

Statement of Work for

NASA Advanced Computing Services
(NACS)

National Aeronautics and Space Administration (NASA)
NASA Ames Research Center
Moffett Field, California

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1. Introduction

This NASA Advanced Computing Services (NACS) Statement of Work (SOW) defines the scope of activities required to support the advanced computing services provided by NASA Advanced Supercomputing (NAS) Division, Ames Research Center (ARC), located in Moffett Field, California. Currently, the primary advanced computing service provided by NAS is high performance computing (HPC, also known as supercomputing, high end computing, or HEC). Other areas of advanced computing (including data-intensive, collaborative, and quantum computing) are increasingly important NAS services. NAS also conducts NASA mission-driven science and engineering using these advanced computing services. All of these are within the scope of NACS.

2. Background

NASA's challenging mission to explore space and understand the universe and the Earth within it requires the Agency to innovatively apply and extend humankind's most advanced capabilities, technologies, and knowledge. Advanced computing, including high-end, data-intensive, collaborative, and quantum computing, as well as scientific and engineering applications utilizing these, may be unrivaled in its breadth of applicability and impact across NASA's mission. As the primary provider of these advanced computing services, NAS plays a critical role in enabling NASA mission success across every mission area—Earth and space science, aeronautics research, space exploration, and supporting technology development.

NAS' mission is "To support NASA's Mission to advance science, technology, aeronautics, and space exploration through the power of advanced computing and high fidelity modeling and simulation." In support of this mission, NAS

- Maintains and operates the NAS facility, including world-class production supercomputing systems, data storage, local and wide area networking, and 24x7 user services;
- Develops and applies advanced computational technologies and services, such as application performance optimization, system and user productivity tools, and data analysis and visualization;
- Serves as the Agency pathfinder by evaluating and implementing advanced computing technologies; and
- Develops mission-driven engineering and scientific models, numerical methods and algorithms, and simulation tools, and applies them in high-fidelity simulations in support of NASA's mission.

Advanced computing is the assimilation of the most advanced computing systems, large-scale data storage, and high-speed networking technologies, the capabilities of which have increased exponentially for decades, into a leading-edge integrated tool set for NASA science and engineering. When combined with sophisticated systems software and state of the art specialized applications, advanced computing provides the premier environment for enabling advances in NASA's challenging missions and solving NASA's complex problems in various science and engineering domains. As a result, advanced computing provides broad support for NASA's greatest achievements, including high-fidelity modeling to design and improve aerospace vehicles, analysis of massive Earth

observation data to predict potential near-term and long-term futures of our planet, and detailed astrophysical simulations and data analysis to understand the history and future of our universe, and our place within it.

In addition to managing the lifecycle of advanced computing systems, NAS provides a comprehensive and integrated set of services designed to solve any user challenges and to help users be maximally productive with these systems. These services include 24x7 user support and helpdesk, application and workflow debugging and enhancement, data storage and management, data analysis and visualization, end-to-end network optimization, and system environment customization. Additional essential services in support of NAS operations include facility operations, IT security, and publications and media services. With these services, it is NAS' goal to enable NASA's advanced computing enabled projects to achieve dramatic and rapid advances in scientific and engineering insight.

NASA currently operates two major HPC facilities. The NAS Division at Ames Research Center, Moffett Field, California, operates NASA's primary HPC facility, with users broadly distributed across all NASA mission areas, most NASA Centers, and numerous partner organizations (universities, corporations and other organizations performing work for or with NASA). NASA's second major HPC facility is the NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center in Greenbelt, Maryland, with users primarily supporting NASA Earth science.

3. Scope

The technical areas and performance requirements for this SOW are to support advanced computing services provided by the NAS Division, as outlined above. In addition, NASA may decide to utilize NACS to support other HPC facilities at Ames and/or other NASA Centers, during some part of the contract. The NACS technical areas and contract management requirements are detailed in Section 6.

4. Definitions

- AMS: Applied Modeling & Simulation
- ARC: NASA's Ames Research Center, Moffett Field, California.
- Best Practice: The best way to perform a function or process.
- CO: Contracting Officer, the primary point of contact between the contractor and the Government.
- COR: The Contracting Officer's Representative, charged with providing the CO with technical information and assessments about the contract.
- CSO: Computer Security Official.
- Cyberinfrastructure: Infrastructure (enabling hardware, algorithms, software, communications, institutions, and personnel) for distributed computing, information and communication technology.
- EA: Enterprise Architecture.
- FIPS: Federal Information Processing Standards, see <http://www.itl.nist.gov/fipspubs/>.

- FISMA: Federal Information Security Management Act of 2002; see <http://csrc.nist.gov/sec-cert/>.
- GSFC: NASA's Goddard Space Flight Center, Greenbelt, Maryland.
- HEC: High end computing, another name for supercomputing.
- HPC: High performance computing, another name for supercomputing.
- HPC application: A computer program that performs a large-scale modeling, simulation, or data analysis computation on an HPC system.
- HSPD: Homeland Security Presidential Directive.
- Hyperwall: A data visualization system consisting of a Linux graphics cluster driving a high-resolution, wall-sized array of flat panel LCD screens, controlled by a master control computer, which allows the user to explore single large images, sets of related images or animations, or composites of various types of visual information.
- IPT: Integrated product team, an interdisciplinary team including the advanced computing staff and (often) users from one or more technical areas, formed to resolve challenging and potentially interrelated bottlenecks in facility operations or application workflows.
- IT: Information technology.
- LAN: Local area network.
- NACS: NASA Advanced Computing Services.
- NAS: NASA Advanced Supercomputing Division and facility at ARC.
- NASA: National Aeronautics and Space Administration.
- NASA Missions: The four NASA Mission Directorates: Aeronautics Research, Human Exploration and Operations, Science, and Space Technology.
- NCCS: NASA Center for Computational Sciences, at GSFC.
- NESCC: NASA Engineering and Safety Center.
- PAO: Ames Public Affairs Office
- POC: Point of contact – the designated contact person.
- SOC: NASA Security Operations Center
- SOW: Statement of Work.
- Supercomputing: Also known as high performance computing (HPC) or high-end computing (HEC), is the highest class of computing capability, as determined by the size and quantity of computations that can be completed by the computing system in a given time.
- WAN: Wide area network.

5. Government Furnished Property and Services

The Government will provide the Contractor the use of all office space, laboratory space,

facilities, and computer hardware and software access, required to support the requirements of this SOW, except as otherwise noted.

6. Advanced Computing Services Requirements

This section describes the advanced computing services requirements.

6.1 Program Management

The Program Management technical area includes managing the contractor's support for all administrative and technical activities, providing an interface between contractor management and the Government, and drawing on corporate knowledge and capabilities to support development of innovative solutions for the Government. The goals of this area are to foster an environment for highly collaborative interaction within NAS, to help NAS implement innovative approaches designed to increase NAS' mission impact, to make day-to-day operations as efficient as possible, to create a working environment that attracts and retains highly qualified contractor staff, and to optimize cost. The outcomes will be NAS' increased capability, flexibility, and efficiency in delivering both routine and novel advanced computing-enabled solutions to the Agency, increased breadth and depth of NAS' mission impact within budget, and increased stakeholder support.

Requirements: The contractor shall:

- Provide a Program Manager as both the primary point of contact between the Contractor and the Government (CO, COR, and NAS management) and the person responsible for performance under the contract and authorized to make binding decisions about the contract.
- Provide a primary technical interface between contractor's staff on each task and the associated Government Task Requestor and Task (or technical area) Lead.
- Seek and retain highly qualified staff who can substantially enhance the impact of NAS activities on NASA missions.
- Determine the types and levels of expertise needed to effectively and cost-efficiently meet the requirements of each task, and implement this staffing plan as approved by the Government.
- Ensure that contractor staff receive necessary technical certifications for performance of work, where required by Government regulations and policies or task requirements.
- Respond quickly, effectively, innovatively, and within budget limitations to changing requirements within the scope of the contract.
- Ensure that contractor personnel employ state-of-the-art approaches (e.g., modern software and system engineering practices) and tools in the conduct of work under this contract.
- Ensure that contract work products are meeting customers' performance, schedule, cost, and documentation requirements.
- Perform all tasks effectively and efficiently within approved budgets.
- Where technical progress is adversely impacted by external factors, develop and recommend alternative work plans to maintain schedule, cost, and performance

commitments.

- Ensure that contractor personnel fully collaborate and exchange technical information with Government and other contractor staff in support of programmatic requirements.
- Provide at phase-in and utilize throughout the contract automated, electronic management tools, including Government access, to support processing task orders, tracking task performance, and documenting work products.
- Incur, in a timely and cost-effective manner, Other Direct Costs (ODCs) under each task, when approved in advance and in writing by the CO and COR.
- Support major advanced computing-related acquisitions, whether NASA- or contractor-owned.
- Comply with all Government policies, regulations and the terms and conditions of the contract.
- Maintain a safe and healthy work environment.
- Facilitate contractor staff travel for short periods of time to attend planning meetings, participate in industry site visits, attend technical conferences, or assist NASA customers.
- Provide a trip/training report for all NASA-funded travel and training, summarizing the value to NAS.
- Provide the Government with all data, databases, software, and documentation created or provided for the functioning of NAS' advanced computing capabilities.
- Provide the seamless management and technical control of subcontractor and vendor activities required to fulfill the requirements of the contract.
- Include appropriate management visibility into all aspects of subcontractor and vendor performance, and integrate with other required management systems and reporting requirements of the prime contractor.
- Provide management reviews and required reports that provide accurate status of progress and performance.
- Identify major risks of not meeting task requirements in each task plan, and provide the risk mitigation strategy.
- Support any secure processing requirements, which could include hiring and employing personnel with required secret or top secret clearances and expertise in any of the NACS technical areas.

6.2 Technical Integration

The Technical Integration technical area conducts or manages any high-level and cross-cutting technical activities such as the development and implementation of advanced computing best practices that are designed and optimized for NASA and the NAS environment. This technical area seeks to create and enhance a NASA-wide advanced computing and data environment, especially including NAS and NCCS, in order to reduce unnecessary duplication and disparity, to efficiently share processes, workload, data, expertise, best practices, and information, and to provide backup for critical data and

functions at each site. The goal of this area is to provide expertise and focus to technical integration such that best practices will be developed and implemented in a useful timeframe. The desired outcomes are to maintain and enhance NAS' performance and reputation as a world-class advanced computing facility; improve responsiveness, reliability, and quality of service for all of NASA's advanced computing users; and increase effectiveness of NASA's advanced computing investments.

Activities in support of Technical Integration:

- Plan, conduct, and document market surveys to assess the state of the art in relevant distributed information system technologies and solutions.
- Maintain and improve facility data backup and recovery.
- Maintain and improve an effective incident response and disaster recovery plan that minimizes the impact of advanced computing system or facility down-time.
- Maintain and improve an accessibility improvement plan for all NASA Centers.
- Enhance Agency-wide approaches to improve the efficiency, effectiveness, and ease-of-use of NASA's advanced computing resources, involving sharing of knowledge, websites and information access, facility operations databases and processes, help desk functions, user accounts and single sign-on, job submission, and remote file access.

Requirements: The contractor shall:

- Coordinate dissemination of technical information among various contract activities, and maximize synergies among various technical areas.
- Support the management of NAS integrated product teams (IPTs), including (as necessary) the advanced computing user and Government and contractor staff from one or more technical areas, formed to resolve challenging and potentially interrelated bottlenecks in facility operations or application workflows.
- Support the development of innovative advanced computing best practice concepts and implementation plans designed and optimized for NASA and the NAS environment that can substantially increase NAS' capability, flexibility, and efficiency in delivering both routine and novel advanced computing enabled solutions to the Agency.
- Support NAS in the implementation process for advanced computing best practices, and in disseminating these practices to the broader community.
- Develop tools for systems analysis of the NASA advanced computing environment, and apply those tools to identify and prioritize advanced computing environment improvement opportunities.
- Support the development of a long-term vision and action plans for NAS to optimize costs, develop innovative best practices, enhance the contractor-Government team, and increase NASA's ability to leverage advanced computing for greater mission success.
- Support requirements gathering for use of NASA advanced computing and related capabilities and services.
- Conduct market surveys and research studies as requested, to assess the state of

the art and NASA requirements in current relevant technologies.

- Conduct trade-off studies to provide a factual basis for cost-performance assessments.
- Adhere to and support NAS in complying with and implementing relevant Government policies, regulations, and initiatives that require technical implementation approaches, including IT security, IT procurement, project management, and NASA Enterprise Architecture, including NASA Enterprise Architecture Procedures (NPR 2830.1A), Security of Information Technology (NPR 2810A), applicable FIPS, HSPD and FISMA documents, NASA program/project formulation and management (NPR 7120 publication series), Section 508 accessibility, and compliance with Section 516 of Public Law 113-6 that requires NASA to conduct an assessment of the vulnerability of IT systems to cyber-espionage and sabotage before acquiring any IT systems.
- Support a coordinated and constructive dialog between NASA's advanced computing facilities, stakeholders, and user community
- Support high-level technical interactions with external organizations when required.

6.3 High Performance Computing Environment

The High Performance Computing (HPC) Environment technical area provides state-of-the-art, robust HPC and data environments to support NASA mission requirements for high-fidelity computational modeling, simulation, and data analysis. The goal is to provide integrated, balanced, leading edge, and yet highly reliable HPC and storage systems that optimally meet NASA's needs. The desired outcome is to maximize the productivity and achievements of facility users. NAS' approach is to maintain extensive knowledge of current and future HPC and storage technology, influence the development of large-scale systems, acquire and install high-productivity and cost-effective systems, improve operational characteristics to match the specific needs of the NASA user community, and operate and support the systems to help users be highly productive and achieve maximum mission impact. NAS simultaneously operates multiple HPC systems of differing sizes, architectures, user bases, and types, including research, development, and production systems. To effectively operate and improve these systems, NAS also acquires or develops software for job scheduling, system health monitoring, and usage reporting.

This technical area supports the entire lifecycle of NAS' HPC and storage systems. This includes the following 4 phases over a period of 6 or more years:

1. Procurement. Within this 12- to 18-month phase, there are four steps:
 - Market Research: Market-wide research and briefings from interested HPC system vendors on their technology roadmaps.
 - Assessment: Broad assessment of the performance, usability, reliability, and other characteristics of the most promising HPC system architectures.
 - Testbeds: Procurement and comprehensive testing of one or more large testbed HPC systems representing the most promising HPC system architectures.
 - Partnership: Support design development, in partnership with one or more selected HPC system vendors, of the next-generation HPC system(s) to be

acquired. These systems will be selected considering the full cost of implementation and delivered performance for large-scale NASA applications, with a goal of tracking commodity price-performance improvements.

2. Build and Test. Once a system is purchased, it must enter production as soon as possible. Thus, the build and test phase requires an extremely disciplined and dedicated approach to quickly overcome the inevitable challenges of building a leading-edge HPC and storage system. NAS intends to improve on its history of excellence in future system installs.
3. Production. During the production phase, which typically covers 3 or more years, NAS pursues continuous improvement of its HPC and storage systems, to extract maximum benefit from these systems for NASA's constantly changing computational workload. For systems that push the state-of-the-art, many aspects of the HPC hardware, software stack, supporting storage systems, and user environment can be improved to better match user needs and improve utility and reliability. NAS aggressively pursues this through the entire production phase.
4. Transition. During the production phase, NAS conducts one or more new HPC system procurements. When new systems are brought into production, NAS transitions users onto these more capable and cost-effective systems, and phases out the old systems. Due to the large number and variety of NAS users, this transition may take 2 years or more, since there are typically a few users whose applications are difficult to port from, or are well matched to, the previous system.

See <http://www.nas.nasa.gov/hecc/resources/environment.html> for current information about the NAS computing environment. As of April 2015, the primary HPC systems at NAS are:

- Pleiades, an InfiniBand-connected distributed memory supercomputer manufactured by SGI, the 11th fastest in the world on the Nov. 2014 TOP500 list
- Endeavor, a shared-memory supercomputer designed for tightly-coupled Big Data computations
- Merope, composed of repurposed Pleiades hardware, and used to augment computational capacity and for system testing.

The activities associated with Supercomputing and Storage Systems technical area can also be partitioned into the following categories:

- Systems Engineering and Development: Determining on-going system requirements and system architecture configurations for balanced capabilities including technology upgrades, identifying system deficiencies, and development and testing of proposed solutions. This also includes evaluation of current and future technology options, regression analysis after configuration changes, and configuration management.
- System Management: Day-to-day operational responsibilities, including activities such as on-going operating system kernel upgrades, system maintenance, patch management, configuration control, and system monitoring.
- Security: Ensure that systems are updated and validated per NASA specification, and enhance data and system usability where specifically impacted by NASA security guidance.

- Tools: Software development and management in support of system operation, including the development of a batch scheduling system to distribute work over the various computational systems, development of a monitoring and reporting infrastructure to assess and report on system health and usage, and installation of tools and third party packages to enhance user productivity.

Requirements: The contractor shall:

- Maintain market-wide expertise in HPC and storage systems to support mission requirements.
- Support the evaluation and engineering of computing and storage systems and environments that will be used to solve large-scale computational modeling problems of interest to NASA.
- Install, test, secure, and stabilize computing and storage systems by improving reliability, feature set, scheduling, performance, and/or other appropriate capabilities as required to achieve significant improvements in computational modeling capabilities within NASA.
- Maintain and manage NAS computing and storage systems, including configuration control and system administration, to support time-critical (and non-time-critical) applications that have high reliability requirements in support of NASA missions, and to support a robust application development environment.
- Support system development to support NASA's largest computations.
- Provide systems engineering and development to maintain and improve the shared file system, and to support development of the HPC operating system, developer and user tools, and run-time systems.
- Perform HPC tools development for job scheduling, system monitoring, and system accounting.
- Support the IT Security technical area (Section 6.7) in implementing and maintaining a secure and usable HPC environment.

6.4 Networking and Communications

The Networking and Communications technical area involves network development, engineering, integration, testing, deployment, operations, and performance studies in support of high-bandwidth and specialized HPC and other advanced computing requirements for the NAS facility LAN (NASLAN) core, border, and access, and the HEC enclave LAN, including existing 1 and 10 Gigabit Ethernet, InfiniBand, future higher-speed technologies such as 40 and 100 Gigabit Ethernet, and other high-speed interconnects. The goals of this area are to provide advanced networking solutions for NASA's advanced computing systems and applications, and to provide remote and local NASA HPC customers with the most efficient and seamless means for accessing shared advanced computing and data resources. Outcomes are to enhance:

- Customer Impact: Utilize emerging networking technologies in order to enable new science discoveries and engineering solutions.
- Network Performance: Dramatically increase network performance available for use in meeting NASA mission requirements.

- Reliability: Improve the reliability of user-requested events executing on high-performance communications systems available for use in meeting NASA mission requirements.
- Customer Usability: Improve the usability of high-performance computing and communications tools and techniques available for use in meeting NASA mission requirements.
- Security: Ensure that network hardware is updated and validated per NASA specification, and enhance network usability where specifically impacted by NASA security guidance.

Specific activities include:

- Network management, including on-call services, troubleshooting, network and port reconfiguration, monitoring and analysis, system administration, metrics capture and reporting, and producing network diagrams.
- Engineering design related to the LAN core, LAN interconnects, building access switches, HEC enclave LAN, routing, switching, and external peering. This includes determining network requirements and solutions that result in end-to-end solutions (from system to user), cost planning, development and testing of proposed solutions, and integration. This also includes evaluation of current and future technology, regression analysis after configuration changes, and configuration management.
- Tool development, including network monitoring and reporting, troubleshooting, assessing network health and usage, as well as efficient data transfer software and protocols for users and operations.

The NAS LAN (NASLAN) border peers with the NASA enterprise network known as the NASA Integrated Services Network (NISN), the ARC LAN (ARCLAN), the Ames Mission Network (AMN), and the ARC Code I metropolitan-area network known as "NREN" that provides peering to other high-speed Federal and research networks, including the regional research network known as "CENIC", Department of Energy's Energy Sciences Network (ESnet), the Department of Defense's Defense Research and Engineering Network (DREN), and Internet2.

The HPC LAN provides networking support for the HPC systems at NASA Ames, listed in Section 6.3. The HPC LAN interconnects the supercomputer front-ends and storage front-ends. Pleiades is connected with a combination of 1 and 10 Gigabit Ethernet. Other NAS systems with high-speed networking requirements include Lou (storage) and the "hyperwall" visualization subsystem. Fiber and copper cable plants are maintained for the HPC data, storage and InfiniBand connections. The storage facilities utilize InfiniBand and Ethernet primarily, with some legacy FibreChannel and other storage area network (SAN) technologies.

The NAS facility LANs support an office network and IT services for about 300 users. These LANs interconnect with outside WANs and LANs via BGP (Border Gateway Protocol) peering.

For both LAN and LAN/WAN border, the concept of "Defense in Depth" is utilized to ensure integrity of the network devices. Access control lists (ACLs) are applied to access interfaces to control the types of traffic allowed. The security perimeter is being integrated

with the DHS "TIC" (trusted Internet Connection) located at ARC, and will provide all required DHS TIC security controls. In addition, the security perimeter also implements all functionality as required by the NAS Security Operations Center (SOC). The "AAA" methodology – authentication, authorization control, and accounting (logging) – is employed. Thus, authentication will be used to control user access, where only authorized users are granted access at the authorized privilege level. Moreover, remote device system logs will provide audit capability to monitor device access. Logs are stored locally on the remote device and also saved to a remote system log server.

Requirements: The contractor shall:

- Support enhancements to network performance, reliability, and customer usability.
- Ensure high-speed external network connectivity for large data distribution and real-time interactive use.
- Facilitate performance upgrades to 40 Gigabits/sec, 100 Gigabits/sec, and beyond, as needed to meet advanced computing networking requirements.
- Support advanced computing access by the NASA research and engineering communities, based on user requirements.
- Support advanced computing access to federal and academic entities via peering with the NASA Integrated Services Network (NISN), and the NREN Metropolitan-Area Network (MAN), for connectivity to CENIC, Internet2, and other high performance research and engineering networks.
- Provide networking support for the advanced computing systems at NASA Ames.
- Support various entities, including NASA LAN managers, advanced computing users, and NAS personnel, to develop end-to-end communication solutions that enable science and engineering advances.
- Support outreach to other NASA networking and network security projects to promote technology infusion and coordinate technology integration.
- Support network monitoring using network flow tools, SNMP, and other technologies.
- Support the development and implementation of the NAS LAN and advanced computing WAN border.
- Provide an integrated, secure network border that, in conjunction with NASA, SOC, and local ARC network security resources, meets all NASA, SOC, and DHS TIC network security requirements, and also meets advanced computing performance and external connectivity requirements.

6.5 User Services

The User Services activity has two primary functions that are required 24x7 (24 hours per day, 7 days per week). The first, control room operation, is to provide operations and monitoring of the NAS supercomputers, their support systems, and the facility. The second is to provide the initial and primary contact with users of the NAS facility in order to provide user access to the computer systems, answer user questions, and resolve user problems.

The User Services activity facilitates information exchange between users, the NAS

facility, and its sponsors. The User Services activity combines data gathered from users and other technical areas to provide information regarding user needs, real and potential accomplishments, usage reports, and suggestions for optimizing the performance and mix of resources and services. The desired outcome is a productive user experience and a demonstration of the mission impact achieved by NAS and its users.

As of April 2015, the primary NAS HPC systems contain over 200,000 combined cores that deliver approximately 150 million standard billing units per year [One standard billing unit is one wall-clock hour of a 12-core Westmere node of NAS's Pleiades supercomputer.] Support systems include but are not limited to: front end systems for pre- and post-processing, disks, archive storage, network equipment, high-end visualization systems, power distribution units, and chillers. Equipment is distributed in four locations in two buildings. In addition to production systems, there may be testbed and/or experimental systems that must be supported. Small remote systems (such as servers) belonging to other organizations are also supported.

The NAS user community consists of approximately 1,400 scientists and engineers from all NASA Mission Directorates, the NASA Engineering and Safety Center (NESC), and university and industry partner organizations. These scientists and engineers are located across the United States and in other countries. Many are foreign nationals.

The systems and users generate approximately 2,000 support tickets per month. The tickets range from automated notifications about undeliverable email or down computer nodes to users requesting assistance with improving code performance, information about compiler flags, or special processing priority.

The User Services activity has a number of ongoing activities as well as special projects that arise in response to specific requirements. The ongoing activities are in the following areas: (1) Control Room Operation, (2) Allocation and Management Process for NAS Resources, (3) Problem/Incident Resolution, (4) Documentation and Training, and (5) Service Management. Requirements in these areas are listed below.

Control Room Operation

The contractor shall:

- Provide 24x7 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.
- Log all problems, requests, and inquiries in the ticketing system.
- Evaluate tickets to determine the priority and the group to which the ticket should be assigned.
- Assign tickets appropriately and perform follow-up notifications if warranted by the priority (e.g., power outage or other emergency).
- Maintain the documentation (including call lists) for operational and disaster recovery procedures.

Allocation and Management Process for NAS Resources

The contractor shall:

- Document and provide end-to-end management and implementation of the process for accessing NAS resources. This involves working with HEC managers

to determine allocations to the Mission Directorates and NESC and then communicating the allocations to these organizations. It also involves explaining the e-Books-based allocation request process to users, collecting requests for computer time, formatting them for Mission Directorate and NESC review and approval, communicating decisions to users, and implementing approved allocations.

- Document and implement processes for users to request and receive user accounts. This includes maintaining current understanding of NASA policies and procedures for establishing NASA identities and granting access to information system resources. It includes developing and implementing processes for granting, continuing, and terminating user accounts (for all users including foreign nationals)--using NASA systems (such as IdMAX and NAMS) and local processes (local, on-line account request form) 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 that are consistent (when appropriate) between HPC facilities at Ames and Goddard.
- Report on utilization of allocated resources and on the status of user accounts. This includes maintaining web-based information and forms pertaining to access to and utilization of NAS resources.

Problem/Incident Resolution

The contractor shall:

- Maintain and operate a state-of-the-art help ticket system, to manage, track, and coordinate completion of tasks and resolution of problems or issues reported by NAS users and facility personnel. 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).
- Resolve basic incidents immediately. These problems 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.
- Assign more complex issues to the appropriate group.
- Track resolution of all incidents and, when appropriate, the underlying problems that cause the incidents.
- Coordinate the resolution of incidents and problems that are complex and/or involve multiple groups.

Documentation and Training

The contractor shall:

- Present informational briefings and training classes, provide on-line and/or hardcopy documentation, conduct workshops and seminars, and capture and disseminate knowledge. The goal is to increase the self-sufficiency of NAS user community, thereby reducing user need for and dependency on User Services.

- Develop and provide web-based and other information about NAS system components, configuration, capabilities, and their effective and appropriate use.

Service Management

The contractor shall:

- Prepare a monthly report summarizing NAS usage by project, mission directorate, and the NAS facility as a whole.
- Review ticket logs to assure that tickets are addressed in a timely manner and to identify recurring issues or problems.
- Gather user feedback through trouble ticket analysis, telecons, site visits, phone calls, annual surveys, and other appropriate methods, and use the information to measure systems, services, and user behavior; to collect user feedback on systems' performance and services; and to identify issues and trends that affect services.
- Inform NAS management in a timely manner regarding critical feedback from users, including both major successes/highlights and major concerns/problems.
- Inform NAS management regarding how well the facility resources and services are meeting user needs and interests.
- Provide recommendations on how to improve overall services. This activity sometimes 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 HPC facilities as well as the general IT industry.

In addition to the above ongoing activities, the contractor shall support or complete development tasks that are required to support the ongoing activities. These are typically done via IPTs with other NAS groups. Examples of past development tasks include: (1) developing an on-line account request form, (2) transitioning to the Remedy ticketing system, (3) implementing additional Remedy capabilities and enhancements (such as providing weekly Point of Contact information for groups), (4) implementing common user identification numbers and group identifiers with the NASA Center for Climate Simulation (NCCS) at Goddard Space Flight Center, and (5) implementing a common Standard Billing Unit with NCCS.

Finally, NAS provides advanced computing services to other non-NAS organizations by hosting their systems at NAS or at non-NAS locations. NAS also operates a 24x7 user services help desk in its control room, operations which may be required to handle calls for some of the non-NAS customers; e.g., NASA Security Operations Center (SOC), which may require 24x7 initial and primary help desk contact support for their users.

6.6 Facility Operations

The Facility Operations technical area includes support for physical plant operations and maintenance (O&M), property control, computer system administration for facility staff, website maintenance, and facility multimedia and communications. The goal of this task is to operate and maintain a safe, efficient, and productive supercomputing facility. The desired outcomes are an improved working environment for facility staff, and enhanced value to users, sponsors, and the public. The activities of this technical area fall into three

sub-areas, as described below.

Facilities and Plant Engineering

This sub-area includes managing the complex subsystems of the physical computing facility, ensuring that all associated safety codes are met, and providing engineering solutions to meet the expanding needs of the facility. These subsystems include electrical power, chillers and HPC cooling (air and chilled water), heating/ventilation/air conditioning (HVAC), plumbing, fire alarms and emergency systems, telecommunication and audio-visual cabling and connections, flooring, lighting, elevators, restrooms, and building structures. Additionally, this sub-area includes handling the facility's physical security system to limit and control access to the facility, performing property management in adherence to federal regulations, and relocating office contents, equipment, and other items within the facility as well as into and out of the facility.

Facilities and Plant Engineering Requirements: The contractor shall:

- Coordinate and ensure completion of maintenance, repairs, and modifications to all NAS facility subsystems, and ensure efficient and effective operation of these subsystems.
- Coordinate and ensure completion of any new construction requested by the Government.
- Ensure facility compliance with all safety and environmental codes.
- Provide site preparation for new HPC systems.
- Maintain and manage facility configuration diagrams.
- Maintain and safely operate the facility machine shop.
- Provide property management services using the NASA NPROP, consistent with federal regulations and NASA Property Management policy for shipping and receiving, excess equipment, and periodic reporting.
- Provide support for relocation of office contents and other facility equipment and materials.
- Provide shipping and receiving services, including the operation of a loading dock, forklift truck, hand trucks, and associated equipment.

General Server and Desktop Support

This sub-area includes providing general data center services and support, including server and user system procurement, administration, and software installation. Specific activities include providing LSA-certified (lead system administrator) system and user support for facility desktop computer systems and Unix computer services (printing, file servers, backups, email, web, etc.), 8x5 POC (point of contact) support for desktop computers, and 24x7 support for critical servers (e.g., file, email, web, fail-over DNS systems and resource usage accounting). The objective is to provide excellent support to users with minimal staffing through the use of automation, configuration control, and clearly defined processes. Standard systems and builds, minimizing the number of operating systems, effective administrative tools, and automated web processes have been implemented to ensure continual achievement of this objective.

Desktop system support includes new system deployments, regular OS and security

patching, OS upgrades, user data backup, general application support, and hardware maintenance. Server support is provided for printing (including printers and print servers), file servers, backups, email, patching, web servers, CVS, FTP, trouble ticketing, databases, account management and system administrative services, as well as OS support for servers utilized by other groups for their services. Server support includes regular OS and security patching, OS upgrades and hardware maintenance and upgrades.

The ongoing support and administration performed by the General Server and Desktop Support staff currently (in April 2015) includes administration of about 90 servers and workgroup systems, and approximately 290 desktop systems. Operating systems currently supported include Red Hat Enterprise Linux, Mac OS X and Microsoft Windows (for specialty servers only). All services currently run on Linux or Macintosh OS X.

General Server and Desktop Support Requirements: The contractor shall:

- Provide LSA-certified system and user support for facility desktop systems.
- Provide LSA-certified system and user support for facility internal computer servers and services.
- Maintain IT security for facility desktop and server computers, consistent with NASA, Center, and NAS standards.
- Provide 8x5 POC support for desktops and servers, and 24x7 POC support for identified critical services.
- Provide support for web content design and development for facility internal and public web servers.
- Provide web programming as requested to facilitate development of web content.
- Provide development of automated tools and services to enhance the mobile computing model used for laptops.

Technical Writing and Multimedia Production

This sub-area supports the organization's communication, public relations, and marketing activities. This sub-area includes technical writing and editing, graphic design and development, website content creation and maintenance, audio and video creation and editing, and event planning and logistics support. This sub-area is responsible for creating a consistent and professional level of written and graphical materials for organization communication products such as management presentations, technical reports, brochures, annual reports, highlights, press releases, and web articles. This sub-area also supports special conferences, facility tours, and other events, and performs digital asset management of graphics, documents, and images for the organization. Finally, this sub-area provides support to all other technical areas to document and describe their work for reporting, advocacy and planning purposes. To accomplish these functions, this sub-area maintains a thorough knowledge of the work being performed in NAS advanced computing projects, and of related trends and developments.

The scale of the Technical Writing and Multimedia Production sub-area can be further understood in terms of the number of various communication products expected annually. While these specifics will change over time, the list below provides a snapshot as of April 2015.

- Division Outreach and Publications: Provide technical writing, editing, design, and production support for highlights, technical papers, reports, presentations, brochures, award nominations, press releases, and web articles. Contact and interact with users as necessary to collect content and communicate goals.
 - Edit and publish 4-8 technical reports on the HECC and NAS Division websites.
 - Compose and edit 4-8 technical papers for conferences (typical length: 10-15 pages).
 - Edit and submit 1-2 division highlights per week.
 - Update and reprint the facility tri-fold brochure twice a year.
 - Compose and edit 6-8 information sheets (one-pagers) describing facility technical activities.
 - Edit 4-5 major NASA reports (average 250 pages), observing NASA policies and procedures.
 - Work with the Ames Public Affairs Office (PAO) to prepare and get approval for 2-3 press releases on major Division accomplishments.
 - Manage and create content for the Division's Social Media outreach, including twitter, flicker, YouTube, and others as appropriate.
- Conference Support: Prepare conference materials and provide onsite support for designated events including the Supercomputing Conference Research Exhibit, local area and onsite workshops, and Technical Interface Meetings.
 - Compose and edit text, design, and layout graphics for NASA booth structure walls, press releases, approximately 40 demo posters, and website content.
 - Conceptualize, develop, and coordinate production and distribution of engaging handout items for the general public.
 - Provide support for conference research exhibit front desk and media contacts.
- Websites: Update external, internal, program, and project websites as requested. Perform quarterly maintenance, monthly updates to home pages, and review and respond to monthly statistics reports. Design and implement site wide updates and revamps as necessary.
 - Manage HECC and NAS Division websites, manage the Heliophysics and Quantum Lab websites, and any additional NAS conference websites for which NAS staff are chairs.
 - Continually update the HECC Knowledge Base for computer technical documentation.
 - Publish and archive the Applied Modeling & Simulation (AMS) Seminar Series.
- N258 Building Graphics/Tour Material: Design and update building graphics and tour collateral as requested or necessary.
 - Provide support and update the presentation for tours on the computer and LED displays in the lobby, computer rooms and in the VisLab (~100 tours/year).
 - Compose or update graphical panels for the facility lobby light boxes (~10).

- Develop 10-12 division research posters for use at technical conferences, NASA public and press events, community events, and other venues.
- Design statement graphics depicting the high-level mission and vision of the facility.
- Design building graphics to highlight branch areas.
- Audio/Visual Support: Manage equipment and provide A/V services for N258 conference rooms, auditorium, and LED displays.
 - Provide technical support as required for division conference rooms, including update of hardware and assisting staff using the conference services (~80 presentations/per year).
 - Broadcast Centerwide presentations as required.
- Digital Marketing Database: Maintain a database of all outreach data for internal Pubs-Media use and create/maintain additional catalogues as requested.
 - Maintain the Cumulus archive of NAS images and document assets.

Technical Writing and Multimedia Production Requirements: The contractor shall:

- Provide technical writing and editing, custom templates and graphics, and audio and video support for communication products and presentations.
- Provide content creation and maintenance for internal and external websites.
- Provide planning and logistical support for technical conferences, facility tours, and other technical interchange meetings.
- Coordinate and provide support for NASA at the Supercomputing Conference and other public events where NAS is required to have exhibits.
- Provide audio/video (A/V) support for conference rooms and the auditorium.
- Maintain a searchable database of multimedia assets and products.
- Support other technical areas in communicating their work for reporting, advocacy and planning purposes.
- Maintain a thorough knowledge of the work being performed, of advanced computing projects supported, and of current trends and developments in the advanced computing arena.
- Manage and create content for the organizations Social Media outreach including twitter, flicker, YouTube, and others as appropriate.

6.7 Information Technology Security

The Information Technology (IT) Security technical area provides comprehensive IT security management, operation, monitoring and safeguards to protect NAS information systems and IT assets in the NAS domain and the HEC enclave. The IT security task also supports monitoring, security situational assessment, audits, vulnerability management, NASA security compliance and incident detection and prevention, for all computer and data systems associated with the NAS facility. The goal of this task is to prevent major IT security compromises, and minimize the occurrence of minor incidents, with minimum impact to the availability of the resources to staff and users, while complying with all

applicable Government policies and regulations. The outcome is to assure confidentiality, integrity, availability, and appropriate use of all NAS computer and data resources.

IT security is a major focus area within the Federal Government. Because NAS supercomputing and data resources are very important for NASA, NAS has been at the forefront of developing effective IT security measures for these resources. NAS' implementation of IT security complies with NPR 2810.1A, the applicable NASA IT Security Handbooks, and the applicable National Institute of Standards and Technology (NIST) requirements. The HEC enclave, consisting of NAS' supercomputers, storage and support systems has a "Moderate" sensitivity categorization based on the NIST SP 800-60, and FIPS 199 guidelines and has an approved FISMA (Federal Information Security Management Act)-compliant IT security plan. This plan addresses the security controls of a moderate system as specified in the current revision of NIST SP 800-53, either by satisfying them or providing persuasive reasons that are accepted by the NAS security plan approving authority (AO) as to why they should not be satisfied for operational or other reasons, such as non-applicability to the NAS situation.

Requirements: The contractor shall:

- Implementation:
 - Support the design, deployment, documentation, enhancement, maintenance, and support of effective IT security for the NAS domain including the systems that exist within the HEC enclave (e.g., supercomputers, storage, and support systems), as well as NAS networks, desktop and laptop computers, and servers. The contractor shall seek approaches that meet both security and usability requirements, while satisfying NASA requirements.
- Monitoring, Situational Assessment and Security Event Mitigation:
 - Implement, maintain and upgrade situational awareness systems.
 - Perform security situational assessment activities to detect and mitigate security events that are important to NAS security and are actionable (i.e., can be subjected to either manual or automated action to counter the event).
 - Provide regular data analysis and reporting, and periodic reviews to the NAS Organizational Computer Security Official (OCSO).
- Assessments/Audits/Compliance:
 - Assess IT resources prior to connecting those resources to the NAS network, and audit all IT resources connected to the NAS network to ensure compliance with NAS' and NASA's IT security requirements at least once per year.
 - Perform any other work necessary to ensure that NAS remains compliant with all security requirements applicable to NASA IT systems.
- Vulnerability Assessments:
 - Implement, maintain, and upgrade security vulnerability scanners, and conduct a credentialed vulnerability assessment on each IT resource connected to the NAS network for security vulnerabilities (where the scanner logs into the target system) at least weekly.
 - Make results available to the appropriate system administrators at least weekly.

- Incident Investigation:
 - Given an indication that some NAS resource has been compromised or is being interfered with, conduct sufficient investigation to distinguish hostile acts from simple errors.
 - Refer investigation of hostile acts to Ames Computer Security and the NASA Security Operations Center.
- Policy, Procedures, and Guidelines:
 - Provide assistance as necessary in developing policy, procedures, and guidelines to ensure that NAS IT resources and practices meet all applicable NASA and government requirements for information security.
 - As necessary, provide assistance in carrying out the policies and procedures (e.g., special access).
- Issue Remedy:
 - Resolve trouble tickets resulting from security-related user problems.
- Training:
 - Maintain certified expertise in IT security, monitor security bulletins, and ensure through the NAS OCSO that facility staff are aware of emergent security concerns.

6.8 Application Services and Tools

The Application Services and Tools technical area focuses on enhancing the performance and productivity of NASA's advanced modeling, simulation, and data analysis applications. The goal is to solve complex application problems, decrease time-to-solution, and increase the achievable scale and accuracy of the applications, resulting in an increase of user and the facility productivity, increasing NASA science and engineering, and enhancing mission safety. This area requires expertise in supercomputing and other advanced computing architectures and parallel programming paradigms, and deep understanding of parallel software development tools, scientific computing programming languages, and related technologies.

This technical area can be divided into four primary activities:

- Scientific Consulting: When users require support beyond the level-1 helpdesk in running their codes, this activity provides level-2 application support. Typical problems resolved include aiding users with system tools, compilation and execution, environment variables, function libraries, code bugs, execution errors, and basic code optimization. In 2015, typically 40-50 scientific consulting requests are fielded per week, with a resolution time of a few hours to a few weeks.
- Advanced Application Support: This level-3 application support involves long-term, focused efforts in application enhancement, potentially including porting, scaling, optimization, algorithmic enhancements, and restructuring of the most important customer codes. There are 5 - 10 level-3 application projects in a year, each of which requires 25-50% of a contractor's time for 3-9 months.
- Application Tools: This area also involves evaluating, developing and utilizing a wide variety of tools, technologies and methodologies for performance and

productivity enhancement. These include tools for compiling, debugging, performance profiling and monitoring, performance optimization, parallel program representation and implementation, and application workflow modeling. This work is episodic based on the maturity of the technologies involved and staff availability. The overall goal is to improve the users' productivity.

- System Performance Assessment: To remain a smart buyer and productive user of HPC, even as capabilities quadruple every 3 years, NAS maintains an effort in assessing current and future HPC architectures to understand their suitability for meeting the current and future needs of NASA applications. This includes system benchmarking and (where necessary) benchmark development.

Requirements: The contractor shall:

- Provide 8x5 POC (point of contact) support for resolving application related user problems in running their application codes on advanced computing systems.
- Support users in porting their codes to facility advanced computing systems.
- Provide level-2 and level-3 application support to advanced computing users.
- Provide application performance optimization expertise to participate in IPTs formed to solve specific challenges.
- Develop and maintain user documentation that aids the users in porting and optimizing their codes for advanced computing systems.
- Provide training on the efficient use of advanced computing systems as requested by the Government.
- Install, evaluate and maintain software tools, both commercial and open source, for enhancing the performance of advanced computing applications and the productivity of users.
- Enhance available software tools where appropriate in conjunction with the tool developers.
- Develop in-house software tools where necessary.
- Investigate new techniques and demonstrate use of new technology for enhancing advanced computing application performance and productivity, such as parallel program representation, translation and implementation.
- Develop tools for application workflow modeling and bottleneck analysis, perform application integration and workflow streamlining, and implement workflow automation.
- Design and develop benchmark suites that will assess the ability of current and new advanced computing systems to meet NASA requirements.
- Develop techniques for performance modeling and evaluation of advanced computing systems.
- Utilize benchmarks, full application codes and performance models to understand the performance of existing systems and to predict the performance of future systems.

6.9 Visualization and Data Analysis

The Visualization and Data Analysis technical area develops and employs advanced data analysis, visualization, and interactive environments to enable users to derive increased value from their computations. The goals are richer data analyses and visualizations, and increased insight into the operation of the supercomputers and applications, with the outcomes being accelerated application advancement, improved science and engineering products, improved supercomputer systems, and increased visibility of impact to all facility stakeholders.

The approach taken in this technical area is highly application-specific. Increasingly, the approach is to leverage concurrent visualization – moving application-specific HPC data analysis and visualization directly into the computations. This allows users to exploit and explore every bit of calculated data, much of which is never saved to disk, and thus it supports interactive and exploratory computational science and engineering much more effectively than the old-fashioned post-process paradigm. Realizing interactive visual supercomputing, which invariably must present vast amounts of multi-dimensional and multivariate data to the user, requires that this area also develop and continually enhance data-rich display, command, and control environments such as the hyperwall (an array of LCDs driven by a graphics workstation cluster). This area also provides state-of-the-art traditional post-processing visualization and analysis. This requires supporting standard visualization and analysis techniques, developing new techniques where needed, and providing large data management capabilities including out-of-core, demand-driven, and remote visualization strategies.

The Visualization and Data Analysis technical area currently (2015) supports typically 6-15 significant, on-going, application-driven visualization and data analysis activities, each of which takes from a week to a year. This area also operates the large (8x16) hyperwall for production rendering, and development of novel analysis and display capabilities, and supports the small (3x3) hyperwall for most tours (typically 1-3 per week) and for use at the annual Supercomputing conference. This area also evaluates and selects compute cluster, storage, interconnect/communication, graphics, and display technologies as part of system-wide upgrades.

Requirements: The contractor shall:

- Support HPC users in their visualization and data analysis tasks.
- Pro-actively seek new applications for the expertise, methods, and technologies of this area from among HPC users.
- Develop application-specific techniques for increased understanding and analysis of data.
- Investigate strategies and methodologies for handling extremely large and complex data.
- Develop and implement both software and hardware based methods and approaches for exploratory data analysis.
- Develop visualization based tools and techniques for monitoring application and system behavior.
- Develop software and hardware infrastructure to support efficient data handling and visualization services.

- Provide visualization and data analysis expertise to participate in IPTs formed to solve specific challenges.
- Provide informative visualizations for research and presentations.
- Support and (when requested) give demonstrations of the products of this technical area.

6.10 Modeling and Simulation

This technical area conducts advanced modeling and simulation analyses requested by NASA programs and projects, where the complexity, expertise, or rapid response required is often beyond the capabilities of other NASA advanced computing users. The goal is to achieve (rather than just enable) mission impact through high-fidelity modeling and simulation. The desired outcome is to achieve significant mission impact and to demonstrate the power of advanced computing and the NAS facility in enabling NASA missions

Requirements: The contractor shall:

- Provide expertise to formulate, develop and optimize the performance of advanced computational simulations and mission enabling comparative analysis tools in support of NASA Earth and Space Science, Aeronautics Research, Space Exploration and Operations, and Space Technology.
- Conduct specific modeling and simulation analyses as requested by NASA, and provide any requested results analysis and documentation.
- Provide modeling and simulation expertise to participate in IPTs formed to solve specific challenges.
- Provide training on the applications and methods used to perform the modeling and simulation analyses, when requested by the Government.

6.11 Big Data Analysis and Analytics Support

NAS is the leading provider of large-scale computation and related services for the NASA engineering and scientific simulation community. At the same time, many supercomputing applications involve large observational datasets. Those applications that involve simulation models often incorporate observed data either for data assimilation or for comparison to model results. In the Big Data era, data collection, acquisition, and analysis are more rapidly accomplished, and innovative approaches to interpreting and manipulating massive data will profoundly influence the way we think about and undertake scientific discovery. NAS plans to continue and enhance its collaboration with other NASA organizations involved with big data initiatives, including the NCCS, the Land Processes Distributed Active Archive Center (LP DAAC), and the Atmospheric Science Data Center (ASDC). NAS will also seek opportunities for outreach to discover new users and create awareness of the NAS Division's capabilities to support big data analysis and analytics on NASA data.

Requirements: The contractor shall:

- Perform work on development of a broad range of methods that form a systematic basis for utilization of big data through data storage, data processing, system management, and integration of other tools and modules.
- Develop data analysis and analytics tools that may use fully custom or semi-

custom software built with packages/libraries and scripting.

- Assist users in identifying, processing and feature discovery from big data by analysis of or analytics on NASA data.
- Provide users of the NASA Earth Exchange (NEX) platform easy access to a variety of potentially very large datasets from the DAACs and at other NASA data centers.

6.12 Enhanced Collaborations and Visiting Scholars Program

This technical area conducts mission-focused collaborations that will leverage and enrich NAS advanced computing services, science and engineering modeling and simulation, data analysis and interpretation, and the NAS Division's other areas of expertise.

NAS shall continue and enhance its dialog with other NASA organizations, academia and the industry and seek opportunities for outreach to discover new users and create awareness of the division's capabilities to support advanced computing.

In the path to achieve this goal, it is desirable to organize workshops, lectures, seminars and collaboration visits by experts in the areas of interest to the NAS Division. These enhanced collaborations would augment NAS Division's expertise in emerging areas of advanced computing in order to demonstrate the use of these technologies to solve NASA's mission critical problems.

Requirements: The contractor shall:

- Collaborate as appropriate with all other technical areas to both leverage and drive their capabilities, and to demonstrate the power of NAS' comprehensive advanced computing services model.
- Provide support for enhanced collaborations with other entities that leverage and enrich NAS advanced computing, science and engineering modeling and simulation, and data analysis and interpretation capabilities.
- Provide demonstrations and presentations of NASA advances and results and impacts for NAS management and for important visitors to NAS, as requested.
- Design, implement and support a NAS Visiting Scholar Program and provide logistics, organizational and procurement support for ongoing and periodic NASA sponsored workshops, seminars, classes, conferences, and presentations.

6.13 Advanced Computing Research, Development, and Enhancement

This technical area would pursue research to explore and selectively implement new approaches to advanced computing that could dramatically enhance the breadth and performance of computational applications executed at NAS as well as the productivity of NAS' advanced computing operations. Technologies could include novel high end, quantum, and cognitive computing systems, Software tools to promote enhanced user and application productivity, and cyberinfrastructure to facilitate use of NASA observational data. The goal is to develop and demonstrate breakthrough computing capabilities that can make major impacts on NASA missions, for example, revolutionizing the design process for aerospace vehicles and subsystems for which it is time-consuming and expensive to obtain reliable and accurate empirical data, or accurately assessing and helping mitigate aerospace mission risks, or simulating human biological response to the space environment and helping to develop countermeasures. The outcome is

dramatically improved accuracy and timeliness of leadership science and engineering in support of NASA missions.

The approach in this technical area would be to maintain a modest level of mission-focused research and development (R&D) in pursuit of new advanced computing applications, enhanced efficiency and performance of NASA's advanced computing systems, and improved productivity of NASA's users. These critical areas include, but are not limited to, innovative computers, novel processors and new architectures, data storage technologies, networking, cyberinfrastructure, productive programming models, intelligent software tools, advanced numerical algorithms, problem-solving environments, assessment of emerging computer technologies, and pathfinding modeling and simulation applications.

Requirements: The contractor shall:

- Conduct mission-focused advanced research to develop methodologies and technologies in emerging platforms, such as, quantum computing, cloud based storage and compute systems and related areas.
- Demonstrate the use of these technologies and codes to solve NASA's mission critical problems.
- Provide science and engineering domain expertise to participate in IPTs formed to solve specific challenges.
- Publish the results of the research in peer reviewed conferences and journals.
- Track technological developments in the computer industry and assist the Government in procuring state-of-the-art technologies for the NAS Division.

6.14 Other Advanced Computing System Support

For this technical area, during part or all of the period of performance of the NACS contract, NASA may request that the NACS contractor provide support for systems operated by NAS in support of Non-NAS organizations, advanced computing facilities at other NASA Centers, or systems and facilities that primarily support other agencies or organizations in collaboration with NASA. The goal would be to coordinate contract support for NASA's advanced computing activities and investments, and to achieve economies of scale and consolidation of knowledge in advanced computing facility operation. The desired outcome would be to optimally leverage NASA's HPC-related knowledge, resources and investments for maximum mission impact, within the Agency's constrained budget.

The support required at Ames or other non-NAS locations under NACS could be in some or all of the technical areas described above.

For advanced computing facilities support at other locations at Ames or at other NASA Centers (e.g., GSFC), the requested support at each site could include all of the technical areas in Sections 6, but most likely at a relatively smaller scale; on the order of 10% to 25% of the amounts at the NAS Division.

Finally, NAS may enter into arrangements to host HPC facilities supporting other agencies or organizations, which would involve activities in one or more of the NACS supercomputing services technical areas.

Requirements: The contractor shall:

- Provide a primary point of contact between the Contractor and the Government (ARC or local CO, local COR, and local facility management) at each site.
- Ensure that contract work products are meeting Government's performance, schedule, cost, and documentation requirements.
- Perform all tasks effectively and efficiently within approved budgets.
- Meet all requirements described in Sections 6 and 7 for each technical area requested by the Government, unless specifically exempted by specific task assignments.

7. Phase-In/Phase-Out

Phase-In: The phase-in process shall be accomplished as expeditiously as possible, with a maximum phase-in period of 30 days. The phase-in process shall not adversely impact the work being done by the outgoing contractor. It shall be conducted in a manner consistent with safe operation requirements. The incoming contractor is responsible for providing a qualified contractor staff by the end of the phase-in period.

Phase-Out: Upon completion of this contract, the outgoing contractor is responsible for the orderly transfer of duties and records to the incoming contractor. This should be accomplished in an expeditious manner, consistent with any contract phase-in schedule, while minimally impacting ongoing task orders. The contractor shall submit a phase-out plan no later than 60 days before the end of the contract for Government review and approval.