



Patricia Seybold Group

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Case Study

Charles Schwab Responds to Market Conditions and Customer Needs

Services-Oriented Architecture Improves
Time to Market and Leverages Existing
Investments

*By David S. Marshak
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A Patricia Seybold Group e-business on demand case study prepared for IBM Corporation

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EXECUTIVE SUMMARY

Thirty years ago Charles Schwab, Inc. revolutionized the brokerage industry with a new business philosophy: providing the individual investor with useful services for a fair price. A dynamic marketplace, however, has created new challenges and opportunities for Schwab. The market downturn and competition from Internet discount brokers have cut into transaction fees, the company's main source of revenue. At the same time, many investors have lost confidence in traditional, full-service brokers due to apparent conflicts of interest. For Schwab, this presented the opportunity to grow and differentiate itself by providing access to independent consultation and advice on a clearly defined fee basis.

Historically, Schwab has tied its IT infrastructure tightly to its business goals – in particular, the company focused on delivering an architecture that supports the best customer experience possible. To grasp this new opportunity, Schwab knew that it would have to standardize and simplify its infrastructure in order to provide seamless support across multiple channels.

Leveraging its long-term relationship with IBM, Schwab elected to create a services-oriented architecture, based on open standards, to support enhanced communications and integration, and virtualization, to make better use of existing assets. Ultimately, the goal is to create a more efficient, available and resilient architecture and set of tools that will permit Schwab to deliver relevant, consistent advice in a more responsive manner—whether the customer is at an investment center, on the phone or on the Web.

The services-based architecture, and the new processes and applications it supports, means that Schwab can provide customized advice to all its customers, whether they choose to work one-on-one with a Schwab Private Client Consultant, with the Schwab Advisor Network, or independently. With its focus on being responsive to market conditions and customer requirements and its commitment to an integrated services-oriented architecture, open standards, and leveraging its existing environment, Schwab is providing a strong example of a company that is positioning itself for success in the on demand world.

Background on Charles Schwab

Schwab Principles:

- Respond and adapt to changing business climate, evolving customer needs, and new opportunities
- Create an adaptive, flexible services-oriented architecture to enable new business applications without impacting existing systems or customer experiences
- Maximize the use of existing resources and reduce costs

The Charles Schwab Corporation (NYSE:SCH), through Charles Schwab & Co., Inc. (member SIPC/NYSE), U.S. Trust Corporation, CyberTrader, Inc. (member SIPC/NASD) and its other operating subsidiaries, is one of the nation's largest financial services firms serving 8 million active accounts with \$758.4 billion in customer assets. Schwab provides a full-service investing experience to customers through 422 domestic offices, 4 regional client telephone service centers and automated telephonic and online channels. The independent, fee-based investment advisors served through its Schwab Institutional division manage about 30% of Schwab's customer assets and 15% of its customer accounts.

Charles Schwab revolutionized the brokerage industry (see Illustration 1) by focusing on the principle of providing the best customer experience within and across all channels and touchpoints. For Schwab, customer experience encompasses not only the specific customer interactions in retail locations, on the Web, and on the phone, but also includes a common, seamless experience across them—after all Schwab President David Pottruck coined the term “Clicks and Mortar.” In addition, customer experience extends to the actual business being done via these touchpoints and channels, while it is critical to maintain the customer's confidence in Schwab as ethical, objective, and independent.

Schwab and Schwab.com are often cited as best in class, and just in the past year Schwab has won top honors from organizations such as Gomez (Internet Broker Scorecard #1 ranking over all and #1 for ease-of-use and onsite resources), Forbes (who singled out CyberTrader as “Best for ‘Hyperactive’ Traders” and Schwab.com as the “Forbes Favorite” brokerage Web site), and CIO Magazine (one of the CIO-100, where Schwab was honored specifically for “effective integration of customer information from various channels”).

Schwab was able to ride (if not drive) the investment wave of the late 90s by sticking to this customer-centric principle, and is now creating its new “post-bubble” identity based on that principle. In fact, rather than simply scaling back as its industry dramatically slowed down over the past few years; Schwab is evolving its focus on customer experience (particularly on customers' desires for ethical, objective, and independent advice) to recast its previous transaction-oriented relationships with the majority of its customers into more of a trusted advisor relationship.

According to Beth Devin (Executive Vice President, Advisor and Client Technology), in order to maintain and extend its relationship with its customers, as well as deal with the day-to-day realities of its business sector, Schwab continues to focus on a set of business and technology principles.

In this Case Study, we will examine how these principles have been and continue to be applied across a set of infrastructure and business application projects at Schwab. We will further see how Schwab is using these principles to guide it as it evolves its business in an on demand world.

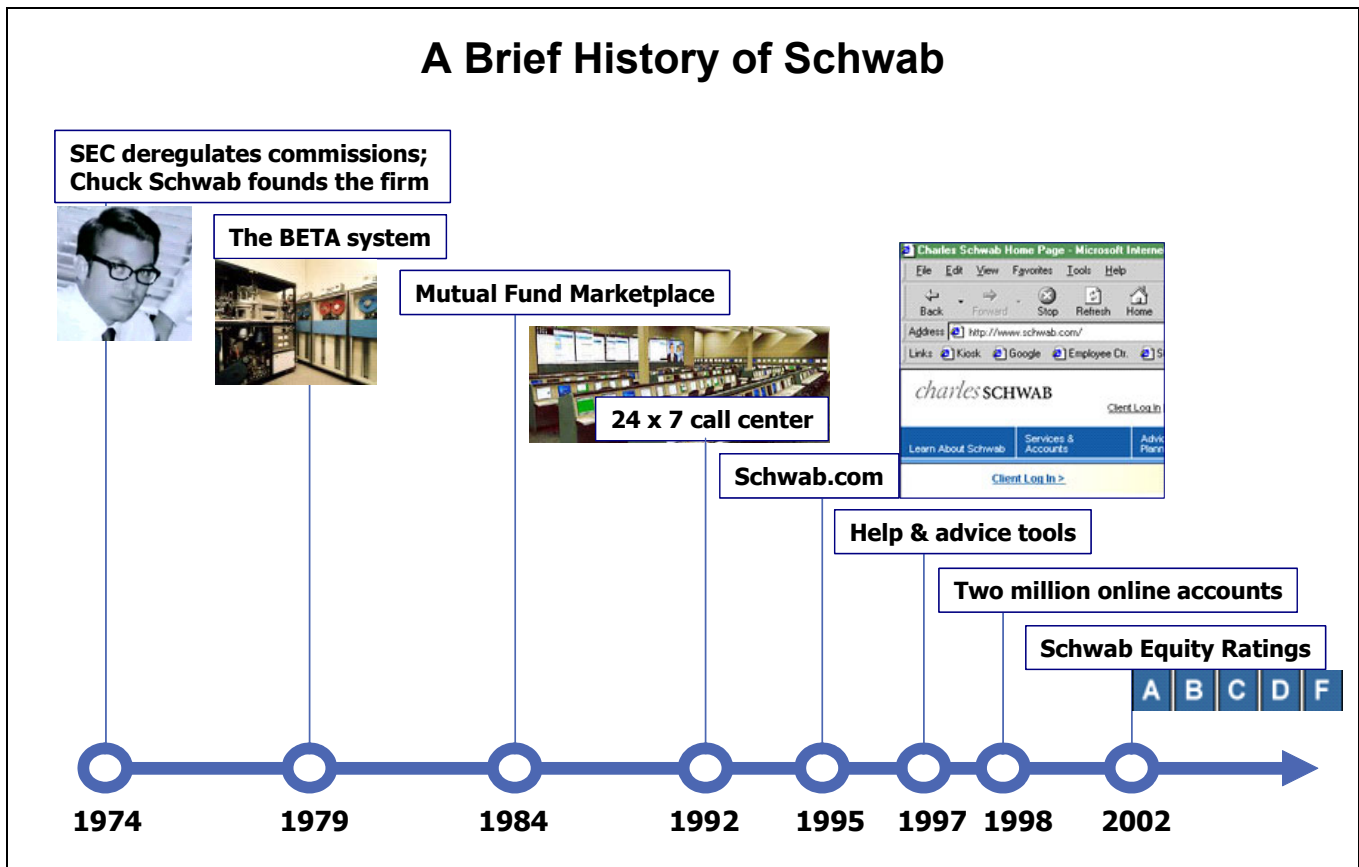


Illustration 1. Over the past 30 years Charles Schwab has continually demonstrated its leadership and innovation.

Schwab’s Challenges

Responding to Changing Economic Conditions

Challenges and Opportunities:

- Changing business climate
- Low trust for some financial advisors
- Schwab’s desire for a deeper relationship with its customers

Like many companies over the past few years, Schwab has had to respond to the changing economic conditions—conditions that were magnified because of Schwab’s primary business being dependent on the volume of equity trading. Thus Schwab has been evolving its business from simply offering low-cost, self-service stock transactions to becoming a trusted, independent advisor to its customers. This evolution has been driven by a number of factors both external and internal.

With the volume of transactions falling dramatically over the past few years, Schwab has had to seek other sources of revenue—with for-fee advice being an attractive business to get into. At the same time, Schwab customers (and investors in general) were becoming increasingly concerned about the independence of their financial advisors—many of whom also have banking relationships with the companies they recommend. This perception of conflict of interests and the highly visible investment scandals have left a place for an independent advisor, such as Schwab is positioning itself.

Finally, Schwab itself was never satisfied with a relationship with its customers that was mainly limited to enabling transactions. Schwab's view of a complete customer experience always extended both widely (across channels and touchpoints) and deeply (encompassing strong financial relationships).

But in order to make an effective—and profitable—transition, Schwab needed to evolve its IT infrastructure. It needed to create a new, more flexible foundation for its business, one that provided open communications and efficient use of resources in order to support responsive, up-to-date information and advice across multiple channels.

Creating a Trusted Relationship

Schwab started to provide advice in 1999. According to Devin, “This was initially simple—how to balance your portfolio. We are increasingly moving towards detailed analysis—including stock recommendations.”

Today, advice is offered via multiple channels—though it is richest when provided directly from Schwab advisors. On the Web, customers can get a “Portfolio Check-up,” which takes customers' age, investment goals, risk tolerance, and current cash requirements and enables them to view their portfolio allocations against the recommended allocation for their situation. The recommendations on the Web are relatively generic and focus on allocations rather than on specific investments (this is due to regulatory issues, since Schwab is not yet able to fully audit and track these interactions).

A limited set of interactions is also possible via e-mail and phone, with the most valuable probably being the ability of the customer to sign up to be alerted via e-mail upon certain events—e.g., Schwab downgrading a stock.

Most detailed, customized advice is provided by Schwab Investment Consultants who interact with customers by phone or in person. These consultants have a detailed set of advice tools—tools that are continually being enhanced.

In addition to obtaining direct advice from Schwab, customers can interact with and get advice from any of the over 5,000 independent financial managers who use Schwab as a back-end (e.g., for brokerage accounts, trades, etc.). Within this group, there is a select number, known as the Schwab Advisor Network, who can provide detailed money management services. Schwab consultants will refer those customers who need money management to this network.

Schwab's strategy for transforming itself from a low-cost provider to one that adds value through a trusted investing relationship is based on continually enhancing its existing advice tools and integrating them across all channels. This, in turn, requires enhancing the IT infrastructure in order to create a system that will permit it to respond more quickly and more flexibly as business conditions and customer expectations continue to evolve.

Schwab Results	
Business Benefits	<p>Standards-based architecture provides a new level of responsiveness for Charles Schwab, positioning Schwab to quickly and dynamically respond to changes in the marketplace and deliver new services that add customer value.</p> <p>An enhanced customer experience that is consistent across multiple customer touchpoints and channels.</p> <p>The right information is delivered into the hands of customers and advisors in a more timely manner—enabling better investment decisions.</p> <p>The grid-enabled system has reduced processing time from eight to ten minutes to just 15 seconds, dramatically changing the character of its customer interactions.</p>
Technology Benefits	<p>Resilient, less-proprietary underlying IT environment allows company to quickly roll out new functions without major disruptions to the infrastructure.</p> <p>Embracing open standards, such as XML, has enabled Charles Schwab to speed development and reduce costs.</p> <p>Evolving its services-orientated architecture has shortened its time to market while minimizing the impact on existing applications.</p> <p>Virtualization through use of grid technology has positioned the company for future growth with an evolving, on demand environment.</p>

Schwab's e-business Strategy

An Architecture to Support Responsiveness and Flexibility

Schwab is able to respond to changing business conditions and customer needs by designing a standards-based, flexible, services-oriented architecture and leveraging its partnership with IBM to enable the transformation of core business and technology processes

Schwab has historically tied its architecture very closely with its business goals—with particular emphasis on delivering an architecture that supports the best customer experience possible, while being able to be highly responsive to customers' current and future needs. According to Schwab Executive Vice President and CIO Geoff Penney, this has led to three key principles that drive all strategic business/architectural decisions:

- Customer Centricity—maintaining the consistency of client experience across all touchpoints and channels on the customer side, including Web, wireless, phone, and in person.
- Flexibility—the ability to respond to new business needs by easily adding new customer types and new channels, without touching the back end, and also adding new back-end services without touching the channels.
- Efficiency—creating cost savings through reuse of existing infrastructure, new development, and internal expertise.

Schwab's e-business Environment

Schwab's e-business Benefits:

- Shorten time to market
- Minimize impact on existing applications
- Maintain consistent user experience
- Leverage investment and skills

These new business initiatives (and enhancing existing initiatives) require the development of new applications on the front end as well as new applications (or services) on the back end. Key goals of all of these initiatives would be to shorten time to market, minimize impact on existing applications, and maintain consistent user experience across all channels.

In addition, in order to be successful with these initiatives, Schwab understood that this would require organizational changes and a better leverage of its resources. Schwab would do this by:

- Evolving its services-oriented architecture—see *Schwab's Services-Oriented Architecture*.
 - Enhancing its ability to deliver components that can quickly be assembled into new applications and services to meet market and customer needs—See *Business Process Modeling and the Barista Frameworks Initiative*.
 - Establishing a system of domain ownership and moving responsibility closer to the customer—see *Domain Ownership* and the section on the *Schwab Content Management System Initiative*.
 - Exploring some leading-edge methods of leveraging systems and skills—see the *Schwab Grid Initiative*.
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Schwab High-Level Architectural Approach

Driven by these principles, Schwab's architecture takes its application environment and enables the company to react to (and many times anticipate) customer needs and market changes by quickly adding new services and products. The architecture takes what began as a hierarchical mainframe environment and turns it into a peer-to-peer services oriented architecture that enables the customer centricity, flexibility, and efficiency that meet the business demands. Supporting the services oriented architecture, Schwab has also evolved its governance and application development processes, with the key initiatives being, respectively, "domain ownership" and a Business Process Modeling methodology.

SCHWAB ENVIRONMENT. Schwab is a huge mainframe, COBOL, CICS shop that runs the core brokerage systems (portfolio systems, customer systems). These corporate offerings are the first and largest suppliers of business services and they are organized into domains (see Domain Ownership below). Schwab's distributed tiers are generally used for building new business services and building new products.

These core systems, services, and applications are connected to a set of channels and touchpoints accessing the common information for a variety of customers and contexts. In between, there is a middleware software tier that both separates and connects the front-end and back-end services and a business logic tier where customer and employee focused applications are built. As we shall see, the middleware layer (or Bus) is evolving to support a standards-based, services-oriented architecture. Schwab also has a large componentization effort to make it easy to add new value, new channels, new features, new customer types, etc. (see Illustration 2).

SERVICES-ORIENTED ARCHITECTURE. For Schwab, moving to a Services-Oriented Architecture was a logical step in its architectural philosophy. According to Tim Heier, Schwab Technical Director, Application, Infrastructure, Domains and Engineering (AIDE), "Given the heterogeneous computing environment at Schwab, the adoption of a standards-based Services-Oriented Architecture (SOA) was an evolutionary step towards reducing the coupling between interacting software systems. Coupling of system implementations is being reduced by hiding system implementations behind a service layer." Heier continues, "Providing a service layer that hides the underlying implementation from the client is a key element in Schwab's approach to a SOA. Since the service becomes abstract, via the layering approach, requests and responses can be made independent of the location, storage, or presentation mechanism."

Moving to the Services-Oriented Architecture delivers several benefits to Schwab:

- Better scalability through location transparency
- Services can be reused across different presentation delivery mechanisms
- Software reuse is promoted by the architecture

And Heier emphasizes, "These benefits are an important part of Schwab's ability to provide an integrated client experience."

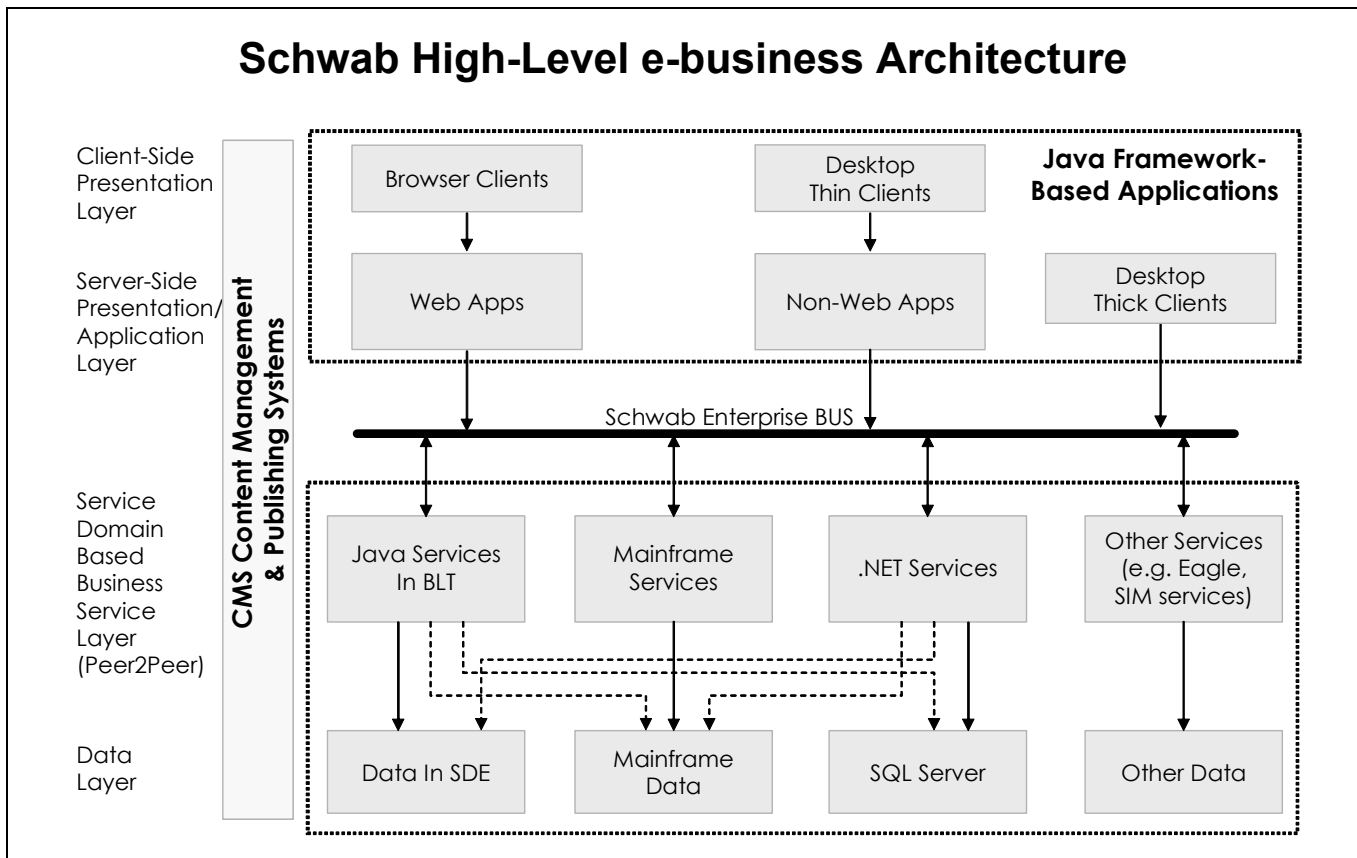


Illustration 2. The logical, peer-to-peer Services-Oriented Architecture at Schwab

BUSINESS PROCESS MODELING. Schwab’s development methodology is based on use case driven object modeling and utilizes Unified Modeling Language (UML) notation. Heier re-emphasizes that this methodology is business process driven, with a “strong and obvious linkage between how the business operates and the software applications that support it as the result of Rational Unified Process (RUP) use case models. Each core business process is modeled end to end, looking across the whole value chain—encompassing customer, internal, and third-party activities, whether these activities are automated or manual.”

Within the domain ownership model, each information object (e.g., Customer, Order, Security) is aligned with a particular business domain for stable, long-term data sharing based on the RUP business object model.

Schwab points to the following reasons that it has adopted its business process driven methodology:

- Ability to capture the integrated business requirements for seamless client experience
- Business and technology stakeholders gain a more comprehensive business view and communicate with clarity

- Strong linkage between application software components and the way the business operates
- User interfaces—based on end-to-end process flows—are easier to integrate

Domain Ownership enables Schwab to:

- Move decisions and actions closer to the customer
- Reduce time to market
- Leverage Frameworks

DOMAIN OWNERSHIP. Schwab’s governance model revolves around domain ownership, where domains are managed sets of reusable services (discrete automated business functions) sharing some common business cohesiveness. In many cases these are subsets of business functions such as Customer Information, Portfolio Information, Customer Ledger, Custody, etc.—as well as investment references like Market Data, Research, and Analysis/Planning/Monitoring Services.

Each domain is responsible for maintaining its own business objects and for publishing interfaces to its services to other domains. The domain offers retrieval and maintenance services for the business object, encapsulating business logic, location, and format associated with its objects and services. When one product or product area (e.g., Advice Suite) wants a service from a domain (e.g., Customer Portfolio) it makes a request and the two determine the relationship creating a service-level agreement. These relationships and agreements also exist between domains (such as Customer Information and Portfolio Information). The domain ownership model is supported by and further supports the services-oriented architecture, as well as extending the services orientation to the business units themselves.

For Schwab, domains are a critical part of its application approach, with key benefits being partitioning services into long-term, manageable subsets, providing subject matter expertise, and promoting ownership which is essential to sustain reuse.

Technology Decisions and Partnerships

“We are counting on our continued partnership with IBM on these projects. Part of the road map that Schwab is developing with IBM is to make Schwab completely on demand.”

David Dibble, EVP,
Schwab
Technology
Services

Schwab is an architecturally-driven rather than a supplier-driven company, as Penney notes “Our basic philosophy is to have multiple vendors.” While maintaining this vendor independence, Schwab has developed a special relationship with IBM. Penney continues, “One of the strengths of IBM is it plays in almost every space—we interact with IBM more than with any other vendor. IBM has helped us in special projects such as with the Barista framework. At the same time IBM has recognized that we represent a leading edge, high-volume, real-world place where they can learn.”

Schwab's e-business Initiatives

From the earliest days, Schwab has understood that being responsive to customer needs would require an ability to easily integrate its own existing systems, future systems that it would develop, and ultimately many external systems. All of these would not be necessarily planned, but would be driven by changing business conditions and relationships and ultimately by how Schwab's relationship with its customers would evolve.

The Bus Initiative—Virtualizing Systems into Services

Schwab's key initiatives include:

- Evolving to a standards-based bus
- Utilizing its Barista Java Framework to build new advice applications
- Designing a new content management system and process
- Piloting a Grid-based method of leveraging existing computing power to enhance new advice applications

One of the key early decisions was to separate Schwab's technology into logical tiers and to virtualize it so that the business could evolve without major disruptions in the infrastructure and visa versa. Penney explains that Schwab's architectural evolution has thus been a "Constant drive for simplicity in the architecture" which has now taken three steps. Step One was to take the backend applications and make them services. "This was many years ago when we added voice response units (VRUs) to offices as the second channel. From then on all backend applications would be services to all channels."

Step Two was to put a middleware bridge (SchwabENTRY or "SEntry") between "the channels world and the backend world." Penney points out that because of SEntry, "When we wrote the wireless channel we wrote no code on the back end." SEntry is based on proprietary Schwab APIs.

Step Three is the design and implementation of a new standards-based Bus whose goal, according to Jim Diven (Schwab Vice President, Design and Engineering, Middleware and Messaging Engineering) is to move away from the proprietary interfaces of SEntry—using Web Services where possible—and create a more publish-and-subscribe, peer-to-peer model for the future evolution of Schwab's architecture.

The evolution from the proprietary middleware to the standards-based Bus architecture is being moved forward by a number of drivers, including avoiding becoming a technology backwater and sun-setting older, end-of-life technologies, lowering the cost of dedicated hardware and software tiers, and increasing responsiveness by eliminating the requirement to rewrite proprietary APIs when services or clients change.

Brad McCarthy (Technical Director, AIDE) notes, "This would potentially get us out of the business of distributing client stubs."

In 2002 Schwab, with the help of IBM's jStart program, ran a successful Web Services proof of concept for the Bus. Diven's major initiative this year is to create and deploy the Web Services layer of the Bus. Within this initiative, Diven feels that implementing the Web Services Definition Language (WSDL) is the most critical, "WSDL is very important to enable different invocation of a service—and the Bus is essentially an enabling technology that supports these multiple services and transports."

According to John Sovereign (Technical Director, SIM—Services for Investment Managers—Technology), the new (Step 3) Bus is being rolled out in three phases:

Phase 1, now in production, supports asynchronous Publish/Subscribe and is deployed on WebSphere Business Integration Message Broker (WBIMB), using the Java Messaging Service (JMS) for distributed connections. WBIMB on the mainframe provides the transformation of COBOL to XML. Phase 1 also reuses Schwab's existing LDAP infrastructure.

Phase 2 will support a synchronous Request/Reply model scheduled for the end of 2003. This work is being built on the IBM WebSphere Web Services Gateway product.

Phase 3 is planned to support Streams, a synchronous form of communication which will provide performance improvement for certain types of applications.

Diven points out one of Schwab's challenges has been to service-enable all of its back-end systems, particularly CICS. "We need IBM to enable CICS as a service provider and eventually as a consumer. We could use Enterprise Java Beans—EJBs (but we don't) or CICS transaction gateway (but we're not doing it because we don't like gateways)." Of course, Diven is "looking forward to the day when CICS is fully Web Services enabled."

Componentization: Barista Java Framework Evolution

IBM Research Labs and Technical Teams played a key role in creating, testing, and implementing a breakthrough framework for building enterprise-class Java applications

Because of Schwab's goals of fast time to market for new services to customers and controlling its own costs through reuse, a second key technical initiative for Schwab is the creation and use of a Java Framework (which Schwab has named Barista.) Originally, Schwab.com had been built as a set of CGI scripts. While this was necessary at the time (given the available technologies), it clearly was not optimal for the long term. As Brad McCarthy (Technical Director, AIDE) recalls, "There was very little sharing, a monolithic structure, data integration was difficult, and reuse was by copy and paste."

This challenge is echoed by Jared Price (Vice President, AIDE) who notes, "We needed to move to a more structured model for reuse and consistency," with, as Jenifer Riley (Senior Manager AIDE, Barista Technical Team) adds, "a better release and maintenance model."

According to Bin Hu, Technical Director, AIDE, Barista Technical Team, the Schwab team began to "work with IBM in 1999 to develop a Java framework to replace the existing environment and create a standardized set of development processes for the whole company." This framework would be called Barista.

Barista is a Java programming framework (a set of compiled code and standards for that code) for application and infrastructure features. Barista is based on a component development model and can be viewed as a container for reusable business logic.

The principles underlying Barista include:

- Reduce maintenance by reuse
- Containers hide technology
- Enforce layer separation
- Portable components that run on any middleware and hardware
- Enable functional releases, rather than completely re-releasing an entire site for each release

BARISTA TIMELINE. The prototype of Barista began in 1999, with the first application going into production in June, 2000. Siva Chandrasekar (Director, AIDE, Barista Technical Team) emphasizes that initial Barista development was a partnership between the Schwab team and IBM Global Services. “IBM consultants were involved at the early stages. We had already begun to develop some Java apps that were developed independent in the electronic brokerage area. Barista began as a way to put these together. The initial prototype, ‘Account Overview’ in Schwab.com was benchmarked at IBM’s Poughkeepsie Labs. IBM still significantly supports Barista by testing the latest releases in the labs.”

Nick Efthymiou (Vice President, Wireless Architecture, Core Portfolio Services) reinforces IBM’s role, “The IBMers were part of the team. It was a true partnership, with IBM providing Schwab with individuals with unique talents.”

In 2001 the Schwab team released Barista 2.0. This release expanded the framework’s use beyond Schwab.com only by providing channel independent functionality.

In 2002 the Schwab team met with IBM to create a roadmap to figure out what parts of Barista could be retired to take advantage of new features in WebSphere and emerging Web Services. Schwab’s goal is to move away from Schwab proprietary to industry-standard or IBM supplied technologies. For example, Schwab plans to begin to describe Barista components using WSDL and retiring its own proprietary component description language.

BARISTA GOALS. According to Efthymiou, Barista has been implemented by Schwab to meet the following goals:

- Component reuse
- Insulate the business logic from the underlying technology
- “Concept of separation of concerns” allowing developers to focus on the business application; not caching, memory management, where it’s going to run, etc.
- Maintainability, sustainability where the applications can be maintained by other than the developer himself providing much more reusability and flexibility of people
- Efficient use of system resources

RESULTS OF BARISTA...THUS FAR. Schwab points to both soft (organizational) results and specific development benchmarks that have come from adopting Barista. Efthymiou explains, “The introduction of Barista got most development groups at least seriously thinking about a structured development environment. It was a cultural shift. The framework has put in the ground rules for common design and reuse.” Jared Price echoes, “The big driver is around consistent experience—this is starting to connect to the component based development. This is what will drive it into the business.”

At the same time, Schwab is facing hurdles in shifting the culture towards component-based development and the ownership model for components (see Domain Ownership),

as Riley notes, “Now we need a business owner for each component. This is a large change and we are working on that. Developers are thinking differently, but we still have a ways to go.”

Ultimately, the results of the Barista framework can best be seen through its use by specific development groups—two of which we shall highlight in the next section.

MOVING PAST BARISTA. Schwab is now evolving its component framework strategy to extend the Barista principles more broadly and create an even tighter linkage to overall e-business strategy. Dubbed Kraftwerk, this initiative is a strategy and high-level design for evolving the Java frameworks in use at Schwab to more tightly align with the services-oriented architecture and bus initiatives to build reusable business services. Kraftwerk will also leverage advances in Java and Web Services technologies that have occurred since Barista was rolled out—with a particular emphasis of moving away from proprietary development that Schwab has been forced to do, towards the adoption of standards-based implementations. Kraftwerk frameworks will thus enable Schwab to build components that run in multiple Java environments, as well as lowering the cost of development and maintenance of its proprietary implementations. Finally, Kraftwerk will enable Java Services to be used as dynamic assets by the Schwab Content Management System (see below). Kraftwerk Phase 1 is scheduled to be released in early 2004.

Examples of Process-Driven, Domain-Owned, Barista-Based Development

Barista is being used to improve development and speed time to market of key initiatives, such as creating a more powerful advice applications suite for Schwab advisors and creating a set of services that define a customer's portfolio.

ADVICE APPLICATIONS SUITE. The Barista framework was initially implemented by the Advice Applications group. The role of this group is to deliver the suite of tools the advisors can use when they talk to customers. Since 2000, this group had used Barista Services that are integrated in the business domain through the business object model. Specific components include:

- Customer risk profile
- Portfolio definition
- OSH pricing
- Asset allocation
- Sector diversification
- Equity concentration
- Bond diversification
- Style analysis
- Cash flow analysis

According to Karin Hempel (Vice President, Individual Investor Technology, CMS Implementation and Business Team), the results of using the Barista components have been, “with the same team size and same budget dollars we are able to deliver more and deliver it faster. We can prototype new functions in a day to send back to the business unit for comment. And we can customize for each client-type faster. We need to do this for our business needs—this is the overall business driver.”

Daniel Masseloux (Managing Director, Investment Technology Solutions) notes that the group has been able to achieve “a lot of the reuse in creating new functionality, as well as gain significant savings in maintenance. We can maintain more with fewer people, and we get savings from common knowledge, common code, and common architecture.”

The Advice Applications group has been working closely with the Barista team. Panos Lambrianides (Technical Director, Investment Technology Solutions) explains, “Last year we were working on making the Suite more cross-channel. Our cross-channel work actually fed back into the Barista framework.”

Ultimately, the value of using the component framework directly impacts the Schwab customer experience—as Robyn Leonard (Senior Vice President, AIDE), relates, “Components let us respond quickly to the changing needs of our customers and our changing business models.”

CORE PORTFOLIO SERVICES. In order to deliver the type of advice applications that Schwab is moving to, a set of fundamental services around the concept of the customer portfolio has had to be built. The Core Portfolio Services group is charged with this task. Under Schwab’s domain ownership model, Core Portfolio Services is contracted to provide its services to other entities, such as the Advice Applications Group.

According to Sid Bhatia (Managing Director, AIDE, Core Portfolio Services), Core Portfolio Services began to use the Barista framework in November, 2001. The major driver was, notes Graham Luce (Managing Director, AIDE, Core Portfolio Services), to provide component reuse. “We’re looking at two levels of re-use: within the domain and for other domains.”

Schwab Content Management System Initiative

In 2001, Schwab found itself in a difficult position. The company and its Web site kept winning awards for customer satisfaction and quality, but the cost of maintaining the content on the site was increasingly becoming an untenable burden. The Schwab sites at the time contained about 3,500 pages and over two million lines of code.

One of the most strategic initiatives for Schwab is the architecting and implementation of a content management system (CMS). For Schwab, CMS is not merely a platform implementation to support the content creation and publishing lifecycle. Rather, according to Robyn Leonard, “CMS is an initiative that will fundamentally change the way Schwab does business.”

The chief problem was each page of Schwab.com had to be created individually by the Schwab development organization. All of the content elements (verbiage, links, images, phone numbers, directions, tables, charts, etc.) had to be added to pages by developers. This then had to undergo all of the normal development and testing procedures—creating bottle-necks and costs that were making it extremely difficult for Schwab to adapt its site to changing customer needs and emerging business opportunities. With this system, it took approximately *six weeks* to make even a simple content change to the site.

Mats Nilsson (Technical Director, AIDE, CMS-Technical Development Team) notes, “The systems and processes made it less likely that content gets created, updated, and retired because of the difficulty and time.” Leonard adds, “It also created maverick ways of getting the stuff out creating a maintenance nightmare—a lack of coordination, control, and consistent client experience.”

Kathy Anderson (Senior Vice President, Individual Investor Technology) cites the following drivers for the CMS initiative:

- Take content creation, updating, maintenance out of the hands of developers and put it into the hands of content owners
- Drive revenue by freeing up innovation resources to pursue new opportunities
- Save costs by freeing up development and maintenance resources
- Increase business timeliness and the ability to respond to and proactively take action on new opportunities

Put most eloquently by Jan-Olof Karlsson (Managing Director, AIDE, CMS-Technical Development Team), “We will with our technology enable the people who have the decision power—the power to make swift decisions.”

SPECIFYING THE FUNCTIONALITY. The Core Technical Schwab Team made the decision to create an architecture that decouples the authoring, publishing, and run-time environments. This enables Schwab to have the flexibility of choosing the best of breed technology for the specific purpose of the actual application or environment. The key decisions in each area were:

- **Authoring Environment.** Schwab decided that the authoring environment would need to be built on browser, Java, and XML/XSL technology, and would support the complete set of content management principles and features.
- **Publishing Environment.** The publishing application would be a standalone service to acquire, deploy, and acknowledge data/file transfers between environments—essentially creating a bridge and independency between the authoring and run-time environments such that each area could optimize their design for their own purpose.
- **Run-Time Environment.** The run-time environment would use XML/XSL, Java, and DB2 Technology to manage the customer experience principles for ease of

change, performance and 100% read consistency while dynamically publishing changes into run-time.

Working with the Business Units

Early in the process, Schwab's technology team enlisted the support of specific business units primarily to verify that the feature set would live up to business expectations and requirements, and secondly to be trained on and test the system and be the first ones to roll it out.

Laurie Ailworth (Vice President, Representative and Client Tools, CMS Implementation and Business Team) notes that her group's role will also be to "help create best practices and educate the next groups for distributed publishing."

SELECTING THE TECHNOLOGY. In July 2001, with the budget approved, the Schwab team began to evaluate the technologies upon which to build its content management system based on the technology design principles and requirements. The team looked at 49 vendors on the initial list and eventually brought it down to three: IBM Content Manager 8 (now called DB2 Content Manager), Vignette Story Server, and Interwoven TeamSite.

After a thorough evaluation of each product, Schwab chose IBM Content Manager (CM8). Leonard explains, "We were really looking at a toolset rather than a solution; we needed the ability to develop a system that we could hand over to the business. The IBM model matched our needs best—particularly basing it on RDBMS. In addition, IBM provided an easier integration path." Nilsson adds, "We planned to develop and integrate a content management solution including the authoring client, publishing bridge, and run-time services into the existing infrastructure and architecture. IBM as a CM toolset/API provider did not put any barriers to us."

Karlsson recalls seeing the first IBM demo of CM8 and saying "this is exactly what we are looking for." And he concludes, "It is an architecturally sound platform for growth. It provides scalability and extensibility, with support for newer technologies such as XPath, XML, Web Services, and extensions for potential streaming technologies. CM8 can, with their data connectors, reside in front of our content repositories. It provides a content middleware layer and much more."

CMS DEVELOPMENT AND ARCHITECTURE. In April 2002, Schwab began to build its content management system using for the authoring environment IBM CM8 as the back-end solution with CM APIs, Library Server, Resource Manager and DB2. IBM was closely involved in the development—McCarthy notes "IBM has put resources to help develop the content management feature set and Schwab fed back requirements for CM8. We were on the 8.0, 8.1, 8.2 beta tracks."

IBM CM is where all content is created and managed as separate assets. These are then published to the run-time rendering system. The CM implementation includes DB2 storage, Library Server, and Asset Manager. The Schwab application uses CM versioning, workflow, ACL and its API.

For Schwab, content is more than documents and pages. Good examples of Schwab content are page templates which reside in the CM system. Templates enable different customer experiences for the same information by controlling layout, design, channel parameters, and functionality.

Key elements of the Schwab content management process include:

- Content providers (business users) are given rights on specific templates, within which they can make specific changes and view/access tasks in workflow. They use a

WYSIWYG browser-based client to create and manage content. The client gives Schwab central control without having to roll-out and install anything on desktops.

- All content published to the run-time environment goes through workflow. A phase in the workflow is the Publishing Certification environment. This environment mimics the run-time environment to test look and feel, behavior, and performance of the content before it is published to the live environment. All new and revised content goes through this process.
- All content in CMS are managed as separate assets that are published into the run-time environment. The CMS run-time services dynamically assemble each page from assets for the users each time they are requested—and it is fast. The Schwab architecture load balances interactions for customers—they go to different servers—and it ensures that the customer experience is identical each time.

Reducing Publishing Time from a Month to a Week:

With the new CMS system, adding content to the Web site (a process that used to take 27 to 35 days) will be reduced to about a week.

SCHWAB CMS RESULTS. Though just beginning to be rolled out, the Schwab CMS is already delivering results to the business units. Ailworth explains, “We, as the first business unit, are very excited by it. It’s because of the potential for Schwab. It’s a very powerful tool with which we are tapping the tip of the iceberg. We can now address new opportunities that we could not have before. When we show this to people, the light bulbs go on—opening a new dimension of creativity. Once we have demonstrated this, it will spread across the company.”

The time savings have also been evident, Ailworth specifically noting that “an executive was able to take the tool and after 15 minutes build a site.” Overall, Schwab expects the time to add content of small and medium complexity to be reduced from 27 to less than 6 days and from over 35 to fewer than 9 days respectively (see Illustration 3). This does not even take into account larger, more complex projects that would previously not have even been attempted. And once widely adopted, this will get the development people out of the content management business.

CMS will also be used by the technology team to componentize functionality and eliminate duplication of code, increase re-use, and enforce standards and consistency. This points to the ultimate direction of the Schwab content management system as a full object/component management and control environment.

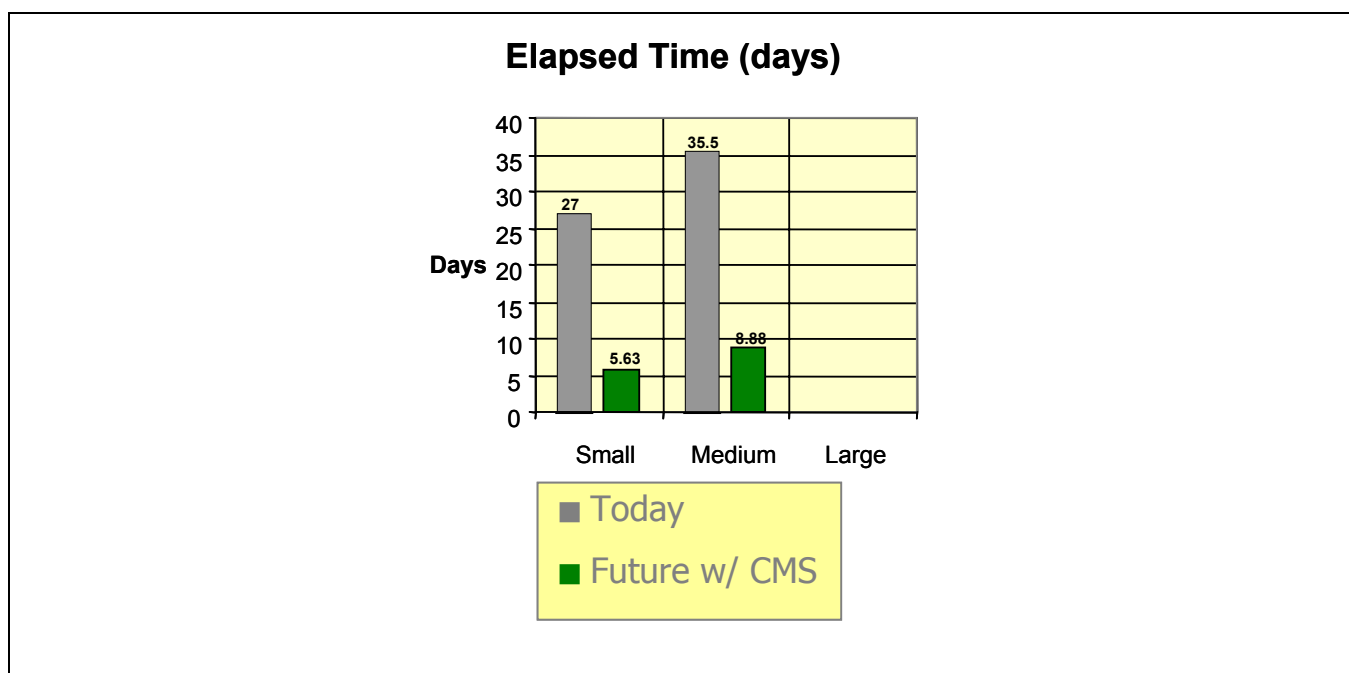


Illustration 3. The Schwab content management initiative will save days and weeks for small and medium scale content updates and enable large scale updates that previously would not have been even undertaken.

Schwab Grid Initiative—Virtualizing Its Resources to Provide a Better Investor Experience

As we have discussed, Schwab is moving from a transactional model to a trusted advisor relationship model. This has created a large number of challenges—business model, organizational, competitive, etc. One of the most interesting challenges is the way this evolution impacts Schwab’s underlying computing infrastructure.

Over the years, Schwab’s infrastructure has been built and honed to handle high volumes of transactions—transactions that frequently occur in very high peaks (particularly at stock market open and stock market close). Schwab’s advice initiatives, according to David Sherr (Vice President, Advanced Technology), require a different type of computing power. Sherr explains that providing independent advice means doing “a lot of computation-intensive ‘what-if’ calculations (such as simulations, random number generation, and Monte Carlo routines). These can take a lot of time and computing power.” Sherr recalls, “A year ago David Dibble, Executive Vice President, Schwab Technology Services, asked ‘How can we create scalable advice?’”

The answer, according to Chalon Mullins (Director, Technology Architecture & Oversight) may be found in Schwab’s existing infrastructure, “Schwab has a lot of extra computing power, if we could leverage the white space (unused cycles) when transactions are below peak.”

All of the initiatives we have observed thus far have had some element of a goal (and in a number of cases a result) of leveraging resources and reducing costs, including the Services-Oriented Architecture, support for standards-based platforms, use and reuse of component frameworks, and the content management initiative. Schwab is now taking this even further by examining how one of the most leading-edge technology developments—Grid computing—can be used to leverage resources in the Schwab environment.

In 2001, Schwab began to investigate the emerging areas of Grid computing as a way to leverage these unused mainframe cycles to provide and scale the investment advice. Schwab was drawn to Grid because, as Sherr notes, “For us Grid is clearly a multi-vendor, heterogeneous initiative that is based on open standards and service-oriented architectures.” IBM’s support for Grid (as well as its support for open standards and service-oriented architectures) was also important to Schwab both because the validation that it gives to Grid and because of the existing strong Schwab/IBM relationship. Mullins emphasizes, “We had our vision about Grid and IBM had its own vision and these were remarkably close—a natural fit.”

And Dibble notes, “IBM shares a common interest in Grid with our insistence on open standards, commitment to open source (Linux), and the need for industrial standards for Grid—with both of us supporting the Globus project, Open Grid Services Architecture, and Open Grid Services Infrastructure.”

In 2002, Schwab ran a Grid pilot in order to prove that it could use Grid within its environment. IBM played a key role in this proof of concept, as Mullins points out “IBM Research helped with the coding on the porting of the code to the Grid environment, and IBM provided the test environment for our POC.” And Sherr adds, “From IBM’s standpoint this was truly a global effort—project meetings included people calling in from Germany, England, US, etc.”

The pilot addressed one of Schwab’s key applications in its advice offering—Forecaster—the ability to recommend optimal portfolios for each customer (see Illustration 4). To do this analysis today requires multi-variant analysis and other advanced numerical techniques. It is thus expensive and time-consuming to provide. The customer generally has to come back to the advisor’s office at a later date or receive the recommendations by e-mail, fax, or mail.

IBM worked with Schwab to break down the application into manageable pieces that can be distributed to multiple processors and then re-aggregated following the compute-intensive analysis work. The Grid-enabled system, using the Globus Toolkit for Linux and the processing power of multiple IBM eServer xSeries 330 servers, reduced the processing time on the application from eight to ten minutes (and sometimes hours) to just 15 seconds, and it could do this by using white space without impacting any transactions. While this reduction may not seem to be a lot, it can change the very character of interaction with the customer. Dibble emphasizes, “One of the things that the grid has done for us is enable us to generate near-real-time results.” Thus, the customer sitting with the advisor and iteratively examining her investment options will have a much different relationship with Schwab than the customer who has to go home and wait for a fax. She is more likely to make the investments, to make better investments (having looked at more options), and have an overall better experience with Schwab.

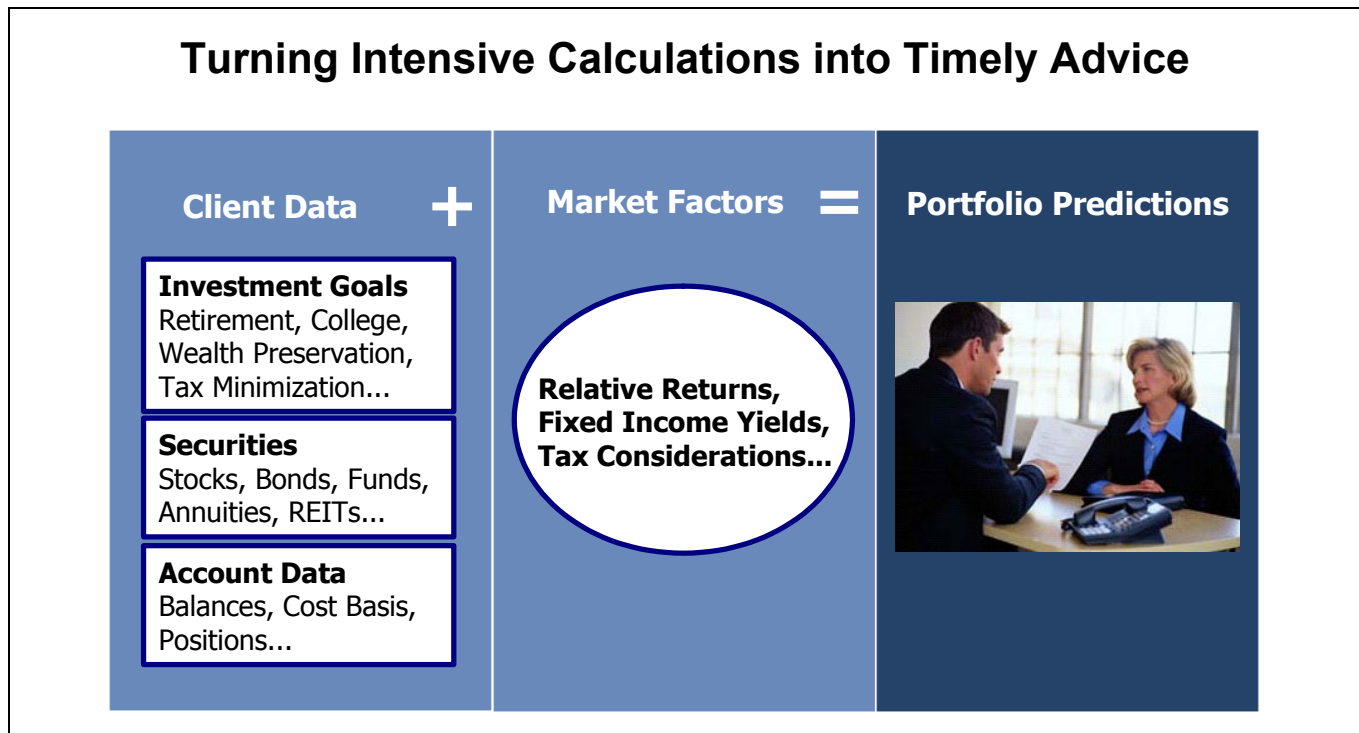


Illustration 4. Schwab's Grid pilot addressed the key issue of providing timely, independent advice to clients.

For Schwab, the Grid approach represents the true value of evolving to a virtualized, on demand environment. Not only can Schwab make use of its existing investment to produce a new product (at no or very little additional infrastructure cost), Schwab can change the very quality of its customers' experience.

The grid-enabled application will not only directly impact Schwab's customers; it will do so at a minimal cost and disruption for Schwab. As Dibble notes, "I'm not going to go out and buy grid boxes. We're going to deploy grid on our existing machines, bought and paid for." Dibble continues, "The initial goal was to provide for a better customer experience. The fact that it can better use existing assets is just an additional payback."

Schwab is planning to role out Forecaster by the end of the year—after putting it through rigorous testing to meet Schwab's standards of availability and user experience. The production version will use IBM Server Allocation for WebSphere, which automatically and intelligently monitors application workload and routes traffic to one server or another according to its workload at a given point in time. The grid system will tie into Schwab's IBM Tivoli Monitor, which monitors UNIX, Windows, and Linux environments.

At the same time, Schwab is investigating other uses of grid, such as data grids, which Schwab plans to pilot shortly. According to Dibble, this "technology will allow the firm to integrate data on a single customer from dozens, if not hundreds, of applications and platforms. That will allow Schwab to offer better integrated, more targeted service and product offerings to our customers than we have been able to in the past." Dibble concludes, "Grid adds a whole new level of computing power and scalability to our client capabilities."

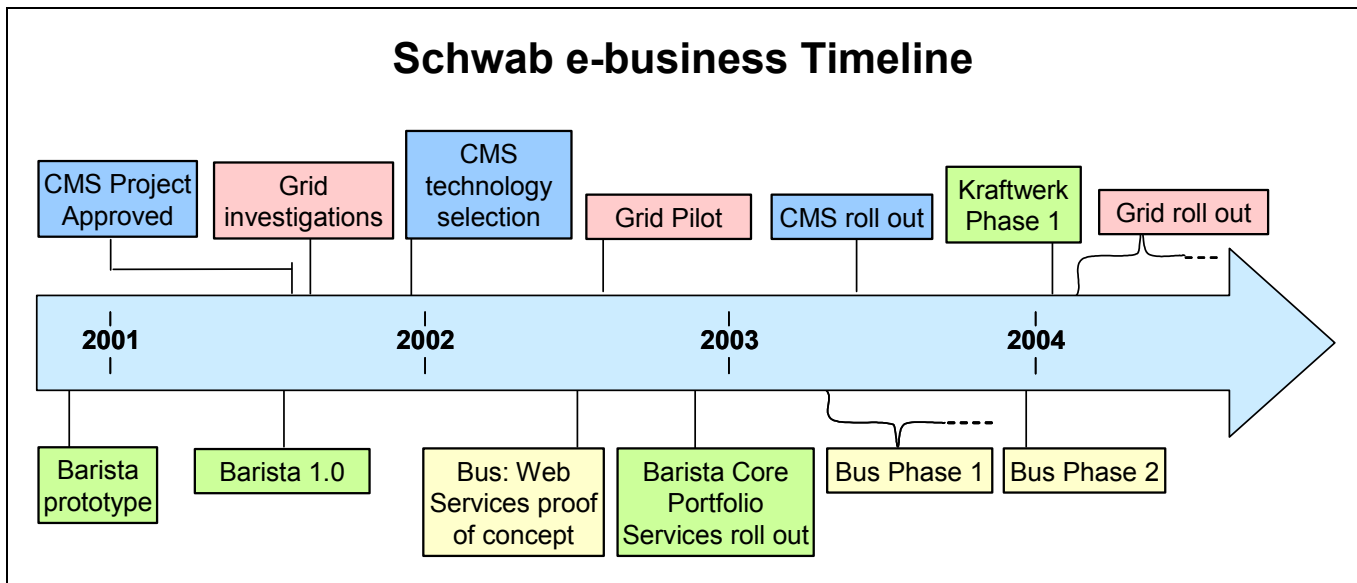


Illustration 5. For the past three years, Schwab has focused on Content Management System (CMS), Java Framework (Barista and Kraftwerk), Grid, and integration Bus initiatives.

Conclusion

In her book *The Customer Revolution*, Patty Seybold summed up her thoughts on Schwab:

“As we’ve watched Schwab plot and execute its technology strategy and its acquisition activity over the past several years, what shines through most clearly is that all of the company’s decisions are grounded in its desire to improve its customers’ experience and their outcomes. There are certainly challenges along the way, and many more seams to stitch up, but I’d place my bets on a company with the kind of singular focus and dedication to customer outcomes that Schwab has, any day.”

Today Schwab is continuing and enhancing this focus by quickly responding to changing business conditions and customer needs and evolving its business model and relationship with its customers to become THE trusted advisor. Schwab is able to do this by leveraging its services-oriented architecture and its investments in key technology initiatives such as Web Services, Java, Content Management, and Grid computing to become a great example of an on demand company.

12-03

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