氏　　名	NGUYEN DANG THANH
学位の種類	博士(情報科学)
学位記番号	博情第 316 号
学位授与年月日	平成 27 年 3 月 20 日
論文題目	Dealing with Dynamic, Intermittent, and Propagating Faults in Distributed Systems （分散システムにおける動的、断続的、伝搬的なフォールトの取り扱いに関する研究）
論文審査委員	主査　DEFAGO, Xavier　北陸先端科学技術大学院大学　准教授 面　和成　同　准教授 土屋　達弘　大阪大学　教授 和田　幸一　法政大学　教授 林原　尚浩　京都産業大学　准教授

論文の内容の要旨

Today, when many computing services are relying on large scale distributed systems, the system reliability becomes one of the most challenging research topics. A distributed system is defined as the set of computational processes that collaboratively work to solve the same problem. In distributed systems, fault, which usually occurs everywhere, is the most critical issue of reliability. In some system configurations, a single simple fault can easily corrupt the correctness of the system. Moreover, the recovering time from failed state is usually much larger than the execution time of a computation in the systems. Thus, fault-tolerance, which ensures the system still works correctly in the presence of faults, becomes a fundamental property of distributed systems.

Fault-tolerant distributed systems have been widely studied in literature for both process and communication channel failure. However, most of existing works focus on tolerating static faults occurring in processes of a stationary network whereas computa- tional machines are more dynamic today due to the development of communication and mobile computing technology. Therefore, dynamic fault-tolerance problem is gaining more research interest. Unlike a static one, a dynamic fault can randomly move between the processes.

Consequently, dynamic faults are more difficult to tolerate due to the change of their location and the increasing of the number of faults.

In this research, we aim to tolerate the dynamic faults, which are modeled as the movement of malicious mobile agents between processes in a stationary network. We study to deal with different levels of dynamicity of faults including the *intermittent* to *propagating* malicious fault. In particular

- For intermittent malicious fault, we propose a model that balances the power between the malicious agent and the correct process, which is not justified in the previous models. Under the proposed model, we prove the tight bound on the total number of processes to tolerate a given number of faults as well as the optimal algorithm.

- For problems with propagating fault, we study the possibility to limit the number of faults in a bounded value. This is a two-side problem of the spread of fault (which is also called as infection) and the containment of such spread. This problem is studied under a stochastic model, in which, three parameters play an important role: (1) the probability of successful infection, (2) the probability of successful detection and (3) the countermeasure against the infection.

By both simulation and mathematical analysis, we found that *long-edge*[1], which connects different clusters, is an important factor favoring the propagation. The propagation can be contained in graph that does not include long-edges, while it is impossible to isolate in graph having long-edges.

Keywords: distributed systems, fault-tolerant, dynamic, transient, propagation

論文審査の結果の要旨

The candidate presented his work on dynamic and propagating faults in distributed systems. The work has two main parts. The first part deals with systems in which nodes may behave maliciously in an intermittent manner. The malicious behavior can thus move from node to node, and the system achieves agreement provided that the number of simultaneously malicious nodes does not go above a certain threshold. The work identifies tight bounds on this threshold and provides an optimal algorithm to solve the problem. The second part deals with the propagation of faults in large networks. The thesis studies the effect of simple countermeasure rules on the propagation in various kinds of graphs (grid, unit disc, small-world) and studies propagation scenarios on the Internet backbone (CAIDA).

The candidate made a very clear presentation of his work, and answered questions very well. The work is significant and has been published and presented at international conferences (including DISC; a leading conference on distributed algorithms).

This is an outstanding dissertation and we approve awarding a doctoral degree to Mr. NGUYEN, Thanh Dang.