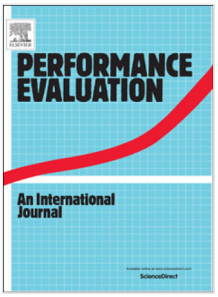


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# Hybrid Petri nets with general one-shot transitions

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## Abstract

*A hybrid Petri net formalism that allows deterministic, and fluid transitions is extended by generally distributed transitions that moves discrete tokens. Models in this formalism can be analyzed with* Parametric Reachability Analysis*, by computing all reachable locations, and by separating the deterministic and the stochastic evolution of the system. Several performance metrics, such as the distribution of fluid over time, can be derived by deconditioning according to arbitrary continuous probability distributions. This efficient concept allows for the analysis of an arbitrary number of fluid places, as opposed to classical stochastic hybrid Petri net approaches. Moreover, validation of our results against a FSPN tool shows that parametric reachability analysis provides more accurate results. A case study motivates and shows the potential of our approach.*

## 1. Introduction

Fluid critical infrastructures, e.g., water, gas and oil treatment and distribution are highly dynamic systems and include assets that are essential for the functioning of a society and economy. Users need to be able to place a high level of trust in the operation of such systems; however, uncertainty in the environment, security and physical attacks, and errors in physical devices pose a serious threat to their reliable operation [1]. Hence, it is very important that critical infrastructures survive catastrophic events [2, 3].

To model these highly complex systems [4], a modeling formalism is needed that enables the description of both discrete and continuous quantities. Examples of discrete quantities are the number of spare parts and the operational state of sensors, actuators and ICT-components, whereas the physical quantities, like the amount of treated water and the quality of the treated water in terms of temperature and pressure naturally constitute continuous quantities. The combination of discrete and continuous variables is usually referred to as hybrid models. Moreover, to model random failures and disasters in the discrete part, stochastic hybrid models are needed. This paper considers a subclass of stochastic hybrid models, where the discrete part controls the continuous one, since this behavior is mostly seen in the considered application area.

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