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Intelligent IT Governance Platform: Strategic level

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Abstract— *The objective of this work is the implementation of a new IT governance platform adaptable to any type of Information system architecture and any kind of business. The proposed platform is intelligent and independent to understand the business needs continuously changing, is distributed to involve all stakeholders and heterogeneous components, and scalable to accumulate the know-how of the company's IT Governance through a learning asset.*

Keywords—Inter-organizational Workflow, Information System, IT Governance, Multi-Agent System, Ontology, Semantic Web.

I. INTRODUCTION

Information systems (IS) have known exponential growth both in terms of architectural complexity and in terms of data processed size. The history of the discipline is more than 30 years during which IS issues' varied from modeling and development concerns of the technical solution to management challenge. Indeed, in the early 80s, the information system was a computer application for which was interested in development methodology and techniques used [10], later we attached importance to the theory of production with cumulative restatement of issues order (references, work techniques, assembling knowledge ... etc.). From the 90s case studies about Information systems took place [10] to focus on the weaknesses and strengths of each type and the operations supported and development. A variety of research topic has opened in the years after, namely the appearance of organization management, collaborative aspect, the use of internet and new technologies adaptation in general.

To this end, companies have adopted solutions such as the use of ERP, outsourcing [9] or even Information System redesign and development project with advanced technology. The results were not always positive:

• Outsourcing: Sustainable and high costs, non-strategic and managerial decisions and contract cancellation serious consequences. [17]

ERP: exceeding the time and cost of implementation, impact on work procedures, change for end users.

• IS redesigned with new technologies such as services oriented architectures a reflection on all the company's services is essential correlation with the return on investment.

A constructive and thorough study of Top Management in collaboration with the Information Systems Department and its potential users is needed, not only before the project but throughout the production of IS. This is called «Information Systems Governance."

Experts in this field have implemented born repositories for collecting good practices and their generalization such as COBIT, ITIL, CMMI, and ISO27001 ... etc. These standards are designed to align the governance of information systems through a set of guidelines that serve as benchmarks to business processes. Measuring scales are also defined for the listeners to evaluate the IS maturity. However these frameworks are extensive documentation that requires an implementation and realization on the part of managers and crafts.

We present in this paper IS governance platform to realize continuously and intelligently best practices implementation for a IS of any type and any size.

The solution is based on:

- Inter-organization Workflow with multi-agent systems to interconnect the various components of the SI,
- Mediation Expert System between real businesses needs and references.
- Semantic Engine to interpret the different demands of users to an IT Governance jargon.

The article is structured as following: After the introduction we talk about IT Governance (ITG) implementation problems after that we present a state of art of Multi-Agent system, Inter-organizational workflows and semantic web, in the fourth part we present the proposed architecture and its components description. We finally present perspectives and conclusion.

IT Governance implementation problem

Information System (IS) main mission is the treatment of business activity through information technology and verification of their compliance with its business and its needs.

To check the alignment of the IS and business strategy, we must have recourse to IT Governance (GSI). In practical terms, the answer to these questions is via standards that address monitoring standards such as

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COBIT and COSO and implementation of good practices such as ITIL and CMMI.

There are many other IT Governance frameworks

COBIT (Control Objectives for Information and related Technology Business), developed in 1994 (published in 1996) by ISACA (The Information System Audit and Control Association) is an IT governance tool that has been designed for the control objectives of information technology. It's a framework of information systems governance that breaks any IS on 34 processes, which are divided into four functional areas:

- ✓ Planning and Organization) (10 processes).
- ✓ Acquire and Implement) (7 processes).
- ✓ Deliver and Support) (13 processes).
- ✓ Monitor (4 processes).

These four areas can cover 318 goals.

Table.1:The most used IT GRC platforms

SOLUTION	ADVANTAGES
Agiliance RiskVision	Governance Management and Analysis financial services Public-health,
TruComply	Automating Governance business processes
ControlCase GRC	GRC Asset Management Vulnerability analysis
Easy2Comply	GRC Engine risk for analyzes complex statistics
Modulo Risk Manager NG	Improving the overall governance of the company. public sector Company Financials
RSA Archer eGRC Platform	GRC Gestion de contenu, Gestion des risques Contrôle, de workflow de gestion
Rsam	assistance and tools (predisposed for industries)
Symantec Control Compliance Suite (CCS)	GRC Management and Analysis, Risk quantification methods based on data (levels of vulnerability, criticality of assets and control functions)

Table.2: IT GRC solutions advantages

Editor	Solution name	Version
Agiliance	Agiliance RiskVision V6.0	V 6.0
ANXeBusiness	ControlCase GRC V4.0	V4.0
ControlCase	TruComply V6	V6
Easy2Comply	Easy2Comply V 4.7.5	V4.7.5
Modulo	Modulo Risk Manager NG	V7.2
RSA Archer	RSA Archer eGRC Platform V 5.0.6	V5.0.6
Rsam	Rsam V 7.2	V7.2
Symantec	Symantec Control Compliance Suite (CCS) V 10.5	V10.5

However there frameworks aren't the only need, there is always a problem of the ITG implementation, which depends on several factors including: organizational culture and structure, strategy, size, regional differences, maturity, ethics and trust.

For this reason, big software editors have marketed Governance solutions for businesses: The most common Governance solutions in the market are [6]:

We carried out the following comparison:

A linear reading of this test and the measurement of the effectiveness of these solutions relative to IT Governance (ITG) dependency factors can deduce that:

- The solutions marketed by major publishers show a discrepancy in relation to the implementation of the ITG in SI of various companies (size, turnover, type, maturity, location etc ...)
- The majority of these solutions are ERP modules working only with the rest of the suite.
- High Cost of implementation with a risk of inefficiency
- .Need for external advice.
- They do not concern all IS stakeholders and all areas of the business at a time.

To remedy these limitations and to address the lack of architecture with theoretical basis we proposed this work.

The proposed architecture is based on many theoretical foundations: Inter-organizational Workflows, Multi-agent systems [8]. and semantic web.

II. STAT OF ART

A. Multi-Agent System

There is no unified definition of an Agent but the closest to our vision is: An agent is an autonomous real or abstract entity that is capable of acting on itself and its environment, which, in a multi-agent world, can communicate with other agents, and whose behavior is the

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result of observations, knowledge and interactions with other agents [2].

In this case, not only one agent is used but a set of agents witch interact among each other that are called Multi-agent system (MAS).

MAS is characterized by:

- ✓ Every agent in the system has his own knowledge and way to resolve problems.
- ✓ There is no global control of an MAS,
- ✓ The Data in MAS is decentralized.

As for MAS Communication is a particular form of action that affects the mental representations of agents to make changes in the environment. It must also be modeled as an act that could affect the status of other agents.

There are two kinds of Communication procedures:

- ✓ Information sharing: it is historically the first model, where shared memory is seen as a table on which agents write and find partial answers and information.
- ✓ Sending messages: proposed by Hewitt [5] actor model defining an actor as an active and autonomous entity that has a partial view of the universe.

This actor is characterized by: acquaintances and behavior described by a script (set of methods that indicate the various actions that can accomplish this actor in response to the messages it receives).

B. *Inter-organizational Workflow*

A workflow in general is the total or partial automation of business process execution, during which documents, information tasks from one participant to another to perform specific activities according to predefined rules.

There are many kinds of workflows [3] namely:

•**Administration Workflow**: devoted to manage administrative procedures whose rules of conducts are established and known by everyone in the company.

•**Production Workflow**: devoted to manage the production process in the company.

•Collaboration Workflow: devoted to manage awareness and group collaboration in a project of creative work

•**Ad-hoc Workflow**: is a class of workflows for specific situations where the flow logic to be followed is set during execution. It forms a hybrid solution collecting characteristics administration, production, and collaboration

The interested on these kinds of Workflow will find in the references more details about them the advantages and drawbacks of every one.

•**Inter-organizational Workflow (IOW):** is an extension of the classical Workflow aiming at cooperating between heterogeneous and autonomous organizations. It is the reason why we choose it as a workflow model for this IT Governance solution.

B. Multi-agents systems

Multi-agent systems are widely used for modeling coordination system [8]. It seems to be appropriate to describe the coordination of IOW as a dynamic system aiming at finding "supply and demand service" and adopting the negotiation between partners. In fact, agent technology is a custom frame for IOW abstraction: it resolves its constraint of distribution, heterogeneity, autonomy and flexibility:

- Autonomy: every organization of the IOW can be encapsulated in an Agent an autonomous entity having its intentions goals and resources and able to be executed alone or in an environment, depending on the context.
- Distribution: IOW is a distributed context and MAS includes specific architecture, communication protocols and languages to support this constraint.
- Heterogeneity: Agent technology allows communication and interaction between heterogonous agents through Agent-Communication-Languages (ACL).

It also provides synchronous and asynchronous ways of communication depending on the agent localization and constraints.

MAS offer many Meta-Models to cover the organizational aspect of Workflow. It also covers the scalability and security worries in loose IOW context.

As for the semantic Web which is the collaborative movement of W3C providing a model that allows data to be shared and reused across applications, enterprises and groups of users It helps to represent shared business terminology of the IOW in a formal way to solve semantic conflicts in the one hand and to define properly services (supply and demand) in the other hand [2]

The best representation of semantic web on MAS context is the use of ontology recognized in communication protocol of agents.

C. Semantic Web and Ontologies

Ontology is a semantic source which includes or implies a certain view of the world with respect to a given domain; this view is often designed as a set of concepts such as entities, attributes, processes…etc.

It can take different forms but it necessarily includes a vocabulary of terms and specification of their meaning.

As for Ontology types, there namely five:

- **Task ontology**: vocabulary linked to special task or activity. Method ontology: the role played by each concept in the argument is made explicit.
- **Application ontology or task and domain ontology:** write concepts depending on both of a domain and a particular task, which are often two specializations of the related Ontologies.
- **Generic ontology**: describe very general concepts such as space, time, matter, objects, events, actions, etc., which are independent of a problem or a particular area of application.

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- **Domain ontology**: vocabulary linked to a generic domain by specifying the concepts presented in Generic ontology: electronic, automobile.

PROPOSED ARCHITECTURE

A. . Introduction

Faced to a competitive market continuously changing IT solutions, and information systems are made of heterogeneous components with various information flows and processes increasingly complex. The decision of top management in the field of IT Governance became sensitive (poor visibility) Hence the need of adequate IT governance tools.

In this perspective, this research focuses on modeling IT governance solution for enterprise with different business flow and heterogeneous partners assisting the Information system process orchestration.

B. Functionality and Benefits of the solution

The objective of this work is to propose a workflow model that encompasses IT Governance support on good practices (we opted for the COBIT) and adaptability to the complexity and changes with agile appearance, distributed and cooperative through a workflow-based on multi-agent systems (MAS).

The proposed architecture is a process oriented solution that enables:

-Strategic analysis of an information system through the Inter-organizational Workflow.

-Exploit the strengths of COBIT for Information Systems Governance namely:

→List the computer activities to implement

→Propose any previous optimization and control activities (agents Learning COBIT).

→Deduce the different levels of maturity, measures and performance indicators to be used

→Define the responsibility matrix.

→Provide adequate control tests

-Distribution, autonomy and learning through MAS.

-Semantic efficiency and portability on the web through the AuditOntology.

In addition, this solution is intended for all users of the IS for a self-audit in real time by combining the raw material of the COBIT framework and know-how of the company.

C. Generic Architecture

The architecture of the loose Inter-Organizational Workflow (IOW) of IT Governance is a solution that allows real-time governance of each IS component without consideration of its technical characteristics and its interconnection with the rest of the components. It is based on multi-agent systems and COBIT framework in version 4.1 it contains:

-IS Workflow Agents: Each agent represents an IS business application not necessarily communicate with each other

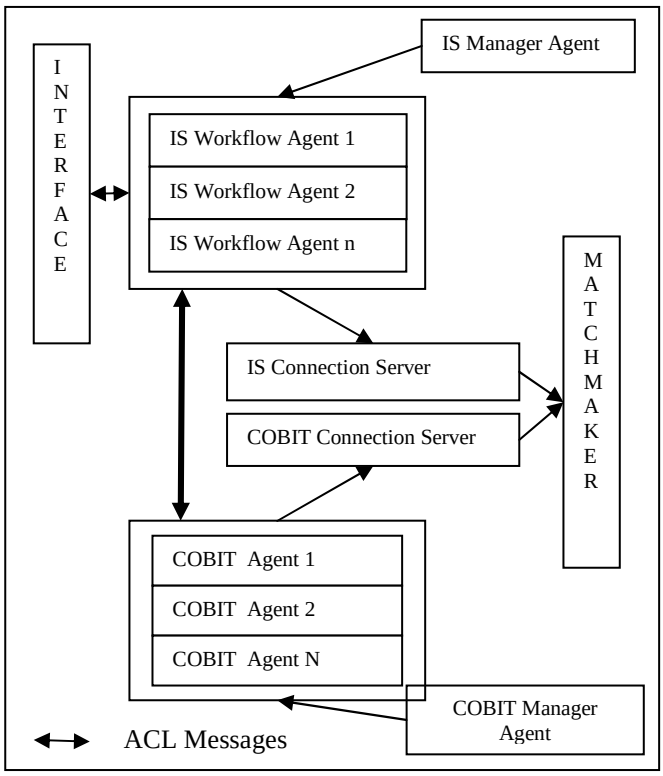

Fig.1: Generic architecture

-Business objective entity/ IT Process entity / IT goal entity: There are three classes of entities managed by COBIT Agent: Business objective entity manages a set of IT goals entities that appeal in its turn to IT processes entities.

-IS Manager Agent: the agent who managed IS Workflow agents (creation / suspension / resource sharing)

-COBIT Manager Agent: the Agent who manages COBIT Agents (creation / suspension / resource sharing)

-Connection Server Agents: Yellow Page for the publication of responses and requests respectively COBIT agents and IS Workflow Agents.

-Mediator Agent: establishes the correspondence between demand of IS Workflow Agents and supply of COBIT Agent.

D. Agents Description

D1. Matchmaker

In literature, there are mainly three types of mediator agents [3] "Matchmaker," "Broker" and "Facilitator" The difference between a "Matchmaker" and "Facilitator" is that the matchmaker allows exchanging the identities of the applicant and the supplier, then both parties communicate directly. The facilitator is an intermediate transaction. As for a "Broker" it has delegated services to the preferences of the applicant then asks the supplier of

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results and directly sends the result to the applicant. In our case, a Matchmaker agent is the best choice to connect COBIT Agent with IS Workflow Agent and information about query is exchanged directly between the two agents without a third part implication. This allows to simulate real audit operation based on user interviews and to propose practical recommendations.

So the role of the mediator is to find the best COBIT agent or agents for IS Workflow agent.

One agent to perform the platform mediation is not enough insofar as several functionalities are needed in addition to the demanded task parallelism. Indeed, we propose mediation architecture that raises three features: requests and offers persistent, semantic interpretation and requests and offers matchmaking. These three tasks in practical terms exceed the capabilities of a cognitive agent. Especially in matchmaking knowledge base consulting is required to match the best offers on demand. Hence the idea to replace the mediator agent by a mediation expert system with a semantic inference engine and the publisher is the persistence entity

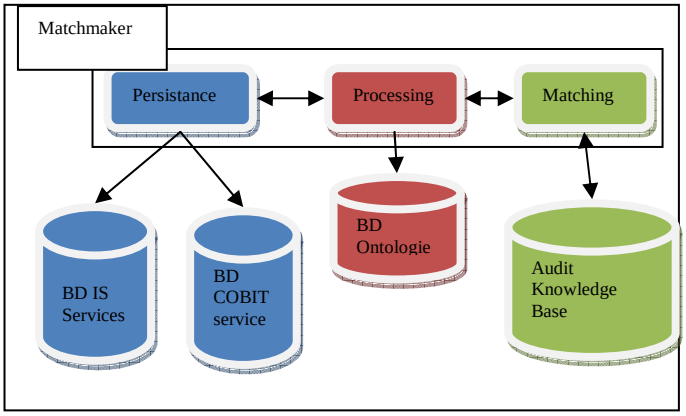

Fig.2: Matchmaker Multi-Agent System

D2. IS Workflow Agent

1. In the foregoing, the IS Workflow Agent has been described as a reactive agent which communicates with the IS component by an interface to encapsulate the request from the user and transmit it to the IS connection server. Technically this function was implemented by a direct display of the user query. The agent triggers and sends this message to the server. In the literature of interfaces agents [17], a reference structure is required to optimize the internal structure of the agent and to make its scalability possible: In fact, the agent has an input interface and an output processing, interconnected to each other with possibility of return of the output to the input:

2. An architecture of IS Workflow agent was therefore proposed based on this reference structure and adapted to its functionality in the global architecture which is the encapsulation of the IS business objectives submitted by the user about an IS component given and published in the IS Connection server .

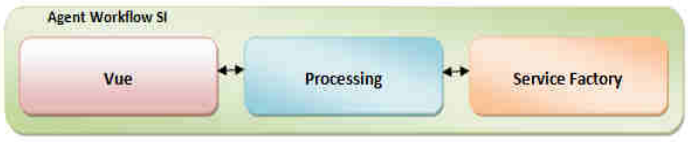

Fig.3 IS Workflow Agent Architecture

The IS Workflow Agent contains three parts:

View: it is the interface of client request expression for an IS component that is launched from the global interface when the user evokes the component in question.

Processing: it is the layer responsible for the reformulation of the customer request in the form of requests processed in the platform by capturing the different variants of the system (date, identity of the applicant, status, priority... etc.).

Service Factory: it is the layer responsible of the service creation and circulation in the platform.

D3. Agent

3. Among the advantages of the proposed architecture is based on both COBIT framework and Organization context: Although COBIT is a leading standard of IS governance, however implementation depends on the company‘s maturity to get a closer context and more efficient platform. In fact, we proposed a reference layer having a COBIT core for its power in structuring and its strengths in ITG, to which we added other business objectives, other IT processes and other metrics by updating the repository (new version of COBIT or merger with other repositories of strategic level) or creating new objectives and IT processes from the expertise of the company proposed by the information systems management. To realize this aspect, COBIT agents were replaced by Framework agents. Manager agent is replaced by MAS of 3 agents namely: -Manager Agent: the agent who manages the businesses Objective agents.

-Update Agent: the agent responsible for the framework update: we should remind that in the iteration i=0, we have COBIT framework in its version 4.1.

-Learning Agent: the agent who learns and logs demands (requests) treaties to enrich the core with IS Management addition capability of Objectives and processes.

As far as semantic matchmaking is concerned, we devoted part of the work to study IT Governance Ontologies in order to afford a performance semantic inference engine to the platform [15]. Let’s resume the important results:

There is no ontology specific to IT Governance, but many modeling works were done to computerize existing frameworks. We proposed a building model of IT Governance Ontologies based on conceptual models and by using the ontology building method “METHONOTOLGY” [15]. We applied this model to

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construct "AuditOntology" used in the 3rd version of the architecture.

The main role of this ontology is to understand users' requests in an IT Governance way. It's consumed in the matchmaker expert system to ensure correspondence between IS Business Goals and Framework Business Goals.

The architecture is service oriented: In fact, the request and response form is a service describing the particularity of the IT Governance matters such as: IT active, user, date, business goal, priority, perspective, target, action.

III. SIMULATION

A. General Presentation

As described before, the proposed architecture aims at ensuring IT Governance of a Complex Information System. It is based on three essential components namely:

1. Loose Inter-organizational Workflow of ITG
2. Matchmaking Expert system with semantic inference engine
3. IT Governance Framework Multi-Agent system

To implement this architecture we proposed a web solution multi-users linked to a knowledge base, intelligent agents are deployed to:

- Capture uses needs
- Interpret their requests to ITG understood goals
- Propose convenient IT Processes from ITG framework to users' requests.
- Update the used framework

To evaluate the platform results we compare them to ITG expert ones for the same request, since one of the main objectives of this research work is to computerize ITG audit mission.

B. Technical presentation

The proposed platform is a web solution developed in Java using the J2EE Technology with Frameworks JPA, EJB, JSF2.2 and MySQL database Management system As for multi-agent systems we used Madkit 5 API

As for semantic analysis we used the Solr server version As for ontology we used OWL-S language in the editor Protégé 4.3 and Fact ++ compiler.

As for AuditOntology development, there are many implementation steps such as entities and classes creation, objects properties and data properties creation, annotations. The compilation is done through Fact ++

As for the Semantic server to analyze the ontology used in the web application, the choice of Solr sever is due to its efficiency as far as semantic analysis is concerned it's API also supports languages specificities to deal with synonyms, tenses and linking words.

C. Functional presentation

As presented before, the platform main functionalities' are:

- ❖ Static configuration
- ❖ Dynamic request creation
- ❖ Results visualization with details
- ❖ Report edition
- ❖ System logging
- ❖ EAS IT-GRC launching

IV. CONCLUSION AND PERSPECTIVES

As conclusion the purpose of this paper is to deploy an IT Strategic platform to provide permanent and interactive Governance of Information systems.

Many literature issues were invoked namely:

- Inter-Organizational Workflows
- Multi-agent System and artificial intelligence
- Mediation Expert system
- Semantic Web and Ontologies

The choice of every issue has an added value for this solution; in fact, Inter-organization Workflows provide the orchestration of heterogeneous components of an IS in an autonomic way.

Multi-agent system insures the intelligent dimension of the solution with high level communication protocol and modeling architecture. Mediation in MAS gives a theoretical model of matching services among intelligent entities.

Ontologies offer the semantic alignment of stakeholders with IT Governance vocabulary

This paper presents the evolution of the proposed solution and also its integration to the global Architecture EAS IT-GRC

In fact, the IT Governance IOW role is not only to find the convenient Business Objectives for user demands but to find the best IT processes to launch with efficient priority order. It's why this work perspective will be the amelioration of priority calculation to get the same results as the expert's estimations.

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