IJARCCE

ISSN (Online) 2278-1021
ISSN (Print) 2319 5940

International Journal of Advanced Research in Computer and Communication Engineering
ISO 3297:2007 Certified
Vol. 5, Issue 12, December 2016

Performance Improvement of Transactions using Service Oriented Architecture in Linux

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Abstract: The computing power, communication, information and knowledge radically changed the way we live, work, and think, due to the growth of high speed networks, coupled with the falling cost of computing power. This explosion of technology is changing the banking industry from paper banks to digitized and networked banking services. Digitalization has already changed the internal accounting Process and management of banks. It is now changing the delivery system, banks use to interact with their customers.All over the world, banks are still struggling to find a technological solution to meet the challenges of a rapidly-changing environment. Banks, with the ability to invest and integrate information technology, will become dominate in the highly competitive global market [1]. Service-oriented architecture (SOA) has become a well-known IT infrastructure for business and increases the efficiency of IT [2]. Business operations are exposed as services, the interaction occur in loosely coupled method that operate independently. SOA architecture allows for service reuse, making it unnecessary to start from scratch when upgrades and other modifications are needed. This is a benefit to businesses that seek ways to save time and money [3] [4]. This paper integrates SOA with banking application to reduce the transaction delay and improve the performance of the system [5].

Keywords: SOA, WSDL, HTTP Protocol, Transactions, Batch Processing.

I. INTRODUCTION

A **payment system** is a process used to settle financial transactions through the transfer of monetary value, that includes the institutions, instruments, people, rules, procedures, standards, and technologies which helps to make such an exchange possible [6] [7] .A common type of payment system, is the operational network that links bank accounts (Savings, Deposits, Credit) and provides for financial exchange [8].

The payment system in any country needs to pass the test of safety, security, soundness, efficiency, and accessibility. In order to address all these, payment systems have evolved from barter system (exchanging goods or services for other goods) to currency, to digital systems. We are witnessing enormous change in the payment systems, disrupting the monopoly of physical/paper-based system by electronic ones [9].

There are basically two types of payment systems:

1. **Paper-based** Cheques and Drafts
2. **Electronic** ECS, NEFT, RTGS, IMPS,Internet/mobile banking, M-Wallet and ATM/POS.

The Indian banking sector has been growing successfully, innovating and trying to adopt and implement electronic payments to enhance the banking system

In the case of India, the RBI has played a pivotal role in facilitating e-payments by making it compulsory for banks to route high value transactions through Real Time Gross Settlement (RTGS) and also by introducing NEFT (National Electronic Funds Transfer) and NECS (National Electronic Clearing Services) which has encouraged individuals and businesses to switch to electronic methods of payment. The online transactions information is given in Table 1.1.

Table 1.1 showing various Online transaction information

Payment System	**Volume(Millions)**		**Value (Rs. Trillion)**	
	2014-15	**Till Q3 FY16**	**2014-15**	**Till Q3 FY16**
RTGS	92.78	72.03	929.33	729.23
Paper Clearing	1196.51	823.04	85.43	61.38
Retail Electronic Clearing	1687.44	2215.21	65.37	63.67
EFT/NEFT	927.55	886.44	59.80	57.96
Prepaid Instruments	314.46	545.34	0.21	0.33
M-Wallet	255.00	452.80	0.82	0.14

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India is clearly one of the fastest growing countries for payment through cards in the Asia-Pacific region. In India plastic cards (Credit cards, Debit cards) have been fast over-taking currency, with 130 million cards in circulation currently, both credit and debit. E-payments have to be continuously promoted showing consumers the various routes through which they can make these payments, like ATM's/POS terminals, the internet, mobile phones and drop boxes.

Due to the efforts of the RBI and the Business Process Specification Schema **(BPSS)**now over 75% of all transactions are in the electronic mode, through online payment gateways and POS terminals, including both large-value and retail payments.

According to RBI's Report in March 2016, the number and amount of transactions done using debit and credit cards of all banks in India through ATM and POS terminals is Tabulated in table 1.2 [10].

Table 1.2 showing various Online transaction information

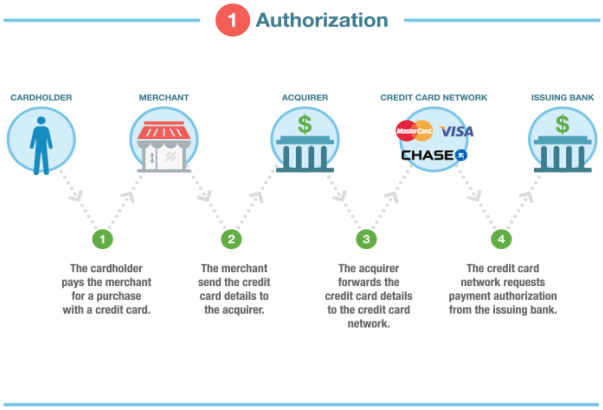
Credit Card Transactions				**Debit Card Transactions**			
No of Transactions		Amount (Rs Millions)		No of Transactions		Amount (Rs Millions)	
ATM	**POS**	**ATM**	**POS**	**ATM**	**POS**	**ATM**	**POS**
612531	72220394	2803.1696	226942.99	731722405	112868336	2245821.75	134631.91

The rest of the paper is organized as follows; Section II provides brief introduction about Card Processing System. Transaction Processing Systemis outlined in section III. Problem statement, proposed solution is discussed in section IV. Section Vspecifies hardware and software used. Implementation details and Execution Results are discussed in section VI. Conclusion and future work is presented in section VII.

II. CARD PROCESSING SYSTEM

A transaction is initiated when a Cardholder presents the card to a Merchant in payment for goods or services. The card can be presented physically in the case of a retail establishment, or indirectly over the Internet by providing the card number, expiration date, and name on the card. The latter is referred to as a "card not present" transaction [11].

The Merchant either "swipes" the card through an electronic reader or enters the card information manually into a computer or special-purpose payment terminal (also known as a "black box"). The transaction amount can also be entered or transferred from a point-of-sale system or shopping cart. The Electronic Payment System or EPS connects to a computer belonging to a Processor, and transmits the card and transaction data.



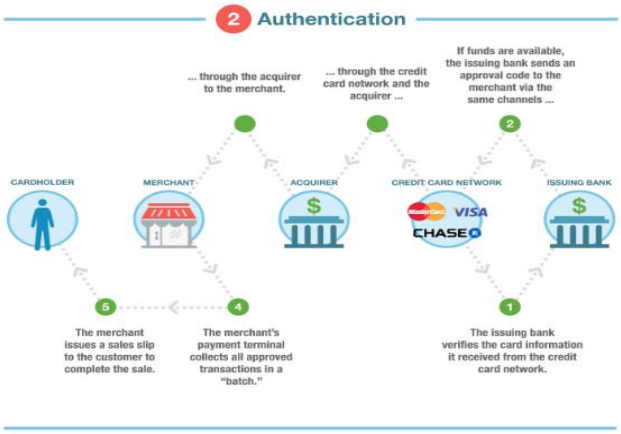


Figure 2.1, 2.2 showing the authorization and authentication process of card transactions

If the transaction is done over the Internet, the Merchant will either connect to a Processor directly or connect to a Gateway provider that formats the data and sends it to the Merchant's Processor, Typically over leased telephone lines.

The Processor's computer system makes sure that the card is valid and there are sufficient funds available for credit in the cardholder's account. The Processor then transmits an approval or denial code back to the Merchant's system.In the case of debit cards, some banks and retailers use on-line systems for clearing purposes while others use automated clearinghouses (ACH).At the end of each business day, the merchant account must be closed or settled. Depending on the Processor, this can either happen automatically or require retransmission of the day's charges. Upon settlement or closing, the Processor notifies the Acquirer, which starts the process of moving the funds.

If the merchant bank is the same one that issued the card used, the Processor posts the transaction amount to the cardholder's credit account or debits their funds on deposit, depending on the agreement with the cardholder and the type of card used. If a different bank, the more

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common situation, issued the card then the pertinent data from the transaction must be transmitted to the appropriate card-issuing bank for billing of the cardholder and settling of accounts between banks. The Processor transmits the transactions to the interchange association (e.g., Visa or MasterCard), which collates the transactions and sends them to the appropriate Issuers (the banks that issued the credit cards). For each transaction, the Acquirer receives payment from the Issuer for the amount of the transaction less the interchange discount. This discount is standard for all members of the interchange association, although it varies depending on the type of transaction. This process is known as interchange. Visa, MasterCard, American Express, Discover, and third-party processors have been built to facilitate authorization and merchant/cardholder accounting and have established processing and authorization centers throughout the world. The amount of this deposit is the total of the payments made by customers, discounted for the merchant fees. The merchant fees have a number of components, some of which are controllable by the Merchant.Finally, the Issuer posts the transaction on the Cardholder's account. The Cardholder either pays the full balance or treats the balance as a loan and pays it off over time.

Figure 2.3 showing clearing and settlement of card transactions

Players

Merchant: is a business that sells services or merchandise and accepts cards as payment.

Cardholder: The individual consumer owning the card and responsible for paying the card account.

Acquirer: The bank through which the Merchant has its merchant account.

Issuer: The bank that issues the credit card to the Cardholder.

Interchange Association: The association of banks that allows any Merchant customer of a member-acquiring bank to accept a credit card from any Cardholder customer of a member-issuing bank. Visa and MasterCard are the dominant interchange associations worldwide.

Processor: A third party company, also known as a processing network that accepts electronic credit card transactions from Merchants and processes them for an Acquirer.

Gateway: A third party company that accepts electronic payment transactions over the Internet and sends them directly to the Processor for processing

Application Developers: The individual responsible for integrating payments into business applications.

III. TRANSACTION PROCESSING SYSTEM

Transaction processing systems (TPS) [12]collect, store, modify and retrieve the transactions of an organization. A transaction is an event that generates or modifies data that is eventually stored in an information system. Examples of TPSs are selling goods at point-of-sale (POS)**,** processing credit card payments.

The four important characteristics of a TPS are:

1. Rapid response,
2. Reliability,
3. Inflexibility
4. Controlled processing

Batch Transaction Process

Batch transaction processing collects the transaction data as a group, or batch, and processes it later. It has a time delay. Transactions are collected and held for processing until it is convenient or economical to process them.

- Waiting for a large volume of data generally results in lower processing costs per transaction. The transactions are collected and stored offline on a magnetic tape or on paper. The time delay before processing or completing a batch run could be several minutes, hours or even days.
- Batch processing is used when a time delay will not decrease the usefulness of the results. A batch approach is used for generating pay cheques and other forms of paper output.
- Batch processing is carried out by large organizations using a mainframe or mid-range computer.
- It involves a large batch of an identical data type, such as payroll or stock information.

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- Batch programs are often run at night when there is less demand for the information system.

There are three disadvantages in batch processing:

- All processing must wait until a set time. The processing schedule is predetermined.
- Errors cannot be corrected during processing.
- Sorting the transaction data is expensive and time consuming.

Examples of batch transaction processing
Cheque clearance usually takes three working days. The cheques are cleared as a group during the bank's quiet period of the day in batches.
Credit card sales transactions and bill processingupdating is done processed in a batch.

IV. PROBLEM STATEMENT

The merchant sends the transactions information to the acquirer at the end of the day. The acquirer process the data, if the acquirer and issuer belongs the same bank they will immediately deposits the transaction amount into merchant account and credit the same in the customer account. If acquirer is different from issuer the acquirer sends the transaction information into the issuer bank through card network in batches through offline. The issuer process the transactions and send the funds to the acquirer bank through the card network and update the respective customer accounts.

The banks are experience delay in receiving the transaction details from acquirer banks, and processing the batches of transactions in less time. Which provides huge financial loses to banks and lack of updated information to the customers.

Statement of Problem

- Integrating different networks services routines smooth
- Integrating cross-platform components. The Real Challenge?
- Reducing the financial cost by reusing the existing software and hardware.
- Performance gain

Scope

There are various ways where SOA can be implemented in both technologies and methodologies. However, we are limiting this edition to .Java and Java Advanced Web Services. Due to limitations in the infrastructure, we are limiting our scope of programming to stimulate only the card processing in the issuer bank and updating it in the database.

Proposed Solution

Issuer banks can utilize Service Oriented Architecture (SOA) to integrate different networks, by exposing the business process as service methods with different end points. These services can be utilized by different client (acquirer or card network) to send the transactions details to issuer in batches online reducing the time delay in receiving. With SOA we can integrate cross platform components.
Financial cost can be reduced by reusing the existing hardware and software with few modifications. The SOA provides more performance gains than the existing architectures.

V. EXPERIMENTAL TESTBED

Table 5.1 showing the hardware and software used in the experiment

Hard Ware Configuration	Software Configuration
Processor : Intel® Core™ i7-4770k[13]	**LINUX KERNEL:** 4.6.3[14]
No of Cores : 4	**Operating System:** Linux Mint 17.3-Mate 64[15]
No of Threads : 8	**No forced Preemption :**Enabled
Base Frequency : 3.5Ghz	**Web Server** : Glass Fish Server 4.1.1
Turbo Frequency : 3.9Ghz	**Java JDK:** 1.7
Intel® Smart Cache : 8MB	**Java EE** : 7.0
RAM : 8GB/1600MHz	**Net beans IDE:** 8.0.2
	Database : MYSQL 5.7.13.0
	Workbench : 6.3 CE

VI. IMPLEMENTATION DETAILS

A normal java program has been created to read the XML file consisting of card transaction details from the acquirer, these records were inserted into the database, and the execution timings has been recorded in the table 6.1.The same algorithm has been modified to create web service server and read the transaction information in XML format file through web service client online, and inserted into the database, processingtimingshas tabulated in table 6.1.

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Execution images are show infigures 6.1, 6.2, 6.3, 6.4, 6.5, 6.6. We have used bulk insert to save records into the database. Respective algorithms has been shown in section 6.1

Algorithm

Algorithm Java program

1. Start
2. Read the transactions from XML file
3. Convert the xml elements into respective values
4. Create Batch transactions
5. Call stored procedure to insert Batch transactions
6. Stop

Algorithm Web Server Service Class

Step: 1 Start
Step: 2 wait for client request
Step: 3 if request is received
3.1 Read the xml transactions file
3.2 Convert the xml elements into respective values
3.3 Create Batch transactions
3.4 Call stored procedure to insert Batch transactions
3.5 Return response to client

Step: 4 return to step 2
Step: 5 stop

Table 6.1 showing execution timings

No of Records	Normal Execution (In Sec)	Web Services Execution (In Sec)
1 lakh	3	2
2 lakh	6	5
3 lakh	7	6
4 lakh	12	10
5 lakh	19	15
10 lakh	56	33

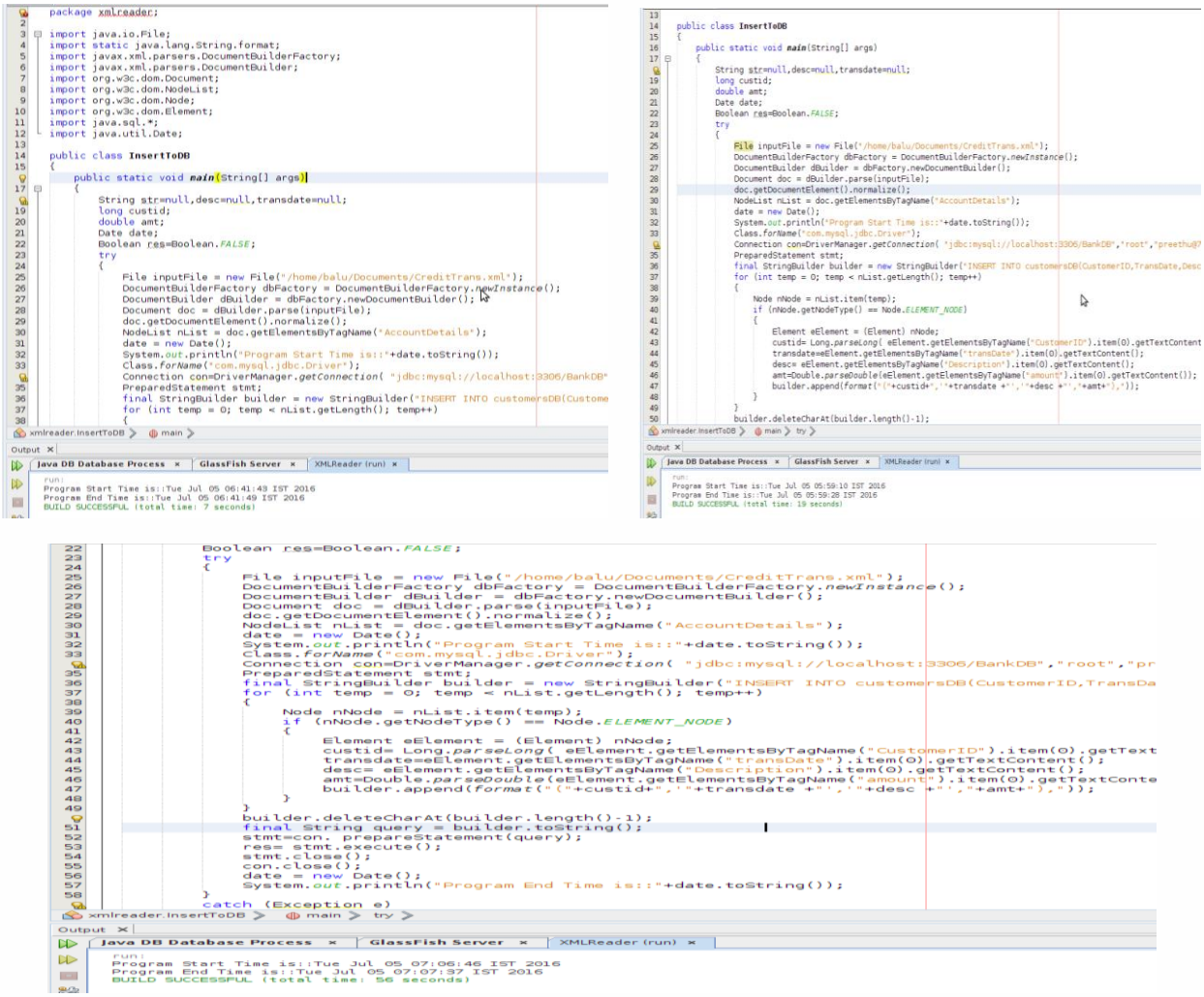

Fig 6.1, 6.2, 6.3 showing processing time of 3 lakh, 5 lakh, 10 lakh transactions

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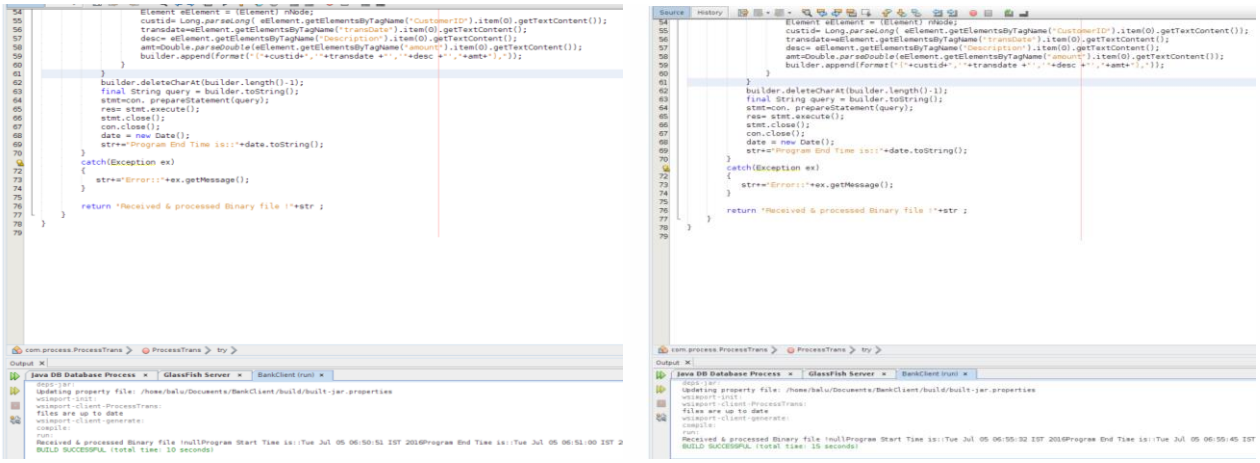

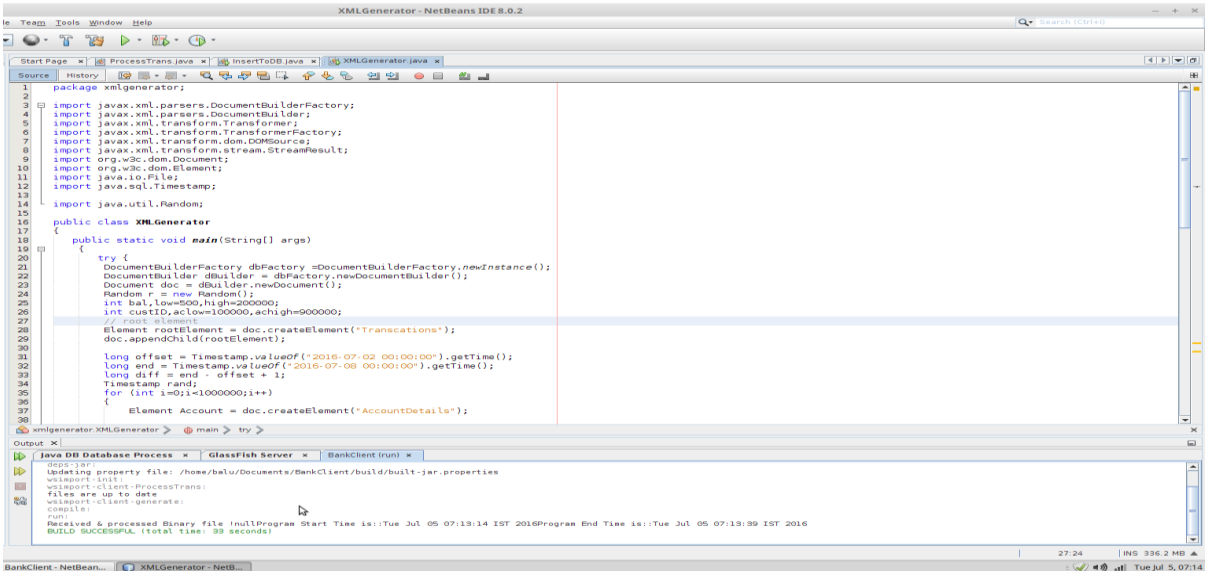

Fig 6.4, 6.5, 6.6 showing processing time of 4 lakh, 5 lakh, 10 lakh transactions using web services

VII. CONCLUSION& FUTURE WORK

The above results shows that with Web services, the banks gain more performance for legacy source code, with few modifications and less expenditure. By adopting web services the banks can directly speak to the acquirer or card network and obtain the transaction information without any delay and reduce the financial losses resulted by delayed information. The banks can expose their business more securely because web services provides more security options. The same work can be extended by implementing security algorithms, and implement the end to end transaction cycle. Further performance gain can be obtained by reducing the context switching and assigning the service process to a core with less load.

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