Design and Implementation of University Level Unified Information System Integration Platform

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Abstract- This paper analyses the current position of higher education informatization, and discusses the aims of university level unified information system. From these, it brings forward a construction thought, scope, and key technologies of the information system integration platform. In the end, Tsinghua university information system integration platform is illustrated as a case study in this paper.

Keyword: University level unified information system; Application integration; Information integration; Information system integration platform

I. INTRODUCTION

A global social innovation is introduced by the rapid development and widely use of information technology since 20th century. Informatization has become a main trend in the current global economic and social development. Higher education informatization system construction in china started in 1980s, which achieved a big improvement through the two stages of system integration and application integration. Network and hardware infrastructure becomes more and more completed, application system is significantly improved. Information resource is gradually abundant. And finally reaches the goal of e-learning, online office, online management and online services.

With the rapid development of higher education informatization, higher education informatization plays an important role in daily work. Account demands more and more information requirement. From the local information management to the cross-department service process integration and decision support, most daily work may be completed relying on lots of information system and multiple data. From simple information publishing to personalized and proactive information service, account expects the boundaries can be weakened and the system can be transparent to account. Therefore, the requirement to build up a global information system is necessary. Lots of universities attempt to make service procedure to be informatizationed from beginning to end. Higher education in china has entered into a new stage with an unified construction of global information system.

II. University level unified information system integration requirement analysis

University level unified information system is a global information system fully established by university with the capability of all services running smoothly. Based on the basic infrastructure, data, account, application, privilege and process integration, information integration can be implemented. This information system provides account with an integrated and customized information service. The finance service integration, management and decision support integration can be implemented as well. University core competence can be improved. From the university level unified information system perspective, the core elements are characterized as below:

- Basic Infrastructure Integration: including hardware platform, software platform and security system to be integrated.
- Data Integration: build up an unified data standard, specific data source management, standardized data sharing. Establish data model, the data is orderly organized and unified management. Establish an integrated data environment, and finally makes the data management standardized, integrated and authorized.
- Account Integration: Establish a standard global unified identifier, build up an unified account data base and a standard account management model. Provide an unified account information publishing and query service, an unified account authentication services, as well as an unified Single Sign-On (SSO)
service.

- Application Integration: utilize an unified authentication service, support SSO, utilize an unified technical platform, utilize an unified access privilege service, support service calling across applications, comply with an unified application management specification, utilize a consistent account interface style, support flow integration on cross-system.

- Privilege Integration: establish a global unified privilege management model. Build up an unified identity and management system, implement a smooth interaction between institutional management, job management and account role management, provide an unified privilege information publishing and query service, provide an unified authorization management, privilege authentication and access control service, provide an unified privilege auditing service.

- Process Integration: all business sections are smoothly associated, establish an unified process interface specification, the process of crossed-business departments can be running smoothly, support business reorganization and process optimization between internal and across departments.

However, university level unified information system construction is hard to be completed in short time. After all, it is a long term and complicated system engineering.

Firstly, information system has become an important supporting environment in university daily work in the past decades. These systems are achievements as well as a burden. Due to information system construction has gone through a long period, almost all system adopts a separate construction model. The technical architectures are quite different at that time. In the previous system construction, university level business association and across functional departments are seldom considered, so that, the systems from high level service functionality to low level data is probably separated. The systems are unable to be accessed uniformly and the data is unable to be uniformly utilized and shared either. The business across departments is unable to connect interactively. Even if in the application integration phase, the application integration just utilizes an unified identity authentication service, supporting SSO. The available application system is quite different. The separated and unconnected information systems have negatively affect the progress of university unified information system construction.

In the meanwhile, information system account has become more and more professional. They expect information can have the capability of finding account proactively, rather than account always finding information.

This situation leads the unified information system construction to a “poor foundation” and “high requirements” status in the information integration stage. Therefore, to achieve the goal of university level unified information system construction, it is necessary to setup an unified information system integration platform from the technology perspective. Integrate all relatively separate information system from data layer, service layer and interface layer. In data layer, implement data integration and data sharing by the way of system construction, and finally achieve data “single sourcing” (including “one entry filled out data, multiple sharing”), so that data isolated island can be broken and the global data flow can be opened, and finally develop a global data service. On business layer, business system boundary can be broken, so that, account only needs to focus on the issues itself to be handled while dealing with daily routines, without caring about the specific system. On account interface layer, the interface that account access should be standardized and unified, account only needs to step into one entrance, from that navigation, all daily routines can be accomplished accordingly.

III. Design for information system integration platform

An information system integration platform to implement an university level unified information system has been built up in Tsinghua University over the past several years. Through the various business department information systems integration, the business system achieves the purpose of unified management, centralized access and business data exchange and sharing. So that university informatization construction is improved from system integration to application integration and information integration.

Information system integration platform has solved all various information system integration issues, from which, account electronic identity, role permission, information system and business data can be managed uniformly. A customized application environment, integrated data environment, secured access environment and dynamic information display environment can be implemented as well. Information system integration platform makes it happen to implement an application integration and information integration for the various information systems in university, and builds up an open, collaborative information support environment to meet university teaching, research, management and service requirement. And finally provides a complete customized service to the people of internal and external university. The main environments are list as below:

- Customized application environment: With the basis of information integration, customization and Single Sign-On (SSO) roaming access for the integrated information portal, build up a customized application environment by the way of portal content organization and planning used for account.

- Integrated Data Environment: Based on Data
Exchange Platform of global data dictionary definition, data change capture and exchange for heterogeneous data, build up an integrated data environment by the way of planning and construction for business database and primary database.

- Secured access environment: with the basis of unified account authentication service, secured password storage, unified privilege management and data access control, build up a secured access environment for electronic identity and role management based on account-model.

- Dynamic information publishing environment: with the basis of a dynamic query for integrated information service and customized reports, unstructured information publishing on information publishing platform, build up an integrated service information display environment by the way of data planning and information organization.

IV. Content of information system integrated platform

Tsinghua University information system integration platform is composed of six sub-systems: information portal, unified identity authentication, unified privilege management, data exchange, integrated information service and information publishing, which provides a series of middleware service for information system running and integration, and also provides a basic support to implement information integration. The unified account authentication, access control, information publishing can be implemented between all various application systems. A data exchange, interaction access and business data integration display between information systems can be implemented as well. From the above, middleware service bus provides a service base for the overall framework. Through bus specification, service providers and service account can comply with the same standard and protocol. All sub-systems can use service call and data exchange. This situation makes service can be working well. The general framework of information integration platform is shown in Figure 1:

- Information portal: information portal is to provide account with an unified access entry for various information system and information resource, which communicates with other services and all types of information system by the way of middleware service bus, and integrates all types of information systems, and finally provides account a business service with transparent system boundaries. Through the unified authentication and access control, information portal has the capability of Single Sign-On (SSO) and roaming access to the information and data of all types of information system in university. Information portal also provides relevant framework, from different account (students, teachers and various administrators, etc) perspective, the information and service provided by various information systems can be organized. Utilizing portal integration technology for integration and consolidation can disable the diversity of information system. Information portal can provide all types of account with a customized, secured and active pushed information access environment.

- Unified identity authentication: Through the establishment of an unique identifier for account in university, university electronic identity can be managed uniformly, which provides a base for account identification. Unified Authentication provides an unified information system for the account authentication services to guarantee the security of account electronic identity and provide billing service for information system, and implement Single Sign-On roaming access between systems, and improve the convenience and security for account to access information system. Unified authentication sub-system access to the middleware service bus and provides identity authentication and Single Sign-On services for various information systems and other sub-system in the platform.

- Unified privilege management: based on university account model, it is valuable to provide an unified privilege management platform for all types of information system. To implement digital campus
information system global function and privilege data center, both functional access control and business data access control is utilized. Through RBAC and ACL, multiple privilege model, a variety types of privilege control used for information system functionality, integrated information service data distribution, information publishing platform and unstructured information publishing can be implemented. Through level authorization and multi-level privilege control, a privilege management system can be implemented to fulfill university management model. This system provides account with a most appropriate customized and proactive information service. Unified privilege sub-system accesses the middleware service bus and provides privilege check service for all types of information systems.

- Data Exchange: Data Exchange provides a global data dictionary definitions and data exchange services. From which, information isolated island can be solved. All data resource can be connected between information systems. Data layer can be integrated, and finally ensure that the data is characterized with single source, consistency and integrity. Using loosely coupled architecture to implement data exchange between heterogeneous systems. Using trigger and Web service interface to implement various model data collection. Data exchange sub-system access to middleware service bus, and distribute data change notification to all application systems, when the application receives such notification, the relevant service will be handled accordingly.

- Integrated information service: based on business database, a dynamic definition of business data query, complicated query editing and a self definition of query results are implemented. From which, various application systems can be provided with common, high efficient data query and export service. With the basis of university shared primary database, through integrated reporting platform, various complicated statistical reports design, Web report display, report printing and report data export are implemented. This service provides various level departments with data report, statistics analysis and decision making. This sub-system account interface is integrated to information portal through middleware service bus.

- Information publishing: an unified information publishing functionality is provided for the information system. All management functionalities such as unstructured information, document, storage, distribution, retrieval and version control are implemented. By the way of column subscribing, editing publishing functionality, multi-column synchronizing publishing model, column layout editing publishing and information publishing access control functionalities, provides support for various information publishing application model, such as, information website establishment, business website establishment for seamlessly integration of information system and information publishing, portal information pushing and information publishing service invoking etc. In addition, through middleware service bus, it is possible to be integrated into the integrated information portal.

V. key technology of information system integration platform

Information System Platform integrates the formerly systems with characteristics of independent, various periods, various techniques and various frameworks. To implement the goal of “system integrated, information integrated, interface standardized, and secure controlled” and construct a valid system integrated framework, the following issues need to be solved:

1) Integrate the majority of separated independent systems.
2) Support loosely coupling, the original system is weakly impacted.
3) Support heterogeneous systems (including B/S and C/S systems) integration
4) High security

From the above, the implementation of Tsinghua University information system integration platform adopts many information service technologies: application integration technology based on EAI, electronic identity management technology based on IAM, information publishing pushing technology based on RSS, portal integration technology based on Portlet, C/S system roaming technology based on Citrix, mixed access control technology based on RBAC and ACL, data exchange technology based on messaging protocol, customized information service technology, rich client technology based on RIA, full-text search technology based on privilege control. From which, loosely coupled and platform independent heterogeneous service system integration are implemented.

With the development of information technology, considering higher education higher education informatization characteristics, “C/S system Single Sign-On roaming technology based on Citrix” and “hybrid access control technology based on RBAC and ACL” have become an innovative Digital Campus construction technology.

1) C/S system Single Sign-On roaming technology based on Citrix

There are quite lot of C/S structured systems in campus information system, especially management system. These systems also have requirement for accessing information portal
to implement unified identity authentication, Single Sign-On, and unified access control. Therefore, Citrix technology is introduced and an application model based on server calculation is constructed. Citrix is constructed on Windows platform. MutiWin technology is adopted, account management is carried out based on Active Dictionary. Access approaches are flexible. Account management can be accessed directly through browser. The requirement for network is not too much, security is high and the maintain cost is low. Meanwhile, the Citrix server is improved. An unified identity verification plug in is added for Citrix account authentication. A Single Sign-On based on trusted third party is supported. Single Sign-On roaming access from B/S information portal to C/S system is implemented. Figure 2 is shown in detail.

![Figure 2: C/S Single Sign-On roaming technology based on Citrix](image)

2) Access control technology based on RBAC and ACL mixed model

In each access control model, Role Base Access Control (RBAC) is a most suitable model to be used for digital campus identity and access management. RBAC model introduced Role concept, the purpose is to separate the direct connection between account and permission, reduce the complexity of authentication management, reduce management cost and improve management efficiency. Regarding the majority and dynamic changed information resource, Access Control List (ACL) model is relatively more simple and flexible. From the above, the two models are integrated, an access control system based on RBAC and ACL are established as shown in figure 3.

![Figure 3: Access control technology based on RBAC and ACL](image)

The two mixed models solution not only solves the requirement of various levels authentication management and control, but also implements the access control to large dynamic information resource, especially the unstructured documents resource.

VI. Summary

In the past six years, Tsinghua University information system integration platform continuously introduced new technology and constructed an unified university level middleware platform, which consists of information portal, unified privilege management, data exchange, integrated information service and information publishing. This platform provides an elementary service for all systems information integration and high efficient secured operation, which gives a big support for university digital campus entire construction. Nevertheless, information integration platform depends on university level information system construction. The requirement for information integration is increasing rapidly, and information system integration platform is needed to be improved on the integration service types, information integration depth, integration efficiency and architecture, so that, the future informatization construction requirement can be fulfilled.

Establishing an efficient and shared scientific research supporting platform is a foundation to improve crossed-subjects innovation and development in university digital campus environment. In this paper, scientific research supporting platform makes fully use of information and network technology, the normal scientific research communication approach, which limited researchers and academic teams, is broken. The efficient and shared information is achieved through networked scientific research. Finally, an unique innovative academic environment is established. Both university scientific research level and innovation capability is improved accordingly.

REFERENCES