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Intelligent Buyer Agent using Multi-Agent Cooperative Negotiation for Retail Electronic Commerce[*]

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Abstract

For the purchase of a cheaper product on the Internet, many customers have been trying to search online shopping mall sites and visit comparison-pricing shops that compare prices and other criteria of the product. Others have been participating into online auction markets or group-buying markets. However, a lot of online shopping malls, auction markets, and group-buying markets provide the same product with different prices. Since these marketplaces have different price settlement mechanisms, it is very difficult for the customers to determine marketplace to purchase, considering different kinds of marketplaces at the same time. To overcome such limitations, decision rules and solution procedures for purchase decision making are necessary, which can cover multiple marketplaces simultaneously. For this purpose, purchase decision making in each market must be conducted to maximize customer's utility, and conflicts with other marketplaces must be resolved. Therefore, we have developed the rules and methods that can negotiate cooperatively the purchase decision making in several marketplaces, and designed an architecture of Intelligent Buyer Agent and a message structure to support the idea.

Keywords: Intelligent Agent, Electronic Commerce, Multi-Agent Negotiation

1. Introduction

Since Electronic Commerce (EC) boomed with the proliferation of the Internet, customers are suffering from the confusion due to the flood of information available. They find it difficult not only to look into too many online shopping mall sites but also to compare a variety of transaction conditions, including prices. In order to lighten such burden, the comparison-pricing shopping model has been utilized in online shopping. It compares prices and other criteria (attributes such as functions, design, manufacturers, etc.) of the product item the customer wants to buy. It searches and shows the arranged information from the merchants it can reach. Comparison shopping websites have many limitations, however. At an early stage, many merchants superior to others in some criteria except price left those sites or would not enter into them. Recently, those sites have taken into account other functions such as free delivery cost, customer evaluation etc., but they are not complete yet. Furthermore, different marketplaces, such as online auction and group-buying markets, are operating successfully on the Internet. They have dynamic pricing mechanism compared with the shopping malls that provide the product with fixed prices. The comparison-pricing shopping mall model cannot operate in such marketplaces.

To overcome such limitations, decision rules and solution procedures for purchase decision making are necessary, which can cover multiple marketplaces simultaneously. Since the

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prices change dynamically in auction and group-buying markets as customers participate, the appropriate purchase decision making is necessary according to the conditions and situations of the market. Therefore, we have developed the rules and methods that can coordinate cooperatively purchase decision making in several marketplaces. For this purpose, purchase decision making in each market must be conducted to maximize customer's utility, and conflicts with other marketplaces must be resolved.

To implement such idea, the agent with the autonomy and personalization is considered the most appropriate. Therefore, we have designed an architecture of Intelligent Buyer Agent and message structure to support the idea.

This paper is organized as follows: Section 2 presents related research Section 3 shows the architecture of the Intelligent Buyer Agent; Section 4 discusses decision rules for shopping; Section 5 describes message layers, and; Section 6 outlines the solution procedure.

2. Related Works

Researches in intelligent agent show a variety of applications in Electronic Commerce. In the view of marketplaces, intelligent agents are utilized mainly for product and/or merchant selection in online shopping malls. In comparison shopping, for instance, they search the product or merchant that matches the customer's request or remove irrelevant ones from some product or merchant sets. They also show the list of the selected items along with their detailed information by sorting them according to some criteria such as price, customer's preference order, etc. PersonaLogic, Firefly(Guttman et al. 1998), and UNIK-SES(Lee et al. 1996) are some of the earliest intelligent comparison shopping agents for product brokering. BargainFinder(Wilder 1995), Jango(Guttman et al. 1998), Roboshopper(Murch & Johnson 1999), BottomDollar(Murch & Johnson 1999), FIDO(www.shopfido.com), Mx BookFinder(Murch & Johnson 1999), Advanced Book Exchange3(www.abebook.com), Kasbah(Chavez & Maes 1996), COOPBOT(Milani & Marcugini 1998), ICOMA(Kang et al. 1998), and MAgNET(Dasgupta et al. 1999) are those for merchant brokering.

In the online auction marketplace, online auction sites such as OnSale(www.onsale.com) and eBay(www.ebay.com) are very popular. Intelligent agents could be used to create contract types in online auctions. A complicated contract type, such as a double auction wherein buyers and sellers submit bids and offers in any order, could be created easier in online auction than real world auction. UNIK-AGENT(Lee & Lee 1998) and AuctionBot(Wurman et al. 1998) are the agents that create contract types. FishMarket(Rodriguez et al. 1997) provides an auction site, where customers can encode several bidding strategies to their agents. AuctionWatch(www.vendio.com) which has changed its name to Vendio is a search engine for items in several auction sites. BiddingBot(Ito et al. 2000a) is one of the shopping support agents in auction sites. Several cooperative bidding mechanisms among agents were proposed(Ito et al. 2000b). A single autonomous agent that can participate in simultaneous multiple auctions was also proposed(Anthony et al. 2001; Preist et al. 2001).

For group-buying marketplace, several researches focus on generating the proposal of appropriate prices of the items being purchased for the sellers(Dasgupta & Das 2000; Maes et al. 1999; Pandey et al. 2000; Song & Lee 2000). GroupBuyAuction(Yamamoto & Sycara 2001) is an agent-based electronic market wherein agents automatically negotiate with each other on behalf of their customers. In particular, buyer agents can form coalitions in order to buy goods at volume discount price. Ito et al.(2001a; 2001b) proposed a cooperation mechanism among seller agents based on exchanging their goods in an agent-mediated electronic market system in order to sell goods in stock effectively whereas buyer agents cooperatively form coalitions in order to buy goods based on discount prices.

On the other hand, researches about cooperation among intelligent agents have a variety of approaches and solutions where cooperation is necessary(Guttman & Maes 1998a; Guttman

& Maes 1998b; Ito et al. 2000b; Ito et al. 2001a; Ito et al. 2001b; Ketchpel 1995; Lander & Lesser 1993; Markoff 1996; Nunamaker et al. 1991; Sandholm & Lesser 1995; Shehory & Kraus 1995; Shehory et al. 1999; Yamamoto & Sycara 2001; Yokoo et al. 1992). However, cooperation among intelligent agents in several marketplaces simultaneously has not been examined yet.

3. An Architecture of Intelligent Buyer Agent

To support a customer's purchase decision making in the electronic marketplace, IBA (Intelligent Buyer Agent) consists of four agents operating independently as depicted in Figure 1. The user interface agent mediates interactions between the customer and each agent in charge of purchase decision in the corresponding marketplace. The remaining agents - shopping mall agent, auction agent, and group-buying agent - start on the purchase decision processes when the customer's purchase requirement is passed through the user interface agent. Using their purchase knowledgebase, they make a purchase decision at online shopping mall sites, online auction sites, and online group-buying sites, respectively. Conflict among agents' purchase decisions is resolved through cooperative negotiation. We explain the function of each agent in this section. The decision rules, the contents of knowledgebase of three agents, are described in the next section.
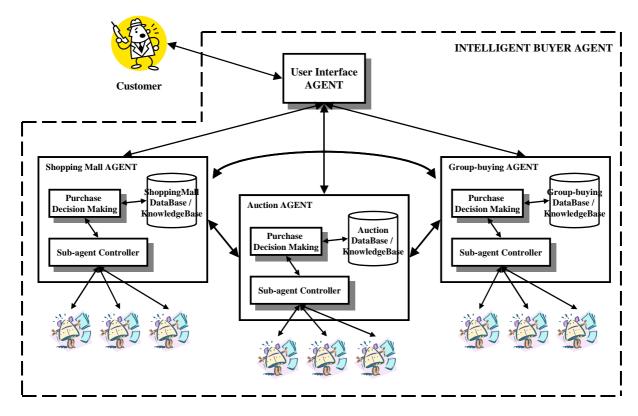
Figure 1. Architecture of Intelligent Buyer Agent

(1) Shopping mall agent

After receiving the message from the user interface agent, the shopping mall agent collects information corresponding to the merchant who sells the product that the customer wants to buy. The shopping mall agent always keeps the stored information about online shopping malls such as name, URL, etc. The sub-agent controller of the shopping mall agent triggers all the sub-agents responsible for each shopping mall soon after they receive the customer's

requested message. And then the master agent periodically gathers information about a certain merchant from the response message of the corresponding sub-agent.

The purchase decision of the shopping mall agent is postponed until the finish time designated by the customer because transaction conditions including price are seldom changed in a short period of time. This information is only given to the auction agent and the group-buying agent while they negotiate cooperatively until the finish time approaches.

(2) Auction agent

While the auction agent conducts the information gathering and sub-agent launching similar to the previous shopping mall agent, the characteristics of online auction market make the purchase decision process different. In the English auction as one of the three marketplaces in this paper, the bidding price of the product increases from opening time to closing time, and the final transaction price is settled by the highest bidding price in the deadline. To make good purchase decisions in online auctions, the agent should watch the change in bidding prices continuously and participate in auctions with a proper bidding price within a closing time.

A sub-agent triggered by auction agent takes charge of a certain online auction site and informs the status of bidding price for the whole period to the master auction agent. When the deadline for a specific online auction draws near, the auction agent which receives the last informed message from a sub-agent determines whether it makes a bid in the online auction site or not and to which bidding price it submits if it does. This purchase decision is made as a result of the cooperative negotiation with the shopping mall agent and the group-buying agent.

(3) Group-buying agent

The operation of the group-buying agent is almost the same as that of the auction agent except the purchase decision criteria. The transaction price of the product is settled by the number of applicants or the order amounts of the product in the group-buying marketplace. As order amounts increase in group-buying, the price for all participants gets cheaper and becomes fixed. Sub-agents inform the number of participants (total order amount) and the corresponding unit price to the group-buying agent. The group-buying agent then determines whether it joins the group-buying market or not. At that time, the group-buying agent requests the cooperative negotiation with the shopping mall and auction agents.

4. Decision Rules for Shopping

In this section, we will describe the decision rules of purchase decision making through cooperative negotiation among three purchase agents of the IBA (Intelligent Buyer Agent). It is necessary to introduce the concepts and their definitions before describing the process in detail. Figure 2 shows a time span for the purchase decision of customer.

There are three types of purchase decision point of time from start time `ust` to finish time `uft`. First, when any online auction site for the product reaches the closing time, IBA determines whether it participates in the auction and to which bidding price it submits. Second, IBA determines whether it participates in a certain group-buying site for the product before a deadline of the group-buying, which means that it is the closing time of the group-buying or the number of applicants for the group-buying reach the maximum number of persons. Third, the purchase decision for the product is settled in the finish time designated by the customer.

4.1 Decision at the Deadline of Online Auction Site

The auction agent should judge that the last bidding price $pa_j(aft_j)$ is the cheapest price

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for all marketplaces, including shopping mall, online auction, and group-buying sites, in order to determine whether it bids in the online auction site AU$_j$ at the closing time.
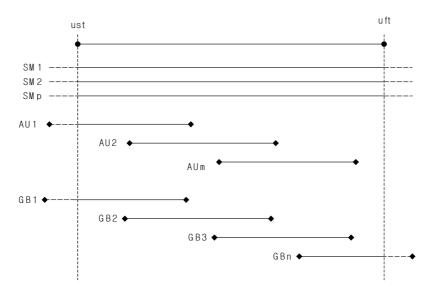
Figure 2. Time Span for Purchase Decision Making


```
ust : start time designated by customer
uft : finish time designated by customer
SMᵢ : online shopping mall site i (i=1,2,…,p)
psᵢ : selling price at internet shopping mall SMᵢ
psₘᵢₙ(t) : minimum price among psᵢ at time t
AUⱼ : online auction site j (j=1,2,…,m)
(astⱼ, aftⱼ) : opening time and closing time of AUⱼ
paⱼ(t) : current bidding price in AUⱼ at time t
GBₖ : group-buying site k (k=1,2,…,n)
(gstₖ, gftₖ) : opening time and closing time of GBₖ
pgₖ(t) : transaction price in GBₖ at time t
pgmₖ : minimum price of GBₖ
```

The participation in the auction and the upper limit of its bidding price are settled according to the result of the judgment as follows. First, in case of shopping mall or group-buying sites in progress where the transaction price is cheaper than the last bidding price, the auction agent never participates in the auction site. Otherwise, the agent should compare the last bidding price with the expected price that reflects the opportunity cost of non-participation in the auction. If the last bidding price is lower than the expected price, the auction agent participates in the auction with the expected price as an upper bound of its bidding price. The formula to calculate the expected price EP($\sim$AU$_j$) is as follows:

$$EP(\sim AU_j) = \int_0^{pa_j(aft_j)} p \times fn(p)dp + \int_{pa_j(aft_j)}^{\infty} fn(p)dp \times Min\left(ps_{\min}(aft_j), \underset{i}{Min}\left(E(pg_i(gft_i))\right)\right)$$

fn(p) : probability density function of a newly created marketplace with transaction price *p*

The first part of the formula is the expected price in online auction markets or group-buying markets newly created after this closing auction site. The probability density function *fn(p)* could be obtained from price distribution of the past transactions of auction and group-buying marketplaces. The opportunity cost of abandonment of participation in the auction multiplied by the probability of absence of newly created marketplaces is added to the expected price EP($\sim$AU$_j$) at the second part of the formula.

4.2 Decision at the Deadline of Group-buying Site

The purchase decision of the group-buying agent is similar to that of the auction agent. The group-buying agent decides to join applicants of the group-buying only if the transaction price is cheaper than the expected price, which reflects the opportunity cost of non-participation in this group-buying. The following formula is used to calculate $EP(\sim GB_k)$, which is the expected price to be paid later when giving up participation in this group-buying.

$$EP(\sim GB_k) = \int_0^{pg_k(gft_k)} p \times fn(p)dp + \int_{pg_k(gft_k)}^{\infty} fn(p)dp \times Min\left(ps_{\min}(gft_k), \underset{i}{Min}\left(E(pg_i(gft_i))\right)\right)$$

$fn(p)$: probability density function of a newly created marketplace with transaction price p

The formula that expresses the opportunity cost of abandonment of participation to the group buying is similar to the expected price $EP(\sim AU_j)$ appearing in section 4.1.

4.3 Decision at the Finish Time

If any purchase decision agents have not determined to buy until the finish time, the marketplace is necessarily determined among shopping malls and group-buying sites of which closing time do not reach the finish time. If there are no ongoing group-buying sites, the shopping mall agent places an order to the online shopping mall with the minimum price. Otherwise, the group-buying agent estimates the final transaction price for each ongoing group-buying marketplace and compares the minimum price among the group-buying sites with the minimum price of online shopping malls. The formula $EP(GB_k)$, which means the expected closing price for group-buying site GB_k, is as follows:

$$EP(GB_k) = E(pg_k(gft_k)) = \sum_{c=0}^{\infty} pn_k(c) \times pgs_k\left(gc_k(uft)+1+c\right)$$

$pn_k(c)$: probability mass function that the number of additional participants for GB_k is c from the finish time to the closing time of the site

$pgs_k(c)$: transaction price of GB_k when the number of applicants is c

$gc_k(t)$: number of applicants of GB_k at time t

At the finish time, the shopping mall agent and group-buying agent determine cooperatively the market to buy, comparing the minimum price of online shopping mall sites with the minimum expected price of group-buying sites.

5. Message Layers

5.1 Agent Communication Language Layer

In communicating with other agents, Agent Communication Language(ACL) is necessary. KQML(Knowledge Query and Manipulation Language) and UNIK-OBJECT are used as the outer and inner language of ACL, respectively (Lee & Kim 1996).

Three message layers similar to the UNIK-AGENT(Lee & Lee 1998) are defined in Figure 3 in order to apply ACL and inner language to electronic commerce. The top layer, which is called the ACL layer, consists of a KQML performative and its parameters as domain independent messages(Lee & Lee 1998). Performative parameters: sender, receiver, and content have the values of the agent IDs that send messages and communication objects.

5.2 Electronic Commerce Layer

The middle layer called Electronic Commerce (EC) layer contains the KQML content details. The messages are constructed using TITLE, TRANSACTION_ID, AGENT_TYPE, DECISION_DUE, etc. TITLE has the value of message name. TRANSACTION_ID

corresponds to the unique number each activating transaction has. DECISION_DUE contains the due date for making the purchase decision. MARKET_PLACE keeps the value of market types. REQUIREMENT has its own parameters: DELIVERY_METHOD, DELIVERY_DATE, PAYMENT_METHOD, and PRODUCT (Figure 3). Customers specify their requirements using REQUIREMENT. PRODUCT also has the following parameters: ITEM_NAME, MODEL_#, and ITEM_SPEC. They receive values from a customer. The agents refer to them when searching prices in their marketplace.
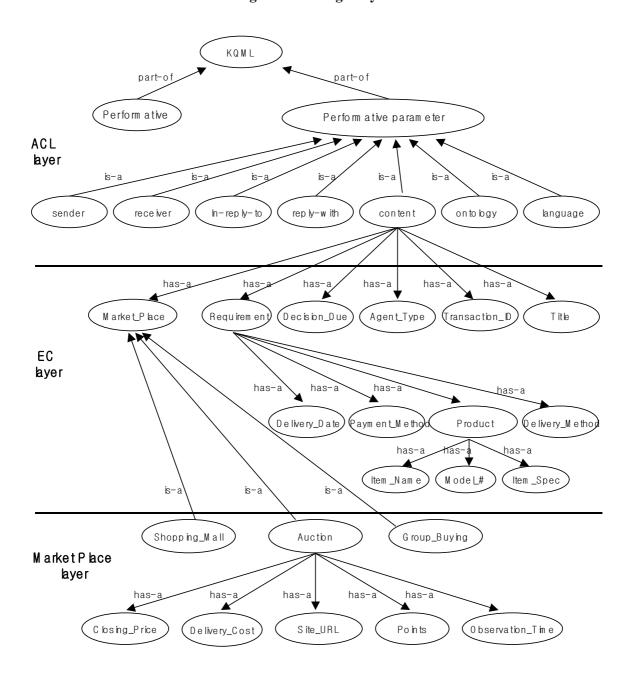
Figure 3. Message Layers

5.3 Marketplace Layer
The marketplace layer defines the marketplaces more specifically. Three types of marketplaces are under consideration for searching the minimum price upon customer's

request as mentioned before. The components for operating the marketplace and the message for communicating with other agents are defined. For instance, CLOSING_PRICE corresponds to the closing price of an auction; SITE_URL the URL of the auction site to be searched; POINTS a kind of cyber money that the customer can use for shopping; and OBSERVATION_TIME the date and time the price is observed. Because of the page limitation, only the auction part is specified.

6. Solution Procedure

6.1 Initiation of Each Agent: User Input by the User Interface Agent

A customer initiates the search process as he or she specifies requirements to the user interface agent. The requirements consist of item name, model number, manufacturer, and the due date for making a purchase decision. The user interface agent transfers them to the shopping mall agent, the auction agent, and the group-buying agent.

The shopping mall agent, the auction agent, and the group-buying agent trigger their sub-agents to start searching as they give the customer's requirement and the following data retrieved from each database: site URL, user ID, and password. The following message shows that the shopping mall agent (SM_AGENT) asks its sub-agent (SM_CHILD1) to search the price of the item requested by the customer.

```
(EVALUATE
    :SENDER                    SM_AGENT
    :RECEIVER                  SM_CHILD1
    :REPLY_WITH                K0061_040708
    :ONTOLOGY                  Agent Based Commerce
    :LANGUAGE                  UNIK-OBJECT
    :CONTENT
         ((TITLE                   Search_Price)
          (TRANSACTION_ID          SM_040708)
          (MARKET_PLACE            Shopping_Mall)
          (MANUFACTURER            Samsung)
          (ITEM_NAME               NICE)
          (MODEL_#                 K0061)
          (SITE_NAME               KYONGGI_SHOP)
          (SITE_URL                www.kyonggi-shop.com)
          (USER_ID                 kgu04)
          (USER_PWD                chu07)
          (OBSERVATION_TIME        JULY 8 10:30)))
```

In this manner, the shopping mall agent sends the message to its sub-agents. The auction agent and the group-buying agent also send those kinds of messages to their sub-agents.

6.2 Transaction Information Gathering: Prices, Current Status

The sub-agents gather the information on transaction status. For instance, auction sub-agents look for opening time, closing time, current bidding price, delivery cost, etc. Each shopping mall sub-agent periodically informs the price of the requested item at its corresponding shopping mall to the shopping mall agent after considering points and delivery cost. The following message shows that the sub-agent SM_CHILD1 informs the purchasable price $200 to the shopping mall agent SM_AGENT.

The shopping mall agent acquires the name and URL of the shopping mall that gives the minimum price along with its price and observation time from the shopping mall sub-agents.

The sub-agents of auction and group-buying also gather related information and wait until every event comes to the closing time in order to report to the auction or the group-buying agent.

```
(REPLY
    :SENDER                  SM_CHILD1
    :RECEIVER                SM_AGENT
    :IN_REPLY_TO             K0061_040708
    :ONTOLOGY                Agent Based Commerce
    :LANGUAGE                UNIK-OBJECT
    :CONTENT
        ((TITLE                  Price)
         (TRANSACTION_ID         SM_040708)
         (MARKET_PLACE           Shopping_Mall)
         (MANUFACTURER           Samsung)
         (ITEM_NAME              NICE)
         (MODEL_#                K0061)
         (SITE_NAME              KYONGGI_SHOP)
         (SITE_URL               www.kyonggi-shop.com)
         (POINTS                 20)
         (DELIVERY_COST          40)
         (PURCHASE_PRICE         200)
         (OBSERVATION_TIME       July 8 15:00)))
```

6.3 Decision Request of Auction(or Group-buying) Sub-agents at Each Decision Time

At each decision time, the corresponding sub-agent reports the current transaction status and asks whether to participate or not. The same procedure is applied to both auction and group-buying marketplace, and the auction case is described here.

(1) Request on the Minimum Price from the Shopping Mall Agent
The auction agent AUC_AGENT sends the message to the shopping mall agent SM_AGENT asking for the current minimum price of the item among shopping malls as follows:

```
(EVALUATE
    :SENDER                  AUC_AGENT
    :RECEIVER                SM_AGENT
    :REPLY_WITH              K0061_040708
    :ONTOLOGY                Agent Based Commerce
    :LANGUAGE                UNIK-OBJECT
    :CONTENT
        ((TITLE                  MIN_Price)
         (TRANSACTION_ID         Request_SM_040708)
         (MARKET_PLACE           Shopping_Mall)
         (MIN_PRICE                  )))
```

The shopping mall agent then informs the current minimum price to the auction agent.

```
(REPLY
    :SENDER                  SM_AGENT
    :RECEIVER                AUC_AGENT
    :IN_REPLY_TO             K0061_040708
    :ONTOLOGY                Agent Based Commerce
    :LANGUAGE                UNIK-OBJECT
    :CONTENT
```

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```
((TITLE                          MIN_Price)
 (TRANSACTION_ID                 Request_SM_040708)
 (MARKET_PLACE                   Shopping_Mall)
 (MIN_PRICE                      200)))
```

(2) Request on the Minimum Estimated Price from the Group-buying Agent

The auction agent AUC_AGENT sends the message to the group-buying agent GB_AGENT asking for the minimum estimated price of the item among the active group-buying marketplaces. The group-buying agent then sends the message asking for the estimated prices of the item to the group-buying sub-agents.

After receiving the estimated prices from the sub-agents, the group-buying agent selects to inform the minimum estimated price among them to the auction agent as follows:

```
(REPLY
    :SENDER                      GB_CHILD1
    :RECEIVER                    GB_AGENT
    :IN_REPLY_TO                 K0061_040708
    :ONTOLOGY                    Agent Based Commerce
    :LANGUAGE                    UNIK-OBJECT
    :CONTENT
            ((TITLE                      Estimated_Price)
             (TRANSACTION_ID             Request_GB_040708)
             (MARKET_PLACE               Group_Buying)
             (ESTIMATED_PRICE            195)))

(REPLY
    :SENDER                      GB_AGENT
    :RECEIVER                    AUC_AGENT
    :IN_REPLY_TO                 K0061_040708
    :ONTOLOGY                    Agent Based Commerce
    :LANGUAGE                    UNIK-OBJECT
    :CONTENT
            ((TITLE                      MIN_Price)
             (TRANSACTION_ID             Request_GB_040708)
             (MARKET_PLACE               Group_Buying)
             (MIN_EST_PRICE              180)))
```

(3) Request on the Estimated Price from Active Auction Sub-agents

All the sub-agents of active auctions except the closing one report their estimated prices to the auction agent. They estimated the prices using the formula mentioned in section 4.1.

6.4 Purchase Decision using Each Expected Price

The auction agent calculates the expected price of each marketplace in order to decide whether to buy or not. For instance, in the auction marketplace, the expected price when the agent does not participate in the auction can be calculated using the following formula in section 4:

$$EP(\sim AU_j) = \int_0^{pa_j(aft_j)} p \times fn(p)dp + \int_{pa_j(aft_j)}^{\infty} fn(p)dp \times Min\left(ps_{\min}(aft_j), \underset{i}{Min}\left(E(pg_i(gft_i))\right)\right)$$

fn(p) : probability density function of a newly created marketplace with transaction price *p*

Means and variances of the distribution *fn(p)* can be obtained from the database. Assume that a closing price of the auction is $190. If the expected price is greater than $190, the corresponding auction sub-agent can participate in the bidding process of that auction. The auction agent notifies the intermediate result to the user interface agent or to the shopping

mall agent and the group-buying agent depending on whether the purchase decision has been made or not as follows:

```
(TELL
    :SENDER              AUC_AGENT
    :RECEIVER            SM_AGENT GB_AGENT (USER_INTERFACE_AGENT)
    :REPLY_WITH          K0061_040708
    :ONTOLOGY            Agent Based Commerce
    :LANGUAGE            UNIK-OBJECT
    :CONTENT
         ((TITLE                   Intermediate_Result)
          (TRANSACTION_ID          Transact_040708)
          (EP_AUC                  210)
          (EP_GB                   205)
          (EP_SM                   200)
          (MIN_VALUE               N)
          (DECISION                CONTINUE)))
```

6.5 Customer's Designated Decision Finish Time
The shopping mall agent asks the group-buying agent for the minimum value among estimated closing prices of active group-buying marketplaces if the purchase decision has not been made until the customer's designated decision finish time. The purchase decision depends on the comparison result of the minimum values between two marketplaces.

6.6 Notification of Ordering Result
Finally, the marketplace (for instance, the group-buying marketplace) is determined, and the ordering result is notified to all the agents and the customer as the following:

```
(TELL
    :SENDER              GB_AGENT
    :RECEIVER            SM_AGENT AUC_AGENT USER_INTERFACE_AGENT
    :REPLY_WITH          K0061_040708
    :ONTOLOGY            Agent Based Commerce
    :LANGUAGE            UNIK-OBJECT
    :CONTENT
         ((TITLE                   Final_Result)
          (TRANSACTION_ID          Transact_040708)
          (SITE_NAME               Onket)
          (SITE_URL                www.onket.com)
          (PURCHASING_PRICE        195)
          (ORDERING_DATE           20040712)
          (MIN_MARKETPLACE         GB)
          (MIN_VALUE               Y)
          (DECISION                STOP)))
```

7. Conclusions
We have proposed a customer's purchase decision making method and design of the Intelligent Buyer Agent that searches and compares the transaction conditions related to the price in multiple marketplaces. In order to overcome the limitation of comparison-pricing model in online shops, the master agents of the Intelligent Buyer Agent make the appropriate purchase decision in their corresponding marketplaces and negotiate cooperatively to reach the optimal purchase decision as a whole. The Intelligent Buyer Agent could expand to different kinds of marketplaces, which would eventually maximize the customer's utility.

As a following study, we consider the implementation of the Intelligent Buyer Agent and performance evaluation, comparing the results of each marketplace.

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