Chapter X

Software Architecture Analysis and Reconstruction

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ABSTRACT
This chapter addresses the research challenges in the area of software architecture reconstruction and discusses the state-of-the-art and practice solutions to these challenges. Software architecture analysis and reconstruction is an area within the software architecture domain that refers to the techniques and tools for processing and recovering high-level information from a low-level software system representation such as the source code. The importance of architecture analysis and reconstruction of a large and complex software system stems from the need to perform continuous maintenance activities to keep a mission critical system operational. Such activities include adopting a new implementation technology, error correction, feature enhancement, and migration to a new platform, in which the architectural reconstruction constitutes the major part of these activities. The authors believe that the discussions of this chapter expose the reader to a systematic approach to the important issues, alternative solutions, and future research in the field of software architecture analysis and reconstruction.

INTRODUCTION
For several decades, we have been witnessing the importance and influence of large and complex software systems into various aspects of our lives. Managers as well as engineers have been confronted with the problem of legacy systems, which are large,
mission critical, and complex software systems that have been operational and modified over a number of years. The average lifetime of legacy software systems is between 10 to 15 years (Wallmuller, 1994) and the replacement of these systems is very expensive; therefore these systems are subject to re-designing and re-engineering. *Software architecture analysis and reconstruction* encompasses various methods and supporting tools for extracting high-level information from some lower level representation of a software system such as the source code. Migrating a legacy system to a new platform such as Windows or Unix operating system requires functional and behavior description of the system’s components, which necessitates understanding the component’s functionality and behavior. The discussions in this chapter are geared towards two main objectives.

The first objective is to address the definitions and the major issues in the field of software architecture reconstruction and the challenges that researchers in this field encounter. These issues include: specific views of the system to extract; representation models for the software system entities and relations; architecture reconstruction techniques; tractability of the reconstruction process; and evaluation methods for the result of the reconstruction process. The second objective is to address the possible solutions to these issues as they are presented by the state-of-the-art techniques in this field. These techniques include: clustering techniques, concept-lattice analysis, query-based techniques, and system composition and visualization. Finally, the proposed future trends in this chapter will serve as a starting point for further research in this field.

**SOFTWARE ARCHITECTURE RECONSTRUCTION**

The following observations form the basis for a definition for software architecture reconstruction. Despite several attempts for automating the architectural reconstruction process it is generally accepted that a fully automated technique is not feasible. It is rather impossible to define the architecture of a large system at once; hence, the architectural reconstruction should be an incremental process. Software systems usually consist of architectural patterns in their design, which are the basis for the reconstruction process. Most reconstruction processes focus on the structural properties of a system, ignoring the high-level behavior of the system. Finally, the role of the user is increasingly important in incorporating the domain knowledge and system documents into the reconstruction process. Based on the above discussion, in Sartipi (2003) the software architecture reconstruction is defined as:

Devising a tractable process, required techniques, and supporting tools for interactively and incrementally extracting a system’s high-level structure or behavior using domain and system knowledge.

The entire software reconstruction process is divided into two phases. In the first phase, namely the *extraction* phase, a tool automatically builds a more abstract system representation, that is, the *source model*, out of the program representation. In the second phase, namely the *analysis* phase, a user-assisted process constructs a high-level view of the system from the source model. For the discussions in this chapter, the
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