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X.500 - Information Infrastructure of Distributed Systems in Heterogeneous Environments

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Abstract

Developing distributed systems in heterogeneous environments often needs to solve the problem of how to access many different kinds of network resources, and that is a rather difficult task. In this paper, we propose that the X.500 Directory Service [4, 5] of ITU-T can be used to solve the problem. First, a project called Platform Supporting Distributed Applications (PSDA) [6, 7] is described. Then the reason of using the Directory Service as an information infrastructure for distributed systems in heterogeneous environments and the integration of the Directory Service into distributed systems are discussed. By integrating Directory Service into distributed systems, several advantages can be achieved.

Keywords

Distributed systems, heterogeneous environments, Directory Service

1 INTRODUCTION

Information Systems in the WWW Environment C. Rolland, Y. Chen & M. Fang (Eds.)

Developing distributed systems in heterogeneous environments has become more and more important in the world. Distributed systems often need to use many different kinds of network resources, for example, users, servers, printers, files and even some processes, etc., to fulfil their functions. These resources should be stored somewhere in the distributed system so that they can be accessed easily by the system whenever needed.

In heterogeneous environments, to store and access these network resources may be very difficult for some reasons. First, these resources are often distributed in different places of networks, so managing and accessing them is very difficult for developers. Secondly, different environments would provide different abilities to support storing and accessing network resources, the applications running in different environments should have to solve the problem with different strategies and ways, and this would also increase the difficulties of developing distributed systems in heterogeneous environments. In order to decrease the difficulties, we have designed a software development environment called PSDA (Platform Supporting Distributed Applications). Though the PSDA is a kind of software development environment, it is also a special distributed system in heterogeneous environments. Below an overview of the PSDA is introduced. Then how X.500 Directory Service can be integrated into distributed systems is discussed. The implementation of the Name Service is also described. Finally, some conclusions concerning the Name Service are given.

2 AN OVERVIEW OF THE PSDA

In order to develop distributed systems in heterogeneous environments we must solve many complex and difficult problems such as the transparency of network communications, the synchronization of time, the security and management of network resources, etc. Different environments often provide different abilities to support the development of distributed systems for the developers, and this often makes it impossible for developers to translate the codes and ideas from one environment to the others. In order to solve the problem of developing such applications in heterogeneous environments and decrease the difficulties for the developers, we implemented the PSDA.

Figure 1 shows the structure of PSDA. The PSDA is a software development platform implemented in heterogeneous environments. It can solve the problem of managing, scheduling, time synchronizing and extending distributed systems.

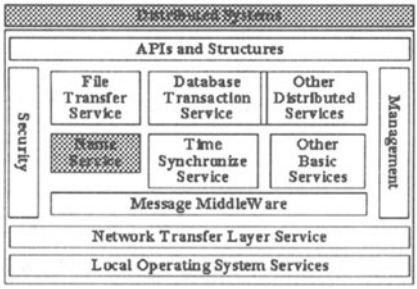

Figure 1 The structure of the PSDA.

By providing a set of well-defined and consistent Application Programming Interfaces (APIs), the differences between heterogeneous environments are hidden to developers. The PSDA is made up of many kinds of services. These services can be divided into two parts, the basic distributed services and the application-oriented distributed services. The basic distributed services include Network Communication Service, Name Service, Time Synchronize Service, etc. These services are the foundation of application-oriented distributed services. The application-oriented distributed services include the File Transfer Service, the Database Transaction Service and other distributed application services.

Developers usually use the interfaces provided by application-oriented services to construct their own distributed applications, and they can also use the basic distributed services to develop distributed systems if needed. More detailed description about PSDA can be found in [6, 7].

3 INTEGRATING X.500 DIRECTORY SERVICE INTO DISTRIBUTED SYSTEMS

The Name Service is a basic and the most important service in the PSDA. It can be used to make developers map each kind of network resource onto a "name" in a natural way, so the PSDA and other distributed systems developing based on PSDA can find and access these network resources easily. Name Service also provides the regulations of network security and accessing right.

The X.500 Directory Service is fit for the design and implement Name Service in the PSDA. This depends on some important factors [6, 7, 9]. First of all, the X.500 standards define an information repository of network resources and this information repository provides a single logic view to each environment, so it can be used under all the circumstances. Secondly, the X.500 Directory Service provides a general naming structure and a simple access interface so that all the network resources can be stored and accessed in a consistent, environment-independent way. Thirdly, the X.500 standards have an international recognition so that it has the potential for growth and acceptance worldwide. The X.500

Directory Service also provides strict regulations of network security and distribution of rights. Finally, the Directory Information Tree (DIT) of the Directory Service is a distributed database, the replication of information would increase availability, reliability and good performance of distributed systems. By using the Name Service or the X.500 Directory Service, we can connect different parts of a distributed system running in heterogeneous environments into a

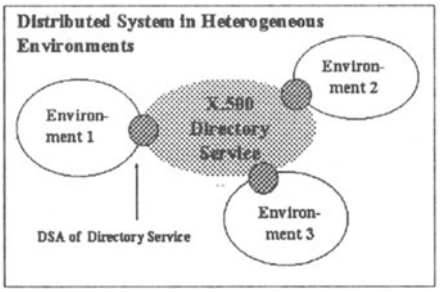

Figure 2 Heterogeneous Environments Connected by the Directory Service.

whole one. Figure 2 shows how the X.500 Directory Service does this.

4 IMPLEMENTATION OF THE NAME SERVICE

In PSDA, the Name Service is designed and implemented based on the NetWare Directory Service (NDS) [8] of the Novell Inc. Our aim is not to implement a product of the X.500 Directory Service, but to implement PSDA using the X.500 Directory Service. The NDS is a mature product. Its implementation is entirely consistent with the X.500 standards. This fact is helpful for us to improve the practical usability of PSDA.

Considering the reality and flexibility, in the implementation of the Name Service of the PSDA, we do not use the NDS directly but use "client/server" structure to do the work. Figure 3 shows the structure of the Name Service in the PSDA.

As illustrated in this figure, we developed a server program running on the NDS server, called Directory Service Agent (DSA). The DSA collects Directory Service Requests coming from its clients – Directory User Agents (DUAs), accomplishes these requests by using NDS SDKs (Software Developing Kits) and feeds results back to the DUAs. The DUA is a software object designed in the PSDA to provide Directory Service for distributed application developers. When developers need Directory Services, they can achieve these services by using the interfaces of DUAs. DUAs interact with the DSA according to the Directory Service Protocol (DSP), receive the results of Directory Services and return the results to the interface invokers. Since only the DSA uses NDS SDKs

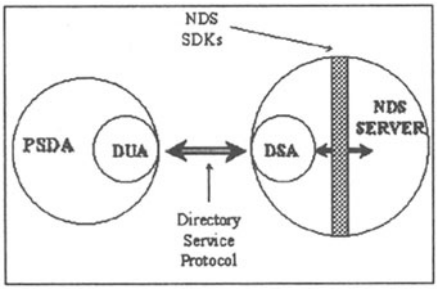

Figure 3 The structure of Name Service in the PSDA.

to implement Directory Service Requests coming from the DUA, if only the DSA is changed, the DUA and the PSDA do not need to be revised, then the flexibility can be assured. Also in this way, we can provide the Directory Service for those environments not supported by the NDS of the Novell Inc., for example, UNIX environment and Windows NT environment.

In Name Service, each network resource can be viewed as an object of DIT. Each object has its own attribute-set and attribute values. Though the NDS has provided more than twenty kinds of definitions of object class, such as Organization, User, File Server, Printer, etc., they can not meet the needs of some kinds of distributed systems. Thus, to use Name Service in the PSDA, we should define new object classes. For example, in the sample of File Transfer Application (FTA) we established based on the PSDA, we added two kinds of object classes, FTA User and FTA Usergroup. FTA User represents the actual users using the FTA. These users can be distributed anywhere. When one user wants to send a file to another user, he/she only needs to provide the name of receiver to the system. The local DUA in the PSDA should ask the DSA for the current network address of the receiver, then the local File Transfer Service can use this address to send file to receiver actually. Also, FTA Usergroup class can be used to provide a simple regulation of right, that is, only two users in the same FTA Usergroup can send file to each other, otherwise the DSA should deny the request of DUA. The more detailed description of the FTA can be found in [7].

5 CONCLUSIONS

We have tested the PSDA in our Laboratory of Network Technology Research Center. The testing environment includes two NetWare servers, one UNIX Host and four PCs, running Windows NT, Windows'95, Windows 3.1 and DOS respectively, as shown in Figure 4. NDSs of two NetWare servers constructs a

sole Directory Service Tree, which is the information infrastructure of the PSDA.

We have also developed two distributed applications based on the PSDA. The

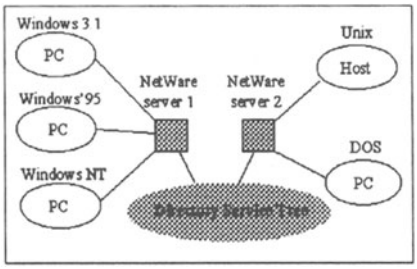

Figure 4 Test Environments.

one is the Multi-File Transfer application, another is the Database Transaction Processing application [7]. These two applications all require the information of some special network resources (These resources do not exist in NDS, so we need to define them entirely.) to accomplish their functions, and they also need the information of authority to ensure the security of the distributed system. All of them were implemented in our experimental heterogeneous environments.

The results of our experiments show that by integrating the Directory Service into distributed systems, several advantages can be easily achieved.

- The main function of distributed system is to exchange information and cooperate with each other among autonomous units. By using the Directory Service as the information infrastructure of distributed system, different units can be connected into a whole one seamlessly.
- A lot of network resources can be configured and managed globally. This will greatly decrease the difficulties of maintenance of distributed system for system managers.
- Based on the Directory Service, the distributed system can be implemented more flexibly. For example, we can locate many network resources at runtime in our test applications, so these applications can be executed under different contexts.

In this paper, using the X.500 Directory Service to solve the problem of network resources of distributed systems in heterogeneous environments is discussed. The way used to integrate the Directory Service into distributed systems is also discussed. By using this Service, several advantages can be easily achieved.

Here only the problem of "why" and "how" to use the X.500 Directory Service in distributed systems is concerned, other problems, such as performance, how to

provide a flexible way for developer to define their own resources, are still need to be studied further.

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7 BIOGRAPHY

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