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ＬＡＮ環境に適したサービスベース システムの構成と実装

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サービスベースシステム（ＳＢＳ）は、ユーザに便利、有効な分散環境を提供することを目的とする。既存の計算機の機能、計算機で蓄えられたデータやプログラムを組み合わせて、容易に新しい機能をユーザに提供することができるのが、ＳＢＳの特徴である。本稿では、特にＬＡＮ環境に適したＳＢＳのモデルと実験システムについて述べる。ＬＡＮの特徴を生かすために、ＬＡＮ環境ではＳＢＳは集中管理モデルを採用した。本稿では、Ｔｒｅｅ形式のサービス記述方法、サービス・ライブラリも提案した。分散サービス管理モデルとの比較及び実験スシテムの結果によって、この集中管理モデルはＬＡＮ環境に適していることを示した。

Modeling and Implementation of Service Base System for Local Area Networks

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Abstract

The main objective of service base system (SBS) emphasizes on providing an efficient and convenient environment for users to use distributed resources. The ability of combining existing functions and data in computers into new services is the main characteristic of SBS. This paper proposes a method to construct a SBS in a local area network environment. To utilize the high speed and other characteristics of local area network environments, a centralized service management model is adopted. This paper also proposes a tree representation method to describe services. A SBS library which is used for application program to make service call is also presented in this paper. Through the implementation of this centralized service management model and the comparison between this model and the distributed service management model, it can be concluded that the centralized service management model is suitable for local area network environments.

1 Introduction

With the development in network technologies, resources sharing becomes available and practical. Resently, workstations evolve from time-sharing systems, letting users continue to share files without sharing a single CPU. Developments in this kind of hardware have steadly increased the amount of computing resources available to an individual user. Data and programs stored in computers are also increased rapidly resulting from the information requirements of the society. To manage distributed resources, many distributed systems (e.g. distributed operating systems and distributed data base systems) have been designed.

On the other hands, from the user's point of view, how to use these numerous resources is important. It is necessary to provide users with an efficient and convenient environment to use these distributed resources. Until now, there are few researches which have been done in this area. Service base system (SBS) provides one approach in this area.

Service base system can be constructed on a wide area network environment or a local area network environment. This paper mainly considers how to construct service base system on a local area network environment. First, we overview the objectives and main concepts of SBS. Next, a centralized management model and experimental system which are suitable for local area network environments are presented. Finally, we make a comparison between this centralized management model and the distributed management model.

2 Objectives and Main Concepts of Service Base System (SBS)

The main objective of service base system emphasizes on providing an efficient and convenient environment for users to use distributed resources.

The purposes of service base system are:

1. User can use or combine the utilities and applications supplied by each computer in a network without worrying their distributions.

2. Each computer in a network can extend its utilities and applications independent of other computers.

The emphasis in SBS is on services which are utilities or applications. Basing on the service request model, SBS allows any machine in the networks to offer and use services. The environment for SBS consists of a set of nodes connected on a network. Each of the nodes can be seen as a service base and offers services that can be used by other nodes. Each node provides the usual local OS environment, plus access to services.

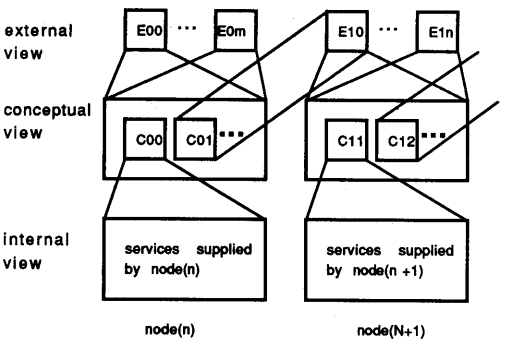

Figure 1: The Three Layered Views

services Utilities and applications which are provided by computer for users are called services. Text processing, data base, and printing facilities are all examples of possible services. A service can be some combinations of functions and data, thus resources SBS have to manage are divided into three classes: data, functions and services.

Three Layered Views in SBS We suppose each node in SBS has the information about services it can use or supply to other nodes. When a service request from user or other nodes comes to the computer, basing on these information, the computer will supply services or invoke a further request to other nodes. In each computer, the information about services are divided into three levels:

- *Internal view*: The internal view is the view that a computer supplies services locally. It is the sets of descriptions about the services which exist in local node.

- *Conceptual view*: It unifies the internal view and external view and absorbs the distribution of services.

- *External view* : It is the descriptions about the services which are offered to front nodes or users.

Fig. 1 shows these three layered views. In this way, the conceptual view of a computer is made of internal view of itself and external view of back nodes. In a back node, it is also divided into three layered views, its external view describes all services which can be used through this node. These mean that each node only has to know the information of itself and its back nodes.

Service Description Before a service can be used in the network, the service must be described in advance. SBS provides functions to create, modify, or remove these service descriptions.

we discussed what kinds of information are necessary to describe a service. Take a file as an example. The information about a file may contain its name, the location it locates in, and its data format, etc. These information are necessary when a file is accessed by computer. Users however, may concern about the contents of the file, such as whether it is the experiment data or text of a paper. In this way, two kinds of information can be classified: one for computer and one for user. We call the first one directory, and the second one dictionary. A directory is used for computers to manage the services. A Dictionary is used for user to search the services he wants. Directory and dictionary contain many attributes. To describe a service is to define these attributes and describe the relationship of these attributes.

3 A Model of SBS for Local Area Networks (LANs)

With the development of LANs in recent years, The linking of workstations by a LAN has become standard practice in organizations or universities. It is necessary to exam a method to construct SBS on a LAN environment.

3.1 Characteristics of SBS in LANs

LANs are different from WANs in many aspects, and offer a greater flexibility and potential for applications requiring resources at many nodes. Next, we discuss the main characteristics of LANs and how these characteristics affect the design consideration of SBS in LANs.

High Speed and High Reliability LANs usually connect systems located at short distances from each others; thus communication delays and errors are small. The whole performances of the system will not be affected largely by the increasement of communication. Resource sharing in SBS is based on service request model. When SBS is constructed in a normal network, communication overhead of request/answer will be a major issue which should be considered. But this issue is not so important in LAN environments. In the SBS of LANs, A centralized management model in which requests and answers occur frequently can be assumed.

Administrative Environments It is common that system administrative in normal networks is according to nodes. But LAN systems usually belong to the same organization, administrative of machine according to subgroups of the organization will be natural, we call these subgroups CLUSTERS. In each cluster, there are maybe some servers, e.g, file server or print server, which are shared by the machines in the cluster. Because all of the machines in a cluster are administered uniformly, centralized service management will be more efficient.

Interconnection of LANs Nowadays, most of the wide area networks are mainly constructed by local area network interconnections. If we want to construct a service base system in a wide area network, considering a LAN or a cluster as an independent component just like one node will simplify the system design.

3.2 Position of SBS in LAN System Software

The software requirements of LANs can be divided into Protocols, OS and application software. The relationship of SBS and these LAN system software is shown in Fig. 2.

SBS and Protocols SBS only defines high level protocols. A concrete method to establish actual system and low level protocols is left to system creators. In the future, with the development of fundamental protocols and protocols used for various applications, it is important to have some system to combine these protocols for applications. To establish the structure of application layer is necessary. SBS is one of such system which tries to establish an unified structure in the application layer.

SBS and OS Service base system is not created as a system from beginning, it is created in the way based on the functions of network operating systems or distributed operating systems. SBS is not designed as a system to many the computer resources (CPU and files etc.),

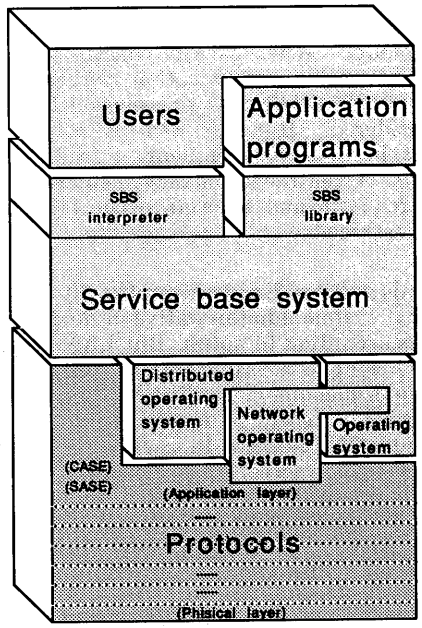

Figure 2: Relationship of SBS and LAN System Software

distributed resources are managed by a network operating system or a distributed operating system. SBS supports users to use these resources conveniently and efficiently.

SBS and Application Software The ability for users to combine some services into a new service is the main characteristic of SBS. Therefore, Application software can be built on a SBS easily. The other characteristic of service base systems is its independent extension function of each node; thus, the concept of service base systems is especially suitable in the environment where new way of application can be developed.

3.3 Configuration of SBS in LANs

A Centralized Management Model To utilize the characteristics of SBS in LANs to make service management more effective, a centralized service management model is adopted in the LAN environments. LANs are divided into CLUSTERS. Fig. 3 shows a configuration of one cluster. In each cluster, We suppose that there are some servers such as file server and print server which are shared by the machines in the cluster. To manage the shared server services and support service requests between clusters, in each cluster a Cluster Service

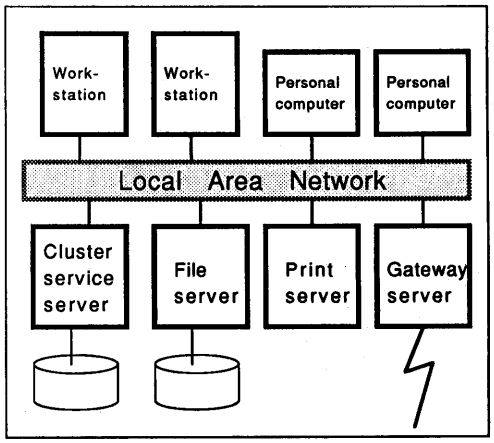

Figure 3: Configuration of One Cluster

Server (CSS) is introduced. The cluster service server is located in one node of the cluster. The CSS centralizes the service management within a cluster and acts as an overall guidance for the cluster. Because the CSS deals with most of the service requests in a cluster, a large and high speed data base will be necessary.

Within each cluster, we suppose that there are some Workstations (WSs) and Personal Computers (PCs) connecting to the cluster. WS nodes not only use services, but also supply services to other nodes in the networks. The configuration of a WS is shown in Fig. 4. Description management module is responsible for describing services supplied locally. Service management module is responsible for service execution. When receiving a service request, service interpreter analyzes it basing on the information supplied by description management module. If this service is in local node, service management module execute it and return the result. If this service is in other node, service interpreter invokes a further request to the cluster service server through communication module.

The processing ability of PCs is usually small, and PCs usually do not contain disks. In some case, a PC is only used as a terminal server to access a remote mainframe. Therefore, we suppose PCs do not supply services to networks, they only use services supplied by other nodes. In this way, PC nodes only need a service interpreter.

3.4 Functions Supplied by SBS

Functions for Users The functions supplied by SBS for users are achieved by a service interpreter, which is provided by SBS in each node.

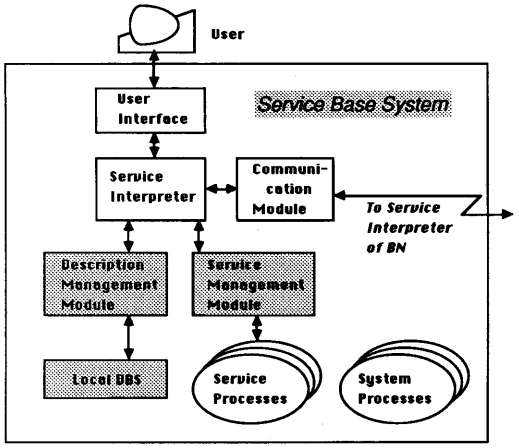

Figure 4: Configuration of SBS in Workstation Node

In each node, the users of SBS are provided with normal local OS mode and SBS mode. In the local OS mode, an user can use the computer just as without the service base system. When the SBS is started, the user enters the SBS mode. In this environment, the user can use distributed services which may involve any combinations of local and remote services. After starting SBS mode, the user can choose to work with services by selecting the options.

Functions for Application Programs Application programs can make service requests directly. This function is achieved by making *service call*. The service call means that an application program uses the routines contained in SBS library to invoke a service request and receive the answer. The service call function is some thing like the Remote Procedure Call (RPC) function used in many distributed systems. The main difference between the service call and the RPC is the problem of location transparency. Before making a RPC, a program must know where the remote procedure is located. But in service call, because SBS contains the information about the service in advance, a program dose not have to concern the location and other attributes of the requested service.

Fig. 2 shows the position of SBS library in service base system, it contains the routines which are used for service call in application programs. The library is something like the other libraries in UNIX OS. In our experimental system, a SBS library for C language is built.

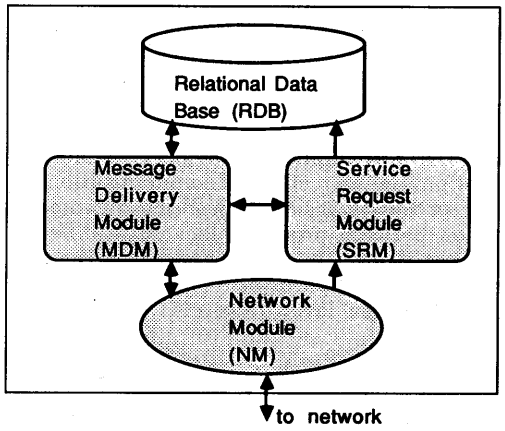

Figure 5: Structure of Cluster Service Server

4 The Service Management in Cluster Service Server (CSS)

CSS acts as a overall guidance for the nodes in a cluster. Whenever a node in the cluster wants to request a service which is not in that node, the node will request to the CSS in the cluster where the node locates in. Basing on the information described in the CSS, the CSS then will invoke a further request to the node where the service is located in.

4.1 Structure of Cluster Service Server

The main structure of the CSS is shown in Fig. 5. The main function of each module will be described in the follows.

The Relational Data Base is used to stored the information about services. Because CSS centralizes the service management in a cluster, a high speed and large scale data base is expected. Any model of DBMS can be used. Our selection of using a relational data base is due to its common uses and that the attributes of a service can be easily stored into it.

The Service Request Module accepts a service request, searches the relational data base, then produces a message delivery process and passes the information about the service to it for further works.

The Message Delivery Module consists of one or more than one message delivery processes. One message delivery process is responsible for handling a service request. The functions of each message delivery process are containing

the meta information of attributes, analyzing the service request, and invoking a further service request to the node a service locates in.

The Network Module manages all the message exchanges between cluster service server and other nodes. We use the socket system call in UNIX to implement the network module. Socket provides a method of communication between processes inside a machine or communication between processes located in different machines. Socket function is based on the protocols under section layer. This saves us from dealing with low layer protocols.

4.2 Service Description in CSS

A Tree Representation Method Information about services consist of different kinds of attributes. Considering the attributes of services, we fine some characteristics of them through actual experiences of service description:

1. There are various kinds of attributes. To describe one service may needs only some kinds of attributes, while to describe another one may needs other kinds of attributes.
2. An attribute may take several values.
3. The value of an attribute may contain other attributes and value. In other words, the relationship of attributes is hierarchical.

To represent services with these characteristics, a tree representation method is proposed. In the tree representation, the nodes of the tree represent the attributes of a service; the leaves of the tree represent the values of the attributes. Because a parent node of the tree can has any numbers of child node, the problem 2 mentioned above can be solved easily. A node may has its sub-tree which contains nodes and leaves, therefore, the problem 3 can also be solved. Fig. 6 is a example of the tree representation. In this example, the relationship of some attributes are represented.

Management of Information about Service by Relational Data Base When the numbers of service are very large, it will be efficient to use a data base to manage the large information about services. We use a relational data base to do this. Before the information about a service are stored into the relational data base, the information about the service are represented by a tree.

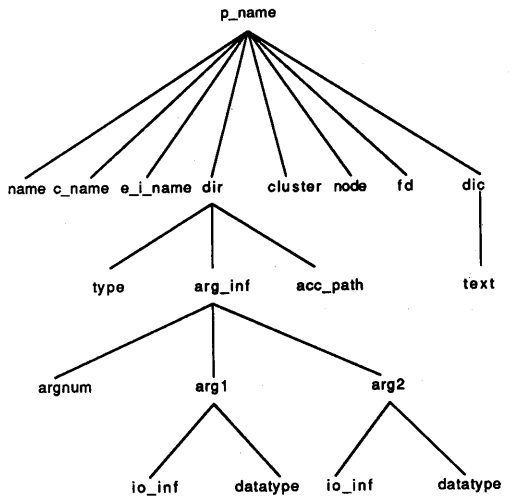

Figure 6: The Relationship of the Attributes

Until now, the attributes and their relationship that our experimental system deals with are shown in Fig. 6. One method to assign these attributes into the relation of the relational data base is to make the whole tree as one single relation. But this relation is not normalized, the relationship of attributes is hierarchical (e.i., the values of the attributes are not atomic). We change this relation into Codd's first normal form of relational algebra as follows:

In this way, the information about a service are divided into six relations.

Specification Description Language (SDL) One of the characteristics of SBS is its extensibility. An user can add a service to networks by describing it. Of course, the user can describe a service by directly using the data base query language to input the information about the service into a data base. But as discussed above, the relational data base in CSS contains many relations, relationship of them is very complicated. For a common SBS user, if he is not very familiar with the internal structure of SBS, it may be very difficult for him to input the information about the service into these relations. Therefore, a easy interface for users to describe service is necessary.

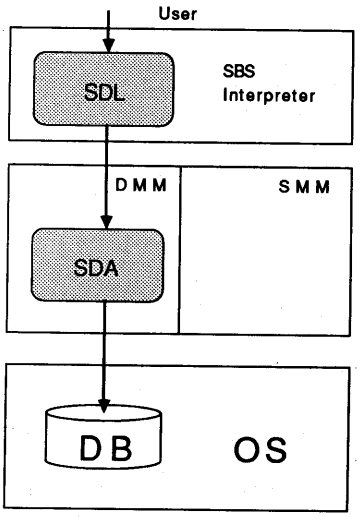

Figure 7: SDL and SDA

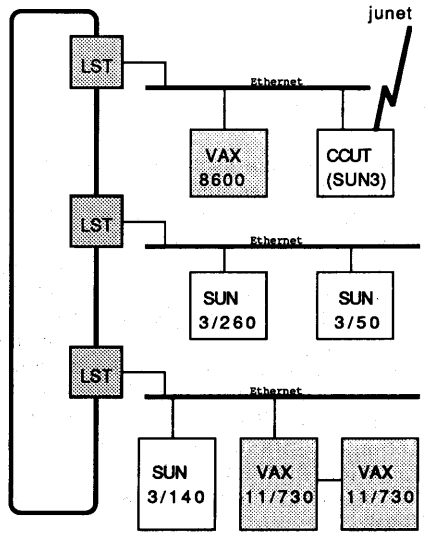

Figure 8: Connection of the Nodes Used in the Experimental System

The specification description language (SDL) is proposed to provide such interface for users.

The user uses SDL to describe the specification of a service. The SDA (Specification Description Analyzer) uses the query language of data base to insert these SDL description into a data base. Thus the interface between a data base and user is achieved by the SDL/SDA. The relationship between the SDL, SDA , data base and other module of SBS is shown in Fig. 7.

To give the user a convenient interface to use SDL, a special structure editor is constructed to support the SDL. the editor has a template for service description. Attribute names which is commonly used are given in the template. The editor also support the function of modifying, deleting and error processing. An user only has to input the values of attributes according to the guidance of the editor.

5 An Experimental System and Application Examples

5.1 Overview of The Experimental System

Based on the model described above, An experimental system has been built up. This experimental system is used to show the effectiveness of this model. Through the implementation, details of the problems which exist in this model are also fond.

The LAN used is the Kougaku-bu LAN which is in the Faculty of Engineering, the University of Tokyo. Our experimental system contains three SUN3 workstations and two VAX11/730 minicomputers. The connection of these nodes is shown in Fig. 8. If it is necessary, we can also connect the VAX8600 computer and CCUT(SUN3) which are located in the Computer Center, the University of Tokyo. CCUT is a gateway server which is used to connect to the JUNET wide area network. The experiment system is divided into two clusters. SUN3/260 and SUN3/50 act as cluster service server (CSS) respectively.

The CSS is written in C language. The relational data base used in CSS is called INGRES provided by UNIX operating system. The interpreter and SBS library for PC nodes are also written in C. The service management module and description management module in workstations are written in dprolog. dprolog is developed by our laboratory, it is an extension of cprolog with process fork function and interprocess communication (socket) function.

5.2 Examples of Service Request

An example of remote compilation is given here. When the user is in a personal computer or a workstation, while a much faster compiler runs at a powerful computing server, remote compilation is extremely effective. In a network operating system, to compile a local file in a remote machine, one may do the jobs as follows:

Copy the local file to the remote machine;

Log in the remote machine;
Activate the compiler;
Log out the remote machine;
Copy the object file back to the local machine;

In all these jobs, the user must take care of the location of the files and the compiler. In other words, the environment of process execution in network operating systems is not transparent. In the environment of SBS, these steps are done by SBS, The user just has to input the local file name, he does not has to know which compiler will compile for him and where the fast compiler is in. The local file will be automatically copied to the remote machine where the compiler locates in. SBS combines the remote copy function, remote log in function and command execution function to form the remote compilation service. Location transparency is also realized.

6 Discussion

This paper proposed a centralized service management model. To construct a service base system, one can adopt a centralized service management model and a distributed service management model. we make a comparison between these two models. In the distributed service management model, each node must contain the information about the services located in the local node, inside a cluster and outside a cluster. On the other hands, the centralized service management model uses a cluster service server (CSS) to manage the services. The CSS is responsible for the information about the services inside or outside the cluster, each node only contains the information about the services supplied by local node.

We compare their advantages and disadvantages as follows:

The centralized model: The merits of adopting the centralized management model can be summarized as follows:

- *Inside a cluster:* Because most of the information about services are stored in CSS, the information about services stored in each node are reduced greatly. Information stored in CSS are shared by each node in a cluster.
- *Inter-cluster:* Service management inside a cluster and outside a cluster are separated. When a node is added to or deleted from a cluster, or the name of a node is changed, the thing that has to be done is only to make a change within the the CSS of the cluster. When new services are supplied or existing services are changed in other clusters, the nodes of a cluster are not affected, only the CSS in this cluster is dealt with.

But in the centralized management model, communication of request and answer is increased. Reliability of the cluster service server can be a bottleneck.

The distributed model: The merits of adopting the distributed management model can be summarized as follows:

- Each node is independent with each others. They can extend services more easily.
- A node only has to describe the services used in this node.

But in the distributed management model, each node needs a large data base to store the information about services. The information about a service may replicated in several nodes.

If the speed of the network is not a problem, we can see that the centralized service management model is more efficient. In the experimental system, generally speaking, communications which occur in the centralized model are 2 to 3 times than that in the distributed model, communications are not increased so much in the centralized model. Moreover, Because of the high speed of the LAN, this increasement of communications hardly affects the performance of SBS. On the other hands, because service description are centralized in CSS, service description in a node is reduced greatly. Especially for personal computer nodes, no service description are necessary. If the numbers of node in a cluster are large, this point should be important.

Usually, the speed of WAN is 10 times slower than that of LAN. So that 2 to 3 times increasement in communications will greatly affects the performance of SBS. Therefore, we can conclude that the centralized service management model is more suitable to a LAN environment, the distributed service management model is more suitable to a wide area network environment.

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