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**MULTI-AGENT PLATEFORME FOR COBIT IMPLEMENTATION**

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**ABSTRACT**

This paper shows how IT-Governance can be computerized by the use of Multi-agent system and Inter-organizational Workflow (IOW). IOW aims at business process orchestration with the particularity that this processes are heterogeneous, autonomous and independent. In fact, Information System (IS) components nowadays should cooperate despite their divergence to ensure a value added services. In addition, their audit requires horizontal communication with all stakeholders as well. In this work we use COBIT as IT Governance framework. We based our approach on its process oriented aspect to evaluate a real business objective with COBIT processes by a “supply and demand” way. This article presents first an architecture of the IOW, after that, it identifies mediation problems in the IWO to match an IS business objective with COBIT processes and proposes a solution. Then it presents the simulator of IT Governance IWO and opens new perspectives.

**KEYWORDS:** Multi-Agent System, COBIT, Inter-Organizational Workflow; IT-Governance, Audit, , Information System, Business Process.

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**INTRODUCTION**

Information Technologies value is actually very important for the Enterprise as a support of its strategy business objectives. The control of IT and their good management are key elements of Enterprises Governance: Successful ones focus on IT added value and recognize their efficiency.

Consequently, the use of an IT GRC framework to well manage IT is now necessary to control the quality, fiduciary and security requirements for the information delivered the IS.

The idea of this work is to integrate IT Governance component through COBIT framework on an Information System, so as to ensure permanent control of every part of it and evaluation of its adequacy with Enterprise business strategy [1].

While modeling this solution, we have chosen Loose Inter-organizational Workflow to computerized COBIT IT Governance and Audit procedures. An IWO aims at cooperating heterogeneous and distributed business processes, coming from different organizations. In our case organizations refers to Sub-IS or IS components which are not obligatory homogenous (as for the architecture, technology, communication protocols and network disposition). In an IOW, organizations should put resources and services in common and coordinate its services so as to insure IT alignment with the business [2].

IOW coordination has two scenarios [3]: loose IOW and tight IOW. Loose Inter-Organizational Workflow refers to occasional and opportunist cooperation, free of structural constraints, where the partners involved and their number are not pre-defined. Tight Inter-Organizational Workflow refers to a structural cooperation among organizations. A structural cooperation means cooperation based on a well-established infrastructure among pre-defined partners. In this case, the organizations involved are engaged in a long-term cooperation and their workflows (business processes) are interdependent.

The “supply and demand “way we propose to match Enterprise business processes to COBIT through the IOW raises many problems, the most important in our case are:

- Services definition
- Matching partners ( Offers - Demands)
- Audit Operation Negotiation.

Indeed, services definition consists in finding the convenient hierarchy and language to express both IS business processes and COBIT processes. We will use Web Services for the interoperability of WIO Agents and the adaptability of our solution in any web context: this will be a topic of another article (Interoperability

of Loose IWO Agents in IT Governance Context through web services).

Matching partners consists on finding for every IS Business objective (launched by potential users for Audit) the convenient COBIT Business Objectives which call IT Objective to define COBIT process capable to audit the demand. In this paper we propose architecture for the mediation entity (Mediation Agent).

Audit Operation Negotiation consists on choosing the optimal negotiation protocols (between IOW agents) and exchange information to measure the maturity level of IT with business, to define responsibilities, and to propose control activities: this will be a topic of another article (negotiation ontology for Intelligent COBIT Audit).

This article is organized as follows. Section 2 gives COBIT overview as IT governance framework. Section 3 describes Multi-Agent systems then Inter-Organizational Workflow based on Multi-agent System in Section 4. Section 5 presents the organizational and functional model and architecture of the IT Governance Inter-Organizational Workflow based on AGR Model. Section 6 presents the mediation level of the global WIO with detailed architecture of the matchmaker Agent. Section 7 shows the implementation in Madkit platform. Section7 presents the conclusion and perspectives of our research

### IT GOVERNANCE AND COBIT

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.

COBIT proposes good practices about a domain and gives well manageable and well structured activities. Its practices focused more on control, less on execution. To optimize IT-enabled investments, ensure service delivery and provide a good measure to face potential risks

COBIT is 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.

COBIT presents many components for the auditors and managers. These components are interconnected as shown in figure [4].

The benefits of implementing COBIT as an IT governance framework include:

- Better alignment, based on a business focus
- Clear view to management, of IT mission
- Clear ownership and responsibilities, based on process orientation
- General acceptability with third parties and regulators
- Shared understanding amongst all stakeholders, based on a common process oriented language.

The process oriented aspect of COBIT and the Component's connection inspired us to propose Intelligent Audit Level of the loose WIO. In fact, COBIT provide an hierarchy able to be divided between Actors who can take the responsibility of giving a full image of an IS business Objective (BO). The added value of our work is the matching between real Enterprise (BO) -expressed by users and managers about IT worries- and standard (OB) proposed in the framework.

This matching is the first mission of intelligent entities of the WIO, and then an Audit operation will be launched in COBIT way.

### MULTI-AGENT SYSTEM

There is no universal definition of what an agent is, but it fits most often to Woolridge and Jennings definition [18]:

"An agent is a computer system operating in an environment, and is able to act autonomously and flexibly in this environment in order to achieve its objectives."

A multi-agent environment is a physical or virtual environment of an agent means anything external to it. There are several types of environments [19]:

- Accessible / Inaccessible: In an accessible environment, an agent can obtain comprehensive and updated information about this environment.
- Deterministic / non-deterministic: an action has a known and guaranteed effect. No doubt is possible on the consequences of this action.
- Static / Dynamic: is only changed by the actions of the agent. In contrast, the agent is not the only actor to make changes in a dynamic environment.
- Discrete / Continuous: a fixed number of shares and ended and possible perceptions.

Multi-agent system (SMA): is a set of agents located in an environment interacting as an organization [20].

### AGENT GROUP ROLE META-MODEL

Agent-Group-Role (AGR) is a Meta model of Multi-Agent-System (MAS) organization first appears in [8] and developed in [9].

According to this model an agent as an intelligent and communicating entity that can play one or more roles through membership in a group or groups without any constraints on its architecture [10].

→A group is a set of agents with common characteristics, used as a business model. Two agents can communicate only if they belong to the same group.

→A role is an abstract representation of the activity of an agent in a group, it can be played by several agents, it is specific to each group and it is requested by the agent who wants to play it.

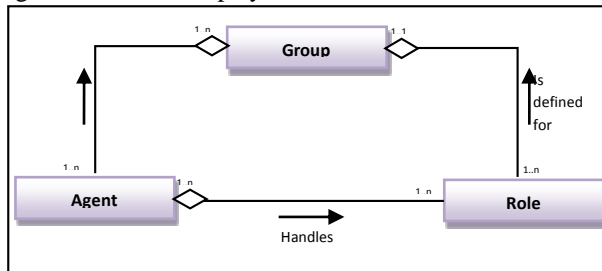


Fig1. UML Diagram of AGR model

AGR Meta-Model is well adapted to IOW, and it presents many advantages in addition of the optimized structure of the MAS. It's synchronized with any type of agent and it imposes no constraint on the global architecture.

It's why we based the organizational model of our IOW on AGR meta-model.

### INTER-ORGANIZATIONAL WORKFLOW USES IN INFORMATION SYSTEMS

Inter-Organizational Workflow is a technology helping Enterprise to fulfill complex worldwide market to which they participate. IOW provide the capability of many organizations to put in common their business processes in order to produce a new service.

IOW can be investigating in two scenarios [3]:

-Loose IOW (dynamic context): occasional and opportunist cooperation, without structural constraints, where the partners involved and their number are not pre-defined,

-Tight IWO (static context): structural cooperation among organizations with a well-established infrastructure among pre-defined partners. Involved organizations, in this case are engaged in a long-term cooperation and their workflows (business processes) are interdependent.

In this article, the Loose IOW is chosen since we deal with IS components which are heterogeneous and not obligatory interdependent.

An inter-organizational workflow processes two kinds of problems:

- The local problem concerns each Workflow Management System (WFMS) of the IOW,
- The global problem concerns the global WFMS.

The IOW raised several constraints about the local and global problems namely:

- ✓ Heterogeneity of Workflow Management System development platforms,
- ✓ Autonomy of participating organizations,
- ✓ Flexibility of tasks,
- ✓ Process distribution implementation;

In addition to that, dynamic context of an IOW is open to Internet standards (UDDI, SAOP, WSDL..etc) so it should take in to consideration how the autonomic coordination of BO in the IOW can be maintain.

In our case, we opted for Agent-Oriented approach to model IT Governance IWO since this technology satisfies almost all these constraints: autonomy, flexibility and distribution. But also many problems appear s as far as Process definition, matching partners and the choice of protocols to negotiate the audit contract.

In IWO literature many interesting solution was proposed to solve this problems [6], [7] . In this paper we will focus on the classical solutions to adapt them to our particular audit context.

### WORKFLOW COOPERATION

The interoperability of an Inter-organizational workflow has many forms such as: capacity sharing chained execution, subcontracting, transfer cases, transfer cases extended to public-private and loosely coupled.

Our contribution is about loosely coupled inter-organizational workflow. This form of interoperability is characterized by the presence of many partners; each has a private local workflow and interaction structure that allows it to interact with other partners using asynchronous messages. it is also necessary, in a Loose IOW, to set an interaction protocol to specify different messages circulating among partners following a sequence diagram messages.

Each partner must develop its local private workflow in line with the interaction protocol.

At this level, [15] authors proposed a workflow execution platform based on (Event, Condition and Action), every workflow of the IOW is represented by a Multi-Agent System and every organization is

represented by an Agent, the execution in this case is divided on inter-execution and intra-execution.

Another way is through messages sequences diagrams (MSD) and Petri Network (PN) [16]: MSD for inter organizational interactions description and PN for workflow process modeling.

A third proposition is to use an agent based model with domain ontology and negotiation ontology for workflow process dynamic coordination.

In our contribution, we choose the last proposition through a solution which:

- ✓ Describe IS Workflow Services and COBIT Workflow Services.
- ✓ Find Partners (requesters and providers).
- ✓ Negotiate the Audit Contract.
- ✓ Execute services.

**IOW ORGANIZATIONAL LEVEL**

Our organizational model (see Table 1) is organized around the following components:

- Five types of groups represented by an eclipse (Audit, Finding Audit, Finding Auditor, Audited and Auditor),
- Ten roles represented by a circle as every agent has double role in every group ( Mediator, SI Connection Server, COBIT Connection Server, IS Workflow Agent, COBIT Agent),
- Communication between agents is represented by arrows.

It explains how groups operate with each other:

One or more IS Workflow Agent or COBIT Agent interact with a connection server (COBIT or IS) from which they get requested partner identity in Finding Audited Group and Finding Auditor Group. Connection server via a mediator Agent (recording COBIT Agents capabilities), release the appropriate COBIT process (offered by COBIT Agent) in Auditor Group.

Connection server submits an audit request about a business objective; it allows the mediator agent to return the identity of the appropriate COBIT agent in Audited Group.

IS Workflow Agent and COBIT Agent, after getting each other identities from connection servers negotiate the more priority COBIT process to implement; the RACI matrix, the key metrics and the maturity model to follow in Audit Group.

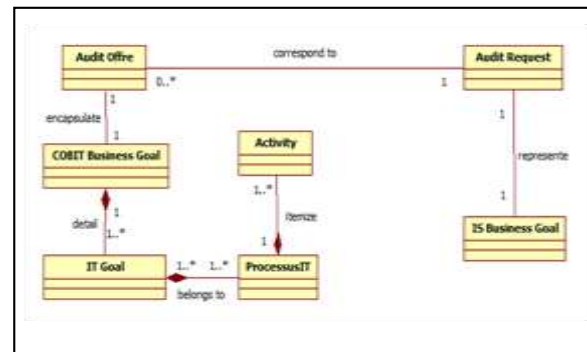
**Table 1. IWO organizational Model via AGR Model**

Group	Role
Finding Audite	Matchmaker
	COBIT Connection Server
	Matchmaker A

Finding Auditor	IS Connection Server
Audited	IS Connection Server
	Workflow IS Agent
Auditor	COBIT Connection Server
	COBIT Agent
Audit	Workflow IS Agent
	COBIT Agent

**IOW FUNCTIONAL LEVEL**

The functional aspect describes the offers and requests audit regardless of the rules, events and actors. This model is inspired from the relationship between the components of COBIT.



**Fig2: IOW Functionnal Level**

**IT-GRC INTER-ORGANIZATIONAL WORKFLOW GLOBAL ARCHITECTURE**

The proposed architecture (see Figure 3) is essentially based on the agentification of COBIT components relationship, in addition to WIO literature [11] and Workflow reference Architecture [12].

IT Governance IOW is interfaced with every part of the IS through an Agent which is launched by stakeholders requests about the audit of one or many business processes instance of the system. This Agent is called IS Workflow Agent. Manager Agent monitors and controls the running of IS Workflow Agents. COBIT Agent is the auditor agent who broadcasts services throw the COBIT Connection Server.

Once into contact with an IS Workflow Agent, it diagnoses the business objective coming from IS Workflow Agent and gives convenient control recommendations of COBIT framework.

Connection Server Agent is responsible for publishing Workflow IS Agents requests and getting convenient COBIT Agents from the mediation infrastructure.

Mediator Agent is a yellow pages that publishes COBIT Agents offered services and requests made by

the IS Workflow agents. We will detail it more in the next section.

### **MEDIATION LEVEL**

In the literature of MAS, there are two kind of agent: end-agent and middle-agent.

- End Agent acts as Provider when he offers the service and as Requester when he needs it.
- Middle Agent exists to enable interactions among end-Agents

Among middle-agent there are principally three kind of mediator Agent: Matchmaker, Broker [13] and Facilitator [14]. The difference between a Matchmaker and a facilitator is that the second one intermediate transaction and the first one matches provider and requester identity and they communicate directly. As for a Broker, he gets delegated services with preferences from the requester, asks the provider for results and sends directly this result to the requester.

In our case we need a Matchmaker agent so as to link between IS Workflow Agent and COBIT agent and let them exchange audit information directly in Audit Group without interfering.

The role of the Matchmaker in our WIO is to find convenient partner (COBIT BO) for every Enterprise BO instance.

### **MEDIATOR AGENT ARCHITECTURE IN THE IT GOVERNANCE IOW**

In our solution Mediator Agent have three principal roles to do( see Figure 3 Mediation Layer):

→ persistence Service: it's the storage of both IS BO and COBIT BO (Offers and demands with owner Agent Address)

→ processing Service: it's the definition and selection of Audit COBIT ontology with a hierarchical way; it also contains the definition of services.

→ matching Service: it's the comparison between the supply and the demand with defined criteria.

A service is considered here as a resource of an Agent (decoupled modeling) [5].

The processing layer is subject of other article which is being published.

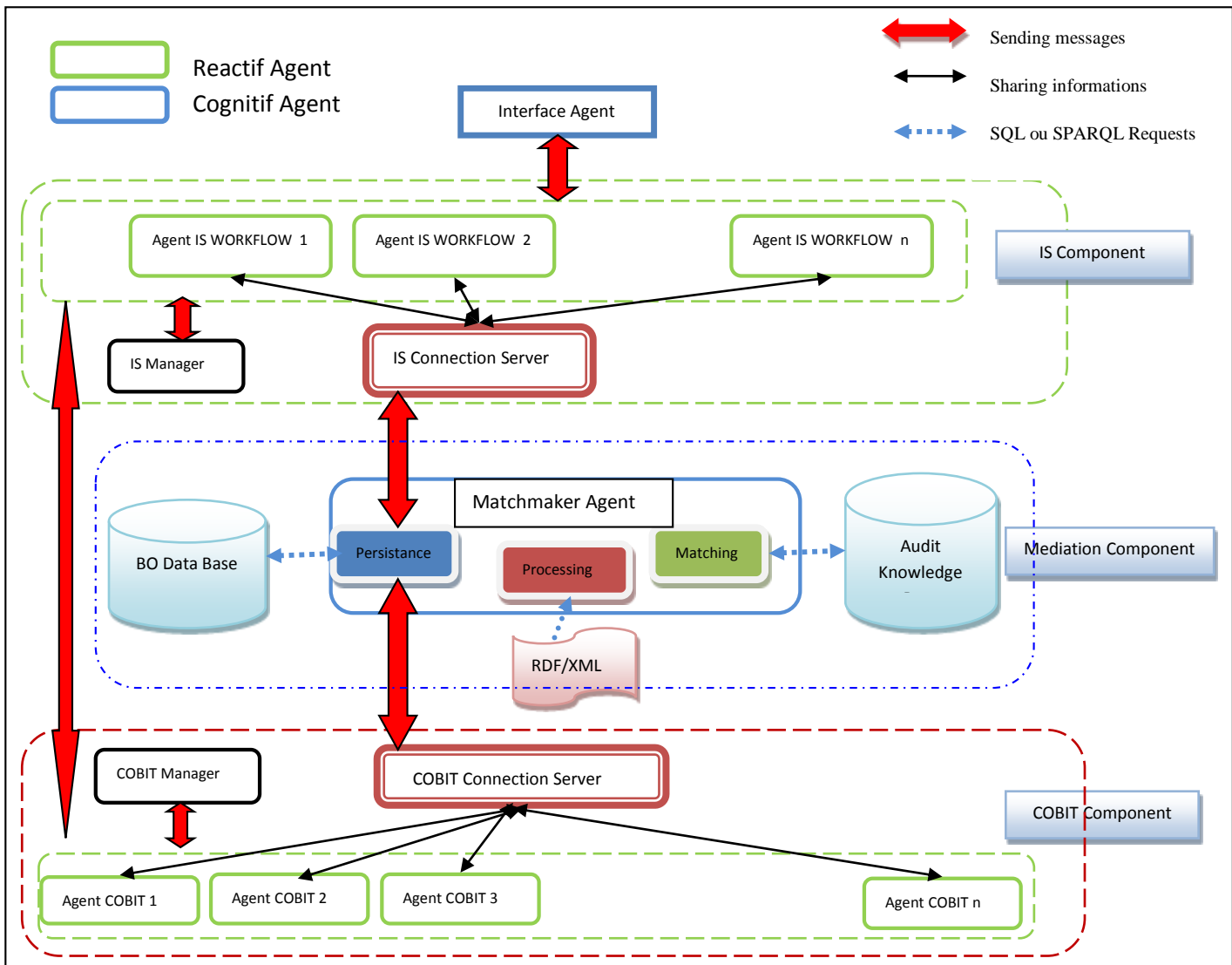


Fig3: IT Governance Workflow Architecture

**IMPLEMENTATION**

The generic architecture is validated with a simulator called EAS-Audit. We use Madkit 5 as MAS platform, Eclipse as integrated development environment and java as development language. Here is the collaboration diagram of the simulator: Mediator Agent, IS Connection Server and COBIT Connection Server, IS Workflow Agent and COBIT Agent.

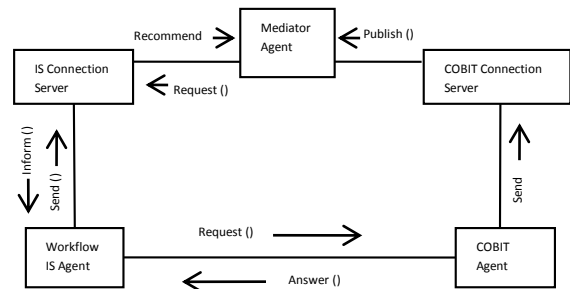


Fig4: Collaboration Diagram of the simulator

The simulator Agents are on Java Application with an execution main, the user interface is not yet developed, it seems like this:

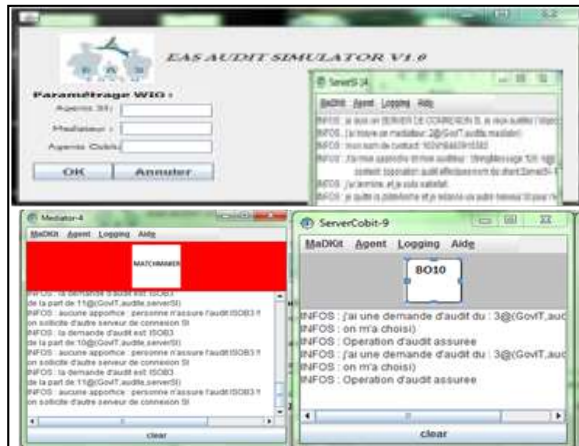


Fig5: Overview of IT Governance IOW Simulator

IS Connection Server has a business objective to which he will find the convenient COBIT Agent to audit it (exchanging the audit contract number between the two connection servers through the Mediator which establish the correspondence).

Every Agent has his own graphic interface the request is imitated to find the convenient COBIT connection server publishing one of COBIT processes (the choice is based on the mediator matching)

Interface 1: IS connection Server Agent named ServerSI+ excremental number. This agent presents a business objective, it asks the mediator to find an auditor and wait for an answer.

Interface 3: COBIT Connection Server named ServerCobit+ excremental number. This agent publishes its service through the mediator, and waits to be chosen as an auditor.

Interface 2: Mediator Agent matches the audited agent with the convenient auditor agent. It sends the answer to the Connection servers.

## PERSPECTIVES AND CONCLUSION

This paper has addressed IT Governance issue in Loose Inter-organizational Workflow. As mentioned in the Introduction IT Governance is more and more important for Information System efficiency. This work has tried to propose a solution to replace external audit operation of an expert ( high cost and not always a good result) with an open model of solution to ensure permanent IT Governance of every IS component and this with the interfere of potential users (auto evaluation procedure) .

To reach these objectives this paper has Chosen:

- COBIT as a generic IT Governance framework,
- Multi-Agent based IOW as technical coordination context.

We propose a general architecture, specific architecture of mediation entity, an organizational model and a simulator to validate the solution.




In next works, we are detailing every part of the architecture and integration witch is subject of other articles.

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