Progress Report in 2007

---- Research on Adaptive Failure Detector

Ph.D Candidate: Naixue Xiong; Number: 520008

School of Information Science

Japan Advanced Institute of Science and Technology

naixue@jaist.ac.jp

1. Introduction of our research

Fault-tolerant distributed systems are designed to provide reliable and continuous service despite the failure of (one or more faults within) some of its components. In such systems, failure detector is a basic block and also is at the core of many fault-tolerant algorithms and applications. It can be found in many systems, such as ISIS, Ensemble, Relacs, Transis, Air Traffic Control Systems. Fault-tolerant systems are designed to provide reliable and continuous services for distributed systems despite the failures of some of their components [1-3]. As an essential building block for fault-tolerant systems, failure detector (FD) plays a central role in the engineering of such dependable systems. Therefore, ensuring quality of service of failure detector is very significant for ensuring fault tolerance of distributed systems.

I present two novel failure detectors: Exponential distribution failure detector (ED FD) and Self-tuning failure detector (SFD) and analyze their implements. For ED FD, it is an optimization over existed methods. In ED FD, Exponential Distribution, instead of Normal Distribution in [4-5], is used for estimation of the distribution for inter-arrival time. Experimental results demonstrated that ED FD over-performs the existed methods from the view of quality of service of failure detector. So far, a lot of failure detectors are designed to try to satisfy different QoS requirements. However, there are no any self-tuning scheme presented. That is, for a given QoS requirement, how do the parameters of failure detectors are tuned by itself to satisfy such requirement? Therefore, in this thesis we address this problem and present a self-tuned failure detector.

Furthermore, the kappa failure detector [6] is an instance of accrual failure detector [5]. This allows for a clearer separation between the monitoring of the system and the interpretation of suspicion information by applications. Hayashibara in [6] gave the original idea and definitions about the kappa FD. While the performance evaluation and analysis is not enough. Therefore, a question then arise: what is the performance characteristic of kappa FD compared with the existed failure detectors? In this thesis, we analyze quality of service of kappa failure detector based on a lot of experiments.

2. Future work

In future work, we would like to explore the QoS scalability, as interference from heavier network traffic (e.g., a scenario where most of the nodes in the networked system have active FDs), to see whether that will affect detection accuracy, detection time, etc. Also, we would

explore their properties and relation in software engineering applications, then propose a reasonable FD in fault-tolerant distributed system, and apply the proposed FD into an actual fault-tolerant distributed system, specially, we are very interested in designing an self-tuning failure detector (SFD) in actual fault-tolerant distributed system. For all the proposed failure detectors so far, the common point of them is that they all can detect the directly connected processes. While, for some processes that are not directly connected, i.e., they only can communicate each other by some middle processes, all failure detectors are not applicable. Therefore, an open question arises: how to design an indirect failure detector to make sure any two processes, even they are not connected directly, can detect each other effectively. Furthermore, we also would like to explore in the following aspects.

(1) New schemes based on different architectures of failure detection;

(2) Build a pragmatic platform on failure detection;

(3) Application of failure detections in Ad hoc, Mobile network, or other environment;

3. Publications in 2007

[1] Naixue Xiong, Yan Yang, Xavier Defago, "Comparative Analysis of QoS and Memory Usage of Adaptive Failure Detectors," The 13th IEEE Pacific Rim International Symposium on Dependable Computing (PRDC'07), Melbourne, Victoria, Australia, December 17-19, 2007, accepted for long paper.

[2] Naixue Xiong, Xavier Defago, "ED FD: Improving the Phi Accrual Failure Detector," Technical report, IS-RR-2007-007, JAIST, Japan, Apr. 27, 2007.

[3] Xavier Defago, Naixue Xiong, Y. Yang, and N. Hayashibara, "Pragmatic Accrual Failure Detection with Kappa-FD," Technical report, JAIST, Japan, November 2007.

4. References

[1] I. Gupta, T. D. Chandra, G. S. Goldszmidt. On scalable and efficient distributed failure detectors. In Proc. 20th ACM symp. on Principles of Distributed Computing, pages 170 - 179, Newport, Rhode Island, United States, Aug. 2001.

[2] C. Delporte-Gallet, H. Fauconnier, R. Guerraoui. A realistic look at failure detectors. In Proc. Intl. Conf. on Dependable Systems and Networks (DSN'02), pages 345- 353, Washington DC, Jun. 2002.

[3] M. J. Fischer, N. A. Lynch, and M. D. Paterson. Impossibility of distributed consensus with one faulty process. Journal of ACM, 32(2): 374-382, Apr. 1985.

[4] N. Hayashibara, X. Defago, R. Yared, and T. Katayama. The phi accrual failure detector. In Proc. 23rd IEEE Intl. Symp. on Reliable Distributed Systems (SRDS'04), pages 66-78, Florianpolis, Brazil, Oct. 2004.

[5] X. Defago, P. Urban, N. Hayashibara, T. Katayama. De_nition and speci_cation of accrual failure detectors. In Proc. Intl. Conf. on Dependable Systems and Networks (DSN'05), pages 206 - 215, Yokohama, Japan, Jun. 2005.

[6] N. Hayashibara. Accrual failure detectors. Doctoral thesis, Japan Advanced Institute of Science and Technology, June, 2004.