Abstract

Today formal verification is finding increasing acceptance in the areas of model abstraction and functional verification. Model checking is one such formal verification technique. The complexity of model checking timed extensions of untimed temporal logics is significantly higher than their untimed counterparts. In spite of the established worst case complexity results, timing verification is one of the most important problems in areas like hardware and protocol verification.

The main focus of this work is to design branching time temporal logics which capture efficiently checkable subclasses of timing properties that are of practical significance, and to develop effective model checking techniques for these logics. Our motivation for choosing classes of timing properties of practical interest is based on the following two observations:

- Designers are often concerned with the extremal timing behavior of the system. For example, a major interest lies in finding out the earliest and latest response times.
- Verification of hardware and protocols often involve reasoning about the timings of events or signal changes. Since events (or signal changes) occur instantaneously, their timing properties are more discrete in nature as compared to the continuous timing properties over system states.

This work attempts to formally capture the above classes through new timed temporal logics and present methods to solve them efficiently.

- We analyze the complexity of evaluating extremal (namely, best-case and/or worst case) timing behaviors of systems. We show that a large class of extremal timing properties can be verified in polynomial time. This is an useful result since we are often interested in the best-case or worst-case timings of a system.
- We define events as changes in signal values. Events are assumed to be instantaneous in nature. We analyze the problem of verifying timing properties between events and show that reasoning about events has certain computational advantages due to the discrete nature of event occurrences. The result assumes significance, since many circuit descriptions are edge triggered (and therefore event triggered).
- Reasoning about the extremal timings of events is expected to benefit from the efficiency of reasoning about extremal behavior as well as reasoning about events. We analyze the problem of evaluating extremal timing properties of events.
- We study the evaluation of extremal behavior of *open systems*, that is, systems that interact with the environment and whose behavior depend on this interaction.