LOTED2: an Ontology of European Public Procurement Notices.

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Abstract. This paper describes the construction of the LOTED2 ontology for the representation of European public procurement notices. LOTED2 follows initiatives around the creation of linked data-compliant representations of information regarding tender notices in Europe, but focusing on placing such representations within their legal context. It is therefore considered a legal ontology, as it supports the identification of legal concepts and more generally, legal reasoning. Unlike many other legal ontologies however, LOTED2 is designed to support the creation of Semantic Web applications. The methodology applied for building LOTED2 therefore seeks to find a compromise between the accurate representation of legal concepts and the usability of the ontology as a knowledge model for Semantic Web applications, while creating connections to other relevant ontologies in the domain.

Keywords: Legal ontologies, European public procurements, Linked Open Data, Open Government Data, Tenders

1. Introduction and motivations

Computational legal ontologies are playing an increasingly prominent role in AI & Law research. Ontologies have proved their value in representing legal knowledge, processing and retrieving legal information, and making explicit cognitive perspectives on legal reasoning [9-4].

Up to now, efforts have focused on the development of legal ontologies, aimed at the representation of fundamental basic concepts of legal knowledge and at the description of specific legal domains, to support legal case-based reasoning, decision support systems, legal compliance check, and more generally to map the complexity of legal knowledge to formal languages such as OWL. Specific methodologies and approaches used for building these ontologies show that legal ontology engineering has its own peculiarities [10], requiring particular conceptual structures for the representation of legal concepts, including notions of legal rules, preconditions, legal consequences, etc. [35-38].

At the same time, the Linked Data trend and the emergence of second generation Semantic Web applications have highlighted the significance of intelligence arising from the integration of disperse and heterogeneous data from many sources, rather than from closed knowledge based systems [13]. Thus, for such kind of applications, there is a need for flexible and modular ontologies, which can be easily integrated to discover non trivial connections between data.

Since law impacts and affects the everyday life of all individuals, representing legal knowledge in the Semantic Web scenario is both a timely need and a challenge. Indeed, the e-Government sector is one of the major drivers in the emergence of Open Linked Data and governments are making accessible a large amount of datasets, about a wide range of topics, such as spending reports, administrative staff organizations, public healthcare, etc.

Data on public contracts notices are open data by their nature. By law, they must be accessible. However, without the right interpretation, data are only raw data, which by themselves may not provide useful information. Government Open Data are in many cases related to the legal domain and, as a result, legal ontologies may play a key role uncovering the

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semantics of these data and driving the integration of this information with other datasets. Thus, it would be possible to build semantic e-Government applications, which may provide a significant contribution in bridging the gap between citizens and institutions [22].

Nevertheless, as recently emphasized by some scholars, this consideration implies to *rethink* the role and the utility of legal ontologies, "questioning the need for a highly axiomatised and unified knowledge representation" and conceiving instead "a new way of designing legal ontologies and of embedding them into architectures for legal information systems and other web services" [9].

Consistently with this new trend, in this paper we employ a novel approach to the design of legal ontologies, which aims to combine the representation of legal concepts with the usability required for the description of data, while also enabling the integration with other vocabularies and ontologies not related to the legal domain.

The application scenario for the investigation of this approach is the European public contracts domain. The public procurements domain is a complex and very technical legal field but also a strategic one, since it concerns a large number of stakeholders. These include: *traders*, for whom it represent interesting opportunities, although sometimes not easy to grasp, especially for small and medium enterprises (SMEs); *public authorities,* for whom it is crucial to choose the best contractor, by maximising information access and then competition; *communities of citizens,* who may be interested in monitoring the management of the *res publica* and of the operating expenses utilized on behalf of the public interest.

The work presented here can be considered as an evolution of LOTED[1] 'Linked Open Tenders Electronic Daily' [6], a project that pioneered the use of Linked Data to enrich the data about public procurement notices contained in RSS feeds of the TED system (Tenders Electronic Daily).[2]

We call LOTED2 the new version of the LOTED ontology, which we have developed. LOTED2 is a legal ontology supporting the modelling of European procurement notices and the description of the data extracted from the TED system. Compared to the original LOTED ontology, LOTED2 has been developed for representing in a more expressive way the domain of procurement. Since LOTED2 is a legal ontology, it aims to provide a representation of legal concepts related to public procurement domain. Such an expressive modeling of the domain allows the discovering of connections with other domains, e.g., business domains, and the integration with other relevant ontologies, specifically *Good Relations* [27].

The rest of this paper is structured as follows: Section 2 outlines related work on reusing linked open data associated with the European public procurement notices and on other existing ontologies on public contracts. In Section 3 we present the LOTED2 ontology, discussing its aims, its design, and the inferences it supports. In Section 4 we describe the integration of LOTED2 with the most widely used ontology for describing e-commerce scenarios, namely Good Relations. Finally, in Section 5 we reiterate the main results from our work on LOTED2 and we outline our future directions of work.

2. Related works

2.1. LOTED ontology

The LOTED ontology[3] was developed inside the eponymous project, in order to introduce an additional level of structure on top of the data extracted from the RSS feeds of the TED system. It has been conceived for the need of the platform and structured to enrich procurement notices data with automatically discovered links to geo-names and DBpedia. So, it is a lightweight ontology, realized to match the semi-structured representation (namely the tabular summary of data) of tender notices as published by the TED website. Although the LOTED ontology satisfies the requirement of usability and is very suited to the purpose for which it has been designed, it does not actually represent knowledge about the domain, as it merely defines the structure of data objects in the domain. However, authors were aware of this aspect and a more expressive representation of the domain of procurement was planned as part of future work on the LOTED project. The LOTED2 ontology has been developed to achieve this goal.

2.2. The Public Contracts Ontology (PCO) developed under the LOD2 project[4]

LOD2 is a large-scale Integrated Project co-funded by the European Commission within the FP7 Information and Communication Technologies Work Program, with the overall aim to creating knowledge out of interlinked data and to develop tools and method-

[1] *http://loted.eu*
[2] *http://ted. europa.eu*
[3] *http://loted.eu/ontology*
[4] *http://lod2.eu*

ologies for exposing and managing very large amounts of structured information on the Data Web and to test and bootstrap a network of high-quality domains, also based on multi-lingual ontologies, from sources such as Wikipedia and OpenStreetMap. A work package of this project, the WP9A ("LOD2 for a Distributed Marketplace for Public Sector Contracts") is dedicated to exploring and demonstrating how the application of linked data principles for procuring contracts in the public sector may help to bridge the gap between advanced countries and countries with low online participation of enterprises in public tenders.

So, the main purpose of this work package is to build a linked data infrastructure in order to produce a "business impact and achieve an effective resource allocation through emulating the market process of meeting supply and demand"[5].

At the heart of this infrastructure there is the Public Contracts Ontology (PCO)[6]. The authors state they are not interested in modeling every aspect related to a contract, but only "information which is available in existing systems on the Web" and "which will be usable for matching public contracts with potential suppliers" [17]. In other words, the goal of this ontology is to model a public contract as a whole, but without going into details of the domain.

PCO is more articulated than LOTED: it is not built to model the data structures of a particular system (TED), but rather tries to represent a variety of aspects of the domain, taking into account the integration with other ontologies (Good Relations, VCard, Payments Ontology and also LOTED). It therefore provides a broader vision of the domain compared to LOTED: some relevant aspects of the domain, such as lots, are represented in this ontology.

Nevertheless, the Public Contracts Ontology shows some weaknesses that cannot be ignored, even while keeping in mind that it is not a legal ontology.

In particular, the ontology aims to provide a conceptual description of both the tendering phase and the phase of the execution of the contract. However, there is not a clear conceptual distinction between these different scenarios in the Public Contracts Ontology. Indeed, in the ontology the different concepts of *call* (call for tenders, such as contract notice) and *contract* (public contract) are often confused.

First of all, the class `pc:Contract` is modeled as `SubClass` of `pc:Call`. In some sense, a contract notice (not a contract) can be considered as a 'call', a

call through which it is announced a competitive bidding for the award of a public procurement contract. In other words, a contract notice *is a* call-for-tenders, which may be submitted for the award of a public procurement contract. Thus, the contract is 'the stakes' of the competitive bidding announced through a notice (i.e. a call), not the call itself.

Secondly, the Contract so modeled in the Public Contracts Ontology has both an estimated and actual price, at the same time. When the notice is published the price is only an estimated one. The final price will be set only at the end of the competitive bidding, on the basis of the award criterion (for an example the lowest price) and of the tender bids submitted. So, it would be appropriate to keep strictly separate the different phases of contract notice publication from the tendering phase, from the award phase of the contract and then from its execution.

Conceptual confusion increases by defining the Class `pc:Contract` as equivalent to the Class `pc:Tender`[7]. The declared aim of the ontology is to match awarding authorities' demand and traders' offering; in our vision, this aim cannot be achieved simply declaring that a (proposed) contract - demand - is equivalent to the tender bid - offer. It is not correct, from a conceptual point of view, as well as potentially harmful. In the Public Contracts Ontology, there is not a specific definition of the class of awarding entities; they are just identified as business entities. From the point of view of the market, this is true and also useful in order to achieve integration with the Good Relations ontology. However, forgetting the ontological definition of this important aspect of the domain entails also forgetting that the procurement domain concerns the PA2B (Public Authorities to Business Entities) scenario and not the B2B (Business to Business) one. Summarizing, this ontology seems to tackle complex subjects through a too simplistic approach.

2.3. The "10ders Information Services Project[8]"

'10ders Information Services' is a Project co-financed by the Spanish Ministry of Industry, Commerce and Tourism and by the European Regional Development Found. It is led by Gateway Strategic Consultancy Services[9] and is developed in collaboration with Exis

[5] *http://lod2.eu/WorkPackage/wp9a.html*
[6] *http://purl.org/procurement/public-contracts#*

[7] Within the Public Contracts Ontology this term denotes the tender bid submitted by the economic operator, that in the same ontology is called "Supplier".
[8] *http://rd.10ders.net*
[9] *http://gateway-scs.es/en/*

TI[10] (both commercial companies) and the Web Semantica Oviedo (WESO) Research Group[11].

The aim of this project is to exploit information about public procurement notices using Semantic Web technologies and Linked Open Data approach, in order to build many services, especially targeted to SMEs. The set of services produced by the research group is currently available on a proprietary platform, Euroalert.net[12] [32], a brand owned by Gateway SCS.

Basically, the commercial services offered to small and medium enterprises span from tenders alerting systems on the basis of the subscriber profile model, to the offer of reports on the major public buyers for their products and services. It also provides a customized data mining analysis of public procurement tailored to the interest of each client.

Aside from the commendable purpose to provide an unique access point ('a pan-European platform') both for EU relevant tender notices published on TED, and for notices below EU threshold published on a wide range of buyer profiles of national, regional and local levels, it should be considered that there are many services providing mail alerts about tenders and other mechanisms of this kind. However, the novel approach of this project is that the platform system is built using structured open data instead of screen-scraping's techniques.

From the same research academic group (WESO) comes also the MOLDEAS ('Methods on Linked Data for E-procurement Applying Semantics') work [2]. This project can be considered as a broader framework, which includes also the experience gained in developing Euroalert.net. Indeed, MOLDEAS aims to apply the semantic web and Linked Open Data approaches to public procurement notices, defining a set of goals.

The first goal is to transform government controlled vocabularies such as CPV[13], CPC[14] and Eurovoc[15] (now available in SKOS[16]) into RDF, SKOS or OWL. The second one is to enrich and model information inside public procurement notices with these controlled vocabularies but also with geographical information available in the Linked Data cloud. Then,

procurements information is published in a SPARQL endpoint providing a node for the linked data cloud and enhanced services (search and sort, matchmaking, geo-reasoning, statistics, etc.) on data.

The main advantages claimed by authors of Euroalert and MOLDEAS are essentially the decreasing of information's dispersion (arising from the different sources where contract notice above and under EU threshold are published); the unification of data models and formats and the support to multilingual issues (through EUROVOC resources used for the enrichment of public procurement notices).

An ontology about public contracts is still in development, as part of WESO group's future work.

3. LOTED2-core ontology

In this Section, we describe *LOTED2-core*, a legal ontology of European Public Procurement notices. The integration of *LOTED2-core* with the Good Relations ontology is called *LOTED2-extended* and is described in Section 4.

3.1. Premise: lightweight vs. expressive representation of legal content

The larger group of legal ontologies developed up to now, can be classified as two diverse categories.

The first is represented by *core legal ontologies*, namely ontologies that draw largely on legal theory in order to extract general patterns for describing the main concepts of legal knowledge: agents, roles, norms, normative effects (such as obligations, permissions and prohibitions) and temporal properties (e.g., about normative rules validity, efficacy). Examples of this type of ontologies are: the LRI-Core ontology [7], DOLCE+CLO (Core Legal Ontology) [20], the Ontology of Fundamental Concepts [37] and LKIF-Core [28].

The second group of legal ontologies is represented by specific *legal domain ontologies*, i.e., conceptualizations of a particular field of legal knowledge drawn from authoritative sources as national or European laws (e.g., concerning privacy, intellectual property, copyright, etc.). Examples are the IPRONTO ontology [16], the Copyright Ontology [21], the Customer Complaints Ontology [31], the Consumer Protection Ontology [39].

The aim of core legal ontologies is to provide an interoperability framework from which other legal ontologies could inherit general categories, and in that way trying to overcome also comparative and multilingualism issues, among diverse legal systems.

Legal domain ontologies are built with a specific application-perspective in mind, usually grounded in closed systems.

The experience gained so far shows that to deal with the complexity of legal knowledge through ontologies requires an intensive design process. Legal ontologies are usually made of a significant amount of axioms and restrictions upon classes, which represent legal concepts. In a certain sense, a legal system can be considered as the whole of all the relations among these concepts.

In the Linked Data trend, lightweight ontologies like FOAF[17], seems to rule the scene. And therefore, given their complexity, there seems to be 'no room' for legal ontologies in the Linked Data scenario; they seem to be destined to dedicated and closed systems, performing complex tasks, but not integrating themselves into the *web* of data.

Nevertheless, ontologies cannot be intended as a way to simplify the complexity of legal knowledge, in the name of the Semantic Web. The main difference between ontologies widely used by the Linked Data community (like for example FOAF or Good Relations) and legal ontologies, is that the first type of ontologies is based on propositional logic. Instead, legal ontologies need first order logic, even though some authors have invoked the use of propositional logic for representing legal texts, such as [1], in order to avoid syntactical ambiguities. There are various reasons why powerful representation languages are needed for legal ontologies.

First of all, legal knowledge cannot be bridled into propositional structures (atomic propositions and propositional connectives): the truth preservation in law does not make sense, because categories of true or false cannot be applied to normative propositions. Secondly only a small part of legal knowledge may be expressed through propositional logic, which is not adequate to support legal reasoning [36]. The reason is that the first step of legal reasoning is to identify a legal concept. The utility of ontological legal concept representation is precisely to provide a way to classify individuals.

This feature of legal ontologies is not however necessarily incompatible with Linked Data requirements. On the one hand, the representation of legal concepts and relations among them is useful to verify and fix the correctness of Linked Data statement on legal content, through the use of reasoners such as Hermit or Pellet. On the other hand, the new triples generated, i.e. inferred or materialized, can be written back into the RDF model, adding a new level of granularity in the data. This type of information is just what is useful to drive the integration of ontologies with other related ontologies and datasets.

However, the modeler of legal knowledge has to achieve a compromise between a full legal 'conceptual coverage' and a 'pragmatic sustainability' [12] focusing on the task that should be performed through the ontology. Therefore, LOTED2 aims to represent a compromise between a suitable and rigorous representation of legal content and a practical way to represent *data* in the dynamic and open scenario of the Semantic Web.

3.2. Aims of LOTED2

LOTED2 has been designed for these specific purposes:

- to express the (main) legal concepts of the domain of public contracts notices as defined in legal sources (European Directives on public contracts);
- to support rich semantic annotation, indexing, search and retrieval of tenders documents, such as contract notices;
- to make possible the reuse of semi-structured data extracted from the TED system;
- to enable the integration with other ontologies and vocabularies about related domains.

The ultimate goal of the ontology is to support Legal Semantic Web applications for improving the meeting of demand and offer in public procurement.

3.3. Design approach of LOTED2

Mainly two Directives cover European public contracts domain: the Directive 2004/18/EC[18] and the Directive 2004/17/EC[19]. The first regulates the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts by contracting authorities (i.e. authorities operating in the so-called 'ordinary sectors'); the second one regulates the procurement procedures of entities operating in the water, energy, transport and postal services sectors (i.e. 'utilities sectors').

Procurement notices are published according to standard forms defined by the European Commis-

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[17] *http://xmlns.com/foaf/spec/*

[18] *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0018:en:HTML*

[19] *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0017:en:HTML*

sion[20]. On the TED system it is available a full version of each tender document in the original language and a compact view in the language selected by the user.

From the notices available in these formats, semi-structured data can be extracted in the form of a tabular summary, as shown in Fig. 1.

Service contract - 382532-2011

TI	Title	UK-Milton Keynes: cleaning services
ND	Document number	382532-2011
PD	Publication date	08/12/2011
OJ	OJ S	236
TW	Place	MILTON KEYNES
AU	Authority name	The Open University
OL	Original language	EN
HD	Heading	Member states - Service contract - Contract notice - Restricted procedure
CY	Country	UK
AA	Type of authority	6 - Body governed by public law
DS	Document sent	05/12/2011
DD	Deadline for the request of documents	16/01/2012
DT	Deadline	16/01/2012
NC	Contract	4 - Service contract
PR	Procedure	2 - Restricted procedure
TD	Document	3 - Contract notice
RP	Regulation	5 - European Union, with participation of GPA countries
TY	Type of bid	1 - Global tender
AC	Award criteria	2 - The most economic tender
PC	CPV code	90910000 - Cleaning services 90911000 - Accommodation, building and window cleaning services 90919200 - Office cleaning services
OC	Original CPV code	90910000 - Cleaning services 90911000 - Accommodation, building and window cleaning services 90919200 - Office cleaning services
RC	NUTS code	UKJ12
IA	Internet address (URL)	www.open.ac.uk

Fig. 2 Tabular summary of Contract notice n. 382532-2011

When there are standard forms for drafting a certain type of document, these can be used as starting point for the analysis of each individual document drafted according to the established format. In a certain sense, model forms are description of classes of documents and each new document drafted is an instance of one of these classes. The analysis of these model forms may tell us information about the terms identifying constitutive part of the document and the interrelationships between terms. In many cases these terms identify ontological classes and the structural relationships between terms can be considered as object properties or data-type properties. Thus, filling out a new document means the creation of new instances for each class.

On the other side, authoritative sources provide us many information about terms and the relationships among them, since they usually contain definitions of these term.

Taking into account these premises, the design approach of LOTED2 is based both on a bottom-up

approach (analysis of standard forms) and on a top-down one (extraction of legal concepts from legal sources). In this way it is possible to achieve a better match between language and conceptualization and then a good level of correspondence between terms, which identify data, and ontological classes.

However, the semi-structured data rendered by the TED system represent only the essential part of all the information contained in these documents. Other relevant information is lost. This is the case, for example, when a proposal for the acquisition of similar or related supplies/works/services may result in contracts being awarded at the same time in the form of separate lots. Since in some cases, economic operators may submit an offer for a single lot only (in those cases in which it is admitted a partial type of bid, for example) this type of information may be very helpful for participation in tenders of SMEs.

An XML standard for legal documents, which allows also RDFa assertions in order to link the structural part of the text with ontological classes, such as AkomaNtoso [3-41], may be used in order to tag the full content of tender documents.

3.4. LOTED2-core modules description

LOTED2 is a large ontology, up to now it represents 180 classes related to the public procurement domain. The ontology is available at http://loted.eu/ontology2 and at http://codex.cirsfid.unibo.it/ontologies/.
In order to facilitate maintenance, LOTED2 has been designed with a modular approach. Modules have been conceived to be 'self-containing', 'independent' and 'reusable' [14].
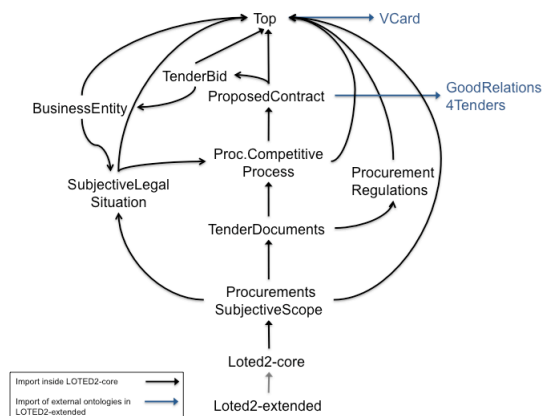
Fig. 2 Dependencies between LOTED2-core modules and external ontologies (GoodRelations4Tenders and VCard) in LOTED2-extended

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Ten modules (Fig. 2) compose LOTED2-core ontology. An extended version of LOTED2 ontology is composed by LOTED2-core ontology, GoodRelations4Tenders and VCard. GoodRelations4Tenders is a version of the Good Relations ontology compliant with the public procurement domain.

- *Loted2-core* is a framework module (as well as *Loted2-extended* module). Its function is to hold together the modules by which is composed LOTED2-core ontology.
- *Procurements Subjective Scope* describes the classes of legal persons who are empowered to issue a tender notice (generally called 'call for tenders') and to award a public procurement contract, i.e. to play the role of awarding legal entities. An enumeration of these entities is contained in art. 1 (9) Directive 2004/18/EC and in art. 2 of Directive 2004/17/EC. The first type of entities may play the role of contracting authorities; the second type of entities may play the role of contracting entities. Although both the Directives refer to 'contracting authorities' and 'contracting entities' as two different types of entities, these terms denote, from an ontological point of view, rather a role than a type of entities. Consider for an example the case of a body governed by public law, that, on one hand, issues a notice for the award of a public contract and, one the other, may submit a tender bid in a tender announced by another entity[21]. Furthermore, any public authority or public body cannot be considered per se a contracting authority or entity. It assumes this feature only when it issues contracts notice or another type of call for tenders. In other words, this is an anti-rigid property [24], since every instance of a public authority, body governed by public law, ministry, etc. is not essentially a contracting authority or entity. However, for the purposes of the European legislator, the distinction between types of entities, which may play the role of contracting authority, and entities, which may play the role of contracting entities, is very relevant. From this distinction, in fact, depends the application of Directive 2004/18/EC (on or-

of Directive 2004/18/EC (on ordinary sectors) or of Directive 2004/17/EC (on utilities sectors). Hence, LOTED2 includes two classes that refer to intermediate legal concepts, namely 'entity operating in ordinary sectors' and 'entity operating in utilities sectors'. If an entity falls in the class of the first type of entity, then it may play the role of contracting authority. Instead, if an entity falls in the second type, then it may play the role of contracting entity. The definition of these classes is based on the main activity carried out by an entity. A detailed list of ordinary sector activities and utilities activities is obtained by standard forms, but should not be considered as a *numerus clausus*. For each type these activities and for each type of legal person who issues a notice, defined also in standard forms, is provided the label of TED data through an annotation property (`rdfs:tedLabel`). This annotation property is provided with the purpose to drive the user in the implementation of the ontology by using the TED data as instances.

- *Tender Documents*. The Procurement Subjective Scope module is connected to the Tender Document module through the object property `Loted2:issues`. In this module are described the majority of tender documents available on the TED system, issued by the entities defined in the Directives. The aim of this module is to provide a full description of tender documents, which represent notices. Other types of tender documents such as specification or descriptive documents are described because they are strictly related to tender notices. Indeed, these documents are attached to a contract notice in order to describe in details the type of service, good or works and the manner in which the competitive bidding is conducted. Data contained in the tabular summaries of TED are basically related to tender notices. So, this module, more than others, has been built emphasizing the bottom-up approach. As in the Procurement Subjective Scope module, also in the Tender Document module the annotation property `rdfs:tedLabel` is used. Another annotation property, `rdfs:tedDataID` is used for providing a reference to the ID of the data to which a data-type property refers.
- *Procurement Regulation*. In this module are described the legislative sources regulating public procurement domain. Apart from the Directives, many other legislative sources regulate the

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[21] The forth whereas of Directive 2004/18/EC and the eleventh of Directive 2004/18/EC, in this regard, state that Member States should ensure that the participation of a body governed by public law as a tenderer in a procedure for the award of a public contract does not cause any distortion of competition in relation to private tenderers.
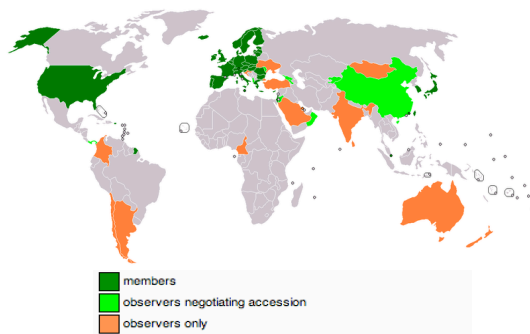
Fig. 3 WTO Members and observers in Government Procurement Agreement (source: Wikipedia)

European procurements domain. The most important is the Government Procurement Agreement (GPA), a plurilateral treaty signed by a number of WTO (World Trade Organization) parties (fig. 3), with the purpose to open up as much as possible public procurement business to international competition [6-15]. The scope and coverage of GPA is based on the type of procurement, the type of entity and the monetary threshold defined in Appendix I of the Agreement. It is worthwhile to emphasize that signatories may negotiate the coverage of GPA with other parties, on the basis of reciprocity.

For example, the utilities sector is not covered by GPA with respect to Canada and there are many limitations with respect to USA and Japan too, just to name the most relevant. This means that we cannot consider the GPA as a unique treaty for each signatory, since there are rather many bilateral agreements (Canada-EU, USA-EU, et.) negotiated by parties under the GPA framework. Thus, simply saying that a tender is within the coverage of the GPA is not enough to clarify the geographical scope of the application of each single bilateral agreement to the single contract notice. These significant divergences in the application of GPA entail a considerable complexity in defining which specific regulation covers a tender document. Unfortunately TED system data do not provide an effective help in this direction since they're articulated in an incoherent manner. In fact the field of 'Regulation' data is referred once to the political geographical area of the country in which is based the entity that issued the tender notice (European Union, European Economic Area); once to the type of authority that issued the notice (European Investment Bank, Euro-

pean Bank for Reconstruction and Development, European Monetary Institute, European Institution/Agency or International Organization); once to the reason for which the notice is issued (External aid and European Development Fund) and finally once to the actual regulation, although not always identified with the exact wording (Agreement between the European Community and the Swiss Confederation, GPA, etc.). Procurement Regulation module of LOTED2-core ontology aims to provide the right interpretation of TED 'Regulation data', i.e. which legal source covers the single tender document. This type of information is necessary to define the jurisdiction of the regulation, namely the geo-political reference within the norm is applied and its effects are binding [8-23]. An additional module covering this aspect will be part of our future work.

– *Procurement Competitive Process.* A notice is issued by an entity acting as contracting authority or contracting entity in order to announce a competition. There are many types of competitions, based on the type of notice. The most relevant type of competition is the tender (i.e. the competitive bidding) that is announced through a contract notice (but not only). Instead, a design contest is announced through a design contest notice. A qualification system is announced through a notice on the existence of this type of system, that we can consider as a competitive procurement process. This system, in fact, is used by only entity operating in utilities, for seeking qualified economic operators, which meet predefined qualification criteria that must be satisfied by potential providers of specific types of works, services and supplies. An applicant of this type of notice, which satisfies these criteria, is registered in the system as potential candidate or contractor for the particular type of contract. A notice on the existence of a qualification system with call for competition is a notice through which is announced both a qualification system and a tender, in which may participate only operators recognized as qualified according to the system. A procurement competitive process takes place with an established administrative procedure, the award procedure that can be of different types (open, restricted, negotiated, etc.). LOTED2-core ontology does not describe award procedures.

– *Subjective Legal Situations.* This module describes roles played by agents in procurements
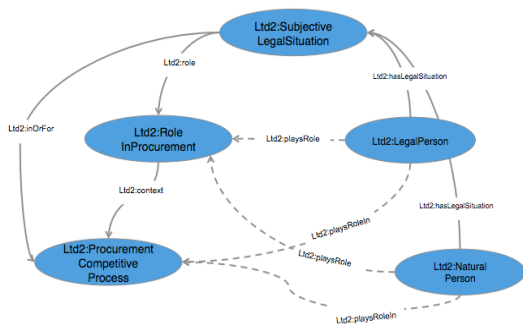
Figura 4 Fig. 3 Subjective Legal Situations and Roles in
LOTED2-core

competitive processes and in organizations. As
highlighted describing the *Procurements Subjec-
tive Scope*, terms such as Contracting Authority
or Contracting Entity denotes roles rather than
types of entities. In particular they denote roles
than only certain entities may play: only entities
operating in ordinary sectors may play the role
of contracting authority while only entities oper-
ating in utilities sectors may play the role of
contracting entities. The two terms indicate ba-
sically the same concepts, namely a property
that an entity assumes when awards a public
contract and when carries out all the set of ac-
tions required for the awarding process of a con-
tract. The first action is to issue a notice[22]. So,
by issuing a contract notice certainly an entity
starts to play the role of awarding legal entity.
Apart from the role of awarding legal entity, this
module of LOTED2 enables us to describe also
roles played by 'business entities' in procure-
ment processes. For example, a natural or legal
person (operating on the market as 'economic
operator') who has submitted a tender bid for the
award of a proposed public contract is a natural
or legal person who plays the role of 'tenderer'.
And if this agent has submitted the best tender
bid, then assumes the role of 'successful ten-
derer'. Another important aspect in procure-
ments' role modeling deserves to be emphasized.
Just as a body governed by public law may play

the role of both awarding legal entity and ten-
derer, so business entities may play many roles
in different procurements competitive processes.

Consider that the eligible customers of many
business entities are public authorities and so
their core activity is precisely the participation
in tenders, even more than one at the same time.
Then, this matter is not trivial. In order to repre-
sent also these cases, the described module rep-
resents (legal) situations more than simply roles.
An agent may have more than one subjective
legal situation that is related to a role played in
a context. In the case of procurement the con-
text is the procurement competitive bidding.
These concepts and relationships have been
modeled reusing and adapting the 'Social Re-
ality pattern' [30-29], one of the proposed con-
tent patterns available from the catalogue of On-
tology Design Patterns initiative [18-19].

– *Proposed Contract.* Since LOTED2 is an ontol-
ogy of public procurement notices, it does not
represent public contract per se. LOTED2 aims
to describe semantics of notices concerning the
award of public contracts. A contract notice is
the means whereby is announced a competitive
bidding for the award of a public contract. So,
the commitment of the ontology is to capture the
information of public contract *to be awarded* (or
proposed contract) not of the public contract
awarded or in its execution. For this reason in
the ontology is specified the class of `Loted2:
ProposedContract` rather than of Contract.
Consider the case in which the tender has been
declared unsuccessful: can we speak about a
contract or not? Of course not, because the con-
tract has not been awarded and then has not
been signed by parties. So, in the stage of notice
publication there is not a contract, but a contract
to be awarded. This is also clear if we consider
that a contract notice is also known in legal doc-
trine as '*invitatio ad offerendum*', namely an
invitation to make offer for a proposal of con-
tract. And only the successful bidder will be
party of the contract. The connection between
the contract notice (the *invitatio ad offerendum*)
and the proposed public procurement contract
module is via a property chain
`Loted2:throughWhichIsAnnounced o`
`Loted2:forAwardOf SubPropertyOf`
`Loted2:throughWhichIsAnnouncedTender`
`ForAward`. Every contract or proposed contract
has an object, namely the subject matter of the

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[22] Please note that in some specific cases public
authorities may award a contract without issuing a
notice: this is the case in which a tender takes place
with a negotiated procedure without contract notice. Of
course this case is not examined in this paper, since
LOTED2 is an ontology for describing tenders
documents published on TED.

contract. A law-full object is an essential of a contract or proposed contract. According to legal doctrine, object of contract can be intended either as the commitment that parties agree to assume (and the consequently transfer or creation of rights and/or modification or settlement of existing bonds) or as the description of the real object (good or service) to which relates the contract (i.e. the substantial content of the contract) [5]. The analysis of standard forms for contract notices and of the other tender documents shows that the object of contract is intended in the second sense, i.e. as a description of the type of good, service or work that the entity issuing the notice seeks. A rather significant aspect of procurement domain is the division of proposed public contract in lots. In some cases and under certain conditions, entities issuing a contract notice for the acquisition of similar or related supplies/works/services may decide to split the proposal into separate single proposed contracts to be awarded with the same tender. These single proposals that are also parts of a
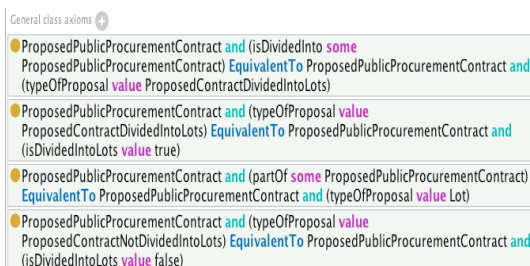

Fig. 5 General Class Axioms declared in Proposed Contract module of LOTED2-core ontology

general proposal are called lots. Since in some cases, economic operators may submit an offer for a single lot only (namely in all the cases in which is admitted a partial type of bid) this type of information may be very helpful for participation in tenders of SMEs. In fact, usually a small enterprise is specialized in one particular sector with one main offering and so it might be interested in bidding for the single lot rather than for the global proposal. Therefore, one of the commitments of LOTED2 ontology is to accurately model this particular aspect of the domain, namely lots, even by ensuring that through ontology were made possible certain inferences. First of all, proposed public contracts may be of three types: proposed contracts di-

vided into lots, proposed contract not divided into lots and lots. A lot is a proposed contract that is also part of a proposed contract divided into lots. When a proposed contract is divided into lots through the contract notice is announced a tender for award also single lots. Through LOTED2 it is possible to infer that through the same contract notice is announced a tender for award each single lot. This result has been achieved through the use of General Class Axioms combined with property chains. Two object properties are inferred in order to show which lots will be awarded through the same tender (`Loted2: forAwardOf o Loted2:isDividedInto SubPropertyOf Loted2:forAwardLot`) and which lots to be awarded are announced through the same contract notice (`Loted2:throughWhichIsAnnouncedTenderForAward o Loted2:isDividedInto SubPropertyOf Loted2:throughWhichIsAnnouncedTenderForAwardLot`). An example in the published version of LOTED2 ontology shows the inference so described (see individual Loted2:Notice1).

– *Tender Bid.* This module describes the tender bid, namely the offer that may be submitted by the economic operator in the competitive bidding for awarding a public contract. An important aspect is about the type of bid, namely if an offer may be submitted for exactly one lot, for one or more than one lot, or necessarily for all lots. A tender bid is evaluated on the basis of an award criterion: lowest price or the most economically advantageous offer. The first is based only on the criterion of price; the second one is based on a set of combined criteria defined by the authority issuing the contract notice.

– *Business Entity.* This module describes the class of the entities playing the role of economic operators (to simplify hereinafter called 'economic operators'). Economic operators are the subjects to whom is addressed the invitation to submit an offer for a proposed public contract. In other words, an economic operator is the potential counterpart of the awarded contract. However, not every economic operator can sign a public contract. There are several eligibility requirements, based on certain criteria that must be fulfilled by an economic operator in order to participate in a competitive bidding. Another module describing these requirements will be part of

our future works. This module describes private legal persons who are business entities, since they assume the legal form of 'incorporates', 'society', 'cooperative', etc. These classes are modeled following the taxonomy of LKIF-core ontology.

- *Top.* This is a sort of upper module in which are contained abstract classes, even useful to match the LOTED2 ontology with core ontologies and in particular with core legal ontologies, in order to foster interoperability. In particular, many classes of Procurement Top Classes module are modeled following the LKIF-core ontology schema. This relationship between LOTED2-core ontology and LKIF-core is what we call 'a compromise' accepted by LOTED2-core ontology designers. Indeed the initial aim of LOTED2 project was to build an ontology of European Public Procurements integrated with both Good Relations and LKIF-core ontology. However, there is one main problem that has prevented us from integrating the two ontologies together with LOTED2: the time representation. Given the importance of time factor in legal domain, LKIF-core represents time (such as 'date of publication') as classes, while Good Relations represents time through data type properties such as `xsd:dateTime`. Thus a full integration of LOTED2 with the two ontologies together was not possible, and because of that our accepted compromise was to define in the top module classes represented in LKIF-core ontology. In that way we used LKIF-core ontology as a source of patterns for modeling legal content of procurements domain.

4. LOTED2-extended: the integration of LOTED2-core with GoodRelations4Tenders

Works carried out until now [2-17] bring up the integration of ontologies about public procurements with Good Relations ontology. In particular, as we have seen in Section 2, LOD2 ontology reuses some classes of Good Relations (Offering, Business Entity, etc.) and also WESO Research group pays attention to an integration with Good Relations, as part of its future works. Even the creator of Good Relations, Martin Hepp often makes reference to procurements as an interesting application domain for his ontology [26]. It is generally agreed that the object property `gr:seeks` could play a key role in order to promote

the opening up of procurements domain to large scale Semantic Web applications. However, the matter, in our opinion, deserves more attention for many reasons.

Good Relation is, currently, the best candidate ontology to complement an ontology of public procurement notices because it represents a strategic domain, such as the eCommerce in a non trivial way, addressing a complex domain and covering "the many intricate situation that this domain requires", "is widely used currently in the eCommerce and linked data communities", "it is easily applicable, actually applied and recommended by the stakeholders from the targeted domain" [12].

This is certainly true and adding to that, we think that is also an ontology that inspires the recognition of some isomorphic patterns between legal and economic concepts, namely between the market and its legal superstructure.

Nevertheless, it should be remembered that Good Relations is an ontology built with the purpose to meet the needs of B2C (Business to Consumer) or B2B (Business to Business) scenarios. In other words, Good Relations has been developed bearing in mind only the private sector. Therefore, is not fully adaptable to the PA2B (Public Administration to Business) scenario, because public procurements domain has its own peculiarities that cannot be ignored, if you want to build a Semantic Web that doesn't distort principles of EC law.

Consider the principle of equality of treatment on which is inspired the Art. 23 of Directive 2004/18/EC. This article states that, unless justified by the subject-matter of the contract, technical specifications shall not refer to a specific make or source, or a particular process, or to trade marks, patents, types or a specific origin or production with the effect of favoring or eliminating certain undertakings or certain products. Such reference shall be permitted only on an exceptional basis, where a sufficiently precise and intelligible description of the object of the contract is not possible; such reference shall be accompanied by the words "or equivalent". So, the integration of an ontology about public procurements like LOTED2 with Good Relations could result in potentially law distorting effects.

Indeed, Good Relations, according to its purposes, describes brands, types of products (such as models), and obviously also the origin of products. These aspects come overtly into conflict with EC procurement principle of equality of treatment, but there are also other aspects whose incompatibility with the

principles of the law is less clear even though harmful.

For example, Good Relations defines the object property 'image=depiction', through which it is possible to link a product to its image available on the web. This is a very useful class in the private market scenario. In the PA2B context, instead, the use of this class may create problems. Indeed, with an extensive interpretation of the Article 23 one may argue that a link to a certain image could be used in order to indicate exactly one specific type of product. This can be a sort of trap that may lead into a conflict with principles of Procurement Regulations.

Given these remarks, we've amended Good Relations ontology, removing all parts non compliant with EC procurement principles. We've called this version 'Good Relations 4 Tenders'. Apart from EC Directives-non compliant classes like `gr:Brand`, `gr:ProductAndSeriveModel`, etc. and related properties like `gr:hasBrand`, `gr:hasMakeAndModel`, `gr:hasManufacturer`, etc., in GoodRelations4Tenders ontology we've removed also other classes and properties not required

by the procurements domain such as `gr:OpeningHoursSpecification`, `gr:acceptedPaymentMethods`, etc.

Changes in this release compared to the original Good Relations ontology consist of just the elimination of certain classes and properties. The original structure of Good Relations has been preserved.

Another point on which is worth dwelling is about how should be understood an integration between an ontology of public contracts and Good Relations. For example, Public Contracts Ontology (PCO) developed by LOD2 group adheres completely to conceptual model of Good Relations, detrimental to the particular (and different) domain of public contracts. Instead the aim of LOTED2 ontology is to represent as closely as possible legal concepts pertaining procurements domain. Such a conceptual analysis allows the discovering of the possible connections with concepts of other domains.

So, by explicitly specifying concepts of proposed contract and of *invitatio ad offerendum* (namely call for tenders or contract notice, etc.), the connection between Good Relations ontology and an ontology of
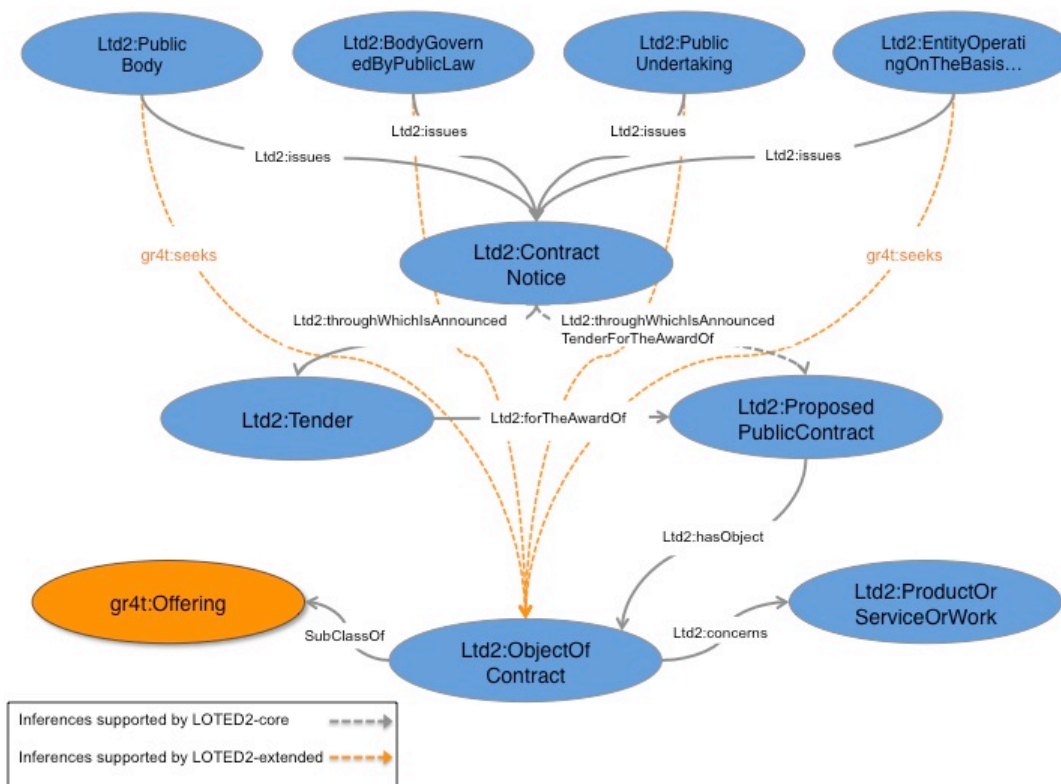

Fig. 6 Inference supported through the integration between LOTED2-core and GoodRelations4Tenders in LOTED2-extended

procurement becomes clear; so clear that this connection can be inferred. Consider the use of property `gr:seeks` in the procurements domain. When an entity issues a contract notice through which announces a tender for the award of a proposed contract, actually is seeking the object of the contract. So the object of the contract is the *Offering* that this entity invites to submit. In LOTED2-extended this aspect is automatically inferred using the reasoner, through a property chain (as shown in Fig. 6).

Through the integration of LOTED2-core ontology with Good Relations ontology, it would be possible to build an application for matching public demand side with the offerings side of market. Recently has been released the 'Open Database of the Corporate World' (OpenCorporates)[23]. This database contains data about more than 44 millions of companies around the world. To each registered company is associated the corresponding Standard Industrial Classification (SIC) code, even useful for define the type of 'offering' that a company offers.

Linking procurements data with the OpenCorporates data should allow the matching between demand and supply side, by alerting every company, which offers the same type of product or service sought by an entity issuing a public procurement contract notice.

However, the information about jurisdiction is essential for such kind of application if you want avoid the 'semantic noise' that can be generated by linking data of companies from states not involved within the scope of application of regulation that covers the contract notice.

5. Conclusions and future works

A fairly unexplored field concerns the integration of legal ontologies with ontological resources related to different domains. A sort of 'rigidity', which derives from the fact that authoritative sources drive the conceptual model, characterizes ontologies about legal contents. It is no accident that legal ontologies are mostly conceived in closed systems rather than open ones. In open systems the heterogeneity, the scale, the data quality, the reliability of information raise significant problems to control the legal effects of heterogeneous linked data, or 'smart' data. And because of this, building Legal Semantic Web applications will require the ability to foresee and to cope

with all kinds of risks that may emerge, in order to avoid that the challenge will turn into a danger. Rethinking legal ontologies in the Semantic Web is a challenging task, not at all simple.

In the legal domain, an exciting research field is emerging on the use of ontologies for checking compliance of legal documents or processes with norms regulating them [11-33], even by combining ontologies with rules formalized through interchange standards specific for the legal domain [34]. Nevertheless, at the same time, it should be more emphasized in legal ontology engineering the aspect of *compliance by design*. Ontologies for compliance and ontologies in compliance might be considered as two sides of the same coin.

Nevertheless the attempt in integrating LOTED2-core and Good Relations shows also many other things.

First, through the property *seeks* and the mirror inverted *offers*, Good Relations represents in an intuitive way the intents of parties when they issue an invitation to treat or a proposal for the conclusion of a contract (an 'offer' in legal terms). In a certain sense, Good Relations shows the final part of the legal superstructure behind the terms *seeks* and *offers*.

Second, the integration of LOTED2 ontology with Good Relations shows that also in the legal domain "a little semantics goes a long way" [25].

However, we must keep in mind that in the legal domain this little semantics is just the superficial layer of the whole of legal knowledge upstream.

The variety of related works about procurements (up to now there are three ontologies of public contracts, including LOTED2, and another is in development) reveals the strong interest of the Semantic Web community in representing legal knowledge. Furthermore, the Semantic Web community should consider the matter more carefully and the Legal Informatics community should try to take up the challenge.

At this point of our work, we're aware that Linked Data users and developers of Semantic Web applications could consider LOTED2 too difficult to use, although our aim was to drive the non-legal domain-expert in its use, through many annotations and documentation.

So, one of our future works, will be the extraction of a simplified version from LOTED2-extended, a sort of LOTED2-lite.

In addition, we will continue to extend LOTED2-core with additional modules, in order to represent two other relevant aspects of the domain. One is about the set of requirements that must be fulfilled by

[23] *http://OpenCorporates.com/*

economic operators (*eligible economic operators*) for participating in European tenders, (such as, for example, the absence of conviction by final judgment for participation in a criminal organization, fraud, money laundering, etc.).

Many initiatives have been started by the European Commission in order to improve the access of traders (in particular of SMEs) to public procurement market in EU. Indeed, this kind of vision is now inspiring the Peppol EU Project[24], which aims to make possible electronic communication between any companies in the European Union with any governmental institutions for all procurement processes. Another initiative is *e-certis*[25], namely a system that helps authorities and economic operators identify the different certificates and attestations (that are evidences for requirements) frequently requested in procurement procedures across the 27 Member States, two Candidate Countries (Turkey and Croatia) and the three EEA countries (Iceland, Liechtenstein and Norway). These two initiatives provide us many useful non-semantic resources for modeling requirements.

The second part of our future work will be the construction of a module about jurisdiction of Regulations, such as Government Procurement Agreement.

These two aspects combined together may allow us to build a Semantic Web Legal application for helping especially SMEs in the formulation of their applications for the participation in a tender. Consider for example the contract notice 2011/S n. 236-382532[26] issued by 'The Open University' (that is a body governed by public law) for the award of a public contract concerning cleaning services.

There are two key questions related to this contract notice, with not easy solutions for traders who are interested in the application for this notice.

First: *I'm a company from Canada, can I apply for this notice issued by The Open University (UK)?*

Second: *I'm a company from Italy: what types of documents should I submit to The Open University for participating in the tender n. 236-382532?*

The answer to the first question depends on the type of 'Regulation' that covers the contract notice. The contract notice states that the Government Procurement Agreement covers this particular type of contract, but this is not enough to give an answer to the first question. It is necessary to consider all the exceptions agreed by single parties to the application scope of the GPA (in this case between Canada and EU).

The answer to the second question depends on the criteria that must be met by business entities that want to participate in EU tenders.

This example shows that in the law, question answering is not only information retrieval. Information retrieval is not enough, since "question requires some deduction or inference before an appropriate answer can be given" and "regulations may contain many different articles about the same topic and one can only assess whether something is permitted or not by understanding the full documentation". "A rather detailed understanding is required, in particular, because regulations generally contain complex structures of exceptions" [4]. In other words, question answering in the legal domain is not a trivial matter. However, we will try to face the challenge, starting from the lesson we have learned so far.

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[24] *http://www.peppol.eu/*

[25] *http://ec.europa.eu/markt/ecertis/login.do*

[26] available from TED system at *http://ted.europa.eu/udl?uri=TED:NOTICE:382532-2011:TEXT:EN:HTML*

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