FY14 Implementation Plan

Volume 2, Rev. 0.5

November 4, 2013

ADVANCED SIMULATION & COMPUTING™

LLNL-TR-643666

This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

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Advanced Simulation and Computing

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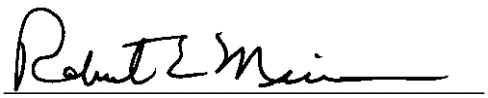
Approved by:

Robert Meisner, NNSA ASC Program Director	 Signature	11/4/13 Date
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I. Executive Summary

The Stockpile Stewardship Program (SSP) is a single, highly integrated technical program for maintaining the surety and reliability of the U.S. nuclear stockpile. The SSP uses nuclear test data, computational modeling and simulation, and experimental facilities to advance understanding of nuclear weapons. It includes stockpile surveillance, experimental research, development and engineering programs, and an appropriately scaled production capability to support stockpile requirements. This integrated national program requires the continued use of experimental facilities and programs, and the computational enhancements to support these programs.

The Advanced Simulation and Computing Program (ASC) is a cornerstone of the SSP, providing simulation capabilities and computational resources that support annual stockpile assessment and certification, study advanced nuclear weapons design and manufacturing processes, analyze accident scenarios and weapons aging, and provide the tools to enable stockpile Life Extension Programs (LEPs) and the resolution of Significant Finding Investigations (SFIs). This requires a balanced resource, including technical staff, hardware, simulation software, and computer science solutions.

In its first decade, the ASC strategy focused on demonstrating simulation capabilities of unprecedented scale in three spatial dimensions. In its second decade, ASC is now focused on increasing predictive capabilities in a three-dimensional (3D) simulation environment while maintaining support to the SSP. The program continues to improve its unique tools for solving progressively more difficult stockpile problems (sufficient resolution, dimensionality, and scientific details), quantify critical margins and uncertainties, and resolve increasingly difficult analyses needed for the SSP.

Moreover, ASC's business model is integrated and focused on requirements-driven products that address long-standing technical questions related to enhanced predictive capability in the simulation tools.

ASC must continue to meet three objectives:

- **Objective 1. Robust Tools.** Develop robust models, codes, and computational techniques to support stockpile needs such as refurbishments, SFIs, LEPs, annual assessments, and evolving future requirements.
- **Objective 2. Prediction through Simulation.** Deliver verified and validated physics and engineering tools to 1) enable simulations of nuclear weapons performance in a variety of operational environments and physical regimes, and 2) enable risk-informed decisions about the performance, safety, and reliability of the stockpile.
- **Objective 3. Balanced Operational Infrastructure.** Implement a balanced computing platform acquisition strategy and operational infrastructure to meet Directed Stockpile Work (DSW) and SSP needs for production and advanced/high-end simulation capabilities.

II. Introduction

In Prague (2009), and more recently Berlin (2013), President Obama articulated his vision of a world without nuclear weapons. These reductions will be made, however, while ensuring that the U.S. maintains a strong and credible strategic deterrent, which is safe, secure, and reliable, for as long as such weapons exist.

The 2010 *Nuclear Posture Review Report* codified the role of the National Nuclear Security Administration (NNSA's) in maintaining the deterrent. In areas essential for stockpile life extensions and stewardship, key investments have been made to:

- Strengthen the science, technology, and engineering base needed for conducting weapon system LEPs
- Mature advanced technologies to increase weapons surety
- Qualify weapon components and certify weapons without nuclear testing
- Provide annual stockpile assessments through weapons surveillance

This strategy includes developing and sustaining high-quality scientific staff, as well as supporting computational and experimental capabilities. These three components constitute the foundation of the nuclear weapons program.[1]

The continued success of the SSP and LEPs is predicated upon the ability to credibly certify the stockpile, without a return to underground nuclear testing (UGTs). Shortly after the nuclear test moratorium entered into force in 1992, the Accelerated Strategic Computing Initiative (ASCI) was established to provide the underpinning computational capability to support stockpile certification. While computing and simulations have always been essential to the success of the nuclear weapons program, the intent of ASCI was to re-envision how NNSA used these tools in support of the stockpile. The ASCI Program was essential to the success of the SSP, providing critical nuclear weapons simulation and modeling capabilities. Now designated as the ASC Program, the mission remains the same—provide the simulation and computational capabilities that underpin the ability to maintain a safe, secure, effective nuclear weapon stockpile, without a return to UGTs.

The capabilities that the ASC Program provide play a vital role in the Nuclear Security Enterprise, and are necessary for fulfilling the stockpile stewardship and life extension requirements outlined for NNSA in the Nuclear Posture Review (NPR). The Program develops modern simulation tools that provide insights into stockpile aging issues, provide the computational and simulation tools that enable designers and analysts to certify the current stockpile and life-extended nuclear weapons, and inform the decision making process when any modifications in nuclear warheads or the associated manufacturing processes are deemed necessary. Furthermore, ASC is enhancing the

[1] *2010 Nuclear Posture Review Report*, April 2010, p. 42.

predictive simulation capabilities that are essential to evaluate weapons effects, design experiments, and ensure test readiness.

The ASC Program's advanced, leading-edge, technologies in high performance computing (HPC) and predictive simulation are essential for meeting the short- and long-term needs of the stockpile. The ASC Program continues to improve its unique tools to solve stockpile problems—with a focus on sufficient imagery resolution, dimensionality, and scientific detail—to enable Quantification of Margins and Uncertainties (QMU) and resolve the increasingly difficult analyses needed for stockpile stewardship. The needs of the DSW and major modernization programs also drive the requirements for simulation and computational resources. These requirements include planned LEPs, stockpile support activities, and mitigation efforts against the potential for technical surprise. All of the weapons within the current stockpile are in some stage of the life-extension process. These simulation and computational capabilities are crucial for their successful execution and for ensuring NNSA can certify these life-extended weapons without conducting a full-scale nuclear test.

ASC Contributions to the Stockpile Life Extension and Stewardship Programs

In FY13, ASC continued delivering science-based simulation tools for annual assessments and next-generation LEPs, focusing on improved physics, fidelity, and calculations in support of DSW and the National Code Strategy. Sequoia, the advanced architecture system, was delivered to Lawrence Livermore National Laboratory (LLNL), and transitioned to the classified environment in the beginning of 2013. This 20-petaFLOP/s (PF) supercomputer will be focused on strengthening the foundations of predictive simulation through running very large suites of complex simulations called uncertainty quantification studies. In addition, it will be used for weapons science calculations necessary to build more accurate physical models. Procurement of the next-generation tri-lab Linux capacity clusters (TLCC2) and the associated common user environment milestones have continued to proceed as planned. However, the acquisition of the commodity technology systems (CTS) that will replace the TLCC2 capabilities in FY14 has been pushed back a year at all three of the NNSA laboratories, with an FY15 start. Roadrunner, the first 1-PF advanced architecture system at Los Alamos National Laboratory (LANL), was retired. A request for proposals was released for the acquisition of an advanced technology system (ATS) to be deployed at LANL in the first quarter of FY16, named Trinity, which will be in the 40–90 petaFLOP/s range. Responses to ASC's RFPs were evaluated for the next round of Predictive Science Academic Alliance Program (PSAAP II) engagements, selection activities were conducted, and recipients of these awards were selected.

In FY14, ASC intends to make an award for the Trinity system at LANL. Joint-investments with DOE's Office of Advanced Scientific Computing Research in exascale-critical technologies, in addition to the ongoing FastForward and DesignForward projects, are being considered but budget constraints may impede this effort. ASC will continue to provide a reliable, available, and secure environment for distance computing.

On the Physics and Engineering Models (PEM) front, a Level 1 milestone to advance capabilities for annual assessments and resolution of significant finding investigations associated with early-phase primary implementation will continue. Verification and Validation (V&V) assessment of improvements in primary performance codes for boost will continue, and the subprogram will continue to strategize and complete common modeling to validate improvements in support of the National Boost Initiative. The Integrated Codes (IC), PEM, and V&V program elements will concentrate on preparations for the next predictive capability framework (PCF) peg post and Level 1 milestone for developing the capability to underwrite the certification of weapons with re-used components, as well as on scalability enhancements targeting future computing platforms.

In FY15 and beyond, ASC will be focusing on supporting the LEPs. To achieve this objective, ASC will continue strengthening the science basis and driving down uncertainties for weapons simulations to a degree where NNSA can credibly claim predictive capability; instituting a robust, formalized peer review system; increasing the number of production computing cycles to support increased use of simulation in stockpile activities and reliance on UQ in weapons decisions; and pursuing next-generation computing to meet time-urgent, future predictive science capability needs as documented in the *ASC Computing Strategy* and the *Predictive Capability Framework*.

III. Accomplishments for FY12–FY13

ASC accomplishments from quarter 4, fiscal year 2012, and through quarter 3, fiscal year 2013, are reflected below for the Computational Systems and Software Environment (CSSE) and Facility Operations and User Support (FOUS) sub-programs.

Computational Systems and Software Environment

LLNL Accomplishments for Computational Systems and Software Environment

- Deployed the Sequoia combined file system and logical volume manager (ZFS)-based file system to the classified network, placed Sequoia into production for classified tri-lab work, and initiated and supported the first CCCs on Sequoia
- Investigated systems level software at scale, including producing a report on investigation of input/output (I/O) forwarding for Linux clusters
- Released new production versions of software, including Tripod Operating System Software (TOSS) 2.1, HPSS 7.4.1, Hopper and Chopper, and MyLC portlets, and actively participated in community development of Lustre 2.4
- Contributed to planning for next-generation architectures and software environment, including interacting with vendors and co-design centers, and collaborating with IC teams
- Provided technical coordination and contractual management for FastForward contracts, released the Collaboration of Oak Ridge, Argonne, and Livermore (CORAL) request for information (RFI), completed the CORAL technical requirements, held the design review and request for proposals (RFP) review, and completed Sierra CD-0

LANL Accomplishments for Computational Systems and Software Environment

- Successfully completed Level 2 milestone on *in situ* analysis in ASC integrated codes, with integration of new capabilities into the Eulerian Applications code base
- Finalized design and deployed new PowerWall Theater
- Completed and deployed the Open Message Passing Interface (MPI) implementation for Cielo, enabling improved debugging of scalability issues for large applications
- Completed the ASC Level 2 milestone for Lustre production on the Cielo system
- Released Trinity/NERSC-8 RFP following establishment of joint technical requirements and the execution of design and independent project reviews

SNL Accomplishments for Computational Systems and Software Environment

- Upgraded all advanced systems technology test beds with the latest available processor, accelerator, software tools, and/or monitoring devices; these systems have facilitated other projects to provide feedback to vendors in areas important to ASC applications (for example, programming models, compilers, and computer architectures)
- Enhanced the KokkosArray software library to support the Intel Xeon Phi accelerator and to provide an OpenMP back-end; demonstrated portable performance across central processing units (CPUs), NVIDIA graphics processing unit (GPUs), and Intel Xeon Phi (many integrated core (MIC)) through mini-applications (mini-apps) using the KokkosArray
- Released the Mantevo software (http://www.mantevo.org), which won an R&D 100 award; seven mini-apps, including CloverLeaf, were provided by the Atomic Weapons Establishment (AWE), and a number of these mini-apps were used to baseline the procurement and acceptance criteria for the Trinity Project
- Completed a study to understand the positional effect in DRAM and SRAM faults by comparing Jaguar and Cielo for error correcting code (ECC) errors, altitude effects, position with data center, and vendor
- Studied software interfaces for power measurement and control; an initial use case model for development of a power application programming model (API) was completed as was the verification and validation (V&V) of the PowerInsight device on one of the advanced system technology test beds

Facility Operations and User Support

- **LLNL Accomplishments for Facility Operations and User Support**
- Accepted and deployed Sequoia to the classified environment; deployed Vulcan to the unclassified environment; deployed a new secret national security information (SNSI) cluster and environment
- Began a project to add a new unclassified HPC facility to house unclassified systems, including the next-generation CTS; selected contractor for this facility
- Deployed 100-G wide area network (WAN) connectivity in partnership with ESNet
- Retired, dismantled, and disposed of uBlueGene/L, BlueGeneL, all Peloton-class clusters, and the TLCC clusters Hera and Eos; retired rzdawndev, udawn, and the Sequoia Initial Delivery System (Dawn)
- Deployed One Way Link (OWL) and enabled electronic transfer of files from unclassified to classified environments

LANL Accomplishments for Facility Operations and User Support

- Completed the integration of Moonlight, a TLCC2 system with general purpose graphics processing units (GPGPUs), into the LANL unclassified computing environment; worked with the applications community for identification of additional software tools for the hybrid architecture
- Completed the Strategic Computing Complex (SCC) upgrade design for bringing water-cooling into the SCC (the ATS-1 system, Trinity, will be a water-cooled system)
- Switched from well water to Sanitary Effluent Reclamation Facility (SERF) water for cooling towers in SCC; the switch has resulted in energy and water savings
- Successfully decommissioned the first petaFLOP/s system, Roadrunner, a hybrid system from IBM

SNL Accomplishments for Facility Operations and User Support

- Completed Level 2 Milestone #4747 *Demonstrate Effective SNL Access and Use of Sequoia System*; ensured access to and documentation for using Sequoia was deployed to the customers prior to the move of Sequoia into the classified network at LLNL
- Deployed data movement tools onto the inter-site high performance computing (IHPC) and the DisCom networks to support efficient data transfer from LLNL to SNL in preparation for Sequoia
- Terminated operations of Dark Storm in September 2012 and recycled the equipment over the first three quarters of FY13

Academic Alliances

The PSAAP I program has completed and participants are currently writing final reports. Accomplishments for the Alliances will be added in the final version of this document, Rev. 1, which is published after the fiscal year budget is finalized.

IV. Product Descriptions by the National Work Breakdown Structure

Computational Systems and Software Environment (WBS 1.5.4)

Commodity Technology Systems (WBS 1.5.4.8)

Production Planning and Integration (LLNL)

Accomplishments in FY13:

- Provided production support for TLCC2 systems

Planned Activities in FY14:

- Provide production support for TLCC2 systems
- Lead the tri-lab process for the next commodity technology system (CTS)-1, conducting a market survey and developing the RFP

Computing Platform Integration and Deployment (LANL)

Accomplishments in FY13:

- Continued to operate Luna and the other capacity systems in both the classified and unclassified computing environments
- Completed the integration of Moonlight, a TLCC2 system with GPGPUs, into the LANL unclassified computing environment; worked with the applications community for identification of additional software tools for the hybrid architecture

Planned Activities in FY14:

- Provide production support for TLCC2 systems
- Participate in the tri-lab planning for the NNSA ASC CTS-1
- Continue to operate Luna and the other capacity systems in both the classified and unclassified computing environments

ASC Commodity Systems (SNL)

Accomplishments in FY13:

There were no activities in FY13.

Planned Activities in FY14:

- Monitor industry hardware and software roadmaps to understand opportunities for cost-effective integration of new commodity technology into future CTS, and implications or requirements for future common computing environment (CCE) software development

Advanced Technology Systems (WBS 1.5.4.3)

Sequoia Tri-Lab Advanced Technology Platform (LLNL)

Accomplishments in FY13:

- Made Sequoia available for unclassified science runs for three to four months
- Transitioned Sequoia to the classified network and completed security testing
- Placed Sequoia into production on the classified network for tri-lab classified work

Planned Activities in FY14:

- Run two CCC processes
- Continue to investigate optimal performance tuning for specific codes

Sierra Tri-Lab Advanced Technology System (LLNL)

Accomplishments in FY13:

- Created CORAL to acquire three leadership computers (two for DOE SC and one for DOE NNSA); created LLNL's companion Sierra Acquisition Project
- Released the CORAL RFI and held a CORAL vendor meeting
- Completed the CORAL technical requirements
- Held the CORAL design review and the CORAL RFP review
- Completed Sierra CD-0 and submitted Sierra CD-1/3a for signature

Planned Activities in FY14:

- Release CORAL RFP
- Evaluate CORAL RFP responses and award CORAL non-recurring engineering contract(s)
- Negotiate and place Sierra build contract
- Complete Sierra CD-1/3a and CD-2
- Provide initial technical coordination and contractual management for CORAL non-recurring engineering and Sierra contracts

Hyperion Test Bed (LLNL)

Accomplishments in FY13:

- Supported the scalability testing of the Lustre file system, high performance storage hardware, system software, and application middleware
- Deployed technology refresh of Hyperion phase 1 servers, including high performance storage class memory

Planned Activities in FY14:

- Procure and deploy a technology refresh of the Hyperion phase 2 servers, including high performance cluster interconnect and potential storage class memory
- Explore new software models to evaluate the use of high performance storage-class memory and the design impacts of storage-class memory on future system software and hardware architectures
- Continue to support scalability testing on system software, middleware, storage, and file systems

Alliance for Computing at Extreme Scale Trinity Advanced Technology System (LANL, SNL)

Accomplishments in FY13:

- Completed tri-lab capability runs on Cielo for Trinity capability improvement metric (using SNL application/SIERRA Gas Dynamics Module/Conchas)
- Completed Trinity CD1/3a
- Completed joint Trinity/NERSC-8 Technical Requirements
- Completed joint Trinity/NERSC-8 Design Review and Independent Project Review
- Released Trinity/NERSC-8 RFP

Planned Activities in FY14:

- Evaluate Trinity/NERSC-8 RFP responses and make selection
- Support Trinity acquisition activities
- Complete Trinity CD-2/3b
- Finalize Trinity procurement
- Award Trinity contract
- Commence Trinity development and engineering (D&E) collaborations between selected vendor and the New Mexico Alliance for Computing at Extreme Scale (ACES)

Alliance for Computing at Extreme Scale Cielo Capability Computing Platform (LANL, SNL)

Accomplishments in FY13:

- Completed the Cielo CCC3 and CCC4 projects; started the CCC5 projects
- Completed the ASC Level 2 milestone for Lustre production on the Cielo system
- Continued to run Cielo in production capability mode
- Managed transition of the Lustre file system into production mode
- Obtained agreement to reciprocate with LANL on the use of privileged accounts from remote locations on the DisCom network; this permits SNL support of systems at LANL and LANL support of systems at SNL

Planned Activities in FY14:

- Complete the Cielo CCC5 and start the CCC6
- Upgrade to Lustre 2.0 on Cielo and attendant platforms
- Continue to run Cielo in production capability mode
- Support production environment of Muzia system as part of the Cielo software quality system (Cielito, Smog, Muzia)
- Provide operations in support of CCCs

Next-Generation Computing Technologies (WBS 1.5.4.9)

Next-Generation Computing Enablement (LLNL)

Accomplishments in FY13:

- Participated in planning activities for next-generation computing, including requirements gathering and joint meetings with DOE Office of Science's Advanced Scientific Computing Research (ASCR) program
- Interacted with co-design centers and ASC IC teams in researching and evaluating next-generation technologies, including many integrated core processors, programming models, power tools, GPUs, and correctness tools
- Explored post-petascale topics, including novel threading environments, power-limited environments, performance characterization, and other code improvement opportunities
- Developed software architecture design and began prototyping elements of a next-generation resource manager designed to support scalable job start-up and integration with scalable library loading mechanism and various run-time tools
- Completed CD-0 and submitted CD-1 for 2017 ATS

Planned Activities in FY14:

- Develop LLNL plan for software for the Sierra ATS, including programming model, code correctness, power, resilience, and performance tools
- Explore next-generation topics, including characterization of power consumption of key application codes, evaluation of development environment software on advanced architecture test systems, performance characterization, and next-generation resource management
- Participate in planning activities for next-generation computing, including joint meetings with ASCR, meetings and workshops with IC, and interactions with academic collaborators
- Participate in tri-lab effort to produce a next-generation plan that addresses requirements identified through co-design interactions and requirements gathering efforts conducted in the various product areas
- Conduct co-design activities with ASC and ASCR co-design centers and vendors, and research and evaluate next-generation technologies
- Execute LLNL portion of the tri-lab Level 2 milestone to evaluate application performance on advanced architectures

FastForward—Industrial Partnerships for Extreme-Scale Technology Research and Development (LLNL)

Accomplishments in FY13:

- Managed contracts and coordinated the multi-lab technical management of the FastForward contracts such that LLNL expects to complete about 50 percent of the milestones by the end of FY13, as planned

Planned Activities in FY14:

- Provide technical coordination and contractual management for FastForward contracts

Systems Requirements and Planning (LANL)

Accomplishments in FY13:

- Planned for the Trinity platform as part of the NNSA ASC Platform program
- Identified facility, power, memory, and file system requirements for the Trinity system
- Participated in site-wide planning for power upgrades for future systems

Planned Activities in FY14:

- Provide program and project management for computing platforms, including requirements gathering and analysis
- Participate in site-wide planning for power upgrades for future systems
- Plan infrastructure to support pre-exascale and exascale systems

Next-Generation Computing Technologies (LANL)

Accomplishments in FY13:

- Worked with ASC code teams to select primary areas for mini-app development, and assisted code teams in developing specification documents and reference codes
- Studied mini-apps and their effective implementation on next-generation architectures; worked with ASC code teams to identify and implement useful abstractions for multi-physics applications on extreme-scale computing systems
- Developed techniques and tools for the analysis and potential transformation of code structures given the dynamic behavior of select applications
- Developed techniques and tools for the analysis of data movement through the memory hierarchy and its impact on application performance and scaling (including the I/O subsystems); BYFL tool has been applied to full integrated codes
- Applied Kernel Samepage Merging kernel features on production systems to reduce memory footprint of integrated codes on many-core systems
- Demonstrated FileSim model of Panasas file-system, reproducing benchmark characteristics

Planned Activities in FY14:

- Explore next-generation programming techniques in the context of an ASC integrated code (supports a Level 2 milestone)
- Characterize existing programming models for application-level resilience and their applicability to ASC science and engineering applications
- Extend tool-chain support on next-generation architectures for application characterization and analysis
- Support the development of the programming environment for Trinity
- Develop proxy applications in support of FastForward efforts and in support of preparing Eulerian Application Project codes for Trinity
- Implement FPGA-based format translation for next-generation accelerators
- Extend FileSim capabilities for future file-systems (Lustre or Burst Buffer)
- Develop proxy applications in support of preparing Lagrangian Application Project codes for Trinity

Co-Design Enablement with Computer Science (SNL)

Accomplishments in FY13:

- Participated in FastForward and DesignForward technical reviews

Planned Activities in FY14:

- Oversee the execution of SNL's portion of the tri-lab Level 2 milestone *Evaluate Application Performance on Advanced Architectures*
- Provide draft technical requirements for ATS-3 RFI and draft RFP

Advanced Systems Technology Research and Development (SNL)

Accomplishments in FY13:

- Completed the following: 1) Phase II of early Advanced Micro Devices (AMD) Fusion upgrade (Teller), 2) Phase III general availability Intel Phi upgrade (Compton), 3) Phase I early Ivy Bridge Cray Cascade installation (Volta), and 4) Phase II early NVidia Atlas card augmentation (Shannon)
- Completed hardware integration of PowerInsight devices (co-designed by SNL and Penguin Computing)
- Compared hand-written CUDA with KokkosArray programming model and showed close correlation in performance with current best-of-class runtimes for miniMD and LAMMPS
- Demonstrated full cluster (64 GPU) miniMD and miniFE run on Shannon using GPU Direct (first platform to demonstrate this feature); utilized pre-release software (UVM, CUDA 5.5) and hardware (NVIDIA Atlas) hardware to investigate further application optimization opportunities
- Provided feedback to vendors on a wide range of topics (programming models, compiler and architectures) that have impacted vendor roadmaps near, mid, and long term

Planned Activities in FY14:

- Provide platforms to support investigating new programming models, and evaluating compilers and application performance
- Provide platforms and/or devices for advanced power and energy research and *in situ* application power and energy analysis
- Provide platform(s) to support Structural Simulation Toolkit (SST) V&V activities
- Provide platforms for advanced node and platform-level architecture analysis and investigations supporting next-generation platforms

Application Performance Analysis for Next-Generation Systems (SNL)

Accomplishments in FY13:

- Provided national leadership in defining the role of mini-apps for next-generation systems through publications and participation in conferences, workshops, and symposiums, which included a major presence at SC12 with two tutorials, a BOF, two workshop posters, and a poster
- Collaborated with the DOE co-design centers and industry, with impact on future product development at Intel, NVidia, AMD, and ARM
- Released Mantevo Suite Version 1.0.
- Defined and baselined the suite of micro-benchmarks, mini-apps, and capability improvement applications to be used in the Trinity project for procurement and acceptance criteria

Planned Activities in FY14:

- Assist DOE co-design centers in applying mini-apps and proxy applications
- Work with the selected Trinity vendor and the tri-labs in the implementation of mini-apps and capability applications for procurement acceptance
- Develop and deploy (as part of the Mantevo.org suite) an adaptive mesh refinement mini-app

Heterogeneous Computing (SNL)

Accomplishments in FY13:

- Ported KokkosArray software to Intel Xeon Phi; this port required generalizing the "gang-worker" thread hierarchy mapping to include both non-uniform memory access (NUMA) core and Intel Xeon Phi's "core-hyperthread"
- Evaluated performance of KokkosArray based mini-app on Compton test bed (cluster of Intel Xeon Phi) for MPI-only versus MPI+threads; full hardware utilization is feasible with MPI+threads but MPI-only has orders of magnitude performance degradation
- Developed OpenMP back-end for KokkosArray as required for interoperability with OpenMP; integrated architecture detection and thread pinning with OpenMP to maintain performance realized by original Pthread back-end
- Ported Mantevo miniFE mini-app to KokkosArray in three days with no loss in performance (porting was performed by a post-doctoral researcher)

Planned Activities in FY14:

- Research portable utilization of architecture-specific extremely fine-grain parallel capabilities such as vector instruction units and thread team shared memory
- Collaborate with library and application teams to prototype strategies to migrate capabilities to heterogeneous computing architectures
- Research performance interactions between MPI and KokkosArray levels of parallelism, including data movement and effective overlapping of communication and accelerator-resident computation

DesignForward (LBNL)

Accomplishments in FY13:

- Managed the RFP release and award selection of the five Interconnect projects

Planned Activities in FY14:

- Re-issue the RFP for the system integration focus areas and manage the award selection process
- Provide technical coordination and contractual management for DesignForward contracts

System Software and Tools (WBS 1.5.4.4)

System Software Environment for Scalable Systems (LLNL)

Accomplishments in FY13:

- Released minor updates to TOSS (version 2.0-2 and 2.1-2) that included security updates and bug fixes
- Released TOSS 2.1 (based on Red Hat Enterprise Linux (RHEL) 6.4, the latest release from RedHat)
- Supported Simple Linux Utility for Resource Management (SLURM) on Sequoia, including the integration/test of new releases from the SLURM vendor
- Completed investigation of I/O forwarding for Linux Clusters, as part of systems-level software at scale; produced a report for completion of this Level 2 milestone
- Investigated/researched true generic and heterogeneous resource scheduling (for example, nodes, sockets, cores, threads, memory, GPUs, disk, and I/O bandwidth)

Planned Activities in FY14:

- Provide ongoing TOSS software development and support
- Develop/deploy TOSS 2.2 (based on RHEL 6.5)
- Develop identified system software projects for efficient operation at ~10,000-node scale, including a generic and heterogeneous resource scheduler
- Initiate development of TOSS 3 (based on RHEL 7)

Applications Development Environment and Performance Team (LLNL)

Accomplishments in FY13:

- Supported the code development environment for LLNL ASC platforms
- Assisted tri-lab integrated design code teams on Sequoia as part of Sequoia Application Preparation activities
- Developed tool infrastructures to improve scalability and performance of applications and advanced the code development environment with parallel I/O capabilities through the Scalable Checkpoint Restart (SCR) project for checkpointing and the SPINDLE project for shared library loading
- Enhanced capabilities for the code correctness tool suite on TLCC2 and Sequoia
- Provided detailed performance tuning expertise for key applications on Sequoia

Planned Activities in FY14:

- Support and improve the BlueGene/Q development environment for Sequoia/Vulcan
- Continue to support and further enhance the TLCC2 environment
- Assess needs for upcoming CTS-1 environment by investigating new hardware, OS/TOSS, program development, and programming model requirements
- Support tri-lab code teams with performance tuning and debugging support in CCC activities on Sequoia
- Continue the development of new performance analysis, modeling, and code correctness capabilities with a particular focus on scalability

High Performance Computing Systems Research (LANL)

Accomplishments in FY13:

- Continued developing redfish library to support exascale services; focused on services that can address issues for upcoming Trinity timeframe and scale, that is, power management; reliability, availability, scalability (RAS); and distributed job launch
- Investigated and developed a Parallel file system layer busting as a simple alternative to the POSIX interface built on top of the low-level, highly parallel services already provided by the Ceph parallel file system, to directly implement the HDF5 scientific data format
- Matured the prototype soft error fault injector into a pre-production research tool for resilience; experimented on fault response to simulated soft errors in applications of interest to the ASC Program
- Investigated application performance on multi- and many-core nodes; investigated a single node for how to optimize the NUMA layout within system and application memory bandwidth limits; identified the memory bandwidth requirements of applications via instruction stream analysis and measured with PAPI and Pintool; verified and validated on multicore and many-core computers
- Created version to simulate Lustre after validating FILESIM with Panasas; used this to design comparisons for large-scale file systems

Planned Activities in FY14:

- Develop distributed software techniques for HPC job launch and monitoring
- Model power-capping for TLCC-class systems with priority queues
- Analyze production system statistics related to reliability
- Extend Chipkill DRAM reliability models
- Develop a model for predicting DRAM reliability on current and next-generation machines
- Explore sub-domain indexing in data-intensive system software for N to M restarts
- Characterize performance of advanced HPC system software, including transparent checkpointing, thread-MPI synchronization, and other programmatically driven needs
- Investigate performance and scalability of next-generation interconnect topologies
- Conduct a detailed statistical analysis of reliability data from HPC systems at various HPC facilities

Test Beds (LANL)

Accomplishments in FY13:

- Managed and enhanced computer test beds for CSSE and IC project use

Planned Activities in FY14:

- Manage computer test beds for CSSE and IC project use
- Upgrade laboratory test bed air-conditioning units
- Refresh technology in Darwin test bed system

Software and Tools for Scalability and Performance (SNL)

Accomplishments in FY13:

- Completed software development, verification and validation of PowerInsight devices (co-designed by SNL and Penguin Computing); fully integrated capability into an advanced architecture test bed (Teller) provided by the Advanced Systems Technology R&D project
- Completed initial analysis of MiniFE CPU, GPU, and memory energy profiles, which was not possibly prior to the PowerInsight integration
- Completed the initial draft of the *Power API Use Case* document, which was subsequently reviewed by external vendors and university and laboratory collaborators; accomplished initial work on reference implementation of portions of Power API using Kitten Light Weight Kernel (LWK) in parallel
- Completed BitTorrent file-system port to Teller and accomplished scalability tests; investigations into BitTorrent's use for Dynamic Shared Library scalability uncovered fundamental obstacles that prohibit use of BitTorrent for this purpose without significant modification
- Implemented and benchmarked virtual-machine-to-virtual-machine communication over Virtual Ethernet Overlay network; analyzed performance analyzed, which proved to be sub-optimal; discovery is driving native Cray networking API, which should have improved performance

Planned Activities in FY14:

- Define power/energy API at all levels identified in scope of *Power API Use Case* document
- Enable two-way communication between LWK and dynamic adaptive runtime system
- Prototype operating system/hardware interface portion of Power API
- Prototype hardware measurement portion of Power API using PowerInsight

Resilience (SNL)

Accomplishments in FY13:

- Completed and documented in an SC13 paper with AMD and LANL, an extensive study comparing Jaguar and Cielo error-correcting code (ECC) memory errors, altitude effects, position within data center, vendor, and crossover from permanent to transient faults during the lifetime of the machine
- Developed and released an open source version of the "Gnawts" Splunk application for HPC log analysis
- Demonstrated 1000-times boost in bit-flip tolerance from robust stencil approach in small-scale prototype partial differential equation (PDE) solver
- Identified three promising technology approaches to implementing persistent data storage for local-failure-local-recovery (LFLR), and a viable approach to emulating LFLR on today's scalable computing platforms
- Demonstrated first mini-app using mock LFLR computing environment; preliminary performance results for a simple linear transient analysis show that writing and performing local recovery from persistent storage is negligible relative to normal computation costs

Planned Activities in FY14:

- Model the relationships between error messages, failed jobs, and likely root causes based on data from production systems but relevant to advanced architectures
- Quantify anomaly detection algorithms (for example, "node info") effectiveness for discovering new fault types on production systems
- Explore parallel scalability of robust stencil approach for silent-error tolerance
- Investigate optimized algorithmic approaches for physics simulations that damp bit-flips more efficiently by operating in concert with specific physical dynamics
- Demonstrate LFLR resilient computing model for PDE mini-app in simulated scalable environment with MPI process loss
- Define prototype LFLR persistent storage API and semantics

System Simulation and Computer Science (SNL)

Accomplishments in FY13:

- Validated SST/macro using UQ for determining accuracy in scaling beyond current capabilities
- Documented and published work on co-design from application to hardware towards saving network power, using SST/macro
- Integrated new and updated models into SST/Micro (in two new releases) and also provided enhanced build/test procedures and Web/Wiki documentation
- Explored the validation space for SST/Micro and have determined that the most viable approach for this combinatorial set of components is to identify key research questions and create a body of evidence that assesses the predictive capability in that research area
- Identified an improved algorithm for assigning MPI ranks to allocated compute nodes (using the scheduler component) to improve communication performance and reduce job run time; integrated it into the Zoltan library

Planned Activities in FY14:

- Perform large-scale macro simulations for design-space exploration of next-generation machines and applications
- Validate SST/macro against more architectures/machines to demonstrate the breadth of capability and improve the quality of existing models
- Work towards automating workflows around SST/macro, including creating skeletons of existing applications and uncertainty quantification
- Publish to community a library of MPI traces (in DUMPI format) taken on different machines for different proxy/mini-apps
- Report results of validating the predictive capabilities of two micro-scale research questions
- Verify newly introduced SST/Micro threading code via experimentation with Mantevo applications using OpenMP
- Use scheduler and power models to assess the performance impact on energy of proposed cluster-level task allocation strategies integrated with a power estimation methodology
- Continue ongoing usability and integration efforts

Scalable, Fault-Resilient Programming Models (SNL)

Accomplishments in FY13:

- Outlined performance, scalability, and development metrics to use when comparing MPI and non-MPI programming models, both with and in the absence of faults
- Developed a shared-memory, asynchronous task-directed acyclic graph (DAG) runtime/API utilized by several simple example applications
- Demonstrated scalability of a task-based dot product on a 32-core node
- Formulated an approach to making the shared-memory task-DAG runtime resilient to on-node soft errors
- Began formulating an approach to adding resilient, distributed-memory parallelism to SNL's task-DAG runtime

Planned Activities in FY14:

- Explore design tradeoffs for scheduling within a resilient, asynchronous, distributed-memory task-DAG runtime using SST/macro simulations
- Develop an SST/macro implementation of the distributed task-DAG runtime and use it to study the performance and fault-resilience limits of the task-DAG approach for a port of mini-FE on an advanced technology architecture
- Based on the results of SST/macro experiments, begin implementing components of a resilient, asynchronous, distributed-memory task-DAG runtime to be used for SNL's FY15 Level 2 milestone

Input/Output, Storage Systems, and Networking (WBS 1.5.4.5)

Archive Storage (LLNL)

Accomplishments in FY13:

- Supported Level 2 milestone *Tri-Lab Data Backup and Recovery* with development, configuration, user interface support, and ongoing data transfers to and from high-performance storage system (HPSS) archives, enabling LLNL and LANL to successfully restore and run codes remotely
- Deployed new Linux-based HPSS Core Server platforms and metadata disk subsystems, delivering 16 times metadata performance improvement to users, better positioning the archives for data produced from runs on Sequoia and Vulcan
- Released HPSS 7.4.1 introducing native 64-bit architecture, support for IPv6, dynamic update of devices/drives, Redundant Array of Independent Tapes (RAIT), and enhanced repack of legacy small files into aggregates
- Continued development and demonstrated viability of HPSS 7.P (a.k.a. Panda), featuring an architecture utilizing partitioned metadata to exploit extreme scalability of the IBM relational model database server, DB2, platform
- Consolidated archive hardware into a smaller footprint by retiring over 50 racks of aging gear, creating operational efficiencies and significantly reducing support costs

Planned Activities in FY14:

- Continue ongoing HPSS software development and support, with focus on development and testing of HPSS 7.P, which features partitioned metadata and is currently targeted for General Availability in CY2015 as HPSS 7.5
- Deploy HPSS 7.4.x with conversion to native 64-bit architecture, support for IPv6, dynamic update of devices/drives, RAIT, and enhanced repack of legacy small files into aggregates
- Evaluate and potentially procure and deploy upgrades to enterprise tape drive environment for increased archive capacity and bandwidth, and begin repack of 8-year old T10K Gen1 media (1-TB native) to T10K Gen2 media (5-TB native) to minimize data loss due to aging media and to reclaim slot capacity in libraries
- Develop and deploy system-based software to automatically failover dual-homed HPSS disk cache devices to alternate disk movers to increase archive availability
- Deploy X86-based platforms and Oracle's Automated Cartridge System Library Software (ACSLS) 8.x for Oracle-based tape libraries
- Provide ongoing support of currently deployed archival storage systems, including selection, deployment, support, and maintenance of all archival storage hardware and media, customer and interface support, ongoing tech refresh, and data stewardship

Parallel and Network File Systems (LLNL)

Accomplishments in FY13:

- Successfully completed Level 2 milestone 4761 *Sequoia File System Deployed to Classified Network*
- Deployed, updated, and supported ZFS-based Lustre file systems in support of Sequoia science runs, classified user/system testing, and production CCCs
- Actively participated in the community software development efforts of Lustre 2.4, which provides a canonical file system layer within Lustre, allowing alternative file system underpinnings
- Maintained and supported Lustre and network-attached storage (NAS) file systems, including middleware and higher level I/O libraries for users

Planned Activities in FY14:

- Focus user support activities on lscratch1 in support of production CCCs on Sequoia
- Enhance ZFS-based Lustre metadata performance in support of user and purge performance
- Support the development, testing, and deployment of Lustre version 2.5 in classified and unclassified environments
- Migrate NetApp-based Lustre file systems to ZFS underpinnings
- Perform required development in support of ZFS software RAID solutions for Lustre object storage targets (OSTs)

Networking and Test Beds (LLNL)

Accomplishments in FY13:

- Evaluated and integrated Intel Xeon Phi, and evaluated quad socket EP-based Intel nodes for large-scale memory applications
- Evaluated and deployed Robinhood into production for Lustre management; tested ZFS on just basic old disk (JBOD)
- Performed quality assurance testing and integration of RHEL6.4 into TOSS 2.1
- Performed Mellanox MetroX testing for long haul Infiniband between buildings
- Evaluated next-generation technologies, including network block device for reliability and performance at scale; performed resource manager prototyping and testing

Planned Activities in FY14:

- Evaluate additional JBOD hardware for use with Lustre and develop tools to manage JBODs
- Evaluate Open Compute Platform for use as compute, data, and Lustre resource
- Evaluate ARM64 as compute platform, and collaborate with RedHat to address deficiencies in software
- Evaluate Aries interconnect on commodity hardware
- Perform RedHat Enterprise 7 alpha testing
- Develop software in support of next-generation resource manager
- Evaluate AMD products: CPUs with host serial adaptor (HAS), discrete GPUs
- Continue evaluating and testing Infiniband Federated data rate (FDR)
- Evaluate production release of Mellanox MetroX

File Systems, Archival Storage, and Networking (LANL)

Accomplishments in FY13:

- Continued co-development of Parallel Log-Structured File System (PLFS) with EMC Corporation under a Cooperative Research and Development Agreement (CRADA) focusing on run-time efficiency and scalability for currently installed systems
- Verified parallel file system software releases (Panasas and Lustre)
- Supported the production archive by assisting users and altering software to address user issues
- Provided applications readiness support on I/O issues and general production needs
- Supported the production archive by assisting users and altering software to address use issues
- Provided programmatically driven application readiness support to users of Luna, Mustang, Moonlight, and other recently integrated systems, tackling hard-to-diagnose problems
- Developed application observation techniques for automated scanning of key application progress and success/failure indications
- Completed and deployed the Open MPI implementation for Cielo, enabling improved debugging of scalability issues for large applications
- Continued performance analysis and debugger support, including work on Open|SpeedShop, component-based tool framework (CBTF), and TotalView

Planned Activities in FY14:

- Provide on-going support and testing for production file-systems and HPSS
- Perform an assessment of network file system (NFS) with respect to limiting data movement
- Explore lower-cost open source or commercial archival solutions
- Provide application readiness support on capacity platforms
- Continue PLFS development under the EMC Corporation CRADA, including burst buffer integration and support for production
- Assist system management personnel with problem investigation and resolution
- Design and prototype a burst-buffer enablement library to insulate application developers from the complexities of next-generation file-systems
- Continue building an MPI support capability by engaging the community support model; focus will be on Open MPI development targeted to tri-lab needs, and interactions with threading models such as OpenMP

- Continue debugger and performance analysis support capability; focus will be on Open|SpeedShop and CBTF
- Initiate an OpenMP support capability

Archival Storage (SNL)

Accomplishments in FY13:

- Transferred all data on classified and unclassified networks to higher density tapes using modern T10KC drives; moved nearly 2 petabytes in total
- Supported consortium with planning for features and development of next versions of HPSS, including RAIT support, enhanced performance, and support for next-generation environments
- Became support organization for mkhpss and security components of development environment (in addition to pftp, startup daemon, and ACLs)

Planned Activities in FY14:

- Deploy HPSS 7.4 releases integrating RAIT and performance enhancements
- Negotiate ownership and support of the HSI/HTAR tools from Gleicher Enterprises for use by ASC

Scalable Input/Output Research (SNL)

Accomplishments in FY13:

- Completed Level 2 milestone *Data Co-Processing for Extreme Scale Analysis;* performed an extensive study comprising over 10 M processor-hours on Cielo to evaluate performance characteristics of *in-situ* and in-transit analysis to detect material fragments for the CTH shock physics code
- Completed Level 2 milestone *SIROCCO File System Performance*, which included an evaluation of the performance of a file system with "smart" storage services; results evaluated an implementation of SIROCCO with support for an emulated burst-buffer on the Cielo system

Planned Activities in FY14:

- Develop and demonstrate a globally accessible data service for in-memory data storage
- Develop extended feature support for the SIROCCO file system, including storage servers that use gossip protocols to exchange information and log-based, on-disk storage
- Analyze topological placement issues related to coupled codes and in-transit data services
- Explore resilience/durability of in-transit workflows, which coincides with the completion of an early career laboratory-directed research and development (LDRD) on distributed transactions

Scalable Interconnects for Extreme-Scale Tightly Coupled Systems (SNL)

Accomplishments in FY13:

- Released a unified reference implementation of Portals 4.0 for shared memory and InfiniBand networks that provided asynchronous progress suitable for many-core processors
- Developed, tested, and deployed an enhanced version of OpenMPI for Portals 4.0 that contained optimized implementations of blocking and non-blocking collective operations using triggered operations
- Completed a study of Portals 4.0 triggered operations to support offload of arbitrary blocking and non-blocking collective operations

Planned Activities in FY14:

- Complete a study to determine the appropriate ratio of power processing element (PPE) threads to MPI ranks for the Intel Phi platform
- Implement and evaluate the effectiveness of using single-instruction, multiple-data (SIMD) vectorization and other node-level hardware capabilities to accelerate MPI tag matching
- Release an enhanced version of the Portals 4.0 reference implementation

Post-Processing Environments (WBS 1.5.4.6)

Scientific Visualization (LLNL)

Accomplishments in FY13:

- Deployed and supported suite of visualization and data analysis tools on LLNL platforms, including software on Graph to support Sequoia users
- Deployed new one-node PowerWall drivers to two classified visualization theaters
- Provided operational support for visualization theaters, provided consulting and development support for data analysis, and provided support for demonstrations and presentation of scientific visualizations and data analysis results
- Performed research and development in data analysis and visualization and participated in next-generation planning
- Developed a volume visualization capability for the WebGL interface to Lorenz using iso-surface rendering, and improved the interface to WebGL visualization using JQuery functionalities

Planned Activities in FY14:

- Provide consulting and maintenance for the data analysis and visualization hardware platforms and software environment
- Provide initial start up and ongoing data analysis and visualization support for users of the Max data analysis cluster deployed to support Sequoia users
- Provide operational support for projection systems and other equipment associated with ASC visualization theaters
- Support large-scale visualization and data analysis efforts, including the creation of movies and visuals
- Develop an initial flow visualization capability using steam-line tracing algorithms to be deployed in Lorenz using WebGL
- Prepare for next-generation data analysis through research in multi-resolution techniques, data compression, and topological methods

Scientific Workflow and Data Management (LLNL)

Accomplishments in FY13:

- Released new versions of Hopper and Chopper with architecture enhancements, enabling better support for multi-zone and multi-site installations, a much reduced resource footprint for client-server operations, and numerous usability improvements
- Incorporated basic Web-based visualization into Lorenz as a general utility
- Developed and released new MyLC dashboard portlets that provide users with additional insight into the computer center

Planned Activities in FY14:

- Release new versions of Hopper and Chopper with a focus on helping users deal with exceptionally large collections of data, including file transfer wizard that optimizes the transfer path in terms of both speed and efficiency of resources
- Investigate the inclusion of RobinHood-based Lustre metadata in Hopper and Chopper, with the expectation of significantly improving directory list and disk usage operations in Lustre file systems
- Develop and release new versions of Lorenz that support the growing number of users who are turning to Web-based tools for interacting with the computing center
- Extend the MyLC dashboard to include more complete information about changes that are occurring within the center, and provide users with a variety of ways to subscribe to this information

Visualization and Data Analysis (LANL)

Accomplishments in FY13:

- Finalized design and deployed new PowerWall theater
- Continued to support and maintain production visualization systems
- Provided contract management and requirements specification, including facilities, visualization cluster, and EnSight contracts; supported and maintained the EnSight software and helped direct EnSight development activities under the new LANL EnSight development contract to Computational Engineering International
- Provided technical guidance on visualization needs for the forthcoming Trinity advanced technology system
- Worked directly with designers in physics-based, iterative discovery process using the petascale visualization and data analysis enabled tool (EnSight) to promote new discoveries in weapons science in programs
- Successfully completed Level 2 milestone *In Situ Analysis for ASC Simulations Codes*; explored, developed, and deployed *in-situ* analysis and feature-extraction visualization on a variety of next-generation supercomputers to improve the understanding of massive scale results
- Participated in and supported the activities of the ASC CSSE exascale planning working group on visualization and data analysis

Planned Activities in FY14:

- Continue to support and maintain production visualization systems
- Provide contract management and requirements specification, including facilities, visualization cluster, and EnSight contracts
- Provide technical guidance on visualization needs for the forthcoming Trinity ATS
- Work directly with designers in physics-based, iterative discovery process using EnSight to promote new discoveries in weapons science in programs
- Extend PISTON, a portable hardware-accelerated visualization library, to Blue Gene, GPU, and Intel MIC, including distributed memory and unstructured mesh support (work with Kitware for integration into open source tools)
- Apply *in situ* data analysis framework to additional ASC codes
- Evaluate data-intensive computing technology for ASC programmatic needs
- Evaluate optimization strategies for efficient data flow in visualization, analysis, and parallel storage systems
- Provide additional expert visualization support to designers and analysts

Scalable Data Analysis (SNL)

Accomplishments in FY13:

- Completed Level 2 milestone *Data Co-Processing for Extreme Scale Analysis*; performed an extensive study comprising over 10 M processor-hours on Cielo to evaluate performance characteristics of *in-situ* and in-transit analysis to detect material fragments for the CTH shock physics code
- Completed initial design of *in-situ* capabilities for the SIERRA engineering code-suite, including development and testing of *in-situ* material performance predictions in SIERRA solid mechanics simulations.

Planned Activities in FY14:

- Deliver initial ensemble analysis on the classified network for use in sensitivity analysis for electrical circuit simulations
- Develop and integrate select many-core algorithms into SNL production toolset
- Develop an *in-situ* capability using Catalyst for applications using the SIERRA toolkit
- Continue *ParaView* releases, with production support in conjunction with Kitware, Inc.
- Deliver scalable analysis and visualization capabilities for Cielo and Sequoia customers

Facility Operations and User Support (WBS 1.5.5)

User Support Services (WBS 1.5.5.2)

Hotlines and System Support (LLNL)

Accomplishments in FY13:

- Provided ongoing support services for hotline operations, documentation, and training
- Developed and deployed new Web-based tools to improve hotline operations and user communication
- Began supporting the new user community of an HPC system on the Department of Defense (DoD) SIPRNet
- Assisted users in their migration of their applications to the BlueGene/Q hardware architecture
- Integrated Front Range and JIRA, an issue-tracking software engineering product, for improved problem reporting and bug tracking

Planned Activities in FY14:

- Continue to provide ongoing support services for hotline operations, documentation, and training
- Continue to migrate existing Livermore Computing (LC) Websites to the new LLNL standard Website format
- Provide support to the new DoD SIPRNet (SNSI) user community
- Deploy new whiteboard, system status, and bank allocation tools for improved user communication and hotline operations
- Continue to assist users in the migration of applications to the BlueGene/Q architecture
- Deploy a secure computing facility instance of the Identity Management System for managing user accounts, groups, and bank memberships

Integrated Computing Network Consulting, Training, Documentation, and External Computing Support (LANL)

Accomplishments in FY13:

- Developed new end-user interfaces to deliver comprehensive job information using distributed data services (DDS) middleware
- Deployed ITIL-based modules to restructure ticketing system into problem and issue hierarchy
- Performed ongoing user support for users of ASC/LANL/ACES computing resources

Planned Activities in FY14:

- Continue to enhance user support tools, capabilities, and infrastructure available to users and the user support team
- Develop Trinity (ATS-1) system documentation and training materials
- Provide assistance for use of emerging ASC platforms/architectures

User Support (SNL)

Accomplishments in FY13:

- Provided coordinated and tiered user support for SNL's ASC resources and, in partnership with LANL, for ACES resources
- Ramped up coordinated and tiered user support for scientific computing desktops and simulation-enabled engineering software for SNL's ASC customers
- Improved up-to-date information availability and management on the HPC OneStop Web portal for both SNL and ACES resources
- Made additional improvements of active content availability and management on the SNL HPC and ACES user-focused Websites for both customers and fellow supporters

Planned Activities in FY14:

- Provide user support for SNL and tri-lab ASC computing
- Deliver user support for Sequoia
- Continue to improve collaborative tools and self-help resources, particularly in support of ACES
- Continue to partner with LANL to strengthen joint user support for ACES platforms; prepare to provide Trinity user support
- Begin addressing user support needs for the National Security Computing Center (NSCC)
- Continue to leverage Information Technology Infrastructure Library (ITIL) as a framework for improving the HPC OneStop Service Desk processes and practices

Collaborations (WBS 1.5.5.3)

Program Support (LLNL)

Accomplishments in FY13:

- Participated in planning with the HPC community for next-generation HPC procurements in partnership with the DOE/SC; this included activities such as workshops and vendor meetings
- Developed and completed the extreme-scale DesignForward procurement and vendor selection phase
- Completed management of the Sequoia contract and its associated R&D and D&E contracts with IBM; managed existing tri-lab contracts, including CCE and TLCC-related contract management
- Continued the HAXTON and NUCLEI projects
- Supported PSAAP collaborations and PSAAP2 call, proposal review, and selection
- Supported NNSA HQ detailee from LLNL
- Continued the Institute for Sustained Performance, Energy, and Resilience and the Frameworks, Algorithms, and Scalable Technologies for Mathematics Institute

Planned Activities in FY14:

- Continue FY13 procurement, contract management, and extreme-scale computing planning
- Support annual HPC Best Practices meeting with Office of Science for FY14, titled *HPC Operations Review Meeting*
- Support bi-annual Predictive Science Panel (PSP) meetings
- Support Presidential Early Career Award for Scientists and Engineers (PECASE) awardee
- Manage new PSAAP2 program

Program Support (LANL)

Accomplishments in FY13:

- Hosted PSP Meeting
- Published ASC newsletter

Planned Activities in FY14:

- Participate in Principle Investigator and PSP Meetings
- Publish ASC eNews online newsletter

Program Support (SNL)

Accomplishments in FY13:

- Organized and hosted successful Fourth Predictive Engineering Science Panel (PESP) meeting
- Supported external panel reviews for Qualification Alternatives to the Sandia Pulsed Reactor (QASPR), Engineering Sciences, Computer Sciences, and Trinity project
- Supported current PSAAP collaborations, completion of reviews, and selection for PSAAP-II program
- Provided support to the ASC Federal program office, including the DOE Exascale Initiative
- Supported the 2012 Supercomputing Conference, PSP meetings, the ASC executive committee, quarterly meetings of the ASC executive committee, and managed the Science Applications International Corporation (SAIC) contract to provide administration support to HQ

Planned Activities in FY14:

- Organize and host fifth PESP meeting and side meetings of PESP sub-panels
- Support external review panel meetings for QASPR, the Engineering Sciences External Advisory Board, and the Computational Sciences External Advisory Board
- Support programmatic needs of the PSAAP-II program and the DOE Exascale Initiative
- Manage the SAIC contract to provide various administration support for HQ
- Support programmatic needs of NNSA tri-lab ASC program and ASC executive committee

Applications in Support of Manufacturing Production and Connectivity (Y-12)

Accomplishments in FY13:

- Performed a coupled neutronic-computational fluid dynamics simulation of a nuclear criticality excursion transient in Uranyl nitrate using the commercial COMSOL multi-physics code in support of production manufacturing
- Completed Penguin 1600 SA cluster upgrades and installations, including operating system to RHEL 6 and Scyld Clusterware 6.4.2; installed SIERRA v4.28.2; acquired the ATTILA parallel discrete ordinates code
- Investigated the use of GPU architectures to accelerate image and signal processing codes developed in support of stockpile stewardship; also investigated the feasibility of GP and Radiation Transport for Y-12 PC environment
- Selected and procured the essential hardware upgrades to develop an immersive virtual environment to support manufacturing prototyping, production training, work flow process development, and maintenance procedure prototyping; approved the telecommunication plan to implement advanced optical motion tracking in a classified environment

Planned Activities in FY14:

- Configure and demonstrate an initial virtual-reality training environment for hazardous manufacturing operations; integrate a physical glove-box interface with an immersive stereoscopic computer simulation and demonstrate the applicability for hazardous operations training
- Upgrade immersive environment software and hardware; evaluate advanced optical tracking systems and haptic feedback solutions
- Work with the Uranium Processing Facility Process Engineering staff to develop an ergonomic evaluation capability to certify process equipment designs based on real-time motion tracking to control a computer-generated ergonomic manikin simulation
- Enhance parallel cluster environment to include COMSOL, quantities of margins and uncertainties for criticality excursions, adjoint-forward ATTILA for multiple particle nuclear radiation source term forensics, and MCNP6.1
- Continue to explore the use of GPU architectures to accelerate image and signal processing tasks (this will require use of Joint Institute for Computational Sciences and/or SNL resources, with the local Linux cluster used as a test bed)
- Continue to evaluate new codes on the Y-12 cluster and utilize Y-12 and remote ASC cluster resources to solve production manufacturing problems
- Participate in National Security Enterprise ASC activities

System and Environment Administration and Operations (WBS 1.5.5.4)

System and Environment Administration and Operations (LLNL)

Accomplishments in FY13:

System Administration and Operations:

- Accepted Sequoia, moved Sequoia to classified environment and began CCCs; accepted Vulcan, which became generally available (GA)
- Deployed SNSI compute environment
- Retired, dismantled, and disposed of uBlueGene/L, BlueGeneL, all Peloton-class clusters, and the TLCC clusters (hera and eos)
- Retired rzdawndev, udawn, and dawn
- Deployed OWL and enabled electronic transfer of files from unclassified to classified environments

Security Technology:

- Upgraded from RSA[2] 6 to RSA 8 in the unclassified
- Moved SCF Kerberos lightweight directory access protocol (LDAP) Security Registry from AIX (IBM's Unix operating system) to Linux platform
- Updated Kerberos environment to support only strong encryption mechanisms
- Enabled tri-lab account processing and provisioning through LC Identity Management
- Integrated CryptoCard authentication with LDAP/one-time password service

Planned Activities in FY14:

System Administration and Operations:

- Dismantle and dispose of udawn, rzdawndev, and dawn
- Deploy Sequoia visualization cluster Max
- Deploy expanded lustre file system hardware (marzen, porter, stout) in advance of ZFS-based software transition
- Retire Coastal and Juno
- Continue 24 x 7 x 365 monitoring and diagnostics of facility and systems

[2] RSA is an algorithm for public-key cryptography and stands for Ron Rivest, Adi Shamir, and Leonard Adelman.

- Upgrade Weapons & Complex Integration's test and development cluster on the open computing facility (replace rzalastor)
- Integrate Splunk into daily monitoring
- Replace NFS home directory servers
- Replace /nfs/tmp servers

Security Technology:

- Deploy full Identity Management capability (classified accounts) on SCF by replacing Identity Access Management
- Upgrade to RSA 8 in the secure computing facility and SNSI environments
- Consolidate infrastructure systems to a virtual machine environment
- Implement log-based security event analysis and detection

System Administration and Storage (LANL)

Accomplishments in FY13:

- Supported HPC systems by conducting ongoing and daily system and storage administration with continuous monitoring of production systems and infrastructure servers
- Ensured workload was carried out by proper configuration of queues and scheduling policies plus daily monitoring and problem resolution relating to workloads running on HPC computing resources
- Enhanced support for capacity computing utilization of GPUs
- Supported requirements for transitioning unclassified HPC operations to the Turquoise network

Planned Activities in FY14:

- Support HPC systems by conducting ongoing and daily system and storage administration with continuous monitoring of production systems and infrastructure servers
- Ensure workload is carried out by proper configuration of queues and scheduling policies plus daily monitoring and problem resolution relating to workloads running on HPC computing resources
- Provide direct user support ASC/HPC systems/architectures through in-person consulting and online documentation
- Expand Lustre file system
- Integrate Zenoss-based HPC monitoring into HPC facility monitoring infrastructure
- Implement software for upgrade of current monitoring system to latest open-source Zenoss version

Operations and Procurement Support (LANL)

Accomplishments in FY13:

- Provided 24 x 7 operations and monitoring of HPC computing resources
- Provided hardware self-maintenance for current and future ASC platforms
- Developed requirements for upgraded tools for monitoring HPC platforms and file systems
- Decommissioned Roadrunner/IBM system, Lobo, and Turing
- Provided technical and administrative support for procurement of HPC platforms, supporting hardware and software, and other products and services required by HPC

Planned Activities in FY14:

- Provide 24 x 7 operations and monitoring of HPC computing resources
- Provide hardware self-maintenance for current and future ASC platforms
- Develop requirements for upgraded tools for monitoring HPC platforms and file systems
- Provide support for SCC upgrades for Trinity system.
- Provide technical and administrative support for procurement of HPC platforms, supporting hardware and software, and other products and services required by HPC

Computing Platform Integration and Deployment (LANL)

Accomplishments in FY13:

- Continued to operate Luna and the other capacity systems in both the classified and unclassified computing environments
- Completed the integration of Moonlight, a TLCC2 system with GPGPUs, into the LANL unclassified computing environment; worked with the applications community for identification of additional software tools for the hybrid architecture

Planned Activities in FY14:

- Continue to update the system environment for capacity systems
- Develop and coordinate the site preparation requirements for CTS-1

Production Computing Services (SNL)

Accomplishments in FY13:

- Delivered twice the amount of computing cycles to the nuclear weapons program in FY13 over that provided in FY12 due to the introduction of the Chama and Pecos TLCC2 systems
- Placed Dark Bridge system into use, supporting SNL, LANL, and LLNL customers
- Collaborated with Cray, NCSA, LANL, and Open Grid Computing on production hardening of SNL's extreme scale HPC resource monitoring tool (Lightweight Distributed Metric Service (LDMS)) and installed it on a SNL platform

Planned Activities in FY14:

- Continue operations support for Cielo, RFP activity on Trinity, and coordination with LLNL on Sequoia software stack needs for SNL mini-Sequoia system
- Continue operations of storage systems, archive systems, and production systems supporting ASC and nuclear weapons programs
- Deploy production version of LDMS on SNL internal and collaborative partners large-scale production HPC platforms
- Develop Red Hat package manager (RPM) for TOSS to include LDMS
- Continue operations of storage systems, archive systems, and production systems supporting the NSCC programs
- Provide additional resources for PSAAP program use in the Open HPC network

Facilities, Network, and Power (WBS 1.5.5.5)

Facilities, Network, and Power (LLNL)

Accomplishments in FY13:

- Completed all of the ancillary support work to replace small staging chiller with a larger in-line chiller to increase reliability and reduce nuisance staging of the chilled water system
- Began a project to add a new unclassified HPC facility to house unclassified systems, including the next-generation CTS-1 cluster; selected contractor for this facility
- Demolished and redistributed power for retired platforms (for example, BlueGene/L and Atlas) in preparation for future platforms and cluster installations
- Deployed 100-G WAN connectivity in partnership with ESNet
- Completed Sequoia classified networking

Planned Activities in FY14:

- Begin construction of the new unclassified HPC facility to house unclassified systems, including the next-generation CTS-1 clusters
- Begin a project to bring in electrical equipment that allows for more widely varying voltages in preparation for the 2017 system
- Complete the cutover of the B453 chilled-water system small staging chiller with a larger in-line chiller to increase reliability and reduce nuisance staging of the chilled water system
- Continue to enhance diagnostic and monitoring of Infiniband (IB) fabrics on Sequoia and other IB-attached Lustre file systems
- Continue to analyze and evaluate emerging network technologies

Facilities, Networking, and Power (LANL)

Accomplishments in FY13:

- Provided ongoing operations and maintenance of electrical and mechanical systems for ASC computing facilities
- Switched to SERF water for cooling towers in SCC
- Started construction phase for SCC Trinity Infrastructure Project upgrade in support of future ASC platforms
- Integrated and deployed hardware and software in support of ASC computing on Turquoise network
- Provided ongoing operations and maintenance of HPC networking components

Planned Activities in FY14:

- Complete construction of SCC Trinity Infrastructure Project
- Provide ongoing operations and maintenance of electrical and mechanical systems for ASC computing facilities
- Write a design document for Next-Generation BackBone

Facilities, Networking, and Power (SNL)

Accomplishments in FY13:

- Completed the upgrade of the New Mexico ESNet link from 1 GE to 10 GE, which was an integrated effort with many entities including LANL, CenturyLink, ESNet, the University of New Mexico, and L3
- Completed the instantiation of the open high performance computing (OHPC) network for sharing open HPC resource with SNL industry and academic partners; this network has full 10-Gbit/s available bandwidth to the Internet through ESNet, and advanced architecture test-bed systems reside in this network location
- Converted TLCC1 systems to institutional resources, removing costs from ASC program while still benefitting the nuclear weapons customer base

Planned Activities in FY14:

- Upgrade SNL's two 10-GE links to LANL to a single 100-G link
- Deploy two 10-GE encryptors at each site to double the aggregate available bandwidth
- Manage operation of the DisCom WAN
- Renew planning activities for Building 725 expansion options

Common Computing Environment (WBS 1.5.5.6)

System Software Deployment for Commodity Technology Systems

Accomplishments in FY13:

- Released minor updates to TOSS (version 2.0-2 and 2.1-2), which included security updates and bug fixes
- Implemented tri-lab access to a new TOSS issue tracker (JIRA based) to allow authentication using local site kerberos credentials
- Released TOSS 2.1 (based on RHEL 6.4, the latest release from RedHat)
- Developed a support process for GPU-enhanced clusters to track performance, assess reliability, and identify issues
- Identified collaborative system software development activities, including better monitoring of Infiniband for TOSS, utilizing Splunk for monitoring and analysis, tri-lab tools integration into TOSS, and using virtualization in TOSS HPC environments

Planned Activities in FY14:

- Provide ongoing TOSS software development and support
- Develop/deploy TOSS 2.X (based on RHEL 6.X)
- Initiate development of TOSS 3.X (based on RHEL 7.X)
- Continue SLURM support efforts through tri-lab collaboration
- Develop identified collaborative system software tasks, including investigation of accelerator architectures; GPGPUs, MICs and Fusion; integration of virtualization; logging/monitoring improvements; and testing infrastructure improvements

Programming Environment Development/Support for Tri-Lab Systems

Accomplishments in FY13:

- Completed enhancements and bug fixes for Open MPI and MVAPICH; conducted many performance/scaling studies across a wide range of tri-lab resources; developed mpileaks and included it into TOSS 2.1; added Open MPI and MVAPICH source to central repository; and provided inter-laboratory support
- Completed new Open|SpeedShop experiments (O|SS) (I/O profiling, memory profiling, and thread profiling; ported O|SS to CBTF framework and developed new documentation/user manual; and continued work in progress on Cuda profiling experiment
- Continued activities with tool providers (O|SS, TAU, Valgrind) for various services, workshops, training, user support, fixes and problem resolution, and minor enhancements on user request
- Progressed on the BIGCAT collaboration for the debugger project with Rogue Wave for improved C++ application support within TotalView, and the TotalView scalability project provided several Scalable Early Access versions that have demonstrated success in several real-world debugging cases

Planned Activities in FY14:

- Evaluate tri-lab needs, with regard to performance analysis and debugging, with evolving MPI+X programming model(s), providing node-centric performance information, power utilization information, and information to help minimize data movement overheads
- Provide enhancements and bug fixes to Open MPI/MVAPICH based on tri-lab need; assess MPI performance across many architectures; assess the impact of process and memory binding policies on application performance; and provide results to end users
- Deliver enhanced capabilities addressing user-identified needs for the TotalView debugger through the BIGCAT tri-lab collaboration
- Continue development and support efforts for debuggers, performance analysis tools, and MPI as programming models and architectures evolve

Resource Management Deployment and Reporting

Accomplishments in FY13:

- Involved with an effort to form an independent SLURM community that includes representatives from Bright Computing, CCE, Intel, Bull, and SchedMD
- Supported development of requirements for future Resource Management/Scheduler products
- Gathered requirements from NNSA/HQ and each laboratory to expand the WC Tool reporting capabilities (completed by Workload Characterization (WC) tri-lab team)
- Developing a new RAILS 3.x version of WC Tool

Planned Activities in FY14:

For FY14, this project is being integrated into the "System Software Deployment for Commodity Technology Systems" and the "High Performance Computing Environment Integration for Tri-Lab Systems" projects.

High Performance Computing Environment Integration for Tri-Lab Systems

Accomplishments in FY13:

- Completed 10-GB networking infrastructure to the tri-lab
- Installed and tested iHPC servers and communication infrastructure at SNL, LLNL, and LANL
- Completed design to expand authentication capabilities to include Security Assertion Markup Language (SAML) for Web applications, targeted within iHPC to support SARAPE, Gforge, and other web-based collaboration tools
- Moved SARAPE Version 2 into production for the tri-lab
- Increased trial/prototypes of collaborative tools (JIRA, GitHub); continued maintenance of Gforge server for CCE project collaboration

Planned Activities in FY14:

- Deploy expanded authentication capabilities to targeted services
- Test implementation of unclassified disaster recovery
- Continue integration of collaborative tools as required
- Continue to integrate next SARAPE development phases; integrate improved authentication capabilities
- Continue WC Tool efforts to meet new and/or expanded ASC HQ reporting requirements; address issues in evolving tri-lab computing environments; deploy a new RAILS 3.x version of WC Tool

Monitoring and Metrics Integration for Tri-Lab Systems

Accomplishments in FY13:

- Identified gaps in Distributed Data Service (DDS) implementation and developed a plan for completion of a production version
- Initiated compute node data collection process using the Lightweight Distributed Metric Service (LDMS) tool, including large-scale evaluation on RoadRunner; shared development and use of a common set of Splunk tools across sites, including integration of LDMS data
- Held a monitoring and testing summit at LANL to broaden the scope of monitoring elements for FY14 integration

Planned Activities in FY14:

- Continue development of Splunk tools as needed across the sites (LANL, LLNL, SNL)
- Deploy LDMS for use as common data collection, transport, and storage tool on tri-lab HPC systems
- Begin investigation of how expected architectural changes and increased scale will impact the ability to effectively monitor and analyze information pertinent to application performance and system operation
- Begin development of information aggregation tools that make use of the information sharing frameworks

File System Architecture and Integration

Accomplishments in FY13:

- Decided against integrating PLFS/SCR because of effort required and changing user and architecture needs; acquired a detailed understanding of the internals of PLFS through the effort to integrate PLFS/SCR
- Improved SCR support of user-defined directory structures on parallel file system and implemented scalable metadata
- Supported efforts to further modify PLFS for burst buffer integration; contributions from that effort for the Fast Forward IOD are ongoing

Planned Activities in FY14:

For FY14, this project is being integrated into the "Next Generation Computing" project.

V. ASC Level 1 and 2 Milestones

Table V-1. ASC Level 1 *Proposed* Milestones and Interfaces with Defense Programs Components from FY14–FY17

Milestone Title	Level	FY	Completion Date	Site(s)	Participating Program Offices
New Level 1 Milestone, Title TBD	1	FY15	TBD	LLNL, LANL	Science Campaigns ASC Campaign
Deployment of capabilities to support full system safety assessments for abnormal thermal environments for the B61-12 LEP	1	FY16	TBD	SNL	ASC Campaign Engineering Campaigns

ASC Level 2 Milestones for FY14

Table V-2. Quick Look: Level 2 Milestone Dependencies for FY14[3]

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
4780	Deliver, within the Nuclear Performance Code System, an Initial Capability for the Simulation of Output	FY14	6/30/14	IC	LLNL
4781	Assess Performance and Scalability of a New Transport Package in Programmatic Applications	FY14	9/30/14	IC	LLNL
4782	Assess Newly Emerging Programming and Memory Models for Advanced Architectures on Integrated Codes	FY14	9/30/14	IC	LLNL
4783	High Explosive Models for Lawrence Livermore Material (LLM)-105-Based High Explosive Formulations	FY14	9/30/14	PEM	LLNL
4794	LLNL Plan for Software for Sierra (Programming Model, Code Correctness, Power, Resilience, Performance Tools)	FY14	9/30/14	CSSE	LLNL
4795	CTS-1 Market Survey Completed	FY14	6/30/14	CSSE	LLNL
4796	Plan for Cluster Systems Software in a Tens of Thousands of Nodes/Cores Environment	FY14	9/30/14	CSSE	LLNL
4797	Early Users on Sequoia Visualization System (Max)	FY14	12/31/13	FOUS	LLNL

[3] Factors such as FY14 Congressional Appropriations, NNSA/DP directives, and National Security considerations may necessitate a change in the current milestone set.

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
4859	Improved Physics Models in the Eulerian Applications Project Codes for Predictive Capability Framework Energy Balance II Peg Post	FY14	6/30/14	IC	LANL
4860	User Release by the Transport Project of a Production Quality Version of the High-Order/Low-Order Transport Package	FY14	9/30/14	IC	LANL
4861	Assessments and Improvements of Material Models Supporting the Pit Reuse Strategy and the FY15 Level 1 Milestone	FY14	9/30/14	PEM	LANL
4862	Initial Development of a Suite-Based Simulation Bounding Capability for Boost Initiation and Burn Efficiency in Primary Performance	FY14	9/30/14	V&V	LANL
4863	A Case Study of Highly Concurrent Programming Models and Tools for ASC Codes	FY14	9/30/14	CSSE	LANL
4864	Strategic Computing Complex Facility Upgrades for Trinity Complete	FY14	9/30/14	FOUS	LANL
4865	Implementation of Atomistic Model for Carrier Recombination in GaAs Semiconductor under Fast Neutron Irradiation	FY14	9/30/14	IC	SNL
4866	Improved Verification and Validation through Integrated Sensitivity Analysis Workflow	FY14	6/30/14	IC, V&V	SNL
4867	SIERRA Performance Optimizations Based on STK with a Focus on SIERRA/SolidMechanics Explicit Transient Dynamics	FY14	9/30/14	IC	SNL

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
4868	Coupled Fluid/Structure Models Including Temperature-Dependent Aeroshell Constitutive Properties for the Prediction of an Arming, Fusing, and Firing Component Due to Clear Air Random Vibration	FY14	9/30/14	PEM, V&V	SNL
4869	SNL Physics and Engineering Models Roadmap	FY14	9/30/14	PEM	SNL
4870	Thermal Decomposition Model for PBX-9502	FY14	9/30/14	PEM	SNL
4871	Assess Predictive Capability for Coupled Thermal Mechanical Capability with Foam Decomposition	FY14	9/30/14	V&V	SNL
4872	Studies to Assess Cavity System-Generated Electromagnetic Pulse Models Capability	FY14	9/30/14	V&V	SNL
4873	Local Failure Local Recovery (LFLR): A Blueprint for a Proportional Response to Local Process Failure	FY14	6/30/14	CSSE	SNL
4874	ASC Workload Energy Efficiency: System and Application Interfaces for Measurement and Control	FY14	9/30/14	CSSE	SNL
4746	SIROCCO File System Performance	FY14	12/31/13	CSSE	SNL
4875	Evaluate Application Performance on Advanced Architectures	FY14	9/30/14	IC, CSSE	LLNL LANL SNL

Milestone (ID#4794): LLNL Plan for Software for Sierra (Programming Model, Code Correctness, Power, Resilience, Performance Tools)		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a planning and scoping activity in preparation for the 2017 advanced technology system to be sited at LLNL. This milestone addresses plans for the post-Sequoia software environment, including the programming models, performance tools, and issues of power, resilience, code correctness, and tasking.		
Completion Criteria: A report covering the experiences with the software environment on Sequoia, information on expected bottlenecks and gaps in the software environment for the 2017 Sierra platform, and an initial plan to address those gaps.		
Customer: ASC		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: Sequoia, CSSE, and FOUS personnel		

Milestone (ID#4795): CTS-1 Market Survey Completed		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 6/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: A market survey will be conducted to understand the current state of the art in commodity computing cluster options.		
Completion Criteria: Market survey including results of studying technologies available from potential vendors in order to inform the CTS-1 RFP		
Customer: ASC		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: CSSE tri-lab personnel		

Milestone (ID#4796): Plan for Cluster Systems Software in a Tens of Thousands of Nodes/Cores Environment		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a planning and scoping activity to determine gaps in current cluster systems software and identify development areas required to scale to a cluster with tens of thousands of nodes/cores.		
Completion Criteria: Professional documentation including the plan		
Customer: LC and ASC		
Milestone Certification Method: Plan is presented to ASC program staff at LLNL. Professional documentation including a viewgraph presentation is prepared as a record of milestone completion.		
Supporting Resources: CSSE and FOUS staff at LLNL		

Milestone (ID#4797): Early Users on Sequoia Visualization System (Max)		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 12/31/13		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: The Max visualization and data analysis cluster will provide Sequoia users with compute cycles and an interactive option for data exploration and analysis. The system will be integrated in the first quarter of FY14 and the system is expected to be moved to the classified network by the second quarter of FY14. The goal of this milestone is to have early users running their visualization and data analysis work on the Max cluster on the classified network.		
Completion Criteria: Racks are assembled in B453 and the system has been moved to the classified network. A visualization user will write a memo certifying that he/she has run successful visualization jobs on Max on the classified network.		
Customer: ASC		
Milestone Certification Method: Professional report and hand-off to ASC program		
Supporting Resources: TBD		

Milestone (ID#4863): A Case Study of Highly Concurrent Programming Models and Tools for ASC Codes		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: The impact of new architectures on critical IC codes has been categorized at a high-level in terms of removing bulk-synchronous communications and increasing levels of concurrency and parallelism. A critical element in meeting these challenges is the adoption of new approaches to programming that reduce the introduction of these characteristics and simplify the programmability of future systems. This milestone will investigate a potential path forward for reaching these goals by developing and applying these techniques in an implementation of an ASC proxy application and/or a portion of a full IC code. In addition to improving concurrency and reducing synchronization points, approaches will be explored that enable interoperability with MPI-based codes to not only minimize the overall impact but also more importantly provide a staged migration path for existing codes. This effort will provide ASC IC developers with reference codes and tools that will benefit them in understanding the impact of programming techniques for next-generation architectures.		
Completion Criteria: Demonstration of techniques used to reduce both bulk-synchronous communications and increase the levels of concurrency within a portion of an application and/or application proxy. Performance and programmability impacts will be documented.		
Customer: ASC integrated code development teams		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion		
Supporting Resources: System resources and participation of code teams and code users		

Milestone (ID#4864): Strategic Computing Complex Facility Upgrades for Trinity Complete		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: FOUS		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: Upgrade the SCC facility electrical and mechanical infrastructures to support the Trinity and CTS-1 water-cooled systems.		
Completion Criteria: The electrical and mechanical upgrades are completed to support the Trinity system. Upgrades include the integration of cooling towers, heat exchanges, pumps, switchboards, and substations into existing SCC facility infrastructure.		
Customer: NNSA/ASC HQ, tri-lab weapons applications community		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: LANL facilities team, LANL support organizations		

Milestone (ID#4873): Local Failure Local Recovery (LFLR): A Blueprint for a Proportional Response to Local Process Failure		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 6/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: Resilience is a crosscutting issue that spans the entire software and hardware stack, and realization of resilient applications will require a multifaceted approach. Global checkpoint/restart (CPR) has been the dominant approach to addressing resilience for many years and, although file I/O performance has not kept pace with computation and data growth, libraries such as SCR have been able to preserve global CPR APIs and semantics while taking advantage of latent locality properties in SNL's application storage and recovery patterns to hide latency. Even so, SCR is still a global model and new approaches need to be explored. Although a suitable alternative to CPR may take a long time to realize, there are elements of the problem that can be addressed early on, providing a path toward the final, long-term solution. Most important is the development and dissemination of workable resilient computing models that enable application and algorithm developers to reason about and implement new capabilities. The local-failure-local-recovery (LFLR) model is one of the most promising approaches to realize a qualitative improvement in application resilience to common system faults. LFLR relies heavily on a fundamental ability to store data persistently such that, if an MPI process is lost, the persistently stored data will be available when a new process is assigned to continue the work of the lost process. The implementation of persistent storage can be done in several ways, but SNL will focus on the API and successful use of the model. The objective is to provide the core 'persistence' capability and demonstrate how it can be used to avoid system-wide checkpoint/restart in favor of application-driven local recovery.		
Completion Criteria: Successful completion of execution for the Mantevo MiniFE mini-app under the simulated loss of one or more MPI processes using a prototype persistent data API and basic implementation of the API; a clearly documented list of OS/Runtime features required for realizing LFLR in a full-scale application on a future unreliable system; and a description of the strategies application developers can used to integrate LFLR resilience into their codes		
Customer: Sierra Team Lead. SNL will look to the lead to confirm that the approach being used will have some promise as a viable approach for future full-scale applications.		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		

Milestone (ID#4873): Local Failure Local Recovery (LFLR): A Blueprint for a Proportional Response to Local Process Failure
Supporting Resources: Technical support from SNL's MPI, system software, and OS research teams to facilitate clear decision making on API design and implementation.

Milestone (ID#4874): ASC Workload Energy Efficiency: System and Application Interfaces for Measurement and Control		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: Addressing anticipated ASC computational needs within reasonable power constraints requires great advances in hardware power efficiency. To achieve the greatest efficiency from next-generation hardware at scale, software at many levels will be required to coordinate and optimize the underlying hardware. While commodity pressures will drive useful innovations in this area that can be leveraged, efforts are distinguished by SNL's requirements at scale. This milestone will first identify the critical multi-level measurement requirements needed for next-generation platforms. Next, SNL will define the scope, interfaces, and information flow important to generate a power API using Unified Modeling Language (UML) tools and processes. The resulting Use Case definitions will form the basis of a power API specification. Both the Use Case document and the power API specification will be socialized with other laboratories, vendors, and university collaborators for evaluation and feedback.		
Completion Criteria: A review meeting of the API will be held and results recorded. As an important element in co-design activities, attendees will be drawn from the broader HPC community, including vendors, other laboratories, academia, and if possible, commercial HPC sites.		
Customer: ASC platform design team members and application developers		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: Advanced Systems Technology Test Beds		

Milestone (ID#4746): SIROCCO File System Performance		
Level: 2	**Fiscal Year**: FY13~~4~~	**DOE Area/Campaign**: ASC
Completion Date: 12/31/2013		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: Exascale computing will likely require fundamental changes in the storage and management of persistent data. Incremental advances in current capabilities are likely inadequate. This milestone will provide performance analysis of a revolutionary approach to persistent storage—one that uses smart storage servers with access to a variety of different local and remote media (for example, disk, NVRAM, memory, and tape) and are pervasive throughout the computing platform. Storage servers have the ability to directly handle I/O requests, initiate third party transfers, or replicate the data as needed. Results will come from implementations for the Cielo system.		
Completion Criteria: Completion of the Sirocco performance analysis.		
Customer: ASC platform design team members and application developers.		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: Cielo and associated test beds		

Milestone (ID#4875): Evaluate Application Performance on Advanced Architectures		
Level: 2	**Fiscal Year**: FY14	**DOE Area/Campaign**: ASC
Completion Date: 9/30/14		
ASC nWBS Subprogram: IC, CSSE		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: Each lab will identify two proxy applications that have been demonstrated to be representative of key performance aspects of ASC integrated codes. These proxy applications will be exercised on test beds, advanced systems, or simulators to analyze both performance and scalability issues.		
Completion Criteria: A tri-lab report will detail key performance indicators related to hardware (such as memory bandwidth or latency, and interconnection fabric performance) or software (such as runtime support for task level parallelism or DSLs, advanced compilers, or application development tools).		
Customer: ASC		
Milestone Certification Method: A program review is conducted and its results are documented. Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion.		
Supporting Resources: Co-design teams from IC and CSSE		

VI. ASC Performance-Based Initiatives for FY14

The contractor's *Performance Evaluation Plan* contains multi-site targets that can be identified by the associate deputy administrator as base or stretch goals.

There are no multi-site targets for ASC in FY14.

Along with the Contributing Factors and Site Specific Outcomes outlined in the *Performance Evaluation Plan*, the contractor's performance will be evaluated against the NNSA's *Strategic Plan*, NNSA performance priorities and deliverables, program execution plans, work authorizations, and other key inputs (for example, multi-year strategic objectives). In evaluating overall performance on the FY14 milestones, the contractor shall receive adjectival ratings "Excellent," "Very Good," "Good," "Satisfactory," or "Unsatisfactory" based on Federal Acquisition Regulation Subpart 16.401(e)(3).

At a minimum, all management and operating sites are expected to perform at the satisfactory level documented in the Strategic *Performance Evaluation Plan* for each site. If not stated specifically in the Strategic *Performance Evaluation Plan*, satisfactory performance includes achieving all milestones and/or keeping NNSA informed of obstacles to achieving milestones that may arise due to the scientific-discovery nature of the ASC work; meeting all reporting requirements; engaging in productive and constructive collaboration with other ASC partner sites especially to achieve joint milestones and to achieve joint, collaborative, scientific goals; productive and constructive peer review of ASC partners; constructive participation in ASC meetings and reviews; professional interactions especially between management and NNSA; and cost-effective management of ASC funds and facilities.

VII. Performance Measures

Table VII-1. ASC Campaign Annual Performance Results (R) and Targets (T)

REDUCED RELIANCE ON CALIBRATION: The cumulative percentage reduction in the use of calibration "knobs" to successfully simulate nuclear weapons performance (Long-term Outcome)

Reporting process: Labs will assess and report within two weeks of the end of Q3, progress toward Level-1 milestones for knob replacement and supporting Level-2 milestones. A briefing will be provided to the Predictive Science Panel at each meeting as a report on progress toward replacing the knobs. The PSP may provide advisory comments regarding the reported progress, but will not evaluate the progress.

At LLNL, progress on this metric was initially measured by assigning a 25% completion metric to each of the original 4 calibration knob L1 milestones. In 2011 these 4 knobs were replaced by 8 new PCF pegposts with modified completion dates. In 2013 the PCF pegposts changed again to those shown in the "New PCF chart" tab, thereby once again changing future estimates towards achieving predictive capability. LANL developed the table shown in the "New Perf. Metric Results" tab. LLNL agrees that the "must hit" targets shown the new table are the best we can estimate at this time and will therefore report 41% for FY13 consistent with LANL. The reason for not meeting the 45% target for FY13 is due to these changes in PCF pegposts. Next year the HQ ASC program office will attempt to rebaseline the OMB targets for the out-years to be consistent with the new "must hit" estimates. It should be noted that the "must hit" estimates will always be subject to change as these future PCF pegpost goals are modified.

LANL: "Progress on this metric will be measured by completion of the number of Level 1 milestone that directly address knob replacement." Completing one knob-replacement Level 1 milestone accumulates 100%/N reduced reliance on calibration. Cumulative percentage is reported for July 1, 2005 though June 30, 2013 (FY05Q4 through FY13Q3). In 2011 we rebaselined this metric from the original 4 major pegpost to 8 new major pegposts of the Predictive Capability Framework. In 2013 the PCF is in the continuing to evolve to provide better alignment with both near term DSW requirements and long term improvements in capability, resulting in a new set of 7 pegposts. Based on the anticipated new pegposts, that the Labs have already started workign to, the OMB metric reported for FY13 is 41%. We recommend that for FY14 the HQ ASC program office attempt to rebaseline the OMB targets for the out-years to be consistent with the new "must hit" estimates. It should be noted that the "must hit" estimates will always be subject to change as these future PCF pegpost goals are modified.

Evidence (Type): NA-10 Milestone Reporting Tool (MRT) reports (Original Documents)

	Q3 FY07	Q3 FY08	Q3 FY09	Q3 FY10	Q3 FY11	Q3 FY12	Q3 FY13	Q3 FY14	Q3 FY15	Q3 FY16	Q3 FY17	Q3 FY18	Q3 FY19
TARGETS	8%	16%	25%	30%	35%	40%	45%	44%*	46%	53%	60%	63%	71%
LLNL	12%	18%	24%	33%	35%	37%	41%						
LANL	12%	18%	25%	33%	35%	38%	41%						
AVERAGE	12%	18%	25%	33%	35%	38%	41%						

*Performance Measure Change Request to update the FY14-22 targets was approved in August 2013: Modifications to PCF goals suggest slightly slower progress on predictive capability than initially planned. In 2013, the PCF is continuing to evolve to provide better alignment with both near-term Directed Stockpile Work (DSW) requirements and long-term improvements in capability, resulting in a new set of seven Pegposts. LLNL and LANL have started working to the anticipated new Pegposts. This re-baselining takes into account the schedule associated with the planned L1 and L2 milestones for the out-years. Targets above have been revised as follows: FY14 (50% to 44%); FY15 (55% to 46%); FY16 (60% to 53%); FY17 (65% to 60%); FY18 (70% to 63%); FY19 (75% to 71%).

VIII. Budget

Product / Project WBS	Lab	PEOPLE ($Ms)	INFOSTRUCTURE ($Ms)	CONTRACTS ($Ms)	Total ($Ms)
1.5.1 Integrated Codes					
Engineering and Physics Integrated Codes		69.795	0.000	0.000	69.795
	LLNL	26.416			26.416
	LANL	24.242			24.242
	SNL	19.137			19.137
	Other				0.000
Specialized Codes and Libraries		26.139	0.000	0.000	26.139
	LLNL	8.472			8.472
	LANL	9.717			9.717
	SNL	6.992			6.992
	Other	0.958			0.958
Applications and Algorithms Research		15.073	0.000	0.000	15.073
	LLNL	5.227			5.227
	LANL	5.535			5.535
	SNL	3.832			3.832
	Other	0.479			0.479
Applications Research for Next-Gen Platforms		28.841	0.000	17.659	46.500
	LLNL	9.528			9.528
	LANL	11.731			11.731
	SNL	6.082			6.082
	Other	1.500		17.659	19.159

Product / Project WBS	Lab	PEOPLE ($Ms)	INFOSTRUCTURE ($Ms)	CONTRACTS ($Ms)	Total ($Ms)
1.5.2 Physics and Engineering Models					
High Explosive		5.323	0.000	0.000	5.323
	LLNL	2.020			2.020
	LANL	3.303			3.303
	SNL				0.000
	Other				0.000
Equation of State		7.087	0.000	0.000	7.087
	LLNL	3.001			3.001
	LANL	3.511			3.511
	SNL	0.575			0.575
	Other				0.000
Nuclear Properties		4.798	0.000	0.000	4.798
	LLNL	1.601			1.601
	LANL	3.197			3.197
	SNL				0.000
	Other				0.000
Plasma and Radiative Properties		4.946	0.000	0.000	4.946
	LLNL	1.600			1.600
	LANL	3.346			3.346
	SNL				0.000
	Other				0.000
Advanced Hydrodynamics		5.921	0.000	0.000	5.921
	LLNL	1.601			1.601
	LANL	4.320			4.320
	SNL				0.000
	Other				0.000
Material Strength and Damage		12.552	0.000	0.000	12.552
	LLNL	3.797			3.797
	LANL	4.013			4.013
	SNL	4.742			4.742
	Other				0.000
Forensics and Cross-cutting Initiatives		8.367	0.000	0.000	8.367
	LLNL	3.156			3.156
	LANL	3.244			3.244
	SNL	1.967			1.967
	Other				0.000
Thermal and Fluid Response		4.880	0.000	0.000	4.880
	LLNL				0.000
	LANL				0.000
	SNL	4.880			4.880
	Other				0.000
Aerodynamics and Vibration		3.780	0.000	0.000	3.780
	LLNL				0.000
	LANL				0.000
	SNL	3.780			3.780
	Other				0.000
Radiation and Electrical Response		4.328	0.000	0.000	4.328
	LLNL				0.000
	LANL				0.000
	SNL	4.328			4.328
	Other				0.000
Russian Programs		1.013	0.000	0.000	1.013
	LLNL				0.000
	LANL				0.000
	SNL				0.000
	Other	1.013			1.013

Product / Project WBS	Lab	PEOPLE ($Ms)	INFOSTRUCTURE ($Ms)	CONTRACTS ($Ms)	Total ($Ms)
1.5.3 Verification and Validation					
V&V Methods		18.787	0.000	0.000	18.787
	LLNL	5.037			5.037
	LANL	8.290			8.290
	SNL	5.172			5.172
	Other	0.288			0.288
V&V Assessments		24.650	0.000	0.000	24.650
	LLNL	4.401			4.401
	LANL	5.040			5.040
	SNL	15.209			15.209
	Other				0.000
Data Validation, Archiving, SQA and Training		9.291	0.000	0.000	9.291
	LLNL	4.438			4.438
	LANL	3.560			3.560
	SNL	1.293			1.293
	Other				0.000

Product / Project WBS	Lab	PEOPLE ($Ms)	INFOSTRUCTURE ($Ms)	CONTRACTS ($Ms)	Total ($Ms)
1.5.4 Computational Systems and Software Environment					
Commodity Technology Systems		1.857	2.900	0.000	4.757
formerly Production Systems	LLNL	0.873			0.873
	LANL	0.984			0.984
	SNL				0.000
	Other		2.900		2.900
Advanced Technology Systems		3.712	74.757	0.000	78.469
formerly Advanced Systems	LLNL	0.084	0.246		0.330
	LANL		0.403		0.403
	SNL	3.628			3.628
	Other		74.108		74.108
System Software and Tools		18.206	0.000	0.000	18.206
	LLNL	4.956			4.956
	LANL	6.161			6.161
	SNL	7.089			7.089
	Other				0.000
Input/Output, Storage, and Networking		12.685	0.000	0.000	12.685
	LLNL	7.160			7.160
	LANL	0.976			0.976
	SNL	4.549			4.549
	Other				0.000
Post-processing Environments		10.115	0.000	0.000	10.115
	LLNL	1.757			1.757
	LANL	4.812			4.812
	SNL	3.546			3.546
	Other				0.000
Next-Generation Computing Technologies		1.600	0.000	9.761	11.361
	LLNL			1.959	1.959
	LANL	1.600		1.926	3.526
	SNL				0.000
	Other			5.876	5.876

Product / Project WBS	Lab	PEOPLE ($Ms)	INFOSTRUCTURE ($Ms)	CONTRACTS ($Ms)	Total ($Ms)
1.5.5 Facility Operations and User Support					
User Support Services		9.727	0.000	1.178	10.905
	LLNL	2.899		1.083	3.982
	LANL	4.721			4.721
	SNL	2.107			2.107
	Other			0.095	0.095
Collaborations		5.365	0.000	7.895	13.260
	LLNL	0.383			0.383
	LANL	0.233		0.165	0.398
	SNL	0.377		0.946	1.323
	Other	4.372		6.784	11.156
System and Environment Administration and Operations		32.758	54.378	0.000	87.136
	LLNL	9.178	30.000		39.178
	LANL	12.160	18.747		30.907
	SNL	11.420	5.631		17.051
	Other				0.000
Facilities, Network and Power		6.739	26.540	1.439	34.718
	LLNL	3.178	10.000		13.178
	LANL	2.407	11.040		13.447
	SNL	1.154	5.500	1.200	7.854
	Other			0.239	0.239
Common Computing Environment		8.692	0.000	0.795	9.487
	LLNL	2.904		0.795	3.699
	LANL	3.167			3.167
	SNL	2.621			2.621
	Other				0.000

	PEOPLE	INFOSTRUCTURE	CONTRACTS	Total
Integrated Codes	139.848	0.000	17.659	157.507
Physics and Engineering Models	62.995	0.000	0.000	62.995
Verification and Validation	52.728	0.000	0.000	52.728
Computational Systems and Software Engineering	48.175	77.657	9.761	135.593
Facility Operations and User Support	63.281	80.918	11.307	155.506
Total	367.027	158.575	38.727	564.329
	65%	28%	7%	564.329

$Ms

Month	Monthly Cost	Cumulative Cost
Oct		0.000
Nov		0.000
Dec		0.000
Jan		0.000
Feb		0.000
Mar		0.000
Apr		0.000
May		0.000
Jun		0.000
Jul		0.000
Aug		0.000
Sep		0.000

Appendix A. Glossary

3D	Three Dimensional
ACES	New Mexico Alliance for Computing at Extreme Scale
ACSLS	Oracle's Automated Cartridge System Library Software
AMD	Advanced Micro Devices
API	Application Programming Interface
ASC	Advanced Simulation and Computing
ASCI	Accelerated Strategic Computing Initiative
ASCR	Advanced Scientific Computing Research (DOE/SC)
ATS	Advanced Technology System
AWE	Atomic Weapons Establishment
CBTF	Component-Based Tool Framework
CCC	Capability Computing Campaign
CCE	Common Computing Environment
CD	Critical Decision
CORAL	Collaboration of Oak Ridge, Argonne, and Livermore
CPU	Central Processing Unit
CRADA	Cooperative Research and Development Agreement
CSSE	Computational Systems and Software Environment
CTS	Commodity Technology System
D&E	Development and Engineering
DAG	Directed Acyclic Graph
DDS	Distributed Data Services
DoD	Department of Defense
DOE	Department of Energy
DSW	Directed Stockpile Work
ECC	Error-Correcting Code
FOUS	Facility Operations and User Support
GA	Generally Available

GB	Gigabytes
GPGPU	General-Purpose Graphics Processing Units
GPU	Graphics Processing Unit
HPC	High Performance Computing
HPSS	High-Performance Storage System
HQ	ASC Headquarters
I/O	Input/Output
IC	Integrated Codes
IHPC	Inter-Site High Performance Computing
ITIL	Information Technology Infrastructure Library
LC	Livermore Computing
LDAP	Lightweight Directory Access Protocol
LDMS	Lightweight Distributed Metric Service
LDRD	Laboratory Directed Research and Development
LEP	Life Extension Program
LFLR	Local Failure Local Recovery
LLNL	Lawrence Livermore National Laboratory
LWK	Lightweight Kernel
MIC	Many Integrated Core
mini-app	Mini Application
MPI	Message Passing Interface
NAS	Network-Attached Storage
NFS	Network File System
NNSA	National Nuclear Security Administration
NPR	Nuclear Posture Review
NSCC	National Security Computing Center
NUMA	Non-Uniform Memory Access
nWBS	National Work Breakdown Structure
OHPC	Open High Performance Computing
OWL	One Way Link
PECASE	Presidential Early Career Award for Scientists and Engineers
PCF	Predictive Capability Framework

PDE	Partial Differential Equation
PEM	Physics and Engineering Models
PESP	Predictive Engineering Science Panel
PLFS	Parallel Log File System
PPE	Power Processing Element
PSAAP	Predictive Science Academic Alliance Program
PSP	Predictive Science Panel
QASPR	Qualification Alternatives to the Sandia Pulsed Reactor
QMU	Quantification of Margins and Uncertainties
R&D	Research and Development
RAID	Redundant Array of Independent Disks
RAIT	Redundant Array of Independent Tapes
RAS	Reliability, Availability, Scalability
RFI	Request for Information
RFP	Request for Proposal
RHEL	Red Hat Enterprise Linux
SAIC	Science Applications International Corporation
SAP	Scalable Applications Project
SC	Department of Energy's Office of Science
SCC	Strategic Computing Complex
SCR	Scalable Checkpoint Restart
SERF	Sanitary Effluent Reclamation Facility
SFI	Significant Finding Investigation
SIMD	Single Instruction, Multiple Data
SLURM	Simple Linux Utility for Resource Management
SNL	Sandia National Laboratories
SNSI	Secret National Security Information
SSP	Stockpile Stewardship Program
SST	Structural Simulation Toolkit
TLCC	Tri-Lab Linux Capacity Cluster
TOSS	Tripod Operating System Software
UGT	Underground Test

UML	Unified Modeling Language
UQ	Uncertainty Quantification
V&V	Verification and Validation
WAN	Wide Area Network
WBS	Work Breakdown Structure

Appendix B. Points of Contact

WBS	Title	Contact
1.5.4	Computational Systems and Software Environment	Becky Springmeyer, LLNL, 925-423-0794, springmeyer1@llnl.gov David Daniel, LANL, 505-665-0883, ddd@lanl.gov Bruce Hendrickson, SNL, 505-845-7599, bahendr@sandia.gov
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Appendix C. Academic Alliance Centers

The ASC Program is currently finalizing the details of the agreements with the awardees for the next PSAAP II academic alliances. Content will be added here for planned FY14 activities at a later date.

Appendix D.
ASC Obligation/Spend Plan

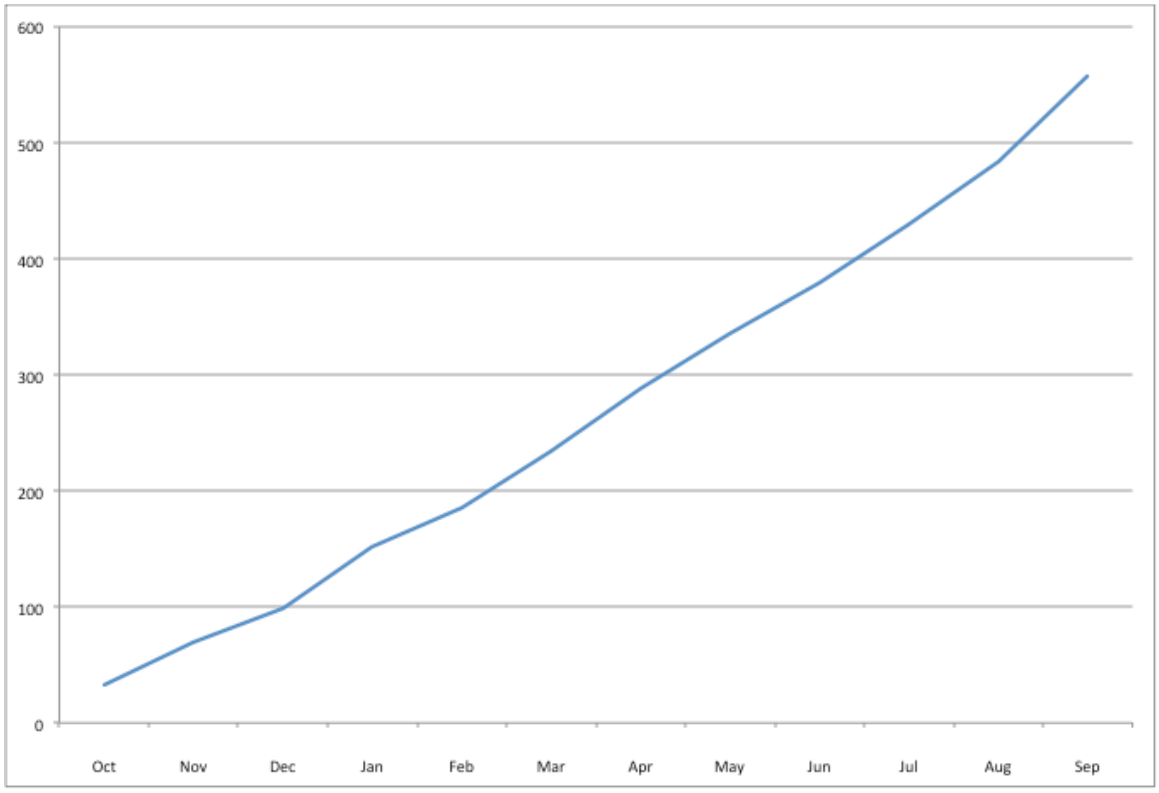

Figure E-1. ASC obligation/spend plan for FY14.

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