

# Model Checking Agent of SMS Management System for Direct Sales and Network Marketing

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## ABSTRACT

*The revolution and globalization towards the use of technology in Short Messaging Services (SMS) has led many electronic businesses in our country. As introduced, the SMS Management System in Direct Sales and Network Marketing is one of the integrated information systems which implemented the SMS technology for greater performance. The enhancement of connection and communication among cluster of distributors has contributed higher level of the business networking system. However, several uncertainties issues that occurred during system implementation have not yet proving the trustworthiness of system validity. Therefore, this problems lead to such an impact in terms of costing for maintenance and to control the quality of the system. This paper presents the issues by proposing the design of model checking agent to verify and validate the system model based on the specification required. This approach investigates how software agent is able to play a role in handling each of the state transition. We use model checker SPIN to SMS Management System agent model for failure detection. This approach is to confirm the system is reliable, robust and secure in controlling the data protocol.*

## Keywords

SMS, software agent, SMS Management System

## 1.0 INTRODUCTION

Internet-based business operations offer considerable potential, but there are accompanied by a broad range of often unprecedented risk. An actual or perceived lack of system security and reliability can significantly constrain the growth of the digital economy. Therefore, in order to resolve this challenge, a systematic management of the associated operational risk is essential. For SMS Management System, it is a business concept that integrates mobile technology with information management system. This system used a Short Messaging Services (SMS) mainly for direct sales and network marketing (Voo, 2007). Nowadays, towards the rapid

development in e-business, SMS Management System has take an advantage to introduce the fast and cost saving tools by using SMS as a medium for distributors to communicate among themselves. SMS Management System is a two ways process that provides sending and receiving SMS among distributors and company itself at one time. The data warehouse which associates with the stock management system, purchasing system and bonus calculation has facilitated the updated information to the distributors at anytime and anywhere (Voo, 2007). By reducing the time consuming and human intervention, all processes are converted into SMS. However, the SMS Management System has due to face uncertainties circumstances when an extensive process occurred. The performance of system became unreliable during hectic time when many distributors are using the SMS Management System at the same time. Consequently, the system has become unstable and possible to errors. Therefore, model checking is one of checking technique for verification of the finite state systems that has to satisfy SMS Management System processes. This technique has been proved for significant use in verifying a complex software system (Bonnie et al., 2005).

As in this paper, we believed that the model checking method has a potential values to be used for checking and verifying the model design and specification of the system. In this context, applying formal verification in SMS Management System provides the quality and enhancement of design reliability to compete with digital environments. We have applied an agent technology in the extended design of SMS Management System that has a potential approach to increase the performance of SMS Management System processes (Selamat et al., 2008). According to (Gerhard, 2000), agents have ability to sense, communicate and achieve the task at a given time once the knowledge is delivered. So, generally we aim to investigate the capability of our model checking agent to check and verify the communication protocols in SMS transaction which includes the format of SMS text data and the time consumed by the delivery of the SMS in specific time frame.

The remainder of this paper is organized as follows. We present the background information of the proposed

method in Section 2.0. The SMS Management System architecture as our case study for model checking approach is discussed in Section 3.0. Sections 4.0 and 5.0 respectively, showed the design of proposed system and the model checking agent architecture. The conclusion of this paper is presented in Section 6.0.

## 2.0 BACKGROUND OF AGENT BASED SMS MANAGEMENT SYSTEM

### 2.1 SMS Technology

The propagation of mobile technology has great potential for upgrading the standard of current system respectively. Short Message Services (SMS) technology is an essential technology that similar to paging but the SMS messages does not required the mobile phone to be active and within the network range (Mobilecomms-Technology.com, 1999). The standardization process has lead by the European Telecommunications Standards Institute (ETSI) (European Telecommunications Standards Institue, 2004) where the SMS technology has been created to provide an infrastructure for the transportation of short messages containing a maximum of 140 bytes (8 bit objects) of useful data in mobile telecommunication networks. Moreover, the SMS technology is already a popular communication technology for mobile phones, where the users are sending billions of text messages to each other every year (Rudy, 2005).

### 2.2 Software Agents Technology for SMS Management System

In recent years, agent technology has been rapidly developed in order to fulfill the needs of new conceptual tools for modeling and developing of complex software systems (Paolo et al., 2006). The agent approach is best suited for design and modeling of crucial system by representing their components, behavior and interactions between them. An agent is a computer system that is situated in an environment, which is capable to make autonomous action in the environment in order to achieve its design objectives (Michael, 2006). The key aspects of agents are their autonomy, where their abilities to perceive reason and act in their surroundings environments, as well as the capabilities to cooperate with other agents to solve complex problems are essential (Mike, 2001).

In SMS Management System for instance, we applied a group of agents which are known as Multi Agent System (MAS) to reach goals that are difficult to be achieved by an individual agent. The MAS are self-motivated, as agents are able to learn from their experience, sharing task, communicate and collaborate with each other in order to achieve their internal goals. We believed that this technology is recommended for design and development of a complex system where agents could provide higher level of abstraction (Mike, 2001; Gerhard, 2000). In SMS

Management System, we have divided the agents in five category with substantial tasks; Distributor Agent (DA), Model Checking Agent (MCA), Order Entry Agent (OEA), Account Management Agent (AMA) and Product Server Agent (PSA) (Selamat et al., 2008). The process of MAS in SMS Management System is explained in detail in Section 4.0.

### 2.3. Model Checking Methods

Model checking is a promising mathematical method that consists in verifying some properties of the model of a system and it is done automatically (Katoen, 1998/1999; Yang et al., 2007; Bonnie et al., 2005). This method is possible to prove the correctness of systems using temporal logics to specify system properties. As to conduct model checking verification, it requires an automata model to demonstrate the sequential of system processes from one state to another under the action of transition (Berard et al., 2001). The process of automata will form the basis of the operational models used to specify the behavior of the systems to be validated. In the case of SMS Management System, we have been able to discover uncertainties as well as sources of incompleteness. The verification of the SMS Management properties can be done by encoding the formulation of property in the Linear Temporal Logic (LTL).

## 3.0 SMS MANAGEMENT SYSTEM ARCHITECTURE

SMS Management System in Direct Sales and Network Marketing is become one of commercial grade for extensive business opportunity. The system has been implemented based on four main modules as shown in Figure 1. The first module is the registration, whereby a customer is needed to register as a distributor. Then, once a customer became a distributor, they need to recruit a new distributor as their sales force to the down line. The second module is the purchasing system where a distributor is able to purchase items by the SMS system. The third module is the bonus calculation module which means the distributor can view their profits of calculation percentage in sales force on multi level. The fourth activity is the SMS group modules that send out news regarding activities and seminars to motivate and recruit as many distributors as they could in sales force. Figure 1 shows the modules of SMS Management System for Direct Sales and Network Marketing as our case study (Voo, 2007).

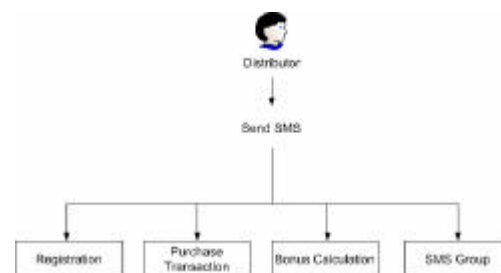


Figure 1. Modules of SMS Management System for Direct Sales and Network Marketing

#### 4.0 MODEL CHECKING AGENT IN SMS MANAGEMENT SYSTEM

As discussed in Section 4.0, the process of purchase transaction occurred when a distributor sends a SMS to create an order. The order entry received the message through SMS station server. Then, the order entry will get the detail input and create order with account management. After the ordered items are in place, bonus calculation and purchased items will automatically be updated to the database. The previous architecture of SMS Management System has not considered the future problems that might occurred such as redundancy and synchronization of data input if more than a user at one time. At the end of the processes, the system will increase the processing time to handle multiple tasks. This will affect the reliability of the system performance. Furthermore, we have identified that, once the system has been deployed to the clients without considering the security issues, the cost for maintenance will possibly be increase.

Therefore, in this paper we present the proposed architecture of SMS Management System by using model checking agent in order to tackle the issues. The proposed architecture

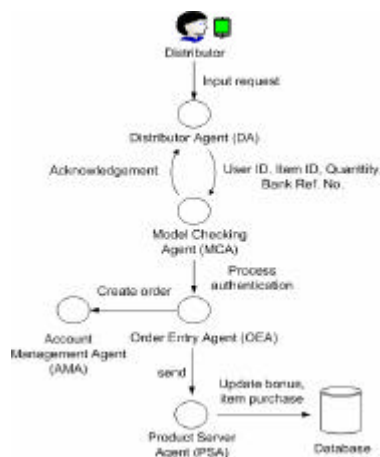


Figure 2. The state transition of SMS Management System for purchase of items transaction

has applied an environment of multi agents with model checking method in order to check and verify the model of the system. Based on Figure 2, the distributor starts to insert an input message with a valid format protocol to purchase an item of product. The Distributor agent (DA) will receive the request message (User ID, Item ID, Quantity and Bank Reference Number) and sends it to the Model Checking Agent (MCA). The message will be verified by the MCA in order to check whether the message is meet the requirement specified or it could be otherwise. The authentication process is done by the MCA and once the message has successfully been checked, the

notification status will be sent back to the distributor. However, if an invalid message is identified the MCA will send an alert notification to the DA for distributor action. The DA will send an acknowledgement to the distributor to key in the message again. Otherwise, the message will be violated. However, if our Model Checking Agent (MCA) checks and verify that the message is valid, the MCA will transmit the details of the message to the Order Entry Agent (OEA) to create an order and place the purchase of items with the Account Management Agent (AMA). The database will be updated with the bonus and item purchase by Product Server Agent (PSA) to the distributor account after all the process has been completed by OEA. Agent plays an important role to ensure that the data transaction is manageable and releasable during the delivery of messages. Detail process of verification is explained in finite state model (FSM) in Section 4.0.

In this paper, we adopt the approach of model checking method to verify the correctness of the SMS Management System. This method is an automated method that is consider fast and robust than simulation and theorem proving (Wang et al., 2006). Additionally, the model checking approach is able to analyze the number of processes in a minute. The counter-examples provided in SPIN model checkers managed to indicate the precise location where a protocol failures are discovered (Bonnie et al., 2005). The input message for each state transition in Figure 2 will be verified by the SPIN model checker in order to ensure the requirement have been satisfied with the specification defined. In a particular architecture, when many processes are distributed and automated, there are many states within these processes that needed to be evaluated. The reliability of the information transmitted among agents with the correct syntax and protocol using SMS need to be checked. SPIN model checker is able to check our propose model is non-tolerable to errors, bugs and deadlock during the execution of the processes. With that, the failure of system can be detected at the earlier phase of development.

#### 5.0 VERIFICATION TASK

The SPIN model checker is a powerful tool for model checking (Yang et al., 2007). In SMS Management System, there are three important properties that need an attention for the model checking agent (MCA) has to verify. We have considered the following properties as the example of verification task.

**i. Properties concerning format and syntax checking.** MCA is responsible to check and verify the format and syntax checking in automata model shown in Figure 3. If the input message (User ID, Item ID, Quantity, Bank Reference Number) satisfies a given specification of a desired system, then the transaction will proceed to S2. Otherwise, system will acknowledge distributors at S0 for their alert action or the transaction will automatically been terminated. This process of format and syntax checking is

important to prevent non-trustworthiness users in the SMS Management System.

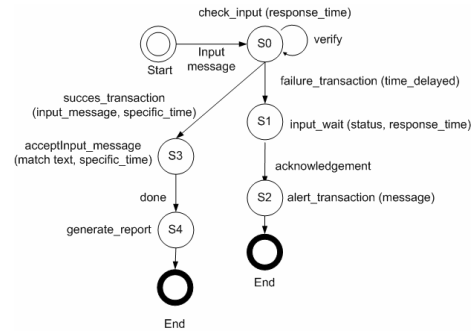
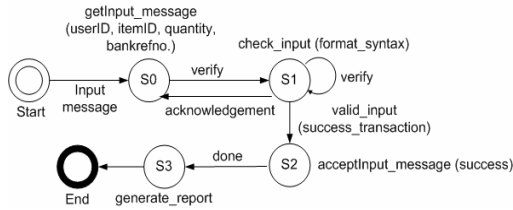
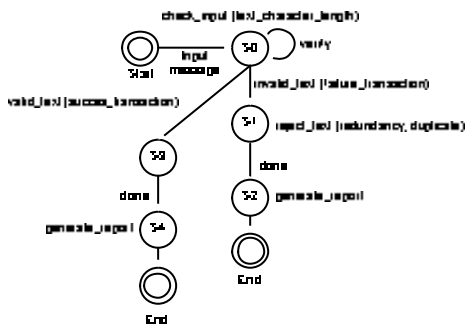


Figure 3: Automata model for format and syntax checking

**ii. Properties concerning byte transaction checking for data control and security.** Basically, an SMS message can contain text or binary data. A single short message can contain up to 160 characters when Latin alphabets are used, and 70 characters when non-Latin alphabets such as Arabic and Chinese are used (Ozeki Message Server, 2005). So, we request to check and verify the accuracy of message input when it will be delivered from the distributors to the SMS center. The length of the characters for sending and receiving messages should be the same as the defined specification. We validate and verify the text characters for each transaction as showed in Figure 4 to ensure the information received by SMS Management System is in control and can assured of the correctness.



<http://www.mobilecomms-technology.com>,

Mobilecomms-

Technology.com, 1999.

<http://www.etsi.org>, European Telecommunications Standards Institute, 2004.

<http://www.ozeki.hu>, Ozeki Message Server, 2000 -2005.

Bujang A.S.D. and Selamat A. (2007). "Dynamic Model Checking for Multi Agent E-Business Control and Assurance", Malaysia Software Engineering Conference 2007 (MYSEC'07).

C.Wang, G.D. Hachtel and F.Somenzi (2006). "Abstraction Refinement for Large Scale Model Checking", Springer.com.

Eugenio D. S., Francesco M. D., Marina M., Giacomo P. (2003). "Web applications design and maintenance using Symbolic Model

- Checking”, *Proceedings of the Seventh European Conference on Software Maintenance and Reengineering (CSMR' 03) IEEE*.
- Gerhard W. (2000). “Multi Agent System – A Modern Approach to Distributed Artificial Intelligence.” The MIT Press Cambridge, Massachusetts London, England.
- J.P. Katoen, “*Concept, Algorithms and Tools for Model Checking*”, 1998/1999, pp. 31-36
- Rudy S., Shailendra R. and Kerry R. (2005). “*Mobile Search with Text Messages : Designing the User Experience for Google SMS*”, CHI 2005, April 2-7 2005.
- Michael Wooldrige (2006). “*An Introduction to Multi Agent Systems*”.
- Mike P.P. (2001). “Agent Oriented Technology in Support of E Business,” *Communication of ACM*, vol. 44, No. 4.
- Selamat A. and Bujang A.S.D. (2008). “The Design of Model Checking Agent for SMS Management System”, *The 2<sup>nd</sup> KES International Symposium on Agent and Multi Agent Systems: Technologies and Applications (KES AMSTA 2008)*.
- Voo.N.Mee (2007). “*SMS Management System for Direct Sales and Network Marketing*.” Universiti Teknologi Malaysia.
- Yang Y. and Xiaohui L. (2007). “A workflow model with temporal logic constrains and its automated verification”, *The Sixth International Conference on Grid and Cooperative Computing (GCC 2007) IEEE*.
- Paolo T., Laura G., Alession B., Stefania M. and Loredana D.(2006). “*SPIN Model Checking for verification of clinical guidelines*”.