UNIVERSITI PUTRA MALAYSIA

SECURITY FRAMEWORK BASED ON MULTI AGENT SYSTEM ARCHITECTURE TO FACILITATE DATA FETCHING FROM CLOUD DATA STORAGE

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By

AMIR MOHAMED TALIB MOHAMED

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

September 2012

DEDICATION

To my mother, my mother, my mother, my father, and sisters, who always has confidence in me, and offered me encouragement and support in all my endeavors

May Allah save them all….

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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Chairman: **Rodziah Atan, PhD**

Faculty: **Faculty of Computer Science and Information Technology**

Cloud computing is Internet-based computing, where information, resources, and softwares are shared through distributed cloud server or Cloud Data Storage (CDS). However, in order to enjoy the wide utilization of cloud computing through wired/wireless networking, providing sufficient assurance of information security such as confidentiality, correctness assurance, availability, and integrity are the critical factors of success promotion. In this research, a comprehensive security framework based on Multi Agent System (MAS) architecture for CDS in order to facilitate confidentiality, correctness assurance, availability and integrity of users' data in the cloud is proposed. This security framework consists of two main layers of agent layer and CDS layer. The proposed MAS architecture includes five types of agents: Cloud Service Provider Agent (CSPA), Cloud Data Correctness Agent (CDCorA), Cloud Data Confidentiality Agent (CDConA), Cloud Data Availability Agent (CDAA) and Cloud

Data Integrity Agent (CDIA). In order to evaluate our proposed security framework based on MAS architecture, a pre-survey is conducted using a questionnaire survey. Rasch methodology is used to analyze the pilot data. This research is carried out in five steps of a Secure System Development Life Cycle (SecSDLC) utilized as a research methodology. The main phases of SecSDLC are investigation, analysis, design, implementation, and testing and validation. An approach that superimposes agents to handle security of CSD is designed using the Prometheus Design Tool (PDT). Ontology-driven MAS architecture that helps in providing a unified agent-based interaction system on top of cloud services using Protégé is implemented. In this research, a prototype named as Ganawa Security as a Service (GSecaaS) for CDS security is implemented. This prototype utilized specialized autonomous agents for specific services and allows agents to interact. To simulate the agents, Oracle database packages and triggers are used to implement agent functions, and Oracle jobs are utilized to create agents. GSecaaS is quantitatively and qualitatively evaluated to determine the most appropriate security policies to the development of cloud security algorithm. Based on the evaluation of the post-survey, GSecaaS has been developed. GSecaaS offered many benefits due to its verified and well-designed architecture in CDS. These include the functionality of the SecureFormula, correctness assurance protocol, availability solution, CloudZone and the overall GSecaaS satisfaction rates are high (90%, 95%, 78%, 92% and 99%, respectively). The security performance of GSecaaS in CDS is increased and GSecaaS's response time is stable and acceptable.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk Ijazah Doktor Falsafah

RANGKA KERJA KESELAMATAN MENGGUNAKAN SISTEM MULTI-EJEN UNTUK MEMASTIKAN DATA MENGAMBIL DARIPADA PENYIMPANAN DATA AWAN

Oleh

AMIR MOHAMED TALIB MOHAMED

September 2012

Pengerusi : Rodziah Atan, PhD

Fakulti : Sains Komputer dan Teknologi Maklumat

Pengkomputeran awan ialah pengkomputeran berasaskan Internet, di mana maklumat, sumber dan perisian boleh dikongsi melalui penyebaran pelayan awan atau Penyimpanan Data Awan (CDS). Walau bagaimanapun, untuk menikmati penggunaan pengkomputeran awan secara menyeluruh sama ada melalui rangkaian jaringan berwayar atau tanpa wayar, jaminan kesahihan keselamatan maklumat yang diberikan seperti kerahsiaan, ketepatan, ketersediaan dan integriti maklumat tersebut merupakan faktor kritikal dalam meningkatkan tahap keselamatan pengkomputeran awan. Dalam penyelidikan ini, satu rangka kerja keselamatan secara menyeluruh berdasarkan seni bina Sistem Ejen Pelbagai (MAS) untuk CDS bagi memudahcara kerahsiaan, ketepatan, ketersediaan dan integriti data pengguna di dalam pengkomputeran awan, dicadangkan. Rangka kerja keselamatan ini terdiri daripada dua lapisan utama iaitu lapisan ejen dan lapisan CDS. Cadangan seni bina MAS ini mengandungi lima jenis ejen: Ejen Pembekal

Perkhidmatan Awan (CSPA), Ejen Ketepatan Data Awan (CDCorA), Ejen Sulit Data Awan (CDConA), Ejen Ketersediaan Data Awan (CDAA) dan Ejen Integriti Data Awan (CDIA). Satu pra-kaji selidik telah dijalankan menggunakan soalan kaji selidik bagi menilai rangka kerja keselamatan berdasarkan seni bina MAS yang telah kami cadangkan. Kaedah Rasch telah digunakan untuk menganalisis data perintis. Penyelidikan ini telah dijalankan di dalam lima langkah yang ditakrifkan sebagai Kitaran Hidup Pembangunan Sistem Selamat (SecSDLC) yang digunakan sebagai metodologi kajian. Fasa utama di dalam SecSDLC adalah Penyiasatan, Analisis, Reka bentuk, Pelaksanaan, dan Ujian dan Pengesahan. Pendekatan penindihan ejen bagi mengendalikan keselamatan CDS telah direka menggunakan Alat Reka Bentuk Prometheus (PDT). Seni bina MAS berasaskan onotologi telah dilaksanakan bagi membantu di dalam penyediaan ejen bersatu berdasarkan sistem interaksi di dalam perkhidmatan awan menggunakan perisian Protégé. Di dalam penyelidikan ini, prototaip yang dinamakan Keselamatan Ganawa sebagai Servis (GSecaaS) untuk keselamatan CDS telah dilaksanakan. Prototaip ini menggunakan ejen autonomi khusus untuk perkhidmatan spesifik dan membenarkan ejen untuk berhubung. Bagi mensimulasikan ejen, pakej pangkalan data Oracle dan pencetus telah digunakan untuk melaksanakan fungsi ejen, dan Oracle berfungsi untuk membina ejen. GSecaaS dinilai secara kualitatif dan kuantitatif untuk menentukan dasar keselamatan yang paling sesuai untuk pembangunan algoritma keselamatan awan. Berdasarkan penilaian pasca kaji selidik, GSecaaS telah dibangunkan. GSecaaS menawarkan banyak kebaikan disebabkan oleh kesahihan dan seni binanya yang baik di dalam CDS. Ini termasuklah SecureFormula, protokol kesahihan ketepatan, penyelesaian kesediaan, CloudZone dan kadar kepuasan

GSecaaS secara keseluruhannya adalah tinggi (masing-masing sebanyak 90%, 95%, 78%, 92% dan 99%). Prestasi keselamatan GSecaaS di dalam CDS meningkat dan masa tindak balas GSecaaS adalah stabil dan boleh diterima.

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APPROVAL

I certify that a Thesis Examination Committee has met on 03 September 2012 to conduct the final examination of (Amir Mohamed Talib Mohamed) on his thesis entitled "**Security Framework Based on Multi Agent System Architecture to Facilitate Data Fetching from Cloud Data Storage"** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the University Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be award the (Degree of Doctor of Philosophy)**.**

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DECLARATION

I 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 University Putra Malaysia or other institution.

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AMIR MOHAMED TALIB MOHAMED

Date: 03 September 2012

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Chapters in Book

1. **Amir Mohamed Talib,** Rodziah Atan, Rusli Abdullah and Masrah Azrifah Azmi Murad. 2011. Towards New Access Data Control Technique based on Multi Agent System Architecture for Cloud Computing in *Software Engineering and Computer Systems Part II*, Springer Series: Communications in Computer and Information Science 189, V. Snasel, J. Platos, and E. El-Qawasmeh (Eds.) ISBN: 978-3-642-22190-3. Publisher: Springer-Verlag, pp. 268-279.

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