Architectural Style as an Independent Variable
Hamid Bagheri, Yuanyuan Song and Kevin Sullivan
Department of Computer Science, School of Engineering and Applied Science
University of Virginia

Motivation
A key idea in modern software engineering is that we can and should make architectural style choices separately from choices about many other system properties. There is a fundamental separation of concerns implicit in this idea: given an application model that expresses system properties independently of architectural style, we can choose a compatible architectural style and then map the application model to one or more architectural models (architectures) in this style. The problem that we are addressing is a lack of a formal account of this separation of concerns, or the associated architectural maps, sufficient to enable automated synthesis of architectures from application models and architecture style specifications. We are investigating a conceptual model of this kind, tested both theoretically and by the development and evaluation of supporting tools.

Approach
ArchMap is the main object of our study. It captures architectural knowledge that we seek to formalize and automate. It embodies knowledge of how to realize different types of applications in different styles. We view it as parameterized by type (AppType) and style (ArchStyle), and develop separate mappings for each compatible AppType/ArchStyle pair.

We implemented such maps using Alloy as a language and satisfaction engine. Four pieces of Alloy specifications are conjoined in the process of mapping.

(1) an application type represented in an Alloy module; (2) an application model, comprising an instance of an application type; (3) an architectural style specification module; (4) mapping predicates that specify the relationships required to hold between an application of the given type and an architecture in the given style. The Alloy Analyzer computes satisfying solutions to the conjoined specification, yielding the synthesized architectures.

A Case Study: Mapping Lunar-Lander application to architectures in implicit-invocation style

Lunar-Lander as an instance of a sense-compute-control (SCC) type of application represented in Alloy language

Part of map(ScC,I) represented in Alloy: an architectural map that takes SCC applications models to architectural models in the implicit-invocation style

A computed instance of mapping. Applying the map generally yields multiple architectures that satisfy the required conformance and refinement constraints in the given style.