

Research Report

Chihsiang Wang
Computer Science
University of Idaho
Email: wang0162@vandals.uidaho.edu

Abstract—This report will be presented those papers which I searched and read from IEEE digital library, and are related to contemporary fault-tolerant, and identify fault models. It will also identify what kind of fault model for each paper. This work is compared with Azadmanesh's five fault models. The section one will present each papers title and the fault model, I will also bring a simple summary for each. Section two will shows what I learned from this research assignment, and what kind of difficult I met while doing research.

I. RELATED WORKS

I have read three papers which related to the contemporary fault-tolerant system. Two of them are related to the cloud service, which get much attention from the current researchs. And another paper is a designing for solving the Byzantine general problem in a new model.

A. Byzantine Fault Tolerance for Services with Commutative Operations

1) Fault Models: MPH-2 Hybrid Fault Model

2) *Summary*: The cloud service gets bigger in the contemporary society. More and more business activities conducted online via cloud service. When the cloud service contains more critical missions like international financial, healthcare or personal information. It means the service become common to personal life and widely used now. So we need to concern both its high availability and high reliability. In this paper mentioned that "To ensure high availability of such services, replication has been pervasively used with a crash-fault only model". But this is not enough for the current society, since the open environment face to more risk of malicious concerns. They also suggested to apply to a more general fault model which give a higher reliability, that is Byzantine fault model. The most common way to apply to Byzantine agreement algorithm may requires that all requests(replications) are executed sequentially according to the total order established. But this is almost impossible for the cloud-based service since it may impose severe runtime overhead, and it is expensive to do this. Also in this paper denote that recent research suggest that the service may be constructed by using Conflict-free Replicated Data Types. And the approach of this paper is to present a study on Byzantine fault tolerant optimistic replication of services with commutative operations. And the service is constructed using conflict-free replicated data types.

B. A self-stabilizing hybrid fault-tolerant synchronization protocol

1) Fault Models: TPH-3 Hybrid Fault Model

2) *Summary*: In this paper, they present "A strategy for solving the Byzantine general problem for self-stabilizing a fully connected network from an arbitrary state and in the presence of any number of faults with various severities including any number of arbitrary (Byzantine) faulty nodes." [2]. The distributed systems have become an integral part of safety critical computing applications, and it's necessary to give a high reliability which must be designed with a well fault-tolerant system. One of the most important issue need to be solved is that the imprecise local clocks. As the result, this paper brings a strategy for synchronizing a distributed system with various faults, including any number of arbitrary (Byzantine) faults. The strategy designed to do clock synchronization for the fault-tolerant system in two steps:

- Converting all Byzantine faults into symmetric faults
- Using a proven symmetric-fault tolerant algorithm to solve the synchronization problem

And they believe that they solve the general case of this problem for fully connected graphs.

C. A Byzantine Fault Tolerance Model for a Multi-Cloud Computing

1) Fault Models: MPH-2 Hybrid Fault Model

2) *Summary*: In this paper, they presented BFT-MCDB (Byzantine Fault Tolerance Multi- Clouds Database). That is, a practical model for building a system with Byzantine fault tolerance in a multi-cloud environment. The multi-cloud model doesn't mean the group of cloud systems, but it is centrally controlled by an administrative domain which controls other clouds in the same domain. Address to this model, it is desired to build with high reliability and high availability. And the model combines Byzantine Agreement protocols and Shamir's secret sharing approach to detect Byzantine failure. And as the result showed from this model increase system reliability and also increase the availability of three security dimensions, that is:

- Data integrity
- Data confidentiality
- Service availability

II. LESSONS LEARNED

There are many difficulties while I am doing this assignment, I will discuss it briefly below.

A. How to start

It's always hard to start for a research work. The basic issue is that what keyword I should use, what library should I look for. Is this paper worth to read through? When does this paper published? And most important is, is it related to what I am looking for. Since we are looking for the "recently" works, I focus on those papers which published during past 5 years.

B. Greatest hurdles to overcome

It's not easy to identify what kind of fault model that the paper is applying for. This is, I must understand the topic and the way they use for computational and communication overhead the approaches. So I could compare it with Azadmanesh's models. Thus not every problems are well domained from papers, or I can say they are talking about the big map but not specific. This is the biggest problem I met since I spent too much time to read details of each papers, and think what is the fault model they are applying for.

C. How much time I spent

Searching the right papers takes me about 30% of time overall my work. Read over the abstract and conclusion helps me to understand the topic for each paper. As I mentioned, read through the paper takes me most of time, because I couldn't really easily to identify the fault model for each problems. Also, I spend some time for each paper's background study.

D. The most difficult issue I met

The background knowledge may be the most difficult issue for me in this research. The fault-tolerance system applies to many area of studies. While reading the papers, I couldn't get some basic ideas for each topic, e.g. multi-cloud. Each papers shows its own different studies related to other papers. Sometimes it's really hard to understand if I don't have enough background knowledge, so I need to search and read the definition for each topic.

E. Conclusion

Fault-tolerance are applying to many different area. And during this research work, I could realize that the survivability for a system becoming more important than 10 years ago. Same as the way to guard our system, malicious acts are evolving as time goes by. Since we can not always prevent the fault occur, survivability and fault-tolerance become more important to think about what should we do after fault occur rather than prevent it happen.

REFERENCES

- [1] Hua Chai; Wenbing Zhao, "Byzantine Fault Tolerance for Services with Commutative Operations," in Services Computing (SCC), 2014 IEEE International Conference on , vol., no., pp.219-226, June 27 2014-July 2 2014 doi: 10.1109/SCC.2014.37
- [2] Malekpour, M.R., "A self-stabilizing hybrid fault-tolerant synchronization protocol," in Aerospace Conference, 2015 IEEE , vol., no., pp.1-11, 7-14 March 2015 doi: 10.1109/AERO.2015.7119170
- [3] AlZain, M.A.; Soh, B.; Pardede, E., "A Byzantine Fault Tolerance Model for a Multi-cloud Computing," in Computational Science and Engineering (CSE), 2013 IEEE 16th International Conference on , vol., no., pp.130-137, 3-5 Dec. 2013