ITIL Ontology-based Model for IT Governance: A prototype demonstration

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Abstract:— Business processes are becoming highly dependent upon information systems that must be as reliable as possible. However, effectively managing these systems is usually a complex undertaking. Depending on the type of the business, an unexpected system failure might bring serious consequences. Therefore, IT governance is constantly looking for new strategies that increase the organizations' ability to react to eventual disruptions. This article proposes an ITIL ontology-based model that can formally represent knowledge about business processes, systems components, and their in- terrelations.

Resumo: - Processos de negócio vêm tornando-se altamente dependentes dos sistemas de informação, os quais devem ser os mais confiáveis possíveis. Por sua vez, a gestão efetiva desses sistemas é uma tarefa de alta complexidade. Dependendo da linha de negócios, uma falha inesperada de um sistema pode levar a sérios prejuízos. Por outro lado a governança de TI está constantemente procurando novas estratégias para aumentar a reposta efetiva em eventuais incidentes. Este artigo propõe um modelo ontológico, o qual representa de maneira formal processos de negócio, componentes de sistema e suas inter-relações.

1. INTRODUCTION

Organizations worldwide are increasingly dependent on the reliability of their business processes. Even minor changes or faults in a tiny system component can result in malfunctioning of large portions of business processes (W. ABRAMOWICZ, 2007). Thus, how can business and information technology (IT) staff provides quick responses and stability to the system that support business processes when incidents take place? Furthermore: Who will be directly affected? What is the impact of the failure to the business processes? What would be the best course of action to reestablish the system?

Several authors suggest the adoption of process management practices for IT governance, such as those of ITIL (Information Technology Infrastructure Library) and Cobit. They provide a rather stable classification and description of systems' configuration items (CIs - software modules, hardware components, or staff members), and facilitate the discovery, specification, implementation, control and monitoring of processes (ABRAMOWICZ, FILIPOWSKA, *et al.*, 2007) (WARD e PEPPARD,

2002). However there is still a gap in the literature both in terms of development and deployment of semantic systems that support IT governance practices. Therefore, intends to shed some light in the area by suggesting an ontological approach for describing CIs and the processes dependent of them. It enables the creation of knowledge bases (KBs) describing processes, CIs, and their relationships for particular enterprises. Then one can use inference on these KBs to determine, for example, (i) which are the CIs involved in the execution of a business process, (ii) which are the activities jeopardized by the performance degradation of a particular process, and (iii) which are the processes affected by a failure of a particular CI.

A prototype of the ITIL ontology-based model has been implemented. A KB was built using this model as a proof of concept. Preliminary experiments using a reasoner to solve queries on this KB suggest that the approach is positively viable. Some queries promptly produced valuable information to leverage the effectiveness of decision making for IT governance.

2. FUNDAMENTALS

2.1. IT Governance, Business Processes and ITIL

Information Technology (IT) governance is an integral part of corporate governance responsible for the management of IT systems (CATER-STEEL, TOLEMAN e TAN, 2006). One of the attributions of IT governance is to manage and improve the effectiveness of processes that are dependent on information systems, and the outcomes of these processes (WARD e PEPPARD, 2002), (SHERRENA, BEST e STEWART, 2008).

A process, for this paper, is a sequence of activities that presents a clearly defined starting point and ultimately results in at least one product and/or service. A business process is a sequence of activities necessary to manipulate an object of interest to an organization in order to achieve a specific goal (MUEHLEN e HO, 2005). A decision making process intends to produce information to support the decision making action on three levels: strategic, tactical and operational (WARD e PEPPARD, 2002).

Every organization has to create and manage its own processes in order to keep up with the demands of the market place. However this task is often not easy, especially when parts of the business processes rely on information technology. The solution found by many corporations is to adopt frameworks like ITIL (Information Technology

Infrastructure Library) that intends to improve the use of the IT resources according to the business demands (HOCHSTEIN, ZARNEKOW e BRENNER, 2005). Shortly, ITIL consists of a set of best practices which describe how the IT governance should carry out its activities of service delivery (CATER-STEEL, TOLEMAN e TAN, 2006), (JOHNSON, HATELY, *et al.*, 2007). This leads to the ultimate goal of IT governance that is the development of synergies between business and IT processes.

2.2. Ontologies

An ontology is an explicit specification of a shared conceptualization (GRUBER, 1993). Ontologies represent knowledge in a formal way, which gives a solid foundation for the development of Semantic Web. They are useful due to their expressiveness for relating concepts. Moreover, the field of information system has provided a fruitful ground for the application of ontological theories (GUIZZARDI, 2005)

One of most commonly used language to write down ontologies is OWL (Web Ontology Language) (JOHNSON, HATELY, *et al.*, 2007), (W3C, 2004), which is based on RDF (Resource Description Framework) triples (W3C, 2004). In order to extract information from OWL or RDF, one can use the SPARQL, a query language intended to serve as the standard query language for RDF data in the realm of Semantic Web (PAHLEVI, MATONO e KOJIMA, 2007). All these languages are recommendations of the World Wide Web Consortium (W3C).

It is possible to reason about the knowledge stated by ontology in a practical, unambiguous away. This is achievable because ontologies are constructed based upon description logics.

3. ITIL ONTOLOGY-BASED MODEL FOR IT GOVERNANCE

In order to fulfill the gap between the statics of the assets and the dynamics of the processes, it has been created a lightly coupled conceptual model that combines the infrastructure concepts from ITIL with business process concepts. This model focuses on fostering a consistent basis for machine reasoning, which in turn, would be capable of providing rapid operational and strategic answers to systems and business administrators alike. The goal is to support the handling of several systems spread throughout the enterprise in a comprehensive, wide and unique view. The proposed models is composed of three ontologies as shown on Figure 1.

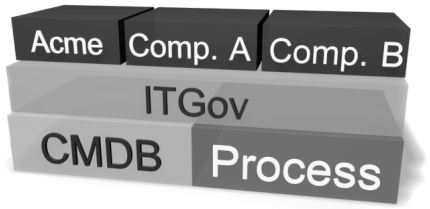

FIGURE 1 – Ontology-based Model for IT Governance

CMDB - Configuration Management Database: is used to describe the configuration items in the ITIL database, i.e., all the organization's assets (LACY e HARROW, 2001). Those assets are also called Configuration Items (CIs) by the ITIL best practices. Yet, according to ITIL books, anything belonging to the infrastructure domain can be individually replaced is denominated CI. Some examples could be enumerated as: computers, mother boards, routers, servers, operational systems and people staff. In the proposed model, the CMDB is built up as knowledge base over an OWL-DL ontology representation.

PROCESS: this ontology describes the basic elements of a process such as: Activity, Agent, Decision, Fork and Junction. Through the instances of those process classes is possible to build business and operational process according to a desired granularity.

ITGOV: this ontology bonds the CMDB ontology and the Process ontology. It serves as a bridge for the two domains, allying dynamic and static dimensions in order to reach the world vision of IT Governance.

ACME , Comp. A and Comp. B are fictitious companies fit in the architecture. Once they have implemented the ITIL ontology-based model (become instances), they are able inter-operate.

Figure 2 shows the major concepts and semantic relation- ships of these three ontologies. The tied zone shows the bond of the CMDB ontology with the Process ontology. It is implemented by the relations has_agent, is_supported by, supports, and is_agent of, all of them pertaining to the ontology ITGov. The full ontological model can be downloaded at http://www.inf.ufsc.br/~marcoshs/ontologies/itgov.owl ;

http://www.inf.ufsc.br/~marcoshs/ontologies/process.owl and

http://www.inf.ufsc.br/~marcoshs/ontologies/cmdb.owl .

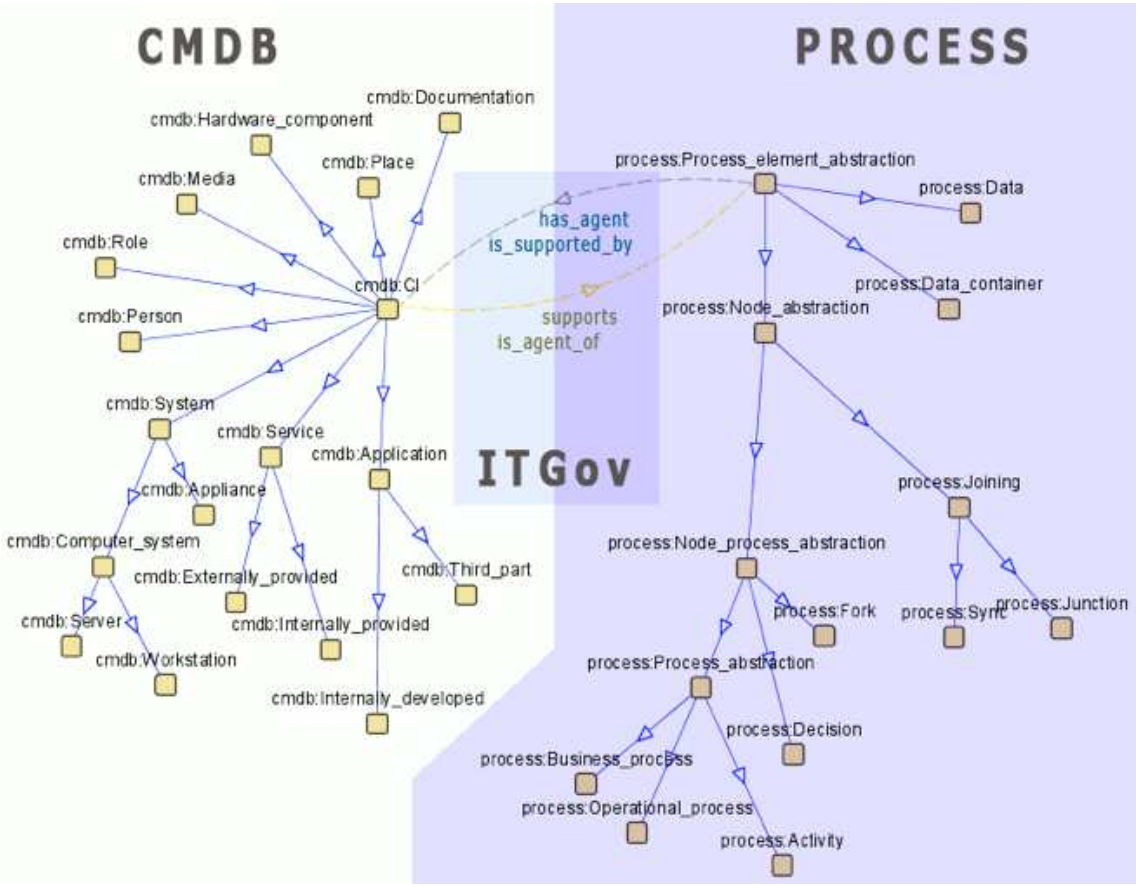

Figure 2. Details of CMDB, PROCESS and ITGov.

4. REASONING OVER ONTOLOGIES

An environment for reasoning on the proposed ontology- based model has been created using Jena (HP - LABS SEMANTIC WEB RESEARCH, 2008) and Pellet (SIRIN e PARSIA, 2007). A knowledge base (KB) for a fictional company called “Acme” was created under this model for proof of concept purposes. ACME has as configuration items (CIs) 6 employees, 6 workstations, 2 servers, 6 staff roles as seen on Figure 3. Further subparts and details were set up. In addition, two processes were created in the KB: “Incident Handling” as shown on Figure 5 from ITIL best practices (LACY e HARROW, 2001) and a simple manufacturing process explained on Figure 4.

Many experiments have been performed against this KB with good accuracy on answering the SPARQL queries. Three of these queries are presented next, with the respective SPARQL expressions.

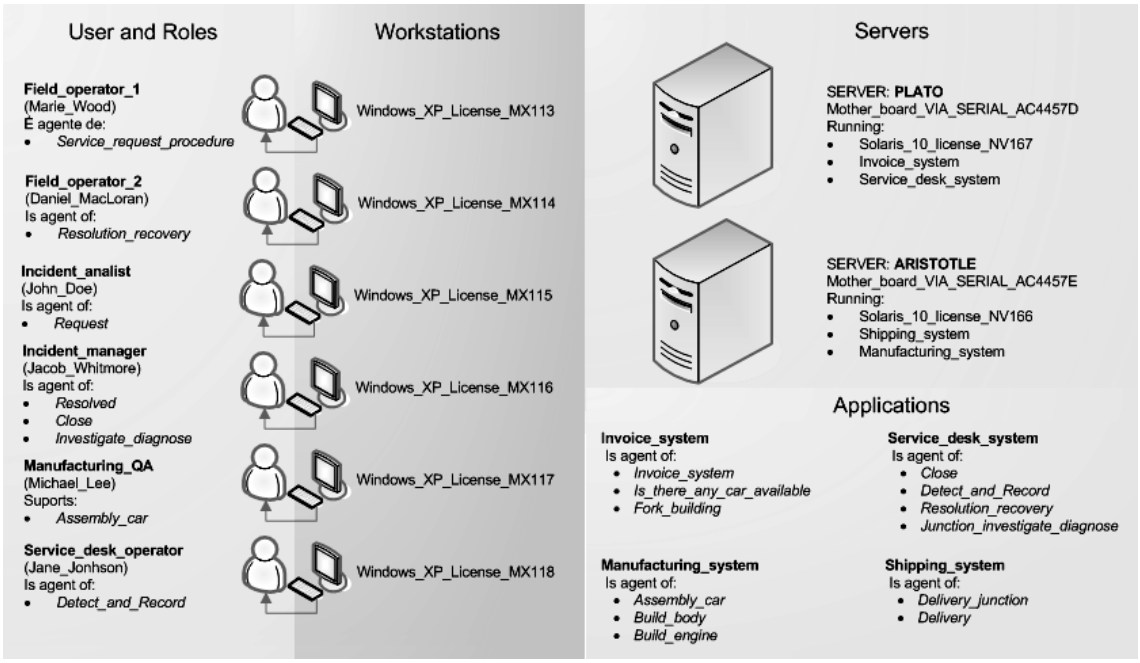

Figure 3. Infrastructure scenario of Acme Corp.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> PREFIX process:
<http://www.inf.ufsc.br/_
 ãmarcoshs/ontologies/process.owl#> PREFIX cmdb: <http://www.inf.ufsc.br/_
 ãmarcoshs/ontologies/cmdb.owl#> PREFIX itgov: <http://www.inf.ufsc.br/_
 ãmarcoshs/ontologies/itgov.owl#> PREFIX acme: <http://www.inf.ufsc.br/_
 ãmarcoshs/ontologies/acme.owl#>

SELECT ?x WHERE { ?x a process:Business_process . ?y process:is_sub_item_of ?x
. ?y cmdb:is_dependent_of ?z . ?z cmdb:has_status cmdb:enum_degraded .

}
```

Frame 1 - Who is involved in the execution of the “Incident Handling” process?

The reasoner returned for this query the exact six people involved in activities of “Incident Handling”, as presented below.

```
x
====================
acme:Jane_Jonhson
acme:Daniel_MacLoran
acme:Marie_Wood
acme:Jacob_Whitmore
acme:John_Doe
```

Frame 2 – Query results.

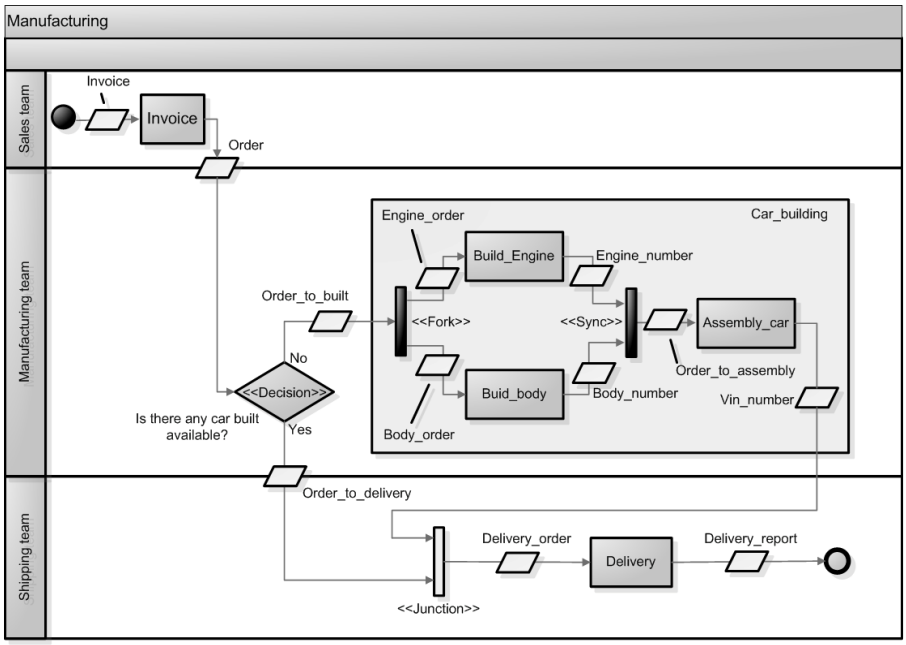

Figure 4. Process of manufacturing of Acme Corp.

```
SELECT ?x WHERE { ?x a process:Node_abstraction . acme:Resolved
process:has_next_statement ?x .
}
```

Frame 3 - Which process elements would be jeopardized in case of the decision activity “Resolved” has been degraded?

As result of the query above, the system retrieved all the process elements affected by the degradation of the activity “Resolved” decision. The reasoner output is shown below.

```
x
=================================
acme:Junction_investigate_diagnose
acme:Close
acme:Resolution_recovery
acme:Investigate_diagnose
acme:Resolved
```

Frame 4 – Query results.

```
SELECT ?x WHERE {

?x a process:Business_process .
?y process:is_sub_item_of ?x .
?y cmdb:is_dependent_of ?z .
?z cmdb:has_status cmdb:enum_degraded .

}
```

Frame 5 - Which BPs have been jeopardized due to a degraded CI?

In order to make this experiment, a CI called “Mother board VIA SERIAL AC4457E” was set as degraded in the KB.

```
x
==================
acme:Manufacturing
```

Frame 6 – Query results.

5. CONCLUSIONS AND FUTURE WORK

This article presented an ontology-based model that integrates static and dynamic aspects of IT governance. The former are based on ITIL best practices for keeping a database about configuration items, and the latter refer to the business processes whose proper functioning relies on the described configuration items.

The proposed model is functional, formal and unambiguous, resulting in a interesting approach for an enterprise to formalize and ultimately optimize its processes. Preliminary experiments show the applicability of reasoning over this model. A prototype built upon this model is capable of answering questions at the strategic level, tactical level, and operational level.

A proper implementation of ITIL contributes to IT governance by developing synergies between business and IT process. ITIL is considered a set of documents that provide a wide range of prescriptive information, indicating “what should be done” instead of “how it should be done”. This gives opportunity to create tools using the framework. For example, some solutions based on relational databases are made available by well know IT vendors such as HP, IBM and Microsoft. The ITIL ontology-based model emerges as an alternative solution that links ITIL models with Semantic Web technologies. This new approach can provide sophisticated inferences, complex queries which are valuable for business intelligence (MARTIN, D., ET AL, 2007).

This model can lead to the establishment of a semantic intranet to support IT governance in an organization. Such intelligent support for IT governance can also be extended to an external network forming a business ecosystem. Nevertheless, further research is needed to extend the proposed ontologies, in order to extract more precise details of the processes and their interactions. It is also necessary to investigate new tools for evaluating and managing the proposed ontologies, such as benchmarks,

reasoners, and frameworks for building semantic Web applications, as well search another ontology models and compare them with this.

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