Communicating X-Machines: from Theory to Practice

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Abstract. Formal modeling of complex systems is a non-trivial task, especially if a formal method does not facilitate separate development of the components of a system. This paper describes a methodology of building communicating X-machines from existing stand-alone X-machine models and presents the theory that drives this methodology. A X-machine is a formal method that resembles a finite state machine but can model non-trivial data structures. This is accomplished by incorporating a typed memory tuple into the model as well as transitions labeled with functions that operate on inputs and memory values. A set of X-machines can exchange messages with each other, thus building a communicating system model. However, existing communicating X-machines theories imply that the components of a communicating system should be built from scratch. We suggest that modeling of complex systems can be split into two separate and distinct activities: (a) the modeling of stand-alone X-machine components and (b) the description of the communication between these components. This approach is based on a different view of the theory of communicating X-machines and it leads towards disciplined, practical, and modular development. The proposed methodology is accompanied by an example, which demonstrates the use of communicating X-machines towards the modeling of large-scale systems.

1 Introduction

Formal modeling of complex systems can be a non-trivial task if the formal method used does not provide the appropriate means of abstraction or does not facilitate gradual development of the system model. In addition, as the complexity of the system increases, it becomes clear that it is necessary to break down the system model into several components that need to communicate with each other. There are mainly two ways to accomplish this: either (a) to built a communicating system from scratch in which models and communications between them will be inseparable, or (b) to model (or even to use off-the-shelf) separate components and then establish the communication between them. We believe that the latter is a more disciplined approach since modeling of components and modeling of communication are viewed as two distinct activities. The communicating X-machines is a formal method that facilitates this disciplined approach. In this paper, we use X-machines for modeling communicating systems.