Journal of Theoretical and Applied Information Technology
28th February 2019. Vol.97. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

ONTOLOGY ALIGNMENT FOR SUPPORTING COLLABORATIVE INFORMATION SYSTEM USING UML AND ODM STANDARDS

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ABSTRACT

This paper presents an approach based on the alignment of ontologies to elaborate a collaborative information system. Nowadays collaboration has become a necessity for the different organizations and requires data and knowledge about the different partners of the collaboration. Our proposal begins with the idea of gathering knowledge from the collaboration network by transforming the class diagram of their information system to ontology using ODM metamodels in agreement with MDA architecture. We will generate Several ontologies according to the number of collaboration partners, and they will be aligned using the AML alignment algorithm to have a collaborative global ontology. To validate we applied our prototype to the case of organ transplantation which requires collaboration between different hospitals.

Keywords: *Ontologies, Collaborative Information System, Alignment, Ontology Definition Metamodel (ODM), UML*

1. INTRODUCTION

Innovation and agility must be provided to companies through active collaboration between them. The cooperation between companies and different organizations has become a necessity to accomplish common processes or to guarantee their economic effectiveness which creates different collaborative networks. The survival of these collaborative networks is conditioned by their ability to be flexible and adapt quickly to market change.

Collaboration networks imply requirements for collaborative platform development that will support collaboration between multiple companies and that go beyond the problem of heterogeneity. According to the standard [1], several levels of collaborative maturity can be used to characterize a company: communication, open, federated and interoperable, the most critical level is the interoperability that ensures connectivity between different collaboration partners. Interoperability is the ability of two or more systems or components to exchange information and use the information exchanged [2] Interoperability is considered as the ability of companies to structure, formalize and present their knowledge and know-how to exchange or share it, which is why it is considered an essential requirement for companies that must integrate dynamically. Interoperability is therefore essential for collaboration between several information systems.

These constraints on collaborative platforms as well as levels of collaborative maturity have highlighted several issues and research questions:

- How to ensure the interoperability of each information system in the collaborative network?

- How to overcome the semantic heterogeneity between the information systems?
- Which techniques can be used to add the abstract level represented by knowledge in the collaboration?
- Which techniques can be used for gathering knowledge from the partners of collaboration?
- How to make knowledge solution more efficient and global?

However, the semantic heterogeneity, between the business processes of the different information systems representing the enterprises participating in the collaboration, is a severe problem for the automatic management of cooperation processes concerning knowledge sharing and interaction based on requests between contributors. In Order to resolve this problem, the use of ontologies was strongly recommended to take into consideration a more abstract level of collaboration that of knowledge, trying to create a collaborative global ontology containing concepts of the different partners of the collaboration. [3], unlike previous solutions that did not take into account the semantic level of collaboration which created a gap between the business and technical level [4].

The use of ontologies for the creation of a collaborative information system has solved many problems including the gap between the business level and the collaborative platforms proposed, seen that ontologies represent the semantic level of collaboration. Despite such progress, there was always a lack of concepts in ontologies created, which makes collaboration unsatisfying for all partners in the collaboration. As a solution, we propose a new approach based on ontology alignment and MDA architecture for model transformation. The idea is to begin by using UML representation of class diagram, that already exist, of each organization in the collaborative network and to transform it into ontology, in this context the OMG group has conducted several searches on the implication of ontologies in the model-driven engineering based on the two OMG standards; UML and ODM. The ODM standard will allow us to transform the class diagram to ontology; this process will be applied to all the class diagrams representing the information system of each organization in the collaborative network to apply the alignment to those ontologies to have as a final result a global collaborative ontology.

Our paper will be organized as follows. In Section II, we present the backgrounds of our research work. We review related works to our theme regarding the various proposed platforms of collaboration, the information system of mediation, the use of the ontologies for the collaborative information systems, the generation of ontologies from UML class diagrams, the algorithms of ontology alignment. Section III describes our prototype and its different phases. In section IV we show the results of our proposal by applying our prototype to a UML class diagram except for the organ transplant process. Finally, Section V concludes the paper.

2. RELATED WORKS AND BACKGROUND

2.1 Related Works

In the literature, there has been a lot of researches and practical contributions in the field of collaborative information system and the use of ontologies to elaborate those systems.

Several solutions have been proposed to solve the problem of interoperability: European Interoperability Framework (EIF) [5], ATHENA Interoperability Framework (AIF) [6], Interoperability Development for Enterprise Applications and Software (IDEAS) [7], e-Government Interoperability Framework (e-GIF) [8], a mediation information system [7] and the project PIM4SOA [9].

A corporate interoperability framework proposed in [10], which defines three interoperability barriers: conceptual, technological and organizational. Considering that enterprise information systems are the practical and operational parts of a business, an important requirement is to remove the technological barriers between them. The possibility of breaking down conceptual barriers by removing technological barriers is also taken into consideration, but several problems arise, an agility problem, an interoperability problem and a business / technical correspondence problem [11].

An agile, interoperable information system that supports business / technical correspondence is called the Mediation Information System (MIS), this is the starting point of the MISE project (Mediation Information System Engineering) [12], which proposes a solution for the design and realization of an MIS. This project

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

aims to develop an approach and methods for the design of collaborative information systems from interoperable information systems following a principle of mediation between these systems.

An engineering approach directed by the mediator models and coupled by a business process management approach based on the SOA (Service oriented architecture) was the focus of the work of [4] who sets the design of this collaborative information system based on the Model Driven Architecture (MDA). He was interested in the passage of a Computer Independent Model (CIM) model [13], [14] where the partners provide their collaboration process to a Service Oriented Architecture (SOA) based Platform Independent Model (PIM) a model that describes a response to the specifications defined in the CIM model. The structure of the mediation information system is represented in Figure 1.

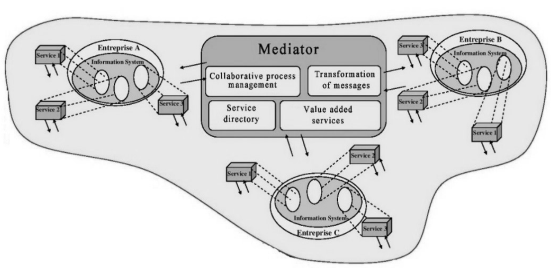

Figure 1: The structure of the mediation information system proposed by the MISE project (2007)

The work of [4] used two metamodels: a BPMN metamodel and an SOA metamodel to make the transition from a CIM level model expressed as a Business Process Model (BPMN) to another SOA-based PIM model.

The previous solutions did not take into account the semantic level of the collaboration which created a gap between the business and technical level which does not give a satisfactory collaboration.

Ontologies are a more abstract level of a collaborative information system; they represent the business level. The work of [3] was interested in a more abstract level of the MISE project: the business level. She defined a knowledge-based system (Kbs) to generate automatically the CIM model and this by offering the different partners the opportunity to describe the desired collaboration.

The primary goal of this work was to be able to capture, adapt and transform all knowledge concerning the collaboration in question, with the intention of producing a collaborative business process compatible with the CIM model.

For this reason, a knowledge-based system (kbS) has been developed in order to support the modeling of the collaborative business process. The system consists of four functionalities as depicted in Figure 2.

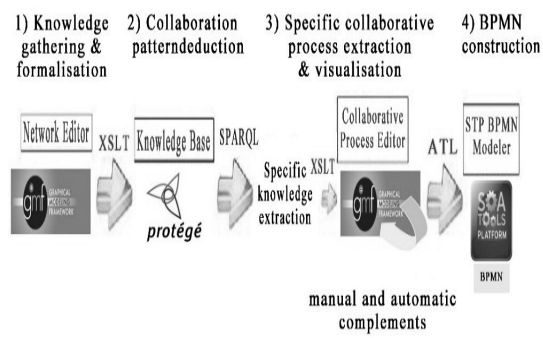

Figure 2: The technical architecture of the solution (Rajisri 2009)

This work of [3] was able to develop an approach to develop a knowledge-based system dedicated to the specification of a valid collaborative process model to be executed under a collaborative platform.

The thesis supported by [15] continued the work of [3] to be able, not only to design a collaborative information system based on mediation, but also to make an evolutionary maintenance in a double movement of reverse engineering and engineering adapted to the recurring evolution of the need and which provides agility in operation.

The thesis research of [16] enriched the works of [3] by automating the generation of the characterization and the transformation of a model of the collaborative situation in a model of mapping (cartography) of collaborative business processes. As a supplement to these works, [17] developed the transformation of business processes in feasible technical processes. This passage consists in selecting among the available services those who cover the features of the activities jobs modeled in the various processes and annotated semantically.

By treating a particular type of collaboration that of the case of crisis by [18],

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

within the framework of the project ISyCri conceived an information system for several partners who have to solve, or at least reduce, a crisis in which they are involved, this proposed solution is an information system of mediation.

The thesis of [19] based itself on the works of [3], while enriching the ontology quoted in the work of Rajisri, by adding dynamic concepts in the ontologies, rules of transformation of the collaborative process and a set of services.

The work of [20] combined to the work of [3] and that of [19], to propose a more generic approach allowing a meta modelization of the inter-organizational collaborative process. This approach starts of the principle that within an inter-organizational collaboration, the various actors do not still have the same point of view on the notion of business process, each evolving in the environment, its universe of skill and each having to sound his model of a business process. The points of view of every partner were separated but, in reality, they establish a representation of the various aspects of the same and unique system. Within the framework of an inter-organizational collaboration; the need to reach a common purpose and the need for information exchange between the various actors lead to opt on second thought in meta-modeling of the collaboration. This work has been a part of global architecture presented in work "Towards a Platform in Cloud for the Integration of the Interorganizational Workflows" made by [21].

The work of [3], as we have already said, completes the approach proposed by [4] by providing a model of the collaborative process, the latter, which can be constrained by shared resources or by processing times, must be checked before being handed over to the collaboration execution platform. In the literature several techniques have been adopted, for verification of the process model, [22], [23] use the technique of model checking for the verification of business processes. [24] explored the structural theory of Petri nets to approach the modeling and verification of business processes by improving a chosen algorithm in the literature. The work of [25] adopts an approach based on automatons as well as formal composition and [26] uses an approach of the check based on the transformation(processing) of graphs.

After having analyzed all the works we have already mentioned it has been found that there is always a need to enrich the collaborative ontology, there was a lack of concepts, that's why we thought about using ontology alignment by aligning ontologies representing the different partners in the collaboration, which will give us; as a result, a richer collaborative ontology.

The objective of the alignment of ontologies is to realize the semantic interoperability. The semantic interoperability is the capacity of two or several information systems to find a common understanding, from the exchanged data, to produce useful results. It by putting two heterogeneous ontologies in an agreement by detecting a set of correspondences between the entities of these semantically bound ontologies, to allow the data to be exchanged, handled and integrated, thanks to the use of various methods and approaches.

There is an initiative every year to define the best matching systems between ontologies, OAEI (ontology alignment assessment initiative) [27] is a coordinated international initiative that organizes the evaluation of much-growing ontology matching systems. Its primary purpose is to openly compare systems and algorithms on the same basis, allowing anyone to conclude the best ontology matching systems. We already produced a state-of-the-art article that cites several works related to the research theme of this paper [28].

After analyzing the works cited in the literature review, we found the presence of several gaps. The lack of semantics in the first collaborative platforms proposed to support collaboration between multiple information systems, which created a gap between the business and technical level. To correct the first gap the use of ontologies was introduced, but the resulting collaborative ontology had a lack of concepts regarding the different partners of collaboration, which resulted in unsatisfactory collaboration, in addition to the problem of the proposed frameworks to collect knowledge about the different partners of collaboration that was not relevant.

The previous works how used ontologies for collaboration tried to create a global collaborative ontology by using frameworks for gathering knowledge from the different partners, those frameworks were not efficient, and this solution gave an ontology with a lack of concepts and associations concerning the collaboration

Journal of Theoretical and Applied Information Technology
28th February 2019. Vol.97. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

partners which created a not satisficing collaboration. To fill the gap of the frameworks our solution proposed the use of the class diagram, that already exists and contains all the classes describing the information system of the organization and its processes, and we transformed it into ontology using the ODM proposal of the OMG group. We also proposed the use of ontology alignment of all the ontologies representing the organization in collaboration so that we can have a more reach global collaborative ontologies to resolve the problem of the lack of concepts.

2.2 Background

2.2.1 Mda

Model Driven Architecture (MDA) is an instance of MDE developed by OMG [13]. MDA provides guidelines for structuring software specifications that are expressed as models and separates business and application logic from underlying platform technology.

MDA architecture is based on the principle of using modeling languages to specify a system at three different levels; Figure 3 shows the different levels of the MDA architecture:

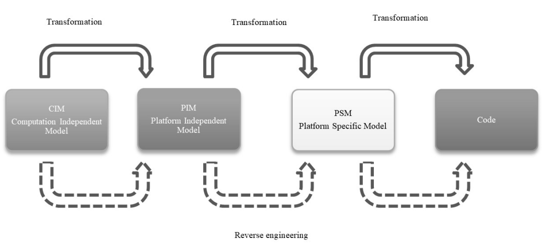

Figure 3. Overview of the MDA Approach

The computation-independent model (CIM) allows the representation the environment and requirements of the system, a platform-independent model (PIM) that describes the system architecture in a technology-neutral manner, and a platform specific model (PSM) that expands the PIM by specifying how the model is to be implemented using a particular platform a set of subsystems and technologies.

The vision underlying the MDA is that automated mappings can be used to the transformation from a PIM to a PSM when a specific platform has been identified and the passage from PSM to code and conversely. The practical realization of this vision is based on many existing and new OMG technologies, in particular, the meta-object facility (MOF) [29].

2.2.2 Uml

The OMG publishes a variety of standard specifications; the best known is UML (Unified Modeling Language) [30]. UML (Unified Modeling Language) is a language to visualize, specify, build and document all the aspects and artifact of a software system [31]. UML is the fusion of a whole of other languages of modeling (OMT, Booch, and OOSE). It is quickly becoming a standard that is impossible to avoid.

UML 2 includes thirteen types of diagrams representing particular concepts of the information system from different visions, these diagrams are: Activity diagram, Class diagram, Communication diagram, Component diagram, Composite structure diagram, Deployment diagram, Interaction diagram, Object diagram, Package diagram, Sequence diagram, State machine diagram, Timing diagram, Use case diagram.

The class diagram is considered the most important and the only mandatory diagram of object-oriented modeling, it shows the internal structure of a system and provides an abstract representation of its interacting objects together to realize the use cases [32].

2.2.3 Odm

The ODM (Ontology definition metamodel) specification was appeared in 2007 by OMG. It defines a set of ontology metamodels; conforming to the MOF, and associated transformation methods (profiles and mappings) [33].

ODM determines five metamodels; RDFS, OWL, Topic Maps, Common Logic, and Description Logic, two UML Profiles (RDFS/OWL Profile, Topic Maps Profile) and a set of QVT mappings from UML to OWL, Topic Maps to OWL and RDFS/OWL to Common Logic [34].

The use of ODM will allow us to use the MDA capabilities for ontology development. In our work we are interested in the transformation from UML to OWL, there are two methods mentioned in ODM for moving from a UML model to an OWL model, either by using UML profiles or by using transformation rules using language processing such as QVT and ATL. We will use the last method to generate our ontology that we will then use in the ontology alignment phase.

Journal of Theoretical and Applied Information Technology
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ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

3. APPROACH PROPOSED

This work proposes a new approach to develop an ontology-based collaborative information system using OMG standards. Our goal is to create a global collaborative ontology that we will transform during our future works into an executable process, so the main idea is to represent each partner's information system of the collaboration by ontology and to make the alignment between them to generate a global ontology. To generate the ontology corresponding to each collaboration partner, we will use the UML class diagram that already exists in each partner information system and transforms it into an ontology based on the OMG ODM (Ontology definition metamodel) proposal.

We present in Figure 4 our development process is based on the MDA architecture using the two OMG standards: UML and ODM.We implemented our process using the Eclipse Modeling Framework (EMF) which supports MDA and complies with the Object Management Group (OMG) standards for UML and ODM.

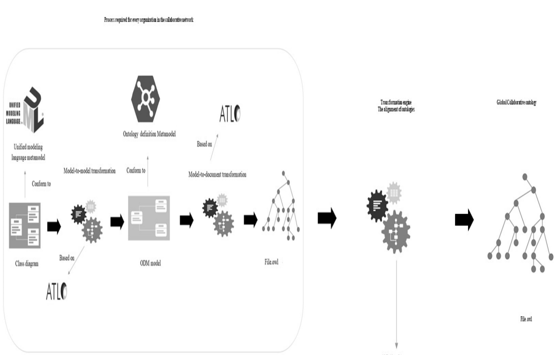

Figure 4: Our process of development

Our development process is composed of three parts: The first two parts are formed of two ATL transformations: the fundamental transformation that UML to OWL takes to enter a UML model and produce an ontology conforming to the OWL metamodel of the ODM. The second ATL transformation is an XML extractor that provides an XML document conforming to the OWL / XML syntax defined by the W3C specification, which will then be transformed into an owl file.

The third step is to align the resulting ontologies of the first two parts using the AML alignment algorithm as shown in Figure 5.

3.1 The Transformation from UML to OWL

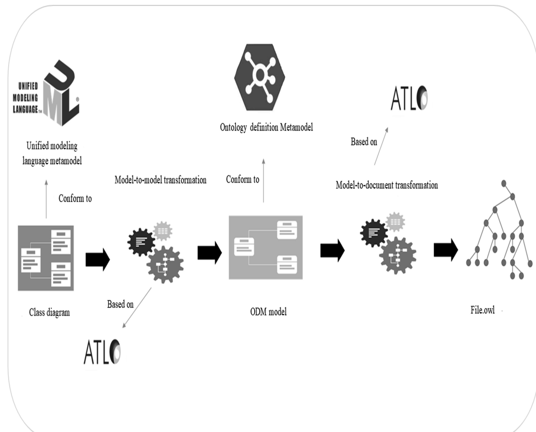

Figure 5: The transformation from UML to OWL process

To achieve this transformation, we have relied on the result of the work of [35]. In the beginning, there is a mapping of the UML model to the ontology, that is, the UML classes are mapped in the OWL classes, the attributes in the data type property, the associations in the property of the object. Secondly, a transformation will be applied to deal with instances. These instances are converted to OWL. This method provides the ability to manage UML instances and to complete the ontology with the corresponding knowledge.

The UML to ODM mapping covered the most used UML components needed for representing UML models (class diagram) and representing them in the ODM standard.

UML Class is transformed into OWLClass. The "OwnedAttribute" relationship defines the attributes of each class. It is an "OrdredSet" of "Property" that can be mapped to either "OWLDatatypeProperty" or "OWLObjectProperty." If a property is a part of an association's "MemberEnds" then the mapping will result "OWLObjectProperty," contrarily if the type of the property is "PrimitveType" then the property will be mapped to "OWLDatatypeProperty" "Domain" is the set of "OWLClass" that contains this "OWLDatatypeProperty" While "range"

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

represents the type of "OWLDatatypeProperty" which is defined by "RDFSClass".

For example, Class to Class mapping, the mapping from Class to OWLClass includes the transformation of generalization relationships between Classes as depicted in figure 6. A generalization is a taxonomic relationship between a more general classifier and a more specific classifier. Every instance of the specific classifier is also an indirect instance of the general classifier. It has the same semantics of RDFSsubClassOf in RDF Schema, and the two ends of the generalization relationships can be accessed by the source and target that are defined in DirectedRelationship.

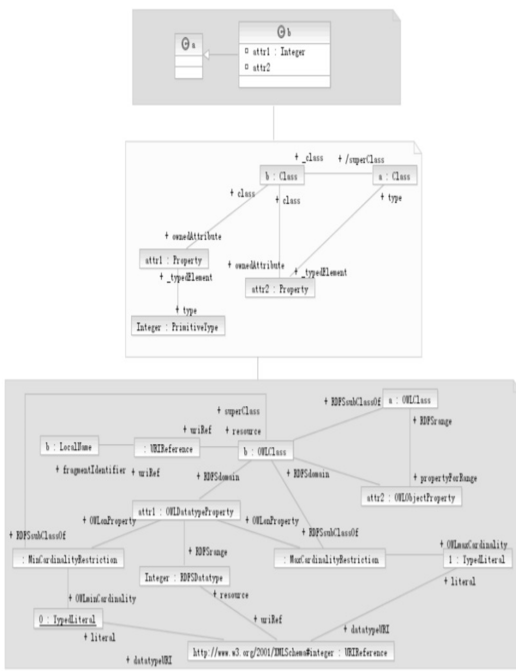

Figure 6: Mapping UML Class to OWL Class

A binary association specifies a relationship that can occur between typed instances. It has precisely two ends represented by properties, each of which is connected to the type of the end. The Association ToObjectProperty relation is used to set OWLinverseOf relationships between inverse properties.

3.2 Ontology Alignment

Ontology is a means of representing semantic knowledge [36] and includes at least a controlled vocabulary of terms and some specification of their meaning [37]. Ontology matching consists in deriving an alignment consisting of correspondences between two ontologies [38]. Such an alignment can then be used for various tasks, including semantic web browsing, or merging of ontologies from multiple domains.

Ontology alignments demonstrate semantic correspondences between the entities of different ontologies. The correspondences of an alignment can be various relations, like equivalence, subsumption, disjointness or instance between entities of the ontologies, which can be named entities, like classes, roles, individuals and function symbols or even complex concepts or terms.

Ontology matching and alignment is a crucial mechanism for linking the diverse datasets and ontologies arising in the Semantic Web. Matching based on statistical methods is relatively developed with yearly competitions since 2004 comparing the various strengths and weaknesses of existing algorithms [39].

3.2.1 The alignment process

The alignment process combines three dimensions: input, alignment process and output. The input or the input that is constituted structures to be aligned, they can be XML schemas, relational schemas, ontologies. In our case, they are the last ones. The alignment process: is a task during which, from ontology O and another O', determines an alignment A' between these two ontologies, this task is carried out using a strategy or a combination of basic alignment techniques as shown in Figure 7.

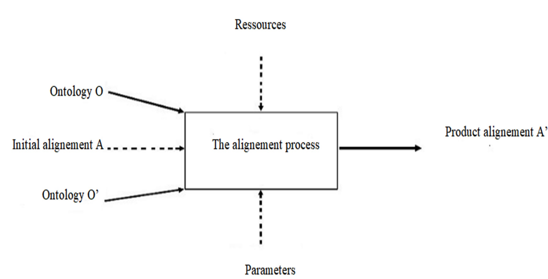

Figure 7: Diagram summarizing the alignment process

Our choice of alignment algorithm was based on the results of the OAEI competition [40], it is an initiative organized every year to define the

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

best matching systems between ontologies and coordinated international initiative that organizes the evaluation of many growing ontology matching systems. Its primary purpose is to openly compare systems and algorithms on the same basis, allowing anyone to conclude the best ontology matching systems. Also, allow developers, from such assessments, to improve their systems.

We chose the algorithm AgreementMakerLight (AML) based on the results of the OAEI 2016 represented in Figure 8. AML is an automated and efficient ontology matching system derived from AgreementMaker that has been in development since the beginning of 2013. It was very successful in the OAEI 2014 competition, ranking first in F-measure in the following tracks: Anatomy, Conference, Multifarm, Library, Interactive Matching Evaluation, and Large Biomedical Ontologies [41].

System	Alin	AML	CroLOM	CroMatcher	DiSMatch	DKP-AOM	DKP-AOM-Lite	FCA-Map	Lily	LogMap	LogMap-Bio	LogMapLt	LPHOM	Lyam++	NAISC	PhenoMF	PhenoMM	PhenoMP	RiMOM	SimCat	XMap	Total=21
Confidence	√	√	√	√	√					√	√		√	√	√				√	√	√	13
benchmarks		√		√					√	√		√									√	6
anatomy	√	√		√		√	√	√	√	√	√	√	√	√							√	13
conference	√	√		√		√	√	√	√	√		√	√	√	√						√	13
largebio	√	√		√		√	√	√	√	√	√	√	√	√							√	13
phenotype		√			√			√		√	√	√		√		√	√	√			√	11
multifarm		√	√							√			√	√						√	√	7
interactive	√	√								√											√	4
process model		√				√	√			√												4
instance		√								√		√							√			4
total		9	1	4	1	4	4	4	4	9	3	6	4	5	1	1	1	1	1	1	7	77

Figure 8: The list of OAEI participants of the year 2016.

3.2.2 The AgreementMakerLight system

AgreementMakerLight (AML) is an automated, scalable ontology matching system developed to tackle massive ontology matching problems, particularly on the biomedical domain. It is deduced from AgreementMaker, one of the leading first generation ontology matching systems [42], and adds scalability and efficiency to the design principles of flexibility and extensibility.

The AML ontology matching framework is divided into four main modules: ontology loading, first matching, secondary matching, and alignment selection and repair as shown in Figure 9.

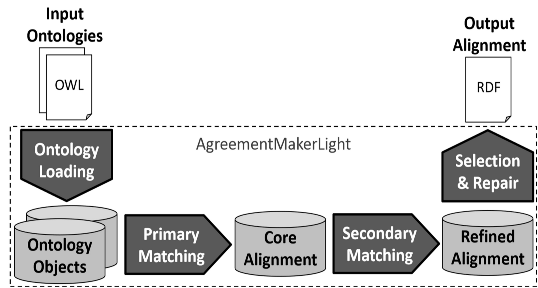

Figure 9: AML Framework

Reading ontologies and parsing their information into the AML ontology data structures is guaranteed by the ontology loading module, which was conceived to enable anchor-based matching [43] AML 2.0 constitute the change from the Jena2 ontology API to the more efficient and flexible OWL API including several upgrades to the ontology data structures. The Lexicon is the most critical data structure AML uses for matching, a table of class names and synonyms in an ontology, based on a ranking system to weight them and score their matches [44].

AML's ontology matching algorithms are contained in the primary and secondary matching modules, the difference between them is their time complexity. The primary correspondents can be applied to all approximation problems because it has a linear time complexity, while the secondary one can only be used locally to significant issues.

One of the critical features in AML is the use of background knowledge in primary matchers, and it includes an innovative automated background knowledge selection algorithm. The alignment selection and repair module ensure that the final alignment has the desired cardinality and that it is coherent which is essential for several applications.AML's approximate alignment repair algorithm attributes a modularization step for coherence by identifying the minimal set of classes that need to be analyzed, so significantly reducing the scale of the repair problem [45].

4. RESULTS AND EVALUATION

In order to verify the validity of our prototype we proceed to search for real cases to implement it, we found the field of organ transplantation very interesting because it requires collaboration between several hospitals. The operations of transplantation are made only in specific hospitals, the patients and the donors are in

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

different hospitals what implies a collaboration between hospitals to make a success of these operations by respecting all the constraints. Transplantation, as a last resort in case of failure of a vital organ, remains a significant operation. This operation involves several intervenes hospitals, doctors, grafts and patients who are divided into two types: donors or recipients.

The following class diagram shown in Figure 10 represents a part of the organ transplant process that we choose as an example of our solution:

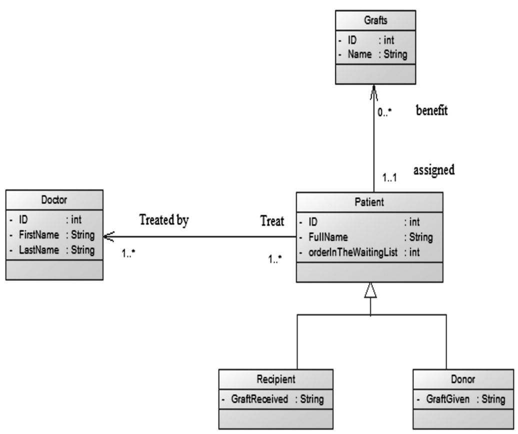

Figure 10: Class diagram of the organ transplant process excerpt

The organ transplant is modeled using the diagram of the class which will be the input of our prototype representing the PIM level. This diagram will be the object of a mapping between UML and OWL by using the ODM metamodels. This mapping is based on ATL to produce an ontology conforming to the OWL metamodel of the ODM, then a second transformation which is an XML extractor that produces an XML document conforming to the OWL / XML syntax, as defined by the W3C specification, which will then be transformed into an owl file.

We will represent some examples of mapping ATL transformation according to the ODM specification, corresponding QVT mapping as depicted in Figure 11.

```
rule PrimitiveProperty2DataTypeProperty {
    from
        p : UML!uml::Property
        (
            p.type.oclIsTypeOf(UML!uml::PrimitiveType)
        )
    to
        d : OWL!OWLDatatypeProperty (
            uriRef <- u,
            domain <- p.class,
            range <- p.type
        ),
        u : OWL!URIReference ( fragmentIdentifier <- l, uri <- uri ),
        l : OWL!LocalName ( name <- p.class.name + '.' + p.name ),
        uri : OWL!UniformResourceIdentifier ( name <- p.class.name + '.' + p.name )

        do {
            if ( p.upper = p.lower )  -- [n-n]
                thisModule.addCardinalityRestriction( p );
            else
                if (( p.upper = 0-1 ) and ( p.lower >= 0 )) -- [*]
                    thisModule.addMinCardinalityRestriction( p );
                else  { -- [m-n]
                    thisModule.addMinCardinalityRestriction( p );
                    thisModule.addMaxCardinalityRestriction( p );
                }}}
```

Figure 11: QVT mapping

The UML to OWL transformation can produce an OWL model in ecore format, or an OWL document conforms to the OWL/XML presentation syntax, and the XML file is transformed into OWL documents that can be used under ontology tools like Protégé and used as input for the alignment using AML algorithm.

An excerpt of the OrganTransplant ontology produced by the UML to OWL transformation from our UML model is given below in Figure 12.

```
<rdf:RDF xmlns:rdf = 'http://www.w3.org/1999/02/22-rdf-syntax-ns#' xmlns:rdfs = '
http://www.w3.org/2000/01/rdf-schema#' xmlns:xsd = 'http://www.w3.org/2001/XMLSchema#' xmlns:owl = '
http://www.w3.org/2002/07/owl#' xmlns = 'http://example.org/OrganTransplant#' xml:base = '
http://example.org/OrganTransplant'>
 <owl:Ontology rdf:about = 'OrganTransplant'/>
  <owl:Class rdf:ID = 'Patient'>
   <rdfs:label>Patient</rdfs:label>
   <rdfs:subClassOf>
     <owl:Restriction>
       <owl:onProperty rdf:resource = '#Patient.ID'/>
       <owl:cardinality  rdf:datatype = 'http://www.w3.org/2001/XMLSchema#nonNegativeInteger'>1</owl:cardinality >
     </owl:Restriction>
   </rdfs:subClassOf>
 <rdfs:subClassOf>
     <owl:Restriction>
       <owl:onProperty rdf:resource = '#Patient.FullName'/>
       <owl:cardinality  rdf:datatype = 'http://www.w3.org/2001/XMLSchema#nonNegativeInteger'>1</owl:cardinality >
     </owl:Restriction>
   </rdfs:subClassOf>
   <rdfs:subClassOf>
     <owl:Restriction>
       <owl:onProperty rdf:resource = '#Patient.orderInTheWaitingList'/>
       <owl:cardinality  rdf:datatype = 'http://www.w3.org/2001/XMLSchema#nonNegativeInteger'>1</owl:cardinality >
     </owl:Restriction>
   </rdfs:subClassOf>
```

Figure 12: OWL file of OrganTransplant

As shown in Figure 12 our ontology was defined by “owl: ontology” tag and identified by an uri embedded in “rdf: about” attribute and the owl class (Patient) is defined by “owl: class” tag.

The “FullName” data type property is represented by “owl:DatatypeProperty” tag and identified by an Uri in the “rdf:about” attribute, this data type property belongs to the Patient class presented in the “rdfs:domain” tag by a reference of its Uri in the “rdf:resource” attribute, the data type of this data type property is defined in the “rdfs:range” tag and referencing the type by a Uri in the “rdf:resource” attribute;This data type property is valid for all the other ones.

5. DISCUSSION

This work is a modest contribution to the elaboration of a collaborative information system based on ontologies. This section we will compare our work with the prior works. It also highlights the benefits of our work.

Firstly, we survey the development of collaborative information system using ontologies, the work of [3] was interested in a more abstract level of the MISE project: the semantic level using ontologies. Several works rely on the work of [3], by automating the generation of the characterization and the transformation of a model concerning a collaborative situation in a model of mapping, developing the transformation of business processes in feasible technical processes, treating a particular type of collaboration which is the case of crisis, enriching the ontology quoted in this work by adding dynamic concepts. After having analyzed all the previous works, we found that the solution proposed for gathering knowledge from the partners of collaboration was not efficient, because it was based on the knowledge that the collaboration partners inserts into their proposed platform which engendered a lack of concepts. As an alternative, we thought to use the class diagram representing the information system of each organization because it already describes the internal structure of the information system. We were able to transform the class diagram into ontology based on the ODM proposition of the OMG and also by using the results of the work of [35].

Secondly, we notice that the perspective of the previous works which used ontologies is to enrich the collaborative ontology, there was a lack of concepts, because of this problem we thought about using the alignment of ontologies representing the different partners in the collaboration. As a result, we will have a richer collaborative ontology.

Thirdly, we choose the alignment of the ontologies as the solutions to the gaps noticed in the previous works; we based ourselves on the results of the OAEI which organizes every year a competition which defined the best algorithms of the alignment. Based on those results we choose the AML algorithm.

The main limitation of those results is the application of our prototype to several hospitals and to execute the AML algorithm, and that will be in our futures articles.

6. CONCLUSION AND PERSPECTIVES

This paper has clearly shown that our approach facilitated gathering knowledge from the different information systems of the collaboration and the population of the global collaborative ontology resulting. The idea started with the transformation of the class diagram of each organization forming part of the collaborative network, since the class diagram is an element that already exists and includes information about each information system, in an ontology using MDA. To realize the UML transformation towards OWL we

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

were based on the ODM metamodels offered by the OMG, by applying two ATL transformations. Finally, we will have several ontologies representing all the information systems in collaboration by applying our prototype to all the information systems involved in the collaboration.

These results are not conclusive; our future work will be the application of the AML algorithm that was previously detailed to these ontologies to have a global ontology transformed into an executable process. The next stage of our research will be experimental confirmation of our solution by trying to applicate our prototype to different hospitals to validate the process of organ transplantation that we choose as an application of our proposed approach.

ACKNOWLEDGMENT

We would like to show our gratitude to The National Centre for Scientific and Technical Research (Morocco) for offering an excellence research grants to our corresponding author so she can undertake her research.

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