

iSeries Application Development Directions

By

The IBM iSeries AD Strategy Team

May 2001

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| | |
|--|---------|
| Executive Summary | Page 4 |
| Today's Application Environment | Page 4 |
| iSeries in Today's Application Environment | Page 5 |
| Navigating the Document | Page 6 |
| Providing Solutions With iSeries | Page 7 |
| Reaching the Masses (Scenario 1) | Page 8 |
| The Problem | Page 8 |
| The Solution: Extend Existing IT Systems to the Internet | Page 8 |
| Key Technologies | Page 11 |
| Related Technologies | Page 12 |
| Enabling Information Flow (Scenario 2) | Page 12 |
| The Problem | Page 12 |
| The Solution: Moving to Workflow-Oriented, Collaborative Applications | Page 12 |
| Key Technologies | Page 13 |
| Related Technologies | Page 13 |
| Knitting the Business Together (Scenario 3) | Page 14 |
| The Problem | Page 14 |
| The Solution: Standards-based, Application Integration Middleware | Page 14 |
| Key Technologies | Page 15 |
| Related Technologies | Page 15 |
| Partnering for Success (Scenario 4) | Page 16 |
| The Problem | Page 16 |
| The Solution: Automating Trading Partner Interaction | Page 16 |
| Key Technologies | Page 17 |
| Related Technologies | Page 17 |
| On the Road and In Touch (Scenario 5) | Page 18 |
| The Problem | Page 18 |
| The Solution: Tier 0 Access with iSeries | Page 18 |
| Key Technologies | Page 19 |
| Related Technologies | Page 19 |
| Mining Those Data Nuggets (Scenario 6) | Page 19 |
| The Problem | Page 19 |
| The Solution: DB2 Warehouse Manager | Page 20 |
| Key Technologies | Page 20 |
| Related Technologies | Page 21 |
| Ray's Scenario Summary and What it Means to You | Page 21 |
| Application Technologies | Page 22 |

| | |
|--|---------|
| iSeries Application Environments | Page 22 |
| Java™ | Page 23 |
| Integrated Language Environment (ILE) | Page 25 |
| The OS/400 Portable Application Solutions Environment (OS/400 PASE) | Page 26 |
| Integrated Netfinity Server | Page 27 |
| Lotus Domino | Page 28 |
| Linux | Page 29 |
| OS/400 Services and Middleware | Page 30 |
| Extensible Markup Language (XML) | Page 30 |
| Web Application Servers | Page 32 |
| Lotus Domino as an Application Server | Page 32 |
| Enterprise JavaBeans | Page 32 |
| Database — DB2 Universal Database for iSeries | Page 33 |
| Integrated File System | Page 34 |
| MQSeries | Page 35 |
| Application Development Environment and Tools | Page 36 |
| WebSphere Development Tools | Page 36 |
| Business Intelligence | Page 36 |
| Smart Management of Your e-Business Environment | Page 37 |
| Tools Network | Page 38 |
| Deploying iSeries Applications | Page 39 |
| The elusive “standard” modernization formula | Page 41 |
| Transforming Existing OS/400 Applications | Page 41 |
| Embracing ported application sets | Page 41 |
| Where can you turn for advice? | Page 41 |
| Summary of iSeries Applications Development | Page 44 |
| Appendix A: iSeries Support for Application Environments | Page 45 |
| Java | Page 46 |
| XML | Page 46 |
| MQSeries | Page 46 |
| Appendix B: Web Site | |
| References | Page 47 |
| Trademarks | Page 48 |

Executive Summary

The one constant in the IT industry today is change. Change driven by customer requirements. Change driven by new technologies. Change driven by competitive solutions. Today, there's a new and ever evolving economic environment. The Internet has fundamentally altered the way businesses operate. In addition to the core operations (accounting, payroll, inventory, etc.) needed to run an enterprise, businesses have moved to the world of e-commerce. Businesses and consumers are linked together in a complex relationship via the Internet. The paradigm is shifting rapidly to a new world of e-trading places, e-marketplaces, as well as business-to-business (B2B) and business-to-consumer (B2C) online trading.

IBM eServer iSeries provides a broad set of application development tools and technologies that help extend many aspects of an enterprise to implement superior B2B and B2C solutions. Perhaps the greatest responsibility given to IT architects and managers today involves charting a course for the organization that will effectively deal with surrounding changes — the opportunities and competitive pressures which drive the need for innovation. Sound IT strategies result in evolutionary change to an organization's IT infrastructure, with a significant amount of reuse of existing IT assets being realized.

iSeries is uniquely positioned to support sound, long-term IT scenarios. With a strong reputation focused on leveraging IT investments, an extensive portfolio of the latest technologies, and performance and scalability second to none, IBM eServer iSeries is a server platform that is capable of reliably servicing legacy, client/server, and Web-based business computing. In addition to running core business applications, this 64-bit operating system efficiently runs [Lotus Domino](#), [Java™](#) and e-business solutions. iSeries also runs Microsoft Windows 2000™ on the Integrated xSeries Server for iSeries and runs AIX applications in the OS/400 [Portable Applications Solutions Environment](#).

Today's Application Environment

These are exciting times for application providers. As enterprises evolve to meet the challenges of e-business, they are adopting new and innovative IT solutions at an accelerated pace never before seen. The Internet provides opportunities to extend rapport with consumers and to further embrace and integrate trading partners. For many companies, support for the Internet and e-business has transitioned from a novelty, to a requirement for doing business. For most application providers, the net result of this expanded enterprise environment is that opportunities — and competitors — exist anywhere in the world.

As illustrated in Figure 1 (next page), many enterprises are optimizing their businesses by expanding relationships with suppliers and customers. These broader relationships involve automating and connecting suppliers with internal teams, such as production, sales and management — all for the purpose of extending the care of the end customer. This value chain is connected with an enterprise's core application solutions as well as other complementary applications.

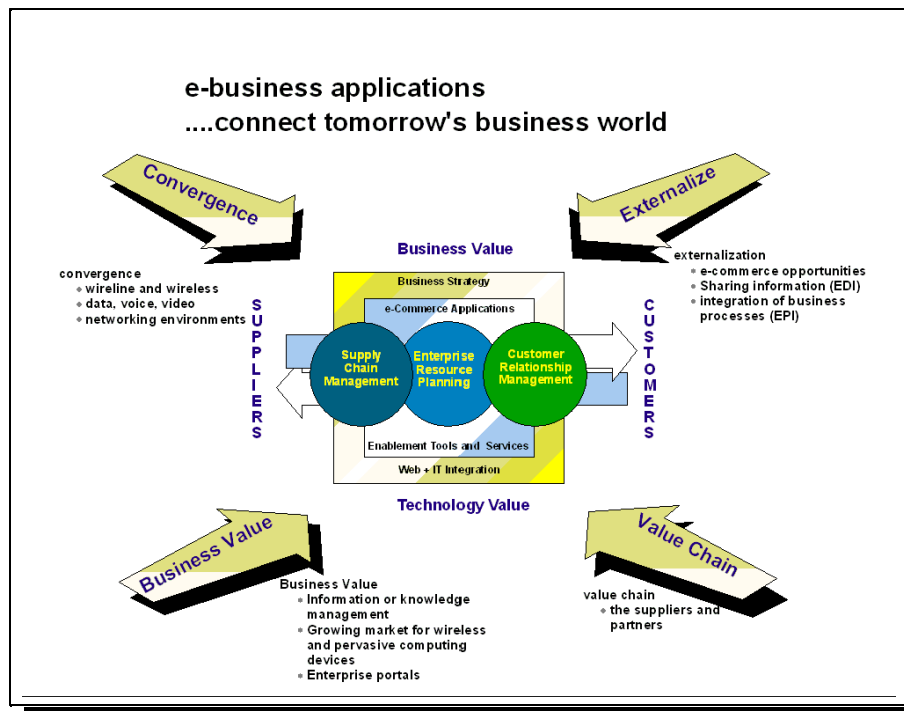


Figure 1: Emerging application environment

Recent advances in key technologies are enabling solutions to fit these changing market dynamics. For example, improved price/performance of processors has occurred at an incredible rate. Business computers will deliver giga processors in the next few years. Combine this with 64-bit applications and the growth in application capability is phenomenal. In addition to its role as the common carrier for information and e-mail, the Internet has exploded to provide a pervasive infrastructure for worldwide B2C and B2B e-commerce. Soon there will be LAN-like bandwidth and speeds for Internet interchange in many parts of the world. Applications are becoming mobile with an ever increasing number and variety of handheld devices being deployed into the marketplace. Finally, with Java and [eXtensible Markup Language \(XML\)](#), there is potential for a portable application environment to develop and deploy applications that take advantage of this connected, global business opportunity. These are indeed exciting times, times of change for today's applications.

iSeries in Today's Application Environment

This paper elaborates on some of the successful, evolutionary modernization strategies that companies are using to deal with this rapidly changing IT environment. It explains the technologies involved in making these modernization strategies happen and provides a glimpse of future application development strategies. In particular, the paper examines the approach and technologies required to:

- ✎ Extend existing business solutions to a broader Internet/intranet audience by exploiting Web technologies.
- ✎ Improve operational efficiencies and reduce internal business operating costs by taking advantage of workflow and collaborative computing-based solutions.
- ✎ Integrate a set of heterogeneous IT solutions using middleware and application integration technologies.
- ✎ Lower costs and enhance relationships by automating transactions with trading partners.

- ✍ Enable geographic flexibility for the workforce and for the consumer base by extending key IT solutions to mobile and wireless platforms.
- ✍ Gauge sales trends and customer preferences by analyzing business data.

The discussions in this paper offer guidance concerning application modernization strategies for IT architects, managers and solution developers who are involved with software application development and the use of software tools. It is hoped that this information will be useful when evaluating software technologies and application deployment platforms for the next generation of software application investment. Current and upcoming IBM application development technologies are also described. This provides an insight into the emerging application models that are expected to become predominant in the industry and on iSeries over the next several years. In general, this paper is intended to provide direction to those planning to modernize, enhance or create solutions that will leverage the many strengths provided by iSeries. However, this document is not a detailed tutorial on these application models and technologies. There is, though, a “For More Information” appendix that you might find extremely helpful as you move further into this topic.

While the scenarios below highlight IBM tool and middleware solutions, third party iSeries tool providers can also be used in some, or all, parts of these solutions.

Navigating the Document

This paper is divided into three main sections. It's designed so that you can read each section independently and start with different sections depending on your role in the application modernization process.

If you are an IT systems analyst ... The first section, *Providing Solutions with* focuses on some of the key business problems that dominate IT today using a small, but rapidly growing company to illustrate the issues companies encounter as they grow and reach out to take advantage of the opportunities provided by the e-business environment. After each problem is introduced, an approach and set of technologies are described, showing how the problem can be solved using the application technologies available on iSeries today. Future technology trends which relate to the problem at hand are also highlighted. Start with this section if you want to see how iSeries application technologies can be used to effectively address the most common IT issues faced in today's fast-paced business environment.

If you are an IT application developer ... The second section, *Application Technologies*, highlights many of the key iSeries application technologies available today and illustrates some of the future investments and trends we expect to see relative to these technologies. If you're interested in learning more about one or more application technologies and the iSeries support provided for those technologies, you'll want to start your reading here.

If you are an IT manager ... The final section of this paper, *How to Get Started*, is meant to serve as a “director,” if you will. It lists many resources, whether they be human, book, training course, or Web site, each of which can provide you with much greater depth and understanding as you plan for, and move into the actual implementation of your modernized, Web-enabled business applications. As you can imagine, this last section could itself be the topic of several white papers. So, we've had to make this section act as more of a jumping off point, as opposed to being self-contained. If you're an IT manager, you'll want to spend a great deal of time exploring these other resources so that you can determine the right path for your IT environment and enterprise goals.

Providing Solutions

Ray's Motorcycle Shop started out as a small, family-owned business, but has grown substantially over the past several years. Fortunately, Ray (who, not coincidentally, is the founder and owner of Ray's Motorcycles) started out with an iSeries solution in the beginning (see figure 2), so he's been able to benefit from the ease of use, reliability and uninterrupted scalability provided by the iSeries platform for quite a few years now. However, the simple IT applications used to manage the business when it was small have required a number of extensions to keep up with the demands driven by a fast-growing company.

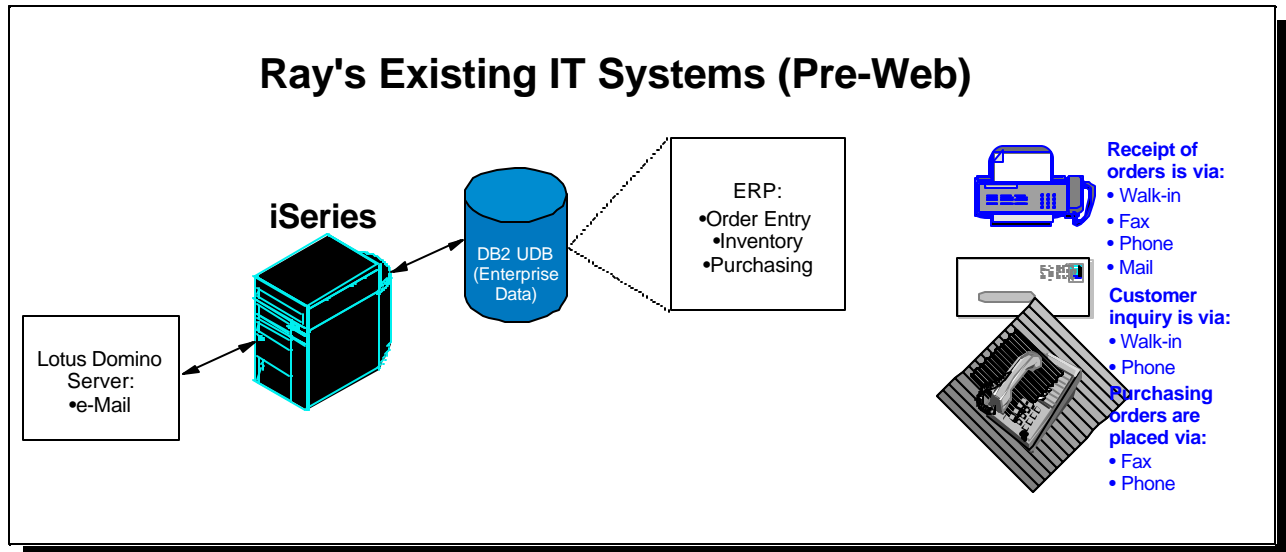


Figure 2: Ray's Existing IT System (Pre-Web)

Other elements have also put a strain on Ray's IT environment. For instance, Ray's has recently acquired several other motorcycle dealers in the region. The company also wants to take advantage of the opportunities presented by the Web to reach a much larger consumer market. And, not unlike other businesses across all industry segments, Ray's has observed that an increased number of its larger customers want to do away with paper and fax ordering and move to electronic purchasing and billing. It's easy to see that Ray's core business solutions had to evolve in a number of areas just to keep up.

The growing demands of the business have led to several fundamental changes in the IT solutions used to run Ray's business. The list of IT opportunities encountered by Ray's company and countless other small, medium and large businesses include:

- ✍ Reaching a much broader set of customers
- ✍ Reducing internal operating costs through better information flow
- ✍ Integrating heterogeneous IT systems
- ✍ Establishing more integrated and efficient trading partner relationships
- ✍ Enabling an increasingly mobile workforce
- ✍ More accurately predicting sales trends and customer preferences

The following scenarios explore each of these opportunities and describe how Ray's Motorcycle Shop has addressed challenges and transitions that the company has faced as it endeavors to exploit the opportunities presented within its current business environment. While not based on

an actual company situation, the scenarios described reflect many of the challenges faced by actual companies today and the solutions that such companies successfully employ.

Reaching the Masses (Scenario 1)

Enterprises can be powerfully assisted in reaching a much broader set of customers by leveraging the Internet and its associated technologies. This transition requires extension of existing IT systems to participate in the new Web model. Let's see how this might play out:

The Problem

Ray has always considered his motorcycle shop to be progressive in its use of IT solutions to manage the business (Ray uses iSeries solutions to manage inventory, orders and billing. Nonetheless, he not long ago discovered he was losing after-market business (service parts, riding apparel, etc.) to competitors who were utilizing alternative media, such as the Internet, for advertising and ordering. Consumers liked the ability to check on the variety and availability of these needed products via the Web and were placing an increasing number of orders via Internet-based storefronts — storefronts that were sponsored by motorcycle shops far away, geographically, from Ray's. Since Ray did not have a Web storefront, this alarming trend was affecting his company's immediate and long-term business results. This was because aftermarket sales had long represented a large part of Ray's profit structure, and historically, had ensured strong loyalty from those who wanted to buy their next motorcycle.

The Solution: Extend Existing IT Systems to the Internet

Ray's problem wasn't in the capabilities provided by his existing IT solutions. It was in how the information from those systems was made available to consumers. Ray was able to overcome this problem by providing a Web-based interface into his existing IT environment. This Web-based interface was implemented in four stages allowing Ray's Motorcycles to have an immediate Internet presence and to add more functions as the company's knowledge and experience with Web technology grew.

At first, Ray deployed a static Web site for his shop that included his business address and phone number, as well as information on the types and models of motorcycles he sold (see figure 3). It also listed aftermarket products that could be purchased on his shop floor. However, the nature of a static Web site is that it is difficult, or cumbersome at best, to keep the site up-to-date if an enterprise has a rapidly changing product environment – which was precisely the case for Ray's since his inventory of motorcycle parts, helmets, jackets, boots, virtually everything, changed as each season progressed.

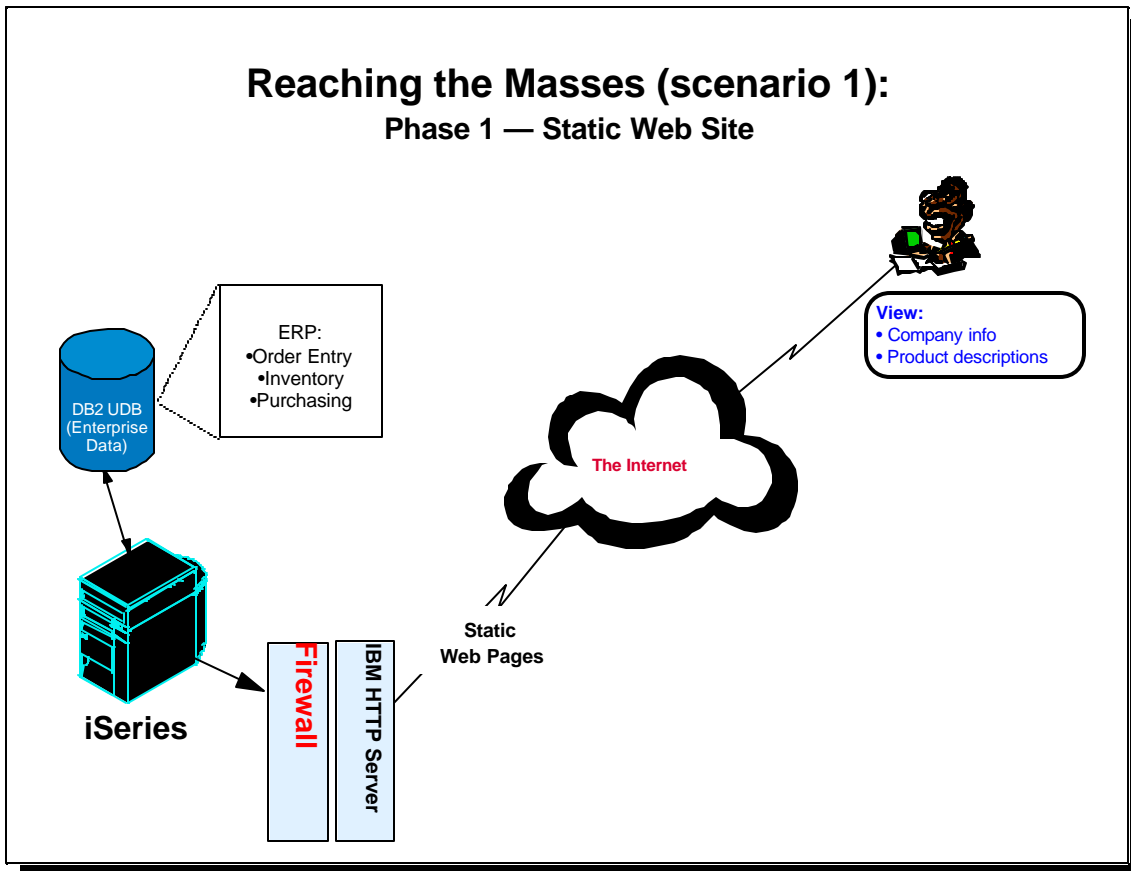


Figure 3: Phase 1 (static Web site)

So Ray next extended his Web site to be more dynamic by incorporating live “availability” data from his inventory system (see figure 4, next page). This was easily accomplished by building variables into the Web pages that were updated with the latest live data from the back-end system. This live data included the pricing and availability of his large inventory of motorcycle paraphernalia. It also included photos or drawings of each product (the images were stored on iSeries). And, Ray could rest-assured that promotional pricing would be automatically substituted as sales and end-of-the-season markdowns took affect since this data was also already stored on his iSeries.

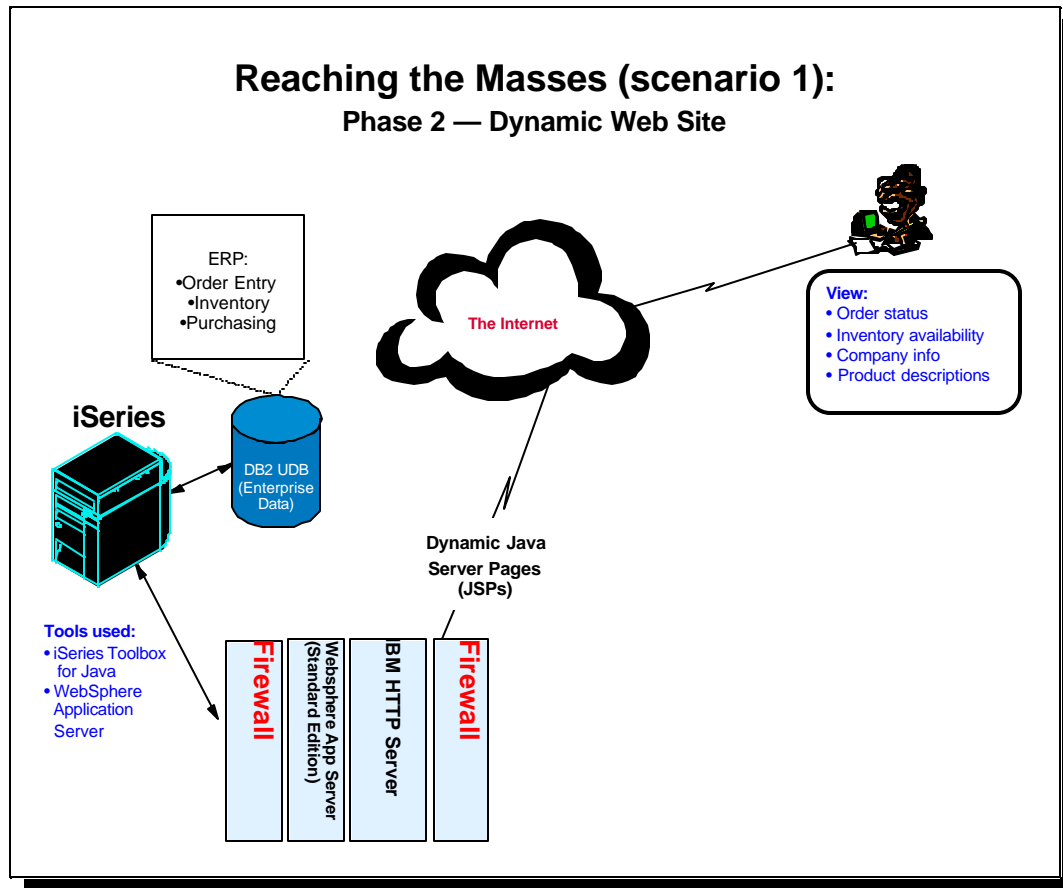


Figure 4: Phase 2 (dynamic Web site)

The third phase of Ray's Web involvement was a natural segue since access to live data was already in place – he began allowing customers to place orders online. This was accomplished by providing a Web ordering form which tied into his order entry system and which also linked to a secure, online payment system.

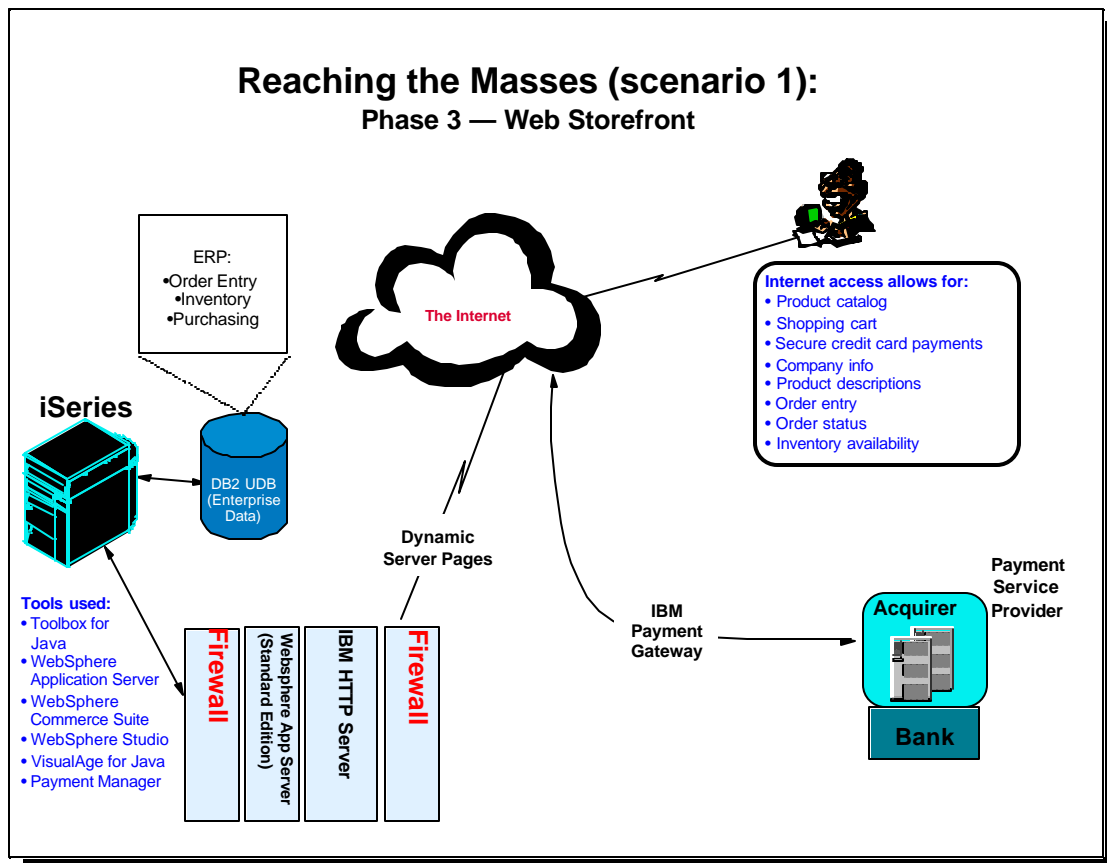


Figure 5: Phase 3 (complete Web storefront)

Finally, Ray implemented a complete Web storefront that supports a virtual shopping cart and includes a catalog containing all the motorcycle and related products Ray has to offer. Ray did not have to replace any of his existing, iSeries-based IT assets to make the transition to the Web. This provided two important advantages: Ray's was able to minimize the cost of moving into the e-commerce environment, and made this transition quickly! Moving fast has been important for Ray's Motorcycles as was evidenced by the fact that sales have climbed dramatically since the company established a strong Web presence.

Key Technologies

The starting point for Ray's evolution to the Web was the [IBM HTTP Server](#) (powered by Apache) on iSeries which supports reliable distribution of information to the Web based on the popular Apache HTTP server. Ray used this technology as the basis for his initial, static Web site. When he was ready to include inventory availability and pricing information at the site, Ray used [IBM WebSphere Application Server Standard Edition](#) to extend his Web site. He implemented a number of [Java Server Pages \(JSPs\)](#) which enabled the easy imbedding of dynamic product information into the static information that is associated with his business. Ray was able to use WebSphere to deploy a number of applications based on Java servlets to tie his order entry system into forms that could be used for placing orders over the Web. In this case, the [IBM Toolbox for Java](#) was also used to provide easy access to his existing RPG order entry application from the Java servlet programming environment.

Finally, Ray used [IBM WebSphere Commerce Suite](#) to implement his current Web storefront and was able to take advantage of all of the product catalog, shopping cart and storefront

development tools provided. WebSphere Payment Manager was used to handle credit card processing associated with orders placed over the Internet.

Throughout Ray's evolution to the Web, he took advantage of the broad set of tools included with WebSphere Development Studio for iSeries including [WebSphere Studio](#) and [VisualAge for Java](#) to greatly simplify development of Web and Java-based extensions to his IT environment. Of course, security was a critical requirement throughout this evolution to the Web and Ray was relieved to discover that iSeries supports a wealth of native security functions, to facilitate extending IT solutions to the Web without compromising security. (These functions include: [IP](#) Internet Protocol packet filtering, (NAT) Network Address Translation, [SSL](#) (Secure Socket Layers) and virtual private networking ([VPN](#)), to name just a few.) Information about the tools Ray used, as well as other tools that perform similar functions, can be found in the [iSeries 400 Tools Network's e-business/e-Commerce](#) category.

Related Technologies

While Ray demonstrated that extending an existing OS/400 application to the Web can be done easily and incrementally, there is a continual stream of new tools to facilitate this process. For instance, IBM and IBM partner solutions automate the process of building an elegant and highly functional [Web face](#) onto an existing OS/400 5250 application. Some of these tools work by mapping 5250 interfaces into [HTML](#) (Hypertext Markup Language) equivalents. Other, more advanced tools such as the WebFacing tool provided with WebSphere Development Studio for iSeries will accomplish transition to the Web by generating Web pages from application source code such as DDS (Data Definition Specifications). As companies deploy more solutions to the Web, they will find it advantageous to move to a reusable software component model. For example, products such as [IBM's Host Publisher](#) allow a series of 5250 screens to be encapsulated as a reusable JavaBean component. [WebSphere Application Server Advanced Edition](#) also supports the option of creating reusable components which follow the [Enterprise JavaBean \(EJB\)](#) component model.

Enabling Information Flow (Scenario 2)Enterprises can reduce internal operating costs and improve efficiencies by moving from paper-oriented processes to more automated, paperless processes which leverage workflow and collaborative application techniques.

The Problem

Just one look at Ray's desk told the story — paper everywhere — orders here, daily service reports there, and current inventory reports somewhere in-between. Everyone in the company suffered from a similar paper overload. All too often, sales figures were lost, or inventory numbers were inaccurate because the latest shipping and receiving counts were still sitting on someone's desk. The flow of paper-based information required to run Ray's business was just too much to manage. On top of all this, the dealers associated with Ray's business wanted to work with Ray to get a centralized view of inventory and to offer promotional requirements; all to help increase sales and customer satisfaction.

The Solution: Moving to Workflow-Oriented, Collaborative Applications

It was easy for Ray to see that he had to come up with a more efficient way to handle the information required to run his company. As his business grew, he knew that a paper-oriented process would be totally inefficient. So, Ray made a decision to use his iSeries to move to an electronic, workflow-based process. Now, rather than having a paper trail for all activities associated with his business, Ray's iSeries maintains a set of electronic

documents that he can query at any time to get up-to-the-minute information on the state of his company.

Here's how this works: An electronic document is created to record the number of specific motorcycles, parts and merchandise received. This document is used by the warehousing team who unpackage and shelve the day's incoming shipments. As boxes of merchandise are appropriately stored, the document is updated to reflect that the products are now part of the inventory available for purchase. A similar workflow is being implemented on the sales fulfillment end, where orders are recorded as electronic documents and routed to the packing team which boxes them for shipment. Updates to the existing inventory system are made as merchandise is processed and shipped to customers.

To accommodate the growing requirements of dealers to have more access and input to Ray's business, the dealers were given a secure Web workspace so that team discussions and documents are maintained in one central location. Everyone can be aware of what is going on by tracking assignments, milestones, meetings, events, and even the inventory status, contracts, and pricing.

On-line meetings give everyone the capability to discuss their promotional requirements so Ray can adjust inventory and shipping schedules to satisfy the requirements of the dealers which will increase sales and customer satisfaction.

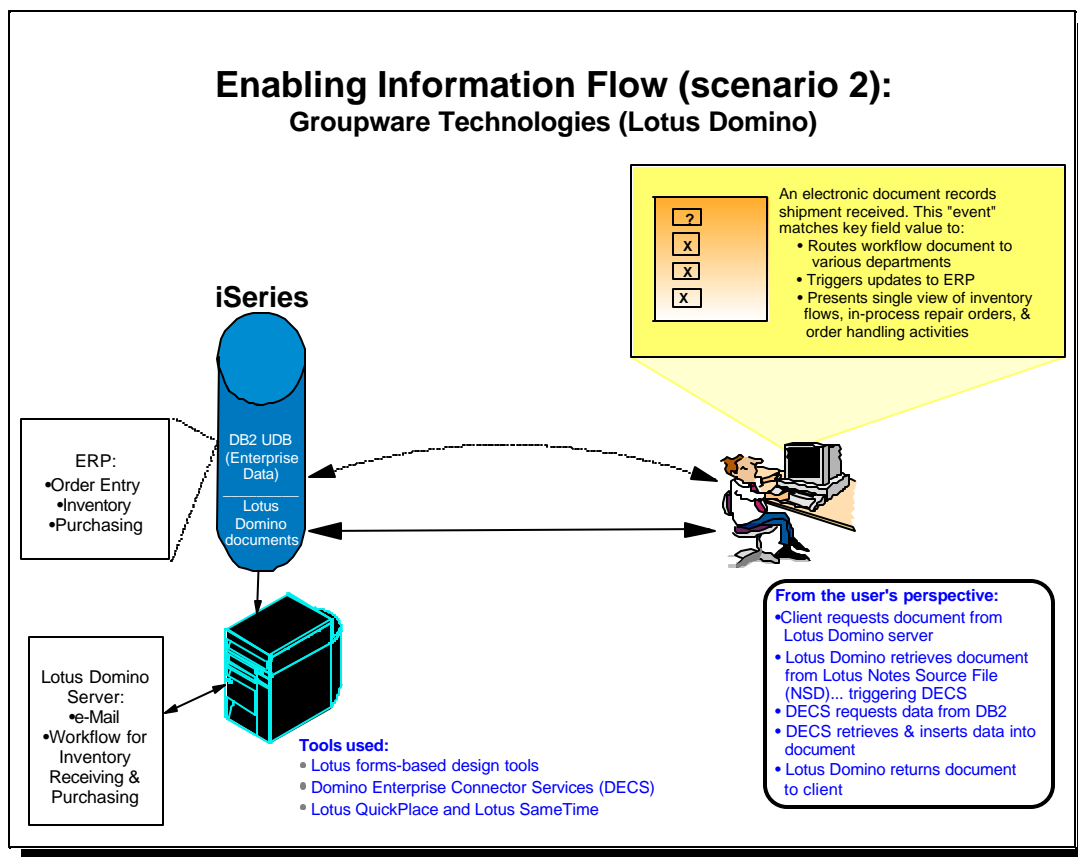


Figure 6: Lotus Domino Groupware Technologies

Key Technologies

[Lotus Domino](#) is a natural solution for electronic workflow. With its easy-to-use, forms-based design and programming environment, Ray implemented a custom workflow solution for his business with minimal effort. [Domino Enterprise Connection Services \(DECS\)](#) now ties

Ray's Lotus Domino workflow application into his existing inventory management system, triggering automatic updates to inventory at various points in the workflow. DECS was chosen because of its realtime data integration capabilities. Using Lotus Domino, Ray can see, from a single view, all inbound and outbound inventory flows, as well as all in-process motorcycle orders and order handling activities. Ray's staff learned the new workflow application with little training because they were already familiar with using Lotus Domino for e-mail. (The Lotus Domino interfaces remain consistent in all workflow applications.)

Lotus QuickPlace and Lotus Sametime are Lotus "value-add" products that help make integration with Lotus Domino an overall solution for any business. **Lotus QuickPlace** is a revolutionary teamware application that allows instant collaboration on the Internet or a company's intranet. **Lotus Sametime** brings the flexibility and efficiency of realtime communication to the business world, such as online meetings, instant messaging and group chat sessions.

Related Technologies

Look for continued integration between Lotus Domino and [WebSphere Application Server](#), enabling more integrated solutions that take advantage of the collaborative features inherent in Lotus Domino and the transactional, Web-based facilities provided by WebSphere. Examples of tighter integration that have been recently added between Lotus Domino and WebSphere include availability of a Lotus Domino plug-in which handles references to Lotus Domino databases within an [IBM HTTP Server](#) environment, as well as the availability of a WebSphere plug-in for use by the Lotus Domino server to handle processing of [Java Server Pages](#).

[Lotus Enterprise Integrator \(LEI\)](#) offers a batch alternative to DECS for accessing DB2 UDB data. In contrast to the realtime access offered by DECS, LEI transfers the contents of one database to another in batch mode. This data can then be used by Lotus Domino as is needed. All of these technologies can contribute significantly to the efficient implementation of a B2C Web presence. For example, Internet access to trustworthy inventory balances can prompt a Web consumer to make an instant ordering decision, spurred by the anticipation of immediate shipment — translate that to mean "instant gratification" for the consumer. For Ray's, it also means higher customer satisfaction levels... higher profits... and higher consumer "be back" tendencies.

Knitting the Business Together (Scenario 3)

Enterprises can integrate heterogeneous IT systems that have been acquired over time through company acquisitions, and can incorporate new IT investments to provide a single view of company information and other key IT assets.

The Problem

Having made several astute moves to exploit the Internet consumer market and improve the efficiency of his business, Ray was able to expand operations by purchasing several other motorcycle dealerships within the region. Ray soon found that each operation had a different IT environment: dissimilar hardware platforms, various software solutions and multiple processes for managing inventory and order tracking. Instead of realizing the efficiencies of a single, larger enterprise, Ray found that he was essentially managing several smaller operations and was expending a significant amount of effort attempting to combine the duplicated resources associated with each operation. At the same time, Ray wasn't ready to scrap the existing IT infrastructure at each store by deploying a single, common IT infrastructure across all his locations. It seemed to Ray that replacing the existing systems would be too costly, at least until the newly combined operations were showing a profit.

The Solution: Standards-based, Application Integration Middleware

Ray realized he needed to move each of his stores to a standards-based IT environment. And, he was quite successful with this goal — with less effort than you might think. Ray improved efficiency of his overall operations without major disruptions by implementing a set of standard interfaces into the IT systems for each retail location. He also used a messaging-based architecture, much of which was automatically triggered, for the interactions required between two or more motorcycle shops. Now, Ray's Web site can show customers the composite of all merchandise from each individual store. Orders received by one store that cannot be fulfilled due to a shortage in local inventory, can be routed to another location that has the item in stock. By moving to a set of standard IT interfaces, Ray was able to build new applications based on input from each operation — without having to incur the expense, headache and time delays associated with migrating to the same hardware/software environment at each store.

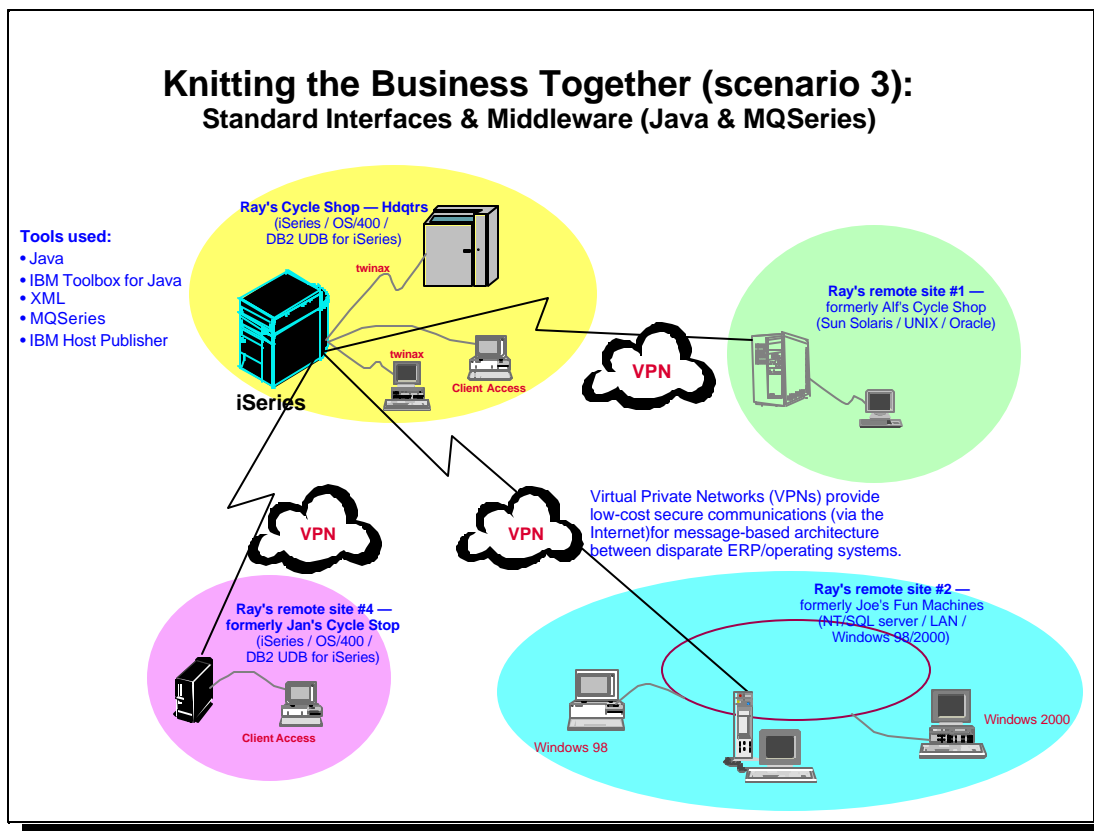


Figure 76: Standard Interfaces and Middleware

Key Technologies

Ray used Java-based components to implement standard interfaces to the heterogeneous IT functions at each store. Java's strength as a bridge technology makes it a natural choice to encapsulate existing data and application resources in order to reuse and combine them into other applications. Again, Ray took advantage of the [IBM Toolbox for Java](#) and [Host Publisher](#) support to build Java components that interact with his existing iSeries-based applications. Ray used [eXtensible Markup Language \(XML\)](#), a standard for exchanging key business data via the Internet, to map inventory and orders between the applications running on different platforms. Finally, Ray took advantage of [MQSeries](#), IBM's cross-platform messaging architecture, to communicate between applications running on different servers. MQSeries' ability to connect applications in a message-oriented architecture versus a tightly coupled

interface makes it easier to snap in and snap out components of the overall IT solution with minimal change.

The [iSeries 400 Tools Network](#) has identified a list of tools to help create and manage applications that have to interoperate across a variety of server platforms and clients.

Related Technologies

Look for technologies, such as XML and messaging-based middleware solutions (e.g., MQSeries), to be combined to provide an even richer set of application integration possibilities. Products such as MQSeries and [MQSeries Integrator](#) are evolving to address not only delivery of information between two applications, but also to address routing and formatting of information based both on a set of rules and on the data preferences of the interacting applications. XML support is also being added to many iSeries tools and other middleware offerings, facilitating the ability to bridge from various iSeries data and application resources to an XML format that encapsulates this information in a standard, portable manner. A good example is the XML Extender support for DB2/UDB which provides new data types that enable storing of XML documents in DB2 databases and new functions that assist with storage and retrieval of XML data. XML Extender supports two modes of storing XML data in DB2; XML columns, where an entire XML document is stored intact within a column of a database table and XML collections, where the individual elements and attributes of an XML document are mapped to/from one or more database tables.

Partnering for Success (Scenario 4)

Enterprises can establish more integrated and efficient trading partner relationships with the implementation of business-to-business solutions. B2B is business which is conducted between businesses via some electronic means. From a commerce standpoint, B2B is when two or more businesses buy, sell or strike trading partner agreements between themselves using e-commerce technology.

The Problem

Ray's Motorcycles had begun to cultivate a large and profitable distributor business because of its large inventory of service parts spanning a broad range of motorcycle brands. Immediate access to these service parts was imperative to the surrounding motorcycle repair shops. But Ray noticed this part of his business was being restricted by the need to receive hard copy (paper or fax) orders from his large-volume trading partners. More and more of these partners were moving to the efficiencies offered by automated purchasing methods and were giving preference to suppliers that conform to those practices. Ray needed a way to plug his business into these electronic purchasing processes. Furthermore, Ray had seen several e-marketplaces sprout up on the Web — consortium sites where parts buyers, parts sellers and cycle manufacturers “meet” to conduct business electronically. Ray saw some of his competitors on a few of these e-marketplaces and could only imagine the business he was losing by not participating in these new B2B commerce environments.

The Solution: Automating Trading Partner Interaction

As with his initial move to the Web, Ray found his core iSeries environment and processes were not in need of upgrade, but rather the interfaces that allowed access to these systems; specifically those required to deal with peer-to-peer and e-marketplace-oriented B2B interaction. While HTML and the credit card payment model used by Ray's consumer site worked well for individual customers, it didn't fit the model for interacting with trading partners which rely on more extensive buy-side procurement processes and software, make repeat purchases of the same items versus a different set of items with each order and rely on a different payment model that is based on invoicing and statements — not credit cards. Ray

found that his partners were moving to a number of buy-side procurement software solutions, each supporting a specific protocol for trading partner interaction. Ray needed to implement a flexible sell-side solution that would tie order, remote shopping and other requests from the various procurement packages into his existing set of IT solutions. He also wanted flexibility in his sell-side solution that would allow tie into e-marketplace systems.

Ray discovered that the work he had done to define callable interfaces to his existing IT assets simplified the task of building a sell-side solution. Furthermore, Ray found that products like Connect for iSeries were a great aid in dealing with the variety of trading partner protocols he was required to support. Connect provided the glue Ray needed to tie his existing IT solutions into a variety of trading partner protocols.

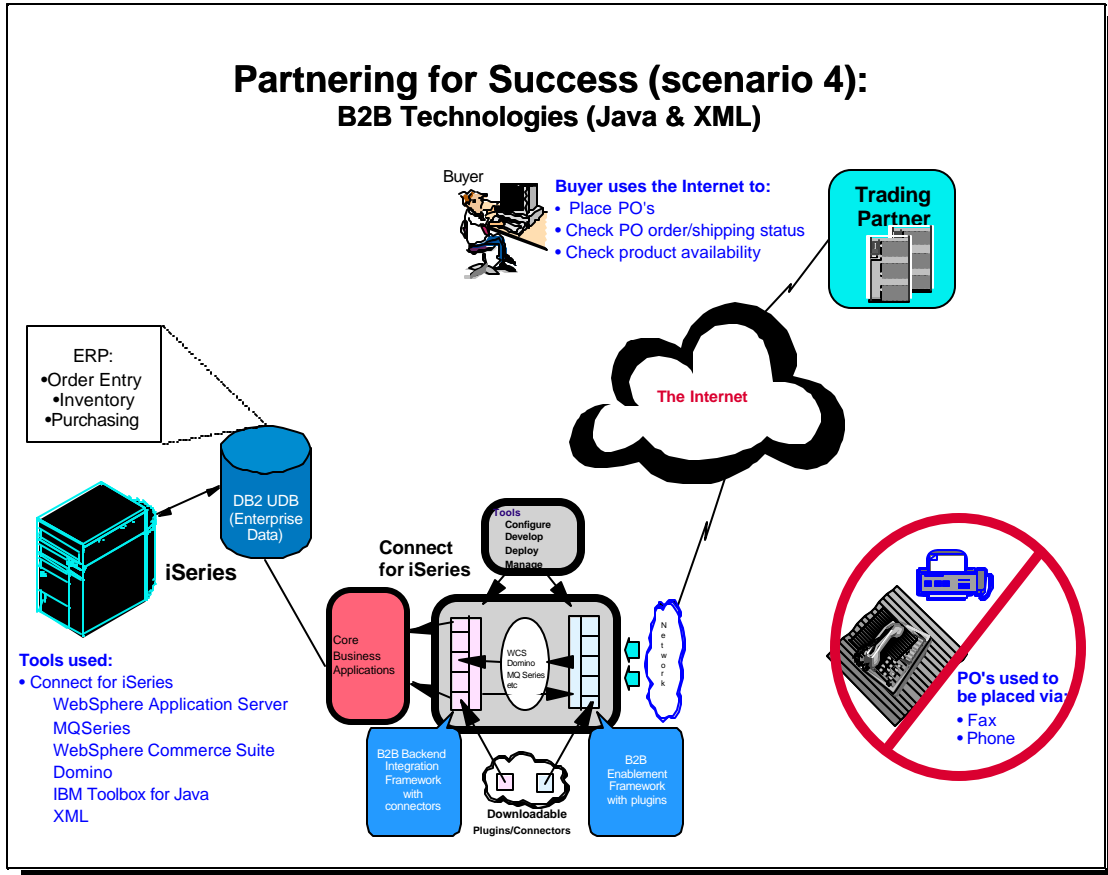


Figure 7: B2B Technologies

Key Technologies

Connect for iSeries was the key ingredient used to implement Ray's first automated B2B sell-side solution. Connect builds upon WebSphere, WebSphere Commerce Suite, MQSeries, Domino, XML and Java to provide a low cost, easy to use and easy to extend environment to "connect" existing business applications with current and future B2B trading partner protocols. Ray leveraged the existing program call and data queue interfaces to his business applications while configuring Connect to handle electronic requests received from his trading partners and larger clients. Ray found that Connect and the technologies it is based on provide a great degree of flexibility; both in the support provided to integrate existing IT assets into an overall sell-side B2B solution and in the support provided for B2B protocols Ray needs to support today and those that will be required for interaction with future trading partners.

Related Technologies

Future focus will likely be placed on standardization of the protocols and technologies used to construct Internet-based B2B solutions. XML will undoubtedly play a key roll in future solutions, but look for additional protocols to be developed on top of the core foundation provided by XML. Examples of these protocols include 1) SOAP, or a similar protocol for defining how to invoke a remote procedure using the Internet as the transmission medium and XML as the content format, 2) Web Services Definition Language (WSDL) a proposed standard for defining interfaces to reusable web-based services and 3) Universal Description, Discovery and Integration (UDDI) which is defining a standard way to register and locate services on the web. The combination of these three standards are aiming to provide a standard method to locate, understand and invoke the services provided by trading partners using the Internet as the medium for communication. Also look for the availability of new and powerful tools which can be used to extend existing IT assets into this new, emerging web-based services model.

On the Road and In Touch (Scenario 5)

Enterprises will enable an increasingly mobile workforce by providing mobile-client access to core business applications.

The Problem

During peak motorcycle season (spring and summer), things get really busy at Ray's Motorcycles. Orders come in from everywhere; individual customers, Web orders, and orders for delivery of large volume service parts from large repair and service shops throughout Ray's geographic region. Several times over the past few years, Ray's sales team has placed orders on behalf of large clients only to discover there was insufficient inventory to deliver in time to meet customer needs. (It's a demanding industry, motorcycle owners don't want to wait two weeks while their bikes are being repaired during the riding season.) And, the problems were getting worse as Ray's business grew. Ray tried to distribute daily inventory reports to his sales team, but found there were always situations where someone was working from a down-level report, or the report sent out the previous evening was already out of date by noon the following day. Ray was tired of calling clients to give them the bad news that their orders wouldn't be fulfilled as promised and knew that customer satisfaction was beginning to suffer.

On the IT side, Ray was feeling pressure to increase his IT staff to keep up with expansion in his overall IT operations. The fact that the systems required to run his business were distributed across the company and the growing need to support a 365x24x7 operation was putting a strain on Ray's IT staff and their ability to monitor and manage Ray's IT environment.

The Solution: Tier 0 Access with iSeries

Ray's problem wasn't that he couldn't keep track of his motorcycle inventory. He was just having trouble making up-to-the-minute data available to his sales and services teams as they went from service shop to service shop taking orders. Ray solved this problem by deploying handheld, wireless cell phones and [PDAs](#) (personal digital assistants) to his sales team. He used WebSphere, Java and [XML](#) to extend his iSeries-based inventory and ordering system to the new client interfaces. Ray found that using WebSphere Transcoding Publisher provided a fast path to mobile devices, with its support for on-the-fly conversion of web content to formats that can be handled by the devices used by his mobile workforce.

Ray was also able to make great strides to alleviate the pressure on his IT staff by taking advantage of the function provided by Management Central Pervasive which allowed his IT staff members to monitor and control iSeries systems from this same set of mobile devices.

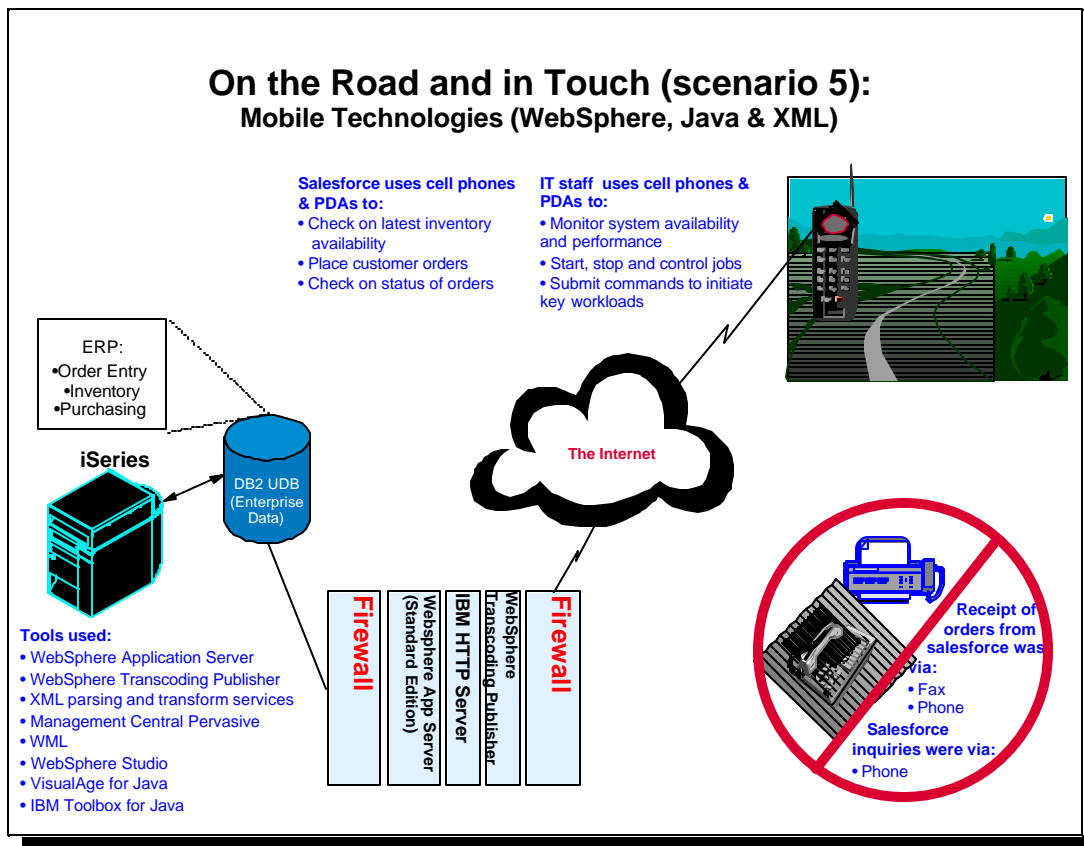


Figure 8: Mobile Technologies

Key Technologies

[WebSphere Application Server](#), [Java](#) and XML were, once again, the foundation technologies for Ray's mobile computing environment. WebSphere and Java provided a robust and scalable application delivery platform for Web and wireless applications, while XML, which has become the de facto standard for describing application content, was used to drive small, handheld, mobile client-computing devices. This approach made it possible to support a wide variety of client interfaces while leveraging existing IT investments.

In Ray's case, he created a Java-based servlet to extend his existing RPG order entry and inventory management systems to the new mobile client platforms. The servlet uses facilities provided in the [IBM Toolbox for Java](#) to call Ray's RPG-based applications from Java. The servlet also uses the eXtensible Stylesheet Language Transformer (XSLT) function provided with WebSphere to create inventory reports and order entry forms using Wireless Markup Language (WML), an XML specification defined for wireless applications. [WebSphere Application Server](#) provides the runtime environment to execute and manage the new servlet-based interface into Ray's existing core business function. For several of his existing web-based applications, Ray was able to use WebSphere Transcoding Publisher to generate content suitable for mobile, handheld devices from the existing content supported by Ray's web site.

Finally, Management Central Pervasive was just what his IT staff needed to monitor system activity while not being tied to the office. Management Central Pervasive not only provides valuable function to Ray's IT staff, but serves as an excellent showcase for the types of solutions that can be built using mobile computing technologies available on iSeries today.

Related Technologies

Pervasive computing is becoming ... well ... pervasive. While cell phones and PDAs are the mobile devices of today and the near future, the number and variety of devices will grow dramatically over the next few years. Some of these will have LCD displays which support interaction with the user, similar to the PDAs of today. But, look for several other user interaction techniques to also become prevalent. One good example of even newer mobile technologies that will come into common use is the speech-driven interface, where the user interacts with the application by talking and listening, rather than by reading and pushing keys. This will put pressure on applications, such as those recently implemented at Ray's, to keep up with the latest mobile client technology.

Partitioning an application into separate presentation, business logic and data management layers will help cope with client-side technology churn. Moving to an intent-based user interface architecture is another good approach for this situation. An intent-based architecture takes advantage of technologies, such as XML, to present a generic, presentation-neutral interface between the application and end users. Specific user interface rendering facilities can be provided to map the generic application data stream to a number of specific devices, each supporting different approaches and standards for user interaction. The [iseries 400 tools network](#) can be a good place to find out about tools to help create and manage applications that need to support mobile computing.

Mining Those Data Nuggets (Scenario 6)

Rigorous analysis of historical data can lead to significant insights into methods for restructuring the way a company does business. For example, an enterprise can more accurately predict sales trends and customer preferences through analysis of prior sales transaction data.

The Problem

Ray realized that, to remain competitive with larger motorcycle dealers and distributors, he must be more flexible and must more carefully target his marketing efforts. He needed to analyze motorcycle purchasing trends by rider segment (cruiser, sports bike, dirt bike, etc.) to spot hot and slow moving products and to determine more effective distribution methods for the service parts end of his business. Ray was also very concerned about customer satisfaction and wanted to link this information into his decision-making process. To maximize overall profitability and customer service he wanted to understand the buying trends within his customer base in order to more accurately forecast parts, apparel and accessories demand, as well as to better plan for special sales and other promotions. Ray's sales force lacked the kind of information that was required to expand their sales. To help make strategic business decisions, Ray needed to analyze historical information to identify trends and hot spots. Furthermore, the company needed this analysis to be fast, flexible and on-demand. This requirement was complicated by the fact that Ray's IT staff had an ongoing 6-month reporting backlog and the Their existing ERP applications could not meet any of these requirements.

The Solution: DB2 Warehouse Manager

Ray started by transferring the data from his ERPonline system onto another iSeries system which would serve as his enterprise central data warehouse platform. (in DB2 UDB) on another iSeries system. By using [IBM's DB2 Warehouse Manager](#) product, the data movement process could be automated. Once the data was extracted and moved from the ERP operationalonline data source to the data warehouse system , it was then transformed and placed into the DB2-based data warehouse tables, usingbased on the business rules defined by the administrative functions within DB2 Warehouse Manager.

With the new data warehouse, Ray's IT staff can now more quickly respond to end user requests for new or modified reports, and power users are able to easily generate their own

reports. This is because, through proper up-front planning, Ray's data warehouse contains all the data needed by his employees. Also, the table structures and data formats found in the data warehouse are designed to optimize the performance of query and reporting operations. In contrast, table structures on the ERP system are designed with the objective of streamlining online transaction processing (OLTP). This key design difference results in similar reports running much faster on the data warehouse system. Ray has also noticed that since the data warehouse is on its own system, he no longer needs to worry about a runaway query taking valuable CPU cycles away from employees who are taking orders. This benefit holds true whether the data warehouse is placed on a separate iSeries (Ray's implementation) or is placed within an LPAR partition on a single iSeries.

The data warehouse provided Ray with the solution to one of his immediate needs - reducing the IT report backlog. But Ray knew that there were additional analysis needs that would not be solved by the data warehouse alone. To provide his sales and marketing team with the powerful yet easy-to-use business analytics they needed, Ray implemented a sales and marketing datamart. Using IBM DB2 OLAP Server, the sales and marketing data was extracted from the enterprise data warehouse, then massaged, summarized, and new values calculated, and finally stored into new data structure (datamart). Using a graphical web-based user interface, Ray's sales managers can now view and compare sales by year/quarter/month, quota attainment by salesperson, profit by customer, and much more. Because this new capability lets them drill down or up through data at the click of a mouse, salespeople can now formulate sales strategies based on the information the warehouse provides. This includes information about the success of previous promotions, regional trends, product profitability, and the effects of product packaging. Salespeople have access to immediate information to make on-the-spot decisions that are customized to particular clients.

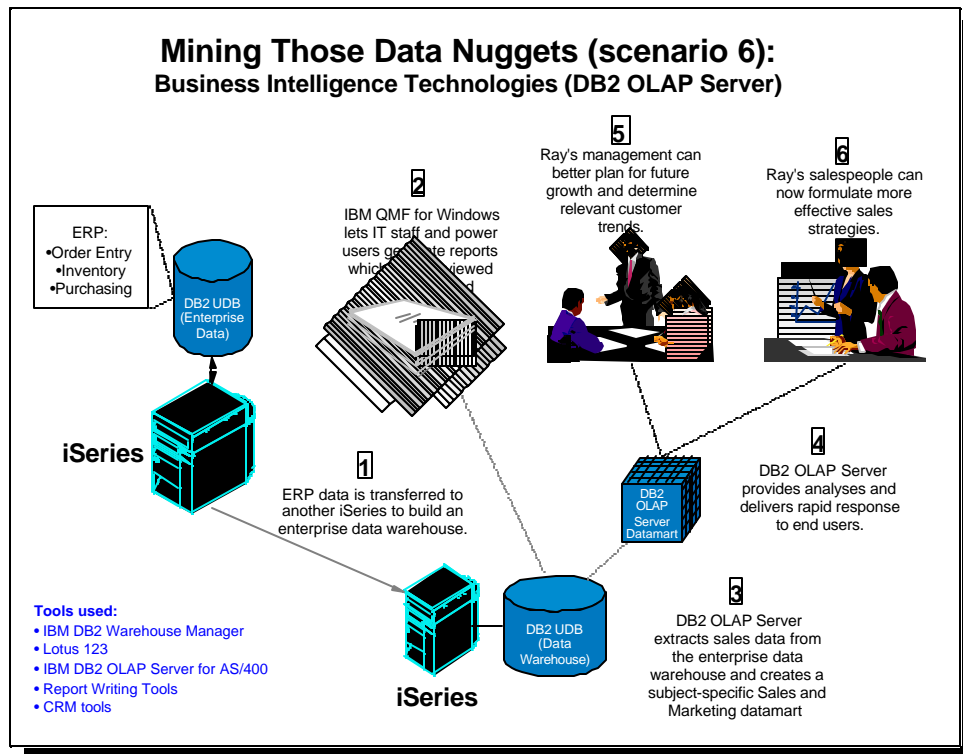


Figure 9: Business Intelligence Technologies

Key Technologies

Ray began by using [IBM DB2 Warehouse Manager](#) to extract, transform, and load data from his ERP system to the new data warehouse system. The resulting data warehouse is made up of DB2 tables, so any ODBC/JDBC/DRDA client-based product, such as [IBM QMF for Windows for iSeries](#), can be easily used to generate reports for IT staff and power users.

IBM and [ShowCase Corp.](#) have joined forces to deliver a comprehensive IBM offering called [DB2 OLAP Server](#).

Ray then used [IBM DB2 OLAP Server for iSeries \(AS/400\)](#) to deliver a comprehensive datamart to his sales and marketing staff. Ray defined the rules and entities that correlated to the specific business values and dimensions needed, and then DB2 OLAP Server that were built and populated the datamart using with Ray's historical sales and production information. With the tables populated and updated to Ray's specifications, the datamart warehouse was ready for end-user data access. Ray's selected [IBM DB2 OLAP Server Analyzer](#) to provide Microsoft Windows and web-based client access to the OLAP Server datamart. initial data warehouse applications used Lotus 123, a standard desktop spreadsheet application, but in the future, Ray will probably want to utilize more sophisticated query report-writing tools, that support the DB2 OLAP Server API set. Now that the data warehouse exists, this additional function can easily be added at any time.

DB2 OLAP Server's features and numerous independent software vendor applications are available to give users a wide choice of Web-ready clients and tools. DB2 OLAP Server performs all analysis on the server, thereby minimizing network traffic and delivering rapid response to Web users. The latest DB2 OLAP products exploit the [Hyperion Essbase](#) technology with either a relational or a multidimensional data storage option.

With the business intelligence solution that Ray has implemented, he now has the ability to link customer data with sales information by using customer relationship management marketing ([CRM](#)) packages to deliver targeted marketing campaigns. Again, Ray will be able to find these solutions by visiting the [iSeries 400 Tools Network](#) Web site.

Related Technologies

As Ray's further embraces B2B technologies, he will find additional opportunities to exploit business intelligence methods and to enjoy the benefits and advantages of its results. With the analytical content of business intelligence, companies can gain access to e-commerce-related key performance indicators associated with commerce processes and supply chain management issues. BI provides understanding of the complex interactions among customers, partners and suppliers in a company's supply chain. Both an enterprise, and its suppliers, can manage the company's inventory and can organize, track and analyze e-commerce transaction information. Visit the [BI section of the iSeries 400 Tools Network](#) Web site for more details.

Ray's Scenario Summary and What it Means to You

While each company is different and unlikely to follow precisely the same IT path as Ray's Motorcycle Shop, many of the challenges and corresponding solutions can be applied regardless of industry. The solutions demonstrated in Ray's situation reflect sound IT practices that emphasize reuse and extension of proven business solutions over total replacement of existing applications. iSeries and the application technologies provided with iSeries make such a smooth transition possible in the face of ever changing requirements and technology. The following sections elaborate on many of the technologies introduced in Ray's situation and illustrate the strategy for support of these technologies on iSeries.

Application Technologies

One of the typical questions asked by developers new to the iSeries platform is why should they develop and deploy solutions on iSeries versus other platforms in the industry. The answer is based on the unique positioning of iSeries within the market — a position that aggressively supports transformation of business applications to an e-business model, while also minimizing disruption within the enterprise environment. iSeries has business-proven values (reliability, security, scalability, low cost of ownership) and supports the latest enabling technologies for e-business. In combination, these two qualities make iSeries a good choice not only for extending existing applications but also for deployment of new solutions.

iSeries Application Environments

One of the great strengths of the iSeries platform is its versatility at supporting a wide range of solutions that have been built using many different application technologies. To facilitate coexistence of both current and emerging application technologies, iSeries supports a number of distinct, yet interoperable application environments which share common system services, such as security, database, backup and recovery, and work management, just to name a few. Nowhere is the “flexible server” nature of iSeries more evident than in the number of application environments it supports:

- ✍ Java, including a [Java Virtual Machine \(JVM\)](#) implementation, standard Java class implementations, and a suite of Java-based components for accessing iSeries data and program resources. iSeries also offers the WebSphere application development and runtime environment which supports the Java standard.
- ✍ Integrated Language Environment (ILE), which supports a number of programming technologies (RPG, COBOL, C/C++)
- ✍ OS/400 PASE ([Portable Application Solutions Environment](#)), a runtime environment for porting [UNIX](#) applications to iSeries
- ✍ [Linux on iSeries](#) enables a native PowerPC Linux kernel to run in a secondary logical partition using either a shared or dedicated processor of OS/400. This is an additional server consolidation opportunity for iSeries..
- ✍ [Integrated xSeries Server](#) and Integrated xSeries Adapter, make it possible to run and manage multiple Windows NT or Windows 2000 servers all managed from a central iSeries server, significantly simplifying management of those environments
- ✍ [Lotus Domino](#), which provide a scalable, reliable infrastructure as the basis for communication, decision making and document management.

[NOTE: See the chart below (figure 11) to see these environments pictorially illustrated.]

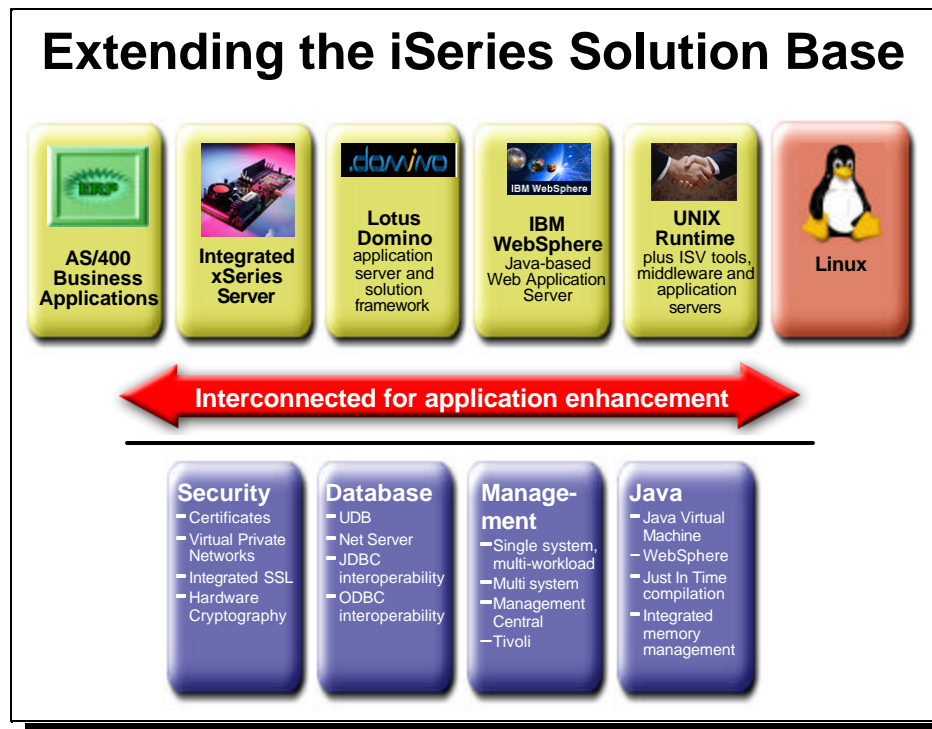


Figure 10: The iSeries application environment is broad and robust.

These six application environments give iSeries a firm basis for both current application development and for the support of newly emerging technologies. The following sections describe these six application environments in more detail.

[NOTE: "Appendix A" summarizes the support available on iSeries for each application environment. It also lists the interoperability supported between these environments.]

Java

Java is a strategic application environment for iSeries. IBM has made, and continues to make, significant development investments in Java for iSeries. The first results of these investments were revealed in February 1998 with the implementation of the [Java Virtual Machine \(JVM\)](#) and the [Java Developer Kit \(JDK\)](#) on iSeries. Today, the iSeries implementation of Java is an industry-leading environment for business applications, where scaling and robustness is critical.

The JVM is implemented below the machine interface on iSeries. The iSeries implementation includes a transformer for optimized Java performance (iSeries transforms the Java byte codes that are typically interpreted into direct executables), advanced garbage collection for optimized memory management, and exploitation of the 64-bit architecture that is inherent in iSeries. (See figure 12 and 13, below.)

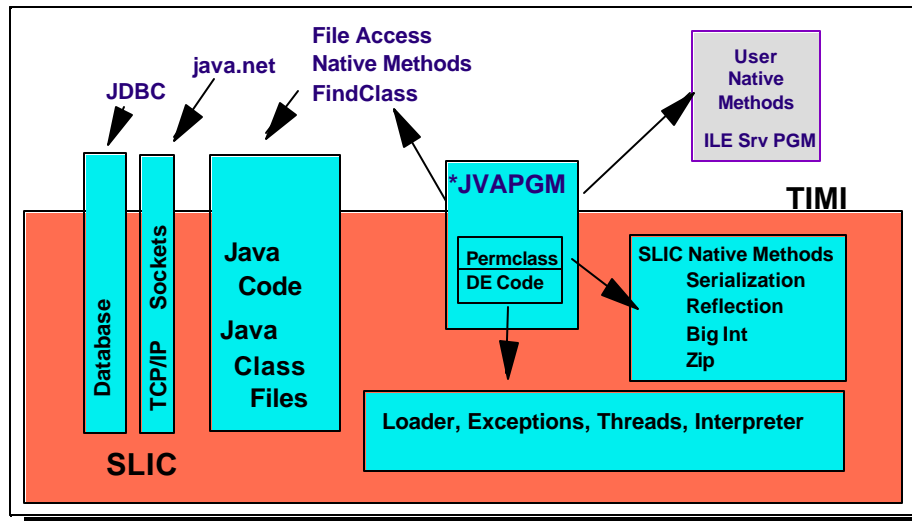


Figure 111: iSeries Java is integrated into the operating system.

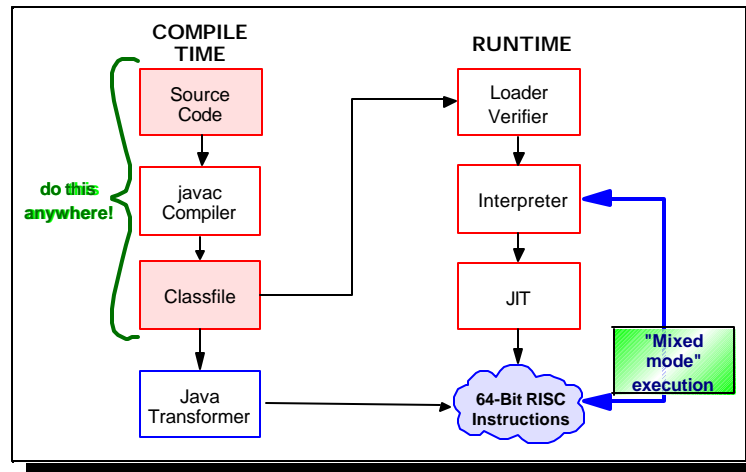


Figure 112: Java on iSeries can run in interpreted mode or can be compiled to 64-bit machine instructions.

As of April, 2001, the iSeries Developer Kit for Java (JDK) supports JDK 1.1.6, JDK 1.1.7, JDK 1.1.8, JDK 1.2.2 and JDK 1.3.0. iSeries supports concurrent use of multiple JDK levels, enabling production applications to run at one level, while new applications are being tested at another JDK level.

The [IBM Toolbox for Java](#) is a set of classes and utilities for accessing iSeries data and resources. The IBM Toolbox for Java is 100% pure Java, so it runs on any machine with a compliant Java Virtual Machine. (**Note:** After V4R5 the Toolbox will no longer be certified 100% pure Java.) This enables client/server and server-to-server program communication. The IBM Toolbox for Java provides a set of APIs for accessing iSeries data via [JDBC](#) (Java Database Connectivity) or via record-level access, a set of interfaces to data queues and user spaces, calls to programs from Java, plus interfaces to many other objects. Communication is accomplished via a normal socket or a secure sockets connection. In addition to these APIs, the IBM Toolbox for Java provides [XML](#) interfaces for program call and GUI (graphical user interface) panels. A visual GUI builder to create XML-based GUIs is also provided.

Performance has been consistently improved for Java applications on iSeries to the point that industry server-side Java benchmarks, such as SPECjbb2000 show iSeries in a clear leadership position when it comes to Java server application performance. (See figure 15.)

SPECjbb2000 Results

April, 2001

| SYSTEM | CPUS | Java | Trans/sec | Max Trans Time |
|----------------------|------|-------|-----------|----------------|
| IBM iSeries 840-2461 | 24 | 1.3.0 | 132,322 | 0.18 |
| IBM iSeries 840-2461 | 24 | 1.2.2 | 130,791 | 0.20 |
| IBM iSeries 840-2461 | 24 | 1.1.8 | 131,479 | 0.15 |
| Sun | 24 | 1.3.1 | 109,146 | 2.80 |
| IBM AS/400e 840-2420 | 24 | 1.2.2 | 80,348 | 0.46 |
| IBM AS/400e 840-2420 | 24 | 1.3.0 | 79,316 | 0.35 |
| IBM AS/400e 840-2420 | 24 | 1.1.8 | 79,250 | 0.35 |

Figure 13: SPECjbb2000 Results Show iSeries Leading the Pack (April 2001)

A variety of products from IBM Software Group and business partners support Java enablement on iSeries. IBM products include [VisualAge® Java](#) for iSeries and IBM [WebSphere Application Server](#). Key partner products for Web application serving can be found by visiting the [iSeries Tools Network](#) Web site.

Java is a popular environment for many developers who are new to iSeries because Java's simple architecture is well suited for the Web and component-based, object-oriented applications. Many Java applications developed on UNIX or NT platforms have been easily ported to iSeries. IBM's continued investment in Java technology on iSeries helps ensure that Java will continue to be an attractive application development and deployment environment for iSeries.

WebSphere also provides a runtime environment that supports the Enterprise JavaBean standard. (WebSphere and Enterprise JavaBeans will be talked about in more length in the "OS/400 Services and Middleware" section that follows.)

Integrated Language Environment (ILE)

As its name implies, the Integrated Language Environment is a robust set of runtime services that enable functionality to be built by using a number of different programming technologies. ILE allows these functions to be seamlessly integrated into a single solution, even though they have been assembled from disparate languages. In addition to its focus on cross-language integration, ILE also supports a very modular programming architecture, enabling solutions to evolve from special purpose, monolithic applications to a more component oriented model which facilitates software reuse and improved flexibility. Recent enhancements to the ILE environment remove application scalability and portability

limitations. For example, ILE applications can now use up to one terabyte of temporary storage, greatly extending the previous limit of 16 Mb.

Recent enhancements to the ILE environment are focused on features to further improve application porting and to enhance integration with other iSeries runtime environments. The ability to port applications from other platforms to iSeries is improved by: support for 8-byte, untagged pointers; and new, native C/ C++ compilers that support more recent ANSI standards for these languages. Extensions to specific ILE languages, such as ILE RPG, have been made to improve integration between runtime environments and will provide direct access to applications, such as Java programs, that are running in other iSeries environments.

The OS/400 Portable Application Solution Environment (OS/400 PASE) is a set of application environments supported by iSeries. OS/400 PASE is an integrated OS/400 runtime for AIX applications. OS/400 PASE is not a new operating system or emulation environment; rather, it exploits the PowerPC's ability to switch between runtime modes, enabling traditional OS/400 applications and AIX applications to coexist natively on the same hardware. The current implementation of OS/400 PASE supports 32-bit PowerPC binaries and comes with a subset of the AIX libraries, simplifying migration of AIX binaries and porting of other UNIX variants. (See figure 16.) Future plans include support for 64-bit PowerPC binaries. In addition to AIX, OS/400 PASE supports runtime environments for C, C++ and FORTRAN.

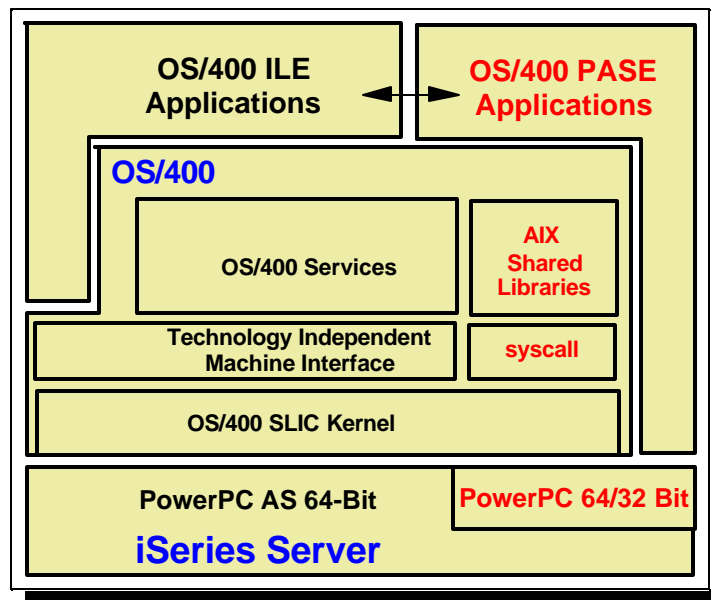


Figure 115: OS/400 PASE — A runtime environment for UNIX applications on iSeries

In addition to simplifying efforts to port UNIX applications to OS/400, OS/400 PASE provides a level of integration with iSeries system facilities and other application environments. For example, OS/400 PASE applications are integrated with the iSeries file systems, can access information in DB2 UDB, and can call Java and ILE programs. OS/400 PASE also fits into the existing OS/400 work management structure.

OS/400 PASE applications are built on AIX systems using AIX compiler technology. The OS/400 PASE runtime supports ANSI standard and historical UNIX C languages as well as applications built using the VisualAge for C++ 4.0 compiler.

In general, OS/400 PASE should be considered when time to market is the key factor associated with porting a UNIX application to iSeries. OS/400 PASE is also attractive for those situations where a specific UNIX or FORTRAN application (perhaps an engineering program) has required the continued support of an RS/6000 system, even though the rest of the business is running OS/400 applications. Migrating that one application can simplify the administration and technical currency demands placed on the IT department.

On the other hand, ILE should be considered when porting objectives include significant application integration with other ILE applications, or in those cases where integration is required with pre-V4R3 solutions. (See figure 17.) A handy [API analysis tool](#) is available to help you analyze whether the OS/400 PASE environment or the ILE environment will better serve your needs.

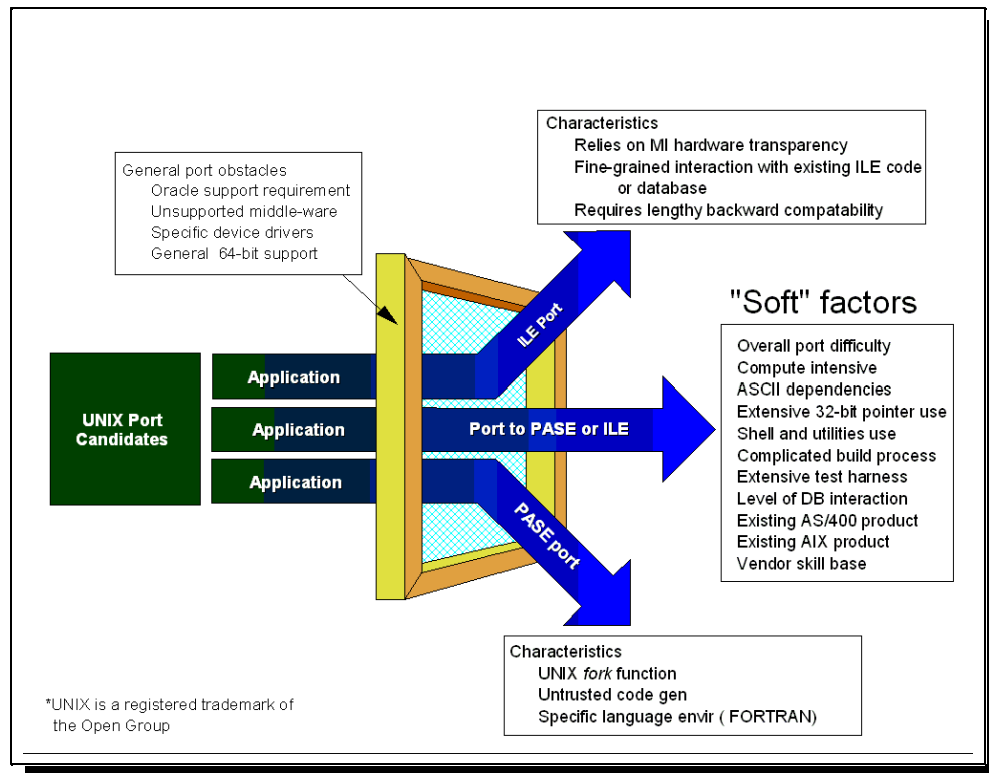


Figure 167: UNIX application porting factors

Windows Integration via Integrated xSeries Server and Integrated xSeries Adapter

The [Windows Integration](#) offering allows OS/400 application providers to collaborate with Windows application providers while still delivering a solution within a single server platform. This offering is made up of two separate but similar in function products.

1) The Integrated xSeries Server is a PC server card that is installed inside of iSeries and enables you to run a Windows 2000 or Windows NT application on iSeries. An Integrated Netfinity Server has its own Intel 850MHz Pentium III processor with up to 4 GB of PC memory and LAN adapters but it shares iSeries hard drives, CD-ROM and tape drives. Up to 32 Integrated xSeries Servers are supported on one iSeries.

2) The Integrated xSeries Adapter provides for the high speed direct attachment of selected xSeries servers to iSeries. The Integrated xSeries Adapter is a card that is installed in the xSeries server that enables a direct connection to iSeries. The xSeries server uses iSeries hard drives, CD-ROM and tape drives. Up to 16 xSeries servers can be directly attached to

one iSeries. The Integrated xSeries Adapter supports Windows 2000 Server and Windows 2000 Advanced Server running on the xSeries server.

In addition to the hardware, IBM provides a set of integration programs that enable combined user administration, single point of backup/recovery and Storage Area Network functionality for your Windows servers that are integrated.

No modifications are necessary to run Windows applications on the Integrated xSeries for iSeries or xSeries servers connected to iSeries via the Integrated xSeries Adapter because they run standard Windows Server software. Windows applications are simply installed following their standard installation procedure and run as normal.

Lotus Domino

Lotus Domino provides a scalable, reliable infrastructure which is the basis for communication, decision making, and document management. It extends beyond electronic mail and enterprise calendaring to include a robust/secure Web application server, a flexible document object store, and a powerful application development environment (see figure 18, below). [Lotus Domino](#) provides a fast start to create e-business solutions. By extending the power of [Lotus Notes](#) to anyone with a Web browser, Lotus Domino has become a premier interactive Web application server for creating and hosting Internet/intranet sites. Lotus Domino bridges the open networking environment of Internet standards and protocols with powerful application development facilities. By using Lotus Domino, any Web client can participate in applications more securely. Lotus Domino is an excellent technology for Web publishing, Web browsing, and Internet/intranet applications. It offers replication, authentication, messaging, and security services that are fully integrated with Internet protocols. Because Lotus Domino is cross-platform, it is ideal for extending business applications to the Internet.

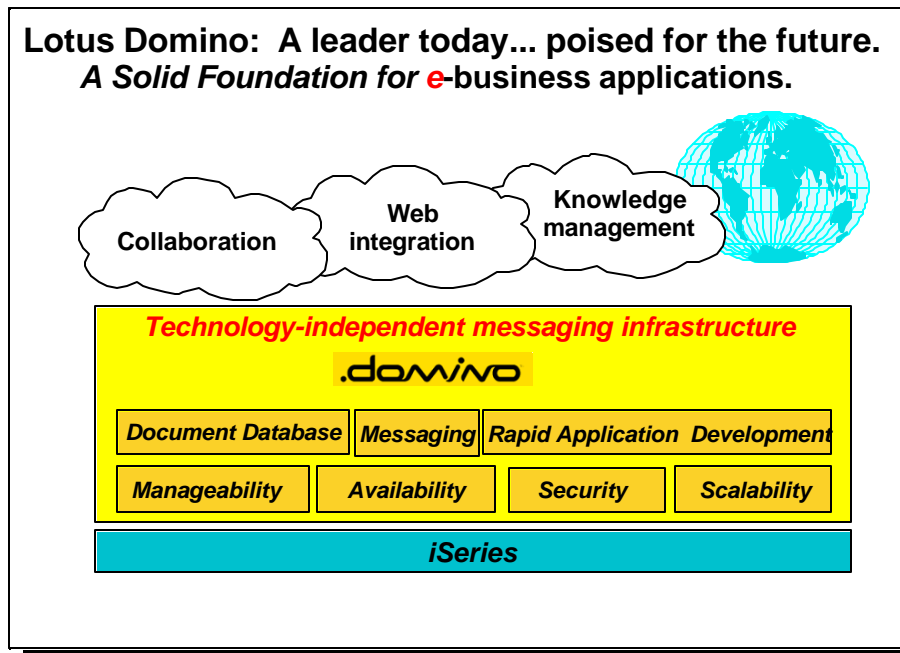


Figure 17: Lotus Domino as a foundation technology for e-business

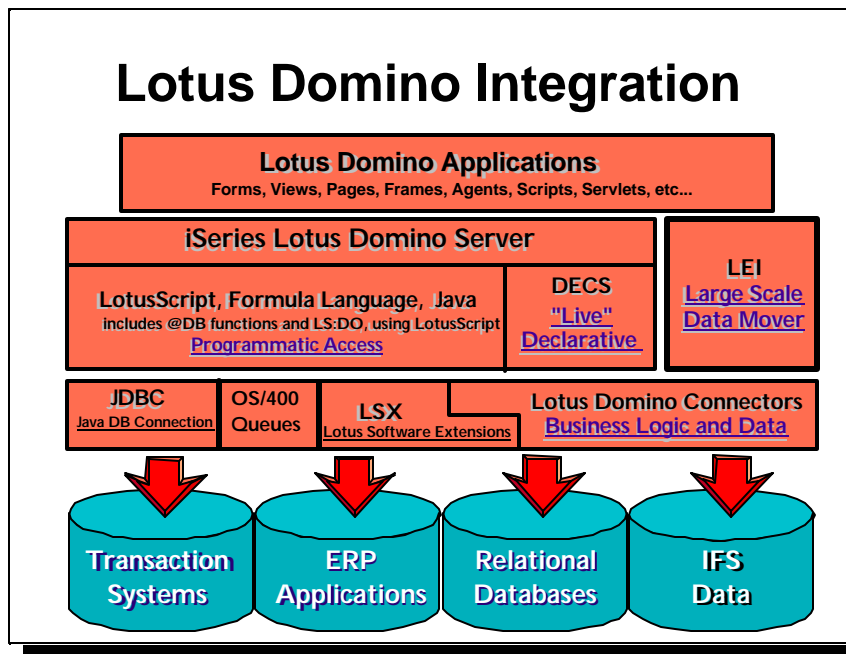


Figure 19: Lotus Domino is a foundation technology for e-business.

When IBM began supporting Lotus Domino natively on iSeries, thousands of Lotus business partners discovered the ease of porting and deploying their applications on the iSeries. At first, these tended to be front-office applications, such as e-mail, discussion groups and ad hoc queries, that were not time-critical. iSeries business partners saw they could easily and rapidly integrate the power of Lotus Domino to Web-enable their back-office applications. Today, Lotus Domino applications developed for intranets and the Internet easily integrate with relational databases, transaction systems, and ERP applications and initiate workflow processes. On iSeries, Lotus Domino supports a wide variety of existing standards, and the infrastructure is extensible to support emerging technologies, such as same-time collaboration, unified messaging, pervasive computing, and knowledge management. Lotus Domino is ideal for extending back-office applications to the Internet while retaining the strength of the respective application models.

Lotus Domino offers a robust application development environment where developers can choose several options for connecting these two application models. As illustrated in figure 18, programming options found within Lotus Domino to access both business applications and data include the Lotus Notes® Formula Language, [LotusScript](#) (very similar to Visual Basic®), Java, [Lotus Domino Connectors](#), and the C/C++ APIs. Non-programming options include a separately purchased product called [Lotus Enterprise Integrator](#) or LEI (formerly known as NotesPump) which allows the movement of data between DB2 UDB for iSeries and Lotus Domino databases. Another non-programming option involves the use of the Lotus Domino server function of [Domino Enterprise Connection Services \(DECS\)](#), which allows real-time access to DB2 UDB data from a Lotus Domino database.

QuickPlace is a revolutionary teamware application that allows instant collaboration on the Internet or a company's intranet. Best of all, users can collaborate, share information and schedules, or manage a project while taking advantage of the reliability and security of iSeries.

QuickPlace provides a central online workspace structured for productivity outside the firewall and secure Web collaboration with suppliers, partners and customers. This

technology allows the needs of projects that require rapid response and coordinated execution to happen.

QuickPlace can help you synchronize team deliverables, discussions, and content, while overcoming the constraints of time and distance. This can lead to increased productivity and reduced travel costs.

Lotus Sametime brings the flexibility and efficiency of realtime communication to the business world. The Sametime family includes the Sametime Server, the Sametime Connect client, and a range of application developer tools. Lotus Sametime merges Web server, Lotus Notes, T.120 data-conferencing and online awareness technologies to allow Lotus Notes and Web browser clients to participate in live, interactive, online meetings, instant messaging and group chat sessions.

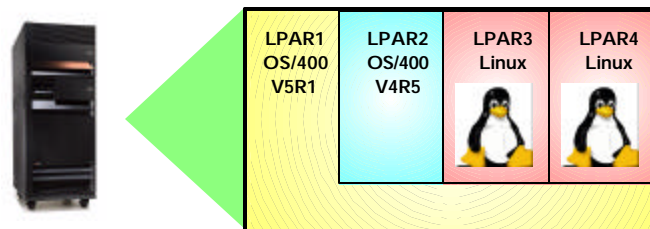
Awareness of other online users is the cornerstone of Lotus Sametime. By knowing who is using the system, users can communicate in many ways, from one-on-one instant messages to virtual meetings. Sametime also provides live document and application sharing. The foundation of Sametime collaboration on the iSeries is — awareness, conversation, shared objects, enterprise-wide security, scalability and management control.

Linux

Linux is seeing rapid growth in popularity as an open platform for deploying application development tools and IT solutions. iSeries has been enhanced to offer support for PowerPC running in secondary logical partition [using either a shared or dedicated processor of OS/400](#) allowing you to extend and enhance your solution suite with Linux applications. More details and new information can be found at the Linux for iSeries web site at ibm.com/series/linux.

To enable Linux to run on iSeries, IBM has been working with the Linux community. IBM has made contributions to the open source 32-bit Linux 2.4 version to enable it to run on PowerPC which encompasses both iSeries and pSeries [systems. The 64-bit linux kernel is under development.](#)

OS/400 continues to offer customers flexibility and consolidation by providing a Linux environment on selected [270, 820,830,and 840 iSeries](#) models. On some models, Linux can share a processor, while on others, a dedicated processor is required.



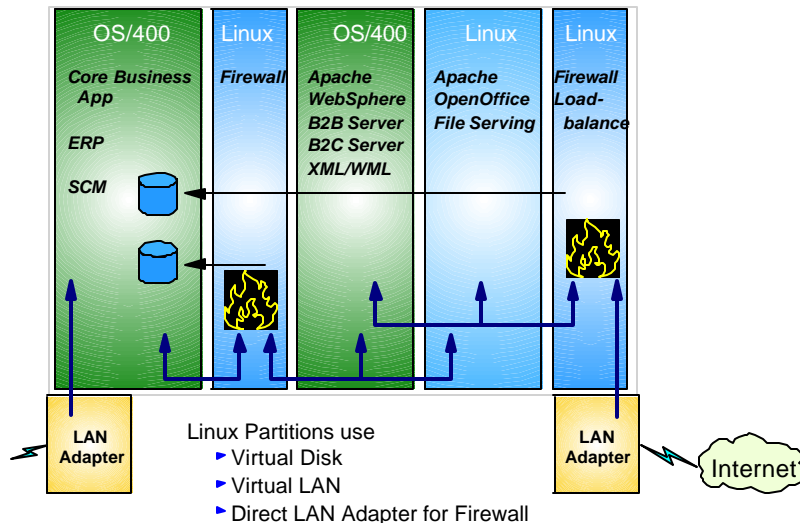
With the flexible partitioning, more resource sharing can be achieved for customers, and iSeries management concepts can start to be applied to Linux environments. The individual Linux servers, each in its own partition are able to share processors, disk, tape, CD-ROM, DVD, and LAN resources with other applications and servers running on iSeries. Up to 31 separate Linux servers can be supported on an 8-processor 8xx system. iSeries provides virtual I/O (like the familiar Network Storage Space) through which Linux servers can share the disk and other devices

attached to the base partition, as well as direct I/O for which a Linux server controls the device directly attached to its partition using a PCI connection.

Linux applications that will run on iSeries will be sourced from many areas. Part of the Linux culture is often working with open source. As a result, much of the tools discussion involves what is available from the Linux software distributions and from the web. The Linux system itself is sourced from one of the Linux software distributions or can be compiled for PowerPC by an ISV or customer as is often done in the Linux environment. Many tools are also available with the software distributions, especially with the “professional” versions. Development tools are available from the open source community, many from the GNU Project and other web sites. These kinds of tools can be downloaded and compiled for PowerPC. To enhance productivity, there are two prevalent Linux graphical user interfaces, KDE and GNOME. There are two frequently used distribution formats, RPM and Debian.

In creating new Linux applications, the developer uses Linux on iSeries just as it would be used on other Linux platforms. Native PowerPC compiler can be used on a PowerPC workstation or on iSeries. Native compilers are most easily obtained with the software distributions. There are also cross-compilers available for Intel systems that generate PowerPC code.

The new solution parts built for PowerPC can add valuable complements to current OS/400 solutions. Linux applications can communicate with OS/400 ILE, PASE, Java, Domino, Windows 2000, and other applications through existing communications protocols.



Initial Linux application access to database will be available via JDBC. Files can be shared using NFS, with care taken to identify users consistently between Linux and OS/400. In the figure above, LPAR is leveraged to support numerous operating environments on one iSeries server. Typically environments like firewalls and Internet servers are installed on their own servers. So what the iSeries can support on one server, a competitive environment could require five different servers.

OS/400 Services and Middleware

In addition to the various application environments just discussed, OS/400 includes many important, integrated features such as security and support for DB2 UDB database functions. On most other platforms, such features are purchased separately and are thus considered “middleware” components. In addition, OS/400 supports functions that facilitate communications and the moving and processing of data across disparate platforms with disparate applications. These functions provide an abstraction layer, common across platforms, that delivers consistent

interfaces to key enterprise application services. OS/400 support for cross-platform applications ranges from common services, such as data access (that is, [ODBC](#) and [JDBC](#)) and communications ([TCP/IP](#)) to complex cross-application operations, asynchronous messaging/queuing, distributed objects and more. Separate middleware products, such as MQSeries, further extend iSeries runtime environments by providing cross-language and cross-platform APIs that can be used to build distributed and portable applications. The following sections describe some of the most important OS/400 features and middleware products available on iSeries today, as well as future trends in this arena:

- ✍ [eXtensible Markup Language \(XML\)](#)
- ✍ [Web Application Servers](#)
- ✍ [Lotus Domino](#)
- ✍ [Enterprise JavaBeans](#)

eXtensible Markup Language ([XML](#)) XML is a hot technology and is being used to greatly simplify Internet commerce. XML defines a format for describing information that is both platform- and application- independent. It's particularly useful for B2B applications that require tying together different applications from different sources, and making database content available anywhere. XML will likely become the predominant way businesses move data between systems because it will provide for data portability what Java has delivered for code portability.

There are many ways XML can be applied today to solve business problems. In some situations, XML will be used as a replacement for HTML, leveraging XML's ability to support very precise, context-based searching of Web information and the ability to define multiple views for Web data using [eXtensible Stylesheet Language \(XSL\)](#) stylesheets. XML will be a popular technology choice for data interchange — between two different applications and between two companies conducting business transactions. In general, XML will be used in a wide range of applications — anywhere information needs to be represented in a standard, reusable and platform-neutral format.

iSeries already supports use of XML today in several ways:

- ✍ A number of key building blocks used to construct XML-based solutions are an integrated feature of OS/400 starting in V5R1. These enablers; XML parsers and XSL stylesheet processors, are key components of most applications that work with XML. A set of procedural language (eg RPG, COBOL, C) interfaces are also provided for XML parsing, making it possible to extend existing solutions with XML technology.
- ✍ XML Extenders for DB2 UDB on iSeries provides a mechanism to exchange data between XML and relational database format. XML Extenders support storage of XML data in DB2 using one of two different models. XML Columns are used to store a complete XML document in a column within a database table. XML Collections are used to map individual elements and attributes of an XML document to separate columns across one or more database tables.
- ✍ WebSphere Application Server includes a Java parser for XML, the LotusXSL processor for handling XSL stylesheets and a library of commonly used XML Document Type Definitions (DTDs).
- ✍ The IBM Toolbox for Java includes two tools which exploit the strengths of XML ...

- Tools based on [Panel Definition Markup Language \(PDML\)](#) use XML as an abstract way to define GUI structure and content. The PDML toolset includes a visual GUI builder, a tool to convert Windows GUIs to PDML, and a runtime which generates a Java GUI from PDML. (PDML insulates the application from changes in client GUI technology.)
- [Program Call Markup Language \(PCML\)](#) uses XML to describe an iSeries program interface. This definition is used at runtime to simplify the task of calling iSeries programs from Java, handling conversion between Java data types and those used in the called program.

NOTE: Both PDML and PCML are proven technologies. They were used extensively to build recent Java component additions to the OS/400 Operations Navigator.

The future of XML on iSeries is focused on enabling end-to-end use of XML within applications. This includes the ability to provide an XML view of existing applications and data via enhancements to products, such as DB2 UDB, [WebSphere Host Publisher](#), and MQSeries. Once in XML format, the data will be delivered to a wide variety of consumers as part of both business-to-consumer and business-to-business scenarios. XML enables information to be generated once and used in a diverse number of ways — from driving the growing number of thin clients and tier 0 appliances (such as Palm Pilots) to interaction with other servers and smart agents using XML as the foundation for commerce on the Internet. (See figure 18.)

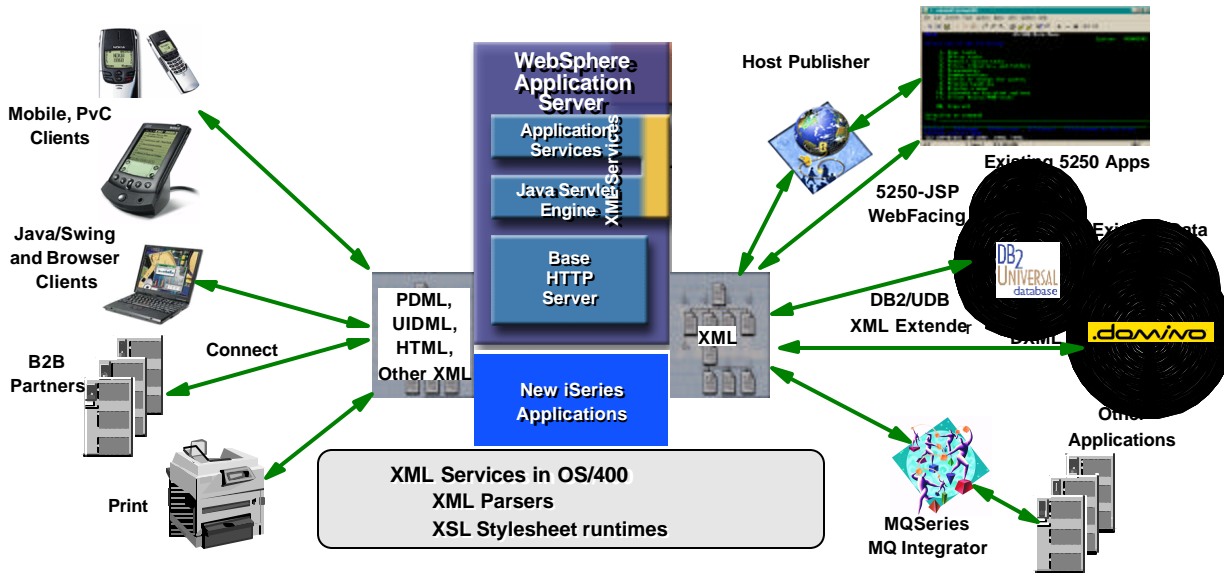


Figure 18: Pervasive use of XML across all aspects of an IT solution.

Web Application Servers

Web application servers provide an easy way to develop n-tier, distributed e-business applications. The infrastructure required to support these applications (e.g., communications support, security, data access, transactional context) is provided by the application server software. This allows programmers to work at a more abstract level, yielding faster solutions to business problems and less time spent on low-level programming details. Most application servers provide support for Web-centric application models, such as HTML/CGI for basic

Web serving, servlets/JSPs for simple Web serving utilizing Java and [Enterprise JavaBean \(EJB\)](#) support for the distributed enterprise application environment.

Another key value these application servers provide is “connectors” to existing core business application systems. These connectors provide access to the existing business assets that allow a strategy of coexistence and gradual transition to the new application models and environments. This helps enable the much lower risk (and cost) of an evolutionary approach to the new technology versus that of the revolutionary approach which involves re-engineering and building the next business systems from scratch.

[WebSphere Standard Edition](#) and [WebSphere Advanced Edition](#) are available on iSeries. If you are writing applications that use [Java server pages](#) or Java servlets, the standard edition should serve your needs. However, if you are using Enterprise JavaBeans, you'll want to use the advanced edition. There are also several complete application servers with an iSeries integration focus that are provided by key iSeries partners. Find out about these at the [iSeries 400 Tools Network](#) Web site.

[Lotus Domino as an Application Server](#)

By delivering the power and flexibility of [Lotus Notes](#) to any user with a Web browser, Lotus Domino has become a premier interactive Web application server. This means you can use Lotus Domino to build and host Internet/intranet sites. Lotus Domino utilizes Internet standards and protocols, along with powerful application development facilities so that any Web client can participate in applications securely. Lotus Domino technology is excellent for Web publishing, Web browsing, and Internet/intranet applications. Its replication, authentication, messaging and security services are integrated with Internet protocols. And, since Lotus Domino is cross-platform, it is a great choice for extending business applications to the Internet

[Enterprise JavaBeans](#)

Java defines the JavaBean component model to enable construction of class libraries that are easily manipulated by application development tools from different vendors. Enterprise Java extends the JavaBean component model to server components, called Enterprise JavaBeans (EJB), which are built on a set of enterprise Java services. These extensions allow components to participate in enterprise application services, such as transactions, database persistence, security, etc. EJB components execute on a server within the context provided by a container. The container provides management and control functions to the component, isolating it from the low-level operating system processes and threads. Containers are necessary for EJB and can be provided by Web application servers.

The diagram below (figure 20) illustrates the container abstraction layer, which provides the infrastructure and standard component architecture for building distributed object-oriented business applications in Java. Programmers can develop business logic and be shielded from the complex, changing systems infrastructure (i.e., they do not have to be “sockets level” coders). EJB is the strategic component model for server-side business logic. Although still maturing, EJB is the long-term application model for distributed enterprise-level business applications for iSeries. [WebSphere Advanced Edition](#) provides EJB support for iSeries. In addition, several partner products provide EJB support on iSeries. You can find out about these by visiting the [iseries 400 tools network](#) Web site.

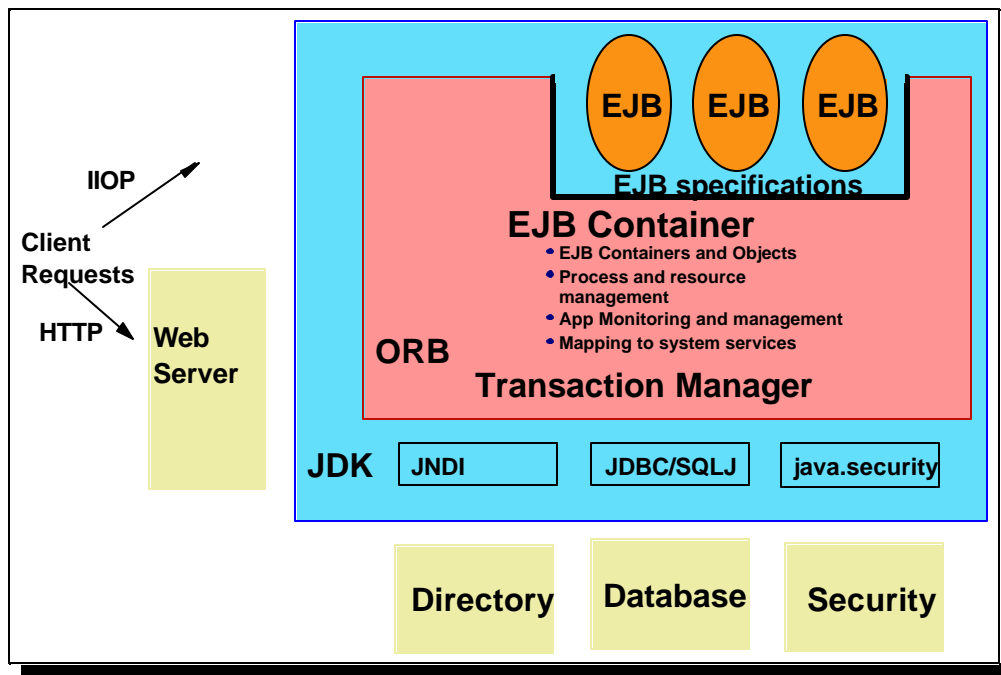


Figure 20: EJB runtime provides a comprehensive suite of services.

Database — DB2 Universal Database for iSeries

An application cannot provide real value without presenting business data or accumulating new information. Data about customers, products, and services can be one of the most important assets in an organization. iSeries values business data so much that it features a functionally rich, integrated, relational database (DB2 UDB). DB2 UDB also includes a standards-compatible SQL interface and its own native non-SQL interface for database processing. Due to the integrated nature of the database, however, these two different interfaces are completely interchangeable. Database objects created with the native interface (i.e., Data Definition Specifications, or DDS), for instance, can be accessed by a Java application using an SQL-based interface such as [JDBC](#) or [SQLJ](#), without requiring that object to be converted or recreated. This unique database architecture allows solutions to evolve by embracing the latest, standard database technologies. IBM is one of the leading database companies and has a large number of patents and technologies that are shared and incorporated into DB2 UDB products on all IBM server platforms.

Features such as constraints and triggers allow for the integration of some simple business rules and processes into the database itself. This integration allows the reuse of these business rules and processes across all your applications. For example, a new order placed from a Tier 0 device or a Web browser would cause the same database referential constraints and check constraints (e.g., order quantity > 0) and triggers (e.g., notify shipping company of upcoming delivery) to be processed. This type of encapsulation also makes it easier to deploy multi-tier applications. Stored procedures are another key database feature that supports multi-tier applications. Just like triggers, DB2 UDB stored procedures can be written in any language supported on iSeries— SQL, Java, C, RPG, etc. This flexibility makes it easy to develop new procedures as well as reuse existing applications and programs. Stored procedures can be called locally or remotely — so as the architecture of your application changes, the stored procedure call remains the same.

SQL is now firmly established as the de facto industry standard for data access. This acceptance is exemplified in that almost all mainstream application and middleware technologies feature an SQL-based interface for data access, ranging from [SQLJ](#) to [DECS](#)

to ODBC. SQL is also the strategic database interface for iSeries. This SQL-based strategy is reflected in that almost all database performance enhancements and new database features, such as DB2 XML Extenders (need to make hyperlink to XML Extender page) and Datalinks), are only available to SQL-based interfaces.

While widespread industry acceptance has made it easy to use SQL on any server, developers should be aware that each SQL engine has its own unique performance personality. A thorough understanding of the engine and query optimizer is required to deliver a high-performing, SQL-based solution. For iSeries, this knowledge is best obtained by attending the DB2 UDB for iSeries SQL and Query Performance Workshop offered by [IBM Learning Services](#). As an alternative, you may want to review two recently created [Internet-based education courses](#): “SQL Coding Techniques” and “SQL Performance Basics.”

Integrated File System

Unlike most computer systems that support a single type of file system, iSeries advanced technology allows for the simultaneous existence of many types of file systems. As you can see from the chart below (figure 22), it can store PC files, UNIX stream files, iSeries relational data, HTML page, images and a variety of other objects in their “native” format. This means that applications running on a wide range of clients can access data on a single server without complex device drivers or other intermediate interfaces. The data in these file systems can be accessed by applications running anywhere within iSeries as well as from client applications.

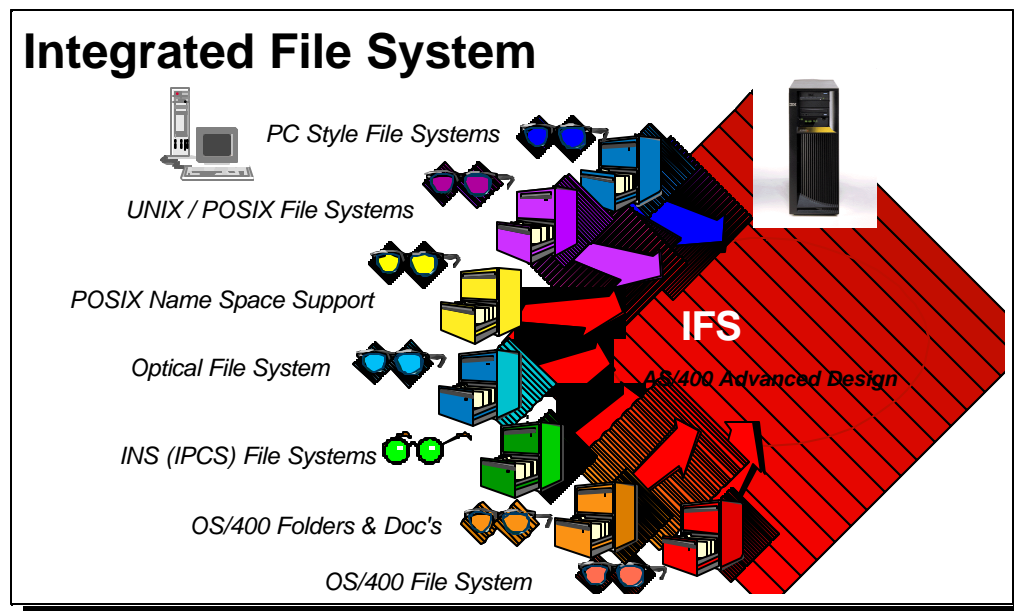


Figure 21: The integrated file system on iSeries supports many file systems, data objects and program objects.

A UNIX application executing in the OS/400 Portable Application Solutions Environment can access and share the relational data normally accessed by an RPG application running under traditional OS/400 services. A Windows 2000 client server application could use PC files stored in the Integrated Netfinity Server as well as iSeries relational data via OLE/DB. Since these objects are all managed by OS/400, a single backup and restore policy can be implemented.

MQSeries

[IBM MQSeries](#) is a family of message-oriented middleware products that help organizations build new applications and leverage existing applications, across different communications protocols, hardware platforms, operating system platforms, and programming languages. It is a leader in providing a scalable, robust application enablement environment for supporting a variety of business integration requirements.

MQSeries provides a firm foundation for building and deploying robust, state-of-the-art, business integration applications. As of December 2000, MQSeries version 5.2 is the current release on the various platforms and is available on OS/400 V4R4 and later releases. It provides enhancements in performance, availability, and scalability to the already rock-solid iSeries implementation of this middleware product.

MQSeries provides a common programming API to shield business application developers from complex, low level "plumbing" and allows them to focus their efforts on high value add, business process and application integration. MQSeries natively supports a variety of programming environments - ILE C, C++, COBOL and RPG, as well as Java, and LotusScript, making it easy to integrate into your development environment. MQSeries takes advantage of OS/400 services such as journaling and commitment control, and can be administered via CL commands or MQSeries internal system management functions.

MQSeries for iSeries is also well suited to support Web-oriented, e-business applications. The MQSeries Java classes for iSeries, a free Internet download, allows any iSeries (at V4R2 or later) to connect to any MQSeries queue manager residing on the same system, another system, or any other MQSeries-supported platform, and to participate as an MQSeries client application that can send and receive messages. An MQSeries client application can also be deployed as part of a Java servlet or Java Server Page in conjunction with WebSphere to help Web-enable your host-based application infrastructure. With MQSeries 5.1 (or later) for iSeries there are also native Java language bindings that utilize the Java native interface (JNI) to provide a fastpath between your Web applications and MQSeries queue managers residing on the same system.

MQSeries Integrator builds upon the base MQSeries messaging capabilities and helps reduce cost and complexity in advanced, large scale environments such as B2B application integration. Integrator uses a formatting engine that allows you to define message types (input and output messages, character data, numeric data, etc.) and a rules component that allows messages to be analyzed, decomposed, reformatted, and routed based on business logic. These two components work together to enable incoming messages to be evaluated, transformed, and routed appropriately without requiring complex programming. MQSeries Integrator is available on iSeries systems at OS/400 V4R3 and later releases.

Two additional MQSeries enhancements have also recently been made available to assist your MQSeries development efforts. The MQSeries Application Messaging Interface (AMI), a free Internet download, allows developers to more easily build applications by moving message handling logic into the middleware. This enables developers to focus on the business application logic, and allow common message delivery service and policy rules to be abstracted into a repository. This is supported for C, C++ and Java applications. The MQSeries Adapter Offering (MQAO) enables integration of 'non MQSeries enabled' applications. It consists of a developer toolkit which imports application interfaces such as C

header files and XML DTD's, and expresses them in a common XML format. It also has a runtime kernel which utilizes MQSeries to reliably deliver messages between applications and perform the necessary data translations. Both the AMI and MQAO are available on the iSeries, with MQSeries 5.1 or later releases.

Application Development Environment and Tools

Middleware and system-provided enablers provide the runtime foundation for today's applications. Equally important are tools which enable new applications to be developed and which provide extensions to existing applications, in order to react quickly to ever changing business requirements. iSeries benefits from a large number of IBM and third-party provided tools that simplify the task of building modern, mission critical applications which exploit the latest in application technologies. Let's take a look at some of the application development facilities that are available for creation and maintenance of iSeries applications.

WebSphere Development Tools

, IBM has did a major shift in the packaging of IBM application development tools for the iSeries server. Rather than continuing to sell individual tools and compilers, this package consolidates all the key iSeries development tools, both host and workstation, traditional and new, into one convenient, integrated, and attractively-priced iSeries offering. The new suite is a no charge upgrade from any of the IBM iSeries AD tools with software subscription. It is used to create web-enabled, e-business applications.

: [WebSphere Development Studio for iSeries](#). will support e-business application development by offering an open standards-based product that supports the programming language technologies available on iSeries. The package includes many existing host-based tools such as [Application Development Tool Set \(ADTS\)](#), ILE RPG, ILE COBOL and ILE C/C++. Also included are workstation-based tools such as [WebSphere Studio](#), [VisualAge for Java](#), [Code/400](#) and [VisualAge for RPG](#). Finally, WebSphere Development Studio features new tools that can be used to build Web-based interfaces for OS/400 5250 applications. This new tools package is designed to address three types of development projects: building new e-business applications, porting e-business applications from other platforms, and extending existing 5250 applications to the Internet. To address the needs of developers involved with such projects, IBM continues to enhanced several existing products that are components of WebSphere Development Tools. For example, [WebSphere Studio for iSeries \(Professional Edition\)](#) has support for iSeries subfiles and iSeries data types to provide easy access to iSeries data and applications. It contains Web palette parts to generate standard HTML and Java Script plus includes entry field with validity checking and edit code support, including, wizards to generate a functional Web user interface. Also, VisualAge for Java is integrated with [Enterprise Toolkit/400 \(ET/400\)](#) to facilitate writing Java applications for iSeries and to make it easier to port Java applications to iSeries.

A central component of WebSphere Development Studio is a new Web-facing tool that will convert a 5250 interface to a Web GUI interface with minimal changes to the host application. This new Web-facing solution will intercept application data prior to 5250 data stream generation, avoiding the overhead of GUI solutions that first require the creation of the 5250 interface and then the execution of a corresponding [screen scraping](#) effort. It converts, at development time, the display file source into JavaServer pages (JSPs) and Java data beans. JSPs and beans are deployed to the WebSphere Application Server (WAS) while requiring little change to the application's business logic. There are no separate tool costs or runtime charges.

Extensions and customizations of the Web application from the Web-facing tool will be addressed with [WebSphere Studio](#) and VisualAge for Java. The Websphere Development Studio tools are available for rapid and cost-effective application development efforts. For more information on WebSphere Development Studio Tools, you can visit the iSeries [Application Development](#) home page.

Business Intelligence

Business intelligence (BI) involves the gathering, management and analysis of historical data for the purpose of finding ways to more effectively compete in a global marketplace. It provides the quantitative basis for strategies that change the way a company does business. iSeries business intelligence applications are a blending of highly optimized tools and services from IBM and its partners for: data replication, data warehouse/data mart creation and management, query and reporting, analytical processing over historical data, data mining and Web integration/enablement. These tools and services provide the means to change raw data into information which can be used to make effective business decisions. It can be used to define things such as “who the best customers are?”, “what the most profitable products are?”, “when are the best times to promote or discount specific lines of merchandise?”, and “which items make the most sense to cross sell to the impulse buyer?” Management can then make more informed strategic decisions about which markets to enter, how to select and manage key customer relationships, and how to select and effectively promote products — all in an effort to increase profitability and market share.

IBM's years of experience point to a three-tiered, data-warehouse architecture as one of the quickest enterprise-wide solutions to implement and one of the most extendible. Implementing a three-tiered structure right from the start provides a mechanism for data and application sharing and, therefore, a more rapid implementation of subsequent data marts. This architecture involves extracting data from the operational databases and then transforming and cleansing this data into a single data warehouse environment. This warehoused data is then used to build one or more specialized data mart applications to support different business functions.

iSeries and DB2 UDB provide excellent support for both data marts and data warehouses and can scale to support any size of database, from the very smallest up to 128 Terabytes. [DB2 UDB](#) has been recently extended with a rich set of universal database functions that enhance its data warehousing capabilities. These functions include: Complex Objects, Data Links, [Blobs](#), User Defined Functions, User Defined Types, EVI (Encoded Vector Index) and Parallel Data Loader.

Smart Management of Your e-Business Environment

As you move into the e-business world, effective management of applications and data is critical. The iSeries server has systems management tools that are designed with a wide range of key management functions, many of which are integrated into the operating system. In addition to operational controls, OS/400 provides a long list of built-in and integrated functions, such as, security, user administration, database administration, performance monitoring, workload management, message management, configuration functions, storage management, problem handling and much more. [Operations Navigator](#), a free component of OS/400, provides an intuitive graphical user interface to perform these functions for managing your system.

[Management Central](#), a component of Operations Navigator, extends these management capabilities to groups of systems, with the same simplicity of managing a single server. Key functions of interest to application developers include the ability to:

- ✍ Automatically distribute objects and files to a group of iSeries servers. This is useful for deploying new and updated applications to targeted servers in your network.
- ✍ Schedule commands remotely. This enables you to set up commands relative to your application and schedule them to run across a group of systems.

In today's rapidly changing world, iSeries users are faced with new challenges. They're moving their businesses to the Internet, expanding their networks, and merging into larger, heterogeneous networks. Additional functions are needed to manage these more complex environments. IBM continues to enhance Management Central. In addition, other systems management options are available from IBM, Tivoli, and key iSeries systems management partners. (You can see from the chart below, figure 23, that there is a complete set of management offerings to suit your needs.) For more information, see <http://www.ibm.com/servers/eserver/iseries/sftsol>.

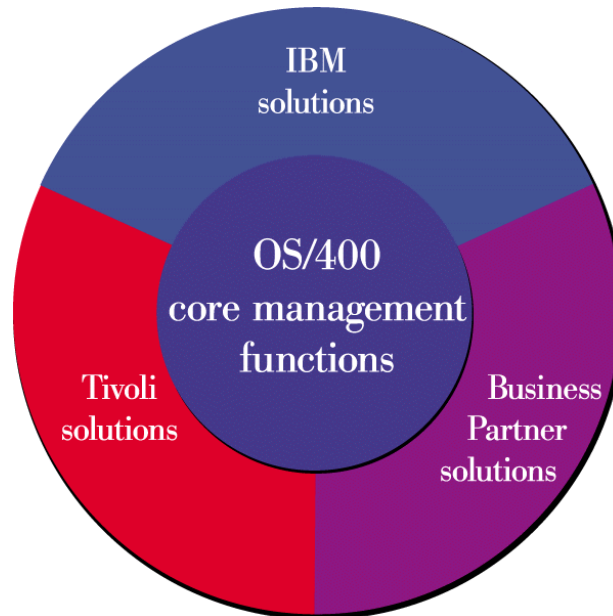


Figure 22: iSeries offers many options for managing your IT environment.

Tools Network

Application Development is key to the future of any software developer. As you can see from the scenarios described in this white paper, customers and solution providers must be able to create new and extend existing applications in ways that take advantage of all of the latest iSeries technologies such as:

- Business-to-Business and eCommerce tools and solutions
- Graphical User Interfaces (GUIs) via a PC form based GUI or browser
- The World Wide Web / Internet
- Integration with Lotus Notes running natively on iSeries
- Transition to Java and the world of Object Oriented programming
- Business Intelligence
- Cross-Platform application and data integration
- Application development and deployment

Some application development staffs prefer to work with low level tools to provide these new interfaces. Others would prefer to use higher level development tools to accomplish the desired

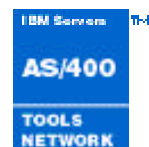
result. Some customers and solution providers are more aggressive than others when it comes to adapting new technologies, but all need enablement resources and tool options in order to get the products to the marketplace as fast as possible at the lowest possible cost.

The [iSeries 400 Application Development Tools Network](#) was created to help developers identify modernization strategies they can adopt to achieve their application development goals as well as help them identify the best tools available for the development challenges they face. Tools Network's other main task is to recruit tool providers that have state of the art development tools that should be added to the tool set available to iSeries customers and partners. .

In addition to IBM products described in this white paper, a wide range of non-IBM application development tools are available to customers and business partners for developing applications. Today, more than 125 tool developers are part of the Tools Network providing over 450 tools and middleware products. [Application Development Tools Network](#) web site makes it easy to find the tool(s) or middleware that meet the solution developer's requirements by categorizing and positioning them in six application modernization strategy types. The products are further divided into subcategories that help narrow a specific tool search.

- ✎ [Application ReFace/ReDesign](#) — Tools that are used to move to a more modern design for applications to take advantage of OS/400 features, such as ILE and DB2 UDB or to put a modern graphical interface on existing applications. This category also contains programmer productivity tools that help programmers create, modify or maintain applications.
- ✎ [Business Intelligence](#) — Tools for in-depth analysis of historical corporate data to turn it into meaningful business information that can be used to make strategic decisions.
- ✎ [e-Business/e-Commerce](#) — Tools that help extend core applications to the World Wide Web — as simple as a classic shopping cart, or as complex as an end-to-end integrated application from supply chain management(SCM) to customer resource management (CRM). This strategy also includes tools that deliver applications hosted on iSeries servers to pervasive computing devices.
- ✎ [Cross-Platform Integration](#) — Tools to help you create and manage applications that have to interoperate across a variety of server platforms and clients. Tools in this category include application generators, GUI builders, and application reface.
- ✎ [Lotus Notes/Domino Integration](#) — Tools to create new collaborative applications with Lotus Notes or integrate Notes clients with existing iSeries applications. This category includes tools such as e-commerce solutions and OfficeVision/400(OV/400) migration tools.
- ✎ [Systems & Application Management](#) —Tools for managing systems and controlling the application development process. Subcategories include tools for performance, security, scheduling, software distribution, and many application related tools.

The complete tool matrix, along with definitions and detailed [tool whitepapers](#) are available on the [iSeries Tools Network](#) Web page. To see how real customers and integrated solution vendors (ISVs) have used the tools in the Tools Network Program to successfully modernize their applications, click on ["Success](#)



[Stories.](#) The Tools Network team is available to you to help with tool selection and evaluation.

Deploying iSeries Applications

Many of the application technologies described here are not unique to iSeries, but can also run on a number of other platforms. This gives the solution provider and user organizations a lot of flexibility in how they deploy IT solutions, being able to choose a platform with the best combination of cost, performance and reliability to meet their own specific requirements. This is also good for iSeries since it enables a very large number of solutions to run on iSeries. However, it also places iSeries in a competitive environment where businesses, as well as application solution providers, will consider multiple platforms. So the natural question is, should they deploy their solution on iSeries?

The answer is a resounding “yes,” given the unique combination of technologies available plus the robust and scalable nature of the platform. In particular, iSeries receives high marks in the following areas:

- ✍ **World Class Reliability.** In a 24x7x365 world, companies cannot afford downtime to their core IT solutions. Downtime means lost revenue. A percent or two difference in system availability can translate into hundreds of hours of downtime; something most of today’s e-businesses cannot afford. Study after study shows that iSeries scored very high in system reliability surveys; being down only a small handful of hours on average per year, while other platforms experience much poorer reliability. Independent studies have not yet been completed for iSeries, however, internal IBM measurement indicates an even higher level of reliability and availability anticipated with iSeries.
- ✍ **Incredible Scalability and Product Line Breadth.** Another key advantage iSeries has over other platforms is the large range of product capabilities represented between the low and high ends of the product line. This is great news for companies which start small and grow rapidly; a common phenomenon in today’s e-business environment. With iSeries, companies can run the same solutions on the same platform architecture as they grow from small startup to large enterprise. (See figure 24.)

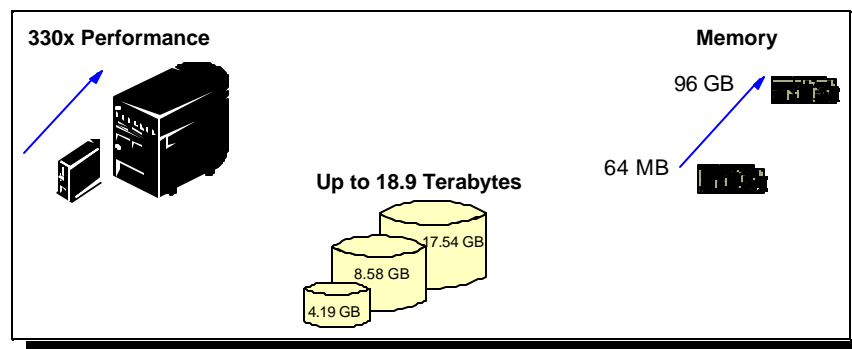


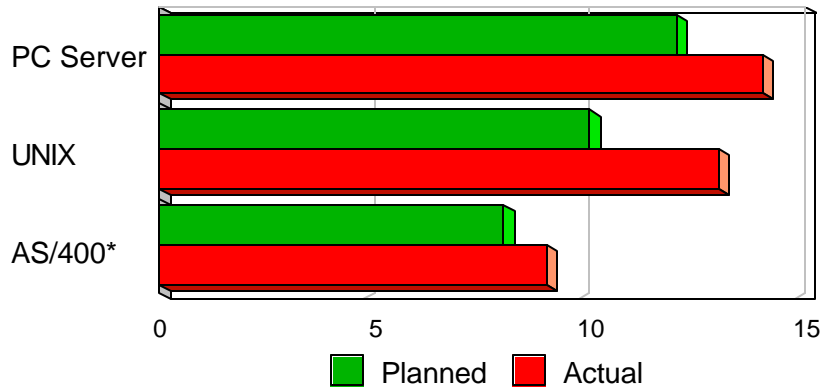
Figure 23: iSeries product breadth spans the low and high ends of the business market.

- ✍ **Extreme Application Performance.** As demonstrated with the latest Java VolanoMark benchmark results, iSeries excels in its ability to scale to extremely large workloads while still delivering very good response times. At the time of this writing, iSeries held the number one position in Java server benchmarks ([VolanoMark](#) and [SPECjbb](#)), as well as

Lotus Domino and TPC-C benchmarks; a performance statement that underscores the iSeries focus on highly scalable e-business solutions (see the Volano performance chart shown earlier in this white paper).

- ✍ **Ease of Use.** Like its predecessor, the AS/400 is very easy to use. The following chart is evidence of the strong heritage iSeries is based on (see figure 25).

You can deploy AS/400 faster



Source: Meta Group ERP Open Platforms-Real Cost of Ownership and Implementation Time Study, 1999

Figure 24: iSeries Application deployment is fast.

- ✍ **Cost of Ownership.** iSeries offers one of the lowest total cost of ownership server solutions on the market today.
- ✍ **Multiple Concurrent Application Environments.** iSeries offers logical partitioning, as well as a Java native machine (JVM), OS/400 Portable Application Solutions Environment (OS/400 PASE), native Lotus Domino, and Linux, and you can expect this to grow. Application sharing is extremely flexible, too, occurring at both the database level and the program-to-program level.

How to Get Started

The elusive “standard” getting started formula

It is impossible to “prescribe” a definitive road map or plan that would work for every situation. Each application and each application provider has a unique set of issues to deal with, including:

- ✍ The state of the application itself (well architected, well structured, maintainable, current and competitive, etc.)
- ✍ The state of the skills within the developer organization (for example: strong domain knowledge, clear understanding of current application, excellent background with emerging technologies, such as object-oriented design and Java)
- ✍ The state of the business (including the ability to take risks and the time and the money to invest in application development)

Bearing in mind that each business is unique, the following paragraphs offer guidance.

Transforming Existing OS/400 Applications

Applications written for an AS/400 were RPG-based, possibly with some COBOL and C/C++ programs. Although a growing percentage of these applications are moving to ILE, the majority still utilize the original program model (OPM). Whether OPM or ILE, these RPG applications are tightly integrated to DB2 UDB. Common application models are host-centric with 5250 terminals or client/server with Windows clients. The first steps many application developers have taken has involved one or more of the following:

- ✍ Extend their applications to [embrace GUI technology](#).
- ✍ Move to ILE for performance or for restructuring and modularizing.
- ✍ Complement RPG applications with 4GL generators that allow programmers to stay at the business level of developmental efforts, while still generating native code in C/C++ or Java.

Embracing ported application sets

In addition to the modernization of existing applications, installations have access to an ever-increasing portfolio of applications that are being ported to iSeries from other platforms. Sources for these new applications include UNIX solutions, most often written in C or C++, Windows solutions, most often written in C++ or Java, and Lotus Domino applications, predominantly from the Windows NT platform.

Of these applications, those that already use a relational database are transferred to DB2 UDB as part of their porting efforts. Often, after being ported through a rather routine process, these applications are being extended to add more integration with existing OS/400 facilities so as to meet user expectations or to cooperate with existing iSeries data or legacy applications upon which users have come to rely. [Applications \(Porting\) Factory](#) is available for consultation.

Where can you turn for advice?

- ✍ [PartnerWorld for Developers](#) — This worldwide organization has support offices around the world. Its mission is to provide the conduit for application developers to get whatever they need to accomplish their various developments missions. This organization provides training, partnering relationships, directional advice, and much more. References to their hundreds of Web sites are visible throughout this document.

- ✍ **User groups** — [COMMON](#) is a worldwide user's group that sponsors conferences, training seminars, certification, and much more. COMMON is very much a participant in the effort to assist its members in their modernization efforts.
- ✍ **Training seminars, conferences, classes and videos** — Partners in Development offers live, instructional [classes and labs](#). IBM also offers [Technical Institutes and conferences](#). Midrange Computing offers [video training sessions](#). You can also participate in [symposiums](#), [Lotus Domino Days](#), [Application Enablement Satellites](#), and much more.
- ✍ **Web-based iSeries Seminars** — The PartnerWorld for Developers web seminars are live, online events dealing with strategic solution architecture issues.
- ✍ **IBM and Tools-provider co-sponsored road shows** —
- ✍ **Trade magazines** — *AS/400 Magazine*, *News/400*, *Midrange Computing*, *Midrange Systems* and *The iSeries Group* all provide excellent sources for information, tips, downloadable code, and success stories related to application modernization.
- ✍ **Platform-related newsletters** — This list is long, but here's a sampling: [IBM PartnerWorld for Developers newsletter](#) (trimester); [Lotus Domino Groupware](#) newsletter;.. Visit these hot links to find out about subscriptions.
- ✍ **Services Network** — This handy Web site can be a very quick jumping off point for finding specific technologies, such as CRM, high availability, etc.
- ✍ **iSeries e-Business Competency Center** — This team of IBMers, operating out of Rochester, Minnesota, is eager to assist organizations in recommending and validating design approaches that best fit a particular environment. These experts can offer advise regarding the various implementation services that are available. They can also answer complex technical questions related to application modernization technologies, such as: the design, installation and programming of a WebSphere Commerce site; Net.Data programming and consulting; and input related to Java, JSPs, EJBs and C++ programming.
- ✍ **iSeries Global Application Delivery** — Located in Rochester, Minnesota, this organization offers fee-based, leading-edge iSeries solution development services. The Global Application Delivery team can help companies of all sizes resolve real business problems and create new business opportunities.
- ✍ **iSeries Product Support Services** — This Web site provides quick hot links to many developer resources and support services.
- ✍ **IBM Custom Technology Center** — part of the IBM Rochester Laboratory, this group provides iSeries users with consultative input related to solutions that can meet their business needs in regard to: Internet and intranet applications (including WebSphere); native Java programming; native Lotus Domino solutions; application porting assistance; client/server development (including Network Station); database applications; TCP/IP and Sockets application development; advanced technology implementation; and RPG, COBOL, ILE C Programming.
- ✍ **Rochester Customer Solution Center** — This IBM group provides customized system solutions for iSeries, pSeries, RS/6000, and other IBM/OEM equipment. You can utilize their services to acquire and manage the resources necessary to integrate diverse hardware and software from multiple suppliers and install these into multiple locations for your application modernization and Web enablement needs.

[Services Marketplace](#) — IBM has a Web-based services e-marketplace designed specifically for iSeries customers and suppliers. Working with eLance.com, the world's largest online services marketplace, IBM has created an electronic forum where businesses can post and bid on a wide range of consulting services and applications.

- ✍ **[Tools Network](#)** — This IBM group promotes a set of premium quality iSeries application development/deployment tools to help customers evaluate, select, and utilize these tools to maximum effect. To some extent, the Tools Network should be seen as a Better Business Bureau for iSeries AD tools.
- ✍ **[White papers](#)** — There are so many white papers on the various iSeries Web sites. And, there are even more on the Web sites of our Business Partners. In particular, there is a very relevant [DH Andrews report](#) on iSeries Application Modernization Strategies that is a good source of information on predominant modernization approaches.
- ✍ **[International Technical Support Organization \(ITSO\)](#)** — This organization has the mission of developing Redbooks and Redpieces. These are an incredible resource for Web enablement, including the meticulous how-to mechanics. You may even want to consider participating in these efforts through a residency... An excellent way to get up-to-speed on a particular technology.
- ✍ **[The University](#)** — and its many education partners continue to make education and services available to complement iSeries development. The University's direction is to provide education that is needed by the application developer. Having the right skills curriculum, coupled with the right tools, increased productivity and results in a positive return on investment.
- ✍ **[Partners in Education](#)** — This unique IBM team works hand-in-glove with universities and colleges, along with Business Partners and large IT shops, to establish complete training curriculums related to iSeries. These courses might be of interest to your IT staff as you move full steam into your application modernization efforts.
- ✍ **[IBM Learning Services](#)** — This IBM organization helps you solve training problems by building the right skill levels within your workforce to support your IT projects. They accomplish this through standardized and customized classes, and are ready to help you with your assessment and certification needs.
- ✍ **[Computer-based training](#)** — is available through Internet-based education courses, Internet-based presentations, and CD offerings.

Summary of iSeries Applications Development

Throughout this paper we have illustrated the leading edge hardware capabilities, application software technologies and tools that make iSeries a vibrant platform for today's IT solutions. However, perhaps the most valuable iSeries attribute is the focus placed on IT investment protection. A number of platforms can claim support for the latest hardware and software technologies. But, how many can claim the ability to bring forward existing business solutions without requiring a wholesale rewrite or replacement of the original application? iSeries can do this through migration of AS/400e to iSeries technology, or via a transition to the Web, or lastly, by transitioning to pervasive computing. iSeries excels by providing a combination of the latest in application solution technologies coupled with the ability to evolve existing solutions. Given the accelerating delivery of new hardware and software technologies, along with the need for companies to react quickly to ever changing business opportunities and competitive pressures, iSeries offers many advantages — both for the short term and for the long haul.

Appendix A: iSeries Support for Application Environments

The following table (which spans two pages) is not intended to be a standalone tutorial. Rather, it outlines the types of options available and the level of support provided for each development environment. Neither is the table an exhaustive cross reference of all possible tools or solutions. Instead, it focuses on IBM's recommendations for tool usage and strategic application development directions. The table shows the tools that directly support the application, such as compilers and libraries of APIs, as well as the "accessibility" of other software. An example of this distinction and the opportunities would be MQSeries, which presents a library of interfaces that can be used to call ILE programs directly. ILE programs can also be wrapped and called from OS/400 PASE. The MQ LSX makes MQ functions available to Lotus Domino programs. Thus, a developer can get the feel of the integration across the tools and development environments on iSeries while seeing what tools are easily accessible for a particular implementation of the application.

| Lang. / Sys. Svcs. | Java (VM & svcs) | ILE | OS/400 PASE | Integrated Netfinity Server | Lotus Domino |
|-----------------------------|---|--|---|-----------------------------|---|
| Java | Java Development Kit 1.1.6, 1.1.7, 1.1.8 and 1.2.2 | Call using Java Native Interface | Call via ILE wrapper for JNI or JNI to wrapper Qp2RunPase API | | Lotus Domino Object LotusScript classes are available as Java classes; Lotus Connector LotusScript classes are available as Java classes; can run Java applets, servlets & programs |
| RPG | Can call RPG via JNI, Toolbox Program Call or PCML | RPG IV | -- | | Can call RPG programs from Lotus Domino. Triangle has an RPG and CL connector that allows RPG & CL programs to call Lotus Domino objects |
| COBOL | Can call COBOL via JNI, Toolbox Program Call or PCML | ANSI X3.23a-1985, ISO 1989:1985 Standard for COBOL updated with AMD1.1992, 23b-1993, FIPS 21-4 | -- | | |
| C | Can call C via JNI, Toolbox Program Call or PCML | ANSI/ISO 9899-1990 Standard | ANSI/ISO 9899-1990 [1992] Standard | | 700+ C/C++ APIs are available |
| C++ | Can call C++ via JNI, AS/400 Toolbox Program Call or PCML | ANSI C++ draft standard X3J16/95-0001 (VA C++ or ILE C++) | ISO/IEC 14882:1998(E) | | 700+ C/C++ APIs are available |
| FORTRAN | -- | -- | FORTRAN 90 ANSI X3.198-1992; ISO/IEC 1539-1:1997 | | |
| Enterprise JavaBeans | EJB 1.1 spec via WebSphere | | | | Can integrate with WebSphere & call |

iSeries Application Development Directions

| | | | | | |
|--|---|---|---|------------------------------------|---|
| | Advanced App. Server V3.5 | | | | EJBs |
| Lang. / Sys. Svcs. | Java (VM & svcs) | ILE | OS/400 PASE | Integrated Netfinity Server | Lotus Domino |
| Java Servlets | WebSphere Standard or Advanced | | | | Can run Java servlets, can write Java code in IDE, but no debugger |
| XML | Java parser for XML, LotusXSL processor, library of DTDs, PDML, PCML | C++ parser for XML, XML parser interface for RPG, COBOL and C (all available from IBM alphaWorks web site) | | | DXL is Lotus Domino data expressed as XML; can use LotusScript or Java agents to extract Lotus Domino data & process it into an XML document; can import XML document & process it into Lotus Domino data |
| Lotus Domino • Notes Formula Lang. • LotusScript • Domino Connectors • C/C++ APIs | LC Java classes connect Domino data sources, Domino agents in JavaScript, Domino agents in Java import Java programs into agents, Lotus connector classes in Java access DECS & LEI | Lotus APIs for C/C++ for apps; can program using other facilities, Domino can call C/C++ and RPG programs | | | |
| DB2 UDB | Native Toolbox for Java JDBC & record level access | Embedded SQL, CLI library, native calls; triggers & stored procedures in RPG, COBOL, C, C++, etc., @DBCommands can access DB2 | CLI library; called within triggers & stored procedures | ODBC client | Can access/update DB2 data using DECS, LEI, LC LSX, LS: DO, & LC Java |
| MQSeries | MQSeries native JNI language bindings & MQSeries Java client | MQSeries library 5.1, MQ LSX gives access from Lotus Domino to MQ objects | ILE call out to MQSeries library | MQSeries products | |

Appendix B: Web Site References

Here is a broad list of Web sites and resources you can use to help you as you move into your application modernization efforts. To find out more about each of these resources, refer to the latter part of this white paper (the section entitled “Where can you turn to for advice”):

- ✎ [PartnerWorld for Developers, iSeries](http://www.ibm.com/eserver/iseries/developer/) go to: <http://www.ibm.com/eserver/iseries/developer/>
- ✎ [COMMON](http://www.common.org), a user’s group go to <http://www.common.org>
- ✎ iSeries [classes and labs](http://www.ibm.com/eserver/iseries/developer/education/classes.html), [Technical Institutes and conferences](http://www.ibm.com/eserver/iseries/developer/education/classes.html), [video training sessions](http://www.ibm.com/eserver/iseries/developer/education/classes.html), [symposiums](http://www.ibm.com/eserver/iseries/developer/education/classes.html), [Lotus Domino Days](http://www.ibm.com/eserver/iseries/developer/education/classes.html), [Application Enablement Satellites](http://www.ibm.com/eserver/iseries/developer/education/classes.html) go to <http://www.ibm.com/eserver/iseries/developer/education/classes.html>
- ✎ [Web-based iSeries Seminars](http://www.ibm.com/eserver/iseries/developer/education/webseries.html) go to: <http://www.ibm.com/eserver/iseries/developer/education/webseries.html>
- ✎ [Trade magazines](http://www.ibm.com/eserver/iseries/developer/comm/index.html) go to <http://www.ibm.com/eserver/iseries/developer/comm/index.html>
- ✎ [IBM PartnerWorld for Developers newsletter](http://www.ibm.com/eserver/iseries/developer/comm/newsletter.html), <http://www.ibm.com/eserver/iseries/developer/comm/newsletter.html>
- ✎ [Lotus Domino Groupware](http://www.ibm.com/eserver/iseries/developer/domino/group.html) <http://www.ibm.com/eserver/iseries/developer/domino/group.html>
- ✎ [Services Network](http://as400service.ibm.com/supporthome.nsf/document/19251245) <http://as400service.ibm.com/supporthome.nsf/document/19251245>
- ✎ [iSeries e-Business Competency Center](http://www.ibm.com/eserver/iseries/service/ebccext.html) <http://www.ibm.com/eserver/iseries/service/ebccext.html>
- ✎ [Global Application Delivery](http://www.ibm.com/eserver/iseries/service/igs/gadovervw.html) <http://www.ibm.com/eserver/iseries/service/igs/gadovervw.html>
- ✎ [iSeries Product Support Services](http://www.as400service.ibm.com) <http://www.as400service.ibm.com>
- ✎ [IBM Custom Technology Center](http://www.ibm.com/eserver/iseries/service/welcome_3.htm) http://www.ibm.com/eserver/iseries/service/welcome_3.htm
- ✎ [Rochester Customer Solution Center](http://www.ibm.com/eserver/iseries/service/csc/rcscmiss.htm) <http://www.ibm.com/eserver/iseries/service/csc/rcscmiss.htm>
- ✎ [Services Marketplace](http://www.ibm.com/eserver/iseries/service/elance.htm) <http://www.ibm.com/eserver/iseries/service/elance.htm>
- ✎ [Tools Network](http://www.ibm.com/eserver/iseries/developer/tools/) <http://www.ibm.com/eserver/iseries/developer/tools/>
- ✎ [White papers](http://www.ibm.com/eserver/iseries/developer/tools/documents/index.html) and a [DH Andrews report](http://www.ibm.com/eserver/iseries/developer/tools/documents/index.html) <http://www.ibm.com/eserver/iseries/developer/tools/documents/index.html>
- ✎ [International Technical Support Organization \(ITSO\)](http://www.redbooks.ibm.com/) <http://www.redbooks.ibm.com/>
- ✎ [The University](http://www.ibm.com/services/learning/community/as400/) <http://www.ibm.com/services/learning/community/as400/>
- ✎ [Partners in Education](http://www.ibm.com/eserver/iseries/education/piintro.htm) <http://www.ibm.com/eserver/iseries/education/piintro.htm>
- ✎ [IBM Learning Services](http://www.ibm.com/services/learning/) <http://www.ibm.com/services/learning/>
- ✎ [Computer-based training](http://www.ibm.com/eserver/iseries/developer/education/ibcs.html) <http://www.ibm.com/eserver/iseries/developer/education/ibcs.html>
- ✎ [IBM Tools](http://www.ibm.com/eserver/iseries/developer/tools/ibmtools.html) <http://www.ibm.com/eserver/iseries/developer/tools/ibmtools.html>

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