From Communication Histories to State Transition Machines

WALTER DOSCH
Institute of Software Technology and Programming Languages
University of Lübeck, Germany

Summary Distributed systems are composed of software and hardware components of different kinds. The components communicate asynchronously by exchanging information along connecting channels. The specification, systematic design, and correct implementation of component-based systems need sound foundations for describing the interface and the behaviour of components.

The behaviour of a (non)deterministic component can characterized by a function (relation) between the communication histories for input and output. A communication history, for short a stream, records the finite or infinite succession of messages of a specified type passing through the component's interface. The input/output behaviour abstracts from the component's implementation determined by the internal state and the state transitions. This results in a functional model of communicating components supporting compositional design and refinement techniques.

When developing an implementation, a crucial design step amounts to transforming a component's communication-oriented black-box view into a state-based glass-box view. On the implementation level, the component is described by a state transition machine reacting on input with an update of the interal state and a possible output. In our approach, the state of a component results from an abstraction of the input history. The state records information from the input history which determines the component's reaction on future input.

The paper presents a formal method for the top-down design of communicating components. The communication-oriented input/output behaviour can be transformed into a state-based implementation with two important development steps: *differentiation* localizes the effect of single inputs wrt. a previous input history, *abstraction* extracts the component's control and data state from the input history. We explicate the approach studying memory, transmission, and processing components.

The history-oriented and the state-based descriptions represent complementary views of the component each showing specific advantages resp. disadvantages wrt. compositionality, abstractness, verification, synthesis, and tool support.