

Project Status Report

High End Computing Capability
Strategic Capabilities Assets Program

8 June 2011

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HECC Provides Resources for Damage Assessment During Shuttle Mission STS-134

- HECC staff provided priority access to the Pleiades supercomputer for damage assessment during the STS-134 mission.
- Several damage sites were identified, including one that looked serious.
- NASA's aerothermal analysis team ran about 8–10 cases to assess the range of severity, based on different initial estimates of the damage (later more definitively characterized by photos and laser scans taken during a "focused inspection").
- Pleiades' speed and capacity were essential to completing the large number of cases with approximately 12-hour run times.
- 1,275 Pleiades node-hours were needed to assess damage and help clear the shuttle for successful landing on June 1, 2011.

Mission Impact: HECC supercomputer resources have enabled NASA groups to quickly perform high-fidelity Space Shuttle debris and damage analyses. For the past 21 missions, beginning with STS-114, groups supporting the damage assessment team have had dedicated or priority access to these resources for input into critical decisions to perform repairs and/or clear the orbiter for safe landing.

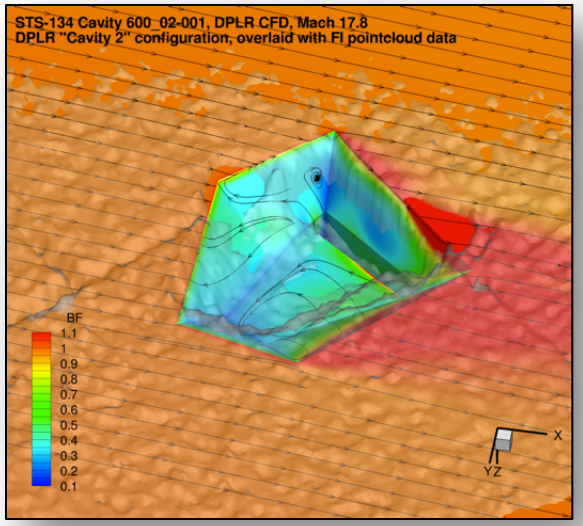


***Figure*:** Computational results of a damage site, designated D-134-RPM-600_2-001, to a thermal protection tile on Space Shuttle Endeavour. (NASA/Entry Aeroheating CFD team)

POC: *Catherine Schulbach, Catherine.H.Schulbach@nasa.gov, (650) 604-3180 , NASA Advanced Supercomputing Division*

High-Fidelity Simulations of Hypersonic Flows for Future Vehicle Designs

- Using an advanced computational fluid dynamics (CFD) code, *ez4d*, researchers at NASA Langley and the University of Alabama at Birmingham are using Pleiades to simulate complex shock patterns and strong, unsteady waves resulting from surface protuberances and imperfections in the thermal protection systems of NASA's hypersonic vehicles.
- Primary objectives of these simulations are to understand transition flow physics due to roughness elements submerged in a hypersonic boundary layer; predict surface heating caused by transitional and turbulent boundary layers; and predict wake flows behind large, blunt bodies.
- The researchers are running large-scale computations (using meshes with 10-100 million tetrahedral elements) on Pleiades to generate high-fidelity numerical solutions for these very complex hypersonic flows.
- The availability of Pleiades has enabled reasonable turnaround times for parametric studies that are otherwise impossible.

Mission Impact: HECC supercomputing resources enable aeronautics researchers to generate high-resolution simulations to understand fundamental flow physics to assist studies for future hypersonic vehicle designs.

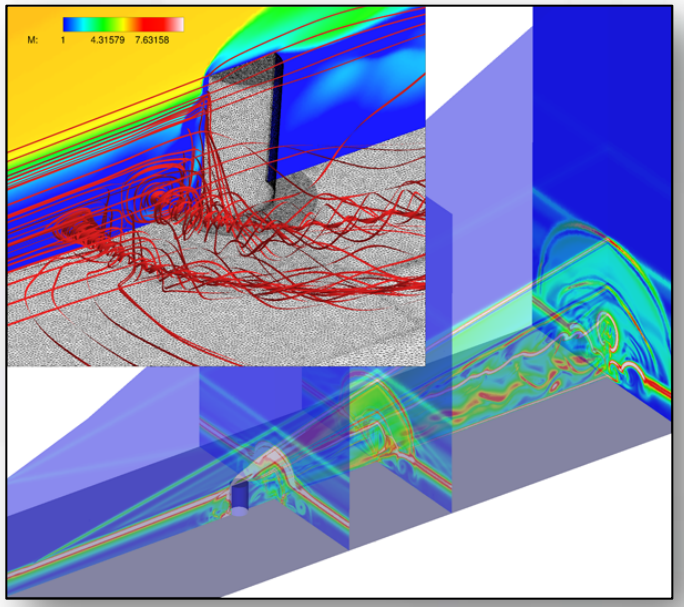


Figure: Mach 6 flow over a cylindrical roughness element, showing surface mesh and instability wave evolution from upstream of the cylinder to the wake region. (Chau-Lyan Chang, Meelan Choudhari, NASA/Langley)

POC: *Chau-Lyan Chang, (757) 864-6369, chau-lyan.chang@nasa.gov, NASA Langley Research Center*

Simulations of Fluid Flows and Magnetic Fields in Giant Planets

- Researchers at the University California, Santa Cruz (UCSC) are using Pleiades to better understand the fundamental physics governing the internal dynamics of Jupiter and Saturn.
- Led by earth and planetary scientist Gary Glatzmaier, the UCSC team is learning how the banded patterns of alternating east and west surface winds and magnetic fields of these giant gas planets are maintained, and how far below the surface they extend; findings include:
  - Thermal convection in a density-stratified, rotating, self-gravitating gas body maintains a banded pattern of east and west winds, with a strong eastward jet in the equatorial region, if the convection extends far below the surface and the effects of rotation are significant;
  - Amplitudes of convection and winds decrease with depth;
  - Electric currents and their accompanying magnetic fields are generated in a thin layer that is deep enough for electrical conductivity to be sufficiently large but also shallow enough for convective flows to be sufficiently high.
- Pleiades' capability is critically needed to handle the tens of millions of time steps required to simulate the turbulent fluid flows and resulting magnetic fields in their 3D nonlinear models of gas giants.

Mission Impact: One of the Science Mission Directorate goals is to improve our understanding of the origin and evolution of the universe; researchers employ HECC supercomputers to explain the observations of the flows and fields on the surfaces of giant planets, and to predict the structures and dynamics deep within their interiors.

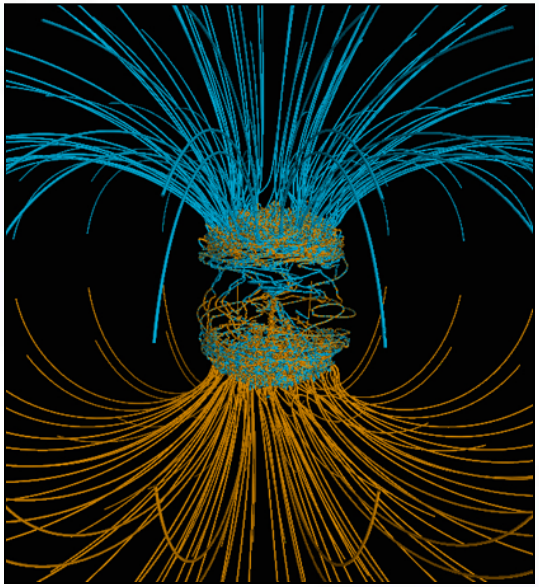


Figure: Snapshot of magnetic field (as magnetic field lines) in the simulation of Saturn, generated by convection and winds. Yellow represents outward-directed magnetic field; blue represents inward-directed field. (Gary A. Glatzmaier, UCSC)

POC: *Gary A. Glatzmaier*, (831) 459-5504, glatz@es.ucc.edu, *University of California, Santa Cruz*

Network Team Deploys Online Performance Measurement and Analysis Tool

- Remote HECC users can now easily access a public website allowing them to initiate a network diagnostic test between their location and the NASA Advanced Supercomputing (NAS) facility: https://npad.nas.nasa.gov.
- The Network Diagnostic Test (NDT) will identify the slowest link in the path, and report any general network errors, such as congestion or packet loss; it supports up to 10 Gigabit Ethernet end-to-end.
- The Network Path and Application Diagnosis (NPAD) tool runs a more thorough test that evaluates system and application configurations, and recommends optimal settings for best performance.
- Results allow the HECC Network team to get detailed information about a remote user's connection, which otherwise could only be obtained by getting accounts at each remote site.

Mission Impact: Deployment of a publicly available network analysis tool allows NASA's supercomputing users to quickly self-diagnose the network connection from their local system, and gives network engineers detailed information to help users resolve issues in transferring their data to HECC resources.

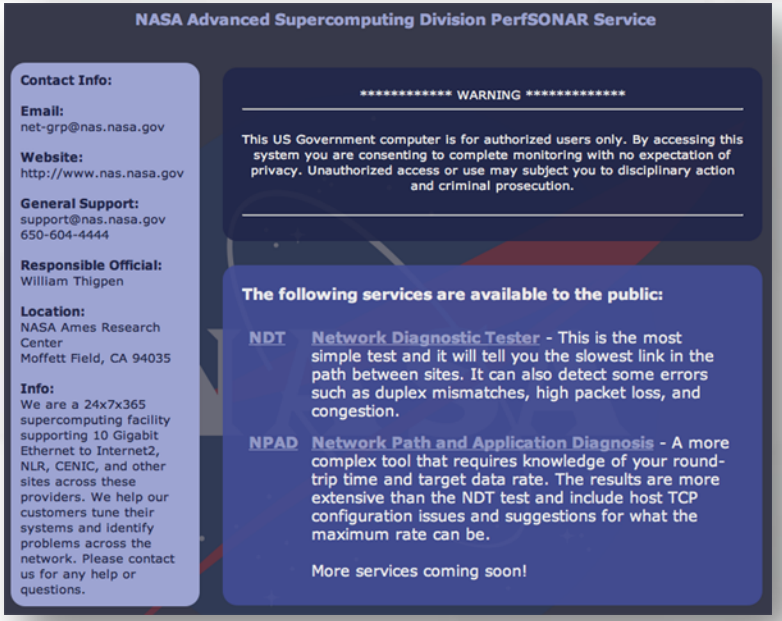


Figure: Through services offered on the network analysis website, users can run quick performance tests to automatically determine network issues between NAS and their system.

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

HECC Redefines Measure of Computer Resource Allocation and Usage

- The HECC Project recently redefined the Standard Billing Unit (SBU) used to allocate computer time and measure computer usage.
- The new SBU, based on one node (12 cores) of Pleiades Westmere hardware, went into effect May 1, 2011, and represents a significant change from the previous SBU, which was based on one core of a Columbia Altix 3700 system.
- Current and historical allocation and usage data were recalculated, and reporting tools and utilities were modified to reflect the new SBU definition.
- The newly defined SBU is intended to help make it easier for users to understand that computer resources are allocated based on a Minimum Allocatable Unit (MAU), which is the smallest unit of each system that the scheduling software allocates to a job.
- The change also makes more apparent the true cost of some jobs (for example, jobs that use all the allocated memory and not all the cores).

Mission Impact: HECC's new System Billing Unit definition helps users be more aware of the underlying computer architecture and true cost of computation—leading to more effective use of resources.

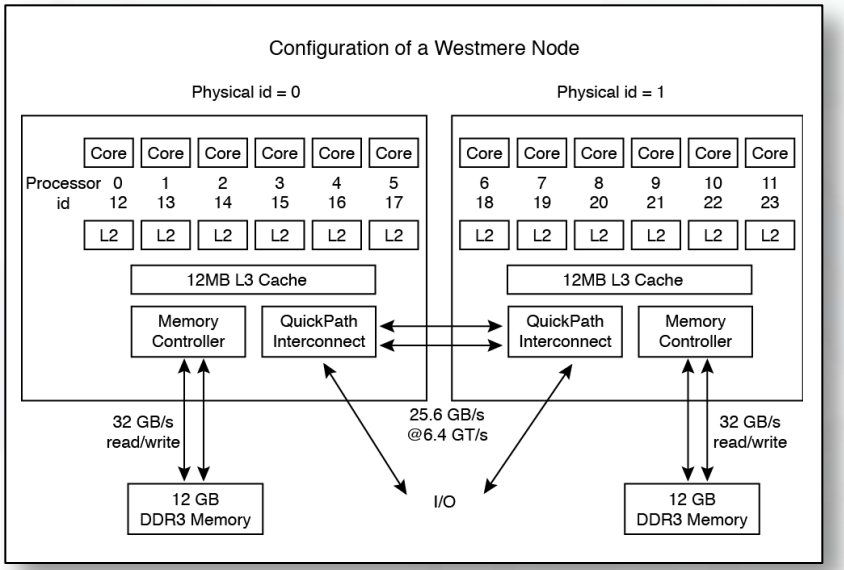


Figure: Configuration of a Westmere Node showing the 12-core Minimum Allocatable Unit.

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

APP Group Determines New Standard Billing Unit (SBU) Rates for HEC resources

- HECC's Application Performance and Productivity (APP) group devised a new methodology for determining Standard Billing Unit (SBU) rates for computer usage at NAS and NCCS (see slide 7).
- The APP group surveyed codes run at the two centers, and identified six applications suitable for use as benchmarks, based on factors including coverage of mission directorate workloads, and stability and scalability of the code.
- APP then chose appropriate datasets to run the codes at processor counts typically used in production jobs.
- The following steps were taken to determine the SBU rates
  - Performed scaling tests on Westmere nodes (the baseline system) to determine the "sweet spot" for each of the six benchmarks; i.e. the number of MPI processes where productivity was maximized.
  - Ran the six codes on all high-end computers at NAS (Columbia and three node types of Pleiades) and NCCS (five node types of Discover).
  - Calculated the SBU rates as a weighted average of performance of the codes compared to performance of a Westmere node on Pleiades— the weights represented the approximate usage of similar codes on the supercomputing resources.
  - The group also developed stand-alone packages of the codes so they can be used to characterize the performance of hardware and software systems for future procurements, and to steer HECC users toward the systems appropriate for their applications.

Mission Impact: Having a broader base of applications in the benchmark suite means that it is more representative of workloads across all NASA missions. The new methodology will accommodate future changes in architectures or benchmark applications. This process is key in determining the "worth" of existing and future hardware solutions.

		Columbia c22	Pleiades Harpertown	Pleiades Nehalem	Pleiades Westmere
	cores/MAU:	4	8	8	12
NTR Workload Apps (run times in seconds)	# of cores				
ENZO	240	2788	1832	1497	1834
FUN3D	960	4844	3270	1616	1734
GEOS-5	1176	4750	2815	1636	2096
OVEFFLOW	480	2231	2931	1364	1786
USM3D	480	3815	3954	1596	1802
WRF	384	6077	3404	1775	2036
	BASE system Pleiades Westmere				**Base**
relative number of runs/MAU compared to Base	**Weight**				
Enzo	0.20	0.22	0.67	0.82	1.00
FUN3D	0.10	0.12	0.35	0.71	1.00
GEOS-5	0.15	0.15	0.50	0.85	1.00
OVEFFLOW	0.20	0.27	0.41	0.87	1.00
USM3D	0.20	0.16	0.30	0.75	1.00
WRF	0.15	0.11	0.40	0.76	1.00
weighted average of number of runs #	1.00	*0.18*	*0.45*	*0.80*	*1.00*
New SBU Rate		**0.18**	**0.45**	**0.80**	**1.00**

Figure: Charging rates for HECC systems are computed as a weighted average of performance of six benchmarks representing work done in all mission directorates.

POC: *Robert Hood, robert.hood@nasa.gov, (650) 604-0740, NASA Advanced Supercomputing Division, Computer Sciences Corp; Piyush Mehrotra, (650) 604-5126, piyush.mehrotra@nasa.gov, NASA Advanced Supercomputing Division.*

HECC Website Launched with Focus on User Effectiveness

- A new High-End Computing Capability website (http://www.nas.nasa.gov/hecc/) serving users, potential users, and NASA decision makers, was officially launched on May 25, 2011.
- The new website—designed, developed, and implemented by the HECC Publications & Media team—provides users with a number of new features designed to enhance productivity on the HECC systems:
  - Live system status to quickly get detailed pictures of system usage and availability, network status, and more.
  - New User Orientation guide: a short introduction to the HECC environment.
  - Knowledge Base containing systems documentation, FAQs, policies, and articles on current best practices (see slide 10).
  - RSS feeds for user news and issues updates.
  - Prominent Quick Links to popular pages.

Mission Impact: The new High-End Computing Capability website will help science and engineering users quickly obtain information and services needed to make the most efficient, effective use of HECC resources.

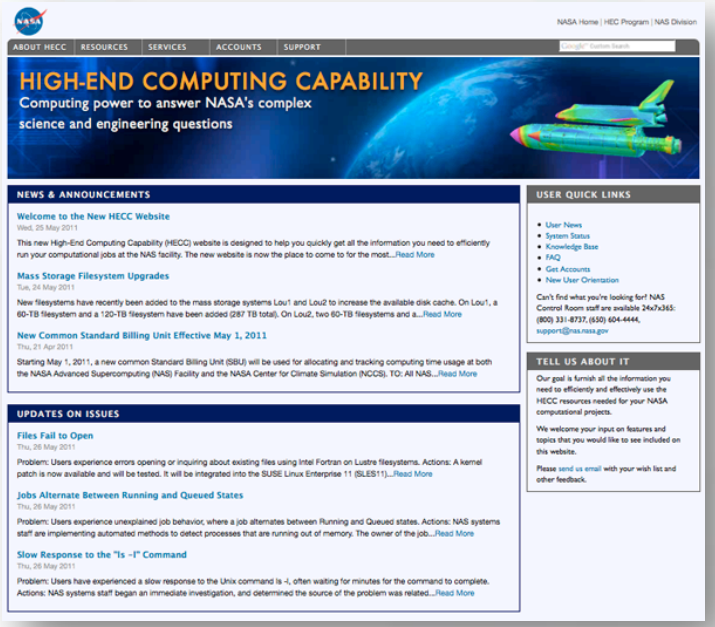


Figure: Screen shot of the top portion of the new HECC website home page, with prominent placement of user news, updates on issues, and Quick Links to frequently accessed information.

POC: *John Hardman, john.p.hardman@nasa.gov (650) 604-0417,*
Jill Dunbar, jill.a.dunbar@nasa.gov (650) 604-3534,
NASA Advanced Supercomputing Division, Computer Sciences Corp.

New HECC Knowledge Base Provides User-friendly Web Documentation

- Part of the HECC website launch (see slide 9), includes a new Knowledge Base (KB) providing users with well-organized, updated documentation: http://www.nas.nasa.gov/hecc/support/kb/.
- Nearly 200 technical articles are organized to accommodate users' workflow (from getting an account to transferring and archiving data).
  - Articles are presented in multiple categories, with an easily browsable navigation structure.
  - Each article is relatively short for easier reading; related articles are grouped and arranged in logical sequence, and users can quickly link to other relevant articles of interest.
  - A collection of downloadable files (such as code examples) is kept in a centralized area.
- A robust search capability in the KB allows users to find needed information quickly by keyword or article ID search—an important improvement over the previous NAS user documentation web pages.
- Users can subscribe to RSS feeds get the latest news and announcements, updates on known technical issues, and new topics of interest.
- They can also rate the usefulness of each article, and can ask questions via the KB, which automatically generates possible answers, or can optionally send a ticket sent to Control Room staff.

Mission Impact: A reorganized and search-enabled documentation site allows HECC users to find answers easily on their own and reduces the number of calls to the help desk and scientific consulting staff.

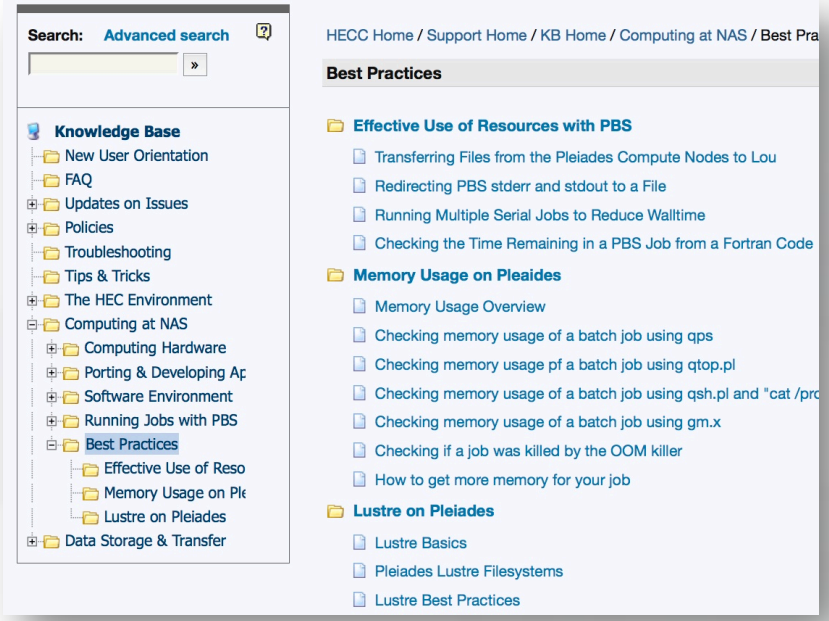


Figure: Left: Showing Knowledge Base with a search field and a navigation structure. Right: Showing article titles under a few sub-categories.

POC: *Sherry Chang, sherry.chang@nasa.gov, (650) 604-1272,*
John Hardman, john.p.hardman@nasa.gov (650) 604-0417,
NASA Advanced Supercomputing Division, Computer Sciences Corp.

HECC Takes Lead Role at 9th Annual SGI User Group Conference

- Strong participation from the HECC supercomputing team contributed to the success of the 9th Annual SGI User Group (SGIUG) Conference; the four-day event was held May 2-5, in the San Francisco Bay Area.
- The SGIUG conference brought together attendees from high-performance computing sites around the world, providing an opportunity for SGI users to interact and learn from each other, and to discuss future products from SGI.
- HECC deputy project manager Bill Thigpen presented the customer keynote address, "NASA Supercomputing at the NASA Advanced Supercomputing Facility."
- HECC members presented five break-out session talks (see slide 15) on experiences.
- HECC systems lead Davin Chan was elected SGIUG board president, and storage expert Liz Cox was elected vice-president and program chair.

Mission Impact: HECC supports NASA knowledge-sharing and outreach goals through participation at technical conferences such as user group meetings.



Figure: SGI CEO Mark Barrenechea (SGI) gives a keynote address at the 9th Annual SGI User Group Conference.

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

Perfect Triennial Inventory of HECC Equipment Completed

Mission Impact: Proper receipt, tracking, and disposal of government equipment are critical components of securing the HECC IT assets and managed data within the NASA Advanced Supercomputing facility.

- The NASA Advanced Supercomputing (NAS) facility at Ames received notification of the successful completion of the 2010 Equipment Physical Inventory on April 27, with no missing items.
- The inventory is comprised primarily of HECC equipment and consists of over 1,000 pieces of decaled equipment located at the NAS facility and valued at over $90M.
- An initial inventory report identified only one missing item, which was located at Goddard; paperwork was completed to identify the current equipment owner and location to clear the record.
- Excellent tracking by HECC staff of government assets included proper scrubbing of data from excessed equipment.
- Snapshot of annual inventory handling (FY2010):
  - 121 new pieces of equipment procured, valued at $16.25M;
  - 167 pieces of equipment excessed, valued at $5.4M.

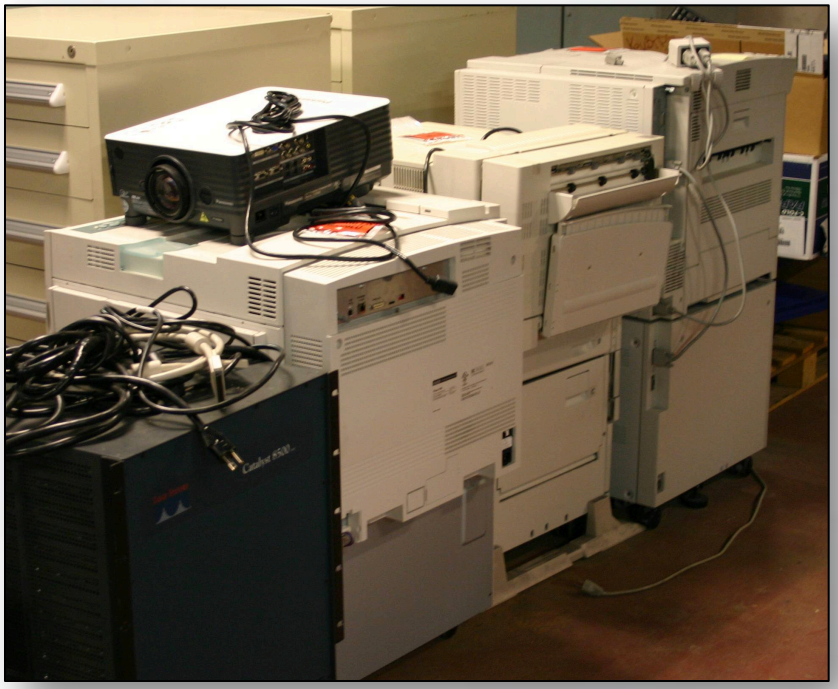


***Figure**: Excessed HECC Project equipment at the NAS facility is staged for transfer.*

***POC**: Judy Kohler, judy.j.kohler@nasa.gov, (650) 604-4303,*
NASA Advanced Supercomputing Division,
Computer Sciences Corp.

Presentations and Papers

- **HECC Presentations at the SGI User Group Conference,** May 2-5, Fremont, CA

  "InfiniBand Tutorial," Jeff Becker

  "Pleiades InfiniBand Update," Bob Ciotti

  "How to Modify Tempo for Large Scale ICE Installations," Jim Karellas

  "Exploring Lustre Performance with System Tap," Jason Rappleye

  "pbs_analyze - Consolidates PBSPro Jobs' Logs on ICE for Debugging, "David Roland

  "Supercomputing at the NASA Advanced Supercomputing Facility," Bill Thigpen

  http://www.sgiug.org/

- "High End Computing Capability (HECC) Program Overview," R. Biswas, presentation at NASA Facilities Engineering and Real Property (FERP) Conference, Nashville, TN, May 12, 2011.
- "Aerodynamics and Debris Transport for the Space Shuttle Launch Vehicle," S.E. Rogers, presentation at Applied Modeling & Simulation Seminar Series, NASA Ames Research Center, May 10, 2011.*
- "On Numerical Methods for Hypersonic Turbulent Flows," H.C. Yee et al., paper presented at 7th European Symposium on Aerothermodynamics, May 9-12, 2011, Brugge, Belgium.*

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

Presentations and Papers (cont.)

- "High Resolution Navier-Stokes Simulation of Rotor Wakes," N.M. Chaderjian and P.G. Buning, paper presented at the American Helicopter Society 67th Annual Forum, Virginia Beach, VA, May 2-5, 2011.*
- "Kepler-10C, A 2.2-Earth Radius Transiting Planet in a multiple system," F. Fressin et al., astro-ph.EP, arXiv:1105.4647v1, draft version May 25, 2011.*
  http://arxiv.org/abs/1105.4647
- "Gas Condensation in the Galactic Halo," M.R. Joung et al., astro-ph, arXiv:1105.4639v1, draft version May 25, 2011.*
  http://arxiv.org/abs/1105.4639v1

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News and Events

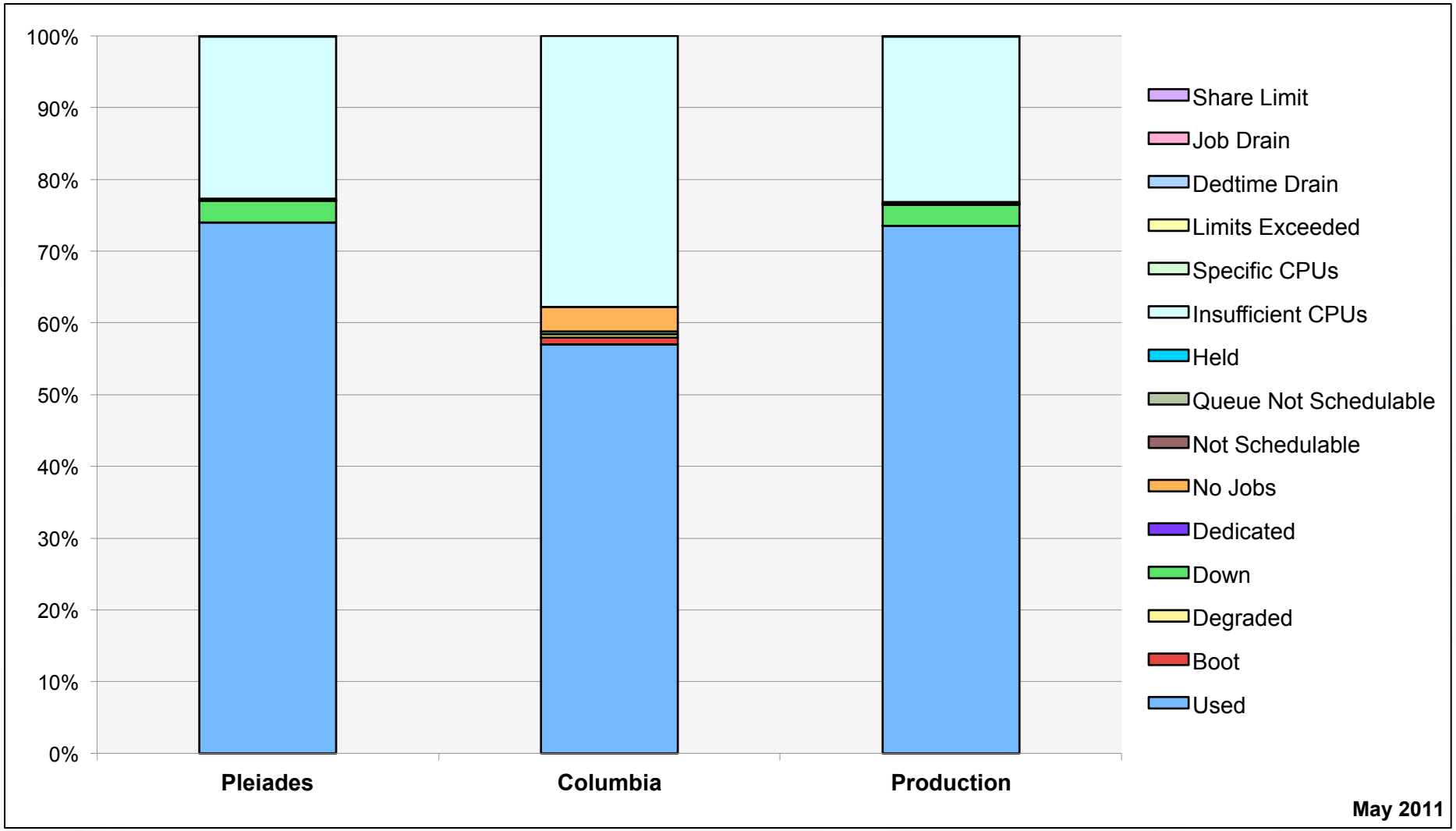
- **NASA Honors 13 Ames Employees with Silver Snoopy Awards**, *NASA Ames press release,* May 3, 2011 – Among the recipients of this award for outstanding work and professional dedication were HECC users Donovan Mathias and Niki Werkheiser, NASA Advanced Supercomputing Division.

  http://www.nasa.gov/centers/ames/news/features/2011/silver_snoopy.html

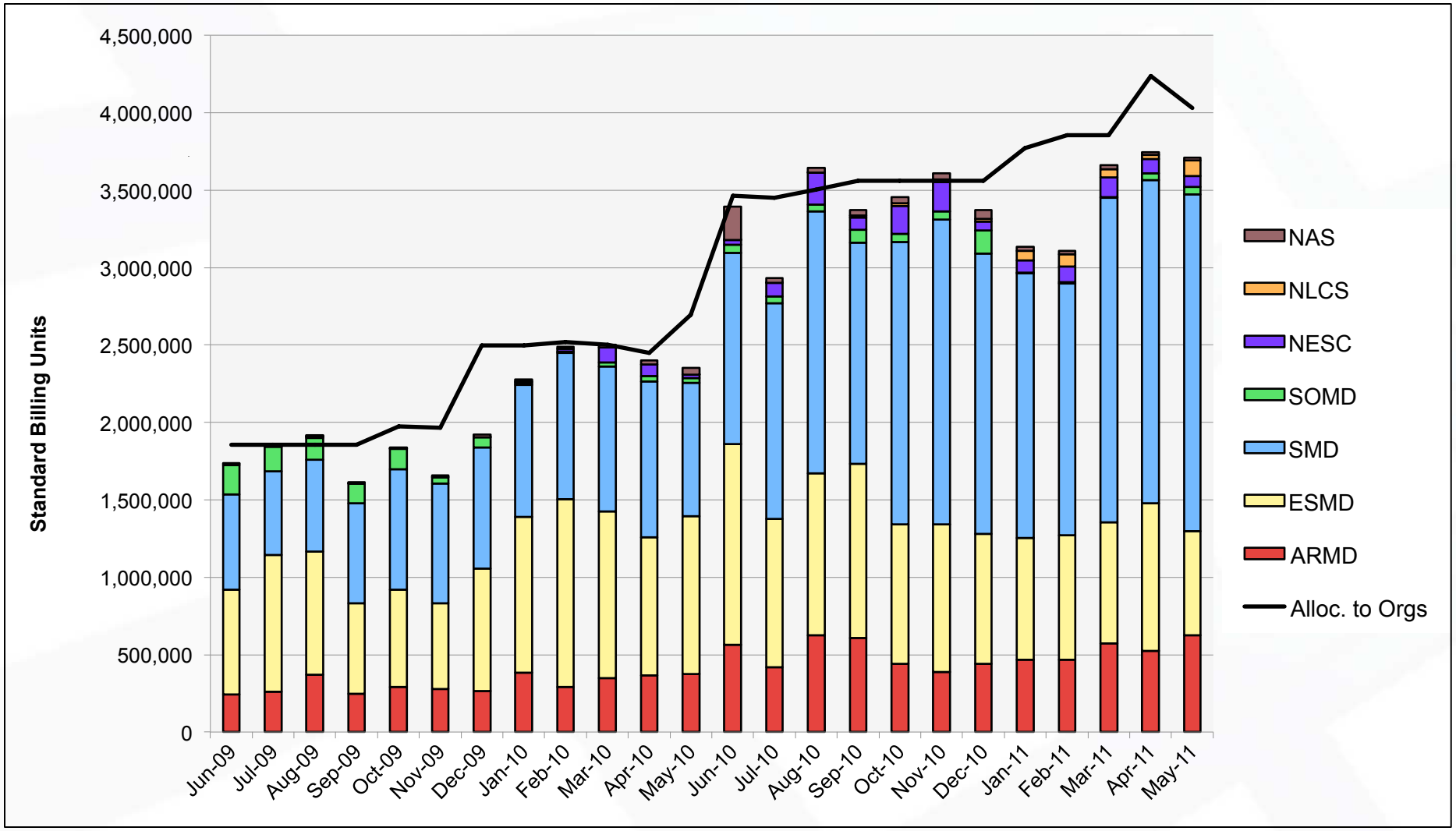
- **SGI CEO Named 2011 Best Large Company CEO by San Francisco Business Times**, *iStockAnalyst*, May 23, 2011 – Includes a quote from Bill Thipgen, HECC Deputy Project Manager.
  http://www.istockanalyst.com/business/news/5173528/sgi-ceo-named-2011-best-large-company-ceo-by-san-francisco-business-times

- **A Dark Matter for Astrophysics Research**, *HPCwire*, May 31, 2011 – Using the Pleiades supercomputer, Stanford University physicists ran a simulation of a region of the universe done with 8 billion particles—one of the largest simulations ever done in terms of particle numbers.*
  http://www.hpcwire.com/hpcwire/2011-05-31a_dark_matter_for_astrophysics_research.html

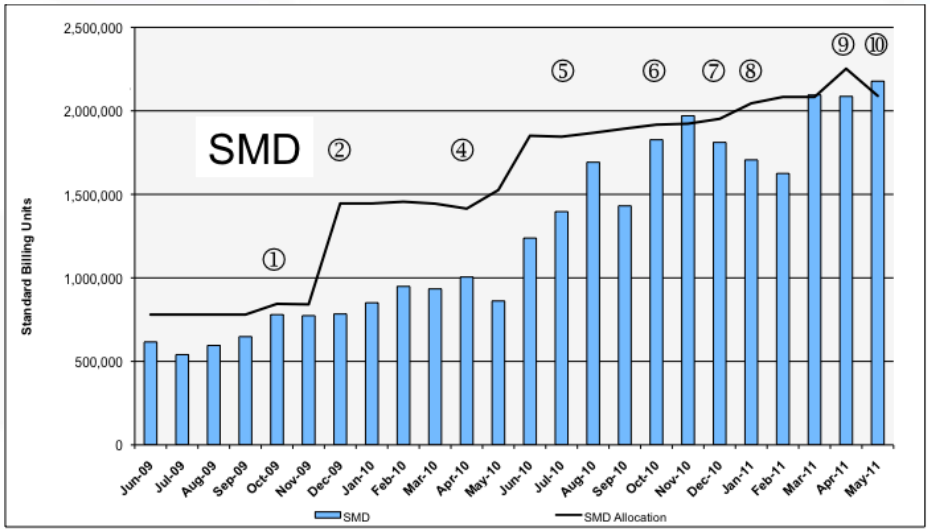
NAS Utilization

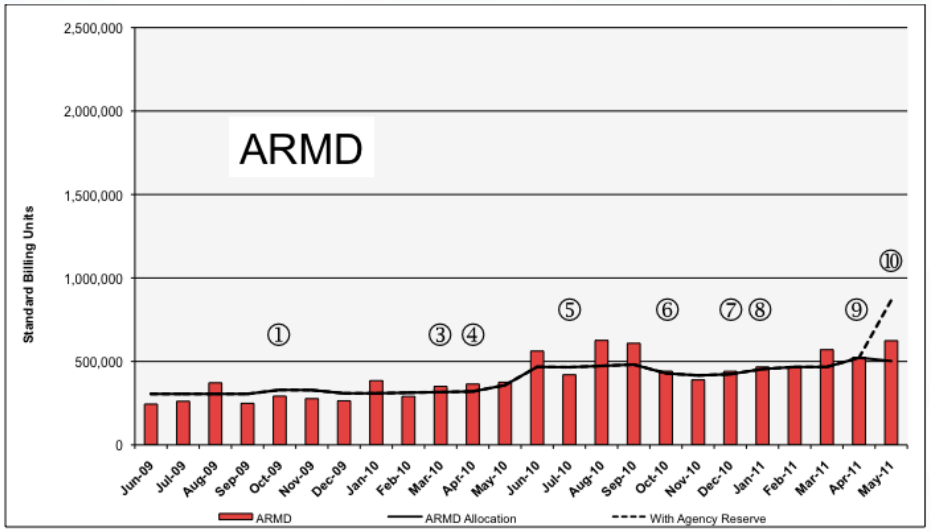


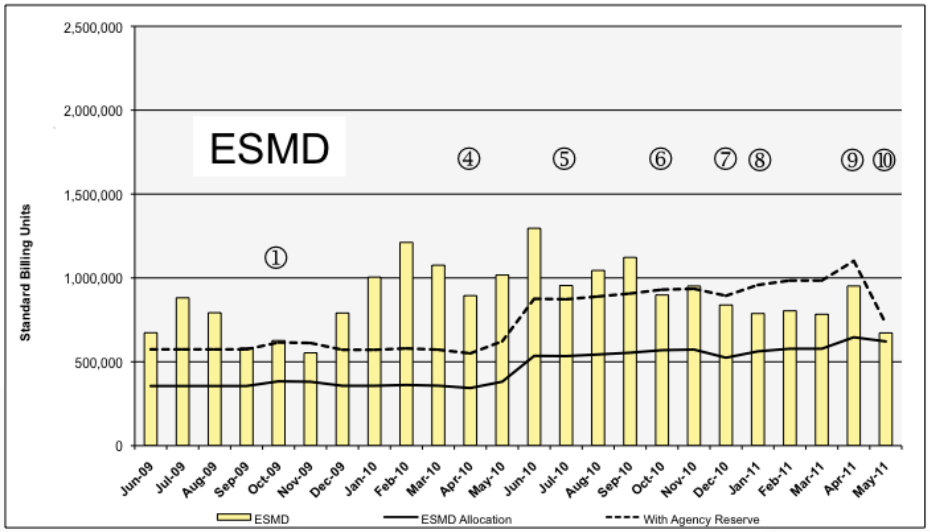
NAS Utilization Normalized to 30-Day Month

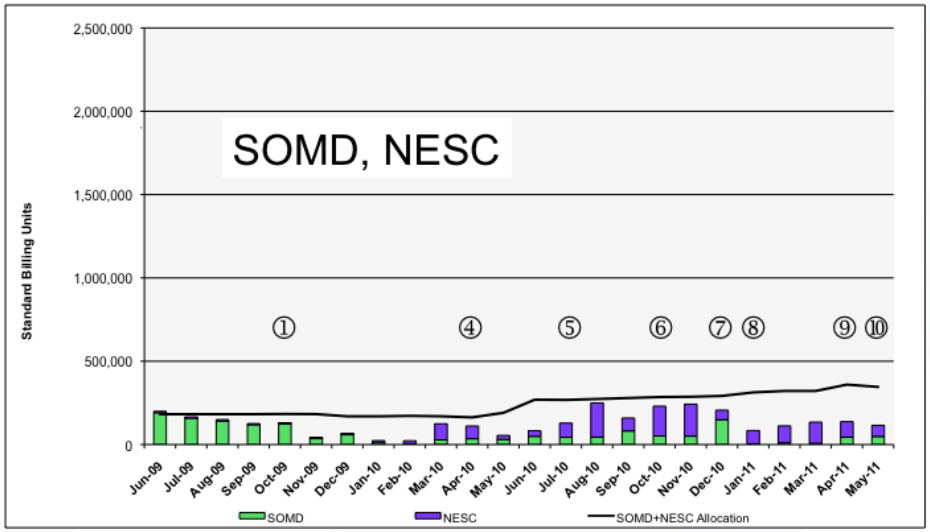


NAS Utilization Normalized to 30-Day Month



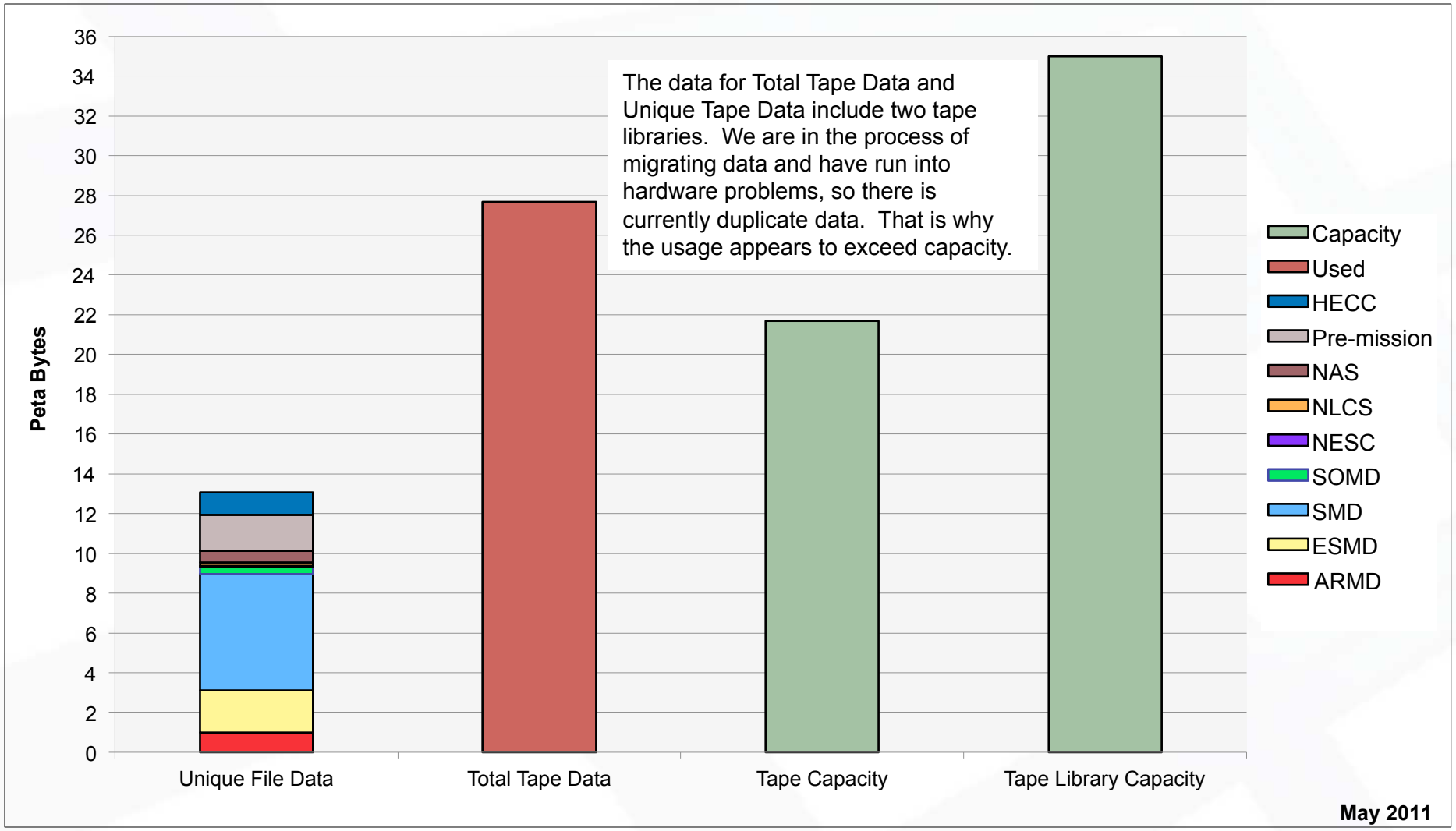




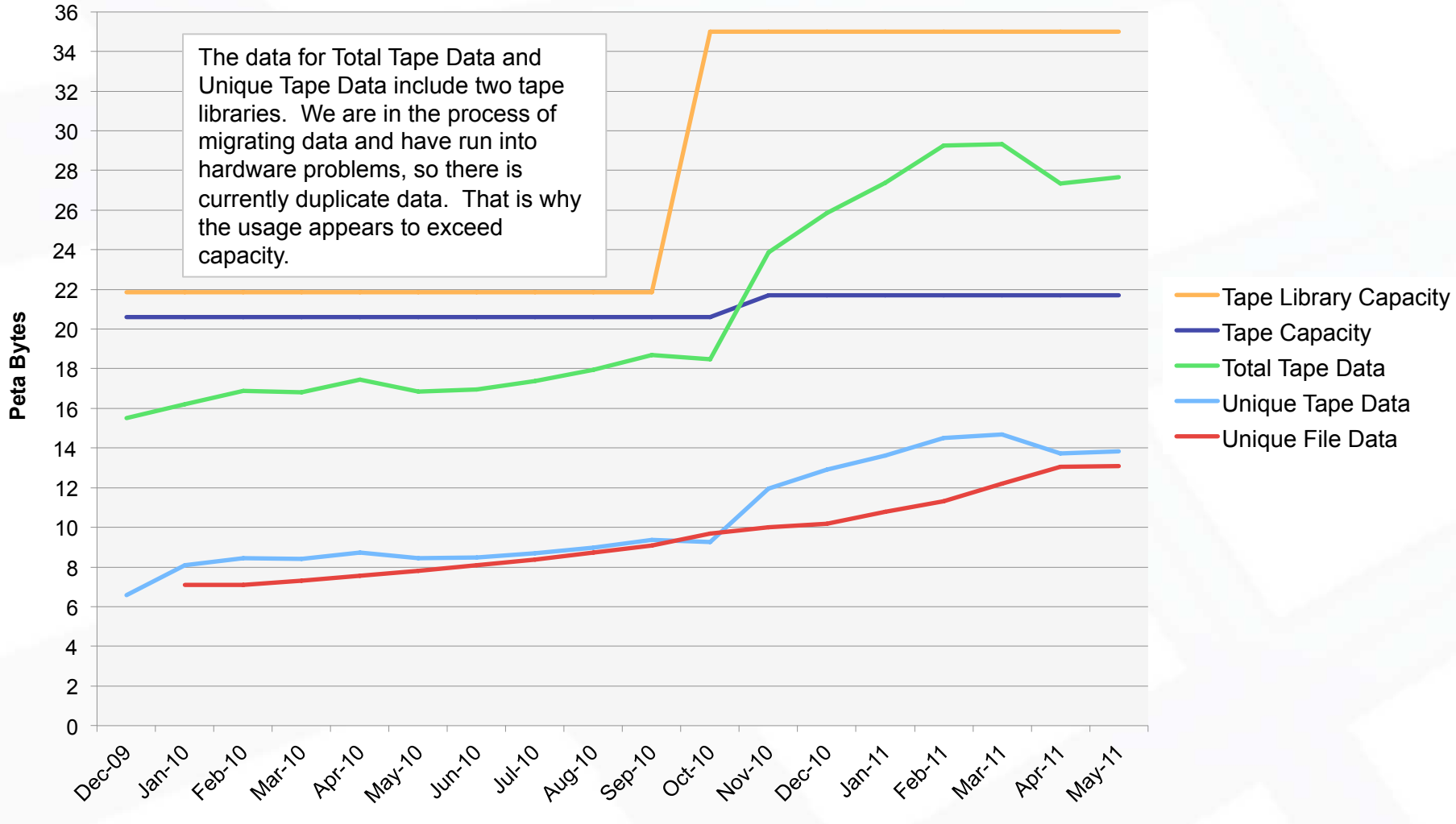


① Allocation to orgs. increased to 80% ② SMD augmentation ③ RTJones retired ④ 32 Westmere racks added
⑤ Schirra retired, 4 Westmere racks added ⑥ RTJones compensation removed ⑦ 8 Westmere racks added
⑧ Devel queue created ⑨ 12 Westmere racks added ⑩ Allocation to orgs. decreased to 75%, Agency reserve shifted to ARMD

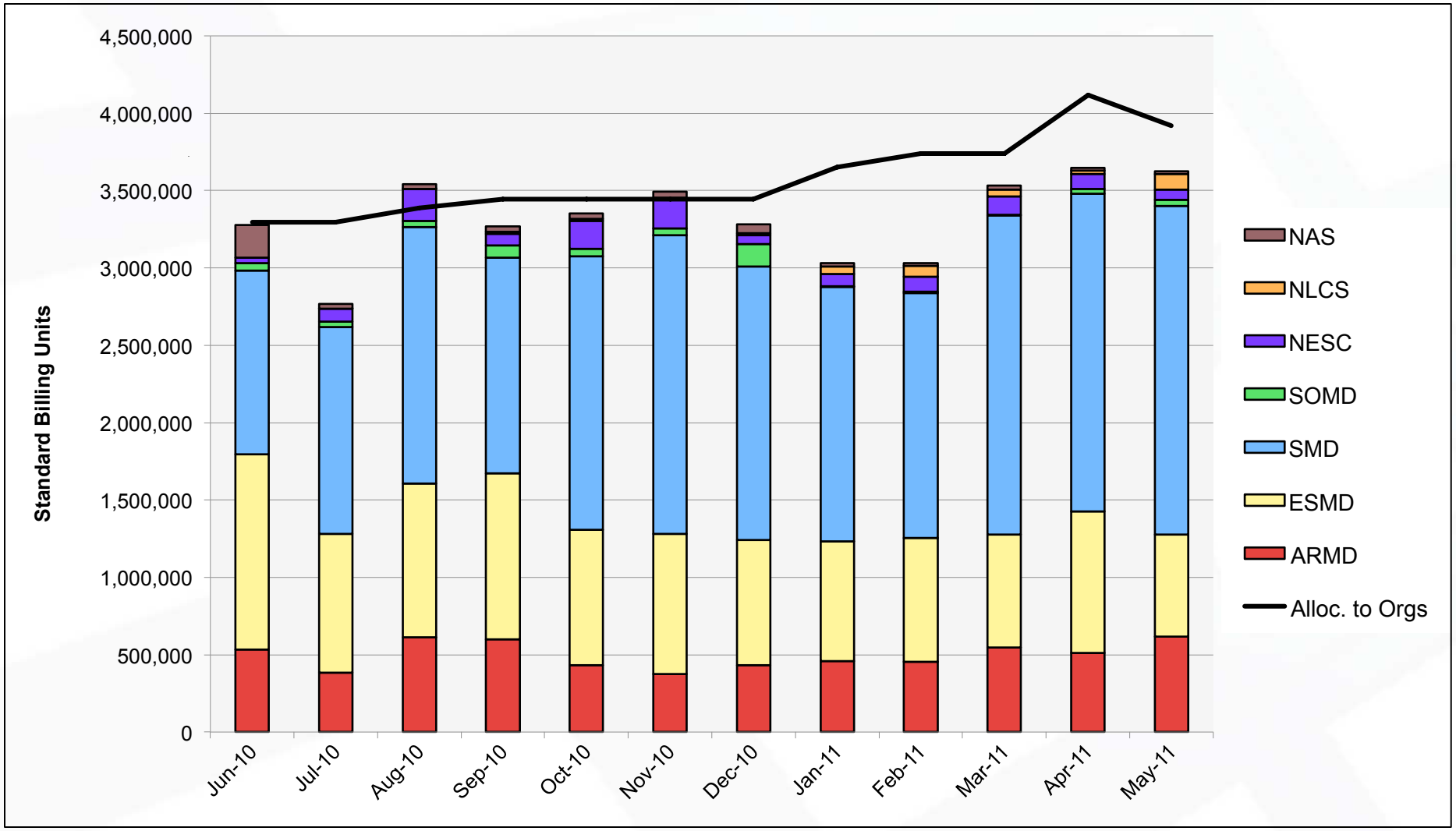
Tape Archive Status



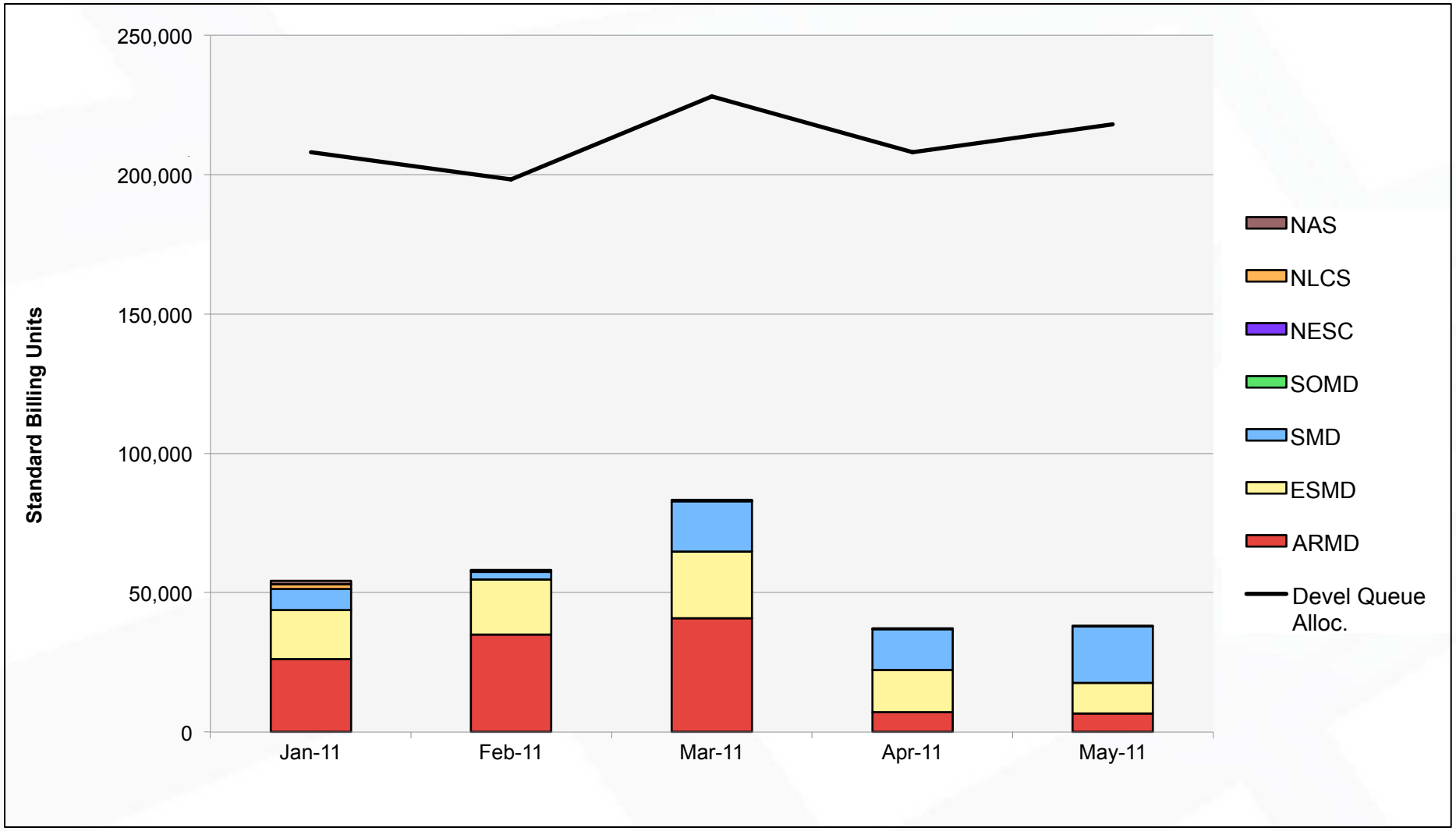
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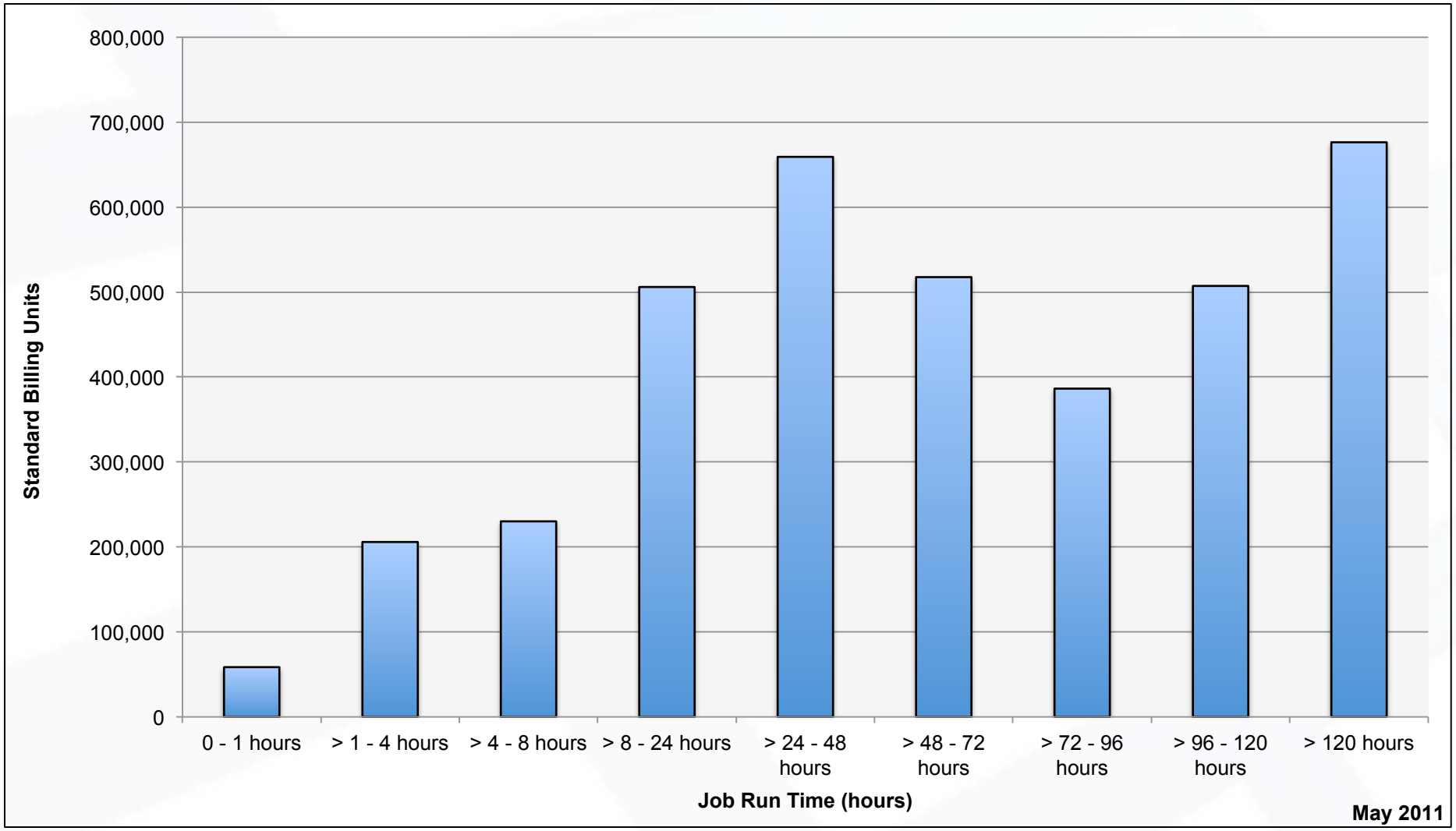
Pleiades:
SBUs Reported, Normalized to 30-Day Month



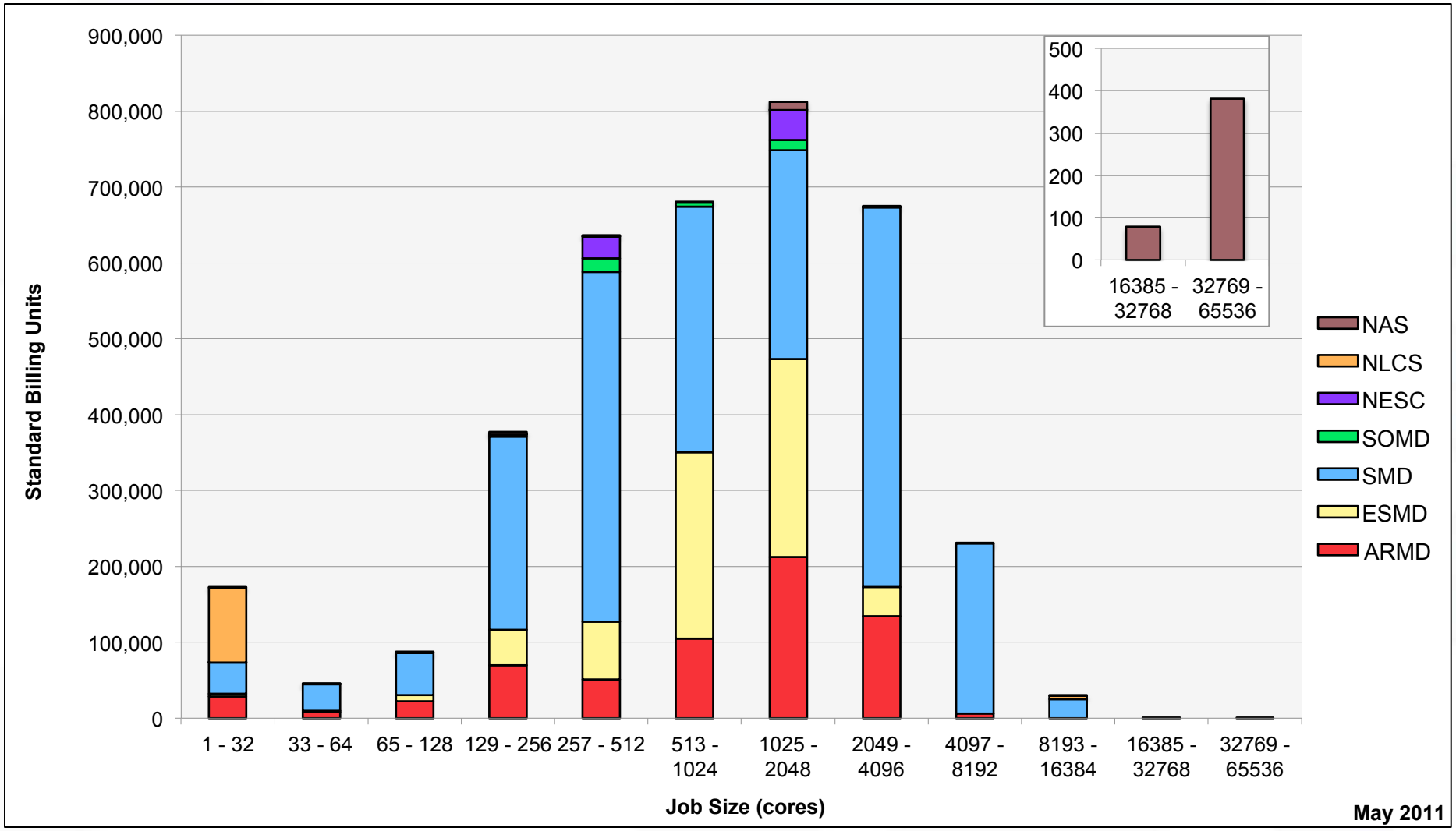
Pleiades:
Devel Queue Utilization



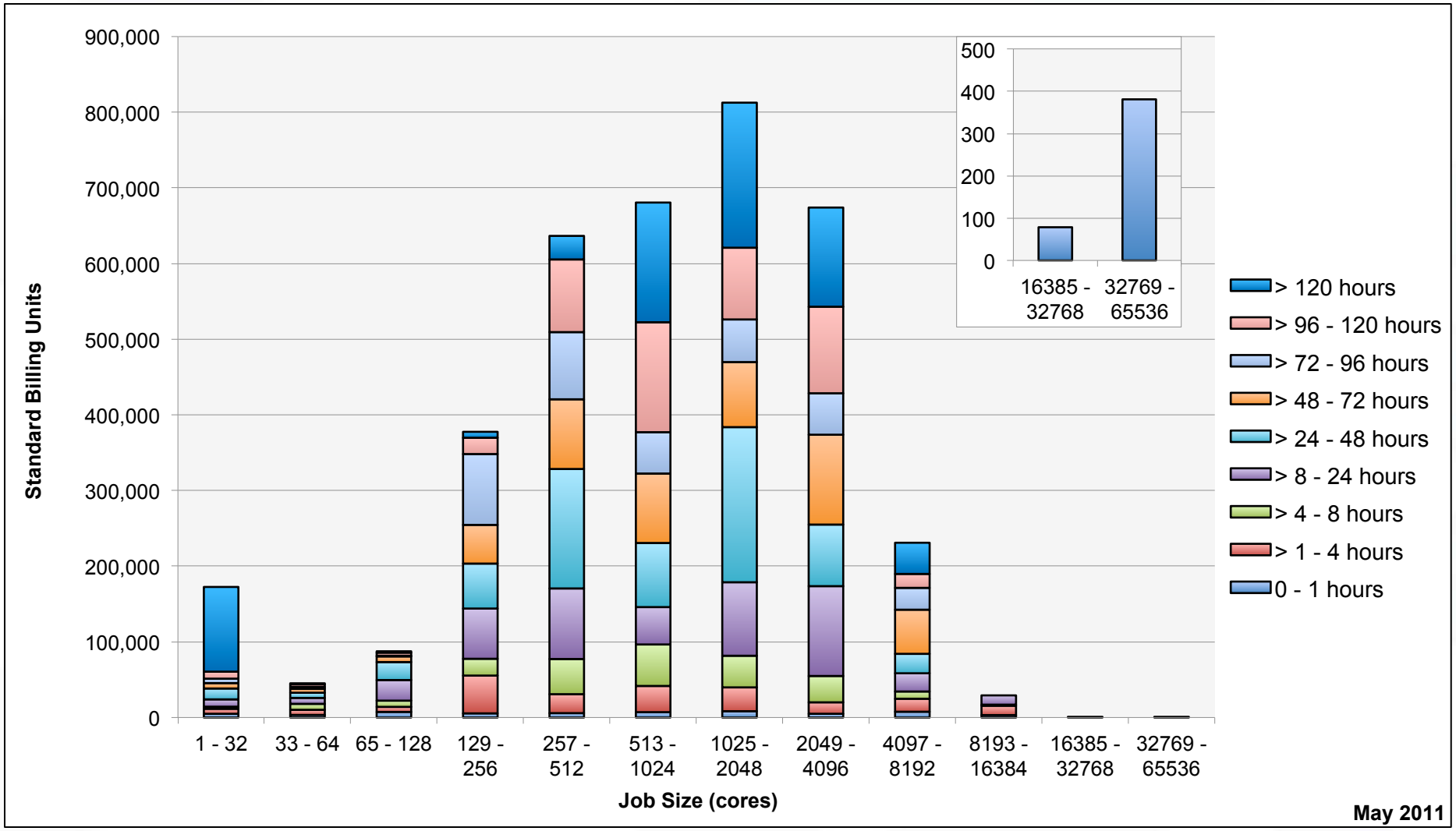
Pleiades:
Monthly SBUs by Run Time



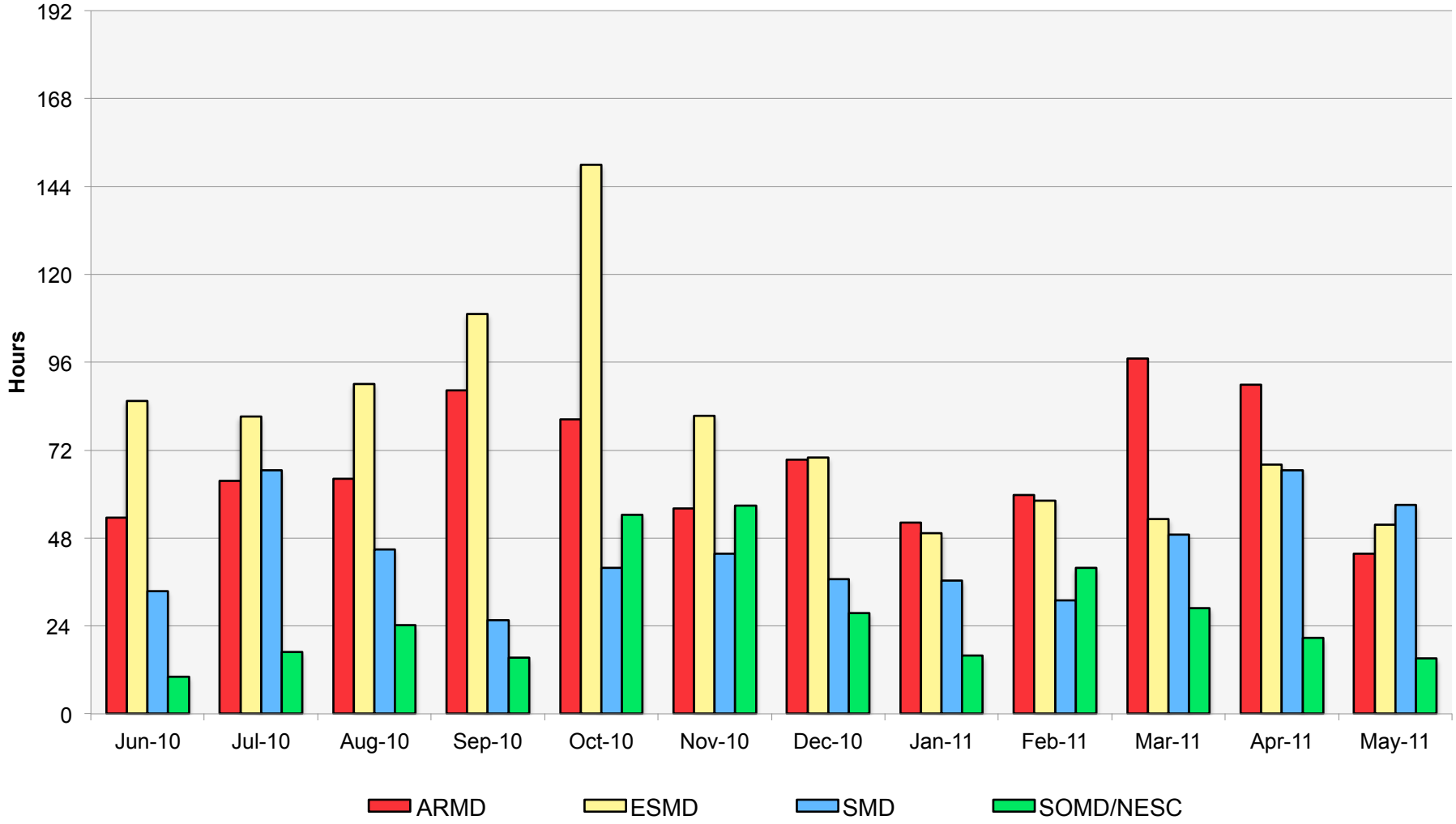
Pleiades:
Monthly Utilization by Size and Mission



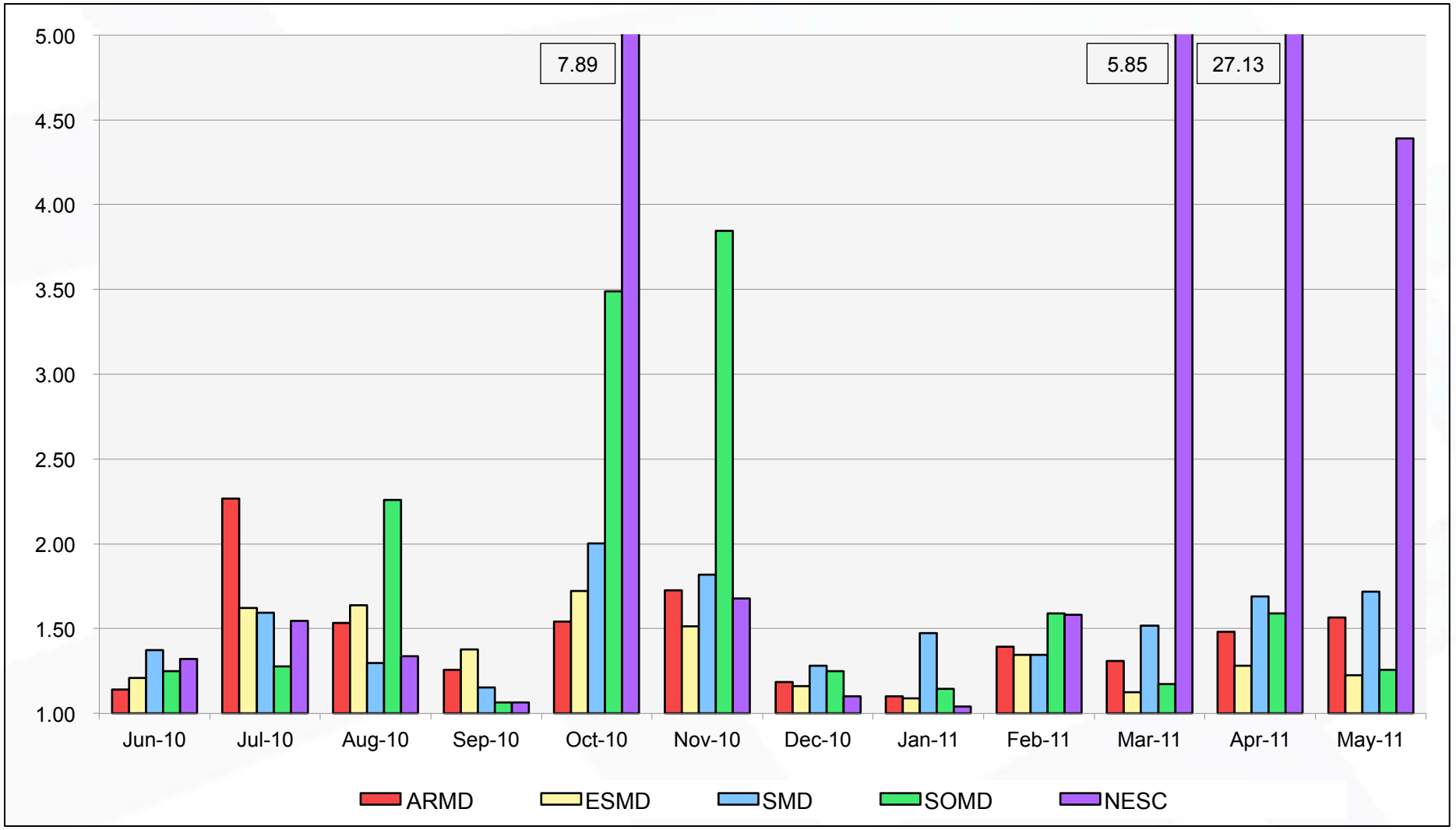
Pleiades:
Monthly Utilization by Size and Length



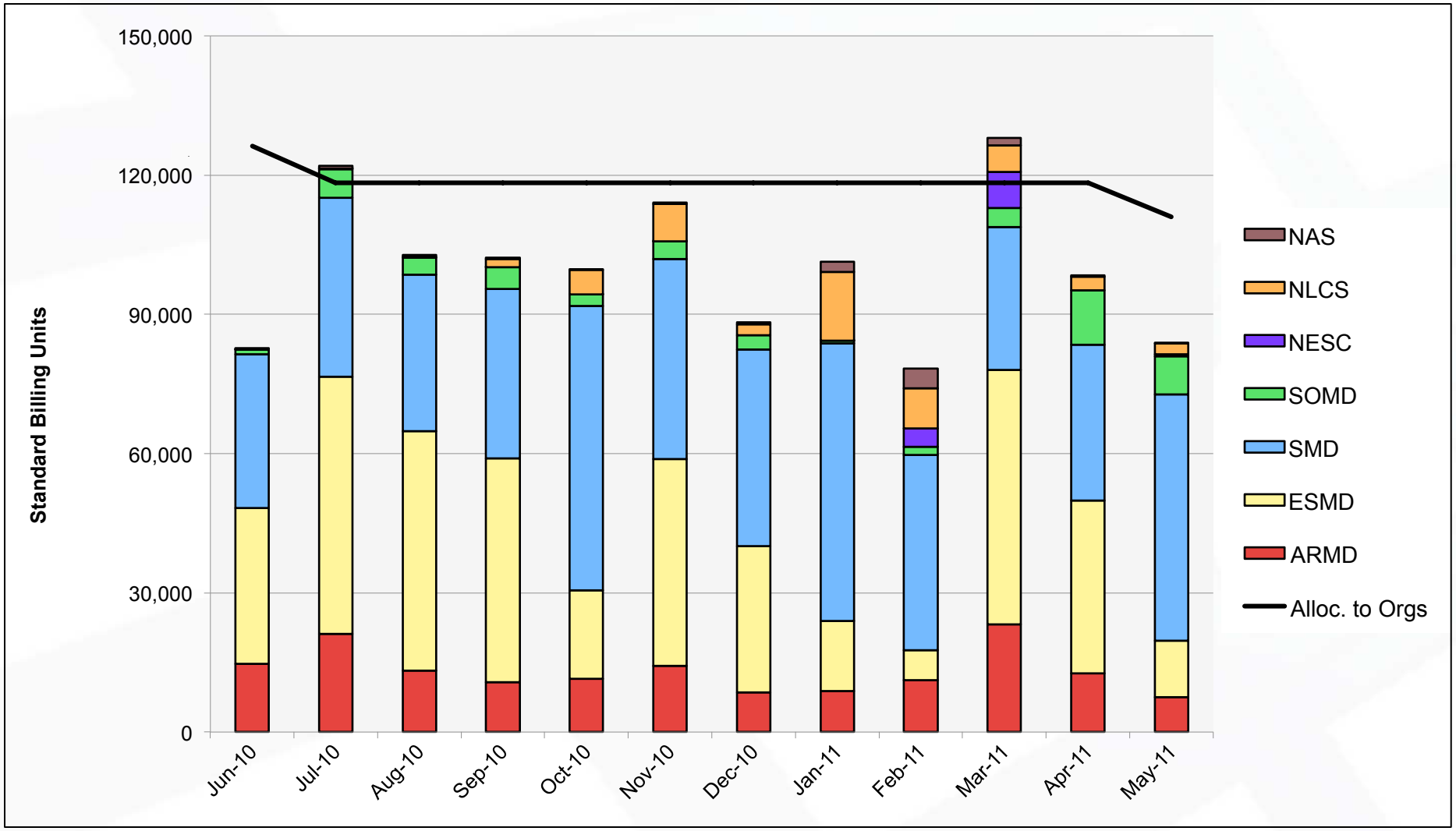
Pleiades:
Average Time to Clear All Jobs



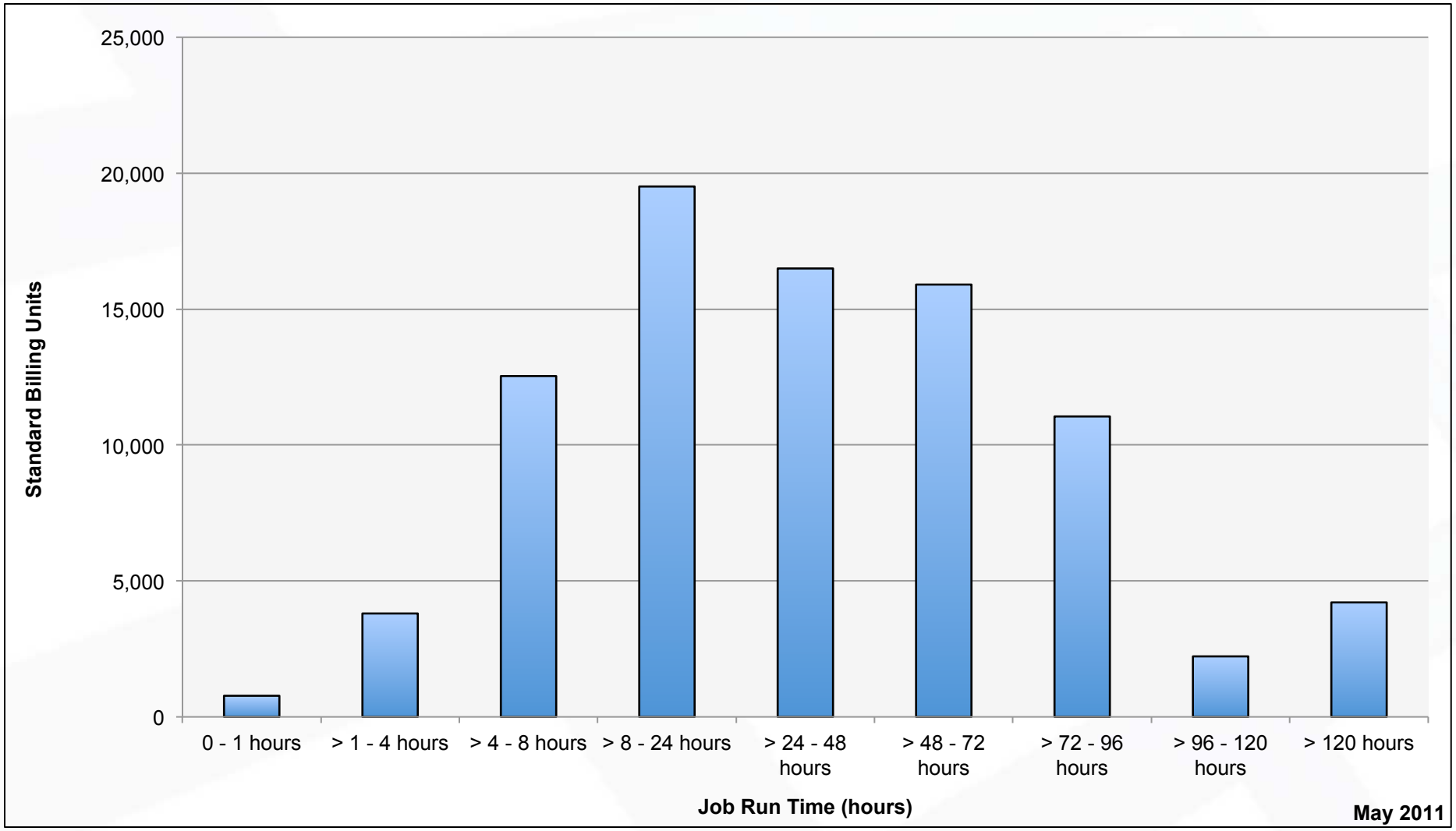
Pleiades:
Average Expansion Factor



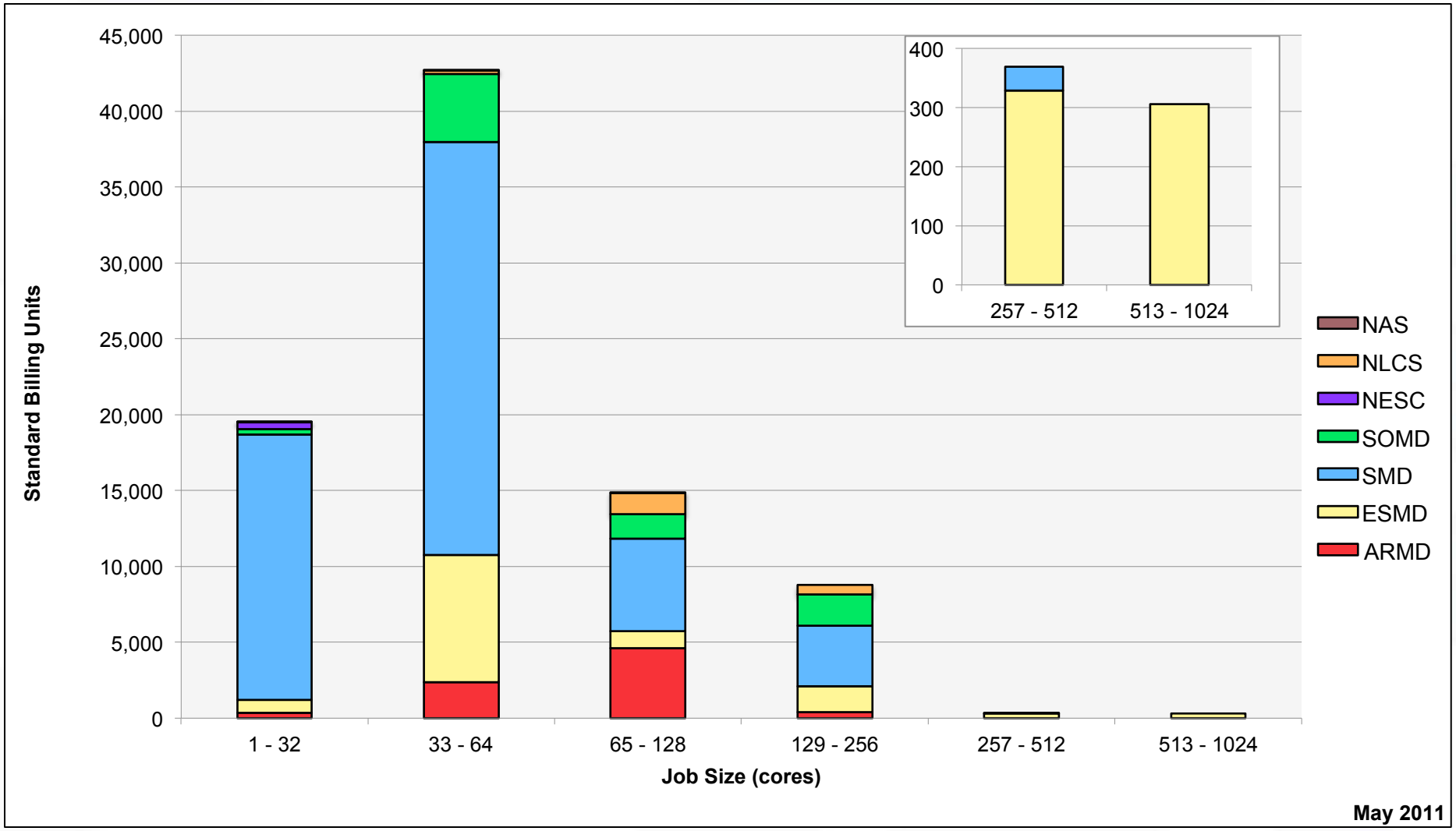
Columbia:
SBUs Reported, Normalized to 30-Day Month



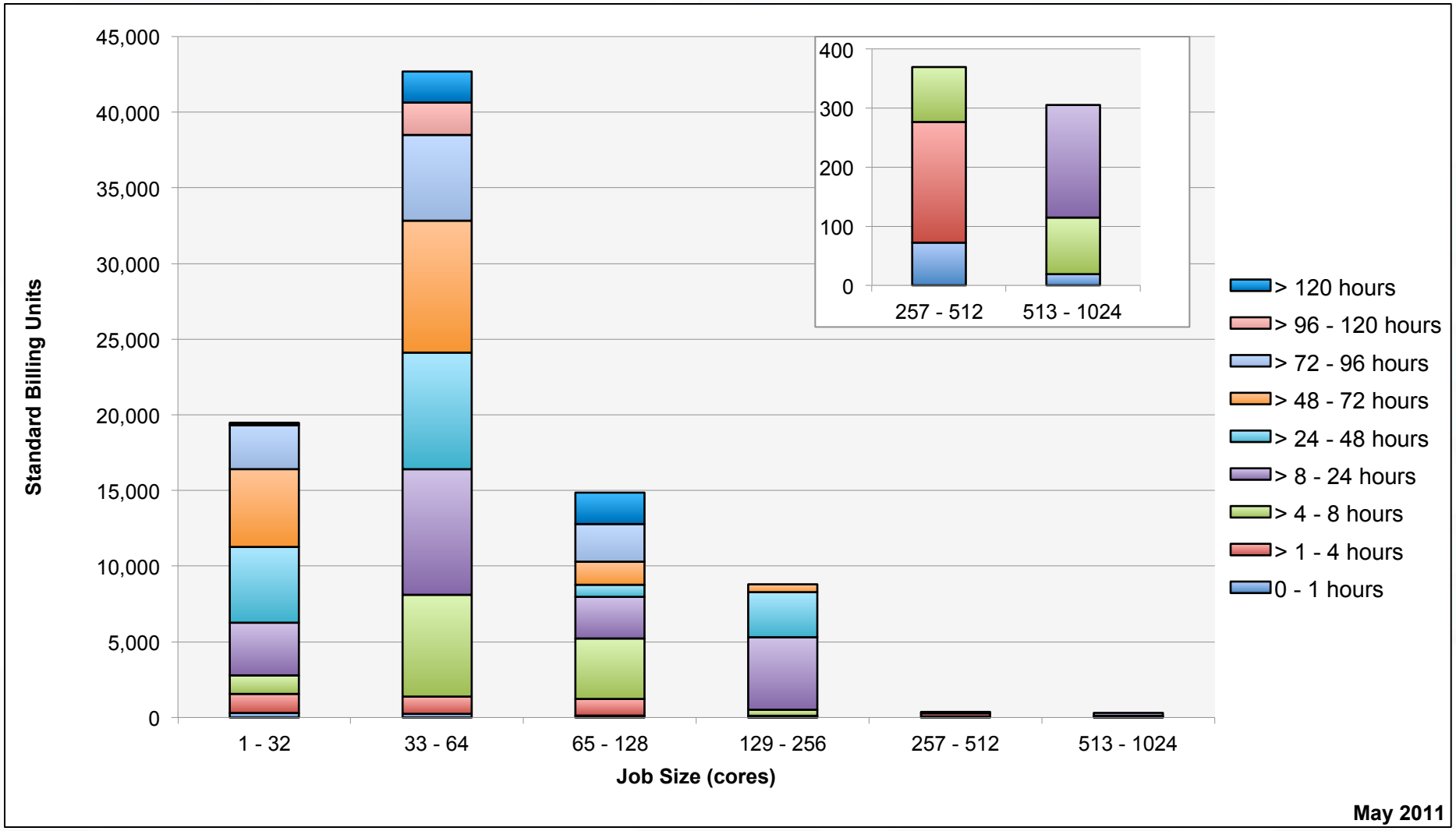
Columbia:
Monthly SBUs by Run Time



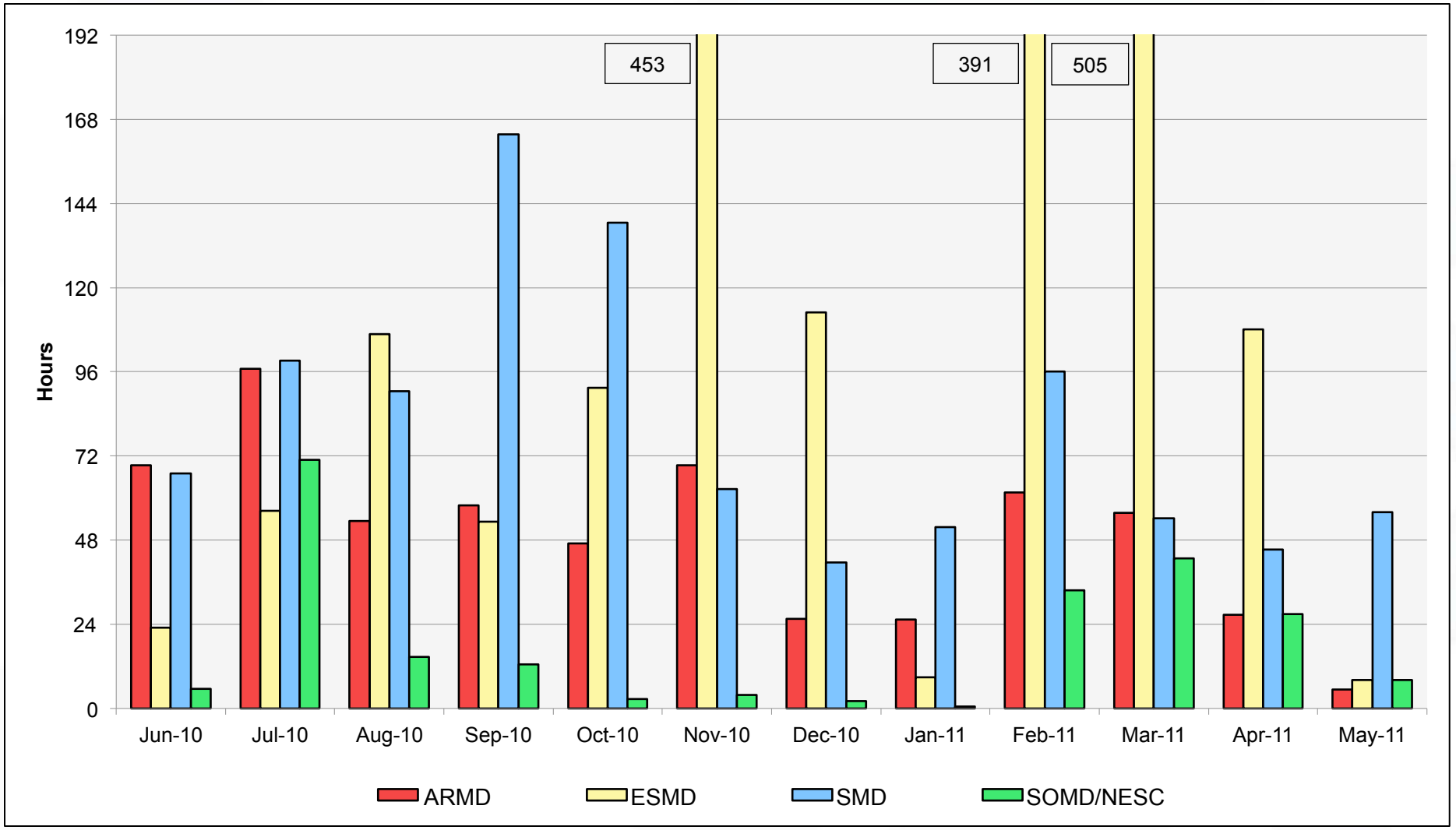
Columbia:
Monthly Utilization by Size and Mission



Columbia:
Monthly Utilization by Size and Length



Columbia:
Average Time to Clear All Jobs



Columbia:
Average Expansion Factor

