Semantic Integration Process of Business Components through Ontology Alignment

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Abstract—**Ontology Alignment (OA) identifies semantically matching of different entities, OA continues to attract great attention within the database, information system and artificial intelligence communities. OA used to solve the semantic heterogeneity and hide the complexity of retrieving entities of heterogeneous source. That's why we rely on the OA for resolving semantic conflict during design phase of information system, particularly in semantic integration of Business Components (BC). Our contribution concerns a solution for the integration of BC based on the ontologies alignment in order to support information system designers.**

Index Terms— **Component, Business Components, Semantic Integration, Ontology alignment, Enriching Ontologies**

I. INTRODUCTION

This field of information systems engineering has always been a sector very claimant in techniques and new methods to improve both the quality of the products and the performance related to the process used for its development. In addition, applications are becoming increasingly complex and are covering wide range of fields. The in-creasing and diversifying role played by the Web and the Internet in the design and implementation of online applications (Semantic web and Cloud Computing) do amplify this situation.

This field, therefore, has evolved enormously since the advent of the computer. These developments have constantly provided reliable software and have been tailored to meet business needs, especially by reducing costs and delays. These developments have focused simultaneously on how to represent the targeted field by the software production, as well as conceptual, technological and methodological frameworks that facilitate and guide the process of software production. One of the most promising approaches herein is "components reuse based engineering ", called also "design by reuse".

In the past information systems engineering, programming activities were the first to be subject to this situation and to be experimented with this approach. Proposals based components emerged later to address problems of engineering requirements, specification and modeling systems. Approaches based on "Business Components" are part of this trend. They usually have

similar concepts representing different objects. Their similarity and difference in terms of concepts, or their appearance necessitate a common specific interpretation of the BC, their innate information, their interface and their general specifications. As a consequence the main problem then is to in building new Business Information Systems (IS) from reusable components is today an approach widely adopted and used [1], [2] and [3].

Our problem is inscribed at the intersection of two scientific fields: the components reuse engineering and the ontology's alignment. The integration of business components is a research problem that has been identified in the field of engineering by reuse. Our proposal aims to assist designers in the IS integration phase. It is a process guided by the ontology domain to provide semantic integration of Business Components (BC). This process allows the detection and resolution of semantics conflicts naming type encountered in the process of integration of business components. Several improved and extended versions of this process were presented successively. This process allows the detection and resolution of naming semantics conflicts encountered in the process of integration of business components. Several improved and extended versions of this process were presented successively in [4], [5], [6], [7], [8].

We hypothesize that the conception of an Information System (IS) generally targets management business area and business components reuse modeled in a high-level language such as UML, fragments of this field. Moreover, semantic integration systems rely mostly on ontology's alignment. We relied on the results of these studies to support the semantic integration process.

Indeed, the application of several rules on candidate concepts to alignment enables to detect new semantic relations and enrich the original ontology. The BC set subject to integration are used as sources to generate semantic relations. A new step of ontology enrichment has also been inserted in our process and an extension of the method of calculating the similarity has been proposed [6]. Two steps namely the production of a correspondence ontology (Alignment) and a proposed action, guidelines and strategies to designers of information system depending on the type of conflict in order to resolve semantics conflicts, were also included in

our process [8]. We validate our results using a prototype that we have developed.

Our paper is organized as follows: First the problem of semantic integration of BC is presented. In section 3 domain ontology based alignment and enrichment-rules based techniques are described. In Section 4 our proposal of BC semantic integration method is given, completed in section 5 by ontology domain enrichment process. In section 6 an example of application and a prototype are presented in order to illustrate our proposal. Finally, section 7 presents the conclusion and perspectives of our work.

II. BUSINESS COMPONENTS

Business components based approach aims to reduce costs, risk and cycle-time of developing software. Components based approach consists in building new systems by reusing available components in the same field. Ac-cording to this approach, a business information system will be built from a set of Business Component (BC) which is generally heterogeneous. In fact, these BC generally emanate from various sources. For example, a company trading IS could be designed from multiple BC such as: {"Sales", "Product", "Customer" etc...}.

According to Object Management Group (OMG), a BC is a representation of nature and behavior of entities of the real world in terms resulting from the company; (supplier, account, etc). It meets cur-rent functional needs (e- mail, etc), company functions (commercial management, etc.) or brings a solution to a particular branch of industry (banks, insurance, etc) [3].

III. SEMANTIC INTEGRATION OF BUSINESS COMPONENTS

The semantic integration of different BC in the same in-formation system goes through a process of detection and resolution of semantics conflicts that may exist between different components. We consider that every conflict is generated by a non-definition of a semantic relation (eg: synonymy semantic relationship which may cause a conflict type naming). We based in this paper on ontologies alignment to align the ontologies associated with BC. Because of its ability to produce ontology what we call Correspondences Ontology (CO) which includes the concepts and their semantic relationships derived from multiple sources ontologies. This task required and appropriate in the process of semantic integration, which is why, we show the usefulness of CO and see how it can be used either in an automatic process as input of the phase integration is a process assisted by the designers of information systems. Which allow to deduct a set of actions (add, edit or delete a concept or relation) in order to achieve semantic integration of BC.

The integration of BC aims to detect and resolve conflicts caused by the heterogeneity of BC. The goal is to produce a single unified component. We define the binary BC semantic integration based on semantic integration of ontologies associated with the BC. We have proposed [5] and [6] an integration processes that

reduces the problem of semantic integration of BC to a problem of ontologies alignment.

Bezivin [9], define the models integration as follow: "*Takes two models M_A, M_B and a Correspondence Model CM_{AB} between them as input and combines their elements into a new output model*".

We are based on this definition to define integration of business components: The integration of business components takes two components BCp and BCq and Correspondence Model CMpq between them as input and com-bines their elements into a new output component BCMpq:

$$\text{BC}\mathbf{pq} = \mathbf{Integrati}(\mathbf{BCp},\text{BC}\mathbf{q},\mathbf{CM}\mathbf{pq})$$

Integration is a binary integration, we rely on the latter to define the integration of a set of BC, denoted BC1 ...BCn, takes a set of components: BC1… BCn and correspondence model CM1….n between them as input and combines their elements into a new output component BC1.... n.

$$\mathbf{BC1} \ldots \mathbf{n} = \mathbf{Integr}\text{ation} (\mathbf{BC1} \ldots \mathbf{BCn}, \mathbf{CM1} \ldots \mathbf{n})$$

The semantic integration requires several pre-processing steps including transformation step of BC to ontologies and ontologies alignment step, resulting from transformation that fit into a phase called preIntegration that we can present it by function. The latter takes as input two BC: BCp and BCq and a domain ontology to produce an Correspondence Ontology (CO), which means:

$$\mathbf{COpq} = \mathbf{preIntegration} (\mathbf{BCp}, \mathbf{BCq}, \text{DO}) \equiv \mathbf{alignement}$$
$$(\mathbf{transformation} (\mathbf{BCp}, \mathbf{BCq}), \text{DO})$$

We present the transformation step of business components to the ontology by function "Transformation" which takes as input a set of BC: BC1… BCn to produce a set of ontologies BCO1… BCOn, which means:

$$\mathbf{BC}\text{O}1 \ldots \mathbf{BC}\text{On} = \mathbf{transformation} (\mathbf{BC1} \ldots \mathbf{BCn})$$

We present ontologies alignment step of ontologies de-rived from BC by the function "alignment" that takes as input a set of ontologies BCO1… BCOn and Domain Ontology (DO) and outputted correspondence ontology, which means:

$$\mathbf{CO} = \mathbf{alignement} (\mathbf{BC}\text{O}1 \ldots \mathbf{BC}\text{On}, \text{DO})$$

The semantic integration of components takes as input two BC: BCp and BCq and correspondence ontology resulting from "preintegration" for produce a single BC Integrated BCMpq, which means:

$$\mathbf{BCpq} = \mathbf{Integration} (\mathbf{BCp}, \mathbf{BCq}, \mathbf{COpq}).$$

Based on the binary integration we define semantic integration among BC:

$$\mathbf{BC1} \ldots \mathbf{n} = \mathbf{semanticIntegration}(\mathbf{BC1} \ldots \mathbf{BCn}, \mathbf{OC1} \ldots \mathbf{n})$$

We use domain ontologies for multiple reasons: Firstly, domain ontologies describe concepts related to a domain, this corresponds fully with our problem, since the design of an IS intended generally a business domain.

Secondly, domain ontologies are reusable inside the same domain, this property is very interesting to consider in BC reusing, which is the central aim reuse approach design.

IV. ONTOLOGIES ALIGNMENT AND ENRICHMENT

Ontologies are recently initiated approach for structuring knowledge and are defined as a collection of concepts and their interrelationships, which provide an abstract view of an application domain. According to Gruber, ontology is defined as an explicit formal specification of terms of a domain and relations among them [10]. Aligning ontologies consists in establishing semantic relations among concepts of various ontologies which describe the same field of knowledge. Aligning ontologies represents a great interest in application domains that manipulate heterogeneous knowledge, such as semantic web, communication in Multi-Agent Systems, data Waterhouse, schemas/ ontologies integration [11],etc. Several works on the alignment of ontologies have emerged over recent years; most of them are based on an external resource that can be either a general ontology or domain ontology [12], [11]. "In the following, we give an account of the concepts that we will use throughout the paper and of the metrics that we used for computing our alignments. We follow the pro-posed terminology in [13], [14] and adopt the same definitions given there, as well as the same symbols within figures, simplifying them for our purposes if it is the case.

Definition 1 (Matching process). A matching process can be seen as a function f which takes two ontologies o and o', a set of parameters p, and a set of oracles and resources r, and returns an alignment a between o and o'.
Definition 2 (Correspondence). *A correspondence between an entity e belonging to ontology o and an entity e' belonging to ontology o' is a 5-tuple <id, e, e', R, conf> where:*

- *id is a unique identifier of the correspondence,*
- *e and e' are the entities (e.g., properties, classes, and individuals) of o and o', respectively,*
- *R is a relation such as "synonym," "more general," "disjointness," "overlapping," holding between the entities e and e', and*
- *Conf is a confidence measure (typically in the [0.1] range) holding for the correspondence between the entities e and e'.*

In our experiments, we only considered classes, business component as entities and synonym, homonym as relation.
Definition 3 (Alignment). An alignment of ontologies o and o' is a set of correspondences between entities of o and o'.

The enrichment of ontologies consists to evolve their semantic content in order to cover new knowledge and increase their semantic consistency. More precisely, the [19], [20], [21], [15],[22] and [23].

Enrichment consists in identifying new items: concepts, terms and relationships, and then placing them in an existing ontology. Enrichment as well as manual construction of ontology turns out to be a tiresome and ex-pensive work [15], that's why several studies have pro-posed automated and semi-automated methods of enriching and building ontologies. All those methods rely on external sources from which new semantic knowledge are identified, evaluated and placed within the ontology to enrich. The sources can be unstructured text such as dictionaries, knowledge bases, semi-structured or structured data such as conceptual schemas [16]. The enrichment process ontology can be divided into two steps: a learning step to search for new concepts and relations, and a placing step to set concepts and relations within the ontology. Several works in the literature have been proposed to cover one and / or other of these steps [17] and [18]. Most of existing approaches, generally based on statistical and linguistic tools, have focused on adding new concepts and / or semantic relations. In this paper we propose to enrich the domain ontology used for support the alignment of components ontologies. The purpose is to improve the efficiency of the similarity measuring method which is based on ontology domain; this will be achieved by adding new semantic relations.

V. BUSINESS COMPONENT INTEGRATION PROCESS.

BC provides the services and / or data. These services and data are expressed in terminology freely chosen by the designers of information system in the majority of cases. The semantic integration of BC is to assign meaning to data and services in order to ensure the integration of data and services across heterogeneous BC to allow their integration into a single BC. We propose in this section a solution of semantic integration of BC that we presented in [4], [6]. Our solution allows:

- Identify and resolve naming semantics conflicts between business components candidates for inclusion in the new information system.
- Produce a new BC resulting from the integration of business components of departure.
- Enrich domain ontology used as support during the integration process.
- Provide guidelines or rules derived from the integration of a set of relationships matches.

Our proposal relies on the results of several research projects including those on the components transformation from a component modeling language into an ontology modeling language, and those related to the alignment and enrichment of domain ontology's [12], this solution consists of two complementary sub-processes:
- *The process of semantic pre-integration.*
- *The process of semantic integration.*

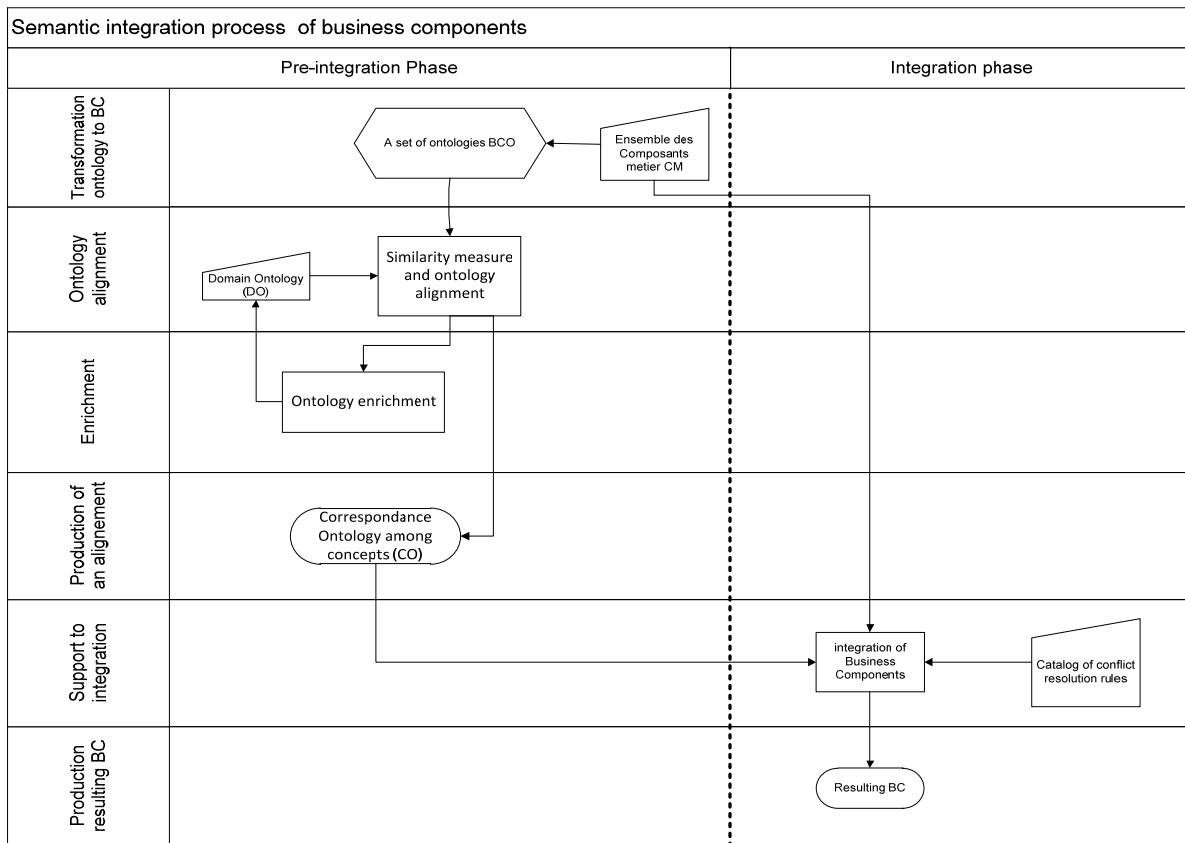A global description is provided in the following figure

Fig 1: Global view of Business Component integration Process

A. The Process of Semantic Pre-integration.

The objective of this process is the production a set of semantic relation between concepts derived from the BC candidates for integration, represented by a Correspondence Ontology (CO) and also enriching the Do-main Ontology (DO). This process consists of a process description is provided in the following: The inputs of the integration process are: - A set of Business Components selected by the designer in order to integrate them in the future Information system. We denote BC1….BCn , these BC.

- A ontology domain chosen by the designer according to the new IS domain. The domain ontology describes concepts and relations among concepts of the IS domain. The domain ontology will thereafter be used to support the integration process.

The outputs obtained at the end of the Pre-integration process:

1. Business Component transformation into ontologies.

UML and OWL have similar concepts in many ways such as: classes, associations, properties, packages, types, generalization and instances.

UML is used to model the dynamic behavior of a system. However, OWL does not allow this type of modeling. OWL is indeed able to infer navigating

- Correspondence ontology (Alignment): In the first step, IS designer can use this ontology to detect and resolve semantics conflicts in a semi-automatic process. In the second step, the ontology could be reused in an automated process from the perspective of integrating BC while defining a set of integration rules derived from the correspondence of BC. It will later be used as ontology support during the second process: the integration process.

An correspondence ontology (Alignment) can be used as enter the integration process

The pre-integration process comprises the following steps:

a. *Transformation the BC candidates for integration into ontologies*
b. *Aligning ontologies obtained based on background ontology.*
c. *Produce correspondence ontology.*

through relations between generalization and specialization classes, also individuals of a class based on the constraints imposed on the properties in the class definition, however, UML does not this feature [28].

A comparison between models and ontologies is given in [35].The differences between the classes of the UML and OWL are studied in [36] and [37]. [38] provided an analysis of approaches for transforming UML to

ontologies. And transformations of UML models to ontologies can be grouped into three categories:

UML Extension [29] presents a UML extension that aims to improve the description (draped Agent Markup Language based) ontologies using UML. (Schreiber, 2002) presents a graphical representation of OWL based on UML; it is extended by OWL annotation [23] presents a method for automated determination of semantic relations between concepts of an ontology generated from conceptual models specified in UML.

An approach based on XSLT: Work Gasevic [40] lead to the transformation of UML class diagrams into OWL ontologies. Transformations are performed by styles Extensible Stylesheet Language Transformation (XSLT) operating models in XML format, in addition to a UML profile was used to model specific aspects of ontologies.

Approaches based on Meta-Models: [29] describes a meta-model for OWL based on Meta Object Facility (MOF) and a UML profile for modeling ontologies using UML. [31] is a preparation for the specification of the Ontology Definition Meta-Model (DOM), it presents an OWL meta-model as a UML profile [30] gave a transformation between UML and OWL ontologies based on Atlas Transformation Language (ATL). [32] Uses the MOF Script tool to perform the transformation UML to owl2. However, their aim is the validation of the Meta-models. And they introduce several elements of UML in the ontology, which are necessary to achieve this goal, but it complicates the use of ontology [22] proposes a methodology based on the driven engineering models (MDA) for the generation of ontologies from annotated UML business model. The authors [28] presented a transformation of class diagrams in ontologies represented by owl2. They specified the transformation in M2 using the QVT transformation language and meta-models and UML owl2. We can make this transformation step of business components in the ontology "Transformation" function which takes as input a set of BC1 ... BCn to produce a set of ontologies BCO1…BCOn, which means:

$$BCO1…BCOn = transformation(BC1…BCn)$$

Relying on the results of these studies, each BC candidate for integration is transformed into ontology, thus bringing the problem of BC semantic integration to a problem of
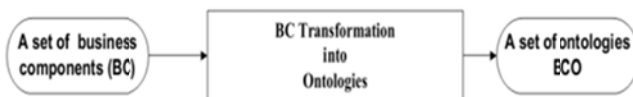

Fig 2: Each BCi to integrate, is transformed into an ontology BCOi [6]

2. Ontologies alignment.

Aligning ontologies is a crucial issue in the field of semantic integration, which aims to find semantic correspondences between a pair of elements of ontologies by identifying semantic relations, they allow detecting and resolving conflicts semantics that may exist between the concepts present in the different BC. We rely for this on a

method for aligning ontologies based on an ontology support, also called in the literature [Safar, 09] ontology background. Ontology supports in our case ontology for the domain to which the information system to build. We will identify and solve naming conflicts with a method for measuring se-mantic similarity.

This step takes as input:
▪ Ontologies obtained in the previous step (Step transformation).
▪ The ontology domain.

It provides a result:
▪ A Correspondence Ontology mapping result of the alignment of all ontologies input.
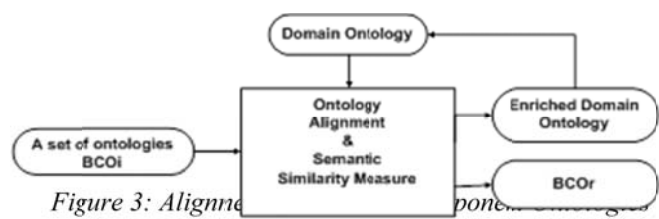

Figure 3: Alignment ... ponent ... [6]

We can make this step alignment of ontologies from BC by the operation "alignment" that takes as input a set of ontologies ... BCO1 BCOn and ontology DO and outputted OC ontology matching, which means:

$$CO=alignment (BCO1…BCOn, DO)$$

In order to carry out alignment we propose a method of measurement of semantic similarity which will be given the responsibility to detect and to solve naming conflicts between concepts. The method of measurement of similarity semantics, noted σ thereafter, will be based on a method of measurement of syntactic similarity noted σ' like on a domain ontology noted DO.

That is to say EC_i the set of concepts present in the ontology BCO_i corresponding to the component BC_i. That is to say EC the set of concepts present in all ontologies of components: $EC = Union (EC_i)$ $1<=i<=n$. Let be C1, C2 two concepts belonging to EC. Let be Term (C_i) a function that returns the term used to describe the concept C_i.

Syntactic similarity measuring

σ' is defined as follows:
σ': EC. ×EC → {0, 1}
begin
if C1 and C2 are atomic concepts **then**
  if Term(C1) =Term(C2) **then** σ' (C1, C2) = 1
  else σ' (C1, C2) = 0
  endif
else
% C1 and C2 are composites. C1 and C2 are then written C1 = (C11.., C1i,….., C1n) et C2 = (C21 …., C2j,…., C2n) %
σ' (C1, C2) =1/n (Σi j σ' (C1i, C2j)) 1 <= i, j <=n
endif
end

The method σ' proposed, thus takes value 1 when the concepts are syntactically identical and 0 in the contrary case.

Semantic similarity measuring.

The method of measurement of the semantic similarity between concepts, is based on the domain ontology and uses the method of measurement of the syntactic similarity σ', defined here before. Are C1 and C2 two concepts of EC, DO the domain ontology, RDO the set of semantic relations available in DO, and R (C1, C2) the subset of the existing relations between the concepts C1 and C2 within DO. RDO ⊃ R (C1, C2.) σ the method of calculating the semantic similarity is defined as follows:

3. *Enrichment process of the domain ontology.*

The proposed method of measuring the semantic similarity uses the treatment enrichment ontology when it contains no semantic relation between concepts align. The enrichment process was indeed intended to discover possible semantic relationships between these concepts.

~ This step takes as input:
~ The domain ontology
~ a set of enrichment rules R1 ... Rn.

~ It provides a result:
~ A new ontology enriched by treatment to add new semantic relations that we use in our process: enrichment using association rules. This ontology will be used as a support during the integration process.

–   We can make this step enrichment ontology by the operation "enrichment" that takes as input a domain ontology ontology will be used as a support during the integration process.

We can make this step enrichment ontology by the operation "enrichment" that takes as input a domain ontology DO and a set of rules R1 ... Rn enrichment and output a domain ontology enriching DO_E, which means:

$$DO_E=\text{enrichissement } (DO,R1…R2)$$

In order to implement this process and demonstrate its feasibility, we chose as examples two rules among different rules enrichment on semantic relationships:

▪   **R1: Two concepts are similar if their nearby equivalent concepts are similar.**

Indeed, according to [34] "Two concepts are similar if their sub-concepts are the same", so two concepts are similar if their "child" sub-concepts are the same. This rule was confirmed in [27]

▪   **R2: Two concepts are similar if their "child" sub - concepts are similar.**

This rule applies to composite concepts. Composite concepts represent the parent concepts and the sub-concepts, linked by part-of semantic relation type, are the child concepts.

Let be C1 and C2 the concepts to be aligned and BCOi the local ontology they belong to; we distinguish three cases:

Case n° 1: C1 and C2 admit a semantic relation within BCOi. This relation is then injected into the domain ontology DO.

Case n° 2: C1 and C2 do not admit a semantic relation in BCOi whereas there exists in BCOi two concepts C'1 and C'2 well as two semantic relations of equivalence; the first between C1 and C'1 and the second between C2 and C'2. According to R1 we can deduce a new semantic relation between C1 and C2 that one injects into the domain ontology DO.

Semantic similarity measuring.

$σ : EC × EC → \{0, 1\},$

Inputs :
- The two concepts C1 and C2 to compare semantically.
- The domain ontology DO
Outputs: 1 if C1 and C2 are synonymous similar, **0** otherwise.
begin
    if (C1 and C2 $\in$ DO) **then**
        if (R (C1, C2) = $\emptyset$) **then**
          Start the ontology enrichment process.
           if a new relation is detected after the enrichment
             then Update RDO and R (C1,C2)
               Recall σ (C1, C2)
    else % semantic similarity Measure coincides with the syntactic similarity measure %
    σ (C1, C2)= σ' (C1, C2)
    endif
    else
    if R (C1, C2) ⊃ a synonymous relation **then**
        σ (C1, C2) = 1
    else
    if R (C1, C2) ⊃ an homonymous relation **then**
        σ (C1, C2) = 0
    else
        σ (C1, C2)= σ' (C1, C2)
    endif
    endif
    endif
    else
    % C1 or C2 do not belong to DO the semantic similarity Measure coincides with the syntactic similarity measure %
    σ (C1, C2)= σ' (C1, C2)
    endif
end.

Case n° 3: C1 and C2 are composite concepts which do not admit a semantic relation in BCOi, whereas there exist semantic relations between their of "child" respective sub-concepts. Let be {C11, C12… C1n} the set of "child" sub-concepts of C1 and {C21, C22… C2n} the set "child" sub-concepts of C2 such that C1i and C2i admit a semantic relation within BCOi. According to R2 we can deduce a new semantic relation between C1 and C2 that one injects into the domain ontology DO.

B. Semantic Integration Process

The alignment process BC candidates for integration outputs a Correspondence Ontology (CO) between the concepts of BC, it will eventually externalize resource or support ontology for integration process, which can help developers achieve their information system design tasks or integrate BC automatically using a set of rules for resolving conflicts that operate the semantic relationships in CO. Correspondence Ontology is used as a new ontology support in future iterations in the integration phase thereby increasing the efficiency of the process.

- A set of business components, denoted BC1 ... BCn selected by the designer for their integration in the future information system.
- An correspondence ontology between the concepts of BC resulting from the pre-integration. semantic integration often requires to find the correspondences between the entities: components, classes, attributes, services, it is in this context that we proposed to create an ontology that includes correspondence of concepts candidates for integration and relationships starting and semantic relationships detected in the pre-integration.
- A catalog of conflict resolution rules, which includes a set of resolution rules (eg, for conflict type homonomie resolution rule is the re-naming by different names, if the concepts are synonymous must remove one of the two) by default which operate according to the types of conflicts. We consider that every conflict is generated by a non-definition of a semantic relation (eg synonymy semantic relationship which may cause a conflict type naming).

At this step of integration, correspondence ontology can be exploited in various ways.

TABLE 1:

THE SEMANTIC RELATIONS AND ACTIONS DERIVED.

	Semantic relation type in correspondence ontology	Actions proposed to designers
The two concepts belong to correspondence ontology	Synonymy relation	Rename by the same name
	homonymy relation	Rename by different names

Conflict resolution assisted by IS designer based on a set of conflict resolution rules stored in a catalogue. Based on correspondence ontology and the conflict resolution rules, we offer IS designer a decisions set represented by derived operations set. For example, if exist a relationship type synonym in correspondence ontology then find in the catalogue the resolving conflicts (conflict resolution rule 1), then propose to IS designer an operation "rename" one of concepts in conflicts and merge the two concepts or delete one of the concepts.

VI. ILLUSTRATIONS AND VALIDATION PROTOTYPE.

In order to validate our proposal, we give an example followed by a prototype which we have developed.

A. Example.

The example is based on a fragment of ontology (figure 4) and two components (figures 5 and 6) all relating to the field of "medical visits management". The fragment of ontology represents the domain ontology which will be used to support the semantic integration process. The business components noted BC1 and BC2, described in UML, represent the components candidates to semantic integration.

Figure 4: Fragment of the "medical visits management" domain ontology.

Step n°1: Transformation of BC1 and BC2 into ontologies.
We apply the transformations recommended in [23] and [24] the transformation of BC1 (resp. BC2) towards BCO1.
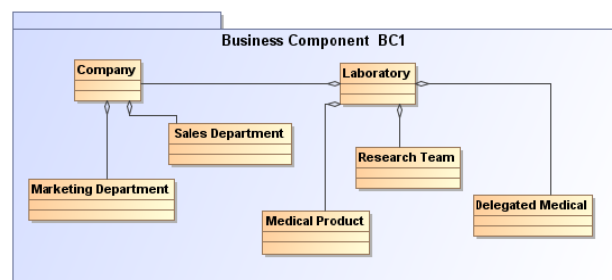

Figure 5: First Business Component BC1 to integrate.

The transformation of BC1 into ontology generates the ontology BCO1 hereafter:

```
Ontology(BCO1
(Class Marketing Department partial
restriction(partOfsomeValuesFrom(Company))
(Class Sales Department partial
restriction(partOfsomeValuesFrom(Company))
(Class Laboratory partial restriction(partOfsomeValuesFrom(Company))
(Class Delegated medical partial
restriction(partOfsomeValuesFrom(Laboratory))
(Class Medical PrDOuct partial
restriction(partOfsomeValuesFrom(Laboratory)) (Class Research Team
partial restriction(partOfsomeValuesFrom(Laboratory)))
```
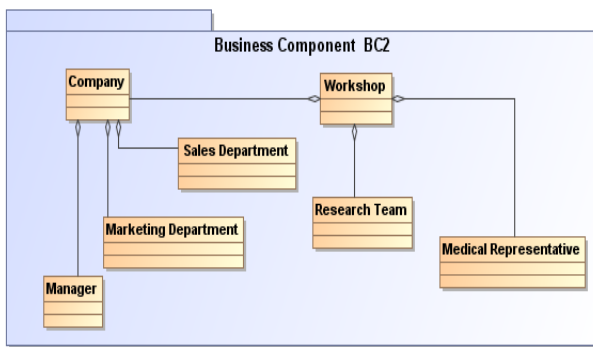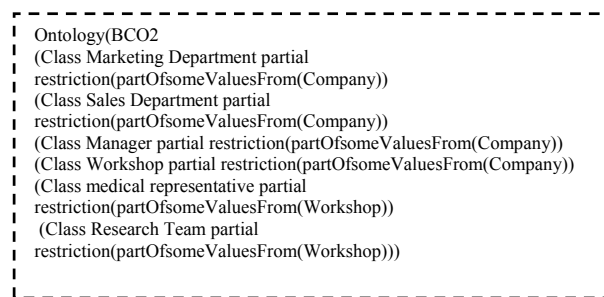
Figure 6: Second Business Component BC2 to integrate.

The transformation of BC2 into ontology generates the ontology BCO2 hereafter:

```
Ontology(BCO2
(Class Marketing Department partial
restriction(partOfsomeValuesFrom(Company))
(Class Sales Department partial
restriction(partOfsomeValuesFrom(Company))
(Class Manager partial restriction(partOfsomeValuesFrom(Company))
(Class Workshop partial restriction(partOfsomeValuesFrom(Company))
(Class medical representative partial
restriction(partOfsomeValuesFrom(Workshop))
 (Class Research Team partial
restriction(partOfsomeValuesFrom(Workshop)))
```

Step n° 2: semantic integration and obtaining BCOr with highlighting the enrichment process.

Ontology BCO1 generated from component BC1 comprises a concept called "Laboratory". Ontology BCO2 resulting from the component BC2 comprises a concept called "Workshop". The two concepts belong to the domain ontology. (C1 and C2 DO) without admitting semantic relation between them (R (C1, C2) $= \emptyset$ .The alignment of the two concepts requires consequently "applying the enrichment process to the domain ontology". The two concepts having child sub-concepts "Medical representative" and "Research team" are similar; according to R2 rule one can deduce that "Laboratory" and "Workshop" are synonymous. A new relation "synonymy" is detected then added to the domain ontology. The calculation of σ ("workshop", "laboratory") then gives value thus the concepts "Laboratory" and "Workshop" thus will be linked by the synonymy type semantic relation. This relation is then added in BCOr ontology. Figure below presents the result of this processing.

Step n° 3: Obtaining the integration process result BCr.
At this step, designers can, as appropriate:

o   Rely on BCOr ontology to note that BC1 and BC2 are synonymous; and to then choose BC1 or BC2 to use it in their new IS.

o   Automatically transform BCOr ontology into a business component BCr. Figure bellow describes the resulting component BCr.
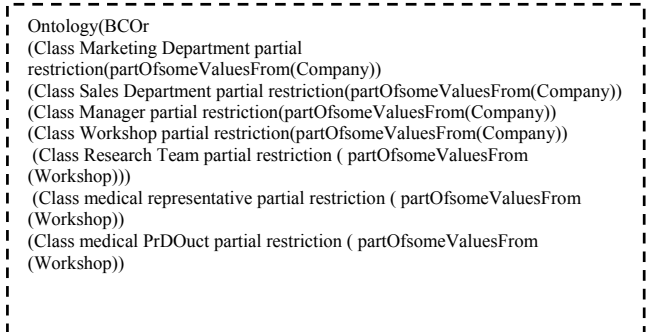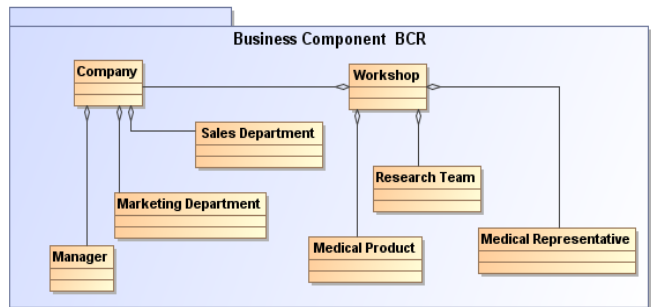


```
Ontology(BCOr
(Class Marketing Department partial
restriction(partOfsomeValuesFrom(Company))
(Class Sales Department partial restriction(partOfsomeValuesFrom(Company))
(Class Manager partial restriction(partOfsomeValuesFrom(Company))
(Class Workshop partial restriction(partOfsomeValuesFrom(Company))
 (Class Research Team partial restriction ( partOfsomeValuesFrom
(Workshop)))
 (Class medical representative partial restriction ( partOfsomeValuesFrom
(Workshop)))
(Class medical PrDOuct partial restriction ( partOfsomeValuesFrom
(Workshop))
```

Figure 7: The Business Component BCr resulting from integration

"Laboratory" and "workshop" are synonym then find in the catalogue the resolving conflicts (conflict resolution rule 1), then propose to IS designer an operation "rename" one of concepts in conflicts, merge the two concepts or delete one of the concepts. It is the same for "Delegated medical" and "medical representative".

B.   Prototype

The last step of our work is to design the interface of our prototype not only to validate and evaluate our semantic integration process, but also it can be used for semantic integration of BC. We describe in this section, the graphical interface of our prototype for the integration of BC, as it is based on the integration process presented in paper. The purpose of this prototype, firstly to implement our prototype and secondly to provide an interface for the user ,especially information system designers to achieve semantic integration through alignment of ontologies derived from BC by establishing correspondences between ontologies entities concerned. This mapping will deduce the rules of integration and then start execution. We have developed our prototype using APIs such as Jena, XML, and OntoSim AROMA [33].

The prototype takes first in entry the domain ontology and the set of business components to integrate; transforms them into ontologies described in OWL. Then, it applies the various treatments associated with each step of our proposed method, in particular similarity measurement and domain ontology enrichment. Finally prototype outputs the resulting ontology described in OWL and its graphical description.
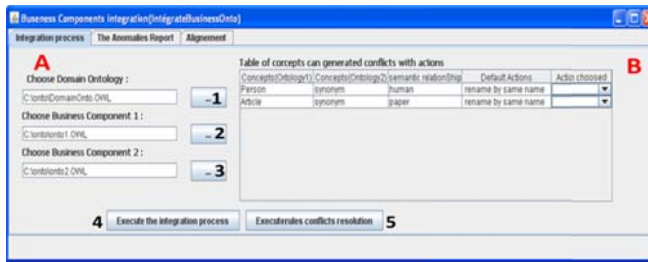
Figure 8: A prototype of Semantic Integration of Business Component

The figure below allows visualization of correspondence ontology: Our interface also provides the user the ability to view the XML code that corresponds to the correspondence ontology result of the alignment. Figure above shows that pressing the button "Execute the integration process" will display the XML ontology matching window in the 'Alignment' of our interface.
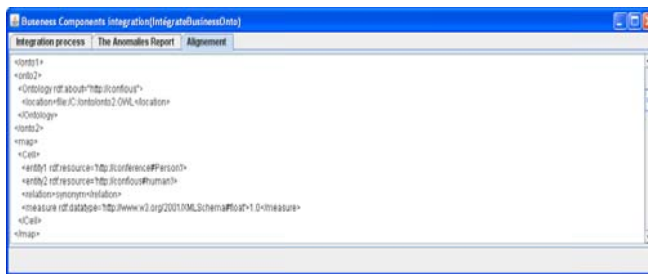

Figure 9: visualization of correspondence ontology

CONCLUSIONS

Our research lies within the scope of information systems engineering by re-use. We were interested more precisely in the resolution of semantics conflicts of naming type encountered during the re-use of business components in the analysis and design phases of new information systems. Our proposal is an application of domain ontologies to design IS by re-using conceptual business components; it is based on the results of recent works on the ontologies alignment and the enrichment methods based on domain ontologies. An example of application has illustrated our proposal. We have also developed a prototype in order to validate the solution. We think firstly to continue this work by a formal validation of the solution, and then by the research of the possibilities of extending it to solve other types of semantics conflicts, in particular measurement and confusion conflicts, however we think of using theories graphs and in particular groups isomorphic to formalize mathematically our solution allow improving it.

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