

TASK STATEMENT OF REQUIREMENTS (SOR)

Task Number: ARC013.10.00

Date: May 20, 2016

Task Title: High End Computing Capability

Requester: [REDACTED]

Period of Performance: August 1, 2016 through July 31, 2017

I Description of Work

HECC provides the agency with an essential compute capability that enables a broad swath of research and engineering activities key to the successful completion of NASA's mission goals and objectives. While not an end unto itself, high-end computing enables scientists and engineers to reach for, and achieve the next step in an expanding universe of solution sets that push understanding to a new level, or provide assurance that the proposed design will meet the demanding requirements.

HECC at its core provides fully supported computational cycles within NASA's largest compute environment. This includes the provision of the compute, storage, communication, software, and analysis platforms. Currently, there are three compute systems, one visualization system and multiple support systems in the HECC enclave. The Pleiades system is one of the largest InfiniBand clusters in the world and is currently the main compute asset on the floor. Merope is the same architecture as Pleiades, but is older, smaller and resides in a separate building. Endeavour represents continued interest in SSI constellation-class clusters. The size and technologies represented in these systems allow for a combination of capability, capacity and time-critical computing to all of NASA's mission directorates simultaneously. To complement these computational engines, there is a large on-line storage environment backed by a multi-petabyte tertiary storage capability. Data analysis and visualization of the data produced on the compute systems is supported through two connected visualization clusters (one is an internal component of Pleiades), and all of the inter-related components are connected by a robust set of networks. Connectivity to NASA internal and external sites generally ranges from [REDACTED]

The hardware is important, but without a full-support organization, the cycles will not be effectively utilized by the agency. HECC provides fully supported cycles, which equates to providing the researchers and engineers with the necessary computer science support to effectively exploit this capability for the best support of the agency's goals and objectives. Code optimization and scaling are a key component to HECC. The identification and improvement of key NASA codes provides an increasing capability to the agency as a whole. Similarly, the support for analysis of huge datasets and visualization of simulation results has a large return on investment, expediting the research and engineering processes by providing a better understanding of the data in a timely manner.

The full scope of the HECC project is defined in the HECC Project Plan and accompanying HECC System Engineering Management Plan. This task supports the NAS division in providing the work described in the four technical and support areas described below:

This task provides support for the HECC Project in five technical areas. These technical areas are:

- Supercomputing Systems (Subtask A): Provide computing power, memory bandwidth, performance, scalability, and ease of use through the development of software tools,

advanced security, system management, and continuous system engineering and development.

- **Application Performance and Productivity (Subtask B):** Facilitate advances in science and engineering for NASA missions by enhancing the performance and productivity of high-end computing applications of interest to the Mission Directorates.
- **HEC Visualization and Data Analysis Systems (Subtask C):** Create functional visualization software to enhance user applications by incorporating traditional post-processing and/or concurrent visualization capabilities.
- **Networking (Subtask D):** As a centralized resource, HECC provides high end computing to scientists and engineers throughout the country. There are even a few that are abroad. It is our responsibility to ensure that the users connectivity to the HECC assets is optimal for each of our users wherever they are and whatever networks they must traverse.
- **User Services (Subtask E):** Supports NASA's scientists and engineers, partners, and stakeholders in using high-performance computes and associated systems.)

Subtask F provides support for the overall management of the HECC Project.

Subtask G is closed.

The HECC Project is managed under the Earth Science Office in the Science Mission Directorate. A High End Computing Program has been created to manage HECC along with the supercomputing activities at the Goddard Space Flight Center. Subtask H is to provide support to this HEC Program Office.

Subtask I is closed.

Subtask J is closed.

Subtask K is focused on developing tools for operating and managing the key HECC processes.

Subtask L is closed.

Subtask M is closed.

Subtask A: Supercomputing Systems Group

Government Point of Contact: [REDACTED]

The Supercomputing Systems Group provides decision support, procurement, installation and operation of the computational and storage components of the HECC environment; and development and support for tools to support this environment.

Area 1: System Engineering and Administration of Large, Parallel Systems

Provide certified, Lead System Administrator support and operations support for Linux and Unix based Operating Systems including, SGI IRIX Operating Systems, and SUSE/SLES LINUX operating systems on both compute focus and graphics focus cluster systems. Support of Red Hat Linux may also be required. It is anticipated that as part of the NTR process, two to three new systems will come online during this performance period. The support includes new system deployments, regular OS and security patching, OS upgrades,

PBS development and support, backups, utilization analysis, and performance improvement recommendation and implementations. Support of global file systems across all the major systems include NFS, CXFS, and LUSTRE.

A key focus during this reporting period will be the stabilization and performance improvements of Pleiades filesystems. This includes QoS and SSD integration into Lustre and the evaluation of pNFS in the NAS environment.

As part of the on-going support, operation and development of computer systems at NASA, it's often the case that source code, scripts, or data will be produced under contract for NASA. In most cases, these efforts rely on collaboration with an external community and make use of existing code, development activities or community meetings that take place outside of both the contractor and NASA. Efforts by the contractor are most typically and substantially derivative works or are only useful when used in combination with those externally developed capabilities. To effectively participate in those external activities, the contractor may need to abide by an Open Source License as preferred or required by that external community. As long as there is no risk to NASA, the contractor, or the individual(s) releasing the software as in no support or warranty is provided or implied and is released as is, the contractor will release the developed code under the same Open Source License as required of a derivative work or under an Open Source License as appropriate and generally used in that external community.

Working with sister NASA centers to move towards a shared compute and data environment is required. It is particularly important to develop and implement an effective disaster recovery plan and tests to verify its efficacy.

The contractor shall provide recommendations on improving the effectiveness of the InfiniBand network within the main computational enclave and work with the government lead and industry partners to provide a network environment that can be exploited by our users.

The contractor shall provide operating system, scheduler software [REDACTED] compilers, tools, applications and libraries for the systems. PBS enhancements that the contractor will implement in production include node release, bucketing scheduler, and reliable job startup.

The contractor shall provide hardware maintenance on supported hardware or coordinate with vendor staff provided through other contracts.

The contractor shall provide 24x7 support for critical services and 8x5 support for normal production systems. This occasionally requires long days and/or extended hours to complete a given task based on any number of external events such as facilities work, NASA programmatic requirements, schedule commitments, or other unforeseen events.

The following development projects are anticipated:

- Install two or three new NTR systems
- Evaluate and report on current/future RAID controller solutions
- Set up/maintain a LUSTRE testbed
- Improve LUSTRE stability, performance and capability

- Develop LUSTRE network QOS or equivalent to reduce single user impacts
- Improve LUSTRE performance over multiple interfaces on large SSI systems
- Improve PBS functionality (node release) and performance (bucket scheduler).
- Improve InfiniBand stability, performance and capability.
- Support cloud activities as required.
- Evaluate pNFS on the production system.
- Evaluate LTO5/6/7 and other tape solutions for most cost effective archive expansion
- Install dedicated parallel shift transfer nodes between LUSTRE and DMF
- Expand InfiniBand connectivity between compute, archive, and graphics systems.
- Enhance I/O fabric performance
- Evaluate methods to improve Lustre performance
- Devise a method to monitor and control compute rack power consumption
- Deploy flash memory for use in supercomputing environment

Area 2: System Engineering and Administration of Multi-Petabyte Archive Systems

The contractor shall provide certified, Lead System Administrator support and operations support for the tertiary storage environment. During this reporting period, we expect to see a growth in this area with continued growth in both the RAID and tape environments

Additionally it is imperative that a disaster recovery plan and process be maintained for the NAS facility. An MOU has been signed between NAS and the NASA Center for Computational Science (NCCS) at the Goddard Space Flight Center to facilitate this effort. The ability to operate in case of a failure at one of the centers should be addressed with the movement of data between the centers.

The contractor shall provide hardware maintenance from Spectra Logic and other vendors or coordinate with vendor staff provided through other contracts. The contractor shall work with the vendor to meet their original performance requirements.

The contractor shall provide 24x7 support for critical services and 8x5 support for normal production systems.

The following development projects are anticipated:

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- Reduce dependence on cache-based archive
- Development to support new tape technologies
- Development to support cold disk storage
- Development of methodology to track Archive Usage

Area 3: System Monitoring and Tools for System Support

The contractor shall develop and deploy tools that help in the monitoring and operations of the high end computing systems.

The following development projects are anticipated:

- Develop tools to monitor InfiniBand Fabric, Lustre file systems, RAID, and HECC systems.
- Develop tools to analyze performance issues on HECC systems
- Develop tools to enhance user workflow on HECC systems

Subtask B: Application Performance and Productivity

Government Point of Contact: [REDACTED]

The goal of this subtask is to improve time to solution for important NASA challenges through efforts to maximize (a) the utilization of the high-end computing resources provided under HECC and (b) the productivity of engineers and researchers who use those resources. Productivity is increased through application enhancement and the appropriate introduction, research, and development of tools that assist in the discovery process. Another aspect of this subtask is to evaluate and characterize the performance of current and future architectures through benchmarking and performance modeling.

This subtask is described by the following three (3) functions:

Area 1: Application Performance Evaluation and Optimization

This area focuses on the enhancement of the performance and productivity of NASA applications on current and future high-end architectures. The applications targeted will be driven/prioritized based their usage on the HEC systems, the needs of the users, and their significance to NASA programs/missions. The area consists of the following major activities, which the contractor shall support:

- Evaluating user project productivity for a prioritized list of projects
 - Maintaining a prioritized list of projects
 - Conducting project evaluation in collaboration with project's technical leads
 - Documenting findings and recommendations so as to direct application optimization opportunities
- Enhancing the performance of applications on the NAS systems and the productivity of their users. This effort, to be performed in collaboration with code owners and domain experts, could include but is not limited to:
 - Modifying scripts and workflow to increase efficiency
 - Optimizing the serial and parallel performance of codes
 - Reducing the memory footprint
 - Reducing the I/O overhead
 - Parallelizing the code

Area 2: Advanced Technologies

This area focuses on advanced technologies in software tools, programming models, and benchmarking in support of efficient utilization and evaluation of HECC compute systems. It seeks to provide a set of tools to enable performance characterization and tuning of NASA applications so that hardware resources can be effectively utilized in the HECC compute environment. Furthermore, to remain a smart buyer and productive user of HPC, NAS needs to be able to assess the current (and predict future) performance of NASA applications on state-of-the-art (and emerging) HPC architectures to understand their suitability for meeting the current and future needs of NASA. This area consists of the following major activities, which the contractor shall support:

- Evaluate, utilize existing tools and support software for optimizing the performance and productivity of applications – including but not limited to tools for debugging, performance profiling and monitoring, and optimization. As appropriate, install and support the tools for the user community.
- Investigate suitable programming approaches for emerging architectures, such as accelerators or coprocessors.

- Determine the need for new classes of existing benchmarks along with new benchmarks; update existing benchmarks or develop prototypes where appropriate.
- Characterize the performance of current and future in-house and external architectures using software tools, benchmarks, and full NASA-relevant applications.
- Maintain a repository for benchmarks and benchmarking results, including the capability of extracting, analyzing, and internal submission of results. Investigate approaches for submitting external results.
- As required, participate with the government in defining requirements for procurements.
- Collaborate and participate with external communities for bi-directional technology transfer and also for driving the community research and development efforts based on NAS user experiences.

Area 3: Scientific Consulting

This area focuses on second-tier, application-based 8x5 problem resolution support for current HEC users. The area consists of the following major activities, which the contractor shall support:

- Support users in all aspects of code execution on the current parallel architectures, including:
 - Troubleshooting job failures
 - Porting codes
 - Advising on usage of compilers, libraries, and tools
 - Debugging/modifying scripts
 - Resolving I/O issues
- Provide support for application-based testing for new hardware and software systems prior to their being put into production. Use automated approaches if applicable.
- Develop and maintain user documentation that aids the users in porting and optimizing their codes for parallel systems including a set of best practices for the effective use of various aspects of the systems.
- Develop training material and provide user training on the efficient use of parallel systems as requested by the Government.
- Maintain a list of the top (by usage hours) applications currently being utilized on NAS system along with their characteristics, including but not limited to: code POC, mission directorate, domain, language used, parallelism approach, and performance characteristics where available.

Subtask C: HEC Visualization and Data Analysis Systems

Government Point of Contact: [REDACTED]

This subtask is concerned with the analysis and visualization of output data from key NASA codes and/or observational sources, and also with the analysis and visualization of the runtime dynamics of the codes themselves, the behavior of the systems on which the codes are run, and in particular the data movement within and between running processes, filesystems and storage devices, the interconnect fabric, and visualization hardware. The work will be driven by customer needs and prioritized based on impact to NASA mission objectives and applications.

The contractor shall provide support for visualization and data analysis services using traditional post-processing methods (i.e. operating on data previously written to persistent media), and shall also provide support for development of concurrent techniques, wherein

runtime data are streamed directly to visualization and analysis routines. Effective implementation of concurrent techniques may require the development of novel software architectures and also hardware configurations; the contractor shall support both sorts of efforts. Both post-processing and streaming methods may be required for analysis and visualization of synthetic data produced by modeling and simulation codes; of observational data by mission-specific processing pipelines; or of internal system performance data gathered by local system loggers and/or hardware/software counters.

Working with the government POC, the task will identify potential applications and work with the appropriate science or engineering teams to increase the utility, understanding, and accessibility of results derived from computational, observational, and system performance data.

Subtask D: High End Computing Networking

Government Point of Contact: [REDACTED]

This subtask shall perform network research, development, engineering, integration, testing, deployment, logistics, and performance studies.

This subtask shall provide sustained engineering and end-to-end network support for the HECC project and its user community. The goals of this subtask are to provide remote and local NASA high-performance HECC customers the most efficient and seamless means for accessing limited and major shared resources. In the event of service disruption, diagnosis is performed to pinpoint the cause as closely as possible. The actual problem resolution may be affected by another organization. The staff shall work closely with all necessary network or system administrators to troubleshoot, tune, and architect solutions for all HECC customers from their desktop to the HECC resources and back.

The production local area network and high-end specialized networks include 10 Gigabit Ethernet, Fibre channel, Gigabit and Fast Ethernet, and InfiniBand. Upgrades to 40 and/or 100 Gigabit Ethernet are planned. The network directly supports the HECC interconnect networks, the LAN core backbone and border routers.

The HECC network team shall work closely with HECC security to proactively identify and resolve any security problems associated within the HECC environment and to evaluate tools and hardware that assists in protecting HECC resources. The HECC LAN is compartmentalized, based on security and HEC user requirements. The compartmentalization is maintained to partition the network, from the perspective network data access utilizing VLANs. The HECC LAN is augmented with an additional border router that simplifies the implementation of building independence and network redundancy. Support of the NAS network border and DMZ require integration with the requirements of the Department of Homeland Security (DHS), NASA Agency security, the SOC, and HECC security.

This subtask shall help improve the network performance for the NAS user community. This is accomplished by one-on-one follow-up with users, documenting user environments, and by collaborating with the local area network staff at each site to identify and remove bottlenecks. An example might be sharing network expertise related to configuring, evaluating, and upgrading network and security infrastructure.

Real-time LAN and WAN network availability status shall be delivered to a network management systems and on-call network engineers. This information will include current state of the network, information on the network and event notifications. Furthermore, application level statistics will be recorded for analysis and troubleshooting. Basic network availability will be provided to the NAS Control Room for troubleshooting and customer interactions. These tools will be incorporated into an operations plan that will support the HECC LAN.

The networking group is heavily involved in at least one conference every year, the Supercomputing conference.

Networking support shall be provided to NASA participants in Supercomputing 2015. This work will include WAN and LAN network set-up, operations and monitoring of the network connections.

Subtask E: User Services

Government Point of Contact: [REDACTED]

The User Services subtask involves a number of ongoing activities: (1) Allocation and Management Process for HECC Resources, (2) Documentation and Training, (3) Control Room Operation (4) Problem/Incident Resolution, and (5) Service Management. These activities are described below.

Allocation and Management Process for HECC Resources: This activity provides end-to-end management and implementation of the process for accessing HECC resources. It involves managing and implementing the e-Books-based process for allocating the computing resources of each Mission Directorate. It includes keeping up with NASA policies and procedures for establishing NASA identities and granting access to information systems resources. It includes developing and implementing processes for granting, continuing, and terminating NAS user accounts (for all users including Foreign Nationals)--using NASA systems (such as IdMAX and NAMS) and tracking the completion IT Security Training. It involves developing and implementing processes that follow NASA policies and procedures (especially those related to IT Security) and are consistent (when appropriate) between HEC facilities at Ames and Goddard. This activity includes reporting on utilization of allocated resources and on the status of user accounts. It also includes maintaining web-based information and forms pertaining to access to HECC resources.

Documentation and Training: The goal of this activity is to increase the community of trained HECC users and to increase the knowledge of existing HECC users. It involves providing information (web-based documentation, web-based workshops or seminars, and on-site training classes, etc.) to users about gaining access to and using NASA HECC resources.

Control Room Operation: This activity provides 24 X 7 systems monitoring and basic user support. This includes constantly monitoring the supercomputers, the associated systems, and the physical facility and being available by phone and email to address user questions and problems. All problems, requests, and inquiries are logged in the ticketing system. Tickets are evaluated to determine the priority and the group to which the ticket should be assigned. Tickets are assigned appropriately and follow-up notifications are done if

warranted by the priority (e.g., power outage or other emergency). This activity includes maintaining the documentation (including call lists) for operational and disaster recovery procedures.

Problem/Incident Resolution: This activity provides end-to-end problem/incident resolution that begins with the first contact regarding a request for information or help in addressing an issue (incident). Basic incidents are immediately resolved by Control Room Analysts (CRAs). More complex issues are assigned to the appropriate group. Resolution of all incidents is tracked, and incidents may be related to underlying problems, which are also tracked. When necessary, this activity involves coordinating the resolution of incidents and problems that are complex and/or involve multiple groups. Basic incidents that CRAs are expected to resolve include bringing up, rebooting and shutting down systems; providing systems' status information; setting passwords; activating SecurID fobs; resolving file permission problems; increasing allocations and quotas; archiving and restoring user data; and answering basic questions on getting allocations and accounts, logging on, submitting jobs, and transferring data.

Service Management: This activity involves identifying issues/trends that affect services, measuring systems and services, and collecting feedback on services, systems' performance and user behavior. Ticket logs are reviewed to identify recurring issues or problems and to assure that tickets are addressed in a timely manner. Information is collected from surveys, user telecons, phone calls, and/or site visits. Based on ticket logs and other information that is collected, recommendations are made as to how to improve overall services. This activity involves supporting the integration of new technology through testing, evaluation, and development of new/modified documentation. It also involves tracking and evaluating developments in user services at peer HEC facilities as well as the general IT industry (e.g., IT Infrastructure Library).

In addition to the ongoing activities, there are several development efforts to support the ongoing activities. These are: (1) Streamlined Account Request Process that is consistent with Agency guidance, (2) Integration of e-Books process (collecting requests for computer time) into the NAS resource allocation and management process, (3) Implementation of additional Remedy capabilities/enhancements, and (4) User/PI/Admin "portal" to provide simplified access to computer usage information. These activities are described in the following paragraphs:

Streamlined Account Request Process: The basic on-line account request process was completed, including a way for PIs to validate users that should be linked to their projects. Integration with the Agency's IdMAX and NAMS needs to be investigated.

Integration of e-Books process: The e-Books system is used to collect requests for computer time for all Mission Directorates. However, the use of e-Books still needs to be made part of the on-going process of resource allocation. Before users are invited to submit requests for computer time, e-Books needs to be reviewed for updates and/or enhancements to the software itself. In addition, e-Books needs to be updated with current Mission Programs and Projects, lists of Points of Contact (and their contact information) for those organizations, new call letters, etc. After allocations have been made, data from e-Books needs to be updated with actual allocations (and any other changes), and the new data needs to be used to update NAS databases such as those used by LAMS.

Implementation of additional Remedy capabilities/enhancements: Remedy is the ticketing system. It contains additional features (such as problem management, configuration management, and change control) that still need to be implemented.

User/PI/Admin “portal”: Users, PIs that own computing projects (gids), their managers, and other administrators need easy access to computer usage information. Tools such as `acct_ytd` and `act_query` can provide basic information, and MicroStrategy is used for monthly reports. However, there needs to be an easy-to-use, web-based tool available to the general community to provide usage information, especially with usage by user, group, Mission, type of job, etc. Work on this is in progress.

Subtask F: HECC Project Office

Government Point of Contact: [REDACTED]

This task represents the integration of a number of activities that in total provide the integrated High End Computing Columbia environment to the division’s customers and funding sources. HECC has a Project Manager and Deputy to coordinate the disparate activities of other groups and present the total integrated HECC solution to our customers. This subtask is responsible for providing the contractor side of this process and to provide the necessary management and tracking to insure the successful provision and management of the high-end computing resources and services to the NAS customer base.

This subtask is described by the following three (3) functions:

1. **Contractor Coordination:** The contractor shall provide a single point of contact to the government to coordinate all contractor groups contributing to the HECC project, including systems, storage, security, networking, user support, applications support, system operations, facilities, and outreach (publications and media) support. As requested, the contractor shall provide budget estimates for labor and materials for each group that are required to accomplish tasks on the Columbia project.
2. **Configuration Management:** The contractor shall provide the tracking and maintenance of records in accordance with the HECC Configuration Control Plan.
3. **Reporting:** It is essential that an understanding of the overall health of the HECC environment is maintained. There are two reports that shall be delivered to the HECC Deputy Project Manager on a weekly basis:
The contractor shall develop a report that displays the number of jobs that successfully completed on the compute assets, the number of jobs that failed and the reason those jobs failed.
The contractor shall develop a report that displays the current status of the main HECC systems focusing on known issues and actions taken to resolve them.
The contractor shall provide and distribute records of HECC meetings, including biweekly update meetings, weekly management summary meeting, and other meetings as requested. This will include the compilation of statistical data on a biweekly basis and for special reports as requested. The contractor shall develop one-time and ongoing reports for NASA management (at NAS, Ames, and NASA HQ) as requested by the government. Rapid response may be required on certain one-time reports.

Subtask G: Closed

This subtask is closed.

Subtask H: HEC Program Support

Government Point of Contact: [REDACTED]

The HECC Project coordinates activities with NCCS at the Goddard Space Flight Center on a regular basis. The two projects, HECC and NCCS, fall under the oversight of the Science Mission Directorate and are treated jointly as the High End Computing (HEC) Program.

This subtask provides support for inter-center activities for the NASA HEC environment and support for HEC program activities. Work on these areas should be tracked in this subtask when performed.

The major emphasis of this subtask is to provide HEC Program Monthly status reports. The monthly status reports leverage the work done under the HECC Tool Development subtask to provide capacity, usage, and other data about the supercomputer systems at NAS and at NCCS. The monthly status reports also include financial and workforce information for NAS and NCCS.

Subtask I: Closed

This subtask is closed.

Subtask J: Closed

This subtask is closed.

Subtask K: HECC Tool Development

Government Point of Contact: [REDACTED]

The purpose of this subtask is to provide the engineering and on-going support for tools that enable key division processes (such as managing access to computer systems, supporting incident/problem/configuration management, and providing data on computer usage). This subtask includes analyzing processes to document workflows, identifying bottlenecks and problem areas, developing requirements, evaluating options, and recommending appropriate solutions and tools. It includes installation, operation, documentation, and ongoing maintenance of tools. User support and support for databases and data used by the tools are also required. Current tools include, but are not limited to: Remedy, MicroStrategy, acct++, and LAMS. In some cases, tools (e.g., e-Books), may be provided by external organizations, and so coordination and collaborations with those organizations is necessary.

This subtask provides monthly, weekly, and ad hoc supercomputer usage information. It supports the ticketing system and develops tools suggested by NAS managers and staff. It also supports the Code I use of Remedy for Code I ticketing.

Subtask L: Closed

This subtask is closed.

Subtask M: This subtask is closed.

II Deliverables/Milestones

No.	Milestone	Metrics	Deliverables	Date
SS1	Participate in the NTR selection process	Approved system configuration	Vendor is selected for the NTR-17	Ongoing
SS2	PBS bucketing scheduler	<60 second cycle with 'ANY' node type.	System in production	Nov 2016
SS3	Lustre SSD Integration for metadata	Metadata Cached on SSD with readcaching enabled on OSS.	System in production	Apr 2017
SS4	Lustre QOS	Enhance Lustre responsiveness during periods of high load	System in production	Feb 2017
SS5	PBS Release Unused Nodes/Reliable Startup	Free nodes integrated with kepler/tess pipeline.	System in production	Sep 2016
SS6	Operate Production Supercomputing Systems	Operate Production Supercomputing Systems	Systems Operating in Production	Ongoing

Table A: Milestones for Supercomputing Systems

No.	Milestone	Metrics	Deliverables	Date
AP1-01	Evaluate the workflow and applications of the top HECC projects to identify how productivity and utilization can be improved	Subject to cooperation from projects, evaluate 4 or more projects per year	Reports with findings including recommendations for workflow and application optimizations; list of high SBU usage projects and their applications	1st report due 1 November 2016, updated as required by changes in the selected projects; list of projects updated semi-annually
AP1-02	Enhance the parallel performance of applications in conjunction with users	Demonstrate substantial serial and parallel performance enhancement for selected codes on large processor counts	3 application codes with enhanced performance. Provide impact statement of optimization.	31 July 2017
AP2-01	Assess, install, and enhance tools, technologies and methodologies to increase the performance and productivity of user applications.	Evaluate/develop/enhance at least three tools/technologies that can assist the users in utilizing the machine or improve overall system utilization	Tools and technologies benefitting end-users	Continuous effort

No.	Milestone	Metrics	Deliverables	Date
AP2-02	If suitable machines become available, evaluate the performance of new architectures using benchmarks and applications.	Subject to availability of test platforms, evaluate at least two new architectures in light of NAS's workload	Architecture evaluation report	Continuous effort
AP2-03	Benchmarks & Results Repository	Accuracy, completeness, timeliness with updates; capability of extracting and analyzing results; capability of submitting internal results	Benchmark repository	Continuous effort
AP2-04	Updated SBU Benchmarks	Update existing SBU benchmarks with up-to-date versions of code and new test cases that scale to larger numbers of ranks than the existing test cases	Updated SBU suite	Continuous effort throughout this performance period.
AP3-01	Provide second-tier application-based 8x5 problem resolution support for current HEC users	100% staffed; ability to provide timely responses to user problems, bring additional resources to bear and escalate issues as necessary	Consulting services for assisting users with application issues	Continuous effort
AP3-02	Assist users in porting and scaling the applications codes on current high-end computing architecture	Performance and productivity enhancements to at least 30 codes relevant to NASA spread across the mission directorates.	Consulting services for porting and scaling	Continuous effort
AP3-03	Provide support for application-based testing of new hardware and software systems prior to them being used in production	Provide 1 business day response for interpretation of automated testing requests performed by other groups	Application-based testing	Continuous effort
AP3-04	Coordinate a training program involving both APP staff and staff from other groups to provide user training webinars on a roughly quarterly basis	Size and feedback from attendees of webinars and other training sessions on topic relevance and quality of presentation, feedback on training materials distributed	Webinars and other training sessions, training materials	Continuous effort
AP3-05	Maintain/enhance the application-based pages in the HECC Knowledge Base	Timeliness and accuracy of user guides and other documentation for HEC users	User documentation	Continuous effort

Table B: Milestones for Application Performance and Productivity

No.	Milestone	Metrics	Deliverables	Date
VZ1	Deploy visualization environment on Hyperwall GPU augmentation	Number of products produced in new environment	Application specific visualizations such as images and animations	Continuous effort throughout this performance period.
VZ2	Enhance applications by incorporating concurrent visualization capabilities.	Increased temporal resolution of visualization and analyses compared to post-processing approach. Decreased time for production of visualizations, compared to post-processing approach	1) Instrumented code, for each concurrent visualization-enabled HEC application. 2) Supporting code for the rest of the visualization pipeline. 3) Concurrent visualization products	Continuous effort throughout this performance period.
VZ3	Provide traditional post-processing visualizations on demand	Customer demand for visualizations; iterative development with customers; customer use of visualizations and testimonials	1) Application-specific visualizations, such as images and animations. 2) Consulting services as appropriate	Continuous effort throughout this performance period

Table C: Milestones for HEC Visualization and Data Analysis

No.	Milestone	Metrics	Deliverables	Date
NT 1	Identify poor user network performance and remedy.	Monthly report detailing metrics of changes	<ul style="list-style-type: none"> • % Improvement • No. of Users • Estimate of time saved 	5th working day of following month
NT 2	Monitor network performance on HECC LAN	Monthly report detailing anomalies	Performance rates	5th working day of following month
NT 3	Support system upgrades and procurements.	Monthly report detailing metrics of changes	Number of cables run and switches added	5th working day of following month
NT 4	Complete NASLAN architectural modifications required to integrate with DHS TIC and NASA EBPro project	Modified NAS border that integrates with NASA EBPro network security project and also continues to provide high-performance access to external customers and all required services to NASA internal customers.	Project completed on schedule and within budget	Oct 2016
NT 5	Design NAS border/DMZ/core upgrades to accommodate 40/100 GbE as required (dependency on SOC/taps).	Requirements review, design, procurement, and implementation of phase 1 of the NASLAN upgrade.	Project completed on schedule and within budget	Dec 2016
NT 6	Complete an update of the NASLAN technology roadmap	Roadmap describing technology advancements and enhancements over the next 3-5 years that relate to HECC	Project completed on schedule and within budget	April 2017
NT 7	Support NASA booth network at SC16	Network design, booth network, final report	Project completed on time and within budget	November 2016

Table D: High End Computing Networking Milestone

No.	Milestone	Metrics	Deliverables	Date
US1	New Allocation Period	Timeliness and smoothness of implementation	New allocations for users Updated PI and project information in LAMS and Updated Mission Directorate POC list	11/2016
US2	User Training Classes	# of training classes User participation	User Training Classes on resource allocation and user account processes	11/2016
US3	Control Room Documentation	Timeliness, ease of use, correctness	Procedure documents reviewed, updated, and tested	4/2017
US4	Problem/Incident Management	Timeliness of ticket reports Reports include information on hardware and software issues	Ticket reports Analysis of problems Problem management in Remedy	Weekly Monthly TBD
US5	Conduct user survey	Timeliness and completeness of report	Analysis of user survey results Recommended actions as a result of user survey	12/2016
US6	Integrated Account Request Process	Functionality Ease of use	Evaluate integration with IdMAX, NAMS, etc.	10/2016
US7	User/PI/Admin Portal	Functionality Ease of use	Web-based computer usage information	10/2016
US8	Identity Management Report	Timeliness and accuracy of report	Report on status of identity requests	As needed

Table E: User Services Milestones

No.	Milestone	Metrics	Deliverables	Date
P01	Produce HECC Monthly Report	Report delivered on time 100% of the time	Report delivered by the 10 th of the following month or by the first working day if the 10 th falls on a weekend or holiday.	Ongoing
P02	Conduct Annual review if desired	Review conducted on time with agreed upon content	Conduct review and provide electronic copy	Annually
P03	Deliver Job Failure Report	Report Delivered weekly, accuracy improved throughout the year	Written Report	Weekly
P04	Deliver Major System Status Report	Report Delivered Weekly	Written Report	Weekly

Table F: HECC Project Office Milestones

No.	Milestone	Metrics	Deliverables	Date
HP1	HEC Monthly Report	Timeliness and accuracy of reports	HEC Monthly Report containing supercomputer capacity, supercomputer usage, workforce, and financial data for HECC and NCCS	Monthly by the 8 th of the month

Table H: HEC Program Support Milestones

No.	Milestone	Metrics	Deliverables	Date
TD1	HECC Usage Reports	Timeliness and accuracy of reports	Automated processes and scripts for generating computer usage reports Updated system capacity, usage, financial, and workforce data along with associated spreadsheets and charts	Monthly, by the 5 th of each month
TD2	Weekly Standup Reports	Timeliness and accuracy of reports	Automated processes and scripts for generating computer usage reports Updated system capacity and usage data	Every Mon. and Thurs.
TD3	Code 1 Use of Remedy	Timeliness and smoothness of implementation	TBD	TBD
TD4	Tools Requested by NAS Managers and Staff	Functionality Ease of use Availability of new tools	TBD	TBD

Table K: HECC Tool Development Milestones

III Documentation and Reporting Requirements

The contractor shall:

- Discuss the monthly progress with the Task Requester.
- Schedule and conduct periodic task reviews after coordinating with the Task Requester, COTR and CO.
- Support in-depth presentations as scheduled by the Task Requester.
- Provide an electronic copy of the NF 533 for this task.
- Provide an electronic copy of the Monthly Technical Progress Report detailing the activity associated with this task, a summary of accomplishments, any problem areas and proposed action plans, and any issues by the 5th working day of the month.

IV Travel Requirements

The contractor is expected to travel as required as necessary to perform this task. Travel will include:

- Attend training and conferences as needed to support this task.
- Travel to other centers as required.
- Attend technical meetings as required.

The Contractor shall provide to the Task Requester and Contract Management a Trip Report for both domestic and foreign travel that includes:

- Name of Traveler
- Trip Itinerary
- Task Name and Number
- Purpose of Trip
- Contact(s) and Summary of Discussion(s)
- Summary of Presentation(s) / Talk(s)

The following information shall be included in all Trip Reports for foreign travel:

- Statement of and Date of Threat Vulnerability Briefing
- Statement of and Date of Threat Vulnerability Debriefing (including the date the debriefing questionnaire was mailed to the Threat Vulnerability office. If no formal debriefing was required, so state)
- Statement of and Date of Export Compliance Briefing (if not applicable, so state and provide date of approval for 1676 package)

V Government Property

The Government will furnish equipment (workstations, offices) as required for the successful completion of the task's requirements. All requests for new equipment will go through the appropriate POC.

VI Ames Management System Requirements

Work on this task shall comply with NASA Management System Policy - NPD1280.1,

NASA Policies & Procedures - NODIS, Ames Management System Directives (APR1280.1), AMS Core Processes: APR7100.1, APR8060.1, APR8800.7; AMS Elements APR1220.1, APR1410.1, APR1440.1, APR8700.3, APR8700.2, and CDMS (see <http://ams.arc.nasa.gov>).

In addition, this work should comply with Ames Management Objectives (MO), for Code TN, specifically:

a. Center Level MO 1

Promote and maintain an organizational culture in which safety is paramount.

b. Center Level MO 2

Deliver key technical contributions to Agency-critical programs and projects, meeting all cost and schedule commitments.

c. Center Level MO 3

Produce outstanding research.

d. Center Level MO 4

Continually improve Ames Research Center processes.

e. Center Level MO 5

Develop and maintain a highly skilled workforce.

f. Continuous Improvement

Use the Center's Continuous Improvement Actions system.

VII Security Requirements

Work on this task shall comply with the NAS Security Model and applicable U.S. Federal Government and NASA Policies and Regulations. In particular, work on this task shall comply with NPG 2810.1A and OMB Circular A-130.

VIII IT Purchasing Requirements

Acquisition of IT products and services required for this task shall comply with applicable NASA IT procurement policies including the ARC CIO's IT purchase approval process (when required), Internet Protocol version 6 (IPv6) compliance policy and other requirements stipulated in NASA Form NF 1707.

IX Other Requirements

Evaluation of Contractor's Response to SOR - Evaluation criteria of task proposal will be based on sound innovative technical approach, completeness of analysis, review and designs, proposed expertise and skill mix, and cost/price.

Award Fee Evaluation - Performance evaluation will be measured based on cost containment, quality of technical and status reports, adherence to metrics, and accomplishment of milestones/deliverables.

Task requires contractor access to Government database(s)? YES

NEMS—Asset Management System

X Section 508 Requirements

Certain subsystem elements are expected to result in spreadsheets or databases that contain a substantial amount of information. This information and its presentation mechanism are subject to Section 508 of the Rehabilitation Act, Electronic and Information Technology (EIT) Accessibility. Complete information on EIT accessibility and Section 508, is available via Internet at <http://www.section508.gov>.

Specifically, the Contractor must propose EIT products and/or services that meet the applicable accessibility standards identified below:

- 36 CFR 1194.41 - Information, documentation and support

XI Quality Assurance Standards

The contractor shall be in compliance with all applicable NASA and Center-level Quality Assurance Standards and safety practices and guidelines.