

Architectural Evaluation for Product Lines

J. Kerner, The Aerospace Corporation

A system's architecture represents some of the earliest and most persistent design decisions about the system. To a very large extent, it determines what kinds of changes will be easy to make during the lifetime of the system and what kinds will be hard. The architecture determines or influences the system's "ilities". Architectural evaluation methods and tools can help the system designer understand as much as possible about the architecture as early as possible.

A product line may be defined as a group of products sharing a common, managed set of features that satisfy the needs of a selected market or mission area [SEI]. Key to developing a product line is defining a product line architecture (PLA). Architectural evaluation of a PLA poses special challenges. Since more decisions have been left to be decided during the design of the instance system, less information is known about the PLA than about the architecture of a single system; at the same time, it is critical to be able to get enough information from the PLA to be able to make good decisions about the related product line and its instance systems.

The state of the practice in architectural evaluation for product lines is still evolving. One of the issues that is not yet very well understood is exactly how the evaluation requirements for a product line architecture are different from those for the architecture of a single system. To begin identifying some of these requirements, a breakout session on Architectural Evaluation for Product Lines was held at the Ground System Architectures Workshop (GSAW2000) held at The Aerospace Corporation, February 23-25, 2000.

At the breakout group, presenters discussed architectural evaluation, with a focus on the special challenges of product line architectures. The issues raised during the presentations and the following discussions were captured and allocated to a number of loosely defined categories:

- Features - Things that can be assessed
- Assessment - What you do to evaluate features
- Quality - Results of assessment
- Process - Development process for an instance of a PL
- Evolution

The questions identified at the breakout group are listed in an attachment to this position paper.

The breakout group concluded that there are still a lot of unknowns, but that many organizations (in academia, industry, and government) are making inroads. The group did not converge on a consensus about which questions have been resolved (even partially) and which are still research issues, but they agreed that it would be valuable to hold another breakout group at GSAW2001 to assess progress. A related workshop on Product Lines for Command-and-Control Ground Systems is planned for the SEI First International PL Conference in August 2000.

Attachment: Questions Identified at the GSAW2000 Breakout Group on Architectural Evaluation for Product Lines, 24 Feb 2000

Features Questions

Architectures

- How do you represent an architecture so that you can better understand its characteristics (e.g., behavioral, performance, optimization, composition)?
- What notations do you use to describe it?
- What parameters of an architecture do you model?
- How do you know something is a product line?
- What (if any) are the interactions between the architecture of a product line and the architecture of any sub-product line?

Variation Points

- How do you specify, define, represent variation points (so that you can better understand their behavioral, performance, optimization, composition, etc. characteristics)?
- What is the granularity of variation points (e.g., component level, subsystem level)?
- What is the nature of the variation (i.e., different implementations or different functionality)?

Components and Connectors

- How do you specify the behavior of a connector or component to capture all of the assumptions in a given architecture?
- What are the issues regarding domain independence and domain dependence both for components and for connectors?

Assessment Questions

- How do you evaluate a product line architecture?
- What are the criteria for assessing goodness?
- How do assessment methods change when you evaluate PL architectures versus product architectures?
- What forms of evaluations are there? (Some examples: modeling, analysis, prototyping, questions, checklists, metrics, cost estimation)
- How do you determine whether your architecture can support a product line?
- How do you infer properties of a system from the combination of an architecture and a set of components (or from potential changes to the components)?
- How do you validate the results of different assessment approaches? How do you fuse the results?

Quality Questions

- What is a good architecture? Depends on context and perspective
- What are the criteria (standards) you use to determine whether the architecture is appropriate or not?
- How do you interpret evaluation results according to different stakeholders' perspectives?

Development Process Questions

- What is the relationship between the PLA and how you intend to produce the products? (e.g., generate, compose, instantiate, build, configure)
- How would you use architectural evaluations as part of an iterative design process?
- What kind of tool support is there for developing PL architectures? (e.g., tools for understanding the impact of variation points)
- How do you manage variation points? How many is too many? Is there a right number?

Evolution Questions

- How do you manage evolution of an architecture and its components?
- How do you accommodate new requirements and avoid architectural drift?
- How do you build in enhancements during sustainment, not just simple bug fixes?
- How do you track architectural conformance during development and evolution? How important is it?