

学位論文概要

題目 A Study on Model-Based Performance Evaluation of Dependable Computer Systems

(ディペンダブルコンピュータシステムのモデルベース性能評価に関する研究)

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Model-based performance evaluation is an analytical approach for quantifying system performance indices by modeling the dynamic behavior of system as stochastic processes. Queuing analysis and Markov modeling are typical methods for the model-based performance evaluation. Compared to simulation approach, the model-based approach can provide highly-accurate assesses of performance measures. Therefore, this is commonly used to evaluate performance criteria of the system in the presence of rare events such as system failures.

On the other hand, as software system is widely used in our daily lives, it becomes more important to prevent fatal system failures in computer system design. In other words, several dependability measures such as system reliability, system availability and data integrity, should be estimated only from the design of system architecture before starting the implementation. This approach is called the model-based software performance analysis, which is one of the most attractive topics even in software engineering.

In this thesis, we consider model-based performance evaluation of three kinds of computer system; distributed database system, open-source software and virtualized system, respectively.

Firstly, we focus on the performance evaluation of distributed database systems with conventional snapshot isolation (CSI) and prefix-consistent snapshot isolation (PCSI) by considering the occurrence of communication failures between a master and replicas. We also revisit our probabilistic models for CSI and PCSI with the restart scheme for the communication failure. We investigate the effect of update interval of snapshot and restart timing for the communication with respect to the abort probability and system throughput.

Secondly, we turn our attention to the maintenance scheduling for open source software products. Applying a patch is one of effective fault-tolerant techniques. We consider an optimized patch management model from the perspective of users by applying an NHPP to the bug-discovery process. Also, with analyzing the characteristic of open source software by applying software reliability models, we predictively propose an optimal maintenance schedule for user according to numerical illustrations.

Finally, we dedicate our interest to the performance evaluation of virtualized system with software rejuvenation. Concretely, we evaluate the virtualized system by using the criterion of resiliency, which is an attitude for measuring the deviation of system when changes happen. We present MRSPNs (Markov regenerative stochastic Petri nets) for the virtualized system with cold and warm software rejuvenation and employ the technique of transient analysis through PH (phase-type) expansion. This technique can reduce MRSPNs to a CTMC approximately. After applying PH expansion to MRSPNs for the virtualized system with software rejuvenation, we present the quantitative measure to evaluate the system resiliency based on CTMC analysis.