A XSEDE PD1.4 Project Execution Plan

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C Project Execution Plan (PEP) Structure and Use

This Project Execution Plan (PEP) is the governing document that establishes the means to execute, monitor, and administer XSEDE (the eXtreme Science and Engineering Discovery Environment) funded under the NSF TeraGrid Phase III: eXtreme Digital Resources for Science and Engineering program. The PEP serves three basic functions. First, it describes the management and project execution processes that are proposed for management of the project. Second, the PEP establishes the project baselines (technical, schedule, and cost) against which project execution will be measured. Changes to project execution will be evaluated in terms of baseline impacts and through graduated change control authority; appropriate levels of management become involved in decisions regarding project changes. Third, the PEP serves as the primary reference document for all levels of the project team. Technical requirements, policies, procedures for resource allocation, procurement, budgeting and finance work authorization, management reporting, reviews and evaluations, etc., all flow down from the PEP. This PEP is a living document and will be updated to reflect additional information as the project proceeds.

D Background: National Science Foundation 08-571

The purpose of the eXtreme Science and Engineering Discovery Environment (XSEDE) project is to build and support a world-class, comprehensive cyberinfrastructure of advanced digital services. The proposal for this project is being submitted in response to the NSF solicitation 08-571: TeraGrid Phase III: eXtreme Digital Resources for Science and Engineering (XD). Specifically, the XSEDE project will address the delivery of a Coordination and Management Service, an Advanced User Support Service, and a Training, Education, and Outreach Service. As described in the XD solicitation:

"Key attributes of XD will be that:

- It is designed and implemented in a way that is consistent with sound system engineering principles.
- Its design is clearly tied to the user requirements of the science and engineering research community.
- It is implemented using a flexible methodology that permits the architecture to evolve in response to changing user needs.
- By default, it will present the individual user with a common user environment regardless of where the resources being used are located and whence the user is authenticating.
- It will offer a highly capable service interface to "community user accounts," such as science gateways, that encompasses all of the services that are made available to such accounts.
- Its design will cater both to research groups that require very large amounts of computational resources for long periods of time and to individuals who seek to use high-end computation to reduce the time required for running their applications to seconds or minutes so that they can rapidly and interactively explore their research questions.
- Its design will cater to both researchers whose computations require very little data movement and to researchers who are performing very data-intensive computations.
- It will include both a production infrastructure and a small-scale, schedulable test grid. The latter will be available both to the XD operators for testing software and administrative policies with new functionality prior to deployment on the production grid, and as an experimental platform for researchers developing new grid technologies.
- To the maximum extent possible, the initial implementation of the system architecture is designed to exploit existing software technology, with some customization, and does not require the development of new software.
- The underlying mix of computing, storage and visualization hardware is heterogeneous.
- The mix of computing, storage and visualization hardware will change with time."

E Project Description

As we move into a new era of scientific discovery and engineering practice, supported access to an array of integrated and well-supported high-end digital services is critical. The **eXtreme Science and Engineering Discovery Environment (XSEDE)** Partnership will accelerate open scientific discovery and enable researchers to conduct transformational science through the provision, integration, and support of the world's most powerful, comprehensive, high-end, balanced, and usable next generation digital services infrastructure. XSEDE's digital services will be integrated with networking, software, and policies such that researchers can quickly utilize the high-end resources needed for any aspect of their research.

The XSEDE Partnership will be led by NCSA, NICS, PSC, and TACC and includes additional partners who strongly complement their expertise. The team will develop the XSEDE architecture based on a user-driven design, evolving it with emerging requirements and technology opportunities. XSEDE will present a highly coordinated user support program offering an array of services from technology experts—ranging from front-line assistance to advanced support and collaboration—to assist all levels of users. This integrated environment of advanced services will provide an unprecedented opportunity for scientists, engineers, and educators to exploit the powerful digital services for scientific discovery. The partnership will establish persistent connections to the requirements of the open science research and education communities—both current and emerging—through participation in management and oversight, and by regular and transparent means by which users can provide input to the evolution of the XSEDE environment. Thus, XSEDE will not only transform the conduct of science, but be transformed itself by the users and communities who are utilizing it for high-impact research and education.

The great strength in the diversity of existing and future sites and services will be brought together into a single integrated project direction and execution organization that will be responsive to inevitable changes, and thus able to provide long-term management and operations of high-end digital services supporting the continuous advancement of science.

E.1 Science and Education Requirements

XSEDE capabilities will provide high-end, and in some cases unique, capabilities for conducting research that advances knowledge and understanding across all domains of scientific and scholarly investigation. XSEDE will also enable the education and training of larger and more diverse generations of researchers and practitioners. Numerous reports articulate the research and education needs of the community for advanced cyberinfrastructure:

- NSF Report of Blue Ribbon Advisory Panel on Cyberinfrastructure ("Atkins Report," 2004) [1]
- A Science-Based Case for Large-Scale Simulation (SCaLeS, 2003) [2]
- Computational Science: Ensuring America's Competitiveness (2005 PITAC Report) [3]
- Workshop on the Challenges of Scientific Workflows (2006) [4]
- NSF's Cyberinfrastructure Vision for 21st Century Discovery (2007) [5]
- NSF's Cyberinfrastructure Framework for 21st Century Science and Engineering (2010)[6]
- Interim Report of the NSF-OCI Task Force on CyberScience and Engineering, Grand Challenge Communities and Virtual Organization. (April 2010) [7]

In addition, the major science funding agencies—NSF, the Department of Energy (DOE), and the National Institutes of Health—have sponsored a large number of disciplinary workshops on the scientific breakthroughs that might be enabled by petascale (and even exascale) computing. [8,9,10,11,12,13,14,15,16,17] While we build on these results, few have focused on how coupling resources of different kinds enables scientific breakthroughs. We will engage key XSEDE stakeholders to identify the scientific breakthroughs and productivity enhancements that can be enabled by effective coordination of distributed sites with distinct, powerful digital resources and services. These engagements allow us to refine and validate known user requirements and identify new requirements.

The XSEDE Partnership has already designed and executed several processes to solicit stakeholder input and needs. In addition to input via workshops and surveys, we conducted more than 80 interviews of current and potential TeraGrid users, educators, Campus Champions, staff at HPC Centers, campus CIOs, and directors of large-scale national project prior to submission of the XSEDE proposal. During the planning grant period, we formed and consulted an Advisory Council of prominent scientists, educators, technologists, and campus CIOs, and we conducted additional interviews, focus groups, and workshops with various stakeholders at the national and international level (see PD3.5 Input Report and PD6.3 TEOS Requirements Report). The extensive and methodical evaluation of the current and projected needs of the science and engineering research and education communities will persist throughout the life of the XSEDE project.

Clearly, the science requirements for XSEDE include both capability and availability. Most researchers, when asked what they need of something like XSEDE, list these two areas—resources should be more powerful, and there should be more of them—as their top requests. For many users, these are closely intertwined; they do not (yet) need more than the maximum capability of any individual resource, but they often need more than their 'share' (whether through allocations or some other method of sharing access, such as quotas). For some users, however, the maximum size of a system, maximum data set size a system can manage, visualization capabilities, and sufficient access to new technologies (e.g. accelerators) rapidly become limits, and thus their science requirements for maximum potential for transformative science include increasing the scale and diversity of even the most advanced resources. XSEDE itself cannot address the individual resource capability requirements for next-generation science; that is a funding/award issue for the deployment of systems at XD Service Providers. Moreover, the availability issue is linked to the number and scale of systems awarded and deployed at XD Service Providers. However, XSEDE will have impact in the capability and availability requirements through such efforts as:

- Further improving the effectiveness and efficiency of the national allocations process as part of the coordinated management service.
- Increasing the efficiency and scalability of applications and thus increasing scientific capability and/or reducing resource requirements through expert support of the most resource-intensive (usage) applications through targeted advanced user support.
- Increasing the effectiveness of training and education that empower a larger and more diverse community of users to optimize their own applications to increase scalability and improve efficiency (thus reducing resource demands) among current and future generations.
- Improving the efficiency of utilization of the underlying resources through careful auditing of systems performance, utilization, applications performance, and usage patterns.

In addition to the science requirements of capability and availability, both the science and the education usage of XSEDE have requirements in the areas of usability, support, and reliability. Productive use of XSEDE for research demands reliability for even the most savvy users; in practice, this is at least as important as availability, and perhaps as important as capability for users operating at the extreme limit of the most capable systems (for whom nothing else will do, and who will suffer through poor reliability and productivity due to having no other choice). However, poor reliability can also impede the effectiveness of learning activities. Effective training and education activities require the resource to not get in the way of learning (with the exception of the need for learning about reliability issues during which "breaking the system" is integral to the learning process), so that difficult concepts can be mastered on the learner's timescale, not the system's availability schedule.

All our stakeholders require effective user interfaces and support resources: consulting, technical documentation, training, etc. These include:

- Common user environments across resources—as much as possible without impacting performance and reliability. XSEDE will build on the TeraGrid experience to make the User Environment as similar as possible across even very different resources.
- Portals, gateways, problem solving environments, etc. The ideal common environment is customized to the individual stakeholder's role and interests. For some users, this is possible through portals, gateways, and other middleware that manages the underlying resources. Assistance with creating such interfaces is also needed.
- Single points of contact for support, allocations, etc. XSEDE must build upon TeraGrid's very successful coordination of allocations and support and improve on these processes:
  - Allocations information needs to be improved and help users choose resources based on system and applications performance and on projected availability, not just on configurations.
  - Advanced user support needs to enable direct collaboration with a large number of research and education groups at any given time, building relationships.

Of course, effective training, education, and outreach activities are required for both educational activities and for science usage of XSEDE. Training and education activities need to be focused on a set of outreach activities designed to promote the impact and value of XSEDE as an integrated cyberinfrastructure rather than a collection of resources.

E.2 Functional Requirements

The XSEDE Partnership has conducted an extensive and methodical evaluation of the projected digital services needs of the science and engineering research and education communities based on the wide range of input described in §E.1 (also see PD3.1 Requirements, §D.2 The User View of Analysis and Design). The decisions on issues ranging from architectural features to technology selection and deployment to user support mechanisms to training to education and outreach were and will continue to be driven by user requirements. No single requirement was or will be a primary design goal; a balance across all of them is necessary to provide a useful balanced and integrated high-end digital services environment for the science and engineering research community.

A comprehensive specification of XSEDE requirements, including but not limited to functional requirements, is documented in the PD3.7 System Requirements Specification (SRS) document and includes:

- Functional requirements: PD3.7 SRS, §D.1
- External interface requirements: PD3.7 SRS, §D.2
- Quality attribute requirements: PD3.7 SRS, §D.3
- Design constraints: PD3.7, SRS §D.4
- Enterprise requirements: PD3.7 Systems Requirements Specifications, §E

For requirements traceability, see PD3.8 Requirements Traceability Matrices.

E.3 Defining and Evolving the XSEDE Environment

XSEDE has adopted a spiral, incremental engineering approach (see PD3.1 Requirements, §D.4 Combining Spiral and Agile Processes: Avoiding False Choices). Each increment is a circuit through a sequence of process steps that collectively ensure that the functional and quality goals of the increment are satisfied. This approach enables the development teams to maximize parallel development while also compressing the overall schedule.

There are two types of increments defined for XSEDE: development and deployment. Each type adds increased functional capability, increased system quality, or both. They differ somewhat in execution but are primarily distinguished by their overall purpose. Development increments reduce development risk, and deployment increments provide users with capabilities that allow them to pursue their science objectives.

1. Development increments facilitate development activities by allowing manageable steps of activity without subjecting the operational system to frequent disruptive updates. Each increment is focused on specific implementation objectives that enforce a strategy of increasing capability per development cycle, culminating in a measured deployment of capabilities into the operational system during a following deployment increment. These increments implement successive development baselines whose control is the responsibility of the configuration item implementation teams.
2. Deployment increments implement production baselines. They build on intervening development increments, and their conclusion is followed by the systematic deployment of the verified and validated implementation into the operational XSEDE system. Deployment is phased in a manner to minimize disruption to the currently deployed system. The initial integration and testing is carried out in an integration facility, but the testing is completed during deployment to the operational system. The production baseline configuration is managed by the XSEDE Senior Systems Engineer who also performs the job of the Configuration Manager.

The system engineering and architecture teams jointly develop and maintain an integration plan (see PD4.5 Systems Engineering Management Plan, §E.5.4 Identified Increments) as well as a system engineering master schedule (SEMS), which together define the sequence, schedule, and anticipated engineering effort for development and deployment increments through the lifespan of XSEDE. The SEMS will be updated during the detailed planning phase for each increment to accommodate the results of the previous increment as well as any changes to the requirements baseline that may have occurred during the prior increment. Table 1 provides a capsule summary of the currently planned increments and their purposes.

Table 1: Spiral Development and Release Plan

Increment	Purpose
V0.1. See PD4.5 SEMP, §E.5.4.1 (Completed)	Increment 0.1 is a <u>development</u> increment. The goal was to test standards-based interoperability between Genesis II and UNICORE 6. While interoperability tests between UNICORE 6, Genesis II, UK GridSAM, BES++, ARC, and gLite (CREAM) had been done in the past as part of various interoperability demonstrations, they had never been done with an eye toward production integration.
V0.2. See PD4.5 SEMP, §E.5.4.2 (Completed)	Increment 0.2 is a <u>development</u> increment. The goals of the 0.2 increment were: 1) to demonstrate that the XSEDE architectural approach of an artful mixture of standards-compliant stacks works at a larger scale than tested in increment 0.1; 2) to demonstrate campus bridging; 3) to uncover problems and identify risks in our architectural plan; 4) to begin testing the realization of the architectural use cases; and 5) to begin performance and availability studies.

Increment	Purpose
V0.3. See PD4.5 SEMP, §E.5.4.3	Increment 0.3 is a development increment. It builds upon the increment 0.2. The increment: 1) tested code modifications made by the UNICORE 6 team; 2) demonstrated the transition strategy for science gateways with the RENCI Biomedicine and BioPortal Science Gateway; and 3) took quality of service measurements for the GFFS and the meta-scheduler[1]. During this increment we came to consensus with the UNICORE 6 team on how to move forward with SAML interoperability and InCommon. A prototype mechanism to support Condor/DAGMAN jobs was also developed.
V0.4. See PD4.5 SEMP, §E.5.4.4	Increment 0.4 is a development increment. It builds on the capabilities integrated in increment 0.2 and focuses on changes to prepare the transition of TeraGrid to XD. Planning and agreements reached during this increment will provide developers and system operators with sufficient information to enable the transition of operational capability with minimal disruption to ongoing operations.
V1.0. See PD4.5 SEMP, §E.5.4.5	Increment 1.0 is a deployment increment. This is the first increment that will deliver capability to the operational system establishing XSEDE's initial operating capability (IOC). Functional capabilities that will be supported in production baseline 1.0 are largely those that are currently operational in the TeraGrid Phase II system. This system will, however, be based on the XSEDE system architecture.
V2.0. See PD4.5 SEMP, §E.5.4.6	Increment 2.0 is a deployment increment. Application capabilities included in this increment include enhancements moving beyond the TeraGrid Phase II capabilities deploying, for the first time, unique XSEDE capabilities.
V3.0. See PD4.5 SEMP, §E.5.4.7	Increment 3.0 is a deployment increment that ends the initial development phase of the award and begins the sustainment phase. V3.0 adds significant new functionality which will enable the operational system, after which it will support all capabilities identified in the initial requirements and mapped to requirements baselines 1.0, 2.0, and 3.0. Additional requirements elicited beyond this point will be managed as part of sustainment activities for XSEDE. This step is the final step on the transition path to XSEDE from the current TeraGrid, establishing the final operating capability (FOC) for the initial deployment of the XSEDE environment.

E.4 Integration of New Capabilities into the XSEDE Environment

The integration plan describes how the products of each development cycle in the XSEDE spiral development process will be tested and integrated into the XSEDE operational environment. The integration plan has a major goal of minimizing disruption of access and services of XSEDE to the researchers and educators who use XSEDE resources and services. The integration plan will be continually updated based on changing requirements. These requirements changes are driven by evolving needs of existing XSEDE users and by the needs of new users or user communities. Additional increments will be defined and included in the integration plan as development of XSEDE proceeds. Near term increments are more completely identified and defined than increments scheduled farther into the

[1] The Global Federated File System (GFFS) is the term used in the XSEDE proposal to denote a level-3 cross-organizational file system.

future. This is driven in large part by the higher level of uncertainty in long-term planning. This uncertainty is reduced as development proceeds, as more is learned about the system and requirements uncertainty is resolved.

E.4.1 Assuring Quality and Establishing Operational Readiness Criteria

Operational (sometimes called “acceptance”) testing is focused on the validation of the system. This means that the system as a whole entity is assessed as to how well it meets the business and mission goals for the system.

This type of testing is undertaken only on deployment increments (see Table 1: Spiral Development and Release Plan). It is a way to ensure that not only have the developers met their requirements but also that the correct set of requirements, those which enable the system to meet the stated goals, have been identified. With the system in operation, the full measure of how capabilities, and the requirements that specify them, interact with each other can be taken. This provides a perspective that is not available when requirements are validated early in the project, by examining needs in isolation, or with only limited knowledge of how they interact or depend on one another.

Each *deployment* increment (see PD3.1 Requirements, §D.4 Combining Spiral and Agile Processes: Avoiding False Choices) includes a Test Readiness Review (see PD4.5 Systems Engineering Management Plan, §D.5.8.4 Test Readiness Reviews) that verifies that all unit tests have been conducted, all operational test plans and procedures have been documented, and all test criteria have been defined (see PD4.5 Systems Engineering Management Plan, §E.4.1.3 Operational Monitoring and Testing). Test criteria are drawn from several sources. The most prominent are:

- Functional and “quality attribute” requirements documented in the system requirements specification.
- System analysis, for example the technical performance measures (TPMs, see PD4.5 Systems Engineering Management Plan, §D.5.7 Technical Performance Measurement) derived from XSEDE System and System of Systems (SoS) quality attribute scenarios (for an example of a refined scenario, see PD3.1 Requirements, §D.3.2 Architectural Approaches to Quality Attribute Analysis).
- Work products consequent to the development of software, for example test scaffolding and instrumentation, test scenarios, and data sets for robustness or “stress” tests.
- Usability panels (see PD4.5 Systems Engineering Management Plan, §D.5.8.6 Usability Panels) that meet regularly during development and deployment increments to assess the ability of the XSEDE system to meet user expectations and perform user acceptance testing on deployed releases.

Following the completion of system integration and testing, a deployment plan will be created that describes the procedures and steps to be followed in the installation of the increment into the XSEDE operational system (see PD4.5 Systems Engineering Management Plan, §E.5.1.2.7 Deployment Planning). The deployment plan will include acceptance testing in the final stages of deployment of new capabilities and services into the production XSEDE environment (see PD5.3 XSEDE Operations Plan, §C.4.2 Acceptance Testing of New XSEDE Capabilities) and provide for minimal disruption to XSEDE operations consistent with timely installation. It will identify any components to be installed or removed at specific Service Provider sites, components currently installed at Service Provider sites that will not be changed, any materials required for the installation (per Service Provider site), XSEDE and Service Provider personnel required for the installation, any testing activities to verify proper installation, and a schedule for the installation. The planning will also examine version numbers of all installed components at all affected sites in the operational system and make sure that those components that will not be replaced at a site are consistent with the versions of new components that are to be installed at that site.

The plan will also include provisions for backing out the installed components should problems occur (see PD4.5 Systems Engineering Management Plan, §E.5 System Integration Plan).

Table 2 summarizes the operational readiness criteria currently defined for deployment increments. Additional technical performance measures will be defined throughout the development process, and the scheduling of when each technical performance measure will be satisfied may change. It is important to note that job failure rate is a measure of job failures due to the XSEDE infrastructure and services, and it does not include job failures once the job is under control of the Service Provider's local infrastructure and services.

Table 2: Operational Readiness Criteria

Deployment Cycle	Common Readiness Criteria	Technical Performance Measures (T = Threshold, G = Goal)	
V1.0	• Test readiness review passed. • All test procedures executed. • All test issues resolved. • Usability panel concurrence. • Deployment plan completed.	• Concurrent Jobs Per Resource (upper bound) • Concurrent Jobs Per User Per Resource (upper bound) • Job Failure Rate (Normal)	• 4096 (T) • 1024 (T) • 0.5% (T)
V2.0		• Job Failure Rate (Interrupted) • Unattended Running Period • Job Failure Notification Delay	• 0.5% (T) • 5 days (T) • 15 min (T)
V3.0		• Urgent Job Submission Delay • Federation Cluster Setup Time • Catastrophic Failure Detection	• 60 min (G) • 60 min (G) • Detect: 10 min (T)

E.4.2 Assuring Non-Disruptive Rollout

To ensure non-disruptive rollout of production releases, pre-deployment testing will be carried out on development resources and FutureGrid resources. After successful testing, deployment and acceptance testing will happen in the production environment. Benchmarks will be rerun on the system, and full regression testing will be used to ensure continuous quality assurance. A usability panel will participate during acceptance testing to evaluate overall capabilities of the system and how well usability requirements–including non-disruption of existing users–have been met.

E.5 Project Deliverables

The XSEDE project will be focused on and committed to providing deliverables that respond to the extensive list of requirements identified in §E.2 and detailed in PD3.7 Systems Requirements Specification (SRS). A number of deliverables will be available upon initiation of the XD award while others will be executed during the first year of the XSEDE project. Each year after Year 1, the project will use the requirements gathering mechanism described in PD4.5 System Engineering Management Plan (SEMP) and captured in the IBM Rational® DOORS® database to determine the deliverables for the next year. This section describes the major deliverables for project initialization and Year 1.

Table 3: XSEDE Major Deliverables.

ID	Name	Date
1.1.1.1	Initial Project Planning Documents	Initial
1.1.1.2	Annual Budget	Yearly
1.1.1.3	Quarterly and Annual Reports	Quarterly/Yearly
1.1.1.4	Risk Register Review	Quarterly
1.1.2.1	Systems Engineering Management Plan (SEMP)	Initial
1.1.2.2	Requirements Baseline and Distributed Requirements Management Tools	Initial
1.1.3.1	Deploy Grid Middleware Infrastructure	Initial
1.1.3.2	Deploy Data Management Software	Year 1
1.1.3.3	Deploy Account Management Software	Initial
1.1.3.4	Deploy Information Services Infrastructure	Initial
1.1.3.5	Deploy Common User environment	Initial
1.1.3.6	Deploy System of Systems Test Environment	Initial
1.1.4.1	Publications: Highlights (Science, EOT, Annual Conference Proceedings)	Yearly
1.1.4.2	XSEDE website	Initial
1.1.4.3	Press releases and website content	Ongoing
1.1.5.1	Elicit workforce development needs from industry partners	Yearly
1.1.5.2	Co-developed marketing materials to attract small and medium enterprises	Year 1
1.1.5.3	Increase awareness of training opportunities to industry partners	Ongoing
1.1.5.4	Solicit industry proposals for software co-development project	Year 1
1.1.5.5	Select industry partner and execute software co-development project	Yrs 1 - 3
1.2.1.1	Deploy XSEDE Certificate Authority (CA)	Year 1
1.2.1.2	Develop Security Awareness Program	Year 1
1.2.1.3	Deploy Security Authentication Program	Year 1
1.2.1.4	Deploy Security Tools	Year 1
1.2.1.5	Deploy Security Infrastructure	Year 1
1.2.1.6	Deploy InCommon Federated Authentication service	Year 1
1.2.2.1	Deploy global parallel file system	Year 1
1.2.2.2	Design archival replication framework	Year 1
1.2.3.1	Maintain and monitor XSEDEnet	Ongoing
1.2.3.2	Tune end-to-end performance	Ongoing
1.2.3.3	Upgrade XSEDEnet to include peering with an R&E network	Year 1
1.2.4.1	Test and deploy XSEDE software	Ongoing
1.2.5.1	Maintain accounting and account management databases	Ongoing

ID	Name	Date
1.2.5.2	Provide usage reports as required	Ongoing
1.2.6.1	Provide Frontline User Support 24x7 XSEDE Operations Center (XOC)	Ongoing
1.2.6.2	Deploy and support XSEDE System Infrastructure	Ongoing
1.2.6.3	Support Deployed Security Tools/Infrastructure	Ongoing
1.2.6.4	Report Operational Metrics	Yearly
1.3.1.1	Develop 10 Training Modules	Yearly
1.3.1.2	Conduct 50 Training Sessions	Yearly
1.3.1.3	Provide On-line Training Tutorials	Ongoing
1.3.2.1	Deploy XSEDE User Portal (XUP)	Initial
1.3.2.2	Deploy XUP Capabilities – Ticket System, User News, User Guides, Mobile Portal, Social Media, Training Delivery System, User Collaborative Tools	Year 1
1.3.3.1	Annual User Survey	Yearly
1.3.3.2	Deploy CRM (Customer Relations Management) System	Year 1
1.3.3.3	User Engagement Data Mining	Ongoing
1.3.3.4	User Focus Group meetings	Quarterly
1.3.3.5	SC Birds-of-a-Feather session	Yearly
1.3.3.6	XSEDE Conference Birds-of-a-Feather session	Yearly
1.3.3.7	Conduct Usability Panels	Ongoing
1.3.4.1	Allocations Policy	Initial
1.3.4.2	XSEDE Resource Allocation Meetings (XRAC)	Quarterly
1.4.1.1	Support 20 Advanced Research Projects	Yearly
1.4.1.2	Create Advanced Research Work Plans	Yearly
1.4.1.3	Advanced Research Project Final Reports	Upon Completion
1.4.2.1	Support 20 Advanced Community Capabilities	Yearly
1.4.2.2	Create Advanced Community Capabilities Work Plans	Yearly
1.4.2.3	Advance Community Capabilities Final Reports	Upon Completion
1.4.3.1	Contribute content for 50 TEO modules	Yearly
1.4.3.2	Support 50 ASTEO projects	Yearly
1.4.4.1	Generate 20 Innovative & Novel Projects	Yearly
1.5.1.1	2 HPC Graduate Level Summer Schools	Yearly
1.5.1.2	5 Summer Workshops	Yearly
1.5.1.3	Launch Certificate Program (Specific Universities)	Ongoing
1.5.1.4	Provide Online Educational Services	Ongoing
1.5.2.1	10 Campus visits	Yearly

ID	Name	Date
1.5.2.2	10 National/Regional Presentations	Yearly
1.5.2.3	2 Targeted Community Workshops	Yearly
1.5.2.4	Develop Mentor Listing	Ongoing
1.5.2.5	Match Mentors with Mentees	Ongoing
1.5.2.6	Recruit 20 Students for Training/Mentoring/Internship	Yearly
1.5.2.7	Increase Membership in Campus Champions Program	Ongoing
1.5.3.1	Independent Evaluator Reports	Quarterly
1.5.3.2	Consultation with TEOS Advisory Group	Semi-annual

E.5.1 Physical Infrastructure Required by XSEDE

To meet the functional requirements for XSEDE, there are three sets of additional physical infrastructure that are necessary:

1. User Support Services: This group of services is deployed for the direct support of all users of XSEDE resources. This set of services includes allocations request processing, account creation and deletion, usage tracking, the ticket system and help desk, user news and mailing lists, the user portal, website, and documentation. These require servers for both the necessary databases and web interfaces.
2. Grid and Data Infrastructure Services: This set of services includes grid identity management, grid information and file management, monitoring and event logging, grid namespace management, security management, replication management and grid job management. It is necessary to support the XSEDE grid infrastructure. These require server systems to host the essential databases and grid interfaces.
3. Networking: This set of services includes grid network resource provisioning and network resource management and is necessary to support the XSEDE grid infrastructure. These require a centralized hub at Chicago/Starlight plus the necessary interfaces to research and educational networks.

For further details see PD5.3 XSEDE Operations Plan.

E.6 Project Constraints

The successful completion of the deliverables for this project depends critically on the following factors:

1. XD Service Providers will have independent contracts, and the XSEDE project cannot dictate to them how local resources will be configured and managed. XSEDE will mitigate this constraint by utilizing agreements (see PD4.4 PEP Supplement: Project Planning, Management and Execution, §D Management of Formal Relationships), giving service providers a voice in decision-making via the XD Service Provider Forum (§F.6.2), and working with NSF.
2. Most resources available to XSEDE will be acquired by the Service Providers but must be dynamically matched with the XSEDE user community’s interests and plans. XSEDE will mitigate this constraint by publishing the allocations policy, maintaining documentation, and developing a smart metascheduling capability.
3. XD Service Providers provide staff to participate in all the required XSEDE project teams and sub-teams. XSEDE will mitigate this constraint by utilizing agreements (see PD4.4 PEP Supplement: Project Planning, Management and Execution, §D Management of Formal

Relationships), giving service providers a voice in decision-making via the XD Service Provider Forum (§F.6.2), and working with NSF.

4. XSEDE must continue to support existing applications and users with minimal changes to their software applications or hardware changes to their systems. XSEDE will mitigate this constraint by including an overlapping period of supporting TeraGrid legacy systems while implementing and transitioning users to the XSEDE Architecture (see PD4.5 Systems Engineering Management Plan, §E.3.9 Backwards Compatibility and Resource Sharing).
5. Components used by XSEDE or incorporated into systems with which XSEDE interoperates may implement standards differently since most standards allow for alternate interpretations or provide options that can be chosen differently by implementers. XSEDE will have to be tolerant of alternate implementations of the standards that it adopts. XSEDE will mitigate this constraint using system-of-systems testing via the FutureGrid testbed (see PD4.5 Systems Engineering Management Plan, §E.5.4.7.3 Integration Requirements).
6. The schedule of deliverables depends on the ability to deploy some architecture components and transition some core service components prior to the start date of the award and depend on the cooperation of existing TeraGrid Service Providers. XSEDE will mitigate this constraint by having a fully developed Project Execution Plan delivered with the full proposal in July, 2010.
7. Existing gateways or workflows are to transition to new architecture methodologies while legacy TeraGrid middleware platforms (for example, Globus) are to be retired. XSEDE will mitigate this constraint by its integrated approach to Training and Advanced User Support that will provide support and training to existing gateways and workflows to transition effectively.
8. Interoperability issues and technical details of federated identity and authentication (for example, SAML extension format) will be resolved using InCommon Federation or other mechanisms as identified and adopted to achieve the goals of XSEDE reaching the identity and authentication capabilities of university campuses and research groups. XSEDE will mitigate this constraint by utilizing agreements (see PD4.4 PEP Supplement: Project Planning, Management and Execution, §D Management of Formal Relationships) and deploying a standards-based architecture (see PD2.3 XSEDE Architecture, §C.1.1 Design Themes),
9. XSEDE-funded network assets will provide a baseline level of network performance of 10Gbps. It is anticipated that spikes of network bandwidth demand exceeding this may occur. XSEDE will mitigate this constraint by exploring deployment of state-of-the-art technology for exploiting dynamic bandwidth between sites (see PD5.3 XSEDE Operations Plan, §C.3 XSEDEnet).
10. Last mile networking issues are affected by local network capacities at campus, gateway, or other user sites. These capacity issues must be addressed in order to achieve networking related performance targets. XSEDE networking staff will consult with end users to understand end-to-end network performance issues and provide advice to local network engineers to address local network issues (see PD5.3 XSEDE Operations Plan, §C.3.1 Remote Access).
11. The AUSS staff's distribution of expertise among application and technology areas must be dynamically matched to evolving XSEDE capabilities and research teams' interests and plans. XSEDE will mitigate this constraint by allocating a portion of the AUSS budget to be used to fund experts as needed and having a process by which we can add expertise to the AUSS team rapidly in response to this type of need (see PD3.3 AUSS Plan, §C.1 Introduction and Summary).
12. Availability of resources that are required to develop specific solutions for particular community needs is limited. XSEDE will mitigate this constraint via an annual planning process to allocate budget and staff resources to develop solutions for users prioritized by the processes defined in PD4.5 Systems Engineering Management Plan including input and review by the User Advisory Committee and the XD Service Providers Forum.

F Project Governance

The XSEDE project is managed by the University of Illinois (Illinois/NCSA) with key partnerships (via sub-awards) to the University of Tennessee at Knoxville (UTK/NICS), University of Texas at Austin (UT Austin/TACC), MPC/Carnegie Mellon University/University of Pittsburgh (PSC), and University of Virginia (UVa), and other partners who strongly complement their expertise. Illinois will ensure that a project governing structure, which promotes efficient and effective project performance, is in place throughout the award period to support all project activities. Illinois is responsible for the satisfactory execution of the project, for the management and oversight of sub-awards, subcontracts, and procurements, and for the submission of timely and complete reports as requested by NSF. The project team consists of highly qualified senior staff members with extensive and current experience executing large projects, high-performance computing operations, and distributed environments.

Figure 1 shows the project organization chart, and it includes the project's relationship with the various advisory committees.

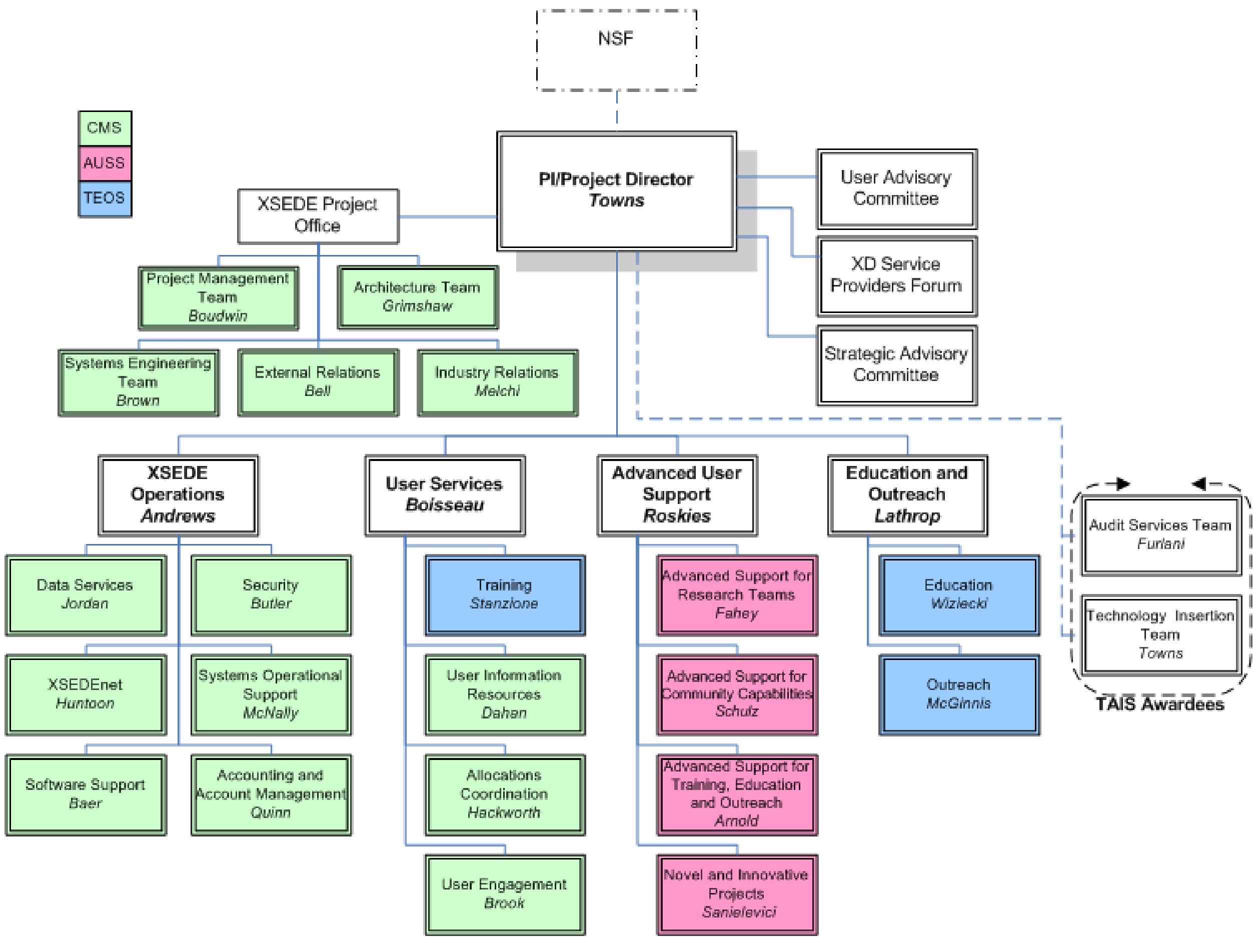

Figure 1: XSEDE Project Organization Chart

As indicated in Table 4, the project team consists of highly qualified senior staff with extensive and current experience executing large projects and high-performance computing operations. In addition, Table 5 indicates the additional personnel required to implement the design and to sustain operation of XSEDE.

Table 4: XSEDE Primary Personnel.

Name	Title/Organization	XSEDE Responsibilities	FTE
John Towns	Senior Associate Director, Persistent Infrastructure Directorate, National Center for Supercomputing Applications (NCSA), University of Illinois	Principal Investigator Project Director	0.90
Phil Andrews	Project Director, National Institute for Computational Sciences (NICS), University of Tennessee	Co-PI Operations Director	0.50
Patricia Kovatch	Assistant Project Director, NICS, University of Tennessee	Senior Personnel Operations Deputy Director	0.50
Jay Boisseau	Director, Texas Advanced Computing Center (TACC), University of Texas, Austin	Co-PI User Services Director	0.50
Chris Hempel	Associate Director, Resources & Services, TACC, University of Texas, Austin	User Services Deputy Director	0.75
Ralph Roskies	Co-Scientific Director, Pittsburgh Supercomputing Center (PSC), Professor of Physics , University of Pittsburgh	Co-PI Advanced User Support Director	0.50
Sergiu Sanielevici	Director Scientific Applications and User Support, PSC, Carnegie Mellon University	Senior Personnel Advanced User Support Deputy Director	0.75
Scott Lathrop	Blue Waters Technical Program Manager for Education, Shodor	Senior Personnel Education and Outreach Director	0.50
Michael Levine	Co-Scientific Director, PSC, Professor of Physics, Carnegie Mellon University	Senior Personnel	0.10
Kathlyn Boudwin	Deputy Project Director, Leadership Computing Facility, Oak Ridge National Laboratory	Senior Personnel Senior Project Manager	0.50
Tim Cockerill	Senior Project Manager, NCSA, University of Illinois	Senior Personnel Assistant Project Director Deputy Project Manager	0.50
Janet Brown	Network Research Manager, PSC, Carnegie Mellon University	Senior Personnel Senior Systems Engineer	0.90
Kurt Wallnau	Senior Technical Staff Member, Software Engineering Institute (SEI), Carnegie Mellon University	Senior Personnel Deputy Systems Engineer	0.80
Andrew Grimshaw	Professor, Department of Computer Science, University of Virginia (UVa)	Senior Personnel XSEDE Architect	0.50
Victor Hazlewood	Senior HPC Systems Analyst, NICS, University of Tennessee	Deputy XSEDE Architect	0.25
Bill Bell	Division Director, Public Affairs, NCSA, University of Illinois	External Relations Manager	0.25
John Melchi	Senior Associate Director, Administration Directorate, NCSA, University of Illinois	Industry Relations Manager	0.20
Randy Butler	Director, Cybersecurity Directorate, NCSA, University of Illinois	XSEDE Security Officer Cybersecurity Manager	0.25
Chris Jordan	Senior Operating Systems Specialist, TACC, University of Texas, Austin	Data Services Manager	0.50

Name	Title/Organization	XSEDE Responsibilities	FTE
Wendy Huntoon	Director of Networking, PSC, Carnegie Mellon University	XSEDEnet Manager	0.25
Troy Baer	HPC Systems Administrator, NICS, University of Tennessee	Software Support Manager	0.50
Steve Quinn	Technical Program Manager, NCSA, University of Illinois	Accounting and Account Management Manager	1.00
Steven McNally	HPC Systems Administrator, NICS, University of Tennessee	Core Services Manager	0.50
Dan Stanzione	Deputy Director, TACC, University of Texas, Austin	Senior Personnel Training Manager	0.50
Maytal Dahan	Software Developer, TACC, University of Texas, Austin	User Information Resources Manager	0.50
Glenn Brook	Computational Scientist, NICS, University of Tennessee	User Engagement Manager	0.50
Ken Hackworth	Allocations Coordinator, PSC, Carnegie Mellon University	Allocations Coordinator	0.80
Mark Fahey	Scientific Support Group Leader, NICS, University of Tennessee	Advanced Support for Research Teams Manager	0.50
Karl Schulz	Associate Director, Applications Collaborations, TACC, University of Texas, Austin	Advanced Support for Community Capabilities Manager	0.50
Galen Arnold	System Engineer, NCSA, University of Illinois	Advanced Support for Training, Education, and Outreach Manager	0.50
Edee Wiziecki	Education Programs Coordinator, NCSA, University of Illinois	Education Manager	0.20
Laura McGinnis	Manager Education and Training, PSC, Carnegie Mellon University	Outreach Manager	0.50

Table 5: XSEDE Additional Personnel.

Other Personnel	*FTEs (not included above)*
Finance and Administration	0.50
Project Management	3.50
Systems Engineering Staff – Systems Engineers	0.90
Architecture Staff – SW Developers	5.00
Architecture Staff – Engineers	3.00
Security Staff - Engineers	3.75
Allocations Staff	1.45
Account Management – SW Developers	2.50
User Information Resources – SW Developers	3.25
User Consultants	3.50
Network – Engineers	2.50
Operations Center Staff	5.10
Operations – Engineer	0.25
System Administrators	2.50
Software Support - Software Engineers	2.50
Data Services – Engineers	2.00
External Relations – Science Writers	2.00
External Relations – Media/Webmaster	3.00
Industry Relations – Business Development Professionals	0.80
AUSS Scientific Applications Specialists	36.00
Training Staff	4.25
Education Staff	3.75
Outreach Staff	3.50
Evaluation Staff	0.35

F.1 Key Roles and Activities

The Project Director (PD) will oversee the management of the project as a whole and direct the activities in WBS 1.1, XSEDE Project Office. The Co-PIs will direct the activities of WBSs 1.2, 1.3, and 1.4 as identified in Table 2. WBS 1.5 will be managed by a senior management team member.

F.1.1 XSEDE Senior Management Team

The XSEDE project is managed by a senior management team consisting of: the PI/Project Director (Towns), the directors of XSEDE Operations (Andrews), Users Services (Boisseau), Advanced User Support (Roskies), Education and Outreach (Lathrop), the Senior Project Manager (Boudwin), the Senior Systems Engineer (Brown), the Chief Architect (Grimshaw), the Chair of the User Advisory Committee (TBD), and the Chair of the XD Service Providers Forum (TBD). The senior management team will meet on a bi-weekly basis to assess project status, plans, and issues. This team is constituted from those responsible for the day-to-day operation of the project and is the highest level management body in the organization. In order to be responsive to both the user community and the set of Service Providers with whom we will collaborate, the chairs of the User Advisory Committee and the XD Service Providers Forum are members of this team.

F.2 Internal and Institutional Oversight

Internal and institutional oversight will be provided by the management team at Illinois in cooperation with the partners. Each partner institution will provide institutional oversight to the WBS elements and subcontracted activities covered by each work scope assigned at level two of the WBS. Oversight includes insuring that all work is done in accordance with the institutional guidelines for business rules, scientific integrity, quality, cost, and safety.

The University of Illinois is a public institution and part of the body politic of the State of Illinois. Several state offices and agencies have responsibility to ensure the ethical conduct and wise use of public funds at all state entities, including the university. Institutional Oversight at the University of Illinois Urbana-Champaign (UIUC) begins with the Board of Trustees of the University of Illinois, with authority for day-to-day operations and oversight delegated to executive management and administrative units at the university and at each separate campus.

Most business functions, including contracting, purchasing, accounting and payables are conducted through the University Associate Vice President and Chief Financial Officer, and the Office of Business and Financial Services, with support from University Counsel. At UIUC, the Office of the Provost and the Office of the Vice-Chancellor for Research, provide oversight for scientific integrity, responsible management of grant funds, operation of campus infrastructure and facilities, and the ethical conduct of the faculty and staff of the campus and university. Rules, policies and procedures are found in several university and campus documents and the Office of University Audits has the responsibility for assessing the effectiveness of university and campus oversight and reviewing university operations and internal controls on a continuing basis.

F.3 Succession Planning

The PI and Co-PIs represent their respective institutions on the XSEDE project. If a replacement is required for these key team members, one will be provided by the institution that is represented by that person. This will be done with concurrence from NSF. The Project Director is a position within the XSEDE project and can be filled by any one of the PI or Co-PIs or selected through Illinois with the PI and Co-PIs contributing to the hiring decision process. If a replacement is required for other management positions within XSEDE, an internal committee will be formed to identify potential candidates and make recommendations to the XSEDE senior management team (§F.1.1).

F.4 Organization and Technical Interfaces with Others

While XSEDE is a well defined virtual organization, there is an extended set of partners with whom XSEDE will have various relationships. The extended organization created by the amalgamation of XSEDE and other separately funded bodies will be referred to as the XSEDE Federation. The relationship between XSEDE and various partners will range from intimate (TAIS Technology Insertion Service (TIS)) to definite (XD Service Providers, TAIS Technology Audit Service (TAS), CI providers, vendors), to possibly peripheral (some entities in other countries). All formal relationships will be documented via agreements that must cover a wide spectrum in both the services and responsibilities involved. Many of these agreements will be specific to the particular partner, but we categorize them into a small number of groups, based on the type of partner. These agreements will form the underpinnings of a pervasive cyberinfrastructure ecosystem.

The types of agreements anticipated by XSEDE are described in more detail in PD4.4 PEP Supplement: Project Planning, Management and Execution, §D Management of Formal Relationships.

F.5 External Oversight

XSEDE is a complex project and needs external oversight and advisory mechanisms to ensure: a) timeliness and technical quality in design and implementation, b) relevance and usability of the resources and services provided to the community, and c) effective synergy with the other cyberinfrastructure initiatives within the nation and around the world. External oversight will be provided to the project through various reviews sponsored by NSF anticipated to occur annually. NSF will review all aspects of the project including schedule, costs, technology, personnel, execution, and strategy. NSF will formally notify the PI/PD of reviews at least 90 days prior to each event.

F.6 Advisory Bodies

The XSEDE governance model is geared towards inclusion of, and responsiveness to, users, resource providers, and the NSF scientific community. The various stakeholders will have input through three distinct advisory bodies, which have direct access to the XSEDE Project Director and the XSEDE senior management team through regularly scheduled meetings. In order to remain well informed of the requirements of the user community, XSEDE leadership will receive advice and counsel from the User Advisory Committee, the XD Service Providers Forum, and the Strategic Advisory Board. These advisory committees will be intimately involved with XSEDE management in guiding the project towards optimal operations, service, and support for users.

Special advisory subcommittees may be convened to address specific topics as they arise. Each will be headed by an advisory committee member and may include members outside of the established advisory committees. A subcommittee of the Strategic Advisory Board on Training, Education, and Outreach has already been established.

F.6.1 User Advisory Committee

The **User Advisory Committee (UAC)** will comprise members of the national community who represent the needs and requirements of the research and education community and will provide guidance with respect to how the activities and plans of XSEDE can better serve those needs. UAC members will be selected by the XSEDE senior management team from the user and prospective user communities. Senior management will seek input from NSF directorates in order to include a wide variety of users representing each NSF directorate or major division. The User Advisory Committee members will number approximately 20 and will select the committee’s chair. The committee will represent the “user’s voice” to XSEDE management, presenting recommendations regarding emerging needs and services and acting as a sounding board for plans and suggested developments in the XSEDE environment and services. They will be both a source of input as well as a means of validating XSEDE plans. This committee will meet quarterly. The chair of this committee will also participate in regular XSEDE senior management meetings.

F.6.2 XD Service Providers Forum

The **XD Service Providers Forum** will consist of representatives from all XD Service Providers and other XD program awardees. The chair will be selected by the committee members but will exclude from consideration representatives from the XSEDE proposing institutions. The forum is the means by which all Service Providers have input into the management of XSEDE and will present issues, recommendations, and feedback on proposed changes to the XSEDE environment to XSEDE management. This committee will meet quarterly. The chair of this committee will also participate in regular senior management meetings.

F.6.3 Strategic Advisory Board

The **Strategic Advisory Board** will include highly respected leaders from academia, industry, national laboratories and other federal agencies. Input on membership will be solicited from the user community, NSF, and leadership of other CI projects such as OSG, LIGO, LHC, DEISA, NAREGI, and others. The committee members will select a chair. The committee will advise XSEDE senior management on current and possible new strategic directions. It will meet semi-annually and act as a high-level board to advise XSEDE senior management on vision and planning.

F.7 Internal Project Communication

In general, this distributed project must communicate frequently and thoroughly in order to provide the aforementioned deliverables and to recognize opportunities and risks early. Enabling open dialog promotes awareness of current activities and future plans, facilitating consensus building by including XSEDE personnel as well as NSF and Advisory Committee Chairs. There will be extensive communications vertically and horizontally across the organization. To facilitate this communication, the XSEDE project will engage in the following events in addition to the other NSF mandated activities:

1. Quarterly meetings with XSEDE WBS managers, NSF, and Advisory Committee Chairs.
2. Fortnightly XSEDE Senior Management Team meeting to assess project status, plans, and issues.
3. An access-controlled collaboration support framework available to all team members that contains important project documents, tracks important conversations, and acts as a clearinghouse for other project documents and media.
4. Multiple, private project email lists for project communication.
5. Meetings by WBS area with attendees from other WBS areas to ensure cross-cutting issues are managed.
6. Project-wide and open meetings including the annual XSEDE Conference that continues and builds on the annual TG Conference and a bi-monthly video conference for all stakeholders.

These activities will be organized and maintained by XSEDE Project Management (WBS 1.1.1) and are documented in PD5.2 Communication Plan.

F.8 Reporting

The XSEDE project will provide *ad hoc* and regular 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 FastLane using the appropriate reporting category; for any type of report not specifically mentioned in FastLane, the XSEDE project will use the Interim Reporting function to submit reports.

The XSEDE project will provide the NSF Program Official with a quarterly progress report that includes monthly expenditures. The quarterly progress report will also include detailed descriptions of the progress, achievements, and expenditures of the sub-contracts.

Annually, one of the quarterly progress reports will include a detailed plan for the following year, and, if necessary, an update to the Project Execution Plan, Project Schedule, budget, and any other related documents.

Included in the annual report will be a self-evaluation of the project based on the Baldrige National Quality Program criteria[18]. The self-evaluation will

- Describe how senior leaders' actions guide and sustain our organization. Describe how senior leaders communicate with our workforce and encourage high performance.
- Describe our organization's governance system and approach to leadership improvement. Describe how our organization assures legal and ethical behavior, fulfills its societal responsibilities, and supports its key communities.
- Describe how our organization establishes its strategy to address its strategic challenges and leverage its strategic advantages. Summarize our organization's key strategic objectives and their related goals.

- Describe how our organization converts its strategic objectives into action plans. Summarize our organization's action plans, how they are deployed, and key action plan performance measures or indicators. Project our organization's future performance relative to key comparisons on these performance measures or indicators.
- Describe how our organization determines resource and service offerings and mechanisms to support users' use of our resources and services. Describe how our organization builds a user-focused culture.
- Describe how our organization listens to our users and acquires satisfaction and dissatisfaction information. Describe how user information is used to improve our success.

As part of ongoing user engagement, the XSEDE project management team will develop an annual call for proposals to conduct the XSEDE user survey. This will be addressed to the national community of experts in survey methodology. The user engagement team will work with the winner to develop a minimally intrusive and maximally informative user survey instrument, to be administered, analyzed, and reported on by the external contractor. The annual survey report will be part of the XSEDE annual report and program plan.

F.9 Key Personnel Changes

Except for the Principal Investigator(s) (PIs) or Co-PIs identified in this award, requests to make any changes to personnel, organizations, and/or partnerships specifically named in the proposal that have been approved as part of this award shall be submitted in writing to the cognizant NSF Program Official for approval prior to any changes taking effect. NSF will respond within two weeks to the specific request; no response indicates approval. Requests for prior approval of changes to the PI/Co-PIs must be submitted through FastLane for review by the cognizant NSF Program Official and approval by an NSF Grants Officer.

F.10 Project Resource Allocation

Staffing assignments and budget are allocated as a result of our systems engineering processes as described in PD4.5 Systems Engineering Management Plan. The funded planning period enabled XSEDE to execute these processes to develop a detailed plan and budget for the first year, and subsequent years will be adjusted as new user needs are discovered via the processes.

The planning process involved the development of the set of processes by which we would identify needs, distill requirements, prioritize and select requirements for adoption, and plan the work necessary to put the capabilities and services in place—this is our systems engineering processes as described in PD4.5 Systems Engineering Management Plan—and a set of tasks and timelines began to emerge. These were the first stages of our project schedule. As this developed and level of effort was assessed with respect to accomplishing those tasks, the inevitable occurred—we had much more work we wanted to complete than our budget would allow. Again, the systems engineering practices we are adopting were very helpful in addressing this in a manner that maximizes our responsiveness to the needs of the research and education community.

During the course of the planning activities we applied the Architecture Tradeoff Analysis Methodology (ATAM [19]) twice. This method, developed by the Software Engineering Institute at Carnegie Mellon University and extensively used for over ten years in systems engineering projects at all scales, simultaneously engages users (and other stakeholders) and exposes critical system quality attributes (see Figure 2). ATAM makes explicit the connections between science drivers and quality attribute scenarios, and identifies risks in satisfying these drivers. ATAM and its variants (quality attribute and mission thread workshops) have been tailored and used throughout the XSEDE planning phase (PD4.5 Systems Engineering Management Plan, §D.2.2.2 Quality Requirements). For example, ATAM has been applied to the XSEDE architecture *and* XSEDE services. Because ATAM is also a key gateway between major steps of the spiral process, it will continue to be used as XSEDE progresses and as new stakeholder needs surface.

By making use of this methodology, the team was able to assess the tradeoffs that could be made and maximize the use of resources to accomplish our goals. This resulted in a firm understanding of how much effort we should put into various efforts and thus helped us establish the corresponding staffing and budget levels. The staffing and budget assignments are given in some detail in §F and §I.

Figure 2: ATAM Method

G Work Breakdown Structure (WBS)

The project will consist of five major activity areas, which are organized into level 2 WBS elements. A high-level work breakdown structure for the project is shown in Figure 3. Given that we have not organized XSEDE strictly along the lines of the NSF 08-571 solicitation, color coding is used in Figure 3 to map the service areas defined by the solicitation to the WBS elements of the XSEDE project. This color coding is further reflected in the subsequent sub-section headings. A WBS dictionary including the detailed WBS elements is included in §G.1. Members of the XSEDE organization have been assigned to act as WBS managers and are listed in Table 6. Each WBS manager is responsible for the cost, schedule, and scope for a WBS area and is considered the "control point" for the work in that WBS.

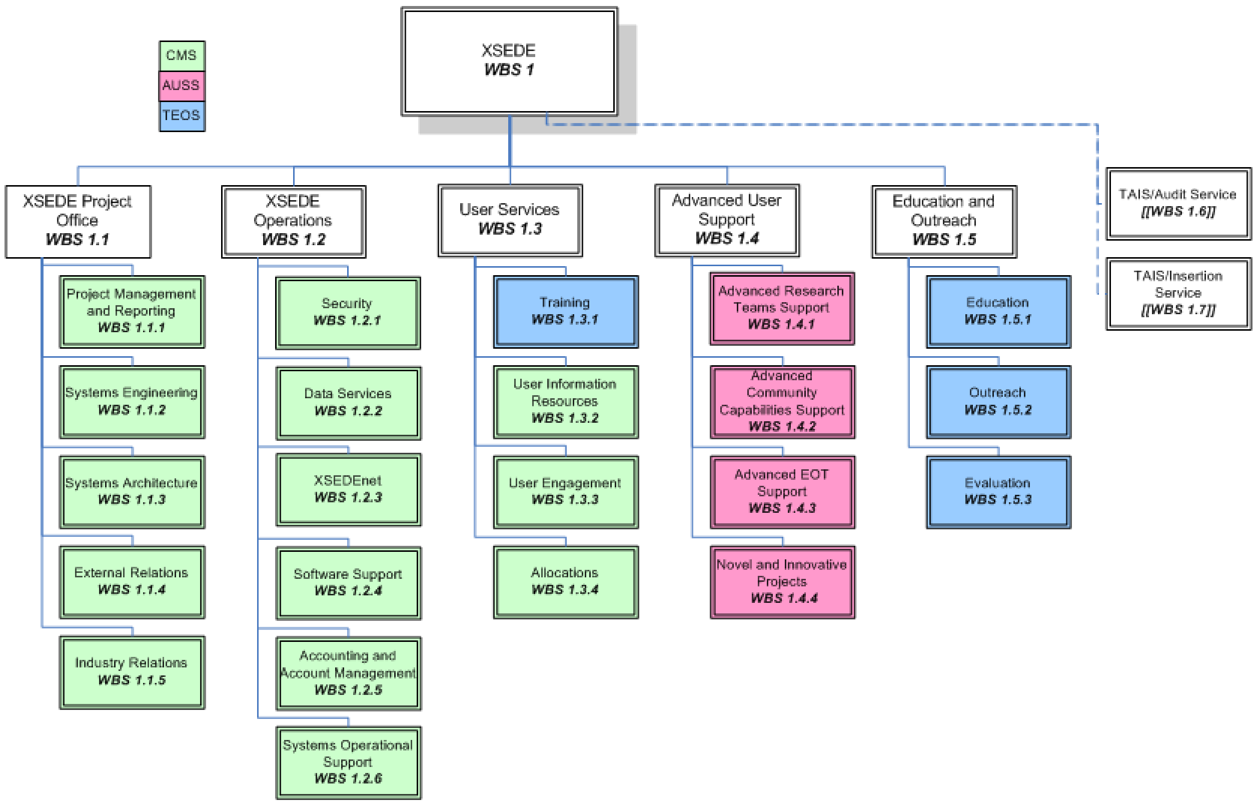

Figure 3: XSEDE WBS

Table 6: WBS Responsibility Assignments.

WBS ID	Element Title	Manager
1	XSEDE	Towns
1.1	XSEDE Project Office	Towns
1.1.1	Project Management and Reporting	Boudwin
1.1.2	Systems Engineering	Brown
1.1.3	Systems Architecture	Grimshaw
1.1.4	External Relations	Bell
1.1.5	Industry Relations	Melchi
1.2	XSEDE Operations	Andrews
1.2.1	Security	Butler
1.2.2	Data Services	Jordan
1.2.3	XSEDEnet	Huntoon
1.2.4	Software Support	Baer
1.2.5	Accounting and Account Management	Quinn
1.2.6	Systems Operational Support	McNally
1.3	User Services	Boisseau
1.3.1	Training	Stanzione
1.3.2	User Information Resources	Dahan
1.3.3	User Engagement	Brook
1.3.4	Allocations	Hackworth
1.4	Advanced User Support	Roskies
1.4.1	Advanced Research Teams Support	Fahey
1.4.2	Advanced Community Capabilities Support	Schulz
1.4.3	Advanced EOT Support	Arnold
1.4.4	Novel & Innovative Projects	Sanielevici
1.5	Education & Outreach	Lathrop
1.5.1	Education	Wiziecki
1.5.2	Outreach	McGinnis
1.5.3	Evaluation	Ferguson

G.1 High Level WBS Elements and Dictionary

G.1.1 WBS 1.1 XSEDE Project Office (portion of Central Management Service (CMS))

WBS 1.1 will include the overall management of the XSEDE project and consolidates the administrative functions of the project along with some project-wide activities. It includes the coordination of the component services that make up XSEDE including the advisory committees (§0), the coordination of regular reporting to NSF (§F.8), the high level management of the XSEDE budgets, the system engineering process including implementing the spiral design process (PD4.5 Systems Engineering Management Plan), the design and evolution of the architecture of XSEDE and creation/maintenance of the XSEDE architecture documents (PD3.2 XSEDE Architecture), and the communication of XSEDE activities with external stakeholders (PD5.2 Communications Plan).

G.1.2 WBS 1.2 XSEDE Operations (portion of Central Management Service (CMS))

WBS 1.2 will include the management and delivery of operational services. XSEDE Operations is tasked with deploying, improving, and maintaining, as appropriate: frontline user support including the 24x7

XSEDE Operations Center; servers supporting online information resources, distributed accounting and account management, authentication services, tools for the use of distributed XSEDE resources, and other services; software maintenance and coordination; data management and coordination services; deployment and monitoring of XSEDE capabilities including acceptance testing and monitoring of production resources and services; networking implementation and support; cybersecurity services including policies and procedures; and training, education, and outreach infrastructure needs including web services to provide on-line training, event participation registration and tracking, and community collaboration tools.

G.1.3 WBS 1.3 User Services (portion of Central Management Service (CMS), portion of Training, Education and Outreach Service (TEOS))

WBS 1.3 will include comprehensive services to provide the foundational *support* for the XSEDE user community. This support will be comprehensive in both resource/technology coverage and in user expertise level, and will be offered through a variety of interfaces, methods, and formats. The XD Service Providers (SPs) will coordinate with XSEDE (and each other) to provide the services that enable this diverse community. The primary focus areas for XSEDE User Services are: Online Information Resources, Allocations, User Engagement, Consluting, and Training. Collectively, this program of user services activities will support researchers throughout the pipeline from new users to productive, regular users of XSEDE, supporting both research and educational usage of XSEDE digital services. These activities will grow the user base of XSEDE in both traditional and new domain communities, with specific efforts to grow usage in under-represented demographic groups.

G.1.4 WBS 1.4 Advanced User Support (Advanced User Support Service (AUSS))

WBS 1.4 will include advanced user support which brings the best available knowledge and skills to bear on the most challenging science issues to maximize the impact of science and engineering results achieved by the XSEDE user community. The persistent AUSS team will be anchored in the expertise of the core partners extended by specific skills required to support users on Track 2 and XSEDE resources and any future service providers that may join the project during its performance period. AUSS will aggressively solicit candidate science or engineering research problems that require or can exploit advanced computing capabilities, seek collaboration with funded projects such as PetaApps, and coordinate with the NSF science directorates. In addition, AUSS will support training, education, and outreach programs in TEOS to foster integration of research and education and will provide AUSS resources for facilitating community portals via science gateways. AUSS projects fall into four categories: Advanced Support for Research Teams (ASRT), Advanced Support for Community Capabilities (ASCC), Advanced Support for Training Education and Outreach (ASTEO), and the Novel and Innovative Projects (NIP) that can intersect with any of these.

G.1.5 WBS 1.5 Education and Outreach (portion of Training, Education and Outreach Service (TEOS))

WBS 1.5 will include Education and Outreach coordination efforts, with support from AUSS and CMS staff. Education efforts will focus on undergraduate and graduate education to prepare the future generations of researchers, K-12 and higher education educators, and digital services practitioners to advance computational science and engineering in all fields. Education will develop core competencies for CS&E and digital services learning and workforce development, work with educational institutions to incorporate CS&E certificate and degree programs, and assist faculty in developing CS&E curriculum materials. Education will engage undergraduate and graduate students through training, internships, and mentoring. Outreach efforts will focus on recruiting new communities into becoming users of XSEDE resources and services. Outreach will engage under-represented communities through campus visits, tailored training, and in-depth consulting. Outreach will coordinate XSEDE's Campus Bridging activities and expand the Campus Champions program to extend XSEDE support on campuses across the country.

Outreach will engage new communities of users through professional society conferences, workshops, and meetings. An external evaluation of TEOS will provide formative information to guide learning and workforce program improvement as well as a summative assessment of program effectiveness and impact. The evaluation is designed to address four key areas: implementation, effectiveness, impact, and institutionalization.

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). The schedule will be maintained in Microsoft Office Project and is available in the document PD 4.1 Resource Loaded Project Schedule. Overall, the project begins on April 1, 2011, and ends on March 31, 2016. Major deliverables with delivery dates are listed in §E.5 and identified in the high-level schedule in Figure 4.

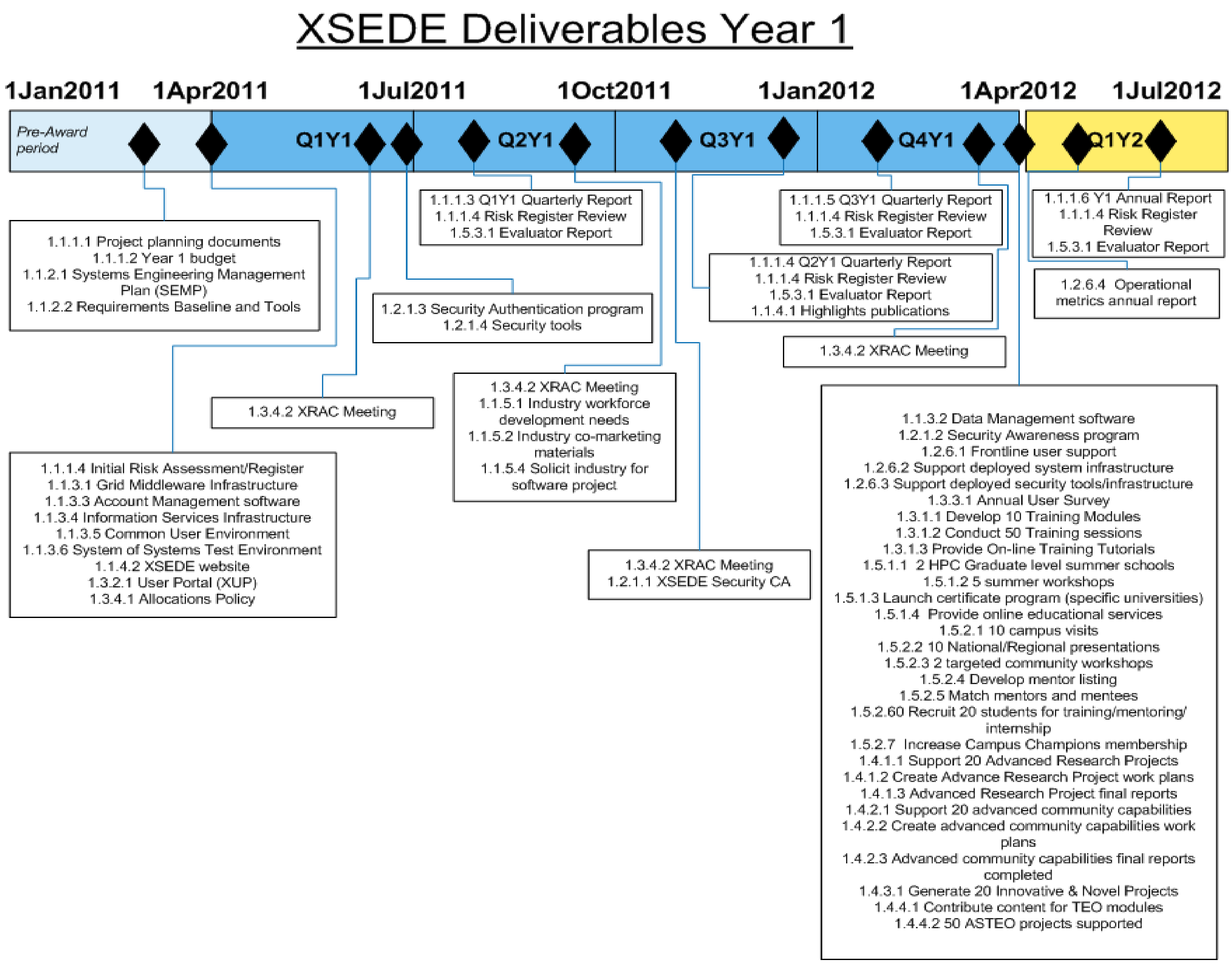

Figure 4: Major Milestones for XSEDE Project Year 1.

I Financial Management

I.1 Methodology and Assumptions Used for Budget Estimates

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 April 1, 2011.

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.

I.1.1 Budget by WBS

This section provides the overall budget at WBS Level 2, details down to Level 3 in the work breakdown structure and a cross walk to the original solicitation categories.

WBS Level 1 & 2 Budget

WBS	Element	PY1	PY2	PY3	PY4	PY5	Total
1	XSEDE	$23M	$23M	$23M	$23M	$23M	$115M
1.1	Project Office	$4.4M	$4.0M	$4.4M	$4.6M	$4.6M	$22M
1.2	Operations	$5.2M	$5.6M	$5.2M	$5.0M	$5.0M	$26M
1.3	User Services	$3.35M	$3.35M	$3.35M	$3.35M	$3.35M	$16.7M
1.4	Advanced User Support	$8.0M	$8.0M	$8.0M	$8.0M	$8.0M	$40.0M
1.5	Education and Outreach	$2.06M	$2.06M	$2.06M	$2.06M	$2.06M	$10.3M

WBS Level 3 Budget

WBS	Element	PY1	PY2	PY3	PY4	PY5	Total
1.1.1	Project Management & Reporting	$1.15M	$0.9M	$1.60M	$1.80M	$1.80M	$7.25M
1.1.2	Systems Engineering	$0.5M	$0.5M	$0.25M	$0.25M	$0.25M	$1.75M
1.1.3	Systems Architecture	$1.60M	$1.60M	$1.60M	$1.60M	$1.60M	$8.00M
1.1.4	External Relations	$0.85M	$0.85M	$0.85M	$0.85M	$0.85M	$4.00M
1.1.5	Industry Relations	$0.20M	$0.20M	$0.20M	$0.20M	$0.20M	$1.00M
1.2.1	Security	$0.90M	$0.90M	$0.90M	$0.90M	$0.90M	$4.50M
1.2.2	Data Services	$0.70M	$0.70M	$0.70M	$0.70M	$0.70M	$3.50M
1.2.3	XSEDENet	$0.70M	$1.10M	$1.30M	$1.20M	$1.20M	$5.50M
1.2.4	Software Support	$0.50M	$0.50M	$0.50M	$0.50M	$0.50M	$2.50M
1.2.5	Accounting & Account Mgmt	$0.60M	$0.60M	$0.60M	$0.60M	$0.60M	$3.00M
1.2.6	Core Services	$1.80M	$1.80M	$1.20M	$1.10M	$1.10M	$7.00M

WBS	Element	PY1	PY2	PY3	PY4	PY5	Total
1.3.1	Training	$0.95M	$0.95M	$0.95M	$0.95M	$0.95M	$4.725M
1.3.2	User Information Resources	$0.75M	$0.75M	$0.75M	$0.75M	$0.75M	$3.75M
1.3.3	User Engagement	$0.70M	$0.70M	$0.70M	$0.70M	$0.70M	$3.50M
1.3.4	Allocations	$0.95M	$0.95M	$0.95M	$0.95M	$0.95M	$4.75M
1.4.1	Advanced Research Teams Support	$2.32M	$2.32M	$2.32M	$2.32M	$2.32M	$11.6M
1.4.2	Advanced Community Capabilities Support	$2.30M	$2.30M	$2.30M	$2.30M	$2.30M	$11.5M
1.4.3	Advanced EOT Support	$2.08M	$2.08M	$2.08M	$2.08M	$2.08M	$10.4M
1.4.4	Novel & Innovative Projects	$1.30M	$1.30M	$1.30M	$1.30M	$1.30M	$6.5M
1.5.1	Education	$1.09M	$1.09M	$1.09M	$1.09M	$1.09M	$5.425M
1.5.2	Outreach	$0.90M	$0.90M	$0.90M	$0.90M	$0.90M	$4.50M
1.5.3	Evaluation	$0.07M	$0.07M	$0.07M	$0.07M	$0.07M	$0.35M

Budget by Solicitation Category (color maps to WBS Level 3 table above)

XD Service Area	PY1	PY2	PY3	PY4	PY5	Total
CMS	$12M	$12M	$12M	$12M	$12M	$60M
TEOS	$3M	$3M	$3M	$3M	$3M	$15M
AUSS	$8M	$8M	$8M	$8M	$8M	$40M

I.2 Subcontracting 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 web site at:

http://www.obfs.uillinois.edu/obfshome.cfm?level=2&path=purchases&xmldata=procedures

I.2.1 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.

I.2.2 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 institution. 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 at least quarterly, unless another payment schedule has been identified in their contracts.

I.2.3 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.

I.2.4 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 (http://www.obfs.uillinois.edu/manual/index.html).

I.3 Financial and Business Controls

I.3.1 Financial and Business Controls

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 (http://www.obfs.uillinois.edu/manual/index.html).

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 and the Illinois finance officer. The Project Director, with assistance from the NCSA Finance Division and the Project Management WBS level 2 lead will be responsible for reporting project financial information to NSF as required.

I.4 Major Project Milestone Schedule

The major project milestone schedule is listed in §H in Table 3 with greater detail provided in PD4.1 Resource Loaded Project Schedule.

J Project Risk Analysis and Methodology

A structured, disciplined approach for risk management has been developed and documented in PD4.4 PEP Supplement: Project Planning, Management and Execution, §C XSEDE Project Risk Management Plan 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 (see PD4.6 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.

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 NCSA Risk Management Tool, which is also being used by the Blue Waters project), 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 listing of project meetings where risks may be identified and discussed is included in PD4.4 PEP Supplement: Project Planning, Management and Execution, §C XSEDE Project Risk Management Plan. 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 projects 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 monthly teleconferences between NSF and XSEDE management. Significant risks will be documented in the required quarterly 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 funded planning period with risks captured in the NCSA Risk Management Tool (see PD4.6 Risk Register for all assessed risks). Table 7 below is a subset of those risks and shows XSEDE's top risks along with each risk's mitigation.

Table 7: Top Identified Risks for XSEDE

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
272	Grid Software System Integration	High	High	High	Software components supporting the distributed system, particularly those that interface directly with specialized components such as HPC and Visualization clusters, require special integration components to effectively operate with system schedulers and other specialized functions such as display export or specialized hardware (i.e., GPUs, FPGAs). Each site and in many cases each resource utilizes software of their own choice, often heavily customized, to implement these resource-specific functions, and there is a risk that the grid software tools will not effectively integrate with these systems. This risk is a reality in the current TeraGrid.	Communicate requirements for individual systems thoroughly to TIS team and software providers. Work with resource providers to encourage selection of compatible schedulers and other system tools. XSEDE architecture and TIS teams must proactively evaluate new systems before they are brought into production and work with all stakeholders and service providers to understand when this risk may arise. If risk arises, immediately begin plans to provide compatible adapters.	Chris Jordan

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
273	Grid Software Scaling	High	High	High	XSEDE will be a very large, complex deployment, and grid software components supporting the federated file system and job execution functions in particular will need to scale to support very large numbers of files, file systems, and jobs. There is a risk that such software components, when presented with hundreds to thousands of simultaneous requests, will either fail or become unusable due to memory or CPU requirements.	Thorough testing efforts to define the limits and characteristics of various components in terms of scaling and system requirements. Communicate these with service providers and encourage the use of appropriately provisioned and/or multiple hosts to distribute loads and achieve acceptable response times. In cases where the lack of scalability of a given software component cannot be overcome via hardware solutions, work with TIS team to identify alternate software components.	Chris Jordan
274	Usage of deployed software and services	High	High	Medium	Based on TeraGrid experience, some XSEDE services and software may be accessed very rarely by users. This can result in wasted effort maintaining those components or lead to poorly maintained components because administrators know they aren't used often.	Deploy services driven by user requirements. Track usage of services. Turn off services that aren't being used (something TeraGrid hasn't done). Have thorough test suites so that even services that aren't used frequently still work well.	Warren Smith
278	Implementation delays and inconsistencies	High	High	Medium	XSEDE will be a large distributed system with software that changes over time. This results in the potential for delays and inconsistencies in the software deployed across XSEDE.	Coordinate software deployments as much as possible. Register software/services so that users can locate specific versions and incorporate them into their environment.	Derek Simmel
239/240/260	Failure of XSEDE Operational Infrastructure	High	High	High	A core XSEDE infrastructure service (such as the central accounting system, the central authentication system, etc.) fails because of hardware outage, power outage, environmental equipment failure, etc.	Backups are performed nightly. The infrastructure services are replicated at remote locations. The replicated service will replace the primary service.	Phil Andrews Kent Milfield

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
258 (248/254/256)	Mismatch between research teams' needs, XD resources, and AUSS staff availability	High	Medium	High	If the hardware and software resources available on XSEDE cannot be matched with the research groups' interests and plans, we will not be able to develop enough novel and innovative projects. If the number of AUSS staff and their distribution of expertise among application and technology areas are mismatched with XSEDE capabilities and research teams' interests and plans, we will not be able to successfully execute these projects.	Maintain relationships with a wide range of groups throughout the research community in order to understand their interests and to help them shape their interests. Hire other staff with appropriate distribution of expertise among application and technology areas.	Sergiu Sanielevici
250/255/257	A suitable project-management framework and process is not created and maintained	Medium	Medium	Medium	Unless there is an easy-to-use comprehensive framework for creating and maintaining project plans and reports, we will not be able to adequately monitor project execution. Unless we develop and consistently apply project management processes suitable for short projects including partners who do not report to XSEDE, we will not be able to ensure adherence to our work plans and reporting requirements.	Develop and maintain an easy-to-use comprehensive framework for creating and maintaining project plans and reports. Revise framework for creating and maintaining project plans and reports as needed.	Sergiu Sanielevici

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
271/276	Insufficient coordination and collaboration between service providers leading to a less than optimal XSEDE environment for users	Medium	Medium	Medium	XSEDE is composed of service providers in different physical locations that are part of different organizations. This situation can naturally lead to problems with communication. While the cooperative agreements and cooperative support agreements for XSEDE and SPs will include explicit language requiring coordination and collaboration, the success of those requirements will depend on the positive outcomes of daily interactions at all levels of XSEDE and the SPs. This required coordination may be less than required for effective NSF cyberinfrastructure operations.	1) At inception XSEDE includes the “at the time” known SP awardees so there is significant “peer pressure” to make XSEDE a success. 2) XSEDE has a single PI, as opposed to the confederated structure under TeraGrid, which improves decision making. 3) XSEDE’s structure includes mechanisms to engage across XSEDE partner sites and allows SP staff to have input. 4) XSEDE’s flexible architecture, unlike TeraGrid’s, is designed to address this risk. Elevate visibility of these issues to successive management layers according to their severity and longevity. Discuss as a regular topic at management meetings and (internal and advisory) committee meetings. If needed, use regular review and issue registration and tracking. Finally, make it a topic of conversation between the NSF and XSEDE and the SPs.	John Towns

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
277 (244/259/262)	Noncompliant service provider	Medium	Medium	Medium	Service providers can be reluctant to implement policies and procedures or deploy services that are contrary to the customs or judgment of the service provider. In this situation, a service provider may refuse to implement an XSEDE-wide policy, procedure, software, or service.	1) At inception XSEDE includes the “at the time” known SP awardees so there is significant “peer pressure” to make XSEDE a success. 2) XSEDE has a single PI, as opposed to the confederated structure under TeraGrid, which improves decision making. 3) XSEDE’s structure includes mechanisms to engage across XSEDE partner sites and allows SP staff to have input. 4) XSEDE’s flexible architecture, unlike TeraGrid’s, is designed to address this risk. Elevate visibility of these issues to successive management layers according to their severity and longevity. Discuss as a regular topic at management meetings and (internal and advisory) committee meetings. If needed, use regular review and issue registration and tracking. Finally, make it a topic of conversation between the NSF and XSEDE and the SP’s.	John Towns

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
264	Failure of Security Systems and Procedures	Medium	Medium	Medium	There is a wide class of vulnerabilities that has historically plagued critical software; and more recently, web application vulnerabilities have become more prevalent. XSEDE architecture may not adequately defend against such attacks.	1) Only authenticated users will be able to use grid resources. 2) XSEDE will provide strong monitoring and audit features to quickly identify misuse of resources, whether inadvertent or intentional. 3) Both the Unicore 6 and Genesis II software stacks that will manage grid resources are based on the Java platform, thus avoiding a wide class of vulnerabilities; e.g., buffer overflows and heap overflow. 4) We will use best-practice development strategies including code reviews and use of trusted containers to prevent attacks such as cross-site scripting attacks and cross-site request forgery attacks. 4) We will use safe APIs to preclude a large class of vulnerabilities. 5) To prevent misuse of resources by misbehaving applications, we will leverage existing operating system and/or virtual machine technology to isolate processes. The Incident Response Team will intervene as necessary.	Janet Brown

Risk Id	Risk	Risk Level	Probability	Impact	Description	Management/Mitigation	Owner
265/266	Technological/Architectural Obsolescence	Medium	Low	High	Before making a time investment in porting, training, and deploying applications on the grid, scientists want assurances that their time investment will not be made obsolete by a new generation of hardware or software. Similarly, a large-scale distributed system that scientists can rely on will require both a modern architecture and dependable software that will provide a high degree of confidence to all stakeholders. Thus, users' uncertainty associated with the long-term viability of grids may hinder adoption of the proposed XSEDE platform.	XSEDE architecture design has been driven by user and other stakeholder needs and is built on an open architecture backed by OGF (the leading body in the grid arena, which has attracted commercial support) that is robustly implemented via Unicore 6 and Genesis II. (Both Unicore 6 and Genesis II have been operational in production environments for years.) XSEDE will support a combination of unmodified binaries and will support multiple environments from Linux, Windows, to Mac OS-based machines. Thus scientists can have high confidence that their applications will not be reliant on a single platform or architecture. Unicore 6 and Genesis II are only two of several that comply with standards such as WSI-BSP, SAML, OGSA-BES, RBS, ByteIO, and HPC-BP. Overall, the XSEDE team has an established track record of architecting and deploying large-scale grids, both in academia and industry. Obtain new user and other stakeholder input and re-design architecture if needed.	Janet Brown

K Configuration Management

Configuration management is the unique identification, controlled access, and status reporting of selected intermediate project work products processed during the life of the project. The management principle expressed is that once a plan, document, or specification has been approved, no deviations from it are permitted unless the deviation is formally identified, analyzed, approved, and reported to appropriate stakeholders. Configuration management is a system engineering function and is described in PD4.5 Systems Engineering Management Plan, §D.5.3 Engineering Change Management/Configuration. Many configuration changes do not trigger a baseline change control action, but if the configuration change impacts a project baseline, the change control process is invoked in parallel to the system engineering process. The XSEDE project change control process is managed by the project management team as described in the following section.

K.1 Change Control Process

Once the baselines have been determined, all changes will be documented and approved through the change control process. Each year the project will determine the schedule, budget, and scope to be accomplished, and this information will be documented in a work package at level 3 of the WBS. The work package will include the distribution of budgets by institution. Budgets distributed through the sub-award process will follow NSF reporting requirements for tracking cost by NSF category. Many changes will result in document modifications (e.g., PEP, budgets, schedules). Subsequent to the acceptance of a baseline set of documents, these modifications will be recorded in each document's revision history table.

Any XSEDE staff member may submit a request to modify the execution of the project. All change requests must be formally submitted to the Project Management & Reporting Team (WBS 1.1.1) for preliminary evaluation and possible distribution to the appropriate decision authority. A Project Change Request (PCR) will document this request for a baseline change. A standard PCR form will be available on the internal XSEDE wiki, and it will provide instructions for submission via email. This PCR process allows for documentation of requested scope, budget, and/or schedule changes. Requestors will provide personal identification and contact information; reason for the change; expected cost, schedule, and technical impacts; and new or modified risks resulting from the change.

There will be three classes of changes, which are described in Table 8. Minor changes are approved at WBS level 2. Moderate changes are approved by the Project Director and major changes must be approved by the cognizant NSF Program Official or NSF-convened review committee. The PD may convene a Change Control Board (CCB) depending on the complexity of the change requested. The CCB will include all WBS level 2 managers, the PD, and others key to the change under consideration. Generally, the members of the CCB will be highly involved stakeholders who are able to determine the impact of the requested changes and weigh the pros and cons of the proposed change in the broader context of technology, cost, schedule, and risk. All changes having direct effect on XD Service Providers will be sent for review and comment to the XD Service Providers Forum; the XD Service Providers Forum Chair will be included in related CCBs. All changes moving budgets from one institution to another must be approved by the Project Director. Additionally, the User Advisory Board and NSF will be consulted when deemed necessary by the PD. At the highest level, approval from NSF is necessary for major changes in technical scope, schedule, or cost. It is anticipated that some recommended changes could have significant impact on one or more service providers and a workable conflict resolution process is essential, both here and in general. In such cases, SPs will be polled within a month on their reaction to the recommendations. If an XD management consensus is achieved, but not complete agreement by the Service Providers who are required to implement the change, it may be necessary to involve the NSF in order to ensure full implementation.

Table 8: Change Control Thresholds.

XSEDE Authorities Level	NSF Major	XSEDE PD Moderate	XSEDE WBS Level 2 Mgr Minor
Technical Scope	Change to PEP deliverables	Moderate impact on the appropriate metric	Minor impact on the appropriate metric
Schedule	Any delay in a deliverable milestone by >six months	Any delay in a deliverable milestone by >three, but <six months	Any delay impacting a deliverable milestone by less than three months
Cost	Any change impacting total yearly funding or total project funding	Any change in a WBS 2 element or change that significantly impacts funds by institution	Any change within a WBS level 2

The project management (WBS 1.1.1) lead is responsible for implementing the baselines and is ultimately responsible for ensuring the change processes are successfully followed. Actual decision authority, however, is vested in the WBS managers, PD, and NSF, depending on the nature of the change. After PCR approval, the change will be incorporated into the project baselines and the PEP, and any other documents will be revised to reflect the new information following the configuration management practices of the project.

L Quality Control

The primary objective of the XSEDE project quality program is to provide quality services to successfully meet the project technical requirements and service goals. The Project Director is responsible for project success, but each person on the XSEDE project team is responsible for the quality of the work they do and for using guidance and assistance that is available to ensure that work products meet expectation and contractual requirements. The quality of all work in this project will be directed, monitored, and reported hierarchically along WBS elements.

A variety of methods are used to prevent quality problems, including equipment inspection and verifications; software code inspections, verification, and validations; baseline change reviews; and work planning. Item characteristics, process implementation, and other quality-related information are reviewed to identify items, services, and processes needing improvement. Any items or services that do not meet specified requirements are formally addressed with written documentation that identifies the discrepancy and the corrective action planned or taken.

Quality will be a specific concern throughout the spiral development process. For development and deployment increments, extensive testing is conducted to assure the quality of the development product (see PD4.5 Systems Engineering Management Plan, §E.4 Testing). For deployment increments, acceptance testing will be conducted by the XSEDE Operations Team before acceptance into the operational environment (see PD5.3 XSEDE Operations Plan, §C.4.2 Acceptance Testing of New XSEDE Capabilities). Finally, when a capability has been deployed into the environment, there will be ongoing monitoring to assure that it does not negatively impact to the quality of the environment (see PD 5.3 XSEDE Operations Plan, §C.6.1.2 XSEDE Environment Instrumentation and Monitoring). The quality of deployed capabilities will be monitored via our regular user surveys and other user contacts to assure that the environment is as responsive to the user community's needs as possible.

Controls will also be included in TEOS, with respect to the quality of training programs being delivered and the quality of trainers delivering content. The verification, validation, and accreditation processes developed by Shodor will be implemented for all TEOS-developed on-line training modules (see http://www.shodor.org/cserd/Help/howhelp). A "Train the Trainers" program will also create XSEDE-endorsed trainers, who can expand the XSEDE training opportunities beyond the limited personnel initially available through the base XSEDE TEOS.

M Integrated Safety Management

A key component of a successful project is to ensure that environment, safety, and heath 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 Cybersecurity Plan

Cybersecurity will be integral to the proposed XSEDE project. The role of cybersecurity in XSEDE is to provide for the confidentiality, availability, and integrity of resources and services. This will be accomplished by providing authentication, authorization, and access control for the provided resources and services, coordinating security among contributing XD Service Providers, educating users on the secure access and use of XSEDE resources, monitoring of the security posture of XSEDE resources and services, and providing adequate and timely response to security incidents. The team will implement the most effective security controls possible given mission requirements, technical and operational constraints, and cost/schedule constraints in order to protect the various XD resources, services, and information. The cybersecurity posture of the XSEDE supporting infrastructure will be designed and implemented to provide adequate protection of the systems and data using best business practices and industry standards. The cybersecurity program will perform a top-down security analysis and a balance will be struck between risks, the mission, the open collaborative nature of the project, and the desire to maintain an adequate security posture appropriate for this endeavor. The team will work with TEOS to provide security training for users and staff. The cybersecurity program will be led by the XSEDE Security Officer (XSO) with a named Deputy Security Officer and supported by the Security Architect, the Identity and Access Management Lead, and the Security Operations and Coordination (SOC) Team. Additional information can be found in PD5.4 PEP Supplement: Operational Planning, §C XSEDE Cybersecurity Plan.

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