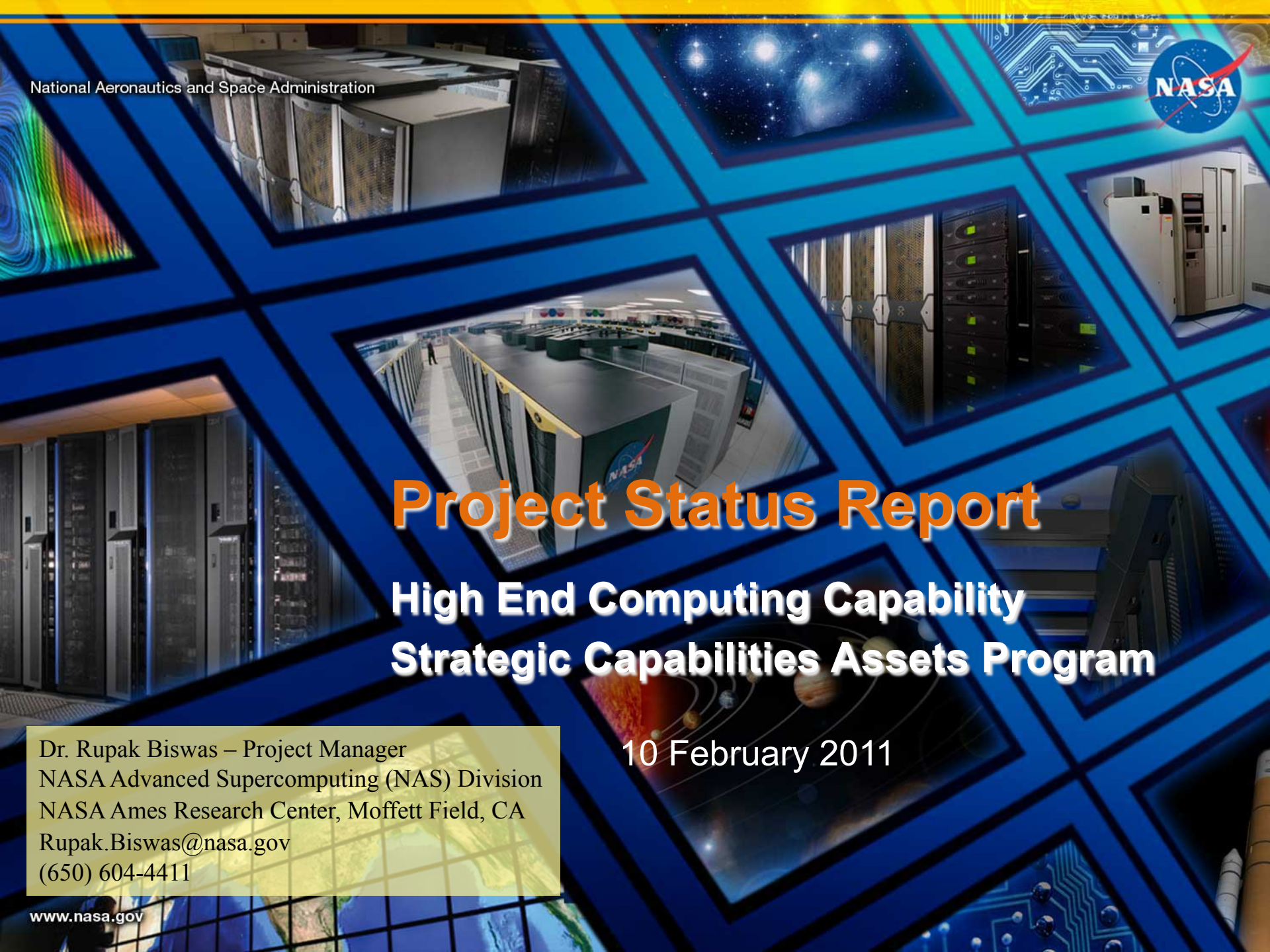


Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

10 February 2011

Dr. Rupak Biswas – Project Manager
NASA Advanced Supercomputing (NAS) Division
NASA Ames Research Center, Moffett Field, CA
Rupak.Biswas@nasa.gov
(650) 604-4411

HECC Resources Support Analysis of CEV Reentry Flow Environments

- Using the Pleiades supercomputer, aerospace engineers at NASA Langley have produced advanced simulations of the Orion Crew Exploration Vehicle (CEV) during reentry into the atmosphere, in support of thermal protection system (TPS) design for NASA's next-generation space vehicle.
- Over the past year, the resulting analyses have been used to: predict surface heating environments for TPS design; understand unsteady wake flow behind the vehicle; assess flow interactions and surface heating caused by the roll, yaw, and pitch jets used during descent; and reduce uncertainties associated with physical flow phenomenon coupled with chemistry when designing new spacecraft.
- This work has required extensive HECC resources to compute the complex flow structures in the CEV; each unsteady calculation solves for over 200 million unknown quantities, and requires about 31,000 CPU-hours on Pleiades for each trajectory point analyzed.
- HECC supercomputing resources have enabled unprecedented simulations that play a key role in understanding reentry environments to design a next-generation vehicle.

Mission Impact: By understanding the intense heating environment of a reentry spacecraft, the Agency can attain its spaceflight mission goals safely and efficiently.

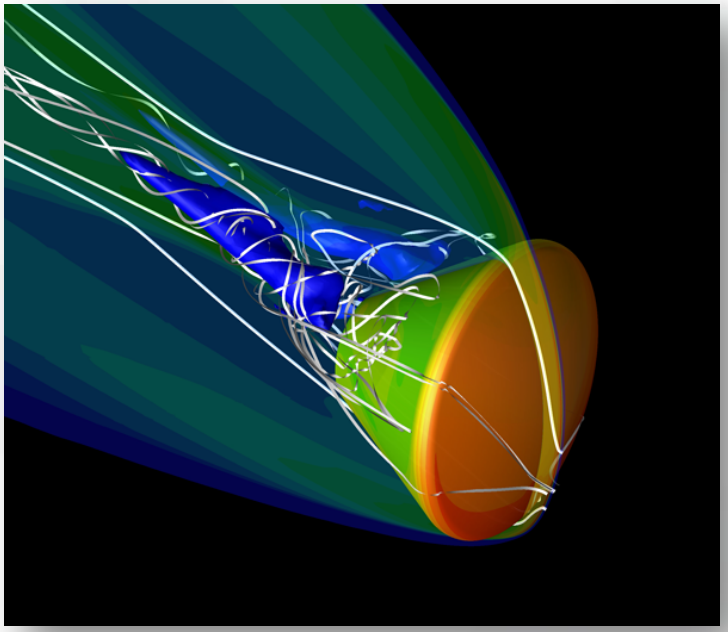


Figure: Simulation of CEV wake flow structure showing asymmetry of the computed flowfield.

POC: *Stephen J. Alter, stephen.j.alter@nasa.gov, (757) 864-7771, NASA Langley Research Center*

Performance Gains Attained on Satellite Data Simulation Unit (SDSU) Code

- HECC's Application Performance and Productivity (APP) experts have improved the performance of a Satellite Data Simulation Unit (SDSU) program developed at NASA Goddard.
- The code is used by NASA's Global Modeling and Assimilation Office to analyze precipitation satellite data as part of a workflow to predict rainfall.
- APP staff first analyzed the time-consuming routines using HECC-developed profiling tools to identify performance hot spots; data in a "do-loop" had to be reordered before OpenMP was used to improve the parallel efficiency of poorly performing regions of the code.
- The parallel code scales almost linearly—achieving an 8-fold speedup using 8 OpenMP threads on a Nehalem node of Pleiades.

Mission Impact: By reducing the runtime of NASA Goddard's Satellite Data Simulation code, users can now process multiple satellite datasets in a fixed window of time during a mission.

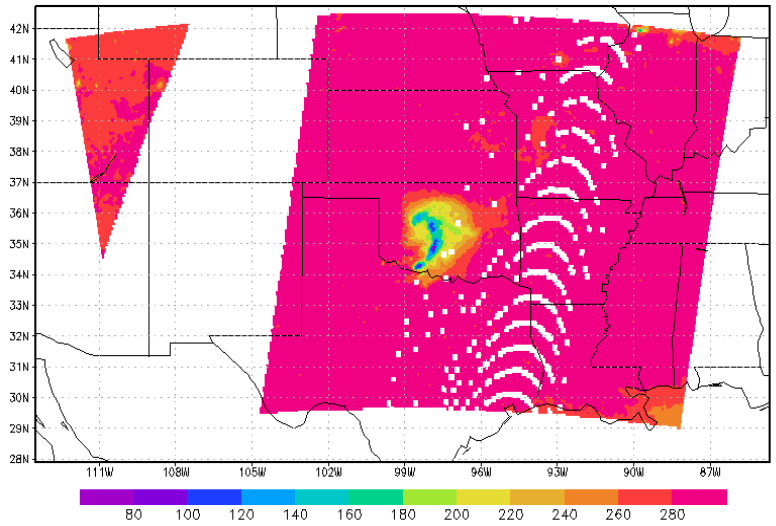


Figure: Precipitation observation with a high-density Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) satellite dataset. The data captures the important feature in the center of the domain (where the tropical cyclone Erin was observed).

POC: *Samson Cheung, samson.h.cheung@nasa.gov, (650) 604-0923, NASA Advanced Supercomputing Division, Computer Sciences Corp.*

Installation of Additional Pleiades Westmere Racks Completed

- In late December, eight new "Westmere" racks were added to the Pleiades cluster, increasing the system's peak performance to 1.081 petaflops.
- The new racks add 6,144 Westmere cores and expands Pleiades to a total of 156 racks with 91,136 cores, which increases the computational capability of the system by 72 teraflops.
- HECC and SGI staff successfully added the new racks via a unique live integration technique, which enabled the system to remain available to users while the racks were added.
- This process saved over 3 million hours of computing time that would have been unavailable if the system had to be disabled for the integration work.

Mission Impact: The continued expansion of Pleiades provides increased computational capability to all NASA Mission Directorates.

Figure: Eight new SGI Westmere racks were installed on Pleiades, which added another 72 teraflops of computational capability to the system.

POC: *Bob Ciotti, bob.ciotti@nasa.gov, (650) 604-4408, NASA Advanced Supercomputing Division*

Network Team Develops Firewall Query Tool to Manage Access Control

- The HECC Network team has developed Firewall Query Tool to help manage the highly complex access control environment on NASLAN, the NASA local area network. The benefits of the tool include:
  - Greatly reduces the amount of time needed while engineers troubleshoot to identify where a firewall problem is in the network, by performing complex, automated queries end-to-end.
  - Learns the dynamic routing table of each router on the network and updates firewall rules daily; this makes the software "network-aware" and able to calculate the path traffic takes through the network, as well as identify which firewalls are crossed.
  - Allows non-technical users to easily and instantly determine if there is an access restriction on the network, without the need to contact an engineer.
  - Identifies which specific firewall rules permit or block traffic, so engineers know exactly which rule to modify.
- A whitepaper describing the capabilities of Firewall Query Tool can be found at:

http://www.nas.nasa.gov/News/Techreports/2011/PDF/nas-11-001.pdf

Mission Impact: The Firewall Query Tool enables HECC support staff to quickly identify service network accessibility across multiple security domains, and helps identify weaknesses in HECC's security defense.

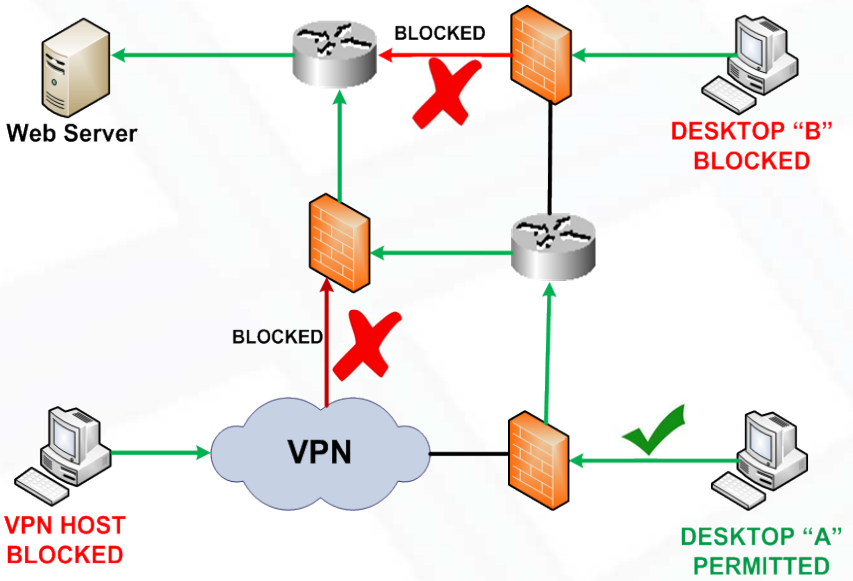


Figure: The above diagram shows how different systems can traverse the network across various routes. Some are permitted by the firewall, while others are blocked when trying to reach a service.

POC: *Nichole Boscia, Nichole.K.Boscia@nasa.gov, (650) 604-0891, NASA Advanced Supercomputing Division, Computer Sciences Corp.*

HECC Supports Technical Collaboration, Outreach at Annual Aerosciences Meeting

- HECC users representing the NASA Advanced Supercomputing (NAS) Division at NASA Ames participated in the 49th AIAA Aerospace Sciences Meeting, held January 4–11, 2011, in Orlando.
- Users shared and disseminated their latest knowledge and research results, obtained using HECC resources, with aerospace scientists and engineers from around the world.
- Eight scientists presented papers and chaired/ participated in panels on various applications of computational fluid dynamics to NASA aeronautics and aerospace projects; see slide #11.
- In addition, HECC staff supported the NASA exhibit (with participation from seven other technical organizations) to explain the Agency's featured work to conference attendees and to hand out printed materials.
- The exhibit drew many visitors and was very well received; notable visitors to the booth were Administrator Charles Bolden, Chief Technologist Bobbie Braun, and industry partner executives from Boeing, General Electric, and Lockheed Martin.

Mission Impact: HECC support for NASA's AIAA exhibit enhanced the experience and interest of booth visitors, and helped increase the dissemination of NASA's state-of-the-art aerospace CFD research and engineering results.

Figure: Aerospace scientists and experts from around the world visited NASA's AIAA booth in Orlando.

POCs: *Cetin Kiris, Cetin.C.Kiris@nasa.gov, (650) 604-4485, Gina Morello, Gina.F.Morello@nasa.gov, (650) 604-4462, NASA Advanced Supercomputing Division*

Presentations and Papers

Presentations

- "Vision, Experience, and Investigation Projects at the NAS Supercomputing Center," W. Thigpen, Universidad de Guadalajara, Mexico, January 26, 2011.
- "HECC Overview," W. Thigpen, Tecnológico de Monterrey in Guadalajara, Mexico, January 26, 2011.
- "Supercomputing at NASA: Current Impact, Future Challenges," W. Thigpen, Keynote address at the Paraninfo of the Universidad de Guadalajara, Mexico, January 27, 2011.

Papers

- "Testing an Eddy-Permitting Model of the Southern Ocean Carbon Cycle Against Observations," M. Woloszyn, M. Mazloff, Dec. 2010, Elsevier, doi:10.1016/j.ocemod.2010.12.004.*
  http://www.sciencedirect.com/science/article/pii/S1463500310001800
- "Crash: A Block-Adaptive-Mesh Code for Radiative Shock Hydrodynamics Implementation and Verification," B. van der Holst, et al, arXiv:1101.758v1 [astro-ph.SR] January 19, 2011.*
  http://arxiv.org/abs/1101.3758

•Learning from the Outer Heliosphere: Interplanetary Coronal Mass Ejection Sheath Flows and the Ejecta Orientation in the Outer Atmosphere," R.M. Evans, M. Opher, T.I. Gombosi, The Astrophysical Journal 728 (2011) 41, doi:10.1088/0004-637X/728/1/41.*
http://iopscience.iop.org/0004-637X/728/1/41

•"Firewall Policy Query Tool Whitepaper," N. Boscia, January 2011.
http://www.nas.nasa.gov/News/Techreports/2011/2011.html

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

Presentations and Papers

Papers (continued)

•AIAA Aerospace Science Meeting, January 11–14, 2011, Orlando *

- "OVERFLOW Validation for Predicting Plume Impingement of Underexpanded Axisymmetric Jets onto Angled Flat Plates," H. Lee, G. Klopfer.
- "Validation of OVERFLOW for Computing Plume Effects during the Ares 1 Stage Separation Process," J. Kless, H. Lee, G. Klopfer, J. Onufer, S. Pandya, W. Chan.
- "Numerical Investigation of the Flow Angularity Effects of the NASA Langley UPWT on the Ares I DAC1 0.01-Scale Model," H. Lee, G. Klopfer
- "Plume-Induced Flow Separation over a Cone-Cylinder Flare Body," J. Kless, G. Klopfer.
- "Best Practices for Aero-Database CFD Simulations of Ares V Ascent," C. Kiris, J. Housman, M. Gusman.
- "Best Practices for CFD Simulations of Launch Vehicle Ascent with Plumes," M. Gusman, J. Housman, C. Kiris.
- "Dynamic Error Estimation and Mesh Refinement in Aerodynamic Shape Design," M. Nemec, M. Aftosmis.
  http://www.aiaa.org/content.cfm?pageid=534&id=1888&luPubID=519

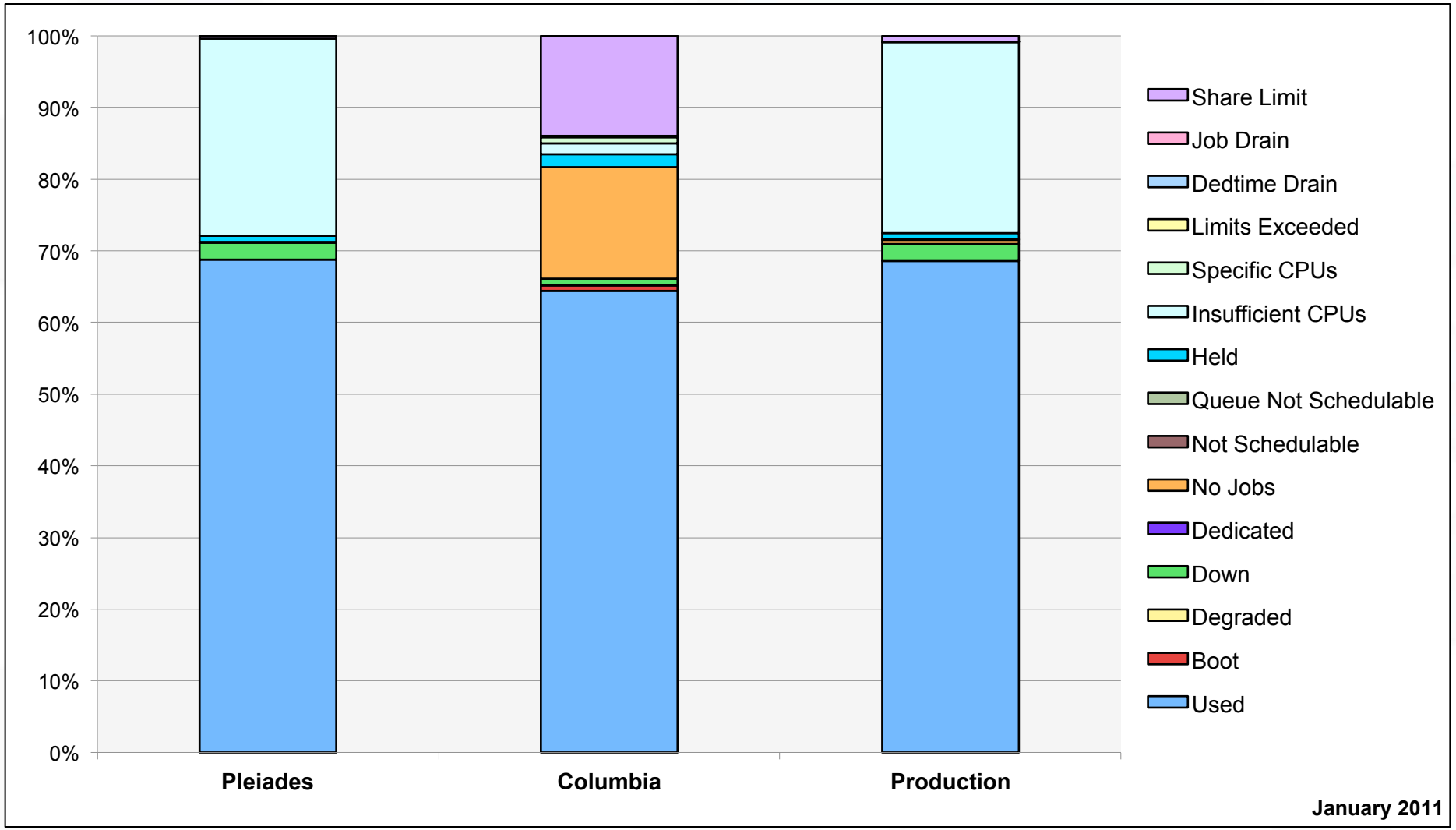
** HECC provided supercomputing resources and services in support of this work*

News and Events

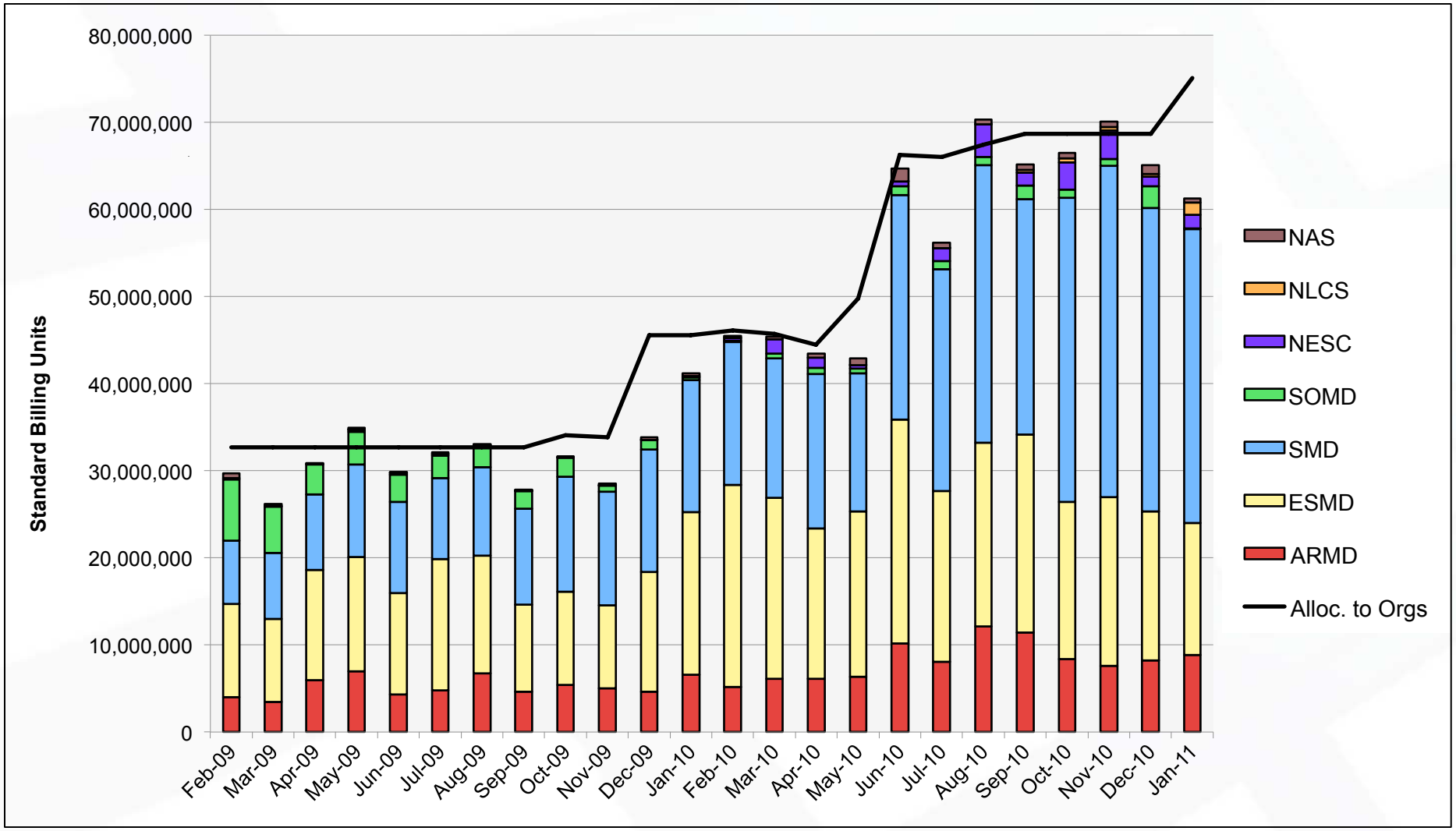
- **Penn State CI Day to Showcase Cyberinfrastructure**, *Gant Daily*, January 16, 2011 – advertises Rupak Biswas, HECC Project Manager, as presenter.
  http://live.psu.edu/story/50699
- **ISUM Supercomputing Conference**
  HECC Deputy Project Manager Bill Thigpen participated in the Instituto Universitario de Mercadotechnia (ISUM) Conference, hosted by the University of Guadalajara, Mexico; Thigpen's visit promoted the use of supercomputing among research communities; numerous online pieces announced this visit.
  http://www.isum.mx/index.php?option=com_content&task=view&id=23&Itemid=28
- **California Academy of Sciences: 'Life: A Cosmic Story'** *San Francisco Chronicle,* January 21, 2011 – The HECC Data Analysis and Visualization group contributed significantly to this project and the article mentions NASA Ames
  http://www.calacademy.org/academy/exhibits/planetarium/life/

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

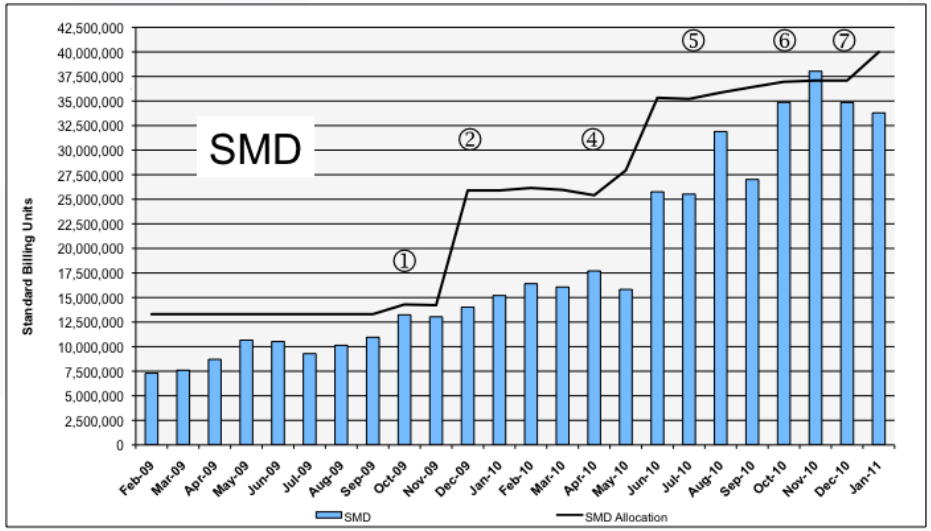
NAS Utilization

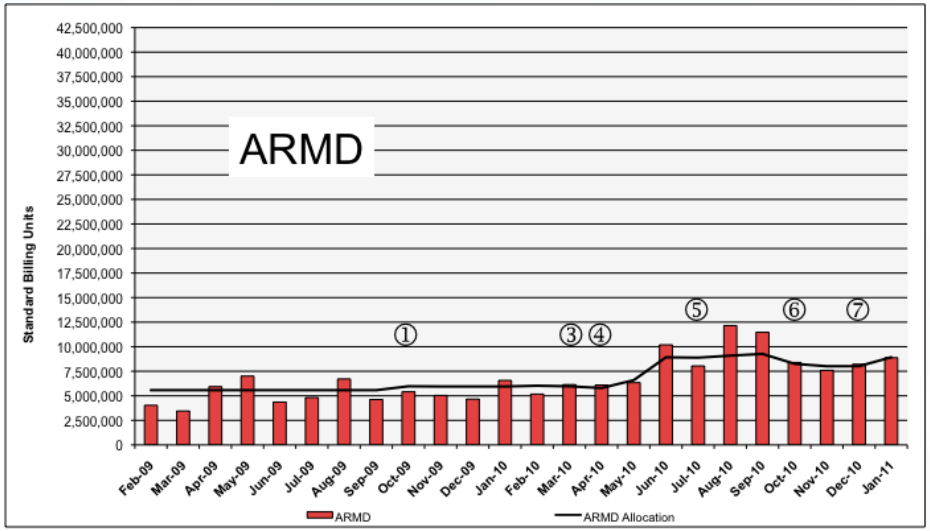


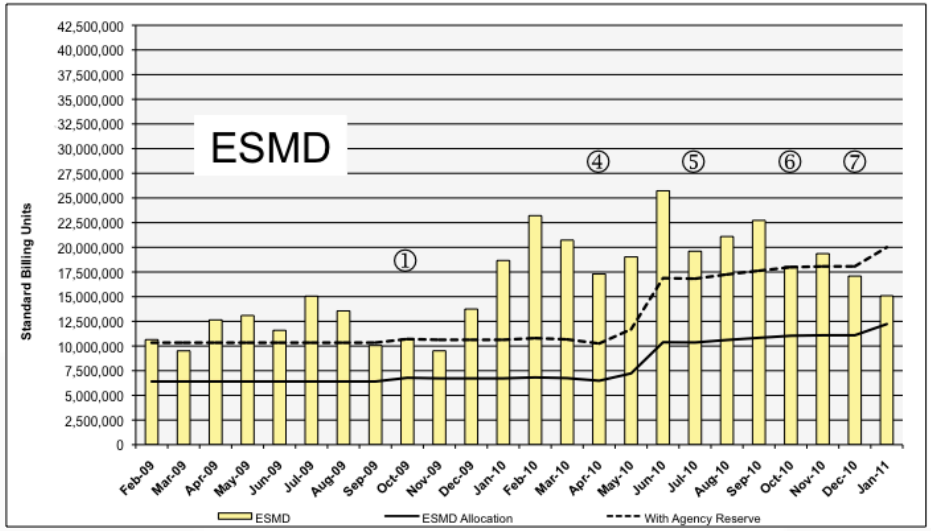
NAS Utilization Normalized to 30-Day Month

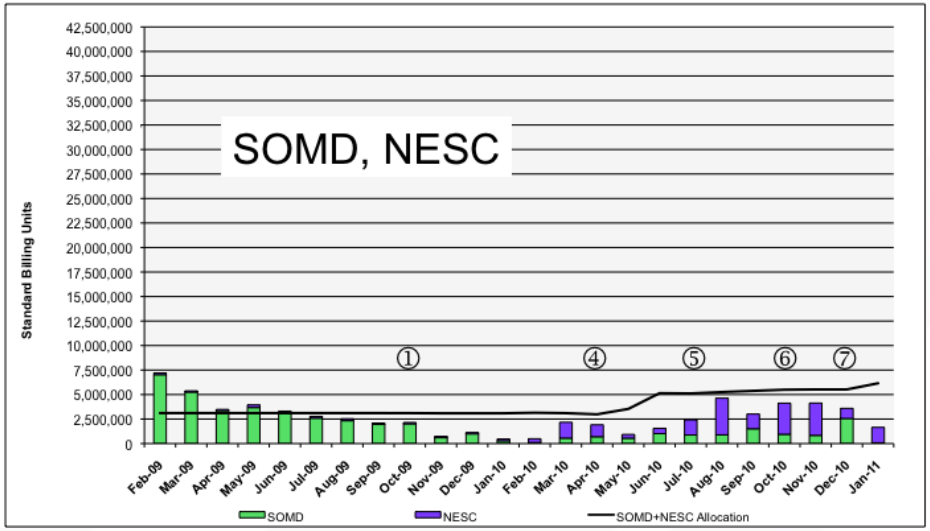


NAS Utilization Normalized to 30-Day Month



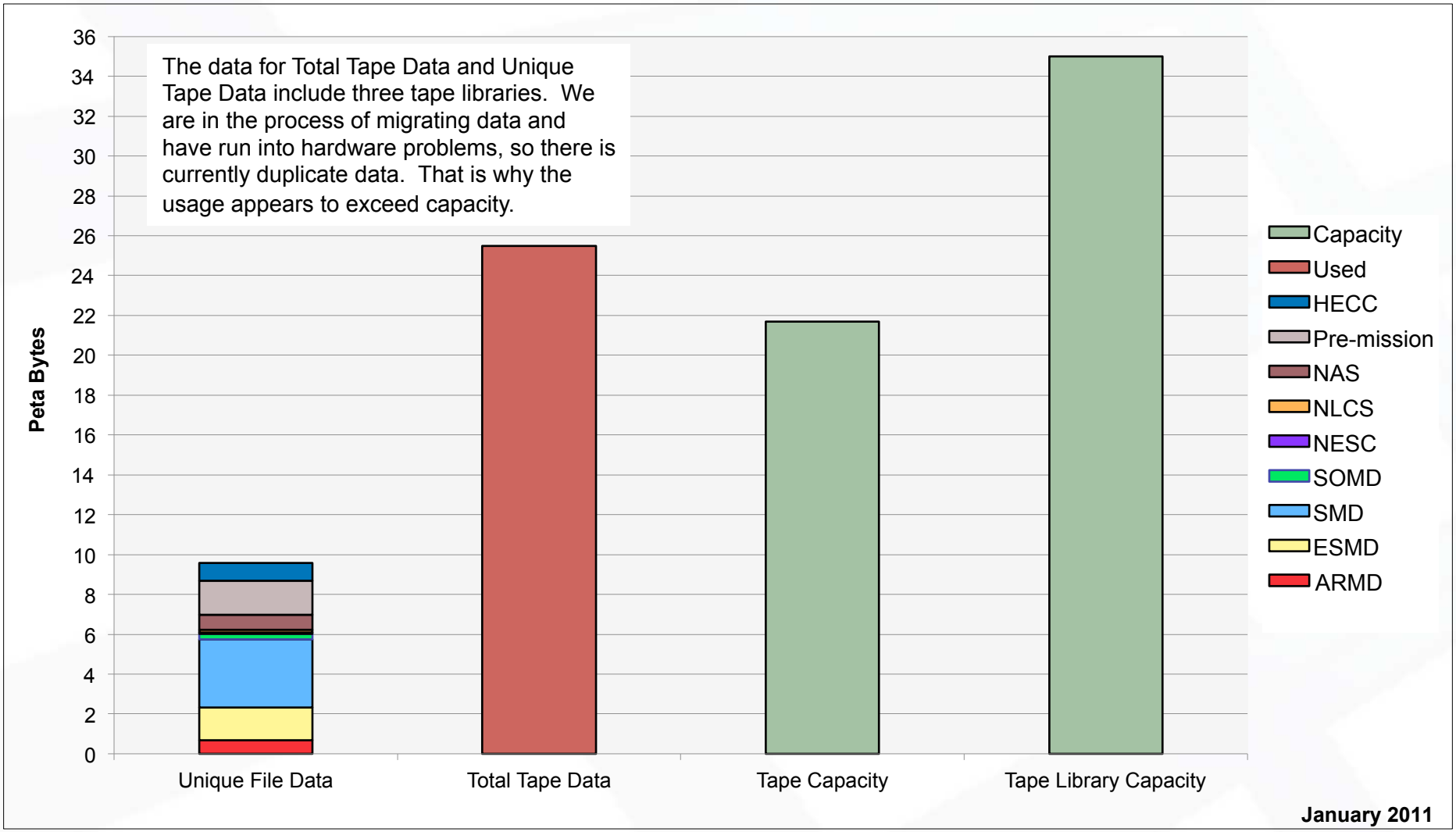






① Allocation to orgs. increased to 80% ② SMD augmentation ③ RTJones retired ④ 32 Westmere racks added
⑤ Schirra retired, 4 Westmere racks added ⑥ RTJones compensation removed ⑦ 8 Westmere racks added

Tape Archive Status



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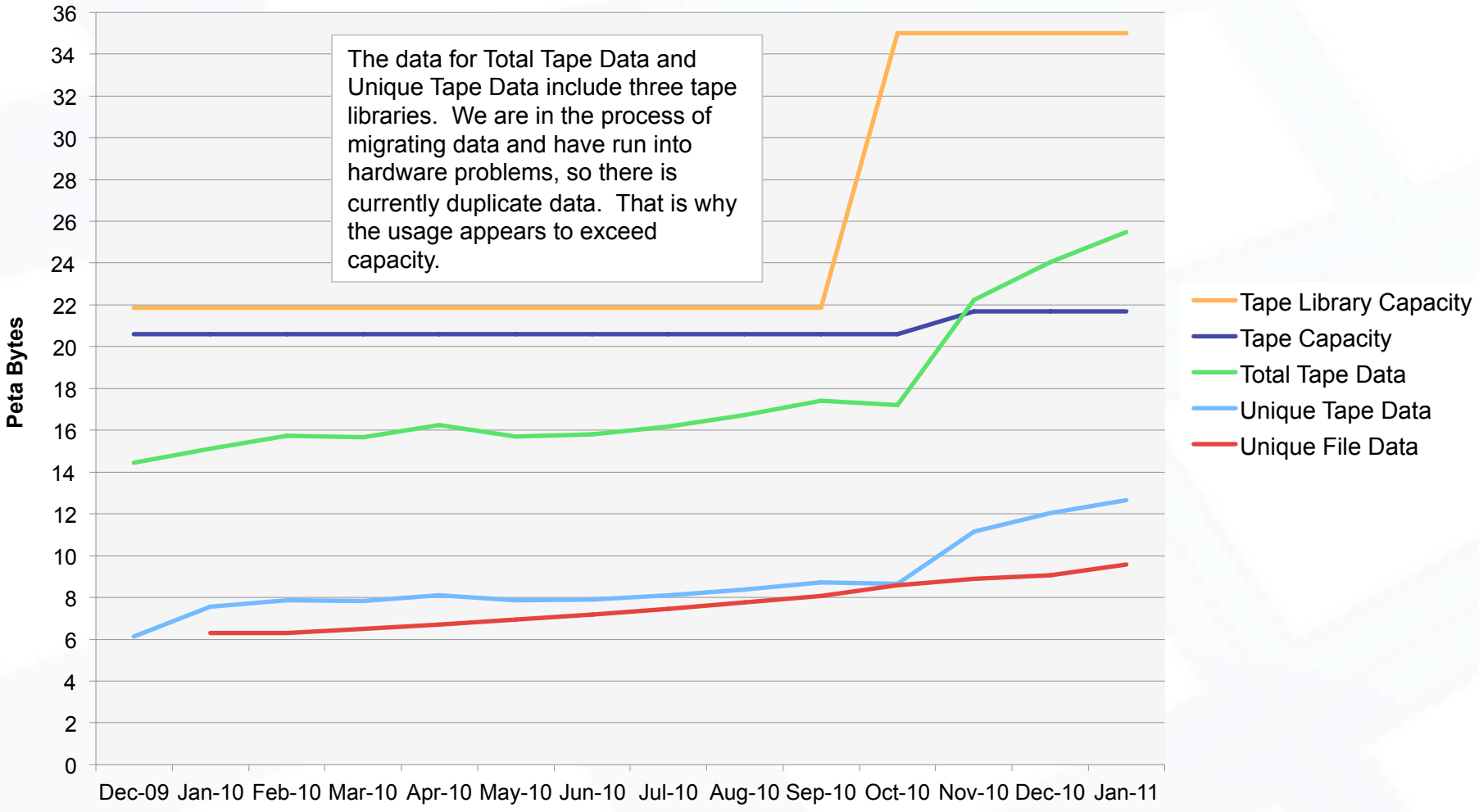
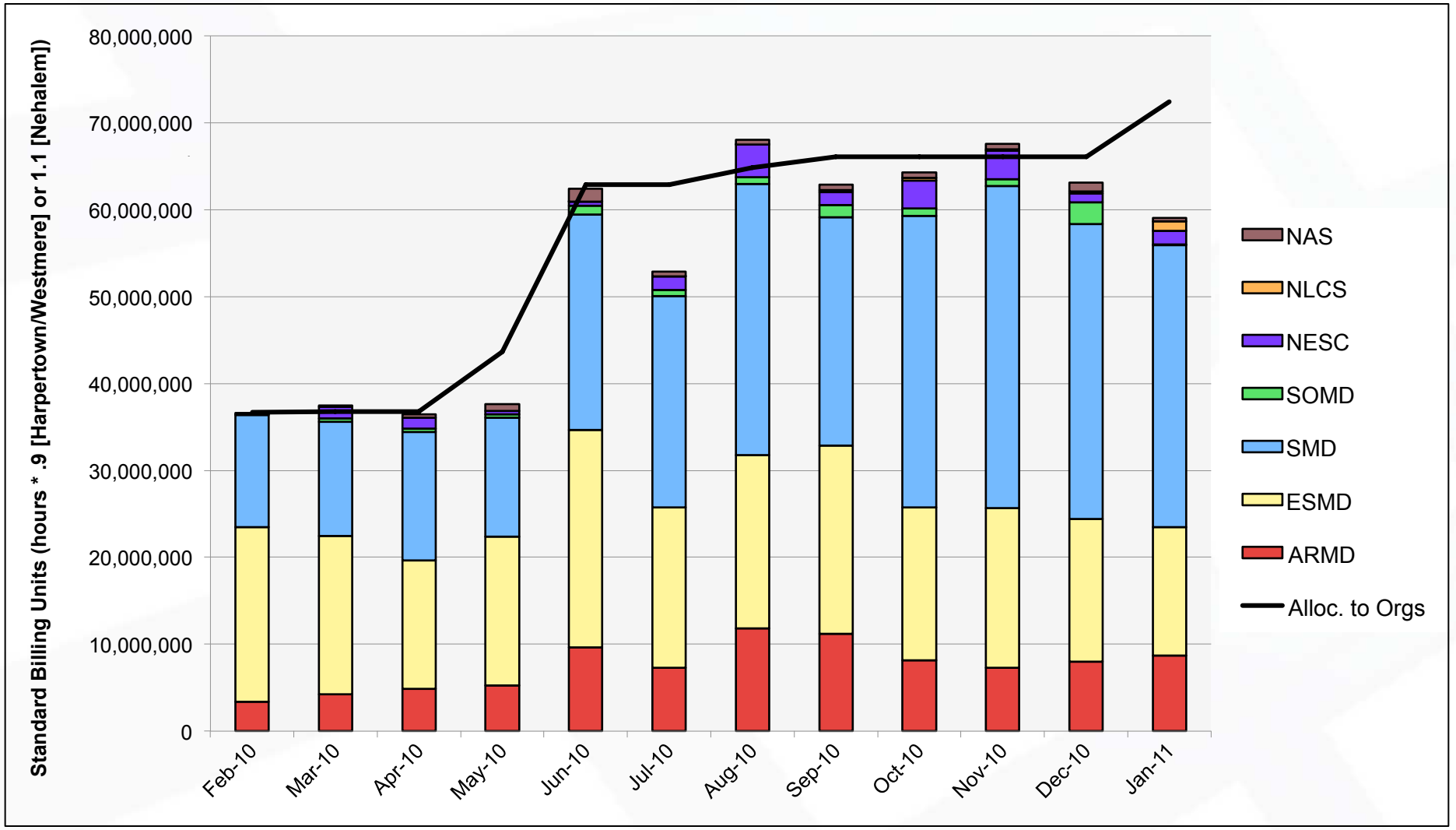
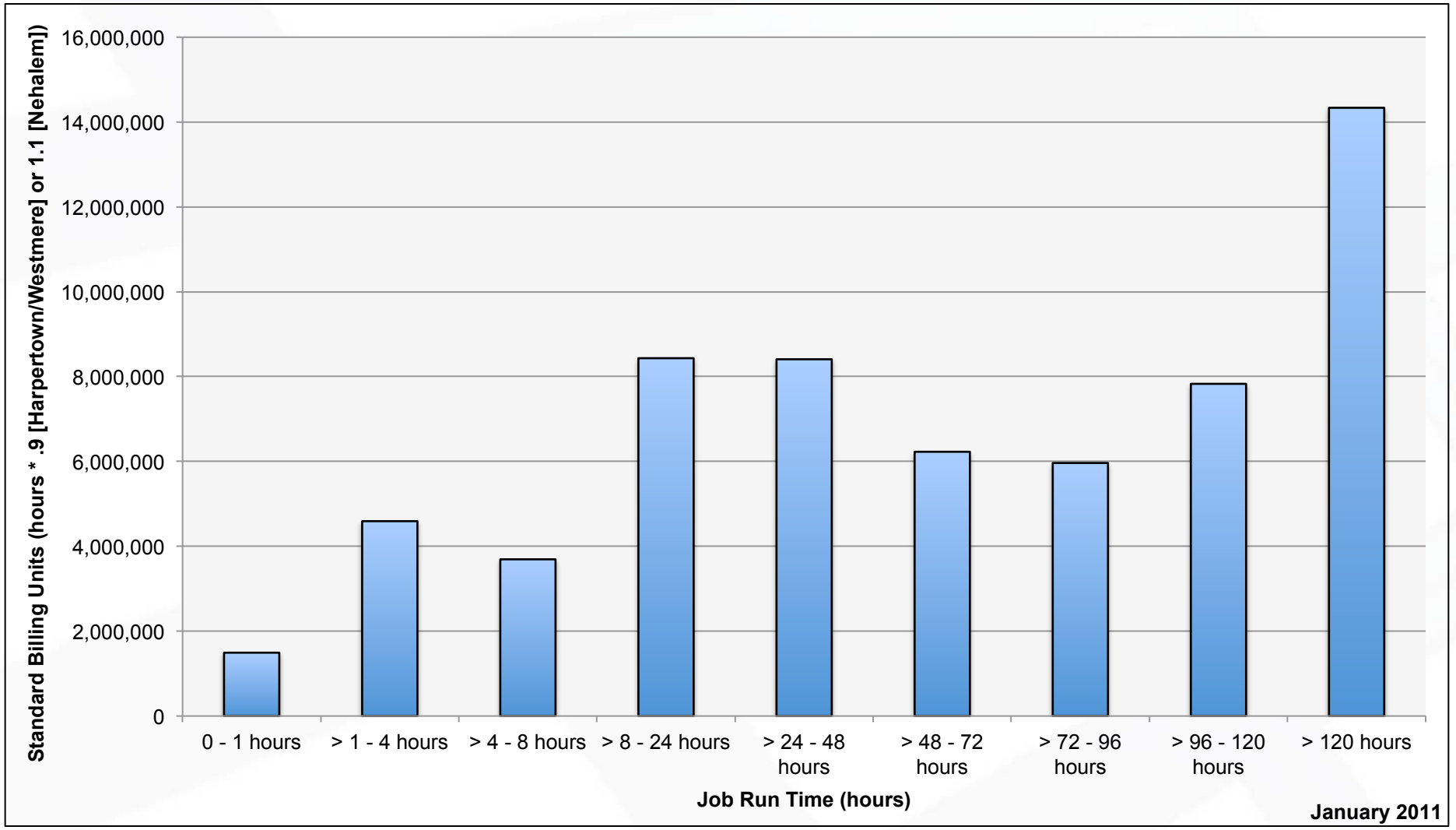


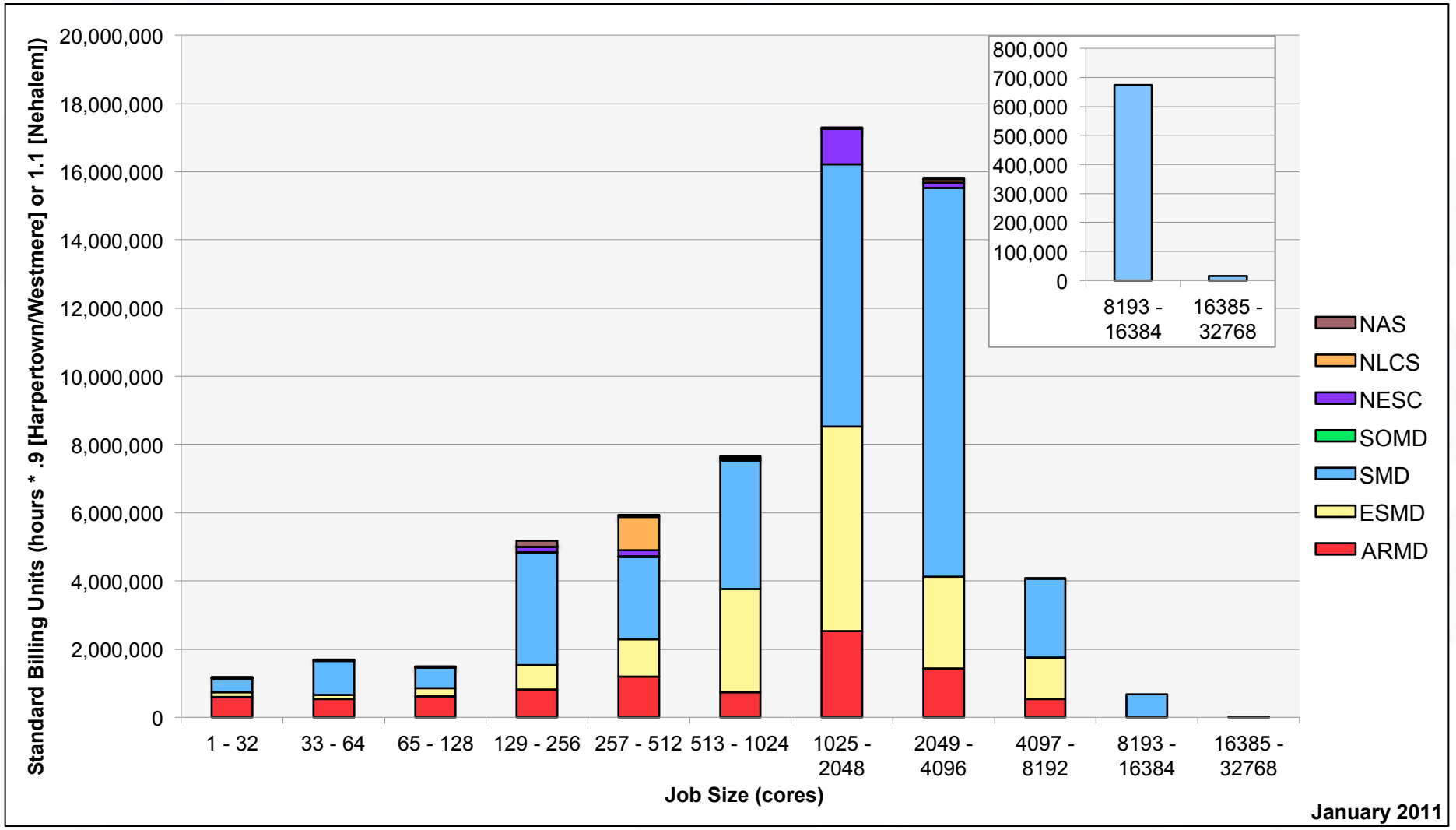
Pleiades:
SBUs Reported, Normalized to 30-Day Month



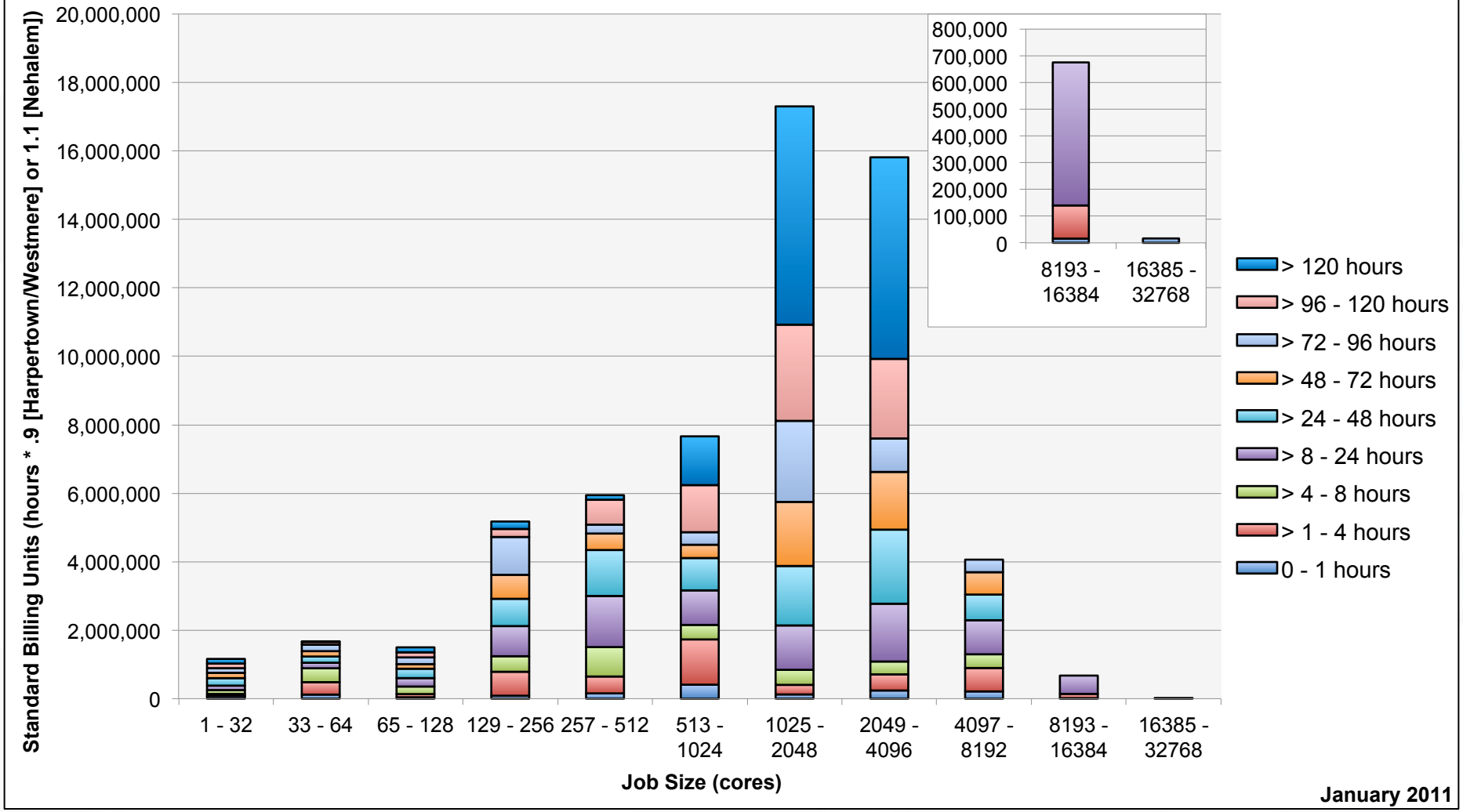
Pleiades:
Monthly SBUs by Run Time



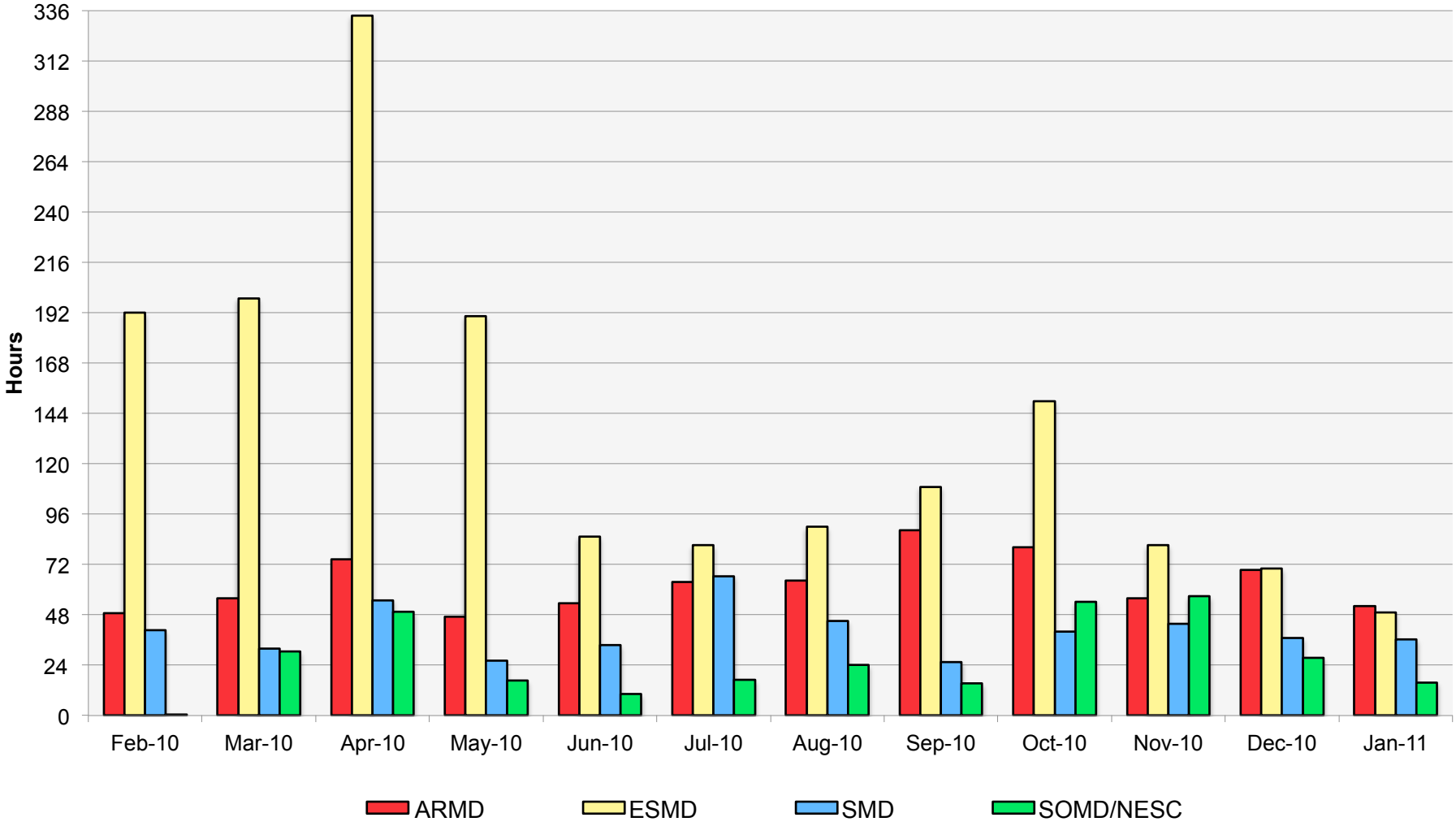
Pleiades:
Monthly Utilization by Size and Mission



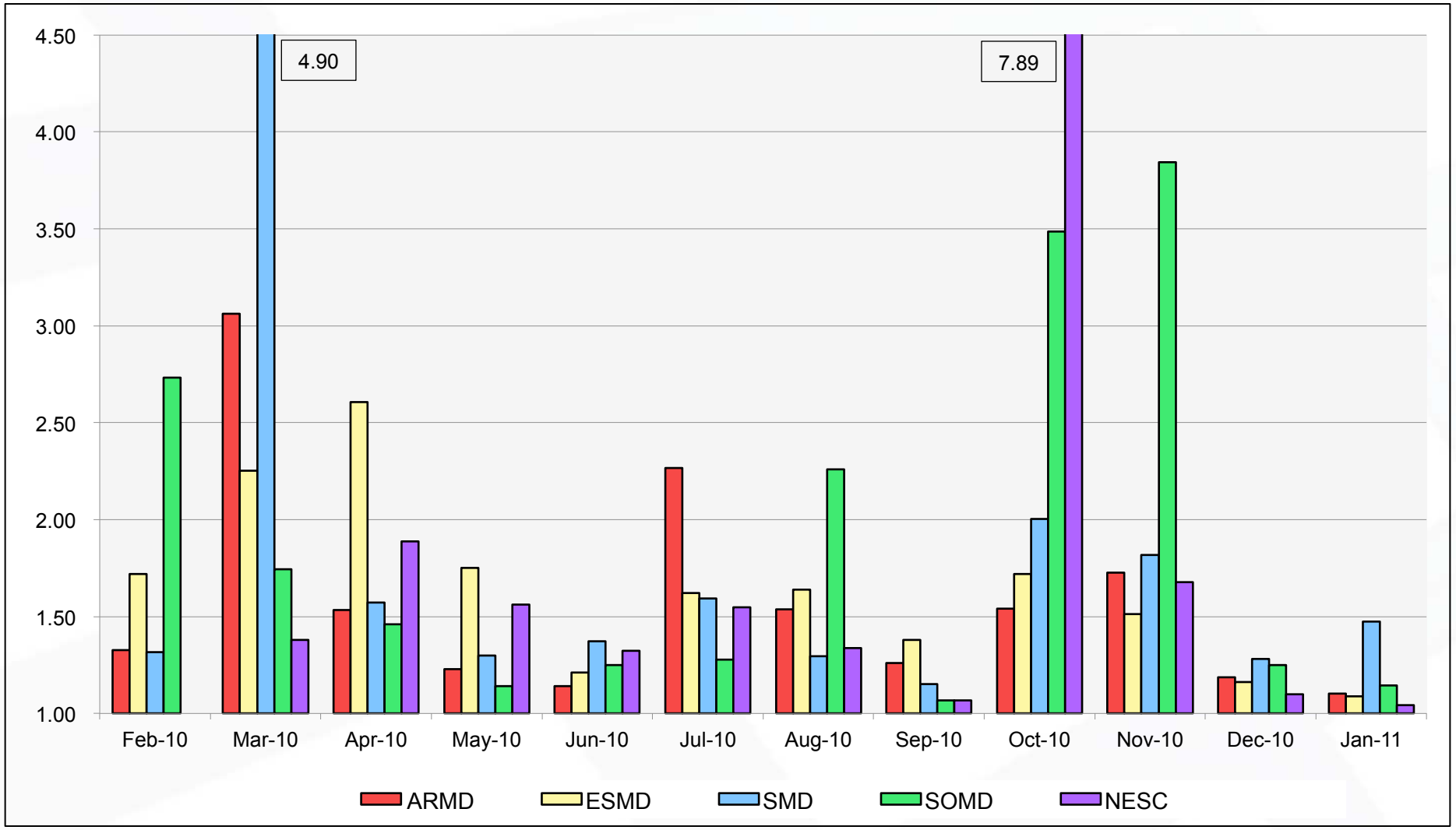
Pleiades:
Monthly Utilization by Size and Length



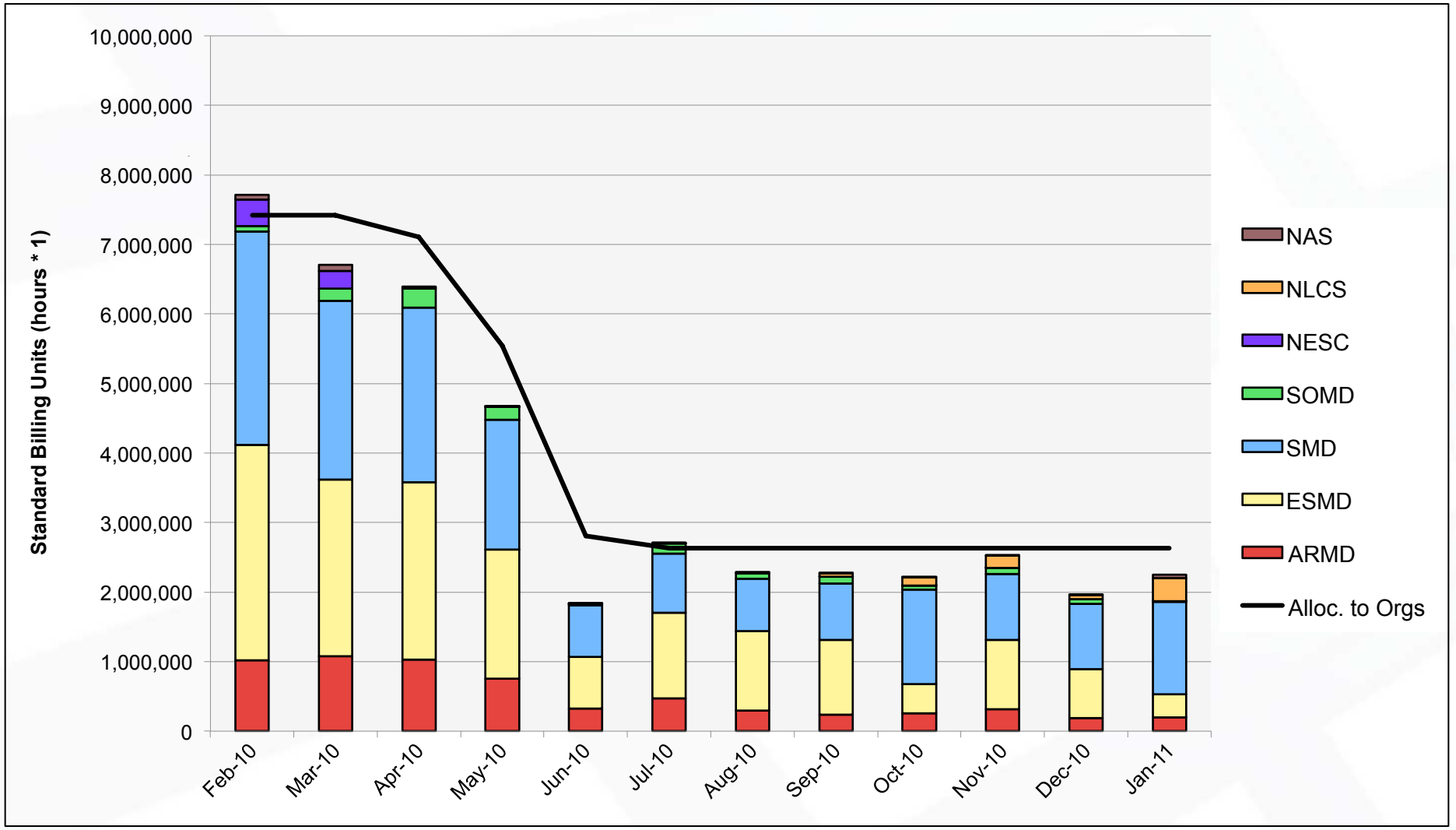
Pleiades:
Average Time to Clear All Jobs



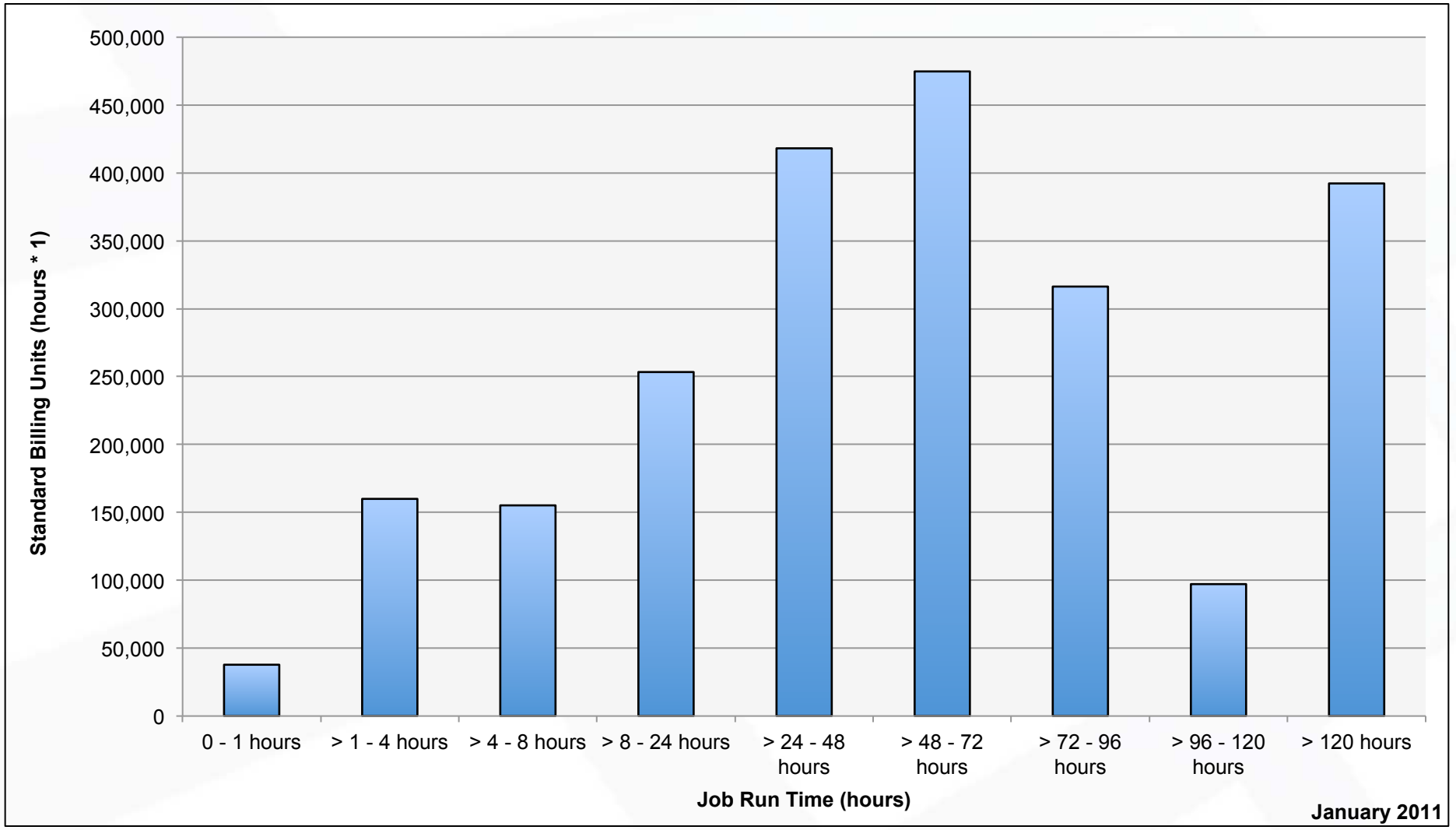
Pleiades:
Average Expansion Factor



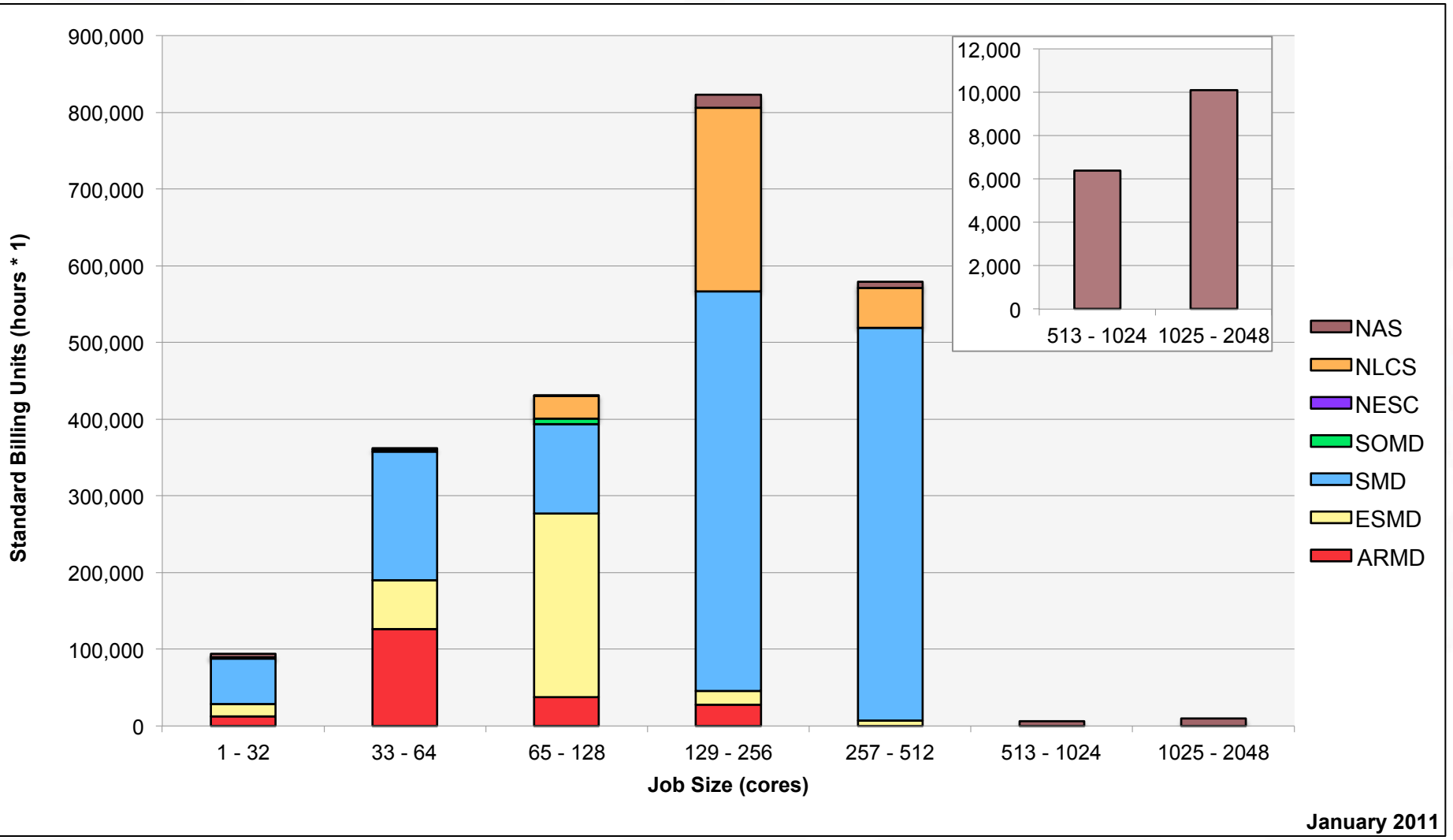
Columbia:
SBUs Reported, Normalized to 30-Day Month



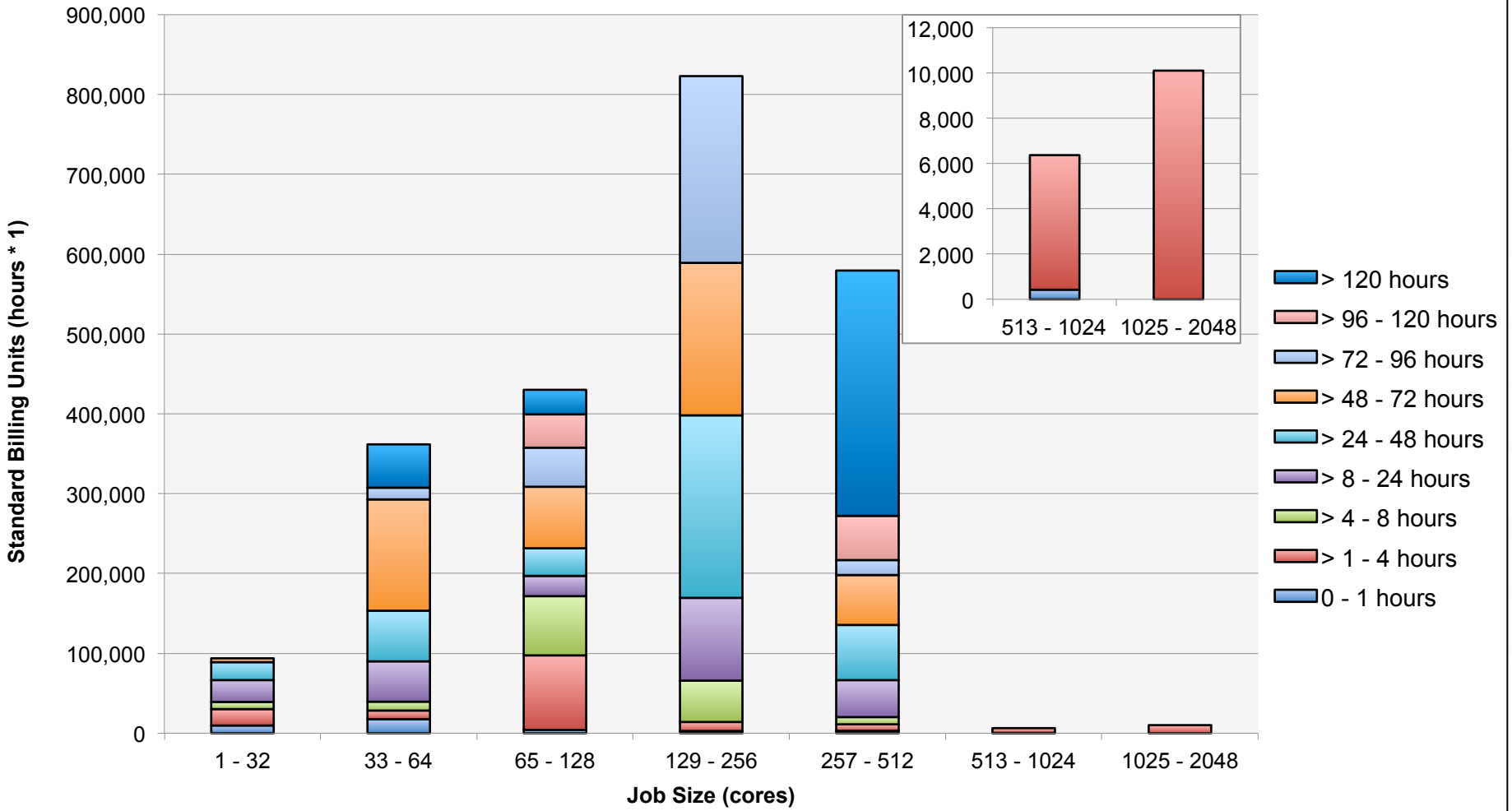
Columbia:
Monthly SBUs by Run Time



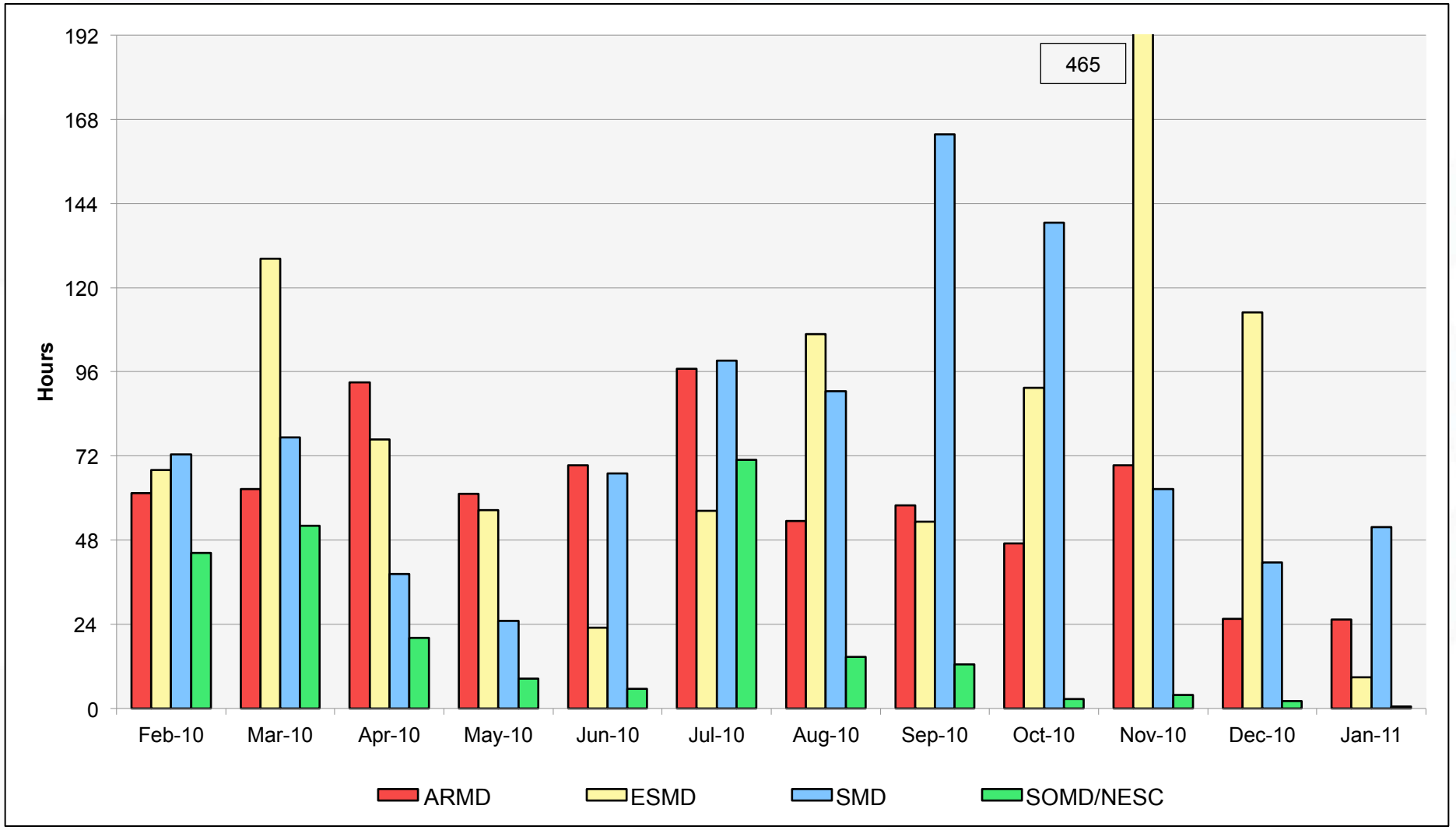
Columbia:
Monthly Utilization by Size and Mission



Columbia:
Monthly Utilization by Size and Length



Columbia:
Average Time to Clear All Jobs



Columbia:
Average Expansion Factor