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Research on Computer Aided Laboratory Based on Cross-Multiplier Multi-Data Flow Collaborative Algorithm

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Abstract. The paper develops a set of mobile laboratories based on the grid data cloud platform. The laboratory proposed a multi-data flow cooperative algorithm based on a cross-bus four-layer temporal space model and a cross-directional multiplier. This algorithm achieves the purpose of updating most data streams as a whole. The system establishes a statistical analysis system of data flow from multiple perspectives and mines and monitors multiple data flows. The paper divides most data streams into several linear modules, and corresponding matrices are formed. Finally, the simulated test results of the paper show that the CPU usage of the mobile laboratory computer-aided system based on the power network is very small. The system processing efficiency is high.

Keywords: cross-multiplication machine algorithm, multi-data-flow collaborative algorithm, computer system, power-assisted laboratory

1 Introduction

The big data collection performance of the power grid business has been widely used in the existing power grid terminal collection equipment. Large-scale real-time data stream processing technology needs a period to adapt to give full play to the value of real-time data collection. However, as far as the current power big data processing method is concerned, the traditional batch processing method has disadvantages in system scalability, fault tolerance and state consistency. These problems make the number of load-balanced data successfully transmitted per unit timeless. It faces unprecedented challenges.

Efficient processing of time-series big data in smart grids plays a key role. Literature [1] applies Spark to the visualization processing of power equipment monitoring data. The purpose of the process is to quickly extract the overall status information of the power monitoring data in the big data environment. Based on the Spark big data computing platform, the scholars designed and constructed the equipment status evaluation index system and the power equipment status data extraction method under the fuzzy C-means clustering algorithm. Scholars construct a three-dimensional parallel scatter plot according to the multi-dimensional and time-series characteristics of the data. The system completes the visual processing of power equipment status information. Literature [2] aims to solve the problem that large-scale time series data cannot be efficiently processed under the background of big electric power data. They were combined with the current distributed technology framework to design and build a real GAIA large-scale time series data management and control platform to ensure the stability and reliability of the system. Literature [3] pointed out that the digital construction of the smart grid can provide large-scale data information. The development of deep learning can provide a reliable way for data value extraction. However, these new methods often adopt centralized database/data warehouse design in system design. With the exponential expansion of the scale of various sensor data, the centralized database needs to continuously improve the performance of hardware equipment and upgrade the network bandwidth. However, these methods are increasingly unable to meet the performance requirements of data throughput. Literature [4] retains the original centralized database/data warehouse while introducing Hadoop, HBase and other technologies. They use the data extraction tool represented by Sqoop to realize the mutual transfer of data. This way of coexistence of distributed data warehouse and centralized data warehouse meets the needs of massive data analysis and also considers the effectiveness of traditional centralized data analysis and processing. The disadvantage is that using tools for regular data transfer cannot maintain data consistency between the distributed data warehouse and the centralized data warehouse in real time. The massive data throughput load during data transfer remains unresolved.

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The paper introduces a cross-multiplier multi-data flow collaboration algorithm to design a power grid data processing cloud platform. This algorithm achieves the purpose of updating most data streams as a whole. The system can establish a statistical analysis system of data flow from multiple perspectives and mine and monitor multi-data flow. The basic outline of the paper is as follows: First, the paper establishes the basic structure of the power grid data cloud platform laboratory based on data streaming. Then a cross-multiplier multi-data traffic cooperation algorithm is introduced to realize real-time data collection. Again, the paper establishes a time series cross-line spatial model to realize data operation and processing. Finally, the paper completes the realization of the power grid cloud data processing platform based on the Domain database. Experimental simulations show that the algorithm proposed in the paper can reduce the load on the cloud processing platform and improve the data processing efficiency of the platform.

2 Power Grid Computing Business System Based on Massive Data Technology

The paper establishes the basic structure of data flow based on data flow. The system has strong computing power. It can support resource scheduling and configuration in stream processing systems. At the same time, the system can also integrate multiple data sources and analyze them effectively [5]. The paper presents a network-based business system for power data traffic (Fig. 1).

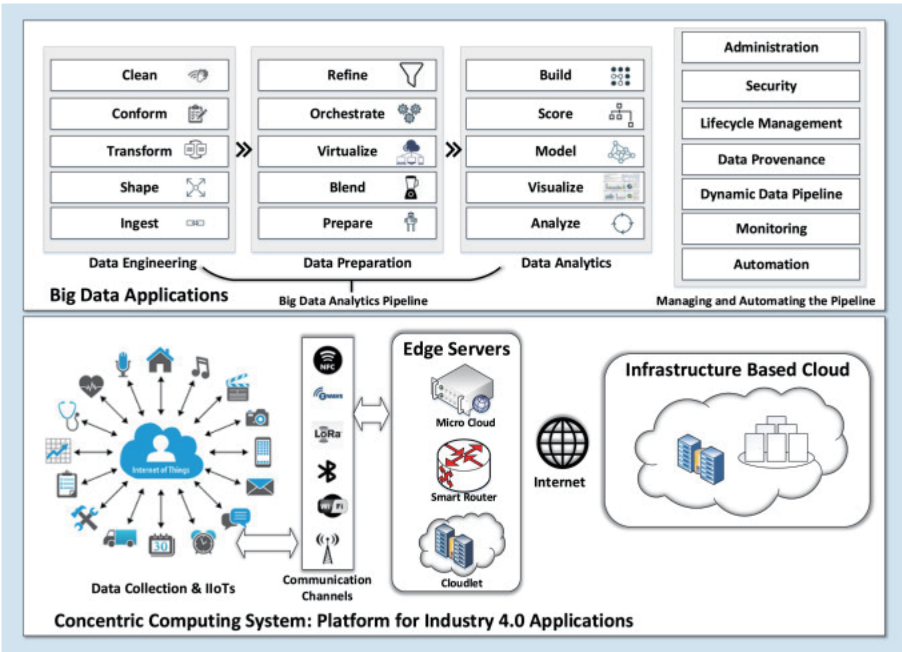

Fig. 1. Grid flow business system based on massive data

1) The system is divided into various types based on a large number of data flow detection, time window calculation, and modeling training. The paper realizes the system's real-time monitoring and application deployment through the distribution, analysis, and calculation of the data flow according to different data characteristics.

2) Analysts provide users with analytical ideas and methods. The system provides model building, evaluation, process analysis, and model management. The system realizes the stochastic optimization of a single data stream and the cooperation of multiple pieces of data. Modeling uses data collection and training data to judge the model's accuracy [6]. At the same time, the system can optimize the model according to the conclusion of the evaluation. The paper proposes a power quality information acquisition process based on real-time acquisition to realize the real-time analysis of the data flow of the power grid. Model management plays a vital role in the system. Others include verdicts for released versions and outages.

3) Software developers need to set parameters in the corresponding programming interface to ensure that the

power grid can realize real-time control of the power grid. They write it into the computer processing system to realize the dispatch and use of the power grid.

4) The management business system provides a unified, real-time monitoring and management business for hierarchical resource administrators. The system regularly feeds back information on the utilization and changes of work data to the classified resource managers. The system also displays the types of each process in an intuitive form, such as graphics. This enables instant monitoring of jobs at all levels.

3 Solving the Polynomial Flow Correlation Factor

3.1 Collection and Monitoring of Multiple Pieces of Data

The system analyzes. It gives some improvement plans [7]. The system uses data such as partial discharge of the power grid, temperature of the optical fiber winding, and dissolved gas concentration in the oil to realize real-time monitoring of working data such as dielectric loss, leakage capacity, three-phase harmonics, arrester resistance current, and circuit breaker partial discharge. The system effectively controls the data flow and a large amount of space storage in the current grid condition monitoring system (Fig. 2).

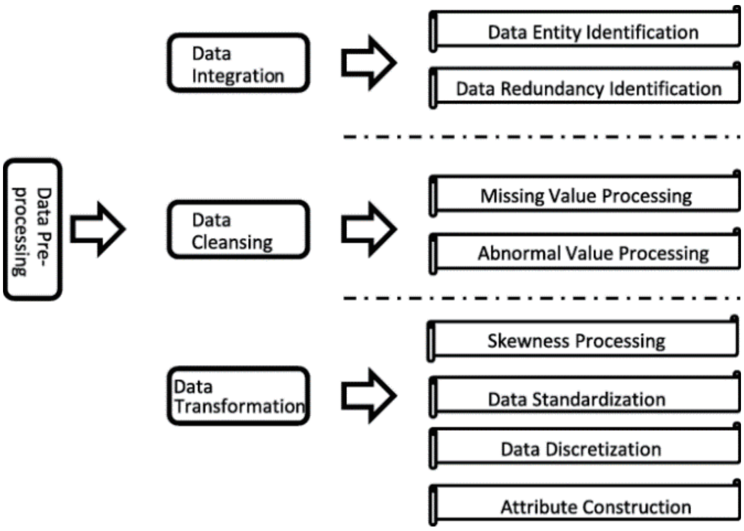

Fig. 2. Data flow-based power significant data processing process

If the sliding time of the slider is 1s, the system can divide the slider into 60 parts. The feature set for each slider represents the number of conditions monitored for each substation. The system performs threshold analysis on multiple windows. The system buffers 60-unit blocks to enable parallel decisions. After the essential window operation is completed, the system summarizes the heterogeneous values of the most recent 60 basic windows. The outlier in the last minute of each output is the mining that needs to be done.

3.2 Real-time Processing of Accurate Correlation between Multiple Data Streams

In this paper, m data streams are established, and various data streams are combined into an association matrix. In this way, the paper obtains the m-level sequence [8]. The purpose of the system is to obtain a more accurate statistical-based correlation of multiple data streams. So, the correlation factor is expressed in any data flow.

$$x_m = \lambda_m \sqrt{\frac{m(m-1)(m+1)}{3}} \cdot \frac{\gamma_m + 1}{\gamma_m - 1} \,. \quad \textbf{(1)}$$

λ_m multiplies the data in the sliding window. γ_m is the spatial transformation factor of the correlation factor matrix. λ_m is the most computationally intensive, and it can achieve memory expansion. The order of m is extracted as a set of computational units. The paper obtains the specific sliding window by constructing the correlation factor.

Time Series Analysis in the Intelligent Power Grid. Sensors and instruments generate the time series of large-capacity smart power systems. Data is collected by sensors [9]. It can have a specific connection with specific objects and devices. The voltage levels shown in Fig. 3 are a typical timing profile.

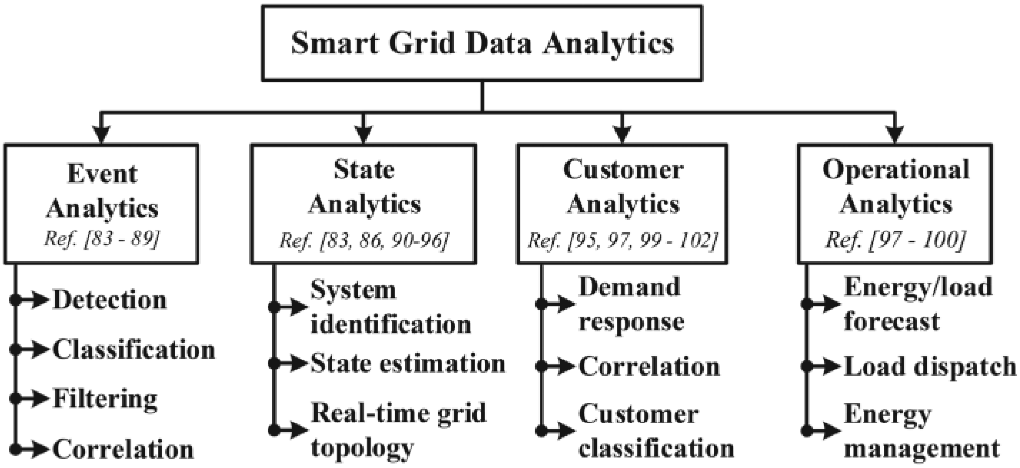

Fig. 3. Time series data graph of the power system

The following three elements can represent time series data.

$$D = \{A_i, B_j, C_q\} . \quad \textbf{(2)}$$

A_i represents the mark of the measuring point from which the data was generated. B_j represents the timestamp at which the data was generated. C_q represents a specific number. The format of the numbers can be integers, floats, or byte arrays. A single time series of data is an independent event in a smart grid. This article determines the activity set in the following format.

$$M = \{D_1, D_2, \cdots, D_m\} . \quad \textbf{(3)}$$

This point D_n represents what happened at a specific moment.

$$\lambda e_t = \frac{S}{t} . \quad \textbf{(4)}$$

Equation 4 represents the number of events that occur in an hour.

Data Cleaning. The figure function is the most critical in this architecture. It cleans data from its original location to usable data. The figure uses several methods to make the cleaning system highly scalable, including filtering, factory, monitoring, etc. Fig. 4 is a schematic diagram of the core of the Figure function.

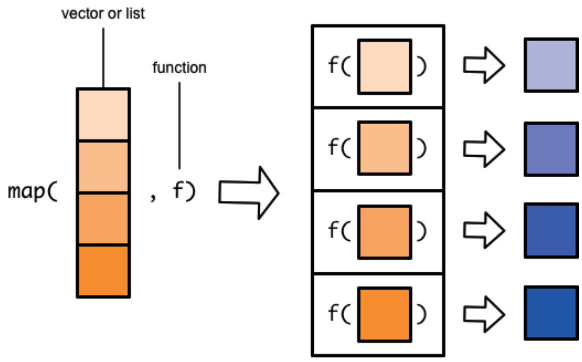

Fig. 4. Schematic diagram of the core of the figure function

The Log Process category is the basic outline compilation of the Figure stage. It can organize the actual data. Handler is a real control of the process. All operations need to be performed during the initialization of the figure. The system is implemented according to the call of the Handler to the process. Filter Chain performs step-by-step analysis and clearing according to a similar pipeline model. The main function of the Filter Chain is to set the filtering state. In the development process of the figure, each category adopts a configurable method. The system can automatically replace according to real data. When recording, the system uses the Journal Clean class to perform basic operations on the original records. At this point, some basic fields are created. This article stores it as a table in the Journal. This forms the Journal record class. This article analyzes this category according to specific needs. Then the system records it into the corresponding document through Journal Writer. Finally, the system outputs the final result.

Classification of Data. The paper implements the construction of the Figure-Reduce mode using the nearest neighbor method. This implements a real-time hybrid approach based on distributed computing technology [10]. If the weight $\gamma_1, \gamma_2, \ldots, \gamma_n$ of each variable is assigned according to the degree of importance, the weighted Euclidean can be expressed by the formula (5).

$$dis(x_i, y_j) = \sqrt{\sum_{k=1}^{n} \gamma_k \left| x_{ik} - y_{jk} \right|^2} \ . \quad \textbf{(5)}$$

Assuming that there is a collection object x_i, y_j in the dimension space of the two sets of data sets, the calculation formula of this relationship is as follows.

$$\left\| x_i - y_j \right\| = dis(x_i, y_j) \ . \quad \textbf{(6)}$$

Suppose $\overline{R}$ is a numerical property and $R_{\max}$, $R_{\min}$ represents the maximum and minimum properties of the property. The feature normalization expression is as follows.

$$\overline{R} = \frac{R - R_{\min}}{R_{\max} - R_{\min}} \ . \quad \textbf{(7)}$$

The paper uses the weighted Euclidean distance method for data classification when the PCHA method is used. This achieves the solution of the neighbor values of the test unit and the training unit.

$$\left\| x_i - y_j \right\| = \sqrt{\sum_{k=1}^{n} \gamma_k \left| x_{ik} - y_{jk} \right|^2} \ . \quad \textbf{(8)}$$

The weighted selection depends on the importance of the data object. In the early days, all data objects were set up similarly. Normalization of attributes refers to the data of attributes [11]. The paper decomposes many large data sets into smaller ones. This process is to figure the objects in each split data set accordingly. Task Tracker will call the idle data to complete the Figure and Reduce work.

Confidential Storage of Data. The paper proposes a real-time large-capacity data storage and processing method for large-capacity power systems based on Hadoop. The paper can use encryption technology to ensure the confidentiality and integrity of a large-capacity smart grid. The information extracted in the paper is obtained after the message is signed. In summary, the cryptographic storage process of data can represent the following steps:

The first step produces a summary. The message summarization algorithm generates the corresponding digital summaries according to the time series of the mass power system to be stored.

The second step is to perform password processing on the data, and then the system obtains a random password according to the password generation function. The system uses it to encrypt the stored data to obtain the corresponding password.

The third step in the paper is to use random keys for information masking.

The fourth step is to store the relevant data in the cloud. Then the system stores the data obtained above and the data together with the file name in HBase to complete the data storage. Cryptography is a very effective means of keeping secrets. A key concealment scheme performs the information masking process for random keys (Fig. 5).

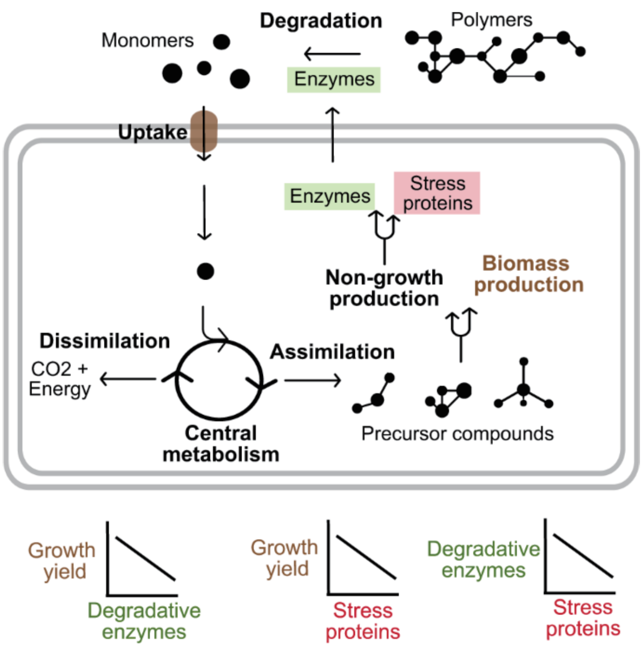

Fig. 5. Schematic of the password-hiding principle

The paper adopts a method based on different attributes and filling times to generate summary information. This article uses a hashing method to generate the required passwords. This function can contain the user's password. The attributes and details of the sources must be kept confidential in advance. Substation properties are based on the Substation type. A key generation architecture designed in the paper is shown in Fig. 6.

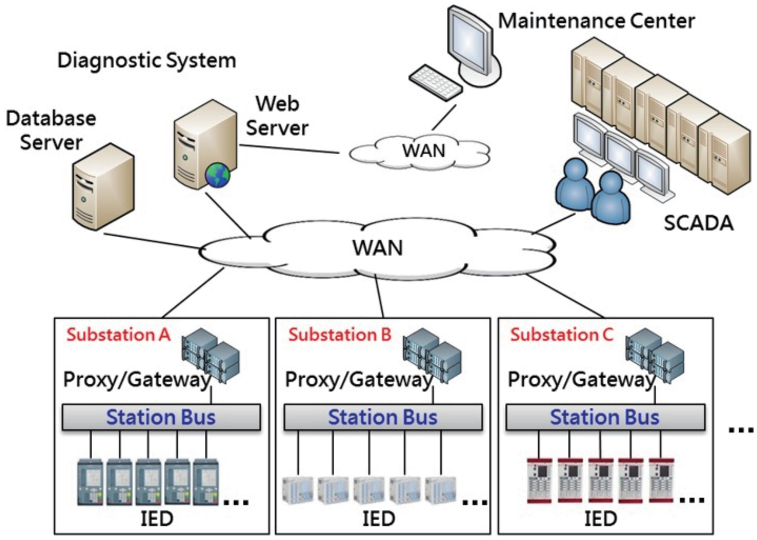

Fig. 6. Random fundamental concealment policy architecture for substations

4 Algorithms for Real-time Processing of Data Streams

4.1 Spatial Modeling of Four-level Time Series Across Buses

The most prominent feature of the sliding window model is that it can divide the data collection. The paper presents a four-level spanning bus time series model (Fig. 7).

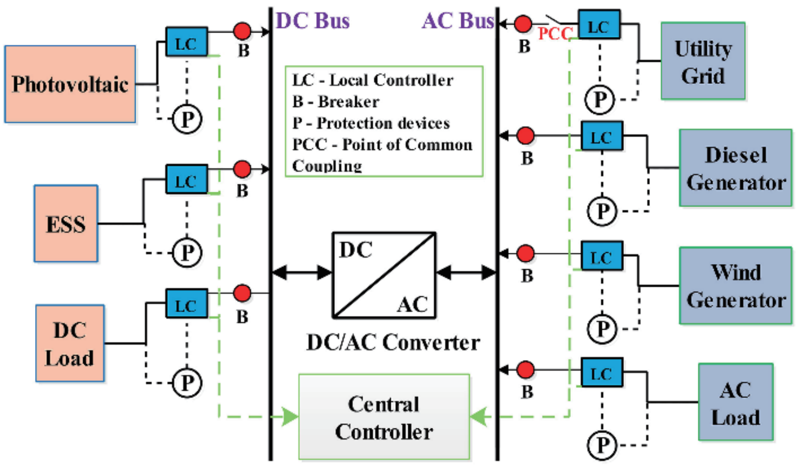

Fig. 7. Time-series space modeling across the four-level bus

The main job of the second-level timing is to cache the IO data. This allows data to have the same security identifier during the sampling period. The system determines whether the data in this table is reached by accumulating. If the system cannot reach it, then perform the linear interpolation.

The second level of the timing diagram is the buffer. Its design goal is to reduce the data transmission between the devices, shorten the transmission cycle, and increase parallel data processing. The data buffer layer is the smallest unit in the parallel processing mode of large data streams. This article completes the update of the internal data of the cache by continuously updating other windows.

The main job of level 3 timing is to interact with a new sliding window with the GPU's memory. This enables multiple new data flows to be combined into a single repository.

The fourth level of timing is mainly used to store the data of the profile matrix. The paper completes mining complex data streams under system scalability, fault tolerance, and state consistency conditions.

4.2 Space Impairment

The paper adopts a four-level parallel spatial pattern based on a data processor to reduce the complexity. The paper sets the array capability of the storage operation as an (a-1)/2. When solving related problems, the paper can reduce the spatial scale of the data and improve the processing speed of the data. The paper calculates all the data by subsections [12]. i and j are the row and column indices of the subsquare matrix. Then the sliding window index formula is formula (9).

$$f(x)=\sum_{t=1}^{k}\left(x_m+\sum_{i=1}^{j}k\right). \quad \textbf{(9)}$$

The system implements the sliding window index through the formula (9). The system reduces the complexity on this basis.

4.3 Cooperative Operation of Multiple Data Streams

The system and parallel operations do most of the flow cooperative operations. The data buffer level is the analysis and fusion of tasks. Its specific operation is as follows

Step 1 establishes a data flow collaborative computing model.

$$F(x)=f(x)\sum_{j=1}^{n}[f(x)+\cos(\theta\sin\theta_j]. \quad \textbf{(10)}$$

Step 2 builds the global function.

$$L(x)=\varepsilon\frac{1}{2}(x,y)-\lambda(x). \quad \textbf{(11)}$$

Step 3 creates a local function for the worker.

$$P=\gamma_a\frac{1}{L(x)}+\frac{a(a-1)(a+1)}{3}. \quad \textbf{(12)}$$

The paper uses an overall update method to construct a multi-data stream based on multiple nodes. The paper is divided into different data blocks and managed by a worker. Business people, analysts, developers, and managers use different types of servers at runtime [13]. Their job is to train various models. The parameters of the model are stored on multiple hosts for horizontal splitting.

5 Development of Domain-based Real-time Database

5.1 Data Source and Storage Model

After completing the definition of compatibility and compatibility, the paper establishes data source and storage models. Fig. 8 shows the Data Source schema. The system includes the basic data of the data source model number, data collection time, data collection life, etc. This article needs to select the minimum dimension table from the measure dimension table, spatial dimension table and custom dimension table. The fact table includes the measure data table foreign key. The fact table also contains two metrics: value-type data metrics and time-type time metrics.

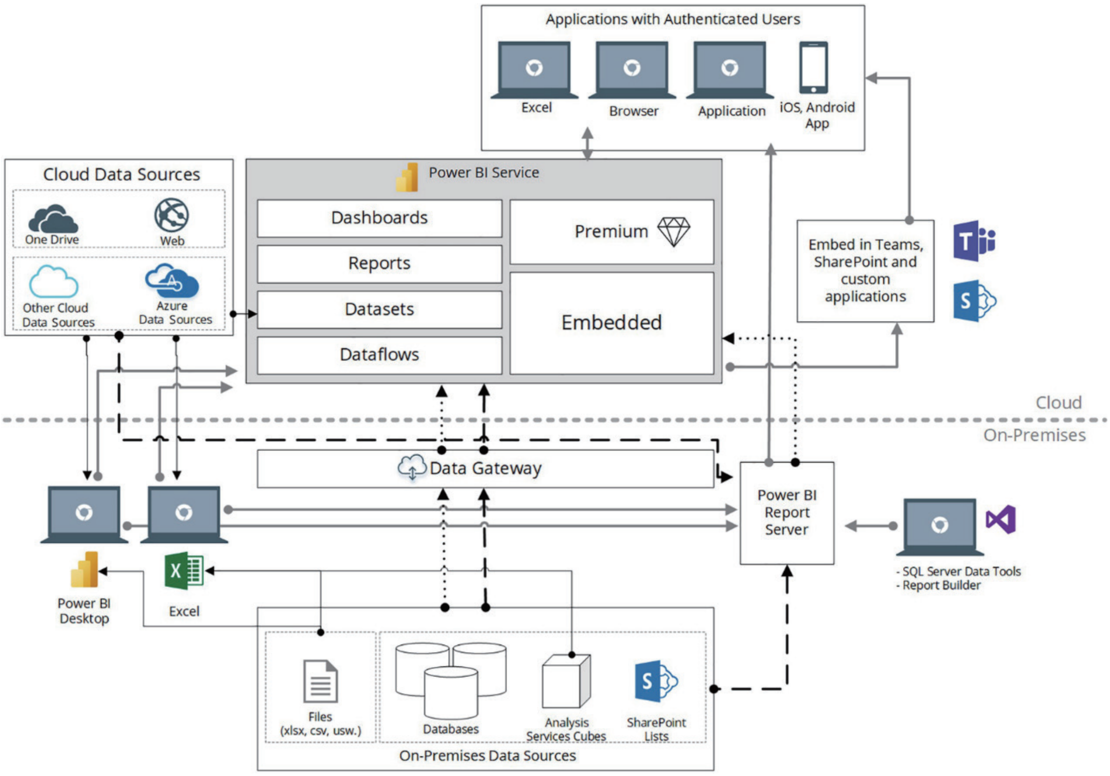

Fig. 8. Power data source mode diagram

Its primary data includes data storage number, engine, and parameters. The platform developer maintains the data storage engine. It can be done with the new Storm Bolt element or the Trident way. The measurement dimension table, spatial dimension table, time dimension table, and custom dimension table are derived from the consistent dimension table [14]. The fact table is defined from the consistency scale. Various measure tables in the same fact table must be generated from the same dimension table. Different data storage modes can be established for the same data source. Different storage methods are selected to meet the needs of different granularities and different needs. Because the system uses compatibility and compatibility, there is no inconsistency when accessing data in these different directions. We also propose to create a minimal data storage model. The aim is to keep the original material intact. Because the system has a lot of original data, this article can use the memory in Hive/HD format [15].

5.2 Horizontal Scaling and Credibility

Horizontal Extension. Kafka message storage uses the Partition method to complete the linear expansion of messages. Kafka's linear expansion can be achieved through appropriate Partition rules. Because power companies have high requirements for equipment status monitoring, the spatiotemporal structure analysis is carried out. Information is divided by time. The system can use a domain field as Kafka information in the compatibility space dimension.

Spouts are part of the user. If the Spouts share the same consumer, then multiple Spouts can share the usage process of Kafka mail. The biggest problem in spout parallel processing is that the consumption of packets cannot be completed in an orderly manner. Data summarization requires the processing of contiguous data. The answer to this question is to create a hash function that takes time grains as parameter values. The system uses a hash function to scatter time data of the same grain size to corresponding values. Bolt will restore the original data based on the timestamp in the data.

Security. Kafka's messages are stored on a hard disk rather than in memory. Kafka messages are persistent. After Kafka0.8, it also provides the function of Replication. The system uses Leader Election to complete the High Available function of Kafka Broker. Due to its characteristics of multiple enslavers and multiple enslaved people, Storm itself has better support for High Available. The Storm also employs a method of data handling failure re-transmission [16].

In data blocking, the paper must use trusted and decentralized storage to buffer data. If the data has a big-time granularity, it does not need to be very efficient. This article can use a distributed file system (HDFS) as a buffer.

5.3 Platform Integration and Collaborative Distributed Real-time Data Warehousing

Establish a set of data platforms that can uniformly schedule different data platforms. The main modules of the system include three modules: resource configuration management module, resource pool management module and resource driver module. The paper proposes cluster configuration information based on basic cluster information, cluster service information, and cluster environment information. In this paper, the system's resource allocation is divided into two categories: server and client. Fig. 9 shows the architecture of a resource allocation module. This article regularly calls various types of resources and publishes the information. The client will subscribe to the messages sent by the server.

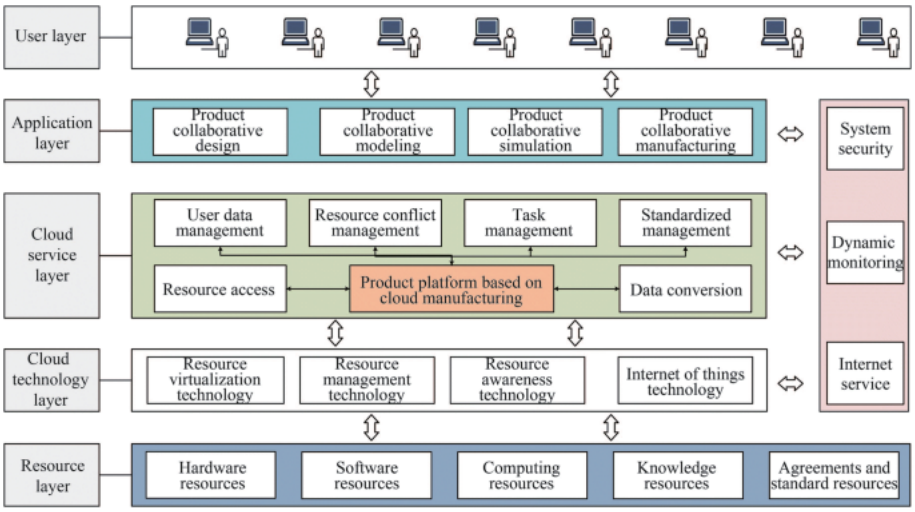

Fig. 9. Power data source configuration structure

The main function of the resource library is to integrate various resources. The system queries and retrieves various resources. At this time, the system will generate a unified report. The system matches according to the requested resources.

6 Mock Test

6.1 Test Structure and Performance Indicators

Power big data includes data on operations and equipment monitoring, testing, management, and marketing. The system uses power data to cover the power consumption of all users. The system collects data every hour. The daily power consumption data reaches tens of billions. The paper selects some of them as experiments. Finally, the paper does a lot of data stream processing on the algorithm. The system uses 3 PCs with the same configuration. They built a cluster using VMware [17]. Table 1 shows the configuration of the PC terminals.

Table 1. Parameters of the test configuration

Project name	Arguments/issues
Working system	Intel 7 processor, 6 GB of memory
Centos Virtual Machine	The data transfer speed is 100 GB/s. Two virtual machines perform system performance control over the entire process.
Data handler	The number of busses of a Gigabit Ethernet network is 2
Python	Python-2.7.3
JDK	Jdk.1.7.0_07
RAM	Memory sticks of the same capacity

The paper measures the 110 kV transformer of a local power company. This article selects the measurement results from February to April 2019. The study found that the characteristic value of the fiber temperature measured within three months was 0.864T. In this paper, the test data of 450 GB is displayed on the monitoring interface in Fig. 10. In this paper, the average delay cluster is calculated.

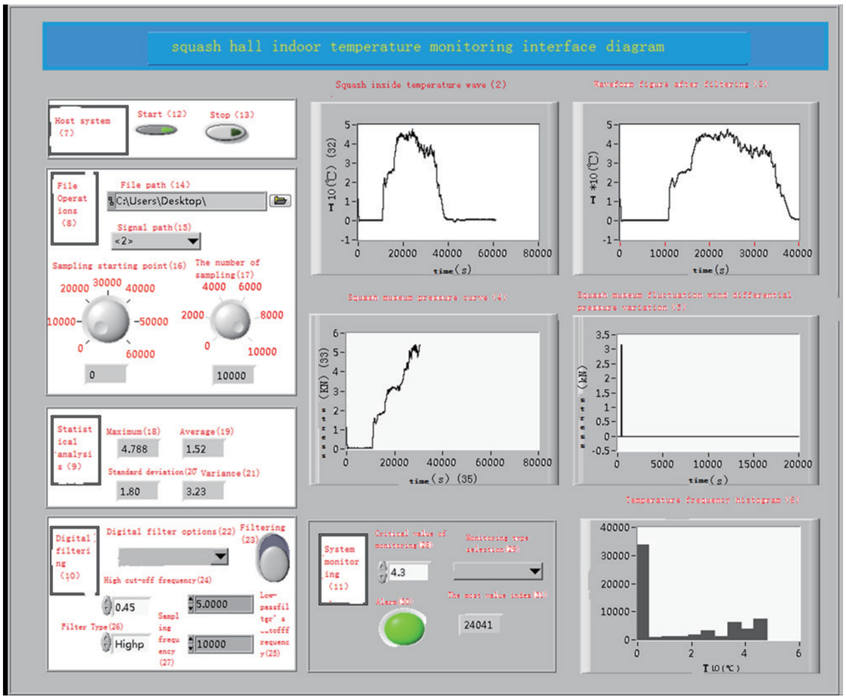

Fig. 10. Optical fiber temperature characteristic parameter monitoring interface

6.2 Average Delay Test

The paper uses different data to examine the processing delay of the system. This article sets up 4 general workflows. The number of set nodes and the output of the sliding window operation is observed. The paper counts the average time lag (Table 2).

Table 2. Average time delay experiments with different amounts of data

Average processing delay/min		Data volume/GB			
		20	100	250	450
Serial number	1	0.231	1.452	2.244	4.378
	2	0.198	1.342	2.31	4.455
	3	0.264	1.496	2.255	4.532
	4	0.121	1.452	2.299	4.29
	5	0.231	1.419	2.321	4.554
	6	0.231	1.452	2.244	4.378

The smaller the amount of data, the more time the system needs to process it. The sending of tasks and data in the network will take up a lot of network space. The larger the amount of data, the faster the data can be processed and the lower the average latency of the data. It can be seen from Table 2 that the safe storage processing and direct storage of time-series big data in the smart grid show good operating performance. Its storage and processing efficiency are high. The main reason is that the network transmission time occupies a dominant position in the data storage process. The cleaning and classification of data lay the foundation for high-efficiency storage. The system effectively improves the storage speed of grid time series big data [18].

6.3 Experiments with CPU Usage

CPU usage is used as the evaluation criterion. The purpose is to test the space compressibility of the algorithm. In this paper, the power data of 75~85 MB capacity is uploaded to the power management program, and the energy consumption test is carried out. The corresponding calculation method is given in this paper.

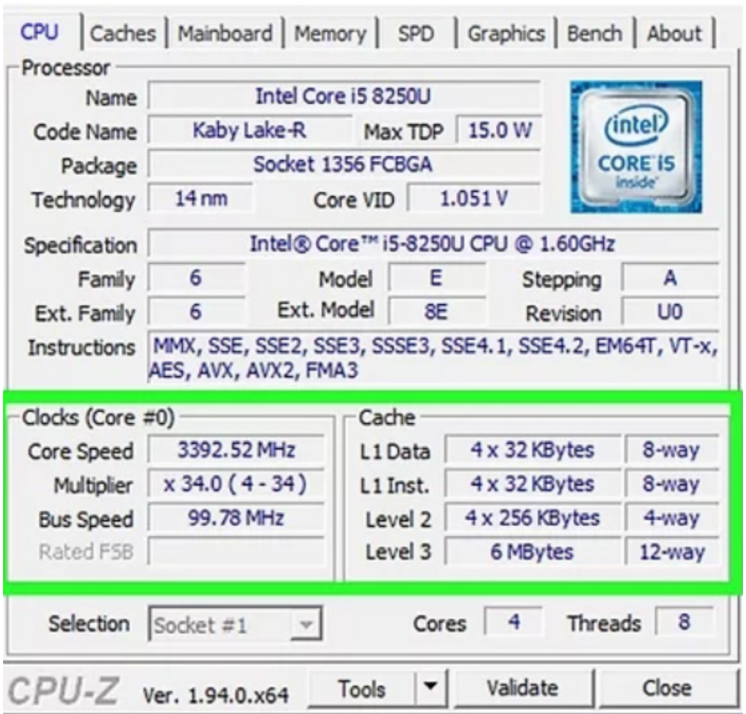

Fig. 11. Data processing techniques occupied by CPU

It can be seen from Fig. 11 that the file size of the method before adopting the method of this study was 76.2 MB [19]. The CPU usage is 5%. When the file reaches 81.7 MB, the CPU usage of the algorithm in the paper is only 0.5%. The disk utilization curve shows that the disk I/O is relatively balanced. This also shows that the Region segmentation method and the original data preprocessing method in the paper have reduced the I/O conflicts between different Region Servers. The performance bottleneck of the cluster is reflected in the fact that the available memory in the entire loading process is less than 100 M. The paper adopts a multiple multilevel parallel space model based on multiple parallel operations. The paper uses multiple parallel computing methods to reduce the complexity of multiple nodes [20].

7 Conclusion

The paper introduces a cross-multiplier multi-data flow collaboration algorithm to design a power grid data processing cloud platform. The proposed smart grid time series big data processing method effectively combines data cleaning, classification, and safe storage in the data processing process. Experimental testing of this method shows that the method has strong anti-attack performance and is less time-consuming. The calculation proposed in the paper is a feasible method for power grid data processing. However, this method is still in its infancy. The experimental environment limits the size of the experimental dataset. The method in the paper only conducts experiments on the real-time processing of numerical data, and it is relatively simple to detect abnormal data through threshold judgment. This may result in lower utilization of the system. The next step is to prepare for computational analysis of larger datasets. At the same time, the real-time processing method of unstructured power big data is studied. Finally, apply the above computing framework and ideas to other fields.

Acknowledgments

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