Software Design and Productivity (SDP)

NITRD Agencies: NSF, OSD and DoD Service research organizations, NIH, NASA, NIST, NOAA
Other Participants: DISA

SDP R&D will lead to fundamental advances in concepts, methods, techniques, and tools for software design, development, and maintenance that can address the widening gap between the needs of Federal agencies and society for usable, 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 (e.g., development environments, component technologies, languages, tools, system software) and the business side of software management (e.g., project management, schedule estimation and prediction, testing, document management systems) across diverse domains that include sensor networks, embedded systems, autonomous software, and highly complex, interconnected systems of systems.

President's 2009 Request

Strategic Priorities Underlying This Request
Software is a critical enabler of America's security, economy, and quality of life and thus is a national priority. The formidable technical challenges of improving software quality, from the fundamental science to the application level, are SDP R&D priorities, including:

Software for tomorrow's complex systems:
- **Mathematical foundations of software and systems architectures:** Next-generation concepts and methods for developing and analyzing software for complex systems; synchronization and timing; dependability; scalability
- **Algorithms and software for petascale levels:** New approaches for advanced applications other than high-end computation
- **Ultra-large-scale (ULS) systems:** R&D in self-adapting system concepts, architectures, and technologies; enabling adaptations and system augmentations at the edge; verifying and certifying the behavior, performance, and reliability of complex, reconfigurable, heterogeneous ULS systems; component-based architectures

Predictable, timely, cost-effective software development: Innovative methods, technologies, and tools for systems and software engineering, rapidly evaluating alternative solutions to address evolving needs; measuring, predicting, and controlling software properties and tradeoffs; virtualized and model-based development environments
- **Standards development and implementation:** New methods and tools with a focus on shortening the development-validation-implementation-testing cycle

Software interoperability and usability: Interface and integration standards, representation methods to enable software interoperability, data exchanges, interoperable databases; supply-chain system integration

Highlights of Request
Software complexity: Foundational computational models, techniques, languages, tools, metrics, and processes for understanding and engineering high-quality software for increasingly complex systems, applications, and systems-of-systems (SoS); model-based software technologies for SoS interoperability; scalable subsystem composition; scalable software architectures – NSF, OSD

Cyber-enabled Discovery and Innovation: Activity to create new computational concepts, methods, tools to spur innovation in science and engineering – NSF

Systems and Software Producibility Collaboration and Evaluation Environment (SPRUCE): Rigorous testing of new technologies, methodologies and theories for testing software-intensive systems; software producibility research products and methods – OSD

Interface standards for information interoperability: Product representation scheme for interoperability among computer-aided engineering systems; standards for exchange of instrument and measurement data; methods to facilitate search and exchange of mathematical data; ontological approaches to facilitate the process of integrating supply chain systems; interoperability of databases for bioinfomatics, chemical and materials properties – NIST

Reuseable Libraries for Common Defense-Specific Software Functions: National Academy of Sciences study on advancing software-intensive systems producibility – OSD

Planning and Coordination Supporting Request

Software Interoperability: Planning for workshop examining interoperability in an era of network-enabled applications that require software systems to interact with other systems over a variety of networks (Internet, cellular networks, enterprise networks, and others) and over a lengthy lifecycle – NIST, NSF

Software for Complex Systems: Planning for a workshop to identify the critical issues in software design and development – NSF, all other interested government agencies

Procedure to release software code base: Working on release of DISA-developed suite of software tools to as wide a community as possible for future collateral development – NSF, DISA

Additional 2008 and 2009 Activities by Agency

NSF: Academic R&D in foundations of software design and development; science and engineering of software for real-world systems (micro and nanoscale embedded devices, global-scale critical infrastructures); software engineering, languages, analysis, and testing; components and composition; formal methods; verification and synthesis; design and implementation; information design and integration in software systems; software for cyberinfrastructure, domain-specific applications

OSD: R&D in product-line systems (expand traditional development into system evolution), incorporate emerging technologies in aspect-oriented approaches, service-oriented architectures, net options value, and mechanism design; dynamic systems (predictability of software systems to meet quality attributes, systems of systems governance, engineering and test methods, model-based engineering, mission success for complex environments); software engineering process management (zero-defect software, integrating enterprise workflow, high-maturity processes, appraisal quality evaluation); acquisition support; capability for successful technology transition

AFOSR: FY 2008 Multidisciplinary University Research Initiative (MURI)) entitled "Harnessing Complexity of Human-Machine Systems" to develop the scientific underpinnings and propose revolutionary approaches for mathematically modeling and comprehending large-scale complex military systems with an emphasis on how human and machine components of these systems interact at a fundamental level

NASA: Parallel programming standards development for increased code scalability and programmer productivity; automated and assistive code parallelization tools and libraries that reduce the barrier to developing efficient HPC software

NIST: Interoperability and interface standards in such fields as automotive, aerospace, semiconductor, building/construction, medical/health care, homeland security; technology focus areas in model-based design/manufacturing, product data integration, sensor systems integration, sustainable (green) manufacturing, supply chain integration, and long term data retention; 2008 NIST Interoperability Conference

DISA: Development of legal, logistical procedures to release DISA-developed Corporate Management Information System (CMIS), a Web-based suite of applications including a learning management system, a balanced scorecard system, a telework management application, an SF50 action tracking system, travel assistance, and other office productivity tools.