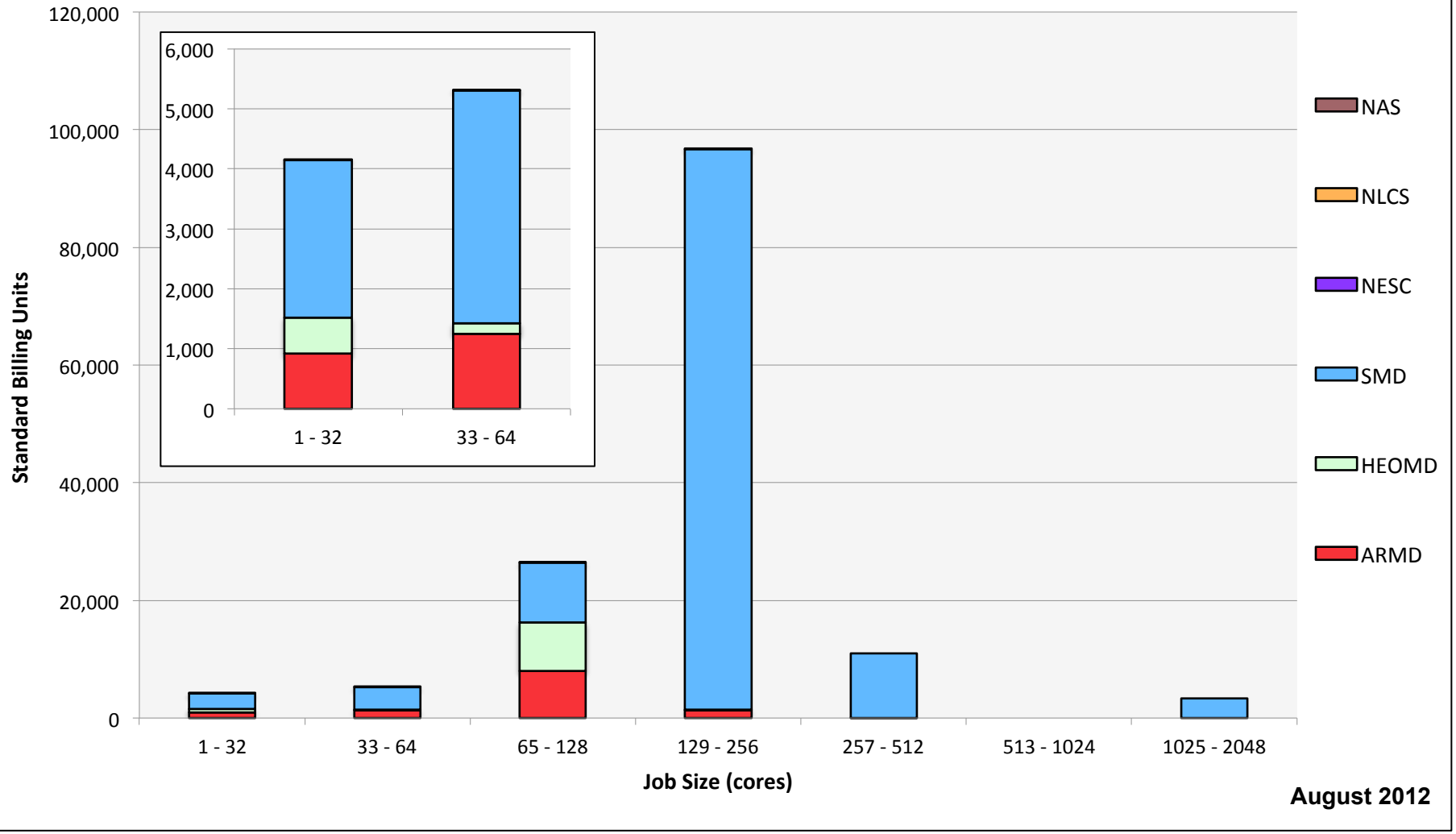
Columbia:
SBUs Reported, Normalized to 30-Day Month



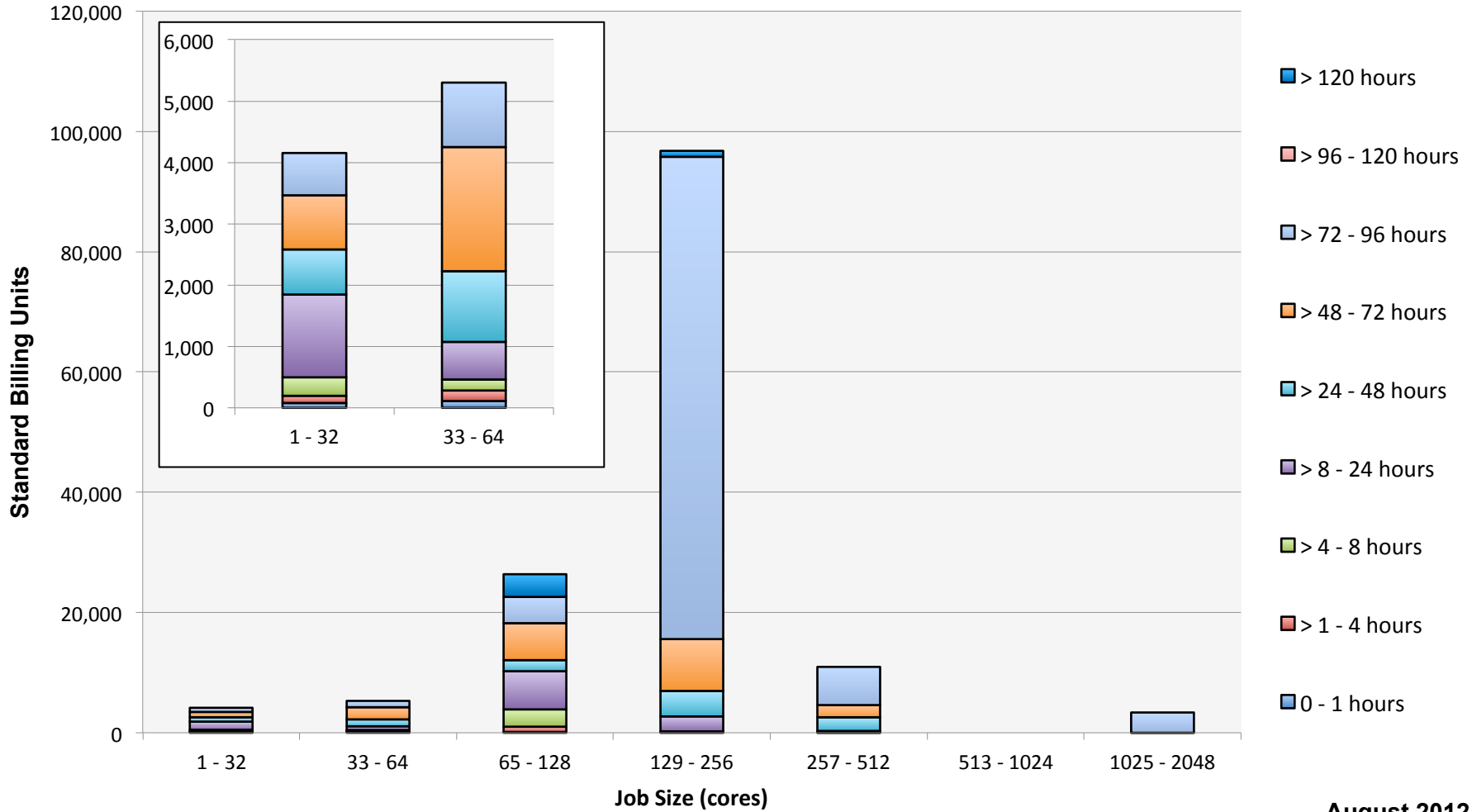
Columbia:
SBUs Reported, Normalized to 30-Day Month



Columbia:
Monthly Utilization by Size and Mission



Columbia:
Monthly Utilization by Size and Length



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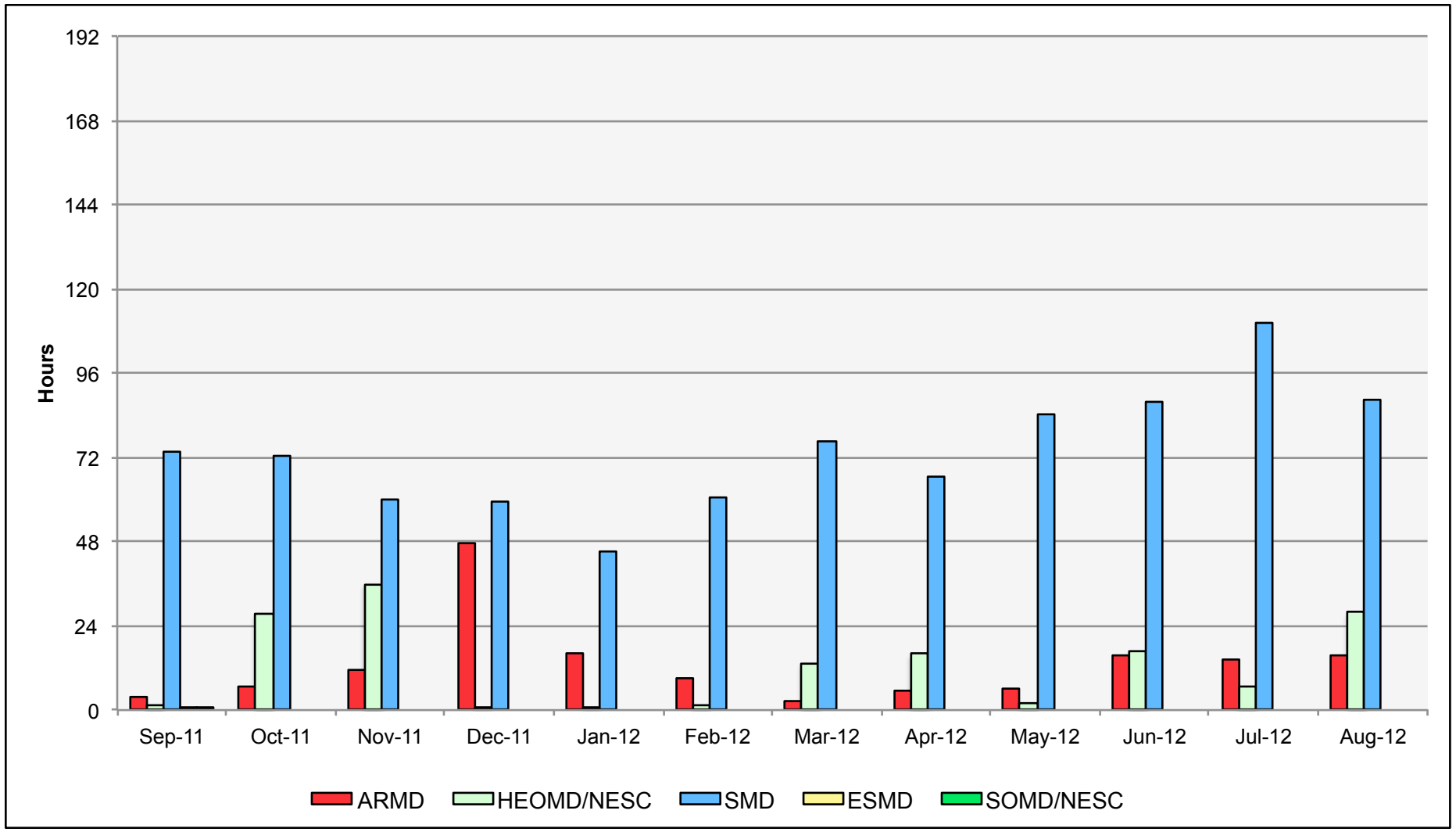

Columbia:
Average Expansion Factor