

A Research on E-Learning Platform Multi-Tenancy Technology Based on SaaS

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Abstract

Through the study on the design of multi-tenancy system and the multi-tenancy key technologies, such as multi-tenancy interface display technology, multi-function cutting technology, access control technology, data isolation and expansion technology, the paper proposes the integral technique-solving schema for multi-tenancy e-learning platform based on SaaS, and it implements multiple tenants sharing learning platform services at the same time and provides us a new model for the use of learning platform.

Keywords

SaaS Model; Multi-Tenancy; System Architecture

Introduction

In the 21st century, the process of education informationization speeds up, with the development of Information Technology, e-learning is becoming a popular way to learn which is accepted by the public, all levels of schools and educational institutions have set up their own network platform. However, under the influence of funds, network transmission speed, data processing capability of the server, the changing user needs and other factors, there are some problems in the actual construction process. For example, redundant construction of e-learning platform is serious, the platform lacks unified data standards and the sharing is poor, the increase and improvement of platform rely heavily on the version upgrade, unable to meet the actual demands of learners, the cycle of platform construction is long and the risk of time control is huge.

With the advent of cloud computing era, SaaS in the cloud infrastructure provides a new business mode for educational institutions to deploy e-learning platform, Multi-tenancy technology provides us the technical support to achieve that multiple organizations share the services at the same time. In order to solve the above problems, the paper proposes the integral technique-solving schema for multi-tenancy e-learning

platform based on SaaS, including the design of multi-tenancy system architecture, the research on multi-tenancy key technologies of data isolation, data expansion, function configuration and so on. It realizes the infrastructure of e-learning platform based on multi-tenant technology with good demonstration of innovation.

The Architecture of E-Learning Platform Multi-Tenancy System

It proposes the architecture of e-learning platform multi-tenancy system shown in FIG.1.

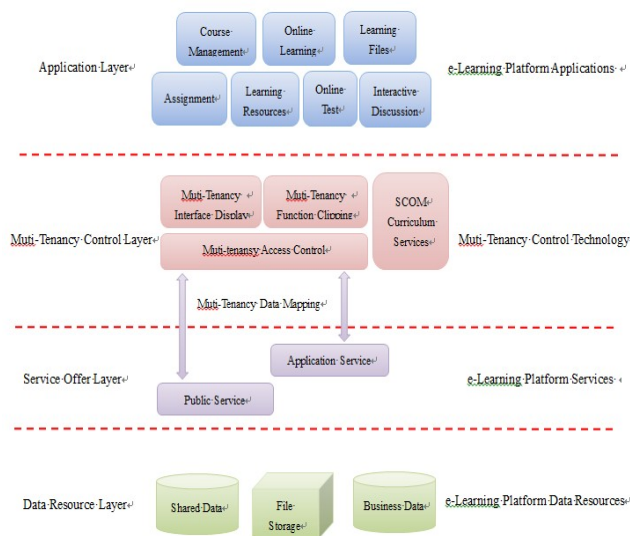


FIG.1 THE ARCHITECTURE OF E-LEARNING PLATFORM MULTI-TENANCY SYSTEM BASED ON SAAS

As the architecture shown in Fig 1, we can build multi-tenant model suitable for learning platform, achieving the overall loosely coupled system and laying the foundation for future platform extension. Where:

1) Application Layer

It includes various learning support functions and applications necessary for learning platform, covering view framework and navigation mode for showing the

learning platform as well as all kinds of tools necessary for learning platform, such as courseware player, discussion, notification, etc.

2) Multi-tenancy Control Layer

It includes all types of control service supporting multi-tenancy system. For upper layer, multi-tenancy control layer provides the service interfaces which meet the demands of single tenant, For lower layer, it provides universal mapping specifications in line with the global data and application specifications. In addition, it is realized through four modules as follows: multi-tenancy interface display, multi-tenancy function clipping, multi-tenancy access control and SCORM course service.

3) Service Offer Layer

It provides available service interfaces for multi-tenancy control layer and application layer. Application service interfaces meet the needs of particular service calls, such as: behavior records, schedule notifications, registration and other specific application service. Public service interfaces meet the needs of the learning platform universal service calls, such as users, sessions, course management, etc.

4) Data Resource Layer

It provides shared data support including the metadata, business data support including the application data as well as support for the file storage which can be used to access a variety of learning resources.

Muti-Tenancy Key Technologies of E-Learning Platform

Multi-tenancy Interface Display Technology

It is necessary to provide a configurable e-learning platform facing different tenants. There are different software versions, interface styles, workflow, configuration information (such as the number of page elements and its location, order, meaning, etc.) provided for various educational institutions to choose according to their own needs. Multi-tenancy interface display technology provides the function of personalized interface adjustment and it makes the overall style configurable, including color, international text, specific icons, images and page layout. By establishing universal interface with some flexibility, we can achieve Skin mechanisms and support personalized customization and configuration

for different tenants, which can be used to display distinct styles of different tenant platforms. Content on functional interfaces is also the elements for interaction between users and system. For specific interface elements relevant to application, multi-tenancy technology will provide framework support for the application implementation and configuration through the unified entrance management.

Multi-function Cutting Technology

According to the principles of function decomposition, each function is valuable and cannot be subdivided, there is no overlap between functions, the entire system is fully functional. Multi-function cutting technology not only focuses on the uniqueness of atomic functions, but also pays attention to the dependencies between functions. When the system functions are divided into a number of atomic functions, we can pack the atomic functions based on user types and usage scenarios, and then provide the appropriate function package for each user. Feature pack is designed to follow high cohesion, low coupling principle, group the related and interdependent atomic functional design features in a package to minimize the dependence between function packages as far as possible, so that each function package can be used dependently. Each user will enjoy the unique services.

Access Control Technology

Access Control model under multi-tenancy architecture not only increase the tenants as the basic elements, but also provides administrator privileges for the functions ordered by tenants, namely, the tenants have authority to order the function which contains all its atomic functions. In addition, access control model add users and roles to the tenant properties. For permission, access control model expand atomic functions, function hire and other elements. In the actual operation process, we can carry out consistency verification between the tenants which the atomic function and role belong to respectively, to ensure tenants can only give its users the ordered atomic functions.

Data Isolation and Expansion Technology

1) The Choice Of Database Schema

For the traditional software, database is usually deployed to the client server in the aspect of data software and the customers should maintain the database themselves, it will cause a lot of trouble to

the customers. The database can only store data corresponding to the client's business and the data structure is simple and independent.

Compared to the traditional software, the biggest difference of SaaS service model is its multi-tenancy features, namely, multiple tenants share a running instance. There are both isolation and sharing between tenant data, and it is important to seek the balance between data isolation and sharing, meanwhile, low cost factor sought by service providers and tenants should be taken into consideration.

According to the characteristics of multi-tenancy service mode, there are three options in the aspect of data storage as follows:

- **Separate Database**

Separate database is the most convenient ways of data storage which each tenant's data is stored separately in a database; it achieves SaaS model data isolation. In this pattern of SaaS service applications, most of the system resources and application codes are shared by each tenant, but physically each tenant has own set of data and the data is stored separately.

Separate database storage scheme has its own advantages, it provides a separate database for different tenants, which are beneficial to simplify the latter extension design of data model and meet the unique needs of different tenants. It is simple to recover the tenancy data if there is a malfunction. However, the scheme is not suitable for SaaS applications; it increases the installation number of the database, along with the increasing cost on maintenance and acquisition.

The scheme is similar to one client, a set of data, a set of deployment in traditional way the only difference lies in the unified software deployment by the service providers.

- **Shard Database, Isolated Data Architecture**

The scheme of shared database isolated data architecture is that all the tenants share a database, but each has own unique data table structure, which stored in a separate mode. When the tenant uses the SaaS service system the first time, the system will create a set of default data table structure at the same time it creates the tenant environment under this data mode, meanwhile, the tenant will be associated to its independent mode.

Compared to separate database storage, the advantages of this scheme are that a server can

support more tenants through the database sharing, meanwhile, it achieves data isolation on some degree to ensure the safety. It can provide certain logical data isolation for the tenants who have high security requirements, but not completely isolated.

- **Shard Database, Shared Data Architecture**

The scheme of shared database, shared data architecture is that all the tenants share the same database, the same data table structure and the data is stored in the same pattern. In this scheme, a data table can contain data records of multiple tenants and distinguish data of different tenants in the table by Tenant ID.

The scheme has the highest level of the sharing and the lowest level of the isolation and cost on maintenance and acquisition, the number of tenants that each server can support is at most.

The project chooses the scheme of shared database, shared data structure based on the evaluations and comparisons between the above three implementation schemes.

2) The Realization Of Data Isolation

We add the data fields TENANT_ID and COMPANY_NO into each business table when creating the multi-tenancy pattern. These two data fields are used to distinguish the data information between different tenants and ensure the privacy of each tenant through the data isolation.

The Tenant ID field is used to distinguish other tenants' data information in SaaS service system which doesn't exist in the traditional software pattern. The tenant can search own business data through Tenant ID when operating the data. The statement of "Tenant ID=?" should be added to each statement When using SQL statements to distinguish the tenant data, avoiding reading the data information of other tenants.

3) The Realization Of Data Extension

When expanding the data under multi-tenancy model, we need create a multi-tenant management table, a field configuration table and a business data extension table. Through the effective combination of three tables, we can reduce the waste of resources and the damage to the business table due to different extension needs of different tenants.

When facing the different field extension needs of different tenants, we can change the horizontal

columns into longitudinal data sets and each field of each original data record will be stored as an extension data line. The data records in data table can be associated to the configuration records in configuration data table to constitute the extension data records.

Conclusions

E-learning platform can play a good support and management role in e-learning. The research combines the thought of multi-tenancy with learning platform and proposes the overall technical solutions for multi-tenancy e-learning platform system based on SaaS. Multi-tenancy technology enables schools and educational institutions share the e-learning platform service, avoiding duplication construction of resources and achieving a highly resource sharing. It provides an innovative model for the use of learning platform and can improve the efficiency and effectiveness of online learning as a result.

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