Objectification Parallel Computing: A Real-time Solution for Big Data Computing

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ABSTRACT

Big data computing is one of the most significant research focuses in the Internet of Things and cloud computing. Hadoop technology in particular has high calculation efficiency in the non-real-time scenario (computing time around 1 minute) for both structured and unstructured data; however, this technology cannot meet the demands of the real-time solution, which requires a computing time of <10s. In order to solve this problem, the authors of this article propose Objectification Parallel Computing (OPC) and provide an efficient real-time solution on this basis.

Keywords: Big data, Hadoop, object-oriented parallel computing, object-oriented parallel computing framework

1 INTRODUCTION

At present, a research hotspot of IT industry is Big data computing[1,2]. The main research contents include the big data acquisition, management, processing, display and other links. Hadoop[2] is one of the mainstream data processing technologies. Although its calculation efficiency is higher than that of many other technologies, its real-time performance still needs further improvement.

Today, Hadoop is an open source code, low hardware requirements and flexible expansibility, so it has attracted high attention of the scientific research institutes and industry, has become one of the mainstream technology for big data.

There are two main types of Hadoop technology. One is the core code to modify the Hadoop to further improve the performance, such as the literature [3,4,5]. Another is for certain scenes, increase the function on the basis of Hadoop such as [6,7]. In contrast, Real-Time Database[8] can perform on real time for structured data when the database size is not big, but is not suitable for data amounts of PB or larger, and thus cannot be widely used in big data computing.

In order to solve this problem, we propose Objectification Parallel Computing (OPC). In this solution, the business data is formatted into objects, distributed stored in computer memory of cluster according to a certain strategy. Using certain principles, the task is divided into subtasks in a cluster and completed in parallel.

The structure of this paper is as follows. The first part presents an improved idea of task scheduling. OPC framework, definition, solution, task execution process is explained in detail in the second. The third part said that this solution has applications in Electric Asset Quality Supervision Manage System (EAQSMS) of State Grid of China (SG). It verifies the object oriented parallel computing system. The fourth part has carried on the summary to the paper.

2 THE IMPROVED TASK SCHEDULING

The task scheduling is derived from the Hadoop technology. Apache™ Hadoop® [9] Project is open source. Apache Hadoop software allows the use of simple models in a cluster large data distributed processing framework. The framework can detect and process the application layer error and ensure the high availability. In Hadoop, MapReduce[10,11] is a distributed programming framework and proposed by Google, for the parallel processing of big data. The framework is divided into Map and Reduce link.

In the MapReduce framework, there is only one node to manage all tasks and this node pressure. So, we improved the task scheduling algorithm. The strategy is the task by a node to all the nodes to be responsible. According to the logic relation of stored data, all nodes can be linked together. The node receives the task and to know whether need other nodes together to complete the task, if YSE, then the other node as a child node with the completion of tasks, sub-node after the completion of the task sends the result to the parent node.

In this case, the cluster workload is not focused on a single node, but is distributed on all nodes. With the help of this strategy, we propose OPC solutions. In OPC, First of all, the task split into sub tasks. Then the sub parallel tasks. Finally the results back to the client.

3 OPC

In OPC, the business data is formatted into object. And then the object cache to cluster computer memory. At last the memory task object according to a certain strategy is divided into sub tasks, and efficient parallel computing to complete the task.

3.1 OPC Architecture

Objectification Parallel Computing Architecture is shown in the Figure 1. In my research, the framework consists of client proxy, object manage server, object servers.

Client Proxy (CP): Receiving a user task, through access to OMS, to acquire the object server location can complete the task. The task is sent to the target server, receives the object server task execution results, the result is returned to the client.

Object Manage Server (OMS): Receive and maintain the object index table for showing that the position of the object. And it is also responsible for the restoration of object server and hot standby.

Object Server (OS): Read the data from the data source and cache to the object pool. Object can be divided into two kinds, one kind is the data object, the other is the task object. The object server management and maintenance of object pool and object, and regularly sends information object pool and object to the OMS.

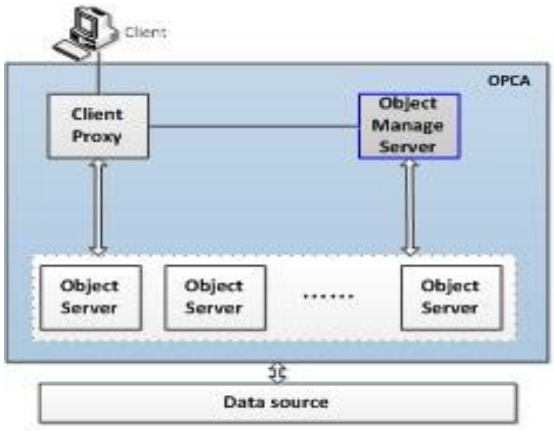

Figure 1: The Architecture of OPC.

3.2 The Solution

Do The solution consists of four steps. The first step according to certain strategy, the data is formatted into object, which is the data modeling. The second step is to calculate the amount of memory for each computer, distributed cache object. The third step OS send object pool and information of object to OMS. OMS creates the object index table. After that all, the cluster can perform the task.

The detailed process is as follows:

1. Object: According to the logic relation, structured and unstructured data is formatted into different data objects.

2. Object in cache: Because each computer memory amount is not the same, so according to a certain strategy, object distributed storage to cluster computer memory. All concentrated objects must be cached on the same computer memory, otherwise the impact of task execution results.

3. Create object index: OS send object pool and information of object to OMS. The OMS receive information and create the object index according to the logical relationship. The object index like the resource manager in Windows Operating System. According to the object indexing information, we can easily understand the distribution information of an object in the cluster.

4. Parallel computing：Created the object index, the system can perform the task. User submits tasks and system receives the task, the task divide into smaller tasks according to the strategy. Small tasks parallel in a cluster and perform small tasks in each computer of cluster. At last the final results are returned to the client.

3.3 Solution Analysis

OPC fuses object oriented, parallel computing, memory calculation theory and technology. Give full play to their respective advantages in the solution, can significantly enhance the task execution efficiency.

The range of applications is wide. Structured and unstructured data can be formatted to objects according to certain strategy. Formatted into an object, you can perform tasks related to using OPC. Therefore, OPC can not only be used in structured data in the scene, also can be used in non-structured data in the scene.

The memory cache data. Data storage location from disk to memory, the memory calculation efficiency is much higher than the disk calculation, so the OPC can significantly improve the computational efficiency. The object cache to cluster different computer memory, in each computer memory object data is not large, the task execution efficiency is very high. Computers in a cluster are executed in parallel, thus the task execution efficiency is high, can satisfy the real time requirement.

Cluster has good scalability. No restrictions on computer data in the cluster, and we can easily to cache more data through the lateral extension cluster. Because the PCs in the cluster are executed in parallel, the calculation efficiency is not significantly lower task. In addition, the cluster computer may be down. If the PC down, the object will be lost.

4 VERIFICATION AND ANALYSIS

In order to prove the validity of the solution, this solution has applications in Electric Asset Quality Supervision Manage System (EAQSMS) of State Grid of China (SG). So the business data is too large about more than 200,000,000 at present. The business logic between data is complex. In this case, the existing system cannot meet the requirement of real time statistical time less than 10 seconds.

The OPC system consists of three software: Object Manage Server Soft, OMSS; Object Server Soft, OSS; Client Proxy Soft, CPS.The memory capacity of cluster is limited, so select the part of data validation. The selected data is registered and operating data about 20,000,000 records. These data are 15 months of information.

In accordance with the distributed caching strategies memory and practice experience, OSS cache the object set. The object pool and object information is transmitted to the OMSS, OMSS according to the logic relationship between objects to create the object index table. Using this index table, the task can be split into sub tasks.

The complex tasks were tested in different test conditions, the test results are shown in the Table 1. We can see the other two environment hardware configuration is much better than that of OPC group, but the execution time than the OPC cluster is high. The object of parallel computing system has high calculation efficiency.

Test No.	HW Config	Execution time
1	4 PCs	6.8s
2	2 IBMP750	53min
3	1 Exadata X2-2(1/4)	18s

Table 1: The execution time of different systems.

In the different number of concurrent tasks, we test totally of 20000 times. The test results are shown in the Figure 2.

The ordinate represents the reliability, the abscissa represents the number of concurrent tasks. In the reliability test, multiple tasks running in uninterrupted.

In different number of concurrent tasks, mission success rate is 100%. In the concurrent task number is 5 cases is 100%, show that the system is stable and reliable when the system in different number of concurrent tasks.

- The choice of the data volume is not large amounts of data, but the cluster can be extended. As long as there are enough of the computer can be cached data. Therefore, the solution is can be used to solve the large data calculation.
- Compared with stored procedures in Oracle database, the execution results is the same. It shows that the system function to meet the requirements of concurrent tasks. In the circumstances, the reliability of the system is always 100%. It shows that the system is stable and reliable.
- The execution time of complex task from hours to seconds, the computational efficiency is greatly improved.
- The system has flexible scalability. With the increase of data, we can add PCs easily to augment cache data. Extended computing performance to maintain constant, do not significantly decrease.

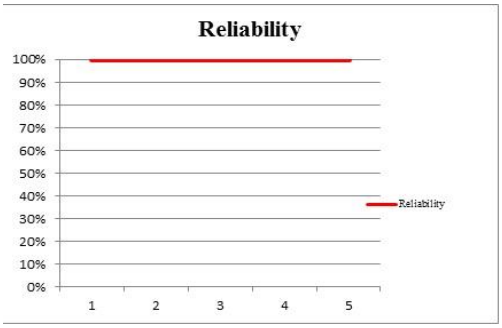

Figure 2: System reliability.

5 CONCLUSION

At present, Hadoop as the representative of the mainstream technology cannot meet the requirements of high real-time scene. In order to solve this problem, this paper proposes the OPC solution, OPC fusion object, parallel computing, memory computing technology, using the object format the business data into object, according to a certain distribution principle, distributed cache to PCs' memory in cluster. Accordance with the task allocation strategy, split the task into sub tasks, parallel implementation calculation.

This solution can solve the problem of real-time data, but the OPC still has some technical problems need further research, such as data compression, cluster monitoring etc. The current development of big data technology rapidly, in order to solve this problem, we need solutions sustained attention to cutting-edge technology to seek better.

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