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Study of Awareness-based Knowledge Communication

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Abstract—**With the development of computer network, the smart of communication agents was significantly increased, more intelligent process can be done by computers. To realize this, agents need more detailed concrete message to be transferred. But what should be transferred? How to transfer necessary message to improve the receiver's understanding capability and not add too much communication load? In this paper, We put forward a knowledge communication definition and knowledge communication protocol to solve this problems. We build knowledge communication protocol stack and KC^{2}A^{2}P protocol ontology for content and context awareness. Based on such model, we utilize SRC algorithm to obtain the semantic relativity value and realize mutual awareness and understanding in communication. At last, some experiments are given to show our knowledge communication would improve the meaning delivery and optimize the communication quality.**

Index Terms—**content awareness, context awareness, knowledge communication, ontology, semantic relativity**

I. INTRODUCTION

With the development and widely application of computer network technology, more and more new requirements for computer communication are put forward. Modern Internet technology has decreased the bit data transportation error and guaranteed the accuracy of data transmission to some extend. But communication goal is to know the opposite's intension and deal with things collaboratively, only getting right data is the most important ,but just the basic process for communication. When interaction happens between entities that have different profiles and contexts, some misunderstanding or information losing maybe happened. For example, in electronic commercial, providers maybe confuse buyer's true requirements because they always do not know each other and they have different backgrounds; in ubiquitous environment the dynamic situation makes that the same transported information always has different meanings. So, some intelligent protocols are required to improve content exchange, not just data transportation on computer communication. That is, agents need more detailed concrete message to be transferred. But what should be transferred? How to transfer necessary message to improve the receiver's understanding capability and not add too much communication load?

In this paper we will answer these questions. Our contributions are:

1) We proposed a kind of of knowledge communication definition and put forward related definitions. In knowledge communication model ,we list the content that should help receiver to understand sender's truth meaning and intension.

2) We build knowledge communication protocol stack and KC^{2}A^{2}P protocol ontology for content and context awareness. We utilize ontology to describe the detailed concepts,attributions,relationships in content and context awareness protocol.

3) We utilize semantic relativity algorithm SRC to realize "awareness" ability in knowledge communication.

The outline is: we will analysis related work in the second part and point out the main problems that knowledge communication is facing. The definition of knowledge communication is put forward in the third part. We build KC^{2}A^{2}P, the common shared ontology framework for knowledge communication protocol in the fourth part. To realize mutual awareness and understanding, a semantic relativity algorithm is chosen in the fifth part. Some experiments are done to verify the effect of KC^{2}A^{2}P and at last some conclusions are given.

II. RELATED WORK

Related researches are mainly divided into two categories:

A. Research on communication protocol content

Many works are proposed to establish communication ontology, add content domain ontology reference in protocol and conducting message content interpretation by endpoint. DARPA's AGENT communication language KQML[1] divides application layer protocol into three layers: communication layer, message layer and content layer. Reference information about communication content ontology is added in message layer so as to achieve communication content understanding. SHADE project [2] exploited KQML as protocol, put forward a scalable known-knowledge-based cooperation framework to achieve information share between multiple participants. Some scholars make use of RDF [3], OWL (Ontology Web Language) to improve the syntax of agent communication protocols. Liu Dayou etc [4] proposed methods for computing ontology deviation and dealing with logical exception information transformation to resolve the deficiency and abnormal contents in communication process. Juan Ignacio Vazquez [5] designed RDF Triples and variables supported PLANT two resources description methods, and use SPARQL and simple pattern to provide endpoint semantic process.

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B. Research on protocol actions

Communication action logic and knowledge-based action express research are always based on language and behavior theory in general. Researchers used modal logic, description logic, empirical semantics [6] and so on to set up communication behavior ontology for resolving the action semantic deviation problem.

Darina [7] proposed a communication schema based on the InFFrA society reasoning framework that used optimized decision-making theory methods to realize understanding communication meaning. Jesu' s Bermu' dez [8] et. al. based on event calculus to construct 3-tier communication acts ontology: super layer, standard layer and application later. Wang Li [9], Wang Xiuling [10], Michal Laclavik[11]et. al conducted related works targeting realization of knowledge-driven communication protocol methods.

As can be seen, current research mainly takes agent-based system for application background. This is partly due to that agent is important in intelligent information system application, another reason is as what WWW founder Tim berners-lee[12] mentioned, agent technology will be one of the main instruments in Semantic Web. Therefore, the knowledge-driven communication protocol in this article also takes agent-based information system as application background.

In the current research, researchers mainly focus on building communication ontology to achieve the translation between different terms and concepts and communication between heterogeneous systems. But as the accurate data transmission does not guarantee the correct understanding and process, different protocols vocabulary mapping and transformation can only realize semantic transmission, it cannot guarantee peers to exactly understand the communication information meaning and make right decision based on protocol content. To realize transfer meaning, we not only need a public sharing Knowledge base, but also the necessary auxiliary information to be added. In this paper, we put forward content and context awareness-based knowledge communication and its protocol mechanism.

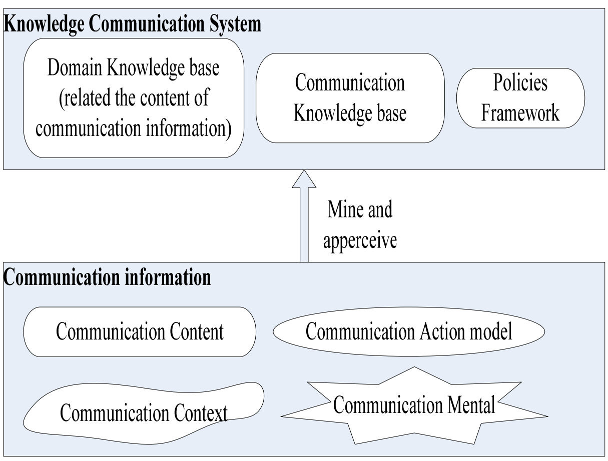

Fig 1 knowledge communication model

III. KNOWLEDGE COMMUNICATION

Definition1 (Knowledge Communication): KC is a 4-tuple:KC=(CI,KD,KC,PF), CI is Communication Information, DK is Domain Knowledge that is message domain ontology, CK is Communication Knowledge that describes the control policy, rule, information and knowledge, CP is Cognize Protocol that shows the framework of communication policy. (Fig1)

Definition 2（CI ,knowledge Communication Information）CI is 4-tuple: CI=（CC,CX,CA,CM）.CC is communication content, CX is communication context, CA is communication action model, CM is communication mental model.

Definition3 (The mechanism of knowledge communication). The mechanism of knowledge communication includes 6 steps (as fig.2) :①detecting communication information② apperceiving ,analyzing message and coding message ③delivering message④ receiving message and decoding ⑤understanding transferred message and discovering implied information ⑥processing information and making decision.

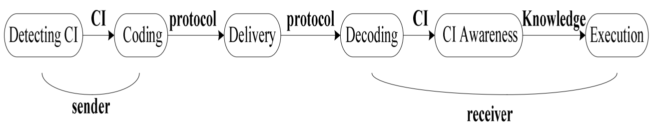

Fig2. The mechanism of knowledge communication

IV. KNOWLEDGE COMMUNICATION PROTOCOL

Knowledge communication protocol, KC^2A^2P (Knowledge-driven Content and Context-Awareness Adaptive Protocol) is a hierarchical structure and it adds context and act layers, extend the content of "content layer" as Fig3. The act layer has two parts, *performative* part defines the basic atomic communication actions, *interaction* part defines the communication state sequence classes that are composed by atomic communication actions based on some patterns. KC^2A^2P takes illocutionary of "speech act theory" as logic base, which is an act performed in saying something. So from the protocol syntax view, content,context and act of KC^2A^2P are the "content" part of protocol ,same as the "body" part of some protocols, which is un-control information; context part is used to assistant understanding content and some action implication will be obtained. At the same time, the "act" definition and logic will offer some semantic verification for content understanding. So in fact the different three parts are related closely.

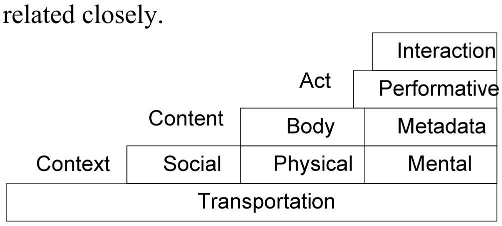

Fig3 The protocol stack structure of KC2A2P

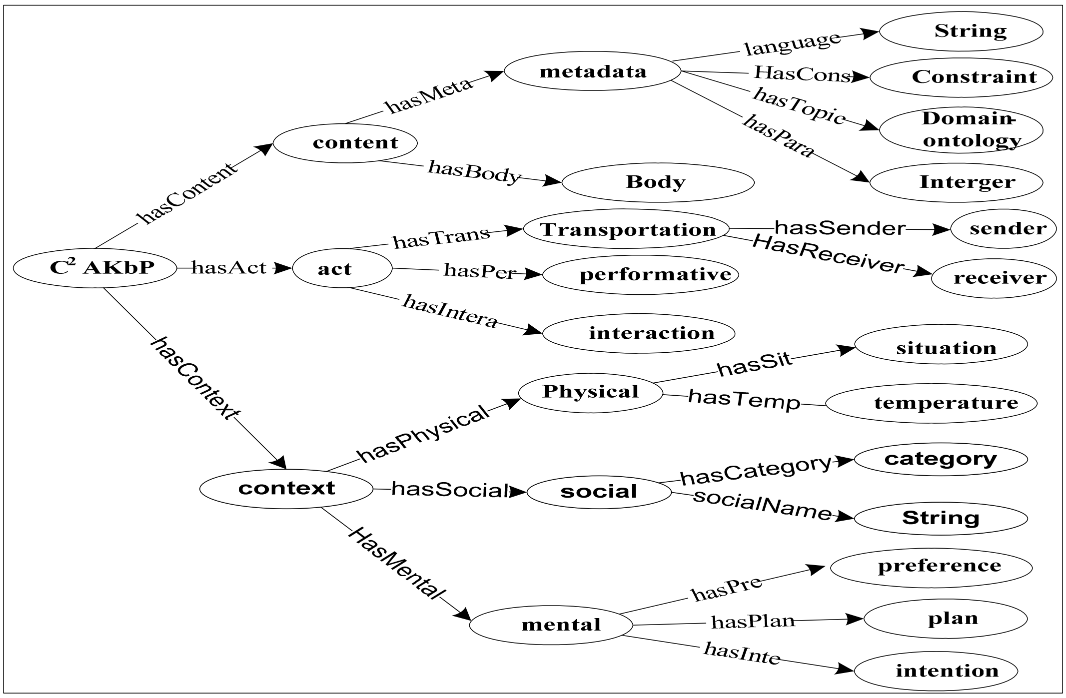

Fig 4. Content and context awareness protocol ontology

To understand each other correctly, accurate information semantic transportation is the first part. The core ontology of KC^2A^2P defines three concepts of content, context, act, which not only support the semantic interconnection between different protocols, but also offer framework for the protocol information formation. (Fig4)

V. ONTOLOGY-BASED AWARENESS COMPUTING

Based on KC^2A^2P ontology, senders can decide what it need to encode and receiver can know what the truth meaning of transferred message is and what is related the requirement.

Ontology-based semantic relatedness computing is important for realizing this mutual awareness. Semantic relatedness is a general concept that could include semantic similarity computing. And it is more useful than just semantic similarity computing. Because similar entities are always semantically related by virtue of their similarity (female-woman), but dissimilar entities may also be semantically related by lexical relationships such as meronymy (car–wheel) and antonymy (hot–cold), or just by any kind of functional relationship or frequent association (pencil–paper, penguin–Antarctica, rain–flood). Computational applications typically require relatedness rather than just similarity; for example, when asking for traveling information, some resource about hotel and weather is also required. SRC (Algorithm of Semantic Relatedness of Concepts) [13] is a semantic relativity algorithm ,which just bases on ontology and does not need any former knowledge. It has three main steps : reading OWL files and building proper graph; according to its subsume axioms producing sub graph(that is a tree structure) consisting only subsumption relationship and counting the semantic relatedness by myObjectMatching method; according to the relation path functions ,calculating the whole classes semantic similarity based on the graph filling with six kinds of relations. Some formulas are:

$Sem\_Related\,[C_1][C_2]$ *is the semantic relativity value of* C_1 *and* C_2

$Sem\_Weight\,[C_2][C_3]$ *is the direct semantic weight of* C_2 *and* C_3

$$Sem\_Road\,[C_1][C_3] = Sem\_Related\,[C_1][C_2] \times Sem\_Weight\,[C_2][C_3] \quad (1)$$

$$Sem\_Related\,[C_1][C_3] = \max_{s}\left(Sem\_Road\,[S][C_1][C_3]\right) \quad (2)$$

VI. EXPERIMENT

We take Education Information Platform as experiment background, Eclipse+JADE (Java Agent Development framework) as exploitation tool, research on the awareness-based knowledge communication process. One client inquires a book named Semantic Web. There are four different providers. Provider1 holds one book on Ontology, provider2 holds Semantic Web Journal and provider3 hasn't any resource about Semantic Web. When the buyer sends a request for looking for a book on Semantic Web, provider3 refuses the request because it doesnot have this resource. Provider1 and provider2 analyze the request by content awareness algorithm and send decision to the client. Client analyses these replies and chooses propose which is close to its own request. The interaction process of this example is illustrated by Figure 5.

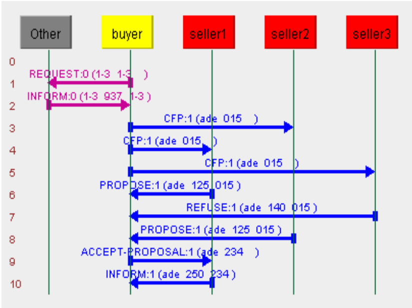

Fig5 one successful interaction process

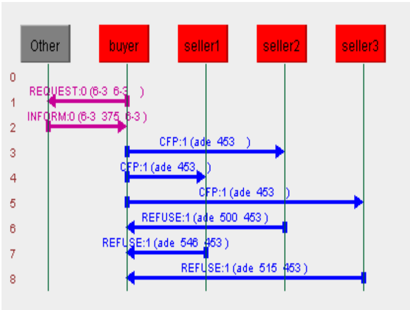

Fig 6 one failing interaction process

The communication without extra content and context information failed (Fig6). By the comparison of interaction process in Figure 5 and Figure 6, we can find out that adding content and context-awareness mechanism to knowledge communication can greatly improve the quality of communication.

VII. CONCLUSIONS

This paper proposed awareness-based knowledge communication, build knowledge communication protocol stack and KC^2A^2P protocol ontology for content and context awareness. Based on such model,we utilze SRC algorithm to obtain the semantic relativity value and realize mutual awareness and understanding in communication. At last, some experiments are given to show awareness-based knowledge communication would improve the meaning delivery and optimize the communication quality.

This article is part of our ongoing project. In the future, we will improve and fulfill the adaptive coding rule and carry out more research on intelligent software mechanism to enable the protocol architecture widely applied to web applications, agent-based systems, ubiquitous computing environment, and mobile communications and so on.

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