UNIVERSITI PUTRA MALAYSIA

IMPROVING THE SECURITY AND ENCRYPTION PERFORMANCE OF CLOUD STORAGE BY USING ELLIPTIC CURVE CRYPTOGRAPHY

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By

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Thesis Submitted to the Faculty of Computer Science and Information Technology, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of
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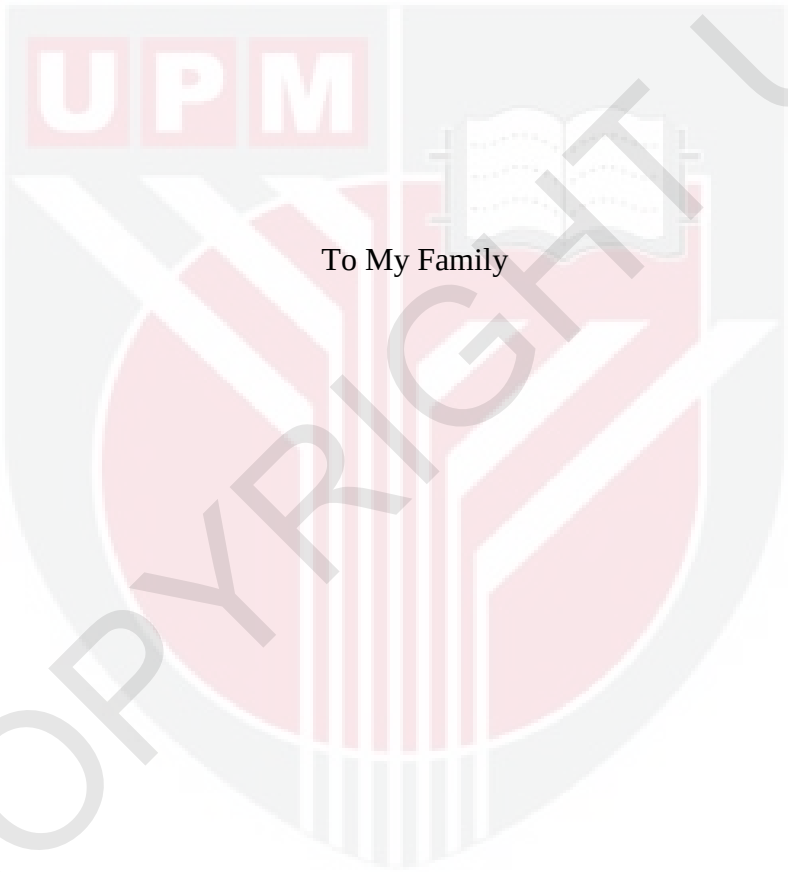

To My Family

ABSTRACT

Abstract of thesis presented to the Senate of Universit Putra Malaysia in fulfilment of the requirement for the degree of Master of Computer Science

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January, 2016

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Faculty: **Computer Science and Information Technology**

Abstract. Cloud services have emerged as one of the most promising solutions for many real world issues. They can be used in a wide variety of applications ranging from cloud storage, cloud computing, and cloud applications. However, they are a double-edged sword from security and privacy standpoints, especially when storing sensitive data in cloud storage. Therefore, besides secure they require efficient security solutions to obtain the necessary security level. The current security solutions are designed to work mainly on either the client side or the server side, and this strategy may cause a reduction of either the performance of the system or the security of the data. In this thesis, we have proposed a security solution based on an ECC algorithm to improve the security and the performance of the data by dividing the file content and encrypting it on both the server and the client side. The proposed solution improves the performance of the standard ECC and outperforms the AES algorithm in terms of encryption speed and response time.

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First and above all, I praise God, the almighty for providing me this opportunity and granting me the capability to proceed successfully.

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APPROVAL SHEET

A thesis prepared by **Nooruldeen Qutaiba Ismaeel** with the title " **IMPROVING THE SECURITY AND ENCRYPTION PERFORMANCE OF CLOUD STORAGE BY USING ELLIPTIC CURVE CRYPTOGRAPHY** " submitted in partial to fulfilment of requirement of the master of Computer Science and Information Technology Universiti Putra Malaysia.

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DECLARATION

I hereby declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institutions.

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Nooruldeen Qutaiba Ismaeel

Date: / 2 / 2016

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CHAPTER 1 - INTRODUCTION

1.1 Background

Cloud services have become a moderately new benefits of the business model in the computing reality such as task collaborating and universal accessibility. The National Institute of Standards and Technology (NIST) defines the cloud as a model that permits ubiquitous access to an imparted pool of configurable computing assets that can be quickly provisioned and discharged with administration or supplier cooperation (Zhang Q, Cheng L, and Boutaba R., 2010). This technique has been developed as an attractive modern model to use the massive inflation of computing requirements, data size, and demand for mobile access to important data (Chun-Ting Huang, Lei Huang, Zhongyuan Qin, Hang Yuan, Lan Zhou, Vijay Varadharajan and C.-C. Jay Kuo, 2014). Cloud service contains computing resources, storage, and networking services that are merged by cloud providers and offered to clients with a simple user interface and access (Armbrust M, Fox A, Griffith R et al., 2009, X. Yu and Q. Wen, 2010). Most recent studies have shown that 79% of companies are working on trying to use data outsourcing to mitigate the expenditures of maintenance and stockpiling of data (Rajkumar Buyya, Chee Shin Yeo, Srikumar Venugopal, James Broberg, and Ivona Brandic, 2009).

The cloud can perform many services; however, there are two main services. First is high performance computing services that focus on performance and give users extra computing resources and the ability to perform high-complexity operations. Furthermore, it works quickly and securely, and it can handle as much data as we

need it to. Moreover, high performance computing services can be used to gain virtually unlimited computing power. With this service we only pay for what we use.

Second is cloud storage that gives users mobile accessibility to massive secure storage space (Grossman R., 2009). By using cloud storage, we can share data amongst specific clients who can be selected by the services' users. Common examples of uses of cloud storage today are Dropbox, Amazon's EC2 services, Microsoft SkyDrive, Google Cloud, Microsoft Cloud, and the CDN Cloud Flare.

Between the client and server side, when users upload their files into cloud storage, the control of file access is physically lost and goes to a cloud provider who is considered a third party and unreliable (Lifei Wei el. Al., 2014).

Because the files have to be transmitted and stored in the cloud, they become vulnerable to unauthorized access. Therefore, the main issue in cloud storage services is the security of those files. In spite of the fact that the infrastructure of the cloud considers greatly robust and reliable than client's hardware but the data integrity, confidentiality, and availability are prone to attack from unauthorized accesses, which comes from inside and outside of the cloud (Xiao Zhifeng and Xiao Yang, 2013). Hence, the data must be secure from malicious users and unauthorized access not only inside the cloud but also when this data is being transmitted to the cloud destination. To handle this issue, the clients and cloud service providers use the data encryption technique to encrypt and secure the files.

Generally, there are two different types of encryption techniques based on the key generation and usage: symmetric-key cryptography (SKC), which is also called

secret key cryptography, and asymmetric key cryptography (AKC), which is also known as public key cryptography.

With the symmetric key cryptography (SKC) technique, one key, which is called the shared key, is used to encrypt and decrypt the data. Therefore, the key has to be exchanged between the system users through a secure communication channel prior to the start of data sharing. Although the algorithms of this technique are fast and secure, it suffers from limitations; first, even though the key size determines the strength of data security, the secret key must be shared and distributed before transmitting the data, and that requires providing a secure channel (Jeffrey Hoffstein, Jill Pipher, and J.H. Silverman, 2014, Dharmendra S. Raghuwanshi, M. R. Rajagopalan, 2014). The second limitation is that the algorithm security depends on the key. Once the key is known by an attacker, the information can be simply decrypted, destructed, and modified (Rounak Sinha, Hemant Kumar Srivastava, and Sumita Gupta, 2013). The third limitation is that the algorithms of symmetric key cryptography have no digital signatures; therefore, the sender identity cannot be detected (Rounak Sinha, Hemant Kumar Srivastava, and Sumita Gupta, 2013, Atul Kahate). Finally, the message cannot be directed to a specific receiver when using SKC in a system of users. RC2, DES, 3DES, RC6, Blowfish, and AES algorithms are examples of using this technique.

On the other hand, in asymmetric key cryptography (AKC), which can be utilized to solve the limitations of SKC, two different keys, which are called the public and the private key, are used to encrypt and decrypt the data. With this technique, the data is encrypted by one key (known as the public key), but it cannot be decrypted by the same key. Hence, the sender encrypts the data by utilizing the public key. Then, on the receiver's part, the data will be decrypted by utilizing the private key (W.

Stallings, 2006, Jeffrey Hoffstein, Jill Pipher, and J.H. Silverman, 2014). Nevertheless, data encryption/decryption speed performance is the main limitation of this technique and is less than SKC. The Rivest-Shamir-Adleman (RSA) algorithm and elliptic curve cryptography (ECC) algorithm are well-known examples of this technique.

1.2 Problem statement

Securing cloud storage data with encryption techniques brings many challenges because cloud services have many limitations and distinctive requirements. First, clients connect to their cloud storage from different locations; therefore, the encryption algorithm should be able to cope with that issue of key distributing and managing. Second, the cloud storage is not physically divided for the clients; therefore, the clients' files may be located on the same storage drive. This requires the encryption algorithm to keep the files secured for a specific client. For all of the above requirements and issues, researchers have proposed many solutions to modify and advance the standard encryption algorithms in order to be able to solve these issues. It is a fact that the previous solutions focus on improving the security of the communication channel, transmitted data, or the data in cloud storage. The solutions that proposed by researchers to secure the transmitted data and the data in cloud storage still have many problems to be investigated, which are; Firstly, the solutions encryption/decryption speed depend generally on the performance of the client device. Secondly, the solutions are not secure enough to protect the file in storage from the cloud service providers' access. Thirdly, the symmetric key cryptography (SKC)-based solutions still have the limitations of SKC techniques such as key

management and data signature issues, and finally the asymmetric key cryptography (AKC)-based solutions have not solved the low performance issue of the AKC technique.

Therefore, we propose a solution that is able to satisfy cloud services' security requirements and solve the issues that the current solutions have by using a distributed encryption solution. The solution is ECC-based; therefore, it is categorized under the AKC technique.

1.3 Objectives

The objectives of our work are:

I. To improve the security of files in cloud storage by using the ECC encryption algorithm.

II. To improve the encryption speed of the ECC algorithm and response time on the client side.

1.4 Project Scope

- Our solution in this research is to advance the security of files in cloud storage and improve the encryption speed of the elliptic curve cryptography algorithm (ECC).

- The solution is proposed to secure document files that consist of text-based documents, spread sheet files, and database records files.

1.5 Structure of the thesis

Chapter 2, Literature *Review*, has sections that are divided as follows: Section 2.1 briefly explains what cloud computing is, including its benefits, characteristics, service models, and deployment models. Section 2.2 shows the authentications in cloud, and Section 2.3 illustrates the importance of security in cloud computing. Section 2.4 explains cryptography and its types, and Section 2.5 shows the use of public key cryptosystems. Section 2.6 discusses about mathematical problems for public-key cryptosystems, and 2.7 answers "Why elliptic curve cryptography?" And Section 2.8 illustrates elliptic curve arithmetic. Section 2.9, *Data Security* in *the* Cloud, it discusses what authors of previous works have done and the related work.

Chapter 3, Methodology, shows the architecture and processing of our proposed solution, experiment tools, platforms, and the data size that has been used.

Chapter 4, Result and Discussion, all the results that have been acquired will be shown and discussed.

Chapter 5, Conclusion, shows the conclusion of our work and future work.

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