# Research and Application of the Four-tier Architecture

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**Abstract.** With the development of the mobile internet and computer software, the requirements for portability, encapsulation and expansibility of computer software system are increasingly high. The traditional three-tier architecture is no longer applicable because of its limitations in the current application environment. Consider the problem of platform migration, changes in the demand and improving the efficiency and effectiveness of maintenance. In recent years, exploration direction in software system development is increasingly turned to the procedural framework and design patterns. In this paper, we propose a four- tier architecture, which is introduced a new layer - a data service layer into traditional three-tier architecture. We describe the advantages of the four-tier architecture from the structure, and apply it to the design and development of TV shopping integrated audio management platform.

## Introduction

Three-tier architecture can disperse concerns, loose coupling, reuse logic and define standardly, that is currently widely used [1]. Every layers of the three-tier architecture can increase, update, delete and replace individually. The architecture can not only reduce the dependence among layers and the costs of construction and maintenance effectively, but also be beneficial to standardization. Upgrading application-level and database-level configuration to server-level configuration can provide strong scalability and fault tolerance. In addition, the biggest advantage of three-tier architecture is its security. The three-tier architecture hierarchically manages data and programs, data control and application logic independently, that can more tightly control access to information.

However, the three-tier architecture also has very obvious shortcomings. First, it is not conducive to the function expansion. It will result in a modification of the cascade when we modify from the top to the bottom. For example, if you need to add a function in the presentation layer, you may have to increase the corresponding code in the business logic layer and data access layer, so that the design can meet the hierarchical structure's demand. Secondly, system migration inconveniences. When we migrating system, if there have differences between the target platform environment and existing system environment, the system cannot work properly and the costs is too high. At last but not least, the code reusability is too bad. When we develop system again or integrate system, if the development language used is different, the three layers substantially all need to re-development.

In recent years, mobile Internet [2] technology develops rapid. As a result panel computer, smart phones and other mobile devices achieved universal. The range of their applications is increasingly wide. Therefore, it is necessary to develop more and more cross-platform application system to meet the demand of the user terminal running diversity. The system needs to have good platform portability and the ability to support the mobile terminal [3]. In this case, the three-tier architecture in response to platform migration, changes in demand, the mixed issues such as database, its shortcomings, such as, bad code reusability and applicability, high cost of system maintenance and platform porting is particularly prominent. In view of this, we bring a four-tier architecture, as the

overall architecture of the system [4]. It is introduced a new layer - a data service layer into traditional three-tier architecture.

In this paper, we discuss features of the four-tier architecture with a data services layer, and then we verify them with the development of TV shopping integrated audio management platform based on four-tier architecture.

## Four-tier Architecture

The four layers of four-tier architecture are presentation layer (PL), data service layer (DSL), business logic layer (BLL), and data access layer (DAL). Four-tier architecture is as shown in Figure 1.
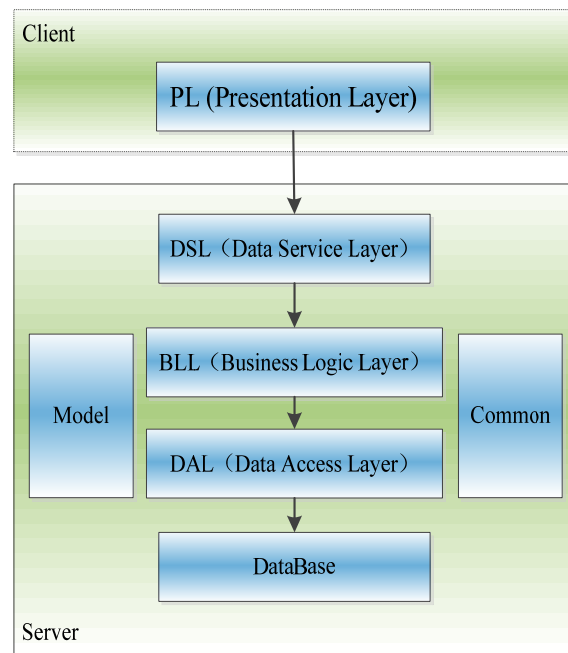


Figure 1. Four-tier architecture diagram

As can be seen from the diagram, according to the geographical location the layers can be divided into two types. One is data access layer, business logic layer, and the data services layer which is located in server-side, as well as the business entity model and the generic class library. The other one is the presentation layer located in client.

The characteristic of the four-tier architecture is as follows.

1) Presentation Layer (PL): It is located in the outermost layer; popular talk is the interface showed to users, users' WYSIWYG when using a system. Its functions contain receiving data inputted, interpreting users' instructions, and sending requests to the data services layer and displaying the data obtained from the data services layer to users by the way they can understand. It closest to users and provide an interactive operation interface.

2) Data service layer (DSL): It is located between the presentation layer and business logic layer (BLL). As the isolation layer, it will separate the business logic from the client, so as to guarantee the security of information. According to the needs of each module, data services layer encapsulates the business logic on high level. Operational activities played a role of confidentiality. For large software systems, cross-platform distributed computing and server farms between communications are essential, which is the function of the service layer's establishment. The main function of DSL is referring data processed by BLL to its immediate upper layer (presentation layer) or transferring data submitted by PL to its directly below that is BLL according to the specified model definitions.

3) Business logic layer (BLL): It is located between the PL and data access layer (BLL), playing a connecting role in the data exchange. Business logic layer is responsible for the various types of business operations of system, the completion of the corresponding functions, which are issue-specific operations, the data business logic processing. The layer's concerns are focused primarily on the development of business rules, business processes and business needs related

system, meaning that it is related to area of systems addressed by the logic. Very often, it's also known as the domain layer.

4) Data access layer (DAL): It is located in the innermost layer that implements persistence logic. The function of this layer is responsible for access to the database; you can access the database system, binary files, text documents or XML document. Operations on the data contain finding, adding, deleting, modifying, etc. This level work independently, without relying on other layers. In accordance with upper layer's requests, DAL extracts the appropriate data from the database and passes the data to the upper. DAL also does the CRUD operations on the data in the database in accordance with the instructions of the upper.

The execution flow of the four-layer architecture is shown in Figure 2. The data request in the figure is issued by the presentation layer, which cannot get the data it requested until to Step 8.
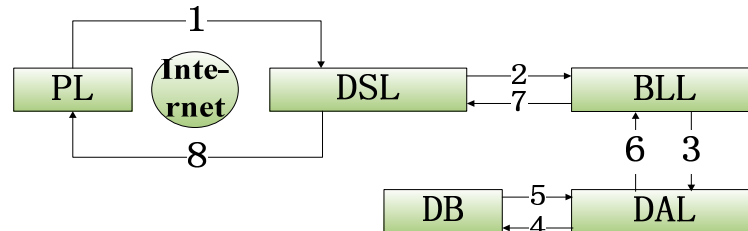


Figure 2. Execution flow of the four-layer architecture

Services can be local or remote. The client is also a party use of a service, in theory, the client can be anything. Clients interact with the service by sending and receiving messages, client always use a proxy forwards the call to service [5].

Service provided to presentation layer in the client, is based on the form of a data service, which has nothing to do with the specific coding languages and technologies. So when we expanding the system and platform migration, we need only develop appropriate system terminal for a specific platform without requiring the development of a data services layer and other lower layers. That can greatly reduce the costs of system migration and expansion. Further, the creation of a service to the outside world is opaque, so that the external client does not know the internal details of the service. However the business logic layer of the traditional three-tier architecture is open to client, as a result, relatively speaking, this four-tier architecture has higher security.

## Application of the Four-tier Architecture

In order to verify the correctness and effectiveness of the proposed four-tier architecture, and prove its advantages. We achieved TV shopping integrated audio management platform based on previously studied four-tier architecture used Intel (R) Core (TM) i5-2320 CPU (quad-core, clocked at 3.00GHz), 8GB RAM PC machine, Windows 7 operating systems, combined with Visual Studio 2010 and SQL Server 2008 R2 and other development tools. The system architecture diagram is shown in Figure 3.
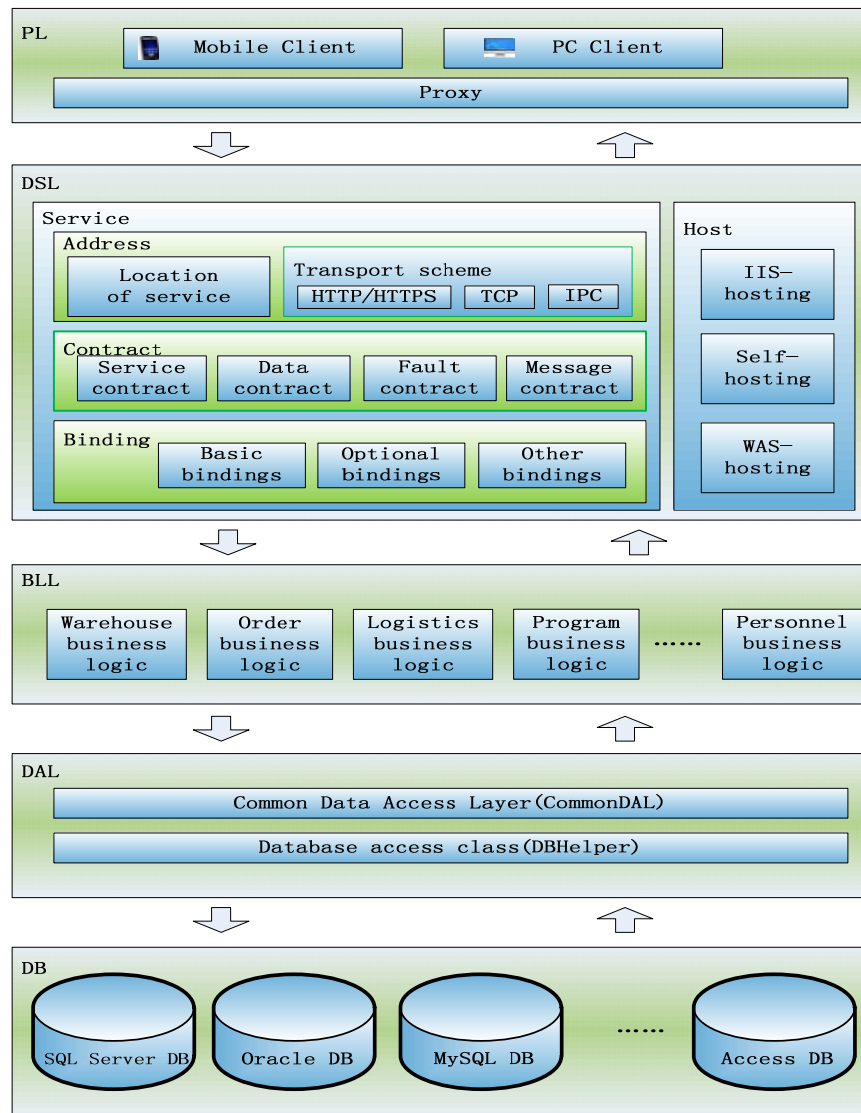
Figure 3. The system architecture diagram

The design of the data access layer using the idea of object-oriented programming was mainly based on factory pattern. We abstracted a database access module and designed a class called DBHelper to access the database, so that the system can face a variety of database.

The business logic layer contained all of the core businesses and the rules applied of TV shopping integrated audio management platform. According to the requests made by PL, BLL issued the corresponding requests to the DAL and returned the results to PL by a certain format. To ensure loose coupling between layers, the call for DAL was done through the interface that has nothing to do with the specific data access logic. The concrete realization of the need to modify the data access layer, as long as it does not relate to the interface definition, BLL would not be affected in any way.

Data services [5] were deployment on a network server. DSL, as the buffer zone of PL and BLL, Implemented the functions of screening the clients out logical businesses, thus avoiding unnecessary risks. Service was made up of address contract and binding. Each service had a unique address, which contains two important elements, service location and the transport protocol or transport scheme for the transmission. The contract had nothing to do with the platform, and it's the standard way of describing functions of service. Bind grouped the data communication features together, which encapsulates such as the transport protocol, message encoding, communication mode, reliability, security, transaction propagation, and interoperability and other related options, making them consistent. Each service must be hosted in the hosting process.

We developed two types of clients – PC client running on the Windows platform and mobile terminal running on the Android platform. They were located at the presentation layer of the system.

Clients accessed service through a proxy.

Developing TV shopping integrated audio management platform using four-tier architecture had the following advantages.

1) The system's architecture is clearer. Coding logic is clear, and it is easy to manage and maintain.

2) Data services layer encapsulating business logic further, isolated presentation layer and business logic layer to further guarantee the safety of the system

3) Using the four-tier architecture design patterns can guarantee the multi-team simultaneous development, shortening the development cycle.

4) The system had good portability and scalability. Service provided to presentation layer in the client, was based on the form of a data service, which has nothing to do with the specific coding languages and technologies. If system needs add new terminal client, we need only develop appropriate system terminal for a specific platform. Getting date by called the original data services or Transferring data to the system underlying to process, basically does not need to make any adjustments to the data services layer and business logic layer and data access layer.

## Conclusion

In order to solve the problem of cross-platform applications based on different terminals, meet the needs of wide range of terminals' application, we analyzed the insufficiencies of the traditional three-tier architecture and then we used four-tier architecture with data services layer in the system development in this paper. Systems based on the four-tier architecture had better platform portability and the ability to support the mobile terminals. The four-tier architecture also had the advantages of high reuse, strong scalability, low coupling and high efficiency. In the future, development with the four-tier architecture will become more and more popular because of its advantages.

## Acknowledgement

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