

Availability Model in Practice

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In this paper, we present analytic modeling taxonomy for availability modeling and evaluation using availability model of a virtualized system. Analytic modeling techniques[4][10] can be categorized into three types: combinatorial models (a.k.a. non-state-space models), state-space models and hierarchical models. Combinatorial modeling paradigms[5][8] such as reliability block diagram (RBD), reliability graph (Relgraph), fault tree (FT) can be used to construct availability models. Combinatorial modeling techniques are easy to use and assuming statistical independence between system components allow a relatively quick solution. Each component can have attached to it a probability of failure, a failure rate, a distribution of time of failure, steady-state and instantaneous unavailability, etc. Combinatorial models can be solved using algorithms such as factoring, sum of disjoint products (SDP), binary decision diagram (BDD)[14] and so on. Extremely large combinatorial models can be solved by deriving upper and lower bounds[13]. However, combinatorial models can not easily handle failure/repair dependencies (e.g., shared repair, warm/cold spares, imperfect coverage, etc). In order to model complex interaction between system components, Markov chains or more generally state-space models can be used[8]. Markov chains generally consist of state(s) and state transition(s). State can keep track of system status such as number of functioning resource of each type, state of recovery for each failed resource, allocation of resources to tasks, etc. A transition can occur from any state to any other state and can also represent a simple or a compound event. The assumption of exponential distribution in continuous time Markov chain (CTMC) can be relaxed; it then can become a semi-Markov process (SMP)[1][2], a Markov regenerative process [12] or a non-homogeneous Markov chain. In Markovian and non-Markovian models may have state space explosion problems (or largeness problem). Stochastic Petri nets (SPN)[8], stochastic Reward nets (SRN), and fluid stochastic Petri nets (FSPN)[11] can be used for easy specification and automated generation/solution of underlying Markov model to tolerate largeness. Also, to avoid largeness problems, hierarchical model[6][7][9] or fixed point iteration[3] can be used. In hierarchical (multi-level) models, for an instance, combinatorial models such as FT or RBD in the upper level and Markov chains in the lower level can be used. We use an availability model of a virtualized system as an illustrative example. We use a two-level hierarchical model which FT in the upper level and CTMCs in the lower level are used and corresponding SRN model is presented.

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