



WebSphere Development Studio Client for iSeries product overview

Version 5.1.2 for Windows



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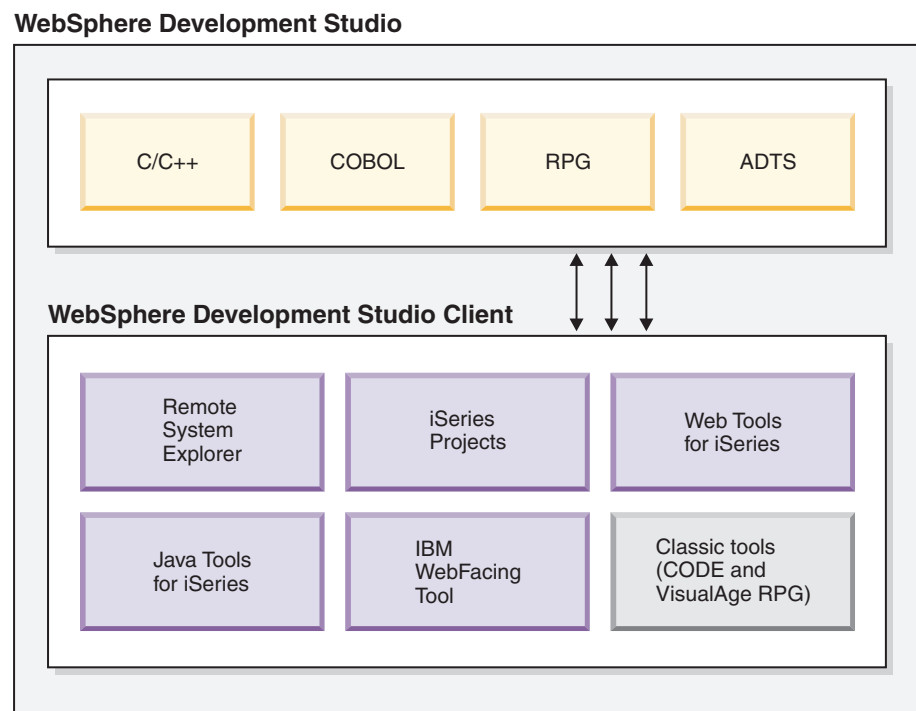
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Chapter 1. Overview of IBM WebSphere Development Studio Client for iSeries

IBM WebSphere® Development Studio Client for iSeries is the ideal set of workstation development tools for creating, testing, deploying, and maintaining traditional and e-business applications for your iSeries server. WebSphere Development Studio Client for iSeries is included with the compiler-based server product, WebSphere Development Studio. The following diagram illustrates the interaction between server and client tools:



The client component of the overall package is designed to help you accomplish three primary programming goals:

1. Develop and maintain iSeries applications
2. Create Web-enabled front ends to iSeries business logic
3. Create GUI front ends to iSeries business logic

You can use this product to perform all of the following tasks from a Windows® workstation.

Goal 1: Develop and maintain iSeries applications

- Connect to remote systems and perform programming tasks
- Edit, compile, run, and debug applications, whether green-screen, Web-based, or combined
- Work on iSeries applications when disconnected from the iSeries server
- Develop iSeries business logic in the Java™ programming language
- Develop in a team-based environment with version control

Goal 2: Create Web-enabled front ends to iSeries business logic

- Develop Java servlets and Java Server Pages (JSP files) that access iSeries programs and data, whether your core skills are in Java or ILE and Original Program Model (non-ILE) programming
- Customize the appearance of static HTML pages and JSP files for a Web site
- Test Web applications in a local WebSphere test environment
- Quickly add a Web interface to an existing application and deploy to an iSeries application server

Goal 3: Create GUI front ends to iSeries business logic

- Develop graphical user interfaces to RPG programs using visual design tools
- Produce Java applets, Java applications, and native Windows applications from the same source

Additional goals

- Develop XML resources
- Develop SQL statements
- Create Web services
- Generate Web pages from local and remote relational databases

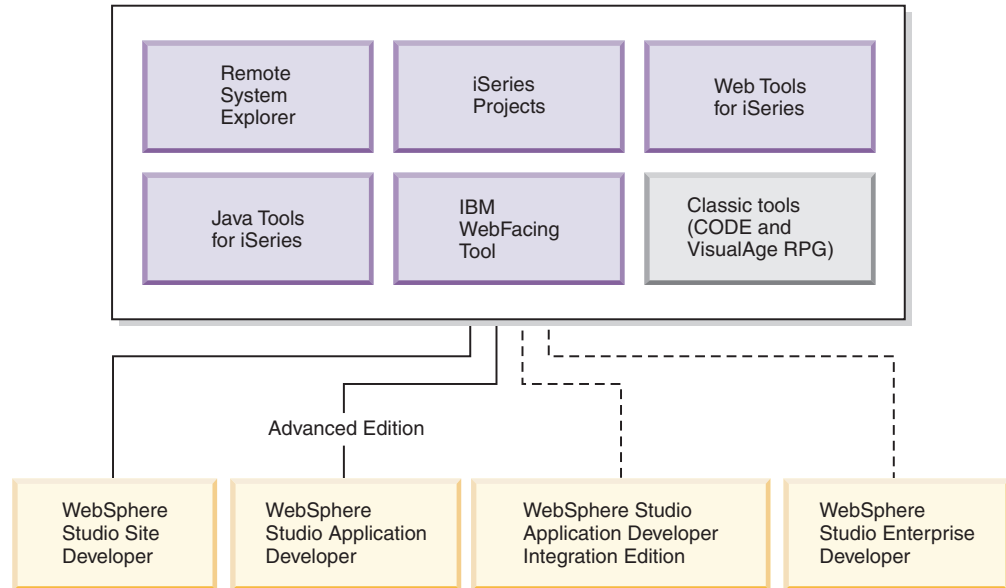
Understanding the WebSphere Studio family

The product comes in two editions for iSeries programmers. Both editions of the product come with an additional base WebSphere Studio product:

- WebSphere Development Studio Client for iSeries includes WebSphere Studio Site Developer.
- **Advanced** WebSphere Development Studio Client Advanced Edition for iSeries includes WebSphere Studio Application Developer.

Either edition can also coexist with WebSphere Studio Application Developer – Integration Edition or WebSphere Studio Enterprise Developer (represented by the dotted lines). The following diagram illustrates how Development Studio Client fits into the WebSphere Studio family of products:

WebSphere Development Studio Client for iSeries



WebSphere Development Studio Client for iSeries is packaged with WebSphere Studio Site Developer. Site Developer includes support for Web services, XML development tools, and core support for Java and Web development tools.

Advanced IBM WebSphere Development Studio Client Advanced Edition for iSeries is packaged with WebSphere Studio Application Developer. This base product provides end-to-end support for the creation and maintenance of J2EE applications and Web services. It also provides extensive support for Enterprise JavaBeans, and for Java messaging services.

The next two sections, *Tasks overview* and *Tools overview*, describe in more detail the main tasks that you can complete with IBM WebSphere Development Studio Client for iSeries, and the tools to use for these tasks:

- Read the *Tasks overview* if you are new to the product and want to understand how to choose the right tools to do your job.
- Read the *Tools overview* if you have used a previous version of this product or a similar product and you want to understand what new tasks you can perform with each of the tools.

Prerequisite information

1. If you have not yet installed the product, see the installation notes on the first product CD or the product DVD under `x:\install\help\helpnls\install.htm`, where *nls* denotes the appropriate language.
2. You can use the integrated server and test environment for the development and testing stages of your product. To deploy and run your e-business applications in a production environment, you need to install and configure IBM WebSphere Application Server for iSeries and an HTTP server such as IBM HTTP Server for iSeries (powered by Apache) on the hosting iSeries server. Some configuration instructions and links to other sources of documentation are included in this guide.

3. You can also deploy your Web applications to WebSphere Application Server – Express. This is an entry-priced, entry-level server in the WebSphere Application Server family, providing support for static content, servlets, and JSP files.
4. If you purchased Development Studio Client as a workstation-only product, you need to ensure that WebSphere Development Studio is installed on any iSeries server where you perform the server portion of your development work. However, WebSphere Development Studio is not required on the iSeries server you use for Web application deployment.

iSeries developer roadmap

The iSeries developer roadmap describes discrete, achievable steps that move developers and applications on the path to an excellently implemented Web future. Go to the the iSeries developer roadmap at http://www.ibm.com/servers/enable/site/ideveloper_j2ee/descript.html and click the graphic to see the roadmap image.

Starting from the left, this is where most IT shops that use the iSeries platform and Business Partners are today. Typically, day-to-day development tasks still involve building and maintaining green-screen applications via traditional 5250 tools such as Programming Development Manager (PDM), Source Entry Utility (SEU), and Screen Design Aid (SDA).

The first step to Web application enhancement involves embracing modern tools to do the same development work previously accomplished via PDM, SEU, and SDA (see the "Better Tools" column).

The next step, which is considered to be urgent by end users, is a better user interface (UI) than the generations-old green screen. For most applications, this is best addressed by moving to a browser-based user interface.

"Better Architecture" is a significant step where—from scratch or from cut-and-paste—you create a Web application, an application enhancement, or even a new Web service. Separating the business logic from the user interface is a very important experience, and is fundamental to a superior architecture that allows for logic reuse.

"Better Portability" involves a move from creating business logic in traditional languages to writing it in Java. You use simple, standard Java—referred to as Java 2 Standard Edition (J2SE)—that accesses data in the familiar SQL ways.

Finally, on the far right, there is "Better Scalability." For companies requiring highly scalable Web applications or the full object-oriented and functional power of J2EE, the J2SE Java code is replaced with Enterprise JavaBeans (EJBs) and Message Driven Beans.

Also see Education for the iSeries developer roadmap at http://www.ibm.com/servers/enable/site/education/abstracts/roadmapj2ee_abs.html for more information.

Tutorials, scenarios, demos, and presentations

Tutorials and samples help you get started with Development Studio Client. See **iSeries tutorials and samples** in the online information. Also be sure to see the product Web page, in particular, our library page at <http://www.ibm.com/software/awdtools/wdt400/library/index.html> for updates to the Development Studio Client tutorials and samples.

What's new in this release?

Version 5.1.2 of Development Studio Client and Development Studio Client Advanced Edition include the following new features, sorted by your role and the edition of Development Studio Client you purchased. (Please see "Tools overview" on page 12 for descriptions of all components):

Your role	New features
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RPG and COBOL iSeries programmer	<ul style="list-style-type: none"> • While editing ILE RPG source with the Remote Systems LPEX editor, the following features are now included: <ul style="list-style-type: none"> – Conversion from fixed-form to free-form code – Automatic indentation for free-form code – Automatic code completion for control blocks – New wizards for creating D-specifications and Java method calls – SQL syntax checking • The inclusion and display of key lists in the Outline view for ILE RPG code • Syntax checking and program verification for ILE COBOL • Automatic uppercasing for ILE and non-ILE COBOL • Customization for the CL automatic formatter • Workbench toolbar buttons for "verify" and "compile" • Reference documentation available from the Source workbench menu • Customization of token colors • The ILE RPG and ILE COBOL syntax checkers and program verifiers are updated to the V5R3 OS/400 level • New iSeries Job Status view for working with OS/400 jobs • Configurations, called Run Launch Configurations, that you can use to edit and save information required to run your iSeries applications • Enhancements to the iSeries Table view: <ul style="list-style-type: none"> – The ability to specify command line parameters for actions invoked from the iSeries table view – The ability to customize and save column layouts – Function key support • Enhanced remote searching capabilities to include: <ul style="list-style-type: none"> – The ability to search the contents of remote files and filters on the iSeries native file system – Asynchronous searching of the iSeries Integrated File System (IFS), Linux, Windows, and UNIX servers • The ability to expand and work with the contents of .zip, .jar and .tar archive files. • Enhancements to iSeries projects so that you can compile individual members. This is in addition to the function that allows you to build whole projects. • Enhancements to the Program Call wizard, (which you use to wrap RPG and COBOL applications into Java calls); more information in the Java, C, and C++ developer section below
Java, C, and C++ developer	<ul style="list-style-type: none"> • Enhancements to the Program Call wizard: <ul style="list-style-type: none"> – Support for version 4.0 of PCML. – You can now import any PCML file generated by COBOL or RPG iSeries compilers. – A new interface to make it easier to select parameters when creating a Web service. • New Remote Error List view to display feedback from shell commands on UNIX, Linux, Windows, and local servers (applicable to Java/C/C++ programmers).

Web developer	<ul style="list-style-type: none"> • Enhancements to iSeries Web Components: <ul style="list-style-type: none"> – Support for cascading style sheets—You can define your own external or internal style sheet, or inline styles, to override the default styles of iSeries Web Components. This gives you extra flexibility in customizing the look and feel of your Web pages. – It is now easier to design your own JSP page with the enhanced Palette view, and entry field validation is provided in Attribute view to decrease the chance of entering erroneous data. – A new Page Template File wizard is available to create an iSeries Web Components Page Template, which you can then use to apply to a JSP file to iSeries Web Components. • Enhancements to the Web Interaction wizard: <ul style="list-style-type: none"> – In addition to iSeries Web Components, you can use JSP files with plain HTML controls to build Web pages that interact with an iSeries program or procedure call. – You can choose a Page Template for the generated input or output pages in the Web Interaction wizard. – Message handling is improved such that you can now associate an iSeries Message file or a Java properties file with your Web application in the iSeries Web Tools Runtime Configuration wizard. This support enables your application to retrieve run-time messages from the properties or message file and display them on your Web pages. – The flow controller feature is improved so that you can now connect multiple output pages from the Web Diagram editor and specify the flow condition in the Web Interaction wizard. – You can now define a program or procedure to call when your Web application session times out. – The flexibility of Java classes created by the Web Interaction wizard has been enhanced to include more methods and be organized into packages. These Java classes are generated from templates, and you can customize these templates as well.
Web services developer	<ul style="list-style-type: none"> • The Program Call wizard is enhanced to include support PCML 4.0, and it can now generate Web Service beans from PCML files created by the ILE RPG or COBOL compiler.
iSeries programmer and IBM WebFacing Tool user	<ul style="list-style-type: none"> • Support for DDS INVITE and asynchronous screen input / output using CL SNDF/RCVF commands • Support for applications that use program-to-system fields for setting the display attributes of protected fields • Performance improvements for applications that require job attribute information to resolve DDS keywords • Improved performance and usability for debugging third-tier Web-enabled applications using the IBM WebFacing Tool <p>Advanced For Advanced Edition users of Development Studio Client</p> <ul style="list-style-type: none"> • Support for portlet applications that can access DDS-based RPG, COBOL, and CL applications. You can run and test the portlet application inside Development Studio Client, and then deploy the application to the WebSphere Portal Server for production. • Support for applications that display system screens during the application flow

All developers	<ul style="list-style-type: none"> • Support for version 1.4 of Java Development Kit (JDK) • Support for migration of projects from the previous release of Development Studio Client • WebSphere Host Access Transformation Services Toolkit (HATS Toolkit) version 5.0, to transform the screens of a server application into a Web application you can deploy to a Web server. This tool, however, is for development use only. When you deploy the application, you need to acquire a user-based license. • Debugging support for DB2 stored procedures • Service entry point management in the Remote System Explorer. See “Integrated iSeries debugger” on page 20 for more information. • While debugging, you can issue a step return in your ILE programs. When you step return, all threads are allowed to run. The current execution point, up to the line immediately following the line that called the function or program, is executed. Execution stops after exiting the current function or program. • You can debug SQL stored procedures, complete with editor source view display. • Support for Enterprise Generation Language (EGL) programming, to create Java or COBOL source, and prepare the output to produce executable objects. This support is available through the EGL and the EGL Web perspectives. Using EGL, you can also: <ul style="list-style-type: none"> – Place the source on a deployment platform outside of the development platform – Prepare the source on the deployment platform – Sends status information from the deployment platform to the development platform, so you can check the results
	<p>Advanced For Advanced Edition users of Development Studio Client</p> <ul style="list-style-type: none"> • Support for the IBM Portal Toolkit. Portals let you organize Web information and access enterprise services through a single consolidated view of Web usage. You can use the Portal Toolkit to create, edit, and deploy an enterprise portal, individual portlets, and associated Web content. The toolkit also comes with the WebSphere Portal Unit Test Environment, which you can use to debug and test portlet applications inside the product before you deploy them to a Web server. • Enhanced security to provide single signon authentication using Enterprise Identity Mapping (EIM), so that users who have been authenticated by the WebSphere server can access WebFacing Web or portlet applications without having to re-login. (This support is for V5R2 and later OS/400 systems only.)

Tasks overview

The section explains how to use the different tools in Development Studio Client to accomplish your major development goals.

Goal 1: Develop and maintain applications

Development Studio Client is designed to ease the entire life cycle of developing and maintaining iSeries applications. Whether you work on traditional green-screen applications, or are responsible for making existing iSeries programs accessible as Web applications, your productivity is greatly increased as you work on the following tasks.

Edit, compile, and debug ILE and non-ILE applications

You can create and manage development projects on your iSeries server from your Windows-based workstation with the Remote System Explorer and iSeries projects. With these tools, you can view iSeries libraries, files, and members. You can also launch the server compilers, the workstation editor, and various debuggers. Your program editing tasks are simplified with the Remote Systems LPEX editor. The editor can access source files on your workstation or your iSeries server.

With the integrated iSeries debugger you can debug your program running on the iSeries server from a graphical user interface on your workstation. You can also set breakpoints directly in your source before running the debugger. The integrated iSeries debugger client user interface also enables you to control program execution. For example, you can run your program, set line, watch, and service entry point breakpoints, step through program instructions, examine variables, and examine the call stack. You can also debug multiple applications, even if they are written in different languages, from a single debugger window.

Develop iSeries business logic in Java

You can use iSeries Java development tools to create Java applications that can access iSeries data. More specifically, you can also call native iSeries applications from your Java code.

Create and edit DDS definitions easily

You can create and update DDS definitions for display files, printer files, and physical files using CODE Designer when you are on or offline. This tool provides a graphical user interface you can use to define your DDS files, and then save them locally or upload them directly to your iSeries server. By creating your DDS screens visually you can improve their usability and your programming productivity (because more of your time is spent on visual design, and less on getting the syntax right).

Goal 2: Create Web front ends

With Development Studio Client you can make your iSeries applications and data accessible beyond the green-screen interface. You can generate a Web-based user interface for your program's DDS screens, or create a new Web interface that connects directly to your program's input and output parameters. Which path you choose depends on the way your iSeries application is designed, and on trade-offs you need to make between rapid deployment and customized look and feel. With IBM WebSphere Development Studio Client for iSeries you can perform the following Web-enabling tasks for your iSeries applications.

Generate Web front ends to existing applications

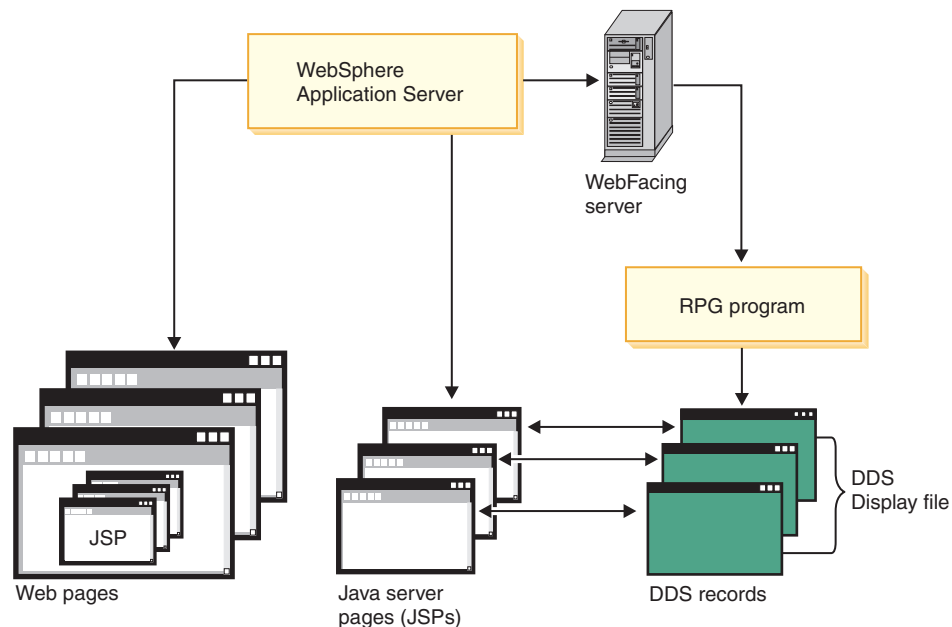
You can use the IBM WebFacing Tool to create Web front ends to iSeries applications that use DDS for their green-screen transactions. You choose a Web style for your green-screen application, generate a set of JSP and XML files that interact with the logic of your program, and then easily test your application in the WebSphere test environment of the workbench. When you are ready to deploy your application, you can generate standard J2EE WAR and EAR files that can be installed on a WebSphere Application Server.

The WebFacing Tool is ideal for applications that you want to deploy broadly over a corporate intranet or the Internet, where rapid deployment takes precedence over customizing the look and feel of each page. With the WebFacing Tool you can continue to deliver your application as a 5250 application, and use the same ILE and non-ILE programs to deliver the application through the Web. Note that there

are some restrictions, described in the WebFacing documentation, on which DDS keywords can be converted to generate sets of JSP and XML files.

CODE Designer has been enhanced to work with the WebFacing Tool. A new **Web Settings** section helps you specify how your DDS fields and constants will be handled by a browser after they are converted using the WebFacing Tool, without affecting their appearance on the green-screen.

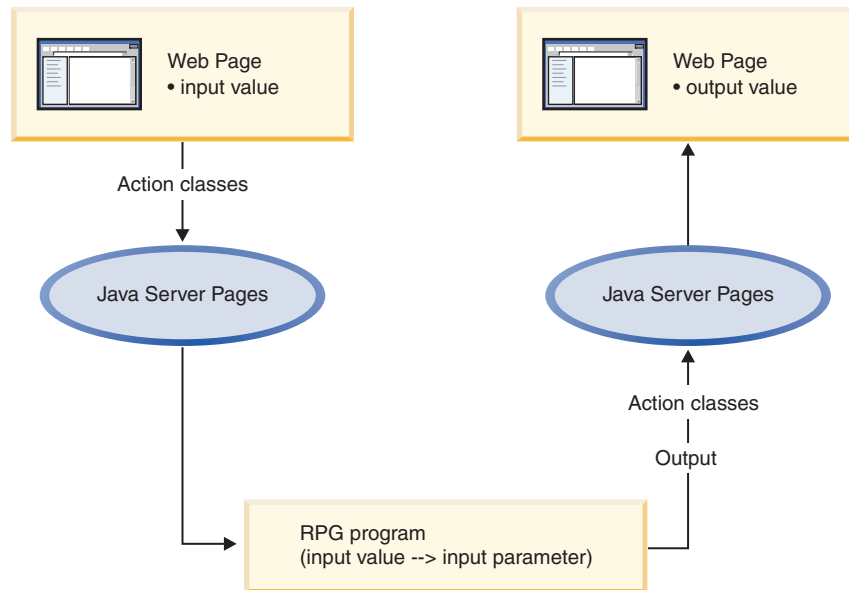
The following diagram illustrates the run-time process for the WebFacing Tool:



Use the WebFacing Tool for programs where the DDS user interface is interwoven with the business logic. If you architect programs with a set of distinct entry points for each element of business logic, and a user-interface component that simply generates appropriate calls to business logic entry points based on user inputs, you should consider using Web development tools to develop your own servlets and JSP files to access your code, as described in the next section.

Develop Web pages, Java Action classes, and JSP files to access iSeries programs and data

You can create interactive Web pages using Web development tools. Use the Web Interaction wizard to define how your pages interact with one or more ILE or non-ILE applications. This wizard generates Java Action classes and JSP files for use with data from HTML forms. When the end user enters data in a form, the input becomes data to your ILE and non-ILE programs, and the output from the programs is formatted for the Web. Your ILE and non-ILE logic can be separated into different programs for each stage of input and output (known as a Web interaction), or can be a single service program with entry points to handle each Web interaction. The following diagram illustrates the Web development tools process:



You can also use Web development tools to develop customized Java classes that run on the iSeries server. These servlets make use of iSeries data directly, or can access the data through ILE and non-ILE applications. IBM Toolbox for Java classes included with Java development tools let you access iSeries data files and issue ILE and non-ILE program calls from the Java servlets. You develop the servlets using Web development tools, and use the Record I/O and Program Call classes from the toolbox to retrieve and update iSeries data. You can launch your servlets or customize their output from the JSP files that you create in the Page Designer editor in Web development tools.

Customize the appearance of your Web site pages

You can easily customize your HTML and JSP files using the editing tools in Web development tools. Use these tools to create and update input forms, change the appearance or placement of blocks of text, and add backgrounds and images to your pages. The iSeries-specific Web components help you create Web versions of your input and output pages with the same kinds of input validation, output formatting, and subfile controls that native DDS screens provide. You do not need a detailed knowledge of HTML or Java to accomplish these tasks.

Test and deploy your Web-enabled applications

You need an easy test mechanism for your Web-enabled applications. These include applications you have hand-coded on your workstation that use:

- HTML
- JSP files
- Java servlets
- Web front-ends created using one of the code-generating wizards in Web development tools.

You can easily run your program in the WebSphere test environment of the workbench, quickly make changes, and retest, rather than redeploy your application every time you want to verify functions. When you are finished, you can package and deploy your Web applications as J2EE-based Web archive (WAR) and Enterprise Archive (EAR) files, and then install them in a WebSphere Application Server.

Goal 3: Create GUI front ends

You do not have to deploy your iSeries applications on the Web in order to give them a more modern look and feel. You can produce graphical user interface (GUI) front ends to your iSeries applications with Java development tools.

Produce applets and native graphical user interfaces from the same source

After you create a visual interface and associated logic on your workstation, you can deploy your application as a native Windows application, or as a Java applet that can run in any Web browser with an appropriate Java Virtual Machine (JVM™). This gives you extra flexibility in making your application available to users. If you want to control access tightly, you can deploy the application as a Windows executable. If you want widespread access you can place your applet (and associated files generated by Java development tools) on a Web site, so that users with browser access to the Web site can run the applet in their browser and communicate with data on the iSeries server.

Create Java-based graphical user interfaces to ILE and non-ILE applications

Use your own custom calls to Java GUI classes (such as Swing classes), and the Java visual editor to develop your graphical user interface, and then use classes provided by IBM Toolbox for Java or Java beans provided by Java development tools to access your iSeries server. Although this option gives you great flexibility over your program's look and feel, it requires a bit more work than using Web development tools to develop HTML-based interfaces to iSeries programs.

Tools overview

This section describes the main tools of Development Studio Client, and the kinds of tasks you can perform with each tool. The tools are:

- “The workbench-based integrated development environment”
- “iSeries development tools” on page 13
- “iSeries Web development tools” on page 16
- “iSeries Java development tools” on page 16
- “Struts environment support” on page 17
- “Web Services development tools” on page 17
- “Server development tools” on page 18
- “The IBM WebFacing Tool” on page 18
- “VisualAge RPG” on page 19
- “CoOperative Development Environment (CODE)” on page 19
- “Integrated iSeries debugger” on page 20

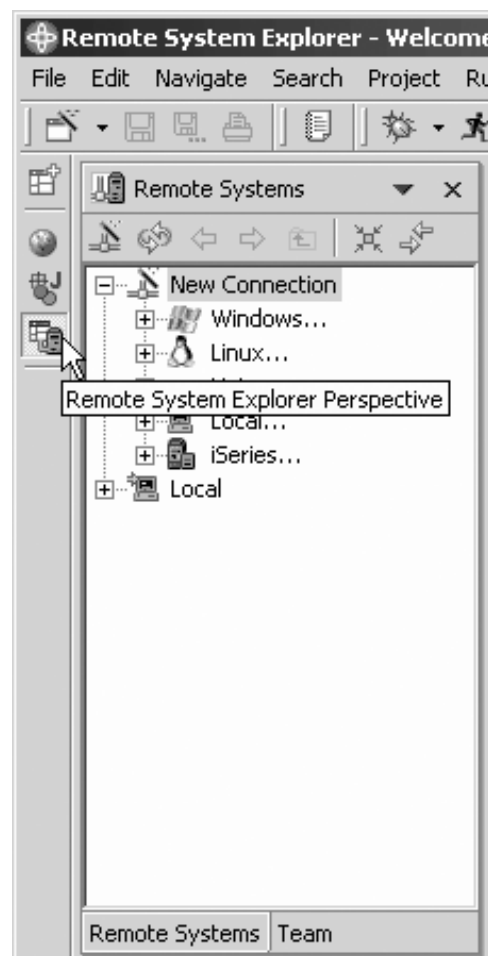
The workbench-based integrated development environment

IBM WebSphere Development Studio Client for iSeries uses WebSphere Studio Workbench. The workbench offers you a comprehensive development environment that integrates all your tools, teams, assets, and other workbench-based projects seamlessly. The platform provides the core frameworks and services upon which all plug-in extensions are created, the run time in which plug-ins are loaded, integrated, and executed, plus a common user interface model for working with e-business tools. Plug-in tools can be integrated into the workbench portable Application Program Interface, yet run unchanged on any supported operating systems. Thus, the architecture discovers these plug-ins and integrates them all

into the new base environment, providing a standard user navigation model for building integrated Web and application development tool projects. Because development resources for a project are stored in a single repository, the workbench is ideal for resource sharing and for providing consistent team support for shared projects.

Perspectives

Perspectives define the initial set and layout of views in the Development Studio Client workbench. They provide a set of capabilities aimed at accomplishing a specific type of task or working with specific types of resources. To open a perspective, click **Window > Open Perspective**. Open perspectives are represented by icons on the shortcut bar (the toolbar at the top-left of the workbench window). When you have more than one perspective open, you can switch between them by clicking the icons on the shortcut bar. Your current perspective displays in the workbench title bar.



You can also save customized perspectives for reuse. To work with perspectives, use the workbench menu items for **Window > Customize Perspective** and **Window > Save Perspective As**.

iSeries development tools

Two major iSeries development tools, the Remote System Explorer and iSeries projects, provide the framework, user interface, editing capability, and performable actions on iSeries objects, commands, and jobs.

Tools to access and edit Native iSeries applications

iSeries development tools support views, editors, and tool extensions, to help you develop and maintain iSeries applications while working with remote operating systems. The Remote System Explorer and iSeries Projects perspectives are the iSeries programming environments you use to complete these tasks. The perspectives guide you through various connections to your remote systems, give you access to files and resources, and help you monitor jobs and run commands. They also provide support for the sharing of work through a team perspective. Most users can easily do their work using the Remote System Explorer perspective. The iSeries Projects perspective is designed more specifically to support structured programming, offline development, and team collaboration.

The Remote System Explorer perspective also supports system types other than iSeries systems, such as UNIX[®], Linux, and Windows systems.

The Remote System Explorer and iSeries projects provide additional support for:

- Seamless access to local and server files
- Using copy, paste, and drag-and-drop support, even between server systems
- Manipulating library lists
- Defining your own actions to support all PDM substitution variables
- PDM-style filtering of iSeries objects from your library list
- Member locking of OS/400 members and Application Development Manager parts
- Navigation through procedures and subroutines in one or more files
- Multiple file search and a file compare utility
- Extending the Remote System Explorer and iSeries projects by plugging in third-party tools

A good place to begin in the help contents is: Introduction to the Remote System Explorer.

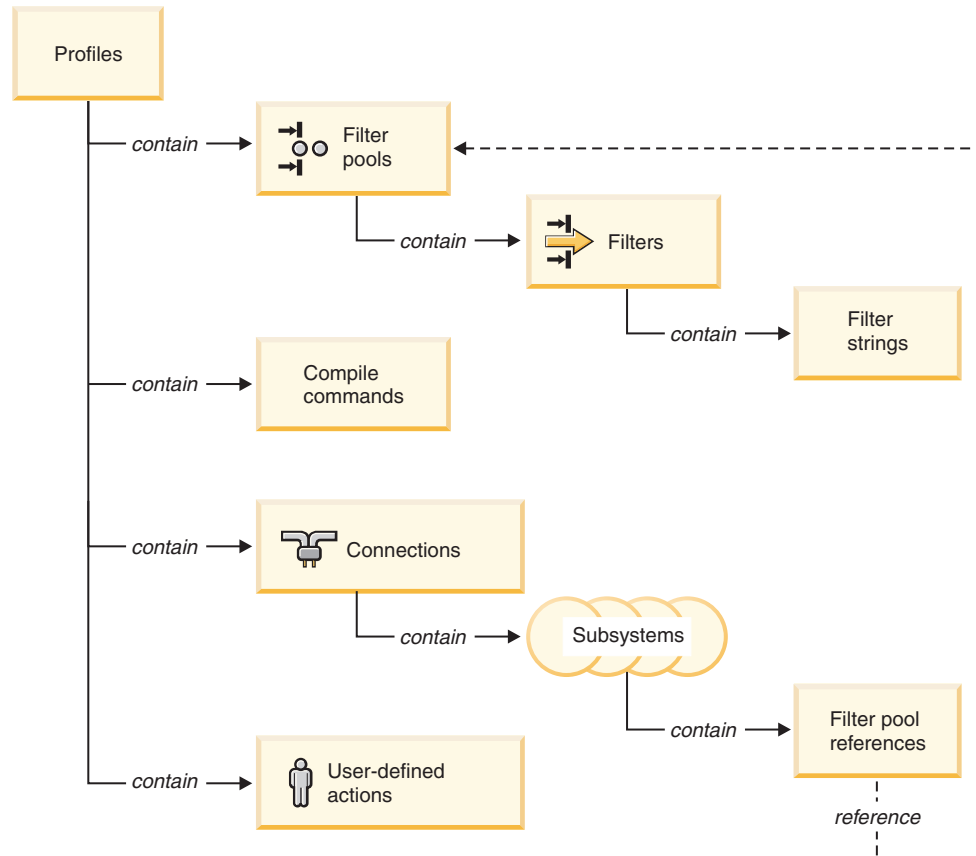
Universal file and command subsystems

You can export and import files, explore remote files, and execute remote commands for servers other than iSeries, such as UNIX, Linux, and Windows servers. Using the Remote System Explorer, you can use the workbench editor of your choice for any remote file on any type of remote server.

iSeries exploration and command execution

Use the Remote System Explorer to list libraries, objects, and source members to your local machine, and organize these elements into filters. You can create and share filters for rapid access to specific artifacts and commands. Filters can also be partitioned into pools to allow for easier organization of filters. To save time, you can also open source members directly in the Remote Systems view without having to create a filter. You can work with iSeries native file system (QSYS) files and CL commands, and generic file and command subsystems that involve the Integrated File System files and QSHELL commands. You can also create your own actions and commands.

The following graphic serves as both a summary and an introduction to the structure of the Remote System Explorer and iSeries development tools:



iSeries actions for edit, compile, run, and debug

The Remote System Explorer contains the Remote Systems LPEX editor, so that you can edit source code directly in the workbench. The interface provides right-click actions so that you can compile, run, and debug your programs.

The Remote Systems LPEX editor also supports:

- Many rich editing features for RPG, COBOL, CL and DDS such as syntax checking and DDS program verification
- Concurrent multiple edit sessions as well as multiple views of the same document
- The Outline view and Content assist for ILE COBOL and ILE RPG source
- Local verification and error feedback
- Command shells for running local or server commands with logged output
- The ability to create a new RPG procedure, D-specification, and Java method call

iSeries Projects perspective

The iSeries Projects perspective is the ideal tool for team-based iSeries application development. The perspective encourages structured programming and allows for disconnected development. In the perspective, you can also monitor error feedback, and inspect timestamps to resolve conflicts between remote and local files.

Extension of the Remote System Explorer and iSeries Projects for business partners

Using the workbench IDE, you can integrate your tool sets into the Remote System Explorer. Many leading iSeries tool vendors are actively integrating their tools into Development Studio Client. In this release, we provide enhanced functions to make this easier.

iSeries Web development tools

iSeries Web development tools give you the ability to create new e-business applications that use a Web-based front end to communicate with the business logic in an ILE or non-ILE language program residing on an iSeries server. In contrast to the WebFacing Tool, with Web development tools you can build a Web application from scratch and control everything about the applications behavior and appearance, with many more tools for customization. You can create the high-level design of your Web site and apply page templates using Web site designer. Then, you can create the individual pages with Page Designer, or generate input and output JSP files with the Web Interaction wizard. You can also add iSeries Web components to your pages, for example, Web equivalents of iSeries command keys, input fields that accept only particular types of data, or a Web component that provides subfile-like support. You can even use iSeries Web development tools to customize the JSP files generated by the WebFacing Tool.

The tools give you open standards, greater flexibility, and the ability to tie in existing applications with Web services wizards to help you write applications that are portable across platforms.

The specific iSeries extensions of Web development tools include:

- Support for the Struts run-time environment and the Struts Web Diagram editor
- iSeries Web Tools run-time configuration wizard that captures server name, user ID, password, and library list information
- A Web Interaction wizard that links the Web components for a Web page to parameters of your Program Call and defines the Program Call parameters without the need to deal directly with JSP files and iSeries classes. The wizard is designed so that you can access iSeries programs from a Web application, or include them as the base for a Web service
- **Advanced** The ability to run a Web application in a portal server with a new iFrame portlet and sample

iSeries Java development tools

iSeries Java development tools give you the ability to develop Java applications and write, compile, test, debug, and edit programs written in Java. Java development tools include an integrated environment that supports the complete cycle of Java program development. Java development tools are the ideal tools for:

- Developing and compiling business logic in Java that runs on a remote server, such as an iSeries or Linux server
- Creating applications and Java GUIs that access existing server data, business logic, and resources
- Deploying or exporting your Java class or source files to a remote server
- Support for EJB query language, container managed persistence (CMP) version 2.0, and message-driven Java beans
- **Advanced** Improved speed and memory performance for Enterprise JavaBean (EJB) deployment

The specific iSeries extensions of Java development tools include:

- iSeries-specific launch configuration support, so that you can remotely execute and debug Java programs on an iSeries server
- A Program Call wizard that can create Java beans and Program Call Markup Language (PCML) files to call your iSeries programs or service programs. The Java beans can also be used to create Web Services using Web Services development tools.
- The ability to trace and determine performance issues for iSeries Java programs with the Profiling perspective
- The IBM Toolbox for Java
- iSeries-specific Java beans

Struts environment support

Development Studio Client offers support for Struts and the Web Diagram editor. Struts is a framework for building Web applications based on the Model-View-Controller paradigm, organizing the application into three separate components:

- Model: the application model with corresponding data representation and business logic
- View: data presentation, providing views for user input
- Controller: to dispatch requests and control data flow

The Web Diagram editor is the visual development environment for developing Struts-based applications. You can drag and drop JSP files and action servlets onto a free-form surface, which is like a blank screen, make connections between items, and then define those items by double-clicking and editing them through a wizard.

Web Services development tools

When components in a system are tightly coupled, and based on database records and flat files, they are rigid and sensitive to change. Web Services tackle the problem of inefficient distributed computing. This is accomplished by ensuring that system components are loosely coupled and dynamically bound to provide greater flexibility, scalability, lower overhead costs, and hence, better business growth. Web services are self-contained, modular applications that can be described, published, located, and invoked over the Internet, employing 'just-in-time' integration of services. The architecture involves a relationship between Service providers, brokers, and requesters. More specifically, Service requesters submit a request to a Service broker, which finds the right service from a Service provider. Web Services development tools allow you to develop this service.

The Web Service wizard creates a Web Service, using a JavaBean generated by the iSeries Program Call wizard, to call one or more server programs or service program procedures on the iSeries server. More specifically, the Web Service wizard works in the context of a Web Project and allows for creation, deployment, testing, generation of a proxy, and publication to a Universal Description, Discovery, and Integration (UDDI) registry of Web services based on Java beans, input and output URLs, DB2[®] XML extender calls, DB2 Stored Procedures, and SQL queries.

Server development tools

Server development tools let you test your applications in locally or remotely installed run-time environments. You do so by creating a server project that represents your environment and can associate your Web projects with a server configuration. This tells your server tools how to configure the instance for that particular Web project.

Server development tools include the following components and features:

- The WebSphere test environment
- A local copy of the WebSphere Application Server run-time environment so that you can test Web and Enterprise Application Archive projects
- A local copy of the TCP/IP Monitoring Server run-time environment, which forwards requests and responses, and monitors test activity
- Support for the local Apache TomCat run-time environment so that you can test Web projects that contain servlets and JSP files
- Support for Remote Agent Controller (installed on your remote machine) if you want to let WAS create a server project instance and configuration for you when you run your Web application (rather than having you create the server project yourself)

Note: If you use an external server instance, such as WAS on your Windows machine or remote iSeries server, you need to deploy your project before running. To deploy, you can use Server development tools to create a remote file transfer instance to handle the details of how and where to copy files.

The IBM WebFacing Tool

With the IBM WebFacing Tool, you can quickly convert your DDS display file source members so that the user interface of your iSeries programs can run in a browser. When you convert your DDS display files, JSP and XML files are generated for you that substitute for the DDS code and make Web access possible.

In the WebFacing Project wizard, you can select one or more DDS source members to convert, and select a Web look and feel from one of several predefined styles, or you can design your own Web style for use with your applications. The tool creates three JSP and XML files for your record formats. The XML files hold the data for the record format, or control its appearance or other characteristics, and the JSP handles displaying the Web version of the screen, prompting for data, and handling input errors. The wizard generates an application home page to launch the Web-enabled version of your program.

When a user invokes a converted application from the browser, the WebFacing server on the iSeries server starts the application. The server intercepts all calls to READ, WRITE, and EXFMT operations to display files, so that in many cases your program (*PGM) can run without modifications, and without even detecting that it is being accessed using WebFacing. You might need to make coding changes if your application uses DDS keywords that are not supported by WebFacing, or if you want to modify the DDS screens so that the conversion to Web format produces a more attractive or consistent result.

The WebFacing Tool also contains:

- Automatic configuration for UTF-8 support when you deploy to WebSphere Application Server version 5.0

- Support for custom tags and run-time extensions
- Support for function keys within window records
- **Advanced** Struts-compliant code generated by the WebFacing Tool conversion process

VisualAge RPG

Using VisualAge RPG you can develop and maintain client/server applications in a visual development environment on the workstation. You leverage your existing RPG skills to create graphical user interface (GUI) applications that you can deploy as native Windows applications, or as Java applets that can run on any Java-capable Web browser. These applications can access iSeries data and other iSeries objects. VisualAge RPG can also create stand-alone Java applications.

With VisualAge RPG you can create, edit, compile, and debug applications on your workstation. You can build an application from the top down. You start by focusing on the look and feel of the interface, and then you tie all the parts together with workstation RPG logic that you write in the VARPG language. You can reuse RPG logic and import display files (DSPF) from an existing application.

You can learn VisualAge RPG quickly thanks to its tightly integrated tools and its visual development environment. For example, you can quickly create text, buttons, and fields in your design window using a point-and-click action.

VisualAge[®] RPG includes the following features and tools:

- The VARPG compiler incorporates the latest changes from the ILE RPG V5R2 compiler.
- You can create interfaces in the GUI Designer by selecting visual parts and dropping them onto your design window, rather than by coding UI capabilities in source code. Select a part such as a push button or an entry field, drag it with the mouse, and drop it on the window you are designing. You can then select an event for the part from the part's popup menu, and use the editor to create the workstation RPG program logic behind the event. From the GUI Designer, you can also launch the editor, the compiler, and the debugger.
- The syntax checker helps you detect syntax errors quickly in your VARPG programs.
- The compiler performs compilations on the workstation, where your applications eventually run.
- The help and message compiler allows you to incorporate online help and messages into your workstation application.
- The editor allows you to add new editor functions or change existing ones. Language-sensitive editing and language-sensitive help are provided with the editor.

CoOperative Development Environment (CODE)

CODE gives you a suite of utilities for creating source and DDS files, and managing your CODE projects. CODE consists of CODE Designer, and CODE Editor.

CODE Designer

CODE Designer removes the drudgery from managing your DDS files. Using a customized visual editor, you perform the following DDS editing tasks with CODE Designer:

- Create new DDS screens, printer files, and physical files

- Add text to DDS screens, simply by clicking and typing
- Insert new screen fields for input, output or both, from a popup menu
- Manipulate fields and text using drag-and-drop actions
- Change the attributes and properties of data fields and plain text
- Link DDS fields to iSeries database fields, by connecting to the database and selecting appropriate fields from a pull-down list
- View the hierarchical relationships among files, records, fields, help specifications, keys, and keywords in each selected DDS object
- Organize records into groups for a particular screen, report, or printer file

You can view the DDS source for each element when you add or update it. You can even edit the DDS code that CODE Designer generates for you. CODE Designer also saves you time by flagging errors before the DDS source is compiled on the iSeries server.

CODE Editor

CODE Editor is the predecessor to the set of powerful editing features found in the workbench, primarily in the Remote Systems LPEX editor of the Remote System Explorer. Please see “iSeries development tools” on page 13 for more information.

Integrated iSeries debugger

The integrated iSeries debugger helps you debug code that is running on the iSeries server or on your Windows system, using a graphical user interface on your workstation. It supports the following tasks:

- Service entry point management in the Remote System Explorer. The service entry point feature is designed to allow easy debugging of Web applications that invoke business logic written in RPG, COBOL, CL, or even C and C++. The service entry point is a special kind of entry breakpoint that you can set directly from the Remote System Explorer, triggered when the first line of a specified procedure is executed in a job that is not being debugged. Thus, service entry points allow you to gain control of your job at that point. A new debug session is started and execution is stopped at that location. While the original service entry point design was meant to assist with debugging Web applications, the feature is also beneficial when debugging applications in an environment where the job name is not known ahead of time. Some sample scenarios include:
 - Debugging WebFacing applications—Typically, the WebSphere Application Server is executing a JSP file that is driving your RPG or COBOL program. The RPG or COBOL code, however, is what you want to debug. Since ahead of time you would not know the name of the job in which your RPG or COBOL program will run, the use of service entry points is an ideal solution.
 - Debugging any application that uses the Toolbox program or service program calls—When a program or service program is called and the code where the service entry point is set is about to execute, the debugger can take control of the application. With this technique, you can put the program or service program invoked by the Toolbox under debug, even though you do not know which job it will be running in.
 - If your application runs in a multi-job environment, service entry points will significantly simplify your tasks while debugging. You can set a service entry point in the program that is about to be spawned in a new job. When the program is spawned and the line where the service entry point is set is about to execute, the debugger will be able to gain control of the program and stop at that line.

- Setting breakpoints on a source code line or on a function or procedure, and setting watchpoints to see when a variable or storage location is changed.
- Three types of stepping operations: step-into, step-over, and step-return. You can even step between functions or procedures written in different languages.
- Viewing the contents of global or local variables, call stacks, and data storage in specialized panes.
- Quick restart of programs you debug repeatedly: Breakpoints and debugger window layouts for a given program are automatically saved between debugging sessions so that you don't have to set them again the next time.
- Attaching to an already running job or Java Virtual Machine on the iSeries server.

The integrated iSeries debugger supports any program written in the following languages:

- ILE RPG, ILE COBOL, ILE CL, C, C++, as well as Original Program Model (non-ILE) RPG, COBOL, and CL.
- Java, when running the program under Windows, or when running on any iSeries server with OS/400 V4R2, V5R1, or V5R2. You can even debug servlets, JavaServer Pages™, and Enterprise JavaBeans on the iSeries server.

By using Object Level Trace along with the integrated iSeries debugger, you can trace and debug applications running on various operating systems including iSeries servers and Windows servers. Object Level Trace provides a graphical view of the different components of your application, and you can click one or more elements to start debugging that component.

Chapter 2. Prerequisites

Before you deploy Web applications using Development Studio Client or Development Studio Client Advanced Edition, and any other relevant tools, you need to ensure that IBM WebSphere Application Server for iSeries and other services are properly configured on your iSeries system. This chapter describes the steps you need to take and provides links to appropriate documentation to prepare your iSeries system for operation. The minimum memory recommendations to run Development Studio Client or Development Studio Client Advanced Edition are 512 MB, 768 MB if you want to use the WebSphere Test Environment. Recommended disk space is 1.8 GB.

If you plan to undertake development work using the Remote System Explorer, Java development tools, or other ILE-focused tools, you need only know how to access your iSeries system to begin development, and you can skip the majority of this chapter.

Therefore, if you do not need to deploy any Web applications, begin here: Introduction to the Remote System Explorer.

Working with your HTTP server and WebSphere Application Server

Your Web-enabled iSeries applications use WebSphere Application Server to run the Java™ servlets and JavaServer Pages™ (JSPs) that allow communication between the Web user's browser and the iSeries programs or data. Advanced In the Advanced Edition of Development Studio Client, WebSphere Application Server can also run your Enterprise Java Beans (EJBs) based on J2EE technology.

To serve your HTML pages and JSPs from the same iSeries system, you also need an HTTP server on that host. We recommend that you use the IBM HTTP Server powered by Apache. You can find documentation about how to use this server in the following place: IBM HTTP Server for iSeries Documentation Center.

WebSphere Application Server handles executing the JavaServer Pages, JavaBeans, Java servlets, and EJBs for the Advanced Edition of Development Studio Client, that are generated for various processes. The primary documentation resources for IBM WebSphere Application Server for iSeries are available at the following Web sites:

- IBM WebSphere Application Server Version 4.0 Advanced Edition for iSeries at <http://publib.boulder.ibm.com/was400/40/AE/english/docs/>
- IBM WebSphere Application Server Version 4.0 Advanced Single Server Edition for iSeries at <http://publib.boulder.ibm.com/was400/40/AEs/english/docs/>

For versions 4.0 of WAS, minimally you need to carry out the steps under the *Installation* link. Becoming familiar with the IBM WebSphere Application Server documentation, in particular the sections on *Installation* and *Setting up multiple instances of the WebSphere administrative server*, is highly recommended.

For WebSphere Application Server version 5.0 and WebSphere Application Server Express:

- RedBooks page for WebSphere: Search for RedBooks for WebSphere Application Server Version 5.0 and WebSphere Application Server Version 5.0 Express Edition at <http://publib-b.boulder.ibm.com/redbooks.nsf/portals/WebSphere>

In order to prepare your system for Web application development and deployment, you need to complete the following tasks. iSeries-specific information is included below, but follow the links above for information about the IBM HTTP Server and WebSphere Application Server servers.

- Become familiar with server port numbers (information provided below)
- Find the port for your HTTP instance
- Find the port for your WebSphere Application Server instance
- Start the HTTP administration server job
- Create your HTTP configuration
- Create your HTTP instance (optional; you can use the default instance)
- Start your HTTP instance
- Install the sample libraries (information provided below)
- Configure your WebSphere Application Server
- Start your WebSphere Application Server instance (information provided below)
- Map a network drive to the iSeries system (information provided below)
- Start the WebSphere Administrative Console

Server port numbers

If you plan to use the default port numbers for WebSphere Application Server and the HTTP server, typically, these default ports are:

- The HTTP server instance uses port 80.
- The WebSphere Application Server version 4.0 instance uses port 900, but this could vary depending on the version of WebSphere Application Server you are using. For WAS version 5.0, there are many default ports. For example, the administrative port is 9090, and the default internal HTTP port is 9080.

If these are not the correct default port numbers, contact your system administrator to determine what these ports are. You can use these port numbers for your HTTP and WAS instances, or you can create your own. See the appropriate documentation for creating your own instances.

The following table lists the ports that Development Studio Client uses to communicate with the iSeries server:

Development Studio Client function	Required iSeries port on OS/400
Remote System Explorer functions: including filtering, editing, compiling, and running	<ul style="list-style-type: none"> • 8470: OS/400 central server • 8475: OS/400 remote command server • 8476: OS/400 sign-on server • 446: OS/400 DRDA (record access) server • 449: OS/400 server mapper server
Integrated File System (IFS) access	8473: OS/400 file server
Interactive job support (via the STRRSESVR command)	8472: OS/400 data queue server
WebFacing (only for run time)	4004: WebFacing server

You need the Remote System Explorer ports (8470, 8475, 8476, 446, and 447) to

remain open for proper functioning of Development Studio Client. However, you only need to keep the IFS, Interactive job support, and WebFacing ports open if you require those functions.

To change the local ports that your workstation uses to connect to the iSeries server:

- Remote System Explorer port:
 1. From the workbench menu bar, click **Window > Preferences**.
 2. Expand **Remote Systems** and click **Communications** to select it.
 3. You can change the port number in the **RSE Communications daemon port number** field.
- Debugger port:
 1. From the workbench menu bar, click **Window > Preferences**.
 2. Expand **Debug** and click **Debug Daemon** to select it.
 3. You can change the port number in the **Daemon port** field.

You also need to reserve two ports on your local machine for TCP/IP 'call-back' communication to the iSeries server.

Development Studio Client function	Required local port
Interactive job support (via the STRRSESVR command)	3001: Remote System Explorer communications daemon
Integrated Debugger	8001: Debugger daemon. This function also uses port 3001.

Installing the sample libraries

To work with the samples in this guide, you need to restore the WHOLESale and WDSCLAB libraries to your iSeries server. You should do this even if you have already restored the libraries for a previous release of the product, because their contents are different. You can use the Development Studio Client workbench to restore the save files for the library, rather than the 5250 emulator. The instructions describe how to restore the WHOLESale library. (To restore the WDSCLAB library, the instructions are exactly the same except in the workbench you select wdsclab.savf instead of wholesale.savf.) The following process uploads the save file to a temporary library on your iSeries server, QRSETEMP, and then restores that save file to a new library called *SAVLIB, or a library of your specification.

Note: The save files used to install the sample library are for use with a V5R1 or later iSeries system.

To restore the libraries:

1. In the Development Studio Client workbench, switch to the Remote System Explorer perspective if you are not there already. From the workbench menu, click **Window > Open Perspective > Remote System Explorer**.
2. In the Remote Systems view, expand **Local > Local Files > Drives**.
3. Continue to expand the **Drives** directory to navigate to the directory where you installed the product. By default, this is **c:\WDSC**.
4. In the **WDSC** directory, expand **wdscsampl**.
5. Right-click **wholesale.savf** and select **Restore on iSeries** to invoke the Restore iSeries Save File dialog box.

6. The first field, **iSeries connection**, specifies the iSeries server to which you want to restore the savf file. In the workbench, you use a connection to communicate between your local workstation and the iSeries server. If you do not have a connection, click **New** to define one to an iSeries server. If you already have a connection, this field is automatically pre-filled with the connection name.
7. Leave the default values for the following fields: **Save file library** and **Save file name**.
8. In the **Saved from library** field, enter WHOLESAL.
9. In the **Restore to library** field, you can accept the default value, enter the name of an existing library you want to use, or create a new library by typing in a new name, for example, MYLIB.
10. Click **OK**. Enter your iSeries user ID and password if prompted.
11. When the wizard completes, go back to the Remote Systems view, and locate wdsclab.sav in the same directory (**Local > Local Files > Drives > C > WDSC > wdscsampl.**)
12. Right-click **wdsclab.sav** and select **Restore on iSeries** to invoke the Restore iSeries Save File dialog box.
13. Select the same iSeries connection you used to restore the wholesale save file in the **iSeries connection** field.
14. Leave the default values for the following fields: **Save file library** and **Save file name**.
15. In the **Saved from library** field, enter WDSCLAB.
16. In the **Restore to library** field, you can accept the default value, enter the name of an existing library you want to use, or create a new library by typing in a new name, for example, MYLIB2.
17. Click **OK**. Enter your iSeries user ID and password if prompted.

Adding the sample library to your initial library list

To make your library addition show up permanently when you expand your library list in the Remote system explorer, you can change your job description (associated with your user profile) to add the library to your initial library list. To add the library:

1. Open a 5250 emulator and sign on to your iSeries server.
2. Enter `dspusrprf <userid>` to display your user profile.
3. Press the page down button to scroll through your profile until you find the lines for Job description and Library. (Library appears right after Job description.)
4. Make sure that the job description is yours or one used by your team. If not, create your own job description and associate it with your user profile. If you need assistance, see your system administrator.
5. Return to the main menu and enter `chgjobd` and then press F4.
6. In the **Job description** field, enter the name and library for your job description. If you do not know the name of your job description, perform a `dspusrprf` to display your user profile. Your job description is on one of the pages of your user profile.
7. Press F10 to access additional parameters.
8. Press the page down button to scroll through your job description until you find the line **Initial library list**.

9. In the field beside the line that says + for more values, type a + followed by a space and then press Enter.
10. On the **Specify more values** display, type WHOLESAL in the first available field and press Enter to change your job description. Repeat this step for WDSCLAB.

Starting your WebSphere Application Server instance

You need to restart your WebSphere Application Server instance each time it is stopped, and each time your iSeries system is restarted. Follow these steps:

1. Log onto the iSeries system and open a QShell prompt by using the `qsh` command.
2. Change to the `bin` directory of the installation directory of WebSphere Application Server using the `cd` command.
3. Enter the following command:
`strwasinst -instance wasinst`

where:

wasinst

is the name of the WebSphere Application Server instance you are using, and

Note that for WebSphere Application Server Express edition you use the `startServer` command instead of `strwasinst`.

4. When the command completes and you see a prompt character (a \$ dollar sign), along with a confirmation message on the console, exit QShell by pressing F3.

Mapping a network drive to the iSeries system

Web development tools deploys your HTML, JSP, servlet, and other publishable files (EJBs for the Advanced edition of Development Studio Client) to the iSeries system on a shared network drive. If you can map a network drive to the /QIBM directory of your iSeries system using the NET USE command or the Map Network Drive command, you already have NET USE access set up correctly. Follow these steps to set up NET USE access to the iSeries system, depending on your operating system.

For Windows 2000 and XP:

1. Open a command prompt and type the command NET USE.
2. If you see a drive letter assigned to the /QIBM directory on your iSeries system, you are already set up for NET USE access.
3. Enter the following command: `NET USE * \\MYHOST\QIBM /USER:USERNAME *` where *USERNAME* is your iSeries user ID.
4. Enter your iSeries password when prompted.

If you can successfully connect to the network drive, NET USE access is set up properly. If instead an error message is displayed indicating problems connecting to the iSeries system, check with the system administrator that TCP/IP is properly started on the iSeries system. You can start it yourself if you have administrative privileges, by logging onto the iSeries system, typing `STRTCPSVR *NETSVR` and answering any prompts as needed. When this command completes, try the steps described above again. If you are unable to map a network drive to your iSeries system, contact the system administrator.

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