Master's thesis

Using Short Message Service (SMS) to Support Business Continuity.

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التفويض

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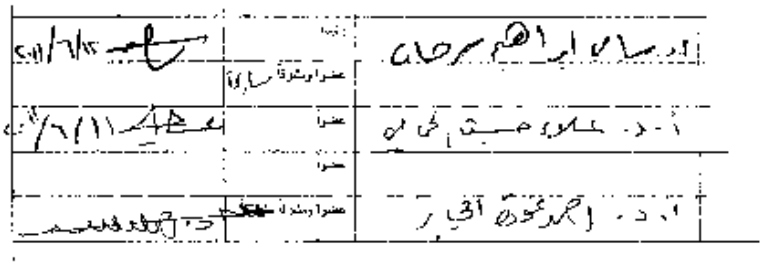

DEDICATION

This thesis is dedicated to my Parents , my wife , my sons and to all friends who have never failed to give me moral support during the time we wrote this thesis and also dedicated to my Supervisor , who taught me that even the largest task can be accomplished if it is done one step at a time.

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Maher Abdel-Qader

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

5.8	SMS-Channel status is ON in Scenario one.
5.9	SMS-JOB is submitted since SMS-Channel status is ON in Scenario one.
5.10	Using application package to carry out remotely a modification on the balance of the Account Number (1000) in scenario one.
5.11	The inserted record in SMS_listener_log table regards Modification of Account balance of number (1000) remotely in Scenario one.
5.12	The inserted record in Ozekimessageout table in site one, regards remote modification of Account balance of account number (1000) in Scenario one.
5.13	The inserted record in Ozekimessagein table in site two regard remote modification of Account balance of account number (1000) in Scenario one.

LIST OF ABBREVIATIONS

Abbreviation	MEANING
ADSL	Asymmetric Digital Subscriber Line
BC	Business Continuity
BC	Business continuity
BCP	Business Continuity Planning
CA	Certification Authorities
CA	Certification Authorities
CDMA	Code-Division Multiplexing Access
CRISCOM	Crisis Communications System
DBMS	database management system
GSM	Global System for Mobile communication

HLR	Home Location Register
HSDPA	High-Speed Downlink Packet Access
ICT	Information and Communications Technology
ISDN	Integrated Services Digital Network
LAN	Local Area Network
MSC	Mobile Switching Center
POC	Points Of Contact
PSTN	Public Standard Telephone Network
RSA	Rivest, Shamir & Adleman
SLA	Service Level Agreement
SMS	Short Message Service
SRRS	Student Record Retrieval System
SSL	Secure Socket Layer

TDMA	Time-Division Multiplexing Access
VPN	Virtual Private Network
WAN	Wide Area Network
WiFi	Wireless Fidelity
WiMax	Worldwide Interoperability for Microwave Access

USING SHORT MESSAGE SERVICE (SMS) TO SUPPORT BUSINESS CONTINUITY

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ABSTRACT

Nowadays, Many organizations need to communicate online on a daily basis, 24-hour, seven-days-a-week, which is essential in order to gain profit and to protect corporate reputation , but there are a variety of disruptions that may occur in business application (connection may be broken between databases because landlines connection failed ,unhandled exception in applications etc…) ,in this case the automation work will go offline and the data will be exchanged with others via papers , storage media or email .

In this thesis, we employ the Short Message Service (SMS) within the application to play an important role in transferring and exchanging critical data. This is done by coding the database transaction statement and sending it via SMS from one node to another, and having these SMSs received and processed by a database package, stored on

these nodes, so that a disruption in connection between these two database nodes is instantly handled, and co-coordinators are informed, at the right time.

Four algorithms were designed to test the proposed model in the four Scenarios related to the model's main functionalities. The experimental work showed that the proposed model supports business continuity since it supports the account balance modification while the database link is disrupted. To ensure the experiment reliability, we carried out each step twice and the scenario was reliable since all of its steps were reliable.

استخدام خدمة الرسائل القصيرة (SMS) لدعم استمرارية العمل

إعداد

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ملخص

في هذه الأيام ، تحتاج العديد من المؤسسات إلى الاتصال المباشر والدائم على مدار اليوم ، 24 ساعة، سبعة أيام في الأسبوع ؛ وذلك لتحقيق التنافسية العالية و الأرباح،ولكن هناك العديد من الأعطال التي تحدث في تطبيقات الأعمال (انقطاع الاتصال بين قواعد البيانات أو بسبب استثناءات غير معالجة في الأنظمة التطبيقية...الخ)، في هذه الحالة سيتوقف العمل الآلي المؤتمت وسيتم تبادل البيانات مع الآخرين باستخدام الورق ، وسائط التخزين أو عن طريق البريد الالكتروني ،وبالتالي استهلاك أكثر للموارد مع إنتاجية أقل مما كانت عليه.

في هذه الرسالة سنقترح أنموذجاً جديداً يتبنى توظيف الرسائل القصيرة (SMS) في الأنظمة التطبيقية بمساعدة منتج برمجي وسيط (Gateway) يتعامل مع الرسائل القصيرة (SMS) مثل "Ozeki Message Server" و حزمة برامج تطبيقية تم إعدادها كواجهة تطبيق مع الأنظمة وباستخدام النموذج المقترح نستطيع المحافظة على استمرارية العمل عند حدوث تعطل جزئي في الاتصال ما بين قواعد بيانات الأنظمة بحيث يتم تفعيل هذا النموذج ليلعب دوراً هاماً في دعم استمرارية العمل من خلال نقل وتبادل البيانات المهمة وتبليغ المسؤولين والمنسقين عن الأعطال والمواقف الحرجة في الوقت المناسب (عن طريق ترميز الأوامر والجمل التي ستنفذ على قواعد البيانات وإرسالها باستخدام الرسائل القصيرة (SMS) من موقع إلى أخر) .

قمنا بتطبيق هذا النموذج على بيئة عمل تجريبية في مختبر الحاسوب /جامعة عمان العربية ، حيث قمنا بتجربة أربعة سيناريوهات لقياس فاعلية وكفاءة النموذج، وقياس مدى صحة النموذج، تم الحصول على نتائج مشجعة. أظهرت النتائج أن النموذج واقعي بالاعتماد على طرق قياس الواقعية من خلال طريقة التجربة وإعادة التجربة ، كما أن النتائج أظهرت أن النموذج يدعم استمرارية العمل في حال حدوث تعطل في الاتصال بين قواعد البيانات حيث تم تعديل أرصدة الحسابات عن بعد بالرغم من عدم وجود ربط بين قواعد البيانات (Database link) .

Chapter One
Introduction

1.0 Introduction

Business and economy automation has been responsible for the shift in the world economy from industrial jobs to service jobs in the 20th and 21st centuries. Nowadays, business automation is playing a critical role in achieving the required business competitive advantages. There have been a lot of researches in this field, most of these researches focus on how to automat continuing business functionalities and tasks.

Also In this thesis, we will develop a new model for business continuity, in which we use the Short Message Service (SMS) technology; by using this technique, we try to maintain the continuity of business operations when a disruption occurs. A New model is about having a standby SMS channel of communication to mitigate opportunities of losing connections among related business sites.

The banking sectors are considered critical business organizations, they have business activities that are performed outside of the normal organization, confines of space, time and need to communicate online on a daily basis, 24 by 7 basis. Such communication is essential in order to gain profit and to protect corporate reputation.

1.1. Business Automation

Humans have used automation and technology to improve their lives. They used the wheel, for instance, to transport goods, to save effort and time, and to move more quickly. In fact, the first automations appeared in the factories, by the end of the 19th century where the first applications of electricity permitted to make some automated operations without the intervention of human beings.

There has been a shift from manual jobs to automated ones, from simple tools, which relied on the ability of a person,

to process chains controlled by programmable controllers; Automation enables making a sequence of machine-controlled activities, often in a faster way. This idea was born in the world of industry, as repetitive jobs can assigned to machines, rather

than human workers. As a result, automated machines and technologies have been developed and adopted to work, to turn manual factories into automated ones.

Automation has a notable impact on a wide range of industries beyond manufacturing. Telephone operators have been largely replaced by automated telephone switchboards and answering machines. Medical processes, such as primary screening in electrocardiography or radiography and laboratory analysis of human genes, sera, cells, and tissues, are carried out at much greater speed and accuracy by automated systems. Automated teller machines have reduced the need for

bank visits to obtain cash and carry out transactions. In general, automation has been responsible for the shift in the world economy from industrial jobs to service jobs in the 20th and 21st centuries, so automation plays an increasingly important role in the world's economy and in daily experience [1].

The above-mentioned applications indicate that there are many advantages of the automation process, and this is can be summarized as follows:

- Eliminate the time spent on handling, retrieving, filing, distributing, faxing, copying, organizing and searching for paperwork; this elimination saves hundreds or even thousands of work hours.
- Maintain and track business status through reporting and monitoring.
- Centralize documents and specifications, for retrieving the required reports and specifications whenever needed; documents and specifications ensure that everyone got the appropriate task and/or function(s) in the right time.
- A higher level of constancy can be maintained by automating the creation of documents based on information already included in the database.
- Accomplish work more quickly, in a way that shortens the production cycles.
- Perform tasks that are beyond human capabilities in terms of size, weight, speed, endurance, etc.
- Economy improvement; automation may improve the economy of an enterprise by achieving greater ROI (return on investment); when an enterprise invests in automation, technology recovers this investment, or when a state or country increases its income due to automation like Germany or Japan in the 20th Century [2, 3].

Considering the above-mentioned advantages of the process of automation; some disadvantages that act against this process worth mentioning. These disadvantages include the following:

- Technology limits; current technology is unable to automate all desired distributed tasks among distributed business domains.
- Unpredictable development costs; development costs of automation may exceed the cost gained by the automation itself.
- High initial cost; automating a new product requires huge initial investments compared to unit cost of the product, although the cost of automation is spreading in many product batches [4].

1.1.1. Obstacles and challenges that faces business automation

Over the past few decades, **lack of interconnectivity** was a major barrier to companies integrating their systems. For years now, most companies have had an efficient internal network to connect all their systems, applications, and databases, although business partners were forced to deploy

very expensive virtual private networks (VPNs) or point-to-point network connections to connect partner systems. Ever since the Internet became available for use by private enterprise and individuals, the connectivity problem somehow solved. Network providers are addressing various associated issues such as reliability, performance, and security, and those factors will not prevent a company from using the Internet to work with its partners.

Nowadays working outside the normal organizational confines of space and time is essential in order to gain profit and to protect corporate reputation. This explains the high importance that mobile phones usage has gained in the business environment today. Shortage of communications can be crucial for company's operations, each second of wasted time means slower rate of service and higher costs, which results in bad customer experience and less profit.

Continuous availability of services is another challenge that faces many organizations especially those in banks sectors. In order to compete and provide differentiation from the competitors organizations need to provide a fully automated fail-over mechanism that eliminates and prevents huge loss in both revenue and customer trust. In fact, customers cannot

withdraw money from their bank account if a communication server is down or disruption in the communication occurs, the bank branches are technically out of work. Without the automated fail-over, the bank would continue to serve clients but there would be inherited risks by doing so without having a view of the customer's financial situation.

1.2. SMS Technology

It is not a secret that wireless technology has become the standard for capacitating communication, entertainment and education across the planet today. Today's organizations, accurate and continuous business procedures highly depend on such technology. One of the most important communication concepts that are based on the wireless technology is the SMS (Short Messaging Service).

SMS is a communication tool that provides a convenient means for people to communicate with each other using text messages via mobile devices or Internet connected computers. Solutions for e-marketers are available to deliver bulk of SMS messages to large group of people, instead of sending SMS

messages one by one manually. Other utilities can collect phone numbers from imported text files or contact information stored in mobile phones [5, 6].

The message (text only) from the sending mobile is stored in a central short message center (CSMC) which then forwards it to the destination mobile. This means that in the case that the recipient is not available; the short message will be stored and can be sent later. Each short message can be no longer than 160 characters. These characters can be text (alphanumeric) or binary Non-Text Short messages. An interesting feature of SMS is return receipts. This means that the sender, if he wishes, can get a small message-notifying if the short message was delivered to the intended recipient. Since SMS used signaling channel as opposed to dedicated channels, these messages can be sent/received simultaneously with the voice/data/fax service over a Global System for Mobile communication (GSM) network. SMS supports national and international roaming. This means that we can send short messages to any other GSM mobile user around the world. With the Personal Computers (PCs) networks based on all the three technologies, GSM, Code-Division Multiplexing Access (CDMA) and Time-Division Multiplexing Access (TDMA) supporting SMS [7].

1.3 The Concept of Business Continuity

"Business continuity is the ability to keep vital business operations running in the event of failure in the existing infrastructure. Typically, when a part of the existing infrastructure fails, IT is expected to provide a response within a given time period, typically referred to as an SLA (Service Level Agreement). These failures can include power failures, application errors, network failures, data integrity issues, human error or any other issue where the majority of the infrastructure is still in place, but operations are halted and need to resume" [8].

Another definition for business continuity is the activity performed by an organization to ensure that critical business functions will be available to customers, suppliers, regulators, and other entities that must have access to those functions. These activities include many daily chores such as project management, system backups, change control, and help desk. Business continuity not something implemented at the time of a disaster; in fact, it refers to those activities performed daily to maintain service, consistency, and recoverability.

The foundation of business continuity is the standards, program development, and supporting policies; guidelines, and procedures needed to ensure a firm to continue without stoppage, irrespective of the adverse circumstances or events. All system design, implementation, support, and maintenance must be based on this foundation in order to have any hope of achieving business continuity, disaster recovery, or in some cases, system support. Business continuity is sometimes confused with disaster recovery, but they are separate entities. Disaster recovery is a small subset of business continuity.

The term business continuity describes a mentality or methodology of conducting day-to-day business, whereas business continuity planning is an activity of determining what that methodology should be. The business continuity plan may be thought of as the incarnation of a methodology that is followed by everyone in an organization on a daily basis to ensure normal operations, so a complete assessment of the information flows must take into consideration the people, processes and systems (including communications infrastructure) [9,10].

1.4 Objectives

An old saying says" Time is money"; therefore most of nowadays enterprises have major goal of producing necessary information needed to improve decision making process in terms of accuracy, reliability and time; which of course return with many benefits for organizations. Thus, the business continuity vitally important for most of organizations and managers, in order to get the needed data and/or information at the right time.

Mobile phone technology capability can provide organizations with many tangible benefits by bringing the workplace to the employee; provide enhanced productivity and profitability by allowing employees to respond quickly to organizational and client requests. It can also provide more flexible working arrangements for staff by allowing 24-hour, seven-days-a-week access to job functions. So we must not disregard SMS mobile phone technology within a business continuity communications plan; because it can be easily integrated into our existing systems, and it can enable specific targeting and efficient mass distribution of messages to any combination of mobiles, pagers and email addresses independent of network. Co-ordinators can also auto alert any unhandled risk.

Multiple channels of communication using SMS, paging and mobile offer the best chances of maintaining contact in a crisis. We live in an uncertain world, if the worst happens, good preparation and communication becomes critical. In this thesis we will highlight the notion of using SMS technology to support business application continuity to reduce the risk and auto-manage the interruptions which come from the failure of landlines connections to handle incoming requests and auto alert coordinators for any unhanding risk, so supporting business continuity by SMS will increase organization recovery capabilities dramatically which means that we can make the right decisions and prevent interruption of mission-critical services quickly, cut downtime and minimize financial losses.

1.5 Problem Statement

Nowadays, many organizations use systems that are connected through more than one database, with assets that lies over large geographical areas; such organizations need to communicate on a continuing daily manner, 24-hour, seven-days-a-week in order to maximize profits and gain the competitive advantages and protect corporate reputation. Though there are a variety of disruptions may occur in business application. In other words, the connection may be broken

between databases sources because of: landlines connection failed, unhanded exception within applications, etc…). Such cases lose the transaction and end the automated business. This will force business users to maintain and continue the business procedures and functionalities via paper work, which causes additional waste of resources with less business competitive advantages.

1.6 Contribution

Nowadays, humans are willing for business continuity when interruptions on critical business function occur. In the proposed model, SMS will be employed to support business continuity concept while transferring and exchanging critical data and/or business procedures (By coding the database transaction statement and sending it via SMS from node to node, and creating package as interface solution that interact with application to handle any disruption in connection between two database nodes) from one database to another when business application connection disruption occurs; in addition, there is a usage for SMS to alert co-coordinators at the right time when failure occurs.

In the proposed model, there is a contribution of adapting SMS technique with the concept of business continuity, by

having automated operations that will transmit data from machine to machine and/or from machine to human, in order to support business continuity if there is any interruptions on critical business function occurs without the intervention of a human being. Another contribution is that using SMS technology to insure scalability, flexibility and a lower cost solution, comparing to other technologies, to support rapid response when any interruption in our business occurs. Also by using SMS via GSM network as another channel to transmit data remotely ensures emergency services and business continuity, in case of the business application disruption.

Security must be taken into consideration toward sensitive information while transmitting business information and/or procedures using SMS. In other words, messages might be subject to interception; therefore, in the proposed model, encryption used in order to maintain the message security and accuracy.

Chapter Two
Literature Review and Related work

2.0 Introduction

This chapter will cover the main concepts and interactions within the proposed model including the history of these concepts and their definitions. The rest of this chapter covers the following sections: In section 2.1, we cover history and main concepts of SMS Models; in section 2.2, we cover the concept of SMS security; finally, in section 2.3, we cover the concept of business continuity and its relation with SMS.

2.1 SMS Based Models

In [11] a framework that uses SMS as a business tool was proposed. The framework supports the use of SMS technology to perform a simple broadcast, or to poll contacts to collect information. It also includes a real-time customizable reporting function, which tracks call results in whatever terms are appropriate for the situation.

The system provides targeted messaging with an unlimited number of possible scenarios, messages, recipients, and groups. In addition, geo-coded mapping can be used to designate notification areas on a web-based map. The system can identify the residents and businesses in that area, generate

phone numbers, and deliver notifications or instructions. Messages can be pre-recorded for later use, created on the fly, and/or changed as the situation unfolds.

Andreas Rosendahl et. al [12] studied mobile home automation, a field that emerges from an integration of mobile application platforms and home automation technologies. They motivated their research and provided a conceptual introduction, which illustrates the need for such applications by a two-dimensional conceptual model of mobility. As a first step towards a solution they took the user's perspective and discussed different options of how it might access a mobile home automation service and the controlled devices. Subsequently, they suggested general system architecture for mobile home automation services and discussed related design decision. This design was implemented in a research prototype, which was named "Remotile". This helps them to discuss typical components, such as modules that integrate various home automation devices.

Edy Jordan et. al [13] proposed a framework that uses SMS as a business tool. The framework supports the use of

SMS technology as a tool for submitting queries to a database. The framework was designed with two major objectives. First, to provide a flexible framework that allows rapid adaptation of the technology to different business scenarios or changes to business environments. Second, to provide a low-cost solution for organization that needs to support mobile access to perform its day-to-day operation. A prototype called “MobileStock” was developed as a proof of concept.

Ibrahim A.S.Muhamadi et. al [14] proposed SRRS (Student Record Retrieval System) by having an SMS automatically being sent to each student once a lecturer submits a marking to their records. The authors addressed that this operation will ensure the student is informed of the new data arriving to his record so that he might go and check his new info or data specially a mark or an examination result. In this paper, main objective the same; to inform or to alert application co-coordinators when any service interruptions on critical business function occurs [13].

In mobile marketing association, 2009 [15] it showed that today’s most large banks offer basic mobile banking solution for their customers. The most common services available today are:

- Account alerts, security alert and reminders.
- Account balance, update and history.
- Customer service by mobile.
- Branch or ATM location information.
- Bill pay.
- Funds transfer.
- Transaction verification.
- Mortgage alert.

In this paper, we will use SMS solution to transmit data from machine to machine and from machine to human mobile in order to support business continuity if there is any interruptions on critical business function occurs.

James Kadirire [16], proposed a system (that uses java servlets, a tomcat servlet container, an oracle database, HyperText Markup Language (html) and an open source SMS gateway called kannel, which runs on a UNIX platform) enables or delegates pupils/students to send SMS comments/messages to their teacher or the presenter in schools or company/university seminars or presentations or conferences. The teacher or presenter can then select each message that will be displayed on a large screen and interactively deal with the question or comment.

The application receives the SMS(s) and stores them in a database. It then adds

Other formatting information to allow the SMS to be displayed on the computer screen as small “posted notes", so the author has addressed the capabilities of storing and retrieving SMS from database.

In this paper, objective is the same (the ability for storing and retrieving SMS from database and ability for adding other formatting information to allow the SMS to be stored in the database).

2.2 SMS Security

Shubat et. al. [17] proposed two applicable end-to-end security mechanisms for SMS based on the RSA scheme and the ID based scheme. The ID-based scheme provides a great simplification of key distribution because all public keys can be derived from the identities of the users. Therefore obtaining someone’s public key, for encryption or verification, becomes a simple and transparent procedure.

Albuja and carrera [18] proposed a model that depends on novel framework for exchanging confidential, non-repudiable SMS messages in a Public Key Infrastructure (PKI) environment that can include X.800 certificates validated by

Certification Authorities (CA). Since SMS message exchange is very similar to sending and receiving emails, their security framework is based on some ideas for securing email, specifically Pretty Good Privacy (PGP) and Secure/Multipurpose Internet Mail Extensions (S/MIME).

[6] showed that SMS is now a very common communication tool. Security protection of SMS messages is not that sophisticated, and it is still difficult to implement in practice. With the increasing use of SMS for communication and information exchange, care should be taken when sensitive information is transmitted using SMS. Users should be aware that SMS messages might be subject to interception. Solutions such as encrypted SMS should be considered if there is a need to send sensitive information via SMS.

[19] Proposed new data-centric process model-based technology, Control's Force Transaction Watchdog™ platform allows customers to build, without programming IT solutions for automated control and monitoring of their long-running core business transactions. These solutions open a door to new business areas where conventional BPM, risk and information management technologies fail to help businesses increase their efficiency and secure information better against the fraud and human errors.

Any complex business task that requires tracking information across different channels, accounts, users, and transaction types can be presented as a type of long-running (multiple) transaction. Control's Force enables one to put process context into application message analysis. Message correlation engine allows one to apply simple rules to compare the content of current message with the previously correlated messages received from a different system. This way assures transaction accuracy, information integrity and fraud scheme detection before a business loss can occur.

2.3 SMS for Business Continuity

Raju Rishi [20] addressed that after many years of providing emergency alerting solutions to institutions, it was found that SMS messaging is a critical component to a robust emergency management plan because we are living in a highly mobile world, where employees, students and individuals can effectively work from anywhere, and the mobile phone has become very important communication tool. No other messaging solution is able to target individuals as rapidly and as ubiquitously, given the penetration and availability of these mobile devices.

[21] Showed that Oracle Beehive Mobile Services in combination with BlackBerry Enterprise Server for MDS Applications provides a rich, secure experience for Blackberry users. Together, these solutions allow mobile users to stay connected to the data, applications and tools they need most to meet critical business requirements.

[22] Addressed that GSM has fully developed as a global standard for digital mobile communications, offering an unrivalled level of coverage and services matched by no other mobile communications standard. Wireless GSM data will play a key role in enabling enterprises to become more flexible and responsive to the needs of their customers. The use of GSM data is becoming a key strategic tool for improving the service level in any organization, providing productivity and efficiency benefits that can only be achieved by strategic use of wireless technology.

An increasing number of companies around the world are starting to see the true benefits of providing their mobile employees with a 100% connectivity solution. Effective use of GSM data is becoming a key factor in providing an organization with a realizable competitive advantage.

[23] Showed that while text message traffic continues to grow domestically and internationally, the business expenses involved in terms of, time, money, and technical expertise can be expensive. Using the short code setup and maintenance will cost more than $20,000/year, keeping in mind the key for corporations whose core competency is not technology but the partner with SMS services companies.

In [11] researcher offered a system called (Crisis Communications System (CRISCOM)) which is a fully hosted Software-as-a-Service (SaaS) solution that can be used to quickly reach any number of individuals or groups. Tactical Flag Command Center System (TFCCS) cost-effective automated solutions assist organizations in conserving resources.

The system can perform a simple broadcast, or it can poll contacts to collect information. It also includes a real-time customizable reporting function which tracks call results in whatever terms are appropriate for the situation.

The system provides targeted messaging with an unlimited number of possible scenarios, messages, recipients, and groups. Also, Geo-coded Mapping can be used to designate notification areas on a web-based map. The system will identify the residents and businesses in that area, generate

phone numbers, and deliver notifications or instructions. Messages can be pre-recorded for later use, created on the fly, and/or changed as the situation unfolds.

Twenty first century's systems are fully web-accessed, with 24/7/365 availability, remote activation capability, and toll-free live technical support.

Whatever the likelihood or frequency of natural disasters, the absolute truth is that they will occur. The critical key to response and recover from best to worst case scenario, is communication: getting the right information to the right people at the right time .

[24] Outlines the various wireless remote access channels that can be used in a remote access solution. The various characteristics of the services have been outlined such as bandwidth, geographical coverage, applications and comparative cost, so referring to remote access report, in new model we proposed the use of SMS technology to provide scalable, flexible, and a lower cost solution, comparing to other technologies, to support rapid response when any interruption in our business occurs.

In [25] shown that government businesses can be prepared for emergency situations by taking a proactive approach to their business continuity planning. A comprehensive plan can provide a range of scenarios ahead of time, with clear processes and responsibilities defined in detail. A critical component of the overall business continuity plan is a secure remote access plan to ensure that remote or isolated workers can continue their work during and after a disaster strikes.

Juniper Networks hardware model (SA Series Secure Sockets Layer (SSL) Virtual Private Network (VPN) Appliances and Speed and Range Expansion (SRX) Series Services Gateways) for the field help to keep government agencies and departments functional by connecting people even during the most unpredictable circumstances—hurricanes, terrorist attacks, transportation strikes, pandemics, or virus outbreaks. With the right balance of risk and cost, the SA Series with the In Case (of) Emergency (ICE) license delivers a timely solution for addressing a dramatic peak in demand for remote access to ensure emergency services and business continuity, whenever an emergency strikes.

The term SSL VPN refers to a new and fast-growing product category comprising a variety of technologies. Working backwards, the term “VPN” is the practice of using a public network like the Internet to transmit private data. Prior to 2001, most VPNs were based on some type of network layer transport such as IP Security (IPSec).

In this thesis, objective is the same since we are using SMS via GSM network as another channel to transmit data remotely, this ensures emergency services and business continuity, in case of the business application disruption.

[26] Mentioned that with network infrastructure and company assets dispersed across large geographies, communication providers and electric utilities must plan for the “what if” scenario. Although risk is uncontrollable, being able to analyze data for enhanced management of a company’s assets drastically improves business continuity planning.

The Solution Pitney Bowes Business Insight risk data solutions enable us to make more informed network management decisions to minimize service interruptions and plan for contingencies in the event of a disaster.

In this research, additional channels of communication have been taken into consideration, SMS, to offer the best chances of maintaining contact in a crisis.

Chapter Three
Remote Access Concepts

3.0 Introduction

This chapter introduces the reader to remote access, business continuity, concepts of distributed systems, distributed databases, database link and ozeki message server.

3.1 Remote Access

Remote access means providing users who are away from the enterprise with the ability to access information resources residing in the corporate network. Remote users can perform their job-related tasks from anywhere they have a network connection to their main site as if they are in the office. The convenience of having access to critical information by using a remote access infrastructure is an early form of ubiquitous computing [27].

Another definition for remote access is a service provided by servers and devices on the LAN that enables users working off-site or allows for a means for servers and devices to communicate between sites. There are various methods to conduct remote access, including dialup access and virtual private network (VPN). Remote access may serve as an

important contingency capability by providing access to organization wide data for recovery teams or users from another location if an emergency or serious system disruption occurs, if remote access is established as a contingency strategy, data bandwidth requirements should be identified and used to scale the remote access solution. Additionally, security controls such as one-time passwords and data encryption should be implemented if the communications contains sensitive information.

The benefits of remote access capability extend beyond business continuity. As the workplace has significantly changed due to the widespread deployment of technology, many job functions linked to an organization's computer network. As such, having an advanced remote access capability can provide organizations with many benefits by bringing the workplace to the employee and allowing employees to respond quickly to organizational and client requests, this means more flexible working arrangements for staff and allowing 24-hour, seven-days-a-week access to job functions. So as organizations prepare a business continuity plan, it’s important to include remote access as a fundamental part of the business continuity infrastructure. During a disaster or other business

interruption, the ability to access critical corporate information and maintain productivity is more important than ever. Moreover, a remote access solution can help protect our revenue stream and guard our company's reputation [24, 28].

Secure remote access using an Aventail SSL VPN, allows employees, customers, and partners to access key data and applications on the network without being at company facility. It enables access from anywhere, on any device, via any Internet connection while maintaining absolute security from internal and external threats. By guarding the revenue stream and keeping the business running during a crisis, the business continuity plan protects the corporate reputation. That makes the company a stronger, more reliable vendor and partner—creating competitive advantage over less-prepared rivals. The business continuity plan also meets regulatory requirements for audit trails on sensitive or protected information. Having secure remote access in the business continuity plan reduces the burden on IT when an event does happen. However, all those benefits depend on one thing that is, advance planning.

In the context of business continuity planning (BCP), remote access means the ability to use information and

communications technology (ICT) systems to sustain key business processes or functions from a remote location for an extended period of time [29].

Based on strategic and operational planning for both steady state and business continuity, there will be specific technical requirements for any organization to access business applications that will be effected by the design of its remote access technology solution. These may involve bandwidth, service availability, service continuity and security. There are many types of remote access technology components available; however, each organization will have different operational needs to consider when selecting an appropriate remote access solution. Devices to assist remote access are generally viewed in relation to cost versus functionality. In this thesis ,we are going to highlight the lower cost service technologies, which is an SMS, as a part of mobile phone technology to support business application continuity [24];

as shown in Figure 3.1.

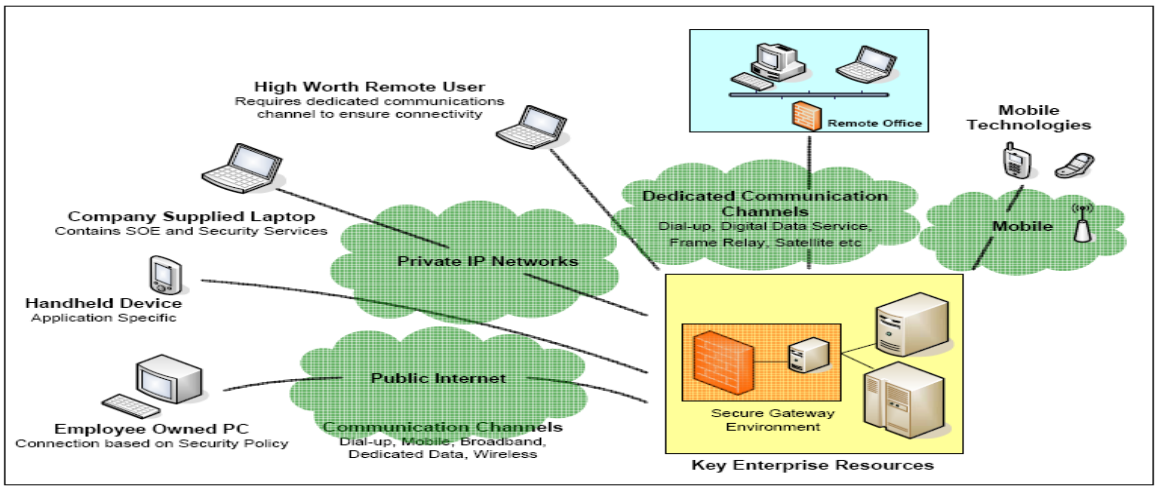

Figure 3.1: Remote access technologies [24].

3.1.1 Remote access telecommunication

Data communications for remote access can be carried over a variety of transmission media, wired and wireless, Furthermore; remote connection can use several different communication paths and a range of different protocols, technologies, software and hardware, available from various service providers that are invisible to the user. The basis of the majority of remote access telecommunication channels is Fixed line services that have been traditionally divided into two classes based on speed, narrowband and broadband.

• **Narrowband services**: are those services that provide low downstream and upstream data rates (generally accepted to be less than 256/64 kbps) provided by dial-up or integrated

services digital network (ISDN) ,Table 3.1 outlines the narrowband landline remote access channels that can be used in a remote access solution.

Table 3.1—Narrowband fixed line remote access channels

Technology	Description	Application	Data rates
PSTN (Public Standard Telephone Network) for remote access.	A modem, connected to the computer and the phone line, dials the number of the remote access device in the network (this could be another modem or an Access Router that enables multiple simultaneous connections) and once authenticated the user is granted	PSTN dial-up used for direct dial-in to enterprise applications that wish to by-pass internet connections for security or functional reasons. PSTN dial-up still used for internet access where	Up to 56 kbps

	remote access to the network and its resources. Before the internet, all remote access was via dial-up, but with the advent of high speed internet, significantly faster connections can be made using broadband technology.	ADSL is not available.	
ISDN (Integrated Services Digital Network)	The name refers to the fact that the services are integrated (i.e. data, voice and fax can all be sent over an ISDN connection), that the service is a	ISDN dial-up used for direct dial-in to enterprise applications that wish to by-pass internet connections	Up to 128 kbps

	digital service, not analogue, and that it is a network, not a fixed line type of service. ISDN accounts have 'telephone' numbers and so any ISDN subscriber can connect to any other, as phone users can. Telstra is currently offering ISDN broadband internet access at a maximum of 128kbps.	for security or functional reasons. ISDN dial-up still used for faster internet access where ADSL is not available.	

• **Broadband services**: provide a variety of access services operating at speeds at or above 256/64 kbps. These services are provided by many technologies such as asymmetric digital

subscriber line (ADSL), ADSL 2+, Cable, frame relay, digital data services and asynchronous transfer mode (ATM). The service can provide direct access to corporate services and Internet or just Internet access. Table 3.2 outlines the various broadband landline remote access channels that can be used in a remote access solution.

Table 3.2—Broadband fixed line remote access channels

Technology	Description	Application	Data Rates
ADSL ADSL 2+ (Asymmetric Digital Subscriber Line**)**	This is most common technology for supplying broadband internet over the Public Standard Telephone Network (PSTN). This technology permits the simultaneous transmission of voice and data traffic. It requires that the users have a	Most common basis of broadband internet connectivity in Australia.	ADSL Up to 8Mbps ADSL2+ Up to 24Mbps

	filter on the phone connections to ensure that the 'squeal' of the data traffic is not heard. ADSL allows for significantly faster data transfer than a dial-up modem with faster download speeds than upload speeds. ADSL 2+ has higher transfer rates than standard ADSL closer to the exchange. However the speeds achieved become comparable to standard ADSL as the distance from the exchange increases.		

Cable	As the name suggests, this is telecommunications over a physical cable infrastructure. The cables are typically used to carry pay TV and other services. Internet services over this infrastructure are usually at broadband speeds or higher.	This has the same application as ADSL however there is a restriction on the coverage of the service. Service deployed in mainland capital cities only.	Up to 17Mbps

Another telecommunication channel technology for data services is wireless communications or wireless remote access channels which have increased substantially in the past few years. The popularity of GSM high-speed downlink packet access (HSDPA) services based on the 3G standard and WiMax services has led to these types of services being incorporated into many everyday business activities.

The data rates offered by GSM HSDPA and WiMax are comparable to domestic broadband services such as ADSL and ADSL 2+. This means that the services that these technologies can support are the same as fixed line broadband services. Remote access technology comparisons, Table **3.3** outlines the various wireless remote access channels that can be used in a remote access solution. The various characteristics of the services are outlined such as bandwidth, geographical coverage, applications and comparative cost.

Table 3.3—Wireless remote access channels

Technology	Description	Application	Data rates	Charge regime
Mobile—GSM 2G	2G refers to the 2nd generation technology for mobile phones. GSM and CDMA are the 2 variants of 2G technology 2G support SMS and limited data transmission.	Primarily a voice application. Can be used for data transmission.	14.4 kbps	Low cost voice based on the corporate plan. High cost for data

				applications.
Mobile—GSM 2.5G	The term 2.5G was never officially used, but was created as a marketing tool for the improved 2G technologies. These include GPRS (General Packet Radio Service) and EDGE(Enhanced Data for GSM Evolution) which support WAP (Wireless Application Protocol) and MMS (Multi Media Streaming). These protocols allow mobile users to surf	Same voice applications as 2G. Data services improved.	Up to 144 kbps	Low cost voice based on the corporate plan. Higher cost for data applications.

	the web and send and receive multimedia messages.			
Mobile—GSM 3G	3G technologies enable the provision of voice, mobile multimedia services such as music, TV and video, rich entertainment content and internet access. The technology on which 3GSM services are delivered is based on a GSM network enhanced with a Wideband-CDMA (W-CDMA) air interface—the over-	Same voice applications as 2G. Enhanced services such as multimedia and data provided.	Up to 14.4Mpbs downlink and 384 kbps uplink with average user speed 250–750 kbps downlink and 40–100	Low cost voice based on the corporate plan. Higher cost for data applications.

	the-air transmission element. HSDPA is the latest specification of the 3G standard and is capable of providing much higher speed.		kbps uplink.	
WiMax	WiMax (Worldwide Interoperability for Microwave Access) refers to the IEEE 802.16 wireless standard for delivering high speed broadband. The service will provide fixed, portable and, eventually, mobile wireless broadband connectivity.	Emerging technology aimed for metropolitan and regional coverage. Complementary to Mobile 2G and	Has the capability to deliver services of 5–10Mbps at a distance of 10–20km from a base-station.	There are very few WiMax networks in Australia and those operational in Australia offer broadband services

		3G networks.		with a pricing regime comparable to ADSL.
WiFi (WLAN)	WiFi (Wireless Fidelity) is a logo given to devices that are compliant with the IEEE 802.11 wireless Standard. This standard has been widely adopted and the technology is now incorporated in most laptops and handheld devices.	Due to the low power of transmitters the service is restricted to public locations such as cafés, airports, hotels	Up to 54Mbps	Low cost monthly subscription or ad-hoc "pay as you go" scheme.

		and shopping centers. Their application is usually associated with Wireless Hotspots.		
Satellite	Used for Voice, data and video applications. Some restrictions on applications based on transmission latency.	Used extensively in regional areas where broadband and tradition	1500 kbps download 512 kpbs upload	Initial capital cost + ongoing.

		al voice services are not availabl e.		
Microwa ve	Microwave frequencies have been used to transmit data for many years. This is a 'line of sight' technology that requires the sending and receiving dishes to be in view of each other. It is often used in remote locations where the installation of cable is prohibitively	Applicati ons for microwa ve can be for back-up links between data centers (part of a DR plan). Typicall y not used in remote access	Carrier class links.	Initial capital cost + ongoing mainten ance and spectru m licenses .

	expensive or difficult.	from home applications.		

Another telecommunication channels technology data services is VPN which using a public network (usually the Internet) to connect remote sites or users together. Instead of using a dedicated, real-world connection such as leased line, it uses connections routed through the internet from the company's private network to the remote site or employee.

Traditionally, remote access solutions have been built and maintained by an organization's IT department. Basic carriage services such as dial-up or broadband were provisioned by various carriers and service providers. In recent years, the growth of managed network services offered by various service providers has increased. These managed services are based on private data switched networks designed and maintained by the carriers and service providers [24].

3.1.2 Short Message Service (SMS)

Short message service (SMS) is a globally accepted wireless service that enables the transmission of alphanumeric messages between mobile subscribers and external systems such as electronic mail, paging, and voice mail systems.

There are many advantages of SMS to the service provider from these advantages or benefits:

- An alternative to alphanumeric paging services
- Enabling wireless data access for corporate users
- Provision of value-added services such as e-mail, voice mail, and fax mail integration, reminder service, stock and currency quotes, and airline schedules
- Provision of key administrative services such as advice of charge, over-the-air downloading, and service provisioning

The benefits of SMS to subscribers center on convenience, flexibility, and seamless integration of messaging services and data access. From this perspective, the benefit is to be able to use the handset as an extension of the computer. SMS also eliminates the need for separate devices for messaging since services can be integrated into a single wireless device — the mobile terminal [30].

In other words, SMS is a service that allows subscribers to send short messages (up to 160 characters) to other mobile subscribers via A SMS Centre (SMSC), usually owned and run by a telecommunication operator, who is responsible for the routing and delivery of SMS. When an SMS message is delivered to the SMSC, a store-and-forward message mechanism is implemented, whereby the message is temporarily stored, then forwarded to the recipient's phone when the recipient device is available. Similar to email messages, a SMS message may pass through a number of SMSCs or other SMS gateways (which act as bridges between two or more SMSCs running different SMSC protocols) before reaching the recipient's device. An SMSC helps route SMS messages and manages the process. If the intended SMS recipient is not online, the SMSC will keep the stored SMS message for a "validity period" before deleting it from storage [6]. Figure 3.2 shows a typical organization of network elements in a GSM network supporting SMS.

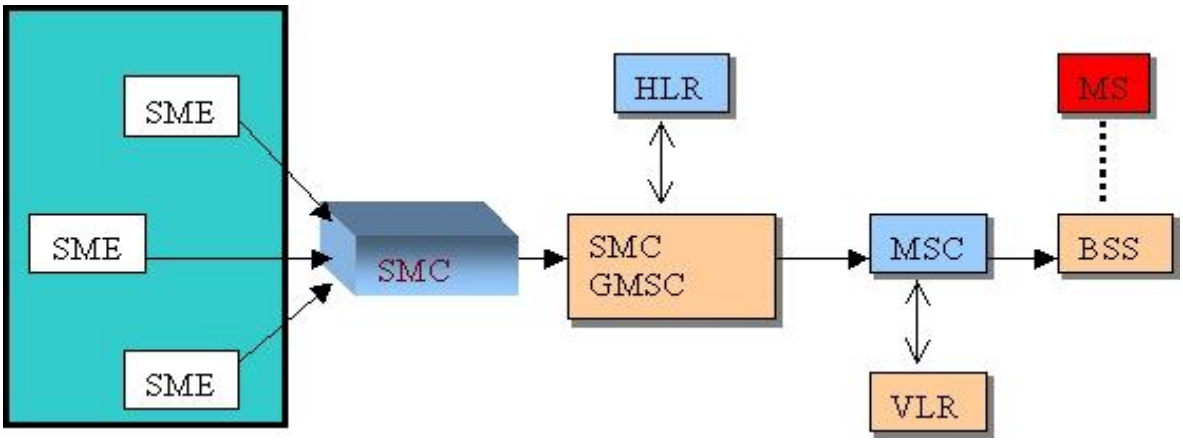

Figure3.2- typical organization of network elements in a GSM network supporting SMS [30].

A Short Message Service Centre (SMSC), usually is owned and run by a telecommunication operator, is responsible for the routing and delivery of SMS, so it is the entity, which does the job of store and forward of messages to and from the mobile station. The SME (short message entity) which can be located in the fixed network or a mobile station receives and sends short messages.

The SMS GWMS (SMS gateway Mobile Switching Center (MSC)) is a gateway MSC that can also receive short messages. The gateway MSC is a mobile network's point of contact with other networks. On receiving the short message

from the short message center (SMC), GMSC uses the SS7 network to interrogate the current position of the mobile station form the HLR, the home location register.

HLR is the main database in a mobile network. It holds information of the subscription profile of the mobile and about the routing information for the subscriber, i.e. the area (covered by a MSC) where the mobile is currently situated. The GMSC is thus able to pass the message to the correct MSC.

MSC is the entity in a GSM network which does the job of switching connections between mobile stations or between mobile stations and the fixed network.

A VLR (visitor location register) corresponds to each MSC and contains temporary information about the mobile, information like mobile identification and the cell (or a group of cells) where the mobile is currently situated. Using information form the VLR the MSC is able to switch the information (short message) to the corresponding BSS (Base Station System, BSC + BTSs), which transmits the short message to the mobile. The BSS consists of transceivers, which send and receive information over the air interface, to and from the mobile

station. This information is passing over the signaling channels so the mobile can receive messages even if a voice or data call is going on [30].

There is no doubt that SMS is very popular. What is more interesting to observe is that popularity has been in spite of many limitations of SMS. Many of these limitations are the driving force behind the developments and initiatives being taken in the field of short messaging. Some of the limitations of SMS are:

- Messages can only contain simple text. There is no scope for any graphics or audio.
- The messages are limited by size. An SMS message can't exceed 160 characters.
- The limitation of easy input mechanisms in mobile devices makes it very uncomfortable sending messages larger than even 5-6 words.
- Many proprietary protocols used by SMS operators and application developers need to implement different interfaces for making their applications work with different

- SMS centers. X.25 is used as a popular protocol for connecting with SMS centers.
- SMS protocol data units as defined in GSM 03.40 are also not very efficient. The various header fields in the Protocol Data Unit (PDU) are fixed which puts a constraint on the scenarios that can be indicated. 3G specifications are being looked up to look and address these constraints.

- Data rate and latency. GPRS and unstructured supplementary services data(USSD) provide better data rates and lower latency compared to SMS. This is because SMS uses the slow signaling channel, which is used for many other things also in GSM.

- The store and forward nature of SMS, though useful in many applications makes SMS not very suitable for WAP [30].

3.2 Business continuity

Business continuity is the activity performed by an organization to ensure that critical business functions will be available to customers, suppliers, regulators, and other entities that must have access to those functions [31]. Business continuity addresses organizational recovery following a disaster. It assumes that prevention arrangements have failed and that an incident has occurred which has interrupted normal business to the extent that corrective action is required [32]. Business continuity is the ability of an organization to continue to function even after a disastrous event, accomplished through the deployment of redundant hardware and software, the use of fault tolerant systems, as well as a solid backup and recovery strategy [29]. In addition, business continuity could be defined as the ability to maintain operations/services in the face of a disruptive event [33].

All previously-mentioned definitions of business continuity ensure that critical business functions are still going to keep running in the case of a disruption, whether due to a major or a minor incident. This comes as a result to the vital role played by the automated information systems in the organization's business processes, which implies that these systems operate

effectively without excessive interruption. Another way to achieve business continuity in an organization is to set contingency plans, that includes procedures and technical measures to enable a system to recover quickly and effectively following a service disruption or a disaster

Business continuity planning ensures that all personnel in an organization understand which business functions are the most important to the business. These activities may include many daily chores such as project management, system backups, change control, and help desk. However, business continuity is not something implemented at the time of a disaster; business continuity requires planning and should include all activities that need to be performed daily to maintain service, consistency, and recoverability [25].

Nowadays many organizations depend on IT systems; IT systems can be a very complex, with numerous components, interfaces, and processes. A system often has multiple missions resulting in different perspectives on the importance of system services or capabilities. The first step must be evaluating the IT system to determine the critical functions

performed by the system and to identify the specific system resources required to perform them. Two activities usually needed to complete this step:

- The Contingency Planning Coordinator should identify and coordinate with internal and external points of contact (POC) associated with the system to characterize the ways that they depend on or support the IT system. When identifying contacts, it is important to include organizations that provide or receive data from the system as well as contacts
- The Contingency Planning Coordinator should evaluate the system to link these critical services to system resources. This analysis usually will identify infrastructure requirements such as electric power, telecommunications connections, and environmental controls. Specific IT equipment, such as routers, application servers, and authentication servers, usually considered critical. However, the analysis may determine that certain IT components, such as a printer or print server, not needed to support critical services.

3.3 Concepts of Distributed systems, Distributed databases and database link

Distributed systems are systems that implemented in environments in which clients and users are widely dispersed. These systems rely on LAN and WAN resources to facilitate user access and the elements comprising the distributed system require synchronization and coordination to prevent disruptions and processing errors. A common form of distributed systems is a large database management system (DBMS) that supports agency wide business functions in multiple geographic locations. In this type of application, data is replicated among servers at each location, and users access the system from their local server.

Distributed database is a database that consists of two or more data files located at different sites on a computer network. Because the database is distributed, different users can access it without interfering with one another. However, the DBMS must periodically synchronize the scattered databases to make sure that they all have consistent data [34]. Furthermore, a distributed oracle database system allows applications to access data from local and remote databases. In a homogenous distributed database system, each database is an Oracle Database. In a heterogeneous distributed database

system, at least one of the databases is not an Oracle Database. Distributed databases use client/server architecture to process information requests [35].

The terms distributed database system and database replication are related, yet distinct. In a pure (that is, not replicated) distributed database, the system manages a single copy of all data and supporting database objects. Typically, distributed database applications use distributed transactions to access both local and remote data and modify the global database in real-time.

Replication refers to the operation of copying and maintaining database objects in multiple databases belonging to a distributed system. While replication relies on distributed database technology, database replication offers applications benefits that are not possible within a pure distributed database environment. Most commonly, replication is used to improve local database performance and protect the availability of applications because alternate data access options exist. For example, an application may normally access a local database rather than a remote server to minimize network traffic and

achieve maximum performance. Furthermore, the application can continue to function if the local server experiences a failure, but other servers with replicated data remain accessible.

In a heterogeneous distributed database system, at least one of the databases is a non-Oracle Database system. To the application, the heterogeneous distributed database system appears as a single, local, Oracle Database. The local Oracle Database server hides the distribution and heterogeneity of the data. Oracle Database server accesses the non-Oracle Database system using Oracle Heterogeneous Services in conjunction with an agent. If we access the non-Oracle Database data store using an Oracle Transparent Gateway, then the agent is a system-specific application. For example, if we include a Sybase database in an Oracle Database distributed system, and then we need to obtain a Sybase-specific transparent gateway so that the Oracle Database in the system can communicate with it.

Alternatively, we can use generic connectivity to access non-Oracle Database data stores so long as the non-Oracle Database system supports the ODBC or OLE DB protocols. For

each non-Oracle Database system that we access, Heterogeneous Services can use a transparent gateway agent to interface with the specified non-Oracle Database system. The agent is specific to the non-Oracle Database system, so each type of system requires a different agent.

The transparent gateway agent facilitates communication between Oracle Database and non-Oracle Database systems and uses the Heterogeneous Services component in the Oracle Database server. The agent executes SQL and transactional requests at the non-Oracle Database system on behalf of the Oracle Database server.

Generic connectivity enables us to connect to non-Oracle Database data stores by using either a Heterogeneous Services ODBC agent or a Heterogeneous Services OLE DB agent. Both are included with Oracle product as a standard feature. Any data source compatible with the ODBC or OLE DB standards can be accessed using a generic connectivity agent. The advantage to generic connectivity is that it may not be required any purchase and configure a separate system-specific agent. Just we can use an ODBC or OLE DB driver that can interface with the agent. However, some data access

features are only available with transparent gateway agents.

Database server is the Oracle software managing a database, and a client is an application that requests information from a server. Each computer in a network is a node that can host one or more databases. Each node in a distributed database system can act as a client, a server, or both, depending on the situation. In Figure 3.3, the host for the hq database is acting as a database server when a statement is issued against its local data (for example, the second statement in each transaction issues a statement against the local dept table), but is acting as a client when it issues a statement against remote data (for example, the first statement in each transaction is issued against the remote table emp in the sales database).

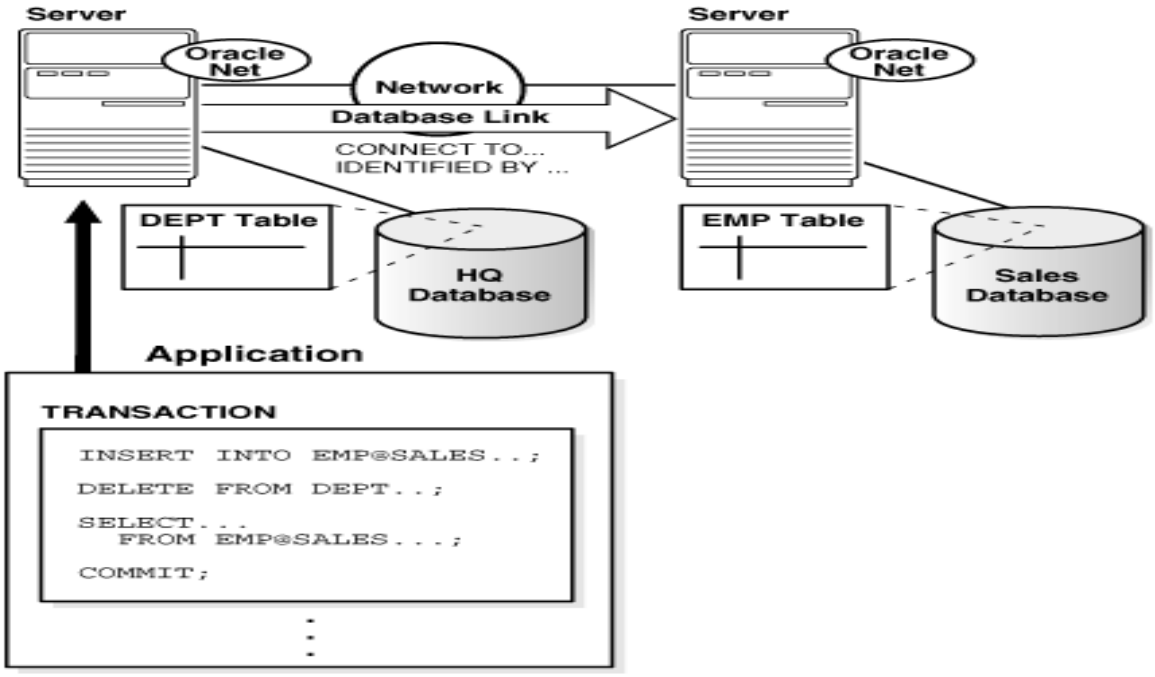

Figure 3.3: An Oracle Distributed Database System [35].

There are two types of connections to a database server **directly** or **indirectly**. A direct connection occurs when a client connects to a server and accesses information from a database contained on that server. For example, if we connect to the HQ database and access the dept table on this database as in Figure 3.3, we can issue the following: (SELECT * FROM dept); This query is direct because we are not accessing an object on a remote database.

An indirect connection occurs when a client connects to a server and then accesses information contained in a database

on a different server. For example, if we connect to the HQ database but access the EMP table on the remote sales database as in Figure 3.3, we can issue the following: (SELECT * FROM emp@sales); This query is indirect because the object we are accessing is not on direct database we are connected to.

An indirect connection can be occurs by using an important concept in distributed database systems which is a database link; it is a connection between two physical database servers that allows a client to access them as one logical database. In other words, a database link is a pointer that defines a one-way communication path from Database server to another database server. This allows local users to access data on a remote database. For this connection to occur, each database in the distributed system must have a unique global database name in the network domain. The global database name uniquely identifies a database server in a distributed system. Figure 3.4 shows an example of user Scott accessing the EMP table on the remote database with the global name hq.acme.com:

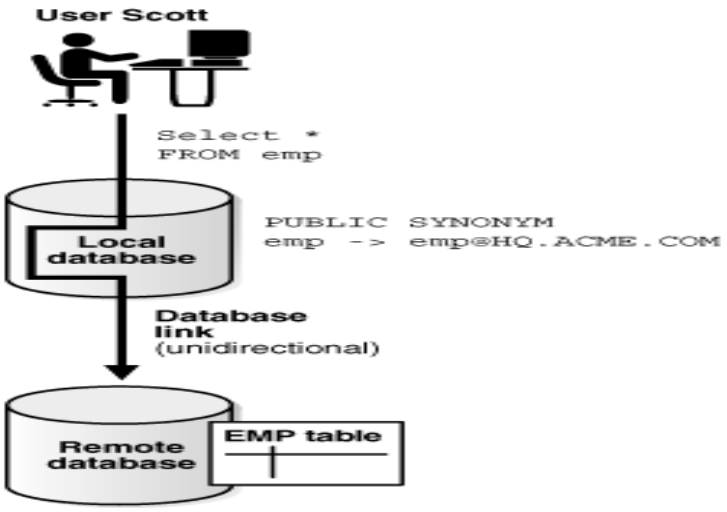

Figure 3.4 Database Links [35].

Database links are either private or public. If they are private, then only the user who creates the link has an access; if they are public, then all database users have access [35].

3.4 Ozeki Message Server 6

Ozeki Message Server 6 - SMS Server is a flexible SMS Gateway application, which enables us to send/receive SMS messages to mobile devices with our computer. It is user interface. The application can use a GSM mobile phone attached to the PC with a phone-to-PC data cable or IP SMS technology to transmit and receive the messages. Ozeki Message Server works on Microsoft Windows XP, 2000, 2003 operating systems. Figure 3.5 show Ozeki system diagram [36]

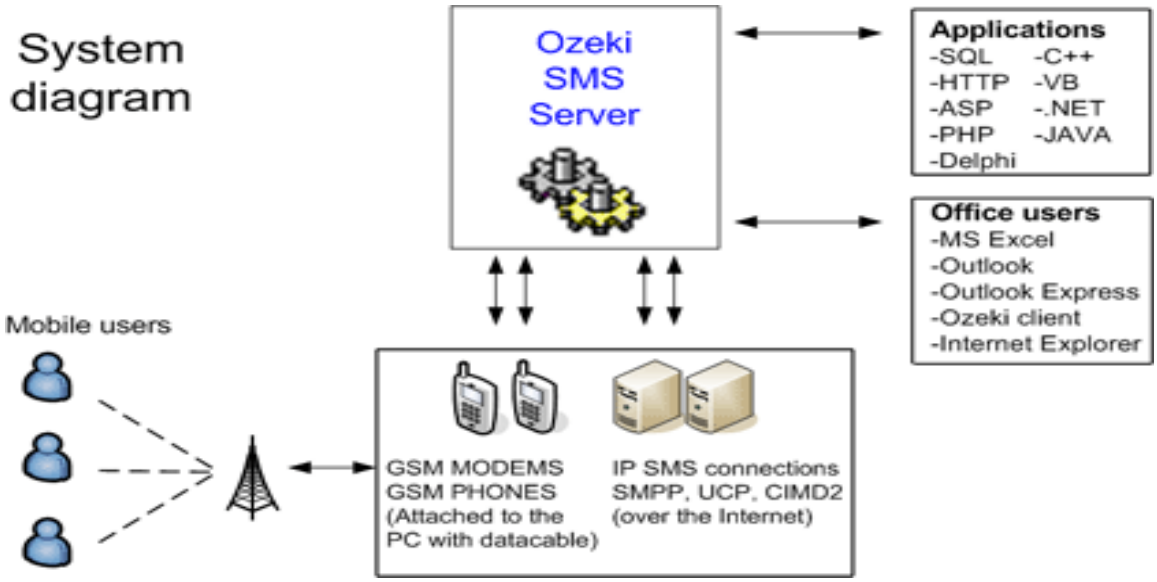

Figure 3.5 - Ozeki System diagram [36].

Chapter Four
New Model for Business Continuity

4.0 Introduction

We build and integrate a new business continuity model in which we use SMS technology and other information systems concepts, such as organized databases, SMS listeners, encryption and decryption techniques and SMS Ozeki Server.

The rest of this chapter is organized as the following: In section 4.1, we will discuss components and interactions of proposed model in section 4.2, we will discuss the structure of the database entities and the application package; finally, in section 4.3, we will discuss the hardware components within the proposed model including mobile devices, network communication and computer.

4.1 Model's Components and Interactions

In this section, we discuss the main parts and the inner interactions within the model, and show how the model supports the concept of business continuity. Figure 4.1, illustrates the representative context diagram of the model.

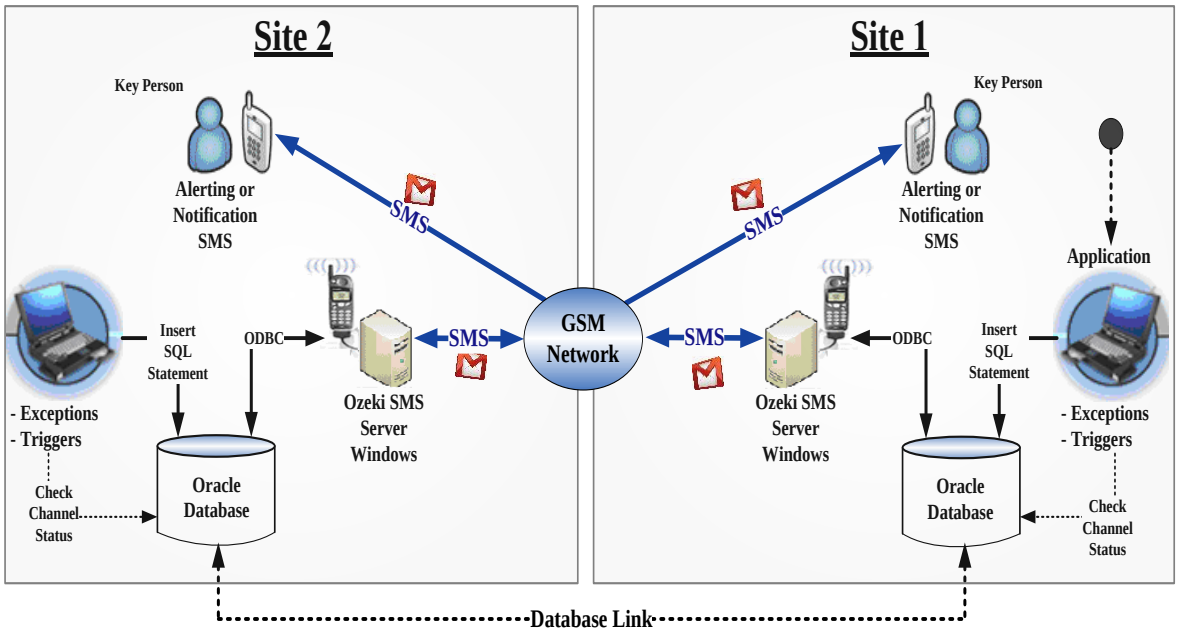

Figure 4.1: Components and Interactions of the proposed Model.

As illustrated in Figure 4.1, two sites are connecting together through a database link. Through the database link, the oracle databases in both sites exchange and execute SQL statements in order to maintain business continuity. In case the database link is broken, there will be no automated business continuity between both sites. Therefore, in proposed model, we aim to support such case by ensuring business continuity through a standby alternative communication channel.

The starting point of the proposed model can be described as, when the application in site 1 finds the ability of using the standby SMS channel is allowed and an SMS related trigger or exception exists; the application is going to insert an SQL statement into oracle database in order to manipulate the uncompleted transaction (exception) or alert the correspondent parties with a particular suspicious situation (trigger). SMS exceptions that occur when the database link between site1 and site 2 is broken, and the running SQL transaction has not been completed yet. Now the application is going to insert the two rows as coded formats in the SMS-Log-Table in the oracle database; one for the uncompleted transaction and another for alerting the key-person. On the other hand, the SMS trigger occurs when a business pre-determined rule exists, for instance, if a banker cashes a check larger than a specified amount with regard to that banker; in this case, the application is going to insert a single row in the SMS-Log-Table in the oracle database in order to alert the key-person with such a situation.

Inside the oracle database there is a programmed listener that periodically investigates the SMS-Log-Table records in order to fetch the new upcoming transaction(s) and insert them

into the OZEKIMESSAGEOUT Table. The Ozeki Message Server monitors the corresponding table and delivers messages with regard to message types which could be either, alerting, query, answer query or disruption as illustrated in Table 4.1.

Table 4.1 Message types**.**

serial	Abbreviation	Message type	Description
1	A	Alert	Used for alerting coordinator or application key-person toward a critical situations.
2	Q	Query	Used to Submit query remotely in other databases.
3	AQ	Answer Query	Used as answer for Submitted query.
4	D	Disruption	Used in case of disruption occurs.

In this model, we use the Ozeki SMS server as an SMS Gateway that sends and receives SMS through the GSM. If the message type is "Alert", then the Ozeki application is going to deliver the message to the mobile of the key-person in site 1; on the other hand, if message type is "Disruption" or "Query", in this case the Ozeki application is going to deliver the message to the mobile that is connected to Ozeki SMS server in site 2. After that, the Ozeki application in site 2 inserts the received message into the OZEKIMESSAGEIN Table.

The programmed listener in site 2 gets the message from OZEKIMESSAGEIN table and calls the correspondent application package in order to read, decode and execute the message containment, and if there is query request, the correspondent answer must inserted into OZEKIMESSAGEOUT table in site 2 in order to be sent by Ozeki application to the mobile that is connected to Ozeki SMS server in site 1.

4.2 Model's Database, Components and Interactions

This section, describes the database tables, package, listeners, entity relational diagram (ERD) of the database entities; in addition, we present and discus the pseudo-code of

the application package and the corresponding programmed listener; finally, it illustrate the work flow diagram of the programmed listener.

4.2.1 Database Entities

This section, describes the database entities and their relationships within the proposed model. Figure 4.2, illustrates the corresponding ERD for each site.

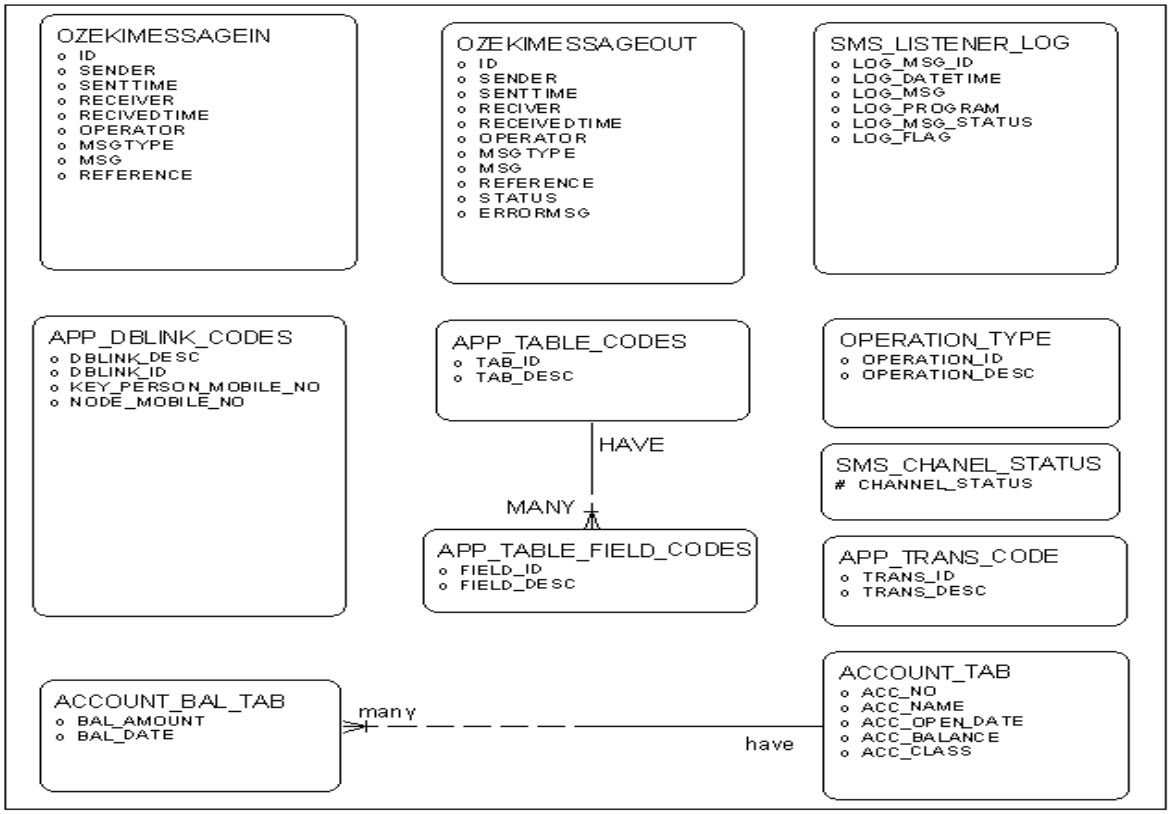

Figure 4.2: ERD of the proposed Model's database entities and relationships.

By referring to Figures 4.1 and 4.2, the OZEKIMESSAGEOUT table contains the outgoing messages from site 1. These messages according to their types (mentioned in Table 4.1) could be transferred to the key-person or inserted into OZEKIMESSAGEIN by the Ozeki SMS application in site 2. The programmed listener reads the new incoming records in SMS_LISTENER_LOG table and inserts them into the OZEKIMESSAGEOUT table in site 1. Records in SMS_LISTENER_LOG are inserted by an application package that we will discus further; this package contains database exceptions and triggers. Each time an exception exists or a trigger fired, the package is going to insert a new an encrypted decoded record to the SMS_LISTENER_LOG table.

The application package exceptions occur when there is a disruption in the database-link; in this case, the package is going to insert two record of message type "DISRUPTION" and "ALERT" respectively. The disruption record contains information about the disrupted database-link and the uncompleted transaction (uncompleted-SQL statement). The alert record contains information about the correspondent key-person whom will be alerted. On the other hand, the application

package triggers are fired when suspicious situations of predefined business rules occur; in such cases, the package is going to insert a new record of message type "ALERT" that contains information about the correspondent key-person whom will be alerted with the suspicious situation. The Programmed listener investigates records in the SMS_LISTENER_LOG table periodically in order to transfer the messages to the OZEKIMESSAGEOUT table in site 1 as encrypted and coded message. After that, the Ozeki SMS server is going to get messages from OZEKIMESSAGEOUT and deliver them to either the mobile device attached to the Ozeki SMS server in site 2 or the correspondent key-person through the GSM network.

Figure 4.3 illustrates the workflow of the database listener.

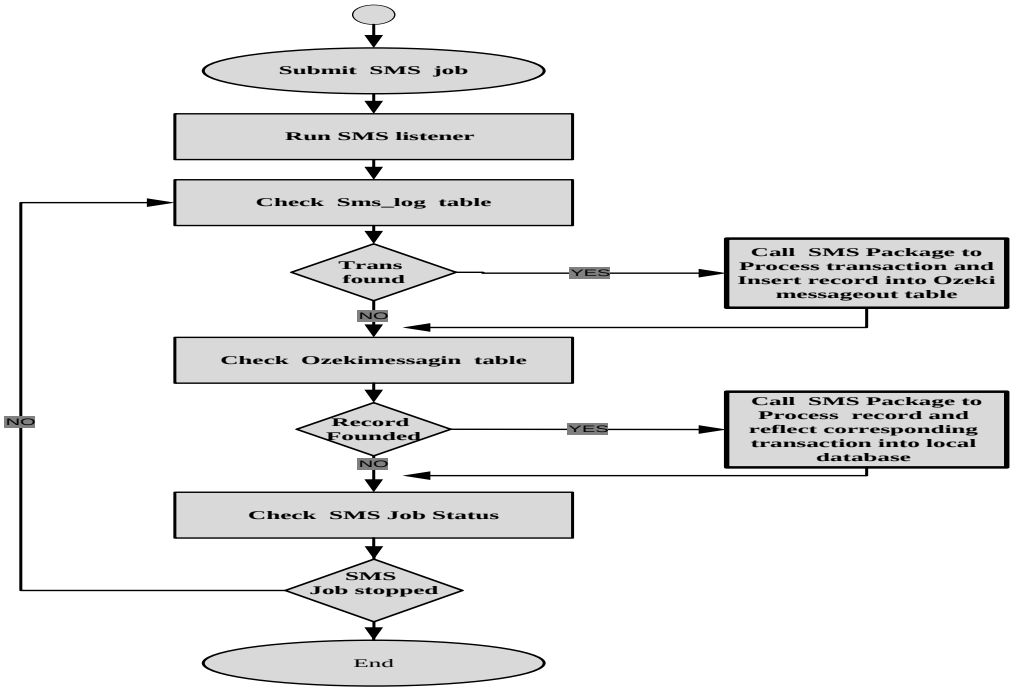

Figure 4.3: The work flow diagram of the database listener

4.2.2 The Application Package

In the proposed model, we deploy the application package for site 1, the package is responsible for ending and starting the database-job and the job is executing the programmed listener; in addition, the application package is responsible for encrypting and inserting the message to the SMS_LISTENER_LOG table, finally handling exceptions and triggers in order to insert the corresponding messages into the SMS_LISTENER_LOG table in site 1. Also the package is responsible of making the decryption and fetching from OZEKIMESSAGEIN table in site 2. Finally, execute the incoming messages in the database of site 2. Since the application package exists in both sites (1 and 2), therefore the opposite of previous operations take place if we start from site 2, Figure 4.4 illustrates the pseudo-code of the application package.

CREATE OR REPLACE PACKAGE

APPLICATION_PACKAGE

IS

-- Function SF_ENCRYPT_MSG: Function to encrypt message by making --

-- sum subsituation in character positions --

-- this method has been followed to keep out message --

-- length same as in message length. --

DEFINE FUNCTION SF_ENCRYPT_MSG(IMSG IN VARCHAR2)

RETURNS THE ENCRYPTED OUTPUT MESSAGE;

END FUNCTION SF_ENCRYPT_MSG;

-- Function SF_DECRYPT_MSG : Function for decryption message by making --

-- sum subsituation in character positions --

-- this method has been followed to keep out message --

```
--                    length same as in message length.
-----
DEFINE FUNCTION SF_DECRYPT_MSG(IMSG IN
VARCHAR2)
RETURNS THE DECRYPTED OUTPUT MESSAGE;
END FUNCTION SF_DECRYPT_MSG;
-------------------------------------------------------------------------
-----
-- PROCEDURE SUBMIT_SMS_JOB : Procedure to start
job that responsible          --
--                    For calling sp_sms_listener periodically
--
_____________________________________________________
 DEFINE PROCEDURE SUBMIT_SMS_JOB IS
GET THE MAXIMUM JOB-ID ;
IF THE MAXIMUM JOB-ID EXISTS THEN
     DO NOTHING
   ELSE
     START A DATABASE-JOB FOR A DATABASE
 LISTENER CALLED SP_SMS_LISTENER;
     INSERT RECORD INTO SMS_LISTENER_LOG
 TABLE IN ORDER TO ALERT KEY-PERSON;
   END IF;
```

END PROCEDUR SUBMIT_SMS_JOB;

-- SP_SMS_LISTENER : Procedure that periodically investigates the SMS-Log-Table --

-- records in order to fetch the new Upcoming transaction(s) --

-- and insert them into the Ozeki-Messageout Table. --

```
DEFINE PROCEDURE SP_SMS_LISTENER IS
DECLARATIONS
  LSTATUS VARCHAR2(10);
  DEFINE CURSOR CHK_SMS_LISTENER_LOG;
  DEFINE CURSOR CHECK_STOP_CUR;
BEGIN
  LISTENER_STATUS := '';
  LOOP
   OPEN CURSOR CHK_SMS_LISTENER_LOG;
    LOOP
      FETCH CHK_SMS_LISTENER_LOG CURSOR
INTO LOG_REC;
      INSERT INTO OZEKIMESSAGEOUT;
    END LOOP;
```

```
    OPEN CURSOR CHECK_STOP_CUR;
    FETCH CURSOR CHECK_STOP_CUR INTO
LISTENER_STATUS;
    CLOSE CURSOR CHECK_STOP_CUR;
    CLOSE CURSOR CHK_SMS_LISTENER_LOG;
  END LOOP;
END PROCEDURE SP_SMS_LISTENER;
-------------------------------------------------------------------------
-- PROCEDURE REMOVE_SMS_JOB : Procedure to
remove the  job that responsible    --
--                    For calling sp_sms_listener periodically
-------------------------------------------------------------------------
--
DEFINE PROCEDURE REMOVE_SMS_JOB IS
  GET JOB-ID FOR THE DATABASE LISTENER CALLED
SP_SMS_LISTENER;
  REMOVE JOB FOR (SMS_PKG.SP_SMS_LISTENER);
  INSERT RECORD INTO THE SMS_LISTENER_LOG
TABLE IN ORDER TO ALERT KEY-PERSON;
END PROCEDURE REMOVE_SMS_JOB;
-------------------------------------------------------------------------
```

```
    -- SP_SMS_LISTENER_LOG : Procedure that be called
from different procedures   --
    --                    in order to insert record/records into SMS-
Log-Table --
    ------------------------------------------------------------------------
-
    DEFINE PROCEDURE SP_SMS_LISTENER_LOG
P_PROGRAM   IN VARCHAR2,
                                P_LOG_FLAG  IN VARCHAR2,
                                P_MSG_TEXT  IN VARCHAR2,
                                P_MSG_STATUS IN VARCHAR2,
                                P_LOG_TEXT IN VARCHAR2,
                                P_LOG_TYPE IN VARCHAR2)
    INSERT INTO SMS_LISTENER_LOG TABLE OF
MESSAGE TYPE, STATUS;
    END PROCEDURE SP_SMS_LISTENER_LOG;
    ------------------------------------------------------------------------
--
    --  SP_GET_ACC_BAL : Procedure to get specific account
number balance in       --
    --  Certain date                                                  --
    ------------------------------------------------------------------------
```

```
   DEFINE PROCEDURE SP_GET_ACC_BAL (I_ACC_NO
IN  NUMBER
                    ,I_BAL_DATE    IN  DATE
                    ,O_ACC_BAL     OUT NUMBER     ) IS
   DECLARATION
     DEFINE CURSOR GET-ACCOUNT-BALANCE THAT
GET ACCOUNT-NUMBER ,LAST ACCOUNT-BALANCE
     FROM ACCOUNT-BALANCE-TABLE;
   END DECLARATION
   BEGIN
     MOVE ZERO TO ACCOUNT-BALANCE;
     OPEN GET-ACCOUNT-BALANCE CURSOR;
     FETCH GET-ACCOUNT-BALANCE CURSOR;
     IF GET-ACCOUNT-BALANCE%FOUND THEN
       MOVE ACCOUNT-BALANCE TO O_ACC_BAL;
     END IF;
     CLOSE GET-ACCOUNT-BALANCE CURSOR;
    END PROCEDURE SP_GET_ACC_BAL;
    ------------------------------------------------------------------------
    -- SP_INSERT_ACC_BAL : Procedure to Insert   balance
for specific account      --
    --                  Number                                  --
```

DEFINE PROCEDURE SP_INSERT_ACC_BAL

(I_ACC_NO **IN NUMBER**

,I_BAL_DATE **IN DATE**

,I_ACC_BAL **IN NUMBER**) **IS**

DECLARATION

DEFINE NO-LINK AS **EXCEPTION**;

PRAGMA EXCEPTION_INIT (NO_LINK, -2019); -- *ORA-02019*

DEFINE **CURSOR** CUR_CHK_BAL THAT CHECK EXISTANCE OF REQUIRED ACCOUNT IN AGIVEN

DATE ;

END DECLARATION

BEGIN

GET COUNT(*) **FROM** ACCOUNT_TAB IN REMOTE DATABASE ;

EXCEPTION

WHEN NO_DATA_FOUND **THEN**

DISPLAY MESSAGE (NO DATA FOUND)**;**

WHEN NO_LINK **THEN**

INSERT RECORD THAT CONTAINS CODED

MESSAGE INTO SMS_LISTENER_LOG TABLE;

INSERT RECORD INTO SMS_LISTENER_LOG TABLE IN ORDER TO ALERT KEY-PERSON;

END EXCEPTION;

MOVE ZERO TO L_ACC_BAL ;

CHECK EXISTANCE OF SPECIFIC ACCOUNT IN AGIVEN DATE ;

IF ACCOUNT **NOTFOUND THEN**

INSERT NEW BALANCE RECORD INTO ACCOUNT_BAL_TAB AT AGIVEN DATE IN HOST DATABASE

ELSE GET SPECEIFIC ACCOUNT BALANCE AT AGIVEN DATE;

UPDATE THE EXISTANCE ACCOUNT BALANCE IN HOST DATABASE ;

END IF;

UPDATE THE EXISTANCE ACCOUNT BALANCE IN REMOTE DATABASE ;

EXCEPTION

WHEN NO_LINK **THEN**

INSERT RECORD THAT CONTAINS CODED MESSAGE INTO SMS_LISTENER_LOG TABLE ;

INSERT RECORD INTO SMS_LISTENER_LOG TABLE IN ORDER TO ALERT KEY-PERSON;

END EXCEPTION;

END PROCEDURE SP_INSERT_ACC_BAL;

-- Function GET_BALANCE_FROM_MSGIN : Function that get account balance from

-- ozekimessagein table regard request id

-- in case disruption occurs .

DEFINE FUNCTION GET_BALANCE_FROM_MSGIN(P_MSG_ID IN NUMBER) RETURN NUMBER IS

DECLARATION

DEFINE CURSOR GET_REMOTLY_CUR THAT GET BALANCE AMOUNT

FROM OZEKIMESSAGEIN TABLE

WHERE FIRST TWO CHARACTERS OF MESSAGE = 'AQ'

AND CHARACTERS IN 3RD TO 7TH POSITIONS = REQUEST ID;

```
 NO_OF_TRAIL NUMBER ;
 L_ACC_BAL NUMBER ;
END DECLARATION
BEGIN

    SET  NO_OF_TRAIL TO ZERO;
    OPEN  GET_REMOTLY_CUR;
    FETCH GET_REMOTLY_CUR INTO L_ACC_BAL;

    IF GET_REMOTLY_CUR%FOUND THEN
      CLOSE GET_REMOTLY_CUR ;
    ELSE
       CLOSE GET_REMOTLY_CUR ;
       WAIT FOR APERIOD OF TIME;
       OPEN  GET_REMOTLY_CUR;
       FETCH GET_REMOTLY_CUR INTO L_ACC_BAL;
       CLOSE GET_REMOTLY_CUR ;
    END IF;
    RETURN(L_ACC_BAL);
END GET_BALANCE_FROM_MSGIN;
--------------------------------------------------------------------------
```

```
   --  SP_GET_REMOTE_ACC_BAL:Procedure to get
remotely the balance of a specific  --
   --                    account number in Certain date
--
   ------------------------------------------------------------------------
--
   DEFINE PROCEDURE SP_GET_REMOTE_ACC_BAL
         (I_ACC_NO              IN  NUMBER
         ,I_BAL_DATE            IN  DATE
         ,O_ACC_BAL             OUT NUMBER ) is

    DECLARATION
      ACC_BAL    NUMBER;
      DEFINE NO-LINK AS EXCEPTION;
      PRAGMA EXCEPTION_INIT (NO_LINK, -2019); -- ORA-
02019
      DEFINE CURSOR CUR_GET_ACCBAL THAT GET THE
REQUIRED ACCOUNT BALANCE IN
                AGIVEN DATE REMOTELY;
    END DECLARATION
    BEGIN
      GET COUNT(*) FROM ACCOUNT BALANCE TABLE IN
 REMOTE DATABASE ;
```

```
        EXCEPTION
            WHEN NO_DATA_FOUND THEN
              DISPLAY MESSAGE (NO DATA FOUND);
            WHEN NO_LINK THEN
              INSERT RECORD THAT CONTAINS CODED
               MESSAGE INTO SMS_LISTENER_LOG TABLE  ;
              RETURN LOG-ID AS REQUEST-ID
              CALL FUNCTION
               GET_BALANCE_FROM_MSGIN(LMSG_ID) TO
               GET
              BALANCE FROM OZEKIMESSAGEIN TABLE;
              INSERT RECORD INTO SMS_LISTENER_LOG
TABLE IN ORDER TO ALERT KEY-PERSON;
        END EXCEPTION;
        MOVE 0 TO O_ACC_BAL ;
        OPEN CUR_GET_ACCBAL;
        FETCH CUR_GET_ACCBAL INTO L_CUR_ACCBAL;
        IF CUR_GET_ACCBAL%FOUND THEN
          MOVE FETCED BALANCE TO  O_ACC_BAL ;
        END IF;
        CLOSE CUR_GET_ACCBAL
```

```
    END SP_GET_REMOTE_ACC_BAL;
    ------------------------------------------------------------------------
--
    --  MASSEGE_PROCESS: Procedure to PROCESS
UPCOMMING MESSAGE IN OZEKIMESSSAGEOUT--
    --                TABLE IN SITE 2                                      --
    --                                                                     --
    ------------------------------------------------------------------------
--
    DEFINE PROCEDURE MASSEGE_PROCESS(MSG IN
VARCHAR2, LOUT OUT NUMBER )  IS
    DECLARATION
    SQL_STMT    VARCHAR2(500);
    TABLE_NAME  VARCHAR2(100);

    ---------------------------------------------------------------
    ---CUESOR TO GET TRANSACTION TYPE :  TRANS_ID
TRANS_DESC        --
    -------------------------------  ======== ============
    --                              1       SELECT        --
    --                              2       INSERT INTO    --
    --                              3       UPDATE        --
```

```
--                          4       DELETE FROM     --
--                          5       NOTIFICATION    --
--                          6       ALERT           --
--                                                  --
-------------------------------------------------------------
    DEFINE CURSOR get_trans_cur TO GET TRANSACTION
TYPE;
-------------------------------------------------------------
    ---CUESOR TO GET TABLE NAME :      TAB_ID
TABSC           --
    -------------------------------  ======== ============
--
    --                          1    ACCOUNT_TAB       --
    --                          2    ACCOUNT_BAL_TAB   --
    --                                                 --
    -------------------------------------------------------------
     DEFINE cursor get_table_cur TO TABLE NAME;
    ---------------------------------------------------------------------
    ---CUESOR TO GET UPDATED FIELD NAME : TAB_ID
TAB_FLD_ID   FLD_DESC     --
    -------------------------------  ======== ============
============  --
```

```
    --                          1     1       ACC_NO      --
    --                          1     2       ACC_NAME    --
    --                          1     3
ACC_OPEN_DATE--
    --                          1     4       ACC_CLASS   --
    --                          1     5       ACC_BALANCE --
    --                          2     1       ACC_NO      --
    --                          2     2       BAL_DATE    --
    --                          2     3       BAL_AMOUNT  --
    --                                              --
    --                                              --
    ------------------------------------------------------------------------
    DEFINE cursor get_fields_cur TO GET THE FIELD TO BE
FETCHED IN WHERE CONDITION;
    ------------------------------------------------------------------------
    ---CUESOR TO GET WHERE FIELD NAME : T AB_ID
TAB_FLD_ID   FLD_DESC      --
    -------------------------------  ======== ============
============   --
    --                          1     1       ACC_NO      --
    --                          1     2       ACC_NAME    --
    --                          1     3
ACC_OPEN_DATE --
```

```
    --                          1     4       ACC_CLASS    --
    --                          1     5       ACC_BALANCE  -
-
    --                          2     1       ACC_NO       --
    --                          2     2       BAL_DATE     --
    --                          2     3       BAL_AMOUNT   --
    ------------------------------------------------------------------------
    DEFINE cursor get_WHERE_field1_cur TO GET FIRST
ARGUMENT IN WHERE CONDITION;
    DEFINE cursor get_WHERE_field2_cur TO GET SECOND
ARGUMENT IN WHERE CONDITION;
    DUMMY NUMBER(16,3);
    LTEMP NUMBER(1);
    LDATE DATE := TRUNC(SYSDATE);
    TYPE BALCurTyp IS REF CURSOR;
    BAL_cv   BALCurTyp;
   END DECLARATION
   BEGIN
     MOVE 0 TO LOUT ;
     MOVE SPACE TO SQL_STMT ;
     OPEN GET_TRANS_CUR;
     FETCH GET_TRANS_CUR INTO TRANS_REC;
```

```
        CLOSE GET_TRANS_CUR;
        SQL_STMT :=  TRANS_REC.TRANS_DESC;
        OPEN GET_TABLE_CUR;
        FETCH GET_TABLE_CUR INTO TAB_REC;
        CLOSE GET_TABLE_CUR;
        OPEN GET_FIELDS_CUR;
        FETCH GET_FIELDS_CUR INTO FIELDS_REC;
        CLOSE GET_FIELDS_CUR;

        OPEN GET_WHERE_FIELD1_CUR;
        FETCH GET_WHERE_FIELD1_CUR INTO
WHERE_FIELD1_REC;
        CLOSE GET_WHERE_FIELD1_CUR;

        OPEN GET_WHERE_FIELD2_CUR;
        FETCH GET_WHERE_FIELD2_CUR INTO
WHERE_FIELD2_REC;
        CLOSE GET_WHERE_FIELD2_CUR;

        CHECK FOR UPCOMMING MESSAGE TYPE
        IF  MESSAGE TYPE DISRUPTION WHILE UPDATING
TRANSACTION THEN
```

```
        PREPARE SQL STATEMENT BY DECODED THE
UPCOMMING MESSAGE UPON PREDEFINED
        FORMATE;
      ------------------------------------------------------------------------
---
      --  Example 1 :this coded message 'D 3 2 3
000000000099999 1 0000001000 2'   --
      --  opposite OF the following sql statement :UPDATE
ACCOUNT_BAL_TAB          --
      --                              SET    BAL_AMOUNT =
99999       --
      --                              WHERE  ACC_NO     = 1000
--
      --                              AND BAL_DATE   =
trunc(sysdate); --
      ------------------------------------------------------------------------
---

        EXECUTE IMMEDIATE SQL STATEMENT ;
        RETURN SPECIFIC VALUE AS RESULT OF
EXECUTION;
    END IF;
```

```
    IF MESSAGE TYPE SUBMITTING QUERY  THEN
       PREPARE SQL STATEMENT BY DECODED THE
UPCOMMING MESSAGE UPON PREDEFINED FORMATE;
       ------------------------------------------------------------------------
---
       --  Example 1 :this coded message 'Q 1 2 3 1000 2'
--
       --  opposite OF the following sql statement :
--
       --       SELECT  NVL(ACCBAL.BAL_AMOUNT,0)
ACC_BALANCE                    --
       --       FROM ACCOUNT_BAL_TAB@REMOTE_DB
ACCBAL                         --
       --       WHERE ACCBAL.ACC_NO= I_ACC_NO
--
       --       AND ACCBAL.BAL_DATE IN (SELECT
MAX(ACCBAL2.BAL_DATE)          --
       --                      FROM
ACCOUNT_BAL_TAB@REMOTE_DB ACCBAL2     --
       --                      WHERE ACCBAL2.BAL_DATE   <=
I_BAL_DATE     --
       --                      AND ACCBAL2.ACC_NO
=I_ACC_NO );          --
```

EXECUTE IMMEDIATE SQL STATEMENT ;

RETURN RESULT OF EXECUTION;

END IF;

END massege_process;

-- PROCEDURE SUBMIT_SMS_JOB : Procedure to start job that responsible --

-- For calling sp_sms_listener periodically --

DEFINE PROCEDURE SUBMIT_SITE2_SMS_JOB **IS**

GET THE MAXIMUM JOB-ID ;

IF THE MAXIMUM JOB-**ID EXISTS THEN**

DO **NOTHING**

ELSE

START A DATABASE-JOB **FOR** A DATABASE LISTENER CALLED SP_SITE2_SMS_LISTENER;

INSERT RECORD INTO SMS_SITE2_LISTENER_LOG TABLE IN ORDER TO ALERT KEY-PERSON;

END IF;

```
  END PROCEDUR SUBMIT_SMS_JOB;
-------------------------------------------------------------------------
-----
-- PROCEDURE REMOVE_SITE2_SMS_JOB :
PROCEDURE TO REMOVE THE  JOB THAT
RESPONSIBLE --
--                        FOR CALLING
SP_SITE2_SMS_LISTENER PERIODICALLY      --
-------------------------------------------------------------------------
-----
  DEFINE PROCEDURE REMOVE_SITE2_SMS_JOB IS
   GET JOB-ID FOR THE DATABASE LISTENER CALLED
SP_SITE2_SMS_LISTENER;
   REMOVE JOB FOR
(APPLICATION_PACKAGE.SP_SITE2_SMS_LISTENER);
   INSERT RECORD INTO THE
SMS_SITE2_LISTENER_LOG TABLE IN ORDER TO ALERT
KEY-PERSON;
   END PROCEDURE REMOVE_SITE2_SMS_JOB;
   -------------------------------------------------------------------------
-----
   -- SP_SMS_SITE2_LISTENER : Procedure that
periodically investigates the
```

```
    --                  OZEKIMESSAGE TABLE records in
order to fetch the new –-
    --                  Upcoming transaction(s) and executing
the incoming   --
    --                  Messages                                --
    ------------------------------------------------------------------------
-----
    DEFINE PROCEDURE SP_SITE2_SMS_LISTENER IS
    DECLARATIONS
     LSTATUS VARCHAR2(10);
     DEFINE CURSOR CHK_OZEKIMESSAGEIN_TABLE;
     DEFINE CURSOR CHECK_STOP_CUR;
    BEGIN
     LISTENER_STATUS := 'TRUE';
     LOOP
      OPEN CURSOR CHK_OZEKIMESSAGEIN_TABLE;
      LOOP WHILE LISTENER_STATUS NOT STOPPED ;
       FETCH CHK_OZEKIMESSAGEIN_TABLE CURSOR
INTO IN_REC;
        CALL massege_process(in_rec.msg,lout);
        INSERT RECORD INTO OZEKIMESSAGEOUT AS
RETURN RESULT TO SITE1(ANSWER
```

```
        QUERY,NOTIFICATION...) ;
      END LOOP;
      OPEN CURSOR CHECK_STOP_CUR;
      FETCH CURSOR CHECK_STOP_CUR INTO
LISTENER_STATUS;
      CLOSE CURSOR CHECK_STOP_CUR;
      CLOSE CURSOR CHK_OZEKIMESSAGEIN_TABLE;
    END LOOP;
  END PROCEDURE SP_SITE2_SMS_LISTENER;

END APPLICATION_PACKAGE;
```

Figure 4.4: The pseudo-code of the application package.

4.3 Hardware & Software Components

Hardware components of Site 1:

- PC with the following specifications :
  - Operating System: Microsoft Windows XP Professional (5.1 Build 2600).
  - System Model : HP Compaq dc 710 SFF (PX2277EC).
  - Processor : Intel (R) Pentium (R) 4 CPU 3.00 GHz (2 CPUs).

- Memory : 504 MB RAM.
- Directx Version : Directx 9.0

- Mobile Phone :
  - Sony Ericsson Model Z710i.

- Connection Cable between Mobile Phone and PC :
  - Phone-to-PC data cable.

- Connection Cable CABEL 1.

Software components of Site 1:

- Ozeki Message Server 6 Version 6.4.0.0

- Microsoft OLE DB Provider for Oracle.

- OCI Version 9.2.

- PL/SQL Developer Version 6.0.4.906.

- Oracle Database 10g Enterprise Edition Release 10.1.0.2.0.

Hardware components of Site 2:

- PC with the following specifications :
  - Operating System: Microsoft Windows XP Professional (5.1 Build 2600).
  - System Model : HP Compaq dc 710 SFF (PX2277EC).
  - Processor : Intel (R) Pentium (R) 4 CPU 3.00 GHz (2 CPUs).
  - Memory : 504 MB RAM.
  - Directx Version : Directx 9.0

- Mobile Phone :
  - Sony Ericsson Model W710i.

- Connection Cable between Mobile Phone and PC :
  - Phone-to-PC data cable.

- Connection Cable CABEL 1.

Software components of Site 2:

- Ozeki Message Server 6 Version 6.4.0.0.
- Microsoft OLE DB Provider for Oracle.
- OCI Version 9.2.

- PL/SQL Developer Version 6.0.4.906.

- Oracle Database 10g Enterprise Edition Release 10.1.0.2.0.

Network Components that are used to connect Site 1 with Site2 (Figure 4.5) **:**

- Cable UTP Cat6 connected with Ethernet card using RJ45 with speed 10/100 Mbps.
- Main switch HP Switch supports 24 ports.

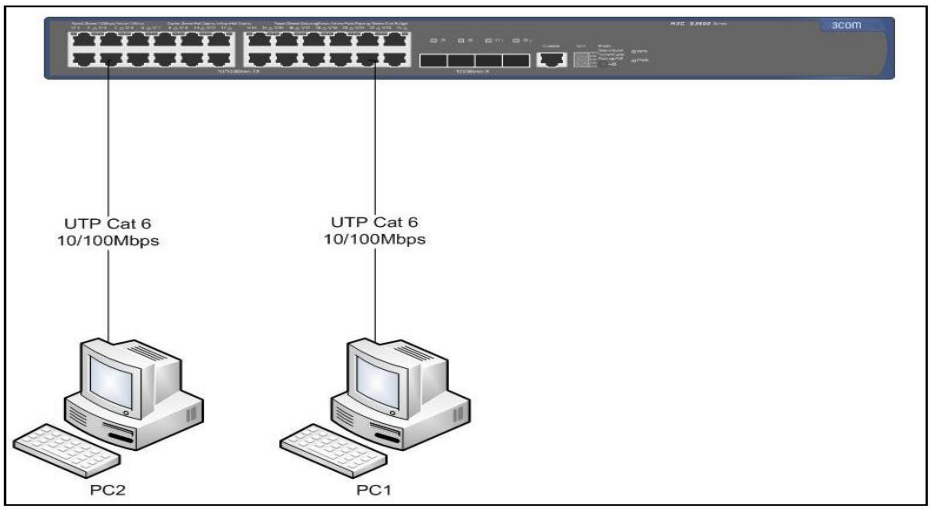

Figure 4.5: Network connection for Site 1 and Site2

Chapter Five
Scenarios, Implementations and Analysis

5. 1 Introduction

In this section, we are going to prove the validity and availability of the proposed model. In order to do these proofs, we present four case-scenarios; these scenarios are related to the main functionalities that the model should do. The four scenarios are as the following:

Scenario one: How to recover from a database-link disruption.

Scenario two: Alerting the key person regarding suspicious transactions and/or situation.

Scenario three: Alerting the database administrator (DBA) regarding invalid database objects.

Scenario four: Submitting query remotely to other databases.

In order to implement the scenarios, the model uses the following:

- Two database schemes; each schema, is related to a particular database user, one for Scott user and the other for the system user. The Scott user is the local database user within new model; on the other hand, the system user is the remote database user.

- Simple database queries (single table) are used in the model. For future work, it is suggested to adopt complex queries (more than one table).
- The format used to encode/decode the message is:
    - In Scenario one: How to recover from a database-link disruption when we deal with update transaction:
        - 1st digit is for message type (D: Disruption).
        - 2nd digit is for transaction type(3: Update).
        - 3rd digit is for table used (2: Account_bal_tab).
        - 4th digit is for field to be updated (3: Bal_amount).
        - 5th-19th digits are for transaction amount.
        - 20th digit is for first argument that used in where condition(1: Acc_no).
        - 21st – 30th digits are for the value of account_no that used as first variable in where condition.
        - 31st digit is for second argument that used in where condition (2: Bal_date).
    - In case Scenario four: Submitting query remotely to other databases.
        - 1st digit is for message type (Q: Query).
        - 2nd digit is for transaction type(1: Select).
        - 3rd digit is for table used (2: Account_bal_tab).

- 4th digit is for field to be fetched (3: Bal_amount).
- 5th-19th digits are for transaction amount(zeros) .
- 20th digit is for first argument that is used in where condition (1: Acc_no).
- 21st – 30th digits are for the value of account_no that used as first variable in where condition.
- 31st digit is for second argument that used in where condition (2:Bal_date).

The rest of this chapter illustrates the following: in Section 5.2, implement, extract and analyze results for scenario one; in section 5.3, implement, extract and analyze results with respect to scenario two; in Section 5.4, implement, extract and analyze results for Scenario three; finally in Section 5.5 implement, extract and analyze results for Scenario four.

5.2 Algorithm One; "How to Recover from a Database-Link Disruption".

In this section, we will implement, extract and analyze results of the first Scenario. This will be working through the local database (the Scott database user) in order to modify the account balance table, which exists in the remote database (system database). The normal modification occurs through a predefined database link between local and remote databases. First, need to break the database link

from the remote database and ensure that the SMS-Channel is OFF and try to execute the modification of the account balance; in this case, the modification will not be completed. On the other hand, need to make the SMS-Channel ON and try to modify the account balance value, which shall be modified although of the disruption of the database link.

The following algorithm describes Scenario one :

Algorithm *one;*

Input : *Account number, transaction amount،key-person mobile phone number،*

site2 mobile number;

Output: *SMS message to alert key-person, notification message that account*

balance modification has been submitted remotely successfully.

Begin

Step 1: *Make sure that the database link is available and make a*

modification on a particular account balance of a particular

account number on the remote database;

Step 2: *Make sure that the modification occurred;*

Step 3: *Disrupt the database link without activating the model*

(SMS-Channel and SMS-JOB are OFF), and make the same

modification in step 1 and then make sure that the modification has

not been submitted;

Step 4: *Keep the database link disrupted, and activate the proposed model (SMS-*

channel and SMS-JOB are ON) and make the same modification in

Step 1 and then make sure that the modification has been submitted

successfully;

End;

Now let us go through scenario one steps in order to implement and analyze the scenario results. To measure the reliability of the model, we measure the reliability using the test-retest reliability method. By using this method, we carry out

each step twice and make sure that the results of each time is the same. If results regards both tests are the same for all of the steps, then we can insure the test-retest reliability.

With regard to steps one and two, we make sure that the database link is available, and then we check the initial account balance value for account number (1000) as it in 31/1/2011. Figure 5.1 illustrates the initial value of the account balance before modification in the remote database. After that, the following statements were executed to make the required modification:

```
UPDATE ACCOUNT_TAB@REMOTE_DB
  SET ACC_BALANCE = 644
WHERE ACC_NO     = 1000;
```

After that, select a statement can be executed in order to check the new account balance value in the remote database. Figure 5.2 shows that the value of account balance of account number (1000) has been modified using database link (Remote_db) from value (524) to value (644) .

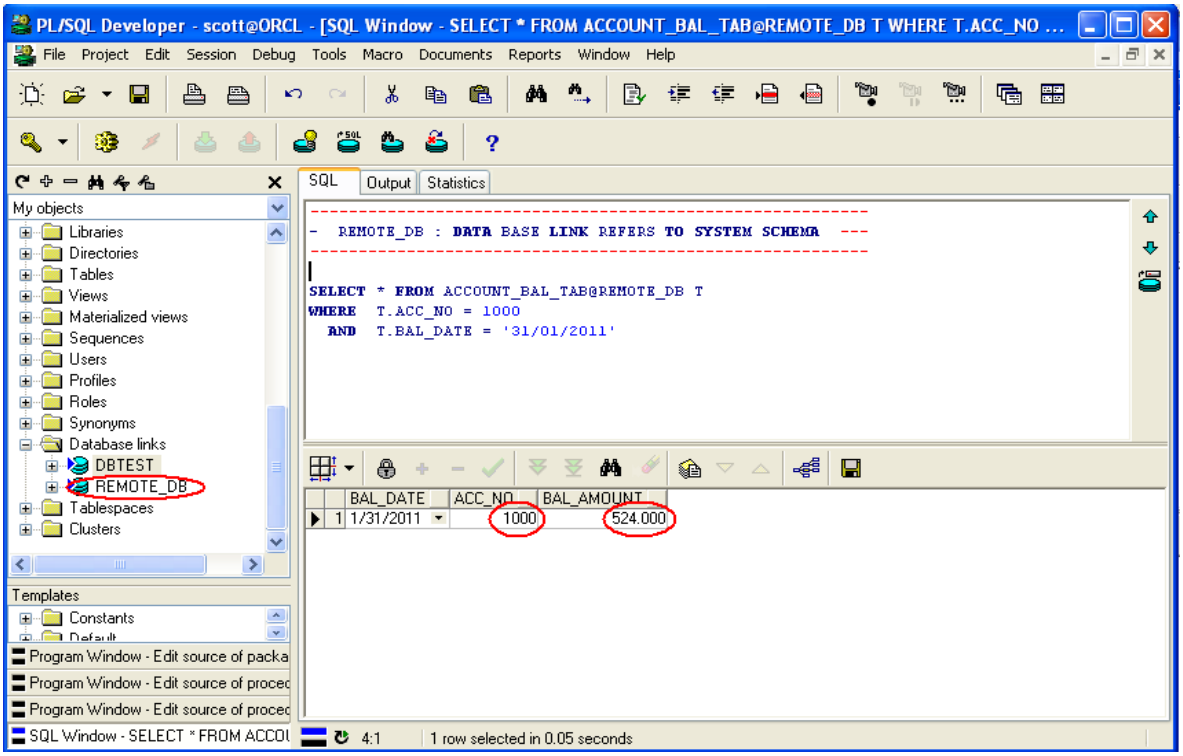

Figure 5.1: The initial account balance value before modification in Scenario one.

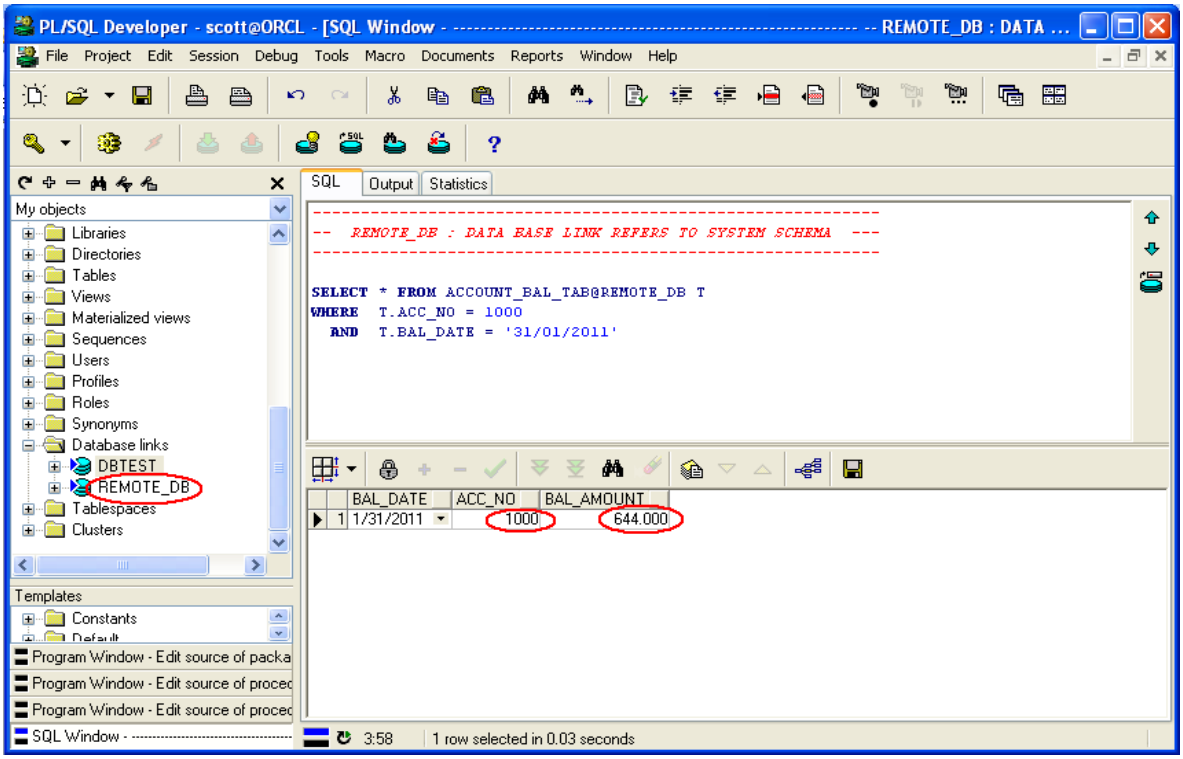

Figure 5.2: The modified account balance value after modification in Scenario one using database link.

With respect to step 3, we will deactivate the database link and carry out a particular modification on the account balance of a particular account number (1000). Figure 5.3 illustrates the value of the account balance before modification. In addition, we need to make sure that the proposed model is not activated by setting the status of SMS-Channel OFF and the SMS-JOB is not submitted, as illustrated in Figures 5.4 and 5.5.

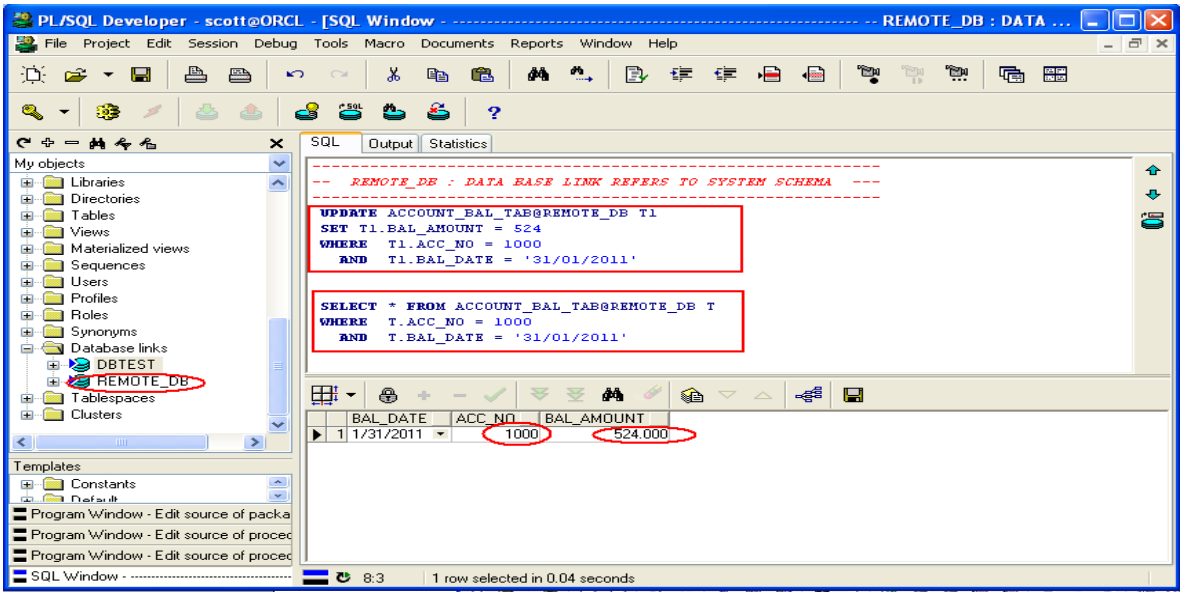

Figure 5.3: The initial account balance value before modification and inactive

database link in Scenario one.

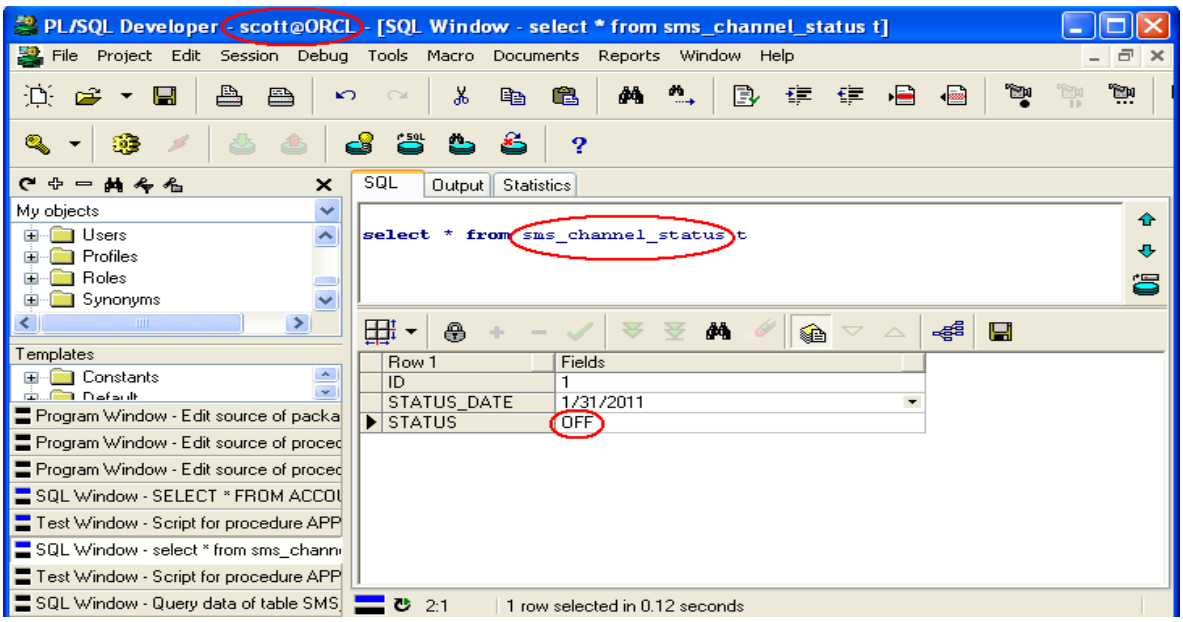

Figure 5.4: SMS-Channel status is OFF in Scenario one.

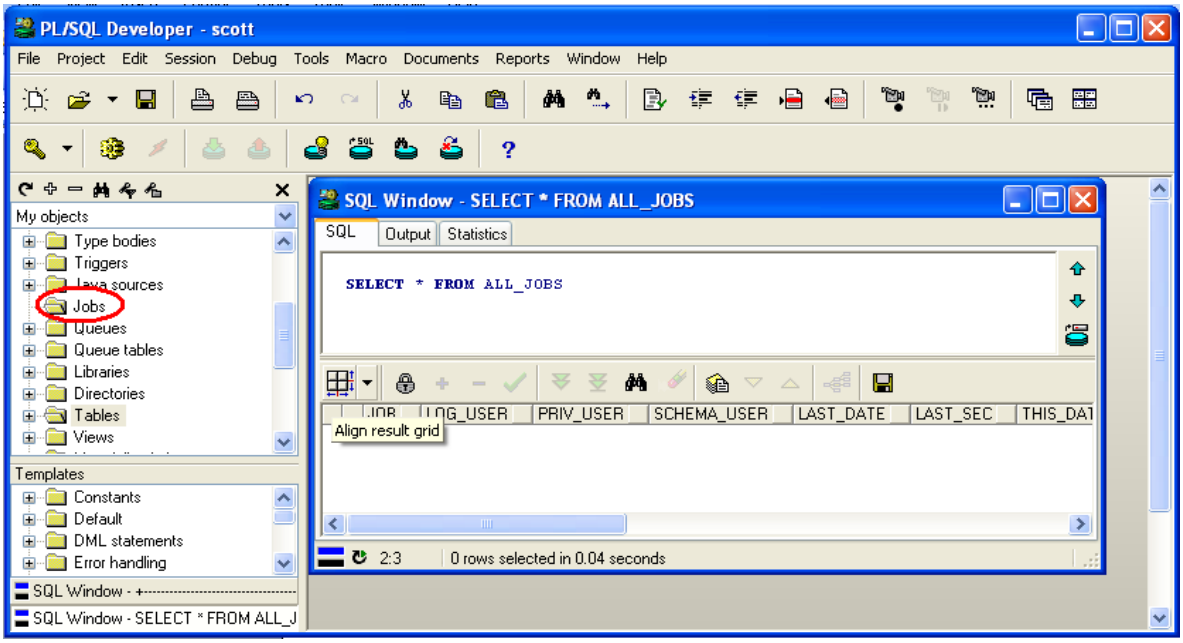

Figure 5.5: SMS-JOB is not submitted in Scenario One.

Finally, and since the connection is disruption as shown in Figure 5.6; we have to ensure that the account balance value has not been modified on the remote database as illustrated in Figure 5.7.

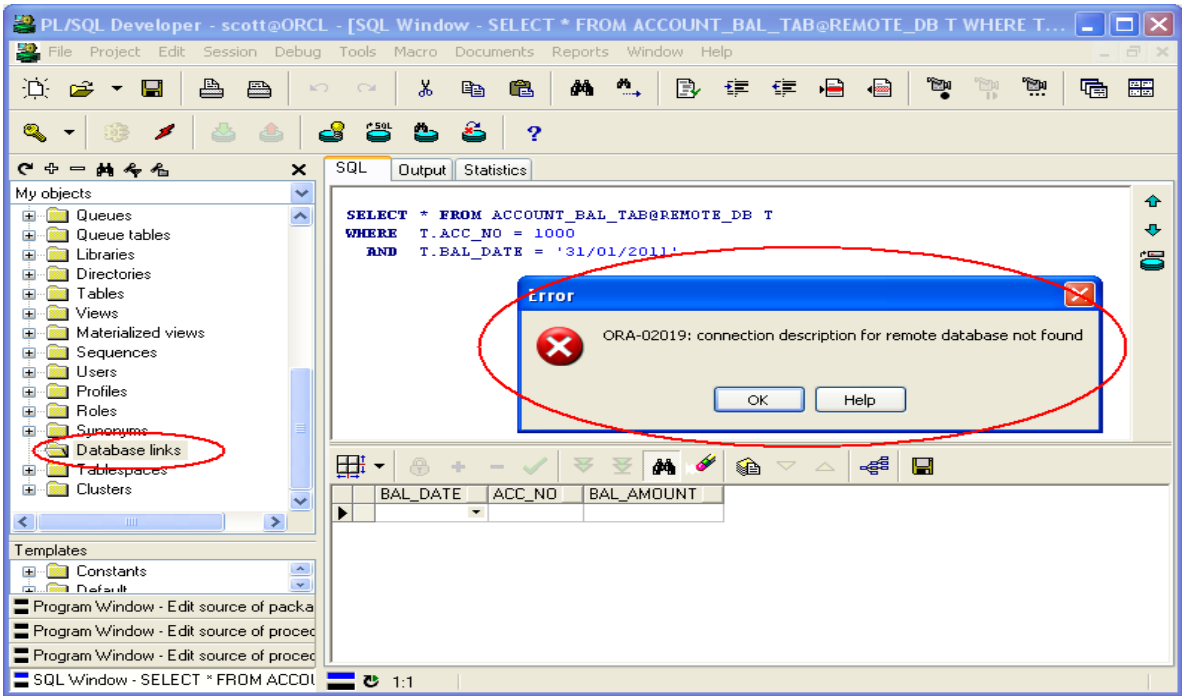

Figure 5.6: The database link is disrupted or not found in Scenario one.

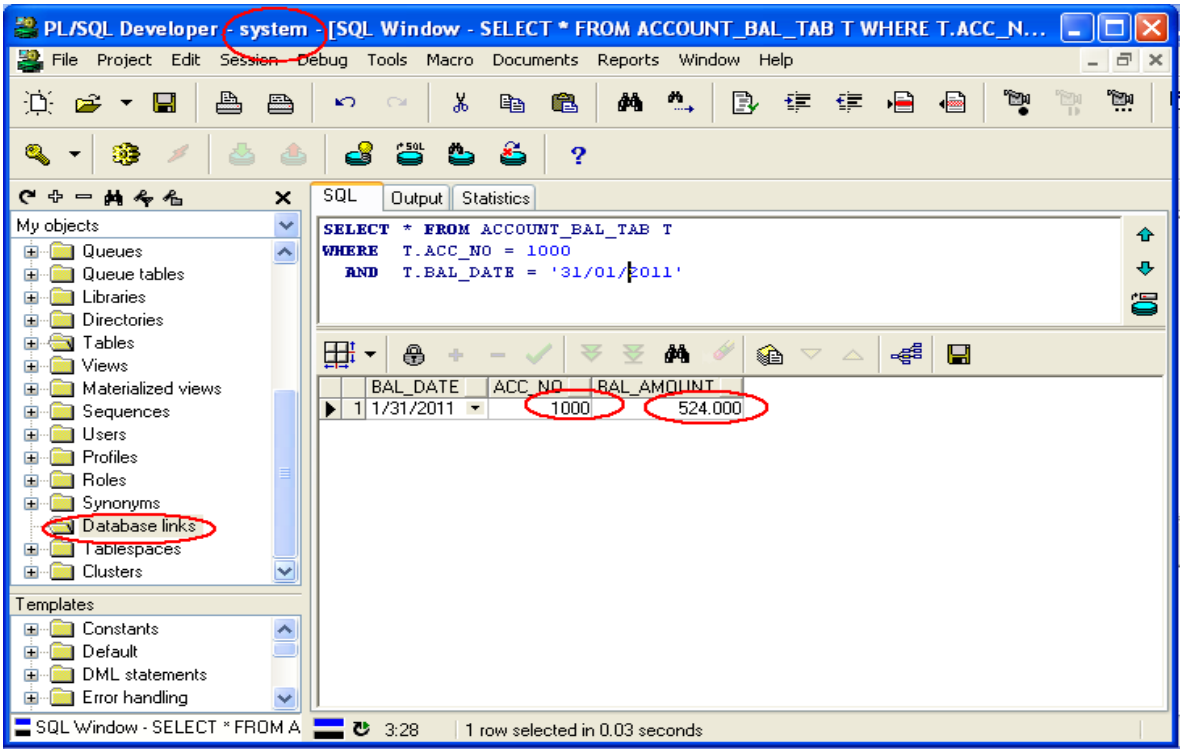

Figure 5.7: The account balance value is not modified in Scenario one.

In step 4, we keep the database link deactivated and ensure that the proposed model is activated by setting the status of SMS-Channel ON and the SMS-JOB is submitted as illustrated in figures 5.8 and 5.9 respectively.

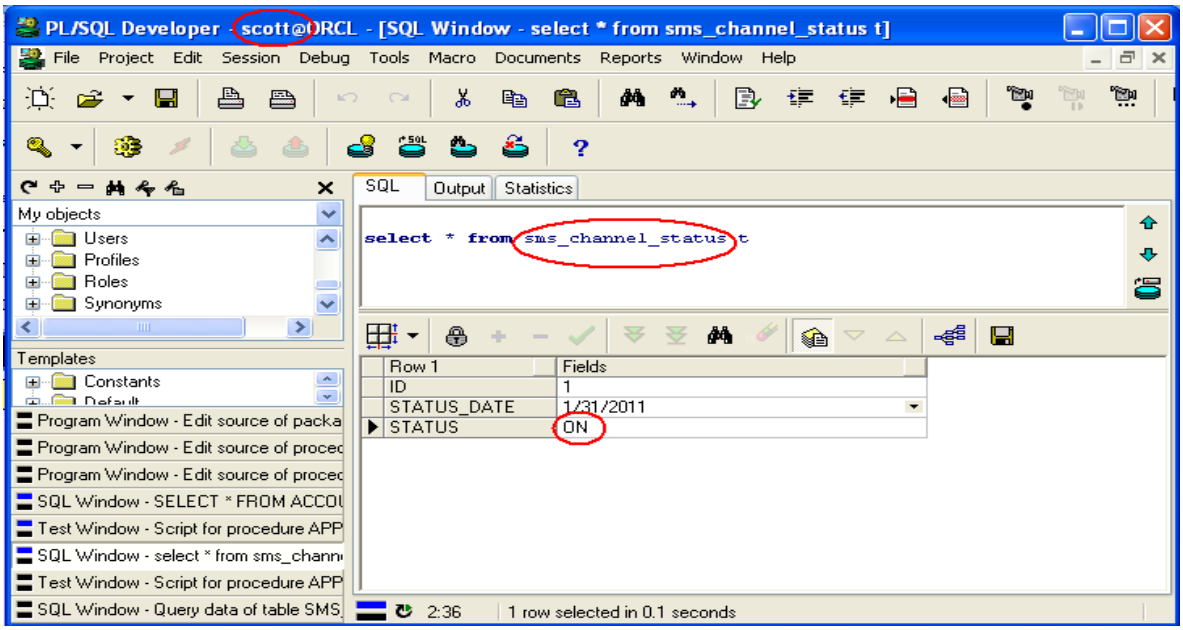

Figure 5.8: SMS-Channel status is ON in Scenario one.

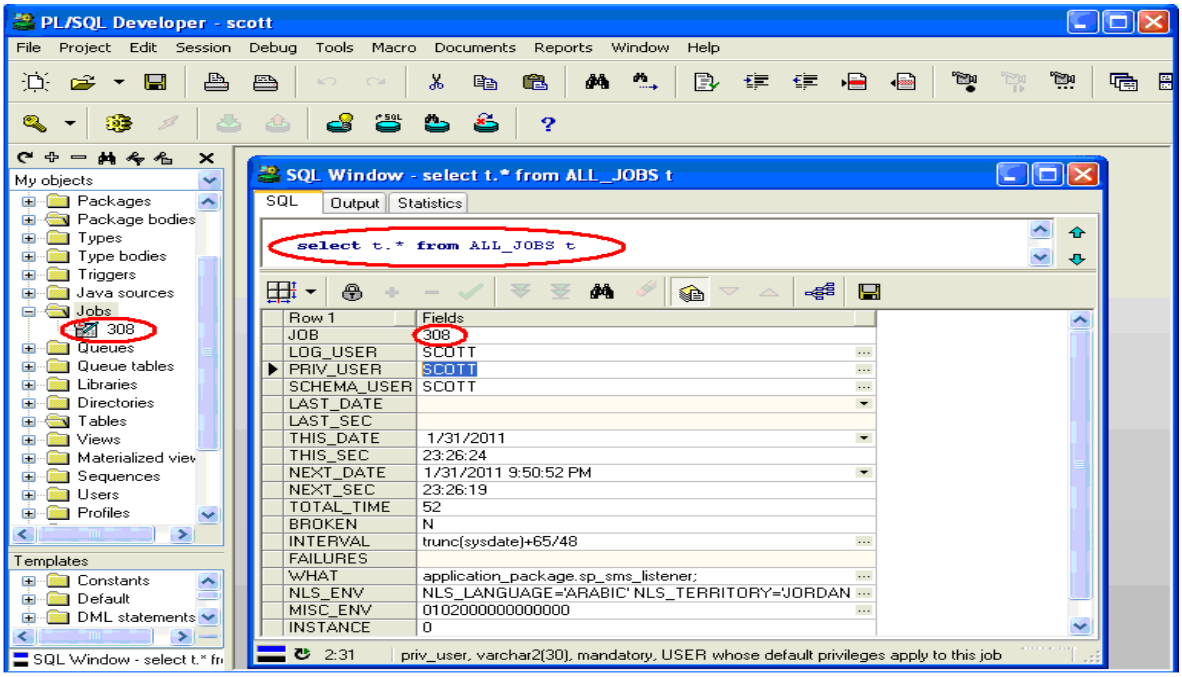

Figure 5.9: SMS-JOB is submitted since SMS-Channel status is ON in Scenario one.

After that, we carry out a modification on the account balance of number (1000) by using application_package as illustrated in figure 5.10.

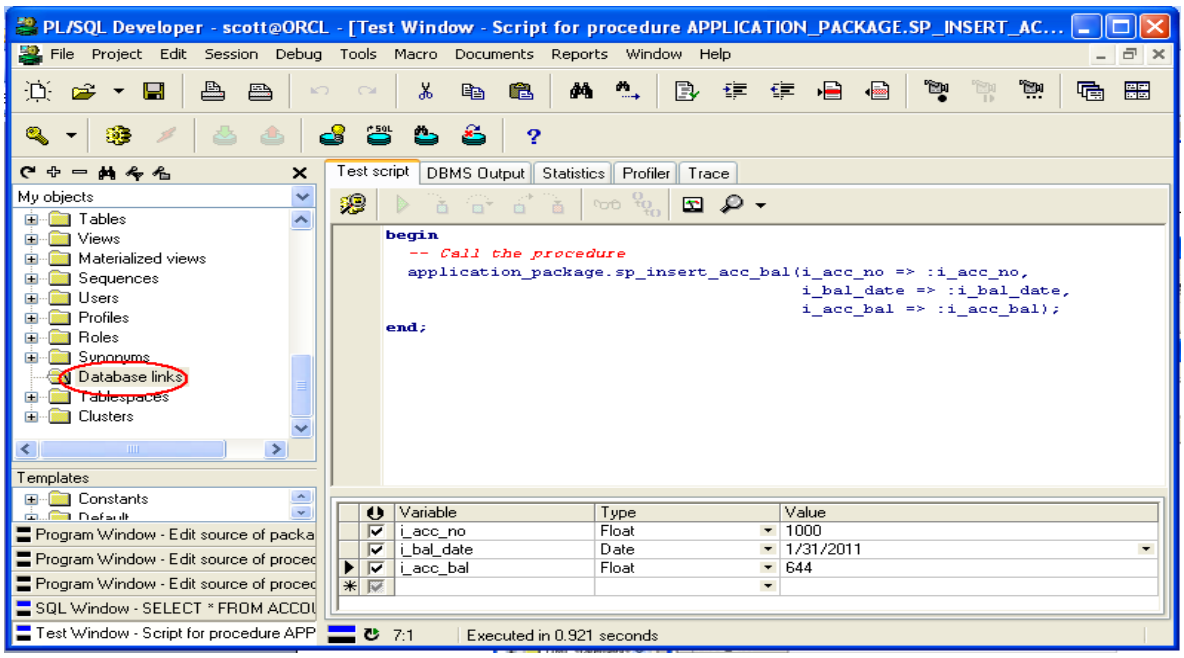

Figure 5.10: Using application_package to carry out remotely a modification on the balance of the Account Number (1000) in Scenario one.

Then we have to make sure that the corresponding record has been inserted into sms_listener_log table, Ozekimessageout table in site 1 and another one inserted into Ozekimessagein table in site 2 as illustrated in figures 5.11, 5.12 and 5.13 respectively.

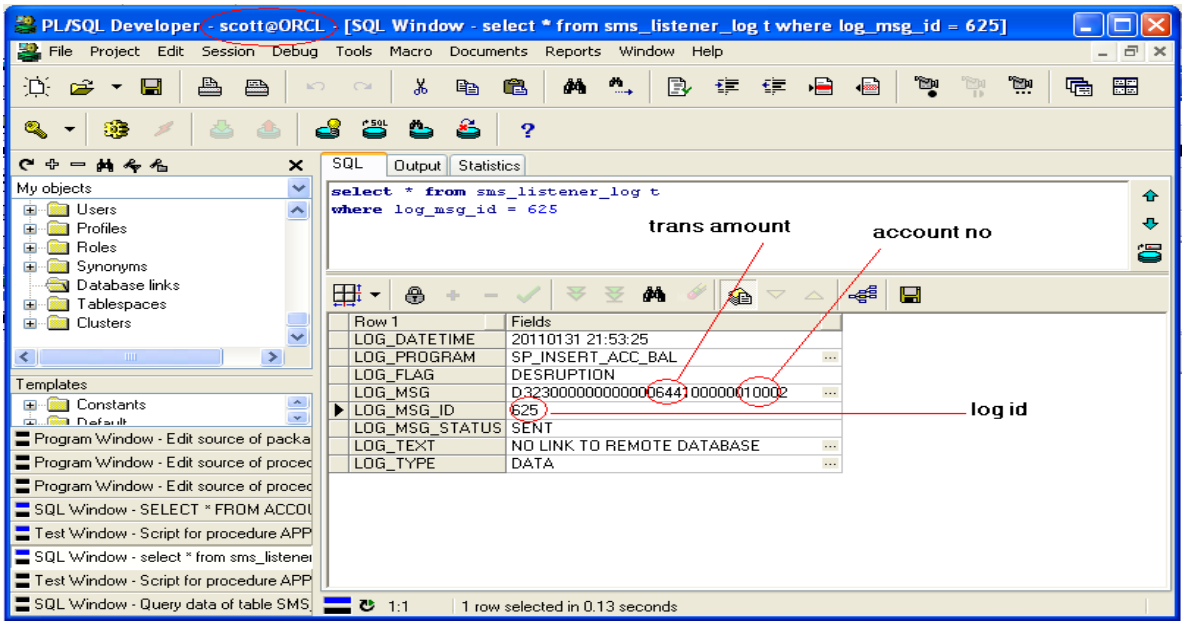

Figure 5.11: The inserted record in SMS_LISTENER_LOG table for the remote modification of account balance of number (1000) in scenario one.

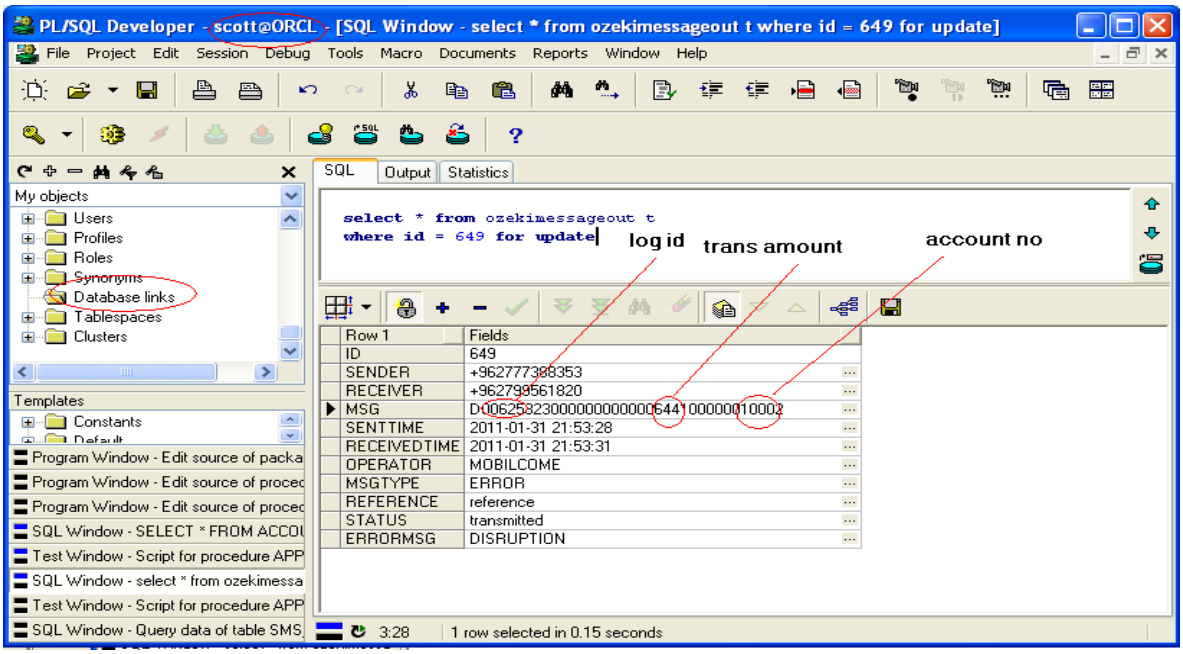

Figure 5.12: The inserted record in OZEKIMESSAGEOUT Table in site one for the remote modification of account balance of account number (1000) in Scenario one.

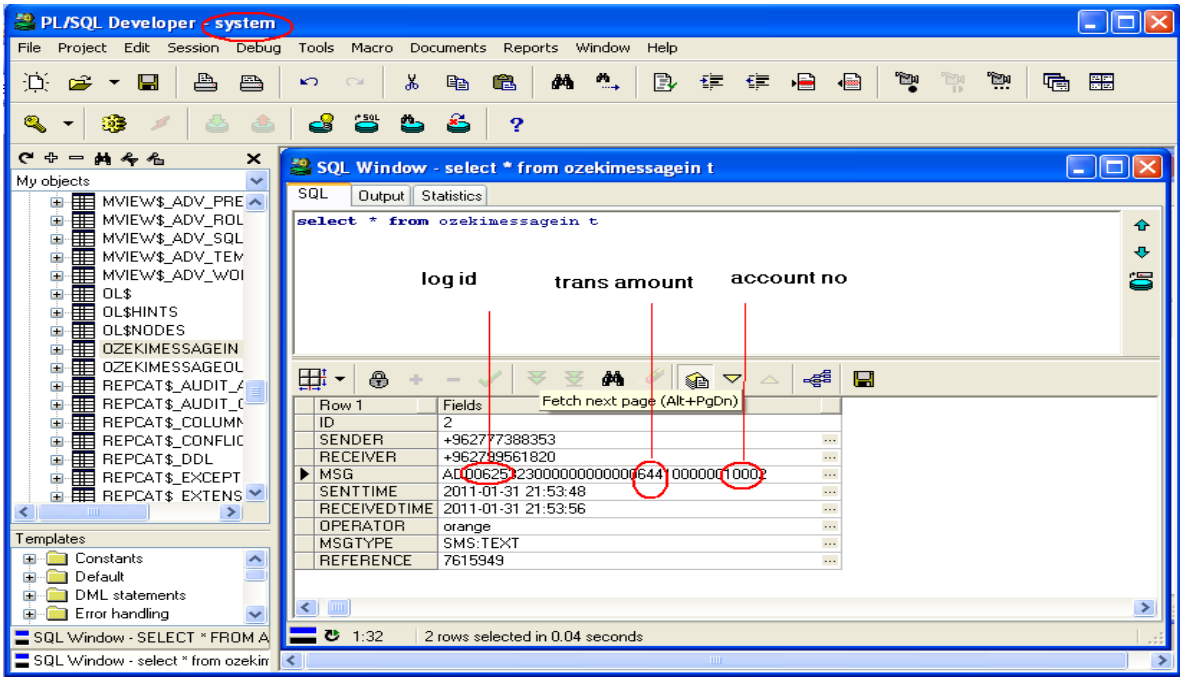

Figure 5.13: The inserted record in Ozekimessagein table in site two for the remote

modification of Account balance of account number (1000) in Scenario One.

Finally, we make sure that the account balance value has been modified on the remote database as through new model as illustrated in Figure 5.14.

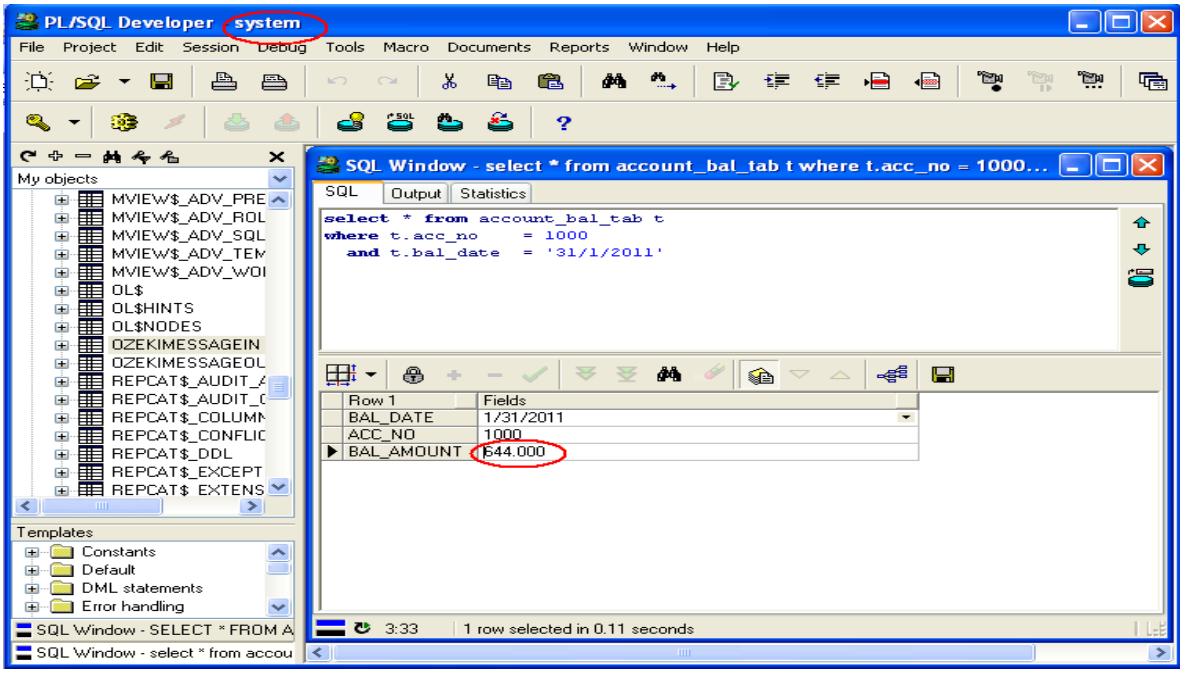

Figure 5.14: The modified account balance value of account number 1000 after modification in Scenario one through the model

From the result of the experimental work, we conclude that the new model supports business continuity since it supports the account balance modification while the database link is disrupted. In addition, we carried out each step twice and the scenario was reliable since all of its steps were reliable. Figure 5.15 show that

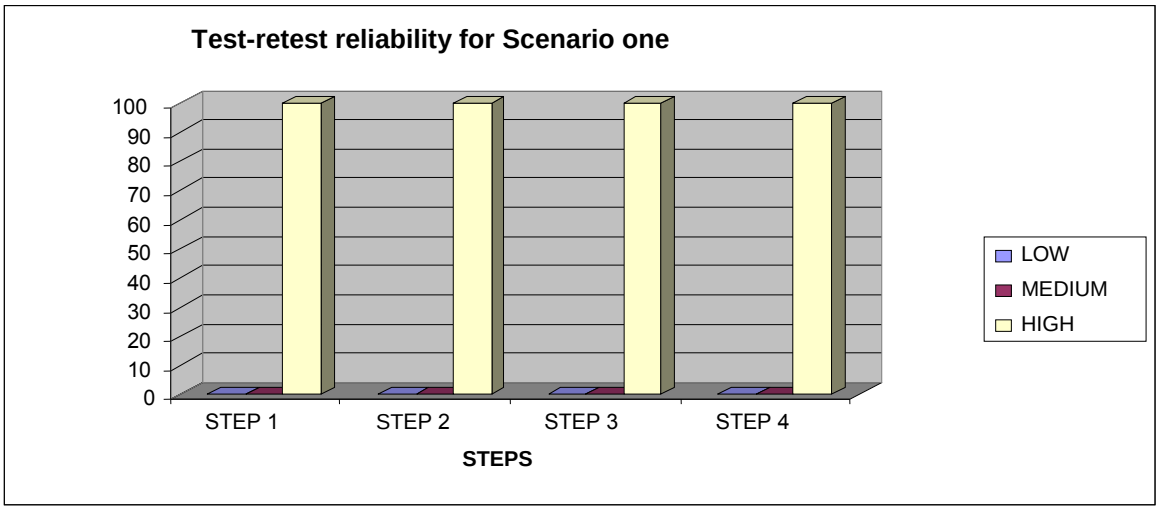

Figure 5.15: Test-retest reliability results for Scenario one.

5.3. Scenario two "Alerting the key person regards a suspicious transactions and/or situation".

In this section, we are going to implement, extract and analyze results for the second scenario. In this scenario, we are going to work through the local database (Scott database user, in order to alert the key-person regards a particular suspicious transaction that is going to tack place at a particular time. The staring point of this scenario is to ensure that the SMS-Channel is ON and the SMS-JOB is submitted. After that, we shall try to modify the account balance by increasing its value above a particular pre-defined number (pre-defined business rules, in this scenario if value > 5000); in this case, an alert-SMS should be sent by the application to a defined key-person in order to notify him/her of the transaction.

The following algorithm describes the second scenario:

Algorithm *two;*

Input *: Account number, transaction amount, Key-person mobile phone number;*

Output: *Alerting SMS message to key person regards Suspicious Transactions*

and/or Situation;

Begin

Step 1: *Activate the SMS-Channel (become ON) and the SMS-JOB*

(submitted), and then make a particular modification on the

Account balance value regards a Particular account number on

the local database. The transaction should exceed the allowable

account value which is pre-defined in the business rules;

Step 2: *Make sure that the modification has been occurred and then check the*

SMS-LOG-FILE Table to find the related message of the modification;

Step3: *Finally, check if the message has been inserted into the*

OZEKIMESSAGEOUT Table in the local database as an outgoing

alerting massage. At the end, this message should be received by the

Key-person in his mobile phone;

End;

Since we are measuring the reliability of the scenarios using the test-retest reliability; we carry out each Scenario step twice, and the results of each should be identical.

In step 1, we activate the model by setting the status of SMS-Channel to be ON and submit the SMS-JOB; Figures 5.16 and 5.17 illustrate the status of the SMS-Channel and the SMS-JOB respectively.

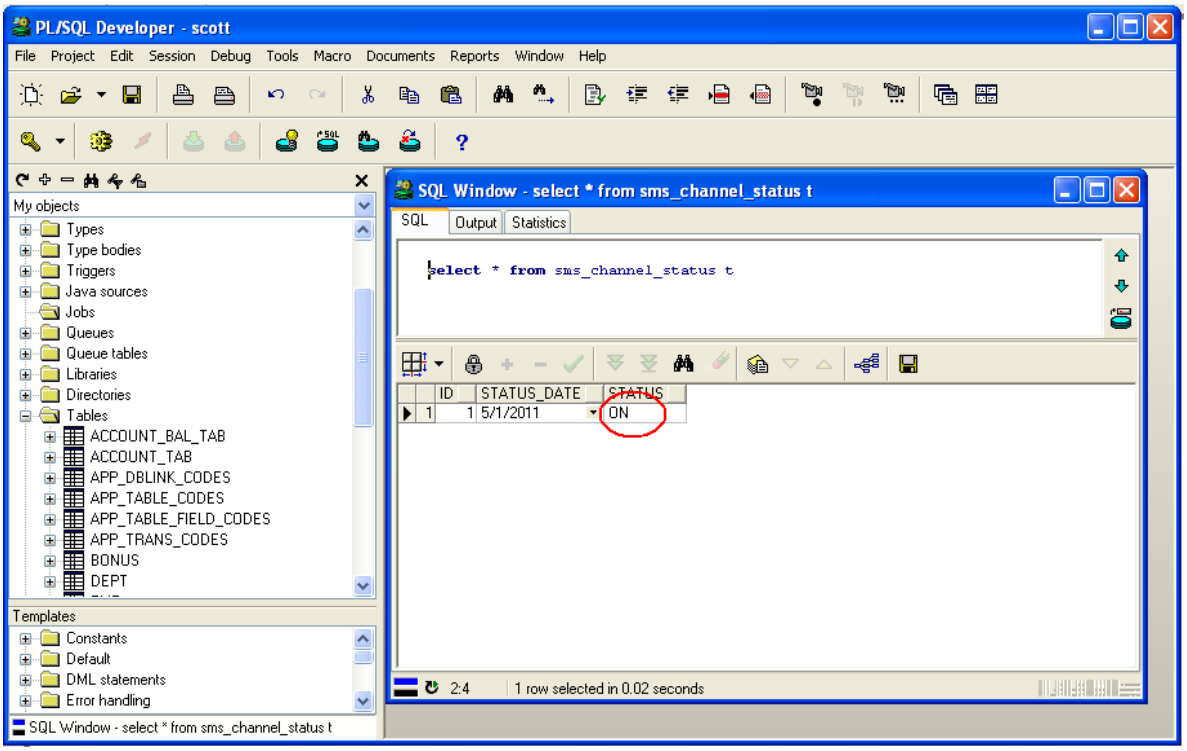

Figure 5.16: SMS-Channel status is ON in Scenario two

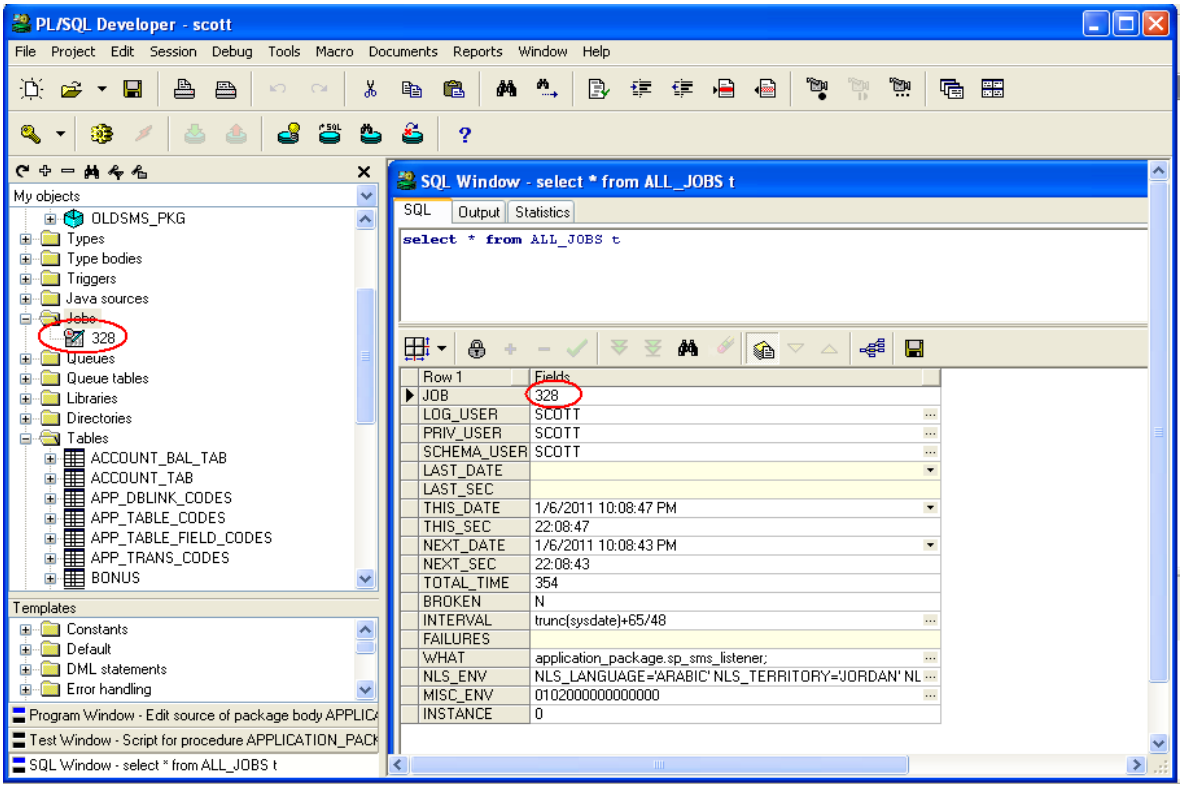

Figure 5.17: SMS-JOB is submitted since SMS-Channel status is ON in Scenario two

After that, we carry out a particular modification on the account balance for account number (2000). The modification transaction is to increase the account value from 3564 to 6600. Figures 5.18 and 5.19 illustrate the account value before and after the transaction.

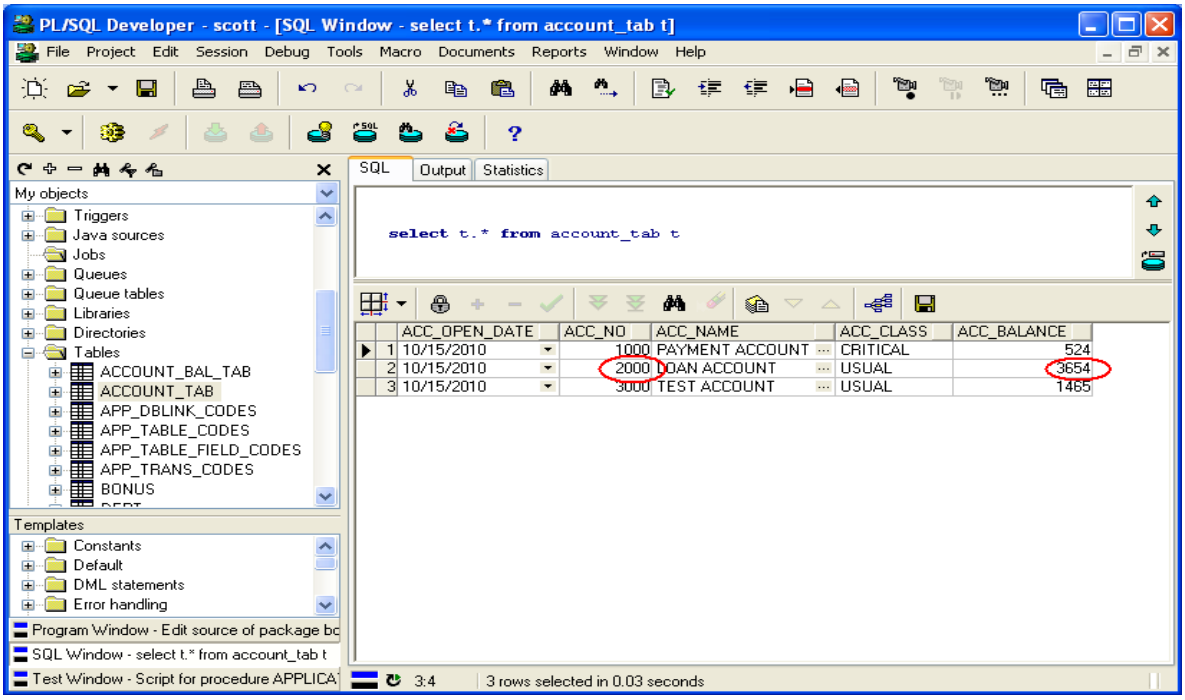

Figure 5.18: The account value before the transaction in Scenario two

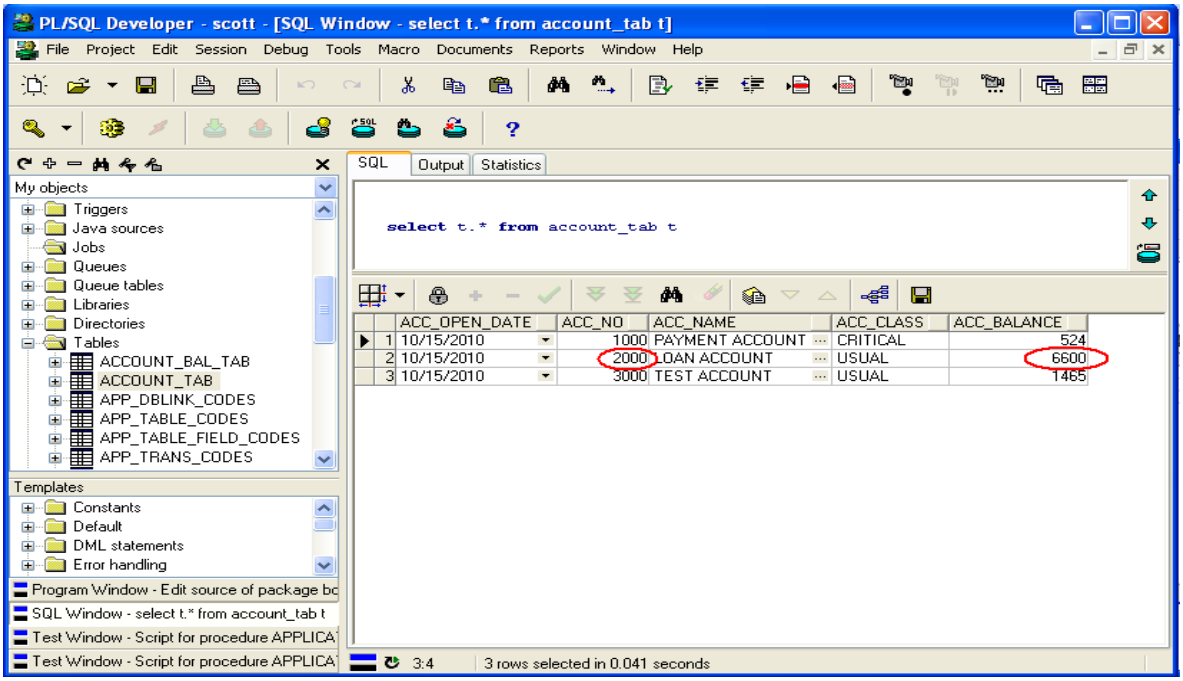

Figure 5.19: The account value after the transaction in Scenario two

Steps two and three, checks if a single record has been inserted in SMS-LISTENER-LOG in order to alert the key-person, and in the ZEKIMESSAGEOUT table as an outgoing message that will be sent by the Ozeki Message server which, in this case, is going to the key-person (phone number +962799561820). Figures 5.20 and 5.21 illustrate that.

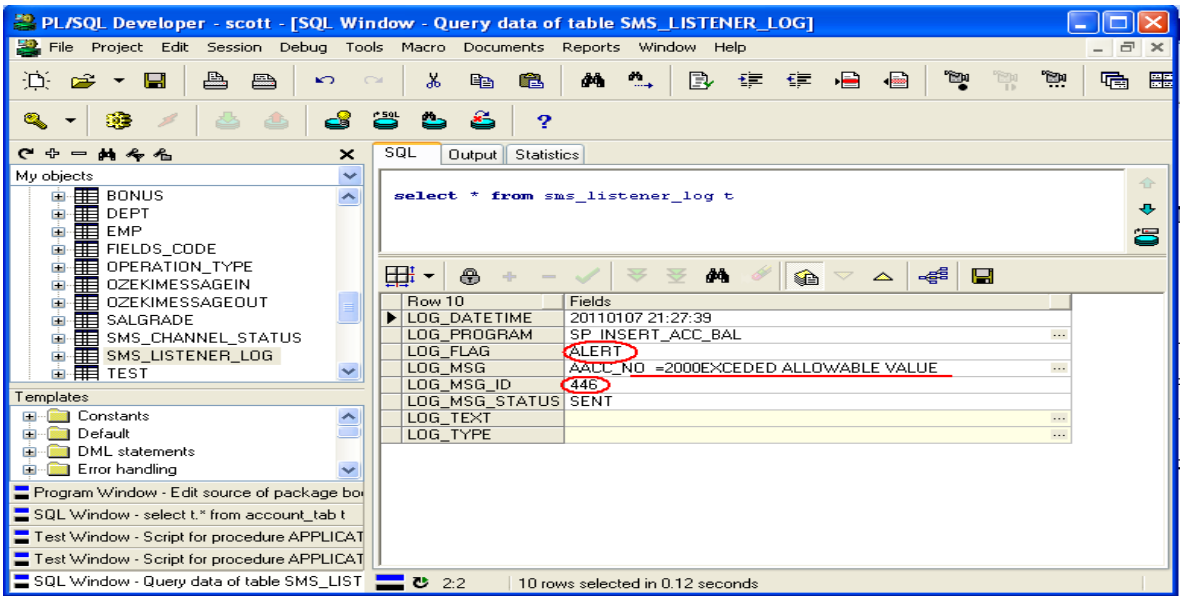

Figure 5.20: The inserted record in SMS-LISTENER-LOG table in Scenario two

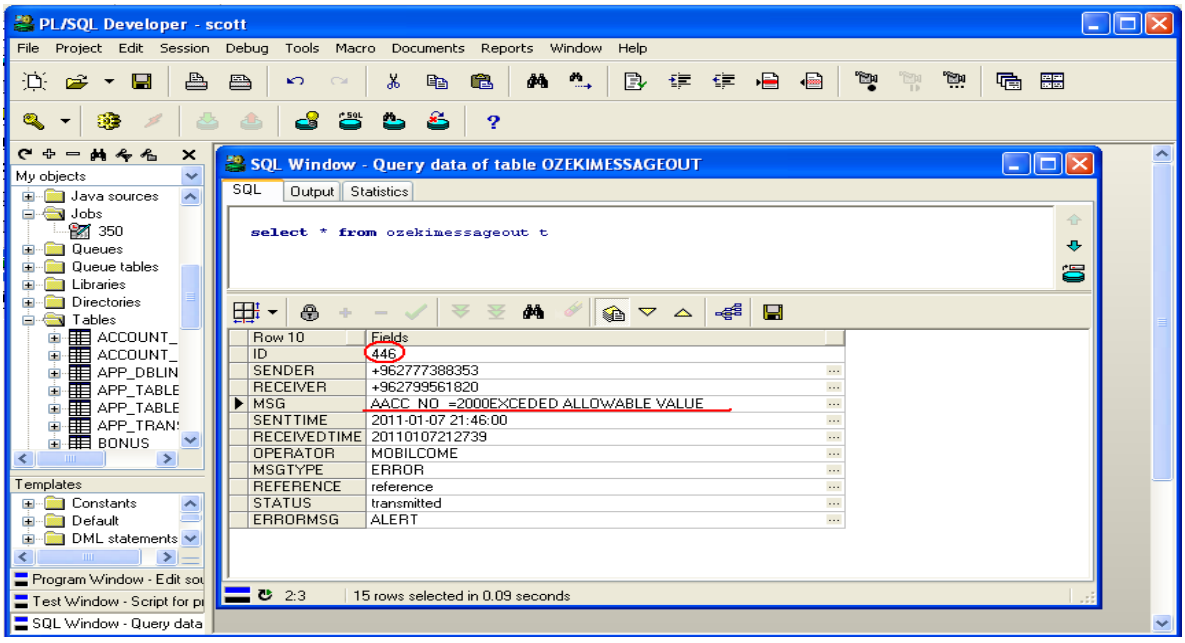

Figure 5.21: The inserted record in the ZEKIMESSAGEOUT table in Scenario two.

At the end of this scenario, the message in the ZEKIMESSAGEOUT table should be the same as the message that shall be sent to key-person mobile phone. Figure 5.22 shows that.

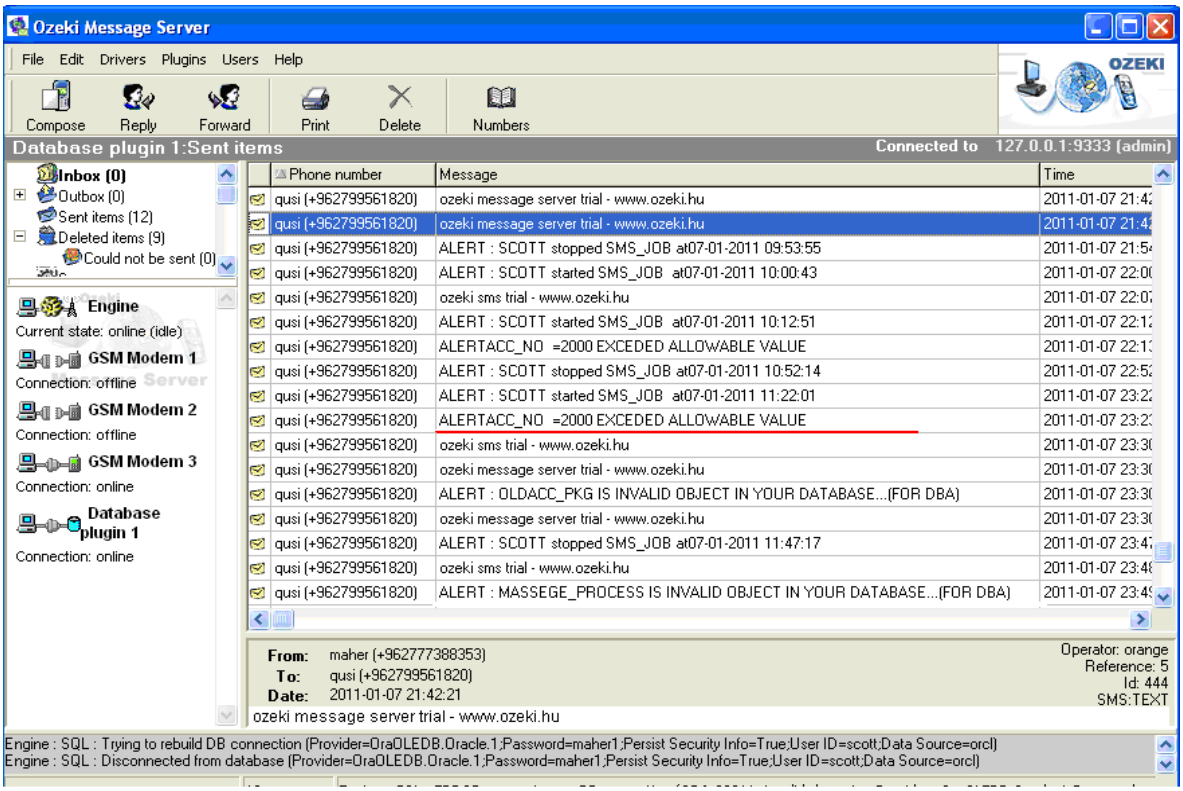

Figure 5.22: The key-person received model message is identical to the outgoing message in ZEKIMESSAGEOUT table in scenario two.

5.4 Algorithm Three "Alerting the DBA Regards Invalid Database Objects"

In this section, we will implement, extract and analyze results of the third scenario; which will work through the local database in order to alert the DBA for the existence of invalid database objects. First enabled the SMS-Channel by sitting it to ON, and submitting the SMS-JOB.

Then we enforce particular database objects to become invalid; in this case, an alert SMS that indicates the invalid database objects will be sent to the DBA (phone number +962799561820). Finally, the DBA shall recompile the invalid database. This advantage is going to reduce the time needed by the DBA to discover such invalid objects within the normal procedures.

The following algorithm describes the third scenario:

Algorithm *three;*

Input ***:*** *DBA mobile phone number;*

Output : *Alerting SMS message to DBA Regards invalid database object;*

Begin

Step 1: *Activate the SMS-Channel (Become ON) and the SMS-JOB*

(Submitted), and then Enforce a Particular database Object to

Become invalid;

Step 2: *Make sure that the message has been inserted into the SMS-log-file*

Table;

Step 3: *Check if the message has been inserted into the OZEKIMESSAGEOUT table in the Local database as an outgoing Alerting massage. At the end, this Message should be received by the DBA in his mobile phone;*

End;

Step one, activate the proposed model by sitting the status of SMS-Channel to be ON and submit the SMS-JOB. After that, we enforce the database object "Process Message procedure" to be invalid by using a non-existing table name (Replace table name SMS-LISTENER-LOG to be SMS-LOG-LISTENER). Figure 5.23 illustrate that.

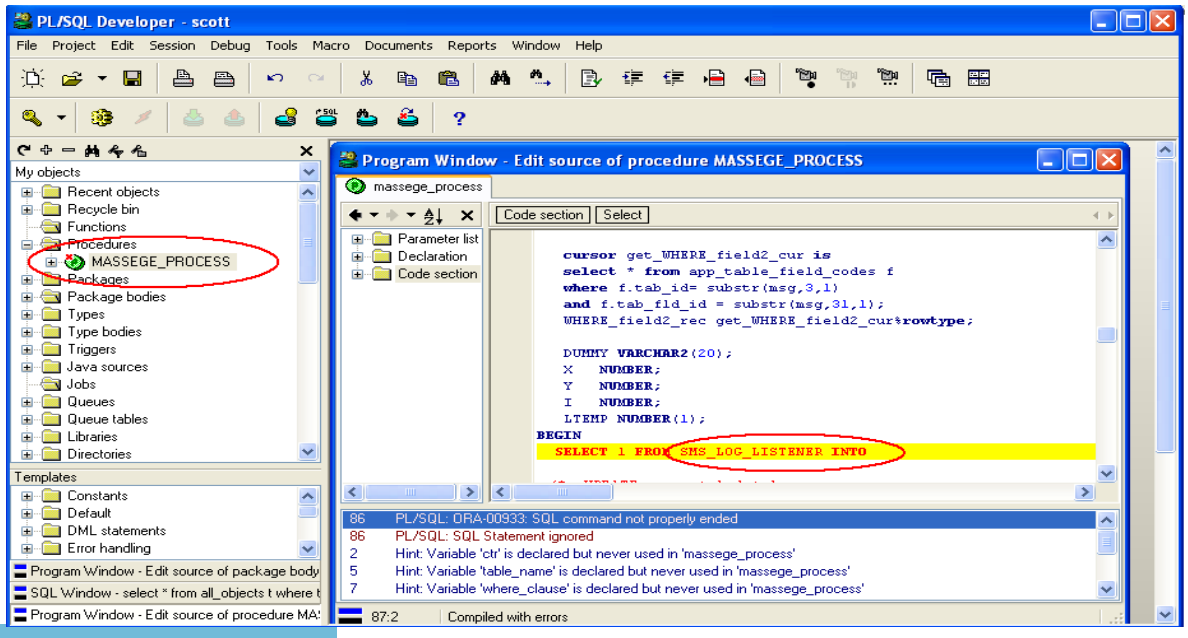

Figure 5.23: The invalid database object and the modification that caused it in Scenario three

Steps two and three, checks if a record has been inserted into SMS-LISTENER-LOG table in order to alert the DBA (phone number +962799561820), and in the ZEKIMESSAGEOUT table as an outgoing message that will be sent by the Ozeki Message server to DBA mobile phone. Figures 5.24 and 5.25 illustrate that.

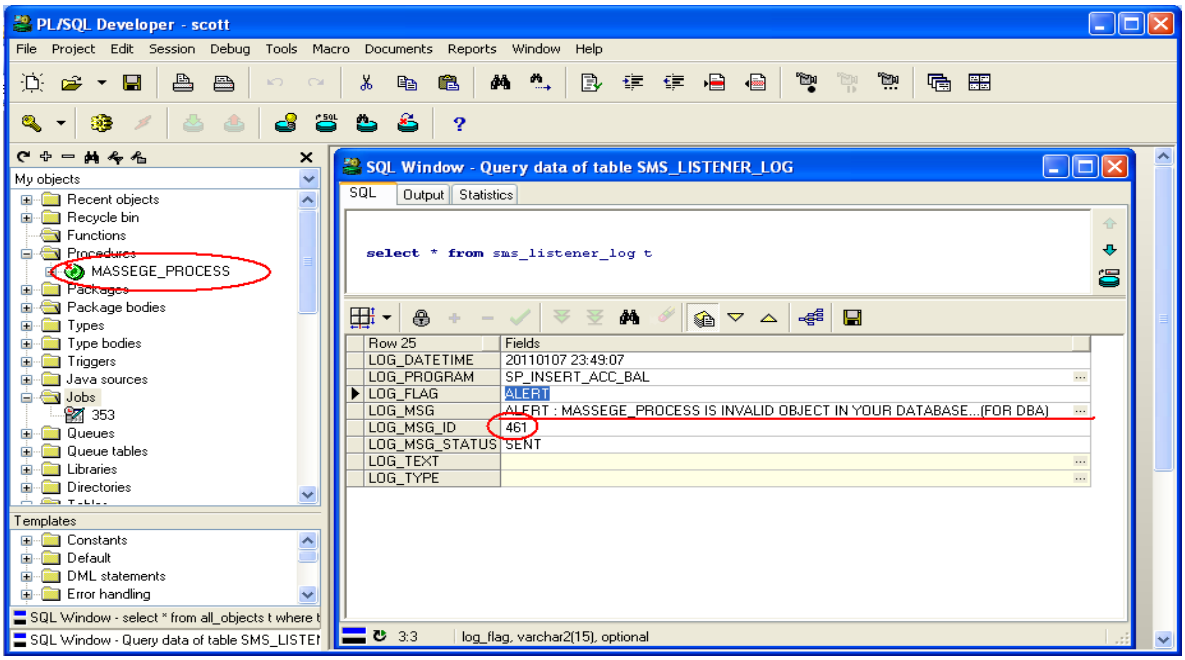

Figure 5.24: The inserted record in SMS-LISTENER-LOG table in Scenario three

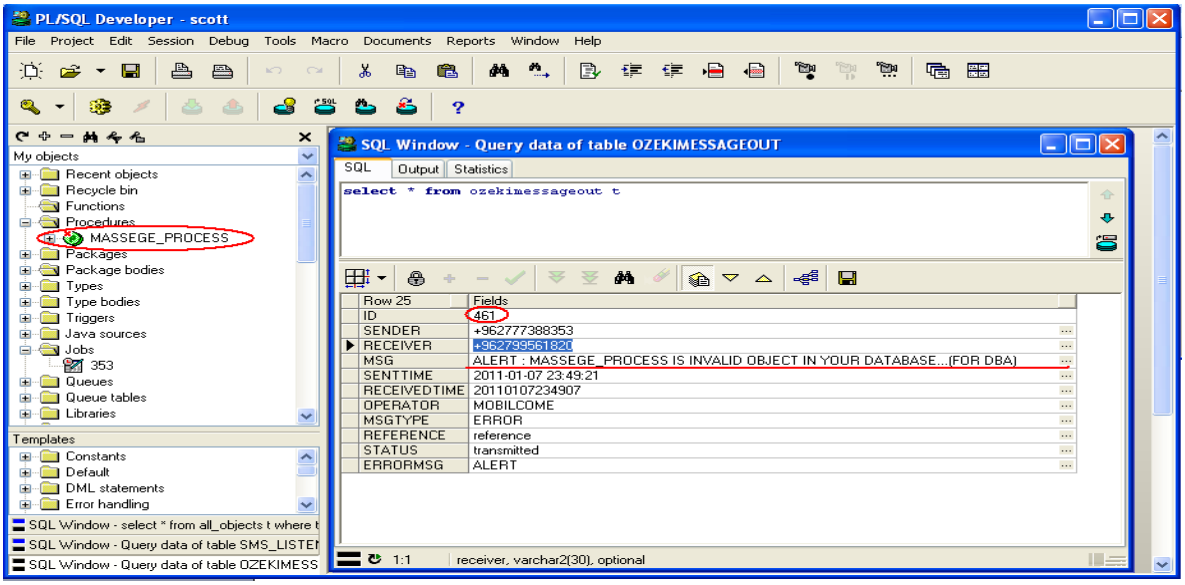

Figure 5.25: The inserted record in the ZEKIMESSAGEOUT table in Scenario three.

At the end of this scenario, the message in the ZEKIMESSAGEOUT table should be the same as the message that shall be sent to DBA mobile phone. Figure 5.26 shows that the message received to DBA phone mobile is identical to the message in the ZEKIMESSAGEOUT table outgoing message. Then the DBA shall modify and recompile the procedure, and this is going to save time and efforts.

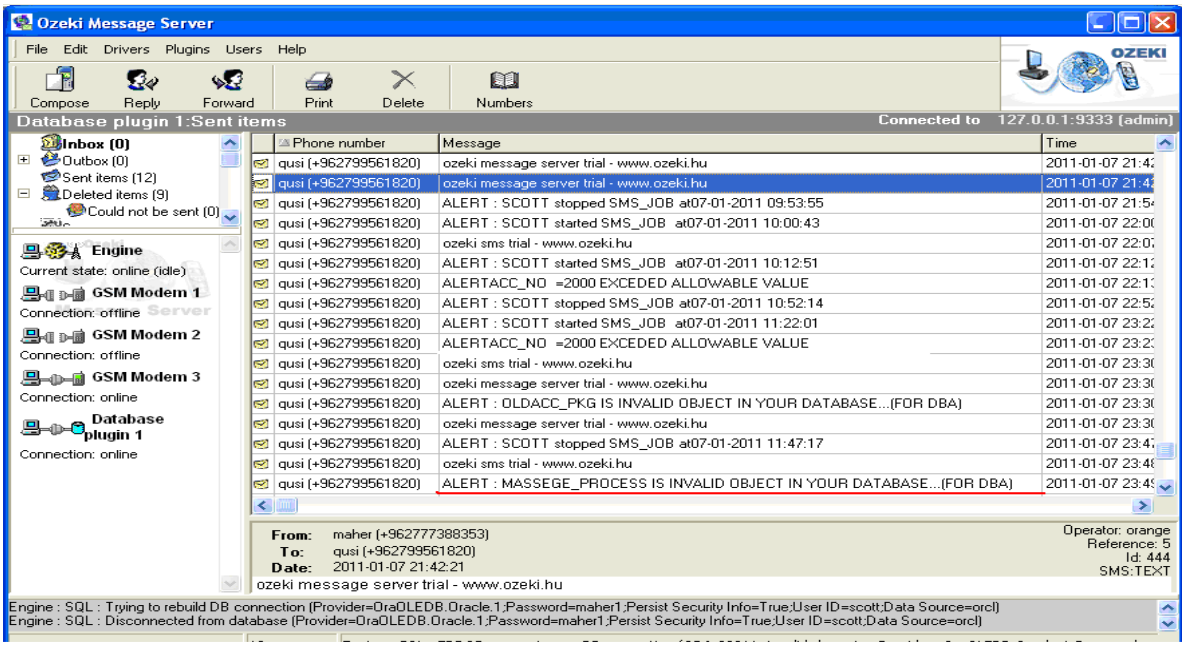

Figure 5.26: The DBA Mobile received model message is identical to the outgoing message in ZEKIMESSAGEOUT table in Scenario three.

5.5 *Algorithm* four "Submitting query remotely in other databases".

In this section, we will implement, extract and analyze results of the fourth scenario. We are going to work through local database (the Scott database user) in order to submit query to fetch the account balance table which exists in the remote database (system database) by using the concept of SMS to transfer data (coded transaction) between databases using listener ,sms-log-table and ozeki message server .

The normal case occurs through a predefined database link between the local and remote databases. First, we need to ensure that the database link is up and running, and that the SMS-Channel is OFF, so we can execute the query that fetches a specific account balance; in this case, the query should be completed and the account balance should be fetched. After that, we need to break or disrupt the database link and try to execute same query that fetch the account balance; in this case, the query should not be completed and the account balance should not be fetched, On the other hand, we are going to make the SMS-Channel ON and ensure that the database link is broken and try to execute the same query through the application package ; in this case, the query should be completed and the account balance should be fetched although the disruption of the database link.

The following algorithm describes the current scenario:

Algorithm *four;*

Input : *Account number ;*

Output: *Account balance;*

Begin

Step 1: *Make sure that the database link is Available and then submit a*

Particular query on the remote Database to get balance for a

Particular account number;

Step 2: *Disrupt the database link within new Model (SMS-Channel and*

SMS- JOB Are OFF), and submit the same query in step 1 and then

Make sure that the query has not been fetched;

Step 3: *Keep the database link disrupted and activate new model (SMS-*

Channel and SMS-JOB are ON) and submit the same query in step 1,

and make sure that the Data has been retrieved successfully in the

local database in order to continue;

End;

Now let us go through Scenario four steps to implement and analyze the scenario results , to measure the reliability of

the new model, we need to measure the reliability using the test-retest reliability method. By using this method, we carry out each step twice and make sure that the results of each time is the same. If results of both tests are the same for all of the steps, then we can insure the reliability of the Scenario.

Regarding steps one and two, we have made sure that the database link is available and then we tried to execute the query that fetches the balance value of account number (2000) from remote database and then notice the results. Figure 5.27 illustrates the account balance from remote database, which is (541).

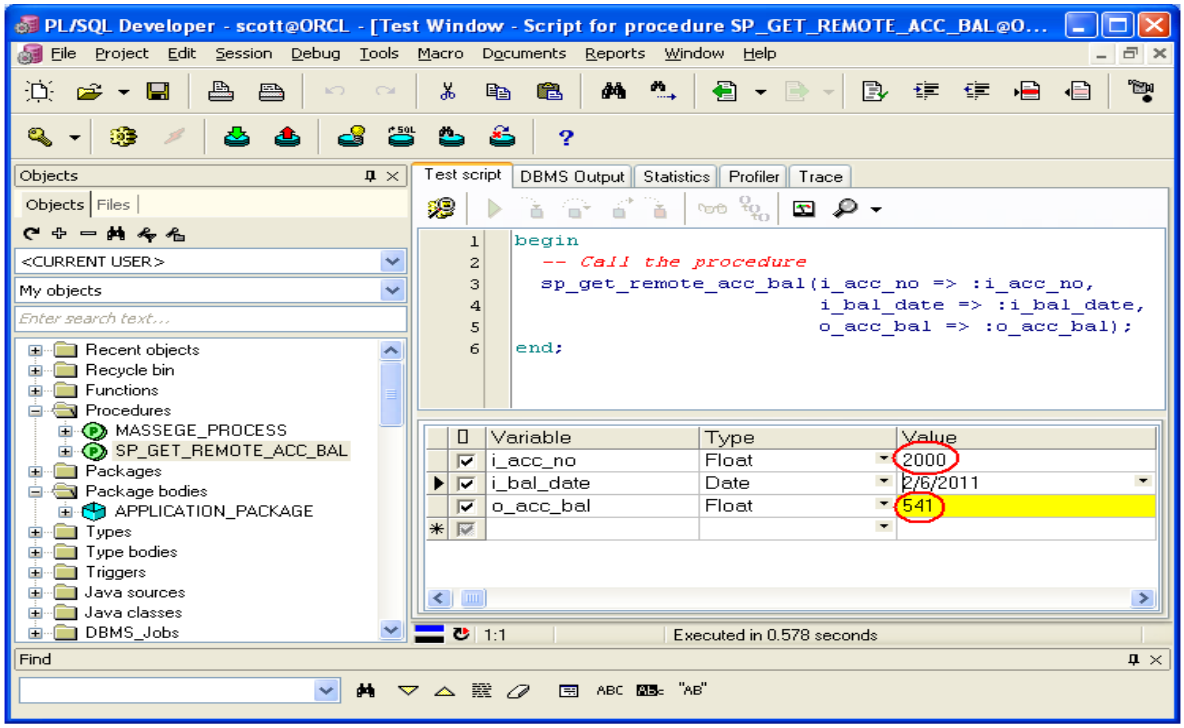

Figure 5.27: The account balance for account number (2000) in Scenario four .

After that, we need to disrupt the database link and execute the same query in step one and then make sure that the query has not been executed as illustrated in Figure 5.28.

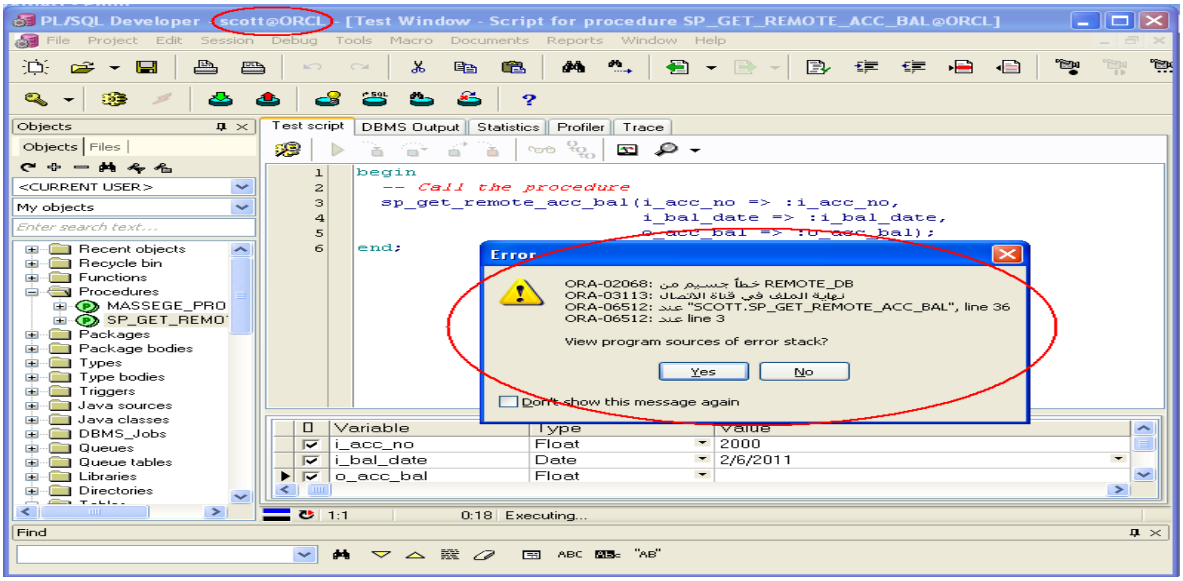

Figure 5.28: The account balance for account number (2000) can not be fetched when database link disrupted in Scenario four.

After that we activating the proposed model (SMS-Channel and SMS-JOB are ON), and we executed the same query in step one and made sure of the following:

- A single record is inserted in SMS-LISTENER-LOG in order to submit a query as illustrated in Figure 5.29.

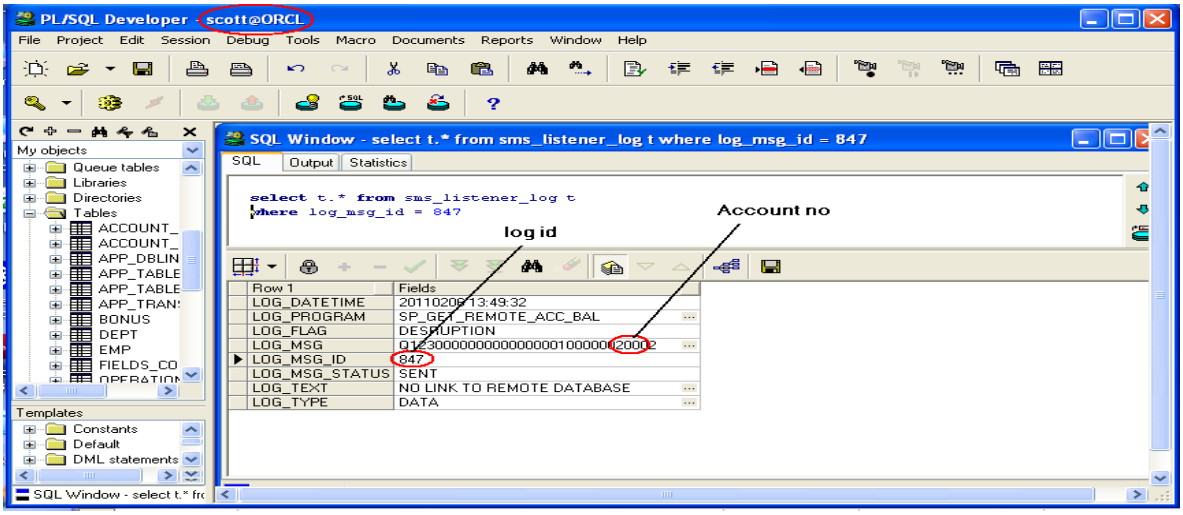

Figure 5.29: The inserted record in SMS-LISTENER-LOG table for submitting query in Scenario four

- A single record is inserted in the OZEKIMESSAGEOUT table and another one in ozeki message server as an outgoing message that will be sent by the Ozeki Message server to mobile phone (phone number +962799561820) that attached to Ozeki Message server in site 2.As illustrated in Figures 5.30 and 5.31 respectively.

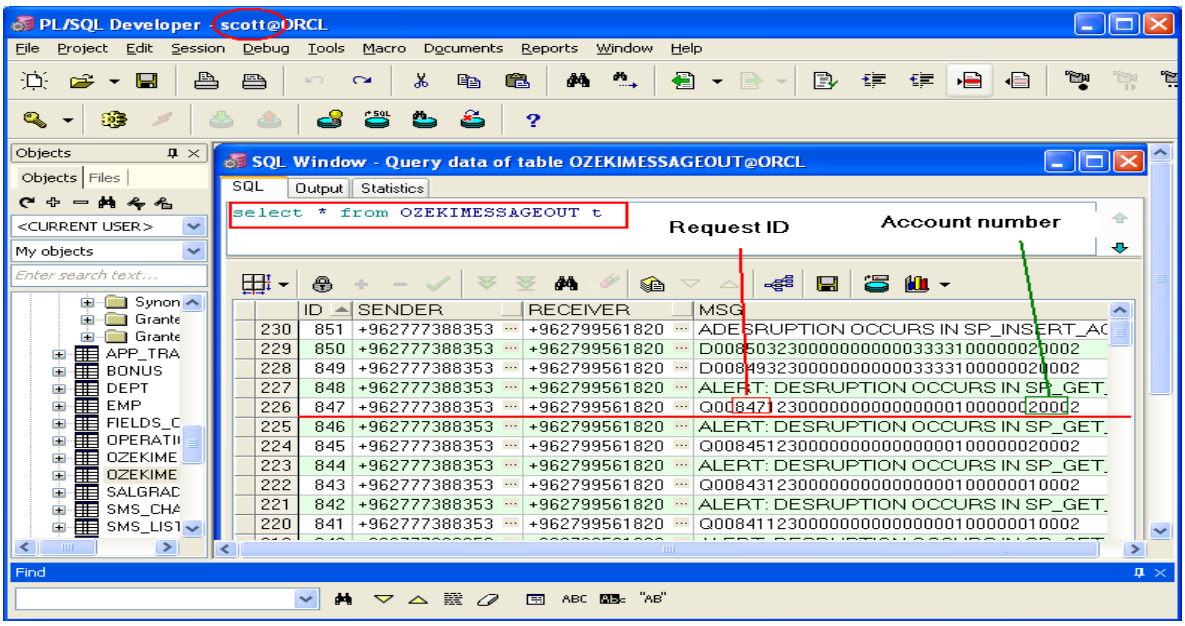

Figure 5.30: The inserted record in OZEKIMESSAGEOUT table in site 1 for submitting query in Scenario four

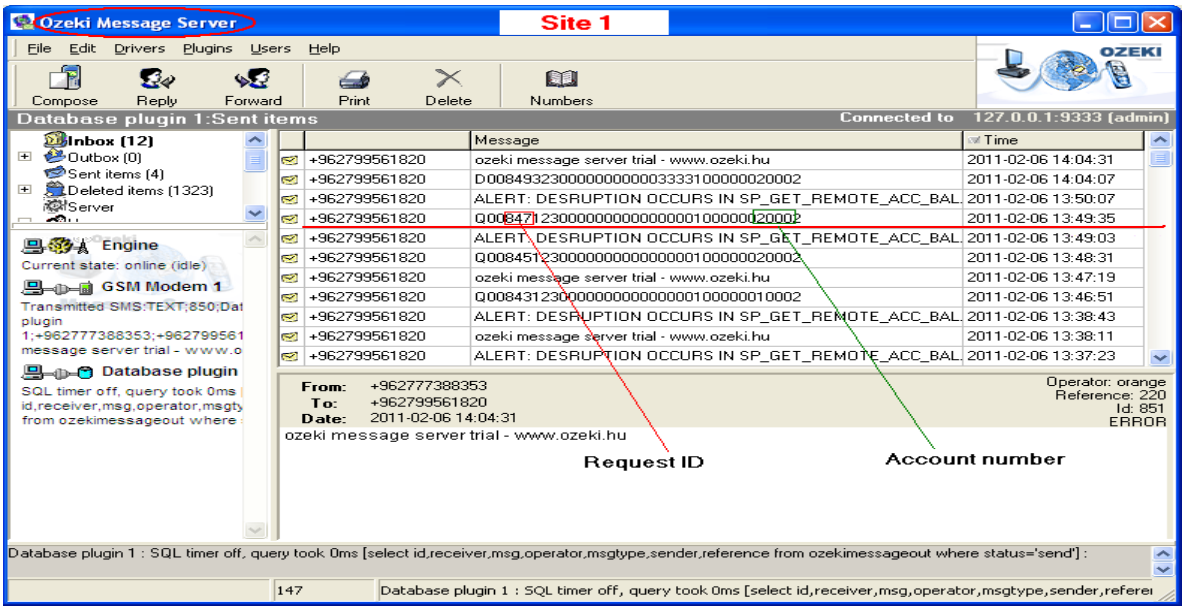

Figure 5.31: The inserted record in ozeki message server in site 1 as an outgoing message for submitting query in Scenario four

- A single record is inserted in the OZEKIMESSAGEIN table in site 2 by Ozeki Message server as incoming message as illustrated in Figure 5.32

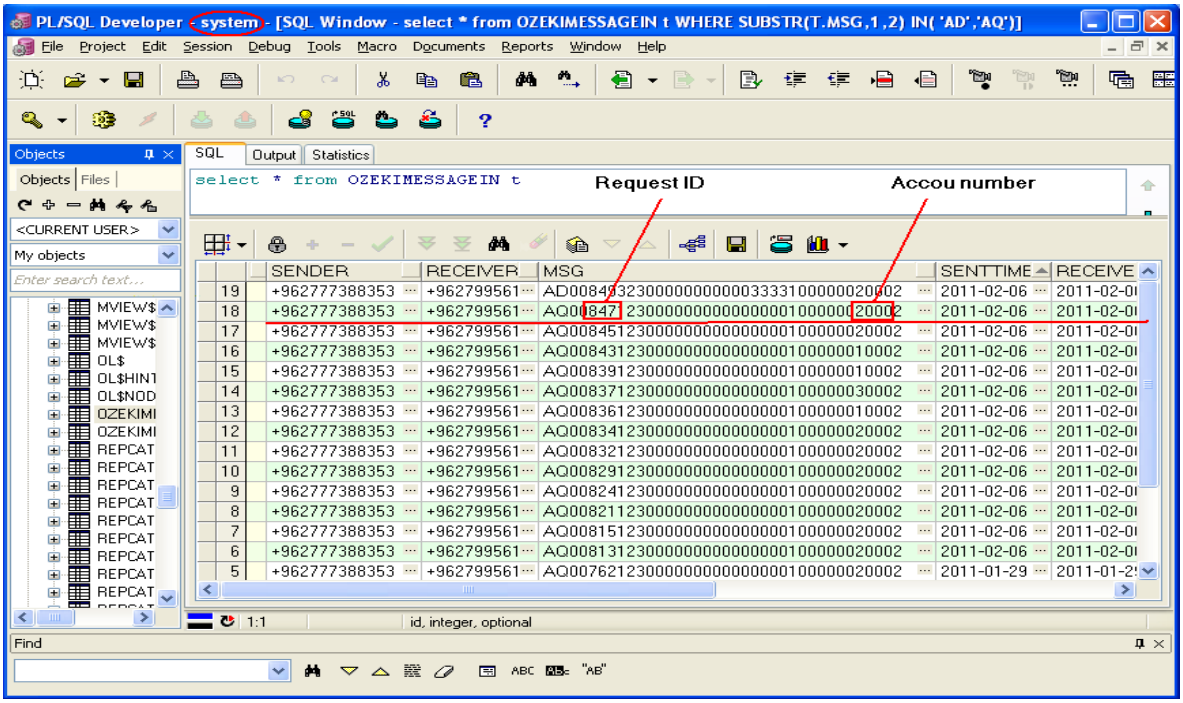

Figure 5.32: The inserted record in OZEKIMESSAGEIN table in site 2 for submitting query in Scenario four

- A single record is inserted in the OZEKIMESSAGEOUT table in site 2 as an outgoing message that will be sent by the Ozeki Message server to mobile phone (phone number +962777388353) that is attached to Ozeki Message server in site 1.As illustrated in Figures 5.33 and 5.34 respectively.

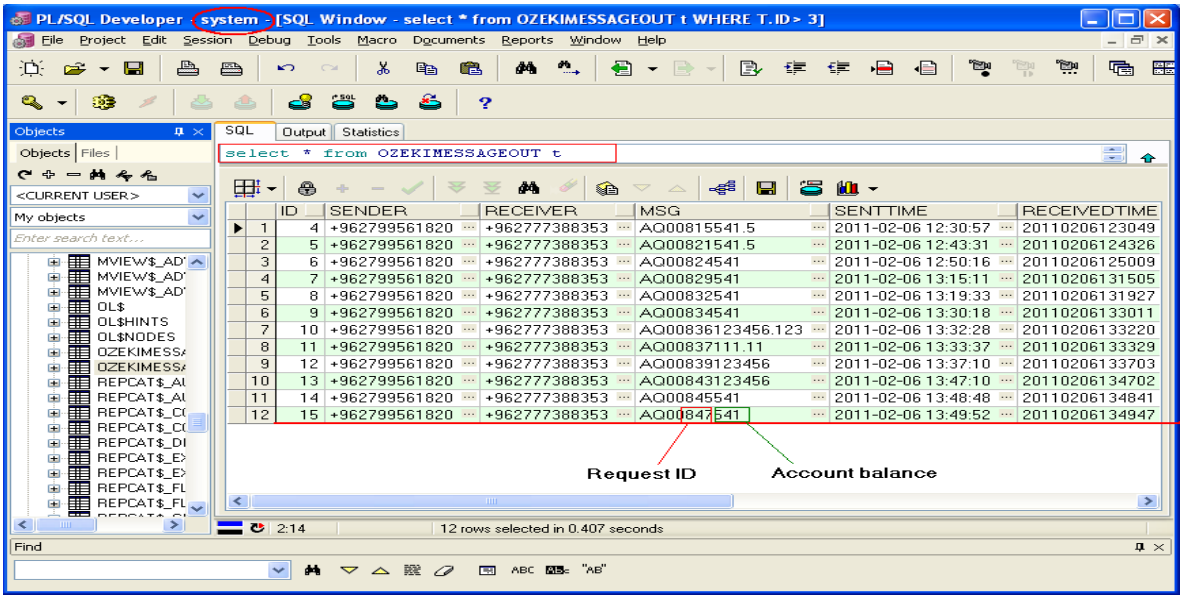

Figure 5.33: The inserted record in OZEKIMESSAGEOUT table in site 2 for submitting query in Scenario four

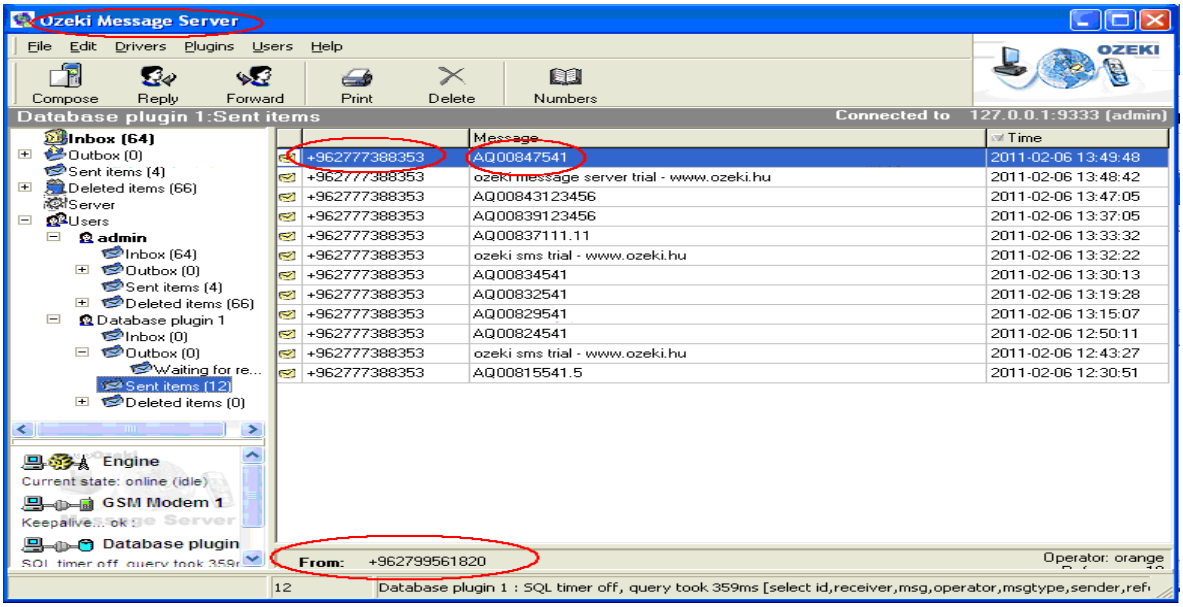

Figure 5.34: The inserted record in Ozeki Message server in site 2 as an outgoing message for submitting query in Scenario four

- A single record is inserted in the OZEKIMESSAGEIN table in site 1 as incoming message (answer for the submitting query) as illustrated in Figure 5.35.

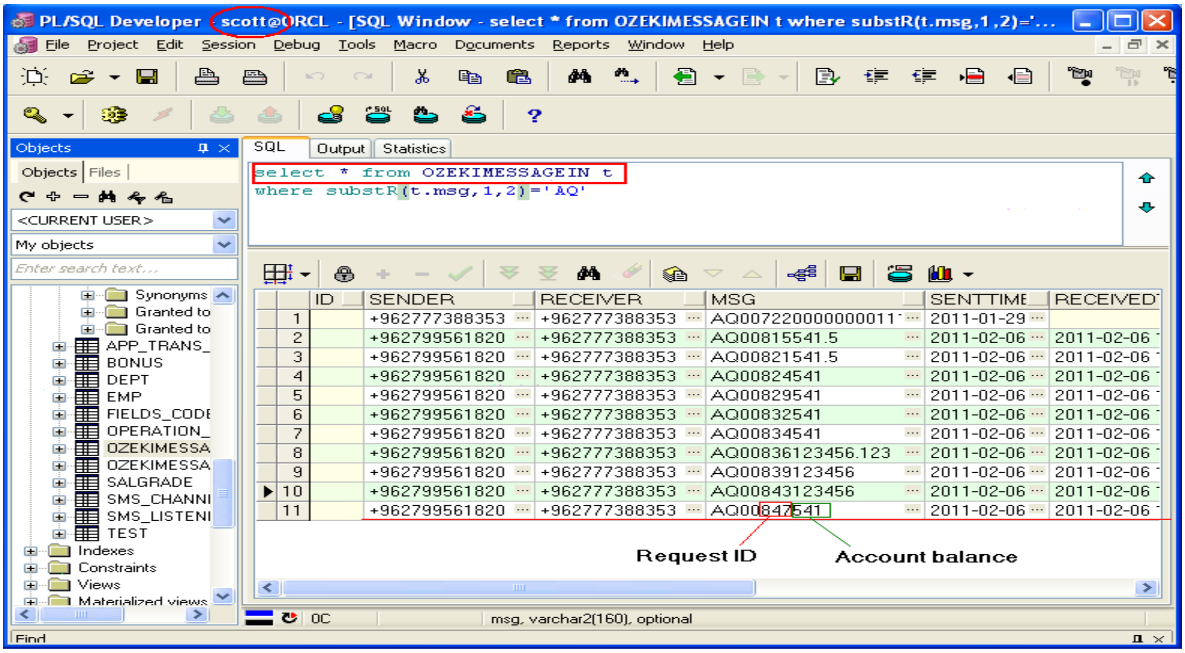

Figure 5.35: The inserted record in OZEKIMESSAGEIN table in site 1 as answer for the submitting query in Scenario four

- The query was executed and fetched the balance (541) for the account number (2000) successfully as illustrated in Figure 5.36.

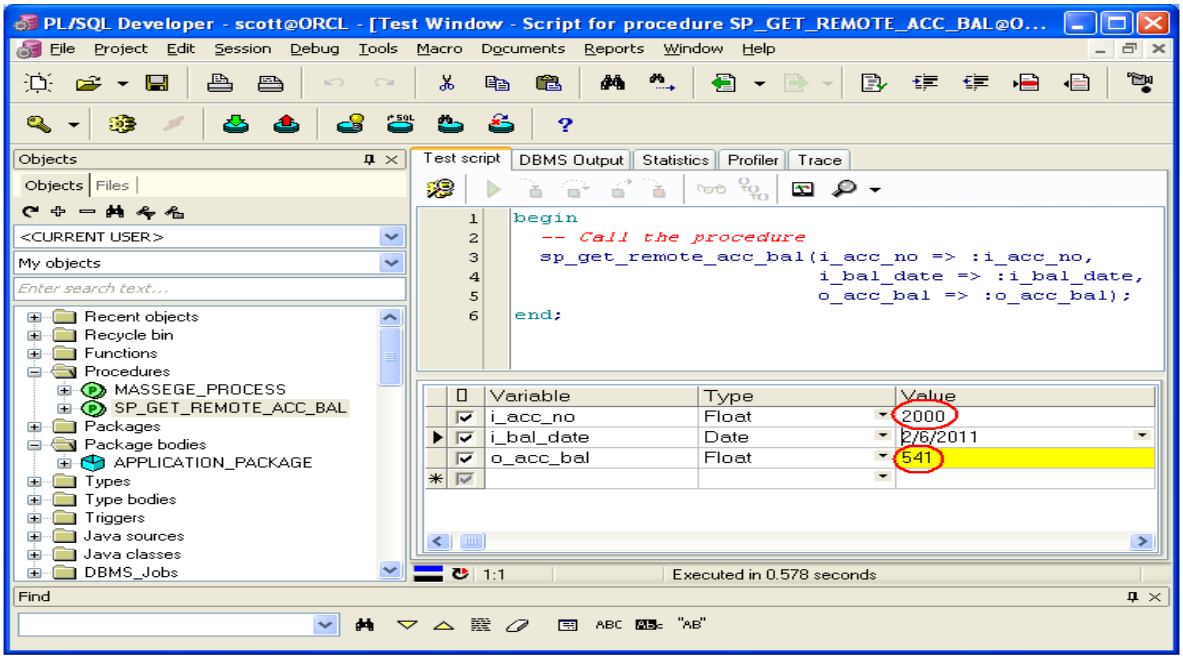

Figure 5.36: The account balance for account number(2000) in Scenario four .

Chapter Six
Conclusion and Recommendation for Future Work

6.1 Conclusions

The recent years have been an area of business economy and competition; which requires facilitating and supporting the process of business continuity; which requires allowing 24-hour, seven-days-a-week access to job functionalities and services. Business Continuity supports organizations managers in getting the required piece of knowledge at the right time in the right place in the right form and/or maintaining the organization functionalities and workflows. In this regards, many methods have been proposed and developed, where most of them are not using the SMS technology and services.

In this thesis, we propose a new model of business continuity in which we use the SMS technology by which business operations of distributed business environments are maintained when a disruption occurs. In addition, we use other information systems concepts, such as organized databases, SMS listeners, encryption and decryption techniques and the SMS Ozeki Server.

In this model there is a contribution of adapting SMS technique with the concept of business continuity, by having

automated operations that will transmit data from machine to machine and/or from machine to human, in order to support business continuity if there is any interruptions on critical business function occurs without losing transaction and without the intervention of a human being, In addition using SMS technology to ensure scalability, flexibility and a lower cost solution, comparing to other technologies, to support rapid response when any interruption in our business occurs. Also by using SMS via GSM network as another channel to transmit data remotely ensures emergency services and business continuity, in case of the business application disruption.

In summary , we employ the Short Message Service (SMS) within the application to play an important role in transferring and exchanging critical data. This is done by coding the database transaction statement and sending it via SMS from one node to another, and having these SMSs are received and processed by a database package, stored on these nodes, so that a disruption in connection between these two database nodes is instantly handled, and co-coordinators are informed, at the right time.

Four algorithms were designed to test the proposed model in the four Scenarios related to the model's main functionalities.

We deploy the proposed model into a test business domain, which is a computer laboratory in the computer department/ Amman Arab University; the four scenarios are as the following :

(1) How to recover from a database-link disruption.

(2) Alerting the key person regarding any suspicious transactions and/or situation. (3) Alerting the Database Administrator (DBA) regards invalid database objects.

(4) Submitting query in other databases.

In order to test the reliability of the proposed model, we carried out each scenario twice and then notice the results. The results show that the proposed model is reliable due to the test-retest reliability, also the experimental work showed that the proposed model supports business continuity since it supports the account balance modification while the database link is disrupted.

6.2 Recommendation for Future Work

SMS technology is an important research topic; this importance is a result of the critical role this technology plays in the communication and transmission of data and commands. In this regard, and since we are in a time of banking economy and competition; banking organizations are requiring robust and

dynamic ATM applications through which customers can carry out their money transactions using their mobiles. As a result, within ATM machines, we need to provide an alternative standby channel based on the SMS technology in case any disruption occurs, but Security must be taken into consideration toward sensitive information while transmitting business information and/or procedures using SMS. In other words, we recommend adopting a security model that works as a filter for upcoming messages before executing them into business domain, in order to maintain the message security and accuracy.

Another area that we can make use of for this model is in data backup domain, so that this model is furthered improved to execute backup of sensitive information or data in different sites.

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