On the Elements of an Enterprise: Towards an Ontology-Based Account

João Paulo A. Almeida, Evellin C.S. Cardoso
Ontology & Conceptual Modeling Research Group (NEMO)
Computer Science Department, Federal University of Espírito Santo (UFES)
Av. Fernando Ferrari, s/n, Vitória, ES, Brazil
jpalmeida@ieee.org; ecardoso@inf.ufes.br

ABSTRACT
In this paper, we work towards a broad semantic foundation that can be used to interpret enterprise models. We review several definitions of the elements of an enterprise, considering approaches in literature that describe the elements of organizations using systematic ontology-based accounts. We address a number of concepts including that of organization, agents, roles, goals, actions/plans, interactions, delegations and norms/rules. We argue that enterprise modeling covers a broad scope of the social domain which is currently not addressed by a single organizational ontology. Therefore, this deficiency led us to survey several ontologies with the aim of providing a thorough account for a real organization. Our aim is to lay down the first step towards a common basis for the study of enterprise modeling languages and enterprise modeling frameworks.

Keywords
Enterprise ontologies; organizations; agents; roles; goals; actions/plans; interactions; delegations; norms/rules.

1. INTRODUCTION
In the past decades there has been growing interest in the subject of ontology in computer and information sciences. In computer science, the term “ontology” has been firstly coined by Mealy in the area of data processing in 1967. Since then, a large number of efforts related to ontology have been put forward ranging from Artificial Intelligence (AI) to Semantic Web, including Model-Driven Architecture (MDA) initiatives (Guizzardi, 2007).

Ontology is defined as a theory in philosophy (a branch of metaphysics) concerned with the nature (kinds of existents) and relations of being (Guizzardi, 2005). The importance of ontologies for information systems is largely recognized as a means for providing foundations for conceptual modeling. These foundations have the role of capturing the ontological categories (concepts) of such domain, providing real-world semantics for language constructs which represent these concepts (Guizzardi, 2005) as well as clarifying the structure of knowledge (Chandra-sekaran, et al., 1999).

Analogously, ontological foundations for enterprise modeling are also an essential instrument for providing a common terminology that captures key distinctions within organizational environments.

These distinctions must be generic across many domains as well as provide adequate specification of the semantics of the terminology of the enterprise (Grüninger, et al., 2000). Moreover, “an ontological analysis of organizations is the first, fundamental and ineliminable pillar on which to build a precise and rigorous enterprise modeling. An ontological analysis makes explicit the social structure that underlies every organizational setting” (Bottazzi, et al., 2005). Furthermore, the usage of foundational ontologies aims at clarifying the representation of the organizational domain not only in the level of particular domain theories (enterprise ontologies), but also promote an interpretation of the social domain in terms of meta-categories.

This paper surveys the current literature in ontologies for enterprise modeling, defining the organization in terms of basic concepts. We are not only concerned about surveying the elements which compose organizations from an ontological point of view, but we also investigate the relations that goals establish with these elements with the aim of implementing the enterprise’s strategy. Our research intends to answer the following questions: “What are organizations from an ontological point of view?”, “What are the ontological interpretations for architectural elements which compose organizations?” and “How are goals related with these architectural elements?”. We review several definitions of the elements of an enterprise (agents, roles, goals, actions/plans, interactions, delegations and norms/rules), considering approaches in literature that employ systematic ontology-based accounts.

Our aim is to lay down the first step towards a common basis for the study of enterprise modeling languages and enterprise modeling frameworks. The ontologies can both provide the relevant concepts in each architectural domain addressed by enterprise modeling approaches as well as provide real-world semantics for the concepts of each modeling language employed. Furthermore, the usage of ontologies can guide one in the usage of the modeling elements of each language and one can suggest well-founded improvements in these modeling languages with ontological analysis (Green and Rosemann, 2005).

We start with the concept of organization from an ontological point of view and present the relationship between the key concept of goals and the remaining components which form organizations. The paper is organized as follows: section 2 introduces the (ontological) definition of organizations. From this point on, each section describes the relationship between goals and other elements of the enterprise. Section 3 defines the relation between goals and roles; section 4 describes how agents and goals are related; section 5 relates actions and plans with goals; section 6 presents some remarks about the relation of goal realization and objects; and section 7 considers rules and norms as mechanisms for enforcing goal realization. Finally, section 8 presents concluding remarks.
2. THE ORGANIZATION CONCEPT

We start our considerations with the concept of institutional organizations. Despite the large amount of literature devoted to describing organizations, especially in social sciences such as economics or anthropology, organizations are very difficult to define from an ontological point of view (ISTC-CNR, 2005-2007b). Some proposals argue that organizations can be: (i) social objects (something like a convention or agreement established by humans as a way of coordinate the human behaviour) (ISTC-CNR, 2005-2007b); (ii) artifacts (social objects can be seen as artifacts) which serves to the purpose of orchestrating the collective behaviour (ISTC-CNR, 2005-2007b), or even (iii) intentional agents that emerge from the aggregation of several natural persons (human beings) (ISTC-CNR, 2005-2007b) (Guizzardi, et al., 2007).

In (ISTC-CNR, 2005-2007b), it is argued that, despite the differences in defining the concept of organizations, at least, there is some agreement (in sociology and philosophy) in facing organizations as a collective of individuals who enacts some roles under some constraints (rules and norms) on behalf of some purpose (goals or ends). This proposal adopts the line which considers organizations as designed agents who act in the physical world with a specific mission (in other words, organizations are an abstract social concept, which is separate from the collective body of agents that composes it (Bottazzi, et al., 2005)).

According to this teleological view, organizations are the result of a decision-making process that is necessarily based on goals and on how these goals can be achieved. According to (Dignum, 2004), “an organization can be seen as a set of entities and their interactions, which are regulated by mechanisms of social order and created by more or less autonomous actors to achieve common goals”. In turn, this proposal admits that organizations are more than the sum of the agents which compose the organization (in fact, roles describe the organizational perspective on individuals, whereas agents represent the perspective and objectives of the individuals themselves), but it does not recognize the organization as a social concept.

Differently from the previous proposals, in (Guizzardi, et al., 2007), Guizzardi and colleagues view an organization as an institutional agent constituted by a number of other (physical, artificial or institutional) agents. It is important to emphasize that, according to this point of view; an organization is not a social concept (but a physical one instead) which is composed by the aggregation of the collective body of agents that composes it. However, it is very relevant to put that this aggregation is not a merealogical sum of the agents. On the contrary, an organization has a functional complex relation with its constituents. According to (Guizzardi, 2005), “(functional) complexes are composed by parts that play a multitude of roles in the context of the whole. The parts of a complex have in common that they all possess a functional link with the complex. In other words, they all contribute to the functionality (or the behavior) of the complex. Therefore, if it is generally the case that essential pathroid entails dependence [...], in this type of pathroid relation, an essential part represents a case of functional dependence. To put it more precisely, for all complexes, if x is an essential part of y then y is functionally dependent on x.”

Therefore, each (physical, artificial or institutional) agent enacts a different functional role within the scope of the organization.

In the current work, we adopt the concept of organizations as social agents created by human societies to manage the behaviour of agents who act on behalf of some goals (the teleological aspect) (Dignum, 2004) (Bottazzi, et al., 2005) (ISTC-CNR, 2005-2007a) (ISTC-CNR, 2005-2007b). Therefore, goals are the drivers for the creation of organizations as the organizational structure which supports the systematic pursuit of goals by autonomous agents.

Since organizations are entities apart from their constituent components, it is important also highlight that the term “organization” refers to the abstract design of the organization (the relations holding among the units of the organization or the “design layer”), rather than the potential realization of some particular organization (instantiation of some organizational environment, the “realization layer”) (ISTC-CNR, 2005-2007a) (ISTC-CNR, 2005-2007b).

Regarding the design of organizations, some proposals (Dignum, 2004) (Fox, et al., 1998) (Uschold, et al., 1998) (Dietz, 2006) conceive roles as the only structural component in the design of organizations (although they can be hierarchically arranged by dependencies or power relations), not making explicit the underlying social structure behind these roles (ISTC-CNR, 2005-2007b). However, other proposals (ISTC-CNR, 2005-2007a) describe organizations as being composed by sub-organizations as a mean of explicitly describing the organizational structure. Adopting the concept of sub-organization opens up the opportunity of representing the organizational structure as a set of institutional relationships, i.e., the organization under consideration can be interpreted as being an element of an institutional network of organizations. This kind of representation is useful since internal sub-organizations can interact with external organizations outside the direct influence or control of the organization (ISTC-CNR, 2005-2007a).

Given this, we take the second approach in which organizations are described as structured in terms of sub-organizations as proposed in (ISTC-CNR, 2005-2007a). According to the model presented in this proposal, organizations are a 4-tuple composed by a set of objectives, a set of (direct internal) sub-organizations, a set of institutional relationships and a set of external organizations. The internal sub-organizations of an organization are the organizations that are linked by a finite chain of direct internal sub-organization relations. The external organizations of an organization are the organizations that have institutional relations with the organization but are not directly controlled by it. Finally, the set of the direct sub-organizations of an organization is the union of the sets of the internal and external sub-organizations.

Regarding goals, since the top organization is formed with the aim of pursuing some goals, these goals must be refined and assigned to its sub-organizations so that these latter jointly become responsible for attaining the goals of the global organization. Observe that in this process of refinement, the top organization refines the organizational high-level goals into more specific goals and assigns them to its sub-organizations. Moreover, this assignment can also include a specific way about how to pursue these goals (ISTC-CNR, 2005-2007a).
Observe that the specification of a particular structure for the sub-organizations can be regarded as the mean employed by the designers of the organization to coordinate sub-organizations to achieve the organization’s global goals. This specification is made through the imposition on norms to regulate the interaction among these sub-organizations, but the sub-organizations can also decide to autonomously establish additional relationships.

3. ROLES
When the refinement of the organization reaches its lowest level, sub-organizations with no further decomposition are denominated as roles (Boella, et al., 2006). Roles are social concepts employed for abstracting from specific agents in organizations (ISTC-CNR, 2005-2007b), representing the part of the organizational design which specifies the activities and services necessary to achieve society objectives (Dignum, 2004).

Besides being properly defined by abstract design, organizations need to exist in reality through some physical structure (what one could informally call the “translation” from the abstract world to the concrete one). This realization is made by assigning individual agents to roles through an enactment relationship. This assignment of agents to roles is made through the signature of legal contracts (created/regulated through the definition of norms) of the organization with the agents. The signature of this contract represents a conveyance of the goals of the role to the agent which is assuming that role, that is, the goals of a role are expected to be executed by the agent(s) enacting that role.

Observe that, although goals of roles are designed from the organizational point of view, there is the possibility that a same agent assumes different roles with contradictory goals. Alternately, even if the role’s goals do not prevent (or negatively contributes to) the satisfaction of the goals of the other roles assumed by the agent, it is also possible that the operationalizations to achieve the roles’ goals can have contradictory characteristics. In both cases, the design of goals by the organization must take into account this issue so that to avoid this type of situation.

Besides the assignment of agents to roles (considering the absence of any kind of contradictory characteristic in the goals of roles), the satisfaction of the overall organization’s goals requires the joint accomplishment of goals of roles as well as the achievement of goals which do not pertain to any particular individual, but are common to many agents (see interactions for a longer discussion about emergent goals). Again, the design of goals of roles (as well as the operationalizations) by the organization must also ensure the absence of any kind of contradiction along its course.

An obvious problem of goal achievement in organizations is the fact that roles are the design from an organizational point of view, i.e., it is assumed that role playing is predictable, although this is not always true. To regulate the possible deviations from the desired behaviour, organizations rely on norms that fix constraints in the behaviour of agents which enact roles (norms are further explored in section 7). These regulative norms are applied to agents as they become affiliated to organizations via agreements or contracts (ISTC-CNR, 2005-2007b).

4. AGENTS
While roles define how the organization aims at implementing its design through the specification of the behaviour of individuals, agents represent the perspective and objectives of the individuals themselves (agents pertain to the “realization layer”). In dealing with goal attainment issues, it is fundamental to regard the characteristics of agents who enact roles in societies in the sense that this can interfere in the adoption of plans to achieve goals.

In this respect, agent-oriented methodologies cope with agents as autonomous and heterogeneous entities that exhibit proactive and flexible behaviour (Ferrario, et al., 2004) as well as mental states (Guizzardi, 2006). In addition, according to Dignum (Dignum, 2004), agents are able to interact and cooperate with other agents, since they are socio-cognitive entities, namely, entities endowed with mental attitudes who assumes that other agents also holds the same characteristic. Dignum also defends that, since agents exhibit autonomous and heterogeneous behaviour, they may be more or less committed with organizational aims and strategies according to the extent to which their own goals are compliant with the organization’s goals. In other words, the autonomy of agents may lead to undesirable behaviours from the organizational point of view. Again, as the roles which are assumed by a specific agent can have contradictory goals (as claimed in the previous section), the agents’ personal goals can also be contradictory with the goals of their roles. In this case, differently from the previous situation, this does not comprise in a problem of design of goals by the organization, but instead, in a problem of adequacy of the agent with its assumed roles. Differently, in Dietz’s work (Dietz, 2006), there is no explicit distinction between agents and roles: this proposal assumes actors (roles) as being autonomous entities whose behaviour is regulated by guidelines, thus avoiding this problem of compliance of agent’s goals with the role’s goals.

In the sequel, we clarify the concept of goal (from an ontological point of view) and relate it with the components of the BDI cognitive model (Rao, et al., 1991) proposed in the AI literature for describing agents. In this model, agents are characterized by three basic mental components: beliefs, desires and intentions. Further, we also recognize a forth mental state, namely, capability. We use these mental states to explain how agents which enact roles within organizations impact in the organization’s goal achievement.

4.1 Intentions
Since agents can exhibit undesirable behaviours from the organizational perspective, there is an evident need for some mechanism of enforcement in the organization to guarantee that the agent’s participation in the society is compliant with the society objectives (Dignum, 2004). In this case, there is no explicit distinction between agents and roles: this proposal assumes actors (roles) as being autonomous entities whose behaviour is regulated by guidelines, thus avoiding this problem of compliance of agent’s goals with the role’s goals.

In addition to norms and rules, one may attempt to reach organizational roles by selecting (human) agents who are fully committed with the organizational goals. In this case, the participation (or admission) of the human agent in the organization is conditioned by the compliance of his/her intentions with respect to the goals of the organization.

From an ontological point of view, intentionality must be understood as more than an “intention of doing something” in its ordinary sense (Searle, 2000) apud (Guizzardi, et al., 2008)) as expressed by sentences like “I intend to go to the movies tonight” (the sense of the sentence “intend something” is further explained soon). Searle (1995) explains that intentionality is the feature of constructing mental representations by which they are about something or directed at something. Intentionality is then the requisite for entertaining intentional mental states (beliefs, desires, fears, or making hypotheses). Therefore, the common characteristic of these mental states is that they refer to possible situations of reality (Bottazzi, et al., 2006a).
In (Guizzardi, et al., 2008), these individualized properties of some individuals are denominated as mental moments and are existentially dependent on these individuals (the bearers) (observe that the term moment does not bear the temporal notion which is associated in the colloquial language).

Every mental (intentional) moment has a type (belief, desire or intention) and some propositional content (the propositional content of an intention is a goal as argued in section 4.2). An intention is a goal that the agent commits at pursuing (Guizzardi, et al., 2008), while desires represent the “will” of an agent towards a specific goal, although it might never actually pursue these goals (Guizzardi, et al., 2007). Actually, the main difference between desires and intentions relies on the association of intentions with the actions, leading agents to be committed in pursuing the goal through the instantiation of some plan (Guizzardi, et al., 2007). The same idea of intentions is explored by (Bottazzi, et al., 2006a) that affirms that "an agent is considered to be intentional when not only it builds a (mental) representation of the goal, but also a representation of the action necessary to its achievement, and of the resulting consequences" (therefore, “intend something” in its ordinary sense is, in fact, a specific type of intentionality termed as intention).

4.2 Goals
The concept of goal is widely used in agent-orientation and related fields, ranging from conceptual goal modeling in Agent Organizations and Requirements Engineering to goal execution in AI Planning and Agent Teamwork (Guizzardi, et al., 2007). For example, in the area of Requirements Engineering, the concept of goal is widely used for the definition and analysis of the objectives of the involved stakeholders and the future system. The need of capturing the aspirations of the human stakeholders for the target system leads to the definition of the concept of goal in terms of the desired functionalities of such system, as shown in (Lamsweerde, 2001) (Regev, et al., 2005).

Even with the widespread dissemination of the goal-orientation paradigm in the aforementioned areas, there are few works which define the concept of goal from an ontological point of view. Among of these works, in (Markovic, et al., 2008), “a goal expresses an attainable, measurable and time-bound state of the world that should be achieved or sustained (...”). Similarly, goals are also defined as “the set of desired state of affairs” in (Guizzardi, et al., 2007) and (ISTC-CNR, 2005-2007b). Another definition of goals states the semantics of such concept on the basis of other ontological concepts: goals are the specialization of a mental moment, i.e., “the propositional content of Intentions” (Guizzardi, et al., 2007). As argued in (Guizzardi, et al., 2007), the external concept regards a state of affairs desired by an agent (here called goal), and the internal one is the desire itself, which is part of the agent’s mental state.

4.3 Beliefs
As exposed by some authors (Ferrario, et al., 2004) (Guizzardi, et al., 2007), beliefs correspond to an external perception of the world, namely, the knowledge about the environment and other agents with whom it interacts, although the origin of these beliefs are slightly different in the proposals.

In (Ferrario, et al., 2004), the perceptions about the external world may cause the creation of mental objects in the agents. The processing of these perceptions by an agent can lead to the creation of beliefs. From these beliefs, desires can be derived. Finally, desires can lead to the creation of intentions. Therefore, intentions are existentially dependent on beliefs to be created. Goals, in turn, are reliant on beliefs to be pursued. In (Guizzardi, et al., 2008), beliefs are intentional moments of agents created from the perception of the world. Guizzardi’s proposal is different from Ferrario’s proposal in the sense that the latter cites a processing step from percepts to beliefs, while the former does not mention the existence of some kind of processing in the agents’ mind.

4.4 Capabilities
Although capabilities are not expressed in the BDI model, other models of mental states in agent-oriented theories acknowledge the need of accommodating additional components such as capabilities, as explained in (Shoham, 1993).

In (ISTC-CNR, 2005-2007b), it is argued that agent’s capabilities determine the potential states of the world that the agent can hold in executing actions. In other words, while beliefs influence agents in the choice of some particular strategy to achieve some goal, capabilities determines how effectively the agent will execute the chosen strategy.

Section 5 discusses that sometimes, capabilities can be necessary both during a planning process as well as in the instantiation of actions to fulfill goals. Section 5.1 argues that often a single agent’s capabilities are not sufficient to bring about a goal, which leads to agents being engaged in collective actions involving other agents with complementary capabilities (interactions). Finally, section 5.2 explains that when an agent does not possess a required capability to fulfill some goal it can opt for delegation.

5. ACTIONS AND PLANS
In previous sections, we have discussed how mental states affect agents to adopt actions in the pursuit of goals. Although the distinction between goals and actions is quite important as demonstrated in the BDI model, it is not always clear in the existing works as argued by Guizzardi et. al (2007) which explicitly recognizes this separation. Goals are a set of states of affairs (i.e. a set of world states), whereas actions are events created by agents with the purpose of attaining goals (Guizzardi, et al., 2007). Therefore, since actions are realized by intentional agents, they are also intentional transformations of reality.

During the process of creation of actions to fulfill goals, agents commonly face different alternative solutions for achieving the same goal. In this decision-making process, there is potential misalignment between the choice of some plan and the satisfaction of the goal associated with this plan. This “misalignment” refers to a possible inadequacy of the plan or due to an intrinsic limitation of the goal to be satisfied in its totality. Therefore, for goals to be achieved, intentions must drive the adoption of “proper” plans.

Concerning this issue, some ontologies (ISTC-CNR, 2005-2007b) (Guizzardi, et al., 2007) distinguish between the planning process (in which agents deliberate about which actions must be executed under some constraints) and the instantiation of actions which actually achieve the goal. Planning comprises in decision-making process with the purpose of choosing which actions are better applied to achieve some situation, considering the current constraints to which the agent is subjected. Therefore, in these frameworks, “a plan is an action type that an agent intends to execute (more correctly the agent intends to execute an instance of that action type) to achieve a goal” (Guizzardi, et al., 2008).
Actions can be atomic (or basic) or complex. In (ISTC-CNR, 2005-2007b), basic/atomic actions are direct successive transactions between two moments (with their associated preconditions). In (Guizzardi et al., 2008), the concepts of atomic action and complex action are not similar to the concepts adopted in (ISTC-CNR, 2005-2007b). In the former, being atomic and being instantaneous are orthogonal notions in the framework, i.e., atomic actions can be time-extended as well as an instantaneous event can be composed of multiple (instantaneous) participations. In fact, the concept of atomic action in Guizzardi et al. is related with the granularity of the actions: while an atomic action is an action event that is not composed by other action events, a complex action is a composition of at least two basic actions (that can themselves be atomic or complex). Furthermore, in ontologies, the concept of an execution of some business process (or a plan execution) can be understood as the execution of one or more ordered atomic actions (a complex action in other words), targeting a particular outcome. In fact, a plan execution instantiates a plan (or plan type) through the creation of action events previously specified in the plan (Guizzardi, et al., 2007).

Actions can be coordinated among agents to achieve common goals or goals that require complementary capabilities. Further, if agents cannot independently reach the goal, they can decide to delegate the goal or the plan that is intended to fulfill the goal (notice that even when the goal is independently reachable, an agent may prefer to delegate it to other agents). The issues of interactions and delegations are discussed in the following sections.

5.1 Interactions
As recognized by Dignum in (Dignum, 2004), interactions are an important factor in the attainment of organizational goals. She affirms that “interactions occur not just by accident but aim at achieving some desired global goals, and that participants are autonomous, heterogeneous and not under the control of a single authority”. In this proposal, the author considers the concept of interaction as being the joint activity of the participating roles.

An important issue in the topic of interactions is that they can occur to satisfy goals that are either common to agents or global goals which pertain to the society as a whole and lay outside the scope of each individual agent (also denominated as “emergent” goals). If we consider sub-organizations as a kind of structured agents, interactions among the sub-organizations can be faced as a way of realizing the society goals. In this case, the coordination to obtain the global goal is established by the global organization via some constraints/norms that regulate the interactions between the sub-organizations. Note that the interactions imposed by the global organization generally are a vague insight about how to realize the global plan, while additional interactions can be set up by the sub-organizations in order to realize the refinement of their goals (ISTC-CNR, 2005-2007b).

Not only the pursuit of common goals justify the establishment of interactions. Concerning this issue, in (ISTC-CNR, 2005-2007b), the authors introduce the concept of collective capability which refers that the states of the world an agent is able to attain participating to a collective action that involves the help of other agents. Thus, interactions can be characterized by the notion of common goals that are shared by agents who presents complementary capabilities to attain these goals. In fact, in some cases goal achievement is associated not with an agent who instantiate an action to fulfill the goal, but with two or more agents who separately are not able to accomplish the goal by themselves (since they are not knowledgeable enough or constrained in their resources) and thus, need to interact to achieve the goal.

A more rigorous interpretation of the concept of interaction is provided by (Guizzardi, et al., 2007). The authors explain the need of establishment of interactions based on the concept of dependency between agents. To explain better what a dependency relation is, remember from section 4.1, that moments are properties from individuals. Moments can be specialized into intrinsic moments and relators. Intrinsic moments are moments that is existentially dependent on one single individual (such as my headache pain is existentially dependent solely on me and the color of an apple solely depends on the apple to exist), while relators are moments that is existentially dependent on more than one individual, such as the marriage of Lisa and John depends on both individuals to exist.

Relations are entities that glue together other entities. They can be divided into two broad categories, called material and formal relations. Formal relations hold between two or more entities directly without any further intervening individual. Examples of formal relations are: 5 is greater than 3, this day is part of this month, and N is subset of Q (Guizzardi, 2005). In counterpart, material relations, conversely, have material structure on their own and need something else to exist, i.e., the relators. Employments, marriages and kisses are good examples of material relations (Guizzardi, 2005).

Dependencies are seen in this proposal as a formal relation and delegations as material relations (delegations are further explained in the next section). An example of dependency explained in terms of formal relation is extracted from (Guizzardi, et al., 2007):

“Suppose that John cannot review this article by himself, since there are some aspects of the article which are outside his field of competence. Now, suppose that George is a colleague of John who is knowledgeable exactly in those aspects that John needs to review article X. In this case, we could say that John depends on George to review article X. Notice, however, that this relation between John and George can be reduced to relations between the goals and capabilities of these individual agents (i.e. between the intrinsic moments of the involved relata). Moreover, this relation does not even require that the related agents are aware of this dependence.”

Interactions, thus, can be explained with the support of dependency relations. Agents can interact to achieve goals based on intrinsic (depended) capabilities of other agents.

5.2 Delegations
As we have discussed earlier, agents may decide to delegate a goal or a plan that is intended to fulfill a goal. When an agent A decides to delegate a goal to an agent B through a relationship of delegation, the act of requesting is denominated as social claim and agent A is called the delegator in the relationship of delegation. The act of agent B of assuming the achievement of the goal on behalf of agent A is, in turn, denominated as social commitment (and agent B is called the delegatee in the relationship of delegation). The commitment/claim pair entails the creation of a social relator (delegaturn). There are two types of delegation, according to the delegaturn: open delegation and close delegation. In a close delegation, when A performs a delegation action, it delegates not only a goal, but also a way of achieving it (also delegates a plan). This means that the delegator A believes
that it is possible that the delegatee accepts and it is able to execute the delegated plan. Instead, in an open delegation, the delegator only delegates the goal to the agent B and the responsibility of finding a strategy to reach the goal relies on B. Observe that, since delegations are a kind of material relation, the relators in this case are the goal (open delegation) or the plan (close delegation).

Open delegations are often motivated by a lack of competence of the delegator who opts to transfer a specific sub-goal (or sub-plan) to the delegatee. The expertise of the delegatee enables him/her to choose the best alternative under the specific constraints. In some more extreme cases, the delegator gives the power to the delegatee to build the optimal context to execute the delegated sub-plan, i.e. the delegatee has the power of structuring a sub-organization (ISTC-CNR, 2005-2007b). Other factors which motivate delegations are: the availability of resources and rights and permissions that limit or empower agents in an environment submitted to regulations (ISTC-CNR, 2005-2007b).

6. OBJECTS
In several ontologies, objects are endurants, i.e., entities that “are in time”, like a ball, a pen, or a flower. Endurants are the opposite of perdurants (or events) that correspond to entities that “happen in time”, like a business process, a wedding, etc. (Guizzardi, 2005) (Bottazzi, et al., 2009).

In (Guizzardi, 2006), the concept of physical object is specialized into physical agent and non-agentive object. The classification in relation to the agentivity refers to the ability of the object of holding intentionality. Physical agents and their relation with goal achievement have already been explored in previous topics. Therefore, here, we refer to non-agentive objects to explain their relation with goal achievement.

Objects can be physical (e.g., an equipment, a device) or social (e.g., money, language and normative descriptions) (Bottazzi, et al., 2009) (Guizzardi, et al., 2008). Normative descriptions are further explored in next section.

Objects are denominated as resources when they are used by an agent with a specific purpose. In this case, how the resource participates in the action affects how goals are achieved. With that respect, in (Guizzardi, et al., 2008), authors define that there are four different modes of resource to participate in actions, namely, creation, termination, change and usage.

Informally speaking, a resource creation and termination correspond respectively to the creation and termination of some resource in the organizational environment. A resource change means that some property (moment) of the resource has been altered by an action and finally, a resource usage is a kind of participation which is not any of the three aforementioned modes. Sometimes, the way how the resource participates in the action is determinant for goals to be achieved. An example of how a resource participation impacts some goal to be fulfilled is when some agent has to access to the resource to achieve a goal.

7. RULES AND NORMS
Organizations are entities that strongly depend on norms; i.e., they are completely made up of norms (ISTC-CNR, 2005-2007b). The proposals in (Boella, et al., 2006) (Bottazzi, et al., 2009) (Guizzardi, et al., 2008) view rules and norms as a collectively recognized descriptions which act as enforcement mechanisms to restrain the individual behaviour of agents, regulating all sort of organizational interactions among them, including delegations, relationships with internal/external organizational entities as well as defining concepts within the organizational setting.

Botazzi (Bottazzi, et al., 2009) and Searle (Searle, 1995) suggest three different kinds of norms based on the different functions they have; constitutive norms, deontic norms and technical norms:

7.1 Constitutive Norms
Searle (Searle, 1995) argues that the social reality is constructed by this kind of norms which create new institutional concepts. In fact, they are responsible for defining the institution itself, since the organization comprehend a social concept defined by norms and collectively accepted by a human community. In (Guizzardi, et al., 2008), social concepts are created by normative descriptions. Among the social concepts that authors cite, we have social objects (such as the crown of the king of Spain), social roles (such as president or pedestrian) and social commitments (such as social contracts).

This kind of norms is responsible for the creation of social concepts which make feasible for goals to be attained within the organizational context. For example, it creates social objects which may be indispensable for the realization of some action to fulfill a goal. Furthermore, they describe the activities and services that must be executed by roles to achieve society goals. In this sense, norms are responsible for providing the linkage between organizational goals and roles (ISTC-CNR, 2005-2007b) since the definition of roles assigns obligations, prohibitions and permissions to specific roles to achieve organizational goals.

7.2 Deontic Norms
Searle in its construction of social reality (Searle, 1995) discusses the distinction between the nature of constitutive and deontic norms. He explains that constitutive norms have the function of creating concepts, whereas deontic norms constrain the existence of pre-existing concepts.

He uses two examples for illustrating the difference between the constitutive and the deontic norms (respectively): the act of playing chess and the act of eating. On one hand, the act of playing chess is created by the constitutive norms, i.e., the activity of playing chess just exist whether the actions performed by players are in accordance to these rules (in other words, playing chess is defined by the norms). On the other hand, the act of eating is a concept which exists independently of the (deontic) rules which state what is polite or not. In this sense, the constitutive norms create the possibility of the existence of an activity denominated as playing chess.

Therefore, deontic norms in this sense have a regulatory function within organizations. With respect to roles, while constitutive norms are responsible for creating roles, deontic norms have the function of avoiding a potential deviation of agents’ behaviour while pursuing organizational goals. Notice that this possible deviation refers to the fact that agents have their own goals which can be non-compliant with organization’s expectation (Dignum, 2004). Since agents are relatively free for adopting the strategies (actions and plans) for attaining organizational goals, norms not only provide the link between an agent and its goals through roles, but also can dictate the plans to be executed to achieve these goals. Moreover, norms can even constrain the way how plans must be executed (please, refer to technical norms).

When goals are collectively pursued, a social contract is a mean of coordinating roles through the description of conditions, rules and agreements applied to an agent while enacting roles (Dignum,
Contracts are valuable instruments for specifying the commitments of participants in relation to each other, i.e., under which terms they interact, the responsibility over the acts, the power of each participant in the interaction and so forth.

Finally, with respect to resources, norms can regulate the possession/access of certain objects. In some cases, permissions and rights are similar to physical resources in a system governed by laws (Bottazzi, et al., 2009).

7.3 Technical Norms

Technical norms describe the correct procedure to do something, i.e., they specify how a plan should be executed. They are different from deontic norms in the sense that deontic norms are assertive (prescriptive) and technical norms are like suggestions (Bottazzi, et al., 2009). Therefore, technical norms basically present the same relation with goals that the deontic norms, i.e., while deontic norms regulate the behaviour of agents in pursuing goals within the organization, the technical norms also provide guidelines for governing the agent’s behaviour in goals’ realization.

Further, a last distinction that could be made about norms is based on their origin. They can be institutionally created by an authority and thus explicitly encoded on some physical artifact, or they can emerge from social practices. In the latter case they can still remain implicit, or later evolve in institutional when their usefulness is recognized by someone in the organization who decides to encode them (Bottazzi, et al., 2009).

8. CONCLUSIONS AND FUTURE WORK

Enterprise ontologies are particular kinds of ontologies employed in clarifying the domain of enterprises and organizations. They have the purpose of capturing what organizations are as well as characterizing organizations through a set of basic building blocks.

We have started with the vision that organizations do not merely consist in the plurality of the individuals that compose them; rather, organizations consist of social (designed) agents organized to support the collective pursuit of goals by the roles which compose the organization. These social roles are the concepts used to abstract from specific agents and to reason in general about the organization. This opens up the possibility of the agents who instantiate the organizational setting to “realize” the organization according to their point of view, deviating from the intended design. This definition highlights the importance of agents in being self-committed in adopting organizational goals (the intentionality aspect), as well as having the abilities for achieving these goals (capabilities).

Since agents have freedom of action, norms are an attempt of organizations to enforce its goal-pursuit by agents (ISTC-CNR, 2005-2007b). They have a meta-role in the achievement of organizational goals in the sense that they regulate all sort of organizational aspects; they prescribe which goals agents must adopt through the definition of roles, they guide the action of agents in the course of pursuing these goals (including interactions and delegations), they create the social concepts that are necessary to fulfill organizational goals and so forth.

The study we have presented here will serve as a basis for our research agenda on the ontological analysis of enterprise modelling approaches. So far, our research group has performed a detailed interpretation of ARIS EPCs (Santos Jr., et al., 2010a), the ARIS Organizational Model (Santos Jr., et al., 2010b) and the ARIS Objective Diagram (Cardoso, et al., 2010c). Further, we have worked on the organizational structure aspects of DoDAF, ArchiMate, BPMN, RM-ODP and ARIS (Almeida, et al., 2009) and on the ontological analysis of Tropos/° (Guizzardi, et al., 2008) and the RM-ODP Enterprise Language (the goal aspect (Almeida, et al., 2010d)). That work has been conducted using primarily the Unified Foundation Ontology as defined in (Guizzardi, 2005) and (Guizzardi, et al. 2008). Here, we investigate other developments in enterprise ontologies which can complement this foundational ontology so as to identify areas for future expansion of the ontology.

It is important to emphasize that the integration of several ontologies can bring about semantic inconsistencies, since each ontology defines its concepts based on different assumptions and foundations. We recognize that this semantic interoperability is an issue that cannot be neglected in this integration. Nevertheless, we argue that enterprise modeling covers a broad scope of the social domain which is currently not addressed by a sole organizational ontology. Therefore, this deficiency led us to survey several ontologies with the aim of providing a thorough account for a real organization. Certainly, a systematization of the concepts presented here in the definition of a coherent formal ontology is a natural direction for future work and remains a significant challenge. Further, we concur with Dietz (2003) that “one can never claim to have a model that is sufficient for studying the organization.” In this sense, further areas of investigation include Language-Action Perspective-based frameworks such as the one proposed in (Dietz, 2003).

ACKNOWLEDGMENTS

We would like to thank Renata Guizzardi and Giancarlo Bottazzi for fruitful discussions on the topics of this paper. This research is funded by the Brazilian Research Funding Agencies FAPES (grant number 45444080/09) and CNPq (grants number 481906/2009-6, 309059/2008-9 and 483383/2010-4).

REFERENCES


Bottazzi, E. and Ferrario, R. A Path to an Ontology of Organizations. EDOC International Workshop on Vocabularies, Ontologies
and Rules for The Enterprise (VORTE 2005), Enschede, the Netherlands. 2005.  
ISTC-CNR. Mostro, deliverable 5 - Methodology for Organization and Security Analysis, Province of Trento, Italy. 2006-2007c.  