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Continuous Auditing: Building Automated Auditing Capability[1]

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Summary

The digital economy has significantly altered the way business is conducted and financial information is communicated. A rapidly growing number of organizations are conducting business and publishing business and financial reports online and in real-time. Real-time financial reporting is likely to necessitate continuous auditing to provide continuous assurance about the quality and credibility of the information presented. The audit process has, by necessity, evolved from a conventional manual audit to computer-based auditing and is now confronted with creating continuous electronic audits. Rapidly emerging information technology and demands for more timely communication of information to business stakeholders requires auditors to invent new ways to continuously monitor, gather, and analyze audit evidence. Continuous auditing is defined here as "a comprehensive electronic audit process that enables auditors to provide some degree of assurance on continuous information simultaneously with, or shortly after, the disclosure of the information." This paper is based on a review of related literature, innovative continuous auditing applications, and the experiences of the authors. An approach for building continuous audit capacity is presented and audit data warehouses and data marts are described. Ever improving technology suggests that the real-time exchange of sensitive

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financial data will place constant pressure on auditors to update audit techniques. Most of the new techniques that will be required will involve creation of new software and audit models. Future research should focus on how continuous auditing could be constantly improved in various auditing domains including assurance, attestation, and audit services.

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Introduction

Electronic commerce, electronic data interchange (EDI), and the Internet are dramatically changing business practices and record keeping. Doing business on the World Wide Web enables organizations to connect into the online world and improve all aspects of their business. In this high-technology environment business transactions are conducted entirely in electronic form. Technological advances have taken the form of low-cost, high-speed digital data transmission by utilizing hardware that produces information quickly and easily, and using software that reduces and, in many cases, eliminates much time, space, and other constraints to information. The progress in information technology, while reducing both transaction costs and asymmetric information problems, has increased economies of scale and scope in all business sectors (Albrecht and Sack 2000). The 1998 Vision Project of the American Institute of Certified Public Accountants (AICPA) states that technological advances are significant forces affecting the accounting profession (AICPA 1998a).

Traditionally, credible financial reports could only be produced on a periodic basis, primarily because the information needed to generate the reports was too costly to obtain on a real-time basis. Consequently, reports have been issued months after the occurrence of the actual events they represent. In this setting, auditing is mostly a backward-looking exercise testing the accuracy of the reported numbers. Today, organizations can produce standardized financial information on a real-time, online basis. The time is near when companies will allow shareholders and others to have access to real-time corporate financial information. Real-time accounting needs real-time auditing to provide continuous assurance about the quality of the data. Thus, continuous auditing is likely to become commonplace as audit clients increasingly shift to electronic real-time accounting systems. Continuous auditing enables auditors to significantly reduce and perhaps eliminate the time between occurrence of the client's events and the auditor's assurance services thereon.

This article discusses the nature of continuous auditing and describes audit data marts as an auditing approach in a real-time business environment. A joint

Canadian Institute of Chartered Accountants (CICA) and Accounting Standards Board (ASB) of the AICPA study group (also known as Wood Committee) issued a report, Continuous Auditing, in March 1999. This exploratory study (1) examines conditions that must be met for continuous audits to be viable; (2) describes how a hypothetical continuous audit engagement might be conducted; and (3) presents areas where further research is needed for the proper implementation of continuous auditing (Study Group 1999). One of the recommendations of the study group is more research by academicians and practitioners on continuous auditing. This article is a response to this important call by the study group.

The remainder of this paper is organized as follows. The next section discusses real-time accounting and electronic financial reporting and their impacts on continuous auditing. This is followed by a description of the definition, concept, and process of continuous auditing. The next section presents a methodology for building continuous auditing capabilities and describes illustrations of innovative continuous auditing applications. Finally, conclusions and suggestions for future studies are offered.

Real-Time Accounting and Electronic Financial Reporting

Making good decisions depends, in part, on the quality and timeliness of information. Electronic and digital information is more timely, flexible, accessible, transferable, transparent, and can be more easily stored, retrieved, summarized, and organized than paper-based information. Technology has enabled organizations to conduct an increasing percentage of their business transactions electronically and prepare their financial statements on an online and real-time basis. Under real-time accounting (RTA) systems, much of the financial information and audit evidence is available only in electronic form (Rezaee et al. 2000). Traditional source documents such as purchase orders, invoices, and checks are replaced with electronic messages. Underlying accounting data are in electronic form such as relational databases that can be substantially different in basic structure than conventional journals, ledgers, and schedules.

The electronic age has already changed the way organizations conduct business and publish their financial reports. Recently, the majority of companies (over 80 percent) are providing some type of financial disclosure on the Internet by using the HTML format (Rezaee and Hoffman 2001). HTML is effective in communicating basic information relating to financial disclosures. However, HTML format does not allow searching, analysis, and manipulation of information without downloading and transferring it onto a spreadsheet or some software application with search and manipulation capabilities. Financial information currently reported on the Internet presents electronically duplicated hard copies of the traditional paper-based reports in hypertext form. The recent development of eXtensible Markup Language (XML) and its financial version, eXtensible Business Markup Language (XBRL), can use accepted financial standards to exchange financial information across a variety of technologies, including the Internet. XBRL will extend beyond

reproduction of a hardcopy report by describing data and establishing individual "tags" for elements in structured documents.

The AICPA has been working with major national and international organizations for several years to develop XBRL specifications. The first XBRL taxonomy, "Financial Reporting for Commercial and Industrial Companies Under US GAAP" was released on July 31, 2000. XBRL taxonomies for not-for-profit organizations and financial institutions are also under development. Taxonomies are data dictionaries of all accounts and financial information needed to prepare a full set of financial statements tagged in XML according to specific authoritative standards (Rezaee and Hoffman 2001). The AICPA is leading the effort to the final development of XBRL and has the support of both the national and international financial community including the Big 5 accounting firms. Under the XBRL format, financial information is entered only once, and then it can be rendered in any form, such as printed financial statements, HTML documents for the organization's web site, EDGAR filing documents for regulatory purposes (e.g., SEC), and other specialized reporting formats for tax purposes or credit reports. Large companies already allow their trading partners real-time access to corporate information. By creating a standard language among companies, organizations, auditors, and financial statement users, XBRL will enhance the availability, reliability, and relevance of financial statements[2].

One of the main features of XBRL is that it allows organizations to prepare one set of financial statements in a format that will be viewable and usable within many applications. This eliminates the need to prepare financial statements in different formats, which, in turn, reduces preparation time, saves cost, and minimizes the possibility of errors in different documents. Users of financial statements can easily read through the financial statements by downloading the XBRL statements from the Internet or from a web site. The tags used in XBRL make searching through financial statements easier than ever, finding information presented in financial statements less time consuming, and auditing of standardized online financial statements more efficient and effective.

The changes outlined in the financial-reporting process require the creation of new procedures to conduct a financial audit. The primary objective of a financial audit and auditing standards do not change. However, electronic documents and reports under the RTA system change the role of independent auditors in the financial-reporting process, including the risk profile of the audit and the nature of the exposures. The increasing use of electronic commerce is likely to require

[2]XBRL is based on eXtensible Markup Language (XML), which is a web-based system that uses tags to describe data. XML is a set of specifications, guidelines, or conventions for creating text formats in a way that are easily generated or read by computers. XML uses tags and attributes to transfer structured data, such as spreadsheets, into a text file that can be read by a variety of applications to fit users' needs. XBRL provides the XML tags and attributes for financial-reporting information as well as business information. XBRL provides both content and structure to financial information and will standardize the preparation, publication, examination, and extraction of financial information across all software formats and technologies, including the Internet (Rezaee and Hoffman 2001).

auditors to employ online, continuous audit techniques. A number of emerging audit technologies, including the utilization of automated software, continuous auditing techniques, embedded audit modules, integrated test facilities, and concurrent audit tools can be employed in performing electronic online auditing. Data warehouses and audit-specific data marts, discussed in this paper, are being created to segregate audit evidence on a real-time basis and make financial data and related audit evidence available for the auditor in a format that facilitates a variety of audit tasks.

Continuous Auditing Definition

The changes in the business and audit environment suggest that the traditional annual reports and the conventional "backward-looking" audit reports attached to the financial statements may not meet the needs of users of financial reports. Thus, real-time accounting systems, electronic financial reports, and continuous auditing are receiving considerable attention from business and accounting communities. A complete understanding of the nature and relevance of continuous auditing requires a commonly accepted definition. Continuous auditing has been defined differently in the academic literature, in the professional literature, and in official reports issued by standard-setting bodies. For example, Rezaee et al. (2001, 151) define continuous auditing "as a systematic process of gathering electronic audit evidence as a reasonable basis to render an opinion on fair presentation of financial statements prepared under the paperless, real-time accounting system." Helms and Mancino (1996, 21) state, "continuous auditing has historically meant using software to detect auditor-specified exceptions from among all transactions that are processed either in a real-time or near real-time environment. These exceptions could be investigated immediately or written to an auditor's log for subsequent work." The joint study of the North American accounting bodies (CICA and AICPA) defines continuous auditing "as a methodology that enables independent auditors to provide written assurance on a subject matter using a series of auditors' reports issued simultaneously with, or a short period of time after, the occurrence of events underlying the subject matter" (Study Group 1999, 5).

For the purpose of this paper, we define continuous auditing as "a comprehensive electronic audit process that enables auditors to provide some degree of assurance on continuous information simultaneously with, or shortly after, the disclosure of the information." This generic definition of continuous auditing is broad enough to cover all three professional services commonly provided by independent auditors, i.e., assurance, attestation, and audit services. The degree of assurance and the type of continuous information determine the type of services to be rendered by independent auditors. For example, when the assurance provided is positive (high-level) and the continuous information pertains to financial statements, per se, the continuous auditing engagement is considered as an audit service. When

the assurance provided is negative (moderate-level) and the continuous information is primarily financial information, the continuous auditing engagement is viewed as an attestation service. However, when the assurance provided entails continuous information of any information (either financial or nonfinancial), the continuous auditing engagement is considered to be an assurance service. Nevertheless, continuous auditing enables independent auditors to lend credibility to the continuous information provided by management or third parties. Continuous auditing serves many clients and provides different degrees of assurance tailored to their specific needs.

Continuous Auditing Process

Continuous auditing affects the traditional audit process in several ways. First, it is reasonable to expect that the auditor's knowledge of client's business and industry should increase to assure reliability and relevance of electronic documents, records, and data. Knowledge of the client's industry and business strategy is important in understanding the objectives of a client's business processes and assessing related risks and internal control activities. For example, in KPMG's audit approach, understanding of the client's business strategy is considered as the first step in assessing the adequacy and effectiveness of internal controls and in forming expectations regarding financial statement balances (Bell et al. 1997). Advances in technology and the use of real-time accounting systems under the XBRL format encourage auditors to place even more emphasis on their clients' business processes in the planning stages of the audit to ascertain the proper use of electronic financial reporting in accordance with the industry specifications and taxonomies. Second, the auditors will need to understand the flow of transactions and related control activities that ensure validity and reliability of information better in a paperless, RTA system. Under real-time accounting systems, transactions are transmitted, processed, and accessed electronically and, thus, auditors need to gain assurance that these transactions are not being altered. The AICPA (1997, 2) states that "the competence of electronic evidence usually depends on the effectiveness of internal control over its validity and completeness."

Third, under continuous auditing the auditor needs to employ a control-risk-oriented audit plan that primarily focuses on adequacy and effectiveness of internal control activities of the RTA system while placing less prominence on substantive tests of electronic documents and transactions. Continuous auditing requires auditors to develop client-specific internal control templates to (1) evaluate the adequacy and effectiveness of the client's internal control structure; (2) assess inherent and control risks; and (3) provide a detailed set of audit tests to be performed. These internal control templates can perform electronic testing of sophisticated controls, including firewalls, authentication, passwords, and encryption of sensitive information. Finally, continuous auditing requires auditors to develop their own software audit tools capable of auditing through the computer or to acquire commercially

available software packages[3]. These continuous audit tools and techniques (CATTs) enable auditors to assess risk, evaluate internal controls, and electronically perform a variety of audit procedures, including extracting data, downloading information for analytical review, footing ledgers, counting records, selecting samples for tests of controls and substantive tests, identifying exceptions and unusual transactions, and performing confirmations.

Continuous auditing enables auditors to shift their focus from the traditional "balance sheet" audit to the "system and operational results" audit. Continuous auditing has a number of potential benefits including (1) reducing the cost of the basic audit assignment by enabling auditors to test a larger sample (up to 100 percent) of client's transactions and examine data faster and more efficiently than the manual testing required when auditing around the computer; (2) reducing the amount of time and costs auditors traditionally spend on manual examination of transactions and account balances; (3) increasing the quality of financial audits by allowing auditors to focus more on understanding a client's business and industry and its internal control structure; and (4) specifying transaction selection criteria to choose transactions and perform both tests of controls and substantive tests throughout the year on an ongoing basis. Audit evidence gathered by performing tests of controls can be used as a basis for reducing more costly substantive tests of analytical procedures, tests of details of transactions and tests of details of account balances. With continuous auditing, auditors may conduct tests of controls simultaneously with substantive tests of analytical procedures and tests of details of transactions to gather persuasive evidence regarding the quality and integrity of the client's electronic system in producing reliable and credible financial information. Auditors perform substantive tests of details of transactions to determine whether erroneous or irregular processing of transactions has caused material misstatements in the financial statements. CATTs can be used in performing tests of transactions continuously throughout the year in order to reduce the extent of substantive tests of account balances often performed after the balance sheet date.

Continuous auditing gathers audit evidence regarding the following questions: (1) how are data electronically gathered; (2) how, from where, and from whom are the data originated; (3) what authentication techniques are used; (4) what networks are used to originate and transmit the data; and (5) how are the data processed. Auditors typically use specialized programs (control agents), which are auditor-defined heuristics, applied to a transaction set. The control agent, upon finding unusual activities, first searches for similar activities to explain the activity pattern and alerts the auditor if unprecedented unusual activities are detected (Kogan et al.

[3]Bierstaker et al. (2001), Glover and Romney (1998), and Lanza (1998) discuss a number of the commercially available continuous audit tools and techniques (CATTs), including Small Audit Support (SAS) and Audit Command Language (ACL). SAS allows auditors to assess risks, evaluate internal controls, and develop audit plans and evidence-gathering procedures and reports. ACL can be used for file interrogation, which enables direct access to computerized client data.

2000). The control agent relies on innovative analytical techniques (e.g., digital analysis) and data mining to detect unusual patterns.

Auditors can develop their own online audit programs or purchase commercially available web-based audit tools (Intacct Corp. 2001)[4]. Intacct web-based audit tools include audit programs, questionnaires, and more than 100 customized work papers that can create customized documents or tests in Word or Excel. These audit tools also provide audit functions such as file interrogation and work paper archiving and retrieval, and allow auditors to perform continuous online audits. More specifically, web-based auditing tools enable auditors to (1) upload or download files for inclusion in the audit file; (2) create lead sheets, ratio analyses, roll forwards, and financial statements; (3) select criteria to interrogate client data, test transactions or account balances; (4) report summary of unadjusted errors; (5) prepare working trial balance with adjusting and reclassification entries; and (6) create general PDF documents for easy printing and viewing. Web-based audit programs enable auditors to gather relevant online information about their clients' business and industry to determine where the potential risks are and what controls can manage these risks. These tools also allow auditors to switch away from the "backward-looking" audit of historical financial statements to "continuous auditing" of accounting system reliability and integrity as well as internal controls adequacy and effectiveness.

Continuous Auditing Methodology

Effective development of a continuous auditing methodology requires creating an information technology infrastructure for accessing and retrieving data with diverse file types and record formats from different systems and platforms. This process entails standardization of data obtained from a variety of data sources and legacy systems. The standardization of data is the most complex and challenging aspect of building continuous audit capacity as the costs and complexities and risks of introducing errors and duplicate records can create formidable obstacles to the development of an end-user audit testing and analysis solution.

Building Continuous Auditing Capability

The degree of automation in continuous auditing can vary depending on audit system design and implementation. The highly automated processes involve embedded audit modules whereby audit programs are integrated with the application source code to constantly monitor and report on events of audit significance. Other less automated processes may involve an ability to automatically capture, transform, and load data but will still require auditor involvement in running queries to isolate

[4]One of the Big 5 professional services firms (Deloitte & Touche, LLP) in cooperation with Intacct Corp. has developed the first web-based auditing program for medium-sized clients (Intacct Corp. 2000).

exceptions and detect unusual patterns. Thus, there are different approaches and methods to carry out continuous auditing.

Corporations with dispersed and varied data systems may opt for designing and implementing a scalable audit data warehouse that allows leveraging of enterprise-wide data for audit testing and analysis. A data warehouse is a repository for storing transactions captured from various business systems. Ideally, a data warehouse should be scalable to allow processing of large volumes of data as audit coverage expands. Often implementation of embedded audit models in complex legacy systems with multiple system features and data interrelationships may be cost prohibitive. In those circumstances auditors can benefit from building scalable audit data marts aimed at automating the transaction capturing, auditing, and reporting processes.

It is imperative that the auditing software and tools used for data acquisition, data transformation, and audit testing and reporting be able to "speak" to each other. To build continuous auditing capability may necessitate developing applications that use several types of software to handle multifaceted data requirements. Figure 1 shows the various phases in developing a continuous auditing capability. The phases are interrelated and not necessarily in linear order and will be discussed in the following pages. Figure 2, shows a generalized approach to audit testing and analysis that also depicts the interrelationships between various stages of developing automated audit testing and analysis capability. In Figure 2, several phases that are

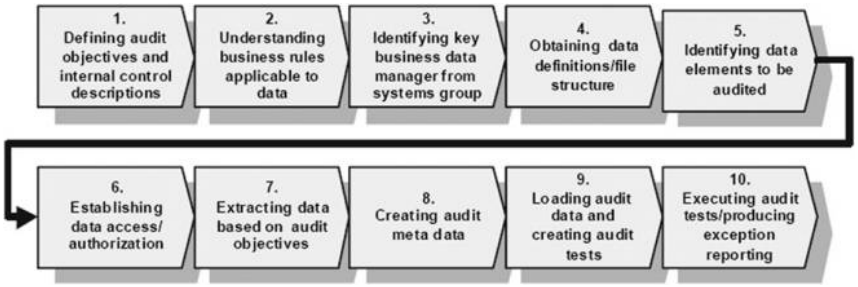

Figure 1: Continuous Auditing Process Flow.

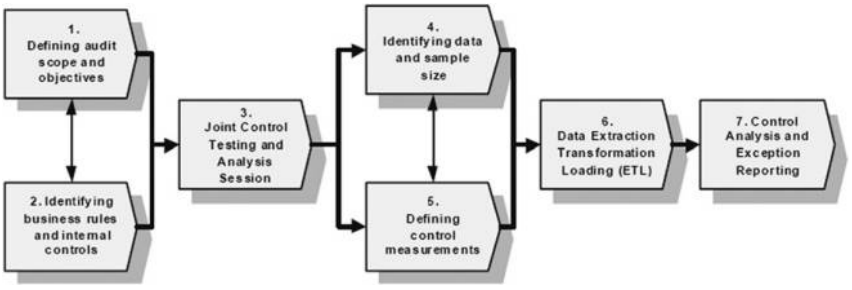

Figure 2: A Generalized Approach to Audit Testing and Analysis.

listed in Figure 1 are depicted as a single phase for process-summarization purposes. For example, the three phases of extracting data based on audit objectives, creating audit meta data, and loading audit data in Figure 1 are combined as ETL in Figure 2. The joint Control Testing and Analysis session in Figure 2 facilitates a common understanding between business unit managers, information technology (IT), auditors, and applications regarding continuous auditing project objectives, control testing methods, query execution and performance criterion, and exception reporting requirements.

In Figures 1 and 2, the first two phases—(1) defining audit objectives and internal control descriptions and (2) understanding business rules applicable to data—are requirements of any auditing function. Every audit engagement involves testing management's assertions (e.g., existence of assets) by gathering sufficient and competent evidence. Independent auditors should consider the availability of evidence in electronic form and its implication to determine the extent of tests of controls and the nature, timing, and extent of substantive tests. Ever-increasing information technology and the use of electronic commerce require auditors to obtain evidence electronically and, accordingly, encourage the accounting profession to incorporate the concept of electronic evidence into professional standards. Thus, in December 1996, the Auditing Standards Board (ASB) issued Statement on Auditing Standards (SAS) No. 80, Amendment to SAS No. 31, and Evidential Matter (AICPA 1996). SAS No. 80 states that auditors of entities that transmit, process, maintain, or access significant amounts of electronic information may be unable to reduce detection risk to an acceptable level by performing only substantive procedures, requiring them to perform tests of controls to obtain evidence to help achieve an assessed level of control risk sufficiently below the maximum. Certain electronic evidence may exist at a particular point in time, but may not be available after a specified period if files are changed and backup files do not exist. The auditor should consider the time during which information exists or is available in determining the nature, timing, and extent of substantive tests. The AICPA also published an Auditing Procedures Study (APS), The Information Technology Age: Evidential Matter, to provide auditors with additional guidance to apply the provisions of SAS No. 80 (AICPA 1997). Recently, the ASB, in April 2001, issued SAS No. 94, The Effect of Information Technology on the Auditor's Consideration of Internal Control in a Financial Statement Audit (AICPA 2001). SAS No. 94, which amends SAS No. 55 (AICPA 1998b), provides guidance on the effect of information technology (IT) on the auditor's understanding of internal control, assessment of control risk and its impact on audit procedures. Provisions of SAS No. 94 are applicable to continuous auditing by providing guidelines for auditors to better understand the (1) effects of IT on the internal control structure; (2) types of IT controls that are important to continuous auditing; and (3) the financial reporting process under real-time accounting systems (AICPA 2001).

The most commonly used CATTs in testing the effectiveness of the internal control structure are (1) test data or integrated test facilities (ITF) determining whether the RTA system is correctly processing valid and invalid transactions and verifying correctness and completeness of processing; (2) parallel simulation replicating of some

part of a client's application system to assess the effectiveness of control activities; (3) concurrent processing audit modules incorporated directly into important computer applications to continuously select and monitor the processing of data; and (4) continuous and intermittent simulation (CIS) used to select transactions during processing for audit review and provide an online auditing capability. Concurrent audit techniques, such as the snapshot approach and systems control and audit review facility (SCARF), are expected to receive increased attention and use under continuous auditing in testing the effectiveness of the client's internal control structure.

Under real-time accounting systems, the paper-based audit trail that would document the sequence of events in processing a transaction often does not exist. When an audit trial does not exist, continuous auditing collects audit evidence concurrently as transactions are electronically processed. CATTs that can be used in continuous auditing, such as ITF, are commonly used in an EDP audit environment and can be found in traditional EDP audit technology literature (e.g., Warren et al. 1996; Kanter 2001). The ITF approach requires the creation of small subsystems within the client's application system files to compare processed audit test data against the client's data as a means of verifying processing authenticity, accuracy, and completeness. SCARF is a method built into the data processing programs to perform test procedures continuously according to selected audit criteria such as special limit and reasonableness. This technique requires embedding audit software modules within the client's application to provide continuous monitoring of the system's processing of transactions. Transactions and events that meet auditor-specified criteria are written into a file available only to the auditor for further examination. Snapshot is a method of taking a "picture" of database elements before and after computer processing operations have been performed to test whether update processing was correct. This embedded software typically captures a before-and-after image of the online transaction and stores the results in an extended record for auditor consideration.

In a large corporation the business unit data administrator/data manager (Figure 1, Phase 3) is of cardinal importance. The business unit data manager can provide essential information about data definitions, file layouts (Figure 1, Phase 4), and identify key data to target for audit testing (Figure 1, Phase 5). The next phase involves setting up data access and authorization protocols (Figure 1, Phase 6) whereby the continuous audit application is enabled to simultaneously log on to multiple platforms for capturing and transferring data. The data contained in enterprise data systems often reside in multiple locations, multiple databases, and in diverse data platforms and systems—some of which are highly interrelated. Multiple platforms, geographically dispersed, can interact to generate a single transaction. A continuous auditing solution must enable auditors to quickly access and retrieve data residing in any enterprise computing platforms, such as SAP R/3, Baan, PeopleSoft, Oracle, or SQL, as well as in various file formats, such as IMS, VSAM, ASCII, MDB, CSV, XLS, TXT, used by business groups. Enterprise-wide computing platforms, such as SAP R/3, offer powerful online auditing and internal control evaluation tools including logging capabilities, the ability to trace available transactions from beginning to end and security tools (Gibbs 1998).

Data captured by continuous audit applications can be held in an audit data mart for testing and analysis. Data marts are well-known concepts in the data warehousing and data mining literature. David and Steinbart (1999, 30) define a data warehouse as "a big data pool—a single company-wide data repository—with tools to extract and analyze the data." A data warehouse integrates data from all application systems throughout the organization. Data marts are smaller subject-based warehouses that focus on only one functional area (e.g., accounting or marketing) and, thus, integrate data across a limited number of application systems (David and Steinbart 1999). Using an audit data warehousing model, the information about data extraction (e.g., linking to source tables, selecting columns), data transformation (e.g., appending, renaming, labeling, sorting), and audit tests (e.g., applying test scenarios), are stored in the audit meta data (Figure 1, Phase 9).

An audit data mart created for a business unit goes through three broad phases: extract, transform, and load (ETL). Phases 7 through 9 in Figure 1 show the ETL process. The final stage in construction of automated continuous auditing capability is to build standardized audit tests that reside in audit data marts. These audit tests run continuously or on a predetermined time interval (e.g., daily, weekly, monthly) and automatically gather audit evidence and generate exception reports for auditor's review and consideration. Several factors contribute to the need for audit data warehouses and data marts. Among these factors are physical and logical data fragmentation, timing differences among databases, lack of enterprise-level data integrity and consistency, inaccurate or incomplete data definitions and business rules, incomplete audit trails, and limitations on access to business production systems and many millions of transactions and records created and updated daily.

The conceptual technical architecture of a continuous auditing system is shown in Figure 3. An optimal continuous auditing model will combine the power of distributed client/server architecture with web-enabled data for delivery to audit workstations. First, data need to be captured from the transactional systems either

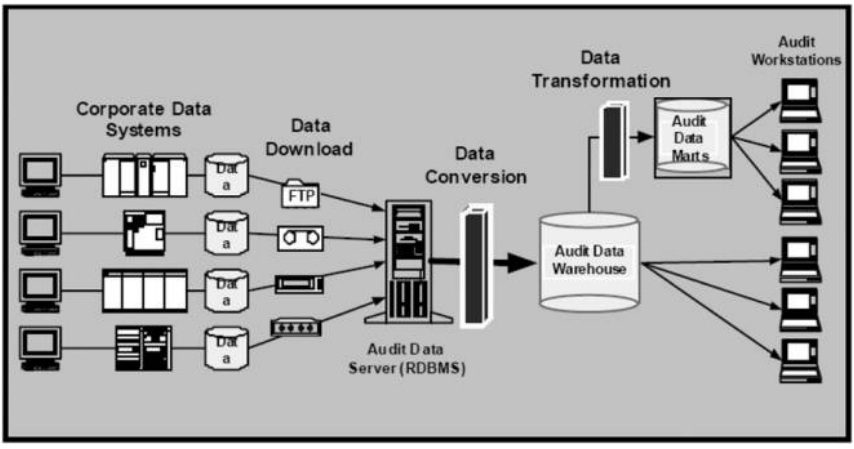

Figure 3: A Continuous Auditing Approach.

through a direct link to specific tables, using file transfer protocol (FTP), reading data from a tape, uploading data stored in a zip drive, or data transferred via a modem line and storing data in a relatively large capacity audit server. Data extracted from diverse platforms and systems should go through a data standardization process. Data standardization requires development of a series of standards for storing data in the audit data warehouse. For example, transaction date maybe stored in different formats (e.g., date-time, year-month-day, Julian). Depending on the complexity of data transformation, the processing can be done either in the source applications or transactions can be downloaded and then transformed/cleansed at the audit server. The method chosen may have significant cost implications because processing in a legacy mainframe environment is more expensive than in a server. The continuous auditing solution model presented here is capable of easily transforming data by cleaning, validating, labeling, renaming columns/variables, and "scrubbing" data with business rules. The data cleaning maybe achieved through several advanced commercial software tools, which use Graphical User Interface (GUI) to generate the necessary data transformation logic, or through custom code generation and batch execution.

The continuous auditing model presented in Figure 3 does not require building an enterprise-wide data warehouse. The cost and complexity of such an initiative may be beyond the scope of most of the corporate audit departments. Instead, the objective is to automatically feed several focused data marts and periodically extract selected data based on an audit-testing plan from source data sets containing fewer data elements for data transformation/mapping. The data mart is a series of standard meta data that contain complete documentation about source transactions and the ETL process (e.g., file definitions, business rules, transaction process flows). Depending on degree of interrelationship between business units, each unit may have its own audit data mart or several units may share a single data mart if they are highly interrelated and use the same databases. Data collected and transformed for various business units' data marts will be physically stored in an audit data server for easy access, analysis, and reporting. The attempt here is not to duplicate corporate databases. Only very selective transactions that have been defined to pose an audit risk will be collected and stored in the audit data warehouse. For example, a brokerage trade file may contain hundreds of columns and millions of records. However, only a handful of columns that contain key audit trails (e.g., user ID, customer name and account number, transaction date, transaction amount, transaction type) will be collected for audit testing.

Access to audit data marts will generally be limited to auditors, business unit managers, and corporate security officers who need to easily perform audit testing and exception reporting from their workstations. These end-users can conduct testing and reporting without being concerned with the complexities of data acquisition, transformation, and data loading. End-users of audit data marts need to be equipped with proper software that facilitates the user's needs. The two generic categories of audit data mart users are oversight users and analytical users. Oversight users are those who only need to examine exception reports and are not interested

in interaction with the data via predefined automated standard audit tests. Analytical users build their own queries in order to find answers to audit questions and need sophisticated data extraction and analysis software tools to support their extensive interaction with audit data marts.

An integrated audit data mart that meets the needs of the above two groups of users must have, at minimum, the following characteristics:

- Integrated query, analysis, and reporting through a unified user interface—across most hardware, operating, and networking environments—via client/server and the Web;
- An easy-to-use product line, yet powerful enough for the most sophisticated analytical users;
- Capacity to run Windows applications (with the results of queries easily exportable to common spreadsheets and database applications for further data manipulation by end-users);
- A query engine capable of retrieving and processing high-volumes of data;
- Data aggregation and multidimensional database capability to enable data summarization across audit-defined dimensions and by relating multiple tables from diverse data sources;
- Advanced statistical processing capability for data sampling (simple, random, stratified, and cluster), data exploration (frequency distribution, data plotting, and clustering, measures of central tendency and measures of dispersion), correlation and regression analysis, data summarization (principal component analysis), and statistical modeling capability (cluster analysis, discriminant analysis, multiple regression analysis); and
- Data visualization capability for data mining exploration and identification of patterns and trends in the data.

Development of a proper audit data report requires collaboration between the business unit's IT systems group and auditors. Interaction between the project personnel for designing and implementing a single audit data mart are shown in Figure 4. Audit data warehouses and data marts together with analytical tools enhance an auditor's understanding of the client business, help auditors deal with the increasing complexities of transactional systems, assess risks and related internal controls, and monitor costs of audits while maintaining quality standards (Goderre 2001; Stinger and Stewart 1996; Nigrini 2000).

Continuous Auditing Applications

The use of data extraction and analysis software among audit departments has been increasing significantly over the past years and is replacing the traditional manual methods of auditing. Glover and Romney (1998) report that the majority of internal auditors (94 percent) are currently using software to extract or import data from the accounting database. Under continuous auditing, external auditors are also

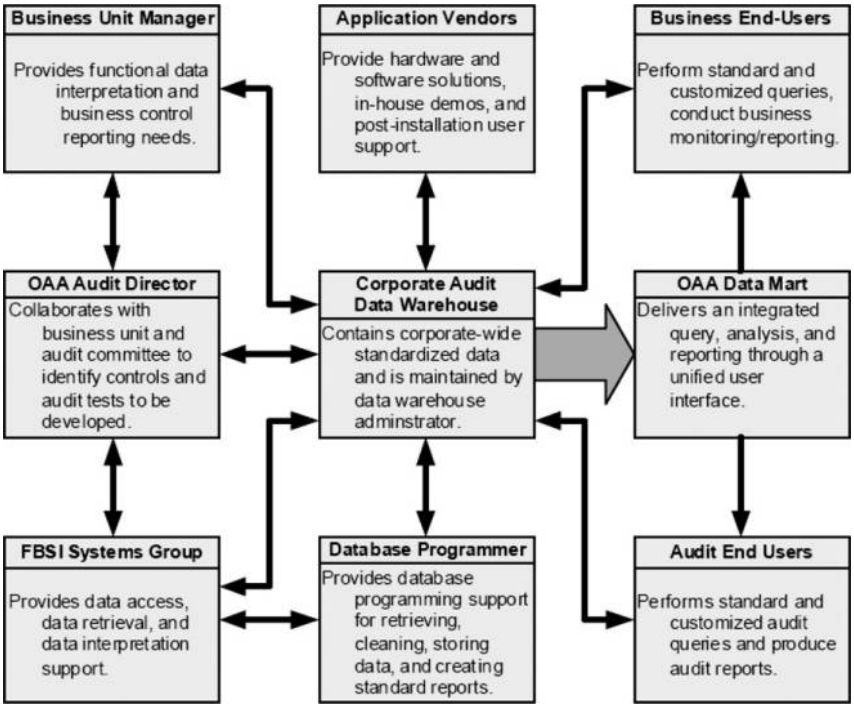

Figure 4: Audit Data Warehousing Project Interrelationships.

expected to use audit data warehouses and audit data marts capable of electronically conducting a significant portion of the audit process. David and Steinbart (2000) report that the use of data warehouses improves audit quality and audit efficiency by reducing the time needed to access data and perform data analysis.

Innovative auditing strategies coupled with the audit data warehouse and data mart concept have proven to be effective and efficient in expanding auditors' capabilities in dealing with increasingly complex business environments. For example, Carolina Power and Light has adopted Selective Monitoring and Assessment of Risks and Trends or SMART Auditing to identify potential problems, unfavorable trends, and unusual variances measured by key indicators. Using CATTs, the Audit Services Department has been able to analyze data inter-relationships across several business groups on a continuous basis.

For monitoring the efficiency of distribution engineers when designing and installing distribution lines, the auditors in collaboration with business units might monitor work-order deviations, compare estimated job costs to actual job costs, and compare estimated customer billings to actual customer billings for line construction (Rose and Hirte 1996).

Another example of the continuous auditing model is Exxon Company USA, a division of Exxon Corporation. Exxon USA has about 85 internal auditors, five of

whom are assigned to a new Audit Applications Group (AAG). The AAG has been created because of the internal audit managers' convictions that advanced computer technology for auditing benefits the entire company. The traditional IS staff did not fully understand the functional needs of the auditors. Retraining auditors to access and transform and load raw data would have been very costly. Instead the AAG was formed to interface with clients to identify data sources, access and load data, provide a data repository of high demand data (e.g., vendors, expense account, financial detail), structure/ create audit tests by setting up queries and forms to help auditors examine data, conduct surveys of document data retrieval steps through the Audit Reference Library (ARL), and provide system reference, training, and special project support. The AAG has been able to create the ARL with information on over 110 major data files and audit processes, to significantly reduce auditing mainframe costs as the mainframe is used in more controlled fashion, and to reduce the need for staff training on data access skills (e.g., JCL, TSO, ISPF) thus saving on the extra skill training costs (Marwil and Lappin 1996).

Auditing issues within transfer departments of a financial services institution provide another example of applying the continuous auditing concept discussed in this paper. In a financial institution, funds are typically transferred per customer request from the customer accounts to external banks. The external banks send confirmation reports detailing the wire payment activities. The auditor is interested in ensuring that all wire transfers have been completed. Although the reconciliation department is likely to detect any unauthorized wire transfer activities by the next day, such a time-span may not be acceptable for preventing transfer of funds to unauthorized accounts and subsequent withdrawal of funds by fraud perpetrators. Given the risks and volume of wire transactions, it is prudent to employ a continuous audit and monitoring system to detect unauthorized transactions. The auditor cannot simply rely on a manual review of the funds transferred. Electronic comparison of the wire transactions and confirmation records requires access to wire transfer files. However, the electronic data is not always in the format that can be readily analyzed by the auditor. The following shows a typical transfer record layout. The source wire transfer file has no column headings and each record is stored in four lines as follows:

1. "NONREP,5419121,CO,ACHCD,36833.19,,,01/14/2000,22,,,,,,,,,"
2. "BENE,,,29019000519053202,John Brown,,,,,,,"
3. "BANK,,191234035,,,,,,,"
4. "DETAIL,NTE*UMB Bank"

Using the continuous auditing methodology delineated in this paper, stored procedures can be developed to transform the above record to a format that is amenable to analysis by the auditor. The following table shows the above wire record after transformation. The wire detail, such as transaction amount, date, beneficiary

account number, ABA, are stored in their respective columns in a single row. This record in now ready to be analyzed by the auditor.

FOLIOCOD	CO	PAYTYPE	AMOUNT	VALDATE	BENACCT	BENNAME	ABA	BKDETAIL
5419121	CO	ACH CCD	$36,833.19	01/14/2000	19019000519	John Brown	191234035	NTE*UMB Bank

Several pre-defined audit tests can be developed and stored electronically in command buttons to be executed by the auditor. Upon clicking a single button the auditor triggers several stored procedures to access/transform and link the wire records received from sending and receiving banks, perform pre-defined audit tests, and generate exception reports to be investigated. Thus, the auditor does not have to worry about how to read the source files, to master programming skills to transform raw data files, or to spend long hours analyzing the data.

A hypothetical audit user interface for a wire transfers department is shown in Figure 5. Each command button denoted by OK triggers stored procedures to carry out the described audit test and generate the exception reports. For example, clicking on the first command button will generate a report containing every record where either the beneficiary name, account number, or wire amount differ between the sending and receiving bank records. To ensure segregation of duties, the wire approver (the person who is authorized to release the funds to be transferred) and wire transmitter (the person who sends the wire) must not be the same individual. This control prevents an individual from both approving a wire transfer and then proceeding to transfer funds for personal benefit to a fraudulently designated account.

The auditor must be able to electronically link the detailed wire transfer files with the wire authorization file that contains the names, user IDs, and staff roles/authorizations to see if there has been a control failure. However the time frame allocated for a typical audit project does not allow the auditor to carry out all of these functions manually. Ideally, the entire wire transfer auditing function can be embedded in the source application files. However, such a solution requires the collaboration of multiple business units, external banks, and commercial vendors who may have restricted development rights on the wire transfer software application.

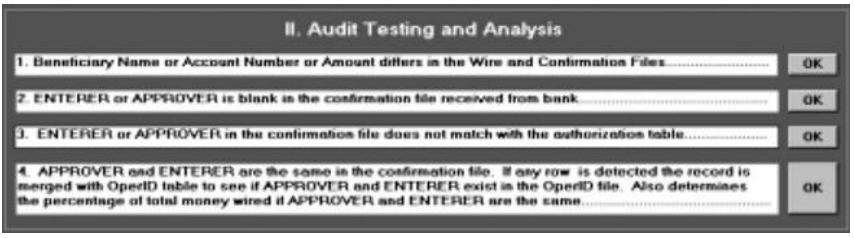

Figure 5: A Hypothetical Guide for Auditing Wire Transfer Transactions.

Summary and Conclusion

Technology allows companies to do business and publish financial information in real-time. Traditional paper audit trails are disappearing as the lag time between transactions and their appearance on published financial statements grows increasingly shorter. Real-time accounting systems require auditors to employ continuous electronic auditing because most audit evidence exists only in electronic form and in many instances only for a very short time. The audit process has evolved from the traditional manual audit of paper documentation to auditing through the computer and is, by necessity, moving toward a paperless, electronic, online, real-time continuous audit. Tagging financial information using standards such as XBRL enables organizations to freely exchange and extract financial information across all software formats and technologies including the Internet.

This paper presents an approach for building continuous audit capacity and a description of audit data warehouses and data marts. Continuous auditing is defined here as "a comprehensive electronic audit process that enables auditors to provide some degree of assurance on continuous information simultaneously with, or shortly after, the disclosure of the information." Auditing electronic financial reports according to existing generally accepted auditing standards (GAAS) presents unprecedented challenges for accountants. Current GAAS contains a number of standards pertaining to electronic financial statements, but they are not currently compiled into a single authoritative document. The use of continuous auditing enables auditors to set a number of predefined attributes (e.g., snapshot approach, systems control, and audit review facility) that continuously select, monitor, and analyze the client's accounting information system and internal control structure. Continuous auditing consists of several phases described in this article. Audit data marts and warehouses can be used to collect evidence simultaneously as application system processing occurs. Data marts provide efficient sources of audit evidence for further analysis using analytical software written by the auditors or purchased from several available sources.

Ever improving technology suggests that the real-time exchange of sensitive financial data will place constant pressure on auditors to update audit techniques. Most of the new techniques that will be required will involve creation of software and audit models. This paper initiates a general discussion and identifies potential implications of continuous auditing and its likely impact on auditing.

Future Research

As the business environment and the financial-reporting process continue to change in response to technological advances, so must auditing. Ongoing research is essential to help auditors keep pace with, if not stay ahead of, changes in technology.

Continuous auditing is a topic with virtually unlimited potential for further research[5]. Future research is needed to address the following questions:

1. **Is continuous auditing inevitable?**
   This article and a study by Vasarhelyi and Halper (1991) have addressed the importance and relevance of continuous auditing under the emerging real-time and electronic financial-reporting process. However, future research should examine practitioner and academician views regarding the demand for continuous auditing and its relevance and applications in various audit domains.
2. **What auditing standards and methods are necessary to effectively and efficiently provide continuous auditing services?**
   This paper identifies data warehousing and data marts as cornerstones for continuous auditing processes. Data warehousing should be studied to identify what data stores should necessarily be replicated to provide complete data sets for auditing purposes. In addition, data-warehousing methodology needs investigation for ways to assure reliability of the replication of production data, data mirroring methodology, and timeliness of replication. Assurance of the data integrity of both the data warehouse and data marts is a matter of critical concern. Specific transformation methodology for creating auditing data marts from data warehouses is a major auditing issue. Further, 100 percent auditing of data subsets is possible with today's technology. New statistical models are needed to capitalize on the quality and quantity of audit data possible within data marts. Future studies should examine (1) the feasibility of creating an open database connecting system that is in compliance with the organization's data warehouse and data mart; (2) the accounting and auditing issues of real-time accounting systems and continuous auditing including valuation, revenue recognition, security, exposures, control activities, and audit procedures; (3) aspects of continuous audit (e.g., timing, nature, and extent) that differ from the traditional financial statements audit; (4) the need for electronic auditing standards; (5) degree of assurance provided and the audit risk taken in various domains of continuous auditing (assurance, attestation, audit); and (6) the effects of continuous auditing on the auditors' objectives and independence when CATTs are embedded in the client's real-time accounting system.

[5]The Study Group (1999) suggested approximately 33 research topics on different aspects of continuous auditing, including (1) demand for continuous audits; (2) requirements to perform substantive procedures in a continuous audit; (3) nature, timing, and extent of substantive procedures in a continuous audit; (4) GAAP as criteria for continuous financial statements; (5) materiality threshold guidelines and level of assurance in continuous auditing; (6) effective application of CATTs in continuous audits; (7) auditor's objectivity and independence; (8) the format and content of continuous audit reports, and (9) continuous auditing education and skills. These continuous auditing-related issues warrant further consideration by audit practitioners, academic researchers, and standard-setting bodies.

3. **What are the experiences of organizations that have implemented continuous auditing?**

   Future continuous auditing field experimental cases could describe an innovative approach that links continuous auditing methodology into an organization, e.g., where an enterprise resource planning (ERP) system is present. Those cases could (1) share ideas regarding the application of continuous auditing in a variety of accounting and auditing domains; (2) establish best practices of continuous auditing services; (3) provide a better understanding and use of continuous auditing methodology; and (4) show how others perform continuous auditing effectively and efficiently.

4. **What should be the educational coverage of continuous auditing in the accounting curriculum?**

   Another issue that needs the attention of researchers is the appropriate education for accountants and auditors. Does the accounting curriculum require appropriate exposure to the technology that accounting majors will confront when they practice as accountants or auditors? Database technology is used by all sized organizations because all employ some type of accounting software, ranging from Quicken to SAP. Auditors are certain to be confronted with servers, databases, and data tagging schemes that they must examine. Appropriate training is essential for all auditors, particularly those working in a real-time financial reporting environment. Future education research should examine methods of (1) integrating information technology including e-commerce and real-time accounting systems into the accounting curriculum; and (2) infusing continuous auditing into auditing courses. With the further development and use of continuous auditing, educational programs that integrate systems analysis and design, data warehousing, data mining, database management systems, electronic-formatted reporting including XBRL and e-commerce into the auditing curriculum will be needed.

5. **What are promising opportunities for continuous auditing and assurance engagements?**

   There are substantial opportunities for practitioners, academicians, and standard-setting bodies to apply continuous auditing in the auditing environment. This study suggests that standard-setting bodies (e.g.; AICPA, FASB) should take a more holistic approach in establishing auditing and accounting standards for the real-time accounting and continuous auditing environment rather than a piecemeal approach. Continuous auditing enables auditors to provide proactive, continuous services rather than reactive, after-the-fact services. Future research should identify and address promising continuous auditing domains including security outsourcing, privacy and security assurance and business continuity assurance, and e-commerce assurance services.

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