Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(8):449-455

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The data study and analyzing of city logistics system based on cloud platform

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ABSTRACT

In the circumstance that the information keeps developing rapidly, the paper designed a kind of high-efficient city logistics flow path by Petri Net and offered a city logistics model based on cloud platform, assisted it with the distributed cloud storage. Meanwhile, the paper used NoSQL to memorize the data involved in the logistics system, enhanced the efficient of the system and saved the data space at the same time, and eventually compared it detailedly with the conventional SQL database, analyze its advantage with space and time complexity.

Key words: IOT; Urban Logistics; NoSQL; Cloud Platform; RFID

INTRODUCTION

A. Urban Logistics

Urban Logistics (UL) is the logistic serves the cities, subordinates to the city economy development. UL also means the objects substantially flow in the city, the procedure that clean up the waste. UL characterized by its high-frequency of logistics, big amount of information and logistics nodes, short transportation range, which are mainly highway ones, small transport amount per time, diversity of all the types, and the high-frequency.

The development of Logistic tech and management degree in China are getting started in recent years, comparably slower than some developed countries. The basal equipment of city logistics transportation are mostly old-fashioned and out of time, lagging the transport ability of the city while the volume of transportation kept increasing. Thus, the logistics efficiency was influenced severely. Moreover, as a result of the unreasonable commodity purchase and deploying, there's detour, backflow and crossing transportations, extended the currencies and the logistics expenses, aggrandized the tendency of the UL and wasted the transport capacity of the country. At the same time, unified management is lacking inside the city transportation. The repeated and one-way transport make traffic chaos traffic jams. Some social pollution, like noise, also produced through these conditions [1].

B. NoSQL

NoSQL, normally equals to non-relational database, first appeared in 1998, a light-weight, open sources database don't offer the function of SQL invented by Carlo Strozzi. With the rise of Web2.0, the database demanded high concurrency read and write, high efficient storage and access, high availability, etc., which can't be met with conventional SQL database. As a result, NoSQL becomes the focus of the developing of Web2.0. Big internet companies as Facebook, Google all put their money in the relevant study. Albeit companied with functional questions compare to the well-developed RDBMS, at this information time, because of the increasingly necessity of the data processing, the heat of NoSQL will last continuously and generally.

C. IOT

The full name of IOT is "The Internet of Things", which is a network connecting everything to the internet for them to exchange information and communicating according to the appointed protocol to realize intelligent identification,

position locating, tracing, monitoring and managing by sorts of information sensors as RFID, infrared sensor, Global Position System (GPS), laser scanner and Gas Inductor.

The IOT was called "The third wave of world information industry development" behind the Computer and Network because of the widely use of intelligent sensing, identification technique and pervasive calculating in the merging of the network. IOT is extended internet, it is business and application more than a network, it included the internet and all of its resources. It's compatible with all of the application in the internet whereas each one of the elements of IOT is personal and privatization.

After decades of development, IOT is now comprehensively used in Intelligent Transportation, environmental protection, public security, intellectual fire-fighting, industry monitoring, etc. [4]. The detailed application contains Cattle Traceability, Personal Health, Secure City Smart Traffic and so on [5].

D. RFID

RFID (Radio Frequency Identification) is a corresponding tech, it's able to identify specific targets and to read and write data through Radio Signal, without recognizing establish mechanical or optical contact between system and specific objectives. Low frequency (125k~134.2k), high frequency (13.56 MHz), ultra high frequency and microwave are commonly used. [6]

RFID devices contain mobile and settled ones. RFID tech is widely used in the current time, like libraries, access control system, Food safety traceability, etc. [7].

Petri Nets Flow Path

The operation flow path of city logistics system works as Fig1:

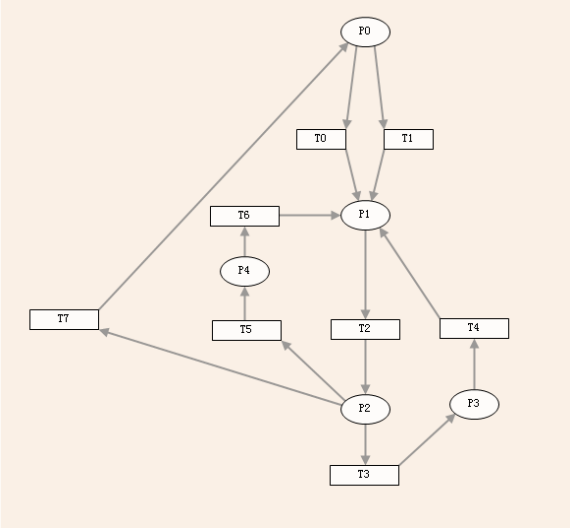

Fig.1: Petri Nets

Declaration of the parameters of city logistics system Petri Nets:
P0: User
P1: Control Center
P2: Delivery Man
P3: Warehouse
P4: Ferry
T0: Order
Users can make their order after login the website of the city logistics system.

T1: Review

Users can review their order after it's handed to the system, they can also retrieve information including the RFID ID of the order, the current position of the cargo, the name and cellphone number of the delivery man and the predict time of the cargo getting destination.

T2: Assign Missions
The Control Center will divide one long-distance order into more than one small orders, each order starts from a warehouse or a harbor and ends with another. The delivery men will be responsible for all the land orders, and the aquatic orders will be deal by the third-party ferry companies. Most of these companies owe well-established system and all the necessary information of the ferry and ship route are accessible on their websites.

T3: Send Cargo to Warehouse
The delivery man will drive to the departure place, get the cargo, read the RFID tag through the mobile RFID reader, and send the cargo to the next warehouse or harbor. By GPS, the position of the driver will be located.

T4: Upload Information
After the cargo gets warehouse, the settled RFID reader in the warehouse will be used to read the RFID tags, and the relevant information will be uploaded to control center.

T5: Send Cargo to Harbor
The delivery man will drive to a warehouse or a harbor, get the cargo, read the RFID tag through the mobile RFID reader, and send the cargo to the next warehouse or harbor.

T6: Upload Information
Same flow as T4 except the information is from the third-party company.

T7: Send Cargo to Destination
Same flow as T3 except the destination is a harbor
The delivery man will drive to a warehouse or a harbor, get the cargo, read the RFID tag through the mobile RFID reader, and send the cargo straight to the destination of the order.

Model of Cloud Calculation Platform
The structure of the system was divided by software and hardware, and presented as three layers: Device layer, Network platform and application layer. All of the three layers transmit data through network and ports and realize the real-time correspondence maximumly.

A. Device Layer
Device layer is also called reading layer. The kernel of Device layer is RFID tags, mobile and the settled RFID reader, GPS and sorts of sensors. Through correlation of the electronic tag and all kinds of sensors, the concept of Electronic Seal was generated. Differ to the earlier RFID tags, it is installed in the container, owes the exclusive identification number in the world, able to automatically detect the switch state of the container, tests environment state change and has time-stamped record information. Mobile aided with Wifi and GPRS module compared to the original ones, which strongly reinforce the instant corresponding capability and enable the RFID reader to communicate with Control Center. The settled RFID readers are placed in some fixed location as the gate of the warehouse and the port, and are able to automatically read plenty of RFID tags coming through at the same time and upload the information to the database directly. After being integrated, the sensor can realize the detection of temperature, pressure, humidity, light, sound, or magnetic change, these parameters will be stored in the electronic label for data reading [8].

B. Application Layer
The data of Application layer mainly come from the websites, mobile and settled RFID readers belongs to the ports, warehouses and couriers, lorries and ships.

The website of the system faces to the consumers. The consumers can sending ordering message and searching message of the order to the Control Center. The warehouses of the containers sending carport and freight space information to the Center. Lorries and ships sending position information to the Control Center, including the location and the current speed. The couriers sending ones working mode, data of RFID tags to the Control Center through RFID readers.

The ports and shipping data of the Application layer come from the third-part, whose database has already contains complete and public information like the shipping number, cruise, leaving and arrival time. These data are facing to the public with high instantaneous and reliability, hence the application data center can taking useful information from Application layer directly, combine them with the information from the device layer by data exchange engine, and eventually uploading the information with the information publishing center for the users to look up [8].

C. Network Platform

Network platform appears to be more abstract than the device layer, it's combined with database, application data center, information publishing center and data exchange engine. The idealized network platform will be transplanting the whole platform to the cloud, realize the cloud computation. The data of the device layer would be memorized to the database through a general port. The application data center is correlative with the application layer, collect and memorize the extant data. After being screened and combined with the data exchange engine, the useful information comes from application center and database would be send back to the application layer through information publishing center, so the customs and shipping company from the third-party can put the data on records, and the users can look up the relevant container information through the website [8].

In the city logistics system, the Network Platform is the control center combined all data interaction models, responsible for the communication with mobile and settled RFID readers, the websites serve the users, the warehouses, the harbors and any other information sources independently.

Through the distributed data storage function of the cloud platform, the control center's able to lighten the store amount of the data. Besides the core data, which memorized in the servers of the control center directly, the remained data can be stored in the subordinate servers of the cloud platform. Table1 describes the data table of NoSQL database of city logistics system based on cloud platform:

Table.1: NoSQL database of city logistics system based on cloud platform

No	Name	Description
1	Order ID	Primary Key
2	TagID	Primary Key
3	Start	Departure/Warehouse/Dork
4	Stop	Warehosue/Dork/Destination
5	DeliverID	
6	Time_Start	
7	Time_End	
8	StartID	Null/WareHouseID/DorkID/
9	DestinationID	WareHouseID/DorkID/Null(Destination)

The Primary Key of the data table is the composite-id combined with OrderID and TagID. An order will be divided into several parts, and each row of the data table represents one of these parts. The Start of the table means the start place of a part, which is the departure of the order, a warehouse or a harbor. The Stop stand for the destination, which can be another warehouse, harbor or the destination of the whole order. Time_Start means the time that delivery man initials his transportation, and the Time_end means the time he finished his job. The DestinationID represents the HarborID, WarehouseID, or Null (When the stop is destination).

The Data table subordinated to the cloud platform server constituted as follows:

Table.2: Data table subordinated to the cloud platform

No	Name	Description
1	OrderID	Primary Key
2	TagID	Primary Key
3	DeliverName	Departure/Warehouse/Dork
4	DeliverTele	Warehosue/Dork/Destination
5	StartAdd	
6	DestinationAdd	
7	CustomerID_Start	
8	CustomerAdd_Start	
9	CustomerID_Destination	
10	CustomerAdd_Destination	

Comparison of the Databases

A. SQL Database

The conventional SQL database will have to utilize more than one tables to store different kind of data when it's applies to the constitution of city logistics system. To protect the integrity and consistency of data, the references among tables will be necessary. The relational SQL database constitutes as Fig 2:

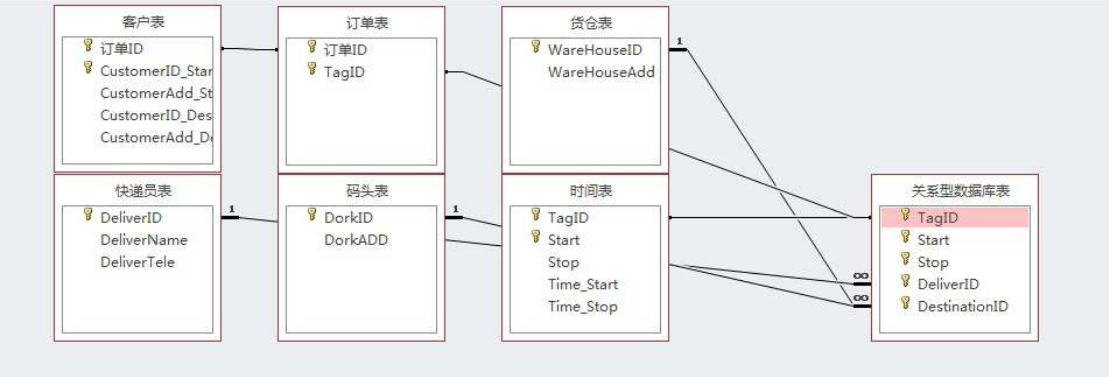

Fig.2: The References of SQL Database

The SQL Database consists of 7 data tables. The SQL table serves the same function as the NoSQL database table, which is record the relevant information of each part of an order. The Client table records the detailed information of the client made the order and the target client. The Order table describes which RFID tag belongs to which order. The Warehouse table owes the ID and addresses of all the warehouses. The Harbor table has the familiar function as the Warehouse table. The Delivery Man table contains the ID and cellphone no. of the delivery men. The Time table records the starting and ending time of each part of the order and its route.

B. Comparison

There's considerable differences between the SQL and NoSQL database, on time and space complexity. The advantage of NoSQL Database is extraordinarily obvious when dealing with big amount of data. The influenced rows are less and plenty of data spaced are saved [9].

For instance, a new order being made by a client. Because the big amount, the system divide the cargo into three parts, and each part is divided into four routes, from the departure to a warehouse, then a harbor, and to the destination after another warehouse. The influenced rows of the select of all the relevant of the SQL and NoSQL database presents as Tabel3.

Table.3: The comparison of the influenced rows

NoSQL	SQL
Total number is 12	3 from Order Table 2 from Warehouse Table 1 from User Table 12 from Delivery Man Table 1 from Harbor Table 12 from Time Table 12 from SQL Table Total Number is 43

The references difference between SQL and NoSQL database of a select presents as Table4.

Table.4: Comparison of References

NoSQL	SQL
None	TagID of Order Table references TagID of SQL Table WarehouseID of Warehouse Table references DestinationID of SQL Table OrderID of User Table references OrderID of Order Table DeliverID of Order Table references DeliverID of SQL Table HarborID of Harbor Table references DestinationID of SQL Table TagID of Time Table references TagID of SQL Table Total references number is 6, influenced 7 tables

From the information in the Table3 and Table4, we can see that the influenced rows and the references of NoSQL database are much less than SQL ones. The select time and the demand for the server can be dramatically decreased, meanwhile the efficiency of the database is improving.

In addition, the data space of NoSQL and SQL database also have two separate direction. Continually utilizing the example described in Table3 and Table4, the data space difference represents as Table5:

Table.5: Comparison of Data Space of each Order

NoSQL	SQL
68B*12 816B in Total	4B*3 from Order Table 54B*2 from Warehouse Table 108B from User Table 18B*12 from Deliver Table 54B from Harbor Table 44B*12 from Time Table 32B*12 from SQL Table 1410B in Total

The space complexity of NoSQL database from a single order is far less than the SQL databse according to Table5. When the order number keep increasing, the advantage of NoSQL can be even more obvious. Hypothetically the number of delivery men, warehouse and harbor is the exact number 100, and it's the same order from the example made before, the difference of data space of multiple orders between the two databases consists as Table6:

Table.6: Comparison of multiple orders of Data Space

Order Number	NoSQL	SQL
1	204B in Total	4B from Order Table 54B*2 from Warehouse Table 108B from User Table 18B*4 from Deliver Table 54B from Harbor Table 44B*4 from Time Table 32B*4 from SQL Table 650B in Total
2	408B	958~1300B
10	2.04KB	3.422~13KB
50	10.2KB	15.74~65KB
100	20.4KB	31.142~130KB
1000	204KB	308.342~1300KB
10000	2.04MB	3.08~4.172MB
100000	20.4MB	30.212~41.612MB

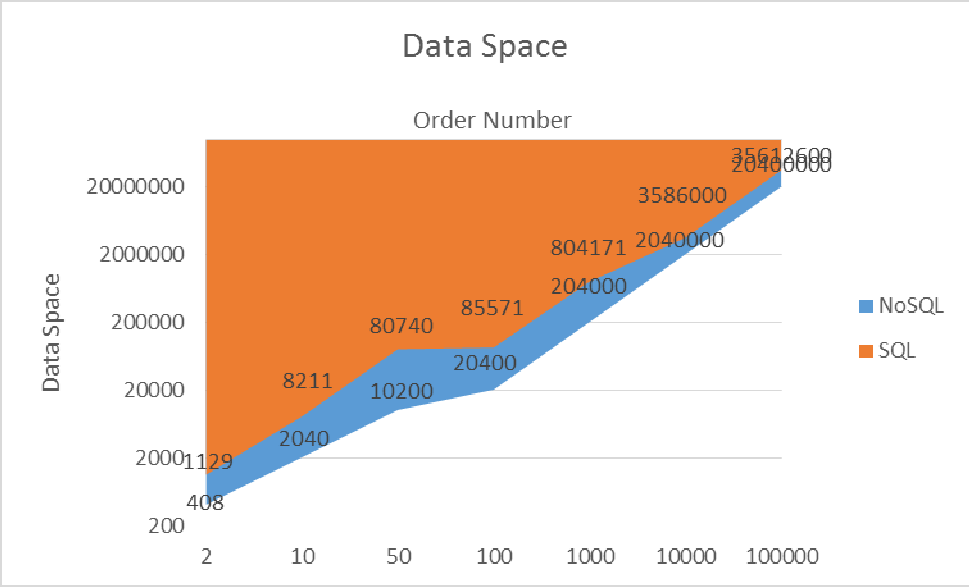

Fig.3: Comparison of multiple orders of Data Space

Tip: The data space number from Fig3 is the average number of the interval in the SQL column of Table6

It's clear that the data space of NoSQL database always less than that of the SQL databse from the tendency chart in Fig3. The space gap between two database culminated when the order number comes to 50, and tended to shrink between 50~10000. Eventually the gap stabled between 10000~100000, and the data space of NoSQL keep being (20400000 – 2040000) / (35612600 - 2586000) = 56% of the data space of SQL database.

CONCLUSION

In the circumstance that the conventional city logistics exits sorts of inconvenient, the rapid development of information and data extended dramatically [10], the paper offered an advanced city logistics system, and analyzed the availability of the city logistics system based on cloud platform, and then designed a cloud distributed NoSQL database model. Through the comparison and calculating between the NoSQL and SQL database in the time and space aspect, the paper made the conclusion that the system based on cloud platform owes huge advantage in both sides as projected. The system can increase the data select velocity and decrease the data space of the server, set up a large-capacity and high-efficiency logistics system. As a result, the system can solve the low-efficiency problem when the city logistics dealing with the increasing nodes, weak management, and let the city logistics dealing with the challenge of the frequent development of information in the future more properly.

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