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E-commerce impact: emerging technology – electronic auditing

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Abstract

Purpose – We expect an explosive application of these technologies to take place when they become mature and may further assist auditors in improving the quality of their work. How to use some of the computer-assisted auditing techniques (CAATs) more effectively with the emerging information technologies.

Design/methodology/approach – Constructed an infrastructure with the support of emerging technologies. Electronic auditing (EA) framework–prepared and used with information technology, these examples are object-oriented distributed middlewares, internet security technologies, and intelligent agents.

Findings – How a CPA may conveniently audit the loan account of a bank with EA framework. Demonstration/application.

Research limitations/implications – Auditors will have to design one specialized audit software for each auditee's electronic data processing (EDP) system if the EDP system uses proprietary file formats or different operating systems. The EA has some limitations. This approach depends on distributed middlewares standards, i.e. CORBA, DCOM, or Java RMI, to enable the interconnections of the auditor's GAS[I], auditee's EDP systems.

Practical implications – This system emulates EDP applications in the banking industry and is based on the Common Object Request Broker Architecture (CORBA) architecture industrial standard.

Originality/value – How auditor could effectively apply existing CAATs with the support of the modern information technologies such as object-oriented distributed middleware, internet security technologies, and intelligent agents. Furthermore, this article proposes a new auditing approach that we call EA. Application in banking and financial institution for auditing banks loan account.

Keywords Auditing, Electronic commerce

Paper type Research paper

1. Introduction

Today's organizations rely heavily on sophisticated electronic data processing (EDP) systems to manage their daily business transactions and strategic accounting records in order to meet the challenge of fierce international competition. The increasing dependence on EDP systems has raised serious concerns from auditing practitioners and professional organizations such ASB (2002a, b; 2003a, b). For example, transaction and account information is kept in electronic form, which is readable only to computers (Foneca, 2003). Furthermore, audit trails exist only for a limited period or even do not

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exist at all since the transactions are automatically processed by EDP systems (Khemakhe, 2001). Therefore, it is difficult to uncover unauthorized transactions and/or other exceptions at later time if they are not detected on a timely basis (a detailed summary of concerns can be found in a recent "The IIA Research Foundation").

In response to these auditing concerns, many computer-assisted auditing techniques (CAATs) have been proposed (ASB and ASB). For example, generalized audit software (GAS) enables auditors to access live account data stored in various file formats that are machine-readable only (EDP and AuG-37, 2003). GAS also can disclose useful information on client master files that are not included in reports produced by the client. Integrated test facility (Helms, 2002), parallel simulation, and other *ex-post* CAATs can be used to validate the correctness of the EDP software module (Weber, 2004). Concurrent CAATs such as embedded audit modules and system control audit review file (SCARF) can be installed to examine transaction flows and to detect exceptions online, such as suspicious transactions (Wells, 2001).

Recent surveys show, however, that CPAs do not frequently and systematically use these CAATs in practice (Kalaba, 2002). For example, GAS is not on the list of the "common software use" according to the survey series conducted (Heffley and Meunier, 2004). Other surveys (1998-2001) indicate that both ex-post and concurrent CAATs are used primarily in internal audit settings by proprietary implementation. Even the most commonly installed CAAT, ITF, is used only by 5-20 percent of organizations (IIA, 2003; Knaster, 2003; Le Grand, 2001; Mehmet, 2002; Schelluch and Gay, 2002).

The failure of CAATs to meet their expectations may be due to the following reasons: first, GAS or CAATs lack a common interface with IT systems, such as file formats, operating systems, and application programs. We start with interactive data extraction and analysis (IDEA; AICPA, Chuck and Carolyn, 2004), one of the most popular GAS packages that is able to extract several file formats, such as ASCII, DBASE III, and others with a common interface. The problem is that auditors will have to design one specialized audit software for each auditee's EDP system if the EDP system uses proprietary file formats or different operating systems.

Second, for other concurrent CAATs such as ITF or SCARF, it is often required that special audit software modules be embedded at the EDP system design stage (Pathak, 2003). Therefore, the early involvement of auditors at the time when the system is under development becomes necessary (IIA, 2003; Tongren, 1999). Furthermore, an auditing policy change may require a major modification not only to individual audit software modules, but also to entire EDP systems (e.g. Wells, 2001; Geired, 2002). In summary, applying these advanced CAATs is usually very costly even if it is possible.

Third, as the auditees' EDP systems become more complex, it is essential for auditors to audit through the computers. The paper stream into and out of computers disappears and is replaced by electronic data streams, which can only be analyzed in an automated fashion (Harold, 2001). Most CAATs currently in use cannot directly access an auditee's live data. Auditors usually gather the historical data file from the auditee's personnel. This situation creates the possibility to be given manipulated or even fraudulent data (Carolyn, 2004). In addition, electronic data tampered by unauthorized personnel can remain undetected forever if sufficient internal controls are not in place.

The AICPA issued a professional pronouncement on the implications of electronic evidence, SAS No. 80, Amendment to Statement on Auditing Standard No. 31, Evidential Matter (Helms and Fred, 2000). This amendment suggests, "Auditors should consider using information technology to obtain evidence supporting electronic transactions." With the rapid advances on the internet, auditors should take advantage of new information technologies in order to gather information that is more reliable.

The primary focus of this article is to discuss how auditors could effectively apply existing CAATs with the support of the modern information technologies such as object-oriented distributed middlewares (Britcher, 1995, 2003; CORBA, 2003), internet security technology (Oppliger, 2000), and intelligent agents (Petit *et al.*, 2003). Furthermore, this article proposes a new auditing approach that we call electronic auditing (EA). The basic concept of EA is to perform audit tasks electronically and automatically over the internet where most of the auditees' accounting systems are processed and stored electronically (Harold, 2001). We demonstrate that the emerging technologies provide sufficient support to facilitate EA.

With EA, we believe:

(1) It is possible to create a common interface via middlewares where heterogeneous auditee's EDP systems can be interoperated across operating systems, application software, and multivendor hardware.

(2) Flexible audit modules can be triggered by the auditor on a periodic basis and may be executed locally. Since the audit module is under the auditors' control, auditors are not required to involve early in the auditee's EDP system and are less dependent upon computer specialists.

(3) EA enables auditors to directly access, with proper authorization of course, the auditee's or auditee's trading partners' live data via standard interface anytime and anywhere. This mechanism reduces the possibility of being given manipulated data (or even fraudulent data) by the auditee.

The structure of this article is as follows. The first part of this article introduces a number of state-of-the-art information technologies that could facilitate EA. Most of these technologies are still under development. These technologies may have a profound impact on how future business is conducted. The second part of this article discusses what audit works can be done electronically and how they can be done. A field study with three actual designs and implementation examples are presented to demonstrate the feasibility of the EA concept.

2. Methodology adopted and literature review

2.1 The emerging information technologies

Figure 1 depicts the EA framework that is constituted of three major advanced technologies: object-oriented distributed middlewares, intelligent agents, and internet security technologies. This section lays out the technical background of these technologies to facilitate further EA discussions.

2.2 Distributed middlewares

The explosive growth of the world wide web (www) (EDP, 2003; Emmerich), the increasing popularity of PCs, and the advances in high-speed networks have brought internet-computing into the mainstream. To simplify information access from the ever-growing www, several object-based distributed middlewares have emerged. Microsoft's DCM (COMS, 2003), object management group's (OMG) CORBA (CORBA,

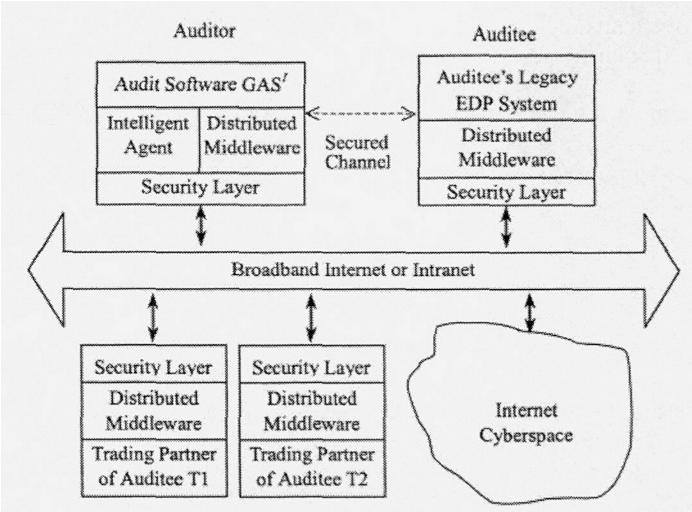

Figure 1.
The EA framework

2003), and Javasoft's RMI (JAVA, 2003) are three of the most important industrial standards.

A distributed object is essentially a component. This means that a distributed object is a self-contained intelligence that is capable of interoperating across operating systems, networks, languages, applications, tools, and multivendor hardware. This component is a unit of packaging, distribution, and maintenance. It is also a unit of deployment on a distributed object bus such as CORBA ORB or DCOM. The object bus provides a unified system architecture that can be of tremendous help to the system integrators of organization EDP systems.

The information or service provided by a distributed object is usually encapsulated into that object, and the interface for this object is described in a standard interface definition language (IDL) (CORBA, 2003). The interface defined by IDL serves as a contract between a server and its clients. Clients interact with a server by invoking methods (or object operators) described in the IDL. The actual object implementation is hidden from the client. Many object-oriented features are represented at the IDL level, such as data encapsulation, polymorphism, and interface inheritance (Lhotka *et al.*, 2003).

Encapsulation is information hiding. The interface to a program is defined in such a way as to hide as much as possible information about its inner workings. Encapsulation also separates the user of an object from the author of the object (Lhotka *et al.*, 2003).

Polymorphism is the ability of objects from different classes to respond in their own appropriate manner to common messages. The characteristic of a method that is applied across classes, changing its implementation to match the class, is called polymorphism. Inheritance is the automatic passing of properties for characteristics from a parent or ancestor to a child. The goal of object-orientation is to make software easier to create, simpler to use, and more reliable through reusability.

The distributed object infrastructure provides a base where EA can be facilitated. Communication between interfaces under our implementation is supported by CORBA, and all of these interfaces are specified using OMG IDL.

With data encapsulation, it is possible to "encapsulate" the legacy EDP systems with standard interfaces. One of the examples is OMG's latest attempt to "hook" organization EDP systems to a distributed object bus with a series of standard interfaces such as the General Ledger Facility (GLF) (OASIS, 2002). Excerpts of the GLF standard interface are shown here.

```
Interface GLRetrieval {
...
Account get_account (in wstring GLAcc_ref)
Raises (BadAccountType):
...
}:
```

This interface indicates that an auditor may use the standard function call get_account to retrieve a particular account from a general ledger in an auditee's EDP system as long as this system supports the OMG's GLF. Furthermore, the information retrieved via this interface returns account information in a standard format.

The advantages of this approach are numerous. Auditors now only have to develop one generalized audit software over the internet (GASI) for all of their clients, since they are able to freely access auditees' EDP systems through one standard interface via a homogeneous object bus over the internet. With a standard interface such as GLF and PnP function, it is possible for an auditor to design an audit module independent of the auditee's EDP system as required in some of the traditional CAATs such as SCARF. Furthermore, auditors can decide when to start the audit module in order to disclose exceptions and potential fraud with a distributed object infrastructure and high-speed networks.

2.3 Internet security technologies

The standard interface defined by distributed middlewares makes it easier for auditors to access EDP systems However, security over EDP systems has become a major concern between the auditors and auditee. The security risks are changing dramatically as the technology moves rapidly. We, therefore, propose to include a robust security layer in the EA framework as shown in Figure 1. This security layer provides a variety of functions to guard not only the safety of the data stored in the EDP systems but also the messages exchanged between two parties over the internet against malicious third parties (Neumann, 2002). These functions include authentication, encryption, and nonrepudiation. Authentication is a process in which both the client and the server must prove their identity to a trusted third party before they can begin a secure session. The authentication process can be achieved using security technologies such as digital certificate (Feghhi *et al.*, 2004).

Encryption allows two principals to hold a secure communication. Each principal must obtain a copy of a session key from a trusted third party. For example, logging on to an EDP system is granted only through legal passwords. Retrieving sensitive information is subject to proper access control. Various encryption algorithms such as public/private key (Feghhi *et al.*, 2004) protect information transmitted over the internet/intranet.

Nonrepudiation means uncontestable proof that a document (or message) was really originated by specific party. In the context of our framework, nonrepudiation implies that a document, such as a financial statement, (auditor) retrieved from an EDP system via an authorized interface over the internet will be considered a legal document. This document can be seen as a "send" out by an organization's EDP system. This security technology requires a form of electronic signature (Feghhi *et al.*, 2004).

2.4 Intelligent agents

With the explosive growth of the www, people often feel overwhelmed or even frustrated with this "unorganized" gigantic cyberspace Recent researches in areas such as artificial intelligence and knowledge engineering have provided some hope for the future. A new concept called an intelligent agent has just emerged (Geired, 2002).

> "An autonomous agent (intelligent agent) is a system situated within and as a part of an environment that senses that environment and acts on it, over time, in pursuit of its own agenda and so as to effect what it senses in the future." (Stone and Littman, 2001)

The most primitive intelligent agents are used in various types of search engines. Figure 2 illustrates a shopping agent that can assist someone with no knowledge of notebook computers to find the best bargains from thousands of notebook vendors on the internet. A thorough market analysis with easy-to-follow shopping recommendations will be presented within a few seconds, as depicted in Figure 3. These intelligent agents are capable of interacting with humans using natural language, analyzing semantics, and cooperating with other agents on the internet.

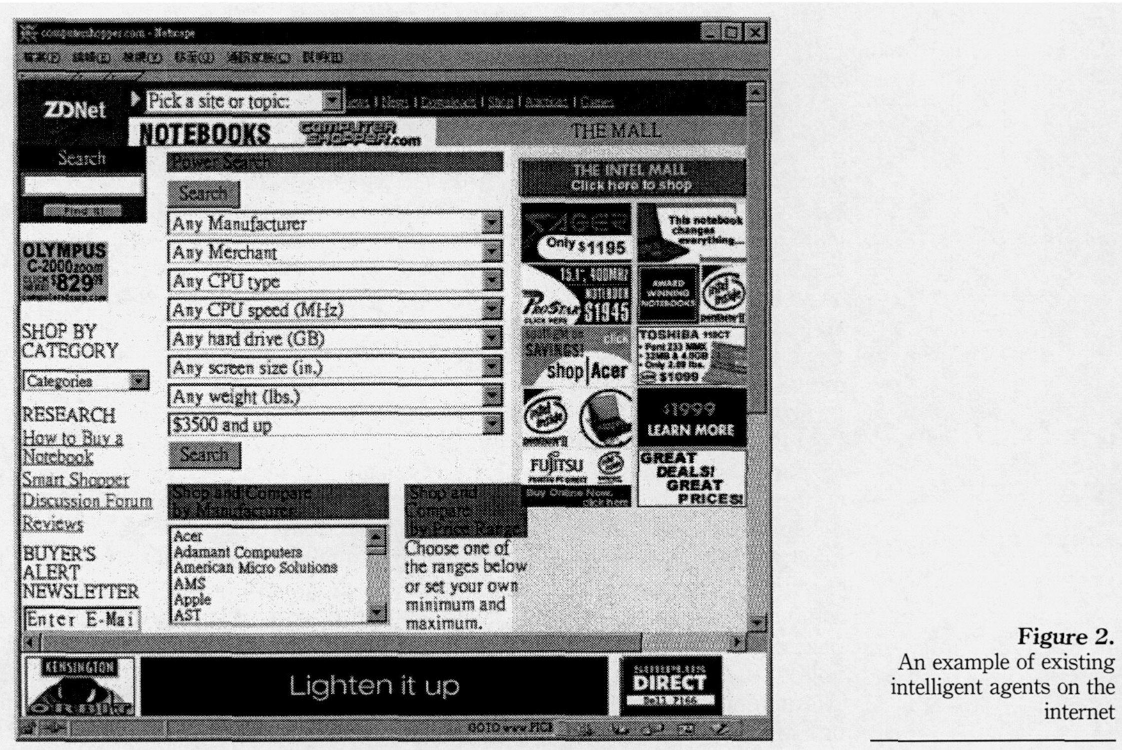

Figure 2.
An example of existing intelligent agents on the internet

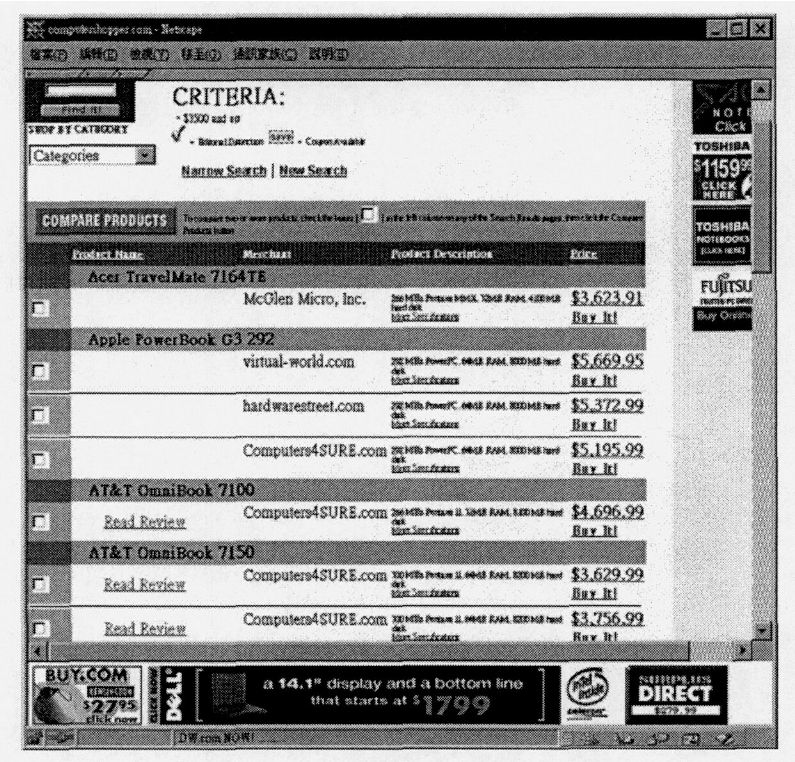

Figure 3.
The research results from an intelligent agent

Since intelligent agents are powerful in gathering professional information from this cyberspace for people without professional knowledge, auditors can acquire industry-specific knowledge (or domain knowledge) easily without the need for specialists such as appraisers and industry specialists. All acquired information could be restricted as much as possible. Intelligent agents will greatly enhance all aspects of audit work including gathering industry information, collecting, and evaluating the value of evidence, assessing the auditee's industry risk, and performing analytical reviews.

For example, FASB Statement No. 115, "Accounting for Certain Investments in Debt and Equity Securities," provides guidance on the valuation and presentation of investments in securities. Whether investments in securities are carried at cost or at market depends on the nature and classification of the securities. Auditors can achieve the specific audit objectives related to the valuation of an investment account using intelligent agent techniques. The first step in intelligent agent techniques is to find the specific domain of these securities by keying in important key words. Next, auditors could take advantage of an intelligent engine to search the fair market value of these securities and the risk level of special type securities in order to achieve the audit objective. As one can search, filter, analyze, and ultimately make decisions using the information gathered by intelligent agents from the www, auditors can benefit from intelligent agents to improve the quality of their work.

3. Analysis

3.1 EA and commonwealth national bank

A field study to demonstrate the feasibility of the EA framework has been conducted This study involves the Cooperation Account Department (CAD) at a commercial bank (Commonwealth National Bank), as depicted in Figure 4. This study consists of three major phases. In the first phase, intensive interviews are conducted with the staff of the MIS department and CAD of Commonwealth National Bank and the auditors from CPA K. The standard operation procedure for account loans at Commonwealth National Bank was thus constructed. Similarly, the auditing procedures at KPMG were derived. In the second phase, the EA software was designed and deployed to the IT systems at both Commonwealth National Bank and CPA K. The CAD was audited electronically via the internet over a period of 2 months. In this section, the EA system architecture design was presented and the results of this study were discussed via three case studies. Finally, the benefits of EA method were illustrated in the KPMG and Commonwealth National Bank perspectives.

3.2 Three scenarios

3.2.1 Scenario 1: On-line access to auditee's live data. Scenario 1 illustrates how a CPA may conveniently audit the loan account of a bank via GLF (CORBA based) over a secured internet channel. GLF (CORBA based) can provide an opportunity to "glue" many heterogeneous systems using one common layer. This common layer defines the standard application interfaces as well as the standard data structures. Therefore, it becomes possible for auditors to download from the client's side live information such

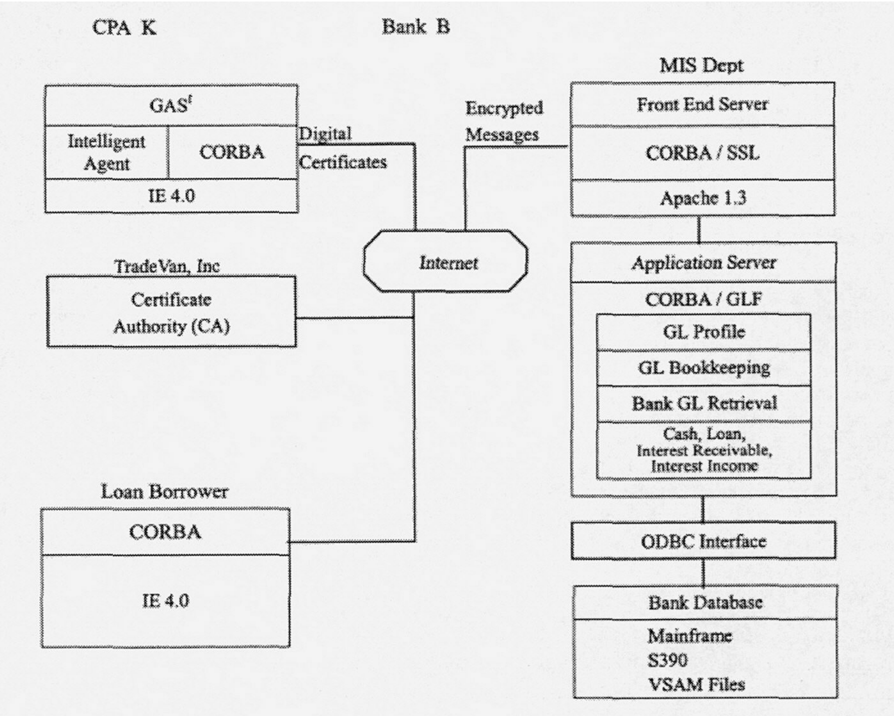

Figure 4.
CAD at a commercial bank

as transaction records, accounts in-general ledger through standard interfaces and to design one GASI for all of auditees. Since GASI can be designed, implemented, and tested on the CPA's platform, it imposes no inference to the auditees' operational EDP systems. This example also illustrates that proper access and authorization controls must be installed (using internet security technologies) at both sides, the auditor (the CPA) and auditee (the Commonwealth National Bank). Only authorized parties are allowed to access the live data. Furthermore, information transmitted over the secured channel will prevent tampering by network "sniffers."

The scenario is that KPMG audits Commonwealth National Bank's Loan (individual or collateral) accounts. Other related accounts involved in this audit are accounts such as interest receivable and interest income. Under the proposed EA framework, KPMG can assess Commonwealth National Bank's general ledger online via its CORBA GLF interface in order to get mortgage balance and interest information from the loan account for each loan borrower. KPMG uses GASI to recalculate all of the loan balances, interest receivable, and interest income. KPMG can then generate loan-aging statements to illustrate the past due interest receivable balance. Exceptions will be raised in the exception reports as well. This example shows how KPMG can take the advantage of the fast GASI process to perform a complete substantive test for all of the accounts. The CORBA BankGLRetrieval and object interfaces such as loan, interest receivable, and interest income are required for this example (Table I).

3.2.2 Scenario 2: Online detection of exceptions. Scenario 2 demonstrates the use of GASI over the EA framework to achieve an audit function: early detection of potential frauds. Auditors can plug an audit module flexibly in order to monitor targeted types of transactions on a periodic basis with GASI. This enables real-time generation of exception reports while audit trails still exist. An active notification that brings exceptions to the auditors' attention can also be easily implemented. This approach accomplishes the same goals as other concurrent CAATs such as embedded module and SCARF but without embedding any audit modules into the auditee's EDP system at the design stage. This can eliminate the auditors' need to be involved in the auditee's EDP system and increase audit flexibility.

The scenario is that KPMG can actively monitor targeted information (for example, past due loans) locally through a plug-in audit module at the auditor's side without

Table I.
Online access to auditee's live data

Business logic	Supporting information technology
1. Connect to the EDP system of bank B via CORBA interface BankGLRetrieval	Authentication, CORBA
Open Loan, cash, Interest receivable, and Interest income from bank B's general ledger via CORBA invocation BankGLRetrieval:get_accounts_by_type.	Encryption, intelligent agent, nonrepudiation, and CORBA
For each borrower in Loan account, perform Steps 3-5	
Get mortgage balance. Interest rate, and beginning day from bank B's loan account	Encryption, nonrepudiation, and CORBA
Retrieve year to date balance from cash per borrower account	Encryption, nonrepudiation, and CORBA
Recalculate the interest income and reconcile the balance with loan, interest receivable and interest income accounts using GASI implemented by CPA K	GAS1
Prepare loan aging statements and exception reports	GAS1

interfering with Commonwealth National Bank's EDP system. The audit strategy used in this example is that an exception will be raised either when a loan borrower fails to pay the interest payments for more than *M* months or when the past due balances are over $100,000. In this example, GASI is used to raise a flag and to pass a warning message to KPMG through CORBA middlewares automatically. Therefore, KPMG can on-line monitor suspicious transaction sets or actively detect potential risks in advance in order to prevent potential misconduct or fraud. The CORBA interfaces required for this example are cash, interest Receivable, and loan (Table II).

3.2.3 Scenario 3: Electronic confirmation. Scenario 3 illustrates how the auditor's proprietary audit objects, such as a confirmation process can be automated using new interfaces that depend on distributed middleware's CORBA under the EA framework. A confirmation letter can be prepared using GASI based on the live data retrieved from the auditee's EDP system. This confirmation request could be sent by the auditor's software to the trading partners directly via a prearranged secure channel. Operationally, the confirmation response would function like an application acknowledgment, except that the acknowledgment is sent to the auditors rather than to the trading partners. If no exceptions are noted, the confirmation process could be automated. If there were exceptions, however, manual follow-up would likely be necessary.

The scenario shows the basic steps in this automated process. First, KPMG manages to retrieve loan (assets) related account information from Commonwealth National Bank via auditee's GLF interfaces over a secured internet channel. Next, the CPA's GASI examines the accounts and prepares confirmation letters automatically. It then sends out the confirmation letter to all loan borrowers through e-mail, EDI, or some other communication means. Once the responses are returned, GASI and an intelligent agent technique automatically evaluates the confirmed information against the auditee's account data. An exception report is then prepared for the auditor's review to complete the process. This electronic confirmation process can reduce the manually intensive process and electronically confirm activity with other financial institutes, loan borrowers, or customers. The CORBA interfaces needed for this example are cash and loan (Table III).

4. Conclusion

This article introduced a new concept called EA where some of the audit tasks can be conducted electronically over the internet with the support of information technologies.

Business logic	Supporting information technology
1. CPA K loads the self-designed GAS1 to actively monitor loan account of bank B via CORBA interface	1. GAS1 intelligent agent
2. The GAS1 program retrieves interest receivable and cash accounts from bank B via CORBA interface	2. Encryption, nonrepudiation, and CORBA
3. GAS1 compares each borrower's last payment due date in cash with interest receivable balance in interest receivable account	3. GAS1
4. The GAS1 prints an exception report and informs CPA K immediately if there exists a payment that is overdue more than *M* days or if the overdue payment exceeds $100,000.	4. GAS1

Table II. Online detection of exceptions KPMG

Business logic	Supporting information technology
Get all loan information from bank B via its CORBA interface (BankGLRetrieval). For each loan borrower in the account loan, perform step 2-8	Authentication, encryption, intelligent agent, and CORBA
Retrieve from loan account the necessary information for a typical confirmation letter, which includes borrower's name, address, account number(s), mortgage balance, due date, interest rate and collateral description. etc.	Encryption, nonrepudiation, and CORBA
Get year-to-date balance of each borrower from cash account via CORBA interface	Encryption, nonrepudiation, and CORBA
Prepare the confirmation letter and get digital signature of CPA K	Nonrepudiation
Send the confirmation letter to the borrowers through e-mail or other online means	E-mail. EDI. Or other internet technology
Repeat until all confirmation letters are sent out	Intelligent agent
Wait for replies from borrowers	Intelligent agent
Examine the replied letters from bank B's (loan) borrowers	
Prepare exception report if needed	

Table III.
Electronic confirmation

We identified three emerging information technologies to constitute a software framework to facilitate EA. These technologies include object-oriented distributed middlewares, internet security technologies, and intelligent agents. We proposed a new CAAT called GASI based on the EA framework. GASI inherits most of the existing GAS features and is able to achieve the same objectives as other concurrent CAATs. Moreover, GASI can be designed and deployed independently from the auditee's EDP systems, therefore, it does not suffer the same drawbacks as concurrent CAATs.

For the purpose of concept verification, we presented a prototype EDP system based on CORBA standards, a well-known object-oriented distributed middlewares from OMG. This system emulates a banking system (EDP) where it supports OMG's GLF. The technical details presented in the examples demonstrate how auditors may develop, deploy, and maintain GASI to detect exceptional transactions process in auditee's EDP systems earlier and how the confirmation process in the audit procedure can be automated.

The EA has some limitations. This approach depends on distributed middlewares standards, i.e. CORBA, DCOM, or Java RMI, to enable the interconnections of the auditor's GASI, auditee's EDP systems, and the www. All of these middlewares technologies are in their infantry stage. This implies that they are evolving standards. We expect an explosive application of these technologies to take place when they become mature and may further assist auditors in improving the quality of their work.

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