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A. Summary of the purpose of the award and its sub-awardees

“XSEDE 2.0: Integrating, Enabling and Enhancing National Cyberinfrastructure with Expanding Community Involvement” was submitted in response to the “XSEDE Renewal RFP,” under NSF’s Extreme Digital (XD) program. NSF determined that it is in the community’s best interest, and can achieve minimal disruption of critical community services, for NSF to invoke the provisions of the cooperative agreement ACI-1053575 that allows submission of a proposal by the University of Illinois for a renewal project, under the conditions set forth in the “XSEDE Renewal RFP.” The goal of XSEDE is to accelerate open scientific discovery by enhancing the productivity and capability of researchers, engineers, and scholars, and by broadening their participation in science and engineering. It does so by making advanced computational resources easier to use, integrating existing resources into new, powerful services and building the community of users and providers. XSEDE is a virtual organization that provisions complex distributed infrastructure, support services, and technical expertise. A prominent opportunity for XSEDE is the growing, diverse collection of advanced computing, high-end visualization, data analysis, and other resources and services available to researchers, engineers, and scholars; these resources have the potential to help understand and solve the most important and challenging problems facing the nation and world. The challenge for XSEDE, as a virtual organization, is to organize these disparate resources, creating integrated services and a coordinated environment that serves the end user needs. The challenge also includes fostering awareness of, and training for, full utilization of the capabilities offered by XSEDE and its associated resources, as well as catalyzing workforce developments. All these tasks need to be accomplished in light of evolving user requirements, resources, and NSF strategies.

With this award, NSF will continue to support an advanced cyberinfrastructure (CI) that uses an increasingly virtualized approach to the provision of high-end services. These services provide a common framework for researchers in computational and data-enabled science & engineering (CDS&E) at all levels of sophistication and aim to create a seamless environment from the desktop, to local university resources to national resources. The objective is to provide the cybertools, software, know-how, assistance, and associated infrastructure required for their research to both sophisticated and novice users, the traditional high performance computing community and new communities who have not used high performance computing resources before.

XSEDE will help assure that NSF-supported compute and data-intensive cyberinfrastructure continues to provide leading-edge capabilities for the research and education community and will facilitate transformative advances in science and engineering.

The XSEDE project is a collaboration between the University of Illinois at Urbana-Champaign (National Center for Supercomputing Applications), the University of Tennessee at Knoxville

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1 The term “XSEDE” refers to the vision, mission, services and support established through the execution of the initial XSEDE award (#1053575) as well as the entire project during its ten year period. "XSEDE 2.0" is used to reference specific additions and/or changes to the XSEDE project as a direct result of this proposal (#1548562).
XSEDE will support six core service areas: Community Engagement & Enrichment (CEE), the Extended Collaborative Support Service (ECSS), XSEDE Community Infrastructure (XCI), XSEDE Operations, the Resource Allocations Service (RAS) and the Program Office.

**Strategic Plan: Achieving Our Mission and Goals**

XSEDE’s mission is to enhance the productivity of a growing community of scholars, researchers, and engineers through access to advanced digital services that support open research by coordinating...
and adding value to the leading cyberinfrastructure resources funded by the NSF and other agencies. Our strategic goals fully support NSF’s vision as stated in Investing in Science, Engineering and Education for the Nation’s Future and strategies stated broadly in the Cyberinfrastructure Framework for 21st Century Science and Engineering and the more specifically relevant Advanced Computing Infrastructure: Vision and Strategic Plan.

**Strategic Goals**

Our strategic goals support our mission and guide the project’s activities toward the realization of our vision of an advanced digital services ecosystem. Three strategic goals are defined:

**Deepen and Extend Use:** XSEDE will deepen the use of the ecosystem by existing scholars, researchers, and engineers, and extend the use to new communities. We will contribute to the preparation—workforce development—of the current and next generation of scholars, researchers, and engineers in the use of this ecosystem; and raise the general awareness of the value of advanced digital services.

**Advance the Ecosystem:** XSEDE will advance the ecosystem by creating an open and evolving e-infrastructure and enhance the technical expertise and support services offered.

**Sustain the Ecosystem:** XSEDE will sustain the ecosystem by ensuring and maintaining a reliable, efficient, and secure infrastructure, and providing excellent user support services. XSEDE will further operate an effective, productive, and innovative virtual organization.

The XSEDE project is operational in nature and is unlike a research project in that, in XSEDE, the expectations and offerings are constantly evolving and are a direct result of the community needs, available CI resources and NSF strategies. While operating in a continued state of CI resource and community needs evolution, it is impractical to define long term goals that are more detailed than the Strategic Goals above, as doing so may unintendedly constrain the project in ways unknown at the present time. There is direct alignment between the mission statement and Key Performance Indicators for every level 2 area, and the project’s strategic goals. In addition, each annual program plan contains specific goals for each level 2 area and level 3 group.

The XSEDE project uses a wiki that is largely open to the public. The home page of the staff wiki can be used as a project map for governance, policies, processes, project documentation, event archives, etc.
The XSEDE Staff Wiki is located at: https://confluence.xsede.org/display/XT/XSEDE+Staff+Wiki

B. Description of the project deliverables, milestones and schedule

Project Deliverables:
- High level transition plan for the solicitation of a successor project
- Detailed transition plan once the successor(s) have been announced
- A comprehensive performance management plan detailing how the XSEDE project is performing against expectations as well as its impact on the research community
- Annual “XSEDE Highlights” booklet with key research projects supported by the XSEDE project
- XSEDE Resource Allocation Services (XRAS)
- A Software Repository of approved tools and software that is supported by the XSEDE project
- A public Wiki page containing information and documents about the XSEDE organizational structure as well as the governance and operation of the XSEDE project
- Documented Use Cases that capture the community needs
- Capability Delivery Plans that document the solutions XSEDE is integrating into the ecosystem and the process for doing so
- Evaluation and assessment reports of the External Evaluators
- Training materials and online resources delivered to the community
- Cybersecurity Plan
- Annual Program Plan will be provided to NSF prior the beginning of each project year detailing the governance, management and specific milestones to be reached by each of the service areas in the upcoming XSEDE project year. The Annual Program Plans will be stored on the wiki and can be found here: https://confluence.xsede.org/display/XT/Annual+Program+Plans
C. High-level Work Breakdown Structure (WBS)

XSEDE 2.0 Work Breakdown Structure

D. Work Breakdown Structure dictionary defining the scope of the WBS elements

2.1. Community Engagement & Enrichment (CEE)

Mission: To actively engage a broad and diverse cross-section of the open science community, bringing together those interested in using, integrating with, enabling, and enhancing the national cyberinfrastructure including support of learning and workforce development via training and education efforts. CEE supports XSEDE’s strategic goals with the following activities:

- Deepen and Extend Use
  - Extend use to new communities
  - Deepen use to existing communities
2.1.2. Workforce Development

2.1.2.1. Training

The Training team will develop and deliver training programs to enhance the skills of the national open science community and ensure productive use of XSEDE’s cyberinfrastructure. XSEDE will expand the breadth and depth of XSEDE training
content based upon a gap analysis of current programs and needs identified by the User Engagement team. XSEDE will expand on existing training roadmaps to include information on which training courses have been vetted and provide pointers to materials available from XSEDE as well as external training providers. Survey data will be collected to assess and improve upon respondents’ abilities to easily find the needed material.

The training team will fully implement the XSEDE training certification program for users and staff in an effort to recognize learners who demonstrate competencies attained through participation in XSEDE training offerings, enabling them to gain recognition for their accomplishments. The Moodle Learning Management System and Mozilla’s Open Badges Infrastructure (OBI) are the basis for implementation. Badges for an additional three competencies will be offered in PY6 with a goal to issue at least ten badges to XSEDE staff and fifty badges to XSEDE users, with 10% growth planned for successive years.

During PY5 of XSEDE, we will offer short duration Massive Open Online Courses (MOOCs). Based on a user assessment of these MOOCs, XSEDE will enrich the interactive and hands-on portions of these training offerings and transform them into smaller, more effective SPOCs (Small Private Online Courses) offered quarterly. Past evaluation data shows SPOC students were much more motivated and had a higher completion rate when provided with mentoring and a badge or university credit.

XSEDE will coordinate training development and offerings with campus representatives and HPC centers interested in developing, delivering, and/or using training materials. The University of Illinois’ Computational Science and Engineering group, the Software Carpentry group, and the Data Carpentry groups have committed to collaborate with XSEDE. These collaborations will gather user requirements for training, share plans for developing training materials among these groups, and foster sharing of training development and the resulting materials. The objective is to expand the breadth and depth of training so researchers, users, students, and XSEDE staff will have ready access to an ever-expanding portfolio of training opportunities delivered via live, broadcast, and online learning platforms.

2.1.2.2. Education
The education team will work closely with training and student preparation to create a cohesive team supporting faculty in all fields of study about advanced digital technologies, and incorporating those capabilities within the undergraduate and graduate curriculum. XSEDE will develop an online community for faculty to share experiences and get advice on curriculum materials and development. XSEDE will work with faculty to develop 50 new, re-usable learning modules and materials. This will include modules for introducing computation and data-enabled techniques within STEM classes and student oriented projects. XSEDE will disseminate educational materials to provide public access to a growing base of peer-reviewed materials that will enhance the graduate and undergraduate experience and contribute to preparing future generations.

The education team will visit campuses and attend regional workshops for faculty. This outreach has proven to be crucial in engaging faculty with integrating computational and data-enabled tools and methods into the curriculum. The campus visits and faculty support have been instrumental in motivating and assisting departments and colleges with developing certificate and degree programs. The outreach also helps raise awareness and usage of the repository of training and education materials available from the XSEDE User Portal for re-use by the community.

2.1.2.3. Student Preparation
The Student Preparation program will actively recruit students to use the aforementioned training and education offerings to enable the use of XSEDE resources by undergraduate and graduate students. Evaluation data show XSEDE’s overwhelmingly positive impact preparing college students to conduct computational science and research. XSEDE will reach thousands of students annually via the vast array of training offerings. XSEDE will provide badging and certification for students on a diverse range of topics including parallel programming, visualization, data analytics, and software engineering practices. XSEDE will broaden participation by engaging with students via conference exhibitions, campus visits, regional workshops, and national conferences. XSEDE will reach out to externally funded student programs, such as NSF Graduate Research Fellows, the NSF Research Experience for Undergraduates (REU), Integrative Graduate Education and Research Traineeship (IGERT), and Broadening Participation in Computing programs. The student preparation program will also establish partnerships with national student organizations (e.g. SIAM, ACS, ACM).
The students in these programs will have the opportunity to access XSEDE’s resources and services, including the workforce offerings.

2.1.2.4. Broadening Participation

Broadening Participation will engage underrepresented minority researchers from domains that are not traditional users of HPC, and from Minority Serving Institutions. This target audience ranges from potential users with no computational experience to computationally savvy researchers, educators, Campus Champions, and administrators that will promote change at their institutions for increased use of advanced digital services for research and teaching.

XSEDE will provide awareness activities—conference exhibitions, campus visits, and regional workshops—while increasing national impact through new partnerships such as the Southern Region Education Board Doctoral Scholars Program, the Institute for African-American Mentoring in Computing Sciences, and the Computing Alliance for Hispanic-Serving Institutions. XSEDE will aggressively promote the submission of papers at professional societies by XSEDE under-represented users and expand our dissemination partners to include new initiatives such as the IEEE Special Technical Committee on Broadening Participation.

Persistent participation is enabled by curriculum reform and larger numbers of researchers adopting the use of advanced digital resources as standard methods. Collaboration with Campus Engagement and Education will support institutional change and capacity building. XSEDE will target institutions with funded initiatives to implement curriculum changes and increase research capacity.

Using the model of the Service Provider Forum, an XSEDE Diversity Forum will be established with outreach and diversity managers at HPC centers and on campuses. The forum participants will share best practices, identify ways to leverage XSEDE activities, and review XSEDE programs to ensure they are encouraging diversity. The diversity forum will be responsible for engaging new national programs and initiatives, institutions with funding to make curriculum change and research infrastructure investments, and major research grant awards at MSIs or with a focus on broadening participation.

2.1.3. User Engagement (UE)
The mission of the User Engagement (UE) team is to capture community needs, requirements, and recommendations for improvements to XSEDE’s resources and services, and report to the national community how their feedback is being addressed. The UE team will process and track actionable items obtained from user feedback and monitor them throughout the UE loop, from assignment to a responsible XSEDE party through communication of subsequent actions back to the user community. To obtain user feedback, we will engage users of XSEDE’s resources and services to gauge overall satisfaction, pervasive problems, emerging needs, and requirements. Integral to this process is the derivation of requirements from diverse sources—micro-surveys, user satisfaction surveys, user interviews—and turning them into actionable Use Cases that can be tracked and handled in all areas of the XSEDE organization. The UE team will use tools provided by the XSEDE Project team including JIRA and issue tracking software to monitor requests and enhancements linked to the stakeholders who originated the requirement. The UE team will use this feedback to create a lightweight Use Case document—an encapsulation of user needs via scenarios—attach it to the JIRA issue, and assign it to the responsible XSEDE area. UE personnel will provide issue status on the user portal to keep the stakeholders and the general community apprised of progress on actionable items. This ongoing feedback loop will encourage further community input for improving XSEDE’s resources and services.

2.1.4. Broadening Participation (BP)
Broadening Participation will engage underrepresented minorities, women, and Minority Serving Institution faculty and students. BP will provide awareness through conference exhibiting, campus visits, and training events —while increasing national impact through new partnerships with other organizations focused on inclusion and diversity such as National Council of Women in Technology (NC-WIT) and the Institute for Broadening Participation (IBP).

2.1.5. User Interfaces & Online Information (UII)
The website is the first place XSEDE stakeholders come to find information about the project, addressing the needs of internal and external stakeholders. The website and user portal will be improved to create a more consistent and easy-to-navigate look and feel. The User Interfaces & Online Information (UII) team will develop an information architecture to support a variety of stakeholders. This information-centric approach is rooted in the ability to answer fundamental questions when browsing the website: Am I in the right place? Do they have what I am looking for? What do I do now? The redesign will include a new layout, enabling a single web and mobile site regardless of device type. The UII team will expand mobile capabilities and build upon the new iOS and Android applications. Managing and publishing approved content to the site will be handled via workflows that enable multiple members of XSEDE to contribute in an organized and effective manner.
Prospective and current users of XSEDE quickly navigate from the website to the XSEDE User Portal for user and project-related needs. For example, PIs can apply for and manage allocations, and record their research accomplishments via the publications feature in the Portal. UII will expand the initial XSEDE User Portal to integrate features such as data management, job execution, and task management. The UII team will incorporate the XSEDE software catalog and its administrative interface and continue to improve capabilities based on stakeholder feedback.

The UII team manages documentation enabling users to easily find resource and service offerings. In addition, the UII team will enable users to create a dynamic environment and tailor the user portal experience to their individual needs. For example, users with allocations on multiple XSEDE resources will be presented with content related to those specific resources, e.g. job submission.

2.1.6. Campus Engagement
Ongoing communication and cooperation with campuses will help to ensure that the resources and services being offered on campuses complement those offered by XSEDE, and vice-versa. This collaboration will enhance the advanced digital resources and services provided to the community.

The Campus Champions effort has established Memoranda of Understanding (MOUs) with more than 190 campuses. On these campuses there are more than 250 Campus, Domain and Student Champions focused on assisting local users to make informed choices of resources and services that may best meet their needs. The Campus Engagement effort will extend XSEDE’s relationship with campus personnel by establishing regular communications with CIOs and VPs for research.

CIOs have indicated that they value communicating with each other and with XSEDE staff to plan the development and delivery of resources and services on their campuses. There will be monthly conferences calls, email lists, and forums for CIOs and VPRs to share challenges, solutions, and information. Other campus individuals who have service roles complementary to XSEDE (e.g. cyberinfrastructure integration and support, training, education, and broadening participation) will be engaged to enhance cooperation among campuses and XSEDE.

The Campus Engagement program will collect information from each campus quarterly to assess the level of activity in working with local users. The Campus Engagement team will provide additional training and consulting, and work with campuses to strengthen their Champion’s productivity and engagement. Campus Engagement will enhance the “Welcome Wagon/New
Champion Development” efforts to provide individualized attention to new Champions so they can more quickly become actively engaged.

The number of campus members has more than doubled in four years, and we project this growth rate to continue based on continuing requests from campuses. To address this rapid growth, the XSEDE Regional Champions program is actively developing models for regional support. The lessons learned from the Regional Champions program will guide further improvements for scaling support of the member campuses. XSEDE alone will not be able to sustain the support needed for the predicted growth of the program. Through collaborations with ACI-REF, Open Science Grid, and the SP Forum, the Campus Engagement program will develop strategies for long-term sustainability.

2.2. Extended Collaborative Support Service (ECSS)

Mission: Improves the productivity of the XSEDE user community through successful, meaningful collaborations to
- optimize their applications,
- improve their work and data flows, and
- increase their effective use of the XSEDE digital infrastructure and
- broadly expand the XSEDE user base by engaging members of underrepresented communities and domain areas

ECSS supports XSEDE’s strategic goals with the following activities:
- Deepen and Extend Use
  - Extend use to new communities
  - Deepen use to existing communities
  - Preparing the current and next generation

Domain scientists should not have to be experts in all areas of cyberinfrastructure to achieve their goals. The ECSS program provides dedicated staff who develop deep, collaborative relationships with XSEDE users, helping them make best use of XSEDE resources to advance their work. These professionals possess combined expertise in many fields of computational science and engineering. They have a deep knowledge of underlying computer systems and of the design and implementation principles for optimally mapping scientific problems, codes, and middleware to these resources. ECSS includes experts in not just the traditional use of petascale computing systems but also in data-intensive work, workflow engineering, and the enhancement of scientific gateways.

ECSS collaborations complement initial engagements with users through the XSEDE Operations Center helpdesk and CEE. They last for at least one month and are expected to have significant
deliverables within a year. Staff members typically spend 20-25% of their time on a single project, but there is flexibility in how these projects unfold.

ECSS support is usually requested by researchers via the XSEDE peer-review allocation process. If reviewers recommend support and if staff resources are available, the ECSS expert and the requesting PI develop a work plan outlining the project tasks. The work plan includes concrete quarterly goals and staffing commitments from both the PI team and ECSS. ECSS managers review work plans and also track progress via quarterly reports. But ECSS is often proactive, reaching out to groups. The Novel and Innovative Projects group within ECSS reaches out to communities which have not traditionally been users of advanced computing, while the Community Codes group works with developers to improve the performance of widely used community codes.

ECSS staff also provides the expertise for the CEE training program and will assist the Resource Allocation Service by conducting allocation reviews of smaller-scale Research requests and all Educational requests. For XCI, ECSS will provide use cases and participate in technical reviews.

2.2.1. Directors Office
The L2 Director’s Office has been established to provide the necessary oversight to ensure the greatest efficiency and effectiveness of the L2 area. This oversight includes providing direction to the L3 management team, coordination of, and participation in, L2 planning activities and reports through the area’s Project Manager. The Director’s Office also attends and supports the preparation of project level reviews and activities.

2.2.2. Extended Support for Research Teams (ESRT)
ESRT is a subarea of the XSEDE Collaborative Support Service (ECSS) focused on the support of research teams. Research team support includes, but is not limited to performance analysis, petascale optimization, effective use of accelerators, I/O optimization, data analytics, visualization, and domain knowledge. This support is provided by staff members organized under ECSS who provide expertise in computational sciences, domain science (many at the doctoral level), data analysis, scientific applications, and visualization.

2.2.3. Novel & Innovative Projects (NIP)
NIP proactively develops projects in areas of science and scholarship that have traditionally not used advanced CI, such as bioinformatics, machine learning; image, text and social network analysis. It focuses on leveraging the science gateway, virtual environment, and data hosting and analysis capabilities of XSEDE service providers, steering nontraditional user groups to the most suitable resources, and mentoring them to ensure the success of their projects.

NIP will focus on efficiently exploiting the capabilities of new SPs and complementary components of the national advanced computing and data ecosystem. NIP experts will work
closely with SPs, recruit and steer appropriate user groups to the most suitable resources, and mentor them to ensure the success of their projects. In particular, the efficient use of the science gateway, virtual environments, and data hosting and analysis support offered by the new SPs should significantly boost the return on NIP effort. These environments promise to greatly reduce the barriers between end-users and the advanced computing ecosystem, especially for people in non-STEM fields and at under-resourced institutions.

NIP will expand its efforts to additional disciplines, such as computational mathematics, applications of geographical information systems, and the arts. Suggestions will be sought from advisory bodies, NSF program directors, and XSEDE internal sources. To improve its impact on underserved minorities, NIP will further strengthen its collaboration with CEE, paying special attention to the development and mentoring of projects that improve the quality and efficiency of teaching at under-resourced institutions. We will use the contract hiring and Domain Champion recruitment processes, as well as the Campus and Regional Champion programs, to ensure active participation by underrepresented groups in the work of NIP.

2.2.4. Extended Support for Community Codes (ESCC)
Extended Collaborative Support for Community Codes (ESCC) extends the use of XSEDE resources by collaborating with researchers and community code developers to deploy, harden, and optimize software systems necessary for research communities to create new knowledge. ESCC projects include collaboration with the developers of widely used community applications and models.

ESCC projects can be proposed by the developers of community codes, the ESCC manager or suggested by staff, XSEDE leadership, and advisory boards. Priority will be given to helping projects funded by NSF programs (e.g., PetaApps, SDCI, STCI, SI2, MREFC) to generate robust, sustainable, and maintainable community applications. XSEDE also supports user-controlled Community Software Areas (CSAs) where any developer can get an account and install and publicize their software. The ability to request CSAs will be featured more prominently in XSEDE.

2.2.5. Extended Support for Science Gateways (ESSGW)
Science Gateways are community-designed, web-based interfaces that build on XSEDE (and other) resources to provide services to their communities. Gateways play a critical role in expanding XSEDE’s user base and account for 40% of all XSEDE users. But the needs of gateway developers can be significantly different from those of researchers requesting other types of ECSS assistance. Gateways require well-defined, secure, web-accessible programming interfaces which are used for remote job submission, monitoring, and management; remote file and data management and transfer; and information services describing the state of hardware and networks, available software, queuing systems wait times, and similar information. ESSGW staff can often use lessons learned working with one user team to advise another. Best practices will continue to be captured through activities like the gateway cookbook. ESSGW staff
members also bring in expertise in areas such as workflows, data analytics and digital humanities and often recruit new gateways through their connections in the community.

2.2.6. Extended Support for Education, Outreach & Training (ESTEO)
ESTEO coordinates bringing technical expertise of ECSS staff members to support CEE efforts. ESTEO staff deliver training in many venues—at XSEDE sites, on campuses, at conferences and offered virtually, as well as serve on committees within XSEDE’s CEE area to jointly plan and support these activities. ESTEO experts develop, review, and present technical content in all areas of ECSS expertise, review education allocation requests and also serve as mentors for Campus Champions Fellows.

The Campus Champions Fellows program pairs XSEDE Campus Champions with ECSS staff members to work together on ECSS projects for one year. Fellows commit 400 hours per year and receive a stipend and travel support in order to participate. For ECSS staff, acting as a mentor to a Fellow counts as an additional ECSS project, allowing time to participate substantially in the mentoring exercise. The goal is to enhance the effectiveness of Fellows on their campus.

2.3. XSEDE Community Infrastructure (XCI)
Mission: To facilitate interaction, sharing and compatibility of all relevant software and related services across the national CI community by building and improving on the foundational efforts of XSEDE. XCI supports XSEDE’s strategic goals with the following activities:

- Sustain the Ecosystem
  - Provide reliable and secure infrastructure
- Advance the Ecosystem
  - Create an open and evolving e-infrastructure

Through XCI, XSEDE will serve as an aligning function within the nation not by rigorously defining a particular architecture, but rather by assembling a technical architecture that facilitates interaction and interoperability across the national CI community. The suite of interoperable and compatible software tools that XSEDE will make available to the community will be based on those already in use by XSEDE, such as Globus. XSEDE will also add additional services that address emerging needs, including data and computational services. The software and tools distributed by XSEDE will adhere to widely held community standards that will provide a foundation for a high degree of interoperability and compatibility among the CI community partners.

XCI is responsible for understanding the community infrastructure requirements in the form of use cases gathered by the XSEDE User Advisory Committee (UAC), XSEDE users via CEE, XD SPs, and commercial cloud service providers. XCI uses those requirements to identify existing tools and services that meet those requirements or identifies and evaluates new tools from the
community that do so. After testing those tools to ensure proper security and integration with existing XSEDE services and tools, they will be tested with the stakeholders that requested them to ensure they address the expressed needs. The tools and services will then be made available in the XCSR along with instructions on how to deploy them. XCI will work with CEE to promote the availability of these new capabilities and hold regular workshops and training to assist the community in their deployment. Feedback will be requested regularly on how well these capabilities are meeting or can be extended to better meet the requirements of the community.

XCI will create the XSEDE Community Software Repository (XCSR), a service and tool catalog available to the national community via the XSEDE website. This catalog will list all services and tools, which SPs have them installed, and links to the source code and/or installation packages along with documentation necessary to install and configure them. A list of all use cases, their stakeholders, and current status will also be cross-referenced with each service or tool. This information will inform discussions of priority and importance with stakeholders and the national community. All this information will be stored in the XCSR, a core deliverable and vehicle for our handoff strategy to the XSEDE successor(s) at the end of PY10.

XSEDE is moving from a direct support model to a subscription model. XCI will identify opportunities to leverage cloud providers for selected elements of service delivery in order to provide a sustainable and scalable approach for integrating critical services and tools into the ecosystem. We will also provide gateway-hosting services as part of the XSEDE organizational infrastructure—hosted within XSEDE on a server to be called XGH (XSEDE Gateway Hosting), based on a refresh of the existing Quarry Gateway Hosting. We expect that over time XSEDE will adopt more cloud-hosted services for its technical infrastructure. Rather than treating these services as part of XSEDE operations, we will take a peer-to-peer approach where XSEDE will interact, contract, and report on the value of such cloud-like infrastructure services as part of our community interaction activities.

Because return-on-investment will be a priority, we will also work with outside developers and software providers to instrument their tools so we can measure usage in a consistent way so as to ultimately feed into XDMoD—the portal by which we share resource and service usage information. Software as a Service (SaaS) providers such as Globus and Science Gateways will be required to provide usage data as well. It will not be possible or even practical to instrument all codes for usage tracking, but anything that requires a significant financial or personnel investment by XSEDE will be an important target. Working with the community, we will communicate this aspect as a critical part of developing community code. We will provide examples and workshops where possible to assist the community in this effort, or a request can be made for ECSS support.

2.3.1. Director’s Office
The L2 Director’s Office has been established to provide the necessary oversight to ensure the greatest efficiency and effectiveness of the L2 area. This oversight includes providing direction
to the L3 management team, coordination of, and participation in, L2 planning activities and reports through the area’s Project Manager. The Director’s Office also attends and supports the preparation of project level reviews and activities.

2.3.2. Requirements Analysis & Capability Delivery (RACD)
The Requirements Analysis and Capability Delivery (RACD) team prepares and supports software and services that: 1) enable user access to and use of XSEDE federated infrastructure, and 2) enable infrastructure and service providers to federate with XSEDE. Starting from XSEDE prioritized user requirements (use cases) RACD coordinates the engineering work necessary to integrate software and services into production at SPs and campuses, as XSEDE central services, as external vendor services, or on user personal systems. RACD uses engineering best practices and tools, works with external vendors and software partners to minimize integration cost to XSEDE, and aims to maximize ROI to XSEDE and the NSF. The RACD Engineering Overview can be viewed here on the XSEDE wiki:
https://confluence.xsede.org/display/XT/WBS+2.3.2+RACD+Engineering+Overview

All of the software implementation, dissemination, and support will be carried out with a sense of “enabled by XSEDE,” rather than “created and branded XSEDE.” Software will be distributed to the XSEDE community through the XCSR. CI operators and the national user community will be enabled and encouraged to treat this repository much like a large menu—where people who manage a CI resource can select those tools that are relevant to the needs of their resource users and the purpose of their CI resource. XSEDE will recommend tools that are appropriate for use in a particular circumstance, or the sets of tools for particular CI provider groups (e.g., Level 1 SPs or campus resources). XCI will create and manage use case capability delivery plans. These plans may be put on hold if constraints limit XSEDE’s ability to deliver a capability, or there is insufficient ROI.

2.3.3. Capability & Resource Integration (CRI)
The CRI team will manage and coordinate working with SPs and campuses to maximize the aggregate utility of national cyberinfrastructure. For SP integration, CRI will have an SP coordinator who will focus on XSEDE interactions with SPs and the SP Forum. CRI will also engage with other national CI organizations such as ACI-REF, EDUCAUSE, SURA, CASC, the Open Science Grid, and campus CI providers. These interactions will play a strong role in cost/benefit analyses and priority setting. They will inform and help all CI providers serving the U.S. research community understand each other’s needs and the needs faced by their users, promote best practices, and synergize provided services. By working with CRI, CI providers will gain a clear understanding of the costs and benefits of interoperability and interaction with XSEDE. CRI will extend and complement Campus Bridging activities in PY1-5 by establishing closer links with organizations that make use of these technologies and soliciting input and greater participation from these stakeholder organizations.
CRI will help CI providers of particular system types by creating “toolkits” within the XCSR that correspond to common usage modalities. The first of these toolkits will be the XSEDE National Integration Toolkit (XNIT). XNIT will include tools that can be installed on a campus cluster to promote interoperability with the national cyberinfrastructure, including XSEDE. XNIT will largely replace what is now called the XSEDE Compatible Basic Cluster (XCBC); however, we will maintain a Rocks distribution of the XCBC for those interested in new cluster installations. XNIT will include a “laptop suite” of tools that can be installed on a workstation or laptop computer at any site, with infrastructure and scientific software to enable researchers to interact effectively with the national cyberinfrastructure from their own personal system.

2.4. XSEDE Operations

Mission: XSEDE Operations installs, connects, maintains, secures, and evolves an integrated cyberinfrastructure that incorporates a wide range of digital capabilities to support national scientific, engineering, and scholarly research efforts. XSEDE Operations supports the project’s strategic goals with the following activities:

- Sustain the Ecosystem
  - Provide reliable and secure infrastructure
  - Provide excellent user support

XSEDE Operations will maintain and evolve an integrated CI capability of national scale, incorporating a wide range of digital capabilities to support the diverse national scientific and engineering research effort. XSEDE will provide first-class facilities, support, and services for users via improved technical capabilities and services, coordinated operation of distributed resources, an operations center, and highly accessible documentation. Operations will innovate by providing new insight and business intelligence in guiding decision making through expanded trend tracking and monitoring, and the analysis and dashboard visualization of operational data related to the ticket system, data transfers, and other collected operational information. XSEDE Operations will build upon the current operational successes with continued improvement based on XSEDE management guidance, advisory inputs, NSF review panel recommendations, and increased interactions with other CI providers (Blue Waters, NCAR, OSG).

2.4.1. Directors Office

The L2 Director’s Office has been established to provide the necessary oversight to ensure the greatest efficiency and effectiveness of the L2 area. This oversight includes providing direction to the L3 management team, coordination of, and participation in, L2 planning activities and reports through the area’s Project Manager. The Director’s Office also attends and supports the preparation of project level reviews and activities.

2.4.2. Cybersecurity

The Cybersecurity group will continue to expand and improve XSEDE security while minimizing impact on users and their productivity. To further increase awareness and rapid response to
threats, knowledge from individual sites will be aggregated and applied across all of XSEDE. A real-time intelligence sharing service for SPs will be deployed that will leverage the Research and Education Networking Information Sharing and Analysis Center (REN-ISAC) Collective Intelligence Framework (CIF) for exchanging attack intelligence. The CIF is an NSF-funded project to improve local protection against cyber threats by sharing security event information in near-real time. This real-time intelligence will feed into a system that will shunt traffic related to the IP addresses of bad actors such as password attackers or network scanners into a black hole network, thereby eliminating the threat. We will extend this service beyond XSEDE sites to include campus participants and operators of Science DMZs. We will further extend our intelligence system to perform cross-site analysis to look for scans, account attacks, and other suspicious activities that don’t reach thresholds at any one site but do trigger an alert when the same action is identified across multiple sites. This derived intelligence will then be shared with all participating sites. This has promise to transform our security ability to monitor and respond to a broad spectrum of attacks, with concomitant potential impact on the entire national CI ecosystem. The widespread deployment of virtual machine technologies including Docker and OpenStack highlights the critical need to understand cybersecurity best practices for these environments. Similar issues result from the adoption of public, private, and hybrid cloud services. We will develop best practices around these topics, document them, and aggressively work to disseminate this information. Outreach to campus CIOs and IT staff through the CEE Campus Engagements program, and Science DMZ operators will further include a collaborative effort working with ESnet, the Bro Center of Excellence, and the new Cybersecurity Center of Excellence with the goal of further documenting and training campus operators in security best practices. Finally, we will also develop specific training for security staff at XSEDE SPs to cover policy, process, controls, and best practices within XSEDE.

2.4.3. Data Transfer Services (DTS)
Data Transfer Services (DTS) will focus on end-to-end data transfer performance, functionality, and efficiency in user workflows between instruments, resources, centers, and campuses. Where applicable, DTS will leverage emerging analytics capabilities and software defined networking (SDN) tools to improve performance, provide quality of service capabilities, and monitor network health and efficiency. The scope of these end-to-end efforts will include the Internet2 network that underpins the national XSEDEnet wide-area network, and, working in conjunction with site-local contacts, the data transfer nodes and local networks at XSEDE SP sites.

2.4.4. XSEDE Operations Center (XOC)
The XSEDE Operations Center provides 24x7 helpdesk support via ticket system and call center, as well as 24x7 monitoring of critical services. The XOC resolves common problems, answers common questions, and routes other tickets and calls appropriately to WBS groups or XSEDE service providers, usually within several minutes. On the monitoring side, the XOC evaluates and documents any critical incidents, contacts the appropriate administrators, and remains a point of contact until the incident is resolved.
2.4.5. **Systems Operational Support (SysOps)**

The SysOps group provides system administration and monitoring for all of the approximately 50 XSEDE centralized services. SysOps provides 24x7 monitoring and high availability for critical services for XSEDE, including geographically distributed backup and failover capabilities for enterprise services. SysOps will continue to employ server virtualization to control costs without sacrificing high availability.

2.5. **Resource Allocations Service (RAS)**

Mission: The Resource Allocations Service (RAS) connects users to resources that can help meet their science needs, using well-defined procedures and integrated infrastructure to ensure the most efficient and effective use of these limited resources. RAS supports XSEDE’s strategic goals with the following activities:

- Sustain the Ecosystem
  - Provide reliable, efficient, and secure infrastructure
  - Provide excellent user support

RAS will build on XSEDE’s current allocation processes and evolve to meet the challenges presented by new types of resources to be allocated via XSEDE, new computing and data modalities to support increasingly diverse research needs, and large-scale demands from the user community for limited XSEDE-allocated resources. RAS will accomplish its objectives through three activities:

1. Carry out the NSF-approved allocation policies and manage the quarterly Research opportunities for large-scale allocation requests, including the associated meetings of the XSEDE Resource Allocations Committee (XRAC). The service also handles other allocation requests for Startups, Educational projects, transfers, extensions, and so on, coordinating all these activities with the Service Providers.

2. Maintain and improve the interfaces, databases and data transfer mechanisms for XSEDE-wide resource allocations, accounting of resource usage, and user account management. These systems include XDCDB, the XSEDE accounting system, and the XSEDE Resource Allocations Service (XRAS)

3. Analyze trends in the availability and use of resources, current technologies, computational science applications, and user requirements to inform project governance.

Supporting the XSEDE allocation and SP activities, RAS will also increase its analytics focus and mine the XSEDE Central Database (XDCDB) to document and project user demand for high-end CI resources. Such efforts will help SPs meet their award deliverables and provide NSF with data it can use to guide the direction of national CI investments. Coordinated within the RAS office of the director and working closely with the XD Metrics Service (providers of XDMoD) and XSEDE Evaluation Team, this analytics effort will investigate metrics-driven approaches to improving
allocations processes and policies (including NSF policies) to better meet user needs and steward national investments in CI. For example, we will conduct analyses leveraging user survey data, XDMoD usage reports, allocation requests and awards, and the XSEDE publications database to understand how users have adapted to the severe resource constraints over the past several years and to identify possible responses from XSEDE, the SPs, or NSF.

2.5.1. Director’s Office

The L2 Director’s Office has been established to provide the necessary oversight to ensure the greatest efficiency and effectiveness of the L2 area. This oversight includes providing direction to the L3 management team, coordination of, and participation in, L2 planning activities and reports through the area’s Project Manager. The Director’s Office also attends and supports the preparation of project level reviews and activities.

2.5.2. XSEDE Allocations Process & Policies

Allocations will oversee the central XSEDE allocation process, a major focus of RAS. The most visible aspect will be support for the quarterly review by the XSEDE Resource Allocation Committee (XRAC) of larger-scale research requests. The XRAC also serves as a key advisory board for RAS and the allocations process. The XSEDE allocation manager will oversee and direct the peer-review process for the largest research proposals (currently nearly 200 submissions per quarter are reviewed by XRAC members) along with the review by XSEDE staff experts of dozens smaller-scale requests. The RAS team recruits new XRAC members as terms expire, makes review assignments, ensures reviews are completed, manages the logistics of the quarterly meetings, and initiates the resulting awards.

The RAS team will support the review and handling of Startup, Education, and smaller-scale allocation requests. Furthermore, the RAS team will process requests, such as extensions, transfers and, to a lesser degree, supplements and appeals. It will coordinate the XSEDE resource guidance process, which leverages ECSS staff to help users identify the best resources for their projects prior to allocation request submission.

To ensure that the allocations process meets the needs of XSEDE stakeholders, the RAS team will engage regularly with the SP Forum, SP allocations representatives, the XSEDE User Advisory Committee, the NSF, and the XRAC on improvements or changes needed to the allocation policies. They will review processes to manage the growing volume of requests and to allocate effectively the evolving and diversifying resource portfolio, such as: human resources for ECSS projects, non-traditional computational resources and, we anticipate, network bandwidth or quality of service with software-defined networking. The XSEDE allocation manager will implement any agreed-upon changes to the XRAC review and meeting format.

The XSEDE Allocations Policy is on the project wiki and can be found here: https://confluence.xsede.org/display/XT/XSEDE+Allocation+Policies
The XSEDE Allocations Procedure is also on the project wiki and can be found here: 
https://confluence.xsede.org/display/XT/XSEDE+Allocations+Procedure

2.5.3. Allocations CI Enhancement & Maintenance
Allocations, Accounting & Account Management (A3M):
The RAS team will augment efforts to support the XSEDE Resource Allocation Service (XRAS) allocation management software. Given the intense demand for XSEDE-allocated resources, the RAS team will update XSEDE infrastructure components to better support researchers and educators in identifying the appropriate and available services across the ecosystem that can support their objectives, a need identified both by existing XSEDE use cases and by an NSF workshop.

RAS efforts encompass improvement, maintenance, and operation of critical services that enable and enhance the allocations process. Led by L3 manager Amy Schuele (NCSA), the XRAS activities not only will facilitate the allocation of resources but will also enable discovery of and access to other services, such as the resources operated by Level 2 and Level 3 SPs but not allocated via XSEDE—better informing users about the range of advanced digital services available to them. XRAS efforts will follow and leverage the processes and tools, including JIRA for feature tracking, defined by XCI.

XRAS will be operated as a robust and stable service in support of XSEDE allocations processes and for client organizations. Support efforts will include maintenance updates to XRAS as XSEDE allocations policies evolve. Additional efforts will focus on enhancing the performance and reliability of the XRAS service and enhancing the reporting and metrics capabilities of the system. Because of the central and critical nature of XRAS to XSEDE, and in view of its anticipated value to the broader CI ecosystem, new XRAS features will be prioritized based on the collective inputs and feedback from users, XSEDE, the SPs, and other stakeholders. Finally, RAS will refine the sustainability and cost model for XRAS as a service. Building upon initial collaborations with NCAR and NCSA’s CADENS project, the team will work with other organizations that have expressed interest in the XRAS technology. The cost of work to support other organizations is not included in the XSEDE2 budget and will be covered by those organizations or through separate grants.

The Resource Description Repository (RDR), part of XSEDE’s Infrastructure Discovery Services, will support XRAS and serve as a cornerstone for an enhanced RAS infrastructure. The RDR will serve as the foundation for a “Resource Selector” service that will guide users to CI resources and services that are relevant and available to them for their research needs. RAS will also formally define and complete the integration of the XRAS, accounting, and XSEDE User Portal components with the enhanced RDR.
The Allocations, Accounting & Account Management (A3M) Services provide centralized mechanisms that integrate usage across XSEDE-allocated SPs and support allocation review and management. To accommodate emerging resources with novel usage modalities, RAS will collaborate with XCI to define accounting use cases and implement enhancements to the A3M environment. The Account Management Information Exchange (AMIE) messaging service is a critical integration mechanism for the A3M Services. In collaboration with XCI, RAS will conduct a trade-off analysis to investigate the impacts of migrating the Accounting Service from the legacy AMIE transport system to a modern, open-source messaging service. RAS, XSEDE Operations, and XCI will work together to evaluate the current infrastructure and status of the XDCDB and, if necessary, migrate the XDCDB to an even more robust, high-availability and high-performance configuration and platform, with appropriate backup and continuity plans and processes.

The XSEDE user publications database is essential to the XSEDE allocations process, to understanding XSEDE’s scientific impact, and to downstream XSEDE services such as gateways. This service will evolve to support RAS requirements in collaboration with CEE team efforts.

The RAS infrastructure will adapt and evolve as other components of the XSEDE infrastructure evolve, i.e. Identity Management and Infrastructure Discovery Services. Because the XDCDB is a primary data source for XDMoD, RAS will ensure that XDMoD remains integrated with the allocations and accounting infrastructure. Through its interactions with the SP Forum and other stakeholders, RAS will also assess interest in building a community around CI management tools that support XSEDE and RAS integration.

The RAS team will engage closely in the sustainability and transition plan from XSEDE to any successor program. The XDCDB encompasses a significant portion of the primary data products being generated and collected by XSEDE. These products will include allocation requests, review, and award information spanning more than two decades by the end PY10, more than a decade of system usage records spread over more than 50 resources, and user profile data including a database of tens of thousands of publications acknowledging XSEDE and SP support. Software maintained and enhanced by RAS, including XRAS, will be transitioned to a successor program according to procedures defined by XSEDE and the successor awardee(s).

2.6. Program Office

Mission: Ensure the critical project level functions are in place and operating effectively and efficiently and provide consistent guidance and leadership to the L2 directors and L3 managers across the project. The Program Office supports XSEDE’s strategic goals with the following activities:

- Deepen and Extend Use
  - Raise awareness of the value of advanced digital research services
- Sustain the Ecosystem
- Operate an effective and productive virtual organization
- Operate an innovative virtual organization

- Advance the Ecosystem
  - Enhancing the array of technical expertise and support services

The XSEDE Program Office will ensure the Project Office; External Relations; Project Management, Reporting, and Risk Management; Business Operations; and Strategic Planning, Policy, and Evaluation teams will effectively support XSEDE project activities and ensure efficient and effective performance of all project responsibilities. By tightly aligning organizational units (by L2 WBS) with strategic goals, the team will simplify accountability and link effort and budget to important outcomes. This approach is consistent with best practices in the management of virtual organizations, where many traditional managerial practices do not apply directly due to the distributed and knowledge-intensive nature of the work. Clearly delineated responsibilities and interfaces reduce uncertainty and enable the autonomy and discretion required for scalability and success. This structure will provide project-wide alignment and coordination while at the same time allowing each organizational unit the autonomy to adapt to the ever changing needs and provide the best service possible to the XSEDE users, service providers and the community in general.

### 2.6.1. Project Office

The XSEDE Project Office will be led and managed by the University of Illinois’ NCSA with key partnerships instantiated via sub-awards. Illinois will ensure that an efficient and effective project governing structure is in place throughout the award period to support all significant project activities and ensure efficient and effective performance of all project responsibilities.

### 2.6.2. External Relations (ER)

ER will promote the resources and services provided by XSEDE and examples of its successful support for science, engineering, and education to internal and external stakeholders. The ER team will communicate upcoming events, project milestones and achievements, science successes, services and resources, etc. via the XSEDE website and other channels; research and write “science success stories” and media releases; distribute a monthly external newsletter and a monthly internal newsletter; coordinate and staff an XSEDE exhibit at each year’s SC Conference; promote the annual XSEDE Conference and create supporting materials; and grow the XSEDE social media presence.

### 2.6.3. Project Management, Reporting & Risk Management (PM&R)

The Project Management, Reporting and Risk Management (PM&R) team members have extensive experience applying project management principles to large, complex, distributed projects, including projects in the private sector, government, and XSEDE. As a focal point for XSEDE project management efforts, the PM&R team will develop and maintain an online Project Execution Plan (PEP) on the staff wiki. The PEP describes the standard operating procedures for the project and is a living document that evolves with the project.
Risk Management - Risk management is incorporated into the project at all WBS levels. The NCSA risk tool—originally developed for the Blue Waters project—will be used to register and monitor risks. Risk reviews will be conducted quarterly; high-risk items and mitigation strategies are included in the PEP.

Project Change Management - As part of the XSEDE annual planning process, the project will define the schedule, milestones, budget, and scope. The PM&R team will ensure that changes to these baselines will be managed through a change management process.

Project Reporting and Communications - The project will provide NSF with regular updates via teleconference and written quarterly and annual reports. The PM&R team will develop a Communication Plan that links all project groups and describes communication methods and frequencies to maximize the effectiveness and efficiency of project communications.

2.6.4. Business Operations

The Business Operations group, working closely with staff at the University of Illinois’ Grants and Contracts Office (GCO) and National Center for Supercomputing Applications’ (NCSA) Business Office, will handle budgetary issues, manage sub-awards and assure timely processing of sub-award amendments and invoices.

2.6.5. Strategic, Planning, Policy, & Evaluation

XSEDE will dedicate effort to project-wide strategic planning, policy development, evaluation and assessment, and organizational improvement in support of sustaining an effective and productive virtual organization. An independent Evaluation Team will be engaged to provide XSEDE with information to guide program improvement and assess the impact of XSEDE services. Evaluations will be based on five primary data sources: (1) an Annual User Survey that will be part of the XSEDE annual report and program plan; (2) an Enhanced Longitudinal Study encompassing additional target groups (e.g., faculty, institutions, disciplines, etc.) and additional measures (e.g., publications, citations, research funding, promotion and tenure, etc.); (3) an Annual XSEDE Staff Climate Study; (4) XSEDE KPIs, Area Metrics, and Organizational Improvement efforts, including ensuring that procedures are in place to assess these data; and (5) Specialized Studies as contracted by Level 2 directors and the Program Office. The Evaluation Team will create a database to support an Area Metrics/KPI Dashboard and results of any specialized studies.

This team is charged with the creation of a comprehensive performance management plan detailing the methodology, tools and data sources used to determine the performance of the XSEDE project and its impact on the research community. The initial release of this XSEDE Performance Management Plan is expected to be provided to the NSF six months after the award start date.
The detailed description of the project metrics and KPIs can be found at the following link:
https://confluence.xsede.org/pages/viewpage.action?pageId=1671762
### E. Project budget and staffing broken out by WBS element and by institution

#### Project Budget by WBS Element

<table>
<thead>
<tr>
<th>WBS</th>
<th>Project Improvement Fund</th>
<th>PY6</th>
<th>PY7</th>
<th>PY8</th>
<th>PY9</th>
<th>PY10</th>
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<td>$145</td>
<td>$165</td>
<td>$185</td>
<td>$205</td>
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</tr>
</tbody>
</table>

| 2   | PY6 Hardware refresh and Sub-award Setup | $714 | $450 | $264 |

| 2.1 | Community Engagement & Enrichment | $3,589 | $3,655 | $3,738 | $3,803 | $3,901 | $18,725 |
| 2.1.1 | Community Engagement, Office of the Director | $332 | $340 | $347 | $355 | $363 | $1,737 |
| 2.1.2 | Workforce Development | $1,431 | $1,461 | $1,492 | $1,523 | $1,555 | $7,463 |
| 2.1.3 | User Engagement | $344 | $352 | $359 | $366 | $373 | $1,788 |
| 2.1.4 | Broadening Participation | $266 | $272 | $279 | $285 | $291 | $1,394 |
| 2.1.5 | User Interfaces and Online Information | $747 | $764 | $781 | $798 | $815 | $3,906 |
| 2.1.6 | Campus Engagement | $469 | $477 | $485 | $494 | $502 | $2,428 |

| 2.2 | ECSS | $6,658 | $6,806 | $6,957 | $7,111 | $7,269 | $38,402 |
| 2.2.1 | ECSS, Office of the Directors | $537 | $549 | $561 | $574 | $587 | $2,906 |
| 2.2.2 | Extended Support for Research Teams | $2,247 | $2,279 | $2,349 | $2,402 | $2,455 | $11,942 |
| 2.2.3 | Novel and Innovative Projects | $1,096 | $1,121 | $1,146 | $1,172 | $1,198 | $5,732 |
| 2.2.4 | Extended Support for Community Codes | $1,033 | $1,067 | $1,090 | $1,115 | $1,142 | $5,404 |
| 2.2.5 | Extended Support for Science Gateways | $693 | $713 | $734 | $755 | $776 | $3,672 |
| 2.2.6 | Extended Support for Education, Outreach and Training | $502 | $520 | $539 | $558 | $577 | $2,695 |

| 2.3 | XSEDE Community Infrastructure | $2,274 | $2,325 | $2,377 | $2,431 | $2,485 | $11,992 |
| 2.3.1 | XSEDE Community Infrastructure, Office of the Director | $895 | $902 | $909 | $916 | $924 | $4,506 |
| 2.3.2 | Requirements Analysis and Capability Delivery (RACD) | $1,196 | $1,222 | $1,250 | $1,278 | $1,306 | $6,261 |
| 2.3.3 | XSEDE Capability and Resource Integration (CRI) | $783 | $815 | $842 | $869 | $896 | $4,097 |

| 2.4 | XSEDE Operations | $3,967 | $4,065 | $4,164 | $4,268 | $4,333 | $20,742 |
| 2.4.1 | Operations, Office of the Director | $1,158 | $1,184 | $1,210 | $1,236 | $1,265 | $6,065 |
| 2.4.2 | Security | $813 | $832 | $851 | $870 | $889 | $4,163 |
| 2.4.3 | XSEDEnet and Data Services | $812 | $831 | $850 | $869 | $888 | $4,148 |
| 2.4.4 | XSEDE Operations Center with Consulting Coordination | $476 | $487 | $498 | $509 | $520 | $2,489 |
| 2.4.5 | System Operational Support | $708 | $724 | $739 | $755 | $771 | $3,697 |

| 2.5 | Resource Allocations Service (RAS) | $1,689 | $1,723 | $1,759 | $1,794 | $1,831 | $8,796 |
| 2.5.1 | RAS, Office of the Director | $162 | $166 | $169 | $173 | $177 | $848 |
| 2.5.2 | XSEDE Allocations Process and Policies | $506 | $514 | $522 | $530 | $538 | $2,610 |
| 2.5.3 | Allocations, Accounting & Account Management Center | $1,021 | $1,044 | $1,067 | $1,091 | $1,115 | $5,339 |

| 2.6 | Program Office | $2,485 | $2,536 | $2,574 | $2,625 | $2,682 | $12,365 |
| 2.6.1 | Project Office | $641 | $668 | $697 | $723 | $748 | $3,339 |
| 2.6.2 | External Relations | $512 | $523 | $533 | $544 | $555 | $2,657 |
| 2.6.3 | Project Management, Reporting & Risk Management | $560 | $572 | $582 | $595 | $612 | $2,928 |
| 2.6.4 | Business Operations (Contracts, Budget, Finance, Accounting) | $196 | $201 | $205 | $210 | $215 | $1,026 |
| 2.6.5 | Strategic Planning, Policy, Evaluation and Organizational Improvement | $576 | $588 | $598 | $611 | $616 | $2,957 |

|       | $21,477 | $21,577 | $22,021 | $22,508 | $22,417 | $110,000 |

**Note:** PY6 - PY10 terminology is used to differentiate between the initial XSEDE award (#1053575) and the follow-up award for an additional five years of operations.
F. Description of the methodology and assumptions used for estimating the budget components

Cost estimates for this project include personnel, equipment, travel, and services required to perform the tasks necessary for completion of the project deliverables. These estimates reflect our knowledge of management and support costs gained from prior experience conducting projects of this complexity, scope, and magnitude. The start date of this project is assumed to be September 1, 2016.

Personnel costs are based on actual salaries for current staff that are identified to work on the project. For new hires, estimates are based on the average fully loaded salary (that is, including fringe benefits and indirect costs) necessary to replace that individual’s experience and expertise at his/her institution. Estimates for goods and services are based on discussions with prospective vendors and are forward-looking.

G. Project risk analysis and a description of the analysis methodology
A structured, disciplined approach for risk management has been developed using the Project Management Institute’s best practices for risk management as a model. The XSEDE Project Director has overall responsibility for risk management. The XSEDE project maintains a risk register, which provides detailed information about each identified risk.

The risk management process, which must be ongoing and dynamic, ensures that:

- risk identification and analysis have the appropriate rigor;
- risk issues are made visible early;
- thorough, credible mitigation plans are prepared/implemented;
- budgets are maintained;
- appropriate personnel are notified when a risk is triggered;

Project risk management consists of a six-step process: (1) identify potential vulnerabilities/risks; (2) determine the likelihood of occurrence; (3) assess the impact on the project scope, cost, and schedule baselines; (4) determine activities, alternatives, or contingencies that would reduce/mitigate/accommodate the risk; (5) execute a plan to accomplish these risk-reducing activities; and (6) report and track risk.

The project will use a risk management software application (the JIRA Risk Management Tool), which will help the project management team to record, track, and report on identified project risks.

The risk register will be updated regularly to reflect the modification to existing risks, addition of new risks, and retirement of risks as the project moves forward. The Project Director will conduct a formal risk review quarterly as part of a quarterly status meeting with the XSEDE project team in order to proactively address risks.

Identified risks can have positive as well as negative impacts on the project’s technical scope, schedule, and cost. The project team will track opportunities in order to take full advantage of information for making decisions that might affect the project. In practice, if the XSEDE team detects a chance to save money by doing X instead of Y, then we record that as a "positive" risk, set triggers, and track it like other risks. The team may even have "mitigations" that increase the project’s chances that the opportunity occurs.

The project management will promptly inform NSF of any significant risk issues or opportunities that may arise during the project lifetime, and the risk register will be maintained for routine communication of potential project risks and mitigation strategies. These alerts will be contained in the conventional status reporting activities of the project where stakeholders are informed about any issues that may impact the project. Typically, these issues will be discussed during the regular teleconferences between NSF and XSEDE management. Significant risks will be documented in the required interim and annual reports. NSF can request a complete report of the risk register in advance of any of these events.

An initial risk assessment was completed during the planning period and has been documented on the wiki, which is located here: https://confluence.xsede.org/display/XT/Risk+Management. Going forward,
the risks will be moved to JIRA for management.

H. Project schedule
The schedule is a living document and will be updated to reflect the baseline for near-term activities (work packages) as well as placeholders for long-term activities (planning packages). Overall the project begins on September 1, 2016 and ends on August 31, 2022.

| XSEDE Schedule             | PY6 Q1 | PY6 Q2 | PY6 Q3 | PY6 Q4 | PY7 Q1 | PY7 Q2 | PY7 Q3 | PY7 Q4 | PY8 Q1 | PY8 Q2 | PY8 Q3 | PY8 Q4 | PY9 Q1 | PY9 Q2 | PY9 Q3 | PY9 Q4 | PY10 Q1 | PY10 Q2 | PY10 Q3 | PY10 Q4 | PY11 Q1 | PY11 Q2 | PY11 Q3 | PY11 Q4 |
|----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| Community Needs Use Cases  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Training materials and online resources |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| XSEDE2 Cybersecurity Plan  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| XSEDE2 Data Management Plan|        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Successor Transition Plan - High Level |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Successor Transition Plan - Detailed |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Appoint XAB Chair          |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Performance management plan|        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Public Wiki page           |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Evaluation and assessment  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Annual XSEDE Highlights    |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Annual Program Plan        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| XSEDE Resource Allocation Awards |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Capability Delivery Plans  |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Software Repository Update |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Project Risk Reviews       |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
| Annual Project Planning    |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |        |

I. Description of the organizational structure of the project team and governance of the project including advisory groups and the processes that facilitate interaction with all external entities

I.1. Project Governance
XSEDE governance delegates decision-making authority to the greatest extent possible, allowing for timely decisions and greater agility in response to opportunities. Making use of the Work Breakdown Structure, which aligns with the organizational structure, each manager of a WBS area has decision-making authority within the scope, schedule, and budget of that WBS area. Decisions are escalated where other WBS areas or budget changes between partner institutions are involved.

The new organizational structure of the XSEDE project allows, in part, for improved communication and interaction between the XSEDE project and the NSF. A careful balance must be struck between the responsibility of the PI and co-PIs and the increased direct
responsibility of L2 Directors to NSF. To this end, weekly communications between the PI, Deputy Project Director, and the NSF CPO will involve the L2 Directors on a rotating basis to ensure clarity in their reporting responsibilities with respect to NSF. To maintain balance, the decision-making process will remain unchanged with the PI holding ultimate authority within the project. The Deputy Project Director will be largely responsible for offloading daily management and some project representation tasks from the PI. The XSEDE Program Manager will be the primary conduit into the project and will frequently communicate project status, risks, issues, accomplishments, and improvements. In addition, the Program Manager will seek direction and recommendations from the NSF on major changes and decision within the project.

XSEDE’s governance model emphasizes documenting activities and decisions and responding to stakeholder needs. XSEDE will continue to use its advisory boards and other input mechanisms, including outreach activities, user engagement efforts, and help requests, to assess stakeholder needs, to prioritize and define impact for these requests, and to ensure that they are implemented within the framework of existing XSEDE best practices. Governance and decision making within XSEDE are made public through the XSEDE Quarterly Reports, and to provide greater transparency in project governance, decisions and decision-making, and in addressing findings and recommendations of review panels, management bodies and advisory bodies, XSEDE will move to using a public project wiki.

As Project Director (PD), Towns with support from the Deputy Project Director (Boerner) will oversee the management of the project as a whole and will direct activities in the XSEDE Program Office. The Co-PIs and Senior Personnel will direct the activities of the Level 2 WBS areas. The XSEDE PI (Towns) and co-PIs (Gaither, Sinkovits, and Blood) hold ultimate authority and responsibility for successful program execution.

I.2. XSEDE Senior Management Team (SMT)
The XSEDE Senior Management Team (SMT), the highest-level management body, will meet biweekly to assess project status, plans, and issues. It is chaired by the Project Director (PI Towns), and includes the Deputy Project Director (Boerner), the WBS Level 2 directors of Community Engagement & Enhancement (co-PI Gaither), the Extended Collaborative Support Service (Co-PI Sinkovits and Co-PI Blood), XSEDE Community Infrastructure (Lifka), XSEDE Operations (Peterson), the Resource Allocations Service (Hart) and the Program Office (Payne). In order to be responsive to both the user community and the set of collaborating SPs, the chairs of the User Advisory Committee (currently Emre Brookes, University of Texas Health Science Center at San Antonio) and the XD Service Providers Forum (currently Ruth Marinshaw, Stanford University) are members of the SMT. These eleven individuals constitute the voting members of the SMT. The Senior Project Manager (Froeschl) is an ex officio, non-voting member of the SMT. The cognizant NSF Program Officer (Chadduck) is also an ex officio, non-voting member. The XSEDE Senior Management team meets on a bi-weekly basis to assess project status, plans, and issues.

I.3. Advisory Bodies

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Stakeholders will have input through three distinct advisory committees that have proved beneficial and will provide guidance on strategy, service, and support priorities for the community.

The XSEDE Advisory Board (XAB) meets semi-annually, either in person or by teleconference, to help ensure that XSEDE is designed to impact a broad range of disciplines, enable both research and education, have broader impacts to society, and have a user community that is diverse (gender, ethnic background, etc.) and includes representation from all types of colleges and universities. The XAB advises in the annual planning process, reviews the annual plans, and recommends strategic directions. While primarily strategic, the XAB may make tactical recommendations that help XSEDE.

The XAB consists of five scientific leaders (selected by the XSEDE management team) from different communities who use XSEDE along with the chair of the UAC and three representatives from the SPF (the SPF chair and two others, self-selected by the Forum). These members are complemented by an additional five senior members of the broader community selected by the XSEDE management team. Members serve two-year staggered terms.

The Chair of the XAB is responsible for ensuring that the XAB meets quarterly and reports back to the XSEDE Senior Management Team the results of the meeting, including any recommendations and/or action items that need attention by XSEDE and the timescale for the action. The Chair will be self-selected by the XAB membership. The selection process will be discussed with NSF. NSF will keep apprised of candidates and the decision process. Comments from the NSF CPO will be considered throughout the selection process. The XAB chair nomination is expected to be provided to the NSF in the Fall of 2016.

The User Advisory Committee (UAC) will meet twice or three times per year by teleconference and consists of 20 active users of XSEDE-allocated resources and services representing the needs and concerns of the community. The committee presents recommendations regarding emerging needs and will review plans and suggested developments. XSEDE will seek input from NSF directorates to include researchers representing each NSF directorate or major division. Members serve two-year staggered terms. The chair, selected by UAC members, will participate in SMT meetings and is a member of the XAB. In addition, they will have the role of User Ombudsperson—the person to whom any user of any XSEDE allocated or supported resource or service can turn if they are not having issues addressed by XSEDE.

The Chair of the UAC is responsible for ensuring that the UAC meets twice or three times per year and reports back to the XSEDE Senior Management Team the results of the meeting, including any recommendations and/or action items that need attention by XSEDE and the timescale for the action. The Chair will be self-selected by the UAC members.

The XD Service Providers Forum (SPF) meets bi-weekly and provides a means by which all Service Providers can voice concerns, make recommendations, and provide feedback on proposed changes to the XSEDE environment, policies, and services. The SPF is more fully defined in the XD Service Providers Forum Charter and the Requesting Membership in the XSEDE Federation as a Service
Provider documents, both available online (www.xsede.org/project-documents). The Service
Provider On-boarding checklist is located on the wiki at:
https://confluence.xsede.org/download/attachments/1671610/XSEDE_ServiceProvider-Checklist-
v2.0.docx?version=1&modificationDate=1468433493813&api=v2

The Chair of the UAC is responsible for ensuring that the UAC meets twice or three times per year
and reports back to the XSEDE Senior Management Team the results of the meeting, including any
recommendations and/or action items that need attention by XSEDE and the timescale for the
action. The Chair will be self-selected by the UAC members and serve a one-year term.

Based on feedback from staff during the preceding award, we will also form an Internal Advisory
Committee (IAC) to give advice on internal matters such as professional development, reporting,
recognition, policies, etc. This committee will be defined in conjunction with the staff to establish a
committee responsive to staff needs.

J. Description of the sub-contracting strategy and controls
All XSEDE procurements will follow the policies of the XSEDE partner institution. For all purchases
made via the University of Illinois, procurements will follow procedures and rules of the University
of Illinois Purchasing Office, which are available on their website at:
https://www.obfs.uillinois.edu/purchases/procedures-rules/

J.1. Capital Items

Only the project director may approve the purchase of capital equipment that is part of the XSEDE
project. Changes to the capital procurement plan may only be made as allowed by the NSF, available
funding, and the approval of the project director.

J.2. Sub-awards
All sub-awards will contain a statement of work (SOW), budget in NSF Form 1030 format, and budget
justification, all of which are submitted through the Sponsored Research Office of the sub-award
institute. The sub-awards will include an executive summary, milestones, deliverables, payment
schedules, and the acceptance and certification criteria for payment. Contractual terms in the NSF
cooperative agreement with the University of Illinois/NCSA will flow down to sub-awardees. Sub-
awardees will submit detailed invoices for payment to NCSA monthly, unless another payment
schedule has been identified in their contracts.

J.3. Consultants
The project director will determine the need, scope, and timing of any consultant services in support
of the XSEDE project and will direct the NCSA finance office to obtain the services under the
University of Illinois procurement process.

J.4. Other Purchases
XSEDE staff may purchase expensed equipment (laptops, cell phones), supplies, and other goods
and services when submitted and approved as part of the materials and supplies portion of the annual budget submission. Purchases of alcohol, business meals, personal gifts, and other like items are prohibited, unless approved in advance by the project director and only if allowed under the University of Illinois’ policies regarding such items. See Section 8.12 and Section 8.13 of the OBFS Business and Financial Policies and Procedures Manual
(https://www.obfs.uillinois.edu/purchases/procedures-rules/).

K. **Description of the financial and business controls to be used**

NCSA will manage the project funds in accordance with Illinois rules and procedures under the day-to-day direction of the NCSA Finance division director. The University of Illinois business procedures are found in its OBFS Policies and Procedures Manual
(https://www.obfs.uillinois.edu/purchases/procedures-rules/).

A budget plan will be established and updated annually. Expenditures will be planned and actual expenses reconciled monthly with the University’s enterprise accounting system, down to Level 3 in the WBS.

Budgets and actual costs will be collected in financial accounts, which correspond with the WBS structure of the project in the Illinois financial system. Elements of costs will also be maintained so that totals for effort, equipment purchases, and other cost categories can be tracked across all WBS elements. Each level 3 WBS manager will be responsible for the charges incurred for their WBS and be responsible for remaining within the budget allocated for their work. The cost incurred at each partner institution will be billed to Illinois and reviewed by the Project Director or Deputy Project Director and the Illinois finance officer. The Project Director or Deputy Project Director, with assistance from the NCSA Finance Division and the Business Operations WBS Level 2 lead will be responsible for reporting project financial information to NSF as required.

L. **Plan for reporting on the technical and financial status of the project**

The XSEDE project will provide interim project and annual reports as designated by the NSF cognizant Program Official with content, format, and submission time line established by the NSF cognizant Program Official. The XSEDE project will submit all required reports via Research.gov using the appropriate reporting category; for any type of report not specifically mentioned in Research.gov, the XSEDE project will use the Interim Reporting function to submit reports.

The interim project report will include monthly expenditures per the NSF 1030 format and by work breakdown structure (WBS) level 2 both per institution and across the project as a whole. Planned versus actual expenditures will be indicated. It should also include detailed descriptions of the progress, achievements, and expenditures of the sub-awardees. Each report must also include relevant performance data.

The Annual Report and Program Plan will also include a detailed plan for the following year and, if necessary, an update to the Project Execution Plan.
**M. Description of anticipated safety or health issues associated with the project, if any**

No health or safety issues are expected in the XSEDE project. Nonetheless, a component of any successful project is to ensure that environment, safety, and health issues are addressed early in a project’s life cycle and fully integrated into all project activities. The project team is committed to providing a safe work environment for all workers and the public. The project team will follow all relevant and applicable safety laws and procedures required by Illinois and the other partner institutions.

**N. Cyber security plan for protecting the confidentiality, integrity and availability of XSEDE resources and services**

XSEDE cybersecurity must support the confidentiality, availability and integrity of XSEDE and XSEDE-allocated resources by: following best practices, employing risk-based approaches, fostering

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**Reporting schedule:**

<table>
<thead>
<tr>
<th>Report</th>
<th>Reporting Period</th>
<th>Report Due</th>
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<tbody>
<tr>
<td>IPR2</td>
<td>Nov. ’16 – Jan. ’17</td>
<td>2/15/2017</td>
</tr>
<tr>
<td>PY6</td>
<td>Sept. ’16 – Apr. ’17</td>
<td>5/15/2017</td>
</tr>
<tr>
<td>IPR3</td>
<td>May ’17 – Jul. ’17</td>
<td>8/17/2017</td>
</tr>
<tr>
<td>IPR5</td>
<td>Nov. ’17 – Jan. ’18</td>
<td>2/15/2018</td>
</tr>
<tr>
<td>PY7</td>
<td>May ’17 – Apr. ’18</td>
<td>5/15/2018</td>
</tr>
<tr>
<td>IPR6</td>
<td>May ’18 – Jul. ’18</td>
<td>8/15/2018</td>
</tr>
<tr>
<td>IPR7</td>
<td>Aug. ’18 – Oct. ’18</td>
<td>11/15/2018</td>
</tr>
<tr>
<td>IPR8</td>
<td>Nov. ’18 – Jan. ’19</td>
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</tr>
<tr>
<td>PY8</td>
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<tr>
<td>PY10</td>
<td>May ’20 – Apr. ’21</td>
<td>5/15/2021</td>
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teamwork throughout the XSEDE team, and integration of new proven cybersecurity technologies, procedures and approaches. The following sections document the XSEDE Cybersecurity Program Plan (CSPP), a comprehensive cybersecurity program for this distributed cyberinfrastructure. Rising to the top of this list are a number of strategies that include:

1. Support for a strong authentication and authorization service that limits access to only legitimate XSEDE users,
2. Coordination of the XSEDE cybersecurity staff among contributing XD and campus Service Providers to develop policies, design secure architectures and review risks,
3. Coordinated incident response and intelligence sharing across Service Providers, trusted partners and other federations,
4. A strong XSEDE cybersecurity education program, and
5. Proactive cybersecurity through careful risk/threat analysis, design and architecture of XSEDE at every level.

Cybersecurity in a highly distributed environment such as XSEDE is built upon the social networking and trust relationships honed over time among the partner cybersecurity staff. During PY6-10, XSEDE cybersecurity will build and improve upon a well-established community of security professionals and many of the successes of the XSEDE PY1-5 cybersecurity program. Successes during PY1-5 include the formation of an incident response team for the coordination of incident response across XSEDE sites and a broadened deployment of a cybersecurity architecture across the growing XSEDE user base. XSEDE will expand the cybersecurity team and draw on the expertise and experience of new individuals.

Additional information can be found in the XSEDE PEP Supplement: Cybersecurity Plan, which will be maintained on the XSEDE Staff Wiki here:
https://confluence.xsede.org/download/attachments/1671245/XSEDE-PEP-CybersecurityPlan-v2.0.pdf?version=1&modificationDate=1468255825449&api=v2

O. Comprehensive performance management plan which supplies reporting data

The XSEDE project currently uses a variety of metrics and KPIs to measure performance against defined strategic goals. While these measures represent the performance of the XSEDE organization and its service areas, they do not adequately represent the impact the XSEDE project has on the research community and science in general. The Strategic Planning, Analysis, and Evaluation team, is charged with the creation of a comprehensive performance management plan detailing the methodology, tools and data sources used to determine the performance of the XSEDE project as well as its impact on the research community. The initial release of this XSEDE Performance Management Plan is expected to be provided to the NSF six months after the award start date.

In addition, an XSEDE Metrics Dashboard will be created to provide access to current and historical metrics and KPIs. This dashboard can be viewed at https://www.xsede.org/web/xsede-metrics/metrics.
The detailed description of the metrics and KPIs can be found at the following link:
https://confluence.xsede.org/pages/viewpage.action?pageId=1671762

P. Description of Project Policies and Standard Operating Procedures
All XSEDE project policies and standard operating procedures are maintained on the XSEDE Staff Wiki. Any changes to these policies and standard operating procedures will be reflected on the XSEDE Staff Wiki located here:
https://confluence.xsede.org/pages/viewpage.action?pageId=1671610