Software Design and Productivity (SDP)

NITRD Agencies: NSF, NIH, DARPA, NASA, NIST, OSD, NOAA, DOE/NNSA
Other Participants: FAA, ONR

SDP activities will lead to fundamental advances in concepts, methods, techniques, and tools for software design, development, and maintenance that can address the widening gap between society's need for usable and dependable software-based systems and the ability to produce them in a timely, predictable, and cost-effective manner. The SDP R&D agenda spans both the engineering components of software creation and the economics of software management across all IT domains including the emerging areas of sensor networks, embedded systems, autonomous software, and highly complex, interconnected systems of systems.

President's 2006 Request

Strategic Priorities Underlying This Request

- Developing, upgrading, and maintaining software has become the most costly, time-consuming, labor-intensive, risky, and frustrating aspect of IT deployment for Federal agencies and indeed all sectors of the economy. Certifying the correct functionality, reliability, and security of products and processes that include software adds costs and delays the deployment of new and improved capabilities. SDP R&D focuses on cost-effective methods to overcome this pervasive problem at the core of computing and networking technologies.
- Because high-quality software is mission-critical for SDP agencies, they are both individually and collaboratively creating frameworks and environments to more efficiently develop and certify such software. The goal is to find next-generation software engineering methods, tools, and techniques that reduce the cost, risk, and difficulties of software development and increase the reliability, security, interoperability, and even reusability, of software components.
- The commonality of agencies' software issues, recent advances in computer science such as aspect-based programming, and the need for interoperability (which is facilitated by data standards) make several topics ripe for enhanced information sharing and coordination. The capability to conduct multiscale modeling and simulation of complex physical systems such as the Earth, the human body, and manufactured products is needed across all science and engineering domains, but developing the necessary software is costly and technically difficult. The SDP workshop activity will assess the state of the art and identify research needs to advance interdisciplinary modeling techniques and tools that many communities could share.

Highlights of Request

- **DOE/SC, NOAA, NSF:** ESMF (component architecture with libraries and utilities to increase portability, reusability, and performance of Earth science software applications)
- **DOE/SC, NIH, NIST, NSF:** Data Uniformity and Standards for Structural Bioinformatics
- **DARPA, NSF:** Embedded Systems Consortium for Hybrid and Embedded Research (ESCHER)
- **NASA, NSF:** Highly Dependable Computing and Communications Systems Research (HDCCSR)
- **NASA, NIST:** Systems Engineering Program

Planning and Coordination Supporting Request

- Planning for a 2006 workshop on multiscale modeling and simulation of complex physical systems
- Briefings by Federal IT user agencies about issues in developing their critical large-scale software applications

2005 and 2006 Activities by Agency

NSF: Supports basic research on foundations of computing processes and artifacts (advanced computational research, software engineering, and languages), science of design (scientific study of the design of software-intensive systems including their complex interdependencies); computer systems research (distributed systems, embedded and hybrid systems, new-generation software); HDCCSR to advance the design, testing, implementation, and certification of highly dependable software-based systems (with NASA)

NIH: Support four National Centers for Biomedical Computing to develop, disseminate, and train users of biomedical computing tools and user environments; encourage collaboration between "big" and "small" science at these Centers; create and disseminate curriculum materials to embed quantitative tools in undergraduate biology education

NASA: Advanced software engineering technologies for modular and reusable flight software, software verification and validation technologies for autonomous systems, and increased reliability for critical flight control software; software systems for autonomy and intelligence; advanced software health management technologies for fault detection, diagnosis, prognostics, information fusion, and degradation management; advanced capabilities in modeling, simulation, and visualization; multi-agent technologies for self-scheduling systems, distributed decision-support systems and other autonomous environments; advanced capabilities to support management of technology; systems design and engineering analysis tools including simulation modeling environments, system models, discipline-oriented analysis tools, parametric-based risk analysis tools, and probabilistic risk analysis models; projects in autonomy and engineering for complex systems end in 2005

NIST: Automated design, procurement, and operation through software (mostly data) interoperability; automated generation of test suites for XML schema; Digital Library of Mathematical Functions (with NSF); manufacturing supply chain software interoperability; standards for ebXML; international testbeds for business-to-business solutions; interoperability of databases for bioinfomatics, chemical properties, and properties of inorganic materials; sharable data structures for neutron research; ontological approach using formal logic to automate process of integrating manufacturing enterprise UnitsML; interface standards and associated conformance tests for interoperability of manufacturing control systems architectures with security; semantically based validated product representation scheme for seamless interoperability among computer-aided design (CAD) systems and with systems that use CAD data; standards for exchange of instrument data and NIST Chemical Reference Data; standards for physical and chemical product data interchange; anthropometric data standards for accurate 3-D representation of human measurement (with the U.S. Air Force for cockpit design); ontological methods for representation and exchange of mathematical data; 3-D representation of schema models; tools for validation and testing of schemas

OSD (HPCMPO): Applications software development (physics-based design, modeling, simulation, testing); institutes on battlespace topics; PET Program tools and techniques (benchmarking, remote visualization, debugging and optimization, interactive computing environments for large datasets)

NOAA: Develop atmospheric, ocean, and coupled climate models for climate projection studies using the FMS programming structure; ESMF; Development Test Center (with NSF/NCAR and the university community)

DOE/NNSA: Deploy software user environment for Advanced Simulation and Computing (ASC) Program's Red Storm system at SNL; deploy and test software components and environment for Purple and Blue Gene/L systems at LLNL; develop high-performance open-source Linux-based environment, initially targeting capacity computing; execute performance-related analysis of interconnects, ASC computational workload, Linux software stacks, and capacity platforms; plan and prepare for software infrastructure of future ASC systems

FAA: Focus on developing secure, dependable software-based systems and the ability to produce them in a timely, predictable, and cost-effective manner