論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Modeling and analysis for design of dependable software systems and operations
著者(和文)	町田文雄
Author(English)	Fumio Machida
出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第10902号, 授与年月日:2018年3月26日, 学位の種別:課程博士, 審査員:三好 直人,樺島 祥介,横田 治夫,DEFAGO XAVIER,中野 張
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第10902号, Conferred date:2018/3/26, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

専攻： Department of	数理・計算科学　専攻	申請学位（専攻分野）： Academic Degree Requested	博士　（学術） Doctor of
学生氏名： Student's Name	町田　文雄	指導教員（主）： Academic Supervisor(main)	三好　直人　教授
		指導教員（副）： Academic Supervisor(sub)	

要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

IT systems have become an essential infrastructure of our society as they are extensively used in our daily lives, economic activities, and social infrastructures. Since malfunctions of such IT systems can cause serious consequences, dependability and performability design of the systems is a crucial issue. A fundamental challenge here is the difficulties in dealing with various uncertainties in complex software systems such as demand changes and component failures that are inevitable during their operations. In this thesis, the applications of stochastic models are investigated in particular for dependability and performability system design and operation. Stochastic models are used to capture dynamic failure-recovery behaviors of systems. Since recent IT systems are becoming more software-intensive, the impacts of software faults and errors must be taken into account. In this thesis, dependability and performability design of software-based IT systems are investigated in three categories.

First, chapter 4 addresses the issue of software aging that is often observed in long running software systems. Service systems consisting of continuously running software components often experience performance degradation after long time execution due to the accumulation of errors caused by software faults. Such phenomenon is called software aging. Against software aging problem, the effective countermeasures such as software rejuvenation and software life-extension were investigated in the literature. After showing the results of a comprehensive survey on conventional studies of software rejuvenation models, a novel approach to formalize the rejuvenation decision problem is presented. A framework of optimal stopping problem is used to deal with the rejuvenation decision problem under degraded system performance. The analysis of the optimal stopping problem yields the condition where the rejuvenation decision achieves the cost optimal solution under the given aging status and associated costs. Another study focuses on the investigation of software life-extension method which is an alternative countermeasure to software aging. The study shows the condition where the optimal software life-extension interval exists through the analysis of semi-Markov process for software life-extension system. It is also shown that the hybrid approach that combines software life-extension and rejuvenation achieves the highest system availability compared with the individual methods where rejuvenation or life-extension is performed exclusively.

Next, in chapter 5, the effectiveness of storage array configuration and data management operation are evaluated. To achieve high data-availability and high performance, storage array needs to be configured in a relevant redundant scheme. Since RAID6 and RAID10 are the commonly adopted storage configurations in practice, the impacts of these configurations on the storage performability are analytically investigated. In the analysis, Markov regenerative process is employed so that non-Markovian state transition for rebuild process is adequately taken into account. The obtained analytic results are useful to find a desirable configuration for the storage which can meet given performability requirements. Another study presents a Markov decision process approach to derive the optimal backup schedules under given data recovery objectives for multiple data sets in a system. Data backup is essential management operation in many critical IT systems to protect data from threats such as system failures and data corruptions. In a system maintenance period, the system can take either full backup or partial backup, or continue the operation without performing backup. The action chosen at each decision time point must impact on the data availability and the achievable level of data protection. To determine the optimal decisions under uncertainties, Markov decision process is employed for modeling the state transitions of data set affected by the backup decisions. The solution of the Markov decision process can generate the optimal backup schedules for multiple data sets that minimize the downtime costs while satisfying all the data recovery objectives.

Finally, in chapter 6, a resource management problem for mobile cloud computing that is established on server virtualization is discussed. Considering enterprise use of mobile cloud computing, security of mobile devices is one of the major concerns. Mobile thin-client service focused in this study can address such security concerns by keeping all the mobile OS processes and data in a private cloud system. However, the cost of ownership for such a private cloud system becomes an issue where over-provisioned server resources cause a dead stock problem, while on the other side the lack of server causes the degradation of service performance. To make a cost-effective trade-off for server resources, a novel server procurement approach is presented where VM demand arrivals and VM workload changes are predicted through stochastic models constructed from empirical data. The proposed approach is implemented as a simulation environment and the effectiveness of the method is evaluated through simulation experiments.

In all of the three studies, dynamic behaviors of systems are captured by stochastic models that are used to evaluate the performance measures quantitatively by analytical solution techniques. The quantitative assessment enables the design improvement and maintenance optimization toward achieving high-available and high-performance software systems.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

注意：論文要旨は、東工大リサーチリポジトリ(T2R2)にてインターネット公表されますので、公表可能な範囲の内容で作成してください。