UNIVERSITI TEKNOLOGI MARA

CONTINUOUS AVAILABILITY OF APPLICATION SERVICES VIA MIDDLEWARE FOR FOG COMPUTING ENVIRONMENT

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ABSTRACT

Application services are the processes that run on the operating system background that are required by all types of software applications ranging from desktop applications to web applications and mobile applications. These applications are distributed and scattered around the globe with highly dependent on internet connectivity which is prone to unexpected interruption and downtime. This eventually affects the availability of the application services that need to comply with Service Level Agreement (SLA) as part of the Confidentiality, Integrity and Availability (CIA) security model of a software application. To date, there are available solutions to provide high availability of application services by implementing redundancy model, fault tolerance and overload protection that are focusing on cloud level applications. However, the fault detection and fault tolerance mechanism for fog and edge level with less dependent on internet connectivity are yet to be deeply covered. Before the recovery action take place, the failure detection should be able to detect failure correctly and this can be obtained by monitoring the targeted node through certain methods. Heartbeat detection is one of the detection methods that send periodical message to the monitored node and await for response to indicate node uptime. From the preliminary investigation, it is found that the heartbeat detection when deployed on edge of network produced high false detection and unable to detect software backend service failure. Thus, the overall purpose of this study is to provide mechanism for detecting application service failure and improving high availability to reduce downtime for software applications that are targeting non-cloud machine as a platform of deployment. The contributions of the research are demonstrated by the proposed failure detection tool and proposed fault tolerance technique. To prove the effectiveness of the proposed solutions, the tools are simulated in a network segment specifically at Universiti Teknikal Malaysia Melaka (UTeM) health centre that runs frontend applications. From the simulations, the results show that the improved heartbeat detection can reduce the false detection. Consecutively, it can trigger the fault tolerance actions at the edge of network where the frontend application is able to access to the backend services when the main server is inaccessible. The outcome of the study will benefit in promoting high availability and software deployment strategy consideration when delivering solution to in-premise server or in the private cloud.

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Every software application in all kinds of sectors could be distributed and scattered around either via intranet or internet and thus, these would require the information to be integrated among each other. Besides integrations, the software application need to incorporates Confidentiality, Integrity and Availability (CIA) (Mesbahi et al., 2017) as part of the solution given to the end users. In terms of availability, software providers or software houses need to meet the agreed Service Level Agreement (SLA) where they need to ensure 99.999% of availability. In other words, high availability can be defined as the allowed downtime of the service that should be less than 5 minutes and 15 seconds per year (Nabi et al., 2016) where the downtime is meant only for scheduled maintenance and upgrade.

With massive amount of devices scattered around the internet and generating humungous of data, the information could be stored in centralized remote database which may reside on cloud hosting server or could be physically located on a machine that deploy in a premise (Eloff & Bihina Bella, 2018). On the other hands, to ensure that the database is accessible to all the applications, a back-end service or sometimes refer as web service is required especially applications involving mobile applications. The web service is a web Application Programming Interface (API) or it could be stand-alone application (Razzaque et al., 2016) that waiting for incoming request as depicts in Figure 1.1 where the back-end web service may be hosted at the cloud as part of middle application via internet. Unfortunately, too much dependent on the internet connectivity would lead to interruptions and unexpected downtime (Eloff & Bihina Bella, 2018) and moreover the web service sometimes unable to retain its availability causing operation to halt (Naim et al., 2018). In addition, both database and web service also require specific service to be run before they can be deployed. For instance, a web service developed using PHP language would require Apache service whereas a MySQL database would require Mysqld service running on a machine that acts as