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Communication System Architecture to Integrate Distributed Systems of an IT GRC Platform Based on Agent Technology and Web Services

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Abstract: Governance, Risk and Compliance (GRC) is an emerging field of research within the Information System (IS) academic because of its importance in business requirements of organize et community. In particular, IT requirements, standards and best practices play crucial role in IT organizations. LISER Laboratory at Hassan II University has developed an architecture that describes the integration of the main processes for IT Governance, IT Risk management and IT Compliance (IT GRC) by adopting existing IT frameworks such as COBIT, ITIL, ISO 27001/27002, PMBOK the strong point of this solution is the use of a communication system which facilitates the integration of multi-agent systems, distributed services and applications to optimize the construction of IT GRC platform. The architecture of this system proposes a new and easier method to develop distributed platform where applications included can communicate in a distributed way with intelligent agents. Communication workflow is based on message passing mode in order to coordinate and control the interactions between components of IT GRC platform which help to perform tasks and achieve a higher level of interaction in an intelligent way.

Key words: IT GRC, multi-agent system, message passing, web services, communication

INTRODUCTION

The last decade, business processes are increasing in complexity and unpredictability ability while demands for regulatory compliance and risk management are becoming obligatory. Consequently, a structured approach to Governance, Risk and Compliance (GRC) of informationsystem has become a high priority goal .

Governance: The set of policies, laws, culture and institutions that define how an organization should be managed (as opposed to the way it is actually managed).

Risk management: Coordinate activities that direct and control an organization forecasting and managing events/risks that might have a negative impact on the business.

Compliance: The act of adhering to regulations as well as corporate policies and procedures. Tools provided by GRC Software vendors become increasingly important in meeting the new standards.

IT GRC platforms should enable an organization to manage risks, reduce costs incurred by multiple installations and minimize complexity for managers (Racz *et al*., 2010). Most large organization world-wide have already adopted IT GRC Software and also Small and Median sized Enterprises (SMEs) are interested lately in following the integrated IT GRC approach fostered by GRC systems (Kooper *et al*., 2011).

Now a days, best practices, frameworks and standards such as ITIL, COBIT and ISO/IEC 27001, represent a distinctive factor in the market (Oliveira *et al*., 2010). Although is difficult to demonstrate that they leverage competitive advantage, ultimately it leads to value creation (Hardy, 2006). The diversity of frameworks raises a strategic difficulty for companies to choose the adequate IT GRC frameworks regarding top management choice.

As a result, IT governance team at LISER Laboratory at Hassan II University has developed an IT GRC platform that aims to combine IT GRC frameworks in an intelligent manner to take the right IT decision for business directives. It focuses on business objectives and proposes the best framework for an efficient IT management. This solution is distributed in an intelligent way since it handles a variety of systems (Strategic system, decision system, processing systems) and these systems can communicate through a communication

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system: EAS-COM. This one is built using Representational State Transfer (REST) web service that manages the workflow between IT GRC platform components. Multi-agents system technology is used to perform tasks within EAS-COM system before delivering result as web services.

Therefore, in our proposed architecture we will combine these two technologies (web service and multi-agent system technology) for communication system within the distributed IT GRC platform.

Motivations: Workflow management became an important aspect of distributed systems implementation. Therefore, integration and communication between those systems will be interrupted. In addition, information technology should have ability to work with each other. Distributed systems don't need to know the details of each work but they need to have enough common ground to exchanger messages without error or misunderstanding in this study, we propose communication system architecture which assure services or messages exchange between heterogeneous and distributed IT GRC platform.

Recently, researchers have shown an increased interest to develop new functional architectures capable of providing adaptable and compatible systems, allowing access to services and applications. Various workflow management technologies are often used as the communication infrastructure for distributed system to ensure flexibility and adaptability especially for achieving higher levels of interactions. The motivation for this research is to investigate:

- How to develop a flexible and autonomous communication system for the distributed IT GRC platform that can support multi-type of message between its components
- How to adopt communication architecture based on message passing mode with multi-agent systems and web service technologies for an intelligent, flexible web solution
- How to develop an automated multi-agent system for message translation and communication across distributed web platform

Research problem: There are many ongoing research works on constructing of IT GRC solution. Most of studies are problem specific to propose a framework which make sure that business needs leads to adequate business decisions and don't achieve the processing level in other side IT GRC platform is a distributed solution which integrate several systems (strategic, decision and processing systems). From this idea, the use of a separate system which must ensure communication and workflows between these components is becoming an important need. As a result, we strongly believe that more research study is needed in this area to support this complex system architecture.

Literature review: Multi-agent system technology is one of well-known technologies for distributed systems communication (Battle and Benson, 2008). IT also include some of significant attributes such as autonomous, adaptive interactive, support multi-protocol and lightweight implementation of atomic reaction. At the same time, the REST web services approach is an approach for using REST as a communication technology to manage workflows between components of a distributed system (Kao and Chen, 2010). Therefore, in our proposed communication workflow we will combine these two technologies.

Many research studies have been found in literature regarding the enhancement of agent technology in distributed system communication. Several research works have been conducted to solve different issues of communication such as reliable asynchronous of communication and form-based agent communication language the attributes used in the evaluation were essentially selected from generic specification requirement for distributed systems communication. Attributes selected can be summarized as follow:

- Communication type
- Availability of application to process other requests
- Autonomous aspect
- Message type: ACL, REST, JSON, XML, SOAP

Scalability: Ability to handle number of requests M. Purvis, S. Cranefieles, G. Bush and D. Carter (Chusho and Fujiwara, 2000) describe framework for building distributed information systems from available resources, based on software agent and distributed technologies. Q. Fengard and Lu (Shafiq *et al*., 2006) have tried to Agent Communication Language (ACL) to implement communications between PABADIS agents.

In outer to fulfill with the final part of project in which grasshopper is used as agent developing platform, FIPA ACL is adopted. Chusho and Fujiwara (2000) describe a multi-agent frame work and an Agent Communication Language (ACL) for the MOON (Multi-agent-oriented office network) systems which are distributed systems of e. Commerce. The multi-agent framework is a java application framework and includes a From-based ACL

(FACL) as common protocol for passing application forms. Shafiq propose a gateway that allows interoperability between web services and multi-agent systems. This gateway is an agent that integrates Foundation for Intelligent Physical Agent (FIPA) and the world wide Web Consortium (W3C) specifications, translating Agent Communication Language (ACL), SOAP (Cerami, 2002) and WSDL messages and web services LI *et al*. (2004) propose a similar approach but focus on the representation of services. They use SOAP and WSDL messages to interact with agents. Liu proposes multi agent architecture to develop inter-enterprise cooperation systems using SOA and web services components and communication protocols.

Although, these developments provide an adequate background for developing distributed multi agent systems integrating a service-oriented approach most of them are in early stage of development so it is not possible to actually know their potential in real scenarios. In addition, EAS-COM not only provides communication and integration between distributed agents, services and applications but also provides a new method to facilitate the development of distributed multi agent systems by means of modeling the functionalities of the agents and the systems as services.

MATERIALS AND METHODS

Before presenting the detailed communication system architecture we should locate it within the global IT GRC platform. This latter solution aims to combine IT GRC frameworks in an intelligent manner to take the right IT decision for business directives (Elhasnaoui *et al*., 2013; Iguer *et al*., 2014). It focuses on business objectives and proposes the best solution for an efficient IT management. IT GRC platform is composed of four principle layers.

Strategic layer: Based on COBIT framework; ensuring permanent alignment of IT and business with stakeholder's participation. The output of this layer is the proposition of IT processes that must be managed.

Decision layer: Assures the choice of the best framework for each IT process and adds a decision-making aspect on every platform of the layer processing.

Processing layer: This layer is composed of different systems which can be implemented; each of these systems relies on a precise IT framework for managing IT processes defined by the strategy layer.

Communication layer: It is responsible for all communications between layers of the IT GRC platform. It is a distributed system which is composed of three sub-system that ensures all communication between strategic, decision and processing layers.

EAS-COM: A communication system based on multi-agent system and web services for IT GRC platform: EAS-COM is a communication system which facilitates the integration of multi-agent systems and distributed applications. IT GRC distributed platform. This system must be dynamic, flexible, robust, adaptable to each demand request, scalable and easy to use and maintain. However this architecture is extensible to integrate processing system desired with no dependency on any specific programing language. Integrated system in IT GRC platform has to follow a communication protocol that must incorporate. Another important functionality is that, thanks to the agents capabilities, the systems developed can make use of learning techniques to handle previous decision making in knowledge bases which can change dynamically over time, EAS-COM proposes a new perspective where multi-agent systems and web services are integrated to provide communications requirements and to take advantage of their strengths and avoid their weakness. Next the structure of EAS-COM is described. As can be seen in Fig. 1, EAS-COM system defines three blocs; strategic-com, decision-com and processing-com. These blocs provide all the functionalities of the architecture.

Strategic-com: This sub-system interacts with EAS-strategic. It receives IT services associated with their information (user initiator of business request, date of creation, the processes list that includes the IT service and their priorities). These IT services will be collected, categorized by IT discipline (Governance, risk and compliance) and associated with adequate frameworks proposed. One categorization is completed, a matrix of IT services is constructed to be sent to EAS-Decision (Decision layer).

Decision-com: It insures the reception of the best choice made by decision layer, register the decision and forward it to processing-com (Fig. 2).

Processing-com: This sub-system integrates a set of agents, each one with special characteristics and behavior. It receives the IT service decided, analyzes each process with its associated framework and choose the adequate processing-system chosen which must start treatment of IT processes and send back processing

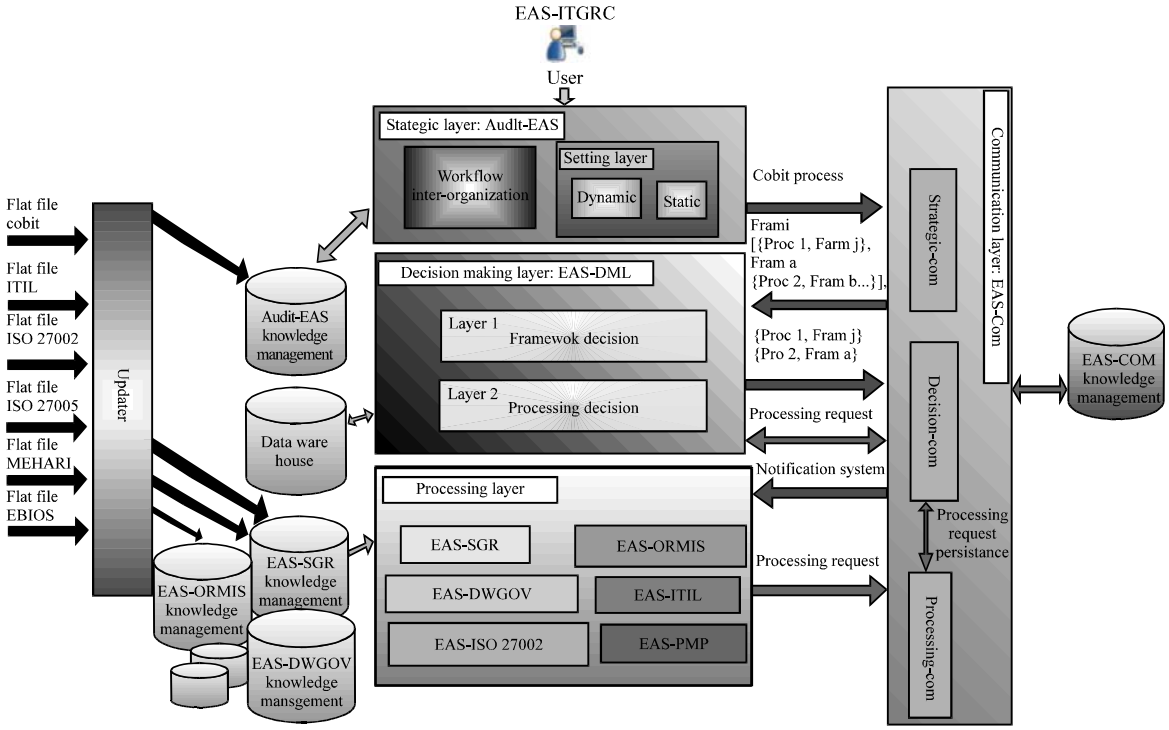

Fig. 1: IT GRC solution: architecture view

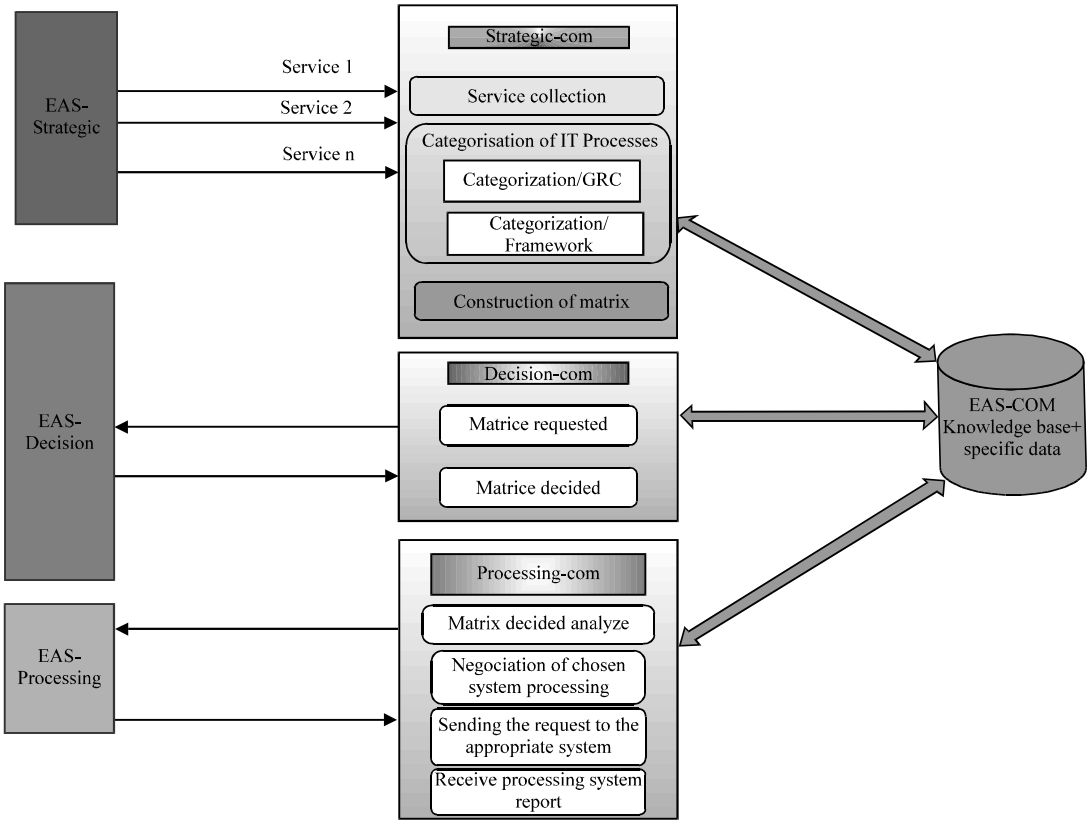

Fig. 2: The architecture of EAS-COM

report. Most of current discussions in distributed system in communication system as an interoperate application because of its properties in time savings. Even though web services over SAOP are the most used as communications mechanism for SOA, other communication techniques are used such as REST and messaging services (Aihkisalo and Paaso, 2012).

Nevertheless, organization cannot truly take advantage of an application's business benefits without a well-integrated and communicate of distributed software infrastructure. EAS-COM enables this integration,approaching IT GRC platform's system out to distributed environment and release the domain-specific value of each IT GRC platform's systems.

One of the main techniques used to solve integration problems between distributed systems is message passing. It is one of two categories of communication modes (Sharing information, message passing) that provide program to program connection. Requirements adopted for EAS-COM system to manage communication for ITGRC platform as a distributed systems are described as following:

- Communication type which is based on message passing mode
- Availability of application to others systems of IT GRC platform3) Autonomous level refers to the intelligent level of application to manage and implement the request of other applications
- Message type which means the type of message that is used in communication such ACL and REST
- Scalability which is the ability to handle number of requests

In EAS-COM architecture, three sub systems (Strategic-com, Decision-com and Processing-com) will be two way interaction and agents included will use the standard messaging proposed by FIPA which is ACL, each agent will analyze each message priorities and which action should be taken. For example strategic-com sub system will receive a service web (IT service) from strategic layer and the data collection agent will analyze the message received and translate it to ACL in order to send it to manager agent using the same language (ACL) (Shoham, 1992). To gain a deeper understanding of the proposed architecture we describe each sub system of the EAS-COM solution (Fig. 3).

Logical diagram presenting communication workflow and interaction with strategic layer and decision layer; strategic-com: It manages the incoming IT processes from strategic layer to be managed by manager agent.

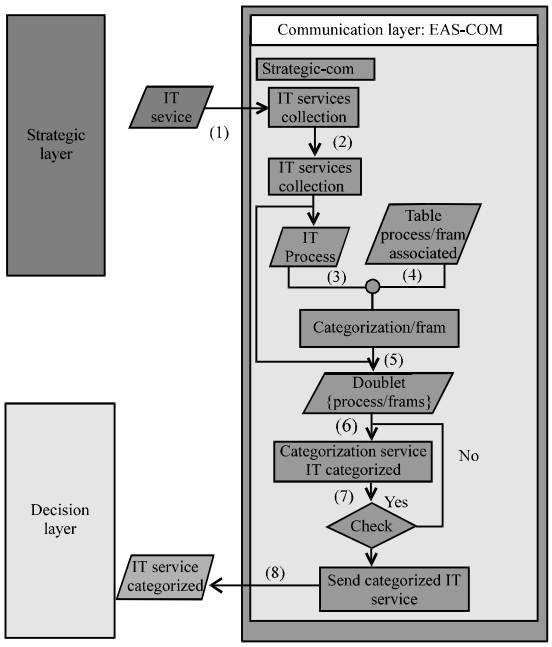

Fig 3: EAS-COM architecture based on message passing interacting with strategic layer and decision layer; 1) EAS-strategic→EAS-COM→service IT [Id service, user, date {idProc, nomProc, priotity}], json/HTTP; 2) Data collection agent→manager agent,*service IT [idProc, nomProc, priotityProc1], [idProc2...],*service IT [id service, user, date, idProc 2, nomProc 2, priorityProc 1]* FIPA ACI; 3) *Service IT [idservice, user, date, idProc, nomProc, priotityProc1],*service IT [id service, user, date, idProc 2, nomProc 2, priorityProc 2], *FIPA ACI; 4) *[Proc, fram1, fram2, ..., framn], *SQL request; 5) *[Proc1, {fram1, fram2, ...,}], [Proc2, framiii...]; 6) *[Service IT {id service, user, date, idProc 1, nomProc 1}], [{frami, framii,...}, priority Proc1], *service IT [id service, user, date, [idProc 2, nomProc 2, framiii...] priorityProc 2]...; 7) *Manager agent→Matrix building agent,*service IT {id service1, user, date, idProc 1, nomProc 1}, [Refi, Refii, Refiii], [priorityProc1], [idProc 2...], *FIPA ACI; 8) *Service IT [id service1, user, date, [idProc1, nomProc1], [frami, framii, framiii], priority proc2, [idProc2...]*Service IT [id service, user, date, {idProc 1, nomProc 1], [frami, framii, framiii], [priority proc2]... json

Data collection agent: Receive requests from EAS strategy and must send them to manager agent by ACL message, according to priority/arrival.

Manager agent: Constitutes a main component of IT GRC.

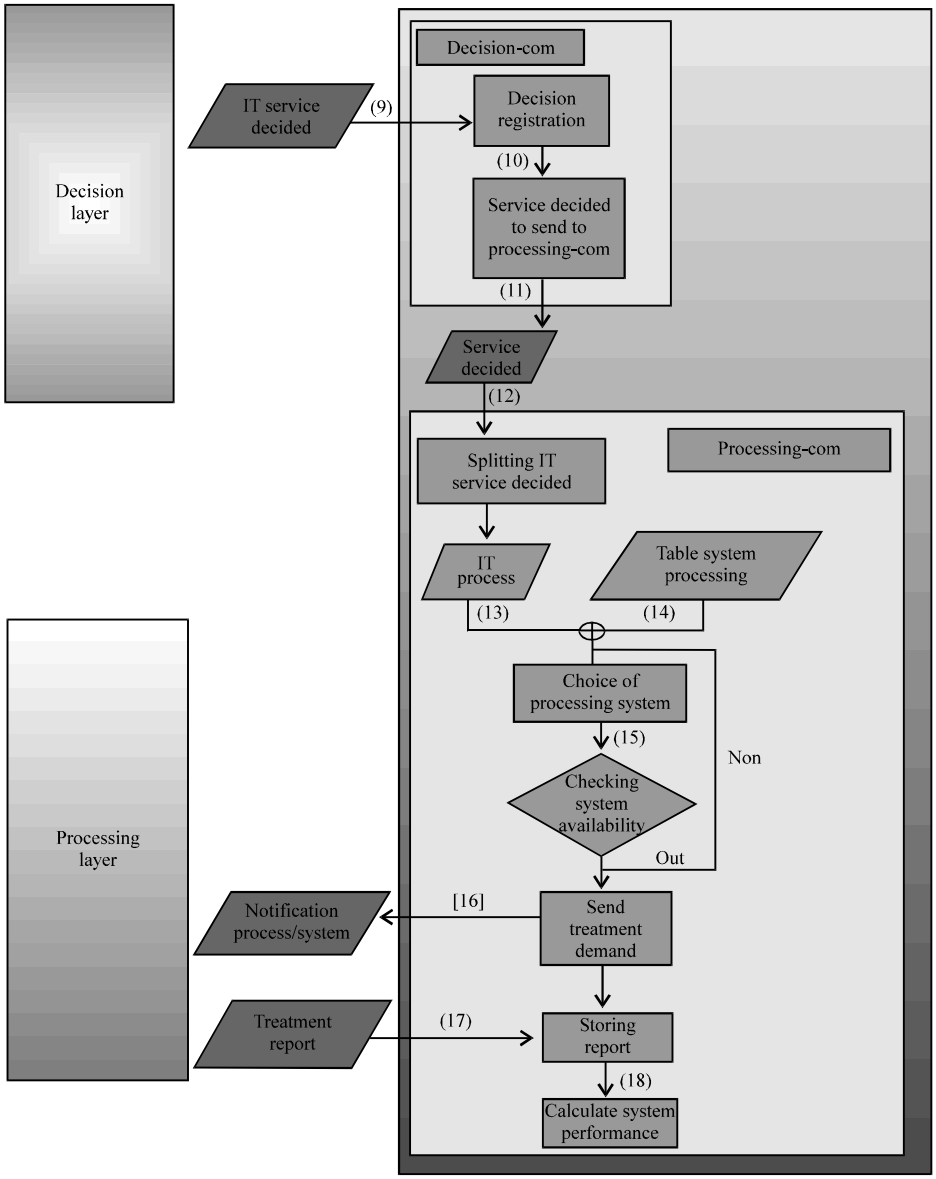

Fig. 4: EAS-COM architecture based on message passing interacting with decision layer and processing layer; 9) *EAS-DML→EAS-COM, *serviceIT decided [id Service, user, date], [id Proc, nomProc, best frami], *json/HTTP; 10) *DD Agent→DP Agent, *service IT decided, *FIPA ACI; 11) *DP Agent→Agent ComIn, *serviceIT decided, /FIPA ACI; 13) *[Proc1, {sys1, sys2}, {Proc2, sys3,..}]; 14) Agent ComIn→Admin Agent *[Proc1 {sys1, sys2...}], *SQL request; 15) *Admin Agent→Agent ComOut, *service IT (id service, user, date), [id Proc1, nomProc1, sys1], *service IT (id service, user, date), [id Proc2, nomProc2, sys2] *FIPA ACI; 16) *Agent ComOut→EAS processing, *service IT(id service, user, date), [id Proc1, nomProc1, nomsys, idProc2], *json; 17) *EAS processing→EAS-COM, *processing report link, *json; 18) *Agent ComOut→Agent directory, *Time of response, *FIPAACI

Categorization system: It allows categorizing the processes received according to three disciplines of IT GRC (IT governance: ITIL, ISO/IEC 27002, PMBOK, CMMI, IT Risk: EBIOS, MEHARI, ISO/IEC 27005, IT Compliance: SOX or 08:09 laws).

It reads queries sent by the data collection agent and associate each IT processes belonging to a discipline of IT GRC and later to one or more IT frameworks. When it finishes categorization, it sends the result to building matrix agent (Fig. 4).

Building matrix agent: It retrieves the result of categorization and constructs the matrix of IT service as following:

$$\left[\left\{\text{Proc1}, \frac{\text{Fram i}}{\text{Fram j}}\right\}\right], \left[\left\{\text{proc 2}, \frac{\text{Fram a}}{\text{Fram b}} \ldots.\right\}\right]$$

Logical diagram presenting communication workflow and interaction with strategic layer and decision layer

Desicion-com: This system provides communication with the decision making layer. It is composed of two agents.

Agent d: Receive the categorized service IT sent by building matrix agent and send it to decision layer. The web service is sent using JSON as data format.

Agent d: This agent receives the result of the decision from decision layer and forwards it to agent Com-in of processing-com system.

Processing-com: This system allows managing communications that are related to processing layer.

Agent com-in: Accesses the second level to read the result of the decision.

Admin agent: Retrieves this result and negotiate to choose processing system that will handle each IT process the matrix.

Agent com-out: Send processing demand to adequate processing system.

Directory agent: Receives the result of processing and saves it in database.

Supervisor agent: It calculates the performance of the processing system. The calculation result will be recorded.

RESULTS AND DISCUSSION

In EAS-COM, each system included in IT GRC platform (Strategic system, decision system and processing systems) sends web service that can be taken into consideration by the components of EAS-COM using JSON as data format interactions between agents of the system are based on message passing communication mode using ACL (Fig. 5).

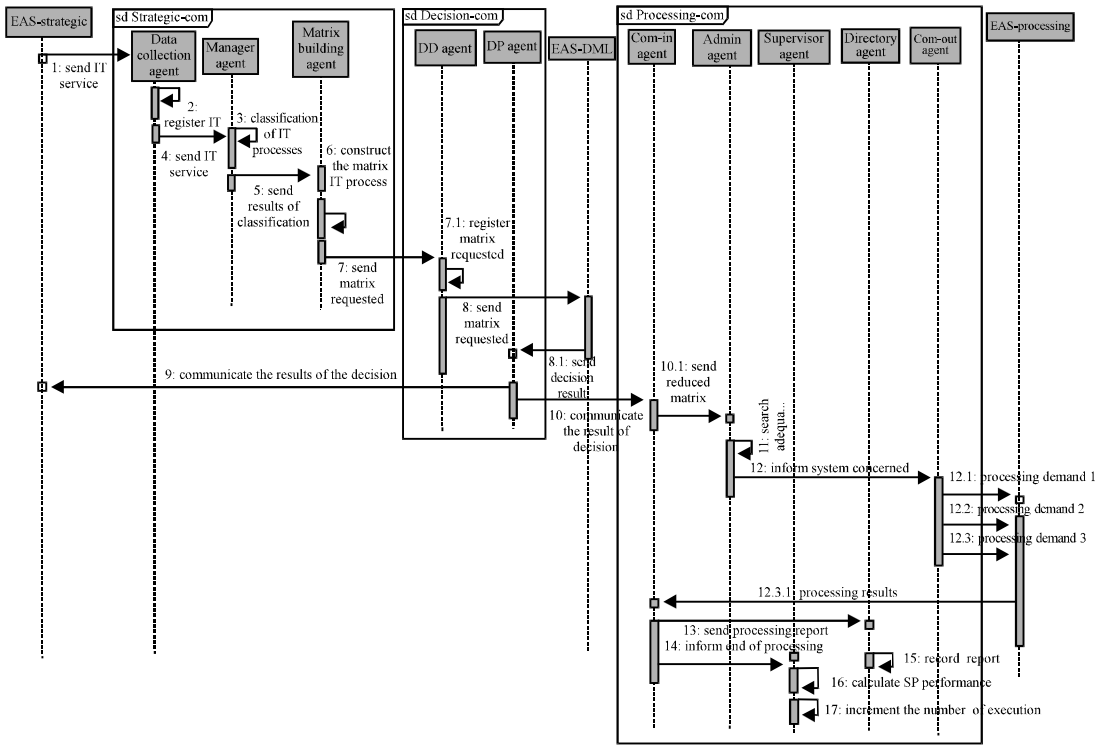

Fig. 5: EAS-COM activities

Fig. 6: EAS-COM receives an IT service from strategic layer and sends a categorized IT service to decision layer

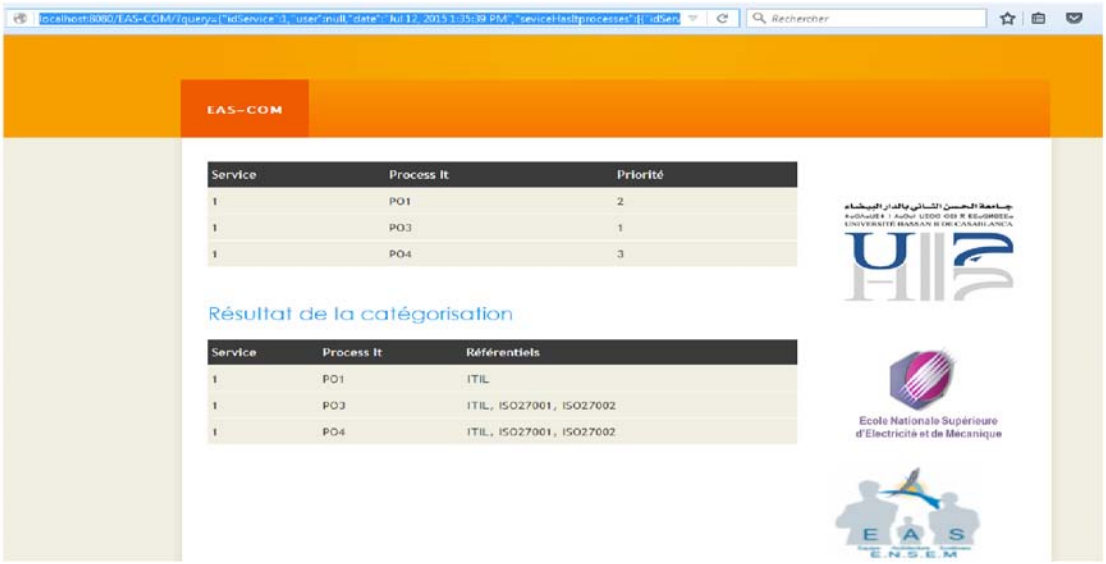

Fig. 7: EAS-COM receives the IT service decided from decision layer and forwards it to processing-com sub system

Every sub-system of EAS-COM has an agent who translate the web service received from each layer to be processed and an agent which translate the ACL message to a web service in order to be interpreted by IT GRC platform's systems.

Figure 5 show a detailed description of EAS-COM's agent's interaction EAS-COM has the objective to establish a powerful communication system between components of IT GRC solution which can multiply their capability and effectiveness.

The proposed architecture is composed of three sub system ensures all communication with strategic, decision and processing layers where agents involved in these systems can communicate in a distributed way thanks message passing mode. Figure 6-8 show the implementations of the proposed architecture which allows validating the proposal. They show the reception of the IT service with an HTTP request and the treatment occurred once it is received.

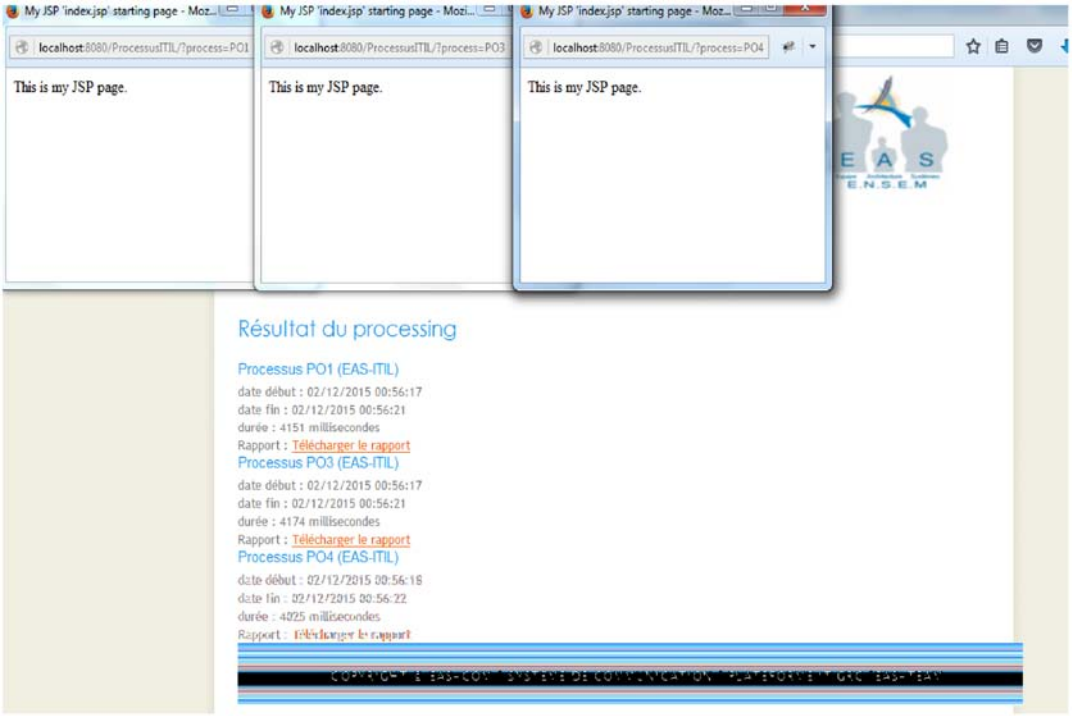

Fig 8: EAS-COM sends processing demands to concerned processing systems and receives report from each one

Processing when the systems receive requests for treatment, they are automatically launched according to their priorities. Once they finish their treatments, they send the link to the report EAS-COM and it proceeds to calculate the system performance and to increment the number of his execution.

EAS-COM system provides the necessary information for the seamless communication and execution of IT GRC platform's systems (Strategic system, decision system and processing systems) to respond to user's request across the distributed IT GRC platform to ensure that the request is fulfilled. EAS-COM architecture has been adopted from a service oriented perspective with a high degree of automation that supports flexible collaborations between IT GRC platform's components.

CONCLUSION

In this study, we illustrated the design of our architecture EAS-COM which has the objective to establish a powerful communication system between components of IT GRC solution which can multiply their capability and effectiveness. The proposed architecture is composed of three sub system ensures all communication with strategic, decision and processing layers where agents involved in these systems can communicate in a distributed way thanks message passing mode. This research is important because of the infinite possibility that it gives to IT GRC solution in order to comply with IT GRC management. In this study, we discussed the general proposed solution. Then, we detailed the EAS-COM architecture and the workflow of procedures from end to end. This particularity of our approach is to use passing message communication mode that add the uniquely intelligence to our application. The advantage of this communication mode is that little information is lost and there is the opportunity to correct the error very quickly. In addition, the combination of a several standards, frameworks and methods, internationally recognized and multi-agents systems provides the ability to achieve the governance of information system and manage risks and compliance activities on an all-encompassing perspective of IT GRC.

RECOMMENDATIONS

Future research consists on proposing a communication architecture based hybrid mode (message passing and sharing information) between agents of the system in order to compare the both proposition and implementing the best proposed model in order to overcomes obstacles and achieve IT organization objectives.

REFERENCES

Aihkisalo, T. and T. Paaso, 2012. Latencies of service invocation and processing of the REST and SOAP web service interfaces. Proceedings of the 2012 IEEE 8th Conference on World Congress on Services, June 24-29, 2012, IEEE, Oulu, Finland, ISBN:978-1-4673-3053-4, pp: 100-107.

Battle, R. and E. Benson, 2008. Bridging the semantic Web and Web 2.0 with Representational State Transfer (REST). Web Semant. Sci. Serv. Agents World Wide Web, 6: 61-69.

Cerami, E., 2002. Web Services Essentials Distributed Applications with XML-RPC. 1st Edn., Reilly &Associates, Massachusetts.

Chusho, T. and K. Fujiwara, 2000. A Formbased Agent Communication Language for Enduser-Initiative Agent-Based Application Development. IEEE, New York, USA.

Elhasnaoui, S., H. Medromi and A. Sayouti, 2013. Multi-agents modeling platform for IT governance based on ITIL. Proceedings of the 2nd International Conference on Digital Telecommunication, July 1-5, 2013, University of Western Sydney, Marrakesh, Morocco, pp: 1-22.

Hardy, G., 2006. Using IT governance and COBIT to deliver value with IT and respond to legal, regulatory and compliance challenges. Inf. Secur. Tech. Rep., 11: 55-61.

Iguer, H., H. Medromi, A. Sayouti, S. Elhasnaoui and S. Faris, 2014. The impact of cyber security issues on businesses and governments: A framework for implementing a cyber security plan. Proceedings of the 2014 International Conference on Future Internet of Things and Cloud (FiCloud), August 27-29, 2014, IEEE, Casablanca, Morocco, ISBN:978-1-4799-4357-9, pp: 316-321.

Kao, Y.C. and M.S. Chen, 2010. An Agent-Based Distributed Smart Machine Tool Service System, in 3CA 2010. In: A Message Oriented Middleware Solution Enabling Non-repudiation Evidence Generation for Reliable Web Services, Parkin, S., D. Ingham and A.G. Morgan (Eds.). Springer, Berlin, Germany, pp: 9-19.

Kooper, M.N., R. Maes and E.R. Lindgreen, 2011. On the governance of information: Introducing a new concept of governance to support the management of information. Intl. J. Inf. Manage., 31: 195-200.

LI, Y., W. Shen and H. Ghenniwa, 2004. Agent-based web services framework and development environment. Comput. Intell., 20: 678-692.

Oliveira, P., D.N.F. Silva and M.M.D. Silva, 2010. A Process for Estimating the Value of Itil Implementations. In: Enterprise Information Systems Design, Implementation and Management: Organizational Applications, Pedro, O., N.F.D. Silva, M.M.M. Silva (Eds.). Springer, Berlin, Germany, Pages: 396.

Racz, N., E. Weippl and A. Seufert, 2010. A process model for integrated IT governance, risk and compliance management. Proceedings of the Ninth International Baltic Conference on Databases and Information Systems, July 5-7, 2010, University of Latvia Press, Riga, Latvia, ISBN: 978-1-60750-687-4, pp: 155-170.

Shafiq, M.O., Y. Ding and D. Fensel, 2006. Bridging multi agent systems and web services: Towards interoperability between software agents and semantic web services. Proceedings of the 2006 10th IEEE International Conference on Enterprise Distributed Object Computing (EDOC'06), October 16-20, 2006, IEEE, Austria, ISBN:0-7695-2558-X, pp: 85-96.

Shoham, Y., 1992. Agent-oriented programming. Artif. Intel., 60: 51-92.