SEMANTIC WEB BASED TO SUPPORT SUPPLY CHAIN MANAGEMENT

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ABSTRACT

Increasing implementation of information technology in the manufacturing environment can be considered in all line of manufacture. Internet introduced heterogeneity of information, such as between supplier and client. The heterogeneity can be data format, representation, and accessing of information. One of starting point in supply chain management is matching process between suppliers and requirement of a manufacture. However, heterogeneity deliver a problem to match between supply and demand, such as different concept of requirement, such as concept 'RAM', 'warehouse', and 'container' in general meaning is place to save something.

Semantic Web and ontology can be considered as an approach to overcome the problem of matching in supply chain management. Discovery and interoperability among parties of information sources in dynamic, open and heterogeneity environment can be improved by the approach.

Semantic web is to enhance understanding of meaning between machine-machine and machine-human. Ontology can be applied as a medium to reduce semantic diversity. Semantic interoperability in our approach will based on semantic similarity by using label matching enhanced by internal and external structure comparison.

***Key Word**: information heterogeneity, information interoperability, ontology, semantic web, supply chain management.*

1. Introduction

James A. Tompkins [5] divide SCM (supply chain management) in three parts : (i). supply – indicate a push, (ii). chain - indicate individual, discrete links, and (iii). management - implies a static environment of control and measurement.

Supply chain management can be defined as optimization of the delivery of goods and services, and optimization of information from the supplier to the customer. For the customer understanding, the

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optimization means that the supplier knows what the customer needs and understands the correct timing in the delivery of goods or services. For supplier point of view, optimization of delivery means that the right product or services are available in the right quantities at the right time.

Integration provides information exchange among parities. Supply chain and network integration means to bring supply chain partners, or network partners in contact with each other. Integration system allows to access information from different sources.

Some new problems can not be full filled any more with traditional approach. Semantic web introduces an approach to handle diversity of information level for integration or interoperability. In advance, web services fit into the semantic web is in enabling web services to interact with other web services. Web service applications can involve comparison, composition, or orchestration of web services which require semantic web technologies. These approaches can support supply chain management to interchange the service and data among the community.

This paper will be divided to some sections. State of the art will be described in section 2. Section 3 and 4 explain problem definition and objective or research. Section 5 bring our proposed approach for the problem, and finally section 6 close the paper with summary.

2. State of The Art

2.1. Semantic Web

Semantic Web exposed to use semantics approach to solve problems of information interoperability. Ontology is an interesting tool and challenge for the approach of semantics. Semantic web is an evolution of WWW to better exploiting meaning of knowledge. There are two vision in development of web forwards, the first vision is to provide good web progressively as media of collaboration, and second view is to give better understanding between machine-machine and machine-human. Berners-Lee [1] stated semantic web need some requirements to achieve the purpose. The requirements are:

- Developing language and terminology. Language used to express something which can make machine more able to comprehend with meta-information for the document, and terminology as ontology used to express consistency of semantic.
- Developing new architecture and tool which use the terminology and language to access, change and information integration.
- Developing Semantic Web application giving a new service level to user.

2.2. Ontology

An ontology defines the common words and *concepts* (meanings) used to describe and represent an area of knowledge, and standardizes the meanings. Ontologies [2] are used by people, databases, and applications that need to share domain of information (a *domain* is a specific subject area or area of knowledge, like medicine, counter-terrorism, imagery, automobile repair, etc.) . An ontology [3] is to represent formal something that explaining by explicit a specific concept to each other to sharing at special domain in computer system . Ontologies include usable definitions of basic concepts in the domain and the relationships among them. They encode knowledge in a domain and also knowledge that spans domains. So, they make that knowledge reusable. An ontology includes the following:

- Classes (general things) in the many domains of interest
- Instances (particular things)
- Relationships among those things
- Properties (and property values) of those things
- Functions of and processes involving those things
- Constraints on and rules involving those things

2.3. Web Services

Web services are software applications that can be *discovered*, *described*, and *accessed* based on XML and standard web protocols over Intranet, Extranet, and the Internet [2]. Web services provide common standards for doing business and software integration —complementing a user-driven, manual navigation architecture to one where automated business process can be the focus.

A web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the Web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards [10].

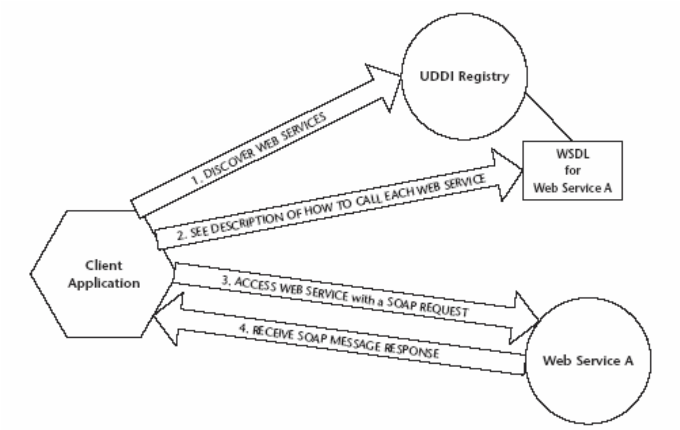

Figure 1. A common scenario of Web services in use.

In Figure 1. depicts the basics of client and Web service interaction. Because of these processes, such as discovery, the client application can automate interactions with Web services. Web services provide common standards for doing business and software integration —complementing a user-driven, manual navigation architecture to one where automated business process can be the focus. Because of different database languages, different communication protocols, and different ways of expressing problems in languages understood by computers, integrating systems is extremely difficult.

2.4. Related Works

In this section we survey some papers which provide an approach for supply chain management by using semantic web, ontology and web service. Robert Haugen and William E. McCarthy introduce REA [7]. REA refers to the Resource-Event-Agent business model developed by Professor William E. McCarthy. As a semantic web, REA can link economic events together across different companies, industries, and nations. The links are activity-to-activity or agent-to-agent or person-to-person, not just company-to-company. This means each individual in a REA supply chain can be linked directly to each other individual. The approach more emphasize diversity among parties in static environment. In our approach, we consider to handle dynamic environment as current issue in Internet era.

IBM provides E2open [4] which not only offers a private, secure registry and data storage repository for capturing and communicating trading partner information and business process definitions, but it also provides the infrastructure that allows for secure publishing and discovery of private and public processes of E2open trading partners. IBM provides E2open with high performance *data centers*. The difference with my approach is that our data is distributed and decentralized. We implement our approach for dynamic and open environment by using peer-to-peer architecture.

Jung Ung Min & Hans Bjornsson [6] introduces *SCVisualizer (Supply Chain Visualizer)*, an information visualization tool using Web Services and computer agent technology for the rapid and seamless generation of a virtual supply chain in construction. The difference with my approach is that *SCVisualizer* use computer agents technology. Push model is implemented in our approach to handle dynamic sources..

3. Problem Statement

Business deals on the Internet can be "hyperlink" like Web pages. These "hyperlink" are formed by the chains of transactions that animate supply chains. They are traversed by business messages, not people. By "semantic model" we mean a computer software model of real-world supply chain activities.

This research will involve three area: 1) Information interoperability 2) Semantic web and ontology 3) Business Process and supply chain; and Information industry

The basic problem statements are : 1) How is supply chain representation from various sources? 2) How to exchange of information based on information source representation? 3) Is the exploiting of semantic web and ontology will improve exchange of information for the supply chain by using web services?

4. Research Objective

Refer to state of the art and problem statement, the objectives of the research are:

- To find an appropriate model to represent the sources of information which can be used in semantic web and web services.
- How to 'map' among sources base on the representation of concepts based on common ontology to utilize semantic web and web service for supply chain management.
- The approach can be implemented in dynamic and open environment.

5. Approach

5.1.Proposed Approach

The approach of interoperability can be divided into two common approaches: tightly solution (schema integrated globally and integrated ontology globally) and loosely couple (such as: mediation).

There are three model of interoperability ontology based to overcome difference of semantics. First model is made a new ontology which merged all ontology of sources. This approach is very central, and suited for static environment. The second model is by mapping from one ontology to other ontology. This model support autonomy of information source, but requiring many ontologies mapping that is counted (n-1). Third model, is developed *reference ontology / common ontology*, therefore mapping only done between source and reference of ontology. This is very lessen the amount of mapping become equal to n, but the problem is how to develop reference ontology which can become reference from a domain. The third model is alliance of idea model one and second.

Our approach consider to use hybrid ontology model. The first focuses is how to develop relation or agreement between common ontology to ontology of community. The process developing of agreement will based on label matching and structural comparison.

Term of Interoperability used semantic to solve semantic conflict that happened between heterogeneous information source. Semantic conflict happened any time if two system do not use interpretation of same information. The simplest Conflict format in interpretation of information is homonym (usage of same word which have different meaning), and synonym (usage of different words which have same meaning).

The approach is called MISWHO (Manufacture Interoperability with Semantic Web and Hybrid Ontology). MISWHO based on basic tuple as <ρ, μ, ρ>, where ρ is common ontology, μ is agreement or mapping between common ontology and local schema/ontology, and ρ is local ontology. The MISWHO will utilize semantic similarity calculation to develop the agreement.

Calculation of semantic similarity between concept is first step to create approval between content and ontology of provider or whom asking for information. Each concept can represent as hierarchy according to containing label some structural or semantic informations. Following three measurement of similarity [8] :

- **Label Matching,** The process will based on linguistic analysis. There are two common techniques at label matching (Fausto Giunchiglia, et.al, 2003). First, a string analysis preprocessing step is used to transform the labels into words for linguistic analysis. Next, the labels are matching by determining relations between them. This is done by techniques that uses thesaurus or WordNet like tools. This Calculation result can be expressed in tuple < LCOi, LPPj, Simlabel>., where LCOi is label of i-th at CO (assembling industry), LPPj is label of j-th at PP (supplier), Simlabel is the calculation similarity based on WordNet. Result of first step enriched with approach of comparison of internal and external structure.

- **Internal Structure,** Similarity between two concept can be obtained compared to 'language' and 'real' attribute and not only from equation between their component description, but also from equation between structure of graph representing them. Similarity of internal structure can be obtained by calculated the number of attribute the similarities divided by maximal amount of attribute from a class. IS = attribute similar / [maximum attribute at a class]. This result is also expressed with tuple < CCOi, CPPj, SimIS>., where CCOi is i-th class at CO (in this case assembling industry), CPPj-k is j-th class at PP (at supplier), SimIS is the comparison calculation of internal structure.
- **External Structure,** Comparison of external structure is by seeing to set of upper-class. Simply to calculate external structure from two class is seen how many upper-class that is sameness will be divided with amount of the biggest upper-class from a classes (Jayant Madhavan, et.al, 2001). ES = upper-class similar / [maximum upper-class at a class]. This result is also expressed with tuple < CCOi, CPPj, SimES>., where CCOi is i-th class at CO (assembling industry, CPPj-k is j-th class at PP (supplier), SimES is the comparison calculation of external structure.

For example, there is a computer assembling company which manufacture some products need special processor to fulfill requirement of customer. When a request of product asked by a customer, the company will search a processor for industrial controller which have ability of middle-speed process, and environment of product above normal condition. The company will deliver a request "requiring special processor for control systems with middle speed". Before sending the query, query rewriting is needed to based on common/reference ontology. If the query is directly sent, sources information can not produce appropriate answers cause of different concept. Result of query rewriting will change query become "requiring a processor for Microcontroller with speed 100-200 MIPS". Figure 2 depicts the model of concept at company 1 and 2 and reference ontology. Creating link/agreement/mapping between the concept will be explained at table 1.

The query is responded by company 1 will consider result of MISWHO (query for Microcontroller will be pointed at *Others*, and value of MIPS will convert to MHz (this is done with table look-up, although in practical is not easy)). Some incomplete or miss information can be occurred in this approach. Because class *Others* is more general concept then class *SpecialPurpose*. For example, *i*n real world, is it possible microcontroller developed by desktop processor. However this approach provide better result compare to keyword based which used by many search engine in Internet. If we send keyword “Microcontroller AND speed 100-200MIPS”, company 1 and 2 will respond with no answer. Because keyword is not enough to represent the knowledge of information.

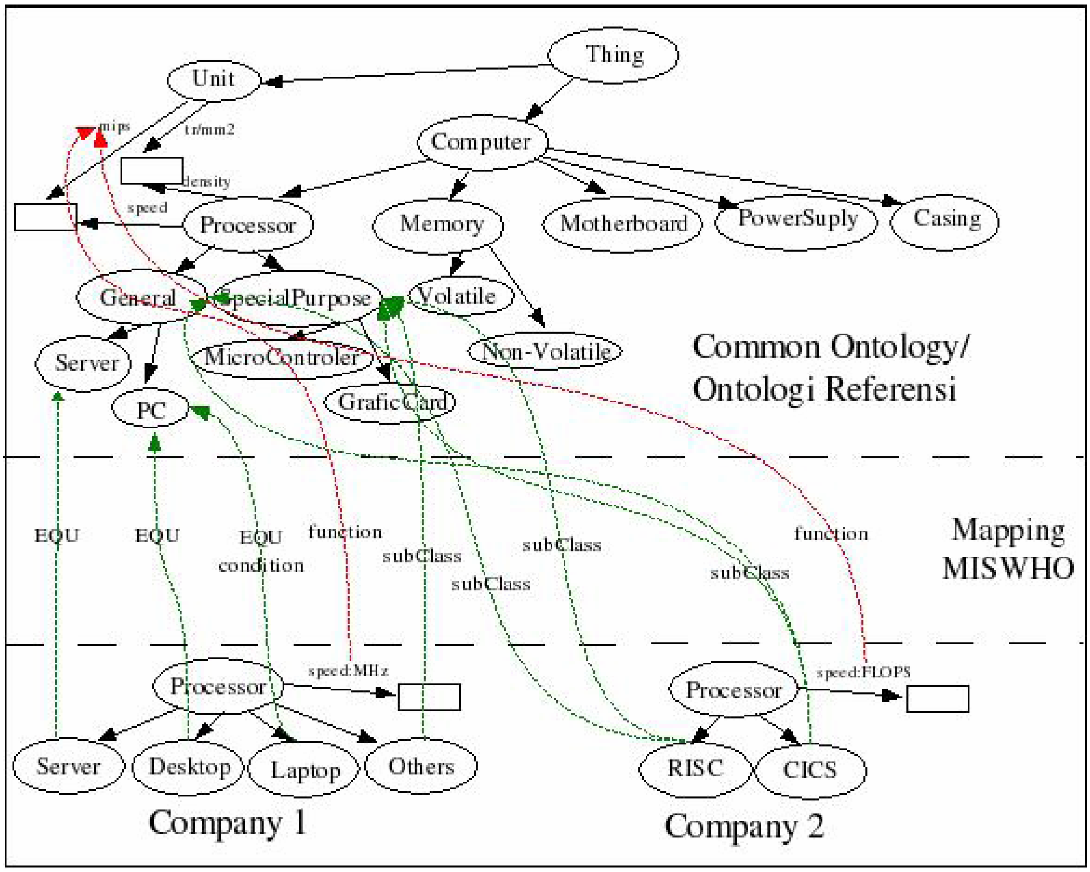

Figure 2. Example case for Ontology Reference, Ontology local and MISWHO

Table 1. Part of MISWHO results from Figure 2

***M*ID**	***O*L**	***Type*L**	***O*R**	***Type*R**	***Mapping***
C11	Server	class	Server	class	EQU:equivalent
C12	Desktop	class	PC	class	EQU:equivalent
C13	Laptop	class	PC	class	EQU:equivalent, with *constraint* for *mobile*
C14	Others	class	SpecialPurpose	class	*Others* is very general, so SpecialPurpose is subclassOf Others
C15	speed:MHz	property	speed,mips	property	Needed a function or look-up table to conversion
C21	RISC	class	General	class	RISC is subClassOf General
C22	RISC	class	SpecialPurpose	class	RISC is subClassOf SpecialPurpose
C23	CICS	class	General	class	CICS is subClassOf General
C24	CICS	class	SpecialPurpose	class	CICS is subClassOf SpecialPurpose
C23	speed:FLOPS	property	speed,mips	property	Needed a function or look-up table to conversion

5.2.Prototype and Evaluation Design

Architecture of the approach can be developed by adoption from various model as follows:

- Using loosely couple architecture, which can exploited at client-server form or pure peer-to-peer with super peer.
- Exploiting of ontology with approach as reference by using common/share ontology.
- Mediation model is also exploited for exchange among various information source.

Basically, components of architecture consist of:

- Super peer will have function to (1). providing and looking after common ontology. (2) noting various information source along with metadata of available information, and (3) informing server or other super peer to avoid ' failure point single'.
- Information source will have function to (1) presenting information or data able to be utilized by external party, 2) presenting information of scheme or local ontology, (3) making mapping among local ontology and in server/super peer, (4) query response of consumer, and (5) registration mechanism to server/super-peer including to advise active/not condition as well as if existence of data or concept.

Evaluation will based on information retrieval model, such as Precession, Recall, and F-measure. The main problem is to find an appropriate example of domain to evaluate.

5.3.Current Status and Planning

Some publications have been issued as effort to get feedback from research community for our approach before go further in a prototype.

We are in progress to develop the first prototype. The prototype will based to the standard development of W3C. For technology issues, open source software is implemented, such as SuSE, Protege, SWOOP, Pellet, and python. Model of dynamic environment simulation and domain for simulation are our main problem of technical issue.

6. Summary

The MISWHO approach is based on semantic web by using hybrid ontology model which gave improvement for information and web service interoperability. The approach has demonstrated to adopt for supply chain management to handle diversity of concepts.

For future work we will develop examination and prototype that more deeply on the condition of reality with burden of amount of class and instance which is bigger far, including also heterogeneity and amount of information source. We will look for tool which suited for developing our prototype in supporting information interoperability.

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