



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

### Who We Are

The Research, Technology, and System Solutions (RTSS) Program is part of the Carnegie Mellon® Software Engineering Institute (SEI). The RTSS team focuses on the structure and behavior of software-reliant systems to enable assured and flexible system capabilities at all scales.

### What We Do

Organizations depend heavily on the behavior of software-reliant systems. The scale and complexity of these systems is increasing dramatically, posing challenges such as evolving systems to keep pace with changing operational needs, sustaining and recombining legacy systems, exploiting technology advances, and achieving global connectivity through software.

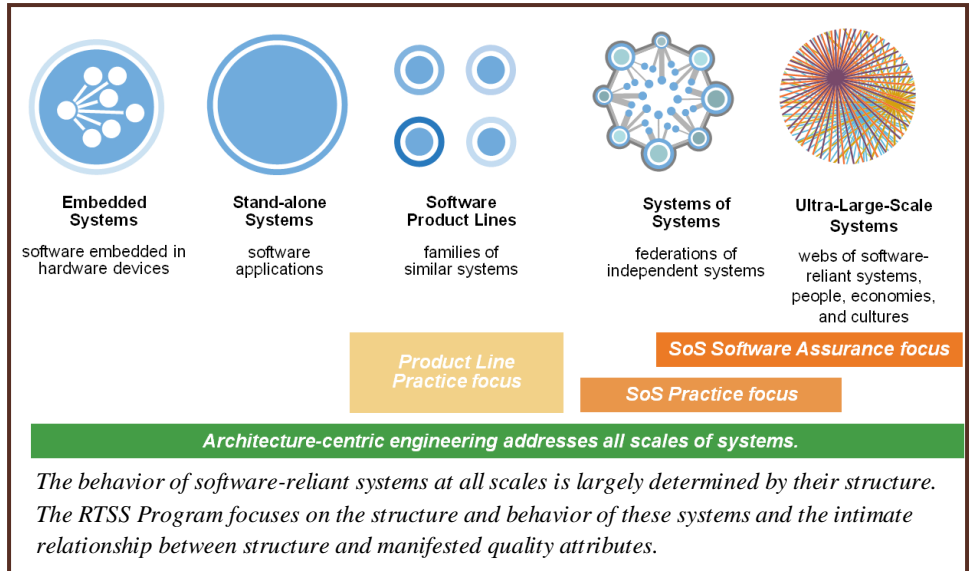
To address challenges such as these, we

- conduct and apply research in architecture, construction, recombination, evolution, and assurance with a focus on quality attributes
- develop and mature theories and methods for acquiring evidence used to predict and bound system behavior
- make solutions available for systems in all domains and at all scales—embedded, stand-alone, product line, system of systems, and ultra-large-scale systems—to meet their business and mission goals

### Our Areas of Work

The RTSS Program pursues this agenda through work in these areas:

- Architecture-centric engineering
- Product line practice



- System of systems practice
- System of systems software assurance
- Ultra-large-scale systems

Cutting across these areas, there is also a Concept Lab, which produces customer oriented proof-of-concept demonstrations and technical experiments, and an Integrating Systems Solutions effort that integrates RTSS and other SEI technologies.

### Architecture-Centric Engineering

**Architecture-centric engineering (ACE)** is the discipline of using architecture to gain increasing levels of confidence that systems will support their goals.

In this area, we develop and use theoretical foundations for analyzing quality attribute behavior and for creating architectures that permit the desirable behavior. Our current research focuses on quality attribute foundations in cyber-physical systems, architecture-centric practices for large-scale systems and ultra-large-scale systems, adaptive resource allocation, and agile architecting.

We also create methods to design, analyze, and evolve software-reliant systems and technologies to ensure that a constructed system conforms to its architecture. The objective is to gather architecture- and code-based evidence that systems will satisfy their quality attribute requirements.

Proven ACE methods include the Architecture Tradeoff Analysis Method® (ATAM®), which has been shown<sup>1</sup> to identify architectural risks early in the development life cycle when they can be mitigated in a cost-effective manner, and the Architecture Analysis and Design Language (AADL) for specifying analyzable architecture models.

### Product Line Practice

Our **product line practice (PLP)** work guides organizations away from traditional one-at-a-time system development and towards the systematic large-scale reuse

<sup>1</sup> A study of 11 significant Department of Defense programs revealed that 10 recognized *significant or very substantial* improvements from the use of the ATAM (*Impact of Army Architecture Evaluations*, CMU/SEI-2009-SR-007).

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

paradigm of product lines. In this area, we create, refine, codify, and transition technical and management practices of demonstrated effectiveness for exploiting commonalities and managing the variations that exist across families of software-reliant systems. We research the use of product line approaches in connection with other software engineering technologies, such as open or service-oriented approaches. Through published guidance, methods, diagnostics, patterns, and adoption support, we provide assistance to address key product line challenges.

## System of Systems Practice

In **system of systems practice** (SoSP), we perform research and provide guidance on effective integration and interoperation of distributed systems that must work together in network-centric operations and system-of-systems (SoS) environments. In particular, our work

- identifies approaches to SoS implementation—such as service-oriented architecture (SOA), grid technologies, and cloud computing
- validates the feasibility for application of those approaches in SoS environments
- provides integrated methods and practices for successfully developing, evolving, acquiring, and governing SoS

## System of Systems Software Assurance

RTSS work in **system of systems software assurance** (SoSSA) aims to reduce the time and effort to achieve justified confidence that systems of systems—particularly large-scale, multi-user, adaptive information and command-and-control systems—will behave acceptably in their environments of use.

In SoSSA, we research which assurance activities contribute most to obtaining justified confidence in a system's behavior, and we develop valid assurance arguments to ensure that SoS failure modes are adequately addressed.

## Ultra-Large-Scale Systems

RTSS work in **ultra-large-scale (ULS) systems** involves the design and evolution, orchestration and control, and monitoring and assessment challenges arising from the characteristics of ULS systems. Ongoing research in this area includes computational mechanism and ULS architecture.

## Built on Previous SEI Work

Current RTSS applied research continues and extends earlier SEI work in software architecture, software product lines, SOA, and ULS systems. In 1998, for example, SEI authors wrote the first book on software architecture for practitioners, *Software Architecture in Practice*. Now in a second edition, this seminal work has been followed by three widely cited books on architecture-centric practice in the SEI Series in Software Engineering published by Addison-Wesley.

The *SEI Framework for Software Product Line Practice, Version 5.0*, provides the latest information about successful software product line practices. The first Framework was published in 1999.

Published in 2006, *Ultra-Large-Scale Systems: The Software Challenge of the Future* is the product of a 12-month study led by the SEI that details a broad, multi-disciplinary research agenda for developing the ultra-large-scale systems of the future. This agenda has inspired multidisciplinary research across the globe.

The SEI led an international team of experts in forming a research agenda for SOA in 2007 that has been the focus of seven international workshops and has spawned a number of research papers and dissertations.

## Working with Us

The RTSS Program

- collaborates with other researchers in academia, industry, and government to develop and test technologies
- applies and validates research results in customer settings
- works with customers to address needs, such as evaluating an architecture, using architecture practices in an agile environment, or developing strategies for acquisition and governance in an SoS environment
- transitions results to the community through publication, the web, training, licensing, and certificate and certification programs

## For More Information

SEI Customer Relations  
Phone: 412-268-5800  
FAX: 412-268-6257  
Email: [info@sei.cmu.edu](mailto:info@sei.cmu.edu)  
Software Engineering Institute  
Carnegie Mellon University  
4500 Fifth Avenue  
Pittsburgh, PA 15313-2612

*RTSS works toward a vision of assured and flexible system capabilities at all scales.*

*About the SEI: The SEI is a federally funded research and development center that provides the technical leadership to advance the practice of software engineering, so that software-reliant systems can be acquired and sustained with predictable and improved cost, schedule, and quality.*