Research and Application of Prosperity Index of Tomato Industry Chain Based on Power Big Data Analysis

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Abstract: In order to solve the serious performance and scalability bottlenecks faced by power data analysis system in the era of big data, and better meet the needs of production, marketing and other systems, the advantages of cloud computing technology are analyzed, and the architecture and key technologies of power big data analysis system based on cloud computing are proposed. Based on Hadoop and hive, a multi-dimensional index and SQL are designed for the characteristics of power big data Automatic translation tools and hybrid storage model supporting data update are three performance improvement technologies to realize the upgrading and optimization of traditional power data analysis system. The actual deployment experience of Zhejiang electric power information acquisition system shows that compared with the traditional electric power data analysis system, the system achieves an average performance advantage of 5 times at 1/8 of the hardware cost. It proves that cloud computing technology can significantly improve the performance of power big data query and analysis and effectively reduce costs.

1 INTRODUCTION

Smart grid technology is the deep integration of traditional power technology and information, control, automation and other technologies. Through collecting a large amount of data in power generation, transmission, distribution, power consumption, dispatching, marketing and other links, in-depth analysis and mining are used to guide the decision-making and optimization of each link, so as to improve the production efficiency of power enterprises, enhance the stability of power grid operation, and better meet the needs of power customers (Cai, Cao, Xu, et al., 2021).

With the continuous promotion of the construction of smart grid, the scale of smart grid is expanding day by day. Various heterogeneous distributed data sources such as smart meters, sensors and information systems continue to generate massive data, which is called power big data. Power big data is regarded as an important support for power grid intelligence. For example, installing sensors on power generation equipment or transmission equipment and collecting equipment operation status, external temperature, wind and other information can dynamically adjust the equipment operation status and give full play to the maximum efficiency of the equipment. Due to the fundamental role of power big data, the collection, transmission, storage, processing and mining of power big data has become an important content of smart grid research and construction (Zhang, Zhao, Li, 2020).

At present, most power data analysis systems are based on relational databases, which have the disadvantages of slow analysis speed and poor scalability. It is difficult to meet the data storage and analysis requirements of power big data in the era of smart grid, and has become the bottleneck of smart grid construction. Aiming at the common requirements of data analysis and application in smart grid and the typical characteristics of power big data, this paper proposes a set of power big data analysis platform based on cloud computing. The platform has been actually deployed and put into operation in State Grid Zhejiang electric power company, and achieved good results.

2 POWER BIG DATA AND ITS CHARACTERISTICS

Power big data refers to a large amount of data generated by smart grid in power generation, distribution, transmission, marketing and management. It is generated by a large number of sensors deployed on various devices, smart meters installed in the homes of power

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users, customer feedback collected by the marketing system and other data sources and converged to the centralized data center for unified storage management (Tang, Ding, 2021).

Power big data is one of the supporting elements for building a stable, reliable, efficient and energy-saving smart grid. By analyzing power big data, we can improve the lean management level of smart grid, formulate a more scientific production plan, optimize energy transmission scheduling, and establish a more accurate user behavior model.

Power big data has the 3V characteristics of large volume, many types and fast speed, which are specifically reflected in:

(1) Large volume. With the in-depth promotion of the construction of smart grid, terminal data collection equipment such as device sensors and smart meters have been intensively deployed, and the scale of collected data will increase exponentially, reaching the TB or even Pb level. Taking Zhejiang Province as an example, there are 22million power users in the province. If all smart meters are installed, according to the requirements of State Grid Corporation of China to collect one piece of power consumption information every 15 minutes, 2.1 billion pieces of power consumption records will be added every day (Wang, Bai, Dong, et al., 2021).

(2) There are many types. In addition to the traditional structured data, production management, marketing and other systems produce a large number of semi-structured and unstructured data such as audio and video materials. The diversity of data types requires the diversity of storage and processing technologies. This paper focuses on the data acquisition and processing system of power consumption information, which still focuses on structured data, and does not discuss the processing of semi-structured and unstructured data.

(3) Speed. The collection and processing of power big data have extremely fast speed. The surge in the number of terminals requires the storage system to meet the requirements of high-throughput data access hundreds of thousands of times per second.

In addition, power big data also has some unique characteristics. According to the "white paper on the development of power big data in China (2013)", power big data also has the characteristics of 3E;

(1) Data is energy. Power big data contains extremely important information such as users' power consumption rules and optimal transmission scheduling strategies. This information plays a unique and huge role in reasonably arranging production and reducing energy consumption losses, and promotes the reduction of energy consumption and sustainable development of the power grid, thus embodying the characteristics of data as energy.

(2) Data is exchange. Through the interaction and aggregation with big data of other industries, and in-depth mining and analysis, the information contained in power big data has extremely important reference value for the country's high-level decision-making and economic situation judgement (Chen, Li, Cui et al., 2019).

(3) Data is empathy. Power big data provides a new way for State Grid Corporation of China to timely and accurately discover and meet the needs of users. Empathy is empathy. Both production and marketing rely on power big data to provide more high-quality, safe and reliable power services to the majority of power users, so as to achieve the goal of common development.

3 CLOUD COMPUTING AND ITS ADVANTAGES

Cloud computing is a new large-scale distributed computing model, which originates from the demand of Internet companies for a large number of computing and storage resources and the pursuit of scalability, high performance, high availability and other characteristics. Cloud computing aggregates a large number of distributed and heterogeneous resources, providing users with powerful massive data storage and computing capabilities. Cloud computing provides users with on-demand services through virtualization, dynamic resource allocation and other technologies, avoids resource waste and competition, and improves resource utilization and application performance. Cloud computing provides horizontal scaling and dynamic load balancing capabilities, that is, Cloud Computing supports adding new nodes to the data center at runtime, and the system will automatically migrate part of the load to the new nodes, and maintain the load balance between nodes, thereby enhancing the business carrying capacity of the whole system. Resources in the cloud computing environment are organized in the form of data centers. A data center contains thousands or even tens of thousands of nodes. Nodes are interconnected through high-speed networks to jointly provide users with computing and storage resources. Cloud computing has developed very rapidly. At present, it has gone out of the laboratory, and a series of mature products and technologies have emerged. In addition to Internet companies, it has been widely used in many traditional industries, such as telecommunications, retail, finance and so on.

4 POWER BIG DATA ANALYSIS SYSTEM BASED ON CLOUD COMPUTING

The big data analysis technology based on cloud computing has a relatively complete reference architecture and software implementation, and has been applied in some industries. However, most of these systems come from the Internet industry, and their design, implementation and functional characteristics fully reflect the needs and characteristics of Internet big data and its business. When applied to industries other than the Internet, the general practice is to customize, develop and optimize the existing system based on the full and detailed analysis of the big data characteristics and business needs of the industry.

There are three main differences between power big data and Internet big data.

(1) In the Internet scenario, typical big data applications need to scan the entire data set sequentially. Therefore, the distributed parallel big data analysis system hive or impala does not provide good support for indexing; In power big data analysis, multi-dimensional region query is very common. Because there is no index, it will lead to access a large number of unnecessary data and significantly reduce the performance of query execution. It is necessary to design an appropriate index structure and corresponding data retrieval mechanism according to the characteristics of multi-dimensional region query.

(2) The typical feature of Internet big data is "write once and read many times". For this data feature, both distributed file system (HDFS) and hive do not provide data rewriting (update or delete) mechanism, and the purpose of rewriting data can only be achieved indirectly by covering all existing data. In the power big data business scenario, there are a large number of data rewriting statements. Executing these queries in a way that covers the existing data will lead to the problem of low execution efficiency. Therefore, there is an urgent need to provide a data rewriting mechanism in the existing system.

(3) Big data query language designed by Internet companies according to their own business needs. For example, HQL is only a subset of SQL, while power data analysis systems are mostly written in standard SQL language, which requires a lot of manpower and time to translate tens of thousands of existing SQL statements into equivalent HQL statements. Therefore, it is necessary to design a tool to automatically translate SQL language into HQL language, so as to improve the migration speed of legacy applications and realize the seamless and smooth migration of power data analysis business.

Based on the above analysis, in order to meet the needs of smart grid for in-depth analysis and mining of power big data, aiming at the typical characteristics of power big data and its business logic, combined with the latest progress of cloud computing technology and actual industry deployment experience, a power big data analysis system based on Cloud Computing is developed.

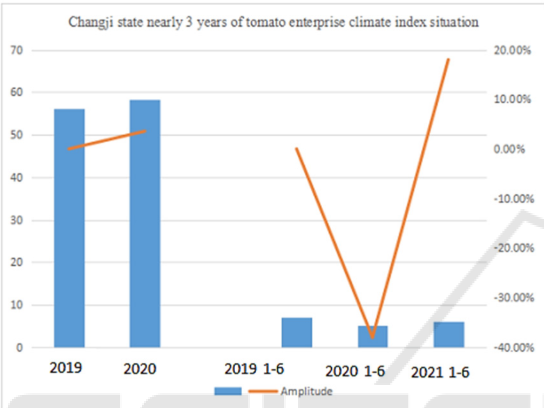
The system is based on the distributed parallel computing framework (Hadoop), uses hive as the data analysis software, and develops key technologies such as multidimensional index based on grid file, SQL to HQL automatic translation tool based on query rewriting, and hybrid storage model supporting data update according to the characteristics of power big data, which comprehensively enhances the performance and ease of use of hive. This system has been successfully applied in Zhejiang electric power consumption information acquisition system. Compared with the original system based on relational database, it greatly improves the system performance and reduces the system cost.

5 APPLICATION EXAMPLES

This paper uses Changji tomato enterprise as a case for implementation analysis. Collect the quarterly data of the primary indicators from 2019 to 2021, select the industry sales revenue as the benchmark indicator, and obtain the leading and consistent indicators and the weight of each indicator through the analysis of the process mentioned above.

From the perspective of enterprise prosperity analysis, COFCO Tunhe Manas tomato products Co., Ltd. had the largest growth rate in the first half of 2021, and Xinjiang Yanyang tiantianhu tomato products Co., Ltd. had the largest growth rate in the second half of 2020; However, the prosperity index of Xinjiang Zhongji Red Tomato Industry Co., Ltd. fangcaohu branch and Xinjiang Tometo tomato science and Technology Development Co., Ltd. in the first half of 2021 and the second half of 2020 showed a significant negative growth, which should be brought to the attention of relevant government departments.

In 2019, the average prosperity index of Changji tomato enterprises was 56.252, and in 2020, the average prosperity index of Changji tomato enterprises was 58.33, 2.08 (3.57%) higher than that in 2019; From January to June 2019, the average prosperity index of tomato enterprises was 7.08. From January to June 2020, the average prosperity index of tomato enterprises was 5.16, a year-on-year decrease of 1.92 (-37.21%); From January to June 2021, the average prosperity index of tomato enterprises was 6.09, an increase of 0.93 (15.27%) year-on-year in 2020. In the first half of 2020, the prosperity index of Changji tomato industry fell significantly, as shown in Figure 1.



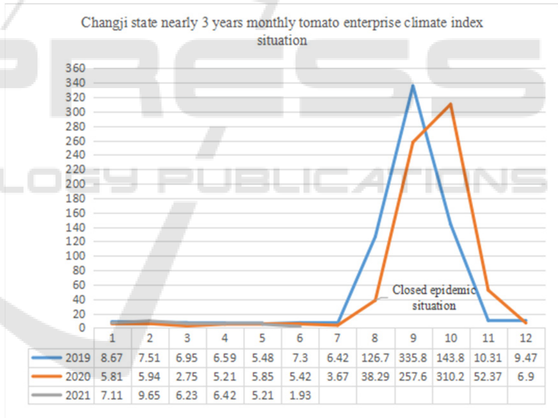
（Photo credit: Original)

Figure 1: Prosperity index of tomato enterprises in Changji Prefecture in recent three years.

In combination with the changes in the prosperity index of Changji tomato enterprises in 2019, 2020 and January June 2021, the changes in the prosperity index of Changji tomato enterprises are mainly divided into two periods, namely, the off-season and peak season, as shown in the following figure.

Off season (January July, December): at this time, tomatoes have not yet reached the stage of large-scale mature harvest, there are a small number of greenhouse planting and harvest, and the power consumption scale of tomato enterprises is low. Judging from the changes of the prosperity index in 2019 and 2020, with the rapid spread of the domestic epidemic, the production and operation of tomato enterprises in Changji Prefecture have been affected to a certain extent. Some enterprises have encountered problems such as insufficient orders, tight sales, poor logistics and financial difficulties, resulting in the prosperity index in the first half of 2020 being significantly lower than that of the previous year. The average prosperity index in the off-season in 2020 (5.19) decreased by 2.11 compared with that in 2019 (7.3). Judging from the changes of the prosperity index in 2020 and 2021, with the effective control of the domestic epidemic, the average prosperity index (6.09) from January to June 2021 increased by 0.93 year-on-year (5.16) in 2020, and it is expected that the prosperity index will continue to increase in the second half of the year.

Peak season (August November): with a large number of mature tomatoes harvested, the power consumption scale of tomato enterprises in Changji Prefecture has increased, the production and operation situation has gradually improved, and the enterprise prosperity index has increased rapidly. Judging from the changes of the prosperity index in 2019 and 2020, with the rapid spread of the domestic epidemic, the production and operation of tomato enterprises in Changji Prefecture have been affected to a certain extent, and the upward trend of the enterprise prosperity index has slowed down. From the end of July to the beginning of September 2020, due to the closure of the epidemic in Xinjiang, the prosperity index in August 2020 was significantly lower than that in August 2019, and the highest prosperity index in the peak season of 2020 (310.19) was 25.61 lower than that in 2019 (335.8). As shown in Figure 2.



（Photo credit: Original)

Figure 2: Monthly prosperity index in recent three years.

6 CONCLUSION

On the whole, in 2019, 2020 and the first half of 2021, with the easing of the epidemic and the continuous drive of the Xinjiang government's various measures to increase production and efficiency, and phased policies to reduce the cost of electricity for enterprises, the prosperity index of tomato enterprises in Changji Prefecture gradually rebounded, and the production and operation of tomato enterprises showed an upward trend.

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