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Research Article

Research on data synchronism model of well completion based on operation log

Ruishan Du
School of Computer and Information Technology, Northeast Petroleum University, Daqing, 163318, China

***Corresponding author**
Ruishan Du
Email: durs918@163.com

Abstract: Synchronization is a key technology to improve the system performance of mobile database. The paper proposes a mobile data synchronous processing model which is based on operation log by relying on the mobile platform of well completion and combining the business data of well completion. The paper mainly analyzes the generation of log sequence in the model and conflict resolution and presents detailed implementation algorithm; the model allows mobile terminal to operate local replica data under the circumstance of disconnection and record user behavior by mobile transaction journal. When reconnecting mobile terminal, synchronous processing is made according to log sequence returned by server and the system finally returns to its consistency. Meanwhile, methods such as log combination and timestamp which efficiently low the resource consumption of mobile terminal and improve the efficiency of synchronization. It turns out that the algorithm can quickly and efficiently finish the data updating and interaction between client and server.
Keywords: Mobile computing; Synchronization algorithm; Operation log

INTRODUCTION

Well completion is the final main part of building an oil and gas well. It directly relates to the production capacity and economic benefit of oil and gas well. Meanwhile, it is the starting point of oilfield exploitation. It is a systematic project including well drilling, running casing, well cementation, perforation and running production tubular column. Its business process mainly consists of conceptual design, well drilling, testing, cementation, operating, and infrastructure [1]. Numerous, multidimensional and scattered business data of well completion are produced in the process. The visual management of well completion and the integration of well completion business are realized by establishing the mobile platform of well completion, which provide workers convenience to collect outdoors information. Workers can manage well completion business without the limit of time or environment. The mobile platform of well completion possesses great practical application value because it changes the office mode of beyond days.

However, due to unstable mobile network and different properties of mobile equipments in practical application, it turns out that the client is often on weak line or offline which prevents to exchange information with server, affects the working efficiency of the platform and lowers the degree of user's satisfaction. Taking the low bandwidth, long delay, frequent disconnection and limited resources into consideration, it's unpractical to keep connecting mobile client and server. In order to avoid the influence of external environment, most user's data should be manipulated at home, however, which makes data inconsistent momentarily. Data synchronism mode can help exchange local replica data with central data base and finally accord client and server to update new local data to server and update new data of server to client. In this case, the paper mainly research how to improve the efficiency of data synchronism and conflict resolution in order to smooth the work of mobile platform of well completion.

Currently, researchers have developed various mobile synchronization algorithms such as two-stage synchronization algorithm [2], and BAYOU system [3]. The former needs to redo all the mobile affairs on synchronization server, which increases the burden of the system; while the latter needs human beings to resolve conflicts, which affects the adaptability of the system. The literature [4] proposes multi-version control algorithms. Control algorithm needs to store the multi-version data on the synchronization client and adopts specific concurrency control algorithm to systematically realize higher complexity and worse adaptability and expandability. In order to overcome the drawbacks of current mobile synchronization modes, the paper proposes a synchronous processing mode of mobile data which is based on operating log by referring to the basic idea of "updating and testing" and

"synchronization coordination" and making the business data of well completion as its base [5]. This mode records the operating process of mobile affairs through blog. Synchronization server generates operation sequence by comparing the operating log and synchronizes data by replaying operation sequence. Showed as the experiment, comparing with traditional algorithm, synchronization algorithm based on operating log possesses smaller data transmission quantity and fewer loads on synchronization server. Meanwhile, synchronization algorithm is efficient in the application of mobile well completion platform, which makes the business data of well completion consistent and integrated.

METHOD AND THEORY

The basic theory of synchronization model

Jim Gary develops four goals of mobile synchronization: availability and scalability, mobility, serializability and astringency [6]. These four goals have ideal synchronization system avoid the influence of network environment. Typical mobile synchronization system consists of trust network, mobile node and mobile terminal [7-8].

Trust network is generally made up of fixed host, synchronization server and database server, which provides the whole system credible and real-time service. Mobile node serves a bridge between trust network and wireless unit, which realize their information interaction. Each wireless unit has several mobile terminals, and each mobile terminal corresponds to a replica database which is managed by the local mobile database management system. Users can operate local replica data by mobile application program (for example the mobile platform of well completion) to make the data of mobile terminal and mobile terminal, mobile terminal and database server and database server fixed host momentarily inconsistent. In order to ensure the integrity and consistency of the data, it is necessary to exchange the data of each unit by synchronization mechanism.

Operating log is converted as the state transition of the information interchange circulation of synchronization server and database server through mobile terminal [9]. They are empty state, record state and synchronization state showed in figure3.

(1) Empty state

After the synchronous processing of mobile terminal and synchronization server is made, they respectively update their own local data according to operation sequence. To some extent, we can say their data are same. There is no record of the operation log of mobile affair which is empty state.

(2) Record state

In the case of disconnection, user can only operate local replica data in real time through mobile terminal. At the same time, the operation log automatically records user's operating process such as data item and the changing state of data object, and each record is stamped timestamp. When the quantity of operation log increases with user's continuous operation, the empty state of operation log turns into record state.

(3) Ssynchronization state

Synchronization can be opened by users with their hand or automatically open by network monitoring module. (When mobile terminal are under WIFI, synchronization is opened and data are updated. Therefore, the cost of communication is lowered and synchronization time is also reduced.) At the beginning, mobile terminal sends operation log to synchronization server; then synchronization server makes the collision detection of operation log, integrates logs and generates the result set synchronization; finally, mobile terminal updates local replica data and accords with the data of database server center. Mobile terminal is always in synchronization state in the whole process. When synchronous processing is over, operation log will be eliminated and returns to empty state.

Conflict resolution

On the base of timing sequence referring to operation log method, the paper presents a timestamp method which record the exact time when affairs happens by stamping timestamp when recording the change of mobile affairs. When write operation is made by several affairs operate on the same data object, write operation can be made at the latest timestamp by comparing timestamps. The timestamp method can quickly realize conflict resolution in transaction journal. Meanwhile, it is convenient to receive the operating frequency, visiting times and on-line time of the user by analyzing transaction journal with timestamp. Through the analysis, we can know the data type that users frequently visit and their operating habits. Newest trends that users may be concerned with can be provided to users by using mobile push mechanism, which can improve the friendly degree and intelligence of the system. When extreme case such as two timestamps are same appears (it can only happen on server not client), this log will be abandoned, center data will be unchanged and friendly reminder will be sent to users.

THE ALGORITHM IMPLEMENTATION OF SYNCHRONIZATION MODEL

In addition to recording basic operations such as the insertion, update and deletion, traditional transaction journal also record the changing of affair modes such as submitting and backspacing, which leads to traditional transaction journal occupy larger space. If traditional

transaction journal is used to fulfill mobile transaction journal, the limited space of mobile terminal will be more limited. Therefore, a simplified mobile transaction journal will be adopted: reduce the occupied space by log record and log combination. As for log record, record only insertion, update and deletion and stamp timestamps on them. As for update, the changes of data before and after updating needs recording. As for insertion and deletion, it is necessary to transfer whole deletion records and insertion records into operation log. As for log combination, design the log combination algorithm according to the principles of log combination. When operation log records every datum, log combination algorithm is used to make collision detection in the existing record of log. Only the newest record of collision can be reserved. MT1, MT2 and MT3 are mobile transactions executed on mobile terminal.

Table 1. Schedule of mobile transaction

Schedule	MT1	MT2	MT3
R1[A]=a1	R1[A]=a1		
R1[B]=b1	R1[B]=b1		
W2[A]=a2		W2[A]=a2	
R3[A]=a3			R3[A]=a3
W3[B]=b2			W3[B]=b2
R1[C]=c1	R1[C]=c1		
W1[B]=b3	W1[B]=b1		
W3[A]=a4			W3[A]=a4
W2[C]=c2		W2[C]=c2	
W3[C]=c3			W3[C]=c3

Table 2. Traditional transaction log

Operation mode	Object	Result
Read	A	a1
Read	B	b1
Write	A	a2
Read	A	a3
Write	B	b2
Read	C	c1
Write	B	b3
Write	A	a4
Write	C	c2
Write	C	c3

Table 3.Transaction log adopting combination algorithm

Operation mode	Object	Result
Write	B	b3
Write	A	a4
Write	C	c3

The synchronization algorithm on the base of operation log consists of two phases, which are uploading log and updating data. The first phase: mobile terminal transfers the operation log to synchronization server, and synchronization server will make collision detection and elimination in log, update central data base and generate the operation sequence of mobile transaction. The second phase: mobile terminal updates the local data to make the local replica data accord with center data according to the operation sequence returned by synchronization server.

The paper makes synchronous update experiment by using the mobile transaction journal of the well completion mobile platform. According to methods in paper, conflict resolution, data writing and the return of mobile updating sequence are made by synchronization server in operation log uploaded by client by recoding mobile transaction and combining, generating and uploading log. Client updates local replica data by replaying log sequence. To verify the property of synchronization model presented in the paper, the experiment respectively the processing efficiency and concurrency control of the model relying on mobile well completion platform and the server of well completion.

Let there is a mobile terminal, when its operation logs are 100, 200, 300, 400, 500, 600, 700, 800, 900 and 1000, response time or processing time of synchronous request is send one after another to synchronization server. 10 mobile terminals (the log quantity of each of them are 500) send the response time of synchronous request to synchronization server at the same.

From the experimental result, we can see that when operation logs are less 1000, the processing time of synchronization server and the volume of log appear linear relationship. The processing time is about 500 milliseconds. When there are 1000 logs, the processing time of synchronization server is 920ms. When the volume of log is less 500 and several clients send at the same time, the processing time (the response time of the system) of synchronization server is 500-1000ms and its average processing time is about 600ms. The concurrent processing time is about 100ms.In conclusion, synchronization model based on operation log is quite efficient because the processing time of synchronous processing and concurrency control is under second grade.

CONCLUSION

Relying on mobile well completion platform, the paper provides a data synchronization model which is based on operation log. It aims to synchronize local replica data and center data. Proved as the experiment, synchronization server can timely synchronize the data whether there is multi-user concurrent access or the user request if large data. What should be done next: one on hand, dispose intelligently network monitoring model. Under the ideal environment such as charging and WIFI, the load of mobile terminal and the cost of communication is lowered by opening synchronization model and completing synchronous processing; on the other hand, improve the speed of detecting log collision by difference algorithm method to improve the efficiency of synchronization.

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