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A Negotiation Supporting System Based on Characteristic of Negotiators

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Abstract: As electronic commerce (e-commerce) becomes more pervasive and dynamic, negotiations between companies are required more frequently than ever. Negotiation Supporting System (NSS) will be a very important subsystem in the development of e-commerce. This study introduces the current research situation about NSS, stresses on the whole system architecture and key technologies, sets forth solution scheme about some important problem, such as multiparty cooperation text technology, inter-stream synchronization and designs a value-added service of knowing negotiation characteristic of rivals as well, by using which favorite type to negotiate in personal favor can be selected. The goal is to develop a NSS prototype and to test its feasibility in simulate environment. The implementation prototype system demonstrates fine performance relative to homogeneous procedure-driven-based NSS.

Key words: Negotiation supporting system, characteristic analysis of negotiator, electronic contract

INTRODUCTION

With the rapid expansion of e-commerce, more and more products are sold through the Web and more people are buying products online. In order to enhance customer satisfaction and meet interaction online, many application systems for real-time online information interaction have been provided, such as ICQ, MSN and AIM. As the Web becoming more acceptable to common users, an increasing number of online merchants are looking for an online negotiation system instead of a face-to-face.

Negotiation Support System (NSS) is derived from group Decision Support System (DSS), it aims to improve negotiation efficiency and coordinate opinion conflict. Most NSS were based on stand-alone computer in early time. Online NSS was first mentioned around in 2000 (Stanley *et al*., 2000) which has become a hot topic in EC domain. A comprehensive platform for any merchants to communicate and negotiate online can be provided by online NSS and much expense in transportation and telecommunication can be reduced as well.

In this study, we studied the generating procedure-driven-based NSS which generally defines that the NSS can provide negotiators with support tools to and with other related actions in negotiation. A value-added service of acquiring negotiation characteristic of rivals has also been designed in which three characteristics are presented in this article, i.e., patience, urgency and equality. Acquiring the characteristics of rivals you can select your favorite type to negotiate.

As indicated earlier our task is performed in three main aspects:

- Designing a negotiation room which is similar to online game room, such as: www.ourgame.com
- Implementing a model which can acquire characteristics of online negotiator by studying their historical negotiation information
- Designing some friendly applied programs to help negotiators have fluent real-time communication and sign electronic contract

A system, CBNSS (Characteristic -Based NSS), has also been implemented. Our experimental results with a large number of analogue negotiators show that CBNSS and its techniques are of high effectiveness.

Negotiation is a decision process in which two or more parties make individual decisions and interact with each other for mutual gain (Thompson, 2000). By performing negotiation activities over the Internet, which has recently become a global communication platform, both transaction costs and time can be greatly reduced. The Internet allows organizations and individuals to communicate among each other, to carry out various commercial activities and to provide value-added services. However, negotiation of contracts is often still performed manually unsupported by computer systems or just by e-mail. The main problem of this is its slowness, which is further complicated by issues of culture, ego and pride (Thompson, 2000).

Computer applications were first employed for negotiation support in the 1960s. In the 1980s, computer-based NSS emerged and they were typically used for training and research in a laboratory environment

were rarely used in practice (Delaney *et al*., 1977). In general, NSSs have the following basic features (InterNeg, 2000):

- A formalism to describe the negotiation activity in terms of choices and outcomes
- A way to generally characterize the associated outcome probabilities
- A methodology for processing the model to evaluate the expected values of choice alternatives

The NSSs normally assist negotiators to assess situations, generate and evaluate options and implement decisions. However, most NSSs do not consider the generation of contracts, which we consider to be the primary aim of negotiation in ecommerce, as an outcome of negotiation process. For example, NEGOTIATOR (Bui and Shakun, 1996) seeks to guide negotiators to move their individual goals and judgments to enhance the chance of achieving a common solution. It supports problem adaptation through information sharing, concession making and problem restructuring. However, NEGOTIATOR only helps the negotiators make decisions without any support to other entities involved in negotiation, such as contracts. INSPIRE (InterNeg, 2000; Support Program for Intercultural Research) (Kersten and Noronha, 1999) is a Web-based prototype for supporting inter-cultural as well as intra-cultural negotiations. It can conduct negotiation anonymously, evaluate the goodness of an offer and review the history of a negotiation. INSPIRE supports the communication among negotiators by exchanging messages, but we propose direct interactions among different entities with Web services.

In the Artificial Intelligence arena, fully automated negotiations using negotiation software agents have been considered. In this approach, the intelligent software agents communicate with other agents and make decisions on behalf of the owner, according to the pre-programmed strategies with or without learning. Strategies of negotiation software agents were designed and analyzed based on game theory and heuristics.

Benyoucef *et al*. (2001a, b) and Bassil *et al*. (2002) studied combined negotiations from the workflow management perspective. The combined negotiation is a negotiation in which a user engages in many negotiations at the same time. They developed a Combined Negotiation Support Systems (CNSS) that helps the user coordinate all the dependent negotiations. They showed the functional requirements of a CNSS and developed a prototype named CONSENSUS, using commercial WfMS-IBM's MQSeries (Benyoucef *et al*., 2001a,b) and BEA's WebLogic (Bassil *et al*., 2002). In the architecture of CONSENSUS, the users design the combined negotiation process at the design time. Then the software agents are assigned to each individual negotiation of the combined negotiation process and execute the process. IBM Zurich Research Lab., is also developing software tools for state machine based negotiation design, ontology editing and communication, in their SilkRoad project (Strobel and Weinhardt, 2003).

Empirical studies have thoroughly analyzed the impacts of many other characteristics of negotiators like their national culture (Valenzuela *et al*., 2005), reputation (Tinsley *et al*., 2002) or fear of loosing face (White *et al*., 2004). One study related to our research question was performed by Rudolf (2007, 2009), who studied whether preferences embedded in a model actually influence behavior and outcomes. In another set of experiments, Bottom (1998) used differences in utility functions for gains and losses to explain the impact of framing effects on negotiation outcomes. Curhan *et al*. (2004) considered the relationship between preferences and negotiation processes as a feedback loop and explored the impact of processes on preferences.

We present model to acquire decision-making characteristics of negotiators by studying their historical negotiation experience and favorite type of rivals can be selected. Again, we give some function program to help negotiators communication and interaction in negotiation.

THE ANALYSIS OF SYSTEM FLOW

There are several parities in a negotiation and usually each of them is a decision maker who always analyze and judge the situation. From the decision-supporting perspective, the essence of negotiation can be considered as a decision-making process of negotiation topic and it can be divided into four steps:

- Subdividing the negotiation topic
- Handling the negotiation items
- Analyzing negotiation solution
- Making decision

Theoretically, decision-making procedure of negotiation is sequential and step-by-step, however, each step is not always accomplished, for there are many repeats in one step or waits of arising of some conditions, that is to say, the process of negotiation is not simple and it filled with much complex judgment and repeats so that assistant tools must be applied. The negotiate system flow is shown in Fig. 1.

Here, negotiation room looks like online game room, such as ourgame.com, there are many negotiation tables in each room. Selecting negotiation rivals can be based on a value-added service presenting characteristics of any negotiators, detailed analysis can be referenced in

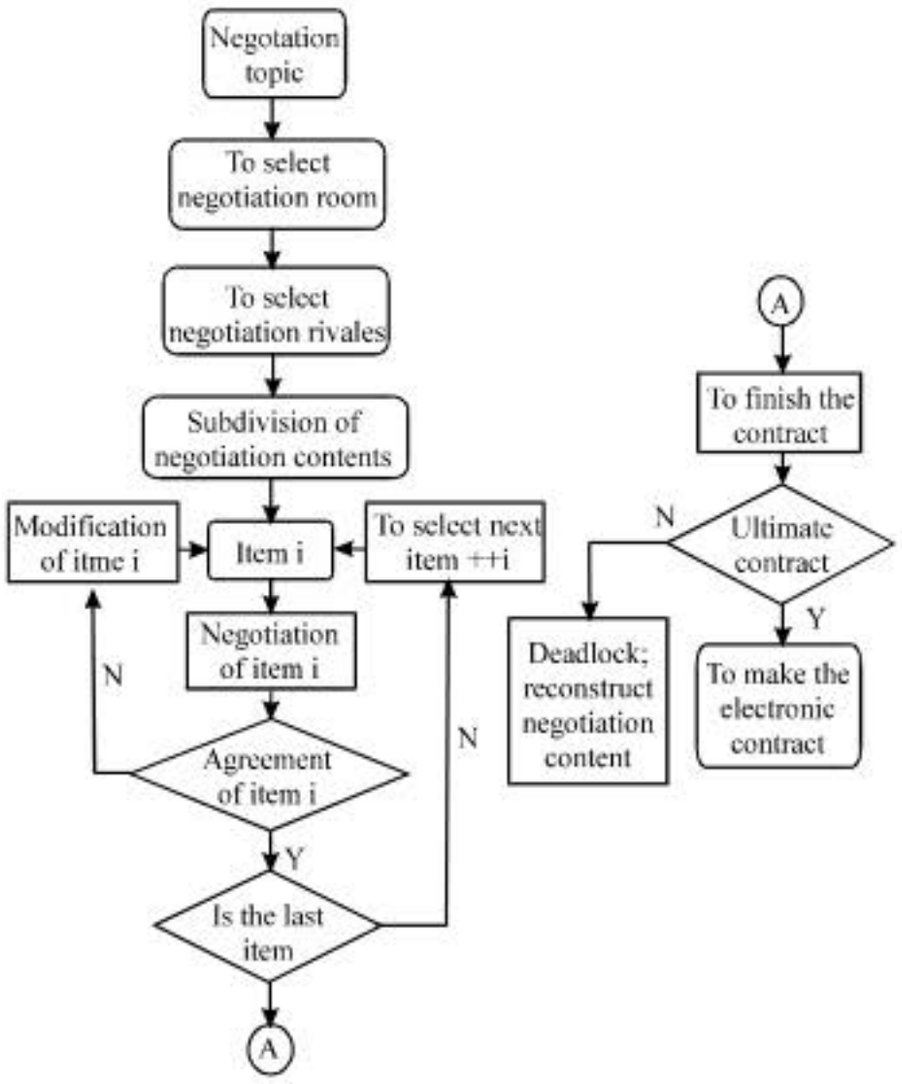

Fig. 1: The flow of the negotiate system

next section. According to the solution by Chiu *et al.* (2005), we have designed many negotiation contract templates based on negotiation topic for subdividing negotiation items. When the contract which includes many items is agreed ultimately, negotiators can put their digital signatures on this contract each other and finally send it to server for signing sever certificate so as to reach legal effect.

ANALYSIS OF IMPORTANT SYSTEM FUNCTION MODELS

This system mainly research on the designing of negotiation room, evaluation of negotiator's characteristics and procedure-driven-based negotiation supporting.

Designing of negotiation room: Negotiation rooms are classified into many types based on topic in order to help negotiators focus their target domain quickly. Each type of rooms has been labeled some keywords which are convenient for customers to search.

Each room is divided into two parts, one is grouped by supplier and the other is grouped by demanders. Either has many negotiation tables like some online game which is similar to www.ourgame.com, the interface of negotiation room are shown in Fig. 2. First-logged-on user can input some negotiation topics and keywords on table label to provide some information for viewer. Negotiators could select corresponding room based on their demands.

Fig. 2: The interface of negotiation room

For example, A is a buyer and need to purchase some printers. One approach: A can input some keywords (such as printer) in search engine to find all corresponding negotiation tables and then log in the selected table according to supplier's introduction on her/his table. The other approach: A can first select a certain type (printer belongs to Computer Accessories) and then click the link of printer listed under the type of computer accessories. Two approaches both can find corresponding negotiation rivals. Undoubtedly, selecting appropriate one in similar rivals also depends on some other factors, the important factor is the characteristic of rival. We propose a model to analyze negotiation process and compute the characteristics of negotiators.

Analysis of negotiation process and selection of rivals: The process of negotiation is often simplified as price negotiation (Wang *et al*., 2007). For each negotiation, buyer and supplier have each initial price B_0 and S_0. The bargaining is shown in Eq. 1.

$$\Delta = S_0 - B_0 \quad (1)$$

$P_B(k)$ and $P_S(k)$ are biddings in round k for buyer and supplier, respectively. Bargaining process is shown as Fig. 3. The equations of coordinate (x and y) are:

$$x_k = [\, P_B(k) - B_0 \,]/\Delta$$
$$y_k = [\, P_S(k) - B_0 \,]/\Delta \quad (2)$$

As shown in Fig. 3, the starting point of bargaining track is A(0, 1). Biddings of buyer and supplier based on coordinate are applied via the following equation:

$$P_B(k) = B_0 + x_{k\text{-}1}\Delta$$
$$P_S(k) = B_0 + y_{k\text{-}1}\Delta \quad (3)$$

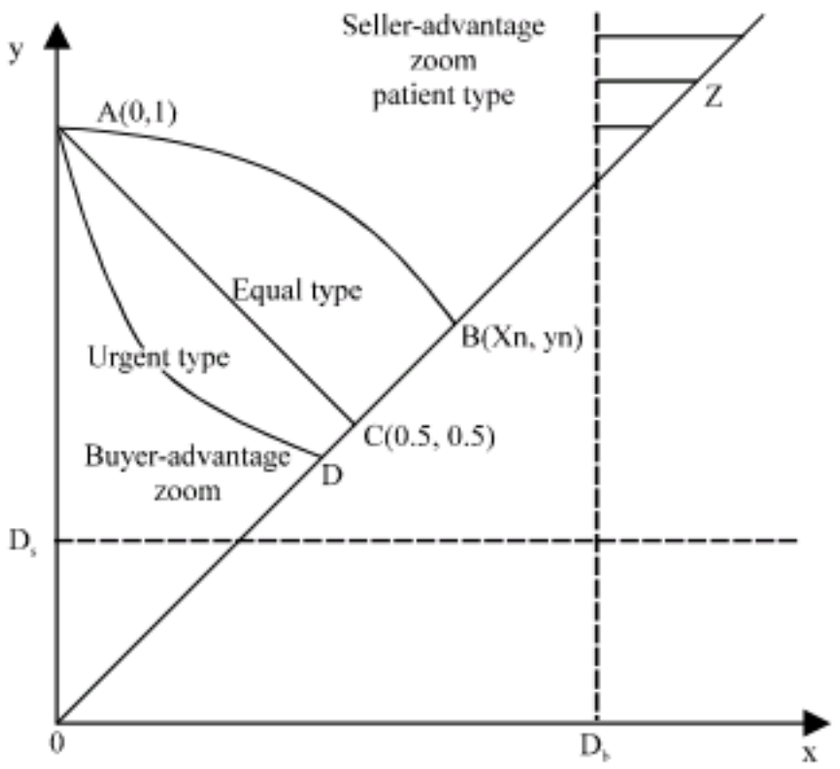

Fig. 3: The track chart of bilateral bargaining

Both agree with one price Z in round n after frequent bargaining, there is an Eq. 4:

$$Z = P_B(n) = P_S(n) \quad (4)$$

In first quadrant, bargaining track lines is intersected with bisector in B. From Eq. 2, it obviously reaches a conclusion of $x_n = y_n$ (Fig. 3).

As shown in Fig. 1, the multistage bargaining always starts with A(0,1), ends in the intersection with bisector OZ. Different negotiation processes have different track curves. If buyer and supplier both increase or reduce same price, the track curve ends in C(0.5, 0.5). For example, at the beginning of negotiation, buyer bids \$50 while supplier requires \$100. In the next bargaining round, buyer increase \$5 and supplier reduce \$5. Finally, both sides reach a target price \$75 after five rounds. The bargaining track curve is a straight line AC shown in Fig. 3. If the track curve is upper right of line AC, it indicates that buyer's rate of increasing the price is higher than the rate of supplier's reducing, so the region upper right of line AC is called seller-advantaged region and the region lower left of line AC is called buyer-advantaged region. Besides, buyer can calculate cost price of purchasing by using Eq. 2, which can be converted into coordination D_B. Negotiators must guarantee that the negotiation tracks don't come into the right domain of line $x = D_B$, i.e., the shadow in Fig. 3. Of course, sellers have their own minimum price shown as line $y = D_S$, however, the price of coordinate Ds often is a trade secret, so the borderline down can not be ensured for the buyer is kept from knowing it.

There are many factors to influence on the track curve of bargaining, such as target price, atmosphere, emotion factors and so on. The influence of important factor on negotiation lies in characteristic of negotiator. Negotiator of impetuousness often increases or reducing price quickly at first and insist on price unchanged after the price has reached his/her target. However, negotiator of patience often increases or reducing price slowly at first and readily agrees to the price of rival at the end of negotiation. Here, we present a function calculating the seller's response to buyer's bidding. The function is as follows:

$$y = f(x), x \in (0,1) \quad (5)$$

where, x and y are coordinate in negotiation track chart. If f(x) is a convex function, as curve AD in Fig. 3, the negotiator always belongs to the impetuous. Contrarily, if f(x) is concave function, as curve AB in Fig. 3, the negotiator always belongs to the patient.

This system can present a value-added service of knowing negotiation characteristic of rivals by studying their historical negotiation process. Through knowing the characteristic of rivals favorite type to negotiate can be well selected. The experiment in next section show it is can increase the success ratio.

Key technologies for procedure-driven-based negotiation: There are many technologies used in our system, some important technologies are detailed as follows.

Multiparty cooperation text technology: Real-time cooperation text editing system (like Grove (Ellis and Gibbs, 1989) and Reduce (Sun *et al*., 1998)) is a very important part during the applications of Computer Supported Cooperative Work (CSCW), it allows a group of cooperators from different places to edit shared files at the same time. This technology is used in our system for implementing negotiation of items of contract. It has characteristics such as (1) rapid response; (2) distribution; (3) high concur and (4) consistency. In order to reach rapid response, full-copy structure is frequently used to deal with shared files in cooperation editing system, which means copy shared files to every participator. This structure allows operations to be executed locally and then spread to other participators, the response time is very short. However, some problems maybe rise under this structure; arithmetic of concurrent control is needed to keep the consistency of files.

This system adopts mark method to realize MCTT (Wu and Gu, 2002), through marking the shared files, it will hide the changed part despite the former executions of many operations. This ensures the file under

operation which is exactly the same as the one before the operation works, to realize the maintenance of operation process.

Synchronization of audio and video stream: A system supporting audio and video communication is based on H.323 protocol. After collecting and encoding, audio and video data arrive the receiver through Internet and get stored to each play-buffer after decoding. The inter-stream synchronization is controlled by media synchronization between these buffers.

During a multimedia system, there are many media streams, the independent stream is named main-media stream; and during playing, those who depend on this stream are named sub-media stream. Main-media stream plays at a normal speed to keep synchronization, the sub-media stream may need to jump or pause. In multimedia communication system, considering our ear is relatively more sensitive to sound pause, repeats and playing rate adjustment, audio stream is usually regarded as the main-media stream and other streams including video are viewed as the sub-media stream, to realize the synchronization by adjusting playing time. As the main-media stream, audio adopts G.723.1 encode standard and the sub-media stream, video adopts H.263 encode standard. When the Internet is unobstructed, it can guarantee the video and audio stream to transfer with the settled rapid, the delay is basically fixed, the jitter is small and the space between audio and video in both sender and receiver keeps the same which means media data are almost integrated. When the Internet is blocked, the inter-media asynchronism may exist and some technologies must be taken to realize the synchronization. In this system, time stamp in RTP package head is used to solve this problem. The algorithm (the pseudocode is shown in Fig. 4) aims at optimizing and dealing with sub-media stream (mainly video data) comparing with the main-media stream. Tv: the time stamp of video frame arrived, Ta: the time stamp of audio frame now, Td: the tolerance of audio frame asynchronism.

```
VideoFrameArrived:          //video frame arrive
 Tv=getVideoFrameTime ();  //get the time stamp of video frame now
    if (Tv < Ta - Td)
       Video data package lag, so to drop;
       else if (Tv > Ta + Td) // ahead of time;
        {
      VideoFrameWaitNum + + ; //the number of pending package in
buffer plus 1
}
else
play(v);          // the audio and video are synchronous, play video
```

Fig. 4: The pseudocode of the amending algorithm

The process of audio stream is relatively simple, as soon as audio data arrive, the audio device plays them as well as system needs to check video data. If video frame is not null at same time, video data is played as mentioned earlier.

Electronic contract module: We have designed some templates of contract for online negotiation. Both negotiators can communicate with aforementioned technologies and modify items in template of contract at real time. When one side presents his modification of one item, he can modify its content directly and the modified content can be shown to other side instantly. At the same time, when one item is accepted by each other, either can lock it in order to prevent it from being modified.

After all items are negotiated successfully, the electronic contract can and must be made by both sides. The contracts of both sides must be sent to server to check identification, if there are no disagreements, both sides must attach their own digital signature and re-upload to server. At last, server side also attaches its digital signature in this contract, thus the electronic contract is actually completed. Both sides can download ultimate contract from server any time.

RESULTS

In order to verify the advantage of this system, we have developed a demo. We organize two classes of students to join the experiment of negotiation for the purpose of verification of system's availability and advantage, the topic of negotiation is printer purchase. Experiment was divided into two equal parts: buyers and sellers. At first, we provided a baseline program including basic negotiation assistance tools without viewing the characteristics of negotiators, the result of which showed the success ratio of negotiation is 68.7% and average negotiation round is 4.3. Secondly, we provided an updated program including all basic negotiation assistance tools as well as value-added service that can view the characteristic of negotiators, the result of which showed the success ratio of negotiation is 84.2% and average negotiation round is 2.6. This compared figure is shown in Fig. 5a and b. By comparing with these two results, it clearly showed the importance of learning the characteristics of rivals for success ratio and efficiency.

In the meantime researchers proposed a multi-party and multi-attribute NSS based on generic multi-party negotiation protocol. In his experiment, he called 106 students to be grouped into three teams before the beginning of formal negotiation and the topic of negotiation was similar. The result of experiment showed the average of negotiation round is 2.9 and the success ratio of negotiation achieves 79.8%. In comparison, our system has higher performance.

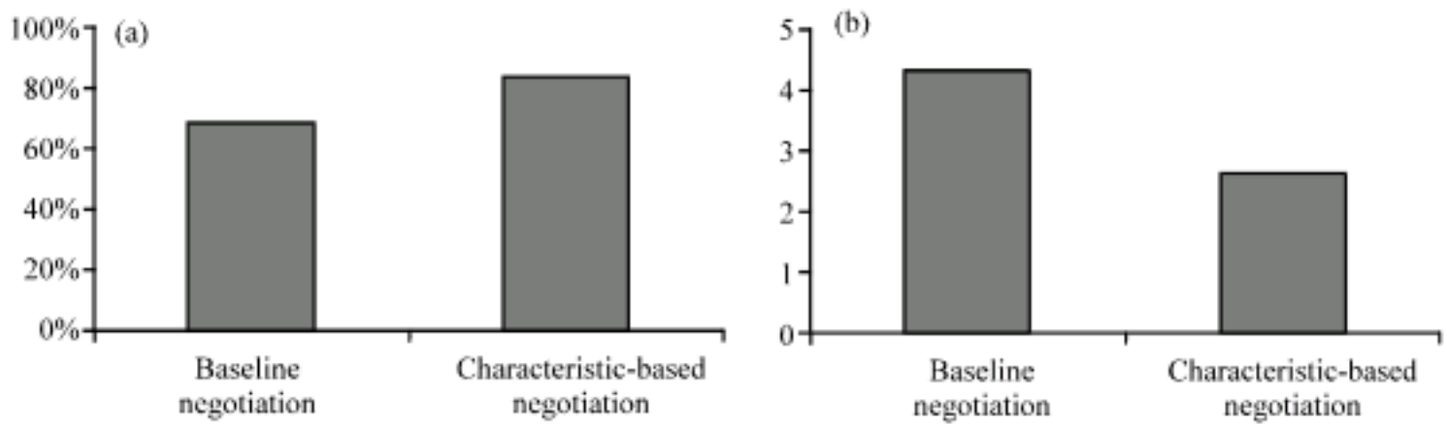

Fig. 5: Performance comparisons on (a) success ratio and (b) negotiation rounds

CONCLUSIONS

The main aim of this study was to analyze and prove the significance of characteristic of negotiators during the process of negotiation. This article presents important concepts of NSS, representative examples and some researches of NSS, at the same time, pointing out the disadvantages and bringing forward a new solution by introducing this system's structure and functions. Present study have been completed as (1) designed a negotiation room which is similar to online game room, such as www.ourgame.com; (2) implemented a model which can acquire characteristics of online negotiator by studying their historical negotiation information, which can increase the success ratio of negotiation and (3) designed some friendly applied programs to help negotiators have fluent real-time communication and sign electronic contract. By simulating experiment in intranet, good performance of this system has been demonstrated after a period of testing time. To some degree, it meets the real-time need of NSS and has some important significance in promoting the development of china e-commerce.

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