A problem solving framework for group decision support system

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Abstract: A new problem solving framework for group decision support system using layer model approach is proposed. This kind of framework includes four basic layers, namely, application layer, task layer, logical layer and physical layer. Based on indicating the respective meanings of those layers a task skeleton of group decision support system and a logical structure of group decision support system generator are put forward and discussed in detail. The framework provides theoretical guidance for developing group decision support system to lower systematic development complexity and support reuse of software.

Key words: group decision support system; layer model approach; group decision support system generator

1 INTRODUCTION

The present group decision support system (GDSS) development is generally based on Sprague’s three-components model which consists of a data management subsystem (DMS), a model management subsystem (MMS), and a dialog subsystem (DiaS) [11]. But Sprague’s model is only to define decision support system (DSS) from the point of view of function, but not to demonstrate the whole process of DSS development. With advanced decision support technologies evolution, Sprague’s model becomes more and more unadaptable to the development of GDSS and it induces GDSS development to get into the state of mixing technologies inevitably and increases the complexity of GDSS development.

Layer model approach (LMA) proposed by Yasuhiko Takahara and Chen Xiaohong in 1999 [2], which has been successfully used in a number of DSS development experiences, is a comprehensive model of a DSS from hardware level to a problem formulation level and is conceived for dealing with every aspect of a problem solution for a DSS. Moreover, one of the aims of constructing LMA is problem solving, which attaches importance to problem expression and emphasizes going hand-in-hand between machine and human. This is in agreement with the view that systematic design is required to change from oriented model to oriented problem because the current decision problems are full of complexity and non-linearity [3-5]. So, the authors attempt to incorporate LMA into the GDSS development to form a new problem solving framework for GDSS.

2 LAYER MODEL OF GDSS

According to LMA, GDSS is delaminated into four basic levels, application layer, task layer, logical layer and physical layer.

2.1 Concept of application layer

Application layer is concerned with a functional formulation of a decision making problem or of a GSP (goal seeking problem) in the cybernetic paradigm [2]. The concept of GSP is well-known in GST (general system theory). Given a context, GSP is defined by the following three relationships:

\[ P : M \times U \rightarrow Y, \text{ image mapping; } \]
\[ G : M \times Y \times U \rightarrow V, \text{ assessment mapping; } \]
\[ C : U \rightarrow \delta(M), \text{ constraint relationship } \]

where \( M \) represents set of alternative decisions;
2.4 Concept of physical Layer

Physical layer provides tools for physical realization of logical layer. Necessary tools of hard
ware and soft ware are hierarchically arranged on
this layer. Symbolically, it is expressed as:
physical layer = < < hardware > , < basic
software > , < ware hierarchy > > .

3 TASK SKELETON MODEL: MAPPING OF
GSP

Task skeleton of GDSS is composed of four
levels: problem solving layer, adaptive layer, or-
organizing layer (user layer) and coordination layer
(see Fig. 1). The former two layers provide clas-
sical DSS support primarily, while coordination
layer provides GDSS support. A model implemen-
ted on a computer following the skeleton is called
“task”. In general, a GDSS always includes sev-
eral sub-DSSs, which constitute relatively inde-
pendent and interconnected decision-making units.
Moreover, every decision-making unit also in-
cludes a series of sub-decision-making units, that
is, subunits. Each subunit corresponds to a cer-
tain pattern of problem solving process.

3.1 Problem solving layer

Let a GSP be $GSP = \{ M, U, Y, P, G, C \}$
according to the definition of GSP.

The function of this layer is to find a solution
(decision) under the condition that a predicted
uncertainty element is given, i.e., $u^* \in U$,
which is selected by the higher control layers such
as adaptive layer or organizing layer. We refer to
the decision problem for the problem solver with a
given $u^*$ as a particularized decision problem.
That is,

$$PP(u^*) = \{ M, \{ u^* \}, g, C \}$$

where $g$ is the composition of $P$ and $G$, i.e.,

$$g : M \times \{ u^* \} \rightarrow \text{Re}$$

where $Re$ is the set of reals, such that:

$$g(m, u^*) = G(m, u^*, P(m, u^*))$$

Then, the task of the problem solving layer is giv-
en by: Given $u^* \in U$, find $m^* \in C(u^*)$ which
is optimal for $PP(u^*)$. 