Semantic Representation of Contract Knowledge using Multi Tier Ontology

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Business contract knowledge exists dispersed in different domains. For successful business process functioning, a precise, clear understanding and interpretation of contractual terms and conditions is required. A semantic interpretation of *contract obligations* and their required *performances* to *fulfill* the obligations, is aimed to bridge the existing gap between business process management and contract management. The increasing impact of e-commerce also necessitates the requirement for centralized, reusable knowledge bases. This paper presents conceptual models and an ontological representation methodology for capturing semantic interpretations of business contracts in a *Multi Tier Contract Ontology*.

1.Introduction

Humanity started trading using simple barter systems, goods in exchange for goods. Business trade relationships are now complex processes of building trust, understanding and mutual agreement. At the center of these processes are the business legal contracts. It is essential that all parties concerned have a clear understanding of the contents and implications of the agreed contractual terms and conditions. With the adoption of legal regulations facilitating e-commerce, electronic contracting and e-commerce should set new trends in the near future. Notable are e-commerce standardization efforts like that of ebXML[1], which enables partners across the globe to participate in electronic trade relationships using the available Internet technology. This means that business organizations can enter into contractual relationships with partners, hereto unknown and unseen. The need for human understanding of the established contract is thus obvious. Added to this, electronic contracting agents for drafting, negotiation and enforcement are the focus of several contemporary research efforts. Considering the current global perspective of contracting and business, the need for a meaningful semantic web for modeling, representing and exchanging knowledge is well established.

The semantic web[2] has a visionary goal and objective of making the World Wide Web into one gigantic knowledge resource. The semantic web is visualized as a grad-

ual stepwise tower of semantic languages as put forward by Tim Berners-Lee[3] (See figure 1). Our contribution to the semantic web movement is currently in the knowledge resource development in the form of ontology. Ontology vocabularies are a viable candidate for such global knowledge pools. The importance of ontology engineering for the success of the net commerce has been discussed by Howard Smith [4].

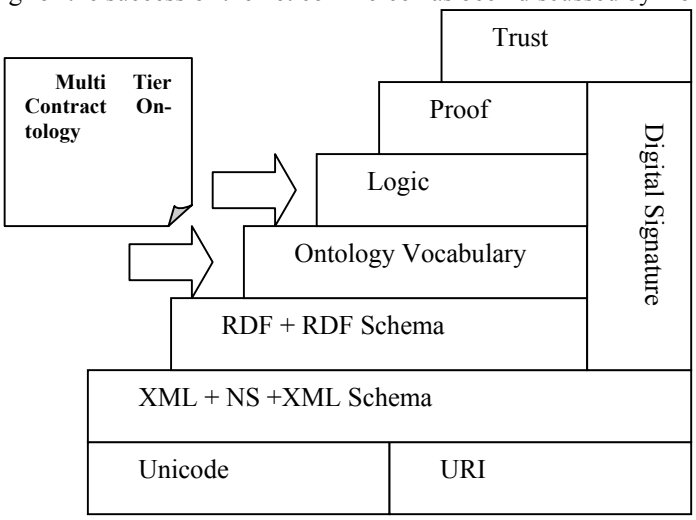

Figure 1: Semantic Web Architecture

Contract Management has existed for some time as well as Business Process Management. However, most available solutions like ERP, CRM or other database applications for enterprise management or contract management, have not managed to integrate the two disciplines seamlessly. A business contract is like a master plan for expected business behavior of the parties involved. Generally, it covers most contingencies and probable scenarios for planned execution of the commitments the parties make to each other. Thus, non-compliance to the contract terms could lead to legal, economic and business repercussions. A business contract should govern and establish the actual business process workflow of the parties. Efforts have been made to build discretionary enforcement agents using subjective logic [5], or deontic logic [6]. Others have treated the contract as documents or processes [7,8]. Our focus has been on the knowledge base representation and modeling methodology for capturing the semantics of a contract. This paper adopts the framework as proposed by the same authors in [9].

Business contracts are one specific application domain in the realm of enterprise application management. This paper presents a layered ontology structure for representing contractual domain perspectives. The conceptual meanings and interpretations of the contractual obligations inherent in a business contract are analyzed and represented in the multi tier contract ontology. The choice of knowledge representation methodology depends to a large extent on the purpose as well as the intended audience for the knowledge base. As mentioned earlier, business contracts are testaments to the commitments made by business entities to each other in the context of a busi-

ness trade relationships. Business contract management depends on several factors that cannot all be automated. Human intervention cannot be sidelined. Thus, the first targets for knowledge transfer are humans and thereafter, machines and software agents. Hence, we present conceptual models using UML [10] as the first step. Next, we propose a transformation of the same to machine understandable format using RDFS [11] /DAML [12].

The main contributions of this paper are the conceptual models of contract knowledge using UML in a multi tier ontology framework. Thereafter, the paper presents validations of the proposed methodology in the form of proof of concept implementations of the conceptual models in RDFS and DAML ontology representation languages.

The rest of the paper is structured as follows. In Section 2 we present a short summary of related research work in the domain of contracting and ontology. In section 3, we discuss our choice of UML as an ontology-modeling tool, followed by conceptual models for our proposed Multi Tier Contract Ontology (section 4). The paper outlines the overall structure of the Multi tier contract ontology and thereafter focuses on the detailed analysis of a specific contract type. We present a proof of concept transformations to DAML and RDFS using Protégé 2000[13] as a tool in section 5. The proof of concept illustrates that the transformation from conceptual model to machine understandable format is possible. In this process, we came across some practical hitches while transforming from UML to DAML or UML to RDFS. We present some of our observations in section 5.3. Thereafter we propose some applications for the Multi Tier Contract Ontology in section 6, followed by concluding remarks in Section7.

2.Related Research

Contracting, especially electronic contracting has been the topic of interest for several groups of researchers. Though most have the same ultimate objective, each has adopted a different methodology to achieve the same. We see that a contract has been viewed in different perspectives in general:

- Document Centric – a contract is considered as a physical document and its contents are analyzed and modeled as entities. This has little or no semantics involved with it [14]
- Process Centric – a contract is viewed as a statement of business processes or workflows. In this aspect, though semantic interpretation has been tried, most efforts tend to interpret the contract conditions as rules, policies requiring stringent enforcements.
- Legal Centric – a contract is a legal instrument. Efforts are on to establish legal dictionaries [15].

Electronic contracting was pioneered by the efforts of Ronald Lee [16,17] who has amongst other things proposed the use of Petri Nets to model contract procedures like the Documentary Credits. Grosof in [18] has proposed Courteous Logic Programs as a declarative approach to model the business rules and policies as expressed in contracts. Grosof has further presented a XML based rule representation language RuleML and has also used it with ontologies to produce SweetDeal [19], an approach to aid automated creation, evaluation, negotiation and execution of contracts. He has

viewed contracts as specification for processes. There exist possibilities of integrating other contract ontologies like our proposed multi tier contract ontology to the system as proposed by Grosof.

Kimbrough, Moore [20] and others have worked on a Formal Language for Business Communication (FLBC), used to model and structure the communication for negotiation of agreements. Daskalopulu [21,22] has used subjective logic to monitor electronic contract performance.

Heuvel and Weigand [23] have presented integrated enterprise architecture to integrate contracts with business workflow and business objects. They have visualized contracts as the binding glue to cross-organizational business workflows. Contracts are scenarios denoting sequences of transactions.

Yao-Hua Tan has used deontic logic to model directed obligations and permissions in [24]. He has also used event semantics as proposed in FLBC to model the semantics of a contract. He then uses Prolog to implement the modeled contract conditions. His work gives this paper its foundation for the classification of obligation states.

Levine and Pomerol [25] have proposed a methodology called ABC (Approach Based on Contract) to construct business models using contracts as a starting point.

Goodchild [26] has analyzed the fundamental concepts for a business contract and has modeled the contract using UML and represented them in XML. However, he has viewed the contract as a document and has placed emphasis on the physical characterization of a contract contents.

From the above discussion we see that though semantic interpretation and automated contracting is not novel but little has been done to model the semantics of a contract in the form of a knowledge base. A semantic knowledge pool would enhance and complement the various methodologies proposed for automated contracting. At the same time, contracts depend on human interaction. Thus human-to-human communication is the first line of approach for our proposed methodology. The Multi Tier Contract Ontology is the representation of contract knowledge for such a purpose.

We believe that one of the fundamental keys to the success of the semantic web is the reuse and integration of other related approaches and methodologies. We have been guided by the works of Noy and Mcguinness [27] and Gruber [28] for design methodologies for the proposed Multi Tier Contract Ontology. McGuinness [29] has supported the role of ontology engineering in the domain of business process engineering. Howard Smith [4] advocates the importance of ontology for agents to rely on and to communicate with other agents.

3.UML as Ontology Modeling Language

Contract knowledge existing in different domains has to be modeled and represented using standard, comprehensible notations. Knowledge Base resources form an essential component of any information system, be it artificial intelligence agents, software tools or enterprise application software. Such a knowledge base should use a knowledge representation language that is independent of application domain. It should be clear, easy to understand and portable. As stated earlier, the first objective in this research is to facilitate human-to-human knowledge transfer. Later, we propose to progress towards deductive logic and automated inference systems for contract

term interpretation and decision support. We chose the Object Management Group's Unified Modeling Language (UML) [10] as our conceptual model representation language.

Advantages of UML as an ontology modeling language has been proposed by Cranefield [30], Hart, Baklawski et al in [31] as:

- It has a growing user audience in the software domain for object modeling languages and other information system design. In our case, those attempting to integrate business contracts with existing business management applications, are more likely to be familiar with UML than other knowledge representation languages like KIF.
- The graphical notation for UML is easy to comprehend and use and is suitable for human-to-human knowledge transfer.
- UML can be extended to suit the need of ontology definitions.
- Object Constraint Language allows expression of rules and constraints.

Moreover, UML conceptual models can be translated into other ontology languages like RDFS or DAML or even in to object oriented database systems. Cranefield in [32] has proposed mappings to transform UML ontology models in to RDF and to generate Java classes from UML using XSLT.

Ongoing research and open source development in the field of semantic web and ontologies have contributed to a rapidly increasing pool of reusable knowledge resources, tools and guidelines. We have used Protégé 2000[13] as our ontology editor tool. Open source plugins are available for automated generation of RDFS ontology from UML conceptual models, DAML storage etc. Others like DUET (DAML UML Enhanced Tool)[33] of the CODIP (Components for Ontology Driven Information Push)[34] project provide DAML support to UML tools like Rational, Argo UML. This paper adopts and uses such available technology and research methodologies in the aim of contributing productively to the vision of semantic web.

Baklawski [31] has presented some mappings for translating in between DAML and UML concepts and from UML to DAML, as illustrated in the figure (2) below, which have been adopted in this paper.

DAML Concept	**Similar UML Concepts**
Ontology	Package
Class	Class
As Sets (disjoint, union)	Difficult to represent
Hierarchy	Class Generalization Relations
Property	Aspects of Attributes, Associations and Classes
Hierarchy	None for Attributes, limited Generalization for Associations, Class Generalization Relations
Restriction	Constrain Association ends , including multiplicity and roles. Implicitly as class containing the attribute
Data Types	Data Types
Instances and Values	Object Instances and Attribute Values

Figure 2. High-Level Mapping of UML and DAML Concepts

4. Multi Tier Contract Ontology

4.1. Background

A business contract goes through different phases in its life cycle from the pre – conception, drafting phase, through negotiation and signing till the execution. Angelov has identified various phases and sub phases of the contracting process in [35] and as depicted in figure (3) below.

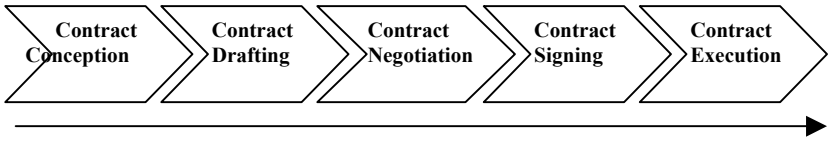

Figure 3: Contract Cycle

Business management, process, requirements and strategic knowledge contribute to the pre conception contract phase. Legal counsel, recommended practices, contract model law play important roles in the contract-drafting phase. Contracts are then proposed to suitable partners by a *proposer*, counter offers and acceptances are then offered. This process of understanding and coming to a mutually satisfying agreement is the contract negotiation phase, followed by the actual signing and validating of the contract document. Finally, the contract is to be carried out and fulfilled. In the contract execution phase, the agreed conditions and promises are acted upon. Contract execution depends on the actual business process workflow. It needs to be monitored and commitments fulfilled within the contract execution phase. The contract execution is terminated once the contract period is over or it leads to a renewed or fresh contract being negotiated. The proposed Multi Tier Contract Ontology would be a central knowledge base for all the above-mentioned phases. But current work is focused on the contract execution phase, especially on deducing the business workflow from contract terms as well as monitoring and fulfillment of commitments.

Contract knowledge has been modeled based on domain input from the legal framework. Business process knowledge has been based on other ontologies and standards like REA ontology and ebXML. Finally, business workflow patterns as proposed by Van der Aalst [36], Sivaraman [37] and others, have been adapted to model contract workflow patterns.

4.2. Multi Tier Contract Ontology framework

Within the realm of business contracts alone, there exist many different types of contracts [38] having different scopes and applicability. It is impractical to represent all the different types by single contract ontology. Following the ontology design principle as proposed by Guarino [39], a structured and layered framework for contract ontology was envisioned. A layered structure provides the scope for defining an individual ontology for specific types yet coherently integrating under one unified framework. The multi tier contract ontology is envisioned to consist of the following layers:

- Upper Level Contract Ontology
- Specific Domain Level Contract Ontology
- Template Level Contract Ontology

The Upper Level Core contract conceptual model defines all the required and necessary components of a business contract in order to be legally valid. For electronic contracts, we would have additional concepts like digital signatures, public key encryption, security and archiving issues etc.

The second Specific Domain level contract ontology relates to specific contract types. As an illustration, we propose a specific contract type ontology specification for Buy-Sell of commercial goods. In this respect, we draw conclusions and guidance from various internationally adopted legal directives like UNCSIG [40], UNIDROIT [41] principles for commercial transactions, UNCITRAL model contract law [42] etc. The research has been focused specially on the *obligations* and the expected *fulfillment* through the execution of *performance events.* This has been done in order to facilitate easy integration and understanding of the required business process workflow to comply with the contract terms.

The third, template level ontology is visualized as a group of pre defined contractual obligation and their fulfillment patterns. These incorporate standard recommended contract forms like that of ICC's [43] contract model form for International Sale of Perishable Commercial Goods [44], or standard forms for sale of used vehicles etc. Each pertains to the same contract type but yet differ in specific information details contained within them.

This framework allows the Contract Ontology to be flexible, extensible and coherent. It can be easily extended horizontally and further layers are also possible. Moreover, users of the ontology can extract and use parts of the ontology as required for their domain of applicability. Multi Tier Contract Ontology is a hierarchy of ontologies moving from the general to the specific and then down to precise Meta data definitions.

In this paper, we present detailed analysis of a specific contract type, the sale of goods contract type. However, we present a brief overview of the basic concepts, which comprise the Upper Level Core Ontology model.

4.3. Overview Of Upper Level Core Contract Ontology

Any legal contract between two business organizations must have information pertaining to the parties concerned, that is the principal *actors.* Each *actor* has a certain part to play in the whole process of contracting, followed by its business execution. In the contract execution phase the actors may take on the roles of *a seller* or a *buyer.* A contract agreement is drawn up to affect the transfer or performance of certain deeds in exchange for some other deeds or money. This is known as *consideration* in legal terms. *Goods* are a common example for *consideration* in case of business contracts. *Services* or non-disclosure promises are could be other examples of considerations. The actors involved in the contract make certain promises or commitments to each other. These are known as *obligations,* which need to be honored or *fulfilled.* These testify to the intention of the two parties to *perform* to satisfy the conditions agreed for the same *obligation.*

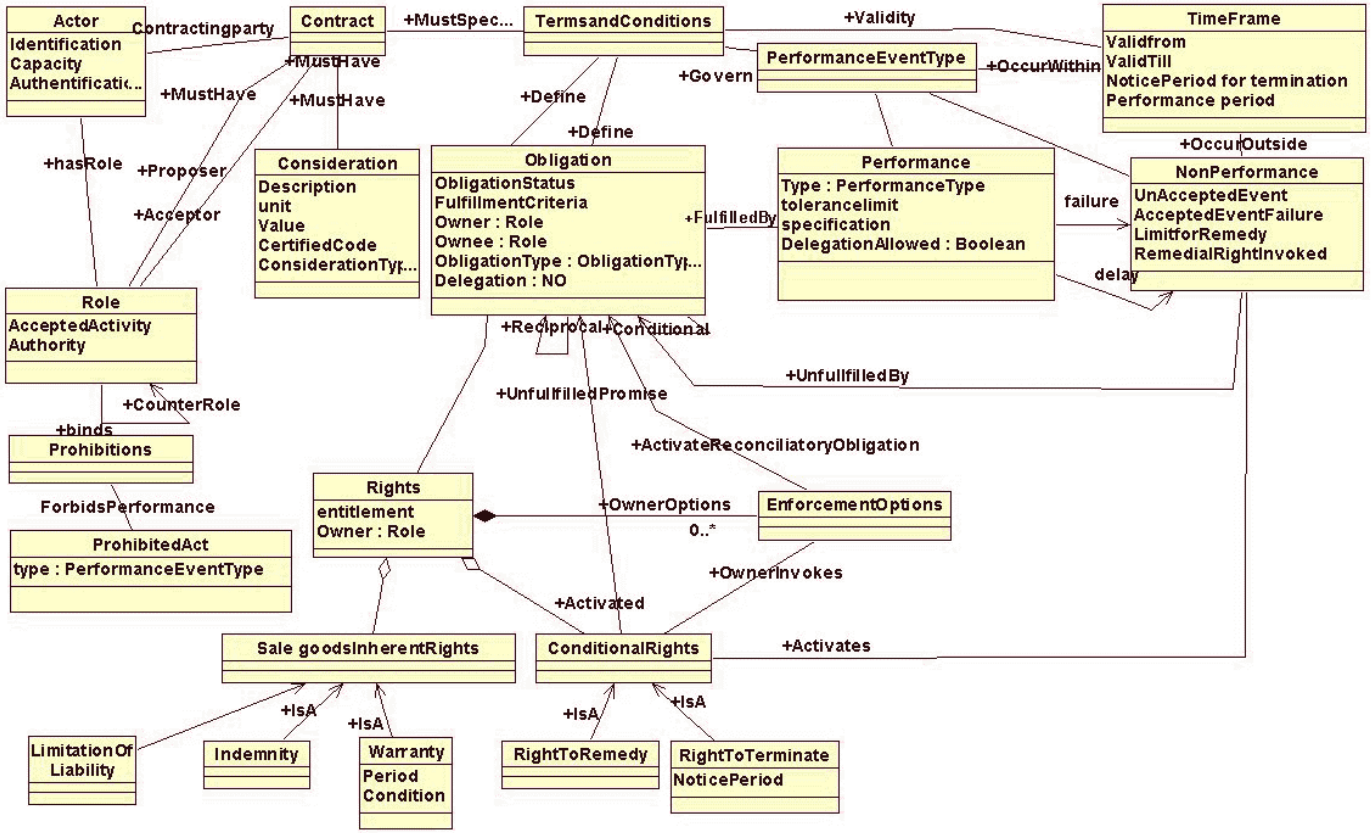

Figure 4: Basic Concepts defined in Upper Level Core Contract Ontology

The legal terms and conditions define all the expected behavior and conditions for satisfactory acceptance of the business behaviors. Like, if a party promises to deliver a pizza made to order within half an hour from the time it is ordered, then the satisfactory condition would be the actual delivery of the pizza that should be conformant to the type of pizza ordered and should be delivered within the time promised. A legal obligation is backed up by the possible consequences in case of failure or *non-performance.* In case the delivered pizza did not match with the type of pizza ordered or it was delivered later than promised, then the customer could reject the pizza or not pay for it or may be demand a replacement of the pizza with another etc. Again these remedial options are also agreed upon and specified in a business contract, to cover all possible eventualities. Thus, along with the definition of the principal actors, their undertaken roles, the object of consideration, the promised obligations, the expected performance events, the fulfillment conditions and terms, the business contract would also have certain *rights, remedies, and prohibitions* too. It is also customary to include terms to limit or protect the liability of the parties involved. Thus the *risks* involved are also defined and appropriately divided and transferred with respect to the execution of business activities.

We explain the above concepts in detail with help of a sale of goods contract type model as discussed in the following section.

4.4 Sale of Goods Business Contract Model

The Upper Core Level ontology defines all the necessary and relevant concepts for any legal business contract. As mentioned earlier, business contracts range over a wide area of application and scopes. Each business contract type has their own specific peculiarities as well as commonly used terms and conditions. However, each of them is a specialization of the same fundamental concepts as defined in the upper level core ontology. Thus the approach methodology adopted for each of the business contract type analyzed is that the upper level core ontology is taken as the point of reference and all specializations and extensions to the basic concepts are modeled based on the identified generic concepts. In other words, each of the shared specific domain level contract ontology inherits from the global upper level core ontology and extends the concepts according to its specific modalities.

For example, in a typical sale and purchase of goods scenario, the principal *actors* are known as *buyer* and *seller*. The *consideration* for business trade transactions are usually exchange of objects in return for other objects or more commonly money. More commonly the *consideration* are referred to as *goods.*

Goods are legally defined as commodities or items of all types, excepting services, which are involved in trade or commerce. *Goods* are characterized by their description, technical specification, type of packaging required, type of cargo etc. We find different international standard vocabularies existing for product categorization like that of the UNSPSC [45], or the CPV [46], which can be readily re, used and adopted within this ontology model. Similarly, UN Recommendation no 21[47] can also be modeled as an integrated or a separate ontology describing codes for types of cargo, packages and packaging materials.

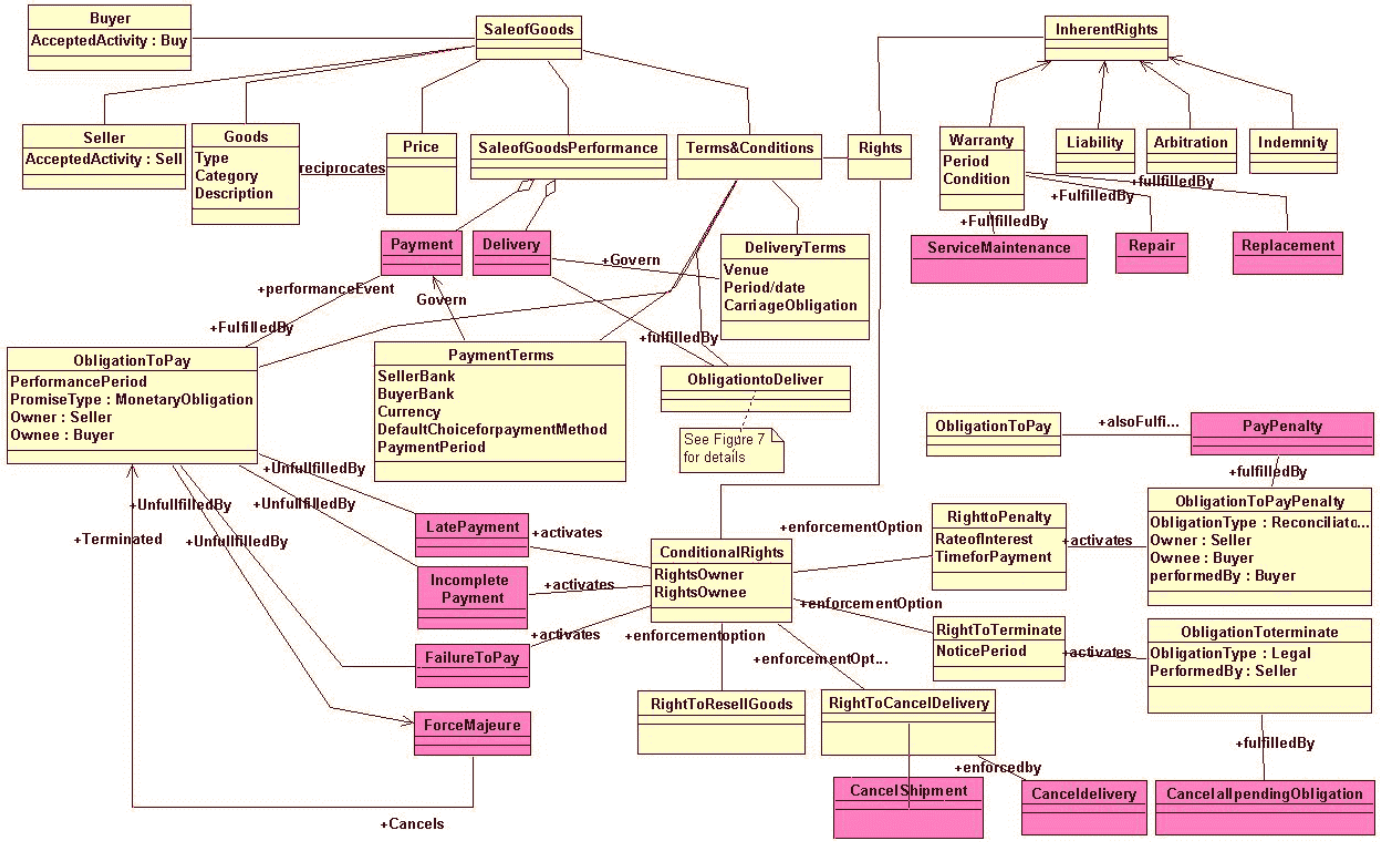

Figure 5: Extract from Sale of Goods Contract Model

Figure 5 shown above is an extract from the conceptual models for a typical sale of goods business contract type.

The *buyer* agrees to pay a certain *price* for the *goods* received. *Price* is usually monetary payment and currency, mode of payment is recommended issues to be discussed and settled between the contract parties. The sale of goods contract should include *payment terms,* which have the details of the agreed payment method and conditions.

Like if the *buyer* is to pay part of the payment amount at the time of ordering and the rest on delivery or if he pays only after delivery. Also payment mode like bank transfer or documentary credits is the preferred method is indicated. Under this concept, we can merge a vocabulary for the Unified Customs and Practice for Documentary Credits [48], which has been discussed and modeled by Lee [17].

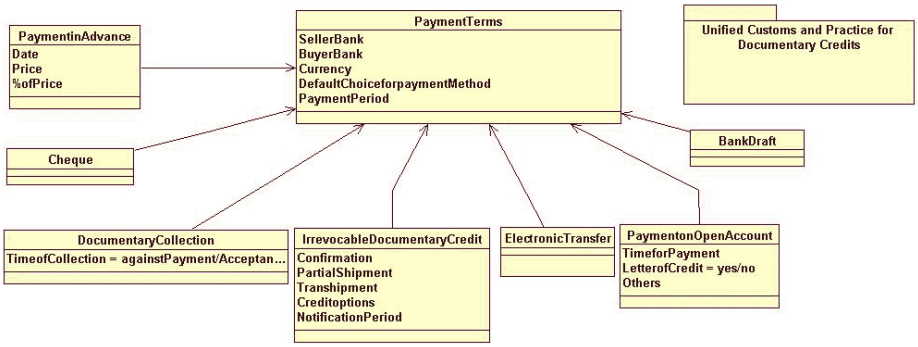

Figure 6: Illustration for common Payment Terms and Methods

Similarly, *Delivery Terms* are also negotiated and expressed in a contract. The *delivery terms* include details regarding the time, venue and choice of place of delivery. Standard delivery terms like International Chamber of Commerce's INCOTERMS [49], can be used to describe the delivery terms. We see that such terms and conditions, either explicitly or implicitly defines some legal or business *obligations* on the part of the parties concerned. These commitments that bind a *role* player, like the *buyer* or the *seller*, to perform certain acts are called as *obligations.* The primary obligations of a buyer are *obligation to pay* and an *obligation to accept goods* as inferred from INCOTERMS. On the other hand, a *seller* is bound by the *obligation to deliver* s his primary obligation. Obligations need to be *fullfilledBy* the execution of expected *performance*. Say for example, a seller's obligation to deliver could be accepted as fulfilled, if and only if, he carries out the business activities that can be termed as a *delivery.* (See Figure 7 for details)

The actual performance of *delivery* would probably be comprised of several other business activities, which have been shown in figure. Such information, presented in the conceptual models of the sale of goods specific domain ontology, form a useful contribution towards generating the contract workflow models for the business entities. It also helps in business process integration by identifying and exposing shared business activities as possible points of business interoperability and interfaces.

In the extract shown, we see that the seller's obligation to deliver is fulfilled by delivery. In reality, it is quite possible that execution of a promised event is not always successful. A contract generally provides alternatives for handling such exceptions and unacceptable *non-performances*. For example, the *obligation to deliver* may be *UnfullfilledBy* if the delivery is late or delivery is not affected or the delivery is made, but the goods do not conform to the specification as described by the *goods* specification. In such cases, the buyer gets the right to seek redress for the failed performance. The buyer may be presented with one or more *enforcement options,* whereby he could make a choice from the available options, like choosing to have the order cancelled or simply imposing a penalty or opting for a re-delivery of the goods or even having the contract itself terminated. The buyer's choice then binds the defaulter, the seller to a *reconciliatory* obligation to fulfill the chosen form of remedy. The seller has a *secondary obligation* to package the goods he delivers.

Similar detailed analysis has been done for each kind of obligation, rights, or prohibitions that can be included in a typical sale of goods contract. Thus a wide range of possible scenarios involved in a commercial business transaction is covered. This forms an essential knowledge base for the business decision, and strategic planning also. Awareness of possible consequences of non-performance or non-compliance to a contract terms could influence the business process management to a great extent. Contract compliance and performance monitoring have been a crucial concern for most business managements. Multi Tier Contract Ontology is visualized to contribute towards business knowledge management, improving efficiency and performance. On a wider horizon, the proposed ontology framework is visualized as a global network of integrated knowledge resources, exploiting the vast potential of the semantic web to its utmost.

In the following section, the paper presents illustrative proof of concepts for implementing the conceptual models in to machine understandable and searchable formats using semantic web ontology languages like RDFS and DAML.

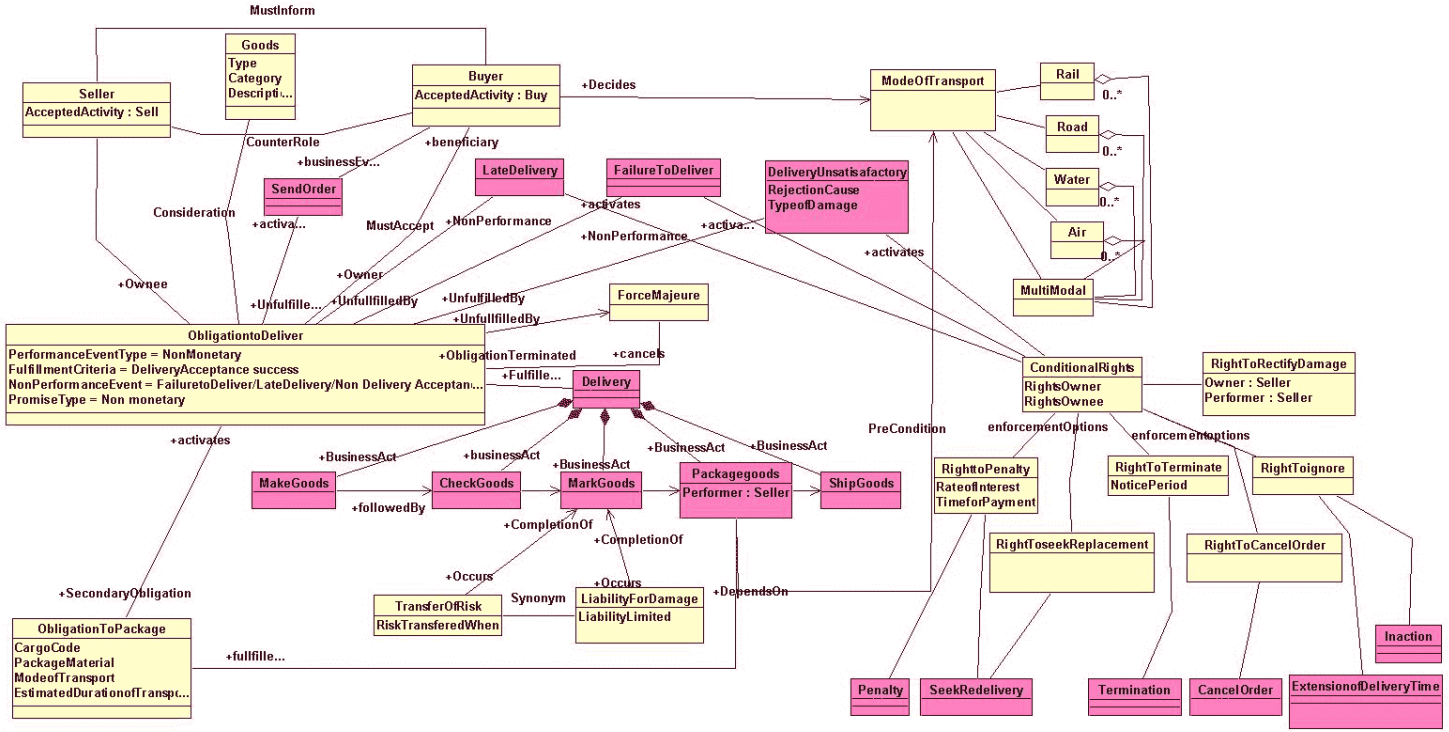

Figure 7: Seller's Obligation to Deliver (expanded view)

5.Proof of Concept for Multi Tier Contract Ontology

5.1. UML to RDFS Transformations

We present a simplified version of our conceptual model for the Upper Core Contract ontology layer, which has most of the main concepts illustrated in figure (8) below. As mentioned in section 2, we chose to represent our conceptual models in UML for the reasons stated therein. We model the concepts as UML classes which could be modeled as Resources in the Resource Description Framework [50]. UML class associations are characteristics or Properties linking the resources to their values in the RDF graphs. The UML association ends are used to depict the property roles or relation to the other resources or classes in this case.

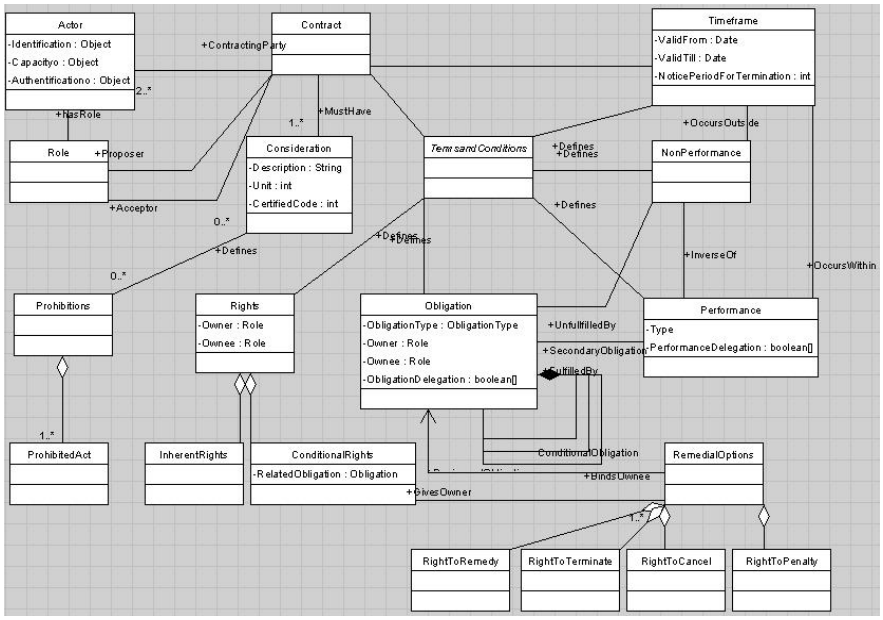

Figure 8: Sample Upper Level Core conceptual model

For example, the concept of an *actor* playing a *role* in context of the contract has been modeled as an association *hasRole* in the above figure.

Using RDF Schema specification, it can be represented as the following extract from our proof of concept RDFS implementation for the Upper Level Core Contract Ontology (Figure 9 below)

```
<rdfs:Class
rdf:about="&contractontology;Actor"
        rdfs:label="Actor">
    <rdfs:subClassOf
rdf:resource="&rdfs;Resource"/>
</rdfs:Class>
<rdf:Property
rdf:about="&contractontology;hasRole"
    a:maxCardinality="1"a:minCardinality="1"
     rdfs:label="hasRole">
     <rdfs:range
     rdf:resource="&contractontology;Actor"/>
     <rdfs:domain
     rdf:resource="&contractontology;Role"/>
</rdf:Property>
```

Figure 9: Extract from RDFS proof of concept implementation

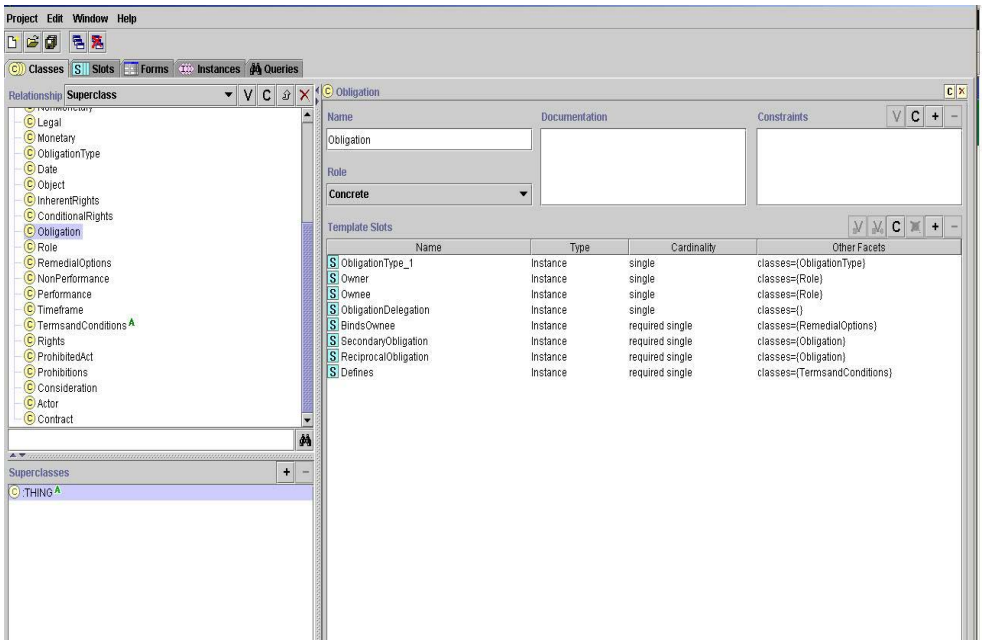

Figure 10: Screenshot from protégé 2000: Using Plugin to transform to RDFS

Current developments in the field of ontology have provided us with several ontology editor tools, including Protégé 2000. Protégé 2000 is a graphical knowledge base editor, which has an increasing user community. The UML plug in [51] supports the import of XMI files and generates the corresponding RDFS and can store in RDFS too. This utility has been used for transforming our UML conceptual models in to RDFS automatically (Figure 10).

5.2. UML to DAML Transformations

The DAML-UML Enhanced Tool (DUET) of the CODIP project provides a UML based environment for the development and manipulation of DAML ontologies. It supports UML to DAML generation for tools like Rational Rose, ArgoUML. Another DAML+OIL plugin is also available from the Protégé community for design and storage of ontology in DAML+OIL .We have used DAML+OIL plugin from SRI[52] for the sample illustrated below. As mentioned in section (3), we have adopted the UML to DAML mapping guidelines as supported by DUET [33,31].

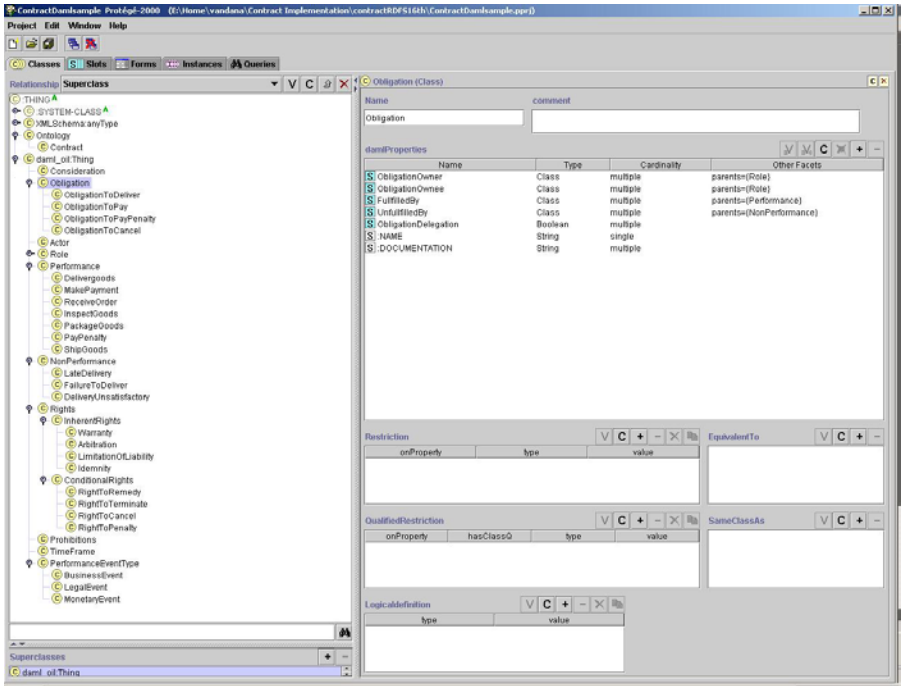

Figure 11: Screenshot of Protégé 2000, using DAML+OIL plugin

The same conceptual model as shown in figure (8), is translated in to DAML+OIL. For example, the concept of the role in the upper layer is reified to that of a buyer in the context of a sale of goods contract model as shown below:

```
<daml_oil:Class rdf:ID="Buyer">
  <rdfs:subClassOf>
    <daml_oil:Restriction>
      <daml_oil:toClass rdf:resource="#Seller"/>
      <daml_oil:onProperty rdf:resource="#hasCounterRole"/>
    </daml_oil:Restriction>
  </rdfs:subClassOf>
  <rdfs:subClassOf rdf:resource="#Role"/>
</daml_oil:Class>
```

Figure 12: Extract from DAML proof of concept implementation

5.3. Observations

From the above discussion, we see that UML has wide usage as an ontology modeling language. The conceptual models are graphical and easy to understand by human users. UML can be translated to other machine understandable forms like RDFS, DAML or databases as mentioned earlier. In case of databases, the concepts would be translated into objects, associations into, and object properties into data properties. It seems a logical choice to represent knowledge in the simplest form and translate it into the required complex language based on the requirement of the application. Our contribution of conceptual models can be reused and extended by other users of the community tailored to their needs and objectives.

DAML+OIL is built on RDFS and has more constructs for expressing more details. It is also closer to natural language and is easy to follow for users not familiar with language constructs like those of RDFS. We found that DAML gave us a greater flexibility in our multi tier contract ontology since we could apply *restriction* to concepts from the upper level easily. DAML also allows us to differentiate between *object type properties* and *data type properties.* Concepts can be expressed in detail including *inverseOf* relations and *equivalentTo* relations.

As the semantic web standardization efforts progress, more such libraries of ready to use language constructs should be available. Structured and predefined common *object type properties* and *data type properties* could be assembled in re usable vocabularies or libraries, for rapid design and development of ontologies in general.

Mapping rules from UML to RDFS and UML to DAML would also need to be standardized, so that everyone uses the same rules and notations. Also, methodologies for transformation from one storage model to another are sorely needed in the semantic web approach. For example RDFS to DAML interchangeability issues need to be addressed. Such methodologies would help the migration from traditional database storage approach towards the semantic web.

6. Applications Of Multi Tier Contract Ontology

Based on the proposed multi tier contract ontology, we are working on a methodology to deduce contract workflow models, which will aid the business entities to organize, restructure or design their business process workflow.

Another direct application of our Multi Tier Contract Ontology is a methodology to monitor and track obligation fulfillment based on the obligation categorization and their states. Detailed specification of obligation states is an ongoing research work.

Other possible application would be to use the proposed knowledge base for automated or semi automated wizard like tools to help monitor contracts or to interpret the required actions for fulfilling obligations etc.

7. Conclusion

The semantic web is meant to establish a network of machine understandable data for software agents and search engines. But, the semantic web can have a far wider

impact and use as a universal medium for commerce. It would be an advantage if all pertinent business information, which so far is stored in traditional databases or other knowledge bases, were also made accessible, machine understandable, and available as a part of the semantic web.

In this paper, we have presented conceptual models for representing contract knowledge in the form of multi tier contract ontology. We have identified the existing gap between business processes and their governing contractual terms and conditions. The proposed ontology is the central knowledge base for deducing the business process workflow, to affect business process interoperability by identifying the shared processes, to improve business performance. One future focus is on mapping to other related ontologies and contract related vocabularies like the UNSPSC, CPV etc.

We have also validated the use of UML as an ontology-modeling tool through our conceptual models and the subsequent proof of concept illustrations using RDFS and DAML. We have presented some observations based on our practical experiences in the implementation process in section 5.3. But we believe that these are minor issues that would be resolved as the semantic web efforts evolve.

Contracting is a large area, and currently we have focused mainly on the contract execution phase. In the approach adopted, there is no distinction between a traditional paper contract and an electronic contract. The ongoing research work is focused on gradual extensions to cover all the phases of the contract life cycle. The Multi Tier Contract Ontology is visualized as a central role player in all the aspects of contracting. In our approach methodology, we have aimed to reuse other related work and methodologies, especially the design guidelines and principles of ontology design.

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