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# A Method for Designing a Large-scale Application System Architecture That Supports Multiple Databases

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**Abstract**

The usage of the word Power quality in recent times acquired intensified interest due to the complex industrial processes. The usage of intelligent tools to improve power quality is increasing day by day, as assumption of present day power system as a linear model is unsatisfactory. This paper deals with analysis of Differential Evolution (DE), Hybrid Differential Evolution (HDE) and Variable Scaling Hybrid Differential Evolution for harmonic reduction in the source current with optimal tuning of PI controller gain values. Shunt Active power Filter is one of the better solution to suppress the source current harmonics which are induced into power system because of nonlinear loads. Current controller called HBCC is considered for gating operation of switches in Voltage Source Inverter. The Intelligent tuned PQ theory is used for reference current generation. The then obtained compensating currents are injected at point of common coupling for current disturbance mitigation. Simulations of MATLAB/SIMULINK environment of the present work shows the efficacy.

**Keywords**: Multiple database, compatible, system architecture, marketing 2.0.

## 1. Introduction

Marketing 2.0 is a software developed based on Oracle database with the same version (Marketing 2.0 Unified Software), deployed and implemented in 26 network provinces and headquarters, each with independent database systems. In order to break free from the single dependence on Oracle in Marketing 2.0 and achieve multi database adaptation under unified software, two key issues need to be addressed: the adaptation of Marketing 2.0 unified software to multiple databases, and the smooth migration from Oracle to multiple databases, ultimately achieving the following goals:

1) Each province can use different relational databases simultaneously, including continuing to use Oracle, but the Marketing 2.0 unified software does not need to be modified; 2) The headquarters and the provincial network can use different relational databases without affecting the data aggregation and distribution on the headquarters and provincial sides; 3) Each network province can smoothly switch from one database to another without affecting the development of marketing business.

To address the issues of multi database adaptation and smooth migration in the Marketing 2.0 system, this paper proposes a design method for a large-scale application system architecture that supports multiple databases to address compatibility and interoperability challenges between different databases. The main contributions of this paper are as follows:

1) A bidirectional adaptation system architecture based on abstract data access layer method has been designed, with a unified data access method that can flexibly adapt to multiple databases.

2) A data model design method for equivalent translation is proposed to provide model support for structural migration and data synchronization between multiple databases.

3) Based on the system architecture proposed in this article, pilot units are selected for scenario simulation and demonstration verification, providing practical basis for supporting the migration and replacement of the entire business 2.0 system business to domestic databases.

## 2. Related Work

### 2.1 Database system architecture design methods

In today's scientific research and industrial practice, the design method of large-scale application system architecture that supports multiple databases has become a highly concerned research field. With the rapid development of information technology, more and more enterprises and organizations are facing the complexity and challenges of data management when building massive application systems [1]. In this context, designing a suitable system architecture is crucial. The system architecture design method that supports multiple databases has received widespread attention due to its ability to effectively address the complexity of data storage, processing, and management [2]. The research background of this method involves multiple aspects such as the development of distributed systems, challenges of data heterogeneity, requirements for data consistency and reliability [3], performance optimization and load balancing, as well as cloud computing and microservice architecture. Therefore, in-depth research on the design methods of large-scale application system architecture supporting multiple databases is of great significance for promoting the development of information technology, improving system stability and performance, and meeting user needs

There are various methods for designing database system architecture, and the following are some common methods: 1) Requirement oriented approach: Use case driven design (UDD) designs the system structure based on system requirements and use cases. Requirement driven architecture design (RDD) closely integrates system architecture design with requirement analysis, and constructs system architecture from the perspective of requirements [4,5]. 2) Model driven approach: Model oriented architecture design (MDA), which uses executable models as the foundation of architecture design. Model Driven Architecture Design (MDD) guides the design and implementation of system architecture through models [6]. 3) Layered approach: The layered system architecture divides the system into different layers, each responsible for specific functions such as data access layer, business logic layer, and presentation layer [7,8]. 4) Service oriented approach: Service oriented architecture (SOA) designs systems through the concept of services, making them modular, loosely coupled, and reusable. 5) Architecture style: The client server model divides the system into client and server sides, achieving distributed computing and data processing. The publish subscribe model uses a messaging mechanism, where publishers publish messages and subscribers receive messages of interest.

In recent years, database architecture has also been continuously developing and evolving. With the increasing amount of data and the diversification of application scenarios, distributed database systems have become increasingly important. In recent years, database architecture methods for distributed environments have been widely studied and applied, such as database systems based on distributed transactions, distributed data storage and processing systems, etc. The rise of cloud computing has also driven the development of cloud databases. The cloud database architecture method not only considers the characteristics of traditional database systems, but also takes into account the characteristics of elasticity, scalability, and high availability in the cloud environment, such as the database architecture method based on cloud native technology.

But we believe that existing system architecture methods may overlook adaptability to new technologies and complexity, leading to limitations in application scenarios. This article proposes a system that is compatible with multiple database architectures, aiming to address the compatibility and interoperability challenges between different databases. Its flexibility and adaptability enable the system to select the most suitable database based on different needs and scenarios, without being limited by specific technology choices. This flexibility enables the system to better adapt to constantly changing business needs and technological environments, providing a foundation for the sustained development of the system.

### 2.2 System design compatible with multiple database architectures

Designing a system that is compatible with multiple database architectures may be more challenging, as different database architectures typically have different characteristics and ways of working, as shown in Figure 1. However, some design methods can be adopted to achieve this goal. Through the abstract data access layer and database middleware, the system can hide the differences in the underlying database, reduce the coupling between different parts of the system, and improve the maintainability and scalability of the system. In addition, a system design scheme that is compatible with multiple database architectures can also improve the resource utilization of the system. By dynamically selecting and switching appropriate databases, the system can more efficiently utilize resources, improve system performance and throughput. Designing a reasonable data synchronization and conversion mechanism can ensure data consistency and accuracy between different databases, and improve the data reliability of the system.

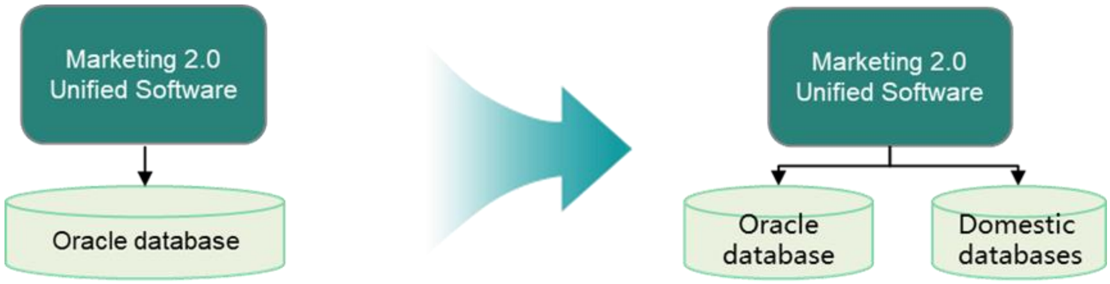


Figure 1 A system design solution that is compatible with multiple database architectures.

A system design that is compatible with multiple database architectures can make technology upgrades and migrations easier. Traditional databases often have high coupling, and once a certain database type is selected, it is difficult to replace or upgrade. A system design that is compatible with multiple database architectures can choose a more suitable database type based on actual needs without affecting the overall stability of the system, achieving continuous technological upgrades and migrations. Simultaneously, multiple compatible systems can choose database types with better performance based on different scenarios [9]. For example, when dealing with large amounts of structured data, relational databases can be chosen, while when dealing with massive amounts of unstructured data, NoSQL databases can be chosen to achieve better performance optimization and resource utilization.

This article is guided by the theory of functional equivalence and proposes a system that can support the unified software of Marketing 2.0 and is compatible with multiple database architectures [10]. The migration method system is constructed from four aspects: planning and design, migration and transformation, migration verification, and online operation. In the domestic database environment, research was conducted on the system architecture, database architecture, and data model design methods for Marketing 2.0. At the same time, a simulation environment was constructed for benchmark testing, scenario testing, and high availability testing to verify the performance and adaptability of the database under different conditions.

## 3. Proposed Method

In terms of the system architecture design method for the application of domestic databases in Marketing 2.0, guided by the theory of functional equivalence, this paper analyzes the current situation of the Marketing 2.0 system architecture and designs a bidirectional adaptive system architecture based on the abstract data access layer method. It can not only support the unified software of Marketing 2.0, but also accommodate multiple databases[11]; In the design of a unified database access gateway, according to functional equivalence requirements, multiple adaptive design methods for database architectures based on adapter patterns are proposed to achieve flexible adaptation of Marketing 2.0 to different database architectures[12]; In the design of a unified database access gateway, a data model design method for equivalent translation is proposed according to functional equivalence requirements, providing model support for structural migration and data synchronization between multiple databases[13,14].

In order to make Marketing 2.0 compatible with multiple databases and maintain a unified software with bidirectional adaptation capability, the system architecture of Marketing 2.0 developed based on Oracle needs to be improved to better adapt to multiple database systems[15]; Need to study the system database architecture to make it compatible with multiple database architectures; Further improvement of the system data model is needed to enable it to obtain support from heterogeneous databases[16]. At the same time, in order to achieve the system architecture of Marketing 2.0 that can bi-directional adapt to multiple databases, it is necessary to study the unified database access gateway technology, build a compatible access channel to heterogeneous databases, and automatically translate data requests from the original Oracle syntax specification of the unified software into requests supported by the target database, in order to achieve the goal of Marketing 2.0 unified software adapting to multiple databases[17-19]. The specific research content includes: Targeting Marketing 2.0, studying the syntax differences between domestic databases and Oracle. Based on this, further research will be conducted on a unified data access technology that is compatible with multiple databases, to achieve automatic translation of data requests.

**3.1 System architecture for bidirectional adaptation of multiple databases**

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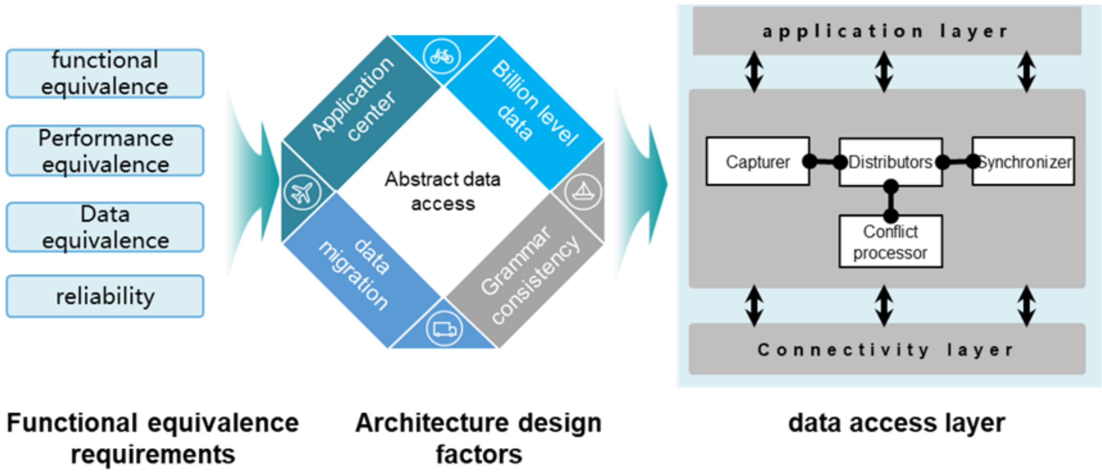


Figure 2 System architecture design method for domestic database application in marketing 2.0

The specific 2.0 application database architecture method is shown in Figure 3-1. According to the basic principle of functional equivalence, if the marketing 2.0 architecture is replaced with a database, it will result in a large amount of code modifications for front-end and back-end microservices, as well as debugging work after code modifications, which poses certain risks [20].

Facing complex marketing 2.0 systems is not simply replacing Oracle databases with a domestic database, but rather achieving bidirectional adaptation of the same business system to multiple databases. Figure 3 shows a comparison of marketing structures before and after the replacement.

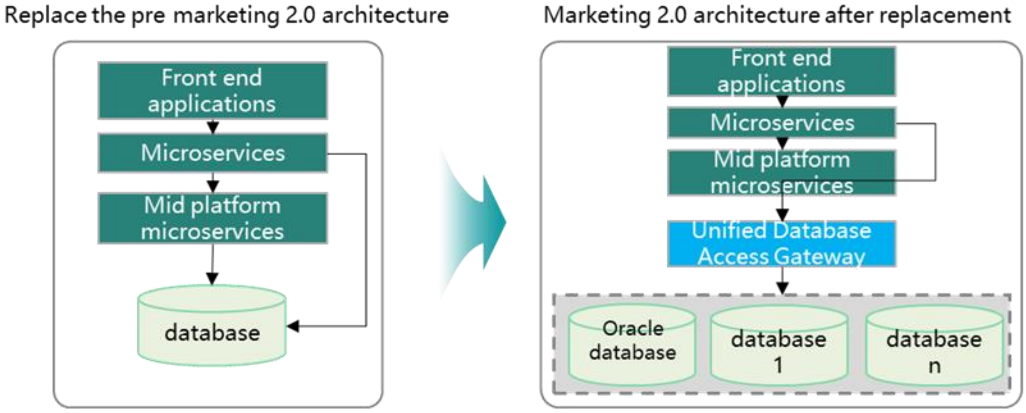


Figure 3 Comparison of marketing 2.0 architecture before and after replacement

According to the requirements of functional equivalence, the bidirectional adaptation system architecture based on the abstract data access layer method should have architecture factors such as unchanged application platform, efficient and fast migration of billions of data, real-time synchronization of data, consistency in syntax processing, and heterogeneous data migration methods after replacement in terms of functionality, performance, data, and reliability, so that the abstract data access layer can match the architecture design requirements of domestic database replacement[21,22]. After the design of the bidirectional adaptation system architecture based on the abstract data access layer method is completed, it is applied to Marketing 2.0 to establish a unified database access gateway layer between the middle platform microservices and the database system. By using the unified database access gateway, the coupling relationship between the Marketing 2.0 business system and the database system is changed, thereby breaking away from the single dependence on Oracle and adapting to multiple databases. At the same time, according to the requirements of performance and data equivalence, analyze the existing database deployment, database architecture, and data storage of Marketing 2.0, identify the influencing elements of database architecture design, and provide current input for database architecture design.

Database deployment: Each province independently deploys a database system, divided into three independent databases: the core database, accounting database, and electricity fee database. Jiangsu will independently deploy the business expansion measurement, customer service, and IoT in the core database.
Database architecture: Each database is deployed as an ORACLE RAC cluster, with the core database deployed as a set of two node RAC clusters, and the accounting and electricity databases sharing a set of two node RAC clusters [23].

Database storage: Each database contains database users from multiple business centers, and the core database includes 23 users including customers, users, products, and business expansion centers; The accounting database includes six users in the billing, trial calculation[24], and accounting centers; The electricity bill database includes 7 users, including billing, payment, and data sharing. The specific model design architecture is shown in Figure 4.

**3.2 Unified database access gateway**

In the design of a unified database access gateway, multiple adaptive design methods for database architectures based on adapter patterns are proposed according to functional equivalence requirements. Use proxy classes to manage multiple database instances, clusters, and global settings, ensuring that the system can flexibly adapt to different database architectures. By using the adapter pattern, specific adapters are customized for each database architecture to achieve transparent access and operation of various databases, while maintaining system scalability and maintainability [25].

The adapter adapts to multiple database architectures through the main proxy class. Instance proxy class: manages connection instances, collects status of computing nodes, statistics alarm information, and handles exceptions of computing nodes. Cluster proxy class: Implement the management and maintenance of cluster metadata, data nodes, and computing nodes under various database architectures. Global proxy class: Global transaction coordination center, used to assist computing nodes in distributed transaction management, mainly including generating and releasing global transactions.

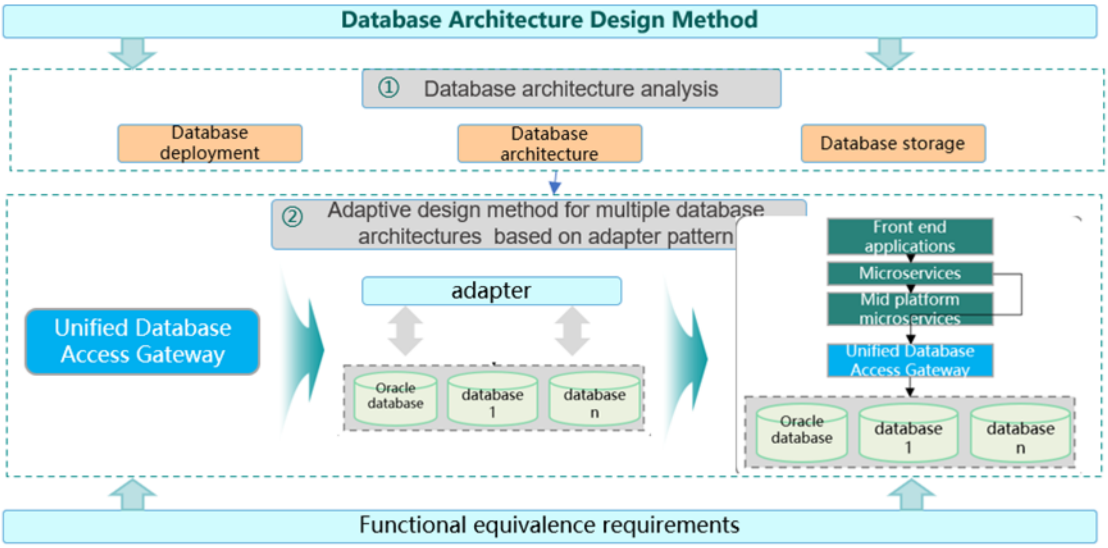


Figure 4 Design method of data model for marketing 2.0 application of stock production database

The Marketing 2.0 data model involves three aspects: business objects, logical models, and physical models. According to functional equivalence requirements, each component is studied and analyzed, and the model design elements that affect the application of Marketing 2.0 in domestic databases are ultimately extracted. At the same time, when processing data models in Marketing 2.0, the business object part is logically processed through Java like methods,

The logical model is related to business functions, data flow, business logic, etc. This project proposes a bidirectional adaptation method for multiple databases without changing the design content of the logical model. Therefore, when adapting to multiple databases, the logical model maintains consistency with the existing logical model in Marketing 2.0. When migrating from Oracle databases to multiple databases, the requirements for the physical model vary due to differences between databases. When adapting to domestic databases, it is necessary to design and optimize the different physical models.

After analyzing the constituent elements of the Marketing 2.0 data model, the physical model is the influencing factor for migrating to the target database. During the migration process, the physical model involves tables, attributes, views, functions, SQL statements, etc. In the design of a unified database access gateway, according to functional equivalence requirements, a data model design method for equivalent translation is proposed, as shown in Figure 5, to solve the data mapping and syntax translation problems of heterogeneous databases and provide method guidance for smooth data migration.

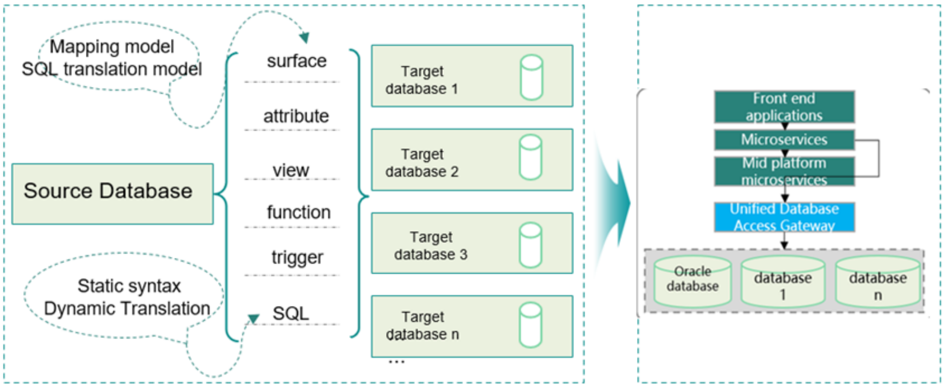


Figure 5 A Data model design method for equivalent translation

### 3.3 Summary

This section proposes a bidirectional adaptation system architecture based on the abstract data access layer method, which supports multiple databases, changes the coupling relationship between the marketing 2.0 business system and the database system, and thus eliminates the single dependence on Oracle and adapts to multiple databases. At the same time, in response to the current situation of marketing 2.0 database architecture, multiple adaptive design methods for database architectures based on adapter patterns are proposed. Through adapter patterns, specific adapters are customized for each database architecture to achieve support for multiple database architectures. Finally, a data model design method for equivalent translation is proposed, which enables the transfer of data models from Oracle to the target database, while maintaining the same business objects and logical models, to achieve structural transfer and data synchronization between the source database and the target database.

## 4. Experiments

In terms of methodology for replacing domestic database migration, a migration method system is constructed from four stages: planning and design, migration transformation, migration verification, and online operation, providing methodological guidance for the replacement of domestic database migration. In terms of heterogeneous database migration technology from Oracle to domestic databases, build database migration tools (structure migration, data migration) and SQL traffic replay components to provide tool support for demonstration verification. In terms of stress simulation testing for the Marketing 2.0 system in a domestic database environment, a performance evaluation index system for domestic databases is constructed from the aspects of time efficiency, resource utilization, and scenario validation. At the same time, stress simulation testing is carried out in the simulation environment. In selecting typical scenarios for domestic database migration demonstration verification in Marketing 2.0, pilot units were selected for scenario simulation verification to carry out demonstration environment construction, business migration verification, business code transformation, data migration transformation, and other work.

In response to the typical business scenarios of high concurrency, massive data, and high reliability in Marketing 2.0, research on migration methods is conducted from four aspects: planning and design, migration and transformation, migration verification, and online operation. A migration prototype tool and evaluation index system are implemented, and four pilot provinces are selected to carry out demonstration verification work. Design a migration replacement methodology for typical scenarios of domestic databases in the application of Marketing 2.0. Construct a migration methodology in detail from four aspects: planning and design, migration transformation, migration verification, and online operation, providing an overall work framework and theoretical guidance for database migration replacement. As shown in Figure 6.

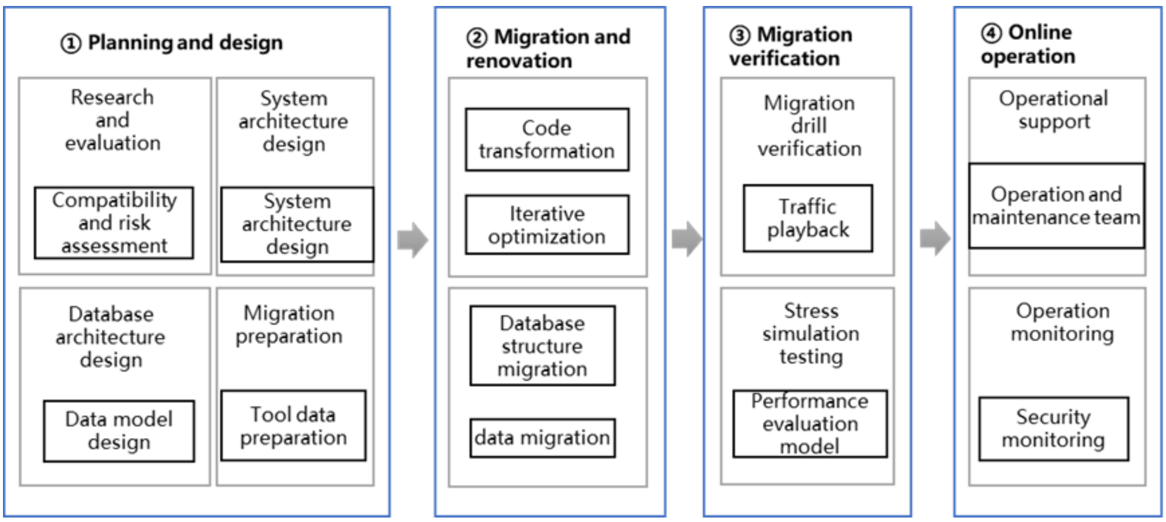


Figure 6 Migration and replacement methods in typical scenarios of domestic database application in marketing 2.0

### 4.1 Prototype tools

The heterogeneous database migration technologies from Oracle to domestic databases mainly include the following. Structure migration component: Based on the "O-Chinese" translation rule library, it realizes the migration of database objects, and implements phased migration of fields, primary and foreign keys, and indexes through migration strategies, ensuring the efficiency of subsequent data migration. Data migration component: Read migration data in batches from Oracle database, and migrate it to domestic databases through sharding and multitasking. With the help of migration logs, provide breakpoint continuation migration function to support reliable and efficient migration of large-scale data tables. Traffic playback component: modeled after traffic recording (mirroring) technology, real-time SQL statements are obtained from Marketing 2.0, using a pattern recognition based SQL translation model to automatically translate SQL statements into the target database language for execution. The specific schematic diagram is shown in Figure 7.

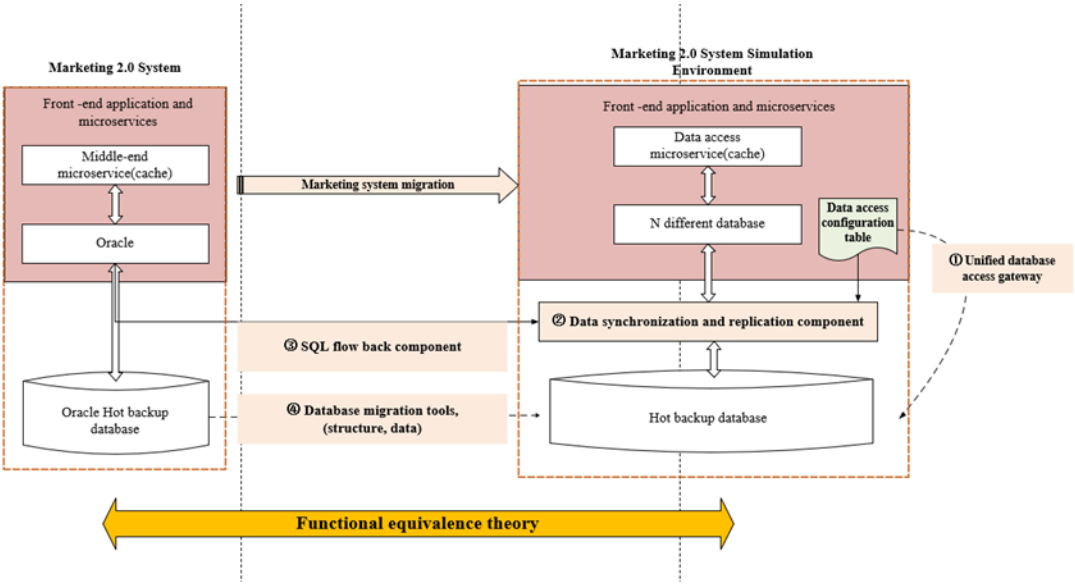


Figure 7 Schematic diagram of the database migration technology prototype tool

### 4.2 Stress simulation testing

Establish a simulation environment based on the key research content and prototype tools of topics 1 and 2, and conduct benchmark testing, scenario testing, and high availability testing in the simulation environment. Collect evaluation indicators and finally use the entropy weight method to obtain a comprehensive evaluation of the domestic database's support for Marketing 2.0 business.

### 4.3 Demonstration verification

Based on the complex and highly concurrent electricity bill direct collection platform interface, customer 360 view, and contract information interface, database localization replacement and transformation are carried out. Through steps such as demonstration environment preparation, system migration and transformation, database migration, and migration drill verification, the migration demonstration and verification from Oracle database to domestic database are achieved. State Grid Zhejiang Electric Power Co., Ltd., State Grid Shandong Electric Power Co., Ltd., State Grid Anhui Electric Power Co., Ltd., and State Grid Hubei Electric Power Co., Ltd. are selected for scenario simulation, providing practical basis for supporting the migration and replacement of full-scale marketing 2.0 system business to domestic database. The flowchart is shown in Figures 8.

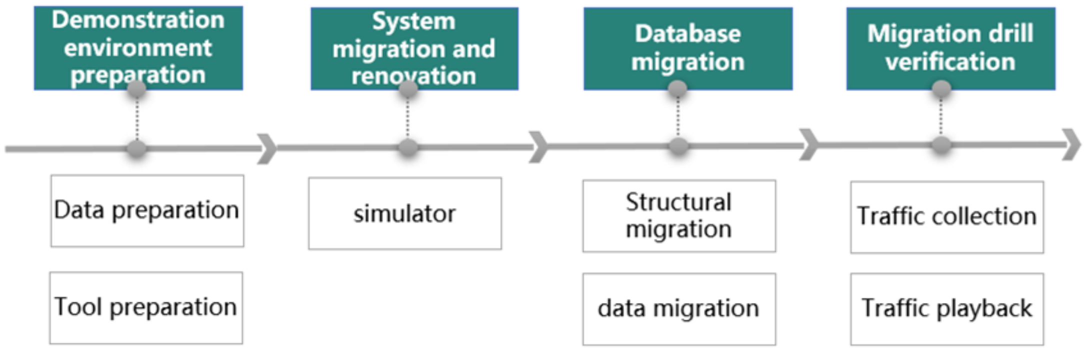


Figure 8 Example validation flowchart.

## 5. Conclusion

For typical business scenarios with high concurrency, massive data, and high reliability in Marketing 2.0, this article constructs a migration method system from four stages: planning and design, migration and transformation, migration verification, and online operation, providing method guidance for supporting the migration and replacement of the entire Marketing 2.0 system business to domestic databases. We provide tool support for demonstration verification based on structural migration components, data migration components, and SQL traffic replay components. We propose a design method for a large-scale application system architecture that supports multiple databases. Based on this architecture, we establish a simulation environment for the key research content and prototype tools of Marketing 2.0 architecture, database architecture, and data model design under the conditions of domestic databases. Benchmark testing, scenario testing, and high availability testing are conducted in the simulation environment to comprehensively verify the responsiveness, high concurrency support, and scenario adaptability of the database. At the same time, we also selected pilot units for scenario simulation verification and carried out demonstration verification work, providing practical basis for supporting the migration and replacement of comprehensive marketing 2.0 system business to domestic databases.

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