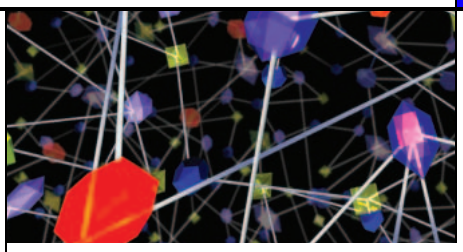
PRICEWATERHOUSECOOPERS

Technology Forecast 2003-2005

The Intelligent, Real-Time Enterprise

Introduction



Welcome to the Technology Forecast

Welcome to *Technology Forecast: 2003–2005,* the latest in a series published annually for more than a dozen years by the PricewaterhouseCoopers Global Technology Centre. As information technology (IT) in all its forms becomes an integral part of business, our *Technology Forecast* series continues to sharpen its coverage. Our firm publishes the series because our clients have found that IT has grown from a set of back-office support systems into a vital part of their ability to deliver goods and services. To an increasing number of companies, IT is both an important source of competitive advantage and a significant component of the products they offer.

Readers familiar with previous editions of *Technology Forecast* will immediately notice that this year's *Forecast* is significantly shorter than previous versions. We have focused our coverage on a smaller number of technologies that are most relevant to our clients and that are experiencing the greatest change. This shorter length is designed to make the *Forecast* a more accessible document (not to mention easier to hold while reading!).

Several features in this year's volume make the book more relevant to senior executive decision-makers. These include "CFO Perspective" and "Global Best Practices" sections as well as more emphasis on topics of special interest to senior financial executives. These topics include the Extensible Business Reporting Language (XBRL), a standard that is easing the creation, distribution, and use of financial reports; the use of the daily virtual close to provide real-time financial information and speed the production of end-of-period financial reports; and the use of business intelligence technologies to assist in compliance with the new requirements of the Public Company Accounting Reform Act (the Sarbanes-Oxley Act) enacted by the U.S. Congress in July 2002.

We have returned to our practice of issuing a single-volume annual *Technology Forecast* as our flagship publication. This year's *Technology Forecast* marks a departure from our tradition of covering the entire range of technologies relevant to enterprise users of IT. The current volume covers some of the major categories of enterprise applications and the software technologies that enable those applications to be constructed and deployed. Extensive cross-references point the reader to related topics in *Technology Forecast: 2002–2004, Volume 1: Navigating the Future of Software* and *Volume 2: Emerging Patterns of Internet Computing.* Coverage of some of the technologies not included in the current book will resume in future *Technology Forecast* publications. *Technology Forecast: 2003–2005* will be complemented by *Information Security: Meeting the Challenge of Internet Computing,* to be published during the third quarter of 2003.

The range of years in the title of this *Technology Forecast* reflect its depiction of multiyear trends and directions in IT. Many items in the forecast sections of our chapters refer to a forecast period of three years, and the title of the book is intended to emphasize this time horizon.

OUTLINE OF THIS YEAR'S FORECAST

Technology Forecast: 2003–2005 begins with the ***Perspectives*** section, highlighting our focus on the intelligent real-time enterprise. In addition to this introduction, ***Perspectives*** contains two chapters tied to the book's theme and three interviews.

The first thematic chapter, "Business Processes & IT," provides a foundation for understanding the links between the applications discussed in this *Forecast* and contemporary business practices. It discusses why business organizations are increasingly thought of as a set of processes rather than as a set of functional or organizational units and why end-to-end automation of business processes has become a major objective of enterprise IT. The chapter also describes how IT is being used not only to automate processes but also to monitor and manage them. The second thematic chapter, "Business Reporting & XBRL," describes XBRL and explains how it will transform the creation, dissemination, and use of corporate financial information during the next few years.

Following the thematic chapters are interviews with three individuals who are known for their views on the future of enterprise computing:

- ***Vivek Ranadivé***—Founder, chairman, and CEO of TIBCO Software, a leading provider of software that enables the real-time integration of business systems. A recognized authority on the real-time enterprise, Ranadivé is author of *The Power of Now: How Winning Companies Sense and Respond to Change Using Real-Time Technology.*
- ***Tony Scott***—CTO of General Motors' Information Systems and Services organization, where he is responsible for defining the enterprise IT architecture and standards across all of GM's business globally. He also provides leadership in emerging technology, a critical area for GM as automobiles incorporate more software and become mobile Internet nodes.
- ***Ronald Weissman***—A venture partner with Apax Partners, a leading international private equity investment group, where he specializes in investment opportunities in enterprise and infrastructure software. Prior to joining Apax, he was vice president of strategy and corporate marketing for Verity.

The remaining sections of the book each highlight a different area of enterprise software; together they comprise ten chapters giving detailed coverage of specific technologies and applications. The three sections are organized as follows:

- ***Enterprise Applications***—Contains chapters on enterprise suites, discussing the evolution of suite architectures, supply chain event and performance management, and enterprise resource planning; customer-facing applications; and business intelligence and enterprise analytics, including coverage of real-time business intelligence and business activity monitoring.
- ***Information Management***—Comprises chapters on knowledge management and e-learning; content management; and collaborative technologies.
- ***Enabling Technologies***—Consists of chapters on business integration technologies, including enterprise application integration and business process modeling, monitoring, and management; Extensible Markup Language (XML) and Web services; application and portal servers; and component frameworks, including extensive coverage of Java 2 Enterprise Edition (J2EE) and Microsoft .Net.

Each of these technology chapters employs the same format. A one-page executive summary of the chapter is followed by sections explaining the functionality and technology of the software being analyzed and discussing the major vendors and their products. After the vendor section is a market overview that uses data from third-party

research services to describe vendor market shares, market size, and expected growth. Each chapter concludes with a series of forecasts for the development of this technology over the next one to three years (the "forecast period").

NEW ELEMENTS IN THE CHAPTERS

On the second page of each chapter is the new "CFO Perspective," providing information that senior executives need in order to understand the business impact of the applications or technologies under discussion. Each "CFO Perspective" briefly describes the applications or technologies, explains who uses them, and summarizes the benefits they provide to an enterprise. Each also discusses some of the trends in enterprise adoption of the applications or technologies, and outlines some of the challenges that may be encountered in implementing them.

In addition, four chapters—the three chapters in ***Enterprise Applications*** plus "Knowledge Management"—contain a one-page summary of some of the best practices associated with adoption of the applications covered in those chapters. These best practices provide an introduction to the information that is available from the PricewaterhouseCoopers Global Best Practices service.

TRANSACTIONAL AND NONTRANSACTIONAL APPLICATIONS

The applications discussed in the ***Enterprise Applications*** section are generally distinguished from those covered in the ***Information Management*** section by two attributes: the type of data they manipulate and the type of processes they implement. The software discussed in ***Enterprise Applications*** primarily deals with structured data—such as accounting transactions, part numbers, product bills of material and costs, inventory levels, and customer records—that is stored in tabular format (rows and columns) in relational databases. Enterprise resource planning (ERP), customer relationship management (CRM), and supply chain management (SCM) systems are all transaction-processing applications implementing highly structured business processes; business intelligence applications are used to analyze and monitor the results of those transactions.

On the other hand, the software discussed in ***Information Management*** handles semi-structured or unstructured data—sometimes referred to generically as content—such as internally and externally generated documents, information in textual form (news stories or Web pages), and recordings of audio- and videoconferences and Webcasts. These applications do not process transactions, and they are typically used to perform tasks that are less structured, such as creating a marketing plan or doing research on prospective customers. One of the significant trends in this area is the growing overlap in the functionality of knowledge management, content management, and collaboration applications, all of which play a role in the creation, modification, classification, storage, and retrieval of content and in the business processes that use content.

The Intelligent Real-Time Enterprise

The theme we have selected for *Technology Forecast: 2003–2005*—the intelligent real-time enterprise—reflects the growing importance of two requirements for business today: the need to make informed decisions and the need for real-time responsiveness.

As the pace of business quickens, companies must eliminate information lag and make more timely and effective decisions. The use of IT to enable businesses to act intelligently and in real time is reflected in a variety of the technologies and products discussed in this year's *Technology Forecast.*

THE WIDENING SCOPE OF BUSINESS INTELLIGENCE

As we discuss in "Business Processes & IT," businesses today are increasingly organized, managed, and automated around sets of processes. These processes include development and production of products and services, managing interaction with customers, and supporting processes such as accounting and human resources. As we discuss in "Business Intelligence," business intelligence (BI) capabilities are increasingly being built into the applications used to automate these processes, as well as into specialty BI tools and applications. During the forecast period, it will become increasingly unlikely for vendors to introduce major process automation applications without including significant BI capabilities.

In the past five years or so, the use of BI has significantly broadened along two dimensions: time and data aggregation. Historically, BI technologies were primarily used as part of data warehouse projects, which focused on postoperational (after-the-fact) analysis of highly aggregated data. BI technologies are now used on data with varying degrees of latency, from real time to historical, and with varying degrees of aggregation, from the traditional highly aggregated data to individual transactions.

At the low end of the scale in both dimensions, BI technologies are applied to individual transactions or customer interactions taking place in a time frame of no more than a few seconds. For example, this technology may be used by the personalization module on an e-commerce Website or by the fraud detection module of a credit-card processing application on the same site.

Higher on the scale on both dimensions, BI is used to monitor business processes and generate alerts or event notifications when there is a departure from expected behavior. These alerts can relate to an individual occurrence—for example, a supply chain event management application that generates an alert if a supplier fails to deliver a parts shipment at the expected time—or to the results of numerous transactions, such as inventory levels falling below predefined thresholds. To be useful, these alerts need to be generated and delivered quickly enough for corrective action to be taken before a problem results—often in a matter of minutes or hours.

At still higher levels on both scales, business activity monitoring tracks the overall state of one or more processes, potentially with a higher degree of latency in the data. For example, key performance indicators can be displayed on a digital dashboard; the scope can range from overall enterprise performance indicators, such as revenue, to process-specific indicators, such as on-time delivery performance of key suppliers. For this purpose, it may be acceptable if data is refreshed only daily. Historical data is used to provide a context for the current data—to see whether similar patterns have occurred in the past, for example.

In addition to their use in monitoring, analytics are also used in planning the execution of tasks associated with specific business processes—for example, selecting customers to be called as part of a telemarketing campaign. This type of planning is one step removed from the execution of a business process and uses BI to plan and optimize how the execution occurs. However, it is still relatively tactical: it takes place within the framework of a predetermined set of business processes and a predetermined business strategy.

Finally, BI using data with the highest degree of aggregation and covering the longest period of time corresponds to traditional data warehousing applications. In addition to being used for tactical decision-making, these are often used to make strategic decisions, such as whether a company should develop a new set of products or services, enter a new geographic or demographic market, or redesign core business processes.

OTHER FORMS OF ENTERPRISE INTELLIGENCE

In addition to the widespread inclusion of BI capabilities, enterprise applications are incorporating greater intelligence in a variety of other ways.

Knowledge and Content Management and Collaboration

While BI systems primarily analyze structured data originating in transaction-processing applications, knowledge management (KM) systems store, classify, search, retrieve, and analyze information from documents, Websites, and other less-structured sources of data.

Improvements in several key KM technologies allow companies to derive greater benefit from the information they possess. Automatic generation of taxonomies (hierarchies of categories) and automatic classification of documents into the appropriate categories allow information to be retrieved more accurately than by full-text search alone. Natural language processing technology is also improving, allowing information to be extracted from documents automatically. Greater use of ontologies—knowledge bases that describe the relationships between categories and allow software to make inferences based on those relationships—will lead to further improvements in these areas. KM vendors are also developing new user interfaces for navigating through collections of documents and visualizing the connections between documents, concepts, and entities.

Content management and KM systems overlap in functionality and use some of the same underlying technologies. However, content management applications are used to automate the processes of content creation (document authoring, workflow-based review and approval processes, and version control) and deployment (standardizing the appearance of content, assembling it from a variety of sources, and transforming it for delivery on multiple platforms) rather than performing the search, retrieval, and analysis functions of KM systems. The goal of enterprise content management is to integrate the disparate systems used to provide document management, records management, Website content management, and digital asset management into a single comprehensive solution for managing semi- and unstructured information.

Collaborative applications are capable of real-time interaction, such as instant messaging, chat, online meetings, and application sharing, and of asynchronous interaction, such as threaded discussions, project management, and shared workspaces. Some collaborative applications overlap in functionality with content management systems; both can be used to create shared work products, but collaborative tools are typically not used for the structured workflows characteristic of content management systems.

XML and Self-Describing Data

Applications of all types are making greater use of XML to tag data with the metadata that describes it, thus allowing software to interpret and manipulate data more effectively. As we discuss in "XML & Web Services," XML is the basis for developing both

general-purpose business process specifications, including specifications for business-to-business transactions, and a wide variety of industry- and process-specific XML vocabularies.

XML is also the basis for encoding the information that Web services use to communicate. One of the goals of Web services is to replace the current model for the Web—humans looking at Web pages—with automated communication between software programs to allow the vast amount of information available through the Web to be used by applications acting on behalf of humans. The increased use of XML is a precursor to the development of the Semantic Web, which goes beyond tagging data to allow knowledge to be represented in a way that is meaningful to software.

Business Process Management and Modeling

As we discuss in "Business Integration Technologies," enterprise application integration (EAI) by means of message brokers is being superseded by the use of process integration servers, which manage business process logic explicitly. Business process management (BPM) is the integration of traditional short-running (taking only a few seconds) EAI processes with long-running processes (which may take days), including business-to-business transactions and workflow, to create a single process-modeling and execution environment. This capability, which is still in the early stages of development, allows BPM to manage strategic end-to-end processes instead of only individual parts of a process.

Graphical modeling tools allow process logic to be designed by business analysts rather than by programmers; the resulting process model is used to generate the software components that execute the process. Standardization efforts are now under way to allow process models created with one vendor's modeling tool to be executed on another vendor's integration server.

Context-Aware Applications

A longer-term vision of the intelligent enterprise includes the concept of context-aware applications. As Ron Weissman explains in his interview, applications capable of understanding the user's context—in particular, the task the user is trying to accomplish—and the context of the information the application is processing will be introduced in the KM area. This will allow KM systems to provide users with the answers they are seeking rather than with a collection of documents that may contain the answers somewhere.

Context-aware applications will benefit other areas as well. Many applications can now generate information in a variety of formats for presentation to the user on different types of devices, including traditional PCs, personal digital assistants, and mobile phone handsets. However, the user currently needs to specify the appropriate format for the device and network connection being used. As Weissman points out, systems that understand the user's context will be able to select the appropriate information and format it in accordance with the requirements of the user's location and device.

REAL-TIME INFORMATION SYSTEMS

As discussed above, real-time capabilities are now an important part of BI systems. These capabilities range from the application of analytic techniques to individual transactions that are in process to the use of alerts, event notification, and digital dashboards. Beyond BI, real-time functionality is being incorporated into a range of other applications.

Supply Chain Event Management

As we discuss in "Enterprise Suites," real-time capabilities are being added to ERP and SCM applications in a variety of ways. For example, supply chain event management applications provide real-time information about order status and inventory levels as well as other supply chain events such as deliveries, shipments, and production. They also provide both real-time notification of exceptions or problems and the ability to respond in real time by changing production plans or diverting shipments.

Real-time capabilities in the supply chain will increase as a result of the growing use of radio frequency identification (RFID) technology, which allows pallets, cartons, and individual units of inventory to be labeled with tags that can be read electronically. These systems greatly improve an organization's ability to know where products, parts, and shipping containers are at any given time, and they provide an unprecedented view of a product throughout its life cycle. RFID tags will come into more widespread use as their cost declines to as little as 5 cents during the forecast period and as organizations such as the Auto-ID Center develop standards for incorporating the tags into enterprise applications.

Accounting, Finance, and Customer Relationship Management

Businesses are also increasing the speed with which their systems process information in the area of finance and accounting. For example, the virtual close is a set of techniques that allow a company to simulate the monthly or quarterly accounting period close on a more frequent basis—often daily. Like the business activity monitoring described above, the virtual close lets companies monitor critical business information in near real time. It also speeds the process of completing the actual end-of-period close, which benefits U.S.-listed companies facing an accelerated schedule for financial reporting under the provisions of the Sarbanes-Oxley Act.

Additional real-time capabilities are being incorporated into CRM systems. Online marketing, merchandising, and personalization systems have been doing real-time tailoring of content presented to Website visitors since the early days of Web-based e-commerce. As we discuss in "Customer-Facing Applications," new real-time marketing applications predict customer actions by using behavioral models that analyze data obtained from the customer during the sales transaction in addition to stored data about a customer's demographic characteristics and past purchases.

Real-Time Business Integration

Business integration technologies are the foundation for many of the real-time capabilities described above. For a BI application to provide business activity monitoring, it must have access to data from a variety of enterprise systems. Similarly, one of the key requirements for a virtual close is achieving automatic consolidation of financial information from multiple systems.

In addition, real-time business integration enables end-to-end automation of business processes, thereby allowing the company to react more quickly to changes in business conditions. As Vivek Ranadivé explains in his interview, the stage beyond process integration is closed-loop integration, in which a company automatically uses information about business events and business performance to modify its operations—ideally within minutes or hours rather than in days or weeks.

Business integration is also being enabled by developments in enterprise application suites. The leading ERP suite vendors have introduced technologies for creating composite applications, which encapsulate the functionality of parts of their suites (or

third-party applications) and allow them to be integrated to create an automated business process. Composite applications are also called cross-functional applications because such a process—for example, customer problem resolution—often spans several functional modules of an application suite. Using this technique, companies can add functionality to an existing group of applications with a small composite application, avoiding the need to write custom code to implement the cross-functional capability, which in turn reduces implementation risk.

Trends in Application Development and Integration

The tools discussed in the four chapters in ***Enabling Technologies*** are the foundation for many of the developments discussed in ***Enterprise Applications*** and ***Information Management***.

BUSINESS INTEGRATION TECHNOLOGIES

The roots of business integration lie in middleware that provided basic connectivity and data integration, the latter involving translation of data between the formats used by different applications. In the late 1990s, attention shifted to application integration, which uses message brokers and application connectors to allow an application to access data and invoke procedures in other applications.

More recently, process integration, which uses explicit modeling of business process logic, has become the preferred approach. Process integration servers use their own set of standard business objects (such as customers, orders, and general ledger accounts) to represent information in a way that is independent of the definitions used by any of the applications being integrated, thus allowing the process model to remain valid even if the specific applications in use change. These servers can also manage long-running transactions—those that take hours or days to complete and in which the application originating the transaction does not sit idle while awaiting a response—as opposed to earlier integration products, which handled transactions that were completed in seconds. Long-running transactions are particularly important for business-to-business integration because it is undesirable for business processes to come to a halt while awaiting a response from a trading partner. The use of standard business objects and the use of long-running transactions both exemplify the trend toward integration that creates loosely rather than tightly coupled applications.

XML & WEB SERVICES

In 2002, the phrase “service-oriented architecture” came into use to refer to a new approach to enterprise computing in which component-based applications are built expressly to share functionality with other components and applications using Web services protocols. With Web services capabilities now included in most development tools and application platforms, and with packaged software vendors exposing the functionality of their products through Web services interfaces, the groundwork is being laid for an enterprise software infrastructure that will require less duplication of development work and in which few applications will function in isolation.

Protocols and Specifications

As described previously, XML is being used to develop a variety of specifications for business transactions and general-purpose and process- and industry-specific vocabularies for exchanging business information. Several other specifications—some providing overlapping functionality, and others designed to be used together—have been proposed or adopted as standards for XML- and Web services–based business processes.

Some of these specifications build on the Simple Object Access Protocol (SOAP), the basic protocol used by Web services for request/response messaging and remote procedure calls, by adding higher-level functionality similar to that provided by certain types of business integration middleware. These additional functions include message routing, reliable delivery, several types of transactional integrity, and coordination of multiple transactions within a business process. Other specifications build on Web Services Description Language (WSDL) by allowing each Web service to provide a detailed description of the way it interacts with other services.

In addition to these extensions to the basic message-exchange capabilities of Web services, other specifications address the defining and automating of business processes. These specifications include XML-based standards that predate Web services and provide many of the same capabilities when used to automate a trading relationship; several overlapping specifications for defining the exchange of messages and documents necessary to implement business processes and transactions (known as Web services choreography); and a library of standardized business documents.

The security capabilities of XML also continue to be enhanced. Authentication, encryption, and nonrepudiation must be applied to XML documents on a fine-grained basis, because those documents may be used in situations requiring encryption and authentication of portions of documents or steps in a transaction. In addition, the ability to provide identity management capable of spanning multiple organizations will be essential to business-to-business transactions. To meet these needs, several specifications for adding security features to XML documents and the Web services that use them have been developed, including the Security Assertion Markup Language; the XML Signatures, Encryption, and Key Management specifications; and the WS-Security and related specifications for Web services security.

Web Services Adoption and Usage

As some of the early enthusiasm for Web services has abated, vendors and enterprises have become more realistic about how they will be deployed. In *Technology Forecast: 2002–2004, Volume 1*, we predicted that the vision of dynamic discovery and integration of Web services into virtual applications that cross enterprise boundaries was unlikely to be realized before 2005—not least because companies were unlikely to do business with previously unknown trading partners simply because they were listed in a directory of Web services. This position has now been generally accepted, leading to a greatly reduced emphasis on the role of public Web services directories based on the Universal Description, Discovery, and Integration (UDDI) protocol.

However, Web services are being adopted in a variety of other contexts:

- ***EAI***—Integration between applications inside an enterprise. One of the important uses of Web services is expected to be integration between applications based on the two major competing component frameworks (J2EE and .Net).
- ***Interenterprise integration***—Integration between trusted business partners, in which Web services will initially be used for pairwise integration of applications. Using Web services for this purpose has two benefits: the participating applications can be modified without disrupting the integration, and a Web services interface added to an application to connect to one business partner can be reused as other business partners are added.

- ***Public Web services***—One of the most unexpected developments in this technology in 2002 was the advent of freely available Web services from major Websites. Companies began to allow access over the Internet to the application that provides the key services used on their Website—for example, Google's search engine or Amazon's product catalog—allowing software developers to create applications that can access these services directly, bypassing the sites' HTML interfaces.
- ***Thick clients***—Desktop applications can use Web services to access information and other resources from the Internet without first locating and downloading the information to their computer's local file system. For example, according to Microsoft, Office 2003 will be able to establish links from spreadsheets or other documents to Web-based information sources, allowing the document to be updated automatically as the data changes.

Before the use of Web services becomes widespread, the IT industry must resolve some of the uncertainty caused by the competition between the standards described above, and vendors must offer tools for developing and managing Web services.

APPLICATION & PORTAL SERVERS

Application servers have become the primary environment for developing, deploying, and integrating enterprise applications. They provide both an environment in which software components can execute and a set of services required by many applications, including transaction processing and message queuing software, interfaces to databases, and the ability to balance workloads between multiple servers running the same application. In the J2EE environment, these capabilities are provided by a variety of vendors selling application servers that run on a variety of operating systems, including Windows, UNIX, Linux, and z/OS; in the .Net environment, these capabilities are built into the Windows operating system, and there is no separate market for application servers.

Application server vendors have been extending their product lines by adding portal servers, integration servers, and identity servers, as well as integrated development environments that give software developers access to the vendor's unique APIs. Portal servers provide enterprise users with a customizable Web page combining information and application functionality from various sources, both internal and external to the enterprise. Integration servers provide data exchange and integration between the application server and applications running on other platforms; they typically offer a subset of the full range of business integration functionality. Identity servers manage user authentication and provide single sign-on to enterprise applications. As Tony Scott mentions in his interview, by offering a suite of server products that have been pre-assembled and tested to ensure their compatibility, vendors are moving closer to realizing the goal of a software appliance.

All J2EE application servers are implementations of the same standard, which, in principle, ensures portability of applications between application servers from different vendors. However, by encouraging enterprises to use the vendor-specific portal, integration, and identity capabilities they have added to their application servers, the vendors have promoted the development of nonportable applications and increased the likelihood that enterprises will standardize on one vendor's suite of servers. There is no portability of applications between a J2EE application server and .Net, because they use completely different component frameworks.

Vendors of packaged enterprise application suites have been componentizing their applications since the late 1990s. Initially, each vendor used its own proprietary component framework and run-time environment. During 2001 and 2002, these vendors began overhauling their product architectures to incorporate application servers that can run components based on an industry-standard framework—usually J2EE—alongside the vendor's proprietary components. For example, in June 2002, SAP replaced the original run-time environment for its R/3 suite with its Web Application Server, which can run both J2EE components and components written in SAP's ABAP language. This allows SAP and its customers to develop new functionality using J2EE while still taking advantage of their investment in ABAP-based software.

COMPONENT FRAMEWORKS

Just as application servers have become the primary environment for application deployment and integration, the use of industry-standard component frameworks—J2EE and .Net—has become the standard approach to software development for both enterprises and software vendors. These two phenomena are tightly linked, since application servers provide the run-time environment for software developed using the component frameworks. The use of components encourages software modularity and reuse, both of which are valuable in their own right and also contribute to increased software reliability. Because packaged applications are increasingly being delivered in the form of components, even enterprises not engaged in custom software development will find component frameworks becoming an important part of their software infrastructure.

The use of industry-standard component frameworks allows application developers to take advantage of a vendor-provided run-time environment—the application server—as well as a set of services that applications commonly use: transaction management; interfaces to persistent data sources, such as databases; component life-cycle services; messaging; and security.

Component environments provide an efficient platform for building distributed multitier applications. Software developers can create different types of components that correspond to the different tiers of a distributed application—user interface (which can be browser-based or use the full capabilities of the client platform's windowing system), business logic, and data management—as well as service and utility components. Component frameworks can also facilitate the deployment of Web services, both within the enterprise, as bridges between infrastructure elements, and externally for consumption by customers, business partners, and the public. Adoption of software architectures based on component software will reduce the difficulty, time, and costs of creating and modifying the applications in enterprise portfolios, allowing enterprises to respond more rapidly to the changing business environment and to more easily use information systems as a source of competitive advantage.

The two major component environments are still under development. The specification for the next version of J2EE (version 1.4), which adds standards for implementing Web services in the J2EE environment, was released in final draft form in late 2002; approval is expected in mid-2003. Microsoft is releasing new .Net-based versions of all its server products, and the scheduled April 2003 release of Windows 2003 Server will mark a major milestone in that process. The choice between J2EE and .Net is a major strategic decision for corporate IT organizations. No matter which framework they select, however, most large enterprises will find they have some presence of both frameworks.

IT and Corporate Accountability

One characteristic that many of the technologies discussed in this *Technology Forecast* share is the role they play in corporate accountability and regulatory compliance.

The use of IT for these purposes is not new: many of the earliest commercial applications for computers in the 1950s were accounting systems whose ultimate product was financial reports for investors. In more recent decades, the motivating factor behind the adoption of certain technologies has been regulatory compliance. For example, the pharmaceutical industry has been one of the most aggressive in adopting document management systems, which they use to collect and manage data from clinical trials and to submit that data to regulators as part of the approval process for new products.

The recent increased interest in corporate accountability and financial transparency has made these factors more significant in shaping the evolution of IT and its adoption by enterprises, as illustrated by the following examples.

FINANCIAL REPORTING

In "Business Reporting & XBRL," we discuss the role that XBRL will play in facilitating the preparation, dissemination, and interpretation of financial reports. XBRL, which is based on XML, provides a standard way to label financial reporting data in a format that can be easily interpreted by software. Availability of corporate quarterly and annual reports in XBRL format will make it significantly easier for analysts and investors to use and interpret the data—for example, by automating the process of comparing financial results between different companies.

As Mike Willis, a PricewaterhouseCoopers partner, points out in his interview, XBRL will reduce the importance of the way data is presented in financial statements by allowing each user of the data to analyze it according to his or her own priorities. For example, the hotly debated issue of how stock options issued to corporate officers and employees should be treated under U.S. accounting standards—whether they should be included as an expense or merely disclosed in the notes to the financial statements—becomes less relevant if the financial reports are issued as XBRL-tagged data. Anyone using the information who believes that options should be treated as an expense will be free to treat them that way in his or her analysis of the company's XBRL-tagged financial data. As Willis explains, in the longer term, XBRL could increase both the frequency of financial reporting and the extent of the information that is reported to investors.

We also describe the relevance of other technologies to financial reporting. "Enterprise Suites" explains how the virtual close helps companies accelerate the process of preparing financial reports at the end of the accounting period. This makes it easier for companies to comply with the accelerated reporting requirements imposed by the Sarbanes-Oxley Act and similar legislation that is expected to be adopted elsewhere. "Business Intelligence" describes a number of ways that business intelligence and analytic technologies can help CEOs and CFOs comply with the certification and controls requirements imposed by the act.

Many of the technologies covered in our ***Enabling Technologies*** section are also relevant to financial reporting. Most companies' ERP systems cannot aggregate the wide range of information from disparate operational systems and external sources that is needed for financial reporting. Therefore, companies cannot increase reporting transparency without either significantly enhancing largely manual processes or reengineering

reporting processes through the use of IT. The technologies described in "Business Integration" provide the basis for automating the aggregation of financial information from multiple systems.

Other technologies described in "XML & Web Services" will also play a greater role in financial reporting over time. Web services will allow analysts and investors to automate the retrieval of company financial information from within an application, either directly from the company's Website or from information aggregators, without first having to use a browser to locate and then download the information.

INFORMATION ANALYSIS

Many of the technologies that are relevant to financial reporting are also useful in meeting other regulatory compliance requirements. For example, financial institutions—particularly those having several back-office systems as a result of mergers or acquisitions—need business integration and business intelligence technologies to collect and analyze the data required for ensuring compliance with capital adequacy requirements such as those specified by the New Basel Capital Accords (Basel II).

In addition to processing highly structured financial data for compliance purposes, companies also can take advantage of tools designed to collect, manage, and analyze less-structured data. For example, the USA PATRIOT Act passed by the U.S. Congress in the wake of the terrorist attacks of September 11, 2001, imposed stricter anti–money laundering requirements on a wide variety of businesses, many of which had never been subject to anti–money laundering regulations. This act includes an expansion of the "know your customer" requirement requiring institutions to verify the identity of their customers and guard against the use of illicit funds in business transactions. As we discuss in "Knowledge Management," analytic technologies that can discover previously unknown relationships between individuals and organizations are gaining significant attention from both businesses and government agencies—particularly intelligence agencies. The same technologies may also be applied in other anti-terrorism applications, such as the new version of the Computer-Assisted Passenger Prescreening System used by U.S. air carriers to identify passengers who could pose a security threat to an aircraft.

For more information about anti–money laundering regulations, see Anti–Money Laundering: New Rules, New Challenges, New Solutions *(published by the PricewaterhouseCoopers Global Technology Centre in 2002). Ordering information can be found in "How to Order" on page vii.*

Companies doing business in the U.S. also are required to file suspicious-activity reports (SARs) with the Treasury Department, reporting transactions of a certain size or character. Because CRM software already captures, stores, and processes much of the information relevant to complying with these requirements, it has been viewed as a way of detecting suspicious activity in transactions and accounts. One detection method is to watch for transactions that are outside the norm for a given account. Many credit card companies already provide this capability as a fraud-prevention measure. In addition, the ability to monitor, profile, and analyze client and transaction data could allow CRM software to detect patterns of activity that warrant further investigation.

NEW COMPLIANCE FEATURES IN APPLICATIONS

In several of the previous examples, existing technologies that were developed for other purposes are proving useful in meeting accountability and regulatory compliance requirements. In other cases, however, vendors are having to add new features to their applications to satisfy these requirements. For example, Microsoft provides a BizTalk Accelerator for health care organizations in the United States that must comply with the electronic transactions and privacy requirements of the Health Insurance Portability and Accountability Act (HIPAA).

Consumer-oriented Internet technologies that make their way into the business world often lack the security and manageability features that enterprises require. In some cases, they also lack features required for compliance purposes. For example, instant messaging (IM) has gained widespread acceptance among users of the Internet. However, it has been seen as unsuitable for business use because of its lack of security and—particularly in cases where a company is required to archive communications with customers, as retail brokerages must in the United States—its lack of a persistent archive of previously sent messages. A number of vendors are now introducing IM products designed to meet the requirements of business users.

In Conclusion

The chapters that follow contain detailed discussions of many key technologies essential to the evolution of enterprise applications and enabling software. They also offer predictions about the way these technologies will develop during the forecast period, the years 2003 through 2005.

We hope you will enjoy *Technology Forecast: 2003–2005* with its extensive coverage of enterprise software. We encourage you to obtain a copy of *Technology Forecast: 2002–2004, Volume 2: Emerging Patterns of Internet Computing*, published in November 2002, which complements this volume with coverage of the entire range of computer systems, from handheld devices to supercomputers; storage devices and displays; semiconductors; wireless and wireline communications; network equipment and protocols; and system and network management. Copies of *Technology Forecast: 2002–2004, Volume 1: Navigating the Future of Software*, which discusses a variety of software technologies not included in the current edition, are still available. Ordering information for these publications can be found in "How to Order" on page vii.

We also encourage you to obtain a copy of the forthcoming *Information Security: Meeting the Challenge of Internet Computing* with its coverage of the issues involved in securing Internet computing. The latest information about upcoming *Technology Forecast* publications can always be found on our Website, www.pwc.com/tech-forecast.

If you have suggestions about how to improve the *Technology Forecast* or suggestions for future publications, we would appreciate hearing from you. Please contact us by e-mail at technology.forecast.editors@pwc.com. After all, this book is written for you.