December 1993

A Problem-Solving Framework for IS Resources Management

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Abstract

With increasing use of computers in the operations and activities of almost all types of business organizations, major component of support service costs of any type of business is the information systems (IS) management cost. IS management involves management of physical IS resources such as hardware and software, and the more expensive human resources. Human expertise is required at several levels in rational allocation and dynamic reallocation of the available IS resources in order to optimise their utilisation. Computing environments are similar for different applications with similar business activities. Author visualizes that similar resource requirements by different applications within a business environment - from one or many organization(s) - could be supported by a shareable support service centre. This paper attempts to look into the issues involved in the IS resource management and proposes a strategy based on effective integration and communication, using a blackboard architecture. Suitability of the proposed architecture is discussed. Each application/user/organisation operates independently and asynchronously. It is proposed to resolve conflicting demands on resources opportunistically, based on pre-defined protocols. Proposed architecture alleviates the necessity of hiring/ maintaining expertise on the hardware and software management of computer and communication systems, for each user / organisation. This expertise is independent of the application domain and can be hired/maintained at one location such as the support service centre ie. at the central panel.

Introduction

With increasing use of computers in the operations and activities of almost all types of business organizations, major component of support service costs of any type of business is the information systems (IS) management cost. This cost depends on the extent of use of computers, complexity and topology of the information systems and the nature of the business of the organization. For example, in the service sector, such as banking, consultancy, etc., most of the support service cost is the IS management cost.

Computer-based information systems management involves management of physical IS resources such as hardware and software, and the more expensive human resources. Human expertise is required at several levels in rational allocation and dynamic reallocation of the available IS resources in order to optimise their utilisation. In many situations, particularly in the case of distributed resource environment, it is observed that required resource - physical or human - for one application and/or location at a given instant may often be available for use in some other application and/or location within the same business environment. Dynamic reallocation of available IS resources is a solution to this problem. With the increasing investments in IS development and management, effective IS resource utilisation is imperative to cost-effective business operations.

From the information systems point of view, computing environment is similar, if not same, for different organizations in the same business sector. For example, most of the computing environments and applications are similar for all banks. In such a situation, it seems ineffective to hire and/or maintain different sets of experts to maintain individual information systems ie. applications, system and communication software, and computer and communication hardware by each individual bank. Particularly, in light of the giant strides made in the field of computer communications, geographical distribution/division of business activities is not any more the economic and/or logistic impediment, as it was earlier, to provide a shared support service.

Author visualizes that similar resource requirements by different applications within a business organization or by different applications from different organizations within a business sector could be supported by a shareable support service centre. The choice of the applications to be supported by and the resources to be shared in the support service centre is left to the respective business strategies of the participants. However, such a move means increasing complexity of information systems.

In the proposed situation, an effective framework is required to communicate the status of resources and impending urgencies or lulls of activities amongst the various applications and/or locations. This paper attempts to look into the issues involved in the IS resource management and proposes a strategy based on effective integration and communication using a blackboard model.

Issues in IS Resource Management

Multiple Knowledge Sources

Many specialised kinds of knowledge are required in IS

resource management. These knowledge sources can be represented in a hierarchical structure as shown in Diagram 1.

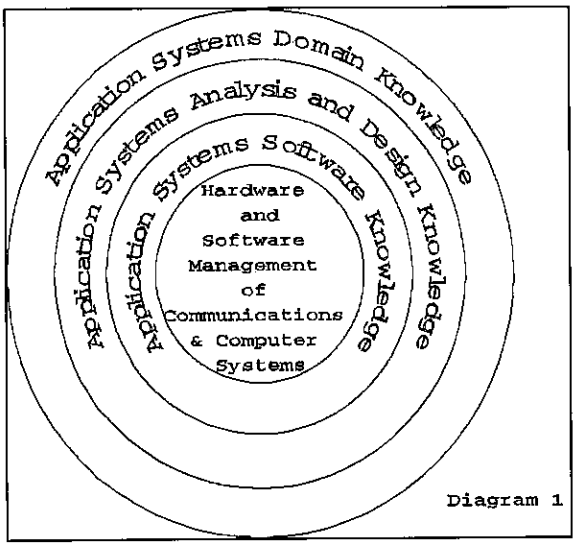

Diagram 1

Application Domain

Subject area specialists are the resource persons in this layer, representing the knowledge and experience in the application domain for which the IS has been developed. Application domain expert may be, as in most cases is, a novice in IS related areas. The expert's decisions are totally based on the domain environment, and are independent of the criteria for IS effectiveness, but affecting the IS.

Application Software

This layer of expertise is the interface between the application system and underlying systems software. This knowledge includes the application systems analysis and design, data structures, user interface design, etc.

Systems Software

This layer includes knowledge of Operating Systems, Data Base Management Systems, Graphics software, Office Automation software, etc.

Communication Software

Various application system protocols, network configuration, inter-networking, communication-media management, etc. form the knowledge base required in this area.

Hardware

Knowledge about availability, compatibility, and reconfigurability of hardware - computer and communication - at different locations and about the hardware requirements, allowable configurations and memory-based design tuning trade-offs of different applications are vital in the exercise.

Data Fusion

Effective decision-making in the resource allocation calls for the integration of disparate information as observed or collected or provided by the multiple experts. For example, a disk failure at one of the locations, triggers a pre-planned contingency operation depending on the type of processes - batch or on-line or real-time, the disk supports. However, an input from one of the application domain experts may temporarily effect the type of the processes concerned or change their priorities, leading to possibilities of more beneficial reallocation of resources.

Framework for IS Resource Management Problem

The problem is looked at as defined here. A set of applications/ users/ organisations have several computer and communication hardware sites running different mix of systems software and application software packages. The application information systems may be cooperative or non-cooperative; they may be from within one organisation or from different organisations with similar application domains or from organisations with different application domains. There are several experts giving their inputs and/or taking decisions in the application domains, application systems analysis and design, and in hardware and software management of the computer and communication systems. The set of applications/ users/ organisations need a framework to minimise the support service costs, particularly in the area of hardware and software management of computer and communication systems.

Problem-Solving Approach

A problem-solving model is a scheme for organizing reasoning steps and domain knowledge to construct a solution to a problem; in other words, it provides a conceptual framework for organizing knowledge and a strategy for applying that knowledge. In an opportunistic-reasoning model, pieces of knowledge are applied either backward or forward at the most 'opportune' time. Blackboard model uses opportunistic-reasoning for problem-solving. The model is discussed in detail by several authors (Nii H.P. 1986, Hayes-Roth B. 1985, Hayes-Roth B. et al. 1986). However, the following paragraph from Engelmore R.S., Morgan A.J. and Nii H.P. 1988, gives a brief account of the model.

In the blackboard model, the solution space is organised into one or more application-dependent hierarchies. The hierarchy may be an abstraction hierarchy, a part-of hierarchy, or any other type of hierarchy appropriate for solving the problem. .... The domain knowledge is partitioned into independent modules of knowledge that transform information on one level, possibly using information at other levels, of the hierarchy into information at the same or other levels.....Opportunistic reasoning is applied within this overall organization of the solution space and the task-specific knowledge; that is, which module of knowledge to apply is determined dynamically, one step at a time, resulting in incremental generation of partial solutions. (Engelmore R.S., Morgan A.J. and Nii H.P., 1988)

Proposed Architecture

A multi-panel dispersed blackboard architecture is proposed for the problem, as shown in Diagram 2. Two levels of blackboard panels are proposed - local panels for each application domain and a central panel for global hardware and software management. A panel can be described as large computer notice board where the data and knowledge are stored and retrieved by multiple users/experts independently and asynchronously. Each panel will have its own control knowledge to maintain the consistency of the data and knowledge bases and also to manage concurrent processing. Systems data is to be partitioned according to the local needs. Even the central panel does not need entire data; for example, data on local application systems design is not required at the central panel.

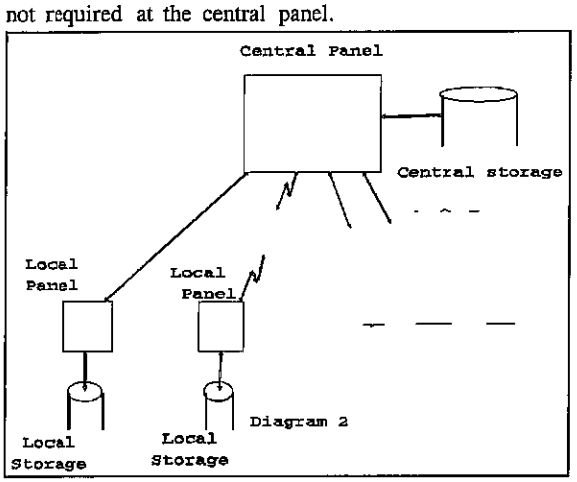

Diagram 2

Experts of the local domain, local application systems analysis and design, and local application software interact with respective local panels. Local panels, on assessing the local demand for processing, storage and other resources, send their requirements to the central panel. Central panel receives the competing demands on resources and takes opportunistic decisions on resource allocation and reallocation. Experts on hardware and software management interact with the central panel and contribute expert inputs as and when required. The decisions taken at the central panel are reflected on the local panels, which in turn, can trigger a sequence of decisions at the local panel.

Suitability of Blackboard Model for IS Resource Management

Modularity

The IS resource management problem architecture is inherently modular (knowledge sources and control structures). Blackboard model is suitable in such situation and also makes design, testing and maintenance of the system easier.

Integration of disparate information

A hierarchy of control structures facilitate effective data fusion. A multi-panel blackboard model can capture such an application environment. The data fusion issues of the IS resource management problem are typically characterized by multi-expert environment. Hence, the data fusion facilities provided by a hierarchical blackboard architecture can meet the data fusion requirements of the problem.

Opportunistic Decision-making

The problem is characterised by continuous data gathering. Solutions are to be built incrementally and opportunistically. In blackboard model, there is always a current-best hypothesis. Such a model is particularly appropriate for continuous data problems.

Efficiency

In the IS resource management problem, using production rules to model the knowledge base may not be appropriate due to the fact that the focus of attention has to be assessed dynamically for different system states. Production system approach can not take advantage of selecting the most beneficial and applicable knowledge depending on the focus of attention. Blackboard model provides more efficient solutions in such an environment.

Conclusions

Proposed architecture alleviates the necessity of hiring/ maintaining expertise on the hardware and software management of computer and communication systems, for each user / organisation. This expertise is independent of the application domain and can be hired/maintained at one location such as the support service centre ie. at the central panel in the proposed model.

Acknowledgements

Work for this paper was conducted under the on-going project 'Blackboard Model for a Resource Allocation Problem in a selected area of application' funded by City Polytechnic of Hongkong Indicated/Block Research Grant No. 700-113.

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