

## THE SEI RESEARCH, TECHNOLOGY, AND SYSTEM SOLUTIONS (RTSS) PROGRAM

Organizations depend heavily on the behavior of software-reliant systems. Those developing and acquiring systems need assurance that software-reliant systems will behave and adapt appropriately and need to quickly deploy them in a net-centric environment. Several trends are leading to technical problems that complicate achievement of these objectives.

- **Scale and complexity:** Mission capability relies on an increasingly diverse spectrum of software-reliant systems including safety-critical and embedded systems, IT applications, cyber-physical systems, socio-technical systems, families of similar systems, systems of systems, and ultra-large-scale (ULS) systems. The scale and complexity of these systems is increasing dramatically, resulting in budget overruns in test and evaluation, delayed delivery of business or mission-critical capability, and late detection of faults.
- **Increased business and operational tempo:** Market opportunities, threats, missions, and contexts change frequently and unpredictably: software and system capabilities do not keep pace with changing mission needs; it is too difficult to integrate and deploy new combinations of systems; and quantitative engineering techniques do not exist to support agile and rapid capability delivery.
- **Decentralization and distribution:** Success often requires timely and precise information at *all* levels of the mission. Tactical situation awareness needs to be distributed across unpredictable networks. There is a deluge of information but an inability to deliver it to end users in a timely and relevant way especially in resource-limited situations. Decentralized, distributed needs are antithetical to current hierarchical, centralized approaches.
- **Disruptive technologies:** Technology advances such as mobile computing, cloud computing, and multicore processors promise tremendous advantage. They also pose great risk if not predictably used and effectively exploited to maintain competitiveness. Currently the use of these disruptive technologies is hampered by the lack of effective architectural principles and analytic techniques and by outdated and inadequate architecture and assurance practices.

To address challenges such as these, the SEI RTSS Program serves the changing business and mission needs of organizations that rely on software.



## Research, Technology, and System Solutions (RTSS) Program

### Learn More

For more information, visit the SEI website:  
[www.sei.cmu.edu/about/organization/rtss](http://www.sei.cmu.edu/about/organization/rtss)



## WHO WE ARE

Quality software that is produced on schedule and within budget is a critical component to U.S. defense systems, which is why the U.S. Department of Defense (DoD) established the SEI as a federally funded research and development center (FFRDC) in 1984. Since then, the SEI has advanced software and systems engineering principles and practices while serving as a national and international resource for the software and systems engineering communities. As an applied research and development center, the SEI brings immediate benefits to its research partners and long-term benefits to the software industry as a whole.

Operated by Carnegie Mellon University—a global research university recognized worldwide for its world-class technology programs—the SEI operates at the leading edge of technical innovation. The SEI leads the field in developing technologies that solve real-world problems and makes sure that these solutions get into the public arena for those who need them.

The SEI RTSS Program conducts and applies research in architecture, construction, recomposition, evolution, and assurance.

The SEI RTSS Program aims to innovate software development for competitive advantage. With a focus on the software itself, the program creates and harnesses innovations for assured development, adaptation, and rapid deployment of software-reliant systems at all scales.



## AREAS OF ESTABLISHED EXPERTISE

The SEI RTSS Program provides solutions to system developers and acquirers through its long-established expertise in the following areas :

### Architecture

For many organizations, the achievement of business and mission goals is frustrated by software system problems such as

- poor quality—seen in, for example, systems crashing or behaving unpredictably, or users judging that a system is unusable; and
- slow time to market—seen in missed integration deadlines due to difficulty in identifying root causes of problems

The SEI RTSS work in architecture-centric engineering exploits the relationship between a system's architecture and its quality attributes, and leverages architecture as the key means for ensuring that systems will support their business and mission goals.

### Product Line Practice

Through software product lines, companies can realize order-of-magnitude improvements in time to market, cost, productivity, quality, and other business drivers. The commercial impact of product lines is now seen in a variety of domains including office appliances, avionics, medical devices, automotive, and telecommunications.

The SEI RTSS Program works to make software product line development and acquisition a low-risk, high-return proposition.

### System of Systems Technology

There are a number of technologies, such as service-oriented architecture (SOA) and cloud computing, which have been developed to support the loose coupling and distributed nature of a system of systems (SoS). Migrating to these technologies and using them in architecturally sound ways challenge many organizations.

The SEI RTSS Program's work in SoS technologies provides an architectural and quality-attribute-informed approach to using these technologies and enables organizations to effectively apply them.

## NEW RESEARCH

RTSS research focuses on specific problems related to accommodating change (development and deployment) and adapting to change (tactical settings):



### 1. Development and Deployment

High-quality capabilities today cannot be fielded rapidly, new system capabilities are not easily derived from combinations of existing, independently developed systems, and sustaining competitiveness in business-critical systems is too costly. To address these problems, RTSS will conduct the following research projects:

#### *Value-Driven Incremental Development*

The SEI RTSS Program will

- create quality-attribute-based analysis models to guide incremental development by discovering runtime dependencies early in the life cycle
- create an economic framework to view development progress in terms of both costs incurred and value produced
- use assurance cases and probabilistic models to understand how different kinds of evidence contribute to overall confidence in incrementally developed system behavior.

#### *Composing Assured SoS*

The SEI RTSS Program will

- extend software product line concepts and software architecture patterns to systems of systems
- use assurance templates to accelerate the test-and-evaluation process for new combinations of independently developed systems

#### *High-Confidence Cyber-Physical System*

The SEI RTSS Program will

- demonstrate precise and scalable algorithms for functional analysis of real-time embedded software
- demonstrate new resource reclamation algorithms for multi-threaded tasks in non-uniform memory access (NUMA) multicore processors.



### 2. Tactical Settings

There is a lack today of effective, context-aware use and adaptation of tactical resources and an inability to get the relevant information to end users at a time when it is critically needed. Software and system capabilities delivered to end users do not keep pace with changing mission needs and need to be adapted at the operational edge. To address these problems, RTSS will conduct the following research projects:

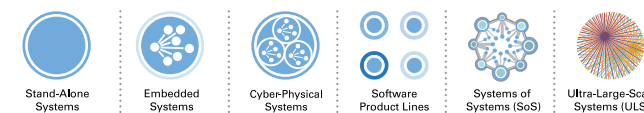
#### *Socio-Adaptive Systems*

The SEI RTSS Program will combine the adaptability of human social institutions, in particular those based in market institutions, with automated network-resource optimization; specifically, RTSS will use computational mechanism design to elicit changing needs and compute an optimal allocation of resources and decentralized quality-of-service optimization to optimally respond to changes in tactical resource capacity.

#### *Edge-Enabled Tactical Systems*

The SEI RTSS Program will employ a virtual machine, peer-to-peer architecture on a cloudlet and a thick client app on a handheld device to provide precise and tailorable context information at the tactical edge while efficiently using resources such as battery life, computational capability, and bandwidth.

## SYSTEM TYPES



The SEI RTSS Program makes solutions available for systems in all domains and at all scales to meet business and mission goals.

## DOMAINS



Domains in which the SEI RTSS Program has applied its research findings include

- Defense
- Healthcare
- High-performance computing
- Energy (Smart Grid)
- Automotive
- Enterprise

## HOW TO WORK WITH THE SEI RTSS PROGRAM

- **Research collaborations:** Our researchers collaborate with others in academia, industry, and government to develop and test technologies.
- **Customer solutions:** We work with customers to address needs such as using architecture practices in an agile environment or migrating to a SOA or cloud approach.
- **Transition of results:** We regularly publish research reports and offer training, licensing, and certificate and certification programs.

## TO LEARN MORE ABOUT WORKING WITH THE SEI RTSS PROGRAM, PLEASE CONTACT US:

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