IBM

e-business case studies

Charles Schwab:
Expanding Internet-based Investing

IBM (e)
an e-business solution ▸

Putting e-business to Work

Contents

List of Figures

Charles Schwab

The Company

- $592 billion in customer assets

- 310 branch offices

The Web Site

- *www.schwab.com*

- Data center in Phoenix, Arizona services approximately one-third of all Internet trading

The Application

- Deployment of IBM's WebSphere Application Server technology within its online trading site

The Benefits

- Increased productivity for application development

- Shorter development cycle

- Lower development cost

- Improved efficiency of hardware utilization

- Lower long-term hardware costs

The Technology

- IBM WebSphere™ Application Server

- IBM CICS®

- IBM RS/6000®

- IBM Global Services

Overview

e-business Case Study: Charles Schwab

Charles Schwab & Co., Inc., one of the nation's largest financial services firms, provides discount securities brokerage and related financial services and offers trade execution services for NASDAQ securities to broker-dealers and institutional customers. Schwab serves 6.2 million active accounts with $592 billion in customer assets through 310 branch offices, four regional customer telephone service centers, automated telephone support and online channels.

Schwab has been an essential force behind the explosive rise of Internet-based investing and has gradually expanded its Web offerings. The expansion incorporates full brokerage services online, including the distribution of advice and investment research. This case study addresses Schwab's use of IBM's WebSphere Application Server technology to improve the productivity of its application developers and to maximize hardware resource utilization and efficiency.

Schwab's e-business Solution

- ■ Transform core business processes

- ■ Build new e-business applications

- □ Run a scalable, available, and safe environment

- □ Leverage knowledge and information

■ Primary e-business solution attribute
□ Secondary e-business solution attribute

e-business Solution Profile

> *"We don't make changes that are going to cause a problem, and we only make changes that offer long-term business value to Schwab."*
>
> *— Purna Roy, Director,*
> *Web Systems Availability,*
> *Charles Schwab*

Schwab recently added a new technology platform to its e-business solution using IBM WebSphere Application Server (WAS), a Java-based application environment for deploying Internet Web applications. Schwab's e-business solution leverages WebSphere's Java servlet infrastructure and Java Server Pages (JSP) support. As will be discussed in detail later in the case, Schwab opted to deploy IBM's WAS technology in order to achieve two strategic goals, defined as:

• improved efficiency of Schwab's ongoing application development process, and

• improved efficiency of hardware utilization within Schwab's trading site.

According to Purna Roy, Director of Web Systems Availability for Schwab and the main driver of its adoption of server-side Java, it was important for Schwab to proceed cautiously in its deployment due to the sheer size and complexity of its online trading platform. "On a site as big as ours," he says, "we cannot make radical changes, especially to business critical applications such as online trading. So to contain the impact of the first deployment, and to use it as a learning experience, we decided to focus on a single non-critical business application." Schwab chose the ability to open new accounts as its first application, which it deemed significant yet not critical.

Schwab's history with IBM can be traced to December 1995, when Schwab established the formidable goal of implementing an Internet trading system within 90 days. Schwab selected IBM by virtue of its experience in building large-scale transactional sites, as well as the depth of its software and hardware solutions. Among the early solution components provided by IBM were RS/6000 SP AIX®-based systems running CICS for AIX transaction server software, which was tightly integrated from the start with Schwab's existing mainframe OS/390® CICS-based applications. Other IBM technology elements added to the Schwab solution include Tivoli systems management software, IBM DB2® Universal Database™ (which stores store client personalization data and Web transactional information), and MQSeries®, which was deployed to provide increased availability and scalability for Schwab's Web trading platform. Since 1995, Schwab's original three RS/6000 systems has grown to 24 in the first nine months and currently "hundreds" power the site, which, according to Roy, is considered the largest secure transactional site in the world.

Schwab's present infrastructure is a three-tiered system. The backend systems run IBM CICS on mainframes, which serves as the platform for Schwab's business transaction applications, and holds all of Schwab's business logic. Schwab's Web servers are located in two redundant data centers located in Phoenix, Arizona. Between these tiers is an intermediate gateway tier, also comprised of IBM RS/6000 servers, which are collectively known as Schwab entry − or "SEntry" − servers, whose function is to link the UNIX and CICS domains within the Schwab IT infrastructure.

Schwab has rolled out IBM's WAS technology to all of its servers, including automatic alerts and backup procedures.
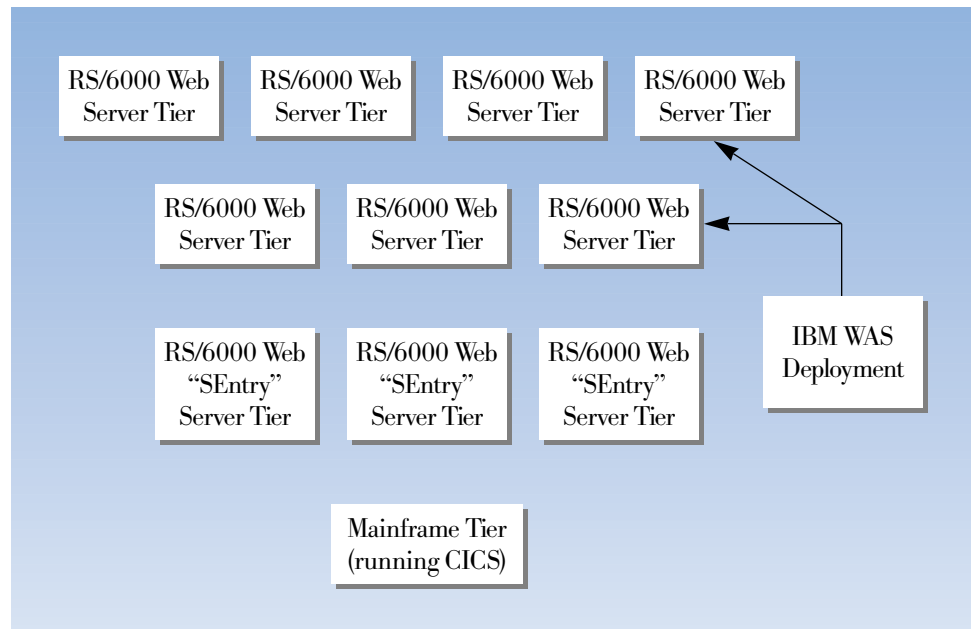
Source: Charles Schwab

Figure 1. Basic System Architecture of the Schwab Platform and e-business Solution*

*Note: Hardware configurations presented for explanatory purposes; actual number of hardware units not known.

Planning and Decision Environment

Late in 1997, it became clear to Roy that servlet technology was developing quickly and may provide even better performance to Schwab than CGI. Following this, Roy's next goal was to establish the business case for deploying server-side Java technology and identifying where to deploy the technology (*i.e.*, which applications). As Roy points out, the project's value proposition from the outset had been the Java environment would lead to both higher developer productivity and increased hardware efficiency. "From very early, this was really considered an IT initiative because the benefits were mainly IT benefits," says Roy. This, in turn, was reflected in the audiences to whom Roy presented the concept.

Roy presented the concept more than a dozen times to audiences including Schwab senior management, senior- and middle-management committees from the technologies subgroup of the electronic brokerage division, the office of the CIO, and operations personnel. Roy also submitted the concept to Schwab's Technology Review Board, a group of senior IT managers charged with examining significant architectural change proposals. Developed to manage the accelerating change that had accompanied Schwab's rapid growth, the Board seeks to ensure that technology decisions are always examined with an eye towards business value, supportability, and other operational issues. This approach, says Roy, is evidence of the importance of prudent technology adoption to Schwab. "We don't make changes that are going to cause a problem, and we only make changes that offer long-term business value to Schwab," he says. The final decision to go ahead with the WAS initiative was made by the Senior Vice President of Electronic Brokerage.

The decision of which application to deploy was driven by the cardinal rule that mission-critical trading applications must not be impacted, says Roy. "The most critical applications for Schwab are those related to quotes and trade placement. Although the Account Open application is important to Schwab, if a problem or outage occurs, it will not impact Schwab customers to the same extent as more mission-critical applications." Indeed, trading down-time means lost revenue for Schwab, while would-be customers can always open accounts by downloading an application form over the Web or making a trip to the local Charles Schwab Branch office.

"Java server pages capability was one of the key things that Schwab wanted, and IBM was one of the earliest vendors to provide full support for that. Strong support matters a lot to us."

— Purna Roy

As the Account Open Java initiative was proceeding, Schwab was also developing a separate Java desktop application for its Active Trader Customer Segment. Roy notes that the two projects created the opportunity to reap substantial benefits from the inherent synergy of the two Java-based solutions. "The server-side Java solution of IBM WebSphere Application Server presented itself as a perfect server-side compliment for this experimental product," says Roy. "A major benefit of having Java on both sides was their ability to communicate using serialized Java objects instead of the large HTML documents filled with presentation directives. This made the product significantly leaner in the usage of Internet bandwidth." The new Schwab product, known as "Velocity," exhibits an almost threefold improvement in response time for a comparable transaction using a Web browser.

Prior to choosing IBM, Schwab also considered other vendors' application servers, including Sun/Javasoft, BEA/Weblogic, and JRUN. As part of its early research phase, Schwab contacted each of these vendors in order to obtain resources such as research hardware and consulting assistance. According to Roy, Schwab selected IBM's WAS solution due to IBM's early support for the JSP standard as well as the longer-term benefits that have accrued from Schwab's ongoing partnership with IBM, such as technical support. "Java server pages capability was one of the key things that Schwab wanted, and IBM was one of the earliest vendors to provide full support for that," says Roy. "Strong support matters a lot to us."

Another key reason for choosing IBM was Schwab's desire to stay within its existing AIX environment, which, says Roy, "made it more beneficial to work with an IBM solution." Schwab also cited the sheer strength of the IBM WAS offering as a significant factor in the decision. "In terms of functionality, our critical need was Java server pages, and IBM's technology was well ahead of other vendors, including Sun Microsystems which developed the standard."

Goals and Business Drivers

Schwab's main goal for deploying the WAS technology on its site was two-fold. First, Schwab wanted to use Java on the server side to improve efficiency of processing at the Web-server level, thus reducing long-term hardware requirements. How do servlets benefit processing efficiency? "Servlets represent a more efficient way of processing request/response, which is a common scenario for a transaction platform such as Schwab's," says Roy.

Schwab's second goal was to increase the productivity of its application development personnel by using WebSphere's JSP support to de-couple the two components of the CGI development process: presentation (*i.e.*, publishing) and logic (*i.e.*, transactional). "By implementing JSP, the application development process becomes more efficient as tasks become more clearly separated in terms of skills and tools," says Roy. Schwab segments its Web development team into two skills-based groups: Web-page designers and software developers. Prior to implementing WAS, much of the presentation logic was embedded inside the CGI programs along with the transaction logic. As a result, a task such as the modification of the presentation of a Web page often necessitated the complex coordination of tasks between the Web designers and software developers. Moreover, this cross-functional interaction also generally required each group to have a working knowledge of the other's functional area, further exacerbating the inefficiencies of the process. "By deploying server-side Java," says Roy, "Schwab can now make changes that used to require days within one-half hour to a day."

Underlying Schwab's JSP initiative is the acknowledged need to remain nimble in the fast growing, yet increasingly competitive online brokerage market. Says Roy, "Schwab needed a more efficient IT infrastructure to improve both time to market and hardware resources utilization. With the rapid growth of our online brokerage solution, we needed to start looking into more efficient ways to leverage our hardware and our development resources."

Implementation Timetable and Strategy

> *"Schwab needed a more efficient IT infrastructure to improve both time to market and hardware resources utilization. With the rapid growth of our online brokerage solution, we needed to start looking into more efficient ways to leverage our hardware and our development resources."*
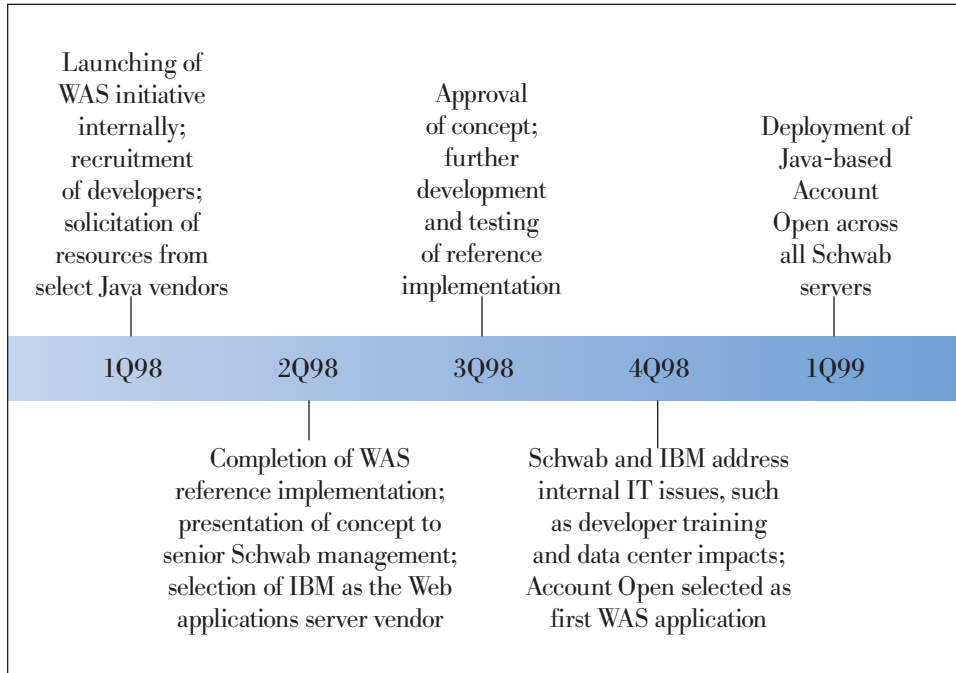>
> *— Purna Roy*

The initial phase of Schwab's server-side planning began in the first quarter of 1998 with the focus on funding and research. During this initial phase, Schwab assembled the internal team of Java and CORBA programmers required to assist in the deployment of WebSphere's JSP technology. Concurrently, Schwab also contacted IBM, Sun and other vendors in order to line up hardware resources and consulting support. In the second quarter of 1998, Schwab began using both Java Web Server (from Sun Microsystems) and Servlet Express, which was IBM's Java server product at the time, to create a demonstrable prototype of the application. Also in this time frame, the idea of deploying server-side Java technology was pitched to Schwab management to gain support and resources.

In the third quarter of 1998, the proposed system was still under review from management, which had lingering questions about such issues as supportability and the impact of using Java on Schwab's ongoing release process. Despite these concerns, the project grew worthy of further attention and additional resources from Schwab's development organization, which were used to make the reference implementation more realistic. At this point, Schwab also began more rigorous performance testing of the prototype application.

In the fourth quarter of 1998, Schwab's focus shifted toward resolving a broader range of issues related to the implementation of new technology architectures. These issues included questions on the likely impact of the new JSP technology on key areas within Schwab's IT organization, such as the Quality Assurance (QA) department, the development organization (especially issues related to developer training requirements), and data center operations management. By the end of the fourth quarter, these problems were resolved, largely with the assistance of IBM Global Services (IGS). For example, IGS assisted the development organization by teaching a training class for Schwab developers on the Internet brokerage side of the IT department. "IBM was also invaluable in reassuring the data center operations people in Phoenix," says Roy. One of the final tasks achieved during the fourth quarter of 1998 was the selection of actual projects for deployment.

The implementation phase of the project began in the first quarter of 1999, during which time the Account Open application was deployed across all of Schwab's transaction servers. Implementation of Account Open was completed in March 1999. While core programming was performed by internal Schwab personnel, IGS played the extremely important role of problem solver for such issues as run-time environment, Java Server Page technology, and Java Virtual Machine. Although the IGS team on site at Schwab averaged five, the virtual team swelled to 20 to 30 during the height of Schwab's JSP actual deployment process. "During a very important phase, IBM came through with a great amount of problem-solving support, working around the clock. Only a company with IBM's technical experience would be able to address such a broad range of problems in as timely a fashion," says Roy.

In addition to general problem solving, IGS was an indispensable source of expertise and development advice throughout the process. "IBM was engaged all the way through," says Roy. "For example, early on, IBM examined Schwab's code and gave some extremely useful comments. This set the tone of IBM's hands-on involvement in the project." Roy also sees IBM's Java expertise as a good foundation for its own planning, by allowing Schwab to capitalize on IBM's first-hand exposure to Java best practices seen in other IBM solution implementations.

Launching of WAS initiative internally; recruitment of developers; solicitation of resources from select Java vendors		Approval of concept; further development and testing of reference implementation		Deployment of Java-based Account Open across all Schwab servers
1Q98	2Q98	3Q98	4Q98	1Q99
	Completion of WAS reference implementation; presentation of concept to senior Schwab management; selection of IBM as the Web applications server vendor		Schwab and IBM address internal IT issues, such as developer training and data center impacts; Account Open selected as first WAS application	

Source: Charles Schwab

Figure 2. Implementation Timetable for Schwab's e-business Solution

> "During a very important phase, IBM came through with a great amount of problem-solving support, working around the clock. Only a company with IBM's technical experience would be able to address such a broad range of problems in as timely a fashion."
>
> — *Purna Roy*

Return on Investment

By deploying WAS within its Web site, Schwab expects to derive significant payback from two main areas: increased application development efficiency and higher levels of hardware utilization efficiency. Roy points out that the root of JSP's positive impact on developer productivity is its inherent separation between what will be built by the developer (mainly logic) and what will be built by an HTML author (mainly presentation content). "This means that Schwab can apply very specialized tools and personnel to different types of deliverables, while minimizing their interdependence. This makes it easier to administer from a personnel standpoint, and will ultimate reduce development costs as Java skills increase," he says.

Using WAS also benefits the application development process by shortening the cycle time significantly, says Roy. "In fact, the Schwab developer who was working on the Account Opening application said that had it not been for the WAS solution, meeting the deadline would have been next to impossible. This says something about the productivity benefit." According to Roy, the clear separation of logic and presentation content in a WAS application shortens the overall development cycle because it allows a programmer to quickly modify the presentation portion of the data as a response to a business requirement change, while obviating the need to change the logic portion. "You know exactly where to make the change to an application," he says. "The deliverable is more adaptive to changes in business requirement and maintenance."

Overall ROI Benefits	
Function	**Benefit**
Application Development	Increased productivity of application developers through increased specialization of tasks and tools
Cost Savings	Lower development costs resulting from increased developer productivity Lower long-term hardware costs resulting from increased efficiency of hardware utilization
Time to Market	Ability to bring new applications to market faster than through CGI-based application development process, thus increasing Schwab's competitiveness against a growing field of agile competitors

Source: Charles Schwab

Figure 3. Benefits of Charles Schwab's e-business Solution

Due to the relatively small scale of its present WAS implementation, Schwab has yet to fully realize the other expected benefit: increased run-time efficiency for WAS-based applications, and attendant cost savings due to more efficiency hardware utilization. Nevertheless, Roy expects the increased performance to materialize before long. "The runtime efficiency, while so far unrealized, is expected to improve fairly rapidly over time, and will ultimately surpass the C/CGI environment." Roy explains that much of WebSphere's run-time benefits relate to lower start-up costs for programs, since JSP Web pages – unlike HTML pages – remain in memory.

Roy is equally confident about Schwab's opportunity to save on hardware costs as WAS drives more efficient hardware utilization. "At our scale, if we can reduce our hardware utilization by, say, two percent per Web page, that represents a huge savings because of the number of times that Web pages is executed. We expect the potential savings in hardware costs – as well as operations and systems administration costs – to be phenomenal."

Implementation Issues/Lessons Learned

"At our scale, if we can reduce our hardware utilization by two percent per Web page, that represents a huge savings because of the number of times that Web pages are executed. We expect the potential savings in hardware costs — as well as operations and systems administration costs — to be phenomenal."

— *Purna Roy*

As the Schwab and IGS team progressed in the planning and early implementation of the WAS solution, it began increasingly apparent to Roy that the success of the project depended upon allaying the concerns expressed by various IT constituencies. There was concern, for instance, within the development organization on how the proposed WAS deployment would impact future training practices as well as Schwab's release process. Similar questions were raised by the operations group on the issue of the supportability of JSP-based applications, while the Data Center Operations group — the heart of Schwab's Web trading operations — needed reassurance that the initiative would not disrupt the normal flow. Roy's group worked assiduously with IBM to address these concerns, thus allowing subsequent development and implementation work to proceed.

Roy further notes that Schwab's WAS deployment experience taught important lessons on developing Java applications that will perform optimally. For instance, Roy points out that careless coding can easily lead to less than optimal application performance and maintainability, effectively neutralizing the inherent architectural benefits of WAS. Another key lesson learned was the need to recognize the relationship between servlet logic and performance optimization, especially as the size of the logic grows. "Non-optimal coding of this logic may actually begin to offset the CPU savings, which are inherent architectural benefits of the server-side Java infrastructure," says Roy.

Future Plans

In the wake of its first WAS deployment, Schwab now plans to build on its success by deploying WAS across more applications, all the while incorporating its lessons learned. For example, Schwab is interested in utilizing the eXtensible Markup Language (XML) Document Services capabilities provided by WAS in other applications. Schwab has already begun an initial XML pilot where data from a Mutual Fund application is being converted from an Oracle database to XML to give Schwab more flexibility in accessing the data. Other projects using XML and the IBM XML4J parser, shipped with WAS, are also under consideration.

"We plan to work with IBM to review the effectiveness of our code. We will also identify our best practices and good application design patterns and incorporate those into new projects," says Roy. "Ultimately, the use of WebSphere Application Server will become an important part of many other Schwab applications. Once the benefits of the new approach to application development becomes clear, I expect that there will be a large rush to use it more widely within Schwab." By adopting IBM's Application Framework for e-business, Schwab has laid the groundwork for incorporating other next-generation capabilities in the near-term future.

Charles Schwab

**For more information,
please contact your**
IBM marketing representative or
IBM Business Partner.

Visit us at:
www.ibm.com/e-business

For information about
Schwab, visit:
www.schwab.com

IBM ®

G325-6631-00