GROUP DECISION SUPPORT SYSTEM BASED ON INTERNET

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ABSTRACT

In designing and implementing the Group Decision Support System (GDSS) Based on Internet, many issues should be considered such as information process, communion and cooperation, heterogeneous data transformation, intelligent management, information security, system topology, distributed model base and distributed database, partition of database and model base, system architecture, system extensibility and many other issues. Many of these issues are the hot spots in GDSS research. By now, there has not been a set of mature and systematic theories about GDSS, especially in data distributed in network environment, synthesizing evaluation of group decision-making, modeling online and model management. Therefore, it has much academic interest and important practical significance to go a step further on the research of GDSS. This paper briefly described the group decision procedure which includes defining decision task, selecting decision-making experts, delivering decision task, organizing expert workshop, meta-synthesis on decision-making schemes, etc. And then takes a closer look at some of the issues mentioned above. This paper puts forward the system architecture for GDSS based on Internet, and debates about the delivery of client subsystem, the dispensation of decision sub-task, the organization of expert workshop, and their implementation techniques. This paper also puts forward a great variety of synthesizing evaluation algorithms that can effectively support the organizer of the decision-making in analyzing the decision-making results collected from all the participated experts, and presents the mathematical description of the preference probabilities algorithm.

Keywords: GDSS based on Internet, the organization of expert workshop, synthesizing evaluation Algorithms, preference probabilities, System Architecture of GDSS, Group Decision Procedure

INTRODUCTION

Group decision-making is an activity having something to do with many factitious factors and individual preferences. Traditional methods of holding this kind of activity include face-to-face conference, conference call, electronic conference, etc. The Group Decision Support System (GDSS) based on Internet mentioned here applies Internet technology to group decision support system. It runs on existing Internet on various places and supports the group decision procedure via man-machine interaction.

GDSS based on Internet has the basic character of distribution, which leads to the following considerations.

1. System topology design. How should the computer network be structured? How many servers should be in the system? What type of computer should be at each server? How should the servers be linked together?
2. The partition of the database and model base. The basic components of this system are the distributed model base and the distributed database, which implement the share in existing models and data among distributed users. How should portions of the database and model base be allocated to the servers? Should a copy of the entire database or model base reside at each server? If not, how do we decide which portion of the database or model base to store at each server?
3. The distribution of data and models should be transparent to the decision-making expert. That is, the decision-making expert should be able to carry on his decision-making as if the referenced data were stored in a single database and the referenced models were store in a single model base. Furthermore, the system should determine how best to retrieve the data or model from remote servers when necessary.
4. System architecture design. Traditional GDSS in a local area network (LAN) usually adopts the client/server model. However, when it comes to the Internet, there are many additional problems should be considered. For example, it is unpractical to let all users use the same platform for the distribution of information process and the magnanimity and multiplicity of information, so the problem is how to improve the compatibility of the system.
5. System extensibility. In this system, we use object-oriented technology and visual programming to make the design of the client sub-system more flexible so that the decision-making expert can customize the client sub-system according to his own demands, which means he can define new models using the easy programming language provided by the system, that is, modeling online. Furthermore, the system also provides an end-user interface specially designed for those decision-making experts who are not familiar with computer technology. In this way, all selected experts living in various places can take part in the decision-making process without going to the real site. They can feedback the result without lost of time and get the support of various models and numerical calculation in a short time.
6. Organization and implementation of expert workshop. The organization and implementation of expert workshop is one of the most important things associated with the GDSS based on Internet. The system provides several common workshop styles such as electronic meeting, electronic Brain Storm, electronic Delphi, etc.
7. Synthesizing evaluation algorithms. The synthesizing evaluation of decision projects is the most important phase in the group decision procedure. The system provides some synthesizing evaluation algorithms that can effectively support the organizer of the decision-making in analyzing the decision-making results collected from all the participated experts by synthesis and finding out the optimal option.
8. Management of distributed model base. In the distributed model base, the developer of a model takes charge of the maintenance and management of the model and shares it with other experts in various places. Three strategies for managing the model base based on Internet are provided in this system, which are centralized management, independent distributed management and joint distributed management (1).
Of course, there are so many other issues should be taken into consideration that we can't list them here.
The group decision procedure is composed of several phases including confirming tasks, selecting experts, drawing up projects, dispensing tasks, organizing expert workshop, expert

decision-making and synthesizing evaluation. Each of these phases can be seen as a sub decision. The group decision procedure mainly concerns the decision-making organizer and the participated decision-making experts. For example, during the drawing up projects phase, the participators generate several projects for selection through studying and discussing. The first four phases mean the issuance and receiving of the decision-making tasks and the decision-making results to the organizer and the decision-making experts. Through the interaction with the organizer, an expert submits his suggestion of the decision-making task. The organizer synthesizes all the suggestions from distributed experts, delivers the tasks for each expert and broadcasts the accessing path. Using the given path, participated experts can acquire his sub decision-making task and the description about the decision-making if he needs. Then the expert on each client can request for corresponding models and knowledge according to the problem to be resolved, generate preselected project and submit it and its description to the organizer or provide it for other experts if being allowed. When all the experts submit their projects, the organizer selects a synthesizing evaluation algorithm to judge whether the description of a project is sufficient and decide whether it is necessary to discuss the synthesized project(s) again. In this way, the efficiency and effectiveness of group decision-making can be greatly improved. In this paper, for the space limitations, we only put forward the system architecture for GDSS based on Internet and debate about some issues associated with the group decision procedure. As to other issues, we will talk about them in detail in other subsequent papers.

System Architecture of the System

GDSS based on Internet adopts Internet standard protocols and chooses Web model as standard platform. Here the Web model is the Browser/Server model, simply called B/S model. The B/S model is an effective way to solve the isomerism problem by performing information share among different platforms. The system makes use of the B/S technology so that it is easier to integrate with other open systems. Group Decision Support System (GDSS) based on Internet can be divided into two subsystems logically, the server subsystem and the client subsystem (2). As shown in **Figure 1**, the server subsystem includes real system, external environment, global control subsystem and managerial staff. The managerial staff is the organizer of this decision-making, who helps to ensure the group decision-making procedure is going on wheel, provides assistance to experts when necessary, analyzes and judges all the submitted decision results to find out the final option. Global control subsystem manages the limits of authorities of all the participators, provides reliable information transfer between client and server or among clients through a suit of communication protocols. The client subsystem includes local decision support system, decision-making expert, external environment and communication subsystem. As the kernel of the client subsystem, the decision-making expert uses his own knowledge and experience and the processing function offered by the client subsystem and the server subsystem to make decision on a task or sub-task that the group decision support system based on Internet assigns to him. After making a decision, the expert can directly send his answer to the server through Internet.

Delivering Client Subsystem and Dispending Decision Sub-task

Decision-making organizers look for the experts of the related fields on Internet and select appropriate experts. They may send E-mails to the experts having been selected and invite them

to join in the decision-making. When receiving confirming letters from the experts, they will send the content of the GDSS based on Internet by E-mail, such as the IP address, the enrolling number, password, the activity regulations, the schedule and so on.
The experts joining in the decision-making may login the server from any computer connected to Internet with the given enrolling number and password by inputting the IP address in the address bar of the browsers.

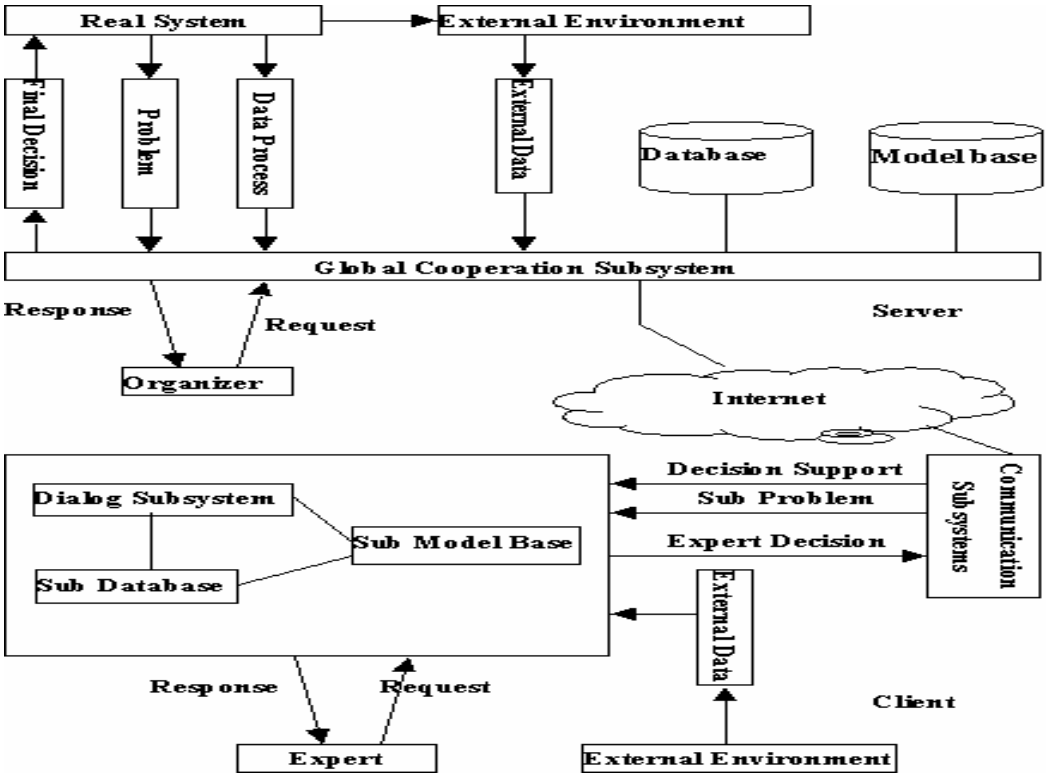

Figure 1 The System Architecture of GDSS

(1) The users who login for the first time should download the client subsystem, which includes communication system, user interface, model management system, database management system and knowledge management system. Here users can download the client system either by HTTP or by FTP.
(2) Client subsystem is a DSS having the functions of an expert system. Decision-makers can download models, database, knowledge from the server according to their own needs, and then customize relevant DSS. Here the customization of the client subsystem is to download different macroeconomic models, computing programs of the models, arithmetic and programs of parameter estimation, help information of using models, etc. The decision-maker on the client then use the things he downloads to customize his DSS. The model base, database and knowledge base are often updated. The client user can update his DSS when necessary. He may choose either way from the following. One is opening the Internet Explorer, typing in the IP address of the server, and downloading directly. The other is the user can link to Internet from the client application. This is implemented by using an ActiveX control named Microsoft Internet Transfer Control in the client subsystem. This control supports two widely used Internet protocols, HTTP and FTP. Using the OpenURL method or Execute method of the control, user can link to any place on the Internet. For example,

Itc1.OpenURL url here Itc1 is the name of the Microsoft Internet Control , url is the server address

(3) The client subsystem can help user to quantify some qualitative targets through interacting with the user. This fulfils the demand of the quantitative model, and avoids irrationality of entirely subjective quantity on some degree. There are two ways to quantification, one is using the expert system, the other is negotiating with server or decision-making organizer.

Organizing and Implementing Experts Workshop

First the server sub-system dispends the decision problem to client users and lists all the workshop opinions, and then the workshop begin. During this phase, the server sub-system returns correlative information when receiving request from client users. After interacting with the server subsystem for many sections, each client user makes out his decision independently and submits his preselected projects to the server sub-system. When getting all the projects from the involved experts, the server sub-system will process and analyze the projects to get the final conclusion and send it back to experts. Both client sub-system and server sub-system have the functions of DSS, but for the reason of spatio-temporal efficiency, the client sub-system cannot be too large and can only implement limited functions. Most models, data and rules are stored on the server, so the server sub-system is much larger than the client sub-system and the client sub-system is just a subset of the server sub-system.

The workshop phase is divided into five or six sections during which the system should be able to create conditions to promote participated experts making decision freely.

1. In the first section, the workshop opinion list sent to the participated experts simply lists out all the initial workshop topics without any preference. The organizer collects, arranges and merges homogenous feedback opinions received from experts, presents a topic schedule with accurate terms and then send it to all the experts for the second section.
2. In the second section, participated experts evaluate all the topics in the workshop opinion list, and explicate their reasons. The organizer sorts out all the expert feedback opinions.
3. According to the statistical data collected from above, the participated experts are organized to study and discuss the list in detail. But some times only those experts whose opinions are heterodox are asked to state their reasons, because these opinions are often some external factors ignored by other participated experts or some problems never discussed. These heterodox opinions usually have some effect on others.
4. According to the requirement of the organizer, some participated experts maybe remake their argumentation based on the third workshop opinion list,
5. After discussing for five or six sections, the opinions of all the participated experts begin to show no difference.

After making a decision, the client user links to Internet by clicking a button on the client application and sends the result to the server (shown in **Figure 2**). This is implemented by using the Execute method of the Microsoft Internet Transfer control (here Inet1 is the name of the control).

Inet1.Execute url, operation, data

url is the URL address of the server; Operation is a string specifying the operation type, the available value is determined by the protocol it used. If it uses HTTP, here we can specify it as Post that is used to transfer data to the server, the data is specified in the parameter data. If it uses

FTP, we can specify it as "PUT file1 file2" which is used to copy a file named file1 on the local machine to the server and be renamed as file2.

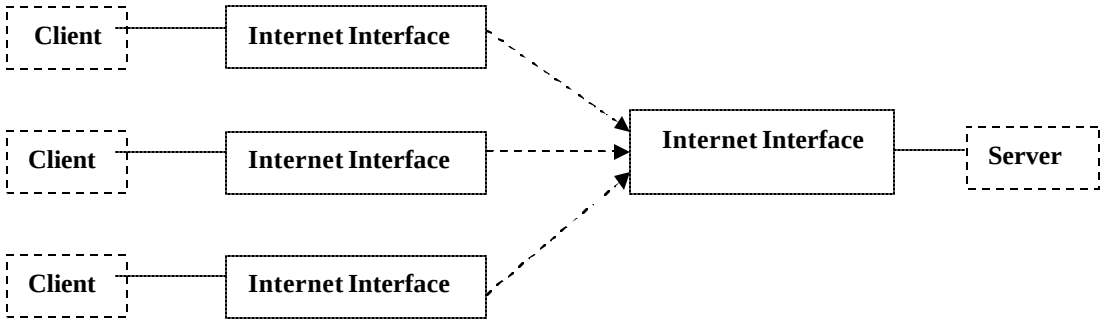

Figure 2 The Interactive Process between Client and Server

Synthesizing and Evaluating the Results of Participators

When the sever sub-system received the decision-making results from client systems, the global control subsystem synthesizes, estimates and integrates these results with the given meta-synthetic algorithm selected by the organizer and finally comes out a synthetic conclusion. The global control subsystem adopts several synthesizing evaluation algorithms, such as uniform affirmation or uniform negation, the minority being subordinate to the majority, averaging on given marks, giving marks on different weight (different expert has different weight), the minority being subordinate to the majority on different weight (in this way, a vote with stronger weight maybe overmatch the sum of several votes), rejection by one vote, affirmation by one vote (adopted in the examination of national natural scientific foundation), preference probability, etc. In this paper, we just give an algorithm description of the preference probability for space limitations.

When the workshop is about some forecasting problems, participated experts can adopt preference probability. Probability mentioned in general probability theory is calculated according to the objectivity of event. However the preference probability is an estimator of the happening possibility of future event given by participated expert, which has something to do with the experience and preference of the expert.

The preference probability should satisfy the basic constraint condition of probability theory,

$$0 \le x_i \le 1 \qquad (1\text{-}1)$$

x_i (i=1, 2, …, n) is the estimator of the possibility of future event given by the ith expert.

p_i is the frequency of event x_i. We can represent the synthesizing opinion of a group of experts by adopting preference probability as

$$E(x) = \sum_{i=1}^{n} x_i p_i \qquad (1\text{-}2)$$

$E(x)$ is the mathematical expectation for the possibilities of future event given by these experts. However, this mathematical expectation maybe not able to apropos reflect the overall opinion sometimes. For example, TABLE 1 shows the preference probabilities of a certain event.

TABLE 1 The Preference Probabilities

Preference Probability x_i	0.7	0.1	0.2	0.3
Possibility of x_i p_i	7/10	1/10	1/10	1/10

The overall opinion of the ten participated experts is $E(x) = 0.55$ according to equation (1-2). But in fact, none of these preference probabilities is 0.55. Therefore, the authors consider that this value is not accurate. If there is no much difference among the bygone accuracies of these experts, we should choose the value 0.7 as the overall opinion because most of the experts choose it. If some of these experts have much more accuracy than others, their weight can be increased. Thus we can rewrite equation (1-2) in the following form.

$$E(x) = \frac{1}{n}\sum_{i=1}^{n} w_i x_i p_i \qquad (1\text{-}3)$$

w_i is the accuracy weight of the ith expert, which satisfies the condition $\sum_{i=1}^{n} w_i = n$.

After participated experts upload their workshop opinions, that is, their preselected projects, the organizer will make the final decision quickly and then broadcast the final decision in the form of HTTP documents and listen to the feedback suggestions from the team of experts joining in the decision-making to prevent the seriously careless mistake or wrong strategic decisions during the process of decision-making. If these experts have no strong adverse opinions or sufficient adverse reasons, the broadcasted final decision can be regarded as the final project, otherwise the workgroup should carry on the workshop for another time (3).

CONCLUSION

The Group Decision Support System based on Internet applies Internet technology and information technology to group decision support system. Thus it can overcome the limitations of traditional electrical meeting or group decision support system based on LAN, and realize truly meta-synthesis of expert intelligence in various places.

REFERENCES

l. Duo Liu, Huizhang Shen, Jidi Zhao, A Distributed Group Decision Support System for Macroeconomics, Proceedings of the Sixth International Conference for Young Computer Scientist

2. Huizhang Shen, Jidi Zhao, A Group Decision Support System of Distributed Macroeconomics, 2001, Proceedings of 2001 International Conference on Management Science & Engineering, Moscow, HIT Press

3. Huizhang Shen, A Modeling and Decision Making Based on Evolution, 2000, Journal of Systems Science and Systems Engineering, Vol. 9 No.3