Study on fault tolerance method of cloud computing accounting service platform for middle data supporting cost-benefit analysis

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Research Article

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Abstract

Study the fault-tolerant method of intermediate data of cloud computing accounting service platform to support cost-benefit analysis, provide cost-benefit analysis function for the platform, and strengthen the fault-tolerant ability of intermediate data of the platform. Build an enterprise cloud computing accounting service platform, use the network environment of the accounting service platform provided by the cloud service provider, collect the internal and external accounting service system data of the enterprise through the data collection layer, and transmit it to the data warehouse of the data processing storage layer after data cleaning, extraction and processing. The data processing storage layer calls the collected data to analyze the transaction cost-effectiveness of the enterprise. The intermediate data fault-tolerant model is constructed. After being solved by ant colony algorithm, the intermediate data generated in the process of cost-benefit analysis and other accounting services are fault-tolerant processed, and the platform accounting service results are output to the interactive interface through the data output display layer, so as to realize the interaction with users. The experimental analysis shows that:this method can effectively analyze the transaction cost and benefit of enterprises, the data availability probability after fault-tolerant processing is higher, and the read-write load is lower.

1 Introduction

At present, with the rapid development of society, the number of small and medium-sized enterprises in China is gradually increasing, which provides more support for the national economy. However, there are many difficulties in the development of small and medium-sized enterprises [1–2], and the problems of financial management and tax declaration of enterprises themselves are becoming more and more complex, which leads to difficulties in the operation of enterprises. As the rise of cloud computing and big data has brought many conveniences, many fields combine cloud computing with big data means by using cloud computing to store data and using big data technology to predict and analyze domain risks [3]. Some enterprises also use cloud computing and big data technology in their daily work. Typical applications are mainly in business management, financial analysis, and stock price forecasting industry.

Accounting service is the most critical link in enterprise management, which will generate a large number of process bills and accounting data. Therefore, in the process of accounting service management, the construction of accounting service platform can optimize and upgrade the management mode, and also help enterprises to manage their own financial problems in time. Among the financial problems of enterprises, the most critical one is the cost-benefit analysis of enterprises. Cost-benefit analysis refers to a method of evaluating the value of a project by comparing all the costs and benefits of an enterprise. Cost-benefit analysis is a typical economic decision-making method, which can analyze the way to obtain the maximum benefit with the minimum cost, and is also an important analytical means in financial management. Through the cost-benefit analysis of enterprises, we can analyze the current operating costs of enterprises themselves, judge the development of enterprises on this basis, and plan the future development direction of enterprises.

In the process of enterprise operation, cloud computing technology can be used to deal with the problem of enterprise accounting service data storage. But a large number of business data will be generated in the storage of enterprise accounting service data. Because the long-term accumulation of data has met the basic requirements of big data application, big data technology can be used to mine enterprise accounting business data. The storage data generated at different stages are analyzed, but there are also some problems in the use of cloud computing, such as the stability of cloud computing, that is to say, if the hardware environment or communication environment fails when cloud computing is used, it will inevitably lead to the loss of some or even all data. The stored data can not be used for predictive analysis. At the same time, if server interruption occurs in the process of cloud computing storage, it will affect the correctness of data storage, and make many high-intensity computing tasks unable to independently verify the results, which requires full attention to the intermediate stage data of cloud computing technology. Analyze the fault tolerance of the intermediate stage data and calculate the reasonable fault tolerance,which is to avoid the problems in the operation of cloud computing can better guarantee the cost-benefit analysis of enterprise accounting service platform. Realize the rationalization mechanism of data collection- benefit judgment- fault-tolerant processing, data analysis model and interactive platform so as to provide scientific and effective help for enterprise benefit decision-making [4].

2 Research Status

The intermediate data fault-tolerant method of cloud computing accounting service platform supporting cost-benefit analysis is the key content of this study. The core content is to deal with the fault-tolerant method. At present, the research on fault-tolerant methods in the cloud computing storage process is still in its infancy, and relevant researchers use coding and decoding technology to deal with the fault-tolerant problem in cloud computing. That is to say, the relevant encoding format is set when the data is transmitted to the cloud computing, and the relevant decoding format is used for decoding when the data is output [5]. This process can not fundamentally deal with the occurrence of fault tolerance problems. Even if the data are encoded, it can not solve the problem of data loss caused by server interruption. Relevant researchers have also designed erasure code fault-tolerant methods in distributed storage systems, mainly to correct and supplement data after data loss caused by server interruption, and to achieve data repair through the judgment of experienced personnel or the calculation of data correction probability [6]. But the final data obtained in this process can not be fully obtained. It also has certain subjectivity. Relevant personnel also divide the data input of cloud computing into three stages, namely, the initial stage, the intermediate stage and the end stage. It carries out the data input protection mechanism according to the characteristics of the data volume and the stage characteristics of different stages, and predict the time when the server may have problems through empirical formulas. When the server problem is repaired, the data input is continued [7]. However, due to the uncertainty of server failure, the data corruption caused by cloud computing cannot be effectively dealt with.

With the deepening of research, some researchers have proposed a kind of recursive data center network fault-tolerant method, which automatically classifies data in the process of data input, inputs different types of data in batches, and timely processes and repairs according to different types of data if data loss occurs [8]. This method does not fundamentally solve the problem of intermediate data generated in the process of cloud computing operation, nor does it propose a fault-tolerant method with strong applicability. Based on the analysis of intermediate data errors by using empirical formulas, other researchers have established a monitoring model to monitor the abnormal state of data input by using the parameters generated in the process of data transmission. When the state reaches a certain abnormal peak, the data input will be stopped immediately. The whole process of cloud computing transmission will be checked and evaluated to deal with potential problems in time. However, this method does not deal with intermediate data or repair intermediate data, but only establishes a monitoring and analysis model to judge the occurrence of potential risks in time, which has some limitations [9].

At the same time, with the development of economy, the research on cost-benefit analysis is also on the rise. Relevant researchers combine cost-benefit analysis with machine learning algorithms, and use data mining ideas to mine the rules of cost-benefit analysis to provide auxiliary support for decision-making [10]. There are also relevant researchers who establish statistical curves based on cost-benefit data and establish analytical models based on the rules found in the statistical process [11]. It can be seen that the combination of cost-benefit analysis and computer means has become a major research trend.

To sum up, through the summary and analysis of the research status of cost-benefit analysis and cloud computing fault-tolerant methods, we can know that the research of intermediate data fault-tolerant methods of cloud computing accounting service platform supporting cost-benefit analysis is feasible. Therefore, through the understanding of accounting cost analysis, this study uses the network environment of accounting service platform to collect data from internal and external accounting service systems, transmit them to the data warehouse of data processing and storage layer for storage, and then construct a fault-tolerant model of intermediate data, which is solved by ant colony algorithm to analyze the cost benefit and other accounting services. The interactive interface with the user is output so that the platform has higher intermediate data fault-tolerant efficiency.

3 Cloud Computing Accounting Service Platform Intermediate Data Fault Tolerance Method

3.1 Cloud computing accounting service platform design

In this study, the cloud computing accounting service platform is firstly constructed. The platform architecture mainly includes data acquisition layer, data processing and storage layer and data output and display layer. In the process of platform operation, big data tagging and platform security mechanism are used. The platform architecture is shown in Fig. 1.

In Fig. 1, since the platform in this paper is built based on the cloud computing model, the network environment is provided by the cloud service provider. In the data acquisition layer, the platform obtains accounting business data through different departments within the enterprise and external networks, including enterprise operating costs, industry development data and other information, and uniformly cleans these data and stores them in the data processing and storage layer, which calls the collected data to analyze the transaction costs and benefits of the enterprise. A fault-tolerant model of intermediate data is constructed to carry out fault-tolerant processing on the intermediate data generated in the process of analyzing the cost and benefit of the cloud computing accounting service platform and other accounting services, and then the processed data is integrated and stored in different databases; in the data output display layer, the processed enterprise transaction accounting service data is provided to users through different functional modules.

3.2 The Accounting cost benefit analysis

3.2.1 The accounting audit transaction cost analysis

The analysis of accounting and auditing transaction cost is mainly the benefit analysis of enterprise transaction cost. Through the transaction data obtained from the internal accounting transaction management system of the enterprise, the internal friction of enterprise cost is deeply analyzed from the aspects of negotiation, adoption, coordination and supervision cost of enterprise transaction. The analysis mainly includes negotiation cost, adoption cost, coordination cost and supervision cost.

(1) Negotiation cost: This cost refers to the cost that the enterprise needs to pay when signing the contract, that is, the cost of manpower and material resources consumed by both enterprises in the negotiation stage before the transaction [12]. At the same time, in the contract agreement, the transaction timeliness, service quality, incentive clauses and corresponding punishment strategies of both enterprises need corresponding negotiation costs.

(2) Adoption cost: When the enterprise completes the negotiation, it needs to make preparations for starting a new business, which is the adoption cost.

(3) Coordination Cost: This cost is mainly the communication and coordination cost during the implementation of the contract. In the process of enterprise projects, due to the diversity of market demand and the variability of the future, the contracts signed between enterprises will be affected by many factors [13], which will lead to accidents in the process of cooperation. Therefore, enterprises need to coordinate accordingly and renegotiate the contents of the contracts to generate new transaction costs, which constitute coordination costs.

(4) Monitoring Cost: The cost is the cost of preventive measures taken by the enterprise to prevent unexpected events in project contracts. Under normal circumstances, during the process of the project, the staff may seek personal gains, which may damage the interests of the enterprise [14].In most cases, there will be information asymmetry between enterprises, leading to deviations in the contract behavior. Therefore, it is necessary to strengthen the supervision of the contract execution process, thus forming supervision costs.

3.2.2 Analysis of direct cost, indirect cost and total cost benefit of investment

According to the above accounting audit transaction cost analysis, assuming that without considering the unexpected losses, the cost benefit of enterprise contract transaction is calculated by Formula (1) :

$$C=\sum_{k=1}^{n} c_k^i \cdot x_k^i$$

1

In Formula (1), C represents the cost-effectiveness. K represents the number of contracts. c_k^i and x_k^i represent the transaction cost and the audit cost respectively. It can be seen that there is a positive correlation between the enterprise transaction and cost. The more transactions an enterprise has, the higher the cost will be, and the higher the enterprise benefit will be [15].

3.3 Design of the fault tolerance method for intermediate data

3.3.1 Build the fault tolerant model of intermediate data

In the process of cost-benefit analysis and execution of other accounting service tasks in cloud computing accounting service platform, due to the large amount of data, massive intermediate data will be generated, which also has a high importance. Due to the uncertainty of cloud computing environment, it is easy to have a low fault tolerance rate. Therefore, this study introduces dynamic fault-tolerant technology in the design of cloud computing accounting service platform.

An effective intermediate data fault-tolerant model requires some assumptions, which are as follows:

(1) If some accounting service node in the cloud computing accounting service platform has intermediate data, the accounting service data can be obtained in real time, and the intermediate data information generated by the accounting service can be broadcast to other nodes in the platform.
(2) Under the isolation protection mechanism of the cloud computing account service platform, when the intermediate data appears on an accounting service node, the same intermediate data does not appear on other accounting service node.
(3) If an accounting service node has intermediate data and cannot execute the task normally, it can continue to execute the task through other alternative operations.
(4) The real-time task cycle is equal to the time limit.
Based on the above assumptions, the following intermediate data fault-tolerant model is constructed: in order to complete the accounting service task of the cloud computing accounting service platform, it is necessary to ensure the maximum tolerance of the intermediate data generated by the platform

accounting service within the corresponding time limit. When the intermediate data appears in the cloud computing accounting service platform, the data can be reasonably divided into various processors.

Assume that the accounting service task set of cloud computing accounting service platform with *n* cycles is:

$$S=\{s_1,s_2,\ldots,s_n\}$$

2

The accounting service tasks in *S* can be reasonably allocated to *m* processors. The accounting service tasks can be described as $s_i=(A_i,B_i)$. In it, A_i represents the fastest execution time and B_i represents the deadline. In *S*, each accounting service task contains four elements, namely, constituent cycle, time limit, basic version and minor version. Figure 2 is used to represent the specific flow of the intermediate data fault tolerance model.

When there is intermediate data in the cloud computing accounting service platform, the platform will open the sub-version of the task and express the implementation in the following form:

$$R=\begin{cases}Y+f\left(s_i\right)\leqslant d,0\\ Y+f\left(s_i\right)>d,1\end{cases}$$

3

In Formula (3), "0" indicates that the task is not executed; and "1" indicates that the task is executed. The completion time of the minor version task is represented by Y. Periodic tasks are represented by s_i whose execution time is $f\left(s_i\right)$. Task deadlines are represented by *d*.

The design of cloud computing accounting service platform can enhance the reliability of the platform. But it will lead to the occupation of platform data and cause redundancy. In this regard, after obtaining the intermediate data of tasks, it is necessary to eliminate the secondary version tasks immediately to avoid occupying the platform space.

3.3.2 Intermediate data fault tolerance technology based on the ant colony algorithm

When performing the accounting service task, each data has set corresponding parameters, such as bandwidth, current load, etc., which can be used to calculate the initial pheromone value. Assume that the combination of each data *i* and the accounting service task *j* is PV_{ij}, and the initial pheromone value can be calculated by Formula (4) :

$$PV_{ij}=\left[\frac{S_j}{bandwidth_i}+\frac{C_j}{MIPS_i\left(1-Load_i\right)}\right]$$

4

In Formula (4), the size of the given accounting service task *j* is described by S_j. The bandwidth available for data *i* is described by $bandwidth_i$. The CPU time occupied during the execution of accounting service task *j* is described by C_j. The processor speed is described by $MIPS_i$.The current load of data *i* is described by $Load_i$.

The initial pheromone value is allocated at the beginning of the algorithm and then used as the data pheromone value. Calculate the initial pheromone value between each data and the accounting service task, and save the calculated results in the PV matrix, as shown in Formula (5) :

$$PV_{matrix} = \begin{bmatrix} PV_{1,1}\ PV_{1,2}\ PV_{1,n-1}\ PV_{1,n} \\ PV_{2,1}\ PV_{2,2}\ PV_{2,n-1}\ PV_{2,n} \\ PV_{m-1,1}\ PV_{m-1,2}\ PV_{m-1,n-1}\ PV_{m-1,n} \\ PV_{m,1}\ PV_{m,2}\ PV_{m,n-1}\ PV_{m,n} \end{bmatrix}$$

5

In Formula (5), accounting service tasks and total number of data are represented by *n* and *m* respectively. The logical state of ant colony topology is described by PV_{matrix}. Under one index, the colony migrates to another index to get the best data.

If the data of the cloud computing service platform has certain correlation in the operation process, it indicates that if a task comes from a specific data, the accounting service task can be assigned to all available data. Feasible accounting service task lists of data *i* and accounting service task *j* are listed by $PV_{matrix}$and displayed in each column that can be passed by PV_{matrix}.

In each column of the matrixPV_{matrix}, the maximum pheromone of ant colony is recognized as the most appropriate data. When the task is assigned, the data within the matrix $PV_{matrix}$of pheromone will update the global pheromone according to the formula (6) in order to reduce the amount of current pheromone of data acquisition. Make the next ant colony not be attracted to the current data and be able to continue to search for other data:

$$\tau_{ij} = (1-\rho)\cdot\tau_{ij} + \rho\cdot \triangle\ \tau_{ij}$$

6

In Formula (6), the pheromone quantity in the data is represented by τ_{ij}, $\tau_{ij} = 1/L_{best}$, and L_{best} is the length of the global optimal route. If $\tau_{ij} = 0$, which indicates that the global optimal route is not obtained. When *m* and *n* are taken as data and task respectively, their dynamically controllable evaporation rate is represented by $\rho$and calculated by formula (7) :

$$\rho = \left[\left(\frac{n}{m}\right)^2\right]^{-1}$$

7

When the accounting service task has completed its assignment, the previously assigned task can be executed again. If the task cannot be executed, the task can be submitted again to other appropriate data at the last stored checkpoint. The information on the checkpoint can be used to record all currently executed tasks, and the information can also be used as a historical execution record for each data update. For each checkpoint, the pheromone can be used to reduce its historical record, and a new round of local pheromone can be updated by using formula (8) so that the pheromone value can be reduced as much as possible. When the task is successfully executed, the semaphore will be reduced accordingly. If the task is not successfully executed, the semaphore will be in an abnormal reduction state:

$$\tau_{ij} = (1 - \rho) \cdot \tau_{ij} + \rho \cdot \tau_0 \left(E_i\right)$$

8

The calculation process of the ant colony algorithm is realized through the following steps:

Step 1: Initialize parameters: configure all parameters, use formula (4) to calculate the initial pheromone value, create an independent ant colony for each task, and select the data with the highest initial pheromone in the first iteration.

Step 2: Start the loop: obtain the most suitable data according to the ant colony algorithm theory, send out the accounting service task submission signal, update the global pheromone by using the formula (6), and analyze whether to implement the task. If the accounting service task is completed, end it. If not, continue to analyze the execution status of the accounting service tasks. If the accounting service task is executed successfully, that is, the storage checkpoint, the new success count is added, and the local pheromone value is updated according to Formula (4)-Formula (8). And if that account service task fails to be execute, retrieve the check point at the tail end, then resubmit, add a failure count, update the local pheromone by using a formula (8), and return to the step (2) after updating until the accounting service task which fails to be executed does not occur.

Step 3: Task completion: When there is no accounting service task with execution failure, complete the operation and terminate the execution.

4 Experimental Analysis

In order to verify the performance of this method, the cloud computing simulation platform CloudSim3.0 is selected to construct the cloud computing accounting service platform, and the functions of DataCenter, Cloudlet and VM in CloudSim are used to simulate the network data in the cloud computing accounting service platform. Construct tasks and virtual machines and design the platform simulation environment. At the same time, the erasure code fault-tolerant method in the distributed storage system and a kind of fault-tolerant unicast method in the recursive data center network are selected to compare with the method in this paper.

The transaction cost of an enterprise in the simulated cloud computing accounting service platform is analyzed. The change of the transaction cost of the enterprise under different transaction times is analyzed. The analysis results are shown in Fig. 3.

According to Fig. 3, there is a positive correlation between the number of investments and the direct transaction costs of enterprises. The indirect transaction costs and the total transaction costs of enterprises are rising in a curve. From this, we can see that the method proposed in this study can effectively analyze the cost expenditure of enterprise transactions, and the analysis results are clear.

The transaction benefit of an enterprise in the simulated cloud computing accounting service platform is analyzed. The analysis results are shown in Fig. 4.

According to Fig. 4, there is a positive correlation between the number of transactions and the different benefits of enterprises. Among them, the marginal benefit of enterprise transaction is always the lowest, while the average benefit of transaction is slightly higher than the marginal benefit. The total benefit of enterprise transaction is always the highest, and the rising range of the three benefits is more balanced, which shows that the application of this method can reasonably analyze the benefits produced by enterprise transaction.

By analyzing the number of accounting service tasks and the number of intermediate data, the intermediate data fault-tolerant success rate of this method is shown in Table 1.

Table 1
Average success rate analysis of this method

Number of accounting service tasks	intermediate data quantity	bandwidthB/S	The number of machines per data	Average success rate /%
100	10	5000	1	98.6
200	20	5000	1	98.4
300	30	5000	1	98.1
400	40	5000	1	97.8
500	50	5000	1	97.6
600	60	5000	1	97.2
700	70	5000	1	96.5
800	80	5000	1	96.2
900	90	5000	1	95.4
1000	100	5000	1	95.1
1100	110	5000	1	94.4

It can be seen from Table 1 that with the gradual increase of the number of accounting service tasks and the number of intermediate data, the fault-tolerant success rate of the method in this paper for intermediate data also decreases. However, when the number of accounting service tasks reaches 1100 and that of intermediate data reaches 110, the fault-tolerant success rate proposed in this study still remains above 90%. It can be explained that this study can achieve intermediate data fault tolerance in a higher degree.

Compare the three methods and analyze the data availability under different data nodes after applying the three fault-tolerant methods. The analysis results are shown in Fig. 5.

It can be seen from Fig. 5 that when the number of data nodes gradually increases, the data availability probability of the three methods also changes. Among them, the data availability probability of the error-correcting code fault-tolerant method decreases due to the influence of the number of nodes, and finally reaches 0.92, which indicates that the data fault-tolerant performance of this method is poor. The data available probability becomes lower after fault-tolerant processing. Although the data availability probability of the fault-tolerant unicast method increases, it is still lower than that of the method proposed in this study. The highest data availability probability of the method proposed in this study is 0.98, which indicates that the data availability of this method is higher after the fault-tolerant processing.

Analyze the performance ratio of the two operations of the method in this paper when reading and writing data to verify the fault tolerance of the method in this paper for intermediate data during data processing. The analysis results are shown in Fig. 6.

It can be seen from Fig. 6 that for different access request sizes, the performance ratios of the read operation and the write operation are almost the same, which indicates that after the intermediate data fault tolerance processing is performed by applying the method in this paper, the data of the read operation and the write operation almost do not change greatly. The intermediate data fault tolerance can be reasonably completed.

Compare the three methods and analyze the read and write loads after data fault tolerance processing by different methods. The analysis results are shown in Fig. 7.

It can be seen from Fig. 7 that under different numbers of disks, the read-write loads of different methods are also different. Among them, the read-write load of the error-correcting code fault-tolerant method increases the most, indicating that the application of this method for fault-tolerant processing will rapidly increase the burden on the CPU, but the read-write load of this method is still lower than that of the fault-tolerant unicast method. However, this method always maintains the highest load, while the method proposed in this study has a lower read-write load, which shows that this method has a lower load when reading and writing data after the fault-tolerant processing. It can speed up the speed of data reading and writing.

5 Conclusion

This paper mainly studies the intermediate data fault-tolerant method of cloud computing accounting service platform of supporting cost-benefit analysis.The paper constructs a cloud computing accounting service platform for enterprises, in which the cost-benefit of enterprise transactions is reasonably analyzed. The main conclusions are as follows:

(1) Use an intermediate data fault-tolerant method to enhance the fault-tolerant efficiency of the cloud computing accounting service platform;

The performance of the method is verified through experiments. Compare the error-correcting code fault-tolerant method with the fault-tolerant unicast method to analyze whether the method is reasonable after application;

(2) In the future research, we can continue to optimize the current method to achieve a variety of data analysis and fault tolerance of cloud computing accounting service platform.

Declarations

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Data Availability

All datasets generated for this study are included within the article.

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Author Contributions Statement

Taolan Jin performed the data analyses and wrote the manuscript;

Bo Zhang contributed to the conception of the study;

Taolan Jin contributed significantly to analysis and manuscript preparation;

Bo Zhang helped perform the acquisition of the financial support for the project leading to this publication.

All authors read and approved the final manuscript.

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Figures

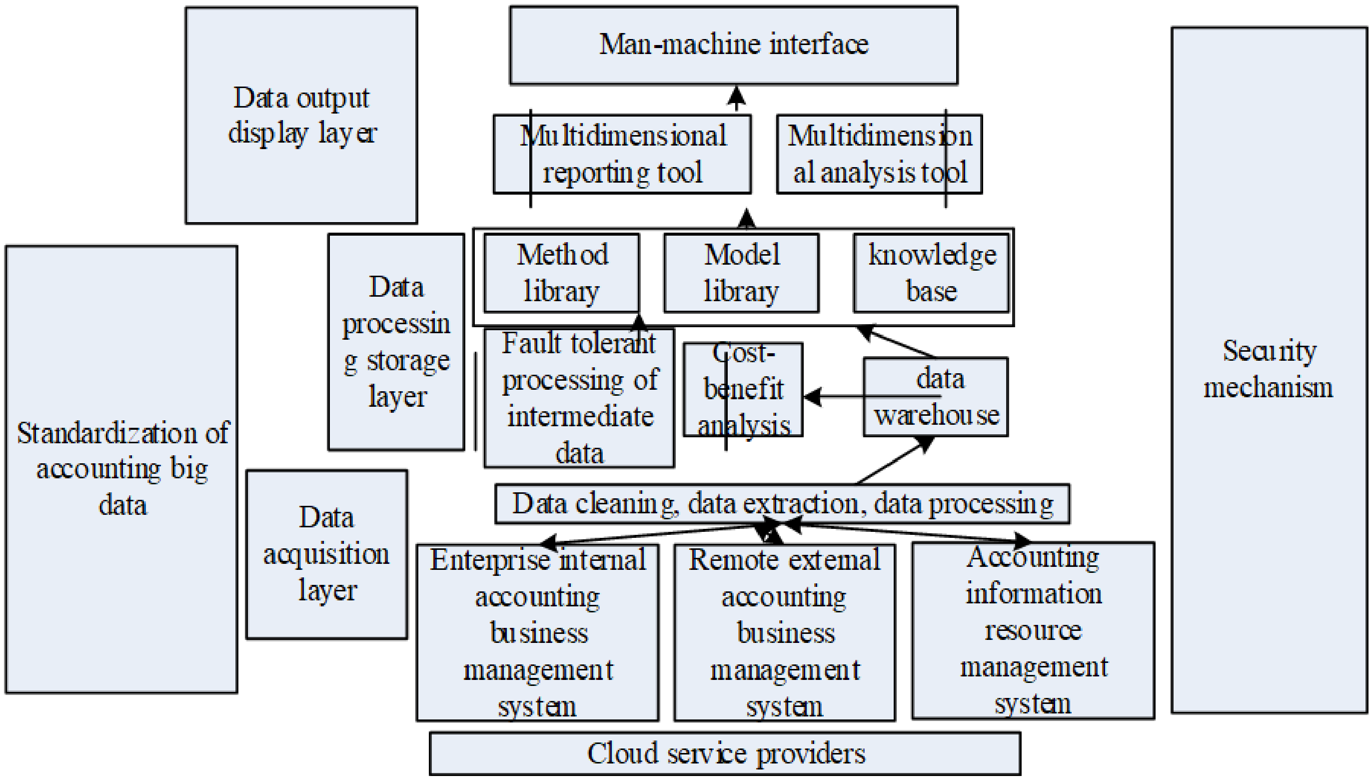

Figure 1

Cloud computing accounting service platform architecture

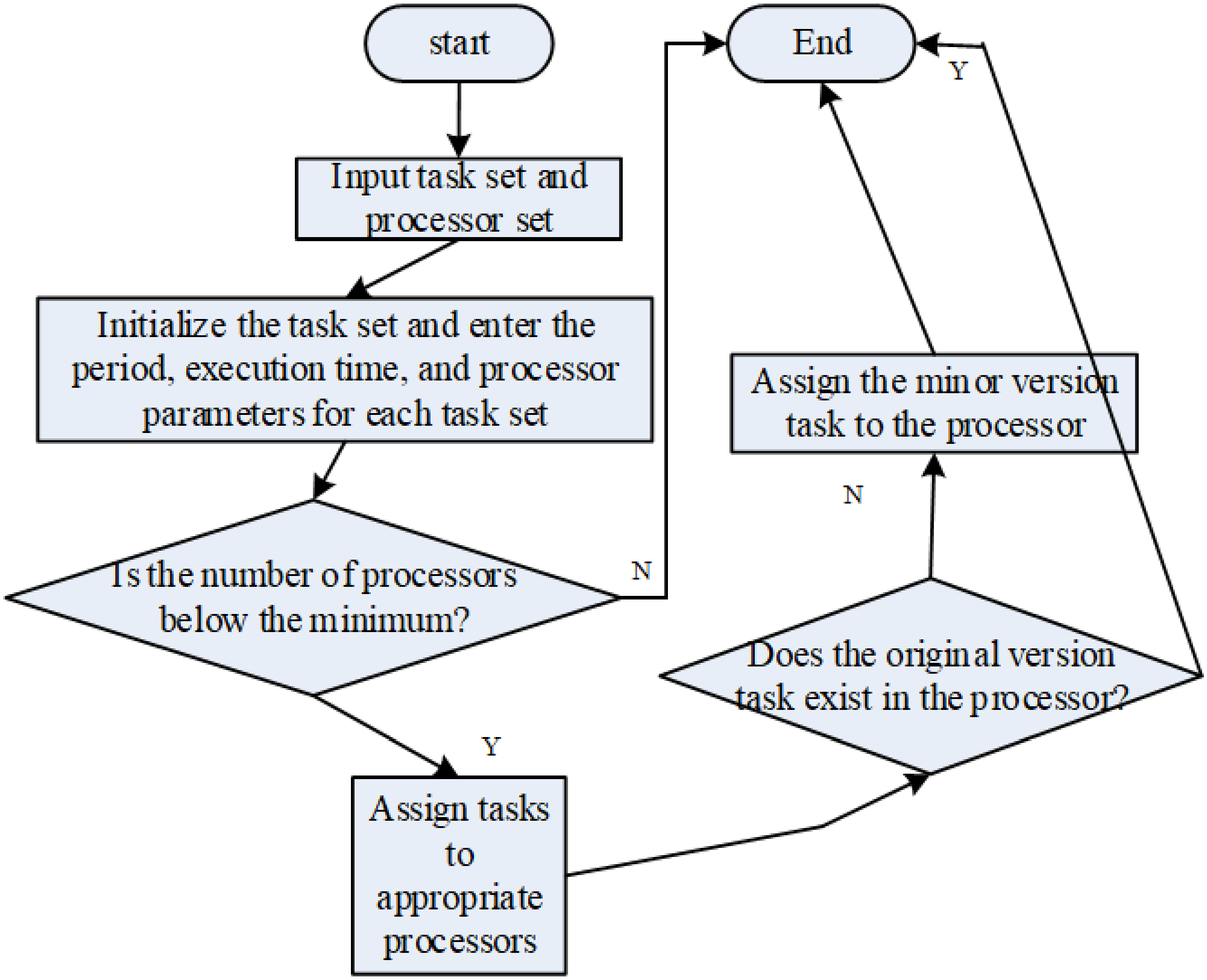

Figure 2

Intermediate data fault tolerance model of the specific flow

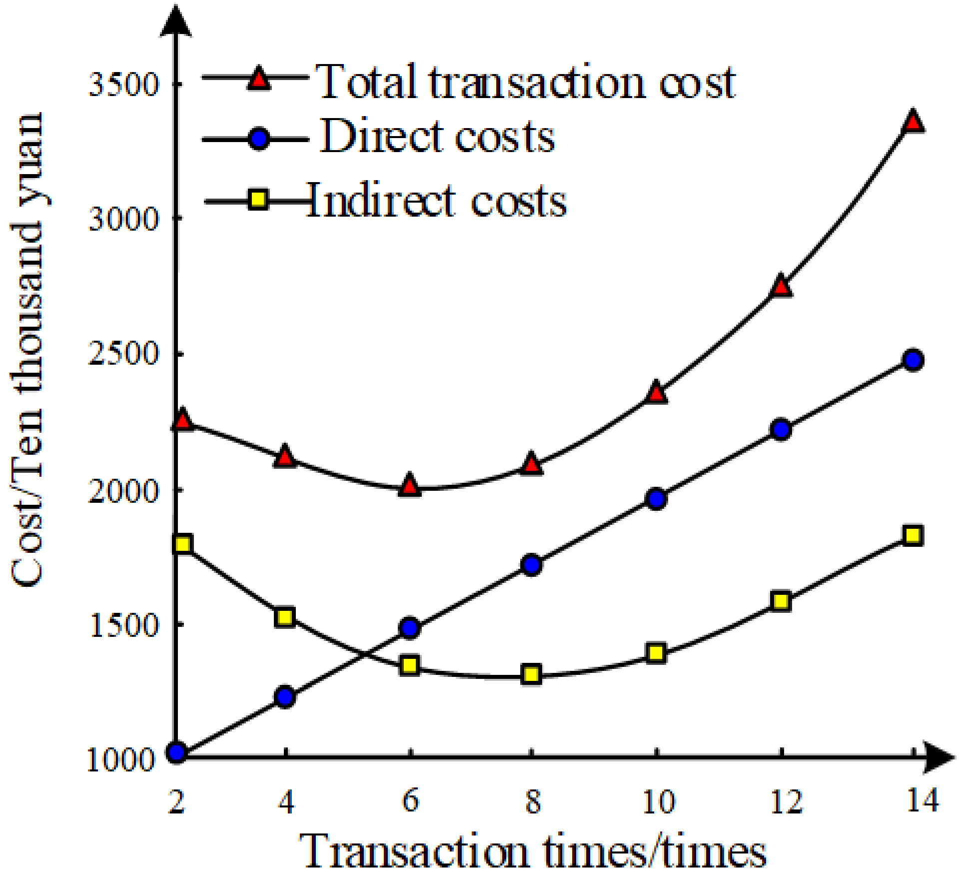

Figure 3

Enterprise transaction cost analysis

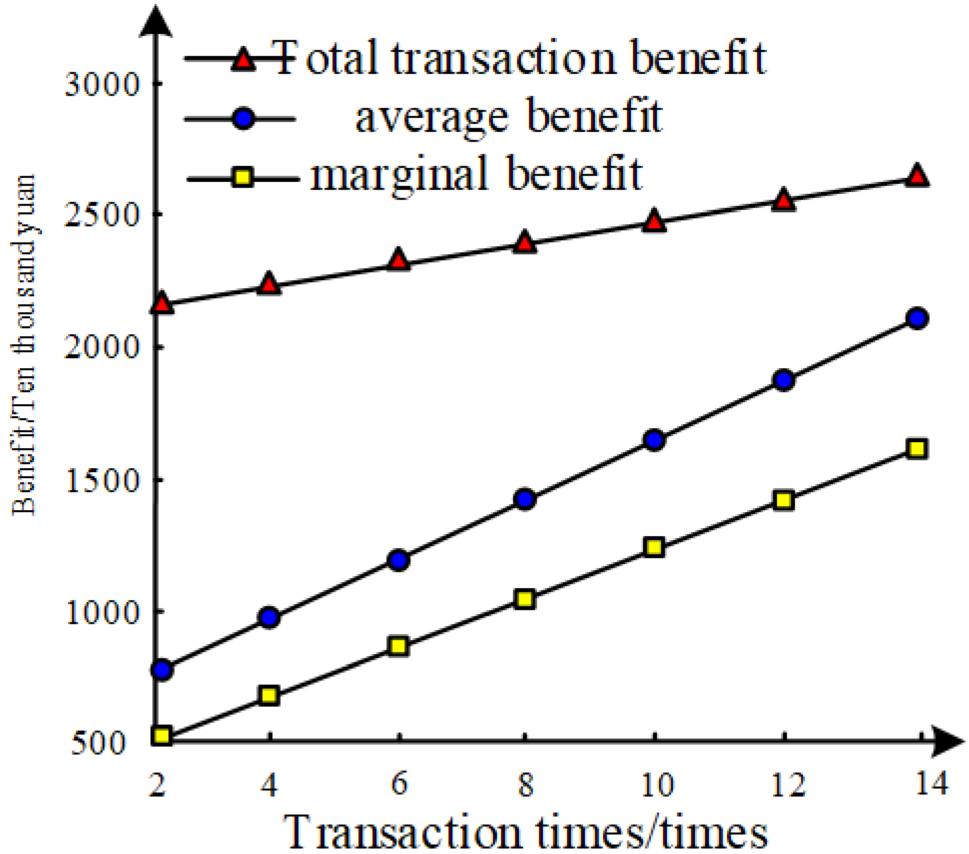

Figure 4

Analysis of enterprise transaction benefit

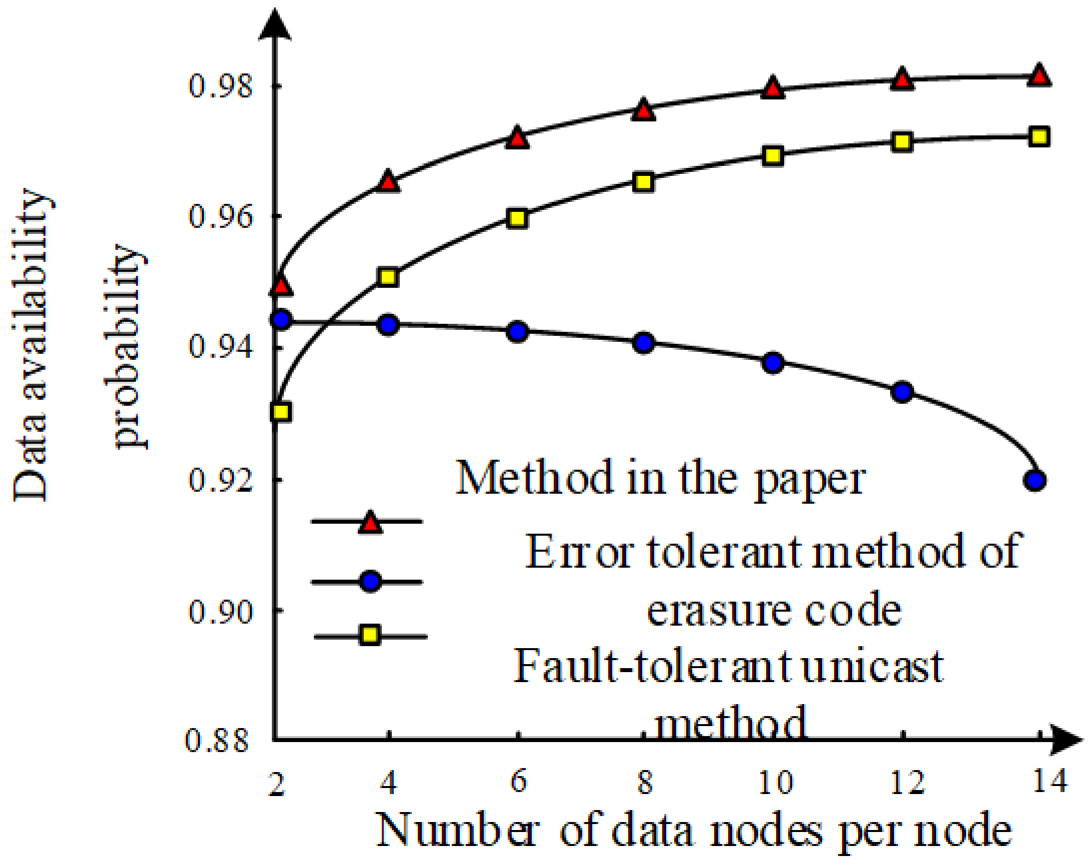

Figure 5

Data availability comparison

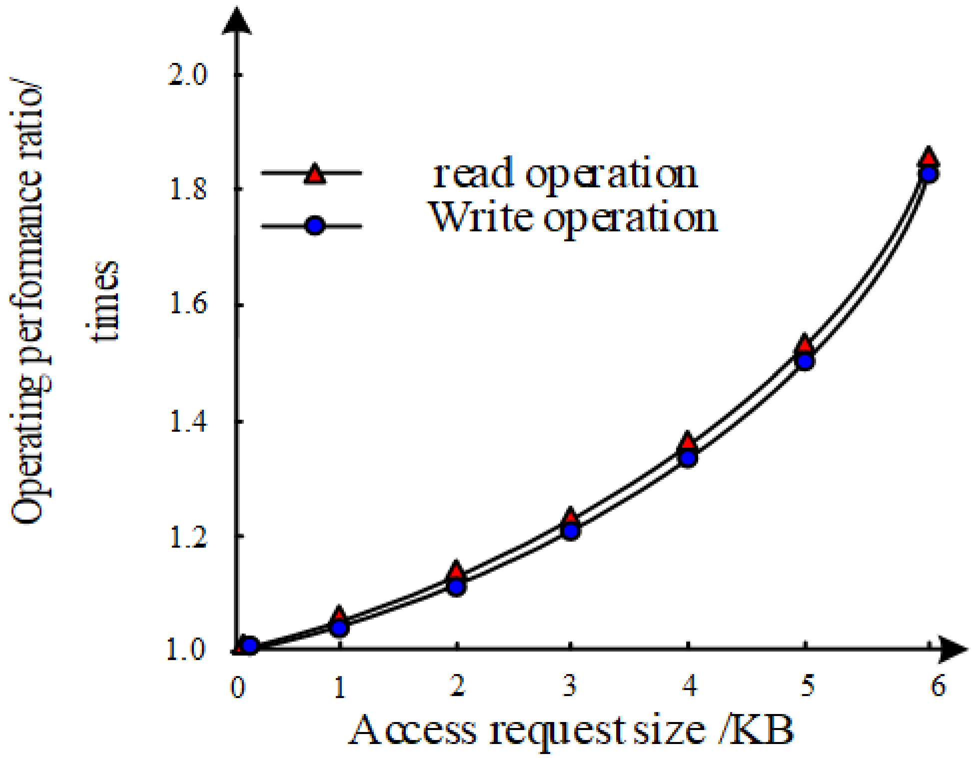

Figure 6

Read/write operation performance ratio

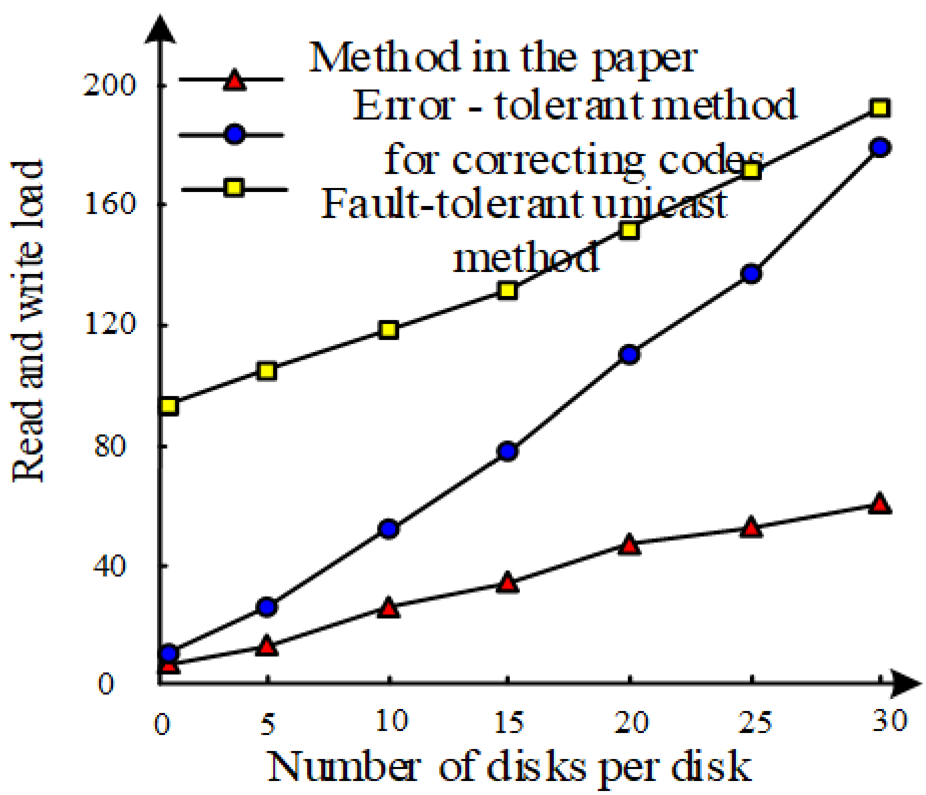

Figure 7

Read/write Load Analysis