Advanced Simulation and Computing

FY15–FY17 IMPLEMENTATION PLAN

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V. ASC Level 1 and 2 Milestones

Table V-1. ASC Level 1 *Proposed* Milestones and Interfaces with Defense Programs Components from FY15–FY17

Milestone Title	Level	FY	Completion Date	Site(s)	Participating Program Offices
Primary Reuse Capability	1	FY15	9/30/15	LLNL, LANL	Science Campaigns, ASC Campaign
Secondary Life Extension Program Capability	1	FY16	9/30/16	LLNL, LANL	Science Campaigns, ASC Campaign
Advanced Safety Baseline Capability	1	FY16	9/30/16	LLNL, LANL, SNL	Science Campaigns, ASC Campaign, Engineering Campaigns
Non-Nuclear Component Performance Capability	1	FY17	9/3017	LLNL, LANL, SNL	Science Campaigns, ASC Campaign, Engineering Campaigns

ASC Level 2 Milestones for FY15

Table V-2. Quick Look: Level 2 Milestone Dependencies for FY15[1]

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Deliver Enhancements of Mesh Relaxation and Remap	FY15	3/31/15	IC	LLNL
TBD	Evaluate and Improve Interactions of Turbulent Mix and Arbitrary Lagrangian-Eulerian Advection	FY15	6/30/15	IC	LLNL
TBD	Evaluate the Use of Arbitrary Lagrangian-Eulerian/Adaptive Mesh Refinement in Full-System Modeling, Part 1	FY15	9/30/15	IC	LLNL
TBD	Material Model Development for Reuse Applications	FY15	9/30/15	PEM	LLNL
TBD	Applications of Uncertainty Quantification Techniques to Predictions of Pit Reuse Success	FY15	3/31/15	V&V	LLNL
TBD	Assess Filtering Methodologies for Uncertainty Quantification	FY15	6/30/15	V&V	LLNL
TBD	Implement a Proxy Application in Support of Researching Parallel Input/Output and Burst Buffer Strategies	FY15	6/30/15	ATDM (Vol. 1)	LLNL
TBD	Planning for Systems Software Environment and Applications Preparation for 2017 Hardware Platform	FY15	9/30/15	CSSE	LLNL
TBD	Commodity Technology System-1 Contract Awarded	FY15	9/30/15	CSSE	LLNL

[1] Factors such as FY15 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
TBD	Livermore Computing High Performance Computing Enduring Facility Master Planning—Modernization and Repurposing	FY15	3/31/15	FOUS	LLNL
TBD	Production Release of the Eolus Project Diagnostics Codes	FY15	6/30/15	IC	LANL
TBD	Eulerian Applications Project Support for the FY16 Predictive Capability Framework Peg Post	FY15	9/30/15	IC	LANL
TBD	Replacement of the Legacy Opacity Code LEDCOP with the ATOMIC Opacity Code for Production of New Opacities	FY15	9/30/15	PEM	LANL
TBD	Parameterization and Implementation of the Pseudo-Reaction-Zone High Explosive Model	FY15	9/30/15	PEM	LANL
TBD	Secondary Validation Suite Support for Energy Balance II	FY15	3/31/15	V&V	LANL
TBD	Demonstrate an Initial Burst Buffer Application Programming Interface	FY15	9/30/15	ATDM (Vol. 2), CSSE	LANL
TBD	Physical Infrastructure Integration for Trinity	FY15	9/30/15	FOUS	LANL
TBD	Thermal/Mechanical Coupling in SIERRA for Pressurization and Breach	FY15	9/30/15	IC	SNL
TBD	Verification and Validation Propensity Improvements via Solution Verification Automation	FY15	6/30/15	IC, V&V	SNL
TBD	A Model for Simulating Photoconductivity Effects in Small-Scale Integrated Circuits in Support of Stockpile Modernization	FY15	9/30/15	IC, PEM	SNL

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Direct Simulation Monte Carlo Simulation of a Massively Parallel, Chemically Reacting, 3D Re-Entry Flow	FY15	9/30/15	PEM	SNL
TBD	Assess Ion Extraction and Beam Transport Models, Including Parameter Sensitivity and Uncertainty Quantification, for Neutron Tube Applications	FY15	9/30/15	V&V	SNL
TBD	Full Quantification of Margins and Uncertainties for a Directed Stockpile Work III-V Heterojunction Bipolar Transistor Circuit	FY15	9/30/15	V&V	SNL
TBD	Programming Models Analysis for Next-Generation Platforms	FY15	9/30/15	ATDM (Vol. 1)	SNL
TBD	Demonstration of Fault-Tolerant Programming Model at Scale	FY15	9/30/15	ATDM (Vol. 2)	SNL
TBD	Demonstrate Advances in Proxy Applications through Performance Gains and/or Performance Portable Abstractions	FY15	9/30/15	IC, ATDM (Vol. 2), CSSE	LLNL LANL SNL
TBD	New Strategy and Guidelines for Campaign Computing on Advanced Technology Systems—Trinity and CORAL	FY15	3/31/15	CSSE, FOUS	LLNL LANL SNL

Milestone (ID#): Planning for Systems Software Environment and Applications Preparation for 2017 Hardware Platform		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Building on the FY14 LLNL plan for Sierra, this milestone addresses hardware and software plans for the 2017 system at LLNL. The plan includes the completion of the Request for Proposals for the 2017 platform, including systems software and the development environment. A code migration and application preparation strategy, including expected programming model and tools support, will also be developed.		
Completion Criteria: A report covering the strategy for applications preparation and a description of the systems software and development environment.		
Customer: ASC		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: LLNL CSSE staff, Sequoia, and other advanced architecture resources		

Milestone (ID#): Commodity Technology System-1 Contract Awarded		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Based on tri-lab Commodity Technology Systems (CTS)-1 process and review, LLNL successfully awards the procurement for the next-generation tri-lab Linux CTS-1.		
Completion Criteria: Signed contract		
Customer: ASC		
Milestone Certification Method: Signed contract		
Supporting Resources: ASC CSSE and FOUS personnel, LLNL procurement staff		

Milestone (ID#): Livermore Computing High Performance Computing Enduring Facility Master Planning—Modernization and Repurposing		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 3/31/15		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: All computational equipment will be relocated from B115 to other enduring high performance computing (HPC) facilities, eliminating ongoing building maintenance costs to the program. Ownership of B115 and B117 will be returned to the institution to repurpose for other non-load-intensive data center uses. The unclassified server room floor in B453 will be modernized, with all infrastructure re-located temporarily and then returned, re-racked, and re-cabled at completion. B453's chilled water plant will be modernized to increase capacity in preparation for the 2017 system.		
Completion Criteria: A report documenting completion of the work will be developed.		
Customer: ASC		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: LLNL FOUS staff, electrical and mechanical outside subcontractors.		

Milestone (ID#): Demonstrate an Initial Burst Buffer Application Programming Interface		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: ATDM, CSSE		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a LANL deliverable supporting the development of hierarchical file systems to enable checkpoint restart at scale. This milestone focuses on demonstrating the initial prototype for the burst-buffer application programming interface (API) on a test bed or other representative system. The prototype burst-buffer API was delivered in FY14. Evaluating the performance of the API through micro-benchmark drivers and applications such as Partisn and XRAGE will be the focus of this FY15 milestone. This should be demonstrated at the largest scale limited by the burst-buffer test beds available. The API should be evaluated during the integration, and pros/cons of the API will be reported as lessons learned. In addition, performance issues with the proposed burst-buffer hardware architectures will be documented and communicated back to the vendors to drive improved designs for our applications.		
Completion Criteria: This milestone will be completed when: • Demonstrate functioning API with micro-benchmarks, mini applications, and or one application at largest scale available with burst-buffer test bed hardware. • A report and/or slides have been completed detailing lessons learned, both successes and failures, in regards to performance and initial API.		
Customer: ASC IC		
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: CSSE advanced architecture test beds		

Milestone (ID#): Physical Infrastructure Integration for Trinity		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: FOUS		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: Design, build, and integrate under-floor electrical and water-cooling distribution system for Trinity/ATS-1 platform.		
Completion Criteria: Under floor electrical and water-cooling distribution system ready for Trinity hook-up.		
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#): Demonstration of Fault-Tolerant Programming Model at Scale		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: ATDM		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		

Description: The several-orders-of-magnitude increase in parallelism is the most commonly cited of the software development challenges on the road to exascale; however, hurdles also include drastically shortened mean times to interrupt, increased imbalance between computational capacity and input/output (I/O) capabilities, silent errors, and complex hardware architectures. Asynchronous, many-task (AMT) programming models show promise at sustaining performance despite node degradation and failures. However, they introduce a challenging distributed consistency problem both within and amongst several interacting components (for example, scheduler, global address server, and transport layer), which demands a large set of programming model and runtime tools to address process failures. Existing many-task solutions often have nascent resilience support, addressing a subset of the resilience problem. This milestone will include a demonstration of a novel holistic approach to distributed fault-tolerant programming models, using one or more ASC Mantevo applications, at scale, on a capability-class system. Furthermore, this milestone will include a performance study using the SST/Macro simulator, in which we will analyze the response to faults in the system and characterize the scalability and performance based on at least one at-scale Mantevo application and a realistic system configuration. Specific deliverables include:

- An SST/macro implementation of a resilient distributed AMT runtime.
- A report summarizing the studies performed using the SST/macro resilient distributed AMT runtime. The performance, scalability, and fault-resilience limits of the runtime will be assessed for one or more ASC Mantevo applications (for example, mini FE and mini Aero).
- Development of optimized dynamic scheduling and work-stealing techniques for distributed AMT runtime.
- Demonstration of one or more ASC Mantevo applications running at scale on a capability class machine in the presence of faults.

Completion Criteria: Completion of program review and final document published as a SAND report.

Customer: ASC 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 or other higher scale HPC platforms

Milestone (ID#): Demonstrate Advances in Proxy Applications through Performance Gains and/or Performance Portable Abstractions		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 9/30/15		
ASC nWBS Subprogram: IC, ATDM, CSSE		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a tri-lab deliverable supporting the ongoing co-design efforts in the program (IC and CSSE) as well as the new ATDM activities. In FY14, a milestone evaluating the performance and underlying bottlenecks of key proxy applications (proxy apps) on advanced architecture test beds or advanced technology systems (ATS) was completed. In addition, each lab has been developing and exploring promising new parallel programming models that will provide abstractions for performance portability, especially at the node level. This milestone focuses on building upon those findings through a combination of internal performance improvements, deeper evaluation of abstractions, and external co-design influence. Each lab will choose at least two proxy applications and refactor them through the use of new programming models and tools, algorithms, or domain-specific languages (DSLs), resulting in either demonstrable speedup, improved portability through abstractions, or as a stretch goal, both. Improvements will be demonstrated across at least two advanced architectures (test bed or ATS). Performance improvements will be relative to proxy apps and related metrics gathered in the FY14 milestone. Programming abstraction demonstrations will use at least one proxy app developed at another laboratory (in collaboration and agreement with that lab) to demonstrate broad applicability across variable programming styles. Successful and unsuccessful attempts will be reported as lessons learned. The tri-lab co-design project will work closely with the *Forward vendors to make available the studied proxy apps and related data (for example, traces or simulator results) for vendor research.		
Completion Criteria: This milestone will be completed when: • At least two proxy apps from each lab have demonstrated performance improvements or improved portability across two advanced architectures. • A report has been completed by the three labs detailing lessons learned—both successes and failures—in regards to performance and/or portability improvements. • The milestone team has communicated appropriate information, including source code, metrics, trace data, and simulator analysis for use in vendor-focused research.		
Customer: ASC application code teams		

Milestone (ID#): Demonstrate Advances in Proxy Applications through Performance Gains and/or Performance Portable Abstractions
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: ASC advanced hardware; CSSE and IC Staff (ATDM)

Milestone (ID#): New Strategy and Guidelines for Campaign Computing on Advanced Technology Systems—Trinity and CORAL		
Level: 2	**Fiscal Year**: FY15	**DOE Area/Campaign**: ASC
Completion Date: 3/31/15		
ASC nWBS Subprogram: CSSE, FOUS		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: Develop and publish a new strategy and guidelines for Campaign Computing use of ATS-class systems supporting needs of the Nuclear Weapons Stockpile Stewardship Program and ASC Program.		
Completion Criteria: A published policy		
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: ASC CSSE and FOUS personnel at LLNL, LANL, SNL		

ASC Level 2 Milestones for FY16

Table V-3. Quick Look: Level 2 Milestone Dependencies for FY16[2]

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Verify and Validate a New Multiphase Capability	FY16	12/31/15	IC	LLNL
TBD	Deliver, within the Nuclear Performance Code System, an Initial Capability for the Simulation of Output	FY16	9/30/16	IC	LLNL
TBD	Evaluate the Use of Arbitrary Lagrangian-Eulerian/Adaptive Mesh Refinement in Full-System Modeling, Part 2	FY16	9/30/16	IC	LLNL
TBD	Develop a Multiphase Equation of State Kinetics Framework; Demonstrate Robustness and Numerical Stability in Large-Scale Simulations	FY16	9/30/16	PEM	LLNL
TBD	Study Multi-Level Memory Hierarchies in at Least Two Proxy Applications	FY16	9/30/16	ATDM (Vol. 1)	LLNL
TBD	Applications Preparation and Outreach for CORAL 2017 LLNL Machine	FY16	9/30/16	CSSE	LLNL
TBD	Complete 15-MW B453 Power Upgrade	FY16	9/30/16	FOUS	LLNL
TBD	Complete B654 Livermore Computing Project	FY16	6/30/16	FOUS	LLNL
TBD	Site Sierra Preparation System	FY16	9/30/16	FOUS	LLNL

[2] Factors such as FY16 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
TBD	Demonstration by the Lagrangian Application and Setup Project of a 3D Implosion/Explosion Simulation Capability	FY16	9/30/16	IC	LANL
TBD	Demonstration of the Eulerian Application Project Simulation Capability Upgrades for Future Architectures	FY16	6/30/16	IC, CSSE	LANL
TBD	Dynamic Fracture Model for Brittle Metal Phases	FY16	6/30/16	PEM	LANL
TBD	Diagnostic Data Analysis, Uncertainty, and Modeling in an ASC Era	FY16	9/30/16	V&V	LANL
TBD	3D Particle Radiation Transport Calculations for Box Internal Electromagnetic Pulse	FY16	9/30/16	IC	SNL
TBD	A Demonstrated Flexible Coupling between SIERRA Modules	FY16	9/30/16	IC, PEM	SNL
TBD	Aluminum Equation of State	FY16	9/30/16	PEM	SNL
TBD	Thermal Battery Design Tool	FY16	9/30/16	PEM, V&V	SNL
TBD	Demonstration of a Newly Developed Sensor Model	FY16	9/30/16	V&V	SNL
TBD	Adaptive Uncertainty Quantification	FY16	9/30/16	V&V	SNL
TBD	Propagate Uncertainties in Re-Entry Coupled Simulations to Component (Gas Transfer System or Neutron Generator or Stronglink) Response Metric	FY16	9/30/16	V&V	SNL
TBD	New TRILINOS Solver Stack with Support for Threading and Accelerator-Based Architectures in Production Solvers	FY16	9/30/16	ATDM (Vol. 1)	SNL

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Impact of Advanced Memory Architectures on ASC Codes	FY16	9/30/16	CSSE	SNL
TBD	Demonstration and Evaluation of Advanced Analysis, Visualization, and Input/Output Capabilities for the SIERRA Toolkit	FY16	9/30/16	CSSE	SNL
TBD	Using Performance Modeling and Simulation Tools and Techniques to Gauge Key Application Performance Characteristics of the Trinity Platform	FY16	9/30/16	CSSE	SNL
TBD	Integrate the Tri-Lab Commodity Technology System-1 Clusters into SNL Environment	FY16	6/30/16	FOUS	SNL
TBD	Demonstrate Integration of Performance Improvements Identified via Mini-Applications into Application Codes	FY16	9/30/16	ATDM (Vol. 1)	LLNL LANL SNL
TBD	Deploy a Common Capacity Computing Environment for Commodity Technology System-1 Systems	FY16	6/30/16	FOUS	LLNL LANL SNL
TBD	Trinity System Integration Readiness	FY16	12/31/15	CSSE, FOUS	LANL, SNL

Milestone (ID#): Applications Preparation and Outreach for CORAL 2017 LLNL Machine		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Building on the FY15 Sierra systems software and applications preparations planning, the Sierra Applications Preparation (SAP) effort will extend the knowledge base, documentation, and training to enable ASC tri-lab code teams to use the 2017 Sierra system. SAP will actively engage tri-lab code teams to address their needs in porting codes. Several multi-physics codes will be engaged to characterize performance, analyze issues, and develop strategies for improving performance on the platform. A deployment plan will be developed, including initial testing and validation of the tool suite.		
Completion Criteria: A report covering the performance findings and recommended techniques and strategies for the codes studied.		
Customer: ASC IC		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: Simulators and test beds to simulate the Sierra system.		

Milestone (ID#): Complete 15-MW B453 Power Upgrade		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: In preparation for siting the 2017 system, B453 requires a power upgrade. This milestone will provide the necessary power projected for the Sierra machine to be sited in B453 in 2017.		
Completion Criteria: Power upgrade complete and tested.		
Customer: ASC LLNL		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: FOUS personnel and contracted electrical specialists.		

Milestone (ID#): Complete B654 Livermore Computing Project		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 6/30/16		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: Early users will be on the CTS-1 machines at LLNL.		
Completion Criteria: CTS-1 racks have been assembled in the new B654 facility, the system has been placed on the unclassified network, and at least one user has ported his/her code. A user will write a memo certifying that his/her code has run on the CTS-1 cluster.		
Customer: ASC/LLNL		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: CTS-1, facilities team, FOUS and CSSE staff		

Milestone (ID#): Site Sierra Preparation System		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: A Sierra preparation system will be sited on the unclassified side and an early user will successfully run a code.		
Completion Criteria: A memo certifying that the user was able to successfully run the code will be completed.		
Customer: User from an ASC code team.		
Milestone Certification Method: A report with a written summary will be prepared as a record of milestone completion.		
Supporting Resources: TBD		

Milestone (ID#): Impact of Advanced Memory Architectures on ASC Codes		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: Develop a next-generation memory system architecture to increase performance of ASC applications in partnership with industry and academia. SNL is performing architectural analysis and supplying application and system software expertise. Analysis of this system shall show improvements in memory system performance or power compared to conventional memory systems. Experiments shall also be used to explore the memory system design space (including bandwidth, capacity, and topology); determine the overall impact on the applications, system software, and system balance; and determine the impact of performing some computation, synchronization, or data movement operations in the memory system. This milestone will focus on the performance of key ASC application kernels and algorithms and will use a variety of tools available at the time, which may include the SST simulator, hardware emulation prototypes such as field-programmable gate arrays, or hardware evaluation test beds.		
Completion Criteria: Completion of program review and final document published as a SAND report.		
Customer: ASC code 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 architecture test beds.		

Milestone (ID#): Demonstration and Evaluation of Advanced Analysis, Visualization, and Input/Output Capabilities for the SIERRA Toolkit		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: The combination of increased complexity of ASC simulations and projected limitations in I/O system performance for the next generation of extreme-scale systems is causing a significant change in the usage model for HPC systems. The standard approach of executing each step in the application workflow in distinct steps, storing intermediate results to a shared parallel file system, will not be practical. To address this challenge, CSSE has been developing technologies to enable a tighter coupling between different elements (for example, simulation and analysis) in the application workflow, and it has been adapting analysis and visualization codes to execute on HPC systems along side the large-scale simulations. This milestone will provide a demonstration and evaluation of the use of these capabilities for important applications using the SIERRA toolkit.		
Completion Criteria: Completion of program review and final document published as a SAND report.		
Customer: ASC application developers and NW analysts.		
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: Access to an advanced technology HPC system for development and ultimate demonstration.		

Milestone (ID#): Using Performance Modeling and Simulation Tools and Techniques to Gauge Key Application Performance Characteristics of the Trinity Platform		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 9/30/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: This milestone has several important goals. SNL wants to develop SST models for Trinity features in advance of the actual physical system deployment for two key reasons: 1) to provide the application development teams a head start on analyzing the behavior of their codes on Trinity (before it is actually available), and 2) to set a baseline for predictive performance of SST for key components of the Trinity system. These are obviously interconnected, and both rely on the core ability to model aspects of application's performance on SST prior to Trinity's full deployment. The first key deliverable is hence the development of SST models of important Trinity features and an understanding of the fidelity of those models, recognizing that a final determination may only be possible after Trinity is deployed and comparative performance data is collected and reconciled with the SST Trinity models. SNL will select one or more ASC applications or mini-apps to focus the work, and data will be collected on the SST simulator and documented such that SNL can later (when the actual Trinity data is available) rigorously compare and analyze the SST's predictive capability in this context. The work is expected to focus on the macro-scale components of SST but may not be restricted to that; final determination will be made closer to the milestone date. Once the application performance analysis is complete and the SST simulator 'calibrated,' SNL expects to subsequently improve the SST models as needed so that they can be used for a wide variety of application performance analysis work.		
Completion Criteria: Completion of program review and draft document to be published as a SAND report when SST quantitative fidelity analysis is complete		
Customer: ASC application developers preparing for Trinity		
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: Access to Trinity after milestone to perform the fidelity analysis		

Milestone (ID#): Integrate the Tri-Lab Commodity Technology System-1 Clusters in SNL Environment		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 6/30/16		
ASC nWBS Subprogram: FOUS		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: CTS-1 resources will be installed, accepted from the provider, integrated into the network environment, and ready for general use within two calendar quarters following delivery to SNL facilities.		
Completion Criteria: System hardware deliveries from vendor to site are complete and contractual requirements for formal hardware acceptance have been completed; system software needed for operation of the system is installed, tested, and demonstrated to be operational; and system has been integrated into local computing environments. Early code transitions and performance evaluations work is substantially complete.		
Customer: NW, ASC		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: CSSE, FOUS, platform funding, SNL facilities.		

Milestone (ID#): Deploy a Common Capacity Computing Environment for Commodity Technology System-1 Systems		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 6/30/16		
ASC nWBS Subprogram: FOUS		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: Deploy additional CCE capabilities for capacity computing environment, working towards a responsive and more efficient infrastructure to support computing for QMU and predictivity.		
Completion Criteria: Deployment of CCE computing environment on CTS-1 systems.		
Customer: ASC CTS-1 users		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a nuclear weapons stockpile customer is documented.		
Supporting Resources: Tri-lab CSSE and FOUS staff.		

Milestone (ID#): Trinity System Integration Readiness		
Level: 2	**Fiscal Year**: FY16	**DOE Area/Campaign**: ASC
Completion Date: 12/31/15		
ASC nWBS Subprogram: CSSE, FOUS		
Participating Sites: LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: Ready Trinity for integration into the LANL computing center. Deliver and install system hardware. Deliver, test, and demonstrate system software. Complete onsite capability scaling testing. Ready Trinity for onsite integration into the local and remote computing infrastructure, including the user software environment.		
Completion Criteria: Follows the ASC Level 2 Milestone criteria for capability platforms: system hardware deliveries from vendor to site are complete, including the basic hardware to integrate "the system" as contractually defined; installation of the system by the contractor onsite to the extent that is contractually required is substantially complete; in general, contractual requirements for formal hardware acceptance have been substantially completed; system software needed for basic operation of the system is delivered, tested, and demonstrated to be operational; vendor has completed onsite capability scaling testing and demonstration; and system is ready to begin onsite integration into local computing environment.		
Customer: NNSA/ASC HQ, tri-lab ASC program managers responsible for CCCs, SSP, 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: CSSE, FOUS, platform funding, ACES program managers, LANL facilities		

ASC Level 2 Milestones for FY17

Table V-3. Quick Look: Level 2 Milestone Dependencies for FY17[3]

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Deliver Initial Capability for Unstructured Adaptive Mesh Refinement	FY17	12/31/16	IC	LLNL
TBD	Advanced Architecture Evaluation of a Weapons Code	FY17	6/30/17	IC	LLNL
TBD	Provide Updated Nuclear Library Data and Evaluations; Deliver in the New International Standard, Generalized Nuclear Data Format	FY17	9/30/17	PEM	LLNL
TBD	Task-Based Programming Models in Sweep Algorithms	FY17	9/30/17	ATDM (Vol. 1)	LLNL
TBD	Site Initial Sierra File System on Open Computing Facility	FY17	9/30/17	CSSE, FOUS	LLNL
TBD	Demonstrated Upgrades to Monte Carlo Transport Capabilities	FY17	6/30/17	IC	LANL
TBD	Lagrangian Applications Project Support for the FY18 Predictive Capability Framework Peg Post	FY17	9/30/17	IC	LANL
TBD	Delivery of Improved Materials Models Supporting FY18 PCF Peg Post	FY17	9/30/17	PEM	LANL
TBD	A Feature Rich Model for Initial Mix Deposition	FY17	9/30/17	PEM	LANL

[3] Factors such as FY17 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
TBD	Deliver a Verification and Validation Assessment of Code Implementations of Physics Models and Numerical Algorithms Using Small Scale Science Experiments and Test Problems in Support of the FY18 Predictive Capability Framework Peg Post	FY17	9/30/17	V&V	LANL
TBD	Demonstrate an Advanced Runtime on Trinity	FY17	9/30/17	CSSE	LANL
TBD	Adaptive Feature Capture Using In-Situ Parallel Hex Meshing	FY17	12/31/16	IC	SNL
TBD	Verification and Validation/Uncertainty Quantification Engineering Analysis Workflow for Next-Generation Platforms	FY17	3/31/17	IC	SNL
TBD	Neutron Tube Simulation Capability	FY17	9/30/17	PEM	SNL
TBD	Gas Transfer Simulation Capability	FY17	6/30/17	PEM, V&V	SNL
TBD	Application of Stencil Approach for Tolerating Silent Errors by ASC Codes	FY17	12/31/16	ATDM (Vol. 2)	SNL
TBD	Demonstrate Scalability of RAMSES Next-Generation Electromagnetic-Plasma Solver for Source Region Electromagnetic Pulse Problems	FY17	9/30/17	ATDM (Vol. 1)	SNL
TBD	Trinity Power Management Application Passing Interface Implementation	FY17	9/30/17	CSSE, FOUS	SNL
TBD	Implement Advanced Inter-Lab High-Speed Network—DisCom II	FY17	6/30/17	FOUS	SNL

Milestone ID	Milestone Title	FY	Complete Date	Sub-Program	Site
TBD	Modify or Develop More Representative Mini-Applications Resulting from Application Integration Experience	FY17	9/30/17	ATDM (Vol. 2)	LLNL LANL SNL
TBD	Trinity System Production Readiness	FY17	12/31/16	CSSE	LANL SNL

Milestone (ID#): Site Initial Sierra File System on Open Computing Facility		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 9/30/17		
ASC nWBS Subprogram: CSSE, FOUS		
Participating Sites: LLNL		
Participating Programs/Campaigns: ASC		
Description: This milestone represents the culmination of the analysis, evaluation, procurement, integration, testing, and deployment of parallel file system hardware and software in preparation for the Sierra machine's arrival in the open computing facility (OCF). Depending on the solution(s) chosen, this effort may also involve targeted development efforts on the part of LLNL's file system development staff. Completion of this milestone will require extensive integration and testing of hardware and software components in the unclassified environment.		
Completion Criteria: The milestone will be complete when initial file system hardware and software is functioning in the OCF in support of available Sierra preparation and test equipment.		
Customer: ASC/LLNL		
Milestone Certification Method: Professional documentation, such as a report or a set of viewgraphs with a written summary, is prepared as a record of milestone completion. The "handoff" of the developed capability (product) to a customer is documented.		
Supporting Resources: Systems and file systems expertise.		

Milestone (ID#): Demonstrate an Advanced Runtime on Trinity		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 9/30/17		
ASC nWBS Subprogram: CSSE		
Participating Sites: LANL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a LANL deliverable supporting the demonstration of an advanced parallel runtime on the Trinity platform. An advanced parallel runtime, such as Legion, would be ported to the Trinity platform and a microbenchmark and a mini-app would be run at scale. This effort would show the viability of the selected runtime on production hardware at scale, and additionally show the viability of the Trinity architecture and platform to run and advanced parallel runtime. The performance would be compared to a traditional run of the microbenchmark and a mini-app under message passing interface (MPI). In addition, performance issues with the selected runtime and the Trinity architectures will be documented and communicated back to the vendors or developers to drive improved designs for our applications.		
Completion Criteria: This milestone will be completed when functioning runtime with microbenchmarks and mini-app at a reasonable scale are demonstrated, and a report and/or slides are completed detailing lessons learned, both successes and failures, in regards to performance of Trinity and the selected parallel runtime.		
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: CSSE, advanced architecture test beds, Trinity		

Milestone (ID#): Application of Stencil Approach for Tolerating Silent Errors by ASC Codes		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 12/31/16		
ASC nWBS Subprogram: ATDM		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: An increasingly important type of failure in HPC involves deviations from intended behavior that occur silently. With extreme-scale computing, these previously rare "silent errors" will become more commonplace. We are developing novel approaches to address a significant concern in this space: silent data corruption (SDC), such as bit flips. Our ongoing research seeks to leverage stability properties of physical systems to engineer related SDC stability properties into digital algorithms for physics simulation. This work has demonstrated the potential for a "robust stencil" approach that can discard an outlier point from a neighborhood in a discretized equation and compute an update of sufficient accuracy from the remaining points. Demonstrations have been run at small scale with simplified solvers, but the underlying theory suggests that the approach can be generalized to more practical solvers for ASC applications and scaled to large numbers of compute nodes. Starting in FY14, we began working on the mathematical and algorithmic innovations needed to bring such physics-based SDC tolerance into HPC practice. For this milestone, we will demonstrate a representative robust simulation application at scale on an advanced technology system. We will evaluate the performance and error tolerance of this application with respect to one or more relevant types of SDC (for example, memory or network bit flips), using emulated error injection or—if present and characterizable—actual system errors.		
Completion Criteria: Completion of program review and final document published as a SAND report.		
Customer: ASC 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: Access to an advanced technology HPC system for development and ultimate demonstration.		

Milestone (ID#): Trinity Power Management Application Passing Interface Implementation		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 9/30/17		
ASC nWBS Subprogram: CSSE, FOUS		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: Power is a constraining factor in the operation of ASC production computing platforms. The Trinity ATS-1 platform includes nonrecurring engineering (NRE) funding to develop power monitoring and control capabilities through an HPC community power management API. This milestone will document the new power management capabilities that are developed for Trinity. New measurement capabilities may include cabinet and component level current and voltage measurements, scalable collection infrastructure, tunable collection fidelity (cabinets to components), and administrative- and user-accessible interface for feedback and tuning. New power control capabilities may include the ability to manage power at the platform, runtime, and application level; policy-driven management, weighted combination of performance and energy, and energy caps based on, for example, time of day and physical capacity. Power measurement and control capabilities (hardware and software tools and APIs) are necessary to meet the needs of future supercomputing energy and power constraints. It is extremely important that Trinity utilize early capabilities in this area and start defining and developing advanced capabilities and integrating them into a user friendly, production environment. Some functionality will be required at time of initial acceptance. Both initial and advanced capabilities will be defined cooperatively between the New Mexico Alliance for Computing at Extreme Scale (ACES) team and the subcontractor.		
Completion Criteria: SNL will define a portion or quantify in another way what portions of the power API or functionality would be implemented by 2017. A program review will be completed and a final document published as a SAND report.		
Customer: ASC application developers, system administrators.		
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: Access to Trinity HPC system for development and ultimate demonstration.		

Milestone (ID#): Implement Advanced Inter-Lab High-Speed Network – DisCom II		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 6/30/17		
ASC nWBS Subprogram: FOUS		
Participating Sites: SNL		
Participating Programs/Campaigns: ASC		
Description: TBD		
Completion Criteria: TBD		
Customer: TBD		
Milestone Certification Method: TBD		
Supporting Resources: TBD		

Milestone (ID#): Modify or Develop More Representative Mini-Applications resulting from Application Integration Experience		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 9/30/17		
ASC nWBS Subprogram: ATDM		
Participating Sites: LLNL, LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is a tri-lab deliverable supporting the ongoing co-design efforts in the program as well as the new ATDM activities. This milestone focuses on taking the lessons learned from the integration and evaluation process and modifying or replacing mini-apps to better represent applications and/or workflows. These improvements will be developed and tested on current test-bed hardware or ASC production hardware. In addition, crucial performance issues with the hardware architectures explored will be communicated back to the vendors to drive improved designs for our applications.		
Completion Criteria: This milestone will be completed when: • Improvements to the mini-apps to more closely represent our workloads are demonstrated on test-bed platforms and/or production systems. • A report has been completed by the three labs detailing lessons learned, both successes and failures, in regards to improvements. • The milestone team has communicated appropriate findings to vendors associated with the platforms evaluated in the milestone.		
Customer: NNSA/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: Advanced ASC hardware, CSSE and IC staff (ATDM).		

Milestone (ID#): Trinity System Production Readiness		
Level: 2	**Fiscal Year**: FY17	**DOE Area/Campaign**: ASC
Completion Date: 12/31/16		
ASC nWBS Subprogram: CSSE		
Participating Sites: LANL, SNL		
Participating Programs/Campaigns: ASC		
Description: This milestone is based on meeting the requirements as outlined in the Production Capability Readiness Milestone Description Guidelines. These requirements certify, through a review, that Trinity is ready for production capability. These requirements include: machine accessibility and integration, operational support, usage model has been demonstrated, user testing of applications has been done, system reliability has been achieved, application and I/O performance testing has been demonstrated, and a milestone review has been completed.		
Completion Criteria: Follows the ASC Level 2 Milestone criteria for capability platforms: that all of the topics identified in the description above have been successfully demonstrated for capability class simulations. These requirements are specifically listed in the usage model for Trinity, which defines that the system has demonstrated an acceptable production user environment with all the associated support, testing, reliability and applications use of the system.		
Customer: NNSA/ASC HQ, tri-lab ASC program managers responsible for capability computing campaigns (CCCs), the Stockpile Stewardship Program (SSP), 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: CSSE, FOUS, Trinity		