Software Engineering Institute | Carnegie Mellon

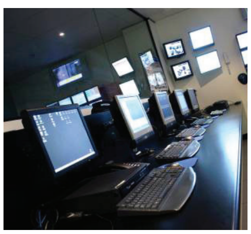
More Accurate Prediction of Security

Through Architecture Analysis using Model-Based Engineering Tools

Security Challenges

A system designer faces several challenges when specifying security for distributed computing environments or migrating systems to a new execution platform.

Business stakeholders impose constraints due to cost, time-to-market requirements, productivity impact, customer satisfaction concerns, and the like. And users exercise power at the desktop over computing resources and data availability.



So, a system designer needs to understand requirements regarding protected resources (e.g., data), confidentiality, and integrity.
And, a designer needs to predict the effect that security measures will have on other runtime quality attributes such as resource consumption, availability, and real-time performance.

After all, the resource costs associated with security can easily overload a system. Security processing can increase usage of processing power, bandwidth, battery (in embedded systems), and other resources.

Despite that, security is often studied only in isolation and late in the process. However, the SEI has developed model-based engineering (MBE) tools, methods, and analytical techniques to validate security according to flow-based approaches and standard security protocols such as Bell-LaPadula, Chinese Wall, and role-based access control.

Modeling System Architectures Using the Architecture Analysis and Design Language (AADL)
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This course may also be offered by arrangement at customer sites. Email course-info@sei.cmu.edu or call +1 412-268-7622 for details.

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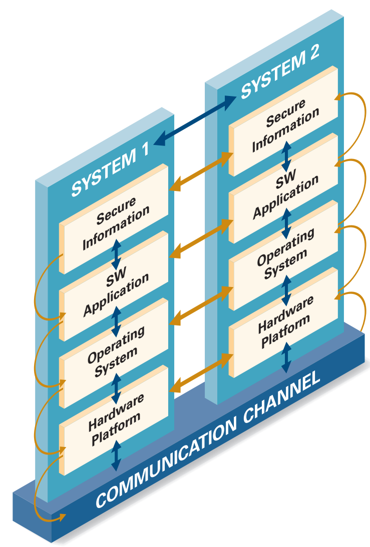
The SEI uses model-based engineering tools, methods, and techniques to more accurately predict system security.

Security Prediction with Less Cost, Less Risk, Increased Confidence

Security analysis using SEI MBE tools, methods, and techniques allows software validation by identifying data elements to be protected, components that should be allowed access to those elements, and appropriate communication channels.

This analysis permits the designer to enforce security at the minimum level required, use sanitization, and map software architecture to hardware.

MBE also allows a designer to identify how security choices affect other quality attributes. For example, a designer can visualize and analyze, for battery-powered devices in embedded systems, the tradeoff between increased execution time and latency that supports the required security levels—to take advantage, for instance, of the multiple independent levels of security (MILS) paradigm.



Security Analysis Concern	SEI MBE	Answer
Sanitization (i.e., controlled lowering of security levels)	✔	Provides metrics on the number of sanitized flows in a system
Security effectiveness applied using minimum security clearances	✔	Derives the minimum security clearance on components in the model (By pointing out differences between actual security clearances and the minimum security clearance required, a system designer can evaluate security effectiveness.)
Integration of security at multiple system levels	✔	Provides system-level solution by checking that secure information is associated with components that have appropriate security clearance and is communicated by secure connections

Read more
Building Secure Systems using Model-Based Engineering and Architectural Models at http://www.stsc.hill.af.mil/crosstalk/2008/09/0809HanssonFeilerMorley.html

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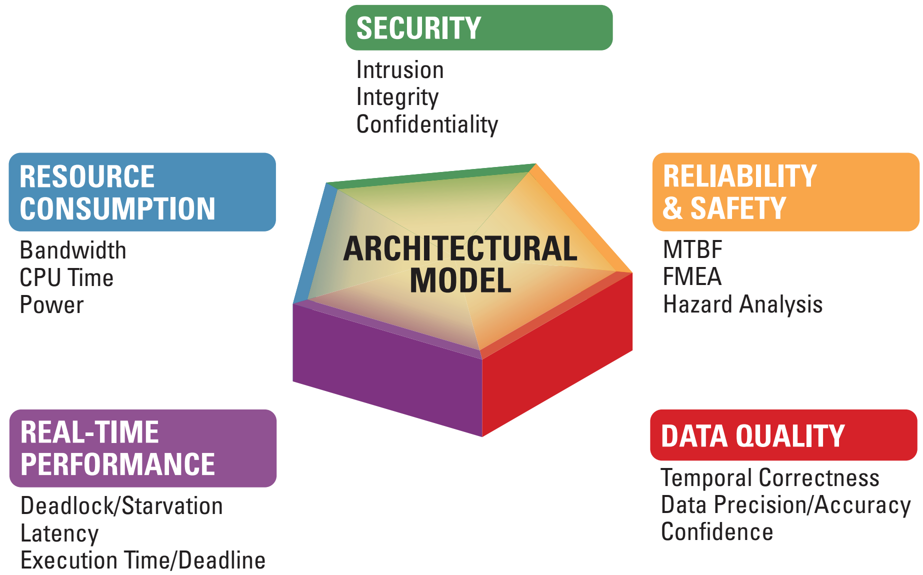

The SEI MBE Toolkit

The SEI uses the ***Architecture Analysis & Design Language (AADL)*** to document a system architecture and provide a platform for multiple analyses.

The AADL, an international industry standard, supports multiple analyses from a single architectural model, enables modeling and analysis throughout the life cycle, and provides analysis of runtime behavior (what) rather than functional behavior (how).

Through its ***XML/XMI interchange format,*** the AADL supports model interchange and tool chaining. And, the SEI offers the freely available ***Open Source AADL Tool Environment (OSATE)*** set of analysis plug-ins. The OSATE security analysis plug-in checks the security levels and flow completeness of components.

The SEI has developed OSATE as a set of plug-ins for processing AADL models that includes:

- a syntax-sensitive text editor, with integrated error reporting
- a parser and semantic checker for textual AADL with conversion into AADL XML
- an unparser for AADL XML to textual AADL conversion
- support for multi-enterprise development through a version control system interface

The AADL also can be used with

- UML state and process charts through its UML profile
- the SEI Architecture Tradeoff Analysis Method®, to drill into root causes and develop quantitative analysis
- assurance cases, to support claims made about the safety, security, or reliability of a system

Prevent System Integration Problems and Simplify Life-Cycle Support

Modeling of system quality attributes is often done—when it is done—with low-fidelity software models and disjointed architectural specifications by various engineers using their own specialized notations.

These models are typically not maintained or documented throughout the life cycle, making it difficult to predict the impact of change on attributes that cut across system functionality. The unanticipated effects of design approaches or changes are discovered only late in the life cycle, when they are much more expensive to resolve.

Analysis of a *system architecture model* offers a better way to predict the behavior of quality attributes. The SEI approach to model-based engineering (MBE) allows analysis

- using a single architecture model
- early and often in the development life cycle or on an existing system architecture
- at different architecture refinement levels
- along diverse architectural aspects such as behavior and throughput

Integration is a major cost and risk in complex systems. System understanding is a major cost driver during system maintenance. Proper use of MBE tools can prevent system integration problems and simplify life-cycle support.

System Architecture Modeling and Analysis

The Carnegie Mellon® Software Engineering Institute (SEI) provides technical assistance and guidance to transform the architectural design process from one based on human evaluation to one based on automated analysis.1

This analysis includes

- validating system quality attributes early in the design phase
- facilitating system integration
- conducting impact and tradeoff analysis using architecture models

For predicting and validating specific nonfunctional properties using model-based engineering, the SEI can help you to

- perform analysis that gives greater assurance that deployment will succeed
- evaluate fault tolerance of architectures
- adopt analytical resource models to validate performance behavior, power consumption, and network bandwidth usage
- model security aspects of architecture
- conduct analysis to guide localized architectural change
- validate data quality requirements such as temporal correctness, accuracy/precision, and confidence

1 One large defense contractor, for instance, blames human interpretation of the complexity involved with embedded systems for decreasing productivity to 6 or fewer lines of code per day.

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