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Integrated Management of Potential Financial Risks Based on Data Warehouse

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Abstract: A data warehouse is used to manage an enterprise's vast data sets, providing a storage mechanism to transform data, move data, and present it to end users. This paper introduces the challenges and changes facing the financial industry in the Internet era, and the new needs for data warehouse architecture transformation. The traditional data warehouse architecture has many limitations in the utilization of storage space, computing power and processing of real-time data flow, which is difficult to meet the needs of the rapid development of financial services. Therefore, there is an urgent need for financial institutions to transition from traditional warehouses to cloud-based distributed data warehouses. As a new-generation distributed data warehouse service, Huawei Cloud GaussDB(DWS) has the features of high performance, low cost, and easy expansion, meeting the needs of financial warehouses in the era of big data. The paper also introduces the traditional mode of financial risk management system and the related work of data warehouse, as well as the methodology and concrete implementation cases of financial data warehouse transformation.

Keywords: Data Warehouse, Financial Risk, Huawei Cloud GaussDB(DWS), Big Data.

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1 INTRODUCTION

In the Internet era, the financial industry is facing many challenges and changes, including trends such as financial disintermediation, diversification of service channels and diversification of financial services. These changes have made the operating environment for financial institutions more complex. In this context, financial institutions need to re-examine and construct their understanding of customer behavior patterns, information security, the new normal of economic development and the international environment. [1] The resulting risks have also become more complex, diversified and diffuse, so the difficulty of risk management has also increased, the risk control management mechanism needs to be redesigned, and the risk management organizational structure is also facing the challenge of restructuring and adjustment.

In the financial business, the data warehouse plays a core role, supporting the normal operation of the banking debit card, finance and other core business systems. However, traditional data warehouse architectures face many challenges, including limitations in storage space utilization, computing power, and handling real-time data streams. With the rapid development of distributed cloud computing architecture, traditional warehouse can no longer meet the rapid development needs of financial services [2].

Therefore, the transformation from traditional warehouse to cloud-based distributed data warehouse has become a new demand for financial institutions. A new generation of distributed Data Warehouse Service (DWS) came into being. Based on Huawei GaussDB, DWS has features such as high performance, low cost, and easy expansion, meeting the needs of financial warehouses in the era of big data

RELATED WORK

2.1 Traditional Financial Risk Management System

The traditional financial risk management system takes internal risk control and regulatory compliance as risk management principles, and establishes risk management objectives, identifies risk events, evaluates risks, formulates risk response strategies and improvement measures, and establishes risk reporting systems as risk management steps. [3-6] The traditional financial risk management organization structure is based on three lines of risk management, namely, the functional departments and business units are the first line of defense, the risk management committee and the risk management department are the second line of defense, and the audit committee and the internal audit department are the third line of defense. Among them, the organizational structure of risk management follows the principles of risk classification management, risk stratification management and risk centralized management [7].

The traditional financial risk management system takes internal control and compliance as the process orientation, and the three lines of defense rely on the supervision and control of key personnel, but it cannot avoid the losses caused by the favoritism and fraud of key personnel. Although the traditional financial risk management system emphasizes the combination of quantitative and qualitative measurement methods to assess risks, it mostly relies on monitoring rules and specific indicators, and lacks the application of advanced measurement methods. In the Internet era, the boundaries of financial risk management have been greatly expanded, and new risk forms have emerged endlessly, such as illegal fund-raising, private placement, abuse of personal information, and shadow banking system. For example, the "fake financial management" case of Minsheng Bank: [8-9] In April 2017, the president of Hangqiao Sub-branch of Minsheng Bank Beijing Branch was suspected of falsifying financial products, and more than 150 high-end clients of private banks bought fake financial products with a scale of 3 billion yuan known as "capital and interest protection". Hanging Bridge branch president suspected of illegal investigation by the public security department.

The case shows that the traditional financial risk management system fails to identify the loopholes in the internal control mechanism and internal control management, and even fails to adopt effective risk early warning, risk avoidance, and risk mitigation strategies, resulting in the occurrence of major risk events [10].

With the increasingly complex internal and external environment faced by financial institutions and the diversification of financial business, the possibility of risk occurrence and the degree of impact are also increasing. How to deal with diverse and complex financial risks under the new situation has become an urgent proposition for the traditional financial risk management system to consider. Enterprise managers should actively explore and adopt innovative technological means to evaluate, avoid and predict financial risks, and transform the existing risk management system to meet the requirements of market environment, regulatory system and their own risk control.

2.2 Data Warehouse

Data warehouses play a central role in business intelligence systems by collecting, integrating, and analyzing data from a variety of data sources. In the late 1980s, [11] IBM researchers Paul Murphy and Barry Devlin pioneered a business-specific approach to meeting an organization's information needs.

In 1970, Nielsen and IRI [12] introduced the concept of a retail dimensional data mart, and in 1983, Teradata introduced a database management system specifically designed for decision support. However, the first enterprise data warehouse appeared in the late 1980s, developed by Paul Murphy and Barry Devlin of IBM. This milestone marks a significant change in data management and its application to informed business decisions. Its innovative architecture facilitates the flow of data from enterprise operating systems to decision support environments, marking the origin of the data warehouse concept.

Since its inception, the concept of data warehousing has been closely related to data-driven decision making and the efficient use of enterprise data. Therefore, a data warehouse is defined as a data storage and integration architecture that facilitates the organization, transformation, understanding, and management of data to make better business decisions.

The use of data warehousing has become an essential part of the proper functioning of a company, combining data storage capabilities with a decision-making process based on data analysis, also known as "data-driven decision making.

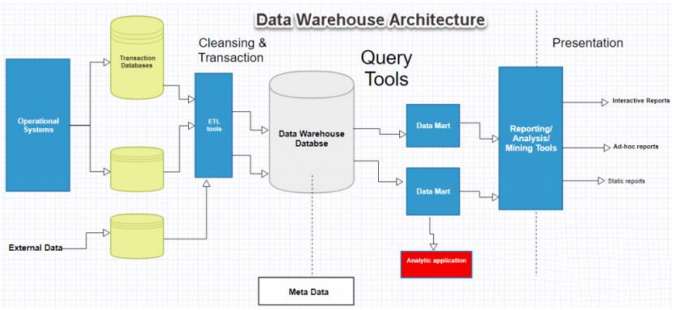

Figure 1. Data warehouse architecture diagram

It is a data integration environment that combines technologies and components to store, query, and analyze large amounts of data, transforming it into valuable and accessible information for users [14]. Unlike a company's operational database, a data warehouse allows access to both historical and current data, facilitating informed decision making. Data warehousing also refers to the process of collecting and managing data to extract valuable information.

A data warehouse can be in two states:

1. Offline: Data is copied from one operating system to another. Loading, processing, and reporting do not affect the performance of the operating system.

2. Online: Data is updated periodically from the operating database. For a real-time data warehouse, updates occur every time a transaction occurs in a relational database, such as in a train or airplane reservation system.

2.3 Data warehousing and financial risk

As the core of mass data aggregation, storage and analysis in the banking industry, data warehouse plays a vital role in supporting the normal operation of core business systems such as debit cards and finance in the banking industry. In the early years, most domestic financial institutions have launched traditional data warehouse architecture such as Teradata data warehouse or Oracle database (collectively referred to as "warehouse") [15].

After years of development, with the rapid development of distributed cloud computing architecture, traditional warehouse has been difficult to meet the requirements of the rapid development of financial services, facing many challenges, such as the peak of storage space utilization, computing power overload, daily batch window limit, poor scalability, inability to handle real-time data flow, and high hardware and software upgrade and expansion costs.

The transformation from traditional warehouse to cloud-based distributed data warehouse has become a new and necessary demand for domestic financial institutions. [16-17] A new generation of distributed Data Warehouse Service (DWS) based on Huawei GaussDB has come into being. As an enterprise-level data warehouse service on the cloud, DWS has the characteristics of high performance, low cost, easy to expand, etc., which meets the demands of financial warehouse in the era of big data.

The key to the transformation from traditional warehouse to DWS is the whole-process data migration service. Due to the high complexity of data migration, the wide range of migration, the lack of DWS data migration professionals, no experience to follow and other reasons, data migration is often faced with the challenge of not advancing as scheduled, or the migration effect is not up to expectations.

For example, a data migration involves at least 1000+ tables, 10000+ jobs, petabytes of data, complex association between database tables, need to be carefully sorted out, reasonable allocation of migration batches, in order to reduce business impact; [18] Data migration involves the collaboration of more than 10+ business departments, applications and platforms, and requires coordination, joint verification, and multi-party collaboration throughout the whole process of data migration projects. With the extremely high migration complexity, most enterprises lack internal personnel familiar with DWS data architecture transformation. In the face of the new needs of DWS data architecture transformation, the industry can learn from a low degree, and the enterprise can follow the "0" experience.

In short, the DWS data warehouse migration and reconstruction project of financial institutions has many challenges, such as large differences in underlying platforms, large amount of migrated data, numerous migration tasks and associated upstream and downstream systems, and unpredictable pressure. In addition, in order to ensure the smooth implementation of the project, the project team should follow the implementation cycle of data migration services in the whole process from migration research, planning and design, delivery and implementation to acceptance assurance, and smooth transition from serving financial business to integrated data in the whole process, so as to help financial institutions achieve data reconstruction, business expansion, cost reduction and other goals.

The transformation from traditional data warehouse to cloud-based distributed data warehouse has become a new demand for financial institutions. [17-19] A new generation of distributed Data Warehouse Service (DWS) based on Huawei GaussDB has come into being. As an enterprise-level data warehouse service on the cloud, DWS has the characteristics of high performance, low cost, easy to expand, etc., to meet the needs of financial data warehouse in the era of big data.

However, the transformation and refactoring project of traditional data warehouse to DWS faces many challenges, including differences in the underlying platform, large amount of migrated data, numerous migration tasks, and the association with upstream and downstream systems. In order to ensure the smooth implementation of the project, the project team should coordinate, jointly validate and collaborate with multiple parties throughout the implementation cycle of the migration service to help financial institutions achieve data restructuring, business expansion and cost reduction goals.

3 METHODOLOGY

Huawei Cloud Data Warehouse, as the representative, integrates and analyzes all business data through its powerful storage and computing capabilities to achieve accurate information extraction, and is setting off a round of industry changes in the banking industry from traditional data warehouses to accelerate the migration to cloud-native data warehouses. Therefore, financial institutions need to grasp the following four core steps to deploy DWS: environment preparation, solution selection, service migration, and data migration [20].

3.1 Data Environmental preparation

Finance, as a highly digital industry, has taken the lead in realizing the integration of data and AI. In order to fully stimulate the value of data, Huawei Cloud provides a data and intelligence fusion platform to solve the data governance problems caused by data non-communication between lakes, warehouses, and AI. Through unified storage, unified metadata and other capabilities, a piece of data can be transferred at high speed between multiple engines. The Industrial and Commercial Bank of China began to explore data analysis based on Huawei Cloud data fusion platform, and the average waiting time for data query was reduced from 300 minutes to 1.5 minutes, and the efficiency of data analysis was greatly improved.

Diverse applications, massive data, and real-time processing pose new challenges to data platforms in the financial industry. Huawei Cloud Data Warehouse GaussDB(DWS) [21] multi-level fully parallel data processing architecture provides millisecon-level real-time analysis, second-level interactive analysis, and minute-level batch analysis, matching typical business scenarios in the financial industry: deep mining data asset value in precision marketing scenarios, interactive query second-level response, personalized financial services, and business efficiency increased by 80%; High concurrency agile online query upgrade intelligent risk control system, 30ms real-time risk control ability, reduce 50% transaction risk; High-efficiency batch data query, one-time batch task export and loading, providing stable, timely and accurate data submission, ensuring the timeliness of regulatory submission.

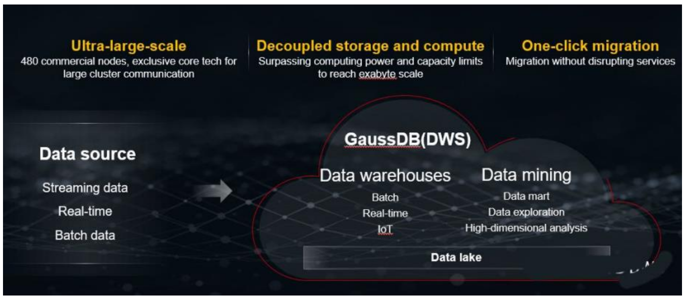

Figure 1. Number of Huawei Cloud GaussDB(DWS) single clusters

As can be seen from Figure 1, at present, in ICBC, the largest commercial cluster has 480 nodes, enabling tens of thousands of analysts to work online. Based on the cloud-native architecture, storage and computing resources can be flexibly expanded based on service requirements, and online capacity expansion and online upgrade services are not interrupted. [22-23] Make full use of the advantages of cloud storage separation and extreme expansion, and greatly improve the cost performance compared with traditional physical machine local deployment. Provides a one-click migration tool for enterprise users to efficiently migrate existing data warehouse platforms, and automatically migrate upper-layer services.

Promote financial data warehouse technology innovation, Huawei Cloud GaussDB(DWS) from China to the world

So far, 11 state-owned banks and joint-stock banks have chosen Huawei Cloud GaussDB(DWS) to build financial data warehouse platforms, and jointly explore and promote the construction of data and intelligence integration platforms with Huawei Cloud.

For example, ICBC rebuilt its data warehouse platform based on Huawei Cloud GaussDB(DWS), upgraded from the traditional all-in-one model to an open and scalable distributed architecture, and took the lead in completing the transformation of the data analysis platform in the financial industry, making data services leap forward to the intelligent era.[24-27]China Merchants Bank built the first large-scale financial cloud warehouse in China based on Huawei Cloud GaussDB(DWS), which reduced the running time of the whole bank's data application by more than 15%, effectively supporting the landing of the big data development strategy of "Everyone uses data".

Based on Huawei Cloud GaussDB(DWS), Everbright Bank completed a large-scale data analysis, aggregated the whole bank's data assets, shortened the batch operation time by 8 hours, and extended the data service time window by 2 times.

3.2 Large-scale backup and recovery of data sets

In the financial sector, Huawei Cloud GaussDB(DWS) is widely used and in-depth, providing financial institutions with efficient and reliable data management and analysis solutions. With the advanced technology of GaussDB(DWS), financial institutions can quickly back up and restore massive financial data to ensure data security and integrity. At the same time, the fine-grained data recovery function enables financial institutions to respond to various emergencies in a timely manner, including accidental data deletion and data damage, to ensure business continuity and stability. In addition, the powerful data analysis capabilities of GaussDB(DWS) also provide financial institutions with in-depth insights into market trends, risk management and customer service support to help financial institutions better grasp business opportunities and enhance competitiveness. Therefore, in terms of data backup, GaussDB(DWS) implements the whole-process lock-free technology, which does not affect the execution of service SQL [28], including [29] DDL operations, even during backup. At the same time, the multi-level parallel fast backup technology enables each node to independently carry out multiple concurrent and multi-channel backup, thus realizing the fast backup and recovery of 10PB level data. In addition, the global consistency snapshot function ensures the consistency of data backup and provides reliable data protection for users.

In terms of data recovery, GaussDB(DWS) provides fine-grained data recovery operations, including emergency recovery requirements such as data deletion by error or table damage. These advanced technologies ensure users' efficient management and reliable protection of data, making GaussDB(DWS) the first commercial data warehouse product with a single cluster exceeding 2,000 nodes in China.

GaussDB(DWS) has been widely used in finance, government, operators, transportation, logistics, Internet and other fields, serving more than 1,000 customers around the world. It not only has a leading edge in technology, but also actively implements the "platform + ecology" strategy, and cooperates with more than 500 partners to provide competitive data warehouse solutions for various industries, providing comprehensive support for users' data management and analysis needs.

Case: A bank completed the [30]GaussDB(DWS) data migration project in more than 7 months, realized the smooth transition of the new and old data warehouses through technical means, realized the non-inductive switch of upstream and downstream, and then officially provided external services. Using the GaussDB(DWS) data migration service, the bank unifies the computing platform, resource scheduling, and data architecture of the data application system, improves the storage space, improves the computing performance, and reduces the storage unit cost. The data storage capacity has been increased by 7.4 times compared with the original, the unit storage cost has been reduced by more than 80%, the performance has been improved by 45 times, and the data warehouse has been effectively optimized, storage resources have been increased, and operation efficiency has been improved. After data migration, the bank's overall batch efficiency has been improved to ensure the normal development of business, batch processing time has been significantly improved, in addition to individual special task requirements, most of the tasks can be completed before eight o 'clock, the data mart can also be completed before eight o 'clock and all issued.

4 CONCLUSION

The financial industry is undergoing significant changes in the Internet era, leading to complex challenges in risk management and data handling. Traditional data warehouse architectures struggle to meet the evolving needs of financial institutions, including limitations in storage space, computing power, and real-time data processing. As a result, there is a growing demand for transitioning to cloud-based distributed data warehouses to better support the rapid development of financial services.

Huawei Cloud GaussDB(DWS) emerges as a solution to address these challenges, offering high performance, cost-effectiveness, and scalability. By migrating to DWS, financial institutions can overcome the constraints of traditional warehouses and leverage advanced features such as real-time analysis, intelligent risk control, and efficient data management. The transition process involves meticulous planning and execution, including environment preparation, solution selection, service migration, and data migration.

Through case studies and industry examples, it is evident that the adoption of Huawei Cloud GaussDB(DWS) enables financial institutions to optimize their data infrastructure, enhance operational efficiency, and unlock new opportunities for data-driven decision-making. With its advanced technology and comprehensive support, DWS facilitates the transformation of financial data warehouses, paving the way for innovation and competitiveness in the era of big data.

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Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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