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ABSTRACT

In the digital economy of the 21st century, the focus of production efficiency and product differentiation is shifted to value creation and relationship management. Customer relationship management is a critical business strategy in gaining competitive advantages. The ubiquity of the Internet has changed the way businesses are conducted. Real-time CRM is becoming increasingly significant to enable the agility of businesses to provide quick, accurate and complete responses to customer needs. This paper examines the structural makeup of real-time CRM that consists of e-business enabled CRM (ECRM), knowledge enabled CRM (KCRM) and business intelligence enabled CRM (ICRM). An architecture is developed for real-time CRM utilizing the components of e-business, knowledge-based systems, virtual data warehousing and real-time analytics.

Keywords: Real-time CRM, ECRM, KCRM, Business Intelligence, Virtual Data Warehousing, Real-time Analytics.

INTRODUCTION

As we move from the industrial economy to the digital economy enabled by globalization and the Internet, the focus of production efficiency and product differentiation is shifted to value creation through relationship management. Customer relationship management (CRM) has become a critical business strategy. Greenburg (2002) described CRM as a comprehensive set of processes and technologies for managing the relationships with potential and current customers and business partners across marketing, sales, and service regardless of the communication channel. CRM strategies have evolved from sales force automation, customer service centers, customer segmentation and target marketing to real-time sense and response. Persistent and contemporary CRM strategies that reflect the ubiquity of the Internet and the real-time demands of the global market are required for companies to compete in the digital economy. Real-time CRM is the next stage in the evolution of CRM strategies (Goldenberg 2005, 2006). Goldenberg (2005) described that the trends propelling real-time CRM include Web services and hosted applications, the wireless revolution, and the broader acceptance of the Internet as a communication, content and application medium. Goldenberg (2006) further pointed out that real-time becomes the norm for conducting business in the future and that the phenomena of "always on" and "always connected" are results of moving from an analog to a digital world. Characteristics of real-time CRM include online self-service, real-time customer segmentation, dynamic pricing, and real-time customer intelligence.

The objective of this paper is to analyze the structural makeup and to propose an architecture for real-time CRM. The paper will examine the e-business enablement, knowledge enablement and business intelligence enablement of real-time CRM. Architectural components including the e-business front-end applications, back-end systems, real-time CRM operations, knowledge-based systems and analytic processing will be discussed.

THE REAL-TIME ECONOMY

The digital economy of the 21st century is characterized by real-time processing and dissemination of information. The ubiquity of the Internet has changed the fundamental ways in which business is conducted. Batched responses to customer needs are replaced by real-time sense and response. Businesses are treating each real-time customer interaction as a mini target marketing campaign. Customer expectations have also changed. The "we will call you back" customer services are no longer acceptable. Customers expect immediate responses and resolutions. Many real-time operations such as airline reservation, online banking, real-time stock quotes, and real-time order status alerts are already the norm. Real-time value chain management is emphasized by Porter (2001)'s characterization of real-time optimization of the entire value chain as the latest stage in the evolution of technology in business. In

supply chain management, the movements of materials are tracked in real-time using RFID technologies (Ferguson 2005). Computer networks have enabled real-time collaborative planning between the firm and their suppliers, distributors, customers and alliance partners. The vendor-managed inventory model where suppliers can be connected to the real-time point-of-sale systems through extranets is exemplified by Wal-Mart's continuous replenishment strategy (Laudon et at. 2006, Turban et al. 2006). Baran (2001) described the formation of a network of partnerships in the financial value chain where interdependent players are linked in real-time over the Net. Real-time demand-driven supply chain reduces inventory and order-to-delivery time. A call center representative requires real-time information in order to provide accurate and speedy resolutions. A salesperson requires up-to-the-minute customer information before a sales call. Leveraging mobile commerce technologies, companies can launch location-based marketing campaigns targeting the needs of customers at the vicinity of certain locations in real-time. The real-time economy is enabled by real-time business operations utilizing e-business infrastructure, knowledge management and business intelligence. E-business provides the framework for real-time communication through computer networks. Knowledge management provides relevant and actionable information to deal with specific business situations. Business intelligence from analytical processing can enhance business operations and improve decision making. Combining these elements allows businesses to sense and respond in real-time.

REAL-TIME CRM

Real-time CRM is becoming a critical element for businesses that emphasize immediate customer experience. For example, in the hospitality industry, a service representative at the check-in counter needs to be equipped with real-time or near real-time data regarding recent changes in reservations and requests, in conjunction with customer profile and previous stays information, in order to make up-to-the-minute decisions regarding room assignments, allowance for late check-out, special rates and other amenities. Hotel staff can also obtain customer information in real-time through the physical presence of the customer. Kontzer (2004) described the anticipated use of RFID tags in HHonors cards so that information from its OnQ customer-information system could be used to alert hotel staff as guests enter a property.

The ecosystem of CRM can be divided into three categories: operational CRM, analytical CRM and collaborative CRM (Greenberg 2002, Gebert et al. 2003, Turban et al. 2006). Operational CRM deals with the typical business functions such as customer service, order management, invoicing, sales, and marketing. Analytical CRM deals with the capture, storage, extraction, processing, interpretation, and the reporting of customer data. Collaborative CRM deals with all the necessary communication, coordination, and collaboration between vendors and customers. Gebert et al. (2003) described collaborative CRM as the management and synchronization of customer interaction points and communication channels such as telephone, email and the Web. In the following, real-time CRM will be examined in each of these CRM ecosystems.

Real-Time CRM Operations

Real-Time Marketing and Sales: Grossman (2002) described the evolution of marketing from weekly or monthly catalogs in the 1980s, to the daily or weekly customer contacts with call centers in the 1990s, to the "next click" time scale with Web sites and emails. As more interactions occur on the Internet, exchanges of information and value between members and marketers will increasingly take place in real-time (Barlow 1999). Goldenberg (2006) described real-time marketing to include automatic re-segmentation of markets based on real-time information, auction-based pricing, collaboration in real-time product testing and feedback. Increasingly, due to the Do-Not-Call registry that protects consumers' privacy, marketing through in-bound calls are becoming much more effective than generating new leads from outbound telemarketing (Morphy 2003). In-bound calls can be related to a variety of customer situations such as general inquiries, product issues, complaints, billing errors and change of contact information. The service representative needs to make assessment about the customer in real-time based on historic and real-time customer data to provide resolutions and to up-sell and cross-sell while the customer is still on the call. Similar capability can be provided when customers interact with the firm via the Web in a self-service mode. Dynamic and personalized contents can be generated in real-time based on the customer's browsing and purchasing patterns. A notable example is Amazon.com's use of collaborative filtering software to make personalized book recommendations in real-time (Laudon et al. 2006). Real-time technologies can be used in many aspects of marketing operations such as online marketing campaigns, online promotional programs, online advertising, and online surveys. New real-time target marketing strategies have emerged, including automatic personalized email responses and location-based marketing in m-commerce. Goldenberg (2006) characterized real-time sales by real-time inventories and collaborative selling where the buyer plays a more important role in the sales process.

Salespersons in the field can get up-to-the-minute information about a customer before sales calls and can update the customer account in real-time. Real-time configuration of products and services is part of an order entry process in many industries as exemplified by Dell Computers and Lands' End. In B2B, manufacturers are sharing real-time information, product configurations, and order fulfillment systems with their sales channel partners (Longworth 2003). Real-time monitoring of point-of-sales and inventory information across the supply chain is critical to an on-demand sales strategy where inventories can be replenished based on actual sales.

Real-Time Customer Service: Customer service has become a critical factor for competitive advantages in a market crowded with offerings where product features and price no longer provide the differentiation. Services can be provided to customers through many types of operations that include call centers, help desks, and online self-service. Effective customer service can enhance customer retention, improve customer loyalty, and advance cross-selling and up-selling opportunities. Using technologies in e-business, knowledge management and business intelligence, real-time customer service provides quick and accurate responses to customer needs. It can be provided in response to general inquiries, complaints, product issues, billing errors and other customer situations. It can also be used in a proactive and preventative manner in the anticipation of customer situations. Goldenberg (2006) characterized real-time service by the pervasive use of self-service that builds off extensive real-time knowledge bases, and vendors that instantly alert customers to anything important. E-service intelligent technologies can be used to implement online customer service solutions including dynamically generated FAQs and the ability to ask the knowledge base questions using natural language (eGain 2005).

Real-Time CRM Analytics

Reimers (2003) described real-time analytics as analytics conducted on data collected within the past hour, and near real-time analytics as those conducted on data collected within the past 24 hours. Analytics based on data collected over 24 hours are typically considered as batched. Batched analytics while providing useful information and intelligence for business operations may not be adequate to fulfill real-time customer situations. Raden (2003) described that 90% of the activities in a call center concerns issues of that business day, and that the usefulness of the call center application can be reduced by roughly 90% if the data available is a day old. Timely and accurate responses to customer situations often require real-time or near real-time facts combined with historic data. For example, on-the-spot decisions on discounts, rebates, up-selling and cross-selling of additional products may require real-time point-of-sales data combined with batched analytical results from historic data regarding customer profitability, customer life-time-value and previous buying behaviors. Real-time analytics is the capability of applying analytic processing based on real-time or near-real-time data combined with analytical results from historic data to create real-time intelligence to support time-sensitive decisions.

Real-Time CRM Collaboration

Customer interactions with the firm can occur through many channels and touch points. Channels may include call centers, point-of-sales, retail outlets, marketing and sales events, services, returns, surveys and rebates. Interactions can be made directly with the firm or through distribution channels, alliance partners, third party service providers, or the Web. Touch points, the methods of interactions, may include Web-based applications, conventional mail, phone, fax, email, and face-to-face interactions. Every customer interaction regardless of channels and touch points can be a marketing and sales opportunity. McKenzie (2001) pointed out the importance of integration along the value chain to provide better customer service by organizing, aligning and integrating the organization processes all the way from the point of customer contact, through the organization and back through the supply chain. Chan (2005) described an enterprise model for a unified view of CRM to include information from various customer interactions with the firm through various channels and touch points, across the entire customer value chain.

Disparate views of customers and the lack of real-time collaboration can cause poor customer experience and may result in the loss of opportunities for the firm. For example, the lack of real-time synchronization between sales channels through the Web and direct sales may result in channel conflicts, where customers may receive different pricing and promotional information. A customer may purchase an item online and return the item at a customer service center in a retail outlet. The lack of real-time synchronization between data collected at the point-of-sale and customer service may result in the customer not receiving the credits in the next billing cycle. Customers may also interact with the firm indirectly through various suppliers and alliance partners. Real-time communication,

coordination, and collaboration between vendors and customers, and real-time synchronization of customer interaction touch points and channels are critical to customer relationship management in the digital economy.

THE STRUCTURAL MAKEUP OF REAL-TIME CRM

Figure 1 illustrates the blending of CRM operations, e-business, knowledge management and business intelligence in real-time CRM. E-business enabled CRM (ECRM) is represented by the intersection of CRM operations and e-
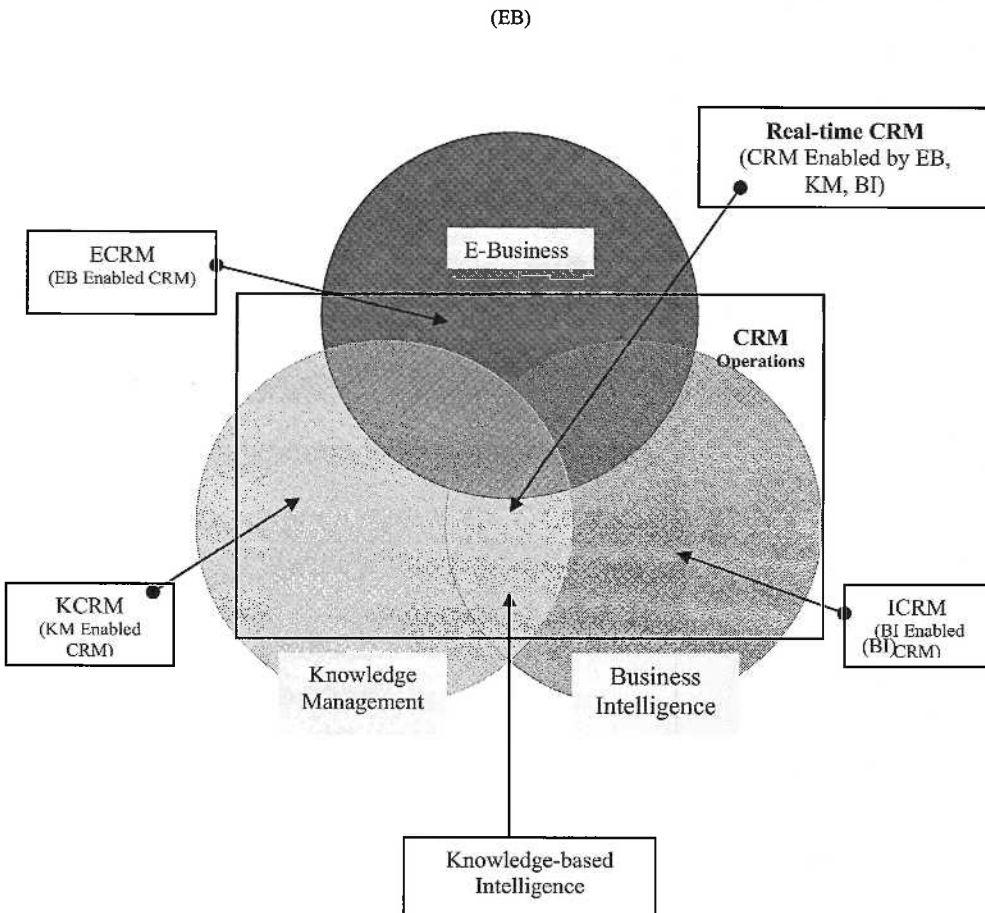
Figure 1: Real-Time CRM

business. ECRM uses computer networks and other information technologies to perform CRM functions. ECRM has become an important channel for managing customer relationships due to the increasingly wide-spread use of the Internet as a means of communication and conducting business transactions. Knowledge enabled CRM (KCRM) is represented by the intersection of CRM operations and knowledge management. Knowledge management provides relevant and actionable information for CRM operations. Business intelligence enabled CRM (ICRM) is represented by the intersection of CRM operations and business intelligence. Business intelligence can be used to enhance CRM operations, predict customer behaviors and personalize marketing campaigns. Real-time

CRM combines these elements utilizing the real-time infrastructure of computer networks, with actionable information and intelligence to enable real-time CRM operations.

E-Business Enabled CRM (ECRM)

New business strategies have emerged leveraging e-business technologies. In the demand-driven supply chain, the traditional push-based model is replaced by a pull-based model where actual customer orders trigger events in the supply chain through manufacturers and suppliers (Laudon et al. 2006). A notable example is Dell Computer's build-to-order system. Mass customization, the ability to tailor product offerings to individuals using the same production resources as mass production, is an e-business strategy that allows companies to reach a mass audience with individualized offerings, services, and contents. Notable examples include real-time self-configuration of products and contents. Dell Computers allows customers to configure the specifications of computers online, Lands' End allows customers to enter measurements on the Web site, and the Wall Street Journal Online allows customers to choose news and email alerts.

E-business technologies are used in many aspects of CRM, including all forms of electronic marketing and sales, electronic customer services and support, and electronic relationship management. ECRM refers to the use of e-business infrastructures in conducting CRM operations. Turban et al. (2006) indicated that the term ECRM was coined in the mid-1990s when customers started using Web browsers, the Internet, and other electronic touch points. The ability to respond quickly to customer demands in the rapidly changing market is critical for businesses to attain competitive advantages in the digital economy. Gustke (2001) described the importance of personalized marketing and quick response. ECRM facilitates real-time sense and response of customer situations and provides an important channel through which a firm can conduct marketing campaigns and provide customer services. It can be operated in a self-service environment or embedded in call centers, help desks, and customer service operations to supplement the traditional touch points such as phone, fax, and conventional mail. ECRM is emerging as a new marketing model in constituent relationship management for non-profit organizations (Bhagat 2004). The use of the Internet and personalized email for fundraising is increasingly important for non-profits. According to the Initiative on Social Enterprise at Harvard Business School, by 2010, one-third of money donated will be given online (Olsen et al. 2001). ECRM provides the platform for personalization and e-relationship for constituent relationship management.

With the emergence the wireless technologies, ECRM activities can be conducted anywhere, anytime and for any person. A traveling salesperson in the field can get the latest customer information and update customer accounts. Location-based services and marketing can be individualized based on the customer's location and profile. As companies are collecting huge amount of information about their customers through various touch points, ECRM can be a rich source of customer information for CRM analytics.

Knowledge Enabled CRM (KCRM)

Customer relationship management and knowledge management (KM) are two key ingredients for competitive advantages as we move further from the production economy. The convergence of these two disciplines is becoming increasingly significant in the real-time economy where responses to complex customer situations are expected to be quick, accurate and complete. The integration of CRM and KM may result in different perspectives, CRM-oriented KM or KM-oriented CRM. The notion of KM-oriented CRM is used in the following discussion of KCRM. Knowledge-oriented CRM processes can be characterized by knowledge intensity and process complexity (Eppler et al. 1999, Gebert et al. 2003). Knowledge intensity is the measurement of the degree to which CRM processes require knowledge to pursue the process goals. Knowledge intensity is affected by the complexity of the CRM process where a highly complex process implies that a high degree of knowledge is necessary. Critical CRM processes in marketing, sales and services can be enabled by knowledge management. Gartner (2003) described the use of knowledge management in marketing resource management (MRM) and in field sales regarding configuration of products, proposals and solving business problems.

Driven by the rising complexity of product configurations and customer situations, and the expectation of real-time responses to customers; knowledge management leveraging artificial intelligence technologies is playing an important role in customer service and customer support (El Sawy et al. 1997, Davenport et al. 1998). Case-based Reasoning (CBR) has been demonstrated to be an effective means of automating help desks (Turban et al. 2005, Bolloju 1996). Lee et al. (2005) described the use of Self-Organizing Map neural network in a survey-based

profitable customer segmentation system that executes and mines customer satisfaction surveys.   E-service intelligent technologies can be used to enable many areas of customer service and call center operations in real-time, including automatic email responses, FAQ, access to product information, problem resolution, collaborative Web browsing, directing customers to different information sources including Web pages and a real person if necessary (Tillett 2000, Cisco 2005, Turban et al. 2006).

Business Intelligence Enabled CRM (ICRM)

Turban et al. (2005) described business intelligence (BI) as the enabler of decision analysis through access to all relevant information that includes data warehousing, online analytical processing (OLAP), data mining, visualization and multidimensionality. Various analytic models utilizing quantitative and qualitative methods can be used for data analysis to generate the intelligence to enhance business operations.

Business intelligence can enhance CRM operations in many ways. Intelligence about customer needs and behaviors helps to determine what mix of product offerings to cross-sell and up-sell. Marketing strategies can be formulated based on business intelligence that utilizes information in market conditions, competitions, brand acceptance, economics, and customer behaviors. Sales strategies can leverage business intelligence that utilizes information about win/loss ratios with respect to market segments, demographics, seasonality, and product affiliations. Intelligence about the reasons for customer loyalty and churn helps to determine strategies to promote customer loyalty, increase retention, and reduce churn. Intelligence about customer profitability helps to determine what focused and value-added services to offer for the segment of customers generating the most profits. Business intelligence can enhance customer service by anticipating and preventing potential product problems, anticipating customer issues, and providing quick and relevant resolutions.

Notice that business intelligence may or may not be knowledge-based. Intelligence resulting from trend analysis using statistical models does not involve a knowledge base or artificial intelligence technologies. On the other hand, intelligence about a customer's credit risks resulting from an artificial neural network is knowledge-based. Business intelligence can also be created by combining the knowledge about a customer's credit risk resulting from a knowledge-based system with customer profitability information from an OLAP application to make real-time decisions on loan applications.

AN ARCHITECTURE FOR REAL-TIME CRM

The key concept for real-time CRM is the enablement of real-time CRM operations by real-time analytics and knowledge management using the e-business infrastructure. The components of the architecture for real-time CRM, as illustrated in Figure 2, consist of the e-business front-end applications, back-end systems, real-time CRM operations, knowledge-based systems, and analytic processing.

The E-Business Front-End, Back-End Systems, and Real-Time CRM Operations

The e-business front-end systems consist of systems that interact with customers through the use of computer networks and other information technologies. They can be classified in two categories: the virtual front-end and the physical front-end. Both categories utilize the e-business infrastructure, the former without human intervention and the latter with human intervention. CRM operations enabled by e-business are referred to as ECRM. As described in Tiwana (2001), front-end systems may include Web store, call center, email, WAP/wireless, direct mail, phone/IVR, and real-time chat. Front-end systems utilizing various touch points have to be connected to back-end systems for practical use. Information from back-end operational systems supporting sales, back orders and shipping is required to respond to a customer's inquiry regarding order status via a telephone call to customer service or via the Web in a self-service mode. Seamless integration of front-end systems to back-end systems is a requirement as well as a challenge in providing accurate real-time responses to customers. Back-end systems may consist of applications in ERP, CRM, SCM and other transactional and legacy systems. Real-time CRM operations such as marketing, sales, and services are supported by back-end systems and utilize the e-business front-ends to communicate with customers.
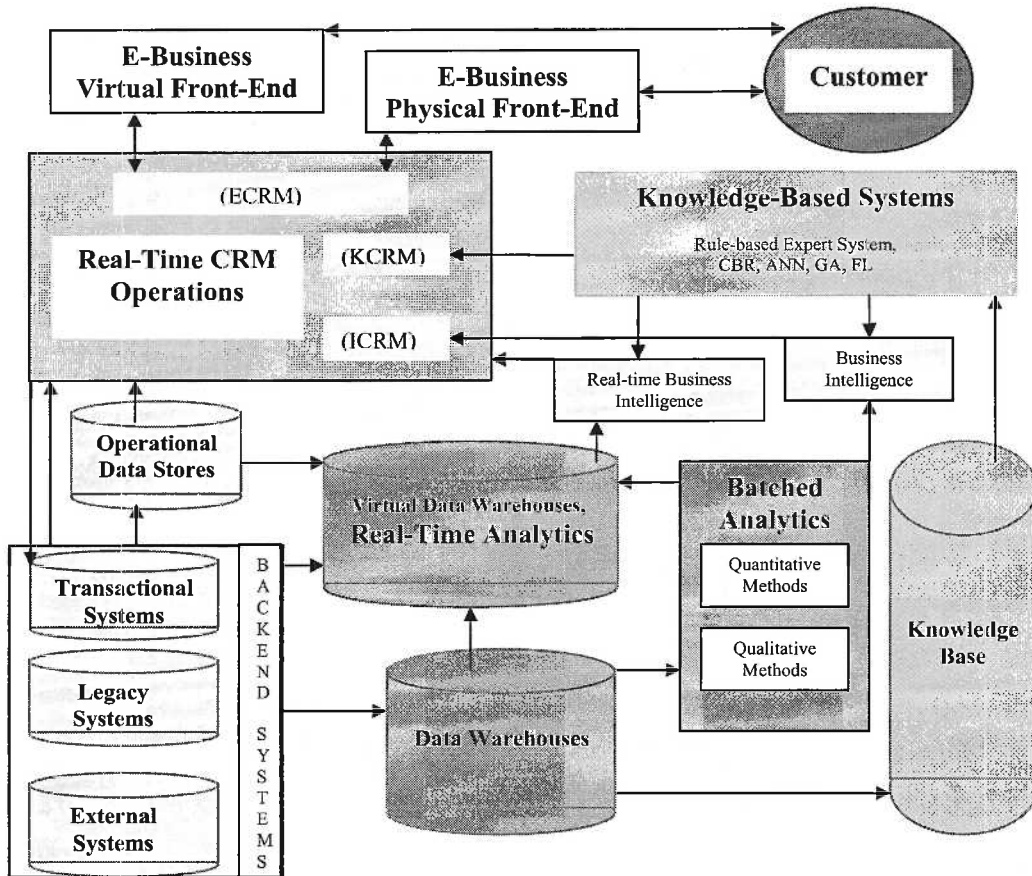
Figure 2: An Architecture for Real-Time CRM

Knowledge-Based Systems

Knowledge-based systems utilize qualitative knowledge, rather than mathematical models, to provide decision support. Various technologies based on artificial intelligence can be deployed in knowledge-based systems. They include rule-based expert systems, case-based reasoning, artificial neural networks, genetic algorithms, and fuzzy logic. CRM operations enabled by knowledge-based systems are referred to as KCRM. Turban et al. (2005) described that the knowledge base consists of facts, heuristics, and rules that direct the use of knowledge to solve specific problems. Knowledge-based systems take inputs from many sources, including data warehouses, results from batched and real-time analytics, and other knowledge sources. Knowledge captured through the knowledge acquisition process from sources such as human experts, textbooks, multimedia documents, databases, research reports and the Web, is stored in a knowledge base, which contains the relevant knowledge necessary for understanding, formulating, and solving problems (Turban et al. 2005). Examples of knowledge-based systems include rule-based expert systems that automate human expertise such as configuration of complex products, and artificial neural network systems in credit card fraud detection. Knowledge-based systems can be used in conjunction with real-time analytics to create real-time knowledge-based business intelligence in real-time CRM.

Analytic Processing

The analytic processing component consists of two parts: the physical data warehouses with batched analytics, and the virtual data warehouses with real-time analytics. Data warehouses are the basic data constructs for analytics. Physical data warehouses are constructed through an ETL process where data from different sources are Extracted, Transformed, and Loaded into the data warehouse. Analytical processes such as statistical processing, OLAP, and data mining can be deployed to create business intelligence to support CRM operations. CRM operations enabled by business intelligence created by the analytical processes are referred to as ICRM. Notice that business intelligence can be knowledge-based when it combines results of knowledge-based systems in the analytics.

The key to real-time CRM intelligence is the real-time participation of data warehouses with real-time analytics. This constitutes the second part of the analytic processing architecture that consists of the virtual data warehouses with real-time analytics. Raden (2003) described the concept of an Active Data Warehouse (ADW) as a data warehouse that participates in real-time with systems such as CRM, ERP, SCM and other systems operating online. Raden (2003) indicated that ADW is not a technology, but rather a concept in the realm of work that addresses the role that a data warehouse plays in the real-time enterprise. In the proposed architecture, the concept of Virtual Data Warehousing (VDW) is used to implement the active participation of a data warehouse in real-time. Virtual data warehouses allow the real-time processing of queries to distributed data sources without the replication of data into another physical database. Sperley (1999) described the virtual data warehouse as a decision support system that sends queries to the actual operation systems. The concept of virtual data warehouses (VDW) gained popularity in the 1990s through the use of middleware technologies, where queries are run against distributed operational data sources in real-time bypassing the physical constructs of data warehouses. Eckerson (2003) indicated that the virtual data warehouse concept failed in that period due to operational system performance degradation issues. Enterprise Information Integration (EII) is the resurgence of virtual data warehousing and is positioned as a complement to data warehouses (Eckerson 2003). Russom (2003) described EII as an integration platform that supports application access of virtual views from multiple data sources, and handles the connectivity with back-end databases and applications. Virtual data warehouses also come with different names, including Virtual Data Marts (VDM),

Virtual Operational Data Stores (VODS) and Virtual Databases (VDB).

There are various dimensions to real-time CRM analytics: the real-time application of real-time information, the real-time application of batched information, the real-time application of real-time and batched information. As in the first scenario, analytics utilizing real-time information about a customer's transaction of returning goods and recent purchases can provide up-to-date billing and credit information upon a customer's inquiry via telephone or via self-service through the Web. As in the second scenario, analytics utilizing a customer's historic buying patterns in conjunction with collaborative filtering of historic data based on market segmentation, can be applied in real-time to cross-sell or up-sell to the customer in a call center operation or via self-service through the Web. As in the third scenario, an airline's real-time decisions of re-routing customers with connections arriving on a delayed flight, reserving the few remaining seats for the best customers and making other offers based on loyalty, lifetime value, policies and the current flight situation, require both real-time and historic information (Raden 2003). The third scenario that requires both real-time and historic information in real-time situations is the most common in the real-time economy. Virtual data warehousing allows the real-time processing of queries to distributed data sources including transactional data sources, operational data stores, and data warehouses as required by the real-time operations. This supports the concept of ADW that emphasizes the active participation of a data warehouse supporting real-time operations. Real-time analytics utilizing virtual data warehousing create real-time business intelligence for CRM operations. Notice that real-time intelligence can be knowledge-based when it combines results of knowledge-based systems in real-time analytics.

CONCLUSION

The real-time economy of the 21st century is challenged by multiple dimensions in complexity, intensity and the expectations of timeliness, accuracy, and completeness. A business enterprise needs to be agile and responsive in the digital economy to differentiate itself in a crowded market where product and price no longer provide the necessary distinctions. Customer relationship management is a key business strategy in the era succeeding the production economy. The ubiquity of the Internet has changed the dynamics of how businesses are conducted, from batch to real-time. Real-time CRM is taking the center stage in the evolution of CRM strategies. This paper examines the components of real-time CRM, including CRM enabled by e-business (ECRM), CRM enabled by knowledge management (KCRM), and CRM enabled by business intelligence (ICRM). The combination of these

components allows CRM to operate in real-time utilizing the infrastructure of e-business enabled by actionable information and intelligence. The paper concludes with an integrated architecture for real-time CRM that consists of e-business front-end systems, back-end systems, real-time CRM operations, knowledge-based systems and analytic processing. Real-time CRM has great practical significance for managers dealing with marketing, sales, and customer service operations where real-time decisions are often required in cross-selling, up-selling, and providing quick and accurate responses to customers. The architecture supports the convergence of e-business, knowledge management, and business intelligence in the real-time economy. Future research focuses on the application of the architecture to real-time value chain management and supply chain management, where CRM operations are extended to value chain and supply chain operations.

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