A Service Oriented Architecture to Integrate Short Message Service (SMS) Notification in Road Traffic Volume Control System

Zahi Abu Sarhan
Computer Information Systems Department
Applied Science University
Amman, 11931 Jordan
zahee_abusarhan@asu.edu.jo

Mohammad Shkoukani
Computer Information Systems Department
Applied Science University
Amman, 11931 Jordan
m.shkokani@asu.edu.jo

Hesham Abusaimeh
Computer Networks Systems Department
Applied Science University
Amman, 11931 Jordan
h_saimeh@asu.edu.jo

***Abstract*—The traffic volume becomes one of the top problems in the world, the volume of traffic spends many time and much money, the traffic volume grows daily, and there is not effective and suitable solutions for grows problem. This paper will present and describe an effective approach to integrate the Service Oriented Architecture with mobile devices and services agents in Traffic Management Systems (TMS). The Traffic Volume Control System (TVCS) should enable mobile short message service (SMS) notifications. Unfortunately, cellular SMS notification based on services that are not aspect of the TVCS. Developing altered exterior systems and services, to be virtually aspect of TVCS, are one of the most incorporation difficulties. In this paper, a Service Oriented Architecture (SOA) approach to include cellular SMS alerts in TVCS is presented. Suggested Structure includes two layers: Service layer and Interface layer. The Service layer includes all the system software. The service layer consists of three sub layers: Orchestration, Application Services, and Agents sub-layers. While the Interface layer interrelates with speed detectors and users via sites, and with exterior organization services via Web services.**

Keywords- Traffic management system, Cellular SMS announcement software agent, service oriented architecture.

I. INTRODUCTION

The development of Intelligent Transportation Systems requires high quality information about the traffic in real-time. For several years, under growing pressure for improving traffic management, collecting traffic data methods have been evolving considerably and the access to real-time traffic information is becoming routine worldwide [1].

Traffic volume studies are conducted to determine the number, movements, and classifications of roadway vehicles at a given location [2]. These data can help identify critical flow time periods, determine the influence of large vehicles or pedestrians on vehicular traffic flow, or document traffic volume trends. The length of the sampling period depends on the type of count being taken and the intended use of the data recorded. For example, an intersection count may be conducted during the peak flow period. If so, manual count with 5-minute intervals could be used to obtain the traffic volume data.

Several key companies have been working on explanations of Traffic control techniques and systems. Traffic management system (TMS) can be defined as the management process created by interaction with digitally delivered content services and support [2]. TMS involves intensive usage of ICT (Information and Communication Technology) to serve, facilitate, and revolutionize traffic-managing process.

Traffic Management System is an extensive incorporated program of variety of tools for the distribution

and treating road status [3].

The Orchestration sub -layer maintains business reasoning needed by system procedures and processes. While, the Application Services include groups of stateless services that can act certain errands [4].

In addition, the Agents' layer provides the proposed needed software agents to provide the overall application. These proposed agents execute as analyzer and tracker. They require analyzing traffic volume to detect the status of the road in the analyzer role. Furthermore, they track users to remind with the changes of the road status in real time in the tracker role.

SOA contributed incorporation of software agents within Traffic Management System (TMS), and realization of new process to support traffic amount status.

Agents' part affords the suggested needed software suppliers to provide the overall program. These suggested suppliers affect as analyzer and tracking system [5].

II. SMS NOTIFICATION IMPORTANCE

SMS notification is an official process that includes a purposeful effort to obtain information about a streets status related to many factors such as: usage of the road, volume and speed of the cars, classification, Occupancy, and presence. It is one of the interesting management elements that should change the Traffic management strategy. The SMS notification that is explicitly designed to promote control and management traffic is the most highly effective tool for increasing requirements and empowering lifelong travelling.

The definitive objective of SMS alert is to obtain legitimate, efficient, and useful information about road status, and efficiency of the traffic volume controlling system.

The notification most contain useful and full information for travelers, about the roadway or street that they went in. the roadway or street name and the roadway status and the last status update time are the important information that the travelers need to evaluate the situation and take the alternative roadway if that needs or possible [6].

The organization of this paper is as follows: The problem definition was provided in section II. Presenting the cellular solutions structure and architecture is in section III. Suggested TMS architecture provided in section IV. Section V concentrates on TMS analysis including the take cellular SMS alert process. Section VI demonstrates TMS design and execution, such as developing Web services and software agents. Summary and future works were provided in the final section VII.

III. PROBLEM DEFINITION

These days most of the automobiles are equipped at least one or several mobile phones, it may be worth using mobile phones as anonymous traffic probes.

The cell phone positioning is consistently passed on to the system usually through triangulation or by other techniques (e.g. handover).

The Global Positioning System (GPS) via mobile can only deliver information with an attention of the special restrictions and benefits of cellular phone gadgets, so known design requirements of maps cannot simply be used into the TVCS using cellular context. Understanding the restrictions of the user interface is vital. Mobile gadgets suffer from small displays, poor contribution methods and restricted life cycle of battery. Therefore, the interface design for TVCS services must meet users' needs without over filling them with needless complexness or managing too gradually. [7]

Furthermore, these days professional TVCSs do not support Cellular SMS announcements. Cellular SMS announcements need incorporation of exterior services; services that are accountable for interchange SMSs between TVCS and tourists or drivers. Besides, Cellular SMS announcements should be incorporated with other TVCS elements, like Road Control system, (RMS). SOA is a design that assisted initiatives to get over incorporation challenges, and obtain nimble and interoperable features among their architectures.

Traffic management departments (TMD) can make use of SOA in developing cellular SMS alert actions in TVCS. Integrating cellular SMS alert is about trading SMSs between TVCS and travelers and drivers, and it is involved with automated of the whole procedure, regulating and orchestrating TVCS to accomplish approved level of performance. A SOA centered TVCS is provided to be able to release SOA benefits for TMDs.

IV. MOBILE SERVICES ARCHITECTURE

Mobile SMS alert uses new mobile services structure to provide entertaining texting instantly to provide Road status and get several reactions Short Messaging Services (SMS).

SMS responses should be incorporated within TVMS to allow traffic managing. As shown in "fig 1", Mobile Service Architecture needed to allow travelers or drivers to communicate via mobile SMS with traffic volume control server that maintains TVMS. Travelers are interconnected with her/his mobile company via cellphones or

smartphones. Mobile service providers apply one or more SMS facilities. Those are facilities that handle delivering and getting of SMSs [8].

TVMS needs an arbitrator in the way to SMS middle. Arbitrator connects directly to different SMS facilities using Short-Message Peer-to-Peer (SMPP) protocol. SMPP is a telecommunication method for trading SMS information between SMS peer entities such as SMS midpoint. It is often used to allow third events to publish information in massive. SMPP has been developed to provide services for various cellular systems such as GSM, CDMA, and TDMA [9]. Arbitrator is connected directly the TVCS hosting server over the internet, via conventional Web services. Via SOAP query, TVCS can get SMSs targeted to it, and via SOAP reaction, TVCS can send new SMSs. TVCS should handle sessions with different drivers.

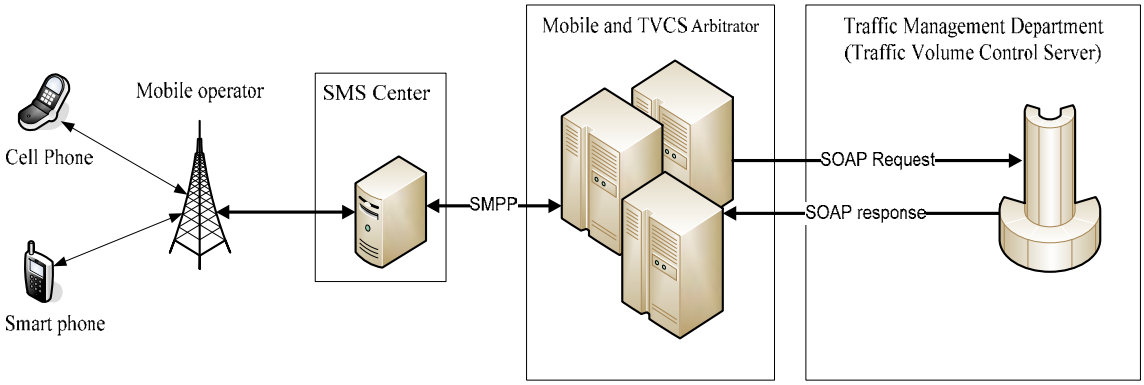


Figure 1: Mobile Services Architecture

V. PROPOSED TVCS ARCHITECTURE

TVCS includes two main layers: Interface layer and Service layer, as shown in “fig 2”.

A. Interface layer

In this layer provides the primary checkpoint of the system with customers and other service providers / customers. TVCS has two kinds of users: Travelers the Pearson who interested in the road status and the second user is the administrator who manages the system entries. Every user has a separate portal, which includes various features. Display assistance is responsible for organizing powerful outcome prepared to users, and calling the appropriate web page to show data. Display assistance passes appropriate set of information to appropriate pages, and acquires feedback from users when needed. There is no company reasoning included within this layer. Separating of user interface style and execution from business logic has proven many advantages [10]. Other solutions providers/customers like Arbitrator have Web solutions (services) as the interface of machines that signify service providers/customers. TMS and Arbitrator reveal set of Web services required to fulfill system-reinforced processes under SOA design pattern.

B. Service Layer

Service layer is the layer that holds services writing primary of the TMS. Service layer includes sub layers: Orchestration layer, Application Services layer, and Agents layer.

- *Orchestration Layer:*

Orchestration layer controls connections information required to ensure that service functions are implemented in specific chains [10]. Chains are identified based on procedures reinforced by system. Orchestra within this layer is SMS Manager.

Orchestration is requirements of creating a SOA, intra - or inter-organization. The layer makes business alternatives from the range of services and information flows discovered in new and current system. Orchestration is a godlike management procedure that is able to put our SOA to work, as well as offer a point of management. Orchestration levels allow modifying the way business processes, as required, to determine or modify any business procedure on the fly. This provides the business with the versatility and speed required to contend these days.

Orchestration must offer powerful, versatile, and convenient mechanisms to fulfill the modifying needs of the domain. This is achieved through the separating of procedure reasoning and the back-end solutions applied. The generally paired characteristics of orchestration are important factors, since there are no specifications for all solutions or services to be up-and-running simultaneously in order for orchestrations to run. This is also important for long-term dealings. Also, as solutions to modify eventually there is generally no need to improve the orchestration layer to offer the changes, or at least if they are architected effectively [11].

Thus, the consideration of orchestration as really another finish layer over and above more conventional program incorporation techniques, such as information- and service-oriented incorporation. As mentioned,

orchestration encapsulates these incorporation factors, creating them together to type advanced level procedures and blend services.

We can strategy orchestration as we would strategy any other new technological innovation. First, determine its value and purpose. Second, determine our own issue domain such as current data and services. Third, model a small issue to obtain efficient experience. Once that happens, it is a chance to create our strategy, then select technological innovation, and fold up our solution. This is one of those technologies that matter in the way of the business operates. It is about time [11].

- *Application Services Layer*

This layer includes groups of stateless services that execute certain tasks. Procedure is the summary of tasks conducted by one or more application services layer in the series that is managed at orchestration layer services

Usually programs need some assisting performance required to execute their job but which is not aspect of the application's "business logic functions". For example, we may be using something to deal with all confident SMS from our program. Now, this element encapsulates some reasoning but it has nothing to do with the objective of our program, and usually when we use this kind of resources, we only need to have only one instance resting around maybe on the Application opportunity, or an instance that is approved around from object to another object. This kind of performance is what we contact an Application Service, and the set of many of these solutions provides a layer of assisting performance to the application. This layer of assistance is what can be known as an Application Services Layer [12].

Furthermore, these program solutions offer extra performance to the program, which may also be needed by other layers; thus creating it difficult to fit this concept within any of the other levels of the program and strengthening the concept of dealing with this selection of solutions as an application layer or level on their own.

The Application Services Layer include: Manage the traffic, Manage SMS, Send SMS notifications, and receive SMS.

- *Agents Layer*

As in the everyday sense, we expect a software agent to act on behalf of someone to carry out a particular task, which has been delegated to it.

However, since it is tedious to have to spell out every detail, we would like our agents to be able to infer what we mean from what we tell it. Agents can only do this if they “know” something about the context of the request. The best agents, then, would not only need to exercise a particular form of expertise, but also take into account the peculiarities of the user and situation [13].

Specific task agents are very necessary to serve the system. Software agents are always the best possible solution for track and analysis projects. Software agents are Analyzer, and Tracking system Agents. Analyzer agents is the application that examines system's log to identify most happen reasons causing unsuccessful imports, thus provide a feed-forward powerful RMS. Tracking system agent is the application that is responsible for guaranteeing that drivers provided reviews for roads they have journeyed [14].

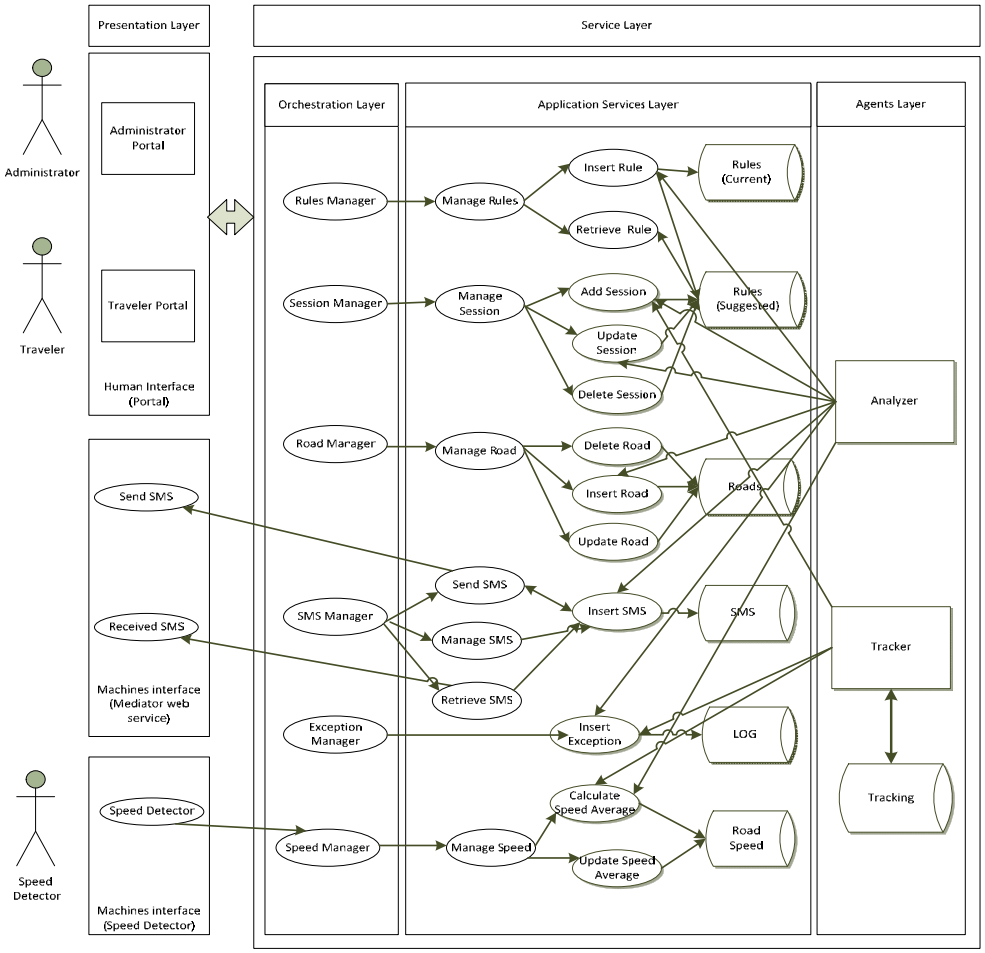


Figure 2: Proposed TVCS Architecture

VI. TRAFFIC VOLUME CONTROL SYSTEM ANALYSIS

System specifications are functional and non-functional requirements [15]. Functional requirements are statements or specifications and services that system should provide. Non-functional requirements should present requirements that stand up because of functional requirements. Architecture design is one-step of system's design that shall satisfy non-functional requirements like integration, interoperability, and agility [16]. Proposed TVCS utilizes SOA to satisfy functional and non-functional requirements. Proposed system addresses four main processes namely Register (Login) Send SMS (request), Receive SMS Notification and Calculate Average speed. The system have some sub processes the main process Register have four sub processes they are Add New road record, Edit road record, Remove road record and Retrieve road record, calculate Average speed needs to update road record, register process enables Administrator to manage the system and control the rules of updating the system database within road repositories managed and maintained by internal and external DBMSs and CMSs, import, and display those roads as shown in "Fig 3".

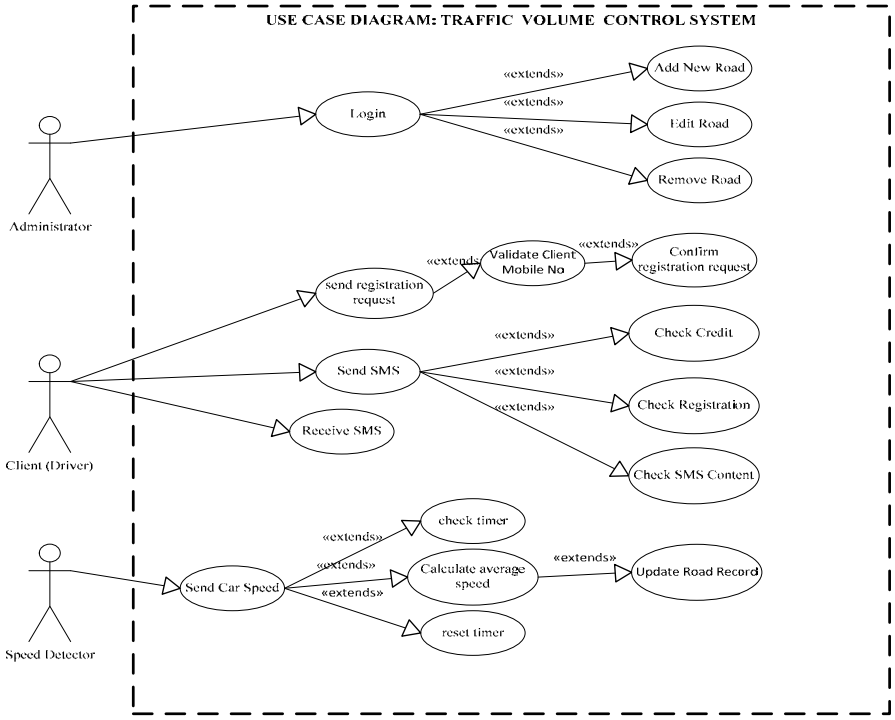


Figure 3: TVCS Use-Case Diagram

A. Register process analysis.

This process enables administrator to login to the system server web site, the administrator have full permissions to manage the system main services and processes such as update and add, remove.

B. Send registration request process analysis.

This process interacts with new clients, the client sends SMS request to the system, the system receives the SMS, and store it in queue and it will pending, then the system validate the user mobile number in the request and checks the client table in the database, if the user not registered and the mobile number is valid the system confirm user and adds hem to the database.

C. Send SMS analysis

The user sends SMS to the system and the system receives the SMS notification, and it begins analysis the SMS, If the system confirms the mobile number and the SMS body which contains the request of starting the session, the system replay SMS notification to the client with the available covered roads by TVCS, the user replays SMS with the Needed road number, finally the system replays SMS Notification to the user with the current status of the road. The system replays SMS notification to the user every update road status while the session begins, the user can terminate or ends the session by sending end session SMS as in "Fig4".

D. Manage the system analysis process

The Administrator enters login name and password, if the login information accepted the system passes administrator to management page and options as shown in "Fig 5"

E. Send Cars speed process analysis

This is the process which the system service depends up on, the speed detector or Radar sends detected speed to the system and the system collected the speeds during 5 minutes, the system every 5 minutes calculates the average of the collected speeds within preceding 5 minutes, resets the timer, and updates the Road record in the database as in "Fig 6".

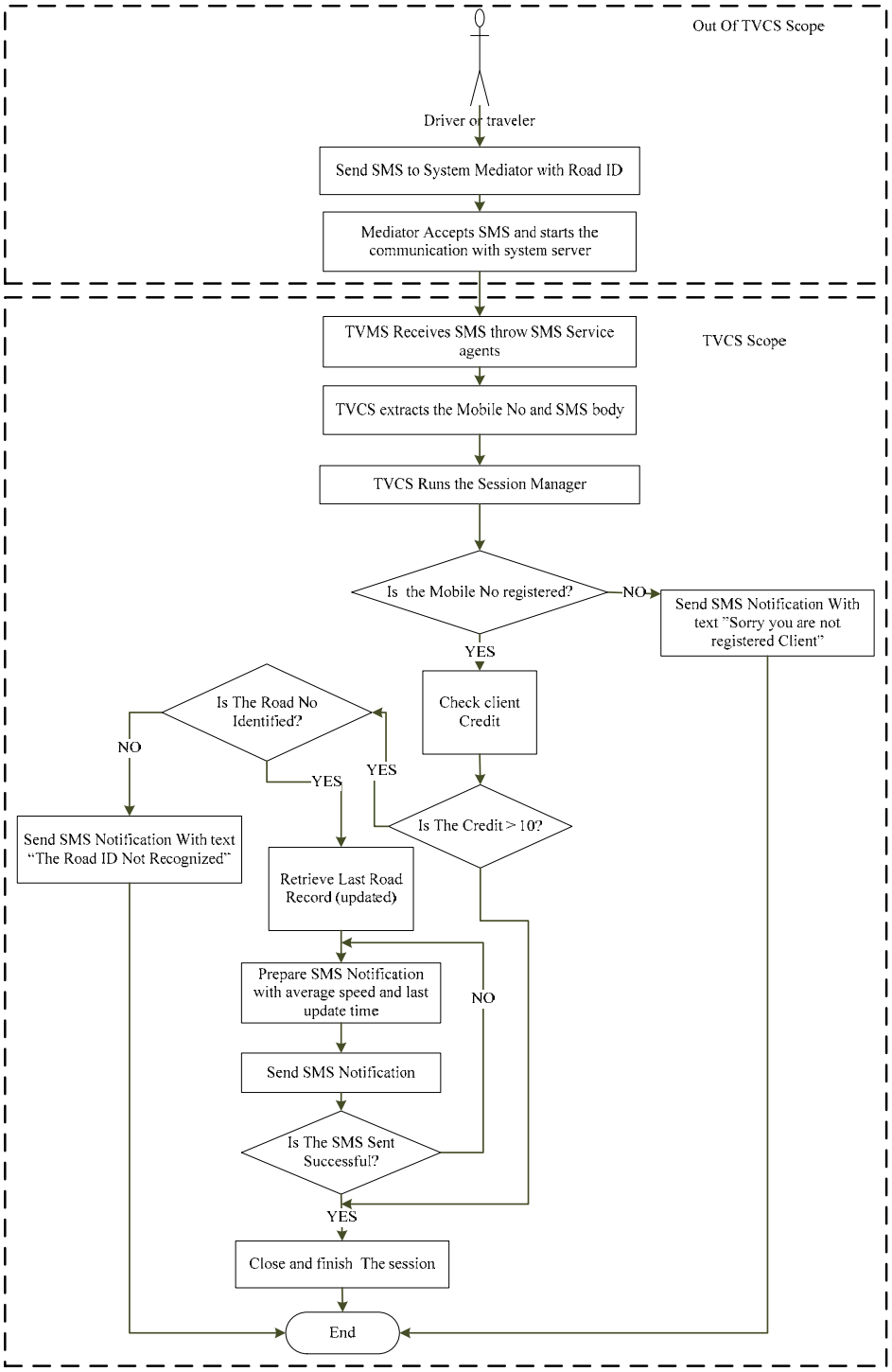


Figure 4: Send \ Receive SMS notification process analysis

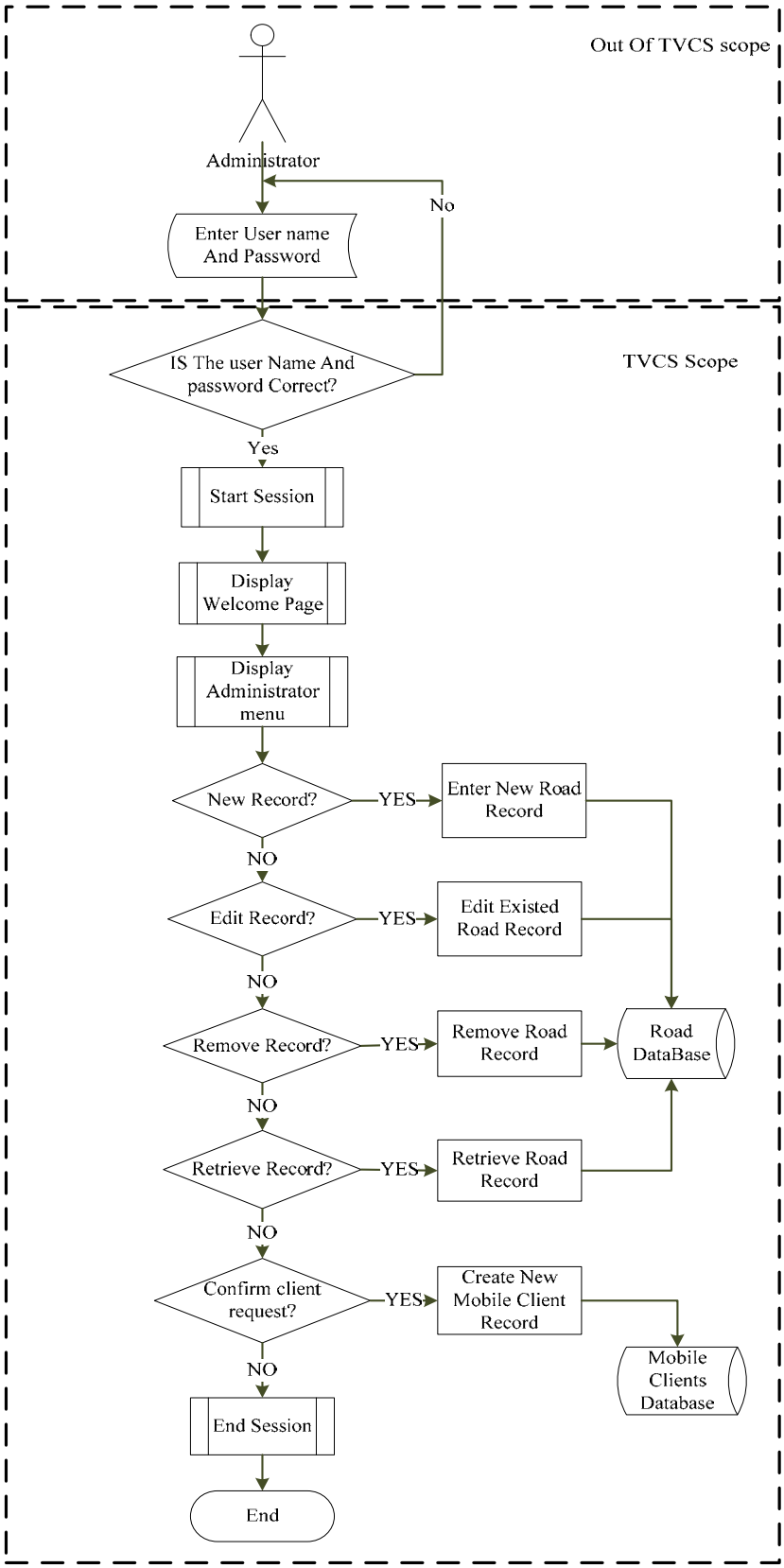


Figure 5: Manage the system analysis process

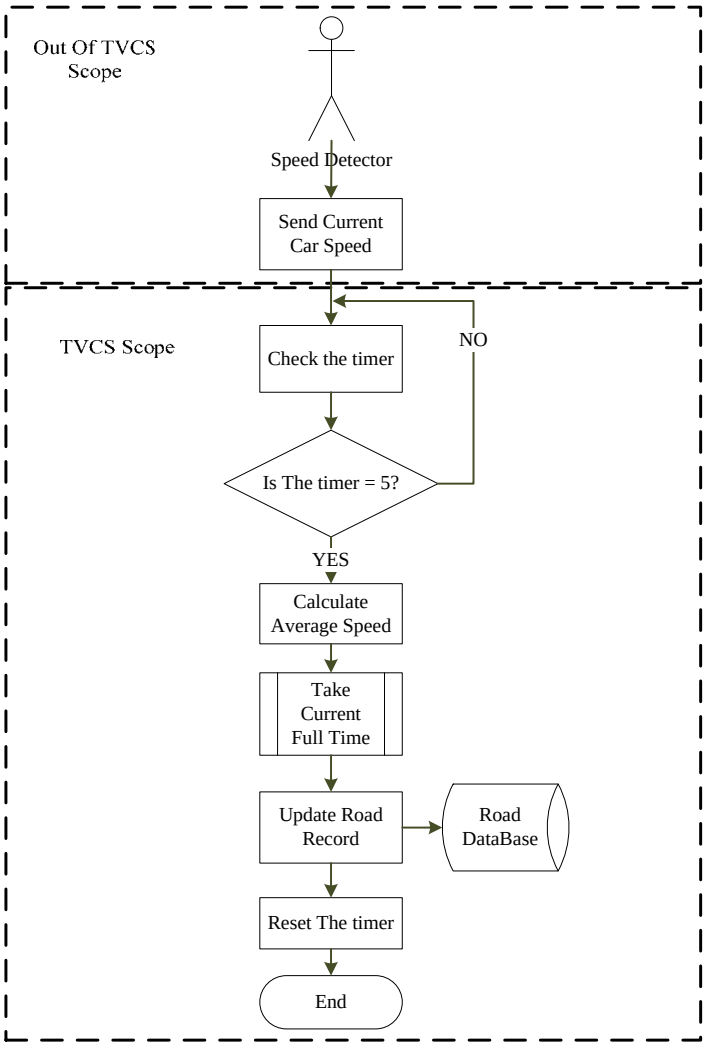


Figure 6: Detect speed and calculate speed average process analysis

VII. TRAFFIC VOLUME CONTROL SYSTEM DESIGN

TCVS design includes designing the computerization of the all cited processes, and designing software agents, which needed to support those processes. Designing processes and designing combining services for each process, activities conducted by each service, and data source needed to support these services. Database design process is needed for effective data source design [17], as shown in "Fig 7"

A. Utilization of Web services as SOA

- *The design of the Service "Manage SMS".*

Managing SMS is a collection of solutions and services that include: Receive SMS, deliver SMS, and insert. Send and receive SMS Services two services that bluff intermediary Web services. The arbitrator gets and delivers actual SMS-messages effectively. TVCS maps are intermediary to send and receive SMS-messages in the internal send and receive SMS. Thus, when TVCS consumes as service, in fact it is a lot of the intermediary to deliver and receive SMS-services.

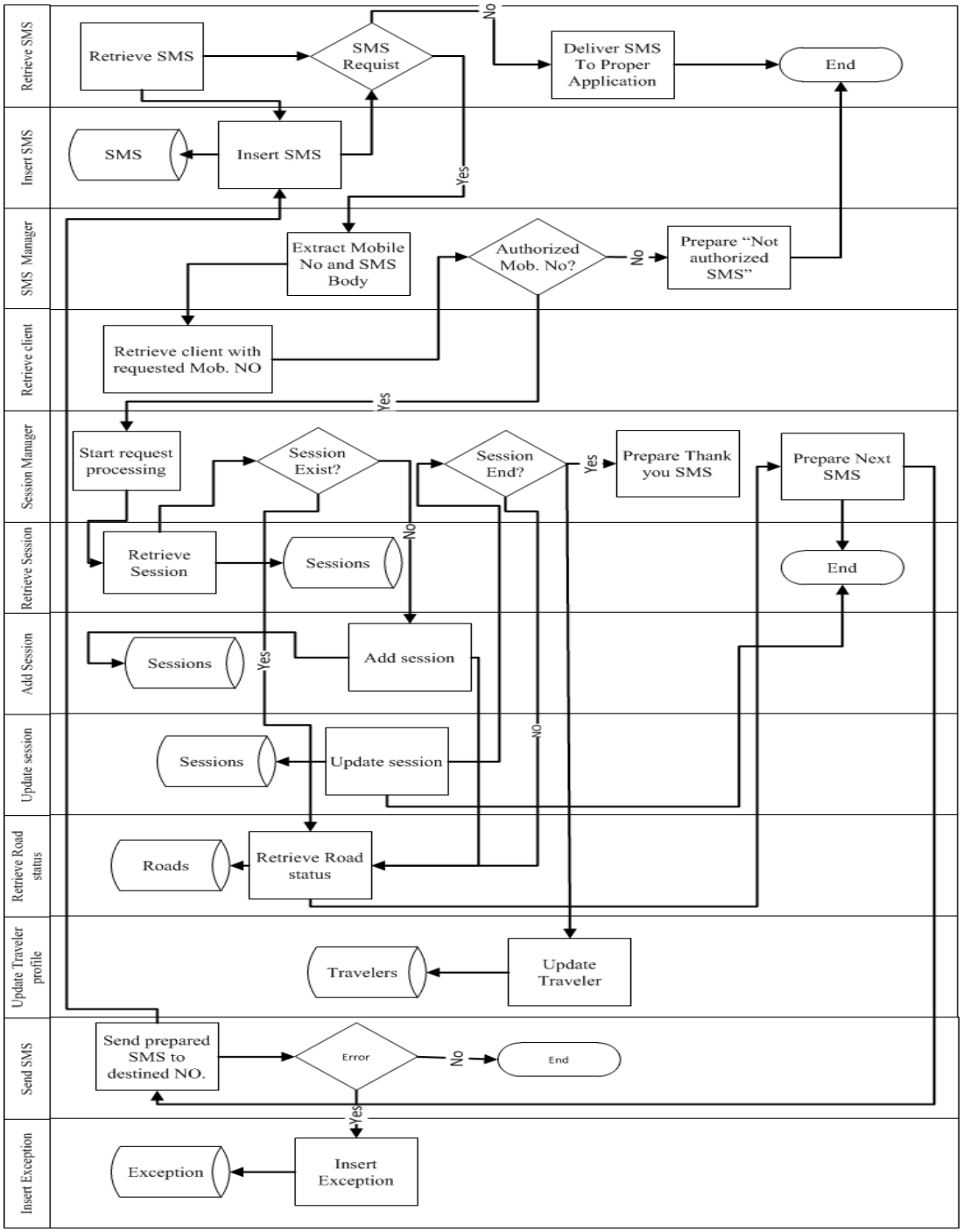


Figure 7: TCVS Design

- *The design of the Service "Manage SMS".*

Managing SMS is a collection of solutions and services that include: Receive SMS, deliver SMS, and insert. Send and receive SMS Services two services that bluff intermediary Web services. The arbitrator gets and delivers actual SMS-messages effectively. TVCS maps are intermediary to send and receive SMS-messages in the internal send and receive SMS. Thus, when TVCS consumes as service, in fact it is a lot of the intermediary to deliver and receive SMS-services.

Insert SMS records of all inbound and confident SMS-messages. This record (log) is essential in the computation of the charges to be compensated for the intermediary, and other problems proceedings. Table 1 reveals the necessary data source table to insert SMS assistance (service).

TABLE I. INSERT SMS SERVICE

SMS	
PK PK PK	**Mobile NO** **Date** **Time**
	Content

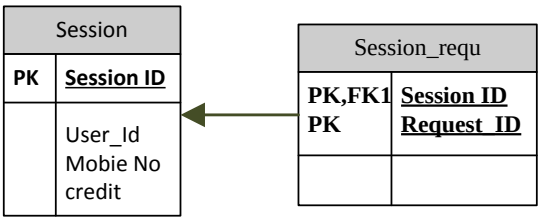
- *The design of the Session manager service*

Sessions are the core contributing of user TVCS interaction. Sessions represents the timeframe that the user is identified by the program as in the center of a process, types and affects of actions that traveler or customer or manager performs on the system. Session manager is responsible for recognizing either the users is already registered user and the system can process the request or he is a new user registration request, so it is a main manager of TVCS, session manager retrieves the next response be sent to the user, and passes it to the Send SMS service.

- *The design of the "Manage session services"*

The main database operations in Sessions performed by Manage session service, there are three core operations: insert record, update record, and delete record. When the user starts a new session, the insert session record operation creates a new session record. The session will be updated if the session already exists and the user sends request. Based on the user's request, the system will update the user credit amount, and the quantity of responses (notifications) sent to the user. The session will be deleted when the user terminates the session and completes it. Table 2 presents the necessary data source tables for manage session services.

TABLE II. MANAGE SESSION SERVICES DATA TABLES



B. Software Agents

Software agent computer system, which is in some environment and is capable of autonomous action in this environment in order to meet its design objectives [15]. Software agents have characteristics that make them suitable for complex functions. Features include autonomy, interaction, reactivity, activity, intelligence and mobility [17]. The proposed architecture uses two specific problems of software agents: Analyzer, and Tracker.

- *Tracker agent*

Tracking systems are widely known and accepted [18]. Table 3 presents the necessary tables to support the tracking activity. "Fig 8" shows the track of the design process. The agents tracking system initializes and maintains the tracking procedure [19]. The tracking procedure needs four core Web services: Read user information, reading credit data, reading request information, and send SMS.

TABLE 3: TRACKING AGENT

Tracking	
PK PK	**Mobile No** **Request_ID**
	Credit Limit Current Credit

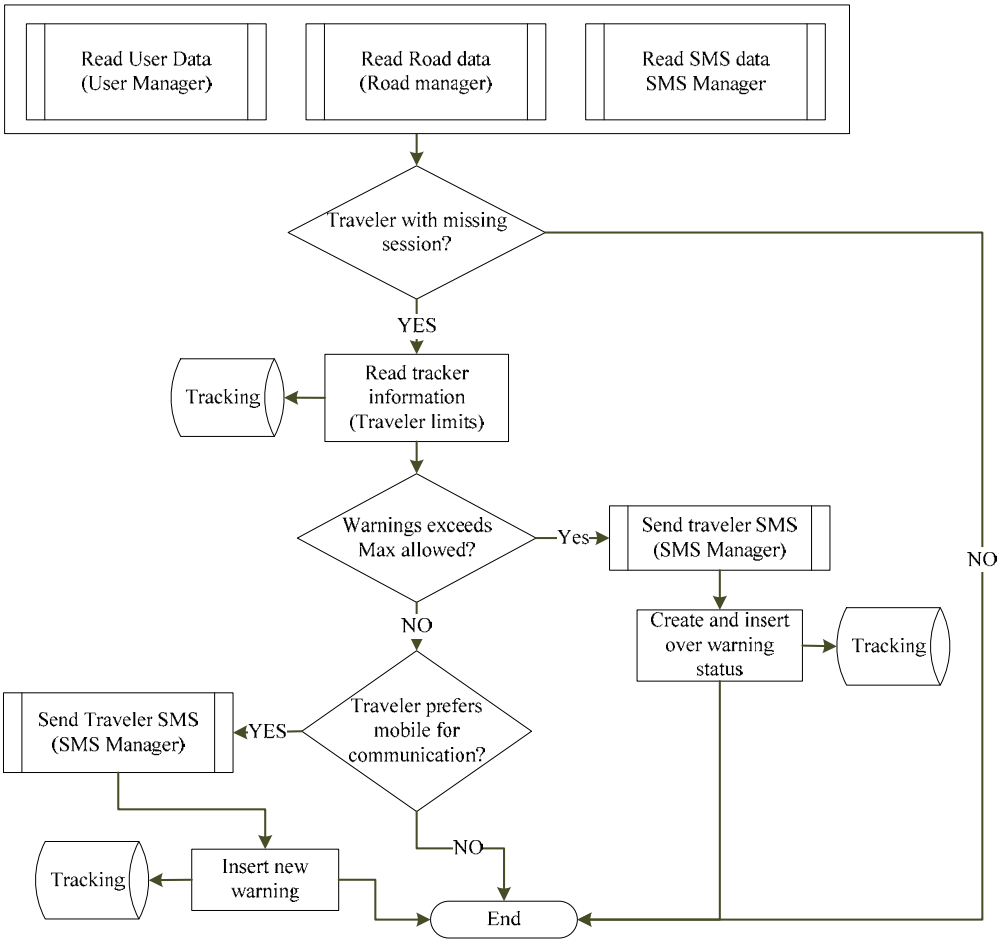


Figure 8: Tracking Process Design

- *Analyzer agent*

This is the software application that responsible for evaluating and exploring the stored information and historical data and results about the road status and requests, by identifying the reason of the most unsuitable feedback and creates new recommendations to improve the control activity [20]. All these recommendations already inserted provisionally in recommendation database, to be approved by the administrator. Data analysis estimates generally mostly increase overall system performance by adapting the system in accordance with / exceeds the expectations of users [21]. “Fig 9” shows the Analyzer design process. Analyzer agent consumes two services Web: Read the evaluation of the data and insert the proposed recommendations. Administrator with administrator portal can approve / reject the recommendations of the analyzer. The analyzer can store information on how many of the recommendations have been approved / denied by administrator to ensure the effectiveness of the analysis rules. The analyzer can manage the accepted recommendations, and new user suggestions to confirm that the new recommendations are met appropriate the user’s feedback.

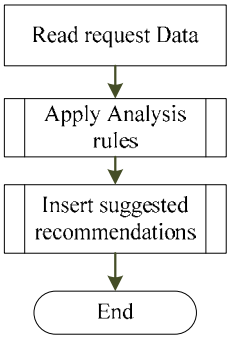


Figure: 9 Analyzer Process Design

C. Interface Design

In this system, there are two types of interfaces, user interface and system interface:

- *User Interface:*

A critical aspect of the information system is the quality of the user interface. The design of the user interface defines how the user will interact with the system. Users' abilities and needs differ widely; each user interacts with the system in different ways [16]. In addition, different approaches to the interface might be needed for different parts of the system. In addition, as information systems become increasingly interactive and accessible, the user interface is becoming a larger part of the system [22].

"Fig 10" present administrator portal interfaces.

Figure 10 Administrator management interface

"Fig 11" presents Send SMS request and receive notification response

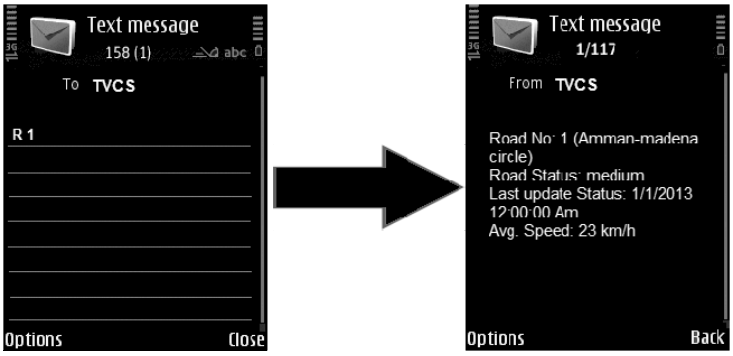


Figure 11 Send request SMS and receive SMS notification

- *System Interface:*

No system exists in a vacuum. A new information system will affect many other information systems. Sometimes one system provides information that is later used by another system, and sometimes systems exchange information continuously as they run. The component that enables systems to share information is the system interface.

VIII. CONCLUSION

This paper presented a proposed TVCS that facilitates integration among different TMSs. An automated traffic volume management, such as send SMS notification to the registered clients about the traffic volume in the requested road, registers new clients to the database and manages the road information. This automated process requires governance of business rules and exceptions. Business rules might be limiting system efficiency, so they must be monitored and modified when needed. Manage business rules process was presented to achieve this goal.

Using Service oriented architecture to incorporate software agents and Web services in TVMS emphasized the advantages and benefits of Web services and its abilities to accomplish software agent's incorporation within systems. TVMS should be thought of as a set of stateless services and web solutions. The excellent granularity and modularity provided by SOA resolved many incorporation issues, but it increases the complexity to systems design and integration. SOA is the design approach that assisted organizations to get over incorporation and integration challenges, and obtain clever and flexible interoperable benefits and advantages utilizing this approach and architectures.

ACKNOWLEDGMENTS

The authors are grateful to the Applied Science Private University, Amman, Jordan, for the financial support granted to cover the publication fee of this research article.

REFERENCES

[1] G. Dimitrakopoulos, “Intelligent Transportation Systems”, Vehicular Technology Magazine IEEE,PP. 77-84 ,march 2010.

[2] T. V. Mathew, “Automated Traffic Measurement”, Trac Engineering And Management, IIT Bombay April 2012.

[3] M.H Malhi, M.H. Aslam ” Vision Based Intelligent Traffic Management System”, IEEE Frontiers of Information Technology (FIT), PP. 137 – 141, 2011.

[4] A. Martinic, K. Fertalj, D. Kalpic, “Tool orchestration framework for virtual team environments”, MIPRO, Proceedings of the 35th International Convention , PP. 313-318, 2012.

[5] M. K. Haki, M. W. Forte, “Proposal of a service oriented architecture governance model to serve as a practical framework for business-IT Alignment”, New Trends in Information Science and Service Science (NISS), 4th International Conference, pp. 410 – 417, 2010.

[6] N. F Aziz, Y. Yahya, M. Mukhtar, “Short Messaging System (SMS) framework development: A case study of catfish industry in Malaysia”, Electrical Engineering and Informatics (ICEEI), International Conference, PP.1-5, 2011.

[7] V. Prokhorenko, V. Ivashchuk, S. Korsun, S. Musiyachenko, V. Borodavka, “Topographic correction of GPR profile based on odometer and inclinometer data”, Ground Penetrating Radar (GPR), 14th International Conference, PP.425-429, 2012.

[8] R. N. Akram, K. Markantonakis, K. Mayes , “Coopetitive Architecture to Support a Dynamic and Scalable NFC Based Mobile Services Architecture”, Information and Communications Security, 14th International Conference, ICICS 2012, Hong Kong, China, PP. 214-227, October 29-31, 2012.

[9] P. Ballon, A. Henten, R. Tadayoni,” Introduction: Mobile service architecture and middleware”, Journal Telematics and Informatics Volume 28 Issue 1, PP. 1-4, February 2011.

[10] A. V. Parameswaran, A. Chaddha, “Cloud Interoperability and Standardization”, Infosys Technologies Limited, SETLabs 2009.

[11] L. Lowis , “Approach for SOA Vulnerabilities”, Computer Software and Applications Conference, COMPSAC '09. 33rd Annual IEEE International, PP. 439 – 444, 2009.

[12] P. Liang , “An approach to semantic re-composition of Web services for service-oriented architecture”, 2nd International Conference on Computer Engineering and Technology (ICCET) , PP. V2-519 - V2-522, 2010

[13] X. Hua, W. Dua, B. Spencer, “A Multi-Agent Framework for Ambient Systems Development”, The 2nd International Conference on Ambient Systems, Networks and Technologies (ANT-2011) / The 8th International Conference on Mobile Web Information Systems, V5, PP. 82–89, 2011

[14] Z. Ma, H. Fan, M. Yizhong, P. Shenglu, “Research of reusable agent model in distributed systems”, 2nd International Conference of Information Science and Engineering (ICISE) , PP.1429 – 1432, 2010.

[15] T. Erl, “SOA Design Patterns”, Prentice Hall PTR; 1 ed., ISBN-13: 978-0136135166, 2009.

[16] T. Erl, “SOA Principles of Service Design“, Prentice Hall; 1 ed., ISBN-13: 978-0131858589, 2007

[17] P. Brooks Jr.,”The Design of Design: Essays from a Computer Scientist”, Addison-Wesley Professional, ISBN13: 9780201362985, 2010.

[18] R. Raboin, E. Eric, U. Kuter, D. Nau. "Generating strategies for multi-agent pursuit-evasion games in partially observable Euclidean space." Proceedings of the 11th International Conference on Autonomous Agents and Multiagent Systems-Vol. 3, International Foundation for Autonomous Agents and Multiagent Systems, 2012.

[19] R. Raboin, E. Eric, U. Kuter, D. Nau, S. K. Gupta, "Adversarial Planning for Multi-Agent Pursuit-Evasion Games in Partially Observable Euclidean Space." Eighth Artificial Intelligence and Interactive Digital Entertainment Conference. 2012.

[20] C. Chen, A. Guoshun, M. Sasa , M. Xia. "A kind of software fault diagnosing framework based on Multi-Agent." Quality, Reliability, Risk, Maintenance, and Safety Engineering (ICQR2MSE), 2012 International Conference on. IEEE, 2012.

[21] K. Khanum, M. Usman, A. A. Alwabel. "Mobile Agent Based Hierarchical Intrusion Detection System in Wireless Sensor Networks." International Journal of Computer Science Issues, IJCSI 2012.

[22] A. Chen, F. Fang, "How shall we design the future vehicle for Chinese market." Work: A Journal of Prevention, Assessment and Rehabilitation 41, PP. 4265-4272, 2012

AUTHORS PROFILE

Zahi Abu Sarhan received the M.S. and PhD degrees in Computerized Control Automated Systems and Progressive Information Technologies from Kharkiv National University of Radio Electronics, Kharkov in 1998 and 2004, respectively. During 2004-2008, he was an Assistant Professor at the Economics and Administrative science/ MIS Department at Applied Science University. Since 2008, he is an Assistant Professor at the Faculty of Information technology, Applied Science University in Jordan. His research interests include Information system reengineering, Service oriented architecture, software agents.

Mohammad Shkoukani received his B.Sc. degree from Applied Science University, Amman, Jordan in 2002, and M.Sc. degree from Arab Academy for Banking and Financial Sciences in 2004, both in computer His Ph.D. degree in computer information systems from Arab Academy for Banking and Financial Sciences, Amman, Jordan in 2009. His research interests include Agent Oriented Software Engineering, System Analysis and Design, and Electronic Commerce Applications.

Hesham Abusaimeh received his B.Sc. degree from Applied Science University, Amman, Jordan in 2003, and M.Sc. degree from New York Institute of Technology in 2004, both in computer His Ph.D. degree in computer science in the field of wireless sensor networks communication and routing protocols from Loughborough University, UK in 2009. His research interests include Network and Controls, Routing Protocols, Network Lifetime and Consumption Energy, wireless sensor networks, and web applications security.