Interoperability between different port information systems

Mehdi ABID, Benayad NSIRI and Yassine SERHANE

Abstract—This paper discusses one of the most common level of data exchange between the different port systems issues in order to exploit the internal resources and the collective resources of all the different systems. Our goal is to overcome any type of heterogeneity conflict: semantic, technical and structural during the exchange of information between each different heterogeneous system. In this paper we propose a practical architecture to facilitate the exchange and communication between all the different port systems without modifying the local information systems. Our architecture is based on three levels: 1) User level 2) Mediation level, 3) Source level. The first level is dedicated to applications and users, the second includes various tools to process queries and solve conflicts (technical, structural, semantic) through mediators and ontologies. The third level concerns local information systems and adapters that provide unified interface information systems. The use of XACML format will establish a secure data exchange and standardization of a good decision for the access control of different types of documents belonging to various port information systems

Keywords: *Port systems, Heterogeneity, Mediation, Ontology, Semantic, Adapters, XACML.*

I. INTRODUCTION

Nowadays technological change has increased significantly so that all firms are connected together by a set of hardware resources and software related to the transmission and exchange of information between different entities. This change requires all companies to develop their cooperation in all sectors to provide their products and services while minimizing the cost and increasing earnings. In addition, studies on relational data exchange scheme and mappings were initiated several years ago [1]-[2]-[13] to facilitate geographical forced exchanges. It is well known that in this year there are a large number of attempts to create a modern intelligent systems, who solve the semantic text analysis between each system [15]-[16].

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Indeed a company's information system in a port area shall not operate as a separate system, however it must be incorporated in a set of business networks to facilitate communication and exchange of data, ensuring confidentiality and security of data exchanged (means of access) and to maintain traceability in the deduction of data (especially the nomenclature).

Variety of information systems for port companies creates a conflict of interoperability between these heterogeneous information systems, which is a difficulty in modeling and designing an information system, that develops a methodology for collaboration between systems ensuring secure communication in a network and ensuring their semantic interoperability, can ensure that the precise meaning of exchanged information is understood and preserved throughout exchanges between different parts, allowing organizations to exploit this information [3]. In this paper we propose a practical architecture that integrates several heterogeneous port companies' information systems to ensure good communication between them and in syntactic and semantic level between them and share their data without changing the internal architecture of each system.

II. BACKGROUND

Information system management that enables interoperability between port companies remains a challenge with unique requirements, so far many studies contributed to the development of a heterogeneous port's information system. Several ports' information systems of the community are used in various port companies, but they are often heterogeneous. Such as, the computerization of administrative and commercial procedures for the development of EDI tools. EDI (Electronic Data Interchange) systems are means of telecommunications which makes it possible to electronically exchange information on the communications networks using standardized forms. [4] This system became clear to ports' professionals as part of their competitiveness. Indeed, whatever the information's level for each separate business, the issue of documents exchange between them are established, where the exchanged data are inconsistent and lead to conflict areas of definitions, meaning or interpretation of the same given. It encompasses more precisely following conflicts: A) name conflicts: synonyms (different words expressing the same information) homonym (different information with the same name) polysemy (same term changes meaning depending on the context). B) Value conflicts: different ways to encode the same information in

different systems (data representation conflicts: integer, boolean, string).

Therefore professionals' main objective is to establish dedicated information system to the port communication to integrate all the heterogeneous information systems and share all available data As in Fig. 1.

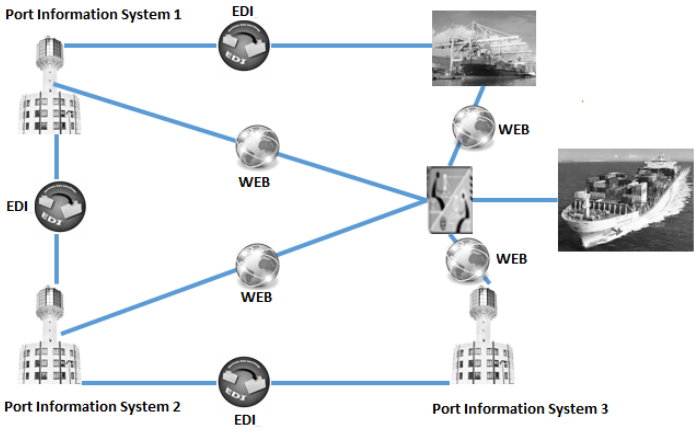

Fig. 1 Exchange Network

Due to the large number of heterogeneous information systems, several aspects of integration are required, namely: data integration in a technical, structural and semantic level as well as the workflow's integration in everything related to the validation of spots between different actors of the systems, which generates the difficulty of establishing a management system that has as role a common standard among all different information systems.

To develop this problem, this paper proposes a mediation architecture of context regarding port information systems, contexts mediation is based on an explicit representation of the data semantics through the notion of context. This context can be described using tools such as metadata [5] or ontology. A context specifies a library of knowledge on structure, features or values of a specific object in order to understand the semantics, The Web Ontology Language (OWL) is the layer of formalism that helps in creating more logically refined descriptions of the concepts [14].

III. Method

The architecture we built is based on a modular information system that focuses on the concept of mediation context to manage the semantic heterogeneity between concepts and vocabulary manipulated by different systems ensuring proper understanding and correct interpretation exchanged. The concept of mediation context is based on four specific elements: The mediator, the global ontology, the local ontology, the adapter.

The mediator simplifies, abstracts, combines and describes the data [6] it aims to obtain and process the incoming data depending on the specific needs of each different port information system. Several mediators can be structured in an organized and structured hierarchy of any information system.

The local ontology: deposit local knowledge ontology of each mediator, all concepts and properties that it wishes to incorporate in its data dictionary; this ontology has its own structure of generalization / specialization that is not imposed by the domain ontology, although it meets the specialization relations [7] at this level this ontology is a class that belongs to the global ontology.

The global ontology is used in a specific domain and describes the vocabulary with a link to a generic domain (loading, handling ...) while specifying the high-level concepts [8], this ontology contains the relative area of an intelligent system description for port's platform.

We can define this ontology as a vocabulary that is based on a knowledge library; the use of the latter implies an agreement between all the different systems on a common knowledge representation to ensure their interoperation. The use of these ontologies have a key role in our system architecture, given the variety of many different port information systems which creates various problems (data analysis, decision making ...) when exchanging data. So the purpose of the use of ontology will allow the unification of exchanged data on a syntactic, semantic and structural level between all ports' systems.

The adapter: acts as a translator and is positioned between mediators and databases to establish consistency between the various port systems sharing the same data sources.

Each integration of a new information system development requires a special adapter to define the conceptual model of these components and the various access rights of its data assigned to each port existing information systems. This adapter has the aim of bringing together different applications by different users through a common interface between all systems to hide the heterogeneity among all port information systems.

The structure of our mediation architecture is designed to assemble & integrate data and keeping their semantics between different heterogeneous port information systems. As in Fig. 2 describes our architecture which is based on 3 levels.

The first level: User level is dedicated to different applications of port systems. the 2nd level: Mediation level which consists of mediators and ontologies (local and global) that encapsulate the various functions, methods and tools to address the queries to resolve the various technical, semantic and structural conflicts. The 3rd level: Source level which consists of adapters and the various ports' information systems' databases.

In our architecture, each mediator presents intermediary services between data resources and port information systems. Their goal is to establish an integrated targeted information without requiring the integration of data sources. In this architecture, the level of mediation is split on several mediators, where each one owns a local ontology in order to use the vocabulary concepts of this local ontology to solve any internal changes' conflict on a syntactic, semantic and structural level.

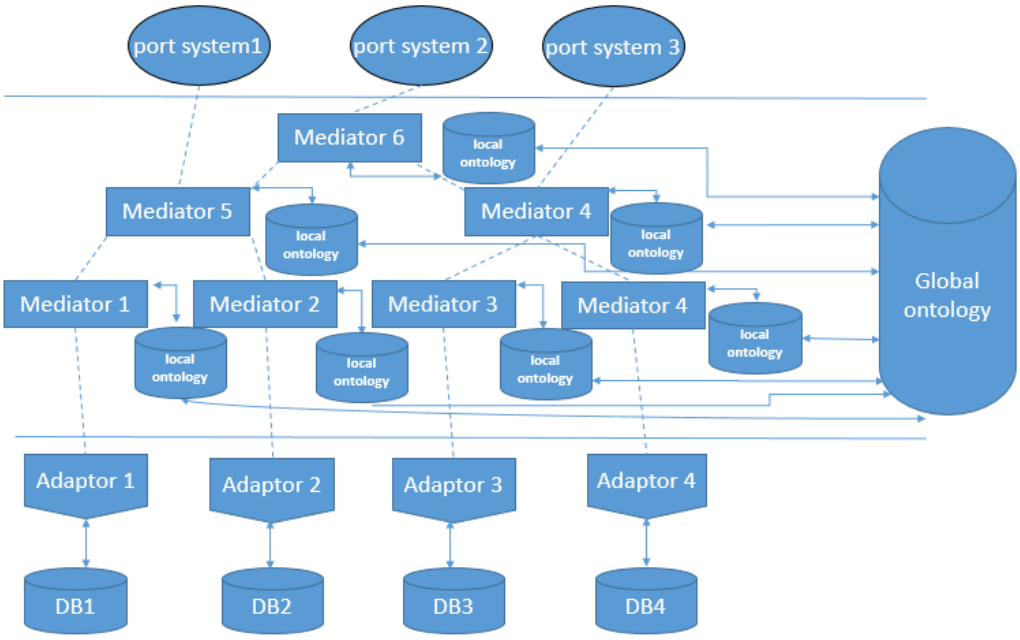

Fig.2 Mediation architecture based on local and global ontology

All local ontologies are related to a single global ontology to solve technical, semantic and structural heterogeneity of each information system as well as to optimize the changed data flow in each internal system without the need of the global ontology.

To incorporate different data, each adapter must be characterized according to the mediator where it was saved in order to translate the requests of the mediator in terms understandable by the data sources. Once a port system user sends a request, it will be sent through the mediator who will handle the sources distribution (sources location, decomposition and query optimization) this request will be interpreted and transformed by an adapter in order to access the data sources, the answer will then be transferred to the mediator via the adapter where the mediator combines, reconstructs and solves all the technical, structural and semantic conflicts of the adapters' results before handing these results to the system user.

Given the confidentiality of the data exchanged between the port information systems and to protect everything that is in the context of a collaboration in the port area, the security approach of XML data remains essential. The main goal of XML is to encourage the interoperability and simplicity in the use and development of the web [9]. In this context, several studies have been developed to provide control over the content of XML exchanged data in Fig. 3, the main reason for choosing XACML, is that it is a mature OASIS [10]. XACML provides a method for facilitating data access control for the exchanged documents, and facilitate the use of different encryption standards during the exchange of sensitive data shared in the case of interoperability of ports information systems.

```
<SIP>
        <ID_AgentMartinie>
                <id type="Id_B1" value="1A230FE5">
        </ ID_AgentMartinie >
        <source>Casablanca</source >
        <destination>Le Havre</ destination>
        <TypeMarchandise>Voiture neuves</ TypeMarchandise >
        <TypeMarchandise>Produit dangereux</ TypeMarchandise >
        <Date Chargement>24/01/2014</ Date Chargement >
        <HeureChargement>15 :01</HeureChargement >
</SIP>
```

Fig.3 Sample of the Exchanged data in XML format

W3C and ITETF offer standard data and XML tags encryption in a document [11]. This will create access to data encryption to protect sensitive information using different keys, this encryption will send the same information to different port systems in Fig. 4, and only systems with the decryption key specific to various files can decrypt the parts concerning the encrypted data.

```
<SIP>
        <ID_AgentMartinie>
                <id type="Id_B1" value="1A230FE5">
        </ ID_AgentMartinie >
        <source>Casablanca</source >
        <destination>Le Havre</ destination>
          <EncryptedData Id='ED1' xmlns='http://www.w3.org/2001/04/xmlenc#'
           Type='http://www.w3.org/2001/04/xmlenc#Element'>
                        <CipherData>
                                <CipherValue>A23B4C56</cipherValue>
                        <CipherData>
        </EncryptedData>
        <TypeMarchandise>Produit dangereux</ TypeMarchandise >
        <DateChargement>24/01/2014</ DateChargement >
        <HeureChargement>15 :01</HeureChargement >
</SIP>
```

Fig.4 Sample of the Exchanged data in XACML format

IV. Results

We adapted a standard model of two extended port systems which aim to develop their collaborative information exchange of raw materials supply to transform them into finished products and distribute them to clients. The problem that arises is that these companies are in two different locations using two different systems which creates a heterogeneity problem in a semantic and structural level. When exchanging information, each company can send different information based on its own architecture.

According to the study of mediation architecture based on local and global ontologies that fit in our article, in Fig. 5 describes the exchange prototype that happens between these two port companies which are totally different on a modeling, design and database management system level.

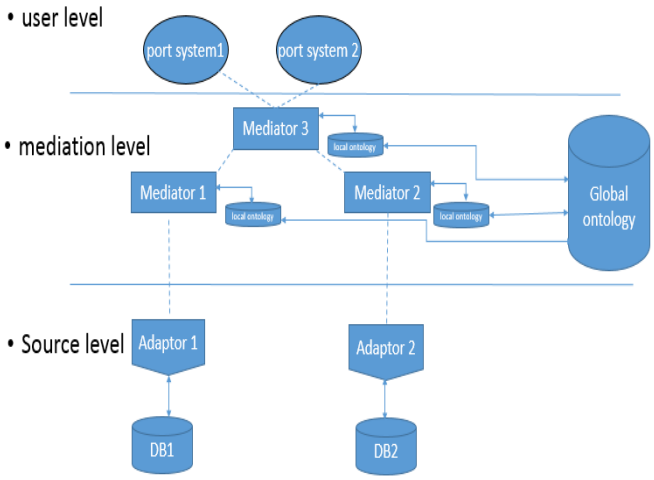

Fig.5 exchange prototype between the two port companies

User Level:

Level that contains different ports information systems where each system handles, collects and broadcasts this information according to its own needs, each system can be modeled or implemented differently.

Mediation level:

This level deals with heterogeneity issues between the two ports information systems; it consists of three mediators where each one of them has a specific task to achieve. The third mediator is based on the sources location, and queries decomposition in queries adapted in order to facilitate the various processes of other mediators (mediator 1 and 3) which are designed to ensure sending the data by solving semantic and structural conflicts as in Fig. 6 before the transmission to the associated adapters.

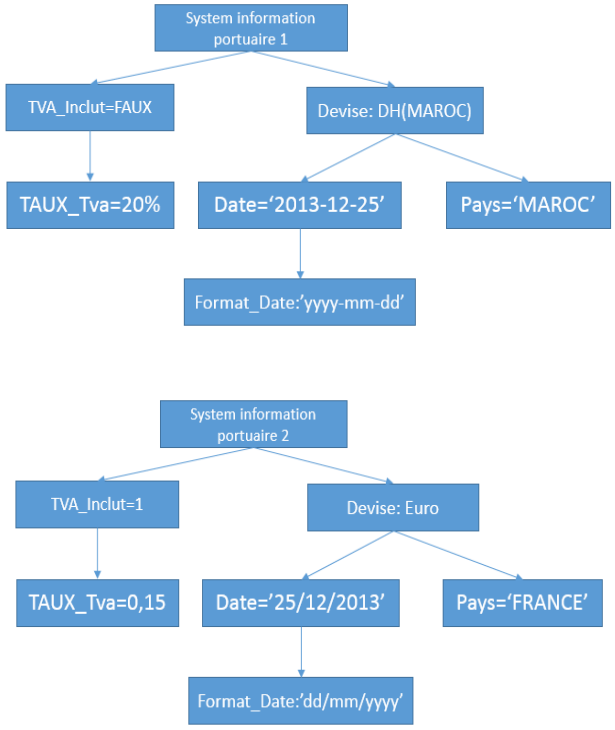

Fig.6 conflict of values between the two port information systems

To improve the interpretation of the data exchanged between the two systems on a data semantic level and thus hide semantic heterogeneity conflicts when sharing information, and to achieve semantic resolution (synonym, homonym, polysemy) we opted to create a port ontology which is based on EDIFACT standards (United Nations Rules for the exchange of computerized for administration, commerce and transport), a set of international standards, directories and manuals for the exchange of computerized data. [12].

We have implemented a knowledge base that depends on different port systems as in Fig. 7.

This global ontology is directly related to the other two local ontologies to unify the language between the different ports information systems.

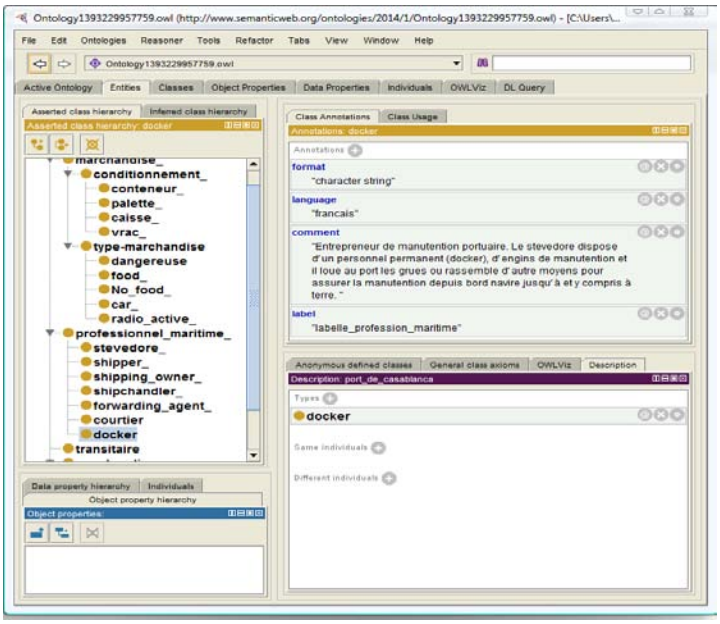

Fig.7 Interface ontology designed as protected

Source level:

We previously advised that these two ports information systems were developed and modeled differently and according to the following figure (With P1 and P2 two ports information systems).

INFORMATION SYSTEM	MODELING	DESIGN
IF PORT P1	MERISE	MySQL
IF PORT P2	UML	POSTGRESQL

Fig.8 Comparative table between the two port information systems

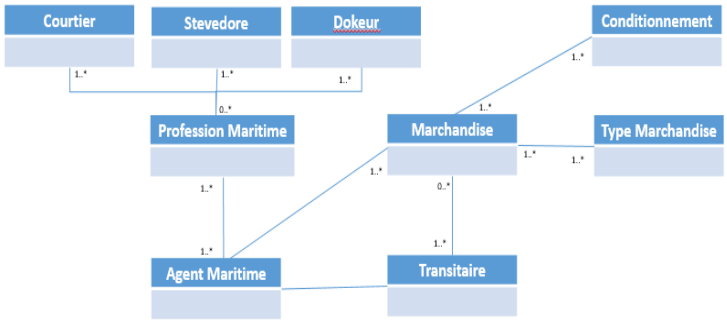

Fig.9 UML class diagram of the first port information system (P1)

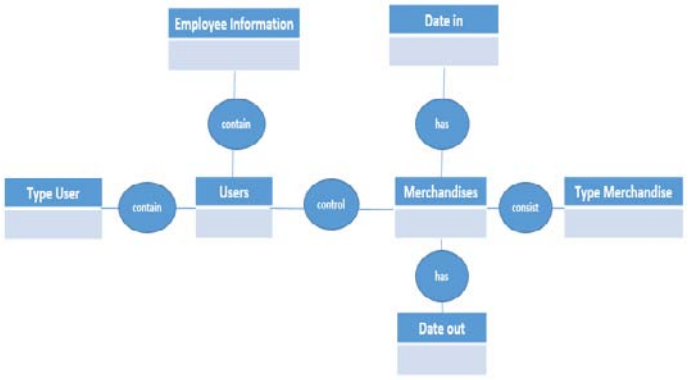

Fig.10 MLD second port information system (P2)

According to Fig. 8 and Fig. 9 we can obviously deduce that there is a heterogeneity conflict:

• Schematic conflict, Date In and Date Out in the table "Merchandises" are represented by attributes in the information system (P1) however they are represented by a table in the information system (P2).

• Generalization / specialization conflict is linked to the differences in the ranking of the same information, in the first information system (P1) data of type Employee are implemented on different entities whereas in the information system (P2) data of an Employee is defined in a single table.

• Type conflict refers to differences in data type in our case the merchandise type is represented in Boolean form {1.0} in (P1) however in the system (P2) the Merchandise type is represented as a string.

Thanks to the prototype defined on the mediation level, heterogeneity problems have been solved thanks to the data distributions as well as ontologies based on the unification of data to avoid all semantic conflicts during the process of data exchange.

CONCLUSION

The work presented in this paper covers the issue of information exchange between heterogeneous ports information systems. We proposed in this paper an architecture based on mediation to resolve any semantic, technical and structural conflict in the data exchange between different ports systems.

This architecture of type 3-tiers (user, mediation and source) ensures the integration and the opening on a new perspective and will improve the inter-exchange and performance in the various port companies on a collaborative level.

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