Research on Data Synchronism Method in Heterogeneous Database Based on Web Service

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Abstract. As the synchronism effect of traditional methods is poor, the research on data synchronism method in heterogeneous database based on Web Service is proposed. Based on the structure of heterogeneous database, the synchronous execution flow is designed, and HTTP based SOAP transport protocols and XML standard are used to encode the data uniformly, the data source can be added or deleted at any moment. By decomposing the SQL statement in synchronous control module of heterogeneous database, the results data returned are converted into XML format with XML conversion function and are returned to uniform Web Service interface. The data synchronization in heterogeneous database based on Web Service is achieved through the local temporary table and its copy of source database. Through the comparative experiment, the following results can be concluded: the synchronism effect of data by data synchronism method in heterogeneous database based on Web Service reached 97%, which met the requirements for dealing with normal business in synchronism application system.

Keywords: Web Service · Heterogeneous database data · Synchronization

1 Introduction

With the development and expansion of modern enterprises, the integration, sharing of enterprise data and the integration of enterprise information have become increasingly important. In the process of information construction, many enterprise departments have established information application systems. However, due to the lack of unified information construction plan, the departments are independent of each other, the software system platform is inconsistent, the data standards are not uniform, and the interface is not perfect. Information between departments can not be shared and shared in time, thus forming information islands. Important enterprise information is generally stored and managed through different database systems, such as Sybase, DB2, Oracle, SQL Server, etc. Meanwhile, due to problems in interoperability, data islands are formed between different data sources; the basic operating system of heterogeneous

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database can be UNIX, Windows XP, Linux; the heterogeneity of computer architecture, each participating database can be run on mainframes, minicomputers, workstations, PCs or embedded systems [1]. The heterogeneity of these heterogeneous database systems will adversely affect the information sharing of the system and hinder the resource sharing within and among enterprises. Therefore, how to effectively implement data sharing is one of the urgent problems in current development of information technology.

The traditional data synchronization method has strong autonomy, neither unified global mode nor local federation mode, which leads to poor transparency. Therefore, users must seek a new data language [2]. For the application environment with physical isolation gatekeeper, the reference [3] proposed a trigger-based SQL file-level heterogeneous database synchronization method, which is suitable for enterprise heterogeneous database synchronization. This paper will explain the working principle of heterogeneous database synchronization in the isolated gatekeeper environment, propose the overall framework of the synchronization system, and give the implementation details of the five steps of change capture, SQL file generation, file transfer, data update and fault handling. However, this method has a problem of poor synchronization. Reference [4] designed a new remote database synchronization mechanism, analyzed the process of application operation database, studied the method of capturing SQL from database connection driver, and proposed consistency check algorithm for data verification. But the synchronization effect of this method is not ideal. In view of the problem that data large-capacity communication often fails due to synchronization problems, the reference [5] analyzes the working principle of digital multiplex system, and explores the application of high-precision clock reference synchronization method at the transceiver end in clock correction, as well as bit synchronization and frame synchronization. The typical synchronization technique and verification of the data multiplexing process using FPGA simulation. However, this method takes a long time, but the final synchronization effect is poor.

Therefore, in order to realize the effect integration of information resources, the key is to realize the integration of heterogeneous databases. Through the analysis and research of Web Service, a data synchronization method in heterogeneous database based on Web Service is proposed, so that the data can be seamlessly communicated and shared in different heterogeneous databases, and the synchronization of data and structure changes can be ensured.

2 Structure Design of Heterogeneous Databases

For research on data synchronism method in heterogeneous database based on Web Service, the structure design of heterogeneous databases is conducted as Fig. 1.

As it's demonstrated in Fig. 1: the heterogeneous database architecture can be divided into three layers: user interface layer, integration processing layer, and database layer. The user interface layer is the interface between the system and the user. It is responsible for the registration of the integrated member database, the establishment of heterogeneous integration mode, receiving user input, and displaying query results. The integration processing layer is the core of the heterogeneous database system, including

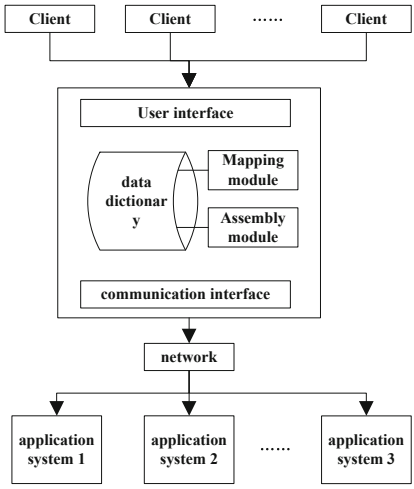

Fig. 1. Structure of heterogeneous databases

the central virtual database for user operations, data dictionary describing the data of each subsystem, data mapping module, data assembly module, and a communication interface. The integrated processing layer uses each function module and data dictionary to map the user's operation to the central virtual database as the operation to each subsystem. The distributed computing technology is used to return the results of each subsystem through the communication interface. The data assembly module is then assembled into the central virtual database, which is finally presented to the user. The member database of each application system is distributed in database layer, the physical operation of the database access is achieved to lay the foundation for data synchronization of heterogeneous databases.

3 Research on Data Synchronism Method Based on Web Service

According to the heterogeneous database structure designed above, the Web Service method is used to research the synchronization of heterogeneous database data. For different databases, access is required to use the data interface in the local system to connect to the database system, and to read data, and to establish corresponding Web Service for data integration calls. Because Web Services on different platforms or different database systems in different locations provide uniform data and consistent publishing methods to data integration in XML format, heterogeneous information of different database management systems can be shielded, so that data integration does not have to ignore the differences with databases. After obtaining the SOAP format information from heterogeneous data transmission centers, the heterogeneous databases are accessed to obtain the data from different database systems in XML format, and then these data are transmitted to heterogeneous transmission centers in the form of SOAP message.

3.1 Design of Synchronous Execution Flow

Synchronous execution flow is as follows:

① The underlying local data source firstly publishes the core database service, uses UDDI through the Web Service adapter to the heterogeneous data transmission center, which is registered in the intermediate database and is an initialization process;
② When the user has an operation request in the Web Service Unified Interface, the global SQL language is firstly transmitted to the control module through security mechanism, then optimized and converted into local SQL statement by the control module through its own SQL statement parser. The access to the intermediate database in the heterogeneous data transmission center in XML format through the XML converter is conducted;
③ If the database is not in the intermediate database, the structure synchronization process is performed. If there is an data change in the operation of the SQL statement, such as DML operation, the Web Service adapter call is used to update the relevant data in the database source, and performs the data synchronization process;
④ The operation result data is returned to the user in the form of XML by the XML converter in the control module.

This kind of loosely-coupled synchronous execution process based on Web Service can solve the problem of heterogeneous data integration across Intemet better. In this architecture, the data is uniformly encoded using the HTTP-based SOAP transport protocol and the XML standard, so that heterogeneous information is shielded. At the same time, data sources can be deployed dynamically and data sources can be added or deleted at any time [6].

3.2 SQL Statement Decomposition

According to the synchronous execution flow, the structure of the heterogeneous database data synchronization control module is designed. Its function is to analyze the SQL statements transmitted from the unified interface of the Web Service, determine whether the format is correct or not, check the syntax decompose into sub-SQL statements, and obtain the results after processing [4]. Heterogeneous database data synchronization control module is shown in Fig. 2.

As it's demonstrated in Fig. 2: the control module is composed of SQL statement parser, data assembler, and data converter. SQL statement parser can parse and verify SQL statements, decompose global SQL statements into sub-SQL statements for each local database, get the connection information and table information of the specific connection to the local database, then send these information to the event manager, and finally perform sub-SQL statement operations; Data assembler can post-process data, but because there may be schema conflict and intersecting data between different data sources, it is necessary to post-process data according to user requirements; the data converter returns the forwarder as a result, and the result data returned by the database are converted into an XML format through XML conversion function and returned to the Web Service unified interface [7].

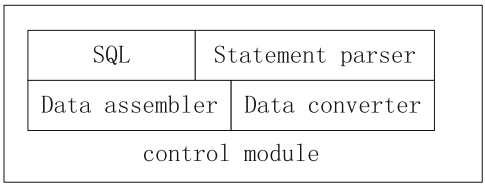

Fig. 2. Control module

3.3 Realization of Data Synchronism Method Based on Web Service

The SQL statement decomposed above is taken as method implementation statement to establish the local temporary table and copy of source database table [8]. The temporary table is generated based on the source database table information and the source table metadata in the base table, and the corresponding data is inserted into the intermediate database. When using by users, the data in the intermediate database is operated. After the data is used, the data in the intermediate database is compared with the copy. If there are changes, the remote database source should update the metadata through the event manager and Web Service adapter, which is shown in Fig. 3.

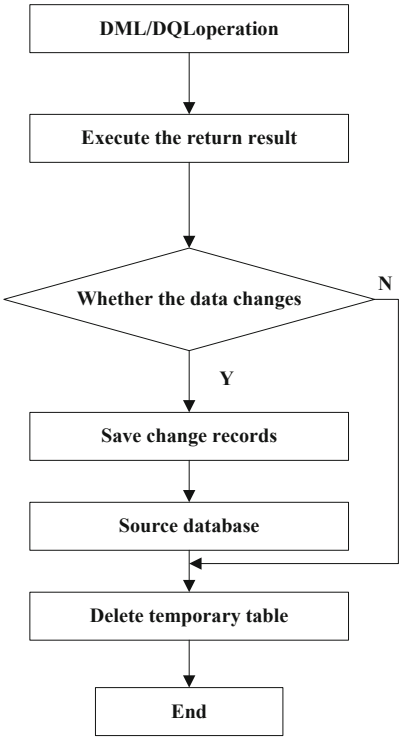

Fig. 3. Data synchronism process

When implementing server-side Web Service program, Delphi 7 Soap Server Application Wizard is used to create a Web Service-based application framework. The framework has implemented the mechanism for providing interfaces to clients, receiving and parsing remote Soap request messages, invoking corresponding processing functions and returning underlying functions such as Soap response messages. It is only necessary to define the custom interface for the client to call in this framework, and write the realization of data synchronization in heterogeneous database [9].

4 Experiment

In this paper, experiment is designed and analyzed for research on data synchronization method in heterogeneous database based on Web Service, and the effectiveness of the control method is verified through experiments, and then the efficient synchronization of heterogeneous database data is proved.

4.1 Experimental Analysis

Network Delay Impact Analysis
Under the influence of network delay, the data synchronization effects in heterogeneous databases by traditional method and Web Service method are compared. The results are shown in Fig. 4.

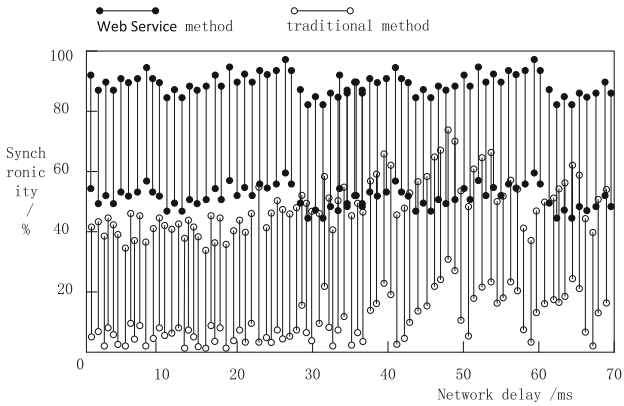

Fig. 4. Contrast of synchronization effect with network delay by two methods

As it's demonstrated in Fig. 4: When the network delay is 10 ms, the traditional method has a synchronization effect of 47%, and the Web Service method has a synchronization effect of 94%; when the network delay is 20 ms, the traditional method has a synchronization effect of 46%, and the Web Service method has a synchronization effect of 93%; when the network delay is 30 ms, the traditional method has a synchronization effect of 55%, and the Web Service method has a synchronization

effect of 97%; when the network delay is 40 ms, the traditional method has a synchronization effect of 77%, and the Web Service method has a synchronization effect of 89%; when the network delay is 50 ms, the traditional method has a synchronization effect of 77%, and the Web Service method has a synchronization effect of 95%; when the network delay is 60 ms, the traditional method has a synchronization effect of 71%, and the Web Service method has a synchronization effect of 97%; when the network delay is 70 ms, the traditional method has a synchronization effect of 67%, and the Web Service method has a synchronization effect of 87%. Under the influence of network delay, the traditional method has poor synchronization effect, while the Web Service method has better synchronization effect.

Clutter Interference Analysis

Under the influence of clutter interference, the data synchronization effect in heterogeneous databases by traditional method and Web Service method are compared. The results are shown in Fig. 5.

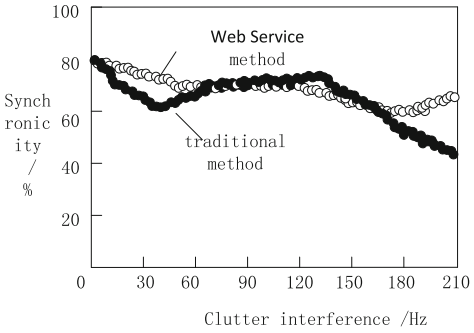

Fig. 5. Contrast of synchronization effect with clutter interference by two methods

As it's demonstrated in Fig. 5: when the clutter interference is 30 Hz, the synchronization effect of traditional method is 59%, and the synchronization effect of the Web Service method is 74%; when the clutter interference is 60 Hz, the synchronization effect of traditional method is 71%, and the synchronization effect of the Web Service method is 72%; when the clutter interference is 90 Hz, the synchronization effect of traditional method is 71%, and the synchronization effect of the Web Service method is 71%; when the clutter interference is 120 Hz, the synchronization effect of traditional method is 73%, and the synchronization effect of the Web Service method is 68%; when the clutter interference is 150 Hz, the synchronization effect of traditional method is 71%, and the synchronization effect of the Web Service method is 66%; when the clutter interference is 180 Hz, the synchronization effect of traditional method is 56%, and the synchronization effect of the Web Service method is 61%; when the clutter interference is 210 Hz, the synchronization effect of traditional method is 43%, and the synchronization effect of the Web Service method is 74%; when the clutter

interference is 30 Hz, the synchronization effect of traditional method is 59%, and the synchronization effect of the Web Service method is 74%. It can be concluded that under the influence of clutter interference, the traditional method has poor synchronization effect, while the Web Service method has better synchronization effect.

4.2 Experimental Results

① Under the influence of network delay, the Web Service method has better synchronization effect for data in heterogeneous databases than the traditional method;
② Under the influence of clutter interference, the Web Service method has also better synchronization effect for data in heterogeneous databases than the traditional method. Therefore, the data synchronization method of heterogeneous database based on Web Service is feasible and effective.

5 Conclusion

In order to make the data synchronization method in heterogeneous database be applied and perfected in practice, many subsequent studies are needed. The future research work focuses on the construction of interregional federal systems. How to build a federal system on multiple data systems in multiple integrated regions is the focus of the next step. The model needs to be improved so that the model can handle a variety of complex business and enhance the practical application of the system.

References

1. Kuang, Y.C., Wang, F., Wei, L.H., et al.: Research on the bottom hole flow field analysis platform of PDC bit based on Web service. Chin. J. Eng. Des. **24**(4), 380–386 (2017)
2. Lai, Q.J., Xu, Z., Chen, D., et al.: Architecture of HVDC transmission design software based on WEB service. China Power **51**(2), 75–81 (2018)
3. Cui, H.X., Feng, J., Ma, W.J., et al.: Research and implementation of heterogeneous database synchronization based on netgap. Softw. Eng. **19**(2), 10–13 (2016)
4. Ding, J.L., Zhou, D.X., Wang, J., et al.: Remote database synchronization mechanism based on SQL capture from connection driver. Comput. Eng. **43**(9), 39–42 (2017)
5. He, S.T., Xue, L.S., Chen, X.H., et al.: Research on digital multiplex system with FPGA. Fire Control Command Control **41**(8), 37–40 (2016)
6. Pan, M.M., Li, D.D., Tang, Y., et al.: Design and implementation of accessing hybrid database systems based on middleware. Comput. Sci. **15**(5), 21–24 (2018)
7. Zhao, L.S., Li, G.Y., Wu, Z.Y., et al.: Historical data archiving technology based on hierarchical heterogeneous database system. Telecommun. Sci. **12**(s1), 21–22 (2018)
8. Liu, M., Li, Z.B., Xiong, T.: Simulation research of incomplete information optimization detection in heterogeneous database. Comput. Simul. **15**(11), 390–394 (2017)
9. Wu, L.H., Lu, Z.M., Gong, J.S., et al.: Integrating distributed heterogeneous food microorganism data by semantic web technology. China Biotechnol. **37**(3), 124–132 (2017)