Software-Intensive Systems
Producibility Initiative

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DoD Software is Growing in Size and Complexity

Total Onboard Computer Capacity (OFP)

Software PRodUcibility Collaboration and Evaluation Environment (SPRUCE²)

- Managed by the Air Force
- Open collaborative research and development environment
  - Demonstrate, evaluate, and document the ability of novel tools, methods, techniques, and technologies
- Facilitate testing of Software-Intensive Systems Producibility research products and methods
- Provide a realistic environment for research of DoD embedded systems and software problems
- Provide an ability for university and industry leverage of technology development,
- Support successful technology transition and transfer
- Investigators will collaborate with major defense acquisition program developers as well as analyzing the utility of tools

Note: SPRUCE² is the new name for the Systems and Software Test Track (SSTT).
• **Defined Concept of Operations (CONOPS)**
  – Facility characteristics for a proposed system from the users' viewpoint.

• **Defined Architecture and the fundamental organization of the SPRUCE²**
  – Components,
  – Their relationships to each other and the environment, and
  – Principles governing its design and evolution.
SPRUCE$^2$ Phase II Goals

- Implement the architecture of SPRUCE$^2$
- Stand up the fundamental organization of SPRUCE$^2$
- Begin experimentation
- Identify challenge problems that require research
  - Develop representative case studies
**SBIR Objective**

Facilitate use of state-of-the-art analysis tools with commercial model-driven development tools

- **Kestrel Technology LLC**
  - Develop architecture and hub language that support semantic integration of models
  - Establish both as formal standards

- **Reactive Systems, Inc.**
  - Collaborate with Kestrel Technology
  - Develop translators between hub language and
    - Simulink® /Stateflow® modeling languages
    - SALSA analysis tool
    - Reactis® automated test generator
**STTR Objective**

Approaches and tools to analyze existence, completeness, and adequacy of error handling policies and paths

- **GrammaTech, Inc.**
  - Analyze error behavior at component boundaries using machine code & file/socket format analysis
  - Trace error propagation, flag policy violations, or uncontained errors

- **WW Technology Group**
  - Model-driven development of error-handling architecture based on SBIR-developed EDICT tool suite
  - Tradeoff analysis of alternative architectures using multiple formalisms and stochastic & statistical approaches
**Sage.** Methods and tools supporting **agile, model-driven development** of high assurance distributed agent-based systems

**SOL.** Declarative specification language supporting **automated synthesis** of distributed agent-based systems

**SALSA.** Static analysis tool establishes **behavioral properties** of **SOL-like** specifications

**SINS.** Secure deployment, management, and communication **infrastructure for distributed agents**

**Secure open source software.** Methods and tools facilitating adaptation, development, and/or **assurance of open source software** for DoD use.
Army Software Technologies for Interoperable Systems of Systems

• Develop and establish principles of interoperability and complexity management
  – Foundation for developing a service-oriented architecture for ultra large scale systems

• Two awards
  – UC Berkeley
  – Vanderbilt University
Composition of systems based on

- Integration technologies for legacy and custom subsystems that provide an understanding of the interaction of subsystems;
- Scalable composition mechanisms for system-of-systems architectures;
- Interface formalisms through which compatibility and properties of compositions can be determined from properties of the subsystems;
- Ontology models for the organization of components together with a semantic type system for the data on which they operate; and
- Hybrid models for designing and analyzing the dynamics of subsystem interactions with their physical environment.
• Enable system architects and integrators in creating large-scale SOA-based systems on MANETs
  – “Model-based tools for Service Architectures on Mobile Ad hoc Networks.” (MOSAMAN)

• Emphasis on model-based approaches
  – Service Oriented Architecture middleware and
  – Applications on Mobile Ad hoc Network platforms

• Results and deliverables include
  – Domain-specific modeling environments
  – Analysis tool chains, and
  – Architecture analysis tradeoffs
Future Activities

• Navy-led new start in FY2008
• Completion of the National Academy of Sciences study
  – “Advancing Software Intensive Systems Producibility”
• SISPI and ULS Technology Focus Team
  – Technology Roadmap
  – Industry Summit
  – Recommendation for POM-10 investment
• Coordinate with National Science Foundation Cyber-Physical Systems initiative
## Program Overview

- Enable DoD to develop and affordably acquire software for large-scale, complex, embedded and net-centric systems by providing innovations in technologies, tools and techniques
- Invigorate DoD software research and provide dedicated efforts to demonstrate and transition improvements to acquisition programs
- **Issues:**
  - Software is an integral part of advanced warfighting systems but owing to technology shortfalls, DoD software-intensive acquisitions experience serious inefficiency, cost/schedule overruns, and critical failures
  - Trends in software size and complexity grow exponentially

## Program Objectives

- Develop new technologies, tools and techniques that achieve 20% productivity improvement and 20% reduction in re-work by FY14
- Demonstrate impacts of technology improvements on representative acquisition program software artifacts
- Transition new technologies to software-intensive acquisition programs
- **Milestones**
  - Release BAA(s) Summer ’06
  - Establish university/industry centers, research mid-’07
  - Software test track, 2007

## Project Structure

- Projects to be funded with POM-08 Request
  - Software and Systems Development Focused Research Centers
  - Software and Systems Test Track
  - Transition

## Metrics/Benefit

- **Long-Term measures –**
  - Improved affordability (improving trends in software cost and schedule from DoD 5000 SRDR*)
  - Reduced software re-work
  - Improved programmatic predictability
  - Increased industry productivity (SLOC/MM)
  - Decreased defect density (defects/1000SLOC)
- Will enable DoD to acquire software with reduced cost/schedule, increased quality, and avoid cost/schedule overruns by reducing rework

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* Software Resources Data Report
SISP Technology Ecosystem

Acq  Oversight  Prog Mgmt  Test  Warfighters

Integrators

Developers

Tool Vendors  Stds Bodies  Start-ups  Champions/Agents  Open Source  Industry Gurus

Research

Academia  Industry  Gov’t Labs

NSF, NIST, DoD S&T
# Opportunities for Progress

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