The Meaningful E-Marketplace

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***Abstract*— A meaningful e-marketplace (MEMP) is a common business information space where computer agents can faithfully deliver the true meanings of e-trade with each other on behalf of their human masters. Partial understanding of any received e-trade information is forbidden since it hides unfavorable legal consequences. MEMP is a new concept. This paper discusses it by putting forward a framework, which consists of four important procedures of design, reification, transformation and inference. The important features of MEMP are representation personalization and localization, accurate cross-domain message exchange, true result reasoning, context-based reification, and model-free template design and use. In future, a successful realization of MEMP in design will drastically change our existing e-trade modes, lift the quality of e-business, and lead to a more efficient e-marketplace brought by higher accuracy of meaning understanding, broader scope of business interaction, and richer e-trade functions.**

Keywords: electronic marketplace, meaningful e-marketplace, MEMP, concept, knowledge representation, ontology, semantic integration.

I. INTRODUCTION

A meaningful e-marketplace (MEMP) is a common business information space, which must satisfy four e-marketplace properties of distribution, autonomy, interdependence and emergence [14]. In MEMP, computer agents on behalf of their human masters can faithfully deliver the true meanings of e-trade with each other for doing e-business yet strictly consistent with the meanings of the human masters. It is different from the traditional e-marketplaces, where the information senders cannot guarantee the true meanings to be understood by the receivers when computer agents are involved. For example, working on MEMP, sellers via computers can fully understand the incoming messages (e.g. inquiries) and exactly infer the outgoing messages (e.g. offers). There is no ambiguity between conversations between humans and computers like "my interpreted result (from agent's) is similar in meaning to the received message" or "I (agent) understand 90% of the customer's offer".

Partial understanding of any received e-trade information must be avoided because they are dangerous to e-trading partners and hide severe legal consequences. For example, if a seller misinterprets the order specification, it will not be able to correctly execute a purchase order. Unfortunately, in traditional e-marketplaces, the misinterpretation of received messages often happens. For instance, given a meaning of "orange refrigerator, price: 200" from a US company, a computer agent of a Japan company could misinterpret it as "easy-to-carry cooler bags used for camping and keeping fruits like oranges in price of 200 Japanese Yens per piece", as compared with the original meaning of "household refrigerators normally used in kitchens to keep foods in low temperature, its color is orange, and its price is USD200 per piece". When this misinterpretation happens by computers, the order could be wrongly executed and then the legal consequences could occur between sellers and buyers.

MEMP is a new concept and still in vision. Its successful design and implementation will drastically change our existing e-trade modes and lift the quality of e-business. It will lead to a more efficient e-marketplace brought by higher accuracy of meaning understanding, broader scope of business interaction and richer e-trade functions. Thus, MEMP target is to maintain the meaning consistency between computer agents on behalf of their human masters. By MEMP, traditional face-to-face or fax mode trade can be replaced and existing inaccurate e-trade messaging methods can be improved. To motivate the design of MEMP, a Hyco and Dilo Example is imaginarily made and shown in Table 1.

TABLE I. : DILO AND HYCO EXAMPLE

Don, a staff of Dilo Trading Company, rushed into the office. He was excited as he got a purchase intention of 200 units of two-door refrigerators. He turned on his computer and instructed his computer agent Dona to check the inventory. Disappointed! Only 10 units left in warehouse and also the usual suppliers have no supplies in the coming month. Dona told Don that a new e-marketplace system called MEMP can promptly find his demand simply by typing in an inquiry. Hesitated but tempted by the new order, Don wrote an inquiry sheet and authorized Dona to send through MEMP. Three minutes later, Dona reported a digitally signed and consolidated offer sheet consisting of 32 suppliers, ranked by the price and product features. Don studied it and selected Hyco Household Electronics from China. He satisfied its prices, features and delivery terms. However, he needed a further negotiation because he wanted to squeeze more profit with a safer delivery time. He modified some product features that final buyers require. He drafted a counteroffer and sent it to Hyco through Dona. Luckily, Hyco accepted the counteroffer and sent back a formal contract through Dona for Don to digitally sign back. "What a nice day!" Don laughed after the click of the "sign" button.

In the rest of this paper, Section 2 discusses method of MEMP design. Section 3 proposes a MEMP framework for MEMP realization, followed by describing key features of MEMP. Finally, a conclusion is made with contribution.

II. MEMP METHODOLOGY

In the Dilo and Hyco example, Don and his suppliers could use their computer agents to carry out all their e-trading tasks in MEMP that will evolve into tomorrow. Most of the e-marketplace content today is designed for humans to read or for computer programs to automatically answer, not

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for humans to understand in the conversation mode of human→computer→computer→human. Computers can parse Web pages, route sharable content and make reasoning on predefined rules, but in general, computers have no reliable way to mediate the human-understandable meanings between humans. For example, computers cannot disambiguate the different meanings of "it is orange" or "I want a refrigerator" if computers have no exhaustive predefined rules of all disambiguation methods.

For MEMP to function, e-marketplace participants must first understand with each other, for example, Hyco's computers must understand Don's inquiring meaning sent by Dilo's computers and the Hyco's computers must also ensure this understanding is consistent with their human masters in terms of Hyco staff. Second, e-marketplaces are distributed, autonomous and emergent and they must be integrated for interoperation since Dilo and Hyco are situated in their different contextual environments. Dilo and Hyco have their own interpretation of the e-business practices and thus they have made different content formats, messaging methods and meaning expressions for their computers to create, store, retrieve and process. Third, e-marketplaces must support all types of e-trading functions like traditional markets, where participants can freely do business by functions such as product search, advertising, inquiry, offer, contract and payment. It is obvious that the first and second problems are foundations for the third problem. Thus, the priority of MEMP design is to solve the first and second problems, which are the major concern of this paper.

The first problem is highly related to concept representation, that is, how our understanding of the world is expressed. Since the different expressions will lead to misunderstanding in conversation, a method is needed for a universal but flexible meaning expression to relieve the problem. The second problem corresponds to heterogeneous concept integration, that is, how heterogeneously expressed concepts can be aligned to deliver meaning, and operations on them will not derive new heterogeneity when MEMP is designed.

In the rest of this section, the methodology of realizing MEMP vision is proposed after the discussion of existing technologies relating to the new MEMP design.

A. *Concept Representation*

Meaning expression is often studied in the areas of knowledge representation and semiotics long before e-marketplace was developed. Concept representation [16], a type of sign systems in semiotics [24][17], is about the way of how the meaning of content is expressed in computational schemes for consistent understanding of conversation. It is slightly different from traditional knowledge representation in methodology, which is a field of artificial intelligence and "concerned with using formal symbols to represent a collection of propositions believed by some putative agent" ([3]:4). The term of knowledge is often in dispute where some people defense it as the justified true belief. Concept is broader in sense than knowledge. It is a notion of human's understanding and unjustified. It can be abstract or concrete, elementary or composite, real or fictitious. In short, a concept can be anything, about which something is seen, heard, smelt, felt, said and imagined, and, therefore, could also be the description such as a term, document, action, process, service, task or strategy. A concept of same form can be either true or false in different context.

The imperceptible difference exists in the definition of representation. The representation in knowledge representation is "a relationship between two domains, where the first is meant to 'stand for' or take place of the second" ([3]:3). Formal symbol of the first domain is usually more concrete, immediate, or accessible than the stand-for object of the second domain in terms of being described real-world. Thus, a representation here must be objective for this relationship to state either true or false regarding the stand-for object. The process of representation is also in argument in different methods: manual, semi-automatic or automatic, or individually designed or collectively designed (i.e. standardized).

Differently, a representation in concept representation is a personal experience of reconstructing the real world and a relationship between the two domains, where the first is a sign system ([24]:65-69) to stand for the second in terms of a perceived world in understanding. The true or false judgment about understanding is subjective to individual who makes representation. Here, representation has two sides: structure (the format that carries the meaning of understanding or signifier) and concept (the meaning understanding of the second domain or signified). Thus, representation implies a causal relationship between its perceived world and concept, such that the former determines the latter, where representation itself entails no public meaning for conversation between people if no meaning agreement is made.

1) *Ontology as Representation*

MEMP design needs to capture the subjective concept through concept representation. It is thus difficult to directly apply the existing ontologies [11] used in e-marketplace design [10][19], since ontology partly assumes the representation of objective things through axioms and facts, for example, OWL (w3.org/TR/owl-semantics/syntax.html). Ontology cannot represent the arbitrary meaning that is individually created and changed in context. "An ontology is an explicit specification of a conceptualization" [11]. It emphasizes on sharing computer-to-computer understanding through an ontological commitment - an agreement about the formal objects and relations being used and talked about among agents. Differently, MEMP design requires an additional level of human-computer understanding to provide a full connection: human ⇔computer ⇔ computer ⇔ human. For ontology design, human-computer understanding is default and assumed in ontology use, for example, the meaning of a concept is objective such that if the sender A uses K to refer to "article", then the receiver B will also know that K means "article" disregarding whether B will misinterpret the "article" meant by A. In addition, any concept in ontology design is a particular specification or a model, which is rather difficult to change in time. For example [11]:

```
(define-class AUTHOR (?author)
```

"An author is a person who writes things. An author must have created at least one document. In this ontology, an author is known by his or her real name."

```
:axiom-def (and (subclass-of author person)
    (slot-value-cardinality author author.name 1)
    (slot-value-type author author.name biblio-name)
    (minimum-slot-cardinality author author.documents 1)
    (same-slot-values author author.name person.name)))
```

This asks that a concept must be designed within a domain and only be designed once because it will not be sharable beyond the domain and may lead to semantic inconsistency if designed twice. MEMP design requires that a concept be designed (or edited) in different domains many times because of the need of satisfying the four e-marketplace properties [14].

2) Ontology for Existing E-Marketplace

Many existing e-marketplaces often represent concepts in domain ontology for field knowledge representation (e.g. [10][19]). These ontologies are usually ad hoc or based on standards. Ad hoc ontology is designed in any way for the shared use in a domain. For example, most industrial and expert ontologies are ad hoc such as alibaba.com category and Specialist Lexicon (lexsrv3.nlm.nih.gov/LexSysGroup). Standard-based ontology is divided into three categories:

- *Format-standardized ontology*. Ontology design follows a standard ontology language for ontology format but the meaning definition is ad hoc. Existing popular ontology languages are RDF/RDFS (www.w3.org/RDF/) and OWL (w3.org/TR/owl-features/). Ontology of this type is domain-wide interoperable for schematic processing but not semantically consistent. Example of such ontology is GeneOntology (geneontology.org). A misleading concept must be avoided that using RDF/RDFS/OWL will automatically create semantic consistent ontology.
- *Meaning-standardized ontology*: Ontology design adopts one or more vocabulary standards, but not use ontology standard language. For example, any ontology adopts standards of UNSPSC (unspsc.org), ecl@ss (eclass-online.com) for products or ISO 31 for quantity and units. This type of ontology shares mutual understanding when two firms adopt the same standards, but they are not technically interoperable if not using the same software or no concept mapping scheme.
- *Representation standardized ontology*. The ontology is designed to meet both standards of ontology language and ontology meaning, for example, the ontology of eclassOWL [18] (heppnetz.de/projects/eclassowl/). This type of ontology can be interoperable for mutual meaning understanding within a domain.

However, no matter whether ad hoc or standard-based ontology, they must be shared within a domain. In e-marketplace, each firm has its own context, which forms a self-formulated domain. Ontology limited in a domain cannot enable cross-domain meaning understanding. MEMP requires a cross-domain design method for accurate meaning understanding between contexts because sellers and buyers are assumed not knowing each other. This becomes a key challenge in MEMP design.

B. Heterogeneous Concept Integration

To relieve the cross-domain problem in e-marketplaces, knowledge representation applies the technologies of ontology integration and intelligent agent to solve the problem.

1) Ontology Integration

Ontology integration is an approach to resolving semantic conflicts between different ontologies. It first presents upper ontology (UO), which describes domain-independent concepts comprising highly general categories such as time, space, inheritance, instantiation, identity, processes and event. In practice, there are types of single and multiple upper ontologies in debate [21]. No matter which type, upper ontology is shared between heterogeneous domain ontologies in a more generic way. It, however, does not well function to enable interoperability even if it may support taxonomy (e.g. UNSPSC) for lower level domain ontologies, because $A, B \subset UO$ does not imply $A = B$. To really solve the cross-domain meaning understanding problem, ontology integration adopts ontology mapping methods developed to map domain ontology [6]. Unfortunately, ontology mapping till now is still an open issue. The prime reason is: no matter whether to create a third ontology to unify ones in mapping or create a meta-ontology to create instances that express mappings between classes and properties in various ontologies, ontology mapping is far too complex due to the need of great effort if manually work on the autonomous and emergent ontologies. Many researchers thus favor semi- or full-automatic ontology mapping through logical reasoning, for example, Context OWL [2] and GLUE [8], but automatic ontology mapping can at most achieve concept similarity because the pre-existed or changing ontology may be different in semantics and the predefined rules may be incomplete. If a close-world assumption ([20]:225) is adopted for reasoning in mapping, the emergence property of e-marketplace [15][16] cannot be satisfied.

2) Reasoning through Agent

A traditional e-marketplace is often designed in two ways – an e-portal or an e-hub. An *e-portal* is a web system that integrates all participants' resources and services in a central repository and is a customizable gateway to its participants. It targets at either selling or buying or both. It can be a website of third-party (e.g. alibaba.com), seller-side (e.g. travelocity.com) or buyer-side (e.g. contracts.mod.uk). An *e-hub* is a web system that integrates all participants' resources and services between the distributed e-business systems of buyers and sellers. It assumes that business partners want to hold their information in their own local sites but not in a central repository like e-portal. Examples of this type could be bolero.net or TradeCard.com. For both e-portal and e-hub, the key challenge in design is the integration of the contents and services that may be differently designed in various corporate e-business systems [5]. Different approaches are applied to solve the problem, for example, multi-agent systems [9], web services [22], semantic matchmaking [1], ontology support [23], semantic mapping [12] and logical reasoning [4]. Most of these solutions involve the design and use of intelligent agent to reason the integration result from the known information, which makes the designed meaningful information discovered, matched, mapped, retrieved or inferred.

Agent technology in e-marketplace design is often widely used. *Agents* are often used as a middleman, which metaphorically refers to the role connecting with e-marketplace participants. Thus, a multi-agent system, which interacts with both humans and agents, constitutes an e-marketplace. An agent acts as both a service provider when it perceives a request and a service requester when it needs a service. Agents for e-marketplaces can be divided into three types of matchmaker, facilitator and broker [25]. In general, *matchmaker* only passively searches and forwards the matched content within a domain between end-agents on behalf of human. *Facilitator* additionally reasons actively on the matched content within a domain to deliver better content as required. *Broker*, in much sense, adds the cross-domain function where some agents function to request and respond the services from and to other domains. Thus, theoretically speaking, matchmaker and facilitator are domain-wide and cannot solve cross-domain problem for achieving mutual understanding. Broker can solve the problem if ontology integration is feasible.

*C. **MEMP** Approach*

To achieve cross-domain meaningful understanding, which is not well solved by existing solutions, MEMP design suggests a new approach, which regards a meaningful cross-domain e-marketplace as a common business information space, governed by the following principles:

(1) *Concept structure versatile*: any concept shall be conveyed in any structure, so that the structure of conveying a concept can be heterogeneous in different domains;
(2) *Concept independent*: any concept shall be self-descriptive, meaning-atomic and independent of any of its conveying structure, so that every concept in transformation and reasoning maintains its original meaning, disregarding its structure and operation;
(3) *Concept agreed*: any concept shall be collaboratively agreed between participative domains, so that every concept in use is meaning consistent between domains;
(4) *Concept causality preserved*: any structure is said to convey a concept only after a concept agrees to be conveyed in this structure, so that any structure can convey a same concept;
(5) *Concept hierarchical*: any concepts shall be arbitrarily assembled in a strict hierarchy and the name of this hierarchy is another concept, so that any concept combination shares a unique and universal representation model for concept transformation and reasoning;
(6) *Concept reified*: any concept shall determine its connotation or instantiation by using itself as the context, so that the accurate meaning interpretation of the connotation or instantiation is available in a given concept combinatory model.

Following these principles, MEMP approach bring structure, concept and context to meaningful content of e-trading partners, creating a collaborative environment where humans and agents work together for reaching agreements to disambiguate inconsistent understanding in different e-trade domains. Such a human-agent collaboration mechanism extends to the entire e-marketplace to include Dilo and Hyco and expands when more firms and e-marketplaces join in. In this MEMP, e-trade content is not monolithic like HTML pages, PDF documents, or referenced by some keywords such as “refrigerator, color, price and size” as might be done today, but represented by concept combinations that are uniquely identified. Any concept combination or its reification formed in different domains is mutually understandable and capable of being transformed and reasoned without semantic inconsistency.

MEMP approach is a development of the existing e-marketplace design in the aspects of the e-trade content representation and the use of agent technology to satisfy the general e-marketplace properties of distribution, autonomy, interdependence and emergence. It better enables humans and agents to work together, faithfully mediating human’s meaning through computers for doing e-business. The key difference between existing e-marketplaces and MEMP is the accuracy of meaning understanding between e-trading partners. In the next section, a MEMP framework will be proposed for realize the design of MEMP approach.

III. MEMP FRAMEWORK

MEMP Framework, shown in Figure 1, includes the procedures of design, reify, transform and infer for all e-trade concepts. It consists of many domain systems distributed in individual firms that more or less require these procedures.

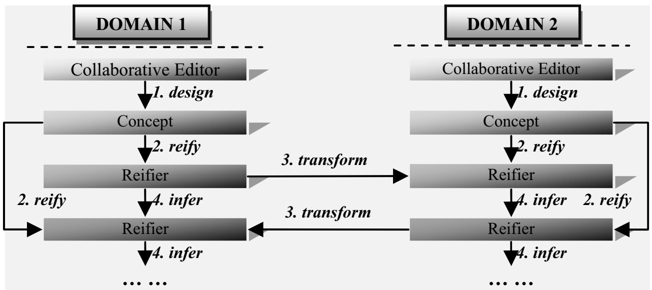


Figure 1. MEMP Framework

- *Design* is a collaborative concept design procedure to creating the semantic consistent concepts through a collaborative editor.
- *Reify* is a concept reification procedure to instantiating a concept to a particular concept, called reifier.
- *Transform* is a heterogeneous concept transformation procedure from one form of concept/reifier to another but still keeping semantic consistency in meaning.
- *Infer* is a concept inference procedure to reason a concluded concept/reifier from one or more antecedent concepts/reifiers.

The implementation of the above aspects constitutes generic components of MEMP, which need particular proper approaches for further design and implementation.

A. Multi-CE Conceptualization

Concepts are created in different domains of buyers and sellers, heterogeneous concepts could only be semantically transformed through a direct or indirect mapping onto common concepts. Direct mapping is not feasible as buyers and sellers do not know with each other before they establish any business relationship. Adopting the indirect concept mapping, MEMP is designed as a service provider that provides common concepts. It allows users to map their local concepts onto common concepts. Users using MEMP do not need to know with each other. The general idea of semantic consistency between heterogeneous concepts is as follows:

> Local concept 1 ⇔ map(local concept 1, common concept) ⇔ common concept ⇔ map(local concept 2, common concept) ⇔ local concept 2.

To materialize this idea, a concept editing system is devised based on two important technologies: XML Product Map (XPM) (Please refer to www.sftw.umac.mo/~jzguo/pages/resource.html) and collaborative editing. XPM is a concept representation language, which governs how the concept designers should format and store their concepts. It is XML-based and can be processed by any XML processor. Collaborative editing provides a collaboration tool that allows concept designers of different domains to design common concepts and map local concepts. The mapped concepts present exact heterogeneous concept transformation.

The MEMP design considers three possibilities. (1) The annotations of common concepts and local concepts may vary in natural language. (2) Local and common concept designers may live in different contexts and their concept design methods could be different. (3) New concepts may appear and local concept designers may find there are no common concepts that can be mapped on. Taking these considerations, the MEMP design suggests a Multiple Collaborative Engine (Multi-CE) conceptualization method [16] derived from the ConexNet ([15]:79-82), shown in Figure 2, such that a collaboration mechanism consists of three types of general collaborative engines (CE) for designing semantically consistent concepts.

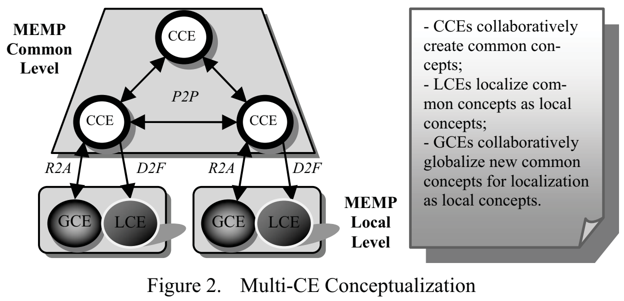


Figure 2. Multi-CE Conceptualization

(1) *Common collaboration engine* (CCE) assists common concept designers to design natural language different common concepts in a *peer-to-peer* (P2P) way. All common concepts are automatically replicated for their concept identifiers, but translated for their annotations in different natural languages in a supervisory way.

(2) *Local collaboration engine* (LCE) helps local concept designers map local concepts of a firm onto common concepts. The LCE works in a *dominant-to-follower* (D2F) manner, where local designer as a follower can only read and map common concepts onto local concepts. The LCE allows localization ability through selective and identifier-based mapping method.

(3) *Global collaboration engine* (GCE) supports local concept designers to create new concepts by creating new common concepts that can be mapped on. The GCE works in a *requester-to-answerer* (R2A) way, where local concept designer as a requester makes request to create new concepts and common concept designer as an answerer responses new common concepts for local concept mapping.

Multi-CE method guarantees that all existing and new concepts can be collaboratively created and mapped to ensure meaning consistency between heterogeneous domains.

B. Context-based Reification

In e-marketplaces, a new message is often generated through filling a blank document template, for example, to prepare an inquiry sheet by filling in a template. When we regard any terms in the template as concepts, the content we are filling in is the run-time generated particular concepts. Interpretation of this content requires us a check on the relation between template content and run-time generated content. To distinguish them, concepts are further classified as abstract concept and reified concept.

An *abstract concept* (or called as a *concept*) is a general and not concrete concept. It can independently express a complete meaning such as color, price or refrigerator. It can be a term (e.g. noun, verb), an identifier of a template, or a process pattern. In contrast, a *reified concept* (or called as a *reifier*) is an instance of abstract concept. It is often concrete. It may not be able to independently exist in conversation to express an accurate meaning and must associate with an abstract concept to make the meaning accurate. For example, "orange" is a reifier of either "fruit" or "color". Other examples could be "123" or "Don". We cannot accurately tell the meaning of "orange" if we cannot find its associated abstract concept. The need for accurately interpreting a reified concept asks us for a proper approach to this problem.

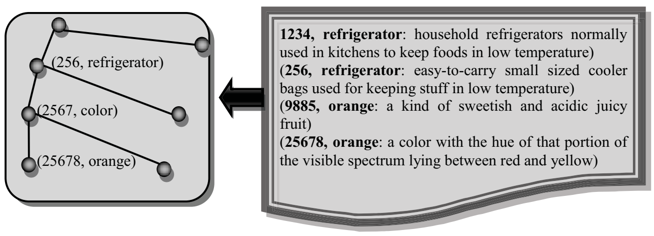


Figure 3. Context-based Reification

MEMP design suggests a Context-based Reification (CR) method [13], shown in Figure 3, where a reifier uses its associated abstract concept as its context to determine its use and interpretation, such that:

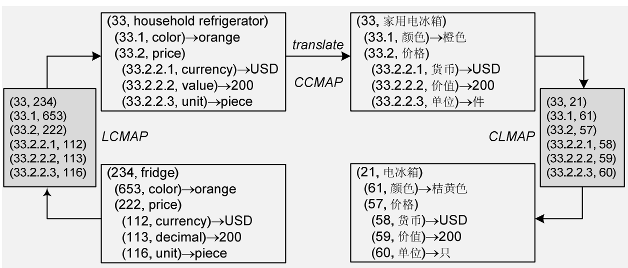
(1) *General rule*: for all concepts in a Product Map (PM) hierarchy [16] $concept_i(concept_j)$, $concept_i$ is always the context of $concept_j$ such that $concept_j$ is a valid connotation of the context $concept_i$;
(2) *Particular rule*: for any abstraction-reification concept hierarchy *concept*(*reifier*), reifier is a *instance* of *concept* such that *reifier* is a valid reification of *concept*.

The CR method can widely used in e-marketplaces for document template instantiation, received document interpretation and multilingual document translation.

C. Identifier-Oriented Concept Transformation

In MEMP design, concepts heterogeneously exist in three places: legacy systems, new MEMP client systems and new MEMP server systems. Accordingly, reified concepts (e.g., a filled document), which intend to meaningfully interact between partners, have three types of heterogeneity: source documents (SD) from legacy systems, local documents (LD) from new MEMP client systems, and common documents (CD) from MEMP server systems. The goal of MEMP for concept transformation is to accurately transform a heterogeneous document from one location to another location without semantic inconsistency, such that:
(1) Source document template (SD) must be able to map onto corresponding local document template (LD), such that SD ⇔ LD;
(2) Local document template (LD) must be able to map onto corresponding a common document template (CD_1), such that LD ⇔ CD_1;
(3) Differently annotated common document templates (CD_1 and CD_2) must be capable of mapping with each other, such that CD_1 ⇔ CD_2.

In SD ⇔ LD transformation, as literature shows [15], some source concepts may be implicitly designed, for instance, price = 500 that omits the currency symbol and unit. In addition, SD is formatted and conceptualized in a different manner as LD. In LD ⇔ CD, both LD and CD are using XPM language, but permitting differences in concept identifier and annotation. In CD_1 ⇔ CD_2, their concept identifiers are the same but their annotations are different in natural languages. These differences require a suitable solution.



Identifier-oriented Concept Transformation

To identify the MEMP problem domain, MEMP design differentiates firm integration (which is in ERP scope) and e-marketplace integration. By this distinction, SD ⇔ LD falls in ERP research and outside of MEMP requirement. The task of MEMP is to build maps of LD ⇔ CD_1 and CD_1 ⇔ CD_2. Utilizing the XPM feature, MEMP design adopts an Identifier-oriented Concept Transformation (ICT) method ([15]:122-132), shown in Figure 4, which utilizes the unique concept identifier within a context as the meaningful concept carrier to map heterogeneously designed concepts. The approach applies the following general rules:
(1) The heterogeneous abstract concepts between two adjacent contexts are transformed by mapping two unique concept identifiers, ignoring their concept annotations. They operate on local-to-common mapping (LCMAP) and common-to-local mapping (CLMAP);
(2) The language different abstract common concepts between two adjacent contexts share a same unique concept identifier;

The ICT method is a *model-free* concept transformation, in which the transformation does not need to consider the model of the transformed document, such as how an inquiry or offer sheet is designed. It means that heterogeneous document templates can semantically transformed in a consistent way. This is a good feature because traditional semantic document transformation requires transformers in different locations to differentiate the templates used on each incoming document. The reason is that traditional document templates are different models of particular specifications, such as ontology models. The ICT method adopts XPM language, which enables the document design only to share one simple model, that is, document is only modeled as a single concept hierarchy no matter how it is complex and personalized.

D. Localized Inference

In cross-domain concept inference, a most disturbing situation is that the operations on concepts of different domains are heterogeneous and thus cause interoperability problem. Current SOAP and WSDL for web service are usually applied to build shared operation interfaces for software programs. However, this requires that any e-trade participants to establish client-service software relationship before they do any business. This is generally not realistic. In many cases, buyers and sellers do not know with each other before they discuss any deals, which is especially true for random purchases. Thus, a feasible solution to interoperability must consider the following requirements:
(1) An execution of any operation shall not need the operation-specific information from the incoming message (i.e. from remote external remote peer domain);
(2) Any operation (i.e. action) design, implementation, reasoning and execution is a local and internal matter with no relationship to external parties;

To meet the requirements, MEMP proposes a *Localized Inference* (LI) method, illustrated in Figure 5, which states:
(1) Any concept (C) is divided into two parts of meaning expression (ME) and meaning implementation (MI). The meaning expression applies the universal XPM format to design concepts, while the meaning implementation realizes the particular operation on the meaning expression;
(2) The meaning expression of concept is public no matter how heterogeneously they are expressing, but the meaning implementation of concept is private no matter who makes the implementation;

(3) All concepts that are used for interaction with the external parties are only a document of the meaning expressions. This shields the internal meaning implementation from public meaning expression;
(4) A meaning implementation consists of three parts: meaning input (Im), meaning execution (Em) and meaning output (Om) such that:

$$C ::= (ME, MI)$$
$$MI ::= (Im, Em, Om)$$

Specifically, the meaning input is given by the concept sender along the meaning expression; the meaning execution is a part of or complete software program; and the meaning output is the interpretation result of the concept receiver, such that:

A MEMP inference is a reasoning step from reading the meaning input of a concept to execute the meaning for a meaning output, which again becomes a meaning input of the next concept, such that:

$$Im(C) : Im(C), Em(Im) \Rightarrow Om(C)$$

The localized inference method separates meaning expression from meaning operation and can solve the complex heterogeneous operation problems between different domains but remain semantic consistency between e-trading partners when messages carrying meanings are sent from one domain to another.

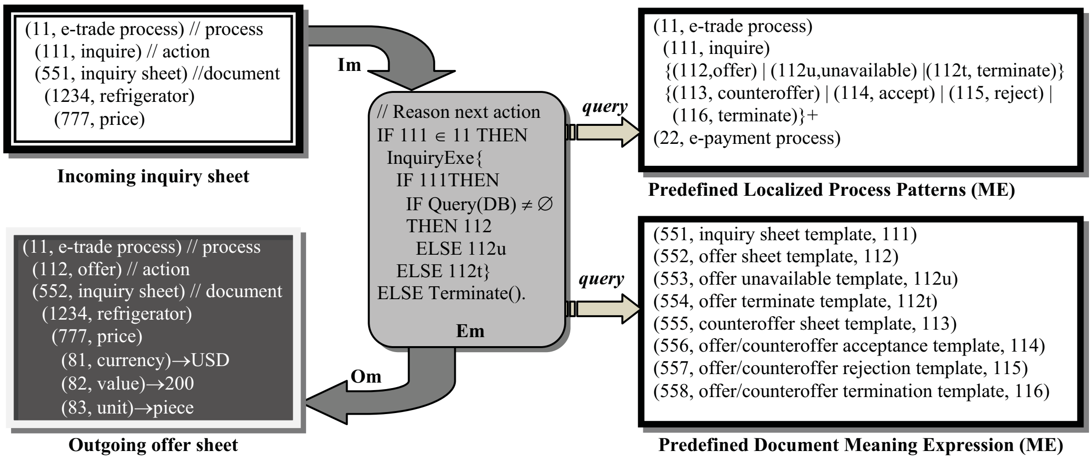


Figure 4. Localized inference

IV. COMPARIING MEMP WITH OEMP

MEMP approach to a meaningful e-marketplace supports cross-domain semantic interoperability between any known and unknown e-marketplace participants. It represents many important improvements in semantic integration as compared with the popular ontology-based e-marketplaces (OEMP).

TABLE II. COMPARISON OF MEMP WITH OEMP

Representation Feature	Meaningful E-Marketplace (MEMP)	Ontology-based e-marketplace
Naming	concept	ontology
Arbitrariness	subjective	objective
Language	XML Product Map (XPM)	RDF, RDFS, OWL
Method	legal collaboration	domain expert or standard
Agreement	cross-domain	domain-wide
Independence	separating meaning from structure	monolithic ontology specification
Modeling	universal hierarchical model for all	particular model for each ontology
Instantiation	reified interpretation by context	run-time logical reasoning
Reasoning	accurate, locally designed	possibly inaccurate

Table 2 presents a key feature comparison between the design features of MEMP and OEMP with regard to semantic integration. By comparison, we find that MEMP design derives some good features:

(1) *Support e-trade content personalization and localization*. This is because MEMP recognizes concept as subjective and cross-domain, It organizes any complex document model in just a concept hierarchy. For example, any differently designed inquiry sheets are different set of concepts hierarchically arranged.
(2) *Support accurate cross-domain e-trade message exchange*. This is because MEMP regards every concept as atomic and independent of structure. Each concept is legally designed by collaboration. For example, a purchase order sent by the buyer can be accurately understood by the seller because the seller can understands it word by word on a universal hierarchy.
(3) *Support accurate reasoning on incoming message for outgoing message*. This is because reasoning operations on incoming message are locally designed in MEMP. These operations are irrelevant to the understanding of incoming message. For example, for an inquiry message sent by buyer and semantically received by seller, it is the seller to determine what will be answered based on

its internal rules and operations. Seller is only responsible for answering a message understandable to buyer. It is similar to that we read a fully understandable letter and decide what content will answer to receiver.

(4) *Support accurate runtime interpretation of incoming reified content*. This is because in MEMP reified concept is always interpreted based on its associated abstract concept as a context.

(5) *Support model-free template design*. This is because, in MEMP, XPM only defines a hierarchy of concepts for modeling any patterns. No heterogeneity happens at all.

There are some other good features, which will not be stated here. The features ensure that MEMP will be a meaningful e-marketplace that can support semantically consistent e-trade functions between MEMP participants.

Comparing with OEMP, ontology is a fixed model lacking the ability of personalization. This is because ontology is often regarded as objective. The modeling method like RDFS/OWL is complex to include many relations. What's more, it is domain-wide. Although new methods are in development to support ontology alignment or ontology mapping, the cross-domain ontology interoperability still has a long way to go.

V. Conclusion

The meaningful e-marketplace (MEMP) is still a vision, but its needed technologies have already partly been there and partly under development, for example, collaborative editing technique of CSCW, logic and agent technology, computational semiotics, and natural language processing. The keys to realizing MEMP are: appropriately representing our subjective world, adaptively linking representation to our contextual thinking, and creatively developing cross-domain functionalities.

The MEMP framework suggested in this paper is an attempt of materializing the MEMP vision. It consists of four important procedures of design, reification, transformation and inference, which involves critical technologies of concept representation, semantic consistency maintenance, context analysis and meaning inference. The MEMP framework presented some desirable features, comparing with the existing RDF/RDFS/OWL-based e-marketplaces, such as representation of personalization and localization, accurate cross-domain message exchange, accurate result reasoning, accurate context-based reification, and model-free template design and use. In future, the MEMP design needs to be improved through step-by-step implementation of the suggested procedures.

VI. References

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