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Intelligent techniques for secure financial management in cloud computing

Lidia Ogiela

AGH University of Science and Technology, Cryptography and Cognitive Informatics Research Group, Al. Mickiewicza 30, PL-30-059 Krakow, Poland

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ABSTRACT

This publication presents new classes of financial management systems. These systems will serve as examples of systems for the cognitive analysis of financial data with particular emphasis on analysing financial ratios. Semantic analysis will be an innovative component in financial management systems which will enhance the traditional solutions by adding elements of cognitive data interpretation and analysis. The systems thus built will constitute a class of intelligent management systems. Intelligent financial management systems will also be used to conceal data of a confidential and strategic nature. For this type of solutions, advanced information sharing schemes will be proposed to enable splitting the information among a defined group of secret trustees in an either equal or privileged way. In addition, a scheme for sharing financial data between groups of secret trustees who can jointly reconstruct the shared financial (strategic) information will be proposed. In addition, a new class of financial management systems will be defined which will be optimal for financial data management processes. The new solution will consist of CFMSiC systems (*Cognitive Financial Management Systems in the Cloud*) dedicated to cloud-based semantic management of financial data.

Motivation of the author's study and this paper is to propose new aspects of the intelligent techniques dedicated for secure financial management in cloud computing. The most important research question is: which secure techniques are the optimal for secure strategic financial data management? To answer to this question it is important to conduct accurate analysis, which shows the efficiency in guaranteeing the secrecy of cognitive data analysis. Also, is necessary to discuss about the advanced techniques dedicated to secure strategic data in financial management processes. As a results of the author's research, in this paper will be presented a strategic data sharing protocols in advanced threshold schemes, a sharing data schemes with a division into groups using advanced threshold schemes, and presentation of these solutions in a new class of information systems – in a CFMSiC systems (Cognitive Financial Management Systems in the Cloud) dedicated to managing financial data in the cloud.

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1. Introduction

Financial data security is the main aspect in financial management processes (Buchanan and McMenemy 2012, Menezes et al. 2001, Ogiela and Ogiela 2014c). Systems which ensure the security of financial data represent one of the basic elements of efficient and safe management. As it is necessary to ensure the security of financial management processes, the data management systems currently operated by commercial organisations and enterprises are increasingly frequently focused on securely storing, processing, analysing and transmitting data (Buchanan and McMenemy 2012, Hachaj and Ogiela 2013, Ogiela and Ogiela 2012, TalebiFard and Leung 2011).

Data security issues do not relate only to the tasks of securing financial information, but also to the security of personal data, strategic data, competitive market data, the implementation of new technologies etc. However, financial data security represents the most important aspect of efficiently managing an enterprise or an organisation (Ogiela and Ogiela 2014a, 2009).

The security of management systems stems from the security of the data protection algorithms used (Ogiela 2014, Ogiela and Ogiela 2011, 2014a). Data protection algorithm secure data from unauthorised access, theft, disclosure and forwarding information to unauthorised individuals.

Data protection algorithms make use of cryptographic protocols to secure information from being stolen or disclosed without permission. They use of cryptographic protocols to protect data in IT systems (Menezes et al. 2001; Ogiela 2013b,c; Ogiela and Ogiela

E-mail address: logiela@agh.edu.pl

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2008), including data management systems, is aimed at protecting data from unauthorised users and from unauthorised access to it. However, the solutions applied do not always guarantee that data will be secure. Consequently, cognitive solutions are used to protect information and efficiently manage data (Ogiela 2008, 2013a).

Data management systems (Laudon and Laudon 2002, Ogiela 2013a, Ogiela and Ogiela, 2015) are most frequently used to efficiently collect data, process it and store it. Smart data management systems are supplemented with cognitive data analysis. This type of data is much more exposed to theft and disclosure to unauthorised individuals. The reason is that cognitive analysis leads to a process of understanding not only the analysed data, but also the reasons for the events that have occurred and of assessing the future situation.

Cognitive analysis serves to determine the meaning of the analysed datasets by describing and interpreting their semantic content. It is an analysis used to determine whether the analysed data is of major importance for the development of the enterprise/organisation or not. It thus allows the unambiguous elimination of those aspects of the analysis process which do not have major importance for the development of the enterprise or organisation.

Ensuring the security of this type of systems is therefore of major importance for the correct (secure) process of managing information, including primarily financial data.

The security of financial management systems is assured by the cognitive analysis implemented in these management systems and the cryptographic analysis aimed at ensuring the security of this data.

Systems semantically analysing financial data and ensuring its security belong to the cognitive system group. This class of systems has been described in publications (Ogiela 2013a, 2014; Ogiela and Ogiela 2014a,c, 2015, in press) which presented their characteristic features and the drivers of data management processes at enterprises.

Information management processes in traditional financial data management systems comprise the following stages (Fig. 1):

- creating data sets from data collected by the enterprise or the organisation,
- data analysis – an analysis of the enterprise/organisation operations:
  - economic analysis – financial analysis (the financial standing of the enterprise/organisation, the asset situation of the enterprise/organisation, revenues and expenses, cash flow), technical–economic analysis (production volumes, tangible fixed asset value, employment levels, material management, technical and technological progress),
  - environmental analysis – in a holistic perspective, in a detailed perspective and of the relations between the enterprise and its environment,
- they use of data held,
- data storage.

The traditional scheme of the information systems is shown in Fig. 1. This type of information systems allow to collect different data sets, describe the data, analyse the data (the financial data analysis and technical, economic analysis), and also use data for different purposed. Information management processes performed in traditional data management systems are extended towards cognitive aspects of data analysis.

Unlike traditional management systems, financial data management processes in intelligent, cognitive data management systems comprise the following stages:

- searching for and collecting financial data using access to data from various sources, including: in-house data collected at the enterprise or organisation, and data obtained from outside the enterprise or organisation,
- semantic analysis of financial data: data analysis based on the interpretation of the cognitive aspects of the analysed data,
- semantic reasoning,
- future standing evaluation – prediction from analysed data.

Cognitive financial data management systems analyse data by interpreting its meaning. In this regard, this class of systems deploys computer intelligence to carry out data analysis processes, thus extending the processes of traditional financial data management by adding cognitive analysis elements (Fig. 2).

In Section 2 will be presented the cognitive analysis aspects in selected financial management systems. In Section 3 will be described the intelligent secure techniques in financial management processes. In Section 4 will be presented the financial management aspects in the cloud and a new class of intelligent systems – Cognitive Financial Management Systems in the Cloud (CFMSiC) dedicated to managing financial data in the cloud.

2. Cognitive analysis in selected financial management systems

In financial data management systems, semantic analysis is executed using mathematical linguistic techniques whose fundamental part consists in developing the appropriate mathematical formalism used for the semantic analysis (Ogiela and Ogiela 2011). In financial data management systems founded on numerical data, grammatical formalisms in the form of sequential grammars have been proposed for semantically analysing data (Ogiela and Ogiela 2011, 2014b).

The essence of this approach is to build a sequential grammar made up of the following components:

- a set of terminal symbols (terminals),
- a set of non-terminal symbols (non-terminals),
- a set of grammar productions,
- a grammar start symbol belonging to the set of non-terminals.

The formal definition of the grammar makes it possible to identify the possible standings of the enterprise that can materialised based on the analysis carried out. These standings are determined by the set of productions which implies every considered situation.

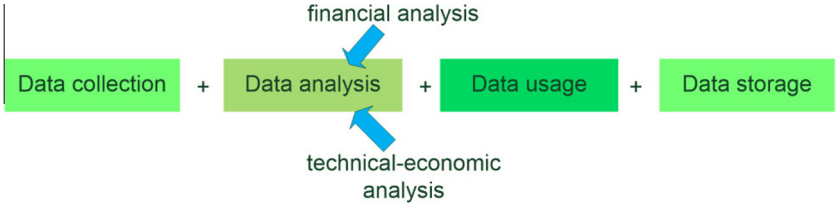

Fig. 1. Information management processes in traditional financial data management systems.

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