WebSphere® IBM Branch Transformation Toolkit for WebSphere Studio

IBM

Version 5.2

Solution Architecture

Note!
Before using this information and the product it supports, be sure to read the general information under "Notices" on page 27.

This edition applies to Version 5, Release 2, Modification 0, of *IBM Branch Transformation Toolkit for WebSphere Studio* (5724-H82) and to all subsequent releases and modifications until otherwise indicated in new editions.

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Contents

Solution Architecture Overview. 1
Introduction 1
Architectural objectives 1
Architectural principles 2
Support for multiple channels 4
Architecture 5
Client 7
Application presentation layer 7
Application logic layer 8
Runtime architecture examples 8
Java client environment 8
HTML client environment 10
EJB and Web services architectures 11
Architectural considerations 11
Components 12
Java client 12
Developing BTT server applications 14
Understanding data model 14
Developing presentation layer 15
Developing business logic 16
Handling exceptions 17
Understanding Initialization 17
Tools 18
Development 18
Development Model 19
Development process phases 20
Physical deployment 21
Cache mechanisms 23
Cache refresh policies 23
JAR files 24
Performance tips 24

Notices 27
Trademarks and service marks 29

Solution Architecture Overview

This document is mainly for Solution Architects, who require an overall description of what the IBM® Branch Transformation Toolkit for WebSphere® Studio (Branch Transformation Toolkit) provides and how it may be used to build a solution. This document is also useful for IT professionals and executives who require a broad understanding of the architecture of this product and the strategy for its implementation.

Readers of this document are assumed to be familiar with object-oriented software and related development techniques, and to have a general knowledge of J2EE and related technologies, network computing, and Internet technologies.

Introduction

The IBM Branch Transformation Toolkit for WebSphere Studio is a component-based toolkit for developing enterprise e-business applications. The Branch Transformation Toolkit enables the development of interfaces to the services of a financial institution's information system so that they become ubiquitous through all delivery channels (such as the traditional branch, call center, banking kiosk, Internet banking, and mobile access). This minimizes the need for developing new code and reduces the time required to make new financial services available to all delivery channels.

The architecture and technological approach of the Branch Transformation Toolkit creates retail delivery solutions that preserve investment in existing enterprise systems while accounting for the inherent instability of any infrastructure due to innovations that appear frequently in the high-tech industry. While providing a way to preserve existing systems, the Branch Transformation Toolkit is not tied to one particular platform because it is built on Java™, the programming language of choice for handling platform change. The toolkit also takes advantage of existing platforms and technologies such as Eclipse, Web Services, J2EE, Struts, and so on. The toolkit runtime architecture is based on the J2EE architecture with extensions, and many development tools the toolkit provides are Eclipse plug-ins.

Architectural objectives

The architectural objectives of the IBM Branch Transformation Toolkit for WebSphere Studio align with IT strategies that have a basis in controlling costs over time. Following are the objectives:

- **Reduce costs** - A network computing architecture should exploit the network in order to reduce costs. It allows reduction of the computing resources required on the client and supports deployment on network computers, using the network as a vehicle for on-demand distribution of software components. In addition, the architecture supports deployment of reusable business components in a managed server environment.
- **Preserve investment** - An important goal is to preserve the financial institution's investment in host systems and computing infrastructure, as well as in the toolkit-based solutions themselves and other new technologies. This makes it important to carefully consider technology selections in order to ensure that they are strategic and will have enduring value.

- **Offer choices** - Allow customers the flexibility to choose their hardware, operating systems, networking systems, databases, communication protocols, and third-party software products. The system must also support flexible distribution of function and data based on the network environment and physical topology.
- **Evolve gracefully** - The system must be flexible and resilient to both business and technological changes. This helps to support rapid application development and to increase competitiveness by improving time to market.
- **Provide manageability** - Once deployed and in production, the system must be easy to manage and resilient to changes in the runtime environment.
- **Allow incremental investment** - The system must support the ability to incrementally develop and deploy new business function and technology. In addition, it must support the ability to include new toolkit-based solutions as they become available.
- **Maximize usability** - The system as a whole must be well suited to the needs of its users: not only end users but also developers and systems management personnel.
- **Maximize reusability** - The system must be constructed in such a way as to maximize reuse of components in all retail delivery solutions. In addition, it must be able to meet the diverse needs of solutions and access channels in financial institutions around the world.

Architectural principles

The architecture must be open, scalable, and easy to implement. These principles are related to the architecture objectives, and are the basis for the platform selections, programming model specifications, and overall non-functional requirements of all the toolkit-based solutions. The major architectural principles of open, scalable, and easy to implement, presented below, demonstrate how the IBM approach for building robust, cost-effective enterprise systems support the architectural objectives. Following are the principles supported by the Branch Transformation Toolkit:

- **Open**
  - **Supports industry standards** - The architecture is open because it uses open industry and e-business standards such as TCP/IP, HTML, HTTP, J2EE (Java, Java Server Pages, JCA, JDBC, EJB, and so on) and Web Services wherever possible. These standards provide a solid foundation and make it easier to use available proven components instead of building custom ones, and to change vendors and implementations to satisfy changing business requirements. Industry standards tend to be strategic and have longer life spans because of the high levels of investment and commitment involved with creating them.
  - **Is extendable and customizable** - The toolkit is extendable and customizable at many different layers within the architecture. This means it can be used in a wide range of situations and can accommodate specialized requirements that are specific to an individual customer, country, or region.
  - **Provides insulation** - The toolkit isolates and abstracts interactions with other systems to insulate toolkit-based applications from the specifics of other systems. In a global solution, this is essential to provide the flexibility to adapt to many diverse environments, particularly different host systems and databases. The programming model of the toolkit insulates applications from changes in the underlying technology.
  - **Preserves investment** - The principles listed above ensure the preservation of customer investments. The toolkit safely preserves the investments in current

hardware, software, operating systems, network, communication infrastructure and protocols, and back-end subsystems of the customer environment.

- **Scalable**
  - **Supports three logical tiers** - The benefits of a logical three-tier architecture such as the network computing architecture are well known. The network computing architecture is logical in that it specifies that the presentation layer must be decoupled from the business logic, which must be decoupled from the data access layer, but it does not specify how to physically deploy the tiers. Although this approach is a form of isolation, it also provides scalability by allowing each of these layers of the system to change independently of the others. That is, the platform selections and design of each layer can change without impacting the rest of the system. This architecture also requires that the presentation layer be ″thin″ to realize the goals of network computing. This means that workstations with a small amount of physical memory and no virtual memory can download and execute the application. The main objective of the solution architecture is to support the model of a multiple-tier network computing application while also allowing engagement teams to implement solutions based on other application models such as a two-tier ″fat client″ application.
  - **Supports replaceable components** - Components are packages of system function with established interfaces and a predetermined execution environment. As long as a component is within its required execution environment and it interacts with other system components through its public interfaces, it is replaceable with minimal effort. This construction enables high levels of reuse and allows the system to evolve without causing large ripple effects. It also allows the implementation of components and their execution environments to vary to meet performance or scalability requirements.
  - **Provides enterprise topology independence** - This notion extends the idea of a logical three-tier architecture so that not only are the three tiers independent of physical location, but system components are independent of any specific physical topology. This makes toolkit-based solutions highly flexible for deployment in different environments by allowing customers to configure the system as needed to achieve the scalability desired for their environment.
- **Easy to implement**
  - **Uses visual programming** - Where possible, toolkit-based solutions use visual programming to assemble the application from parts. This technique is particularly effective in developing application screens and rapid assembly of graphical user interfaces.
  - **Separates analysis from design** - Analysis should be a separate process from design and have its own distinct work products. Solutions of this product suite should use analysis to form an entirely logical representation of system function that is independent of technology or implementation. This helps to retain the value of earlier development effort even if the implementation must change entirely.
  - **Provides a development methodology** - This solution provides a methodology for guiding the development process in an engagement project to make solution implementation easier and the deployment faster.
  - **Is transaction-oriented** - Most projects require a solution in which an enterprise-centric back-end system executes most of the application business logic and the front end of the solution, running in a delivery channel, must behave as a transaction posting engine to run the transactions in the back-end

system. The Branch Transformation Toolkit excels at this type of solution and optimizes the processing of the transactions especially in high transaction volume environments.

– **Minimizes development effort** - The toolkit highly promotes the externalization of parameters so that business operations behave differently depending on their specific set of parameters. This enables solutions to delivery new functionality without requiring new code, simply by adding new external parameters to the system. One example is the toolkit business processes that are defined with BPEL. This enables toolkit application developers to edit process logic using visual design and modeling tools.

Support for multiple channels

The IBM Branch Transformation Toolkit for WebSphere Studio provides an architecture for building applications that are deliverable on multiple channels. Enterprises within the banking and financial services industries have successfully deployed the toolkit in various topologies as the infrastructure for enterprise systems with high transaction volumes. While the following topologies are specific to the banking and financial services industries, for which the toolkit was originally conceived, the ability of the toolkit to handle multiple business distribution channels is generic and can apply to other industries.

Bank teller

A bank teller application topology consists of a number of client workstations with financial devices attached. The workstation downloads the client applicationon on request from a Web server. The client applications, which mainly deal with presentation and local financial device handling, have access to the branch server (that is, the solution application server) using the HTTP or SSL protocols.

The solution application server provides common services such as electronic journaling and parameter tables to the client workstations, as well as access to the transactional logic of the back-end enterprise servers. A toolkit server application can also be deployed on the physical server for a regional or central data center without changes to the application.

Internet banking

In an Internet banking topology, users obtain access to financial services through a Web browser (or other device) connected to the Internet. The user interface is normally HTML with additional technologies such as JavaScript™, DHTML, or XML. In such an environment, the solution application server is able to process requests from Web browsers (or other devices that issue HTTP requests), obtain the proper data from enterprise servers, and generate the appropriate view for the client device to display using HTML pages for Web browsers or XML messages for those devices that support it. The application server is usually located at the central site, and is protected by a firewall.

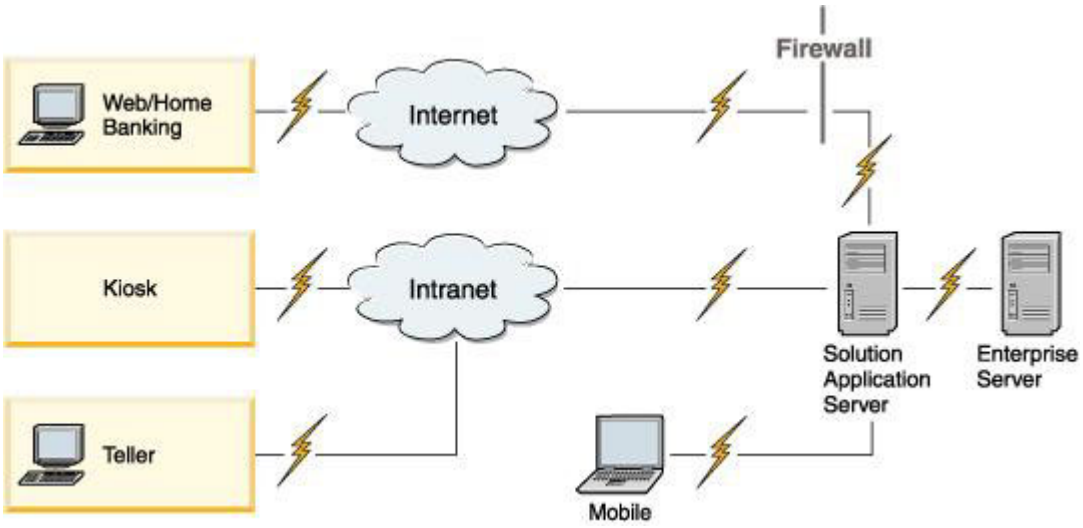
Kiosks

The toolkit can be used in kiosks or ATMs that run Internet technologies such as a Web browser and Java. In this environment, the client usually is a Java application (or applet). In addition to the presentation logic, the client application manages the financial devices normally present in a kiosk (such as MSR/E, chip card reader, receipt printer, passbook printer, bar code readers, and touch screen displays) using the financial device services that the toolkit provides. The kiosk connects to the application server using the HTTP or SSL protocols. In some cases, kiosks are located in branches,

which handle them as branch workstations. Kiosks can also be connected directly to the server through public or private lines.

Mobile terminal
Users equipped with laptops running a Web browser can connect to corporate toolkit servers using the SSL protocol. In this scenario, the toolkit server is usually located at the central site and is protected by a firewall. It is also feasible to have mobile users connected to the branches to which they belong.

The following diagram illustrates these business distribution channels:

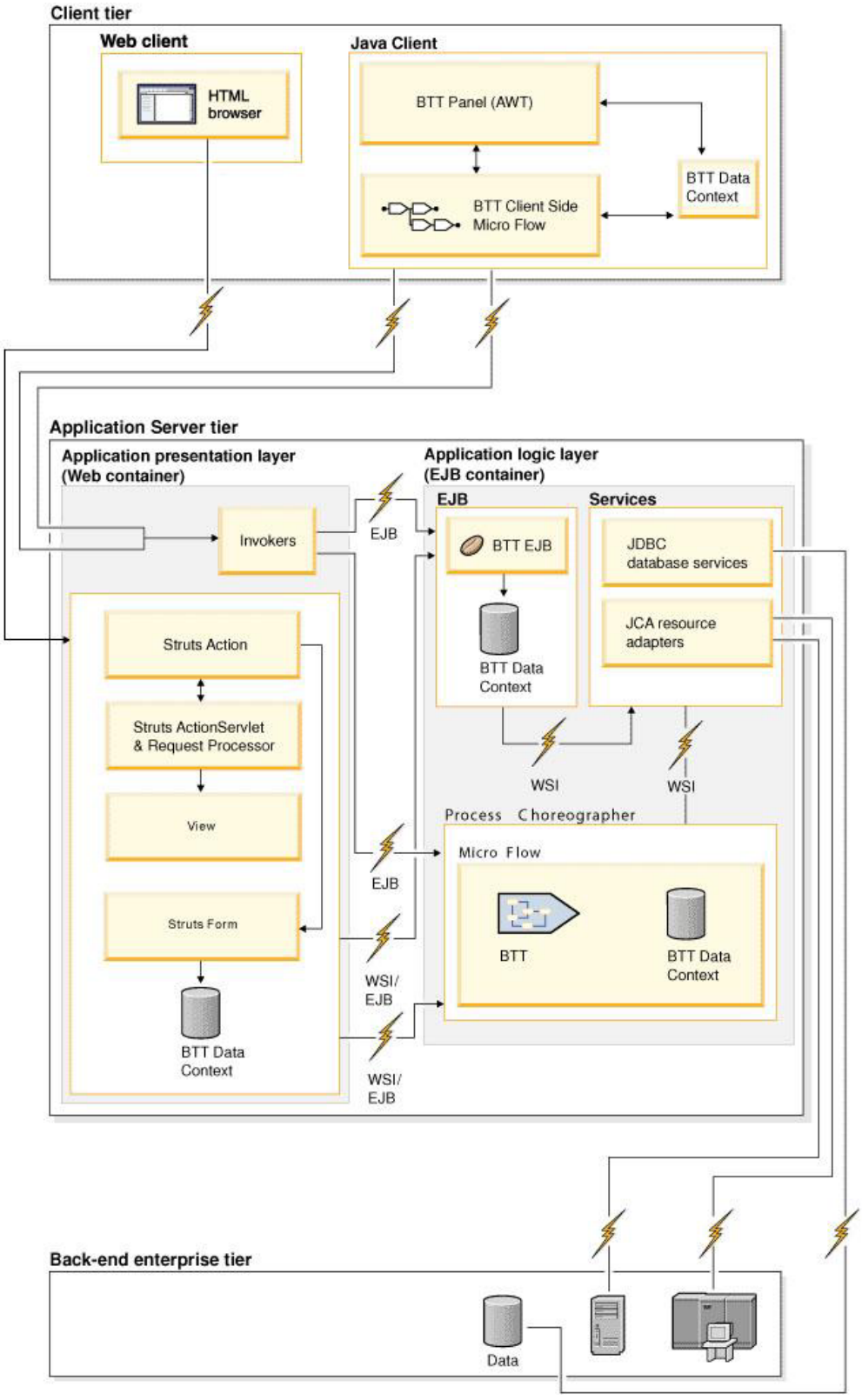


Architecture

The architecture of the Branch Transformation Toolkit application solution is based on a logical three-tier model: back-end enterprise tier, application server tier, and client tier.

Within the application server tier, the toolkit has two separate layers. The application presentation layer is responsible for receiving requests from the client and passing that request on to the application logic layer. It also passes the response back to the client. The application logic layer is responsible for performing the request as a process and passing the response back to the application presentation layer. The individual components within the layer are discussed later in this document.

For the most part, the application presentation layer resides in a Web container in WebSphere Application Server while the application logic layer resides in a EJB container. The services are the exception because they can reside anywhere.



Note: WSI stands for Web Service Invoker in the figure above.

The design and portability of the toolkit (resulting from being Java code) allow the middle-tier servers to exist at either the branch level (one server per branch), the

regional level (one server per group of branches), or even a centralized level (a single server for the entire financial institution). The design provides flexibility to achieve the right balance between the number of servers and the network bandwidth without affecting any application logic. Besides the application server, there may be a ″technical server″ responsible for providing common services (such as disks or printers) to the client workstations. If the application presentation layer and the application logic layer are on the same architectural level, they can physically be on the same machine.

Client

A client in the three-tier architecture contains little logic. The logic it does have is usually presentation logic or logic required locally to do such things as access financial devices or validate entered data. The code to execute the client logic is downloaded on an on-demand basis, and therefore does not reside on the client, but on a Web server. The Branch Transformation Toolkit supports any kind of physical client device that uses the following technologies:

- Java applets in a browser environment
- Java applications
- HTML clients

The toolkit provides implementations for current client technologies but these concrete implementations anticipate that significant differences may be found when realizing solutions. The toolkit is not limited to these technologies because its design is generic and can be extended to support other technologies.

A clear separation exists between Java clients and HTML clients. For a Java client, the application, which may also be executed inside a browser, can be built from toolkit-provided visual components (implemented as Java beans) using visual composition. The visual components of the toolkit and the interaction with toolkit services facilitate implementing required application tasks such as interacting with financial devices, database access, and other services. For an HTML client, the flow of the navigation is delegated to the server.

Application presentation layer

The application presentation layer works in conjunction with a system application server (such as IBM WebSphere Application Server) to provide a layered multiple channel architecture. The application presentation layer works as a bridge that connects the clients with the application logic layer, which performs business transactions. Java clients and HTML clients uses different application presentation components to connect to the application logic layer.

To get connected with the application logic layer, the presentation layer defines the following entities:

- **Java RequestHandler** processes a Java client request for a particular type of requester. The toolkit registers these handlers to determine which specific handler it needs for a specific request. For example, there are different RequestHandlers for requests coming from a Java client in a home banking environment, from a Java client in a branch teller environment, and from a Java client in a call center environment. The RequestHandler is responsible for interacting with the client side operations that controls the dialog navigation for a specific client type and for interacting with invokers that call application logic layer transactions.
- **Java PresentationHandler** processes the reply for a particular type of requester.

- **Struts Extensions** processes requests from HTML clients, calls application logic layer components for business transactions, and renders presentation for HTML clients based on the business transaction results.
- **HTML RequestHandler** is responsible for processing a particular request from an HTML client. The handler may need to be aware of the device type. This is managed by the channel context. The request handler performs the following tasks to integrate with the application:
  - Establishes the session between the client and the server for the specific device
  - Executes a generic application operation for the HTML channel
  - Determines the appropriate presentation handler from the handler registry to render the results back to the client.
- **HTML PresentationHandler** is responsible for processing the reply to the HTML client. The main API provided by this class is void processReply(ChannelContext, ServerOperation). This starts the process of dynamically creating the HTML and rendering it to the client using the servlet JSP engine.

To pass business process requests to the application logic layer, the application presentation layer has the Bean Invoker Factory. The Bean Invoker Factory creates invokers so that the requester can invoke the EJBs that perform the business processes in the application logic layer. The requester can be a request handler from the Java client or an EJB Action from the toolkit Struts Extensions component.

Application logic layer

The application logic layer provides the core business logic using **Enterprise JavaBeans™**. It does this in a channel neutral manner. That is, it handles a transfer funds request whether the request came from a Web client or kiosk.

The mechanism for performing the business logic is a business process running in the Process Choreographer in WebSphere Process Server or a business process running as a Single Action EJB. The business process can involve interacting with Web services, host applications using the JCA Connectors, and enterprise datasources to fulfill the request. The toolkit provides a set of services that support the application logic layer by providing connectivity to enterprise datastores or to legacy systems.

From WebSphere Application Server version 6, the work area feature is supported too. So, the presentation layer can use a work area to pass the session IDs to the application logic layer. Or the application presentation layer includes the session ID with the data required to process the business request in the request message.

Runtime architecture examples

This section contains two examples that describe the flow of two transactions from end to end: one with a Java client with the application presentation and application logic layers running on WebSphere Process Server and the other an HTML client with the application presentation and application logic layers running on WebSphere Application Server. The transaction is a customer search in which the user, a teller, enters the data for the customer search criteria on a view. The view displays a list of customers who meet the search criteria.

Java client environment

In this example, the Java client is within a browser that has the Java plug-in and starts the client application. This is one of many possible implementations for a

Java client but it makes the example independent of the virtual machine provided by the browser. The startup applet launches the XML Desktop. Once the desktop is available, the navigation controller and the actions configured for the visual components control the view navigation and which business processes the user requests. The flow processor is an implementation of the Automaton (a state machine) that controls what happens when user's actions reach the server in the application presentation layer.

The application presentation layer and application logic layer run on WebSphere Process Server so that the example can show how the application logic layer uses the work area and Process Choreographer features of that edition.

1. The user requests a customer search and provides the required input data:
   a. The user clicks a desktop button to search for a particular customer's data.
   b. The search button has an associated operation panel. The panel contains a set of entry fields for the search criteria and a list field.
   c. The user enters the required data. The operation panel enables the OK button only when the user has typed values in all mandatory fields.
   d. When the user clicks OK, the client creates the customer search client operation and creates a context for it. The client then chains it to an upper level context. The client operation may identify the parent or the toolkit may use the default context of the client/server session as the parent.
   e. The client operation checks that the operation context contains the data needed to process the operation. This validation is a cross-field validation. If data is missing, the client operation may execute a local service or send a request to a remote server. The client operation unformats the data resulting from executing the service and places the unformatted data in the operation context.
   f. The client sends the client operation to the server using the multichannel support component.
2. The application presentation layer sends the customer search request to the application logic layer.
   a. In the server, the servlet acting as the request handler receives the customer search operation.
   b. The request handler calls the Bean Invoker Factory to get the invoker for the customer search operation.
   c. The request handler uses a formatter to populate the request with data from the context.
3. The request handler places the session ID in the work area.
4. The invoker makes an EJB call to the to Business Process Component on the application logic layer to execute the customer search process.
5. The application logic layer executes the business process:
   a. The Business Process Component receives the request and retrieves the session ID from the work area. Note that a previous process (typically a logon process) has created the session and the session CHA context.
   b. The Business Process Component creates a CHA context to hold the process data and chains the process context to the session context.
   c. The Business Process Component performs the process using the Process Choreographer.
   d. The Process Choreographer performs the activities of the process such as performing a search in the customer database and logging the search in an electronic journal.

e. The Business Process Component creates the response message and formats the data resulting from the search into the response message.
f. The Business Process Component sends the response back the presentation server.

6. The client view displays a list of customers matching the search criteria:
   a. The flow processor unformats the response into the process context. The flow processor broadcasts an event so that the navigation controller is aware that the customer search process has completed and its data is available.
   b. The navigation controller updates the Customer Search panel with the response data (in this case, a list of customers that match the provided search criteria).

HTML client environment

An HTML client is generally used for a home banking application built to use the Branch Transformation Toolkit. An HTML client can also be used in any other kind of application, such as a bank teller application or a CRMS. The client machine requires only a Web browser to run the application.

When the user visits the start page of the application and logs in, the browser displays a menu or HTML desktop with a list of available processes. In this example, the toolkit Struts Extensions in the presentation server controls the navigation. The application presentation layer and application logic layer run on WebSphere Application Server so that the example can show how the application logic layer works when Process Choreographer is not available and uses Single Action EJBs to perform the logic.

1. The user requests a customer search and provides the required input data:
   a. The user clicks a customer search link in the HTML desktop. This user action sends a request to toolkit Struts Extensions.
   b. The toolkit Struts Extensions component in the application presentation layer starts the corresponding action (Struts action A) specified in the Struts configuration file. That action then returns the JSP page name. The presentation layer processes the JSP into an HTML page.
   c. In the client side, the browser displays the HTML page.
   d. The user enters the input data and clicks a Submit button. This sends the form data as an HTTP post request to the Action servlet of the Struts Extensions which in turn starts a Struts action (Struts action B) specified in the Struts configuration file. The request data contains a process ID as hidden fields along with the other input data.
   e. Struts Action B requests an invoker from the Bean Invoker Factory.
   f. The invoker formats the data into a process context.
   g. The invoker calls a method in a Single Action EJB to perform a customer search process in the application logic layer. Struts action B uses a formatter to add data from the context as a parameter of the method call. The method call also includes the session ID.
2. The application logic layer executes the business process:
   a. The Single Action EJB performs the logic contained in the invoked method.
   b. The Single Action EJB returns the response to the presentation server.
3. The client view displays a list of customers matching the search criteria:
   a. The invoker unformats the response into the process context.
   b. Struts action B points to a JSP that generates an HTML page with the response to the customer search request. The page contains a list of customers who match the search criteria.

c. The client displays the HTML page.

EJB and Web services architectures

The Branch Transformation Toolkit provides both runtime and development architectures for building front-end solutions that access back-end enterprise applications and data. As part of the runtime architecture, the toolkit uses an application presentation layer with a client and server and an application logic layer. For the application logic layer, the business logic resides in a business process running in the Process Choreographer of WebSphere Process Server or within a Single Action EJB. The business process or EJB can invoke Web services to perform business logic.

The Web services architecture defines a dynamic business-to-business programming model, where services are published, discovered, and accessed through standard definitions and interfaces. The toolkit integrates with this architecture and complies with both schemas to provide the following benefits:

- The toolkit application code can access any EJB or Web service
- The toolkit can build transactional-access EJBs or Web services, which are components that delegate transactional integrity to an external transaction monitor such as IMS™
- The toolkit can be extended and customized to create black-box EJBs or Web services
- The toolkit can make implementing a client front-end to an EJB or Web Service easier while providing the overall application with the ″n tier″ network computing architecture model based on the internal architecture of the toolkit's multichannel application presentation layer

However, the main benefit is that the integration preserves the flexibility of the toolkit while providing the benefits of the EJB and Web services architectures and a clean path to a components model for toolkit-based solutions. The application presentation layer can access the EJB or Web service using the EJB interface or the proxy classes which are generated by the development tool respectively. From the point of view of the application presentation layer, they are black boxes.

Architectural considerations

This section contains the set of considerations to be taken into account when wrapping the Branch Transformation Toolkit logic into an EJB or Web service. These considerations provide the application architect or designer with an understanding of the product's facilities for wrapping toolkit logic. Keep the following in mind when constructing a solution using EJBs or Web Services:

- Depending on the solution being implemented with the toolkit, encapsulating the logic in EJBs or Web Services may not provide any benefit in terms of transactional integrity. This is particularly true when the back-end system fully provides integrity and the logic implemented in the middle tier is a pure passthrough. That is, from the client's point of view the middle tier is acting as the front door of the server logic.
- Irrespective of your model choice, the toolkit provides its full set of features to build your end-to-end solution. You are free to define the proper architecture for the application and then use the toolkit to fulfill the requirements based on the chosen architecture.
- Due to the internal implementation of the toolkit, having more than one EJB or Web Service implemented by different uncoordinated teams (such as different vendors) running in the same Java Virtual Machine and the same namespace

may result in some coexistence problems. Since the use of different namespaces by different solutions based on the Branch Transformation Toolkit cannot be always ensured, it is better not to run EJBs or Web Services that have been implemented using the toolkit in the same JVM with the same namespace. This can be easily achieved during the deployment of the components, by assigning the different EJBs or Web Services to different containers (perhaps under different application server nodes).

Components

The Branch Transformation Toolkit splits into components in the application presentation layer and components in the application logic layer.

Note that the Business Process component of Branch Transformation Toolkit components can only run on WebSphere Process Server, while some toolkit components can run on both WebSphere Process Server and WebSphere Application Server. Since WebSphere Application Server v6.0 already supports the features like Work Area, Startup Bean and Activity session, BTT v5.2 application can adopt these features while running on WebSphere Application Server.

Java client

Branch Transformation Toolkit components that run on Java clients interact with each other to provide the Java client navigation function, pass client requests to the application presentation layer, and enable Java clients to present a response to the request.

BTT 5.2 provides no explicit Java client components. Instead, similar to BTT 5.1, it inherits the BTT 4.3 Java client using modified servlets and request handlers in the server side that translate requests from a BTT Java client into a form that is manageable within the BTT 5.2 server environment.

The main focus of this BTT Java client support is to provide a work-alike server environment that existing Java clients can interact with or without client code changes. This requires that the BTT server supports the following:

- A BTT 4.3-compatible Session subsystem (described under 'Sessions')
- A BTT 4.3-compatible Event subsystem (described under 'Events')
- Servlets for Session establishment, operation execution, Event registration, event processing

For the Java client, no *client* code changes are necessary, but configuration changes may be needed to change server operation names to process invoker names. All changes are made to the client/server channels, request and response handlers as well as any classes they interact with such as the BTT Context.

The following components run on Java clients:

Contexts

A context is the container for the data elements needed by a business entity such as a user or branch. Contexts have a hierarchy to enable these business entities to share common data. For example, in a branch each teller would have a context that contains data about the teller but they would all share the branch context, which would contain data about the branch. The branch context is the parent and each teller context is a child in the relationship.

Formatters

A formatter transforms a string into data in a context or data in a context to a String. This enables an application to move data into and out of the context hierarchy and to create messages to send to a host, financial device, or service in a format understood by the message's destination. The toolkit provides an extensive set of the most commonly needed formatters for financial service applications including EBCDIC, date, numeric, packed, binary, and other formatters.

Data elements

A data element is a field that contains a value or a collection of other data elements. Certain data elements are type-aware. The typed data elements represent business objects such as Date, ProductNumber, and Money. Each typed data element has an associated property descriptor, which provides information about the data such as its type, its validator, and its set of converters.

Flows A flow is a particular route through a business process or presentation sequence in the application presentation layer. A flow processor handles a specific flow and it is typically with many branches and compound and complex conditions on those branches. Within a flow, there is a sequence of states. These states can have actions. An action is a task that the flow processor performs such as display a view or invoke a business process in the application logic layer.

Externalizers

An externalizer is an object factory that uses definitions in an external file to instantiate a specific toolkit entity. The toolkit provides externalizers for contexts, data elements, formatters, services, and flow processors. The definition files are ASCII files using XML syntax. This makes configuring and customizing these defined objects (or implementing new ones) possible with something as simple as a basic text editor although the Development Workbench provides an easier and more controlled environment for this editing.

Events

An event is how components within the application presentation layer communicate with each other. A notifier is the sender of an event. A handler, as the receiver of that event, is responsible for consuming the event or propagating it to other handlers. An Event Manager acts as the event controller between notifiers and handlers to manage both local and remote events.

Exceptions

A toolkit exception enhances the standard Java exception mechanism to facilitate applications accessing information about the exception.

Visual beans

The visual beans facilitate the development of a GUI for Java clients by adding features and properties to normal visual beans to support financial applications such as date fields, numeric fields, or account data entry fields. The navigation controller provides a way for the Java clients to have a multiple view GUI.

Desktop

The Desktop is a fully configurable desktop for Java clients. It contains most of the features commonly required of this type of user interface. It includes many common UI features and can by dynamically personalized to the current user.

Operations
An operation is what Java clients use to launch business processes in the application logic layer. An invoker maps the client operation to the business process.

Generic Pool
The Generic Pool service enables multiple client operations to share certain objects (classes and services), which makes the objects reusable. This reuse reduces the average time to execute these operations and also reduces the garbage collection work.

Trace Facility
The Trace Facility provides a way to see what is happening with an application while it is running. The information it logs can be used to solve problems during development and during runtime.

Financial device services
The Branch Transformation Toolkit provides services to access the most commonly used financial devices in financial service applications, including financial printers, check readers, magnetic stripe readers, chip card devices, and passbook printers. Financial device services allow applications to access devices that are compliant with WOSA/XFS protocol. The toolkit also supplies 100% Java access to specific financial devices following the current specifications of the J/XFS Forum.

JXFS Service
The JXFS Service enables applications to access devices that use J/eXtensions for Financial Services (J/XFS). The JXFS Service uses the typical interface between applications and J/XFS devices: Device Control (DC) and Device Manager (DM).

WOSA Device
The WOSA Device service enables applications to use WOSA/XFS to access financial devices. These devices include financial printers, identification cards, and teller assist units

Developing BTT server applications

No. 003

To develop Branch Transformation Toolkit application on application servers, you need to do the following:

Understanding data model

The following Branch Transformation Toolkit components are shared across the Web container and EJB container of the application server:

Data elements
A data element is a field that contains a value or a collection of other data elements. Certain data elements are type-aware. The typed data elements represent business objects such as Date, ProductNumber, and Money. Each typed data element has an associated property descriptor, which provides information about the data such as its type, its validator, and its set of converters.

Typed data
Typed data elements represent business objects such as Date, ProductNumber, and Money.

CHA The Common Hierarchical Area holds data within a context hierarchy for the Business Process Component when it performs a business process. This

is a distributed component that allows the data to exist anywhere. It also enables non-toolkit applications to store general global session data. The application uses the CHA API to mover data into and out of the CHA.

Formatters

A formatter transforms a string into data in a context or data in a context to a String. This enables an application to move data into and out of the context hierarchy and to create messages to send to a host, financial device, or service in a format understood by the message's destination. The toolkit provides an extensive set of the most commonly needed formatters for financial service applications including EBCDIC, date, numeric, packed, binary, and other formatters.

Developing presentation layer

The following Branch Transformation Toolkit components run in the presentation layer of the application server:

Events

An event is how components within the application presentation layer communicate with each other. A notifier is the sender of an event. A handler, as the receiver of that event, is responsible for consuming the event or propagating it to other handlers. An Event Manager acts as the event controller between notifiers and handlers to manage both local and remote events.

Note: This component works only for Java clients.

Sessions

A session is a conversation between a user (browser), client, or server that contains one or more sets of requests and responses. Sessions enable these entities to share data within the conversation yet distinguish the data from data in other conversations.

Invoker

An invoker is the interface to an EJB in the application logic layer. A request handler (part of the multichannel architecture) or the toolkit Struts Extension uses a specific invoker to start the business process performed by the EJB associated with the invoker.

Client/Server Messaging API

The Java Client/Server connectivity component enables the Java client and application presentation layer to communicate through a specific communication channel. The component contains a request handler, a Bean Invoker Factory, and a presentation handler. The request handler passes the request to the Bean Invoker Factory, which then instantiates an invoker to call a Single Action EJB or a business process in the application logic layer. The presentation handler handles the response from the application logic layer to render the result appropriately for the Java client.

Note: This component works only for Java clients.

Struts Extensions

The Struts Extensions component provides a set of features and mechanisms that support an HTML-based graphical user interface (GUI) that is presented in a Web browser using an HTTP connection. The toolkit Struts Extensions component is based on the Apache Struts Web Application Framework.

Note: This component works only for HTML clients.

HTML Channel

The Branch Transformation Toolkit's multichannel support provides a standardized way of handling messages between the server-side toolkit application and the client-side user interface. HTML Channel uses and extends this functionality to enable an HTML-based user interface to send requests to and receive responses from a toolkit application using the HTTP protocol. Different with Struts Extension, HTML Channel is based on BTT RequestHandler multichannel mechanism and architecture, work with Java Channel together to fulfill multichannel request.

JSPs and JSP tags

JSPs and JSP tags enable the application presentation layer to dynamically generate HTML pages for HTML clients. They separate the generation of dynamic content from its presentation.

Note: This component works only for HTML clients.

Developing business logic

The following Branch Transformation Toolkit components run in the business logic layer of the application server:

Business Process support

This component enables applications to perform business processes using the Process Choreographer in WebSphere Process Server. Applications can invoke the business process through the web service invocation. In BTT v5.2, to reduce the impact on the change of Process Choreographer of WebSphere Process Server, the support approach is changed to provide the helper for the application to access the components of BTT instead of making extension on top of Process Choreographer.

Single Action EJBs

This component enables applications to perform business process using stateful or stateless session EJBs. The Invoker component in the presentation layer is the interface to the single action EJBs.

Operations

An operation is what the Java™ clients use to launch business processes in the application logic layer. An invoker (see Bean Invoker Factory) maps the client operation to the business process.

Operation Steps:

An operation step is an entity that represents one or more actions performed inside an operation. An operation can invoked one or more operation steps during its operation flow to perform some or all of the actions that the operation is to perform. The actions within an operation step can include performing data validation, interacting with a service such as inserting a row in the database, performing a set of interactions with a group of services such as a set that adds a record in the journal, sends data to the host, updates an entry in the journal, and prints a form in the printer, or a combination of many actions. The action may also include executing another operation if the business process requires the execution of more than one operation. Since these actions can be common to several operations with the only difference being the format of the data interchanged with the system services, the operation step can be a highly reusable part. Formatters handle the differences in data formatting.

An operation step can, for example, handle the entire communication process with the host including registering the corresponding handlers, sending the data streams, handling the responses, deregistering the

response handler, and letting the operation know whether any exceptions occurred. A more generic operation step might access the journal before and after establishing the host communication process. This type of operation step represents a kind of atomic unit that the operation step itself can roll back if a failure occurs. It also provides greater opportunity for reuse.

Connectivity and Services
The following services enable the business process to connect to the back-end enterprise tier.

Communication services
These are JCA-based services that applications can use to access data and services in the back-end enterprise tier. The toolkit provides the **SNA JCA LU60 resource adapter** and the **SNA JCA LU62 resource adapter**. Both of the adapters conform to the J2EE JCA architecture and implement the Common Client Interface (CCI). This interface isolates the application from differences between communication protocols.

Database services
These provide JDBC connectivity to databases. The database services are similar to BTT v4.3 database services but removing some of functions related to use the database driver manager directly. The **Database Table Mapping** service enables any application to access a database through a common application interface. The service converts messages into SQL statements to perform the requested database operation for the application. The **Electronic Journal** service enables a financial institution to store the services and processes used or performed by an entity such as branch, user, or terminal in a set of database tables. The Electronic Journal service uses the Java Database Connectivity (JDBC) standard to store its data.

Handling exceptions
To handle exceptions, you need to understand Exceptions:

Exceptions
A toolkit exception enhances the standard Java™ exception mechanism to facilitate applications accessing information about the exception. Furthermore, from BTT v5.2, to make the exception more informative, the exception message will contain more historical information for the application debugging.

Understanding Initialization
To understand initialization, you need to know the following:

Startup beans
A startup bean is a session EJB that loads and runs before an application starts. The Branch Transformation Toolkit uses the startup beans to do the initialization for some of its components, such as the CHA, Formatter, and services.

Externalizers
An externalizer is an object factory that uses definitions in an external file to instantiate a specific toolkit entity. The toolkit provides externalizers for contexts, data elements, formatters, services, and flow processors. The definition files are ASCII files using XML syntax. This makes configuring and customizing these defined objects (or implementing new ones) possible

with something as simple as a basic text editor although the Development Workbench provides an easier and more controlled environment for this editing.

Tools

The Branch Transformation Toolkit provides a number of tools that support the development of applications. All the tools are plug-ins of of Rational® Application Developer (RAD) and WebSphere Integration Developer (WID). Note that some functions of the Graphical Builder are only available when you are using WebSphere Integration Developer.

The Graphical Builder provides a set of functions to define entities required by applications, and distribute the runtime files. It also acts as a portal from where the application developers can start other tools that the toolkit provides.

The CHA Editor and Formatter Editor provide user-friendly interfaces for creating or maintaining the definitions needed by the CHA and the Formatter. Both of CHA Editor and the Formatter Editor provide the features of the validation and the synchronization when there is any change happening in either tool.

The Struts Tools BTT Extension provides a GUI to help you extend your Struts configuration files for taking advantage of toolkit specific entities.

The BTT Business Process Editor makes extension on the top of Business process editor of Websphere Integration Developer to help the developer to create the BTT like business process by embedding the necessary field declaration, the BTTSystemData initialization and the endup statements.

Apart from all the development tools listed above, the toolkit also provides a toolkit migration tool to help you migrating the applications that developed with version 4.3 of the toolkit to the new version 5.2 architecture.

Furthermore, to achieve the team development goal and reduce the dependency from other developers, BTT v5.2 provides the self-define capability in the development time to assure the parallel development and perform the unit testing separately by individuals without full set BTT definition files ready.

Development

The Branch Transformation Toolkit was developed using Rational Application Developer or WebSphere Integration Developer. The Branch Transformation Toolkit consists of a set of tools that support end-to-end development and deployment of e-business applications. It facilitates development tasks such as rapid application development, creating industrial-strength Java programs, and maintaining multiple editions of programs.

The toolkit provides a set of components built as Java classes and JavaBeans. The method signatures and class definition of a bean follow a pattern that permits visual development environments to determine the bean's properties and behavior.

The following development tools may be used to build a solution using the Branch Transformation Toolkit:

- Rational Application Developer or WebSphere Integration Developer to develop the application runtime engine and views, exploiting the required components provided by the toolkit using the following plug-ins:

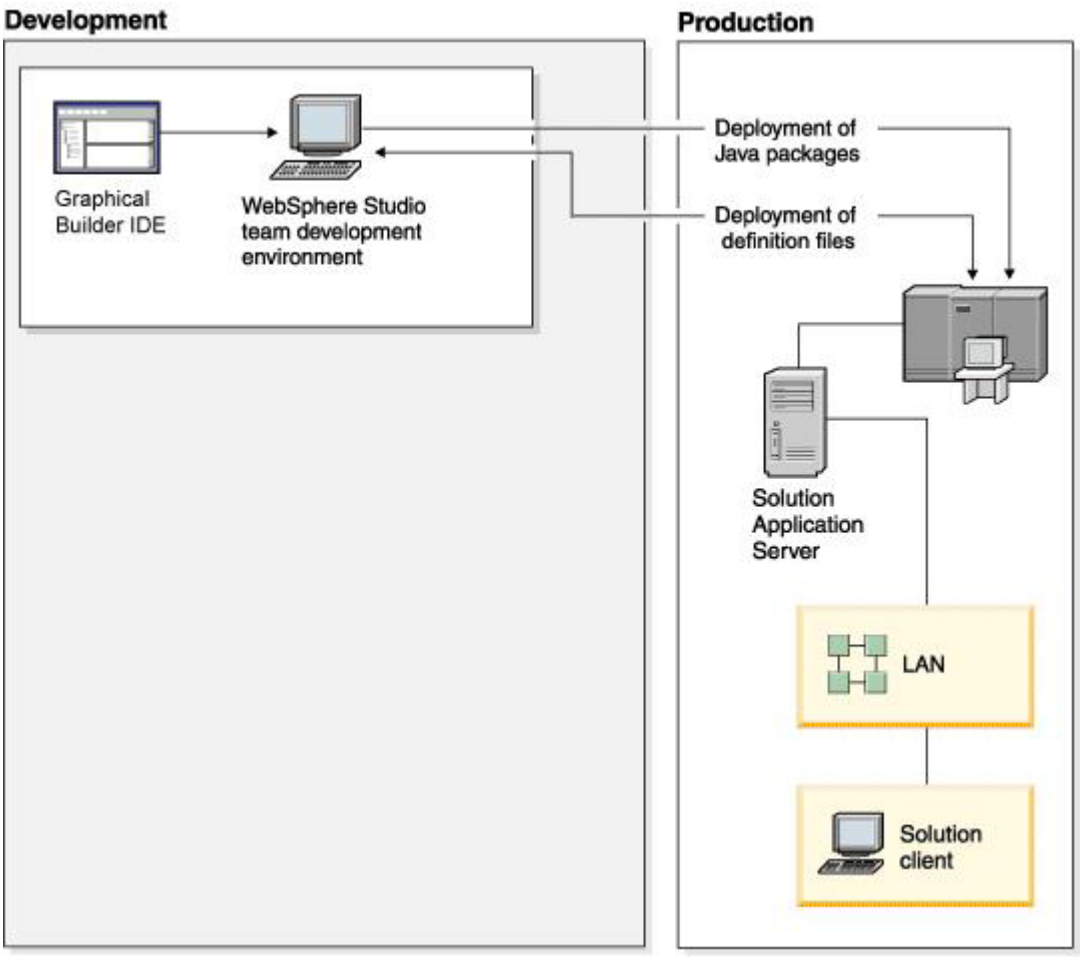
- The Graphical Builder to define the entities required by the applications in runtime in the application presentation layer, and help the user to more quickly deploy the set of resources needed by the runtime application when new business functions are added, all focused to encourage reusability of work, lower the costs of maintenance, distribution, and installation, and reduce the overall time to market. The Graphical Builder also acts as a portal from where you can start other toolkit provided tools.

  Note that certain functions of the Graphical Builder are only available when you are using the WebSphere Integration Developer.
- The CHA Editor to define the CHA contexts and the data elements they contain.
- The Format Editor to define formatters for the CHA contexts.
- The Business Process BTT Wizard to extend your business processes for taking advantage of toolkit specific entities through a Graphical User Interface (GUI). Note that this tool is only available when you are using the WebSphere Integration Developer.
- The Struts Tools BTT Extension toextend your Struts configuration files for taking advantage of toolkit specific entities such as CHA contexts through a GUI.

• An authoring tool such as IBM WebSphere Studio Site Developer to create HTML pages.

Development Model

The Branch Transformation Toolkit proposes a repository-based development model where all the relevant information about financial transactions (data, formats, contexts, services, processors, and views) is externalized to a set of definition and configuration files and separated from the Java code. The development model allows developers to add new processes or transactions in a toolkit-based application with minimum coding required, by adding some definitions into the definition repository. The following diagram depicts the role that the definition repository plays in the development and deployment of a toolkit-based solution:



This separation allows parallel resources to be focused in each of the areas, but it requires a common understanding and definition of the model to get a final consistent solution.

The Branch Transformation Toolkit provides development tools such as Graphical Builder to help you create, modify, and the definition files.

Development process phases

During the overall development process four main phases are identified:

1. Analysis and design.
2. Coding reusable entities.
3. Code the runtime application and feed the repository.
4. Generate the runtime resources and test.

The phases are iterative and contain tasks that may be refined during the project life cycle. For information on the tasks within Branch Transformation Toolkit development and where you can find more information on these tasks, see Creating an application with Branch Transformation Toolkit.

Physical deployment

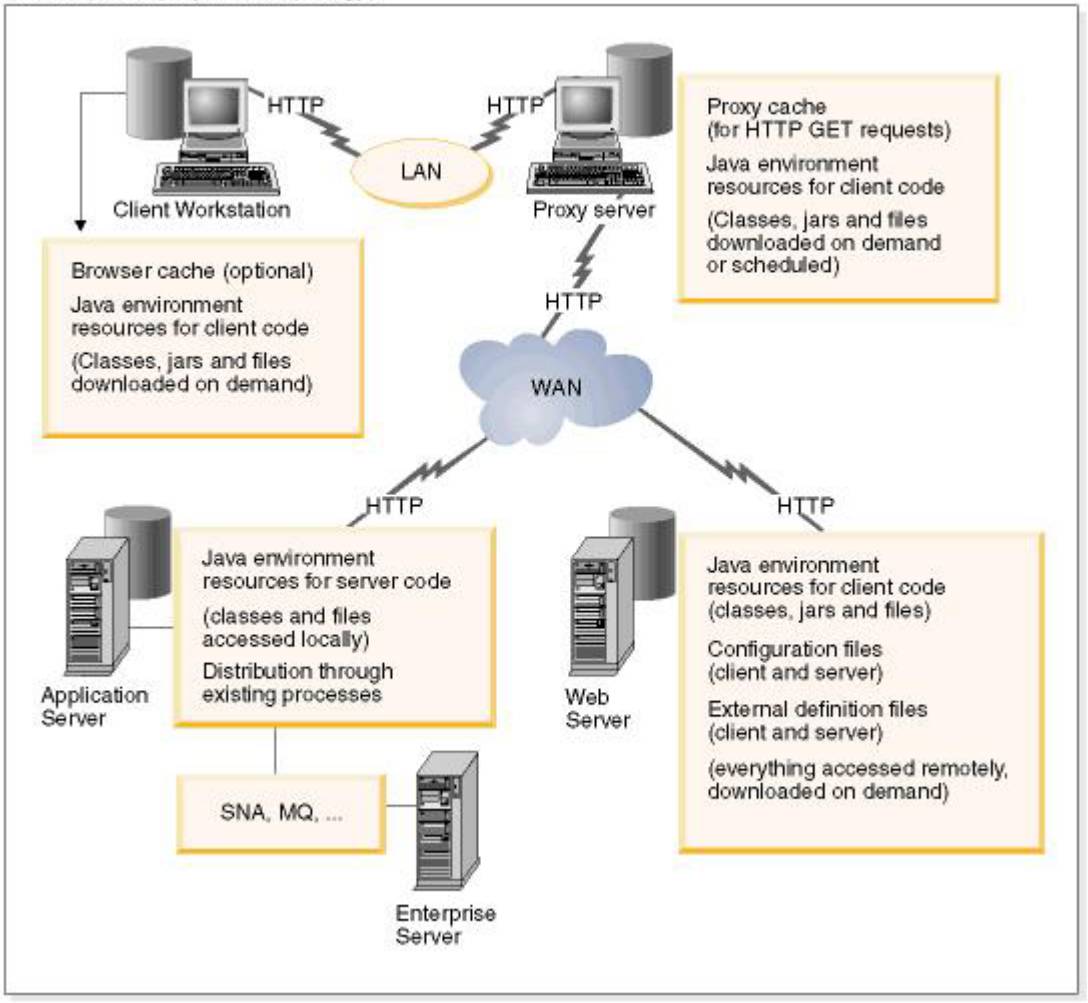
A toolkit-based application should use the standard mechanisms of the Internet or network computing technology for the distribution of objects and should exploit the cache mechanisms to get the best response times.

The physical location of the toolkit components depends on the particular project environment and requirements. The classes and required resources for the toolkit components, such as configuration files, definition files, and icons, may reside either on the local workstation where the application is executed or on a remote server being accessed through HTTP. Its resources are drawn from two main sources:

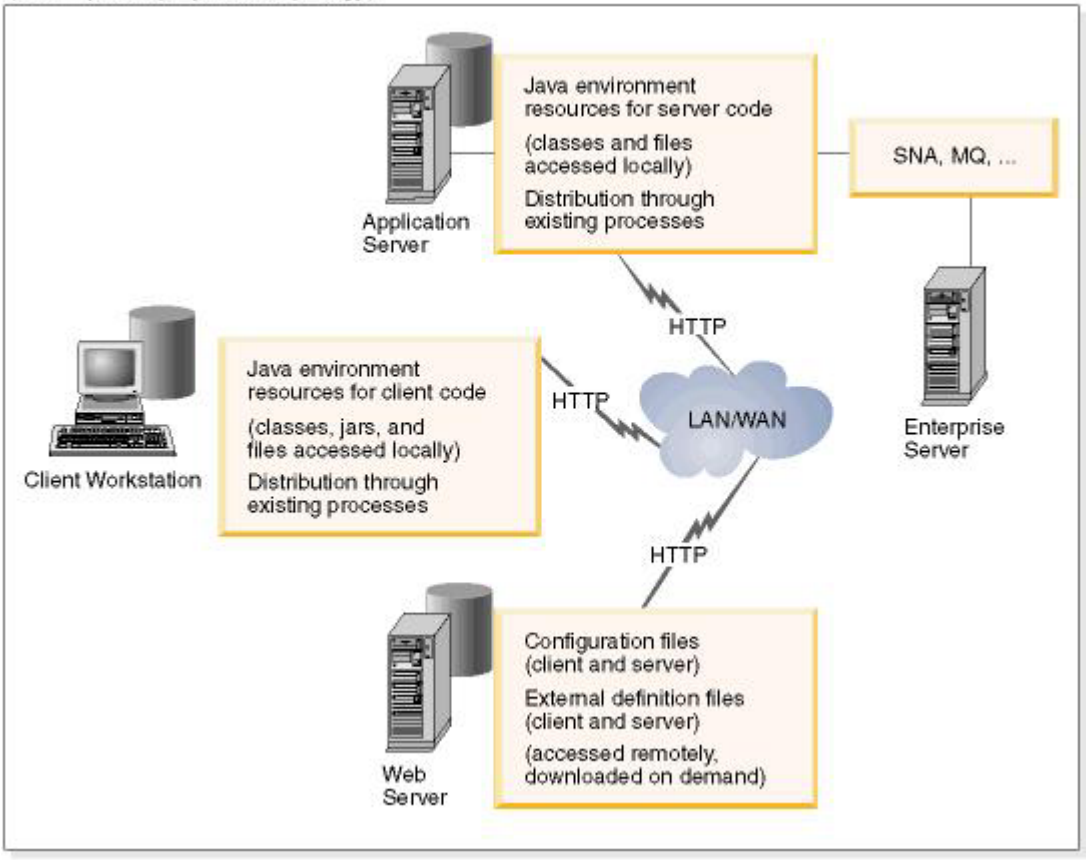
- The classes with their corresponding resources, obtained from the Java resources environment; that is, loaded by the existing class loader following the active classpath. This will be done regardless of whether the code is executed as an application (resources will be located locally) or as an applet running inside a browser (resources will be located either locally or remotely).
- The required configuration and external definition files, as specified in the user settings of the toolkit environment. These allow the resources to be located either locally or on the server, regardless of whether the code executes as an application or inside a browser.

The following diagrams depict sample deployments, with the application code being executed inside a Web browser in the first diagram, and with the application code being executed as an application in the second diagram. Note that the application server and the Web server are different logical entities and can be located in different physical locations, although in simpler configurations, they would coexist in the same server.

Code running inside a Web browser
(a sample deployment topology)



Code running without a Web browser
(a sample deployment topology)



Cache mechanisms

An Internet or network computing architecture has the required installation base code and resources in a central location. Nothing is installed on the client workstations and the central location distributes the required resources on demand from the Web server through the communications network for execution on the client. This topology requires high-speed communication lines, and is enhanced by the use of cache mechanisms in the Web browser and in the proxy servers. The cache mechanisms allow the reuse of objects previously distributed, thereby reducing the requirements of the physical transport layer.

Cache refresh policies

The use of caching requires a refresh policy that prevents the executing application from using out-of-date versions of objects in the caches. Proxy servers can be scheduled to refresh their caches automatically at a prescribed interval or on demand at a particular time. All refresh policies are based on actions started in the proxy server, either because an object has expired or through scheduled processes for checking the versions of server objects. There are no dynamic updates of objects in the proxy when the objects are updated on the Web server. Therefore, depending on the specific system environment and the detailed analysis of the proxy server features, the issue of consistency between the proxy and the server must be resolved, and its solution built as part of the application process.

JAR files

Part of a physical deployment strategy is to set the policy for packaging the code and the resources for an application, as well as to decide the locations for code and resources and their distribution to the final destination workstations. A solution based on the toolkit may use Java Archive (JAR) files, which provide a physical packaging mechanism for a set of HTTP objects or resources (including classes and files). The JAR files have the following advantages:

- Reduce the number of interactions with the server during the download process of the resources
- Compress the objects, thus improving the performance in the transmission and the memory optimization in the cache of the browser

The following packaging considerations regarding JAR files enter into finding a satisfactory balance between the number of objects to handle and the desired network performance:

- The number of JAR files
- Grouping objects that are used when a specific business function is executed
- Grouping objects on the basis of likelihood or frequency of change
- Size of the JARs

Application components and toolkit components may be packaged in JARs, since JARs can be used to package not only the Java classes but all the configuration and external definition files required by the solution.

Performance tips

The performance tips given in this section are intended to help Branch Transformation Toolkit solutions achieve the best performance results. A solution architect should decide, based on the solution design, which of the following suggestions apply.

- **Object cache**:
  - The caching of formatters and operations is enabled or disabled in the configuration file (check enableFormatsCache inside the initialization section). However, the application must exploit this feature by returning objects to the cache.
- **Configuration file**:
  - The toolkit expects some configuration settings to be available in the configuration file. If these settings are not available, internal exceptions are thrown and trace entries are generated, thus consuming CPU cycles even though the default values are still used. When migrating existing applications to an environment where a new product release is installed, consider reviewing the provided configuration file and identifying the changes. An example is the ″queueBufferSize″ settingn at the main settings level, which defaults to 12. Also, consider removing any setting not required in your solution from the configuration file.
- **Shared typed data descriptors**:
  - With the addition of the parameters Hashtable into the base data element class, any data element instance may have its own parameters and reuse the same data descriptor instance associated with the unique data type, thus also reusing the type converters and validators. Check the ″shareDataDescriptors″ setting inside the initialization section of dse.ini.
- **Mapper formatters**:

  - When defining mappers to map elements from/to a flow to/from an operation or subflow, use DataMapperConverterFormat instead of DataMapperFormat. Also, consider using byReference="true" for each of the mapping elements (always keeping in mind the implications that this behavior may have in the context hierarchy).
- **Data access:**
  - Avoid using wildcards when using the getValueAt access method. Use complete data element's paths instead.
- **Synchronized code**:
  - The application flow definitively needs to synchronize those critical code lines when they are executed from concurrent threads (such as arranging the context hierarchy). However, big chunks of synchronized code lines may represent a bottleneck in the solution and reduce the overall throughput.
- **Services access and pooling**:
  - Usually, a solution seeks to improve performance when launching business operations after logging on. It is therefore good design to perform as much process as possible during the initialization of the services, during the session establishment or user logon, so that the actual business processes execute as quickly as possible.
  - To avoid bottlenecks while accessing services that cannot be re-entered from concurrent users/threads, use services pools. The number of services in the pool must be sized according to the expected load rate. Correct sizing will have a definitive impact on the overall solution throughput.
- **Formatter decorators**:
  - When a record formatter definition includes many formatter entries followed by the same kind of decoration (such as a fixed "#" as a delimiter), consider extending the formatter class to include the decoration inside the format process. This mechanism will create only one object (usually a StringBuffer) instead of several strings.
- **Exceptions that are part of the normal flow**:
  - Avoid exceptions that are normal during the application execution flow (such as DSEObjectNotFound).
- **Extended classes to be customized**:
  - Classes available in extension packages (such as com.ibm.dse.automaton.ext and com.ibm.dse.base.types.ext) are especially provided to be further extended in a solution. Consider extending these classes both to add your own logic and to remove non-required logic.
- **Client/Server Mechanism**:
  - Consider using a compression decorator in the client/server request and response formatters to minimize the amount of data sent through the communications network.
- **JSPs**.
  - Use JSPTags and do not use JSPBeans.
  - Consider a solution based on an XML-formatted data set being returned to the client and processed by a template processor in the client (XSLT). The corresponding request handler may be extended to build a faster stream based on formatters instead of JSPs. This approach requires less network bandwidth and is faster than building the response on the server. However, it has other implications that need to be considered such as the XSL support in the Web browsers.
- **Deployed JARs**:

  - Choose only the JARs that belong to the components that are used in the solution. Keep JAR files granular and as small as possible.
- **High availability, load balancing, failover, and session persistence**:
  - 24x7 available solutions have a very high performance or monetary cost. Consider using load balancing with session affinity, so that once the user establishes a session with a server image or clone, all the requests will be routed to that clone. If session persistence is enabled, tune the minimum boundary size of the session data to be persisted in order to enable compression (check setting minSizeForCompression inside the initialization section of DSE.INI).
- **Trace**:
  - Do not use the product trace mechanism as an application log. Instead, use database access services for this purpose.
  - Configure the trace settings according to the running environment. Settings such as whether to trace to file, intermediate buffer size (linesOfBuffer), and showOriginator have direct impact on the solution performance.
  - Use the Trace.doTrace method as a Boolean condition for tracing (before using the Trace.trace method) in the application flow, to check whether the system will trace the entry based on the external configuration. The application will only create the string if the returned Boolean for the doTrace method is true.
- **Application sessions table management**:
  - The application is responsible for maintaining the sessions table through the Context class protocol. It is crucial to clean session information from the table when the user logs off or when a session expires, to avoid apparent memory leaks and performance degradation. Both session entries and processor instances maintained in a session need to be removed from the table. Processor instances available in the cache also need to be removed in these cases.
- **JDBC Table access services**:
  - Consider using stored procedures when requiring access to several tables in the application flow. Cross-logic against several tables using many JDBC Table access calls is not recommended.
- **Java Profiler**:
  - Identifying the objects that are created most often and the classes and methods that use more CPU time during the request process is crucial to optimizing the solution performance. Any Java profiler may be used to get this information, and this is a task that should be done during the whole development cycle, without waiting until the final implementation of the solution.

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