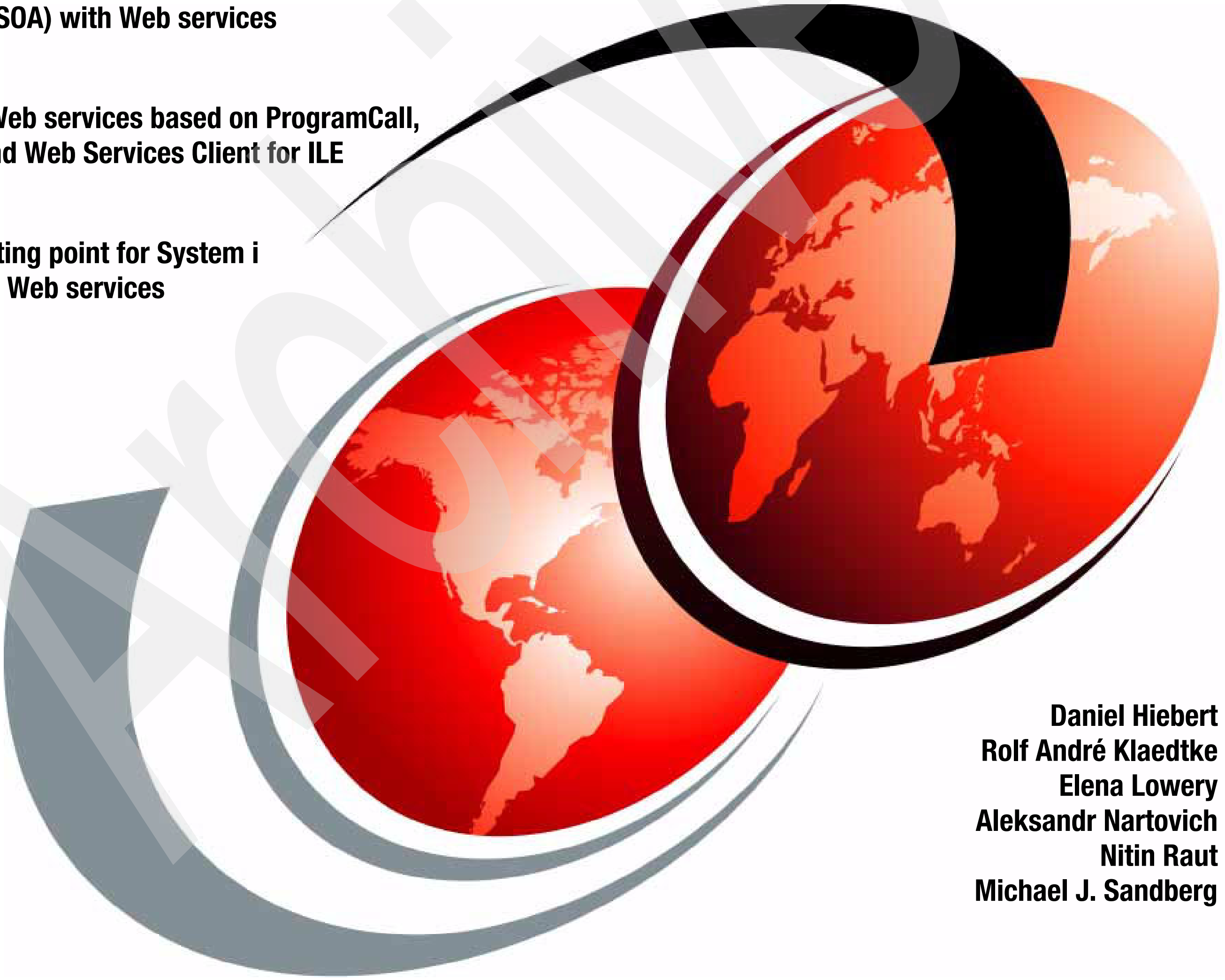
IBM

Building SOA-based Solutions for IBM System i Platform

Implementing service-oriented architecture (SOA) with Web services

Examples of Web services based on ProgramCall, HATS, PHP, and Web Services Client for ILE

Excellent starting point for System i developers on Web services



Daniel Hiebert
Rolf André Klaedtke
Elena Lowery
Aleksandr Nartovich
Nitin Raut
Michael J. Sandberg

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Preface

There is a strong shift in the industry toward reuse of the existing software and hardware resources within the companies to minimize the IT cost. Instead of creating or buying a new solutions, companies are trying to build a set of reusable software components based on the existing applications. These components can be quickly assembled in many different ways to satisfy the business needs of the companies. This environment is based on service-oriented architecture (SOA) and solutions that support business process automation.

This book provides the detailed information about multiple ways for building SOA-based solutions around the System i™ platform. The discussion in the book covers the server and client side implementations that include:

- ProgramCall in IBM® Toolbox for Java™
- Host Access Transformation Services (HATS)
- DB2® Web services
- PHP
- IBM Web Services Client for ILE
- Java-Server Faces (JSF)

Parts of the book are appropriate for CIOs, system architects, and application developers.

The team that wrote this book

This book was produced by a team of specialists from around the world working at the International Technical Support Organization (ITSO), Rochester Center.

Daniel Hiebert is an Advisory Software Engineer with IBM Systems and Technology Group. He works with the Web services and the SOA runtime within WebSphere® Application Server on System i. He has also authored several articles and technical papers on application integration through SOA and Web services. He has three years of experience with Application Integration connecting RPG with Java, Web Clients, C#,.NET, and DB2 technologies and six years of experience with J2EE™ technologies including JSP™, JSF, Servlets and EJB™.

Rolf André Klaedtke is an IBM Certified Application Developer and owner of RAK Software, Consulting and Publishing in Kreuzlingen, Switzerland. He has a commercial background and accumulated over 20 years of experience in the IT industry, initially starting as a software developer using RPG and CL on IBM S/38. Since then, he has used a wide array of DBMS, tools, and languages. In the recent years he concentrated on Web development, mostly using PHP and CSS, as well as on Java and C#.NET. He has co-authored IBM Redbooks® publications, has written for magazines such as PowerTimes, and has organized technical conferences and user group meetings in Switzerland. He can be contacted through his company's Web site at `http://www.raksoft.ch`.

Elena Lowery is a Technical Consultant in the IBM eServer™ Solutions Enablement organization at IBM Rochester. She helps IBM Business Partners implement various WebSphere technologies on theSystem i platform. Her areas of expertise include WebSphere Application Server, WebSphere Portal Server, Web services, and Java development.

Aleksandr Nartovich is a Senior IT Specialist in the IBM ITSO, Rochester Center. He joined the ITSO in January 2001 after working as a developer in the IBM WebSphere Business Components organization. During the first part of his career, Aleksandr was a developer in AS/400® communications. Later, he shifted his focus to business components development on WebSphere. Aleksandr holds a degree in Computer Science from the University of Missouri-Kansas City and a degree in Electrical Engineering from Minsk Radio Engineering Institute.

Nitin Raut is an Advisory Software Engineer at System i5™ Technology Center, e-Business Team, located in IBM Rochester, MN. He has been involved in e-Business consulting and education targeting the System i platform for past seven years. His expertise include WebSphere Application Server, WebSphere Portal Server, WebSphere/Rational® Development Studio, WebSphere Business Integration, WebSphere Host Access Transformation Service, WebFacing, Apache, and so forth. He has 18 years of experience which includes assignments in SAP® Basis Consulting, Enterprise Application Development and ERP (BPCS & Mapics XA) Implementation on the System i platform.

Michael Sandberg is a technical consultant working for IBM ISV Business Strategy and Enablement, located in Rochester, Minnesota. For the past five years, he has been involved in supporting System i solution providers as they enhance and innovate their applications. As part of this work, he has accumulated technical expertise in the IBM WebFacing Deployment Tool with HATS Technology, PHP: Hypertext Preprocessor (PHP), and other technologies that focus on application innovation for the System i platform.

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Nadir Amra
Tony Cairns
Pat Fleming
Kent Milligan
IBM Rochester, MN

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Part 1

SOA: Understanding the big picture

In this part, we introduce service-oriented architecture (SOA). It includes the overview of the architecture and its benefits, application design methodology, and Web services (which is a major set of standards for implementing SOA).

1 SOA overview

This chapter provides an introduction to service-oriented architecture (SOA) and discusses Web services as one of the specific technologies that are associated with it. SOA is a wide field, and it is impossible to cover all related themes herein. Therefore, we also include a list of references that allows you to find more material on this vast topic.

1.1 A simple definition of SOA

With architecture, from the latin word *architecture*, we identify the art and science of designing buildings and structures. This type of design generally includes the creating of complex systems, which probably nobody would start without having a good idea about the underlying structure or architecture. *SOA* is a concept that allows various approaches to realize a system designed according to its guidelines. In this book we concentrate on a technologies that is popular today, Web services.

1.1.1 Defining SOA

SOA is a methodology that you can use in software development. Just as the concept of an *object* is central to object-oriented architecture, SOA is based on the concept of a *service*. In SOA, a service is an application that can be invoked by other applications.

The concept of a service in software is similar to a concept of a service in real life. For example, if you want to relocate, you look up available relocation services in the telephone directory. Then you can contact the relocation company directly and work out the details of the move. The same scenario can apply to a software interaction. A company can have software that handles relocation procedures. The software can search a public service registry for relocation services. Based on some selection criteria (for example price or delivery time), the relocation application can choose one of the relocation providers and work with them directly to schedule the move and arrange payment.

The described services scenario involves the following three participants:

- Service Requestor: An application with a business need
- Service Broker: A registry of all available services
- Service Provider: An application that implements a business function

A *service provider* implements a service and publishes it to the *service broker*. A *service requestor* searches the registry to find a service of interest. Upon finding a service, the service requestor binds to the service provider and invokes the service with the help of an XML file that describes the Web services interface.

1.2 Introducing services

In May 2006, a search for the keyword *Web services* on the Internet brought back over 4 200 000 000 documents. We do not know on how many of them you can find an explanation of Web services. Sometimes the concepts are explained in a language that is difficult to understand. Explaining technical concepts to an unknown audience is indeed a challenging endeavor, especially if the background of that audience varies from complete beginner to expert.

Therefore, to introduce the concept of services and to relate that concept to your applications, we provide an example based on a coffee-making machine. We then follow this simple concept with a non-technical example to introduce you to the topic of Web services.

1.2.1 A coffee making machine based upon services

Here, we use a coffee making machine example for some initial considerations on services in general.

Imagine you are standing in front of a coffee making machine, ready to drop some coins into it, select the appropriate button, and after a little while served a coffee. See this serving of coffee as a service that the machine is providing to you. But, what type of coffee? With sugar and milk or just black? Big or small? There are many possible variations, so let us have a look behind the scenes.

After you drop the coin, you can select a few choices by selecting some buttons to have the machine create exactly the coffee that you want. Each selection triggers some action inside the machine:

- Heat water
- Prepare coffee powder
- Add milk
- Add sugar

Each action needs to be a single service because people might want to have milk and sugar or just one or the other. (As an analogy in IT, you can influence the results that a particular application provides by using different services.)

Now, imagine this coffee making machine is an older model, and you do not have many choices. Either you get a big coffee with milk and sugar or you do not get anything. If this were the case, customers would not be very happy. So, you might have to either replace or update the machine. The same is true with some older applications that are important to your business but that might not satisfy new needs or changing business requirements.

But just how much modernization, respectively cutting into single services do you need? Well, you might decide that heating water and pressing it through the ground coffee could be a single step. But what if later you would like to offer hot tea as an option from the same machine?

The same is true with your application: good judgement and a good overview of the system architecture and your business needs is necessary to identify the functions that should be made ready to be called from the outside.

One more point: coffee is also called Java. Do you need to use Java to enter the world of Web services? No, in this book, we show various other approaches to solve your business requirements.

1.2.2 A non-technical but business-related example

The previous section provided a more general introduction to services. Now, we present an example that is more specifically about services in the IT world.

You are the owner of a general store in town that sells all types of goods. One of your main suppliers is located out of town. Both of you are well equipped with phone lines, Internet access, and computers for your business administration. While you are using a Windows®-based application, your supplier is running business software on a System i platform with applications written in Report Program Generator (RPG), because the business is serving many customers all over the country.

To place an order for new goods with your supplier, you can usually send a fax or an e-mail or you place a phone call. All of these means require an employee of your supplier to enter the order into their system. This process is not only time-consuming, it is also a source for possible errors due to wrong entries or typographical errors.

Now, if your supplier has a Web site with an order form, you can place that order yourself directly into the system. Assuming that the Web server is running on the System i platform, the supplier still needs to integrate the Web site frontend, possibly written in a combination of HTML and PHP or using JavaServer™ Faces, with the backend software written in RPG.

Let us go back to your side of the business. Suppose that your business software allows you to enter all your sales and keep your stock information up-to-date, therefore allowing you to order new products when stock is decreasing below a certain level. However, you still have to check your stock figures and place that order manually.

Do you see what is coming next? Right: wouldn't it be nice if your software could—as soon as the stock for a certain product is below a certain level—enter in direct contact with your supplier's system to order a specified quantity? That automated action would eliminate the need to constantly have an eye on your stock and place an order when needed. On the supplier's side, it would also eliminate the time-consuming need to enter that order into the system.

Web services can make this type of action happen. In short, a Web service is a function in an application that can be called from a program or a system somewhere else using the Internet, very similar to a Remote Procedure Call (RPC). Instead of a human interacting with a computer through a Web interface, we have applications interacting directly together with the help of Web services.

But wait... we said that one system is running Windows and the other is running i5/OS®? What if instead of Windows, you have a Linux®-based system? The good news is that this process still works. In fact, all big players in the IT industry have joined forces to support a common standard—IBM, Microsoft®, and Sun, to name just a few. This standard makes it possible to integrate systems based on different technologies using the SOA approach.

1.3 SOA characteristics

After looking at the concept of services on a general level, followed by a non-technical sample but with some relation to service-based solutions in a business environment, we now have a look at some characteristics that distinguish an SOA from other architectures. With the key components and differentiating points for an SOA, you can:

- Implement SOA in many different ways.
- Take advantage of the benefits of loose coupling.
- Continue to use existing applications.
- Implement quality of services.

1.3.1 Implement SOA in many different ways

SOA is an architecture. As with any architecture, SOA defines the overall design principles for constructing a software component. Implementation of that component, however, is a different thing. Let us illustrate with an analogy about building a house. You can use an excavator to dig the foundation of the house, which will make the job move along quickly and easily, or you can do it using a simple shovel, which will make the task more difficult. Similarly, there might be many ways to implement an SOA solution.

However, most often companies benefit from using a standard or a set of standards for implementing an architecture. SOA is not an exception. There is a set of standards called *Web* *services*. Web services are recognized as the best way for implementing SOA solutions. Web services are developed as an open source project, because they do not lock you into any single vendor. This is one of the main attractive points for adopting Web services.

However, do not assume that SOA and Web services are the same. You can implement an SOA solution using technologies, such as CORBA or .Net, but these technologies do not realize all the possible benefits of SOA. Instead, they imply very strict requirements for implementing a service, possibly locking you into a single vendor.

You can learn more about the Web services standards in Chapter 3, “Web services technology stack” on page 17.

1.3.2 Take advantage of loose coupling

One of the key points of an SOA is that an applications’s different functional units, called *services*, are interrelated through well-defined interfaces and contracts between these services. The interface is defined in a neutral manner that should be independent of the hardware platform, the operating system, and the programming language in which the service is implemented. This independence allows services that are built on a variety of such systems to interact with each other in a uniform and universal manner.

This feature of having a neutral interface definition that is not tied strongly to a particular implementation is known as *loose coupling* between services. The benefit of a loosely-coupled system is its agility and ability to survive evolutionary changes in the structure and implementation of the internals of each service that make up the whole application. Alternatively, tight-coupling means that the interfaces between the different components of an application are tightly interrelated in function and form, thus making them brittle when any form of change is required to parts of or the whole application.

This benefit of loosely-coupled applications requires an additional functional layer in your solution that has to convert the platform neutral interfaces to the platform specific APIs. However, the benefits of loosely-coupled solutions outweigh the downside of having an additional functional layer.

1.3.3 Continue to use the existing applications

A lot of talk and promises has gone into reusing application code or business logic. Unfortunately, as many have found out, this reuse of existing code is not always as easy as they thought in the beginning. It certainly is more difficult with monolithic applications that might have to be modernized, that is modularized, before reusing parts of its business logic to integrate with other applications or systems. For many, the term *reuse* remains limited to “change the underlying hardware, recompile, and continue using your applications.”

With an SOA, there is again that promise, but let us say “continue to use the existing” instead of “reusing.” In fact, in earlier times, when two companies with different systems merged, it was often the case that one company took over the system of the other, because integrating them was not possible or too difficult. That type of merger could have a huge impact, especially if the staff on site did not know the operating system and programming languages that was used on the other system.

Now, integrating systems has become easier, because the hardware does not play such an important role anymore. In addition, companies can integrate the software, thanks to SOA, with other systems and, therefore, can continue to use it. Of course, this integration does not come without a cost, but the alternative is not free either.

1.3.4 Implement quality of services

When doing business with an external partner, on whose operations you have no control, you need to define and agree to some rules, often in the form of *service-level agreements* and *operational policies*. Understandably, security is very important in enterprise computing. It is equally important that you can trust upon that all business processes are executed reliably and conforming to the terms agreed. This might seem unspectacular for a simple operation but can become very complex in transactions that span over several loosely coupled distributed systems.

Therefore, the following services are part of what is called *quality of service*:

- Security
- Reliable Messaging
- Transactions

1.4 SOA from a business perspective

One of the goals of IBM is the development and adoption of open standards within its products. SOA is the latest architecture that has received a tremendous interest among CIOs in today's companies. SOA is well positioned to allow *business needs* to drive *development*. This positioning enables you to realize the value proposition of SOA within your company's IT infrastructure. SOA promises to optimize the alignment of business needs with IT, decoupling business process activities from service implementations, and to reduce operational costs. You can accomplish these capacities without vendor lock-in, when technologies, targeted for SOA implementations, are integrated seamlessly (open standards) to construct comprehensive end-to-end solutions.

1.4.1 Reasons to consider SOA

On white boards and on paper, the concepts of SOA can be very compelling and more easily justified when the company takes into consideration strategic business goals and initiatives. However, the decision to implement SOA should not be taken lightly. It is similar to committing to a lifestyle change because the IT governance to which your development and operational teams adhere to will be quite different. Business-driven development is one of the key components of SOA. The process involves refining business needs to IT requirements, and then IT requirements to IT capabilities, to identify technology to address the needs. Good reasons to consider using SOA include:

- Your company has existing business logic that needs to be accessible by other intranet applications, strategic business partners, or external Internet applications
- Integration costs continue to grow without being offset by new business opportunities that provide a real return on investment (ROI).
- Mergers and acquisitions are central to your company's business model for growing market share and pursuing new opportunities.
- Solutions require the integration of business capability from disparate systems and programming models.
- The livelihood of your business depends on your ability to adjust quickly to changes in the marketplace or to respond immediately to competitive threats.
- The impact of the global economy necessitates that your company does more with less and that your company relies on business partners to provide non-core business functions.

- The efficiency of working with business partners is critical for your company in driving revenue.
- The value of your company's business assets are diminished because they are not assessable for reuse outside their original purpose.
- The efficiency of your company's employees is in question because they do not spend the majority of their time delivering capabilities or services that are core to your company's business model.
- Your company's business thrives on opportunistic business endeavors.
- Your company develops new applications from scratch. Our belief is that SOA should be a default architectural style to position new applications for the future, unless business conditions dictate otherwise.

1.4.2 SOA is not always a perfect fit

In an ideal world where there are no budget constraints, schedule deadlines, skill gaps, and priority differences between you and your business partners, it is safe to say that everyone would be adopting SOA or, at least, would have plans to adopt it. However, in the real world, our choices are often influenced and limited by past decisions (for example, investment in technology, adoption of programming models, or commitment to contractual agreements of services). As a result, we are not always at liberty to make what appears to be the perfect choice for addressing a business need or technical requirement. Some indications that SOA might not be a good fit for your company include:

- A small percentage of your company's IT budget is spent on integration activities.
- A majority of your company's processes are manual or document-centric, with little opportunity for automation.
- A large majority of your company's application development uses the same programming model.
- The operation of your company is managed by one or two customer relationship management (CRM) and enterprise resource planning (ERP) applications with little integration requirements.
- There is a significant mismatch between your company's existing skill base and that which is needed to implement an infrastructure to support SOA.
- A clear business need or opportunity has not been identified that would benefit from the IT capabilities offered by SOA.
- An existing revenue stream would be adversely affected due to the availability of new business services.
- Business partners with whom your company relies upon have different priorities about automating intercompany processes.
- Your company's primary business revolves around extremely high-volume, synchronous, real-time transactions.

Every engagement or project brings unique requirements, so the decision about whether to adopt SOA depends on your company's business situation. The value proposition of SOA is hard to trump, but choosing to commit your company to embrace SOA must be balanced by the reality of your business environment. In addition, you do not have to adopt SOA in one large leap. Typically, adoption of SOA is done in small steps. Finding a project where you can use the concepts and principles of SOA and then measuring its value with key performance indicators is powerful in cultivating a community of stakeholders.

1.5 Further reading

If you are interested in knowing more about SOA and the Web services Platform Architecture, see *Understanding SOA with Web services*, by Eric Newcomer, Greg Lomow, ISBN 0-321-18086-0 (Pearson Education).

1.5.1 IBM Redbooks publications

The following IBM Redbooks publications also deal with the subject of SOA and Web services:

- *WebSphere Version 6 Web Services Handbook Development and Deployment*, SG24-6461
- *Patterns: SOA Foundation Service Connectivity Scenario*, SG24-7228
- *Patterns: SOA Foundation Service Creation Scenario*, SG24-7240
- *Patterns: SOA Foundation - Business Process Management Scenario*, SG24-7234
- *Enabling SOA Using WebSphere Messaging*, SG24-7163
- *Patterns: SOA Client - Access Integration Solutions*, SG24-6775

1.5.2 Web sites

There are also numerous Web sites that provide interesting material about SOA. Here are just a few:

- SOA introduction

  http://www-128.ibm.com/developerworks/architecture/roadmap/#2
- Wikipedia: Service-oriented architecture

  http://en.wikipedia.org/wiki/Service-oriented_architecture

2

SOA application design

This chapter discusses the process of designing an application based on SOA. We explain how to identify and design services, which are the building blocks of an SOA application.

2.1 Designing an SOA solution

Designing an SOA application is an art, not a science. In other words, when you understand the key guidelines of SOA, you can design several SOA-compliant application designs. The key architectural principal of SOA is creating loosely-coupled services that can be combined into applications. *Loosely-coupled services* in an application can be used independently of each other. Another way to understand the term *loosely coupled* is by looking at an electrical appliance such as a vacuum. With a vacuum, an electrical cord is tightly coupled with the vacuum but loosely coupled with a power outlet. Loose coupling allows services reuse. In our vacuum example, you can plug any electrical appliance into a power outlet, not just a vacuum, and the vacuum can be plugged in to any power outlet.

A service is a basic building block of an SOA application. The first step in designing an SOA application is identifying and creating *services*.

2.1.1 Designing services

Few companies today have the luxury of starting software development from scratch. This is especially true for System i customers and independent software vendors (ISVs) who have applications that were developed up to 20 years ago. These applications are robust, stable, and proven. Thus, completely rewriting these applications does not result in a significant return on investment (ROI). At the same time, traditional applications need to be extended to support changing business requirements. Implementing services is an example of extending a traditional System i application.

SOA-based IT infrastructure or a product might be the end goal of any company that started on the SOA path, and creating a service is the first step on that path. What part of your application makes a good candidate for a service? The answer to this question is in *business requirements*. Business requirements can be as informal as one of the users saying “I want to track shipped packages from our Order Entry system” or as formal as “We need to provide standards-based order process for our suppliers.”

Identifying business functions that make useful services

In some cases, the process of identifying a service is simplified because services creation is specified as a requirement. For example:

- You need to expose your business functions to external companies, and SOA/Web services was chosen as an architectural approach and a standard.
- Your company requires that all applications provide a standard business logic interface so that applications can be easily integrated into an Enterprise Services Bus or similar infrastructure.

If you do not have an explicit requirement to convert business functions to services, you will need to do some analysis to identify useful services.

Services today are used for functions as simple as a spell check and as complicated as an e-Commerce system. The similarity between these services is that they provide a business function that can be used by multiple applications in multiple contexts.

Here is a sample list of steps for identifying feasibility of a business function as a service:

1. Identify a business requirement.
2. Identify a business task that fulfills the requirement. The business task becomes a service.
3. Verify that there could be at least two different uses (clients) for this service.

Let us apply this decision process to two business requirements in a sample scenario where a company that sells school district management software received two new business requirements from customers. As an example, we show two possible scenarios.

Here is the first scenario:

1. Business requirement: Expose student attendance information to external users.
2. Business task: Look up student attendance in the attendance database and return it in a standards-based format.
3. Verify that there could be at least two different uses (clients) for this service: This service can be used by ISV software and integrated into other systems, such as School District's Web applications.
4. The ISV made a decision to implement this requirement as a Web service.

Here is the second scenario:

1. Business requirement: Keep track of teacher's continuing education credits.
2. Business task: Look up and update teacher's continuing education credits.
3. Verify that there could be at least two different uses (clients) for this service: At this time, the only use of this service is by ISV software. There is a restricted set of users who can access this information.
4. The ISV made a decision to implement this function as a reusable modular software component but not as a Web service. The deciding factors were only one identified client for this service and a limited group of users.

Why not make every business task a service

One of the things to keep in mind when designing SOA-based applications is implications of loosely-coupled architecture on application complexity, performance, and maintenance. An on-going challenge in software design is the trade off between the best possible architecture and the best architecture for performance. Your task as an SOA architect is to come up with a solution that satisfies both SOA architecture and performance requirements. If performance is a concern, in addition to the decision criteria for identifying services that we outlined in the previous section consider the following criteria:

- Create large-grain services versus creating many small-grain services, that is implement an entire business task as a service versus a component of a business task.
- Provide two interfaces for business logic: the services interface and an interface for integrating with clients written in the same programming language.

Today's uses of services

Looking at existing services can give you additional ideas on what business functions make good examples of services. For example, United States Postal Service offers address standardization, zip code lookup, and city and state lookup services. Amazon.com, one of the leading online retailers, is a pioneer in providing e-commerce Web services. Using Amazon's Web services, you can build your own front end to Amazon's warehouse of products. Another Web service offered by Amazon is a "Simple Storage Service" that provides read/write capabilities for any amount of data over Internet. Other services examples are search and spell check Web services provided by Google.com and services to create maps and driving directions provided by Mapquest.com.

All these examples are services that are created for use by external applications. Services can also be created for use strictly by internal applications. In the intranet environment, services are used to solve a variety of business problems, such as:

- Provide a single point of access to multiple back-end applications
- Integrate applications written in different programming languages
- Build flexible applications that can be easily extended and integrated

An automobile manufacturer, DaimlerChrysler, uses Web services to integrate applications within their human resources, procurement, supply chain management, and manufacturing organizations. Their applications reside on several platforms which include AIX®, OS/390®, SUN Solaris™, and Windows and include Java, COBOL, Visual Basic®, and PowerBuilder applications. Wachovia, one of the leading U. S. financial institutions, uses Web services to integrate Microsoft .Net, the rich client with back-end applications.

You can find additional Web services case studies at:

- IBM Case Studies

  http://www-306.ibm.com/software/success/cssdb.nsf/solutionareaL2VW?OpenView&Count=30&RestrictToCategory=wp_ServiceOrientedArchitecture&S_TACT=106AJ04W&S_CMP=campaign
- Web Services information

  http://www-306.ibm.com/software/ebusiness/jstart/casestudies/webservices.shtml

Service design considerations

After you identify a good candidate for a service, the next task is to design the service interface. The service interface consists of *input* and *output* parameters. Your goal should be to design an interface for maximum interoperability. Let us look at the factors that affect interoperability between services and clients implemented in different programming languages:

- *Data type*: Primitive data types (strings, integers, and so forth) are supported by all programming languages. When designing the services interface, use primitive data types and avoid programming language specific data types. If you are planning to use SOAP as a messaging mechanism for services, verify that the chosen data types are supported by SOAP. See Chapter 3, “Web services technology stack” on page 17 for more information.
- *Simple* or *complex*: A complex parameter includes many simple parameters, usually primitives. For example, we can pass customer information in a complex Customer parameter which contains several attributes—customer name, address, and so forth. In Java, this parameter is implemented as a JavaBean, in RPG as a data structure. We can also pass customer information in an XML document included in a simple String parameter. Which approach is better for interoperability? The simple String parameter provides the best interoperability because strings are supported by most programming languages. The disadvantage of this approach is that the service is not *self-describing*, that is the service returns a string, but it does not describe the content of the string. In addition, the client has to parse the XML document that is included in the string. With the complex parameter, the service is self-describing: the output is a Customer object that has several attributes. On the client side we do not have to worry about parsing XML because SOAP APIs parse the Customer output parameter and get information back to the client in the form of a Customer data type. The disadvantage of this approach is that not all programming languages (SOAP APIs of these languages) support complex objects. To determine which parameter type to use in your application, create a Web service client prototype in programming languages of your choice and test integration with complex

parameters. Also, consider designing two interfaces for the same service: one with a complex parameter and one with a string that includes an XML document.

If you are creating services over existing code and cannot change method or procedure interface because they are used by other applications, consider building a *facade* layer that transforms services parameter types to parameters that are used by existing code.

Another decision that you have to make is whether your service is going to be *stateless* or *stateful*. While state is usually an implementation discussion, it can have some impact on your service interface. For example, if your service in stateless, and state is maintained on the client side, you might need to pass state information in the input parameter.

Interaction between service clients and services can be *synchronous* or *asynchronous*. Asynchronous communication is used when a service takes a long time to complete or when response is not required by the client application. In some cases, you might want to get a confirmation that your request was received by the service but you do not want to wait for results, in other words, a combination of synchronous and asynchronous model. In this case, implement a service that receives a request from a client and posts a message that will later be processed by a batch program. The service can return an output parameter containing request id. In addition, implement other services that will return request status and request results.

You should give special security considerations to services that are created for consumption by external applications. You need to decide if authentication and authorization should be done on a individual service on an application level. If you decide to implement security on a service level, you need to pass user authentication information as an input parameter. If you are implementing security on an application level, you might still need to pass a parameter to each service verifying that the user has been authenticated.

Creating SOA applications from services

After you create services, you need to integrate them into existing or new applications. If you are adding services to an existing application create a services layer or an *adapter* that encapsulates access to all services. Figure 2-1 illustrates a sample application architecture.

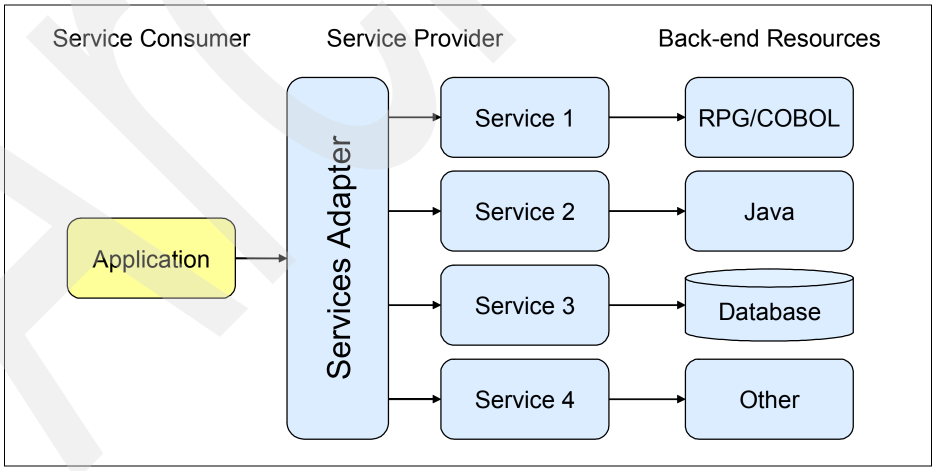


Figure 2-1 Sample application architecture

If you are building new applications based on a large number of services, consider using Business Process Execution Language (BPEL) to define and create composite services and process choreography to define relationships between services. Both technologies are industry standards, WS-BPEL and WS-CDL (Choreography Description Language), respectively. IBM provides tools and middleware for building SOA applications using BPEL and process choreography.

See the following Web sites for more information and links about BPEL:

- Wikipedia: Business Process Execution Language

  http://en.wikipedia.org/wiki/BPEL

- Web Services Choreography Description Language Version 1.0

  http://www.w3.org/TR/2004/WD-ws-cdl-10-20041217/

3

Web services technology stack

This chapter describes technologies that are used for building and invoking Web services. We describe the following technologies in this chapter:

- SOAP
- HTTP
- WSDL
- UDDI
- Basic Profile

3.1 Web services technologies in action

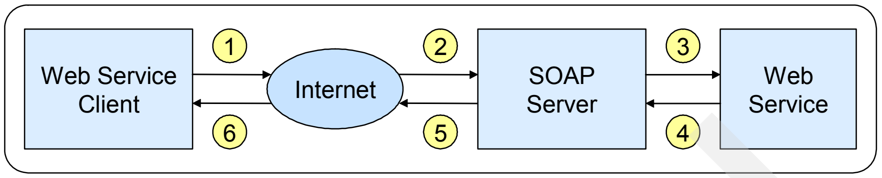
Web services technologies are best explained in the context of how they are used during the development process and at runtime. A developer implements modular code, for example an RPG module with several procedures or a JavaBean with several method according to a previously defined interface. At this point, no Web services-specific code has been implemented. Next, the developer creates a Web service from modular code. Web services creation does not add logic to implemented modular code, but creates the infrastructure around it that allows modular code to be invoked as a Web service. Most IDEs, including WebSphere Development Studio client for iSeries®, provide tools for creating Web services from existing code. One of the key artifacts generated during Web services creation is Web services Definition Language (WDSL) file. WSDL is an XML document that describes Web service interface: methods, parameters and service location.

The last step in developing a Web service is to test it. Communication between Web service clients and Web services is achieved with SOAP—an XML standard for the exchange of structured information in a distributed environment. A test application, or Web services test client, must create a SOAP message to invoke a Web service. You can create test client manually or use tooling in WebSphere Development Studio client for iSeries to generate test client code.

Web service client developer needs information about the Web service to implement Web service invocation code: service location, methods, and parameters. As mentioned previously, this information is captured in the WSDL file. Using information in the WSDL file, the Web service client developer uses SOAP API to create a SOAP request message to invoke the Web service. WebSphere Development Studio client for iSeries and some other IDEs provide wizards to generate SOAP APIs based on a WSDL document. A term *Web services invocation proxy* or just *proxy* is used usually to describe a generated code artifacts that includes SOAP API.

Next, let us take a look at how Web services technologies are used at runtime. A Web service client creates a SOAP message and sends it over HTTP or another transport protocol to a known service location. If HTTP is used, the service location is specified as a Uniform Resource Identifier (URI), for example `http://myhost:9080/SampleWebService/services/SampleWS`. Web service is deployed in an application server with a special component, SOAP server, that is responsible for processing SOAP messages. The SOAP server processes the incoming message, invokes the Web service, and sends the response message back to the client. Some implementations of SOAP server use WSDL to process request and response messages.

Figure 3-1 shows the interaction between the Web service and the Web service client.



1. The Web service client creates and sends a SOAP message.
2. The SOAP server listens for SOAP messages. SOAP server is an application running in an Application Server (for example, WebSphere Application Server).
3. The SOAP server processes the SOAP messages and passes the request to a Web service.
4. The Web service runs the specified method and returns the result to the SOAP server.
5. The SOAP server forwards the result back to the Web service client.
6. The Web service client parses SOAP response.

Figure 3-1 Web services interaction

With the right tooling, for example, WebSphere Development Studio client for iSeries or IBM Rational tools, Web service and Web service client developers might not have to write any Web services-specific code. However, it is still important to understand some basics about Web services technologies.

Web services technology stack consists of industry standard technologies that can be divided into four categories:

- Web services messaging
- Web services transport
- Web services description
- Web services discovery

3.2 SOAP: Web services messaging layer

From the client perspective, a Web service call is a remote procedure call (RPC), and one of the main differences between Web services and other inter-program communication mechanisms is the way that a program is invoked. SOAP is an XML dictionary that's used to perform a remote procedure call. A more generic definition of SOAP is a specification for the exchange of structured information in a decentralized, distributed environment. Key characteristics of SOAP are:

- SOAP is transport-independent protocol and can be used in combination with a variety of protocols such as HTTP, JMS, SMTP, or FTP. Today, the most common way of exchanging SOAP messages is through HTTP
- Because SOAP is an XML dictionary any programming language that can process XML can create SOAP messages
- A SOAP message is an envelope that includes zero or more headers and one body.
  - The envelope is the top element of the XML document, providing a container for control information, the addressee of a message, and the message itself.
  - Headers that include control information, such as quality of service attributes.
  - The body includes the message identification and its parameters.

Note: For more information about SOAP specifications, see *Web Services Handbook for WebSphere Application Server 6.1*, SG24-7257.

Let us take a look at a simple Web service and a SOAP message that is used to invoke it. Example 3-1 shows Java Web service code. Notice that there is no Web service specific code in the method implementation because Web services technologies are used outside of the business logic implementation.

Example 3-1 A business logic method

```
public String convertTemp(String tempIn){

      Double tempFahrenheit = new Double(tempIn);
      // Convert temperature
      Double tempCelsius = new Double ((5/9)*(tempFahrenheit.doubleValue()-32));
      // Return a String value
      return tempCelsius.toString();
}
```

Example 3-2 shows SOAP request message from the Web service client to invoke this Web service. Notice that the SOAP request message includes the name of the service to call (which matches the Java method name), and the input parameter `tempIn` with a value of `90`.

Example 3-2 Sample SOAP request

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"><soapenv:Header/>
<soapenv:Body><p831:convertTemp xmlns:p831="http://services.ibm.com">
   <tempIn>90</tempIn></p831:convertTemp>
</soapenv:Body>
</soapenv:Envelope>
```

Example 3-3 shows the SOAP response message. The most interesting part of the message is the return parameter, `convertTempReturn`, that includes the converted temperature.

Example 3-3 Sample SOAP response message

```
<soapenv:Envelope xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"><soapenv:Header/>
<soapenv:Body><p831:convertTempResponse xmlns:p831="http://services.ibm.com">
   <convertTempReturn>32.2</convertTempReturn></p831:convertTempResponse>
</soapenv:Body>
</soapenv:Envelope>
```

If you do not have any SOAP code in the Web service implementation, how are the SOAP request and response messages created? The SOAP request message is created by the Web service client. Web service client can use SOAP APIs of the programming language in which the client is written. Most programming languages have a SOAP API. If they do not, it is possible to create a SOAP message manually, but this approach can be tedious and error-prone. If the programming language does not have a SOAP API, consider building a *SOAP client proxy* in a programming language that has a SOAP API. Many IDEs, including

WebSphere Development Studio client for iSeries, can generate Web service client code that includes SOAP APIs based on a WSDL file.

Web services response message can be generated by the SOAP engine or created manually with the SOAP API. The SOAP engine also handles SOAP request messages. WebSphere Application Server comes with a built-in SOAP engine. In addition, you can use the open source Axis SOAP engine in WebSphere Application Server. WebSphere Web services engine is based on Axis principles but extended for performance and for enterprise Web services (support for session EJB as Web services and for SOAP over JMS).

3.3 Web services transport

SOAP messages can be sent over several protocols, including HTTP, JMS, FTP, and SMTP. HTTP and messaging protocols, for example JMS (Java Messaging Service), are currently the most popular choices for Web services transport. HTTP provides synchronous communication between a Web service client and a Web service. HTTP is the most used protocol for several reasons:

- HTTP is mature: It has been used for Web applications for several years.
- HTTP requests can travel through firewalls. (HTTP ports are already configured for Web applications.)
- HTTP can be secured with SSL.
- HTTP is the only protocol supported by the basic profile standard (which we explain in 3.6, “Basic Profile” on page 24).
- Most IDEs, including WebSphere Development Studio client for iSeries Web services wizard, generate Web services infrastructure for HTTP communication.

JMS provides asynchronous communication between a Web service client and a Web service:

1. The client request to the Java proxy is handled by the SOAP client and is placed into a JMS queue through a JMS sender.
2. In the server, a message-driven EJB (MDB) listens to the JMS queue and routes the message to the WebSphere SOAP engine.
3. The WebSphere Web services engine invokes an EJB Web service.
4. Optionally, the server replies to the client using a dynamic queue.

WebSphere Development Studio client for iSeries does not yet provide tooling to generate Web services infrastructure for JMS transport. This functionality has to be implemented manually. For more information about JMS implementation, see *Web Services Handbook for WebSphere Application Server 6.1*, SG24-7257.

3.4 Web services description: WSDL

A WSDL document describes a Web service: Web service location, methods, and method parameters. Example 3-4 shows a sample JavaBean implementation. Notice that this Web service has one method `convertTemp` that has an input String parameter and output String parameter.

Example 3-4 Sample JavaBean implementation

```
public class TempConversionService {

   public String convertTemp(String tempIn){

      Double tempFahrenheit = new Double(tempIn);
      // Convert temperature
      Double tempCelsius = new Double ((5/9)*(tempFahrenheit.doubleValue()-32));
      // Return a String value
      return tempCelsius.toString();
   }
}
```

Example 3-5 shows a WSDL file that the WebSphere Development Studio client for iSeries Web services wizard generated for this JavaBean. While the document can seem complicated at a first glance, you can still see familiar elements from the Web service implementation: Web service method name and parameter definitions. At the end of the document you find the following Web services location:

```
<wsdlsoap:address location=
"http://localhost:9080/SimpleWS/services/TempConversionService"/>
```

Notice that the generated URL points to `localhost`. This URL is the only part of the WSDL document that you need to change before deploying the Web service to the server and sending WSDL to the Web service client developer. You need to replace `localhost` and the default port with the host name of your server and WebSphere Application Server port.

Example 3-5 Sample WSDL file

```
<?xml version="1.0" encoding="UTF-8"?>
<wsdl:definitions targetNamespace="http://services.ibm.com"
xmlns:impl="http://services.ibm.com" xmlns:intf="http://services.ibm.com"
xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
xmlns:wsdlsoap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:wsi="http://ws-i.org/profiles/basic/1.1/xsd"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
 <wsdl:types>
  <schema targetNamespace="http://services.ibm.com"
xmlns="http://www.w3.org/2001/XMLSchema" xmlns:impl="http://services.ibm.com"
xmlns:intf="http://services.ibm.com" xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
xmlns:xsd="http://www.w3.org/2001/XMLSchema">
   <element name="convertTempResponse">
    <complexType>
     <sequence>
      <element name="convertTempReturn" nillable="true" type="xsd:string"/>
     </sequence>
    </complexType>
   </element>
   <element name="convertTemp">
    <complexType>
     <sequence>
      <element name="tempIn" nillable="true" type="xsd:string"/>
     </sequence>
    </complexType>
   </element>
  </schema>
 </wsdl:types>
   <wsdl:message name="convertTempRequest">
      <wsdl:part element="impl:convertTemp" name="parameters"/>
   </wsdl:message>
   <wsdl:message name="convertTempResponse">
      <wsdl:part element="impl:convertTempResponse" name="parameters"/>
   </wsdl:message>
   <wsdl:portType name="TempConversionService">
      <wsdl:operation name="convertTemp">
         <wsdl:input message="impl:convertTempRequest" name="convertTempRequest"/>
         <wsdl:output message="impl:convertTempResponse"
name="convertTempResponse"/>
      </wsdl:operation>
   </wsdl:portType>
   <wsdl:binding name="TempConversionServiceSoapBinding"
type="impl:TempConversionService">
      <wsdlsoap:binding style="document"
transport="http://schemas.xmlsoap.org/soap/http"/>
      <wsdl:operation name="convertTemp">
         <wsdlsoap:operation soapAction=""/>
         <wsdl:input name="convertTempRequest">
            <wsdlsoap:body use="literal"/>
         </wsdl:input>
         <wsdl:output name="convertTempResponse">
            <wsdlsoap:body use="literal"/>
         </wsdl:output>
      </wsdl:operation>
   </wsdl:binding>
   <wsdl:service name="TempConversionServiceService">
      <wsdl:port binding="impl:TempConversionServiceSoapBinding"
name="TempConversionService">
<wsdlsoap:address
location="http://localhost:9080/SimpleWS/services/TempConversionService"/>
      </wsdl:port>
   </wsdl:service>
</wsdl:definitions>
```

The WSDL file is sometimes called a *contract* between a Web service and a Web service client. After you create a contract, your goal should be not to introduce any changes to it. Otherwise, the communication between a Web service client and a Web service will be broken. You *can* change Web service implementation (for example, change the way you calculate temperature conversion). However, if you change your method of signature (method name or parameter types), you will break the contract. Changing Web service location will not break the contract. Just remember to notify the Web service client of Web service URI change.

Some developers prefer to start Web services development by manually creating the WSDL file and then generating a programmatic interface (JavaBean or another code artifact usually called a *skeleton* or a *stub*) based on the WSDL file. This approach requires advanced XML and WSDL skills. You can learn more about WSDL in *Web Services Handbook for WebSphere Application Server 6.1*, SG24-7257.

3.5 Web services discovery: UDDI

In general, SOA overview Web services discovery is often described as a part of interaction between a Web service client and a Web service. *Universal Description, Discovery, and Integration* (UDDI) is the component used for Web services discovery. UDDI is also called *yellow pages* or a *broker*, because it includes information about Web services. Web service developers publish information about their Web services to UDDI (usually a WSDL file). A Web service client can lookup this information at either design or run time.

Figure 3-2 shows interaction between a Web service client, a Web service and UDDI.

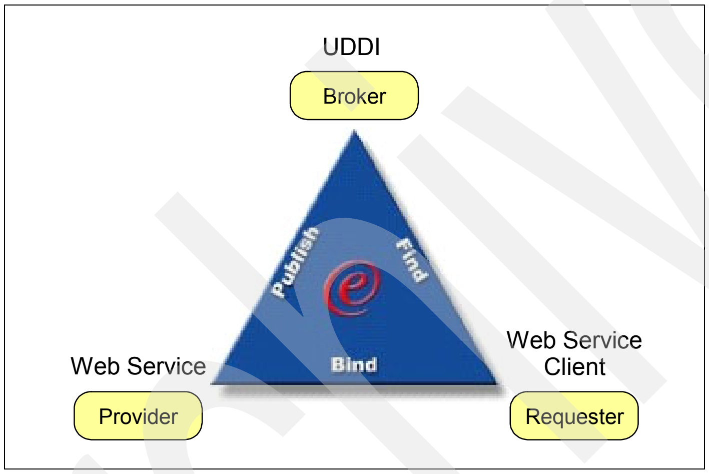


Figure 3-2 UDDI interaction

While UDDI has been introduced in the very early descriptions of SOA, it is not widely used in Web services implementations today. Most Web service client and Web services developers exchange Web service description information without UDDI. UDDI might become more popular when many vendors deploy similar services (for example, a credit card check), and a UDDI provider decides to become a *broker* of these services.

Another way to describe a set of Web services is Web services Inspection Language (WSIL). WSIL is not a repository like UDDI, but an XML file that describes how to find Web service.

3.6 Basic Profile

One of the main goals of Web services is to provide interoperability between applications written in different programming languages using different IDEs and running on different middleware. However, using Web services does not mean that your application is going to integrate seamlessly with any Web service client. The key to interoperability is using the same version of core Web services technologies: SOAP, WSDL, HTTP, and others. That is why the Web services Interoperability Organization created Basic Profile, which is a set of guidelines for creating interoperable services.

Basic Profile V1.0 specifications include:

- SOAP V1.1
- WSDL V1.1
- UDDI V2.0
- XML V1.0 (Second Edition)
- XML Schema Part 1: Structures
- XML Schema Part 2: Datatypes
- RFC2246: The Transport Layer Security (TLS) Protocol V1.0
- RFC2459: Internet X.509 Public Key Infrastructure Certificate and CRL Profile
- RFC2616: HyperText Transfer Protocol V1.1
- RFC2818: HTTP over TLS
- RFC2965: HTTP State Management Mechanism
- The Secure Sockets Layer (SSL) Protocol V3.0

The profile adds constraints and clarifications to those base specifications with the intent to promote interoperability. Some of the key constraints include:

- Precludes the use of SOAP encoding (document/literal or RPC/literal *must* be used)
- Requires the use of SOAP/HTTP binding
- Requires the use of HTTP 500 status response for SOAP fault messages
- Requires the use of HTTP POST method
- Requires the use of WSDL V1.1 to describe the interface
- Precludes the use of solicit-response and notification-style operations
- Requires the use of WSDL V1.1 descriptions

Basic Profile specification is used mostly by tool and middleware developers. They need to make sure that their products comply with the Basic Profile specification so that Web services can interoperate. As a Web service or a Web service client developer, you need to be aware of the Basic Profile version supported by technologies that you use. WebSphere Development Studio client for iSeries V6.0 and later and WebSphere Application Server V6 and later support Basic Profile V1.0. To ensure interoperability between a Web service and a Web service client, make sure that they support the same version of the Basic Profile.

3.7 Summary

In this chapter we highlighted the most important Web services technology standards. For a full description of Web services standards, see *Web Services Handbook for WebSphere Application Server 6.1*, SG24-7257.

4

Sample scenario

In this chapter we introduce the sample scenario used throughout this book to provide a common basis of understanding. We describe a fictitious travel agency and its current system. From there we provide ideas to solve some of the issues the company is facing. Later on in this book we show several solutions to these issues.

4.1 Introducing the existing environment

In our scenario, we use the sample application called Flight400 that has been used in other IBM Redbooks and presentations. The Flight Reservation System application is representative of a commercial application. Though the application does not include all of the necessary error handling that a typical business application requires, it has the logic that we use to demonstrate how we can modernize applications and make parts of it available through Web services.

4.1.1 Overview of the Flight400 application

The Flight Reservation System application is used by the agents to create, query, modify, and print reservations. For example, in a case of a reservation received, an agent is required to manually enter necessary data into the system.

For more information about the Flight400 application and articles on various topics around that sample application, check out the following Web site:

http://www-03.ibm.com/servers/enable/site/ideveloper_j2ee/etoe/index.html

4.2 Facing new challenges

As everywhere, a business is changing and customers are expecting more or better service (or actually both). To stay ahead of the competition, we constantly have to think about ways to improve our offer.

4.2.1 New opportunities

Currently, creating a new reservation requires a lot of manual work. But let us step back and look at the business process that triggers this action.

An employee of one of our partner companies, a travel agency, desires to make a new reservation on behalf of one of their clients. She picks up the phone and calls our office. We get the call, start the Flight400 application, select the option to make a new reservation and then enter all the necessary data that we get from our partner over the phone.

Problems might arise if we misunderstand our business partner or mistype the information received. If the information is received by letter, fax or by e-mail, we still have to transfer that information into the system in a manual process, which is both time-consuming and error-prone. But the most time-consuming part is to provide information about flights and customer data over the phone.

Therefore, we identify these business cases as the first ones that we want to modernize and possibly automate. The idea being that our business partners can query information about flights or customers themselves without interaction from our part and enter their reservations directly into our system.

4.2.2 Technical issues to address

However, there are some important points that we need to consider:

- Some of our partners are running on different platforms and are possibly using different Database Management Systems (DBMS).

  The solution to this possible issue in our case is to implement the identified functions as Web services and therefore allow their functionality to be exposed to the outside world, which in this case are our business partners.

  But this brings up another important point that needs to be considered even before thinking about connecting to the outside world:

- Our application might have to be modularized, respectively modernized before we can re-use its functions in the form of Web services.

  In fact, RPG programs can be converted to Web services by building a Java Web service wrapper around them, either automatically or manually. But before that step, you need to make sure that the RPG program implementation is suitable for a Web service. The following two main requirements must be met:

- Separation of business logic and presentation logic. The RPG program must be a callable program that does not contain any display logic.
- Thread safety. By default RPG programs are not thread safe. If two or more Java threads call the same RPG program at the same time, you might get unexpected results.

For more information about RPG application modernization, read *Modernizing Flight400* white paper at:

http://www-03.ibm.com/servers/enable/site/education/wp/40d2/40d2.pdf

Implementing thread safety in an RPG program

Programs or routines need to be thread-safe in order to avoid the risk that one thread interferes or even modifies data elements used by another thread. In a Web service context that could be the same RPG program which is being called from two or more different processes where each process generates a thread calling the same RPG program. It could be fatal if this program modifies some global data or the heap.

- RPG IV has a thread safety option that can be specified on the H spec: THREAD(*SERIALIZE). When the program is compiled with this option only one thread will be active in one module at one point in time. However, you still have to make sure that shared storage (such as IMPORT/EXPORT fields) is handled in a thread-safe way.
- The RPG IV runtime is thread-safe, RPG II and RPG III are not thread-safe.
- It is not possible to have thread-scoped files using RPG file support. If the file is left open, the next thread will get the old file state. On the other hand, it is possible to have some of the storage thread-scoped by using allocated storage or userspaces. The program will have to know which thread is active (using a parameter from the caller) to know which basing pointer or userspace to use.
- C runtime I/O functions should be used to do thread-scoped I/O, if necessary.

We highly recommend to read the text on thread-safety on Wikipedia, as it provides some basic but important definitions and outlines ways to achieve thread-safety in programs. There are also links to articles on how to write thread-safe programs:

http://en.wikipedia.org/wiki/Thread_safety

4.2.3 Flight400: From monolithic System i application to SOA

In the previous sections we demonstrated the valid justifications for creating Web services. In this section we elaborate on the previous example to identify other parts of the application that are the good candidates for Web services.

The original version of Flight400 application is a flight reservations system written in RPG III application. Our business requirement is to allow other applications (internal or external) place reservations in the Flight400 reservation system.

We started the design process with identifying tasks in our typical daily use of the application:

1. Lookup flights based on a search criteria
2. Lookup to/from cities
3. Lookup airlines
4. Get detailed flight information
5. Place reservation
6. Update reservation
7. Delete reservation
8. Add customer
9. Lookup customer

Each task might or might not be a good candidate for a service. For example, services 2 and 3 (cities lookup and airline lookup) could be considered too granular and useful only within the application, and not as an external services. We decide not to implement these services. You should do these analysis for all tasks.

Tip: If you're just starting with Web services, pick one task that is self-contained. It will be the prototype to understand time and effort involved in developing Web services.

Next, we defined input and output parameters and parameter types for each valid service. For example, the flight lookup service has four input parameters: from city, to city, departure date, and return date. The output of the lookup service is a list of flights that match the search criteria. We decide to use both simple and complex parameters for services. Flight lookup service has four string input parameters and returns multiple occurrences of the Flight data structure. All of our services are stateless and synchronous, state is maintained on the client.

The next step is to review existing RPG code and to find pieces of the code that can be used in the service. We create a new RPG ILE prototype and a module that contains a procedure with input and output parameters identified in the previous step.

Example 4-1 shows the prototype of RPG procedure. The prototype describes input and output parameters for three RPG procedures and a data structure that represents flight information.

Example 4-1 RPG procedure prototypes

```
d FlightInfo      ds                    qualified
d  Airline                       3
d  Flight                        7
d  DoW                           2
d  DepartCity                    3
d  ArriveCity                    3
d  DepartTime                    8
d  ArriveTime                    8
d  Price                         3


d FindFlightsDoW  pr

d   FromCity                    16      const
d   ToCity                      16      const
d   DeptDoW                     16      const
d   ReturnDoW                   16      const
d   FlightCount                 10i 0
d   Flights                             likeds(FlightInfo) dim(50)


d FindFlights     pr

d   FromCity                    16      const
d   ToCity                      16      const
d   DeptDate                     8      const
d   ReturnDate                   8      const
d   FlightCount                 10i 0
d   Flights                             likeds(FlightInfo) dim(50)


d GetFlightInfo   pr

d  FlightNumber                  7      const
d  FlightInfo                           likeds(FlightInfo)
```

After designing services interfaces, we identified workflow between the client and services. In our scenario services are used independently of each other, but they need to be executed in a particular order. Figure 4-1 shows Flight400 application workflow.

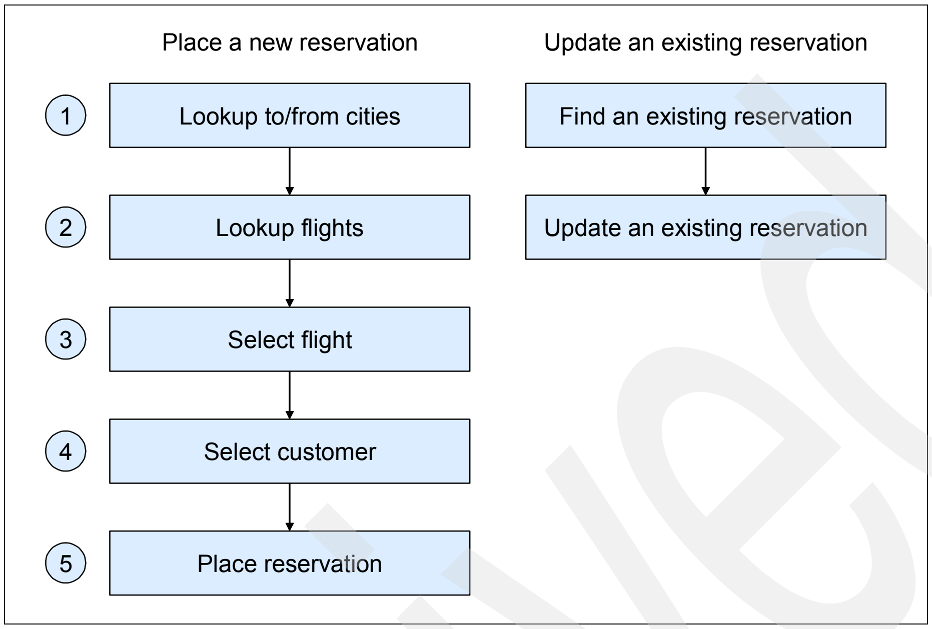


Figure 4-1 Application workflow

4.3 Conclusion

As the result of this design effort, we have identified the services that we want to build. We have prototyped the procedure calls in RPG. The procedure calls should match our Web services interface.

The next step is to change, if needed, the business logic that implements the services. In our scenario the original RPG application requires additional effort to make it modular (according to the ILE concepts). You can find the detailed instructions for modernizing the Flight400 application at:

`http://www-03.ibm.com/servers/enable/site/education/wp/40d2/40d2.pdf`

After we have the callable interface to the RPG application that matches the Web services interface, we need to implement a Web service itself. This includes:

- Implementing a Web service. It will act as a “glue” layer between platform independent SOAP messages and platform specific business logic. The Web service is responsible for:
  - Receiving and unpacking the SOAP request message
  - Invoking the business logic with the correct arguments
  - Returning a result of the business logic execution, if appropriate, in a SOAP response message
- Creating a client for testing a Web service
- Deploying a Web service along with modified business logic on a production server

All these steps are discussed in the next chapters.

Part 2

Implementing the service provider

SOA defines two major participants in its architecture: a *service provider* and a *service consumer*. In this part of the book, we demonstrate several technologies that you can use to create a service provider participant. This service provider builds Web services around i5/OS applications.

Note: We developed all examples in this book using WebSphere Development Studio Client for iSeries V6.0.1.

We use Flight400 RPG application for most examples in this book. You can download this application using the instructions in Appendix D, “Additional material” on page 281.

5

ProgramCall (RPG, Cobol) Web service

Our first example of building a Web service is based on the ProgramCall capability in IBM Toolbox for Java (5722-JC1). In this chapter we discuss the typical method for generating a Web service that invokes an RPG procedure.

5.1 Project investments in developing a service

In externalizing existing business logic as a Program Call Web service, you should consider the following items:

- Analysis of the current state of a business application
- Time frame for prototyping and deploying a services application
- Application development and deployment expenses

5.1.1 Analyzing the existing application

How do you determine whether your business logic needs modernization? The term *monolithic* has been used to describe an application that requires modernization. In a monolithic application, there are two primary areas for analysis:

- Display logic
- Essentially stateless procedure

Important: You do not have to rewrite an entire RPG business application to take advantage and demonstrate the power of Web services for the RPG business logic.

Displaying logic nested within business logic

Many System i applications are written as a monolithic application where display and business logic are intermixed. As the result, there are no callable interfaces to such applications.

Consider a company with a monolithic application. Can you still take advantage of the Web services framework without a complete rewrite of the application? The answer is yes. Because a business task was described as service, you can extract and create a procedure that does not include display logic but still includes the business logic with the required input and output parameters.

The whole process involves several steps. Start with a single business task that is self-contained (that is, it does not depend on other tasks). Extract the business logic into an RPG procedure and create a service program. Use WebSphere Development Studio client for iSeries to generate a Web service.

Essentially stateless procedure

Essentially stateless procedure is the term for a procedure or a set of procedures that can be used in stateless environments such as Web applications. While some state might be kept between procedure calls (for things like list processing) within a transaction, the procedures should not maintain state between transactions.

Application modernization

Traditional (*green screen*) applications are often written as monolithic programs with a display and business logic intermixed. While there are tools and wizards that you can use to generate Web services from callable routines, a process of converting a monolithic application to a set of callable routines requires a significant amount of design and programming effort.

The steps required to create a set of callable routines from an existing application include:

1. Determine what functions are required. The functions should implement business operations that are required by the Web service interfaces.

2. Design interfaces for the required functions. The interfaces should be essentially stateless.
3. Determine where those functions are currently implemented.
4. Decide how much of the current implementation should be used as a base for the new functions.
5. Develop the new functions.
6. Determine whether the new functions should be used in the existing (green screen) application.

The callable functions should be essentially stateless because the application state is controlled by the calling applications and to allow the use of techniques like connection pooling which are critical for scalable Web applications. This requirement drives several new considerations for the function developer, particularly in list handling and record locking.

Traditional applications handle lists using the display file subfile support. Because a subfile can handle multiple records, the application programmer does not have to be particularly concerned about the number of records in a list. Because the application maintains the data file cursor position between user interactions, the application programmer does not have to be particularly concerned about cursor positioning as the user scrolls through a list. The introduction of essentially stateless functional interfaces requires that a programmer handle these considerations in the function code (on the service requestor side).

There are several techniques that can be used to handle a variable length list as set of callable functions. The most flexible technique is to use multiple functions, the first function sets up the request, the second function returns the next record in the list, and the third (and optional) function closes the request. Because this technique can potentially result in a large number of functions calls, you should not use it in cases where there is a large call overhead. Another technique is to return a set of records as a parameter of the function call. The main disadvantage of this technique is that the parameter has to be defined large enough to handle the maximum expected number of records. A practical approach is to use the first approach as the lowest level interface and use those functions in a second level function that can be used where call overhead is a concern. There are also techniques using SQL result sets or messaging interfaces that can provide more flexibility in distributed applications.

The second consideration in list handling is list continuation between user interactions. List continuation is not usually a problem if the data includes unique keys. However, it does require application support, which can be difficult in data without such keys.

The stateless nature of Web interaction can make record locking a concern. Because a user can leave the application or shut down the browser without notifying the application, locking a record between user interactions can cause problems. One approach is to use some type of *optimistic locking*, where the application sends both the *before* and *after* record images to a function, which does the update only if the *before* image matches the data currently in the record. While this can work when the amount of data being updated is relatively small, it can also result in problems if the amount of data is large and a user is told that all the changes must be entered again.

While converting a monolithic application into a modular set of callable functions can be a major effort, it can extend the life of the application and make it available through a wide variety of interfaces. In addition, it can result in an application that is more easily maintained and expanded.

5.1.2 Time frame

In this section, we analyze how much time should be allocated to use the program call beans interface into an RPG business logic.

Prototype

Identify a single business task and ensure that an RPG procedure is modularized as described in 5.1.1, "Analyzing the existing application" on page 36.

Important: You should not have to rewrite the entire RPG business application to take advantage and demonstrate the power of Web services for the RPG business logic.

Using WebSphere Development Studio client for iSeries, the Web service and Web service client can be prototyped within a few hours. Using the example in this chapter as a reference, any exported RPG procedure can be prototyped rather quickly. WebSphere Development Studio Client generates everything from Web service to JSP and Web service Test Client, directly from RPG source code.

Production

After prototyping is done, is the service production ready? There are additional considerations to keep in mind. Additional testing of a service is essential for the business logic and business application to continue to run smoothly.

In addition to testing the application with a variety of clients that might interface with your service, it is also advisable to ramp up the number of users that might be accessing this business logic to test the throughput. There are products such as Rational Performance Tester or Mercury LoadRunner that would simulate multiple users accessing your application.

Security is a very big concern if you need to pass sensitive information, such as a credit card number. Web services provides several standards that deal with this issue. There is a specification called WS-Security built into the Web services framework. WS-Security describes enhancements to SOAP messaging to provide quality of protection through message integrity, message confidentiality, and single message authentication. You can use these mechanisms to accommodate a wide variety of security models and encryption technologies.

5.1.3 Development environment

To develop a Web service based on ProgramCall successfully, ensure that your environment meets the requirements that we provide in this section.

Prerequisites

Note: We did the testing in this chapter on i5/OS Version V5R4, V5R3, and V5R2. Other versions of the operating system should work too.

Ensure that the following products and optoins are already present in the environment:

- Qshell, 5722SS1 Option 30
- Host Servers, 5722SS1 Option 12
- IBM Developer Kit for Java, 5722JV1 Options 5 and 6
- IBM Toolbox for Java, 5722JC1
- 5722WDS Option 31 Compiler - ILE RPG IV
- 5722WDS Option 34 Compiler - RPG/400®
- The latest Group PTFs are installed on the target System i:
  - Cumulative Group PTF SF99540
  - WebSphere Group PTF SF99312
- The Host Servers are running on the target System i:

  ```
  STRHOSTSVR *ALL
  ```

The following products are installed on the development machine (such as a desktop PC):

- WebSphere Development Studio Client for iSeries V6.0.1. Use Rational Product Updater to install the latest fixes for V6.0.1
- Firefox 1.0.7 or higher (or equivalent browser).

Skills assumptions

This technical reference assumes the following technical skills and knowledge:

- Experience with and basic working knowledge of tools such as Rational Web Developer or WebSphere Development Studio client for iSeries
- Basic knowledge of i5/OS administration
- Familiarity with the behavior and operation of the existing application that you want to modernize

5.1.4 Deployment environment

The deployment environment should include:

- WebSphere Application Server - Express, Base, or Network Deployment running on one of the supported platforms. We run it on i5/OS.
- Server on which the RPG application is deployed.

In addition, you should have the following skills:

- System i administrator
- WebSphere Application Server administrator

5.2 ProgramCall bean example

In this example we demonstrate the RPG business task in Flight400 called *ReserveFlight*. We use WebSphere Development Studio client for iSeries Advanced Edition to create a Web service from RPG source code using single wizard and publish it to i5/OS using WebSphere Administrative Console, as illustrated in Figure 5-1.

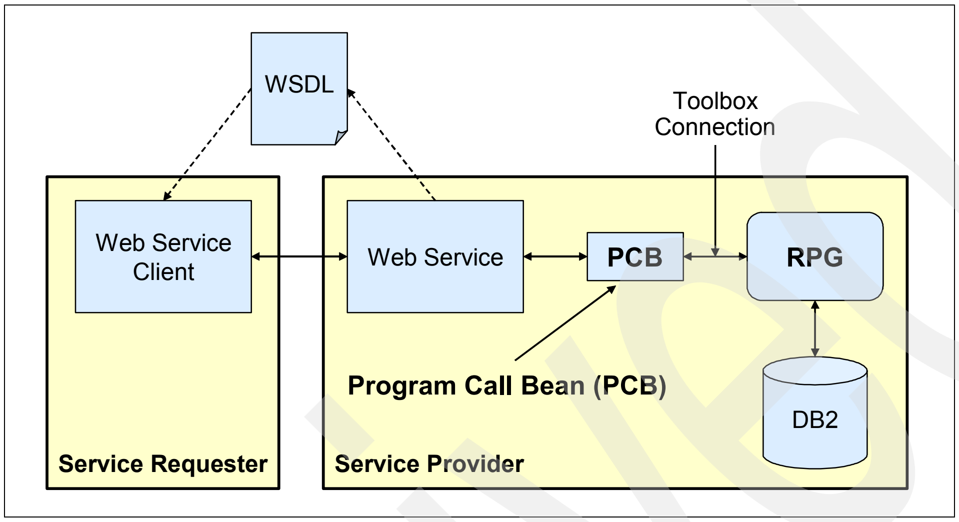
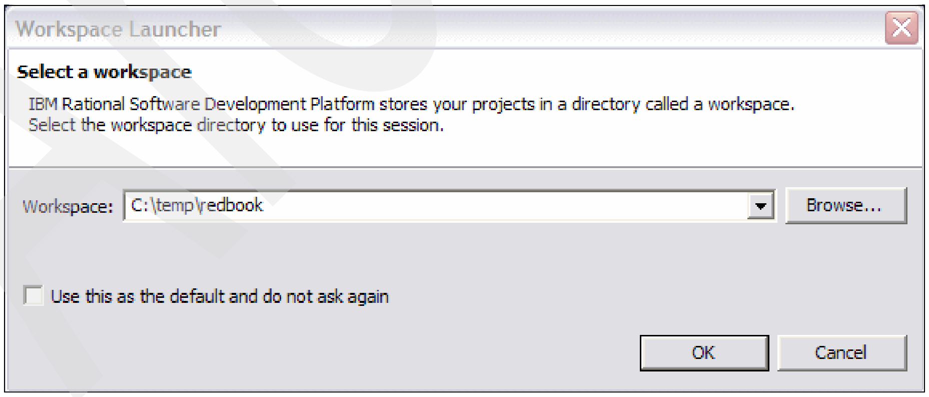


Figure 5-1 Web service diagram

5.2.1 Starting WebSphere Development Studio client for iSeries

Open WebSphere Development Studio client for iSeries and set up the workspace by following these steps:

1. Go to **Start** → **All Programs** → **IBM Rational** → **IBM WebSphere Development Studio Client for iSeries V6.0** → **WebSphere Development Studio Client for iSeries**.
2. In the Workplace™ Launcher window, in the Workspace field, enter `c:\temp\redbook` and click **OK** as shown in Figure 5-2.



Select a workspace

IBM Rational Software Development Platform stores your projects in a directory called a workspace.
Select the workspace directory to use for this session.

Workspace: C:\temp\redbook

Figure 5-2 Start WebSphere Development Studio Client for new workspace

3. If you did not use WebSphere Development Studio client for iSeries before, you see a Welcome page. Click **X** to close the Welcome page, as shown in Figure 5-3.

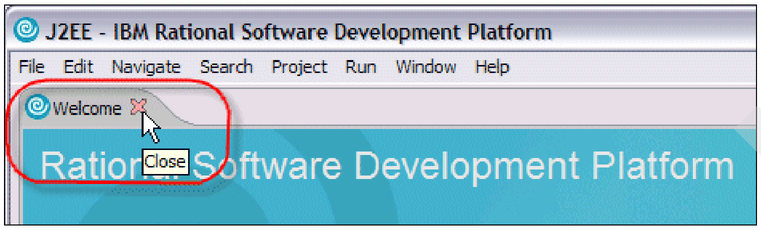

J2EE - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Welcome
Close
Rational Software Development Platform

Figure 5-3 Close the Welcome Page

Note: There are two known issues with running WebSphere Development Studio client for iSeries. If you encounter any problem, see Appendix A, "Setting the connection to WebSphere Application Server V6.0" on page 249 and Appendix B, "URI length limit of 259 characters on Windows" on page 255 for possible solutions.

5.2.2 Opening Remote System Explorer perspective

Open the perspective for System i development:

1. Click **Open perspective icon** on the right-hand side or select **Window** → **Open Perspective** and select **Other** (see Figure 5-4).

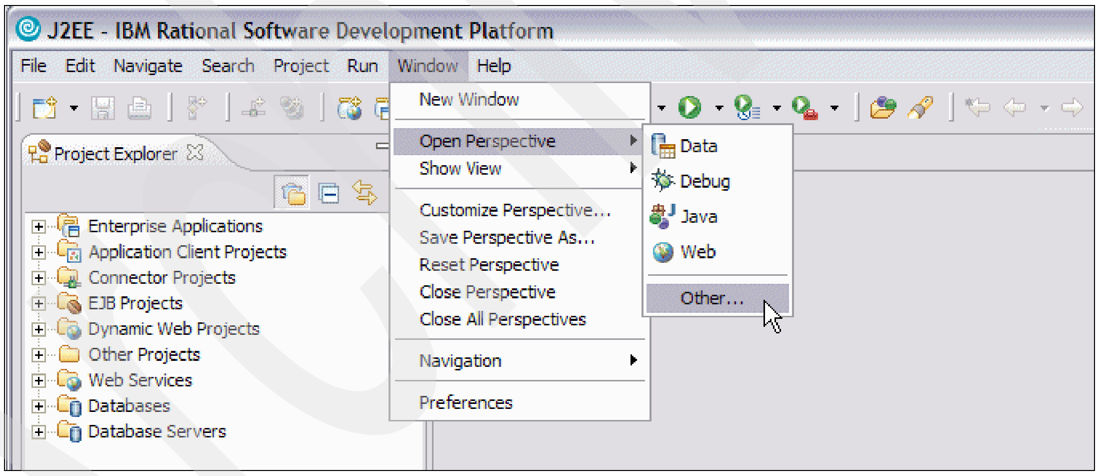


Figure 5-4 Open Remote System Explorer Perspective

2. In the Select Perspective window, select **Remote System Explorer** and click **OK**.

5.2.3 Defining a connection to the i5/OS server

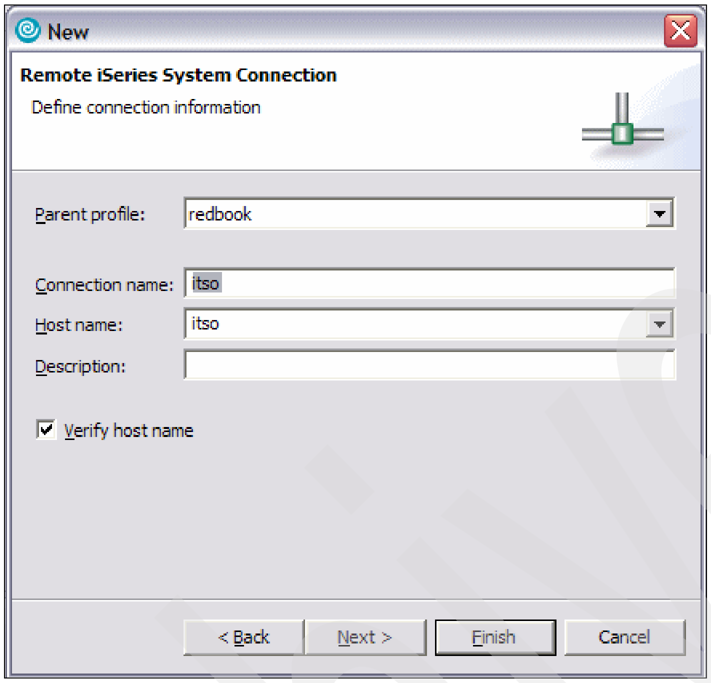
Create a connection to your i5/OS server:

1. Click the plus sign (+) next to *iSeries* under New connection in Remote Systems view.
2. If you have not used WebSphere Development Studio client for iSeries before, you see name personal profile screen. Enter `redbook` as the Profile and click **Next**.

3. On the Define connection information screen, enter the following information (as shown in Figure 5-5):

   a. Host name as `<iSeries_Server>`.

   b. Enter Connection name as `<iSeries_Server>`.



New
Remote iSeries System Connection
Define connection information

Parent profile: redbook

Connection name: itso

Host name: itso

Description:

[✓] Verify host name

< Back
Next >
Finish
Cancel

Figure 5-5 Define connection to System i

4. Click **Finish**.

5. Right-click **iSeries Objects** under itso and select **Connect** to connect to the i5/OS server, as shown in Figure 5-6.

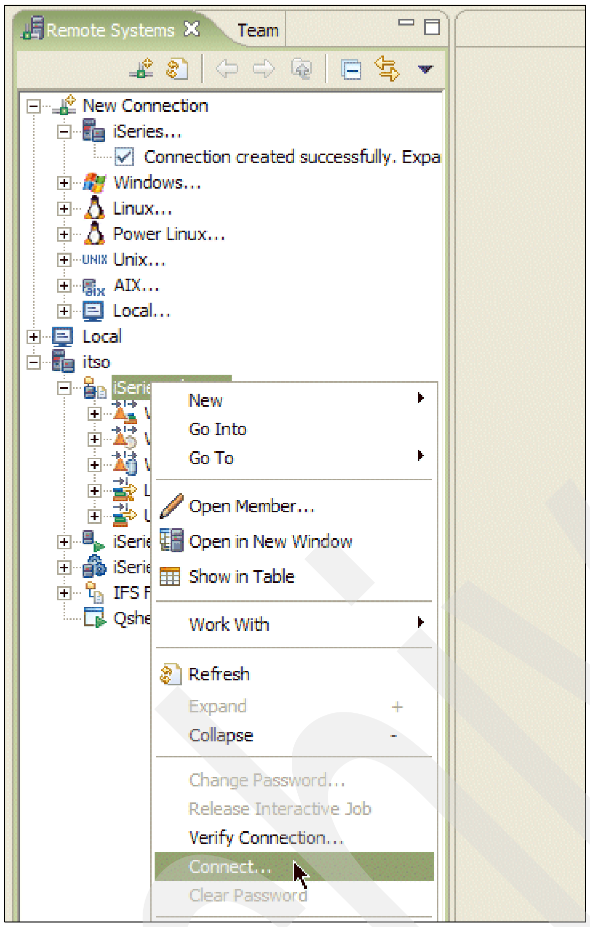
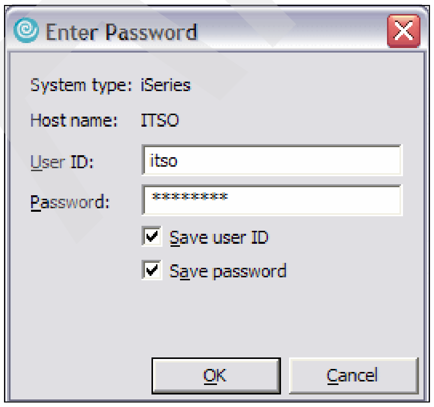


Figure 5-6 Connect to System i

6. In the Enter Password window, enter the following information and click **OK** (see Figure 5-7):
   a. User ID as your user profile on the system.
   b. Password as password for the user profile entered in the previous step.
   c. Select **Save user ID**.
   d. Select **Save password**.



Enter Password

System type: iSeries
Host name: ITSO
User ID: itso
Password: *********
☑ Save user ID
☑ Save password

Figure 5-7 Connection settings

7. After successful connection you should see an arrow next to iSeries connection as well as the iSeries Objects and other subsystems .

5.2.4 Reviewing the RPG modules

Examine the RPG code to understand exported procedures:

1. Expand your System i connection.
2. Right-click **iSeries Objects** and select **Properties**.
3. In the Properties window, click **Initial Library List**.
4. Enter `FLGHT400` in the Library field and click **Add(B)** as shown in Figure 5-8.

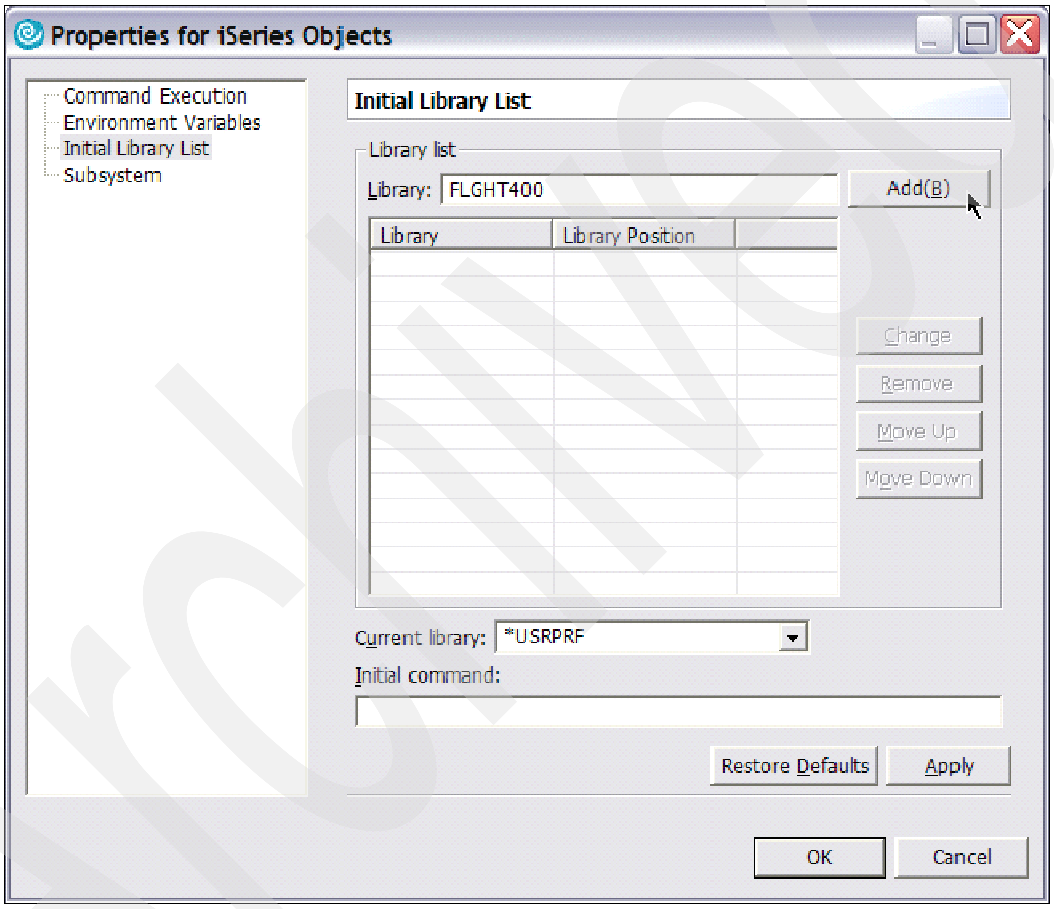
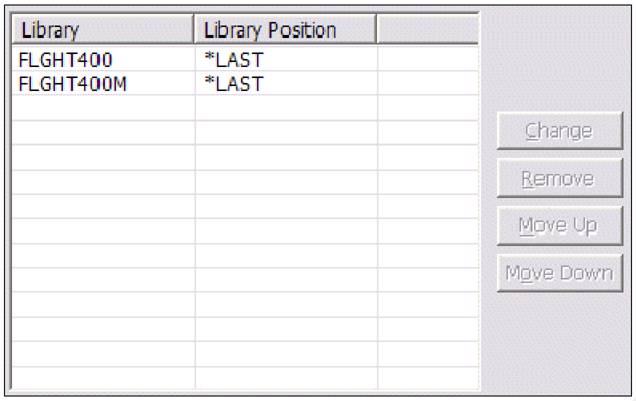


Figure 5-8 Add Library

5. Add the **FLGHT400M** library in the same way. Your library list should look similar to that shown in Figure 5-9.

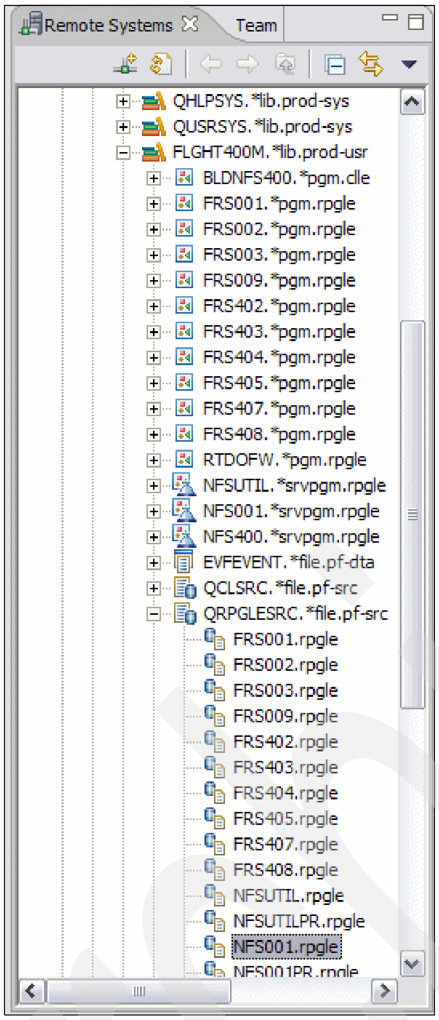


Library	Library Position	
FLGHT400	*LAST	
FLGHT400M	*LAST	

Figure 5-9 Library list

6. Click **OK**. Now every time you reconnect to your System i platform, both libraries are listed under **iSeries Objects** → **Library list**. You might need to disconnect and connect again to see these libraries in the list.

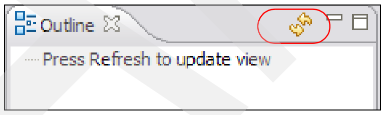
7. Expand **iSeries Objects** → **Library list** → **FLGHT400M.*lib.prod-usr** → **QRPGLESRC** and double-click **NFS001.rpgle**, as shown in Figure 5-10.



QHLPSYS.*lib.prod-sys
QUSRSYS.*lib.prod-sys
FLGHT400M.*lib.prod-usr
BLDNFS400.*pgm.clle
FRS001.*pgm.rpgle
FRS002.*pgm.rpgle
FRS003.*pgm.rpgle
FRS009.*pgm.rpgle
FRS402.*pgm.rpgle
FRS403.*pgm.rpgle
FRS404.*pgm.rpgle
FRS405.*pgm.rpgle
FRS407.*pgm.rpgle
FRS408.*pgm.rpgle
RTDOFW.*pgm.rpgle
NFSUTIL.*srvpgm.rpgle
NFS001.*srvpgm.rpgle
NFS400.*srvpgm.rpgle
EVFEVENT.*file.pf-dta
QCLSRC.*file.pf-src
QRPGLESRC.*file.pf-src
FRS001.rpgle
FRS002.rpgle
FRS003.rpgle
FRS009.rpgle
FRS402.rpgle
FRS403.rpgle
FRS404.rpgle
FRS405.rpgle
FRS407.rpgle
FRS408.rpgle
NFSUTIL.rpgle
NFSUTILPR.rpgle
NFS001.rpgle
NFS001PR.rpgle

Figure 5-10 Open RPG Source for ReserveFlight

8. The procedure that we are interested in is *ReserveFlight*. Click the refresh button in the outline frame as shown in Figure 5-11.



Press Refresh to update view

Figure 5-11 Refresh RPG Code

9. Select **ReserveFlight** from the outline view as displayed in Figure 5-12.

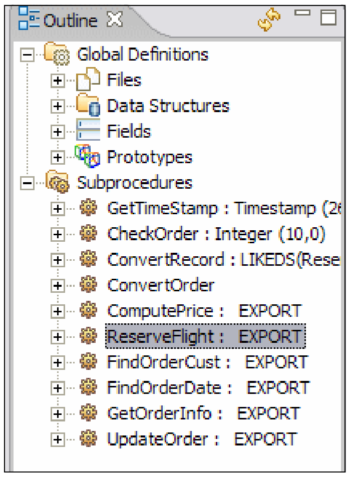
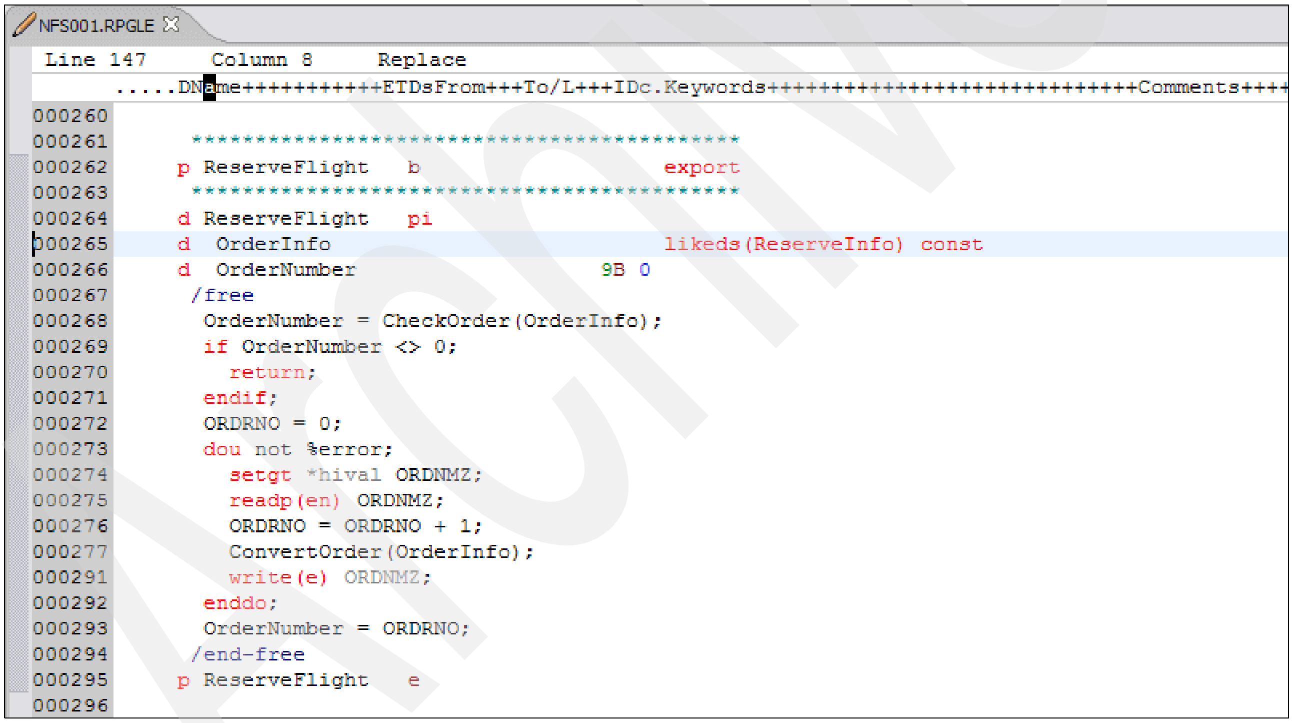


Figure 5-12 ReserveFlight Procedure

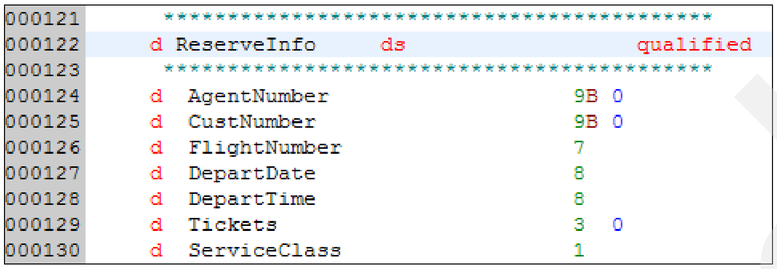
10. Review program code for the ReserveFlight procedure as shown in Figure 5-13.



```
 Line 147      Column 8      Replace
      .....DName+++++++++++ETDsFrom+++To/L+++IDc.Keywords+++++++++++++++++++++++++++++Comments++++

            *******************************************
           p ReserveFlight    b                     export
            *******************************************
           d ReserveFlight    pi
           d  OrderInfo                             likeds(ReserveInfo) const
           d  OrderNumber                      9B 0
            /free
             OrderNumber = CheckOrder(OrderInfo);
             if OrderNumber <> 0;
               return;
             endif;
             ORDRNO = 0;
             dou not %error;
               setgt *hival ORDNMZ;
               readp(en) ORDNMZ;
               ORDRNO = ORDRNO + 1;
               ConvertOrder(OrderInfo);
               write(e) ORDNMZ;
             enddo;
             OrderNumber = ORDRNO;
            /end-free
           p ReserveFlight    e
```

Figure 5-13 RPG ReserveFlight

The ReserveFlight procedure inputs OrderInfo, which is a data structure of ReserveInfo. The ReserveFlight returns a confirmation number with OrderNumber displayed (see Figure 5-14).



```
     *******************************************
    d ReserveInfo     ds                    qualified
     *******************************************
    d  AgentNumber                   9B 0
    d  CustNumber                    9B 0
    d  FlightNumber                  7
    d  DepartDate                    8
    d  DepartTime                    8
    d  Tickets                       3  0
    d  ServiceClass                  1
```

Figure 5-14 OrderInfo is data structure with following declarations

11.Click **X** in the NFS001.RPGLE tab at the top of the window to close the window.

5.2.5 Creating and testing RPG Web service

In the previous section, you examined the RPG procedures. Now, you create a Web service directly from the RPG source code that externalizes the RPG procedure:

1. Under QRPGLESRC, right-click **NFS001.rpgle** and select **Web services** → **Create Web service** as shown in Figure 5-15.

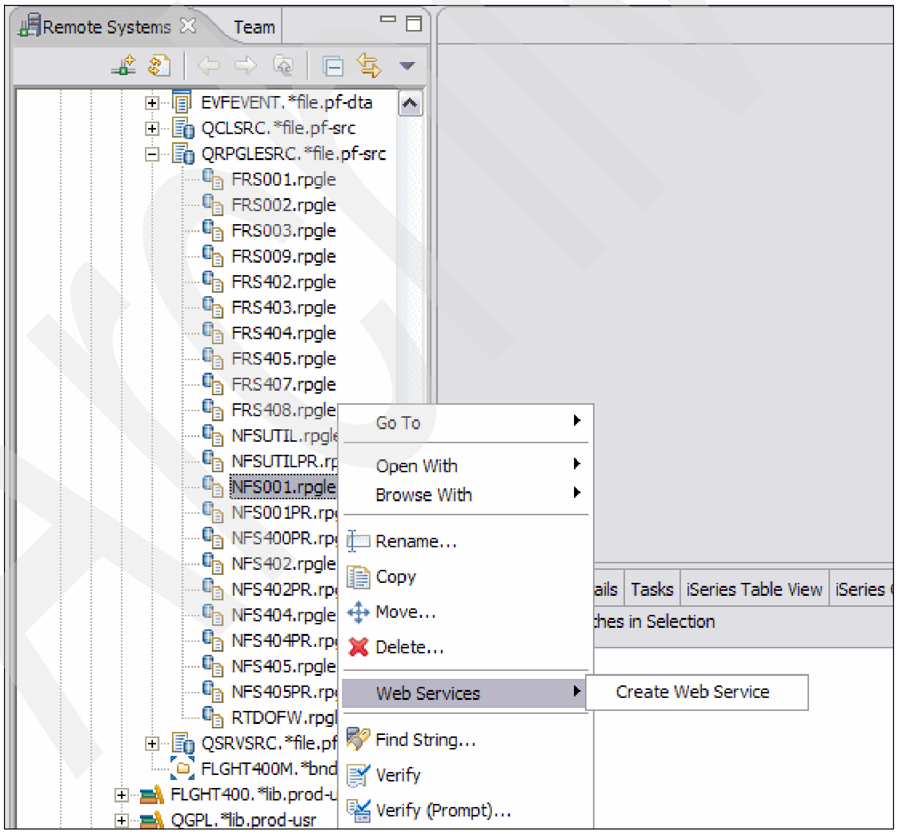
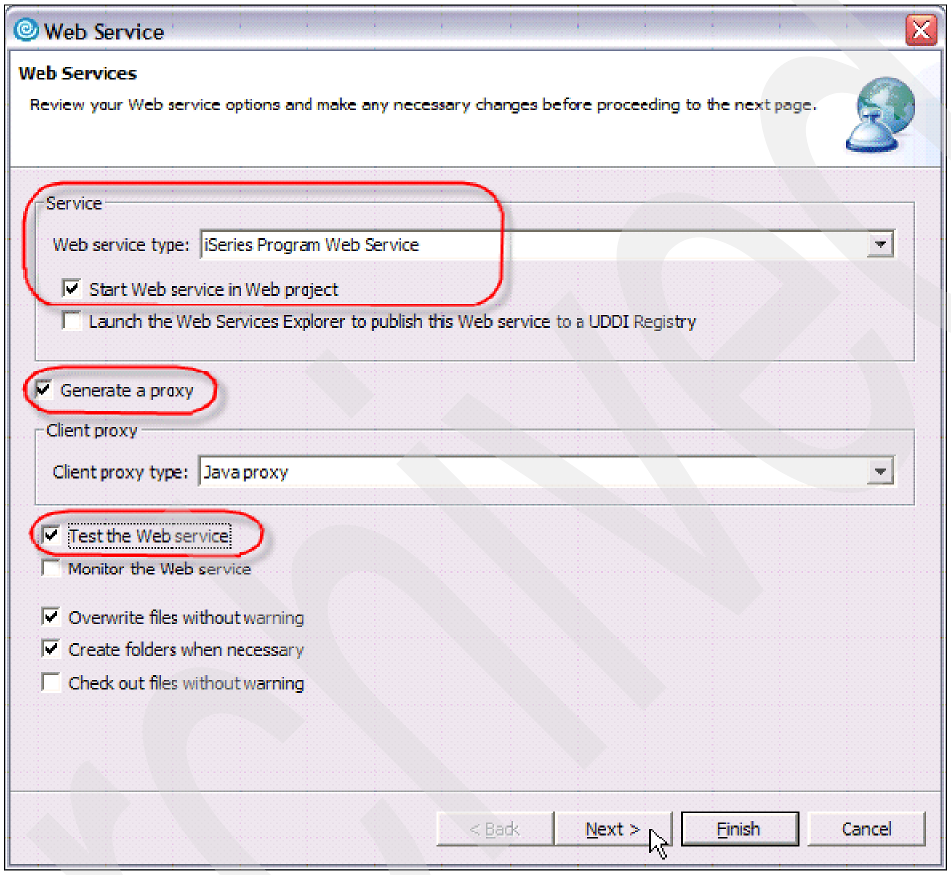


Figure 5-15 Create Web service from RPG code

2. In the Web service dialog box, make sure that the following options are selected as shown in Figure 5-16:
   - Web service Type: **iSeries Program Web service**
   - Check **Start Web service in Web Project**
   - Check **Generate a Proxy**
   - Check **Test the Web service**
3. Click **Next**.



Web Service

Web Services

Review your Web service options and make any necessary changes before proceeding to the next page.

Service

Web service type: iSeries Program Web Service

[✓] Start Web service in Web project

[ ] Launch the Web Services Explorer to publish this Web service to a UDDI Registry

[✓] Generate a proxy

Client proxy

Client proxy type: Java proxy

[✓] Test the Web service

[ ] Monitor the Web service

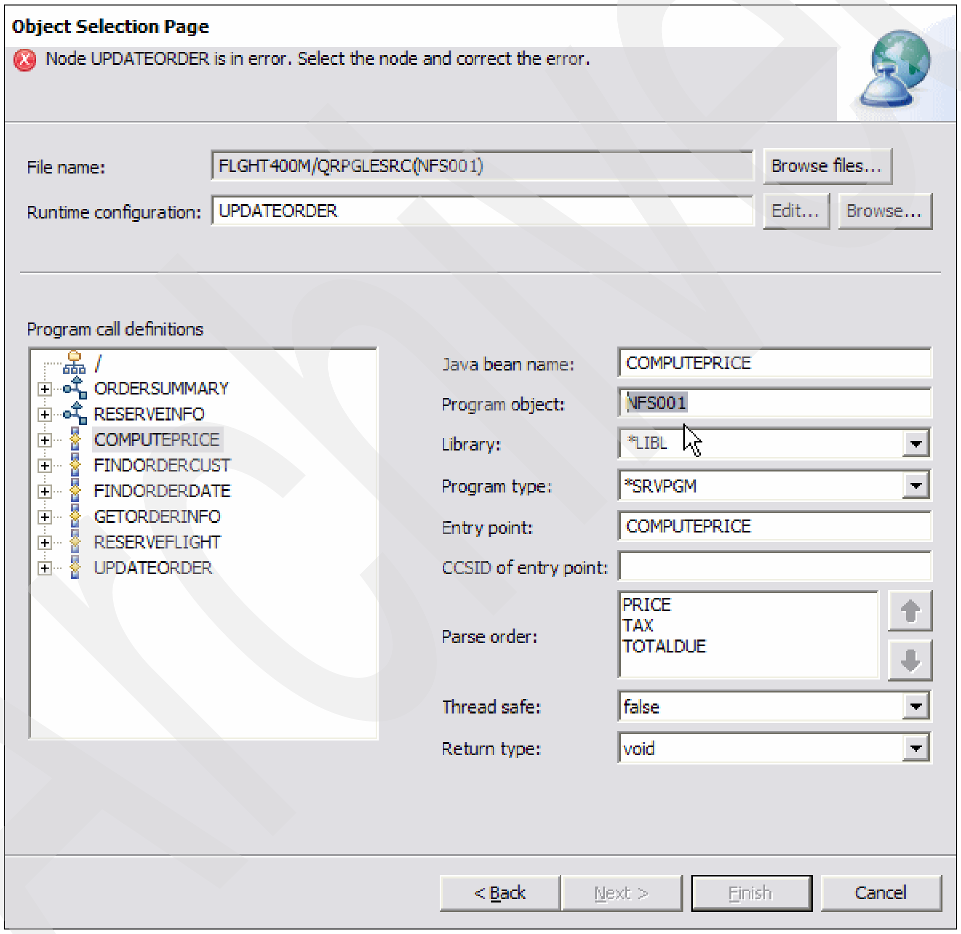
[✓] Overwrite files without warning

[✓] Create folders when necessary

[ ] Check out files without warning

Figure 5-16 Web service Wizard

4. On the Object Selection Page, do the following (see Figure 5-17):
   - Select **COMPUTEPRICE** in Program Call Definition and change the value of Program Object to `NFS001`
   - Select **FINDORDERCUST** in Program Call Definition and change the value of Program Object to `NFS001`.
   - Select **FINDORDERDATE** in Program Call Definition and change the value of Program Object to `NFS001`.
   - Select **GETORDERINFO** in Program Call Definition and change the value of Program Object to `NFS001`.
   - Select **RESERVEFLIGHT** in Program Call Definition and change the value of Program Object to `NFS001`.
   - Select **UPDATEORDER** in Program Call Definition and change the value of Program Object to `NFS001`.


Object Selection Page

Node UPDATEORDER is in error. Select the node and correct the error.

File name: FLGHT400M/QRPGLESRC(NFS001)

Runtime configuration: UPDATEORDER

Program call definitions

- /
  - ORDERSUMMARY
  - RESERVEINFO
  - COMPUTEPRICE
  - FINDORDERCUST
  - FINDORDERDATE
  - GETORDERINFO
  - RESERVEFLIGHT
  - UPDATEORDER

Java bean name: COMPUTEPRICE

Program object: NFS001

Library: *LIBL

Program type: *SRVPGM

Entry point: COMPUTEPRICE

CCSID of entry point:

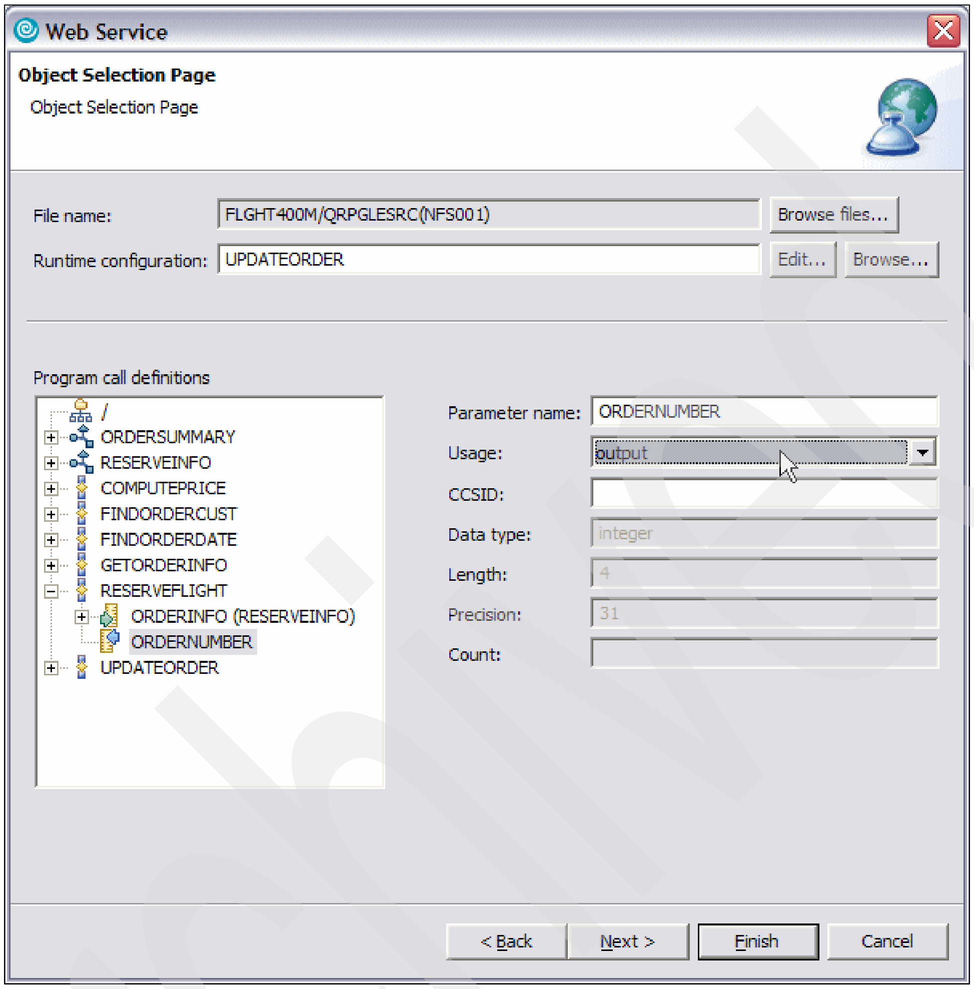
Parse order: PRICE, TAX, TOTALDUE

Thread safe: false

Return type: void

Figure 5-17 Setting Service Program for Program Object

5. Expand **RESERVEFLIGHT** and select the **ORDERNUMBER and** change the usage value from input & output to **output** as shown in Figure 5-18.



File name: FLGHT400M/QRPGLESRC(NFS001)

Runtime configuration: UPDATEORDER

Parameter name: ORDERNUMBER

Usage: output

CCSID:

Data type: integer

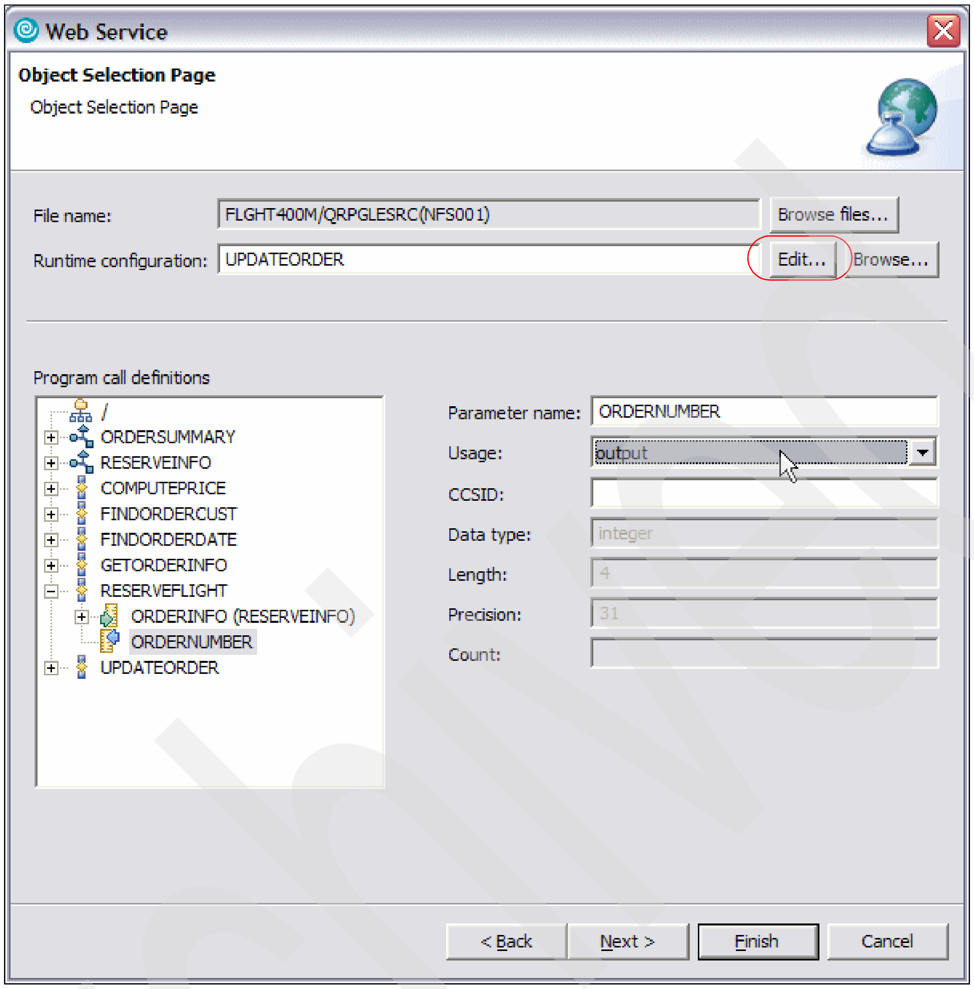
Length: 4

Precision: 31

Count:

Figure 5-18 Setting ReserveFlight Parameter

6. Click **Edit** as in Figure 5-19.

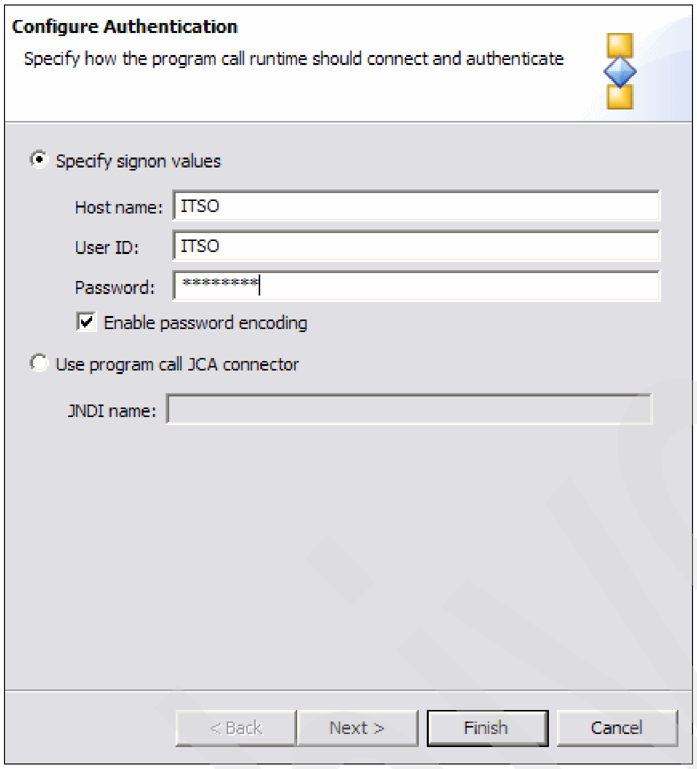


File name: FLGHT400M/QRPGLESRC(NFS001)
Runtime configuration: UPDATEORDER

Parameter name: ORDERNUMBER
Usage: output
CCSID:
Data type: integer
Length: 4
Precision: 31
Count:

Figure 5-19 System i Connection Information

7. Ensure all the System i information is correct (see Figure 5-20) and click **Next**. *Remember* that you might have a different system name and user ID.


Configure Authentication

Specify how the program call runtime should connect and authenticate

(●) Specify signon values

Host name: ITSO

User ID: ITSO

Password: *********

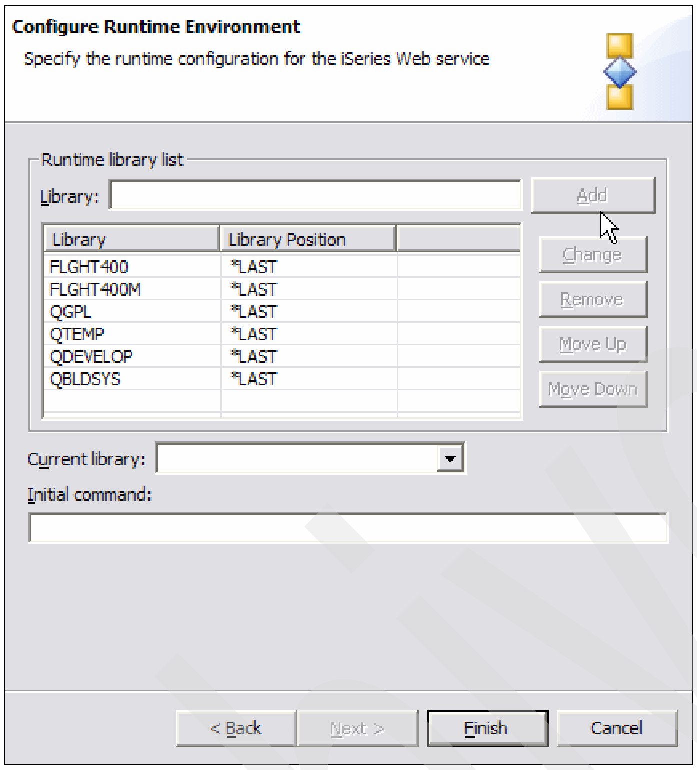
[✓] Enable password encoding

( ) Use program call JCA connector

JNDI name:

Figure 5-20 System i Connection Values

8. Ensure FLGHT400 and FLGHT400M are on the library list as in Figure 5-21. If they are not, enter `FLIGHT400` in the LIbrary field and click **Add** button. Repeat this step for the *FLGHT400M* library.

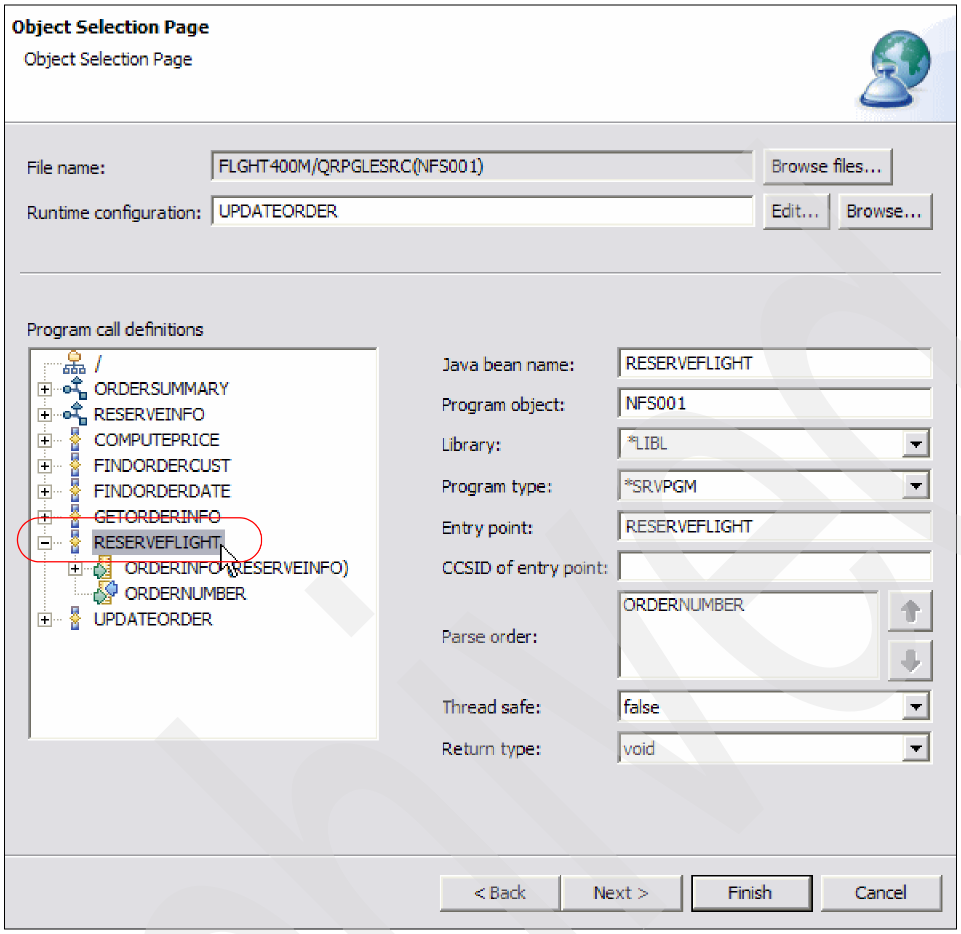


Library	Library Position
FLGHT400	*LAST
FLGHT400M	*LAST
QGPL	*LAST
QTEMP	*LAST
QDEVELOP	*LAST
QBLDSYS	*LAST

Figure 5-21 System i Library information

9. Click **Finish**.

10. Ensure that **RESERVEFLIGHT** is highlighted or selected and click **Next** (see Figure 5-22).


Object Selection Page
Object Selection Page

File name: FLGHT400M/QRPGLESRC(NFS001)
Runtime configuration: UPDATEORDER

Program call definitions
/
ORDERSUMMARY
RESERVEINFO
COMPUTEPRICE
FINDORDERCUST
FINDORDERDATE
GETORDERINFO
RESERVEFLIGHT
ORDERINFO (RESERVEINFO)
ORDERNUMBER
UPDATEORDER

Java bean name: RESERVEFLIGHT
Program object: NFS001
Library: *LIBL
Program type: *SRVPGM
Entry point: RESERVEFLIGHT
CCSID of entry point:
Parse order: ORDERNUMBER
Thread safe: false
Return type: void

Figure 5-22 Reserve Flight is selected

11. On Service Deployment Configuration frame click **Next**. This step might take some time to complete.

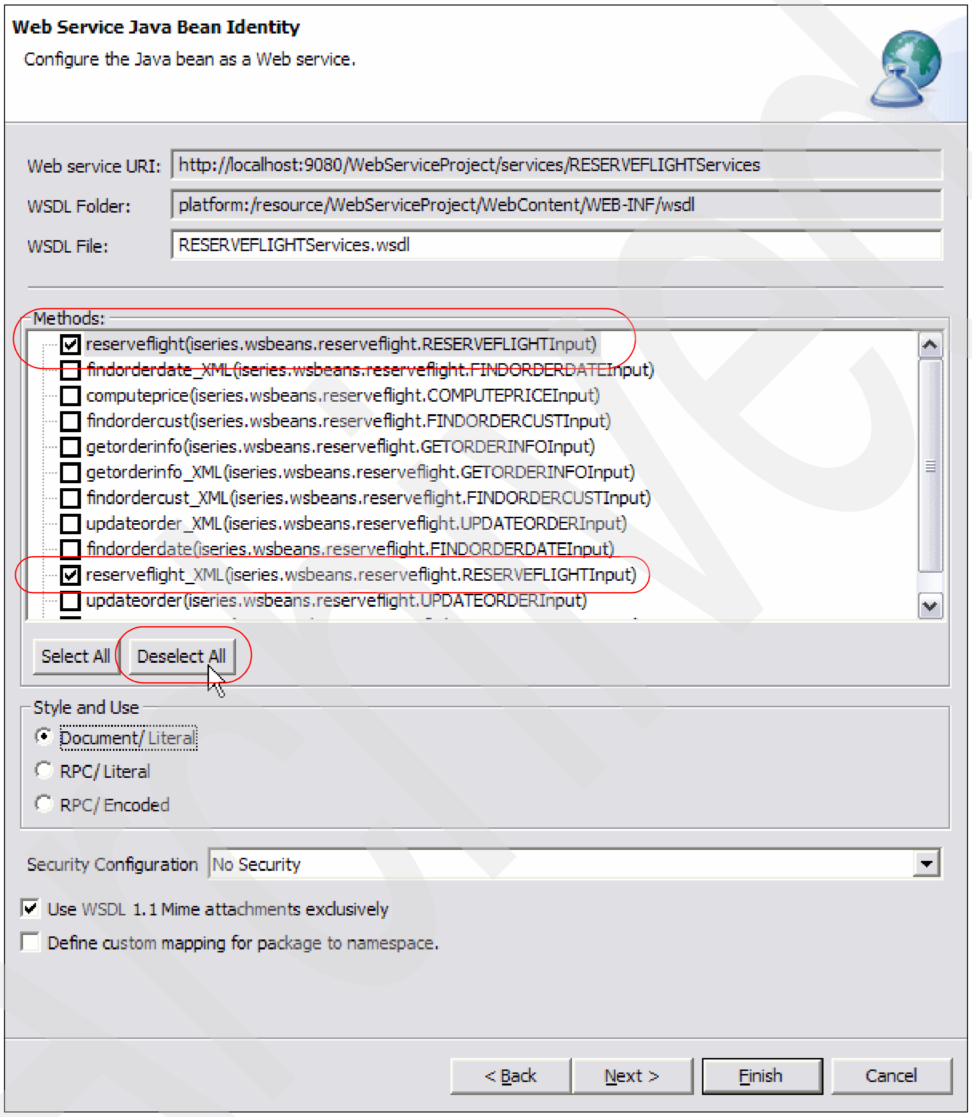
12. On Service Endpoint Interface frame click **Next**.

13. On Web service Java Bean Identity frame:

   a. Click **Deselect All**.

   b. Select **reserveflight(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)**.

   c. Scroll down and select **reserveflight_XML(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)** as shown in Figure 5-23.



Web Service Java Bean Identity

Configure the Java bean as a Web service.

Web service URI: http://localhost:9080/WebServiceProject/services/RESERVEFLIGHTServices

WSDL Folder: platform:/resource/WebServiceProject/WebContent/WEB-INF/wsdl

WSDL File: RESERVEFLIGHTServices.wsdl

Methods:

- [✓] reserveflight(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
- [ ] findorderdate_XML(iseries.wsbeans.reserveflight.FINDORDERDATEInput)
- [ ] computeprice(iseries.wsbeans.reserveflight.COMPUTEPRICEInput)
- [ ] findordercust(iseries.wsbeans.reserveflight.FINDORDERCUSTInput)
- [ ] getorderinfo(iseries.wsbeans.reserveflight.GETORDERINFOInput)
- [ ] getorderinfo_XML(iseries.wsbeans.reserveflight.GETORDERINFOInput)
- [ ] findordercust_XML(iseries.wsbeans.reserveflight.FINDORDERCUSTInput)
- [ ] updateorder_XML(iseries.wsbeans.reserveflight.UPDATEORDERInput)
- [ ] findorderdate(iseries.wsbeans.reserveflight.FINDORDERDATEInput)
- [✓] reserveflight_XML(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
- [ ] updateorder(iseries.wsbeans.reserveflight.UPDATEORDERInput)

Style and Use

- [●] Document/ Literal
- [ ] RPC/ Literal
- [ ] RPC/ Encoded

Security Configuration: No Security

- [✓] Use WSDL 1.1 Mime attachments exclusively
- [ ] Define custom mapping for package to namespace.

Figure 5-23 Select RPG Procedures to externalize as Web service

14. Click **Finish**. At this time the wizard generates a lot of code, so this operation can take a while.

Note: Alternatively, you can click **Next** if you want to see the rest of the Web service Wizards. In our example, we accept the default values for the rest of the wizard.

Important: If this is your first time using the wizard, click **Yes** or **Yes to All** in the information messages window, as in the example shown in Figure 5-24.

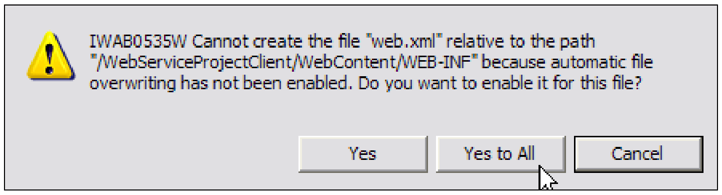
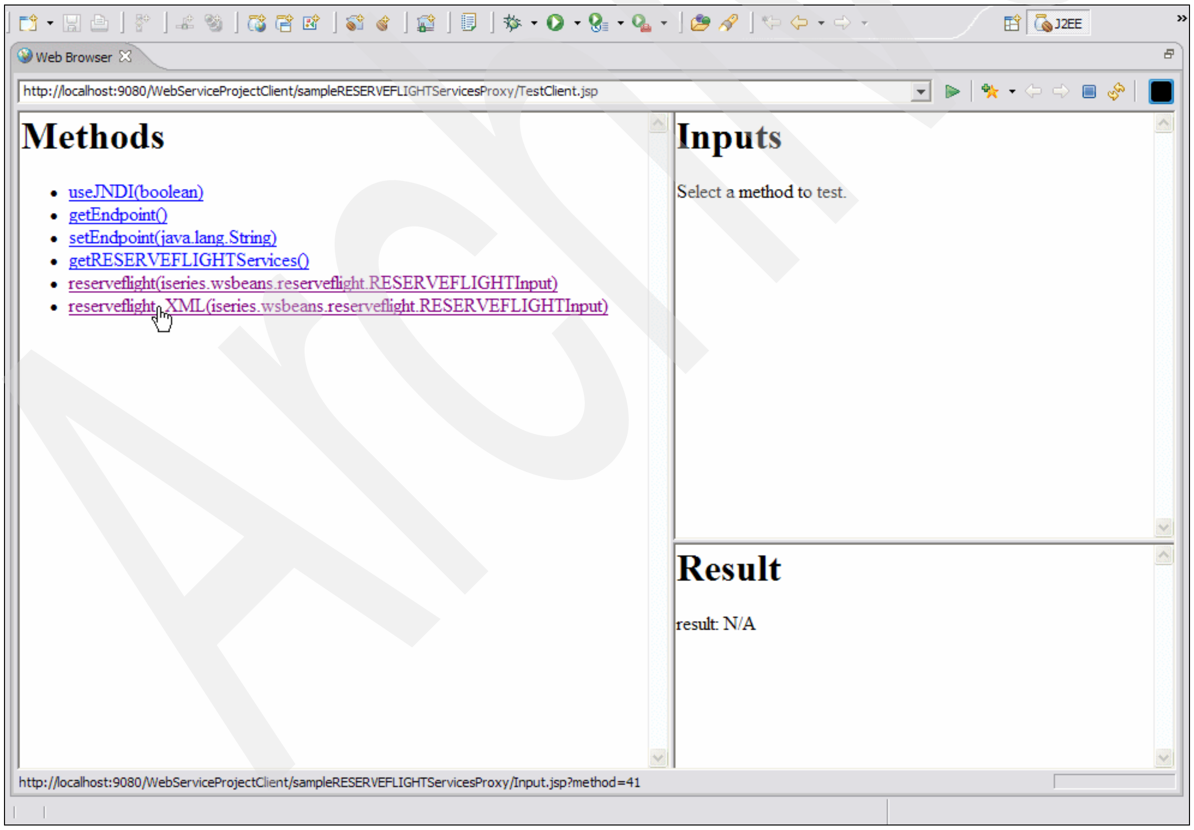

IWAB0535W Cannot create the file "web.xml" relative to the path "/WebServiceProjectClient/WebContent/WEB-INF" because automatic file overwriting has not been enabled. Do you want to enable it for this file?

Figure 5-24 Warning message

5.2.6 Testing the Web service Test Client

The wizard from the previous section generated a Web service and a JSP based Web service Test Client. Now we are ready to test the generated code:

1. After the wizard generates all the required artifacts, you see a Web Browser window. The wizard generates a Web service Test Client as a JSP based Web application. Click **reserveflight_XML(iseries.wsbeans.updateorder.RESERVEFLIGHTInput)** as shown in Figure 5-25.



http://localhost:9080/WebServiceProjectClient/sampleRESERVEFLIGHTServicesProxy/TestClient.jsp

Methods

- useJNDI(boolean)
- getEndpoint()
- setEndpoint(java.lang.String)
- getRESERVEFLIGHTServices()
- reserveflight(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
- reserveflight_XML(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)

Inputs

Select a method to test.

Result

result: N/A

http://localhost:9080/WebServiceProjectClient/sampleRESERVEFLIGHTServicesProxy/Input.jsp?method=41

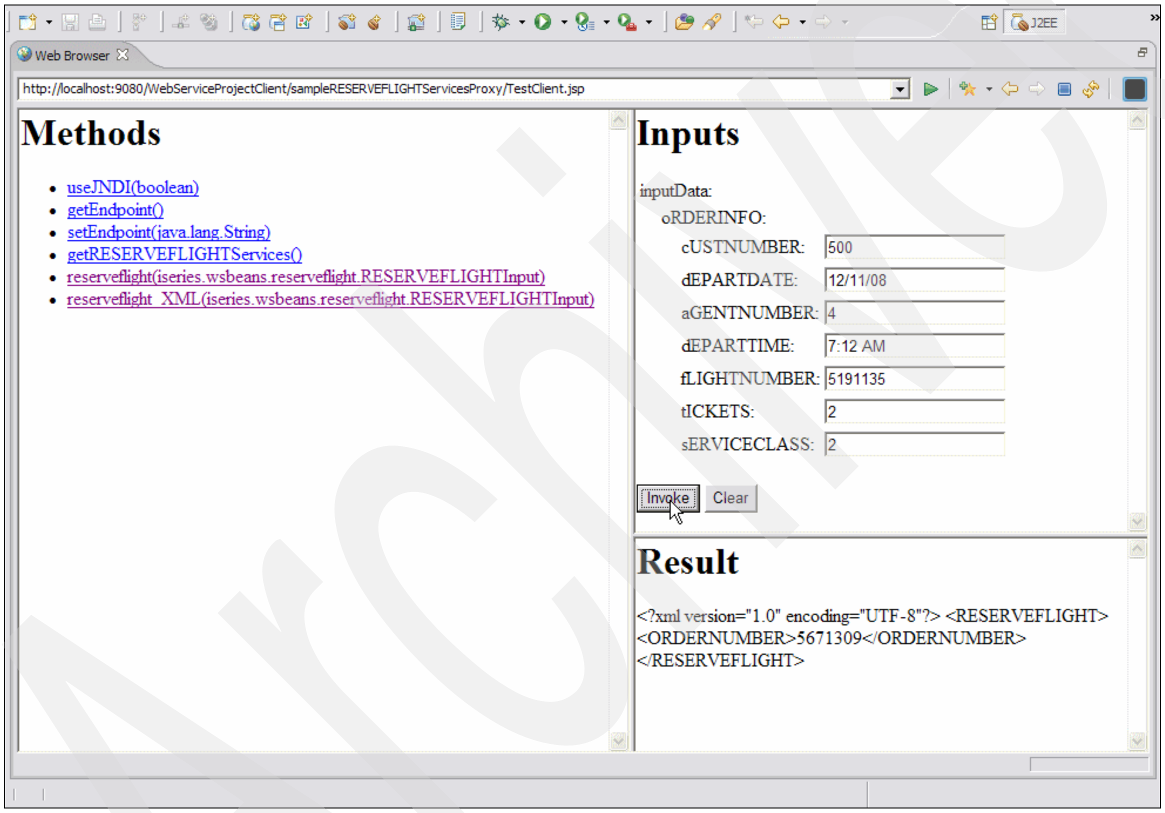
Figure 5-25 Web service Test Client

Note: You can copy the URL into any Web browser, including Firefox or Internet Explorer®.

2. In the Inputs frame of the Web Browser window, enter the following values and click **Invoke** (see Figure 5-26):

   – cUSTNUMBER: `500`
   – dEPARTDATE: `12/11/08`
   – aGENTNUMBER: `4`
   – dEPARTTIME: `7:12 AM`
   – fLIGHTNUMBER: `5191135`
   – tICKETS: `2`
   – sERVICECLASS: `2`

Note: The values for *dEPARTDATE* and *dEPARTTIME* are specific to this sample. You *must* enter them as we note here. You can use Alternative Date mechanisms if you change the RPG program or Web service code to handle unique formats.


Web Browser
J2EE
http://localhost:9080/WebServiceProjectClient/sampleRESERVEFLIGHTServicesProxy/TestClient.jsp
Methods
useJNDI(boolean)
getEndpoint()
setEndpoint(java.lang.String)
getRESERVEFLIGHTServices()
reserveflight(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
reserveflight_XML(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
Inputs
Invoke
Clear
Result

inputData:
oRDERINFO:

cUSTNUMBER:	500
dEPARTDATE:	12/11/08
aGENTNUMBER:	4
dEPARTTIME:	7:12 AM
fLIGHTNUMBER:	5191135
tICKETS:	2
sERVICECLASS:	2

```
<?xml version="1.0" encoding="UTF-8"?> <RESERVEFLIGHT>
<ORDERNUMBER>5671309</ORDERNUMBER>
</RESERVEFLIGHT>
```

Figure 5-26 Values for Inputs Frame

The Web service Client has demonstrated a successful Web service invocation because you receive the order number as the result.

Note: If you want to check whether the FLGHT400 Database was updated with the ReserveInfo, issue the following command on 5250 SQL session and scroll to the bottom of the file:

```
SELECT * FROM FLGHT400/ORDERS
```

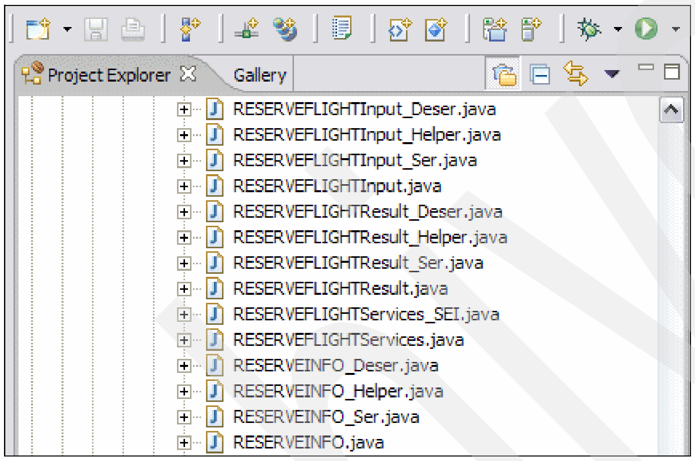
5.2.7 Reviewing the generated Web service and Web service client code

At this point, WebSphere Development Studio client for iSeries has generated the Web service code, which in time might need some modifications. Thus, you might want to examine the code and begin to build a general understanding of the Web service implementation.

Reviewing the generated Web service code

Review the Web service and Web service generated client code using WebSphere Development Studio Client for iSeries:

1. Open Web Perspective by going to **Window** → **Open Perspective** → **Web**.
2. In Project Explorer expand **Dynamic Web Projects** → **WebServiceProject** → **Java Resources** → **JavaSource** → **iseries.wsbeans.reserveflight**. Spend some time reviewing the generated Web service Source files (see Figure 5-27).



RESERVEFLIGHTInput_Deser.java
RESERVEFLIGHTInput_Helper.java
RESERVEFLIGHTInput_Ser.java
RESERVEFLIGHTInput.java
RESERVEFLIGHTResult_Deser.java
RESERVEFLIGHTResult_Helper.java
RESERVEFLIGHTResult_Ser.java
RESERVEFLIGHTResult.java
RESERVEFLIGHTServices_SEI.java
RESERVEFLIGHTServices.java
RESERVEINFO_Deser.java
RESERVEINFO_Helper.java
RESERVEINFO_Ser.java
RESERVEINFO.java

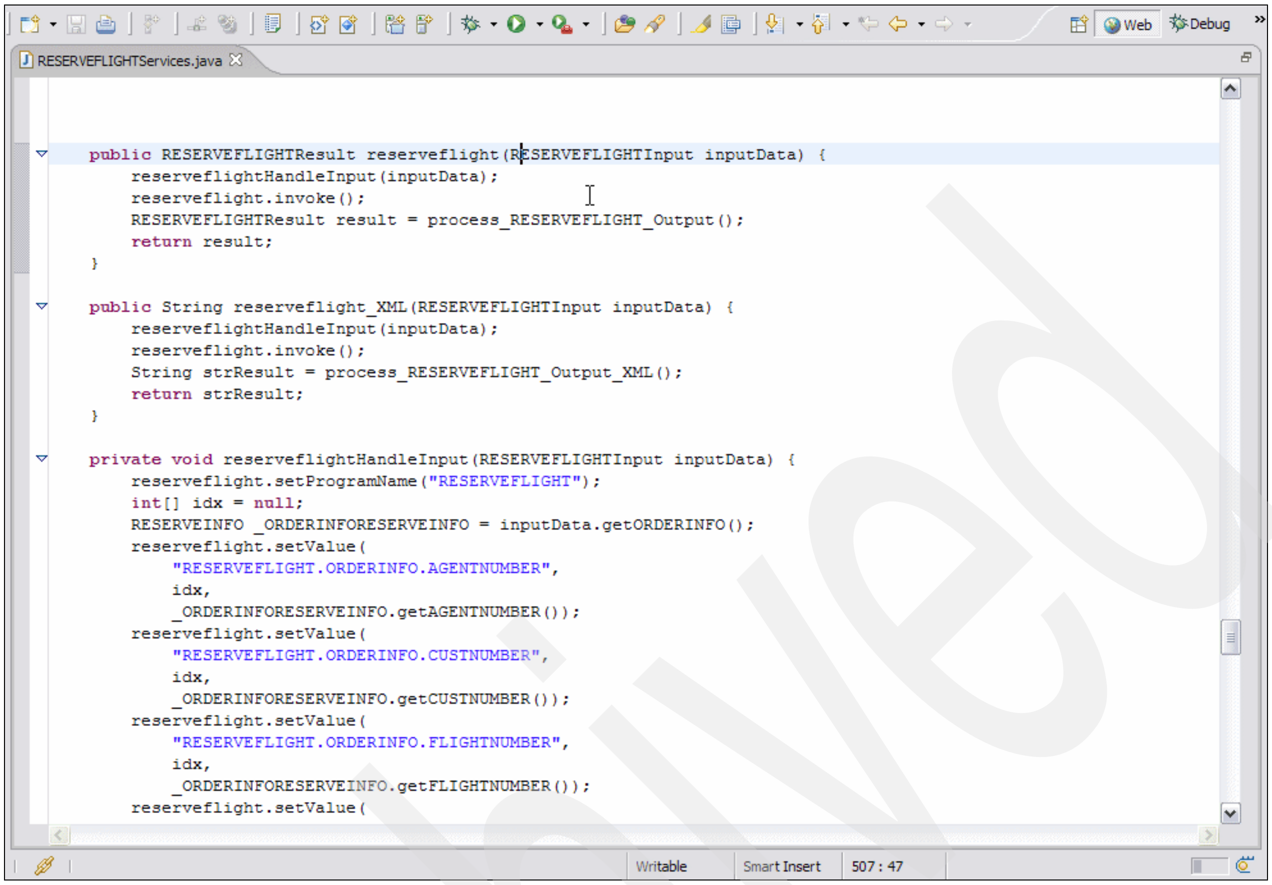
Figure 5-27 Generated source files

3. The Web services Wizard generated various Java classes and two properties files:
   - *RESERVEINFO.java*: This class captures information that is stored in FLIGHTINFO data structure defined in the nfs001 RPG service program.
   - *RESERVEFLIGHTInput.java*: This class encapsulates input parameters to pass to the RPG service program.
   - *RESERVEFLIGHTResult.java*: This class encapsulates output parameters that are returned from the RPG service program.
   - *RESERVEFLIGHTServices.java*: This class performs RPG service program call using Toolbox classes.

   Let us take a closer look at RESERVELIGHTSServices.java.

   Double-click **RESERVE FLIGHTServices.java**. Two methods in this Java Bean invoke nfs001 RPG program, the difference is in the method's return parameters:

   - reserveflight(…): returns RESERVEFLIGHTResult object
   - reserveflight_XML(…): returns a String object that includes an XML document, which is shown in Figure 5-28



```
    public RESERVEFLIGHTResult reserveflight(RESERVEFLIGHTInput inputData) {
        reserveflightHandleInput(inputData);
        reserveflight.invoke();
        RESERVEFLIGHTResult result = process_RESERVEFLIGHT_Output();
        return result;
    }

    public String reserveflight_XML(RESERVEFLIGHTInput inputData) {
        reserveflightHandleInput(inputData);
        reserveflight.invoke();
        String strResult = process_RESERVEFLIGHT_Output_XML();
        return strResult;
    }

    private void reserveflightHandleInput(RESERVEFLIGHTInput inputData) {
        reserveflight.setProgramName("RESERVEFLIGHT");
        int[] idx = null;
        RESERVEINFO _ORDERINFORESERVEINFO = inputData.getORDERINFO();
        reserveflight.setValue(
            "RESERVEFLIGHT.ORDERINFO.AGENTNUMBER",
            idx,
            _ORDERINFORESERVEINFO.getAGENTNUMBER());
        reserveflight.setValue(
            "RESERVEFLIGHT.ORDERINFO.CUSTNUMBER",
            idx,
            _ORDERINFORESERVEINFO.getCUSTNUMBER());
        reserveflight.setValue(
            "RESERVEFLIGHT.ORDERINFO.FLIGHTNUMBER",
            idx,
            _ORDERINFORESERVEINFO.getFLIGHTNUMBER());
        reserveflight.setValue(
```

Figure 5-28 Generate source code for RESERVEFLIGHT

The Web services Wizard generates two methods to give developers flexibility in using the Program Call bean. For example, in a Web services integration scenario, developers might want to use the method that returns an XML document. In addition, for the Java integration scenario, the method that returns a Java object is preferred.

Reviewing the generated JSP Web service client code

Now review the generated test code. This code helps you to test the Web service without writing the client's part of the Web services invocation model. In addition, you can reuse the generated code in your own client's application. To review the code, follow these steps:

1. In Project Navigator frame expand **Dynamic Web Projects** → **WebServiceProjectClient** → **Java Resources** → **JavaSource** → **iseries.wsbeans.reserveflight**. Spend some time reviewing the generated Web service Source files.
2. Expand **Dynamic Web Projects** → **WebServiceProjectClient** → **WebContent** → **sampleRESERVEFLIGHTServicesProxy** folder to look at the test clients JSPs.

Important: If you lose the URL for the Web service Test client, the following steps open the Web Browser with the correct URL:

1. Expand **Dynamic Web Projects** → **WebServiceProjectClient** → **WebContent** → **sampleRESERVEFLIGHTServicesProxy**.
2. Right-click **TestClient** and select **Run** → **Run on Server**.
3. Click **Finish**.

5.2.8 Deploying your Web service to WebSphere Application Server for i5/OS

When deploying the Web service, you need to update the WSDL for your production system. The wizard generates this file for testing in the WebSphere Test environment using *localhost* as the host name.

Modifying the WSDL document

Note: This step is not required to run the Web service. This step *is* required for Web service Clients to locate the Web service based on the WSDL document. The WSDL document should have the correct URI location specified.

To modify the WSDL document, follow these steps:

1. Make sure you are in Web Perspective.
2. In Project Explorer view expand **Dynamic Web Projects** → **WebServiceProject** → **WebContent** → **wsdl** → **iseries** → **wsbeans** → **reserveflight** folder.
3. Double-click **RESERVEFLIGHTServices.wsdl** to open in editor window. Graph view shows various elements of WSDL document in graphical format as shown in Figure 5-29.

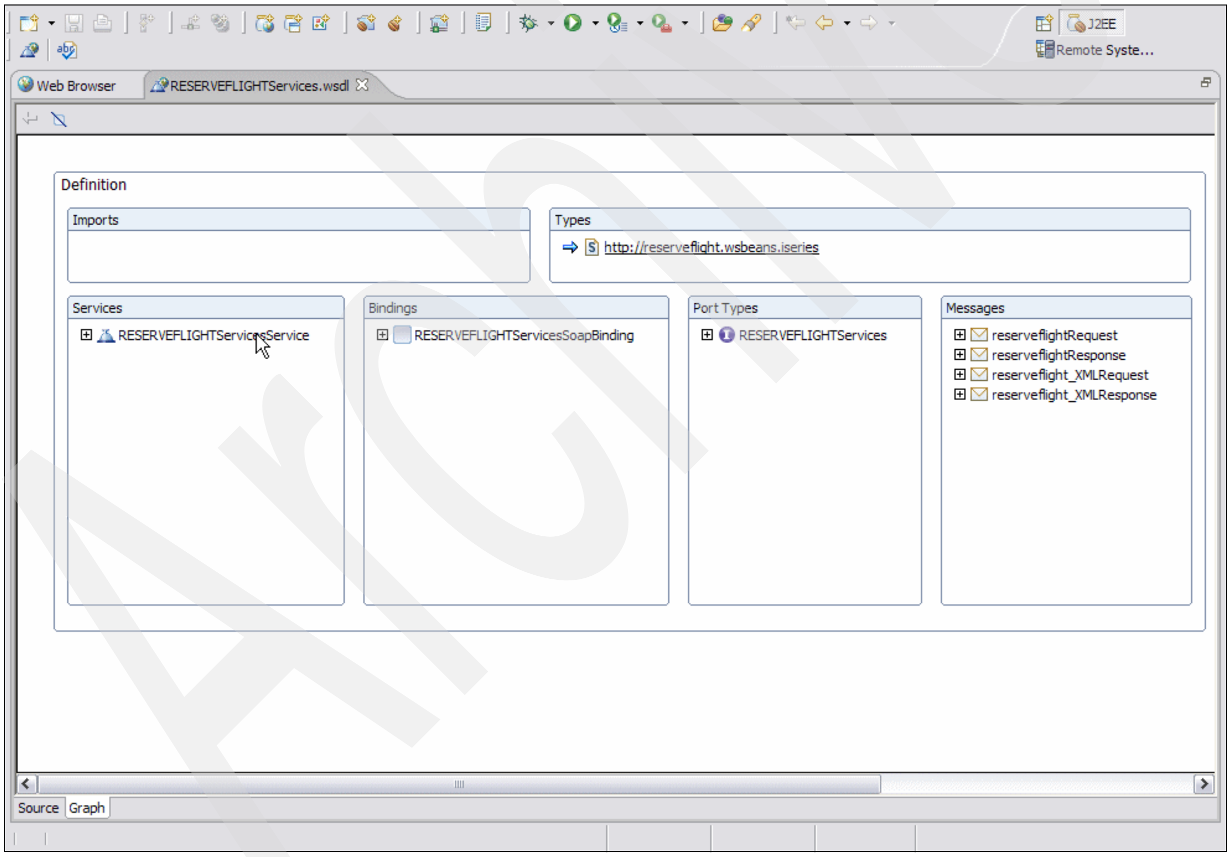
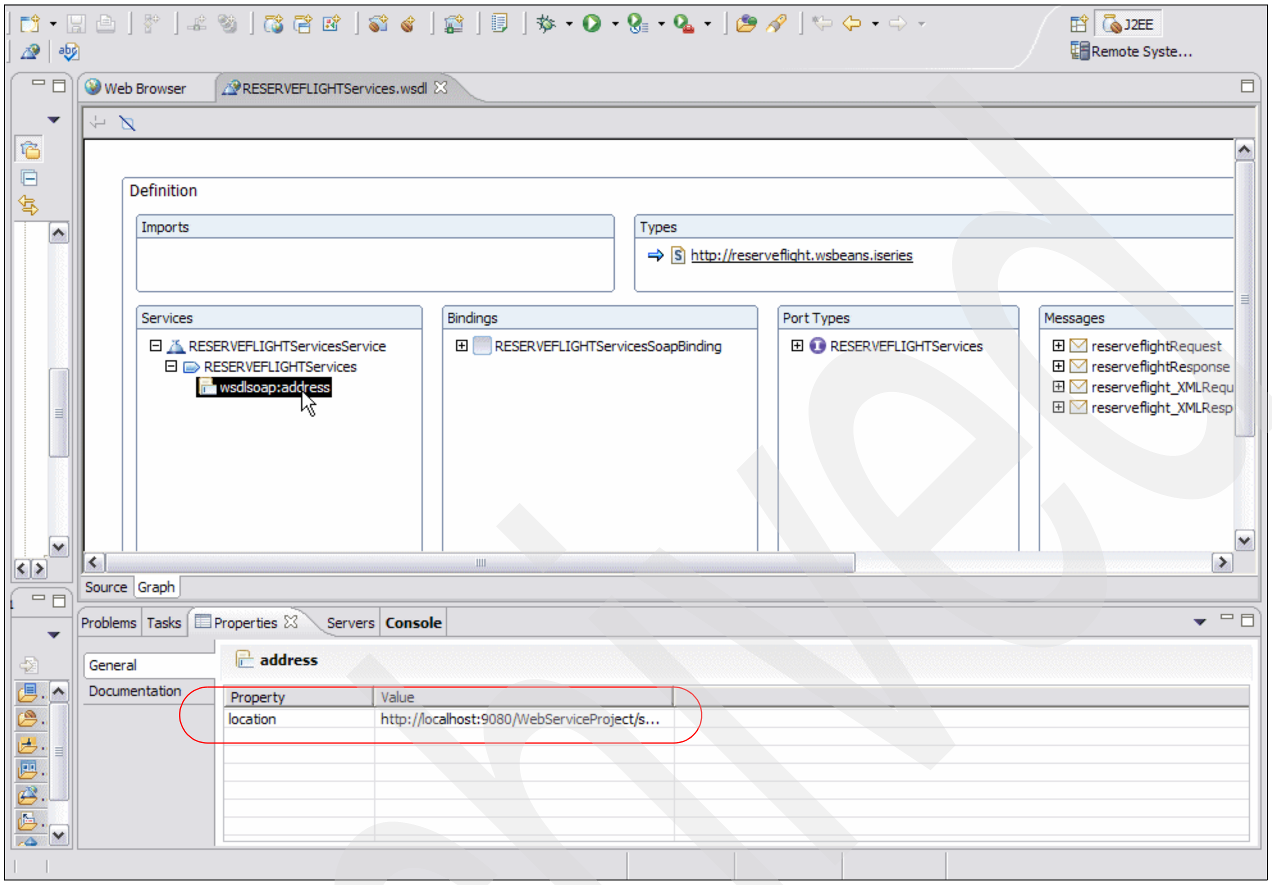


Figure 5-29 ReserveFlight WSDL

4. In the Services section of the file, expand **RESERVEFLIGHTServicesService** → **RESERVEFLIGHTServices** and click the **wsdlsoap:address** element. The actual property and its value is shown and edited in the properties view as shown in Figure 5-30.



Property	Value
location	http://localhost:9080/WebServiceProject/s...

Figure 5-30 Change the URL destination

5. Edit the location property and replace **localhost** with <*iSeries_Server*> and **9080** port with <*http_port*> (HTTP server port).

> **Note:** These values are unique to your system and the WebSphere Application Server profile that you have created on your server. See the WebSphere Application Server for i5/OS Information Center for additional information about profiles.
>
> If you are using the default profile created in i5/OS, the port is 9080; however, you must change the value for *localhost* to your system's fully qualified host name.

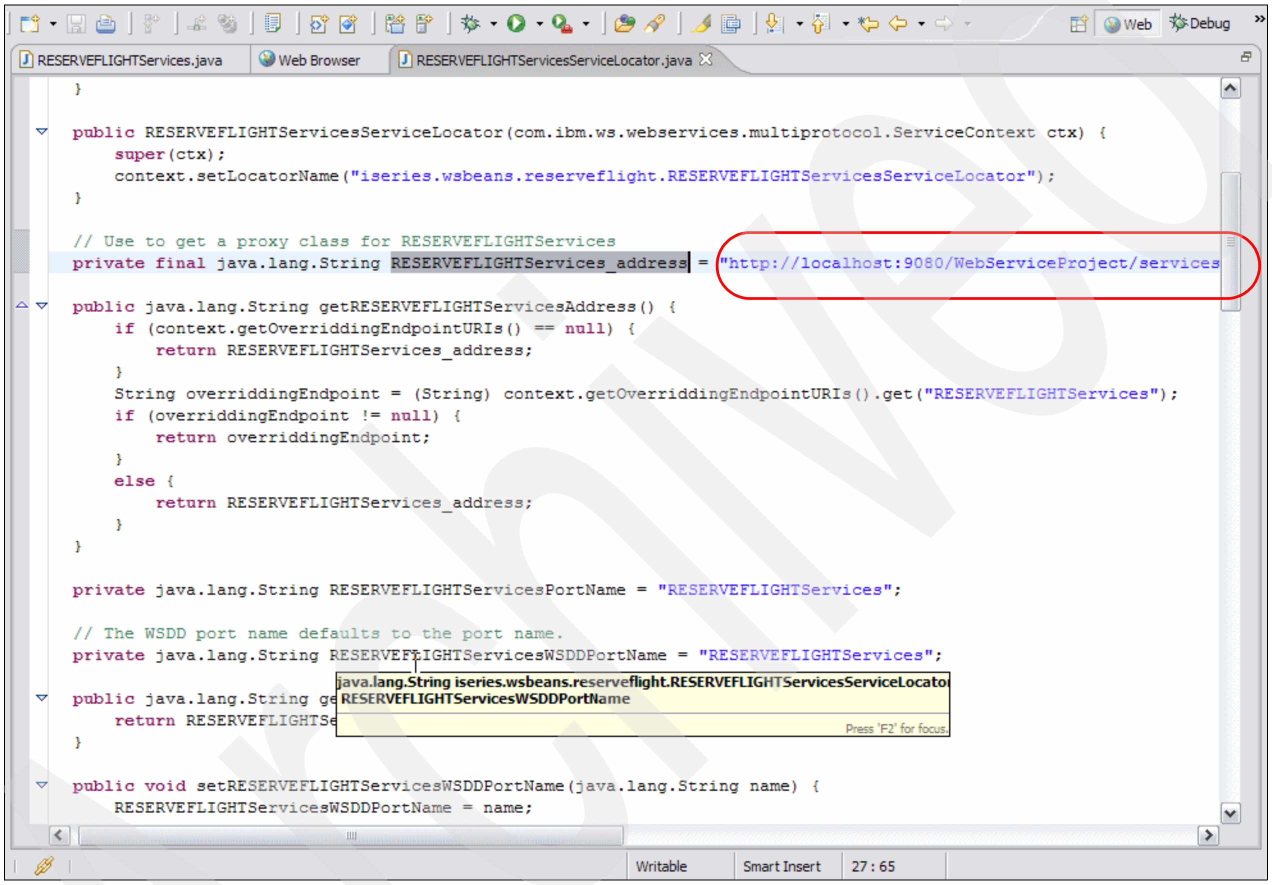
6. Save the RESERVEFLIGHTServices.wsdl document by going to **File** → **Save** from the menu bar or by pressing CTRL+S on the keyboard.

7. Close RERSERVEFLIGHTServices.wsdl.

5.2.9 Modifying the Web service Client URI

Change Web service URI in Web service Client project. We need to change Web service URI, because the Web services wizard has generated a URI that points to the local host. This step is not required for Web services deployment, but it is a good practice to complete this step because it allows you to test the Web service with Web service client code that is generated by the Web services wizard after the Web service has been deployed on a server. To modify the Web service Client URI, follow these steps:

1. In Project Explorer view expand **Dynamic Web Projects** → **WebServiceProjectClient** → **Java Resources** → **JavaSource** → **iseries.wsbeans.reserveflight**.
2. Double-click the **RESERVEFLIGHTServicesServiceLocator.java** file.
3. Modify **RESERVEFLIGHTServices_address** value (see Figure 5-31):
   – Replace **localhost** with your System i host name.
   – Replace **9080** port with the WebSphere profile port number (listen port for accessing WebSphere applications).



RESERVEFLIGHTServices.java
Web Browser
RESERVEFLIGHTServicesServiceLocator.java
Web
Debug
Writable
Smart Insert
27 : 65

```
    }

    public RESERVEFLIGHTServicesServiceLocator(com.ibm.ws.webservices.multiprotocol.ServiceContext ctx) {
        super(ctx);
        context.setLocatorName("iseries.wsbeans.reserveflight.RESERVEFLIGHTServicesServiceLocator");
    }

    // Use to get a proxy class for RESERVEFLIGHTServices
    private final java.lang.String RESERVEFLIGHTServices_address = "http://localhost:9080/WebServiceProject/services

    public java.lang.String getRESERVEFLIGHTServicesAddress() {
        if (context.getOverriddingEndpointURIs() == null) {
            return RESERVEFLIGHTServices_address;
        }
        String overriddingEndpoint = (String) context.getOverriddingEndpointURIs().get("RESERVEFLIGHTServices");
        if (overriddingEndpoint != null) {
            return overriddingEndpoint;
        }
        else {
            return RESERVEFLIGHTServices_address;
        }
    }

    private java.lang.String RESERVEFLIGHTServicesPortName = "RESERVEFLIGHTServices";

    // The WSDD port name defaults to the port name.
    private java.lang.String RESERVEFLIGHTServicesWSDDPortName = "RESERVEFLIGHTServices";

    public java.lang.String ge
        return RESERVEFLIGHTSe
    }

    public void setRESERVEFLIGHTServicesWSDDPortName(java.lang.String name) {
        RESERVEFLIGHTServicesWSDDPortName = name;
```

```
java.lang.String iseries.wsbeans.reserveflight.RESERVEFLIGHTServicesServiceLocato
RESERVEFLIGHTServicesWSDDPortName
                                                        Press 'F2' for focus.
```

Figure 5-31   Updating the location URI of the Web service

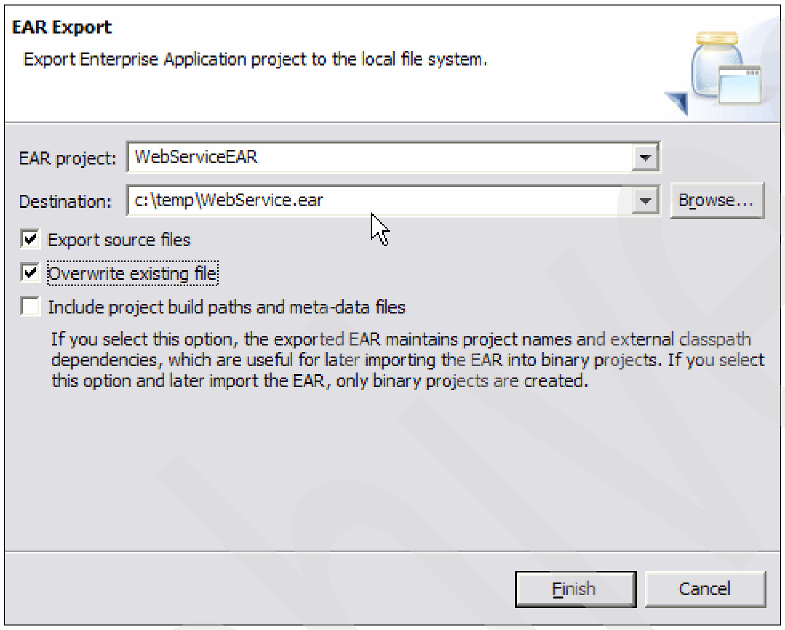
4. Save GETFLIGHTINFOServicesServiceLocator.java by going to **File** → **Save** from the menu bar or by pressing CTRL+S on the keyboard.
5. Close GETFLIGHTINFOServicesServiceLocator.java.

5.2.10 Exporting the Web service EAR file

The Web Applications have been updated with correct values, so this section explains how to export the application so that you can install it on the production system. Typically, you export the Web applications in the form of an Enterprise Archive (EAR) file.

Follow these instructions to export the EAR file from WebSphere Development Studio client for iSeries:

1. In the Project Explorer view expand **Enterprise Applications** and right-click **WebServiceEAR**.
2. Select **Export** → **EAR** file.
3. On the EAR Export windows enter a destination: C:\temp\WebService.ear. Select the “Export source files” and “Overwrite existing file” options and click **Finish** as shown in Figure 5-32.


EAR Export

Export Enterprise Application project to the local file system.

EAR project: WebServiceEAR

Destination: c:\temp\WebService.ear

[✓] Export source files

[✓] Overwrite existing file

[ ] Include project build paths and meta-data files

If you select this option, the exported EAR maintains project names and external classpath dependencies, which are useful for later importing the EAR into binary projects. If you select this option and later import the EAR, only binary projects are created.

Figure 5-32 Export the EAR file

Important: By selecting the “Export source files” option, the entire application is encapsulated into a single EAR file. However, if you are going to redistribute this application to external customers, you should consider carefully whether to export the source.

4. You can export the Web services client EAR file in the same way. However, we use WebSphere Test environment in WebSphere Development Studio client for iSeries for testing our service.

5.2.11 Installing Web services application on System i platform

The application is located currently on the desktop of the client machine. Now, you will install it into i5/OS system using a Web Browser and the WebSphere Application Server administrative console.

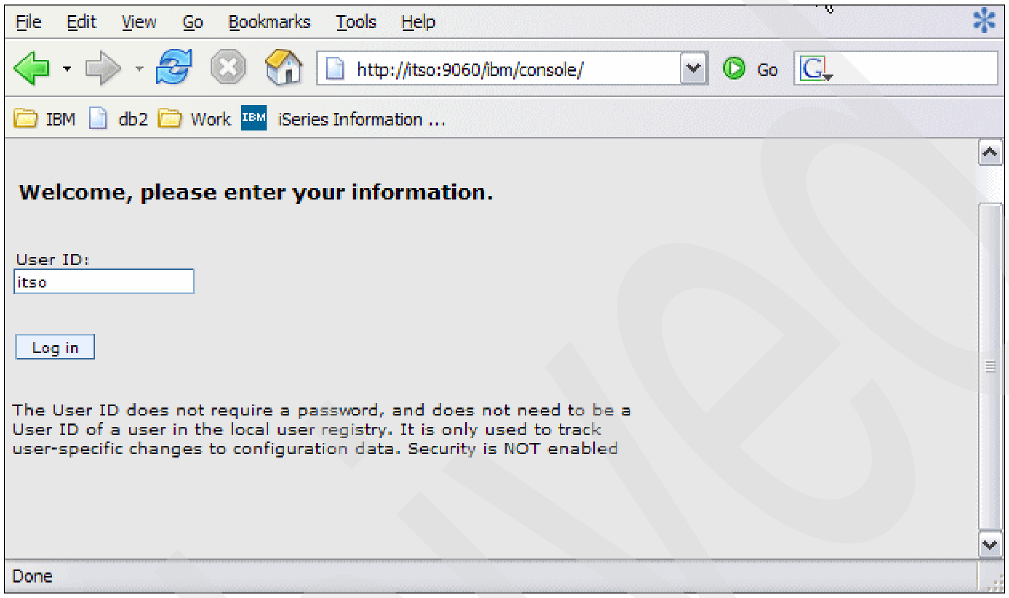
Note: In our example, we use the *default* WebSphere profile. The administrative console for this profile runs on port 9060. If you use a different profile, use the administrative console port specific to your profile.

To install the Web service application into the WebSphere profile, follow these steps:

1. Open a browser, enter the administrative console URL:

   `http://<iSeries_Server>:<was_admin_port>/ibm/console`

2. In the Wecome panel, enter your user ID (if your profile is not secured, you can enter any string as your ID) and click **Log in (**see Figure 5-33).


File Edit View Go Bookmarks Tools Help
http://itso:9060/ibm/console/
Go
IBM db2 Work iSeries Information ...
Log in
Done

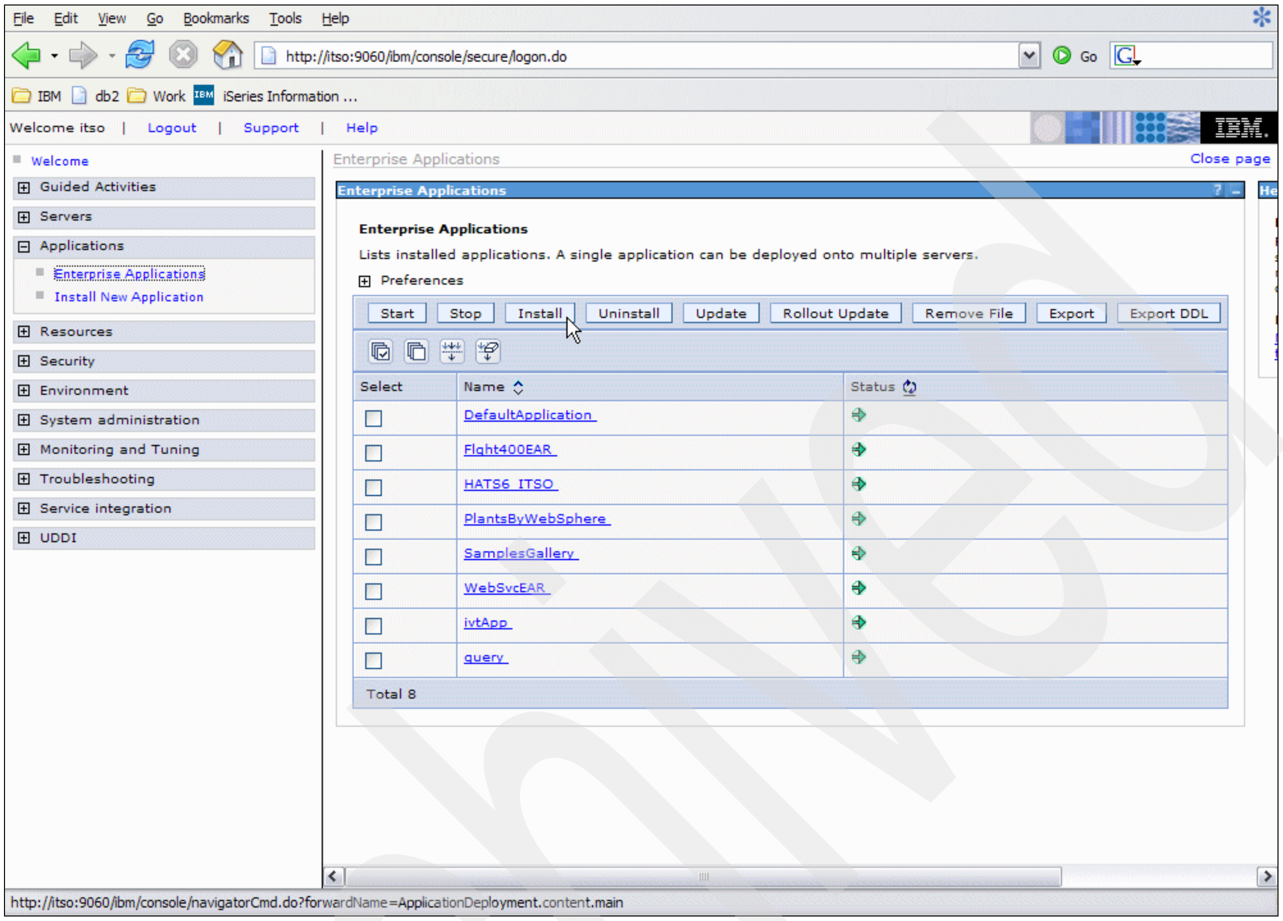
Welcome, please enter your information.

User ID:
itso

The User ID does not require a password, and does not need to be a User ID of a user in the local user registry. It is only used to track user-specific changes to configuration data. Security is NOT enabled

Figure 5-33 WebSphere Application Server Welcome window

3. Expand **Applications** in the left navigation bar and click **Enterprise Applications**. Then, Click **Install** as shown in Figure 5-34.



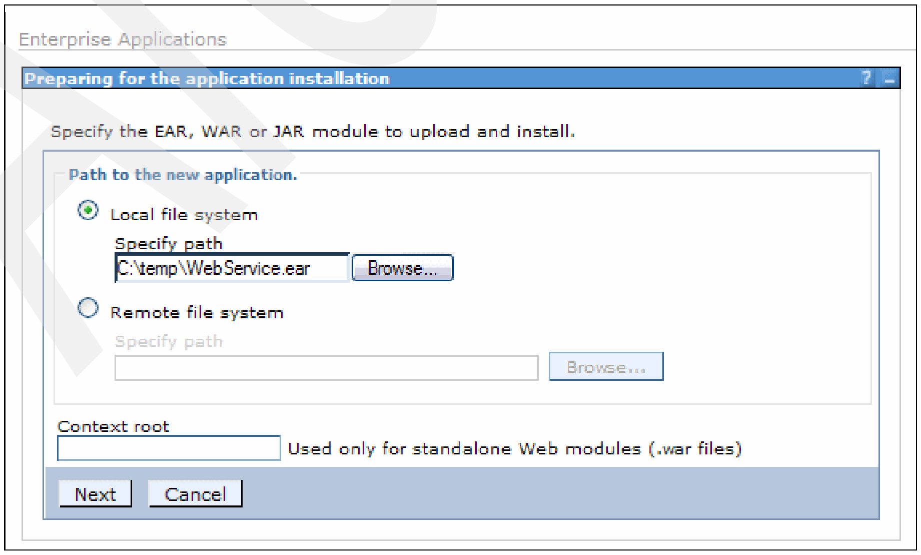
Enterprise Applications

Lists installed applications. A single application can be deployed onto multiple servers.

Select	Name	Status
☐	DefaultApplication	➜
☐	Flght400EAR	➜
☐	HATS6_ITSO	➜
☐	PlantsByWebSphere	➜
☐	SamplesGallery	➜
☐	WebSvcEAR	➜
☐	ivtApp	➜
☐	query	➜
Total 8		

Figure 5-34 Install Enterprise Application

4. Select the **Local file system** radio button and specify C:\temp\WebService.ear or click **Browse** to locate the file. Then, click **Next** (see Figure 5-35).



Specify the EAR, WAR or JAR module to upload and install.

Path to the new application.

[✓ Local file system]

Specify path: C:\temp\WebService.ear

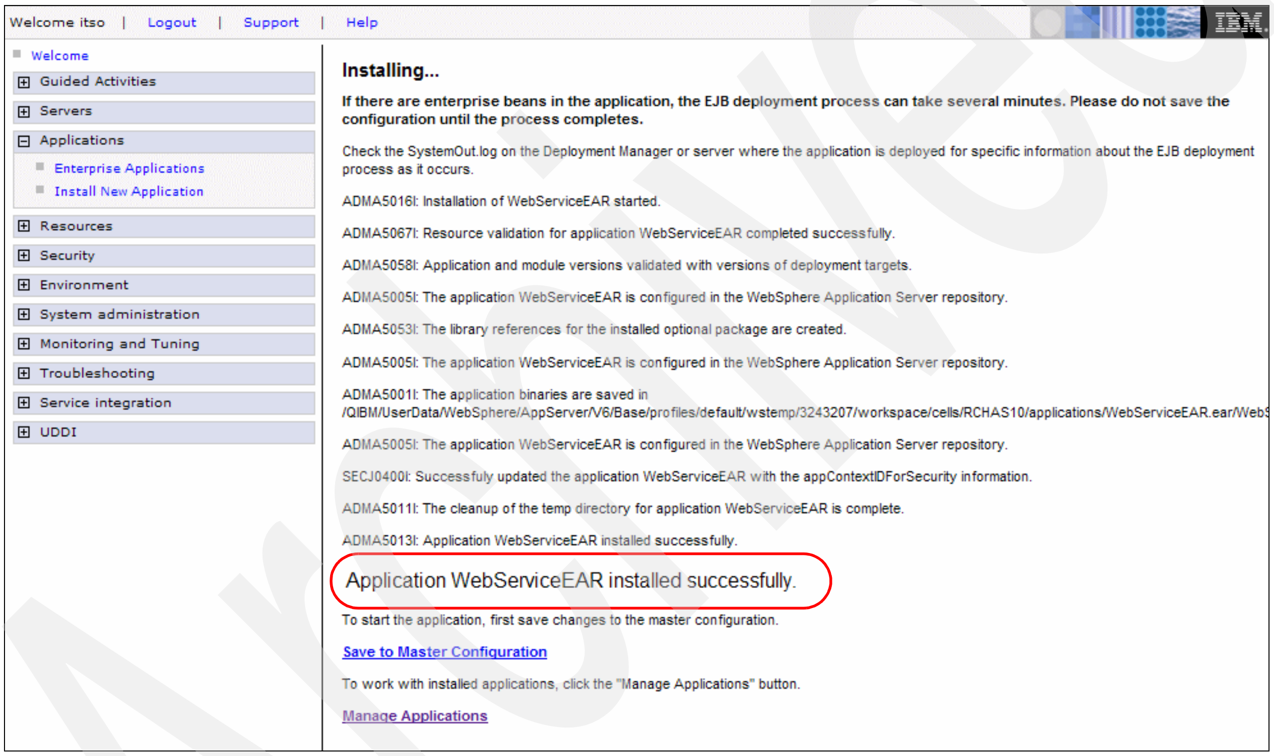
Remote file system

Specify path

Context root: Used only for standalone Web modules (.war files)

Figure 5-35 Ear file to install

5. On the “Choose to generate default bindings and mapping” panel click **Next**.
6. On the “Step1: Select installation options” panel click **Next**.
7. On the “Step 2: Map modules to servers” panel:
   a. In the “Clusters and Servers” section, select both servers: WebSphere server and your HTTP server. (You can hold the Ctrl key and click both servers to select them.)
   b. Click **Apply**. This allows users to access your application through the external HTTP server.
   c. Click **Next**.
8. On the next panel click **Step 4: Summary**.
9. On the “Step 4: Summary” panel click **Finish**.
10. You should see a confirmation message similar to that shown in Figure 5-36 that the application was installed.



Installing...

If there are enterprise beans in the application, the EJB deployment process can take several minutes. Please do not save the configuration until the process completes.

Check the SystemOut.log on the Deployment Manager or server where the application is deployed for specific information about the EJB deployment process as it occurs.

ADMA5016I: Installation of WebServiceEAR started.

ADMA5067I: Resource validation for application WebServiceEAR completed successfully.

ADMA5058I: Application and module versions validated with versions of deployment targets.

ADMA5005I: The application WebServiceEAR is configured in the WebSphere Application Server repository.

ADMA5053I: The library references for the installed optional package are created.

ADMA5005I: The application WebServiceEAR is configured in the WebSphere Application Server repository.

ADMA5001I: The application binaries are saved in /QIBM/UserData/WebSphere/AppServer/V6/Base/profiles/default/wstemp/3243207/workspace/cells/RCHAS10/applications/WebServiceEAR.ear/Web

ADMA5005I: The application WebServiceEAR is configured in the WebSphere Application Server repository.

SECJ0400I: Successfuly updated the application WebServiceEAR with the appContextIDForSecurity information.

ADMA5011I: The cleanup of the temp directory for application WebServiceEAR is complete.

ADMA5013I: Application WebServiceEAR installed successfully.

Application WebServiceEAR installed successfully.

To start the application, first save changes to the master configuration.

Save to Master Configuration

To work with installed applications, click the "Manage Applications" button.

Manage Applications

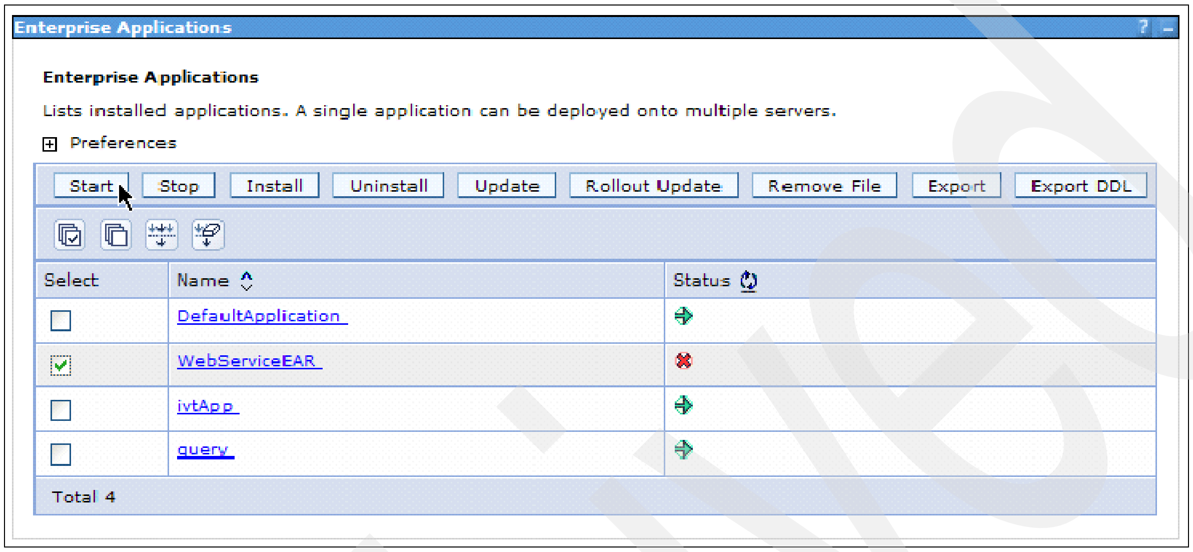
Figure 5-36 Installation of Web service EAR file

11. Click **Save to Master Configuration** to save changes to the WebSphere Application Server configuration.
12. Confirm your choice by clicking **Save** on the next panel.

5.2.12 Starting your Web service application

You have successfully installed the Web application. However, by default the application is in the *Stopped* status. You need to start the application to access the Web service:

1. Expand **Applications** and click **Enterprise Application**.
2. Select **WebServiceEAR** and click **Start** (see Figure 5-37).



Enterprise Applications

Lists installed applications. A single application can be deployed onto multiple servers.

⊞ Preferences

Select	Name	Status
☐	DefaultApplication	➜
☑	WebServiceEAR	✖
☐	ivtApp	➜
☐	query	➜

Total 4

Figure 5-37 Start Web service application

5.2.13 Testing the Web service on System i

The last step is to verify that the Web service works correctly. For this step we use WebSphere Development Studio client for iSeries:

1. Switch to the WebSphere Development Studio client for iSeries window.
2. Expand **Dynamic Web Projects** → **WebServiceProjectClient** → **WebContent** → **sampleRESERVEFLIGHTServicesProxy**.
3. Right-click **TestClient** and select **Run** → **Run on Server**.
4. Click **Finish**.
5. The WebSphere Test environment is started (if needed), and you should see the TestClient.jsp page in the browser window (see Figure 5-25 on page 57).
6. Click the **getEndpoint()** link.

7. Click **Invoke** (see Figure 5-38). This method returns the URL for your Web service. Verify that the returned value includes the correct host name and port number.

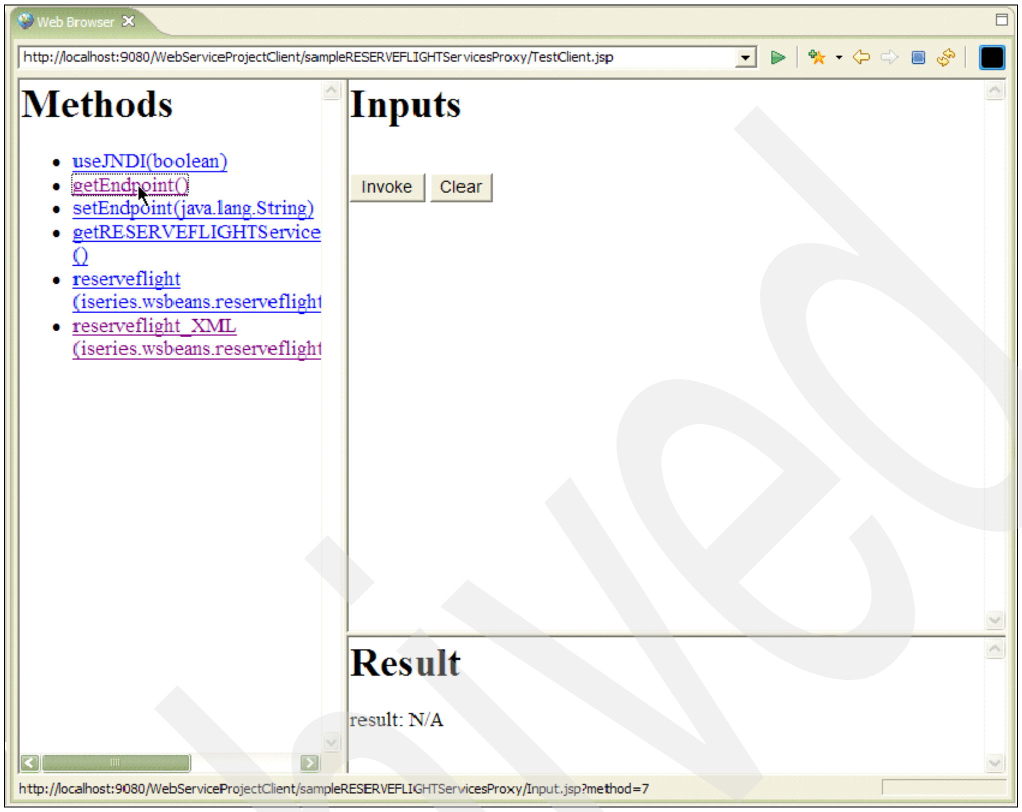

Web Browser
http://localhost:9080/WebServiceProjectClient/sampleRESERVEFLIGHTServicesProxy/TestClient.jsp
Methods
useJNDI(boolean)
getEndpoint()
setEndpoint(java.lang.String)
getRESERVEFLIGHTService ()
reserveflight (iseries.wsbeans.reserveflight
reserveflight_XML (iseries.wsbeans.reserveflight
Inputs
Invoke
Clear
Result
result: N/A
http://localhost:9080/WebServiceProjectClient/sampleRESERVEFLIGHTServicesProxy/Input.jsp?method=7

Figure 5-38 Verifying the endpoint

8. In the Method frame click **reserveflight_XML(iseries.wsbeans.updateorder.RESERVEFLIGHTInput)** as shown in Figure 5-39.

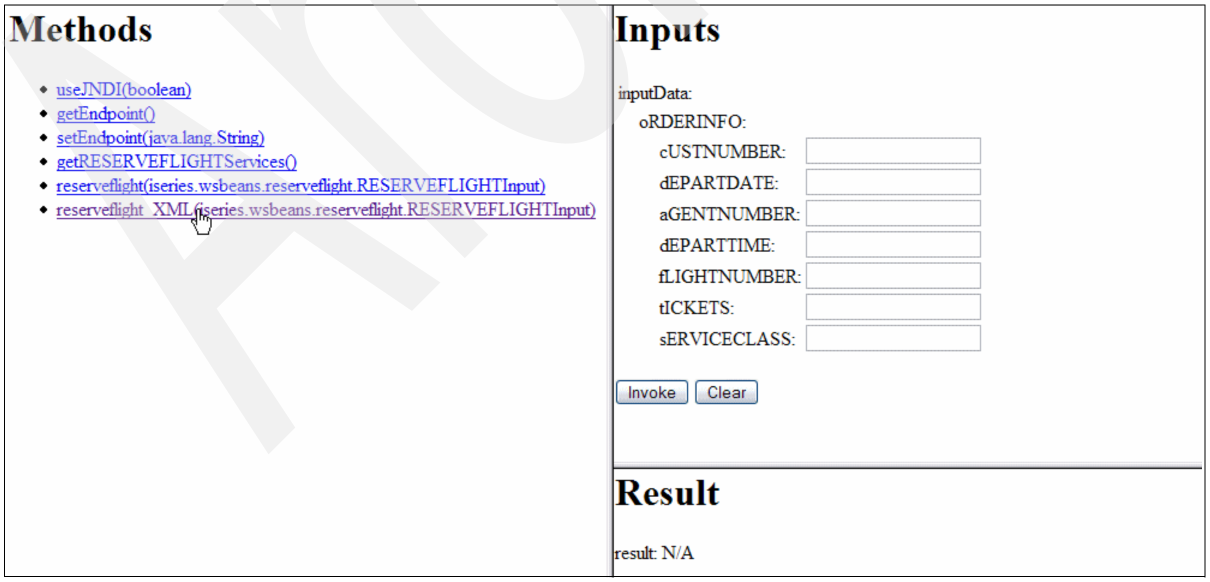
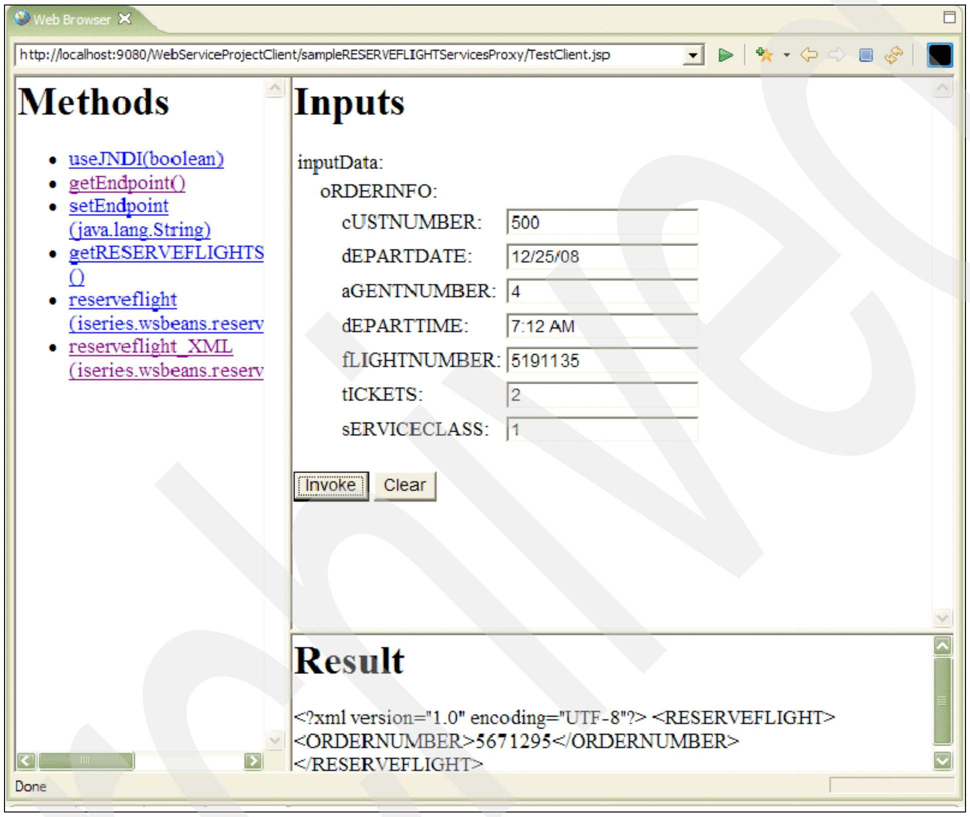

Methods
useJNDI(boolean)
getEndpoint()
setEndpoint(java.lang.String)
getRESERVEFLIGHTServices()
reserveflight(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
reserveflight_XML(iseries.wsbeans.reserveflight.RESERVEFLIGHTInput)
Inputs
inputData:
oRDERINFO:
cUSTNUMBER:
dEPARTDATE:
aGENTNUMBER:
dEPARTTIME:
fLIGHTNUMBER:
tICKETS:
sERVICECLASS:
Invoke
Clear
Result
result: N/A

Figure 5-39 Web service Test Client

9. In the Inputs frame of the Web Browser window, enter the following values and click **Invoke** (see Figure 5-40):
   - cUSTNUMBER: `500`
   - dEPARTDATE: `12/25/08`
   - aGENTNUMBER: `4`
   - dEPARTTIME: `7:12 AM`
   - fLIGHTNUMBER: `5191135`
   - tICKETS: `2`
   - sERVICECLASS: `1`


Web Browser
http://localhost:9080/WebServiceProjectClient/sampleRESERVEFLIGHTServicesProxy/TestClient.jsp
Methods
useJNDI(boolean)
getEndpoint()
setEndpoint (java.lang.String)
getRESERVEFLIGHTS ()
reserveflight (iseries.wsbeans.reserv
reserveflight_XML (iseries.wsbeans.reserv
Inputs
Invoke
Clear
Result
Done

inputData:
oRDERINFO:
cUSTNUMBER: 500
dEPARTDATE: 12/25/08
aGENTNUMBER: 4
dEPARTTIME: 7:12 AM
fLIGHTNUMBER: 5191135
tICKETS: 2
sERVICECLASS: 1

```
<?xml version="1.0" encoding="UTF-8"?> <RESERVEFLIGHT>
<ORDERNUMBER>5671295</ORDERNUMBER>
</RESERVEFLIGHT>
```

Figure 5-40 Input values

The **Result** frame shows a confirmation number similar to Figure 5-40.

5.2.14 Adding additional Web services: GetFlightInfo and FindCustomers

In the previous sections, we demonstrated how to build the Web service for the flight reservation part of the application. For this service to work properly, you need to provide the departure time and flight number. These values cannot be received from a person calling to reserve a ticket. Thus, you need to add an additional Web service that allows you to search for this information based on customer data, such as the date, destination city, and preferred time of the day for departure.

To implement these services, you need to apply the same process (using the Web services wizard in WebSphere Development Studio client for iSeries) to other RPG procedures. Namely:

- NFS404.RPGLE: We use the FindFlightInfo or FindFlights procedures to get flight information.
- NFS405.RPGLE: We use the FindCustomers or GetCustNumber procedures for getting customer information.

FindFlightInfo, FindFlights, FindCustomers, or GetCustNumber RPG procedures are compiled into NFS400.SRVPGM.

To generate additional Web services, follow the instructions in 5.2.4, “Reviewing the RPG modules” on page 44, 5.2.5, “Creating and testing RPG Web service” on page 48, and 5.2.6, “Testing the Web service Test Client” on page 57.

Important: Make sure that you replace NFS001 with NFS400 in these instructions.

When you are done with this work, deploy the new Web services on the production server. Now your business partners can create an application that uses FindFlights, FindCustomer, and ReserveFlight procedures to look up and reserve a flight on behalf of their customer.

5.3 Exporting WSDL document (Optional)

The WSDL document includes several parameters that are required by the Web services clients to find and invoke this Web service over the Web. Thus, you should publish the WSDL document to the UDDI registry, e-mail it to your business partners, or place it on some HTTP server for other clients to access it. In this section, we show how to export this WSDL document from your project in WebSphere Development Studio client for iSeries.

In “Modifying the WSDL document” on page 61, we demonstrate how to modify the WSDL file before deploying your Web service application to the production server. After you have modified your WSDL file, follow the instructions here to export the modified WSDL file:

1. Start WebSphere Development Studio client for iSeries and open the Web perspective by selecting **Window** → **Open Perspective** → **Other** → **Web** and clicking **OK**.

2. In the Project Explorer view select **RERSERVEFLIGHTServices.wsdl** as shown in Figure 5-41.

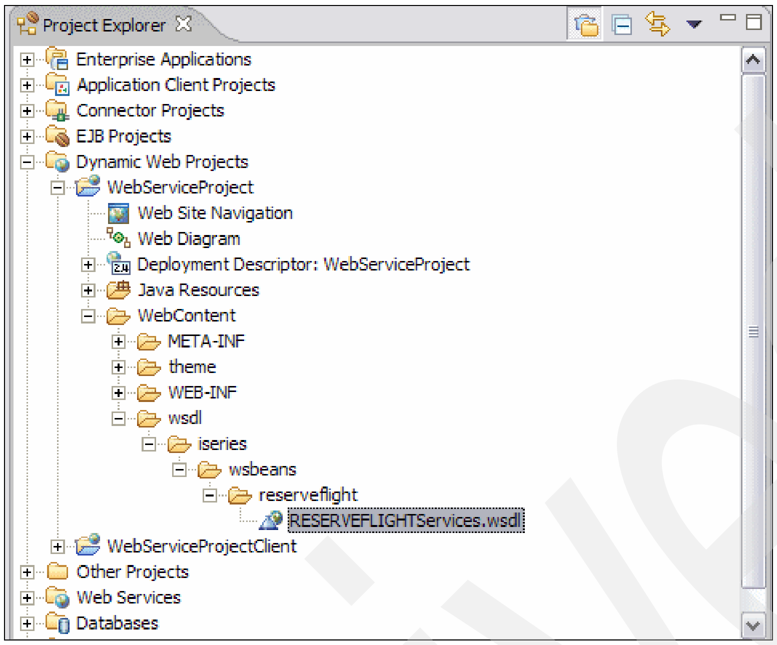


Figure 5-41 Select WSDL file

3. On the WebSphere Development Studio client for iSeries menu, select **File** → **Export** → **File system** and then click **Next** (see Figure 5-42).

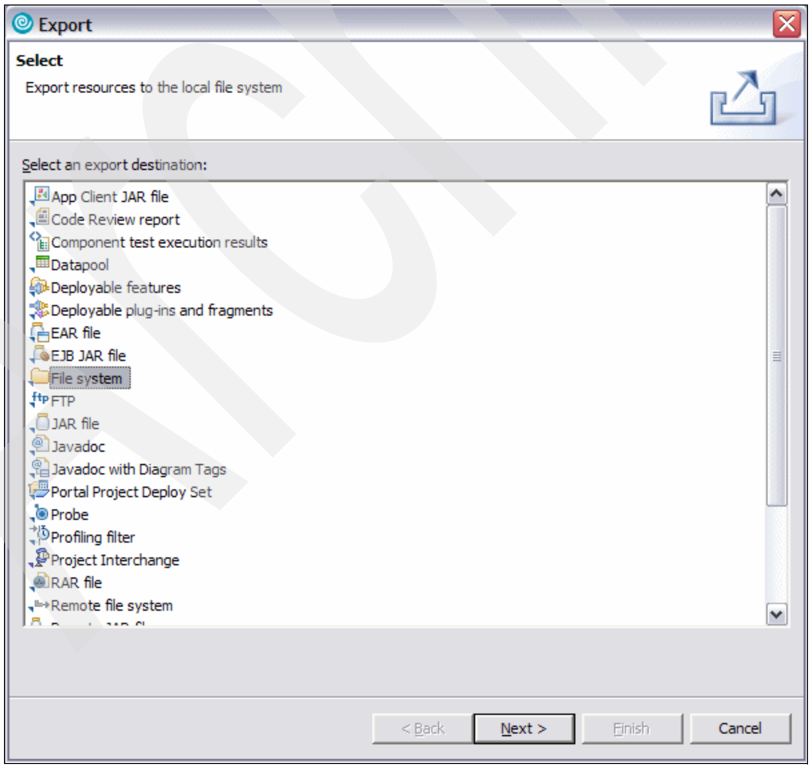
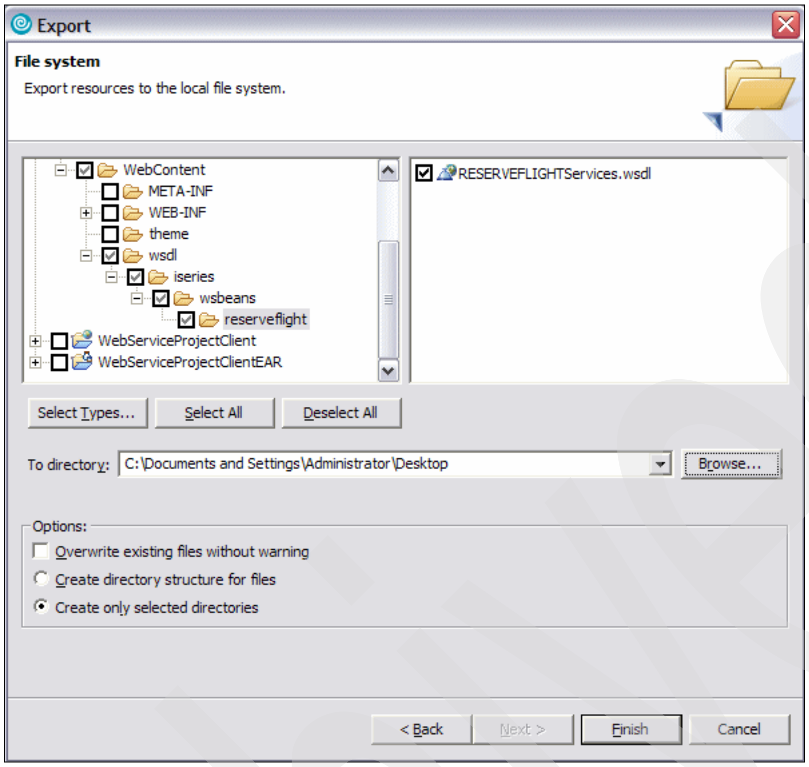


Figure 5-42 File System Export

4. Ensure that RESERVEFLIGHTServices.wsdl is selected in the next panel and click **Browse** (see Figure 5-43).

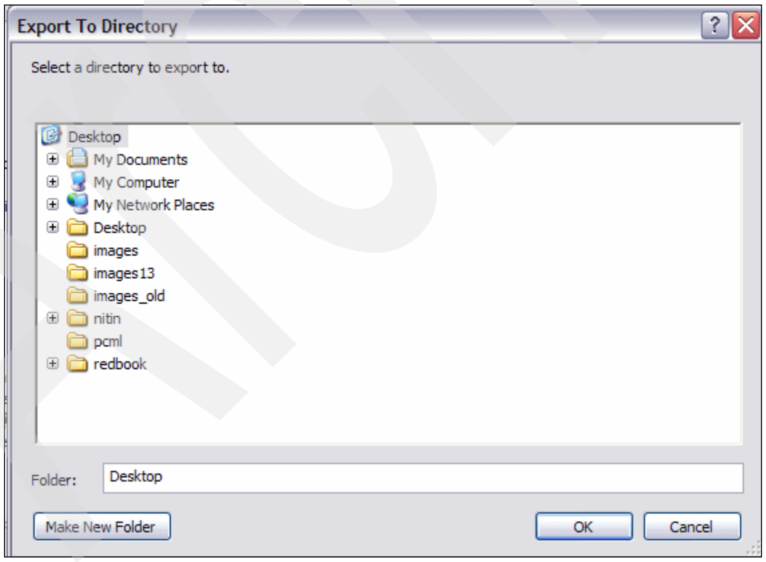


To directory: C:\Documents and Settings\Administrator\Desktop

Options:
- [ ] Overwrite existing files without warning
- ( ) Create directory structure for files
- (●) Create only selected directories

Figure 5-43 Export File

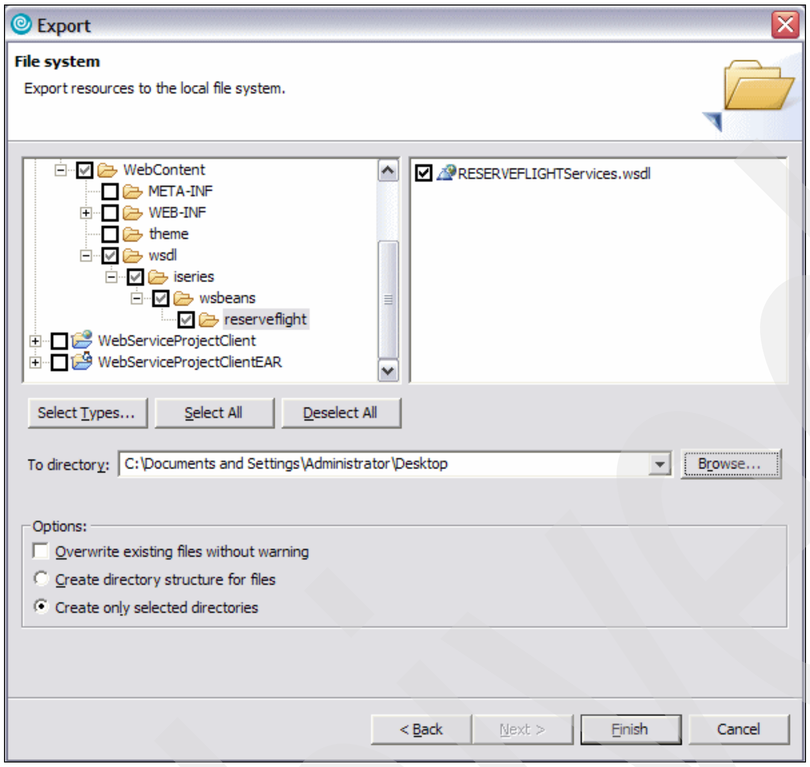
5. Select **Desktop** and click **OK** as shown in Figure 5-44.



Folder: Desktop

Figure 5-44 Export to the desktop

6. Click **Finish** as shown in Figure 5-45.


Export

File system

Export resources to the local file system.

- [✓] WebContent
  - [ ] META-INF
  - [ ] WEB-INF
  - [ ] theme
  - [✓] wsdl
    - [✓] iseries
      - [✓] wsbeans
        - [✓] reserveflight
- [ ] WebServiceProjectClient
- [ ] WebServiceProjectClientEAR

[✓] RESERVEFLIGHTServices.wsdl

To directory: C:\Documents and Settings\Administrator\Desktop

Options:

[ ] Overwrite existing files without warning

( ) Create directory structure for files

(●) Create only selected directories

Figure 5-45 Export WSDL to Desktop

You have now exported the WSDL document to the desktop, and you can forward it through e-mail or some other means to the various client developer teams for generating Web service Client to invoke the RPG Web service. The Web service Client that can consume the Web service include, but are not limited to, Java, RPG, C, C++, PHP, COBOL, and .NET.

5.4 Summary

In this Web service example, you extranlized an RPG procedure as a Web service. This Web service is accessible by any application that has access to your System i platform through port 9080 (default profile) and can communicate with a SOAP/HTTP protocol that adheres to the WS-I basic profile, including applications such as Java, J2EE Web Clients, JSF, JSP, .NET, and PHP.

In addition, you can build services to let your Web service clients explore even more business logic within your environment as we describe in 5.2.14, “Adding additional Web services: GetFlightInfo and FindCustomers” on page 70.

6

DB2 UDB Web service

One of the simplest ways to build a Web service for your i5/OS applications is to use the DB2 Web services framework. This chapter list several scenarios for starting with DB2 Web services and illustrates some of these scenarios with the sample applications.

6.1 Reasons to use DB2 UDB based Web services

Why would you want to use DB2 UDB based Web services? There are certainly a few reasons and you might find even more. This section elaborates on just a few of the reasons why you would want to use DB2 UDB based Web services.

6.1.1 Get a feeling for the technology

This book, or any other book for that matter, could be the best technical publication ever written by human beings. Even if that were true, reading this book will not give you the same feeling for the technology as trying it out for yourself. A picture might be worth a thousand words, but some hands-on experience is worth even more!

"Playing around" with a small sample application can provide with a better feeling for the technology than pages of explanations and figures or graphics. Of course, this is not always possible, because it might be difficult for you to set up the environment. However, in this case, setting up the environment, at least if you have WebSphere Application Server and SQL installed on your system, should be fairly easy to do.

6.1.2 If you cannot modernize the whole application

By now you are probably aware of the fact that depending on the architecture of your current application or applications, you might have to envisage some modernization steps, such as converting your RPG OPM programs to the ILE architecture. Otherwise, it might be impossible to continue using them with the solutions that we introduce in this book, such as Web services based upon RPG programs.

However, this type of modernization might not be possible or might not even make sense in all cases. If the application in question is not functionally adequate, it probably does not make sense to modernize it. You would probably rather rewrite or re-engineer it.

If, nevertheless, you need to provide access to certain information in your database, information that continues to be maintained through your existing application, then you could create DB2 UDB based Web services to give access to that information without having to go through a potentially time and cost intensive modernization process.

6.1.3 There are strong SQL resources available

If in your team you have good SQL knowledge available, even developers without RPG knowledge at all, or if your RPG developers are not available because of other tasks, you might want to have your SLQ-savvy person create SQL stored procedures and create Web services based on them. These Web services could then be used in other applications or to give external partners access to certain information through them.

6.1.4 You have invested in developing stored procedures

There are two types of the stored procedures in i5/OS: *SQL* and *external* (any system or service program or REXX™ procedure). Many companies develop host application using *stored procedures*. If your company has invested in stored procedures, there is a quick and easy way to externalize these stored procedures as Web services.

You can take advantage of DB2 Web services invoking stored procedures. In 6.4, "Creating a DB2 stored procedure" on page 95, we show an example of how to build an SQL store procedure in WebSphere Development Studio client for iSeries and how to generate DB2 Web services to invoke this stored procedure.

6.2 Introducing the concepts and terminology

In this chapter, we use the terms that are typical in the context of DB2 UDB Web services discussion. To better understand the concepts described in this chapter, we define and explain these terms in this section.

6.2.1 DB2 Web services architecture overview

In the previous sections, we listed several business reasons for investigating and developing DB2 Web services solutions. There are also technical reasons for adopting this approach. IBM provides tooling and runtime support for DB2 Web services. Tooling and runtime support considerably simplifies the development and deployment effort for building DB2 Web services.

The runtime architecture of DB2 Web services is based on Web services Object Runtime Framework (WORF). WORF supports two paths for accessing DB2 UDB:

- Through DB2 XML Extender product
- Through a direct JDBC™ connection

Figure 6-1 shows the high-level architecture of WORF.

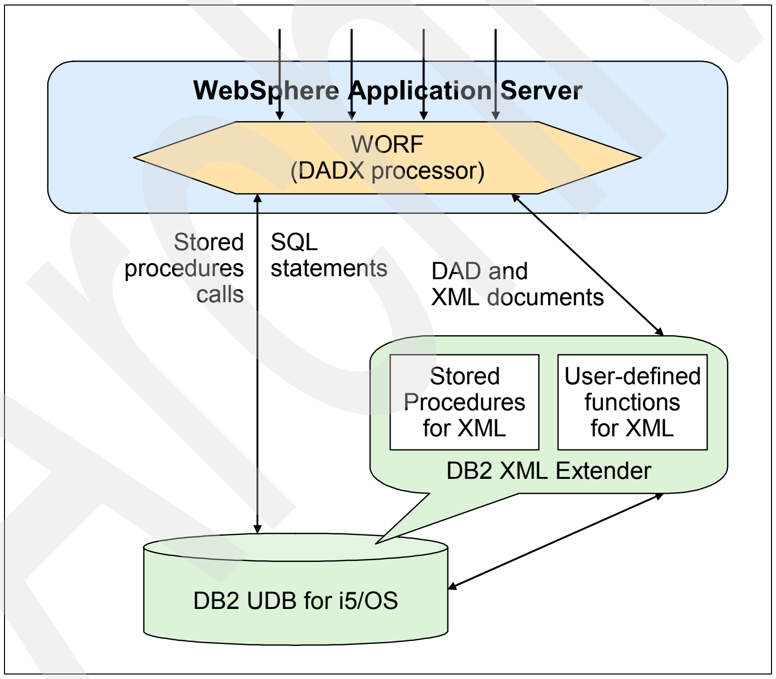


Figure 6-1 WORF runtime architecture

In the following sections, we explain all the components that are shown in Figure 6-1.

6.2.2 XML-based access and Document Access Definition (DAD)

This approach is based on the *DB2 XML Extender* functionality. DB2 XML Extender provides a mapping between elements in the XML documents and columns in the relational database. A special XML file, called Document Access Definition or DAD file, is used by DB2 XML Extender to specify:

- The operations that needs to be performed
- The mapping between XML document structure and DB2 UDB table columns

The syntax of a DAD file is unique to DB2 XML Extender. The following XML-based operations are supported by DB2 XML Extender:

- *Query*: An XML-based query enables you to compose XML documents from relational data
- *Storage*: An XML document is broken down into its component parts and stored in relational tables

6.2.3 SQL-based access and Document Access Definition Extender (DADX)

A *Document Access Definition Extender*, or *DADX*, file is the extension of a DAD file. A DADX files specifies a Web service using a set of operations that are defined by SQL statements or DAD file. Effectively, a DADX file allows you to combine two distinct paths to access DB2 UDB for i5/OS in a single framework.

DADX approach is architected in the following way:

- First, you define a DADX group. This group is represented in a form of the directory. This directory includes several files, one of which is group.properties. This file defines the connection properties for the group. Example 6-1 shows a sample properties file. The most important properties are highlighted. As you can see, it includes the JDBC driver class, database URL, user ID, and password.

Example 6-1 group.properties file

```
#Tue Sep 19 11:31:36 CDT 2006
namespaceTable=namespacetable.nst
groupNamespaceUri=
reloadIntervalSeconds=5
dbDriver=com.ibm.as400.access.AS400JDBCDriver
dbURL=jdbc\:as400\:rchas10
enableXmlClob=true
useDocumentStyle=true
password=encoded\:AQACAgQEBgYKCwgJDAOMDxQVEhMQFRYTGBEaExwVHhcwITIjNCUmJwgJCgsMDQ4PcHFyczR1dnc4OT
o7PDO+Pw\=\=
datasourceJNDI=
initialContextFactory=
userID=test
autoReload=true
```

- Second, you need to create one or more DADX files. All DADX files are placed in the group's directory. Each DADX file includes one or more operations. Remember that the operations can be SQL or XML based. *Each DADX file is mapped to a single Web service.* Example 6-2 shows the example of the DADX file with SQL based operation.

Example 6-2 Example of the DADX file

```
<?xml version="1.0" encoding="UTF-8"?>
<dadx:DADX xmlns:dadx="http://schemas.ibm.com/db2/dxx/dadx"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema"
      xsi:schemaLocation="http://schemas.ibm.com/db2/dxx/dadx dadx.xsd">
    <dadx:documentation xmlns="http://www.w3.org/1999/xhtml">
        <![CDATA[
        Query Customers
        ]]>
    </dadx:documentation>
    <dadx:operation name="QueryCustomer">
        <dadx:documentation xmlns="http://www.w3.org/1999/xhtml">
            <![CDATA[

            ]]>
        </dadx:documentation>
        <dadx:query>
            <dadx:SQL_query>
                <![CDATA[
               SELECT * FROM FLGHT400.CUSTOMERS WHERE FLGHT400.CUSTOMERS.CUSTOMER_NAME LIKE :CustName
               ]]>
            </dadx:SQL_query>
            <dadx:parameter name="CustName" type="xsd:string"/>
        </dadx:query>
    </dadx:operation>
</dadx:DADX>
```

The following SQL based operations are supported in the DADX file:

- call to a stored procedure
- insert
- update
- delete
- query

An SQL-based query allows you to send SQL statements, including stored procedure calls, to DB2 and to return the results with a default tagging. Data is returned using only a simple mapping of SQL data types, using column names as elements.

Important: SQL-based operations do not require DB2 XML Extender because there is no need for user-defined mapping of SQL data to XML elements and attributes.

6.2.4 Web services Object Runtime Framework (WORF)

The Web services Object Runtime Framework (WORF) enables you to define easily a basic Web service using standard SQL statements stored in an XML file to access local DB2 data. WORF provides an environment to create easily simple XML based Web services that access DB2 using the SOAP and the DADX.

WORF supports resource-based deployment of Web services, which means that you define your Web service in a resource file (DADX file) that you place in a directory of your Web application. When you request that resource file, WORF loads it and makes it available as a Web service.

If you edit the DADX file and request it again, WORF detects the change and loads the new version automatically. This process of automatically reloading the resource file makes Web service development more productive.

Note: With WORF you achieve dramatic decrease in the number of lines of code that you need to develop. Besides, you rely on well architected and tested framework. If there are any improvements in the framework, you get them without rewriting your applications.

6.2.5 Additional information about DB2 Web services

The following list provides links to additional information about DB2 Web services:

- DB2 UDB for iSeries and Web services at:

  `http://www.ibm.com/servers/enable/site/education/wp/db2web/db2web.pdf`
- DB2 Web services for DB2 Practitioners (examples are given for DB2 UDB for Windows):

  `http://download.boulder.ibm.com/ibmdl/pub/software/dw/dm/db2/dm-0405brown/db2webservices.pdf`

6.3 Developing a DB2 UDB Web service

You can use the WebSphere Development Studio client for iSeries development tools, to develop a DB2 Web service. In this section, we show you how to create a DB2 UDB Web service based on a DADX file.

These are the steps to follow:

- Create a dynamic Web Project for the application
- Setup the DB2 connection
- Create an SQL Statement
- Configure the DADX Group
- Create the DADX file
- Generate the Web service based on the DADX file

We explain the steps in more detail on the following pages.

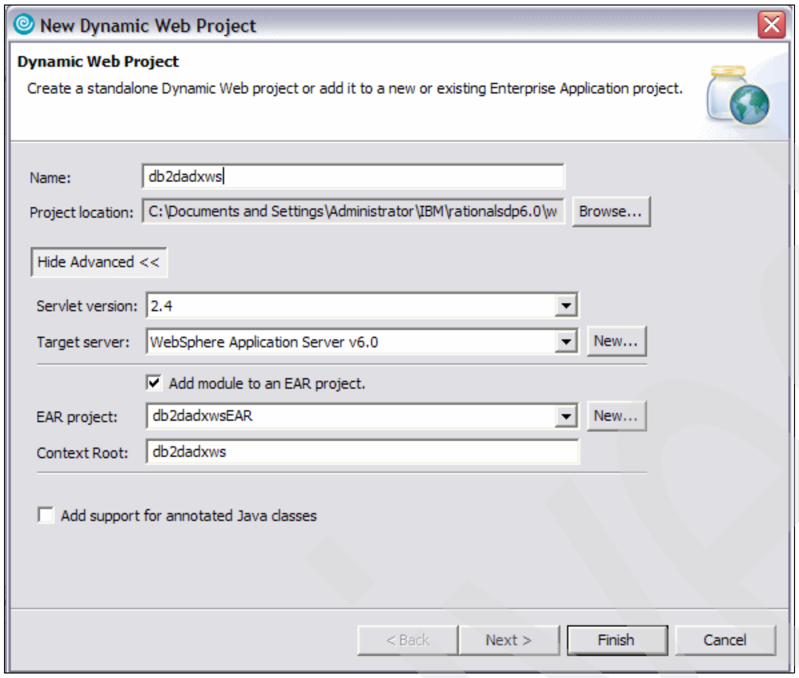
In 6.4, “Creating a DB2 stored procedure” on page 95, we provide a quick overview of how to create a DB2 stored procedure and then a Web service that uses the stored procedure.

6.3.1 Creating a dynamic Web Project for the application

First we need to create a dynamic Web Project in WebSphere Development Studio client for iSeries. Follow these steps:

1. Open WebSphere Development Studio client for iSeries.
2. Select **File** → **New** → **Project** from the menu.
3. In the pop-up window, select **Dynamic Web Project** and click **Next**.

4. Enter a name for the project, such as `db2dadxws` in our example in Figure 6-2 and click **Finish**.



New Dynamic Web Project

Dynamic Web Project

Create a standalone Dynamic Web project or add it to a new or existing Enterprise Application project.

Name: db2dadxws

Project location: C:\Documents and Settings\Administrator\IBM\rationalsdp6.0\w

Servlet version: 2.4

Target server: WebSphere Application Server v6.0

[✓] Add module to an EAR project.

EAR project: db2dadxwsEAR

Context Root: db2dadxws

[ ] Add support for annotated Java classes

Figure 6-2   Create and name a dynamic Web project

6.3.2 Setting up the DB2 connection

Next, you define a connection to the database that you use with your Web service:

1. In WebSphere Development Studio client for iSeries, switch to the J2EE perspective by clicking the window icon in the upper-right corner of the window and selecting **J2EE** (see Figure 6-3).

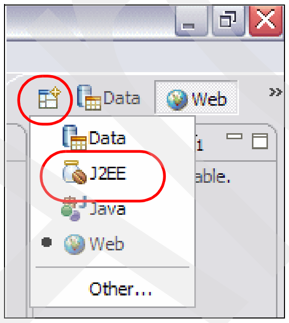


Figure 6-3   Switch to the J2EE perspective

Note: If you do not see J2EE in the list, select **Other**. A window opens. Select **J2EE** and click **OK**.

2. In Project Explorer, right-click the **Database Servers** folder and select **New Connection**.
3. Input a name for the connection you are creating, such as `connDB2DADXWS`, and click **Next**.

4. In the “Select a database manager” list box:
   a. Expand the **DB2 Universal Database™** subheading (Figure 6-4).
   b. Select **DB2 for iSeries V5R3.**

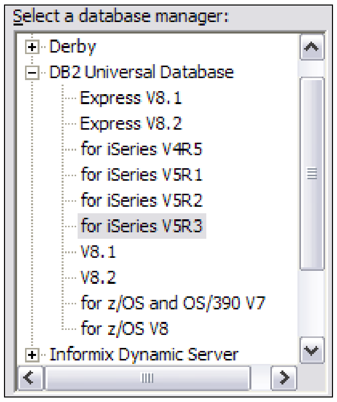
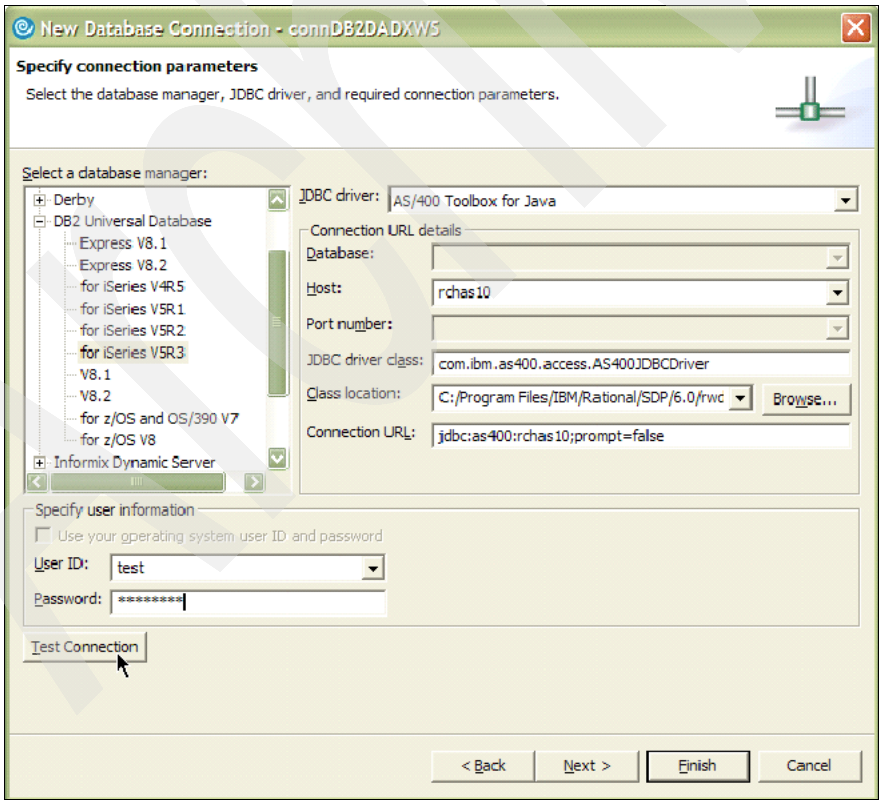


Figure 6-4 Select the DBMS

   c. In the “Host” field, input the host name of the database system.
   d. In the “Specify user information” group, enter the iSeries User ID and iSeries Password for the system that you entered in the previous step.
   e. Click **Test Connection** to verify that the setup is correct (see Figure 6-5). If the connection is successful, you should see a window. Click **OK**. Then, click **Next**.


New Database Connection - connDB2DADXWS

Specify connection parameters

Select the database manager, JDBC driver, and required connection parameters.

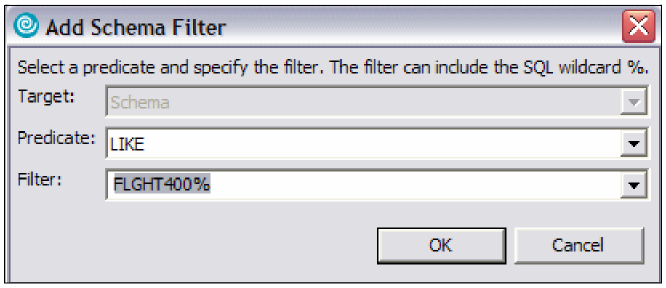
JDBC driver: AS/400 Toolbox for Java

Connection URL details
Database:
Host: rchas10
Port number:
JDBC driver class: com.ibm.as400.access.AS400JDBCDriver
Class location: C:/Program Files/IBM/Rational/SDP/6.0/rwc
Connection URL: jdbc:as400:rchas10;prompt=false

Specify user information
Use your operating system user ID and password
User ID: test
Password: ********

Figure 6-5 Connection window

5. In the “Include schemas that match the following conditions” group, click **Add**.
6. Enter `FLGHT400%` into the Filter text box as shown in Figure 6-6 and click **OK**.


Add Schema Filter

Select a predicate and specify the filter. The filter can include the SQL wildcard %.

Target: Schema

Predicate: LIKE

Filter: FLGHT400%

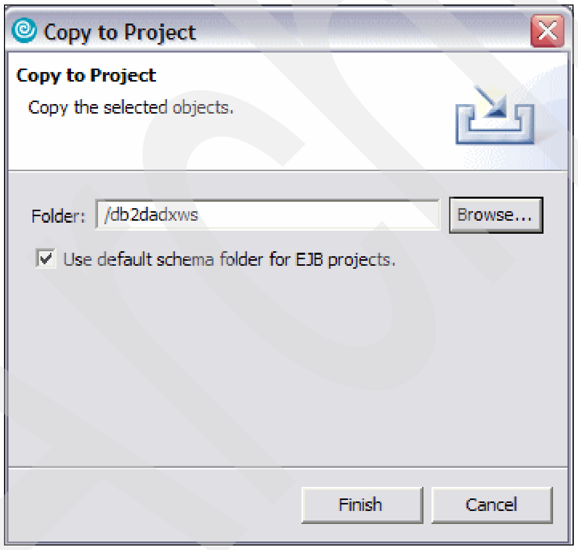
Figure 6-6 Add Schema filter

7. Click **Finish**.

6.3.3 Importing the connection

When the DB2 connection setup is completed, you see your connection listed underneath the Database Servers folder in the Project Explorer. Next, you need to import it into your current project to make it available there:

1. Right-click the connection and select **Copy to project**.
2. Click **Browse** and select the name of the Dynamic Web Project. In our example, that is *db2dadxws* (see Figure 6-7).


Copy to Project

Copy to Project

Copy the selected objects.

Folder: /db2dadxws

☑ Use default schema folder for EJB projects.

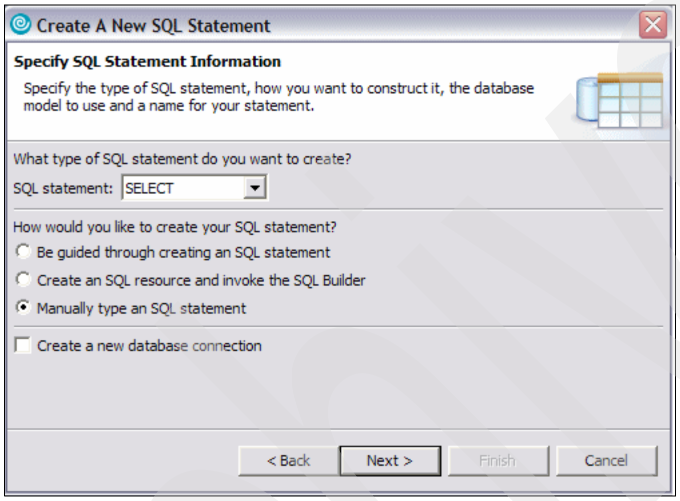
Figure 6-7 Import the connection into the dynamic Web project

3. Click **Finish**.

6.3.4 Creating an SQL statement

Next, you create the SQL statement that you want to use as the basis for your Web service. WebSphere Development Studio client for iSeries provides the wizard that guides you through SQL statement creation. In our example, we choose to manually enter a SQL statement. To create an SQL statement, follow these steps:

1. Select **File** → **New** → **Other**.
2. Expand the **Data** folder.
3. Select **SQL statement** and click **Next.**
4. For the drop-down box SQL statement, leave the default value SELECT. Select **Manually type an SQL statement**.
5. Deselect **Create new database connection**. Then click **Next** (see Figure 6-8).



Specify the type of SQL statement, how you want to construct it, the database model to use and a name for your statement.

What type of SQL statement do you want to create?

SQL statement: SELECT

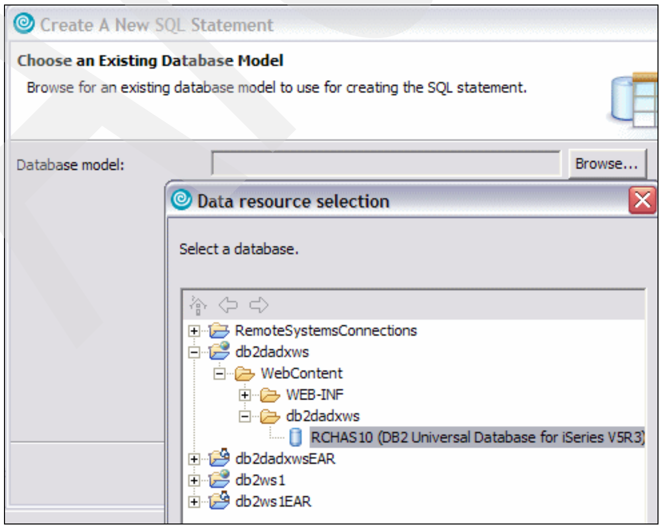
How would you like to create your SQL statement?

- Be guided through creating an SQL statement
- Create an SQL resource and invoke the SQL Builder
- [✓ Manually type an SQL statement]

Create a new database connection ☐

Figure 6-8 Create a new SQL statement

6. Select **Browse** in the Choose an Existing Database Model panel. In the Data resource selection panel, expand the folder named the same as the Dynamic Web Project (*db2dadxws* in our example) until you find the database that was created under the Databases folder in the Project Explorer (see Figure 6-9). Click **OK**.



Browse for an existing database model to use for creating the SQL statement.

Database model:

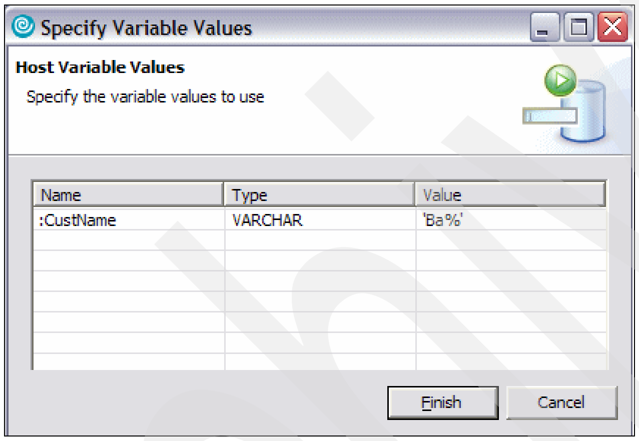
Select a database.

Figure 6-9 Select a database

7. Click **Next**.
8. In the next panel, enter a name for your query. In our example, we enter **QueryCustomer**. Click **Next**.
9. Enter the following SQL statement:

```
SELECT *
FROM
   FLGHT400.CUSTOMERS
WHERE
   FLGHT400.CUSTOMERS.CUSTOMER_NAME LIKE :CustName
```

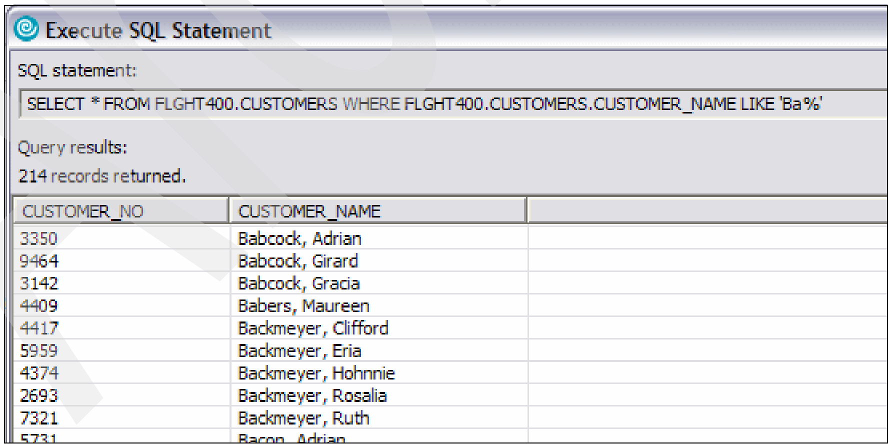
10. When the statement is entered, click **Parse**.
11. Next, verify that the query is correct by clicking **Execute**. Click **Execute** again in the next window.
12. Double-click the first cell in the *Value* column and enter `Ba%` (see Figure 6-10). Click elsewhere in the table to deselect the current cell and click **Finish**.



Name	Type	Value
:CustName	VARCHAR	'Ba%'

Figure 6-10 Specify the host variable value

The output of the query should look like that shown in Figure 6-11.



SQL statement:
SELECT * FROM FLGHT400.CUSTOMERS WHERE FLGHT400.CUSTOMERS.CUSTOMER_NAME LIKE 'Ba%'

Query results:
214 records returned.

CUSTOMER_NO	CUSTOMER_NAME
3350	Babcock, Adrian
9464	Babcock, Girard
3142	Babcock, Gracia
4409	Babers, Maureen
4417	Backmeyer, Clifford
5959	Backmeyer, Eria
4374	Backmeyer, Hohnnie
2693	Backmeyer, Rosalia
7321	Backmeyer, Ruth
5731	Bacon, Adrian

Figure 6-11 SQL Query output

13. After you have verified the output, click **Close**. Then click **Finish** to complete the SQL Wizard.
14. Close the SQL statement editor window by clicking **X** on the tab.

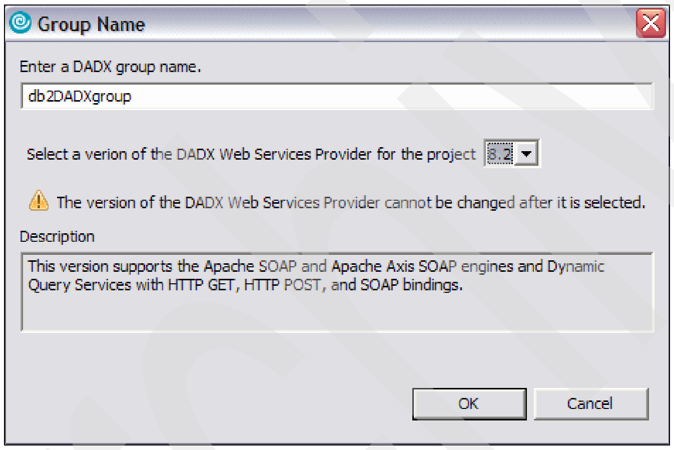
6.3.5 Configuring the DADX Group

This section explains how to configure the DADX group. Using the DADX approach, you save time and effort in building DB2 Web services. IBM provides excellent development tools and runtime support for this architecture.

The DADX group is a group that can include one or more DADX files. All files in the group share the same set of the properties, namely: JDBC driver, DB2 system, and user ID and password.

These are the steps to follow:

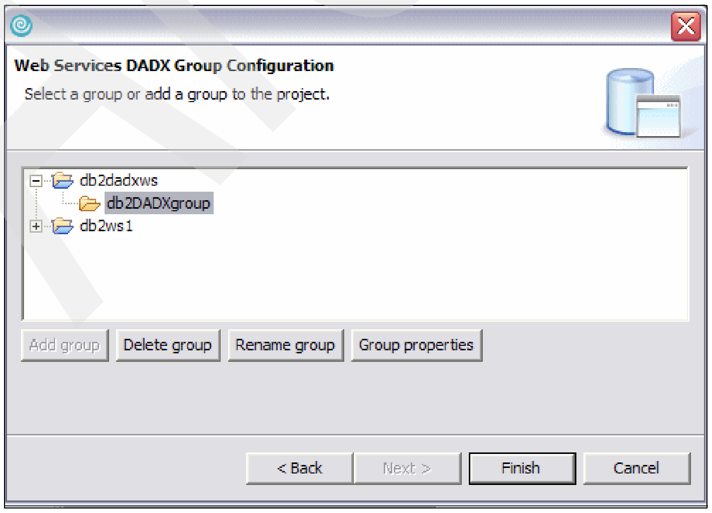
1. In WebSphere Development Studio client for iSeries, select **File** → **New** → **Other**.
2. Expand the Web services folder and select **Web services DADX Group configuration**. Click **Next**.
3. Select the folder named the same as the Dynamic Web Project, which is *db2dadxws* in our example. Click **Add group**.
4. Enter the name for the group. We use *db2DADXgroup* in our example (see Figure 6-12). Click **OK**.



Enter a DADX group name.
db2DADXgroup
Select a verion of the DADX Web Services Provider for the project 8.2
The version of the DADX Web Services Provider cannot be changed after it is selected.
Description
This version supports the Apache SOAP and Apache Axis SOAP engines and Dynamic Query Services with HTTP GET, HTTP POST, and SOAP bindings.

Figure 6-12 Name the DADX group

5. Select the newly created group folder and click **Group properties** (see Figure 6-13).

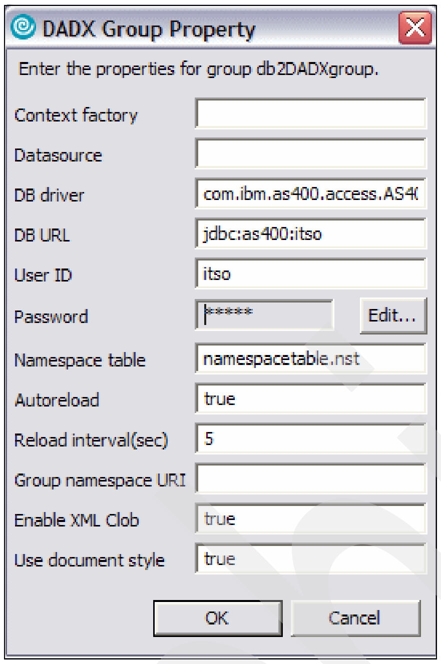


Web Services DADX Group Configuration
Select a group or add a group to the project.

Figure 6-13 Select Group properties

6. In the Group property window (Figure 6-14), replace the following:
   - DB driver: com.ibm.as400.access.AS400JDBCDriver
   - DB URL: jdbc:as400:<*your host name*>

     (replace <*your host name*> in this line with your system's host name)
   - User ID: enter your user ID
   - Password: Click **Edit**. Enter the password for the user ID. Select the box labeled **Store encoded** and click **OK**.



Enter the properties for group db2DADXgroup.

Context factory	
Datasource	
DB driver	com.ibm.as400.access.AS4(
DB URL	jdbc:as400:itso
User ID	itso
Password	******
Namespace table	namespacetable.nst
Autoreload	true
Reload interval(sec)	5
Group namespace URI	
Enable XML Clob	true
Use document style	true

Figure 6-14 Set DADX Group properties

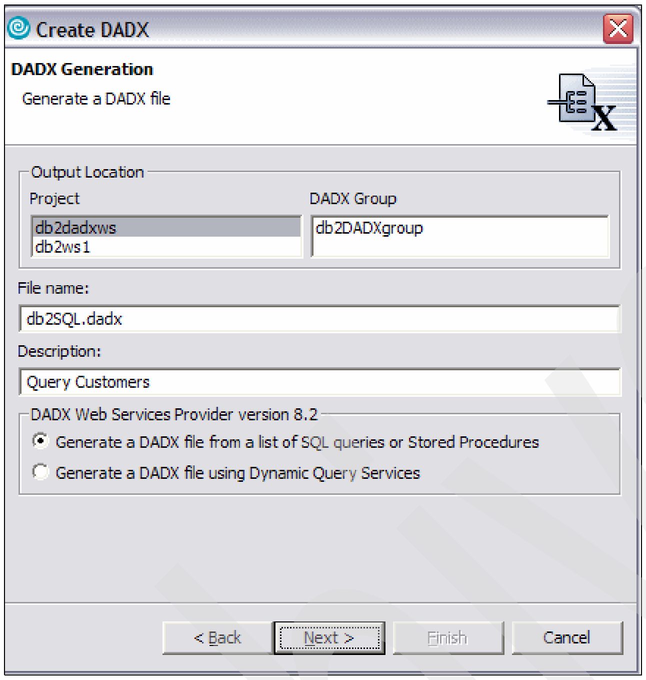
7. Click **Finish**.

6.3.6 Creating the DADX file

Next, you create the DADX file that you use in the next section to generate the Web service:

1. In WebSphere Development Studio client for iSeries, select **File** → **New** → **Other**.
2. Expand the Web services folder and select **DADX File**.
3. Click **Next**.

4. In the Project frame select your project name, *db2dadxws* in our example (see Figure 6-15).
5. Enter a name for the DADX file and add a description.
6. Select **Generate a DADX file from the list of SQL queries or Stored Procedures**. Then click **Next**.



Project: db2dadxws (selected), db2ws1

DADX Group: db2DADXgroup

File name: db2SQL.dadx

Description: Query Customers

DADX Web Services Provider version 8.2

(●) Generate a DADX file from a list of SQL queries or Stored Procedures

( ) Generate a DADX file using Dynamic Query Services

Figure 6-15   Enter a name and description for the DADX file

7. Expand the folder with the same name as the Dynamic Web Project (db2dadxws in our example) until you find the query that was created in the previous section. Select the query and click **Next** (see Figure 6-16).

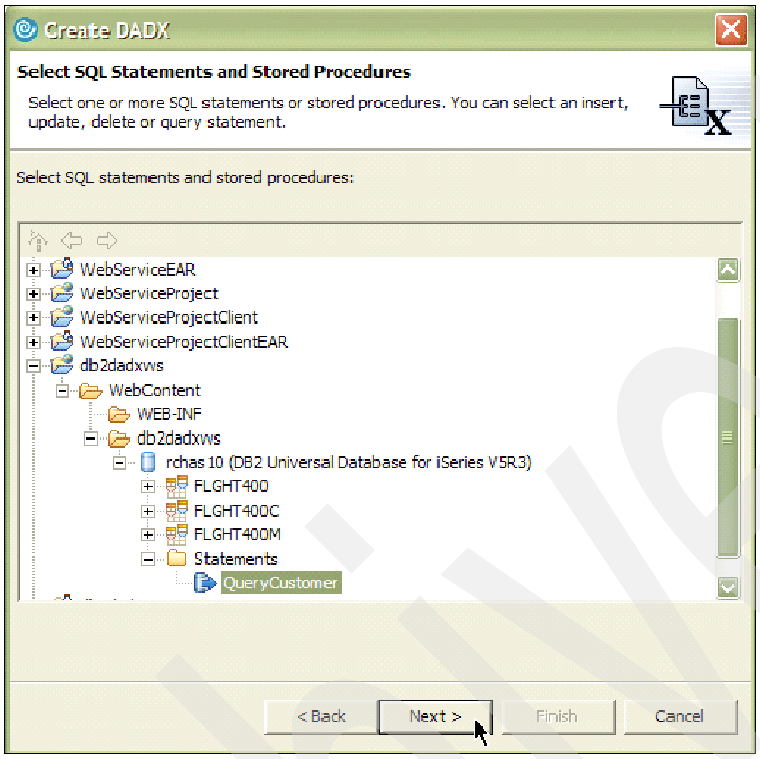

Create DADX
Select SQL Statements and Stored Procedures
Select one or more SQL statements or stored procedures. You can select an insert, update, delete or query statement.
Select SQL statements and stored procedures:
WebServiceEAR
WebServiceProject
WebServiceProjectClient
WebServiceProjectClientEAR
db2dadxws
WebContent
WEB-INF
db2dadxws
rchas10 (DB2 Universal Database for iSeries V5R3)
FLGHT400
FLGHT400C
FLGHT400M
Statements
QueryCustomer
< Back
Next >
Finish
Cancel

Figure 6-16 Selecting the SQL statement

8. Click **Next** again and then click **Finish**.
9. The wizard now creates the DADX file and opens it in the editor's view. The file should look similar to the code shown in Example 6-3.

Example 6-3 DADX file

```
<?xml version="1.0" encoding="UTF-8"?>
<dadx:DADX xmlns:dadx="http://schemas.ibm.com/db2/dxx/dadx"
      xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
      xmlns:xsd="http://www.w3.org/2001/XMLSchema"
      xsi:schemaLocation="http://schemas.ibm.com/db2/dxx/dadx dadx.xsd">
    <dadx:documentation xmlns="http://www.w3.org/1999/xhtml">
        <![CDATA[
        Query Customers
        ]]>
    </dadx:documentation>
    <dadx:operation name="QueryCustomer">
        <dadx:documentation xmlns="http://www.w3.org/1999/xhtml">
            <![CDATA[

            ]]>
        </dadx:documentation>
        <dadx:query>
            <dadx:SQL_query>
                <![CDATA[
                SELECT * FROM FLGHT400.CUSTOMERS WHERE FLGHT400.CUSTOMERS.CUSTOMER_NAME LIKE :CustName
                ]]>
            </dadx:SQL_query>
            <dadx:parameter name="CustName" type="xsd:string"/>
        </dadx:query>
    </dadx:operation>
</dadx:DADX>
```

10.Review the file and close it by clicking **X** on the editor's view tab.

11.If you want to open the file later, you can find it by expanding the Dynamic Web Projects folder in the Project Explorer as follows:

   – Expand your project in the Dynamic Web Projects folder. In our case it is db2dadxws.
   – Expand **Java Resources** → **JavaSource** → **groups.db2DADXgroup**.
   – There you find the file db2SQL.dadx.

6.3.7 Generating the Web service based on the DADX file

This section explains how to create a Web service based on the DADX file created in the previous section. Before generating the Web service, you need to specify the iSeries Web Tools Runtime configuration:

1. In the Project Explorer view expand **Dynamic Web Projects** folder.
2. Right-click the project name, which is *db2dadxws* in our example. Select **Specify iSeries Web Tools Runtime Configuration**.

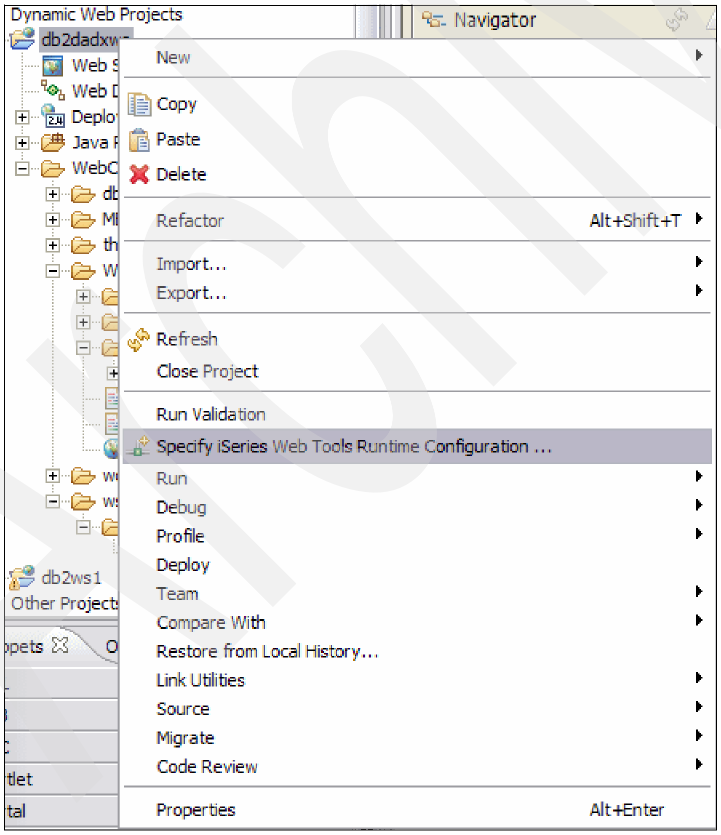
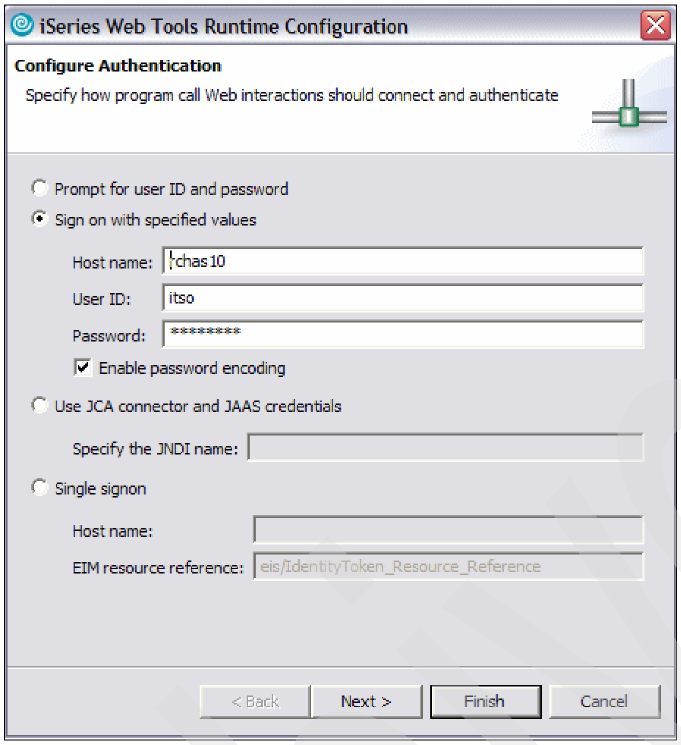


Figure 6-17 Specify iSeries Web Tools Runtime configuration

3. In the next panel (see Figure 6-18), enter the host name, user ID, and password. Make sure the “Encode password encoding” option is selected. Then, click **Finish**.


iSeries Web Tools Runtime Configuration

Configure Authentication

Specify how program call Web interactions should connect and authenticate

( ) Prompt for user ID and password
(●) Sign on with specified values

Host name: rchas10
User ID: itso
Password: *********
[✓] Enable password encoding

( ) Use JCA connector and JAAS credentials

Specify the JNDI name:

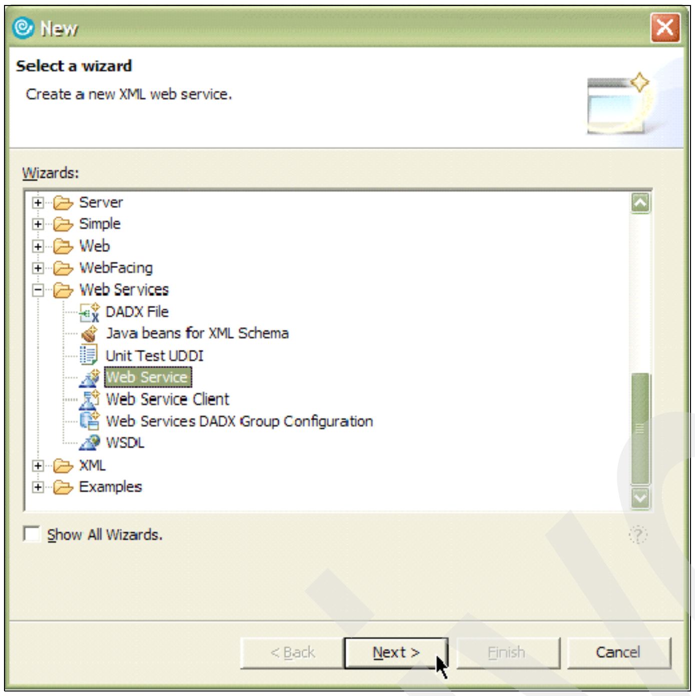
( ) Single signon

Host name:
EIM resource reference: eis/IdentityToken_Resource_Reference

Figure 6-18 Set the host name, user ID, and password to configure the authentication

4. In the Project Explorer view expand **db2dadxws** → **Java Resources** → **JavaSource** → **groups.db2DADXgroup**.
5. Right-click the **DB2sql.dadx** DADX file.
6. Select **New** → **Other**.

7. Expand **Web services** and select **Web service** (Figure 6-19). Then, click **Next**.


New

Select a wizard

Create a new XML web service.

Wizards:

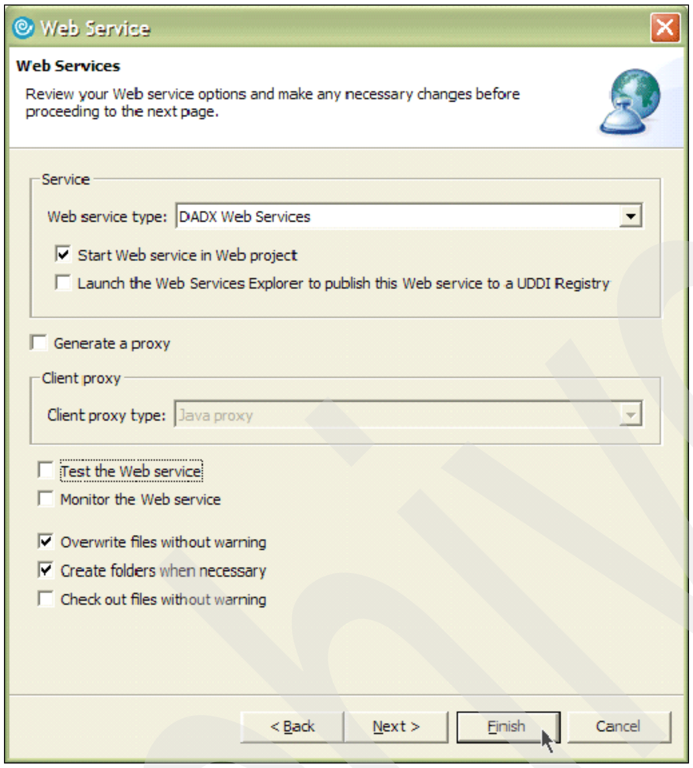
- Server
- Simple
- Web
- WebFacing
- Web Services
  - DADX File
  - Java beans for XML Schema
  - Unit Test UDDI
  - Web Service
  - Web Service Client
  - Web Services DADX Group Configuration
  - WSDL
- XML
- Examples

Show All Wizards.

Figure 6-19 Selecting Web service

8. Make sure the options are selected as shown in Figure 6-20 then click **Finish**.

Attention: You might see a warning message pertaining to the fact that the Web service does not comply with the WS-I SOAP Basic Profile. This is OK. Click **Ignore All**.


Web Service

Web Services

Review your Web service options and make any necessary changes before proceeding to the next page.

Service

Web service type: DADX Web Services

- [✓] Start Web service in Web project
- [ ] Launch the Web Services Explorer to publish this Web service to a UDDI Registry

- [ ] Generate a proxy

Client proxy

Client proxy type: Java proxy

- [ ] Test the Web service
- [ ] Monitor the Web service
- [✓] Overwrite files without warning
- [✓] Create folders when necessary
- [ ] Check out files without warning

Figure 6-20 Create the Web service

The Web services wizard starts the WebSphere Test Environment and generates all artifacts for the Web service. This operation takes a while.

6.3.8 Testing the Web service

Next, test the Web service:

1. Expand the **Dynamic Web Project** folder (Figure 6-21).

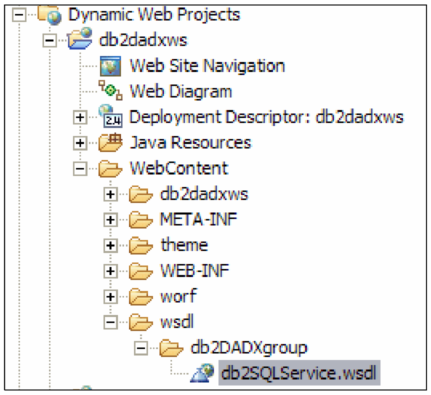
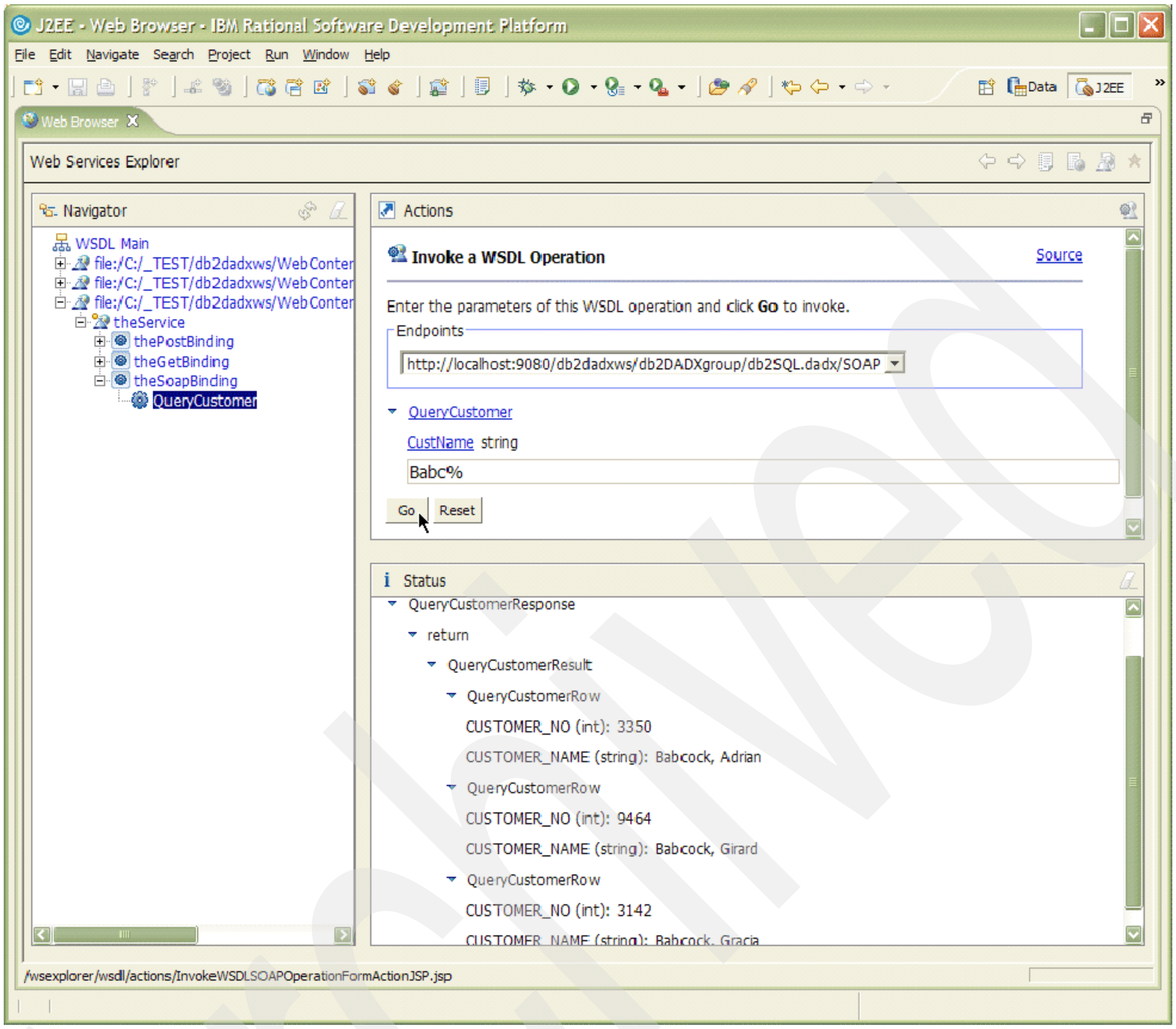


Figure 6-21 Location of the WSDL file

2. Right-click the WSDL file and select **Web service** → **Test With Web services Explorer**.
3. In the Web services Explorer expand **theService** → **theSoapBinding** and click **QueryCustomer** (see Figure 6-22).
4. In the *CustName string* field enter `Babc%` and click **Go** . You should have three names returned.


J2EE - Web Browser - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Data
J2EE
Web Browser
Web Services Explorer
Navigator
WSDL Main
file:/C:/_TEST/db2dadxws/WebConter
file:/C:/_TEST/db2dadxws/WebConter
file:/C:/_TEST/db2dadxws/WebConter
theService
thePostBinding
theGetBinding
theSoapBinding
QueryCustomer
Actions
Invoke a WSDL Operation
Source
Go
Reset
Status

Enter the parameters of this WSDL operation and click **Go** to invoke.

Endpoints

http://localhost:9080/db2dadxws/db2DADXgroup/db2SQL.dadx/SOAP

QueryCustomer

CustName string

Babc%

```
QueryCustomerResponse
  return
    QueryCustomerResult
      QueryCustomerRow
        CUSTOMER_NO (int): 3350
        CUSTOMER_NAME (string): Babcock, Adrian
      QueryCustomerRow
        CUSTOMER_NO (int): 9464
        CUSTOMER_NAME (string): Babcock, Girard
      QueryCustomerRow
        CUSTOMER_NO (int): 3142
        CUSTOMER_NAME (string): Babcock, Gracia
```

/wsexplorer/wsdl/actions/InvokeWSDLSOAPOperationFormActionJSP.jsp

Figure 6-22 Testing the Web service in the Web services Explorer

6.4 Creating a DB2 stored procedure

This section explains how to first create a DB2 stored procedure and then how to create a Web service using this procedure. As you will see, this is pretty easy and most of the steps are almost identical to the previous example with an SQL statement.

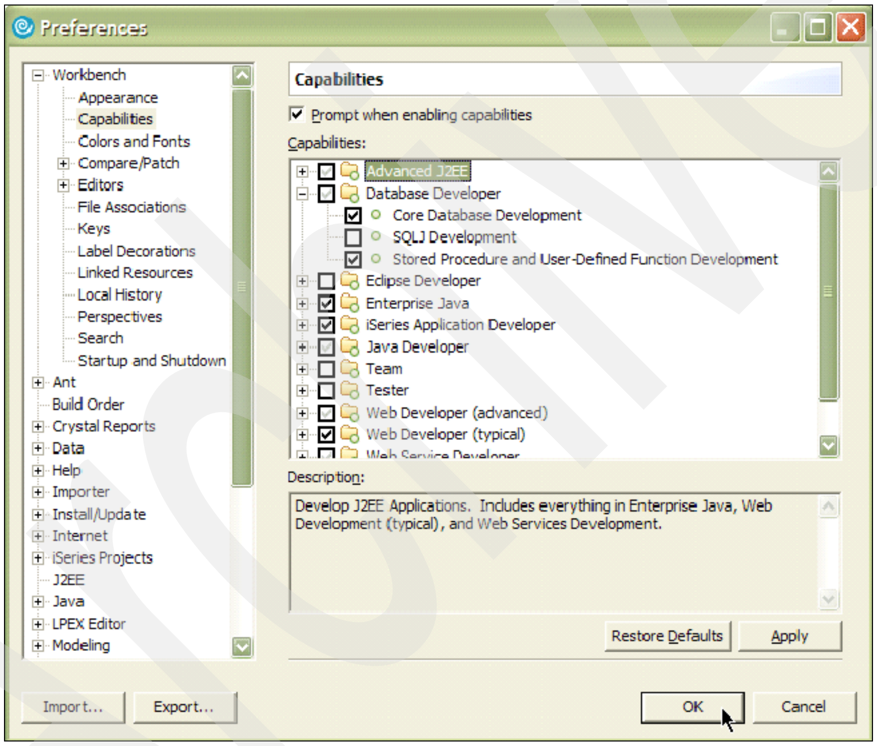
Note: In this example, we assume that you have done the first example from this chapter that we describe in 6.3, “Developing a DB2 UDB Web service” on page 80. We reuse some of the objects that created from that example in the SQL statement example here.

6.4.1 Setting up the environment

Before you can begin developing stored procedures in WebSphere Development Studio client for iSeries, you must enable the database development capabilities. These capabilities are groups of functions that can be disabled or enabled as you need them. When you start the workbench for the first time, the database development capabilities are disabled.

Follow these steps to enable the database development capabilities:

1. Start WebSphere Development Studio client for iSeries.
2. From the menu bar select **Window** → **Preferences**.
3. Expand the **Workbench** node, and click **Capabilities**.
4. Expand the **Database Developer** node in the Capabilities list.
5. Select **Core Database Development** and **Stored Procedure and User-Defined Function Development** as shown in Figure 6-23.
6. Click **OK**.



☑ Prompt when enabling capabilities

Capabilities:

- ☐ Advanced J2EE
- ☑ Database Developer
  - ☑ Core Database Development
  - ☐ SQLJ Development
  - ☑ Stored Procedure and User-Defined Function Development
- ☐ Eclipse Developer
- ☑ Enterprise Java
- ☑ iSeries Application Developer
- ☑ Java Developer
- ☐ Team
- ☐ Tester
- ☑ Web Developer (advanced)
- ☑ Web Developer (typical)
- ☐ Web Service Developer

Description:

Develop J2EE Applications. Includes everything in Enterprise Java, Web Development (typical), and Web Services Development.

Figure 6-23 Enabling database capabilities

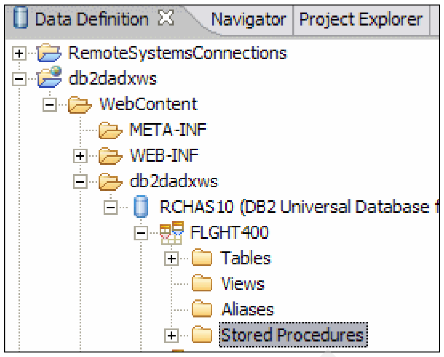
6.4.2 Creating and building an SQL stored procedure

In the previous example, you created a dynamic Web project and a database connection. So you can skip these steps and move forward to the steps to create a stored procedure.

This section explains how to use a wizard to create a DB2 SQL stored procedure. This simple procedure receives two parameters and returns a result set.

Follow these steps to create the stored procedure:

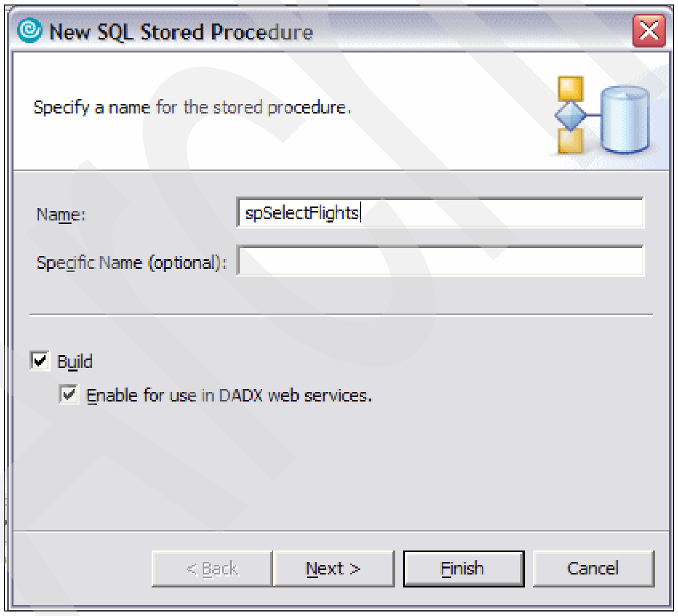
1. If you followed the steps in the previous example, your workbench should display the J2EE perspective. Now, select **Window** → **Open Perspective** → **Data** to switch to the Data perspective.
2. In the Data Definition view navigate to the Stored Procedures folder: expand **db2dadxws** → **WebContent** → **db2dadxws** → **<connection name>** → **FLGHT400** (see Figure 6-24).



RemoteSystemsConnections
db2dadxws
WebContent
META-INF
WEB-INF
db2dadxws
RCHAS10 (DB2 Universal Database f
FLGHT400
Tables
Views
Aliases
Stored Procedures

Figure 6-24 Data Definition view

3. Right-click the Stored Procedure folder and select **New** → **SQL Stored Procedure**.
4. The new window displays. In the name field, enter a name for the stored procedure, such as `spSelectFlights` in our example. Select the “Build” and “Enable for use in DADX Web services” check boxes. Click **Next**.



New SQL Stored Procedure

Specify a name for the stored procedure.

Name: spSelectFlights

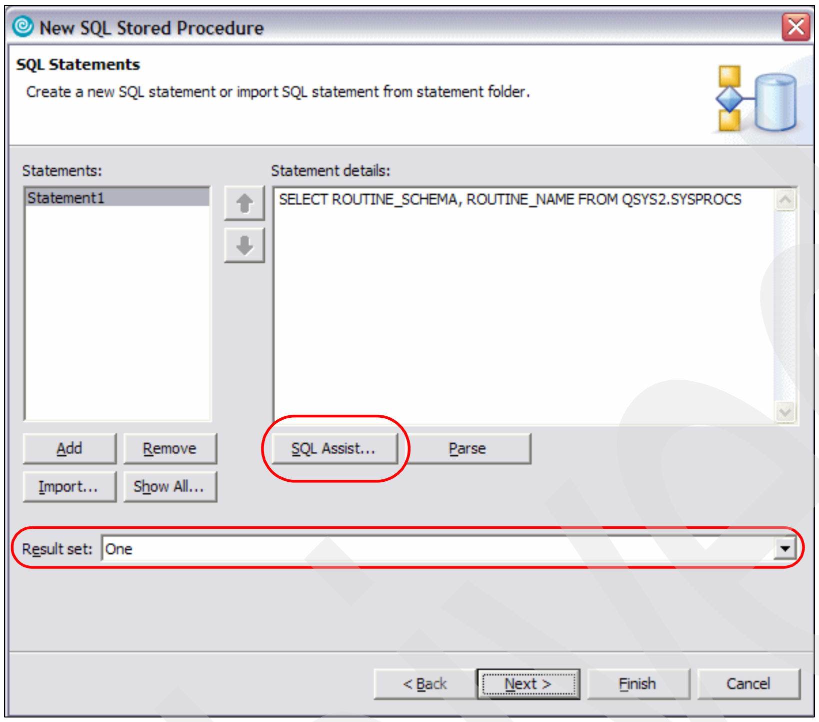
Specific Name (optional):

[✓] Build

[✓] Enable for use in DADX web services.

Figure 6-25 Creating a new SQL stored procedure

5. On the New SQL stored procedure panel, select **One** in the Result set drop-down selection list. Then click **SQL Assist** as shown in Figure 6-26.



Create a new SQL statement or import SQL statement from statement folder.

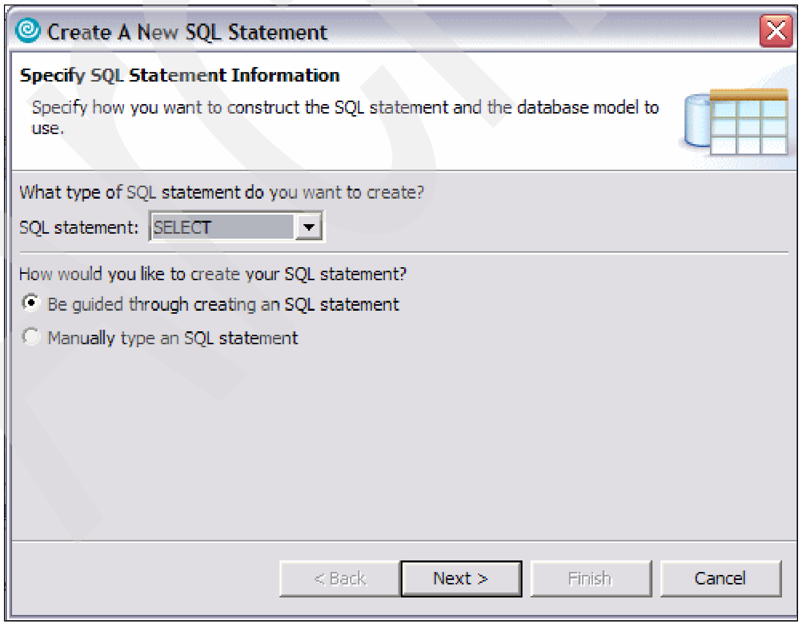
Statements: Statement1

Statement details: SELECT ROUTINE_SCHEMA, ROUTINE_NAME FROM QSYS2.SYSPROCS

Result set: One

Figure 6-26 Select Result set and SQL Assist

6. In the Create A New SQL Statement panel, select the value **SELECT** in the SQL statement drop-down list and select the “Be guided through creating an SQL statement” option (see Figure 6-27). Click **Next.**



Specify how you want to construct the SQL statement and the database model to use.

What type of SQL statement do you want to create?

SQL statement: SELECT

How would you like to create your SQL statement?

(●) Be guided through creating an SQL statement

( ) Manually type an SQL statement

Figure 6-27 Specify SQL statement information

7. In the next panel, we compose the actual SQL statement. On the Tables tab, drill down in the FLGHT400 database until you can select the **FLGHT400.FLIGHTS** table. Click the **>** button to add it to the selected tables window (see Figure 6-28).

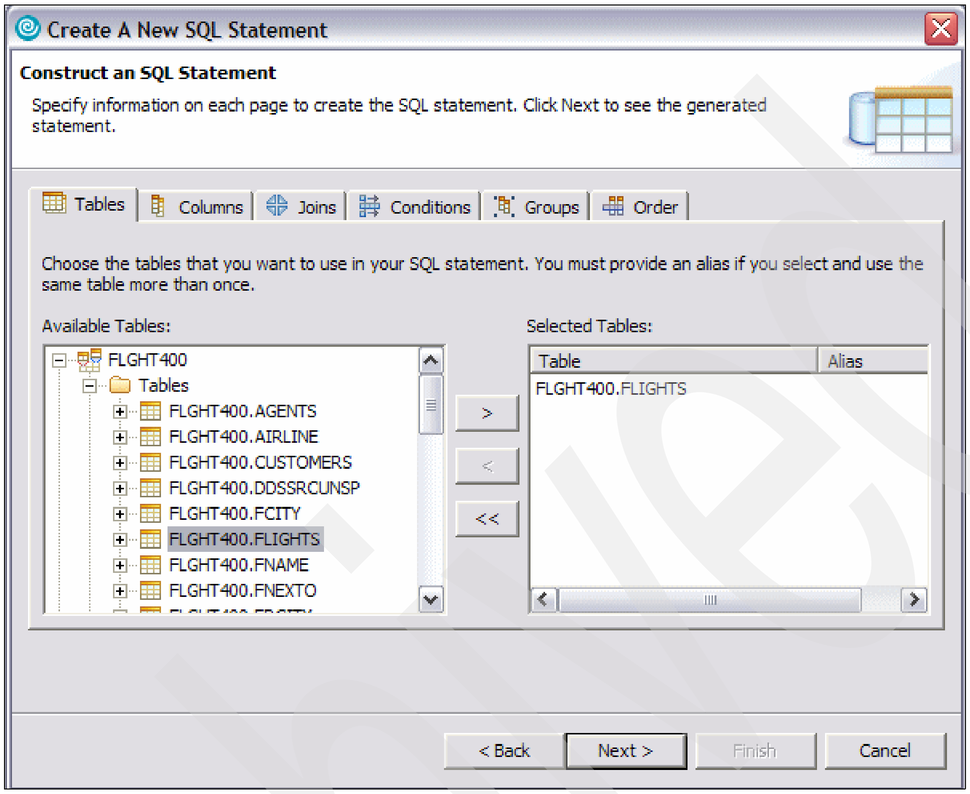

Create A New SQL Statement
Construct an SQL Statement
Specify information on each page to create the SQL statement. Click Next to see the generated statement.
Tables
Columns
Joins
Conditions
Groups
Order
Choose the tables that you want to use in your SQL statement. You must provide an alias if you select and use the same table more than once.
Available Tables:
FLGHT400
Tables
FLGHT400.AGENTS
FLGHT400.AIRLINE
FLGHT400.CUSTOMERS
FLGHT400.DDSSRCUNSP
FLGHT400.FCITY
FLGHT400.FLIGHTS
FLGHT400.FNAME
FLGHT400.FNEXTO
Selected Tables:
Table
Alias
FLGHT400.FLIGHTS
>
<
<<
< Back
Next >
Finish
Cancel

Figure 6-28 Select the FLIGHTS table on the Tables tab page

8. You do not need to select individual columns, and you do not need to create table joins. So, click the Conditions tab page and perform the following actions on this tab:

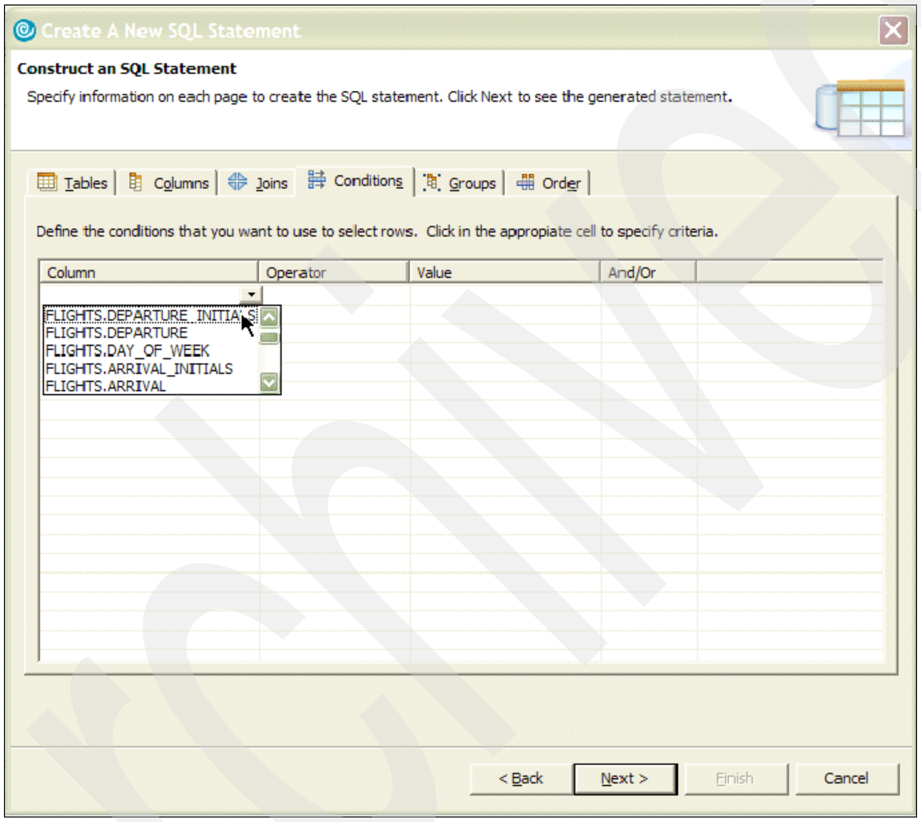
   a. Enter these values on the first line (see Figure 6-29):

      i. In the Column field, double-click the first cell and select **FLIGHTS.DEPARTURE_INITIALS** from the drop-down list.

      ii. Double-click in the first cell of the Operator column. Select the equal sign (=) from the drop-down list.

      iii. Double-click the first cell in the Value column and enter `:dept` in the Value column.

      iv. Double-click the first cell in the And/Or column and select **AND**.



Construct an SQL Statement

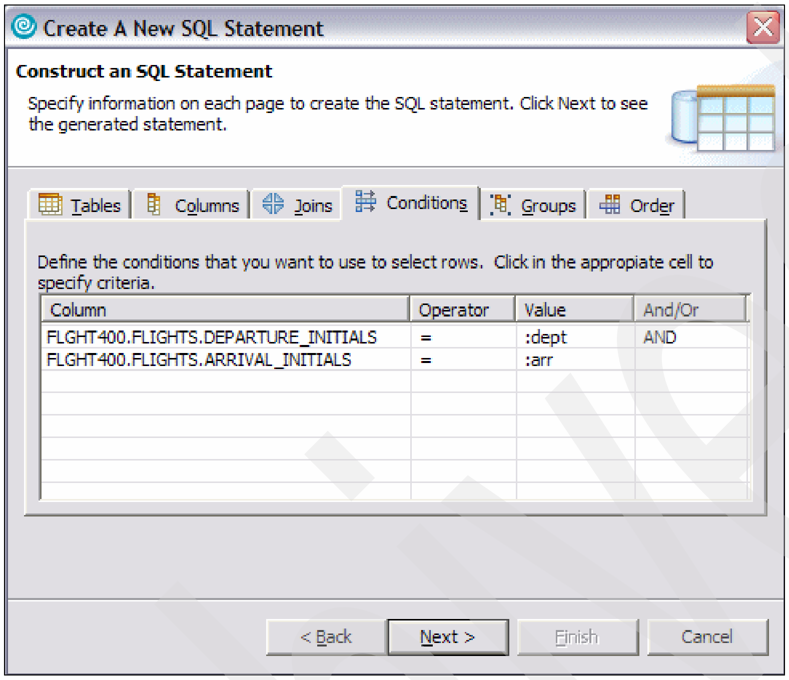
Specify information on each page to create the SQL statement. Click Next to see the generated statement.

Define the conditions that you want to use to select rows. Click in the appropiate cell to specify criteria.

```
FLIGHTS.DEPARTURE_INITIALS
FLIGHTS.DEPARTURE
FLIGHTS.DAY_OF_WEEK
FLIGHTS.ARRIVAL_INITIALS
FLIGHTS.ARRIVAL
```

Figure 6-29 Adding the conditions

b. In the second line, enter the following values (see Figure 6-30):
   i. In the Column column, select **FLIGHTS.ARRIVAL_INITIALS**.
   ii. In the Operator column, select the equal sign (=).
   iii. In the Value column type `:arr`.


Create A New SQL Statement
Construct an SQL Statement
Specify information on each page to create the SQL statement. Click Next to see the generated statement.
Tables
Columns
Joins
Conditions
Groups
Order
< Back
Next >
Finish
Cancel

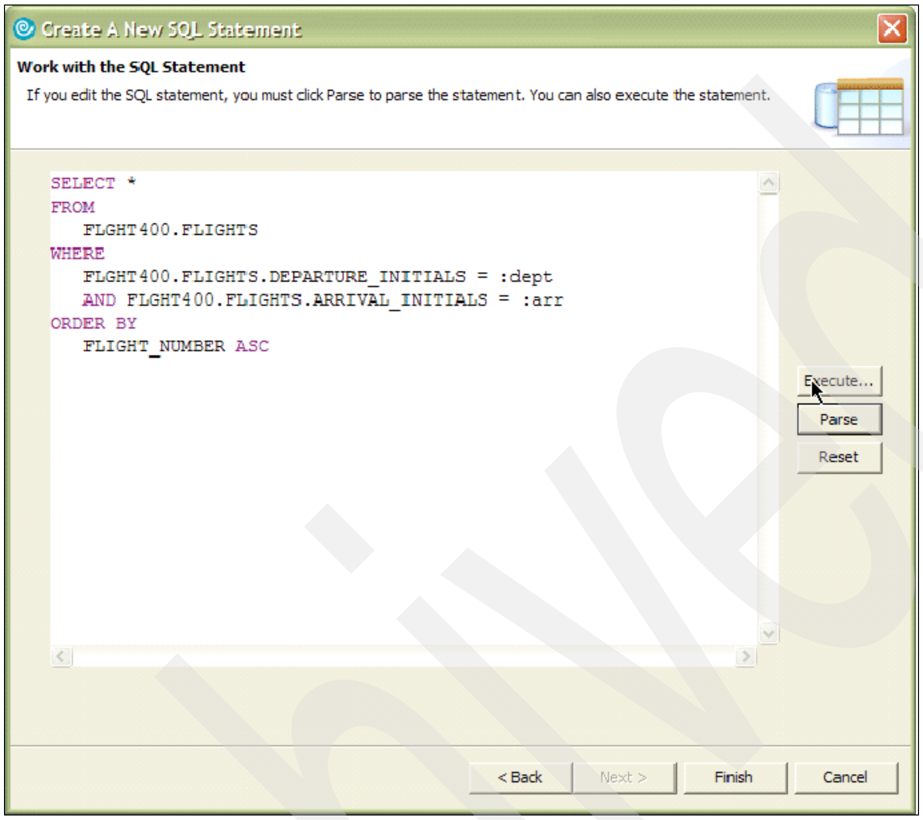
Define the conditions that you want to use to select rows. Click in the appropiate cell to specify criteria.

Column	Operator	Value	And/Or
FLGHT400.FLIGHTS.DEPARTURE_INITIALS	=	:dept	AND
FLGHT400.FLIGHTS.ARRIVAL_INITIALS	=	:arr	

Figure 6-30 Set the conditions for the SQL stored procedure

9. Click the Order tab.
10. Expand **FLGHT400.FLIGHTS**, select **FLIGHT_NUMBER**, and click the > button. Now the results in the result set are ordered by flight number. Click **Next**.

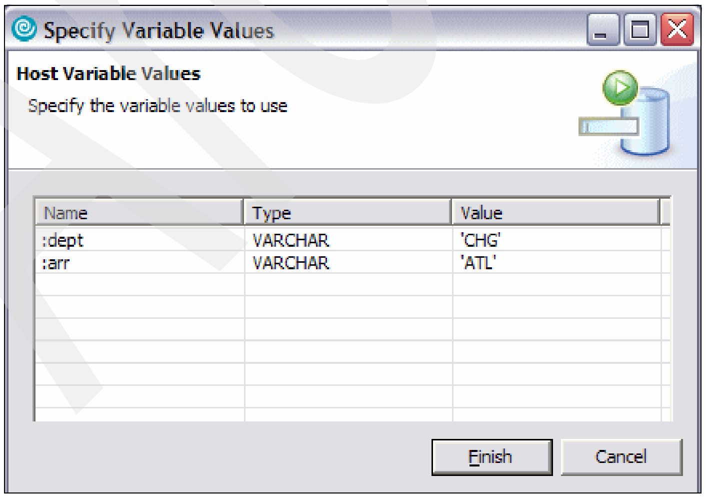
11. The wizard displays the created SQL statement in an editor window where you could edit it (see Figure 6-31). You can click **Parse**, to parse the statement, but if you don't edit it, this is not necessary. Click **Execute** to test the stored procedure. Click **Execute** again.


Create A New SQL Statement
Work with the SQL Statement
If you edit the SQL statement, you must click Parse to parse the statement. You can also execute the statement.
Execute...
Parse
Reset
< Back
Next >
Finish
Cancel

```
SELECT *
FROM
   FLGHT400.FLIGHTS
WHERE
   FLGHT400.FLIGHTS.DEPARTURE_INITIALS = :dept
   AND FLGHT400.FLIGHTS.ARRIVAL_INITIALS = :arr
ORDER BY
   FLIGHT_NUMBER ASC
```

Figure 6-31 Created SQL statement

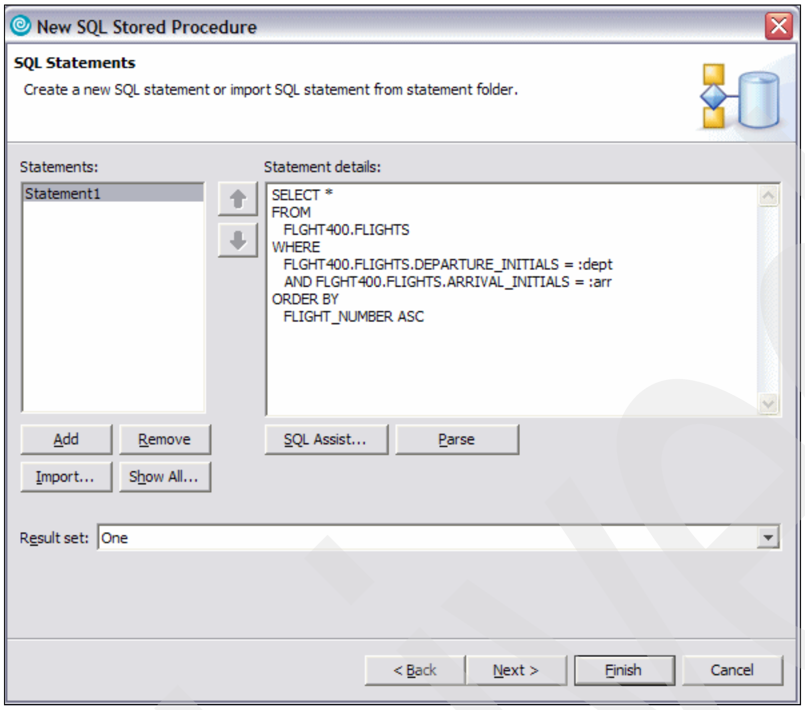
12. In the Specify Variable Values, enter the values `CHG` for the host variable :dept, and `ATL` for :arr (see Figure 6-32). Click in any other cell of the table. Then, click **Finish**. The result set is displayed in a separate window.



Name	Type	Value
:dept	VARCHAR	'CHG'
:arr	VARCHAR	'ATL'

Figure 6-32 Specify host variable values

13. Click **Close** and then click **Finish.** The generated SQL statement is displayed in the New SQL Stored Procedure panel (Figure 6-33). Click **Next**.

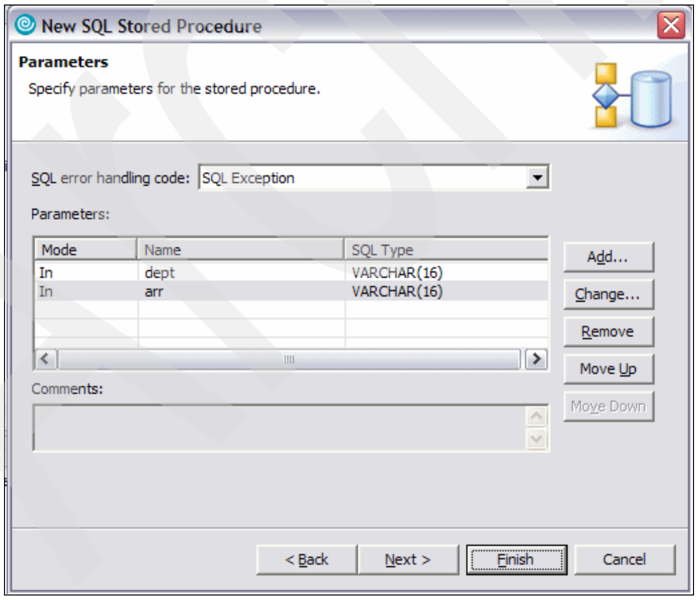


```
SELECT *
FROM
  FLGHT400.FLIGHTS
WHERE
  FLGHT400.FLIGHTS.DEPARTURE_INITIALS = :dept
  AND FLGHT400.FLIGHTS.ARRIVAL_INITIALS = :arr
ORDER BY
  FLIGHT_NUMBER ASC
```

Result set: One

Figure 6-33 The created SQL statement

14. The Parameters panel displays (see Figure 6-34). There is no need to change anything here. Click **Finish**.



SQL error handling code: SQL Exception

Parameters:

Mode	Name	SQL Type
In	dept	VARCHAR(16)
In	arr	VARCHAR(16)

Figure 6-34 The specify parameters for the stored procedure panel

When you are done with these steps, the SQL stored procedure is created and displayed in the editor's view. The code should look similar to the one in Example 6-4.

Example 6-4 SQL stored procedure code

```
CREATE PROCEDURE FLGHT400.SPSelectFlights ( IN dept VARCHAR(16),
                                            IN arr VARCHAR(16) )
    RESULT SETS 1
    LANGUAGE SQL
------------------------------------------------------------------------
-- SQL Stored Procedure
    -- dept
    -- arr
------------------------------------------------------------------------
P1: BEGIN
    -- Declare cursor
    DECLARE cursor1 CURSOR FOR
        SELECT *
        FROM
           FLGHT400.FLIGHTS
        WHERE
           FLGHT400.FLIGHTS.DEPARTURE_INITIALS = dept
           AND FLGHT400.FLIGHTS.ARRIVAL_INITIALS = arr
        ORDER BY
           DEPARTURE ASC,
           FLIGHT_NUMBER ASC;

    -- Cursor left open for client application
    OPEN cursor1;
END P1
```

6.4.3 Creating the DADX file and generate the Web service based on it

Now, that you have created the SQL stored procedure, you need to create the DADX file. This step is almost identical to the one described in 6.3.6, "Creating the DADX file" on page 87. Instead of repeating all these steps here again, we refer you to that section. Just remember to give the DADX file a different name than the one used in the previous sample.

When you have created the DADX file, you can follow the steps in 6.3.7, "Generating the Web service based on the DADX file" on page 90 to generate and test a Web service based on the DADX file.

6.5 Deploying the Web services

Before the Web services created in this chapter can be consumed, you must deploy them on the WebSphere Application Server. The whole process of deploying a Web service to WebSphere Applicatoin Server is described in detail in 5.2.8, "Deploying your Web service to WebSphere Application Server for i5/OS" on page 61. Therefore, we provide just an overview of the necessary steps in this section.

6.5.1 Modifying the WSDL file

The WSDL file is one of the main components of any Web service. It contains the URI of the Web service (its location on the Web), the methods that can be invoked, and so on. Any Web service client needs to read this file to learn how to use a Web service.

In our examples, we generated two WSDL files: db2SQLService.wsdl and spSelectFlightsService.wsdl (see Figure 6-35).

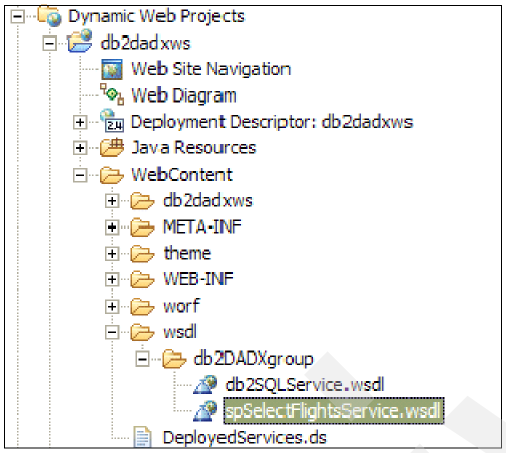


Figure 6-35 Generated WSDL files

To modify the WSDL file, follow these steps:

1. Double-click the db2SQLService.wsdl file. It opens in the WSDL Editor view.
2. Click the Source tab (at the bottom of the view). At the bottom of the source file, you should see the Service section, similar to Example 6-5.

Example 6-5 WSDL file segment

```
<service name="theService">
    <port binding="tns:theSoapBinding" name="theSoapPort">
      <soap:address location="http://localhost:9080/db2dadxws/db2DADXgroup/db2SQL.dadx/SOAP"/>
    </port>
    <port binding="tns:theGetBinding" name="theGetPort">
      <http:address location="http://localhost:9080/db2dadxws/db2DADXgroup/db2SQL.dadx/"/>
    </port>
    <port binding="tns:thePostBinding" name="thePostPort">
      <http:address location="http://localhost:9080/db2dadxws/db2DADXgroup/db2SQL.dadx/"/>
    </port>
  </service>
```

3. Replace `localhost` with the host name of the system where you run WebSphere Application Server. Replace `9080` (the default port for the WebSphere Test Environment) with the port number of your WebSphere Application Server profile. Save the file.
4. Repeat this step for the second WSDL file.

Now your WSDL files reflect the correct information about the future location of your Web services. Any client that can connect to your WebSphere Application Server will be able to access these WSDL files, download them, and build the Web service client code to invoke these Web services.

6.5.2 Exporting the EAR file

Now when your application is ready for the production environment, you need to export it in a form of EAR file. Follow these steps:

1. Open WebSphere Development Studio client for iSeries.
2. Switch to the J2EE perspective.
3. Expand **Enterprise Applications**.
4. Right-click **db2dadxwsEAR** and select **Export** → **EAR file** (see Figure 6-36).

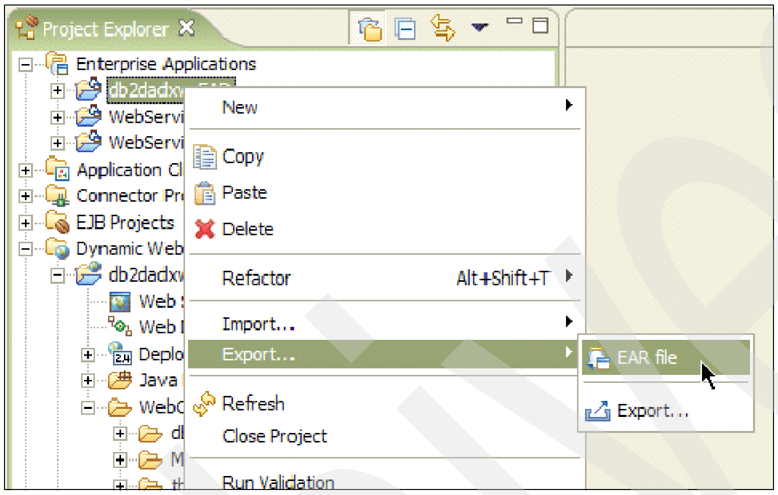
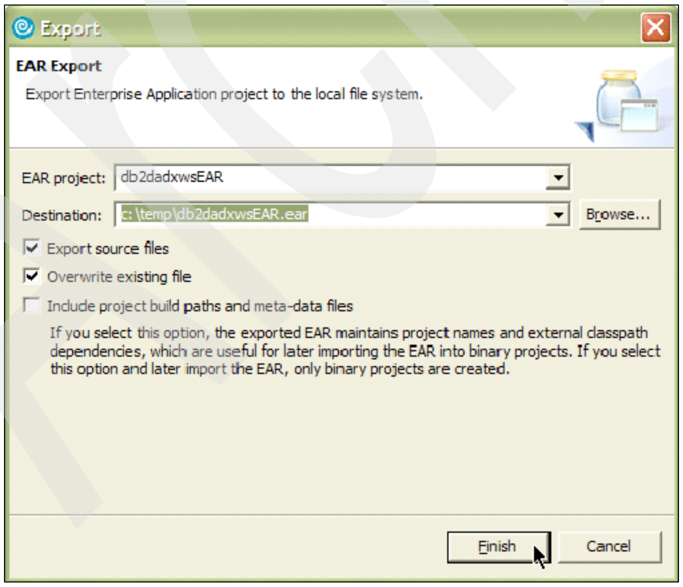


Figure 6-36 Selecting Export option

5. In the window that displays, specify the fully qualified path to the EAR file that will be created by the wizard. In our example, we enter c:\temp\db2dadxwsEAR.ear and click **Finish** (see Figure 6-37).



Export

EAR Export

Export Enterprise Application project to the local file system.

EAR project: db2dadxwsEAR

Destination: c:\temp\db2dadxwsEAR.ear Browse...

☑ Export source files

☑ Overwrite existing file

☐ Include project build paths and meta-data files

If you select this option, the exported EAR maintains project names and external classpath dependencies, which are useful for later importing the EAR into binary projects. If you select this option and later import the EAR, only binary projects are created.

Finish Cancel

Figure 6-37 Exporting the EAR file

6. Open Windows Explorer and verify that the EAR file has been created in c:\temp.

6.5.3 Installing the application on WebSphere Application Server

To install the exported application on WebSphere Application Server profile, perform the following steps:

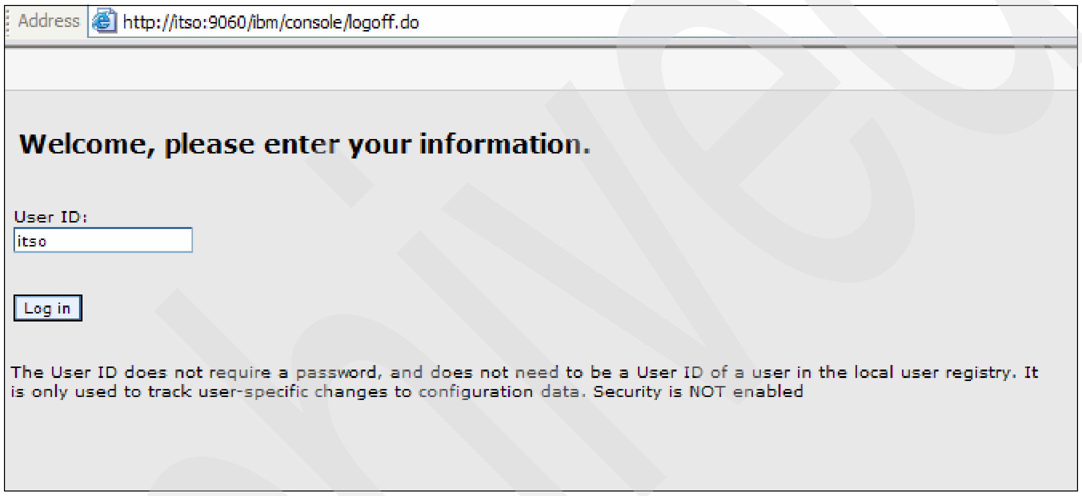
1. Start your WebSphere Application Server profile.
2. Open a browser and enter the WebSphere Application Server Admin Console URL, in the form:

   ```
   http://<iSeries_Server>:<was_admin_port>/ibm/console
   ```

   In our example this would be:

   ```
   http://rchas10:9060/ibm/console
   ```

3. On the administrative console login screen, enter your user ID (you can enter any ID you want) and click **Log in** (see Figure 6-38).



Address http://itso:9060/ibm/console/logoff.do

Welcome, please enter your information.

User ID: itso

Log in

The User ID does not require a password, and does not need to be a User ID of a user in the local user registry. It is only used to track user-specific changes to configuration data. Security is NOT enabled

Figure 6-38 Admin console login window

4. On the WebSphere Administrative Console, expand **Applications** and click **Install New Application** in the navigation menu on the left hand side (see Figure 6-39).

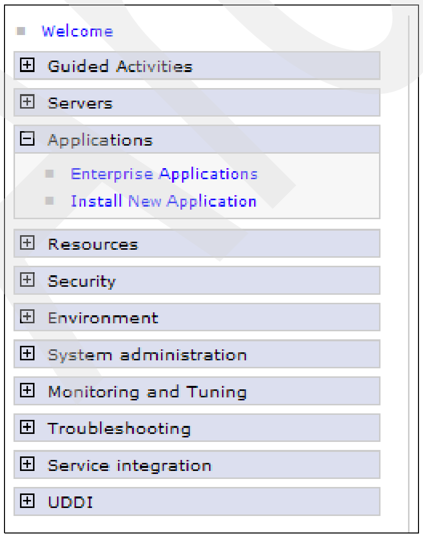
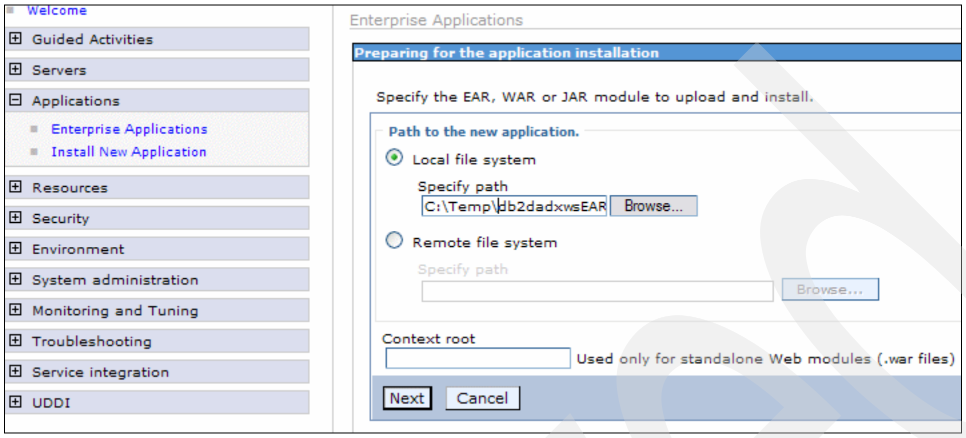


Figure 6-39 Administrative Console navigation menu

5. On the Preparing for the application installation panel, select **Local file system** and browse to the previously exported EAR file and select it and click **Open**. In our example, that location was C:\Temp\db2dadxwsEAR.ear (see Figure 6-40). Then, click **Next**. This step can take a little while, depending on network speed.



Specify the EAR, WAR or JAR module to upload and install.

Path to the new application.

● Local file system

Specify path

C:\Temp\db2dadxwsEAR

○ Remote file system

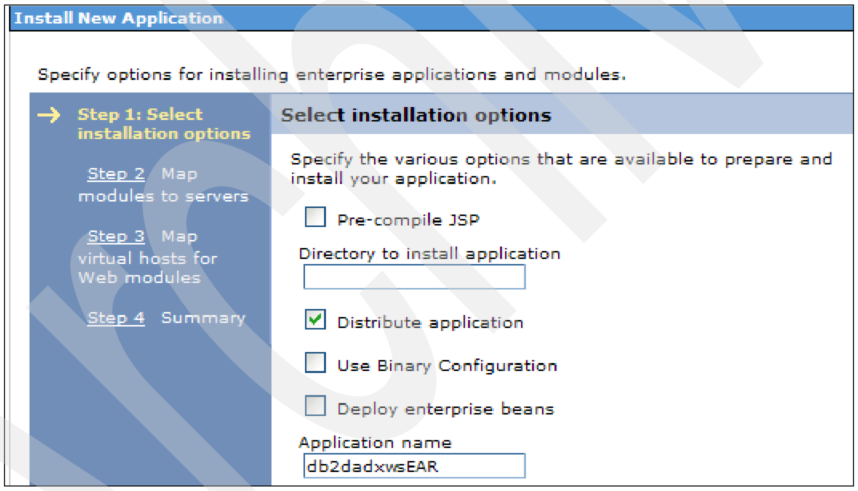
Specify path

Context root

Used only for standalone Web modules (.war files)

Figure 6-40 Select the previously exported EAR file

6. On the “Choose to generate default bindings and mappings” panel, click **Next**.
7. On the “Step 1: select installation options” panel, click **Step 4 Summary** (see Figure 6-41).



Install New Application
Step 1: Select installation options
Step 2 Map modules to servers
Step 3 Map virtual hosts for Web modules
Step 4 Summary
Select installation options

Specify options for installing enterprise applications and modules.

Specify the various options that are available to prepare and install your application.

☐ Pre-compile JSP

Directory to install application

☑ Distribute application

☐ Use Binary Configuration

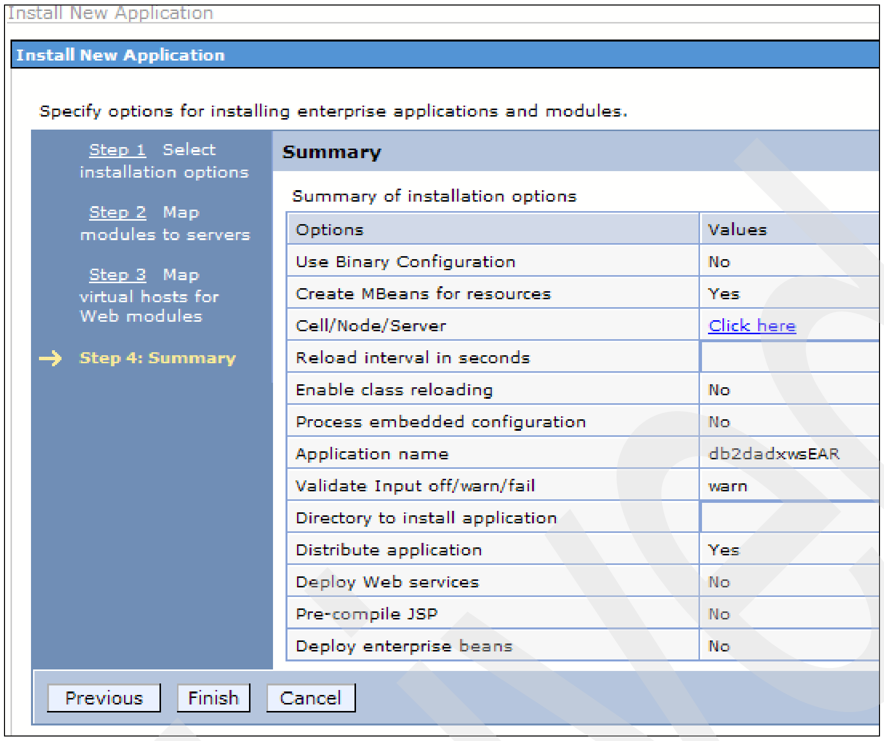
☐ Deploy enterprise beans

Application name

db2dadxwsEAR

Figure 6-41 From Step 1 we immediately jump to Step 4

8. On the “Step 4: Summary” panel, click **Finish** (see Figure 6-42).


Install New Application
Install New Application
Step 1 Select installation options
Step 2 Map modules to servers
Step 3 Map virtual hosts for Web modules
Step 4: Summary
Previous
Finish
Cancel

Specify options for installing enterprise applications and modules.

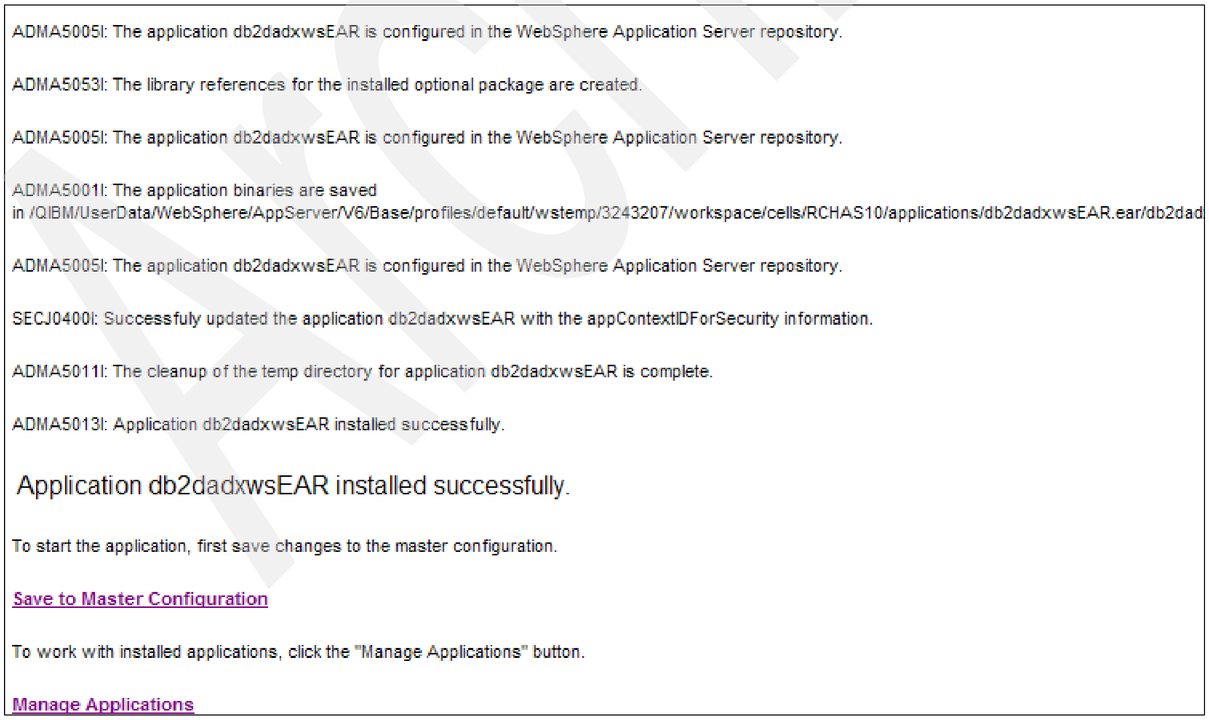
Summary

Summary of installation options

Options	Values
Use Binary Configuration	No
Create MBeans for resources	Yes
Cell/Node/Server	Click here
Reload interval in seconds	
Enable class reloading	No
Process embedded configuration	No
Application name	db2dadxwsEAR
Validate Input off/warn/fail	warn
Directory to install application	
Distribute application	Yes
Deploy Web services	No
Pre-compile JSP	No
Deploy enterprise beans	No

Figure 6-42 Summary of installation options

If the application is installed correctly, you should see a confirmation message (see Figure 6-43).



```
ADMA5005I: The application db2dadxwsEAR is configured in the WebSphere Application Server repository.

ADMA5053I: The library references for the installed optional package are created.

ADMA5005I: The application db2dadxwsEAR is configured in the WebSphere Application Server repository.

ADMA5001I: The application binaries are saved
in /QIBM/UserData/WebSphere/AppServer/V6/Base/profiles/default/wstemp/3243207/workspace/cells/RCHAS10/applications/db2dadxwsEAR.ear/db2dad

ADMA5005I: The application db2dadxwsEAR is configured in the WebSphere Application Server repository.

SECJ0400I: Successfuly updated the application db2dadxwsEAR with the appContextIDForSecurity information.

ADMA5011I: The cleanup of the temp directory for application db2dadxwsEAR is complete.

ADMA5013I: Application db2dadxwsEAR installed successfully.
```

Application db2dadxwsEAR installed successfully.

To start the application, first save changes to the master configuration.

Save to Master Configuration

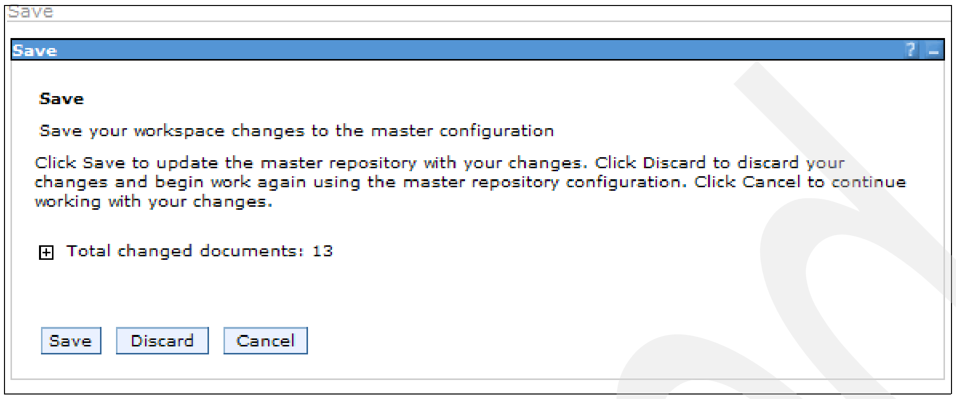
To work with installed applications, click the "Manage Applications" button.

Manage Applications

Figure 6-43 Installation confirmation

9. Click **Save to Master Configuration** to save the changes to the WebSphere Application Server configuration.

10. On the Save panel, click **Save** (see Figure 6-44).



Save

Save

Save your workspace changes to the master configuration

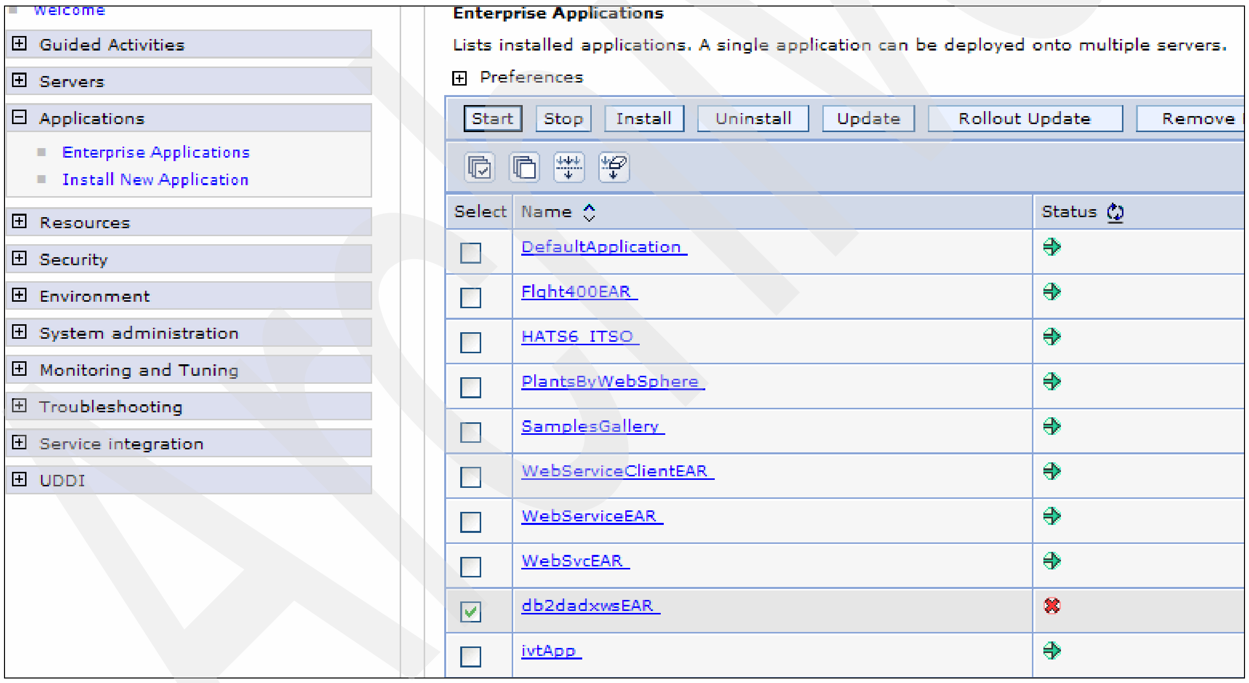
Click Save to update the master repository with your changes. Click Discard to discard your changes and begin work again using the master repository configuration. Click Cancel to continue working with your changes.

⊞ Total changed documents: 13

Save | Discard | Cancel

Figure 6-44 Save the configuration

11. In the Administrative Console navigation, expand **Applications** and click **Enterprise Applications**. Locate the installed application (db2dadxwsEAR in our example), select the check box next to it, and click **Start** to start the application (see Figure 6-45).



Enterprise Applications

Lists installed applications. A single application can be deployed onto multiple servers.

⊞ Preferences

Start | Stop | Install | Uninstall | Update | Rollout Update | Remove

Select	Name	Status
☐	DefaultApplication	➔
☐	Flght400EAR	➔
☐	HATS6_ITSO	➔
☐	PlantsByWebSphere	➔
☐	SamplesGallery	➔
☐	WebServiceClientEAR	➔
☐	WebServiceEAR	➔
☐	WebSvcEAR	➔
✓	db2dadxwsEAR	✖
☐	ivtApp	➔

Figure 6-45 Start the application

12. The next steps are additional (and not typical for other applications) steps for the DB2 Web services based on WORF and DADX. First, you need to create the classes folder under your profile's directory in IFS. For our default server the directory is:

/QIBM/UserData/WebSphere/AppServer/V6/Base/profiles/default/classes

13. Copy the following three JAR files that are bundled with your DB2 Web services applications to the new directory:

   – worf.jar
   – worf-servlet.jar
   – jt400.jar

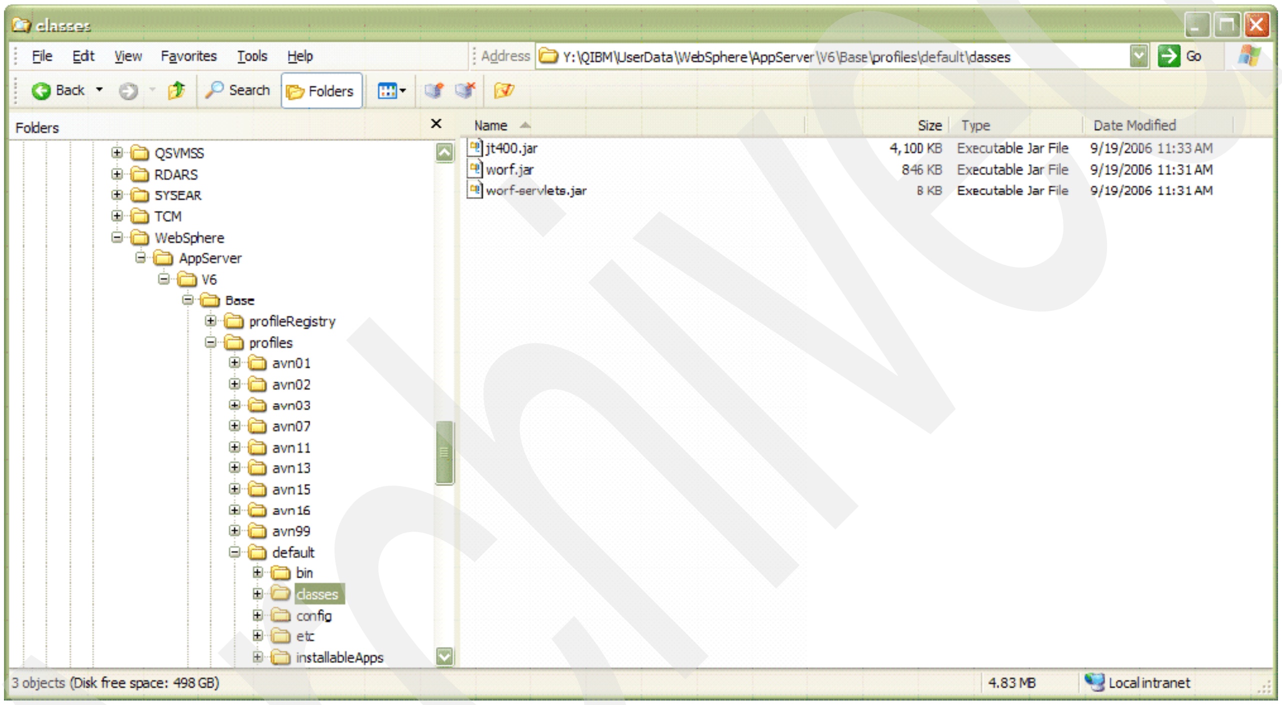
   For example, copy the files from:

   /QIBM/UserData/WebSphere/AppServer/V6/Base/profiles/default/installedApps/<*systemName*>/db2dadxwsEAR.ear/db2dadxws.war/WEB-INF/lib/

   to

   /QIBM/UserData/WebSphere/AppServer/V6/Base/profiles/default/classes

   Now you should have three JAR files in your classes folder as shown in Figure 6-46.



Name	Size	Type	Date Modified
jt400.jar	4,100 KB	Executable Jar File	9/19/2006 11:33 AM
worf.jar	846 KB	Executable Jar File	9/19/2006 11:31 AM
worf-servlets.jar	8 KB	Executable Jar File	9/19/2006 11:31 AM

3 objects (Disk free space: 498 GB) 4.83 MB Local intranet

Figure 6-46 JAR files

14. Restart your WebSphere Application Server profile.

> **Note:** You need to copy three JAR files because of the way class loaders work in i5/OS. This step is not required if you install the DB2 Web services application to WebSphere Application Server on other platforms.

6.5.4 Testing Web services on the production server

After you deploy the Web services application on the production server, you can test them with Web services Explorer in WebSphere Development Studio client for iSeries:

1. Start WebSphere Development Studio client for iSeries and open the J2EE perspective.
2. Click the Launch Web service Explorer button on the toolbar (see Figure 6-47).

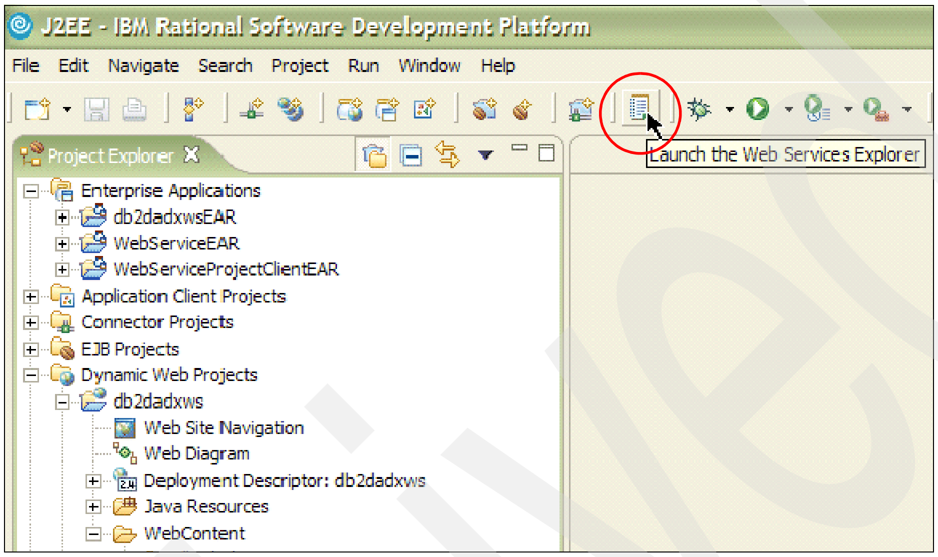
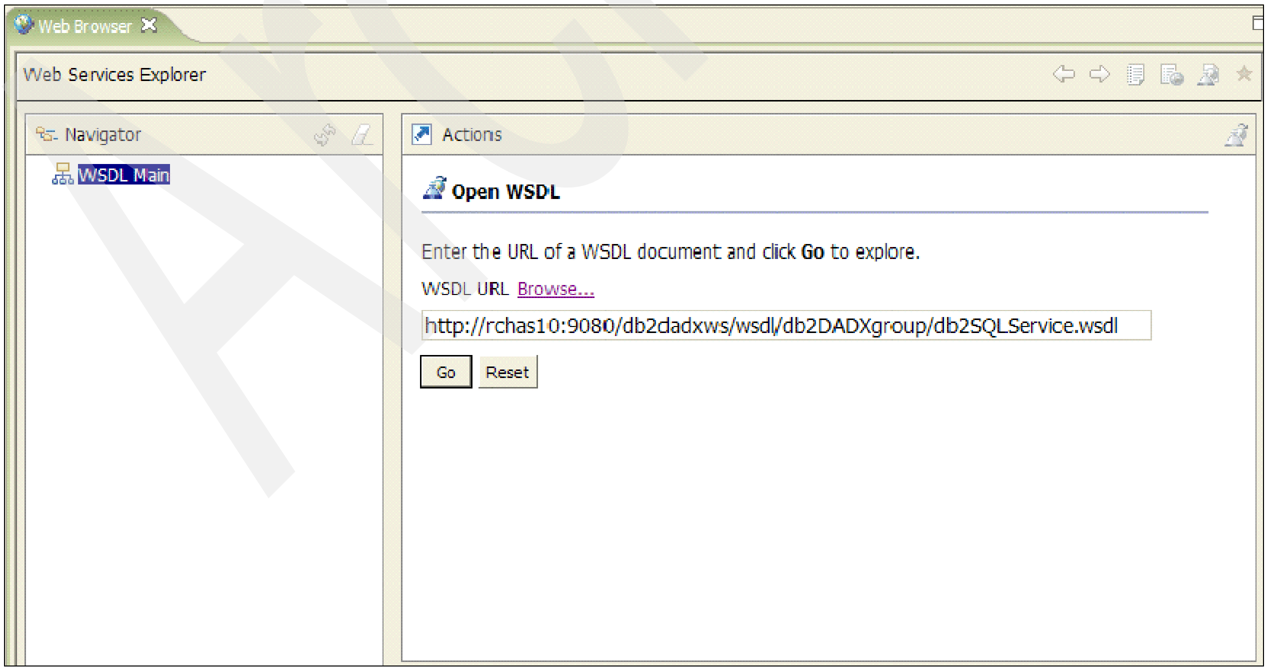

J2EE - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Launch the Web Services Explorer
Project Explorer
Enterprise Applications
db2dadxwsEAR
WebServiceEAR
WebServiceProjectClientEAR
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
db2dadxws
Web Site Navigation
Web Diagram
Deployment Descriptor: db2dadxws
Java Resources
WebContent

Figure 6-47 Launching Web services Explorer

3. In the WSDL URL, enter the location of the WSDL file on your server. In our example running the application in the default profile the URL is:

```
http://rchas10:9080/db2dadxws/wsdl/db2DADXgroup/db2SQLService.wsdl
```

4. Click **Go** (see Figure 6-48).



Enter the URL of a WSDL document and click **Go** to explore.

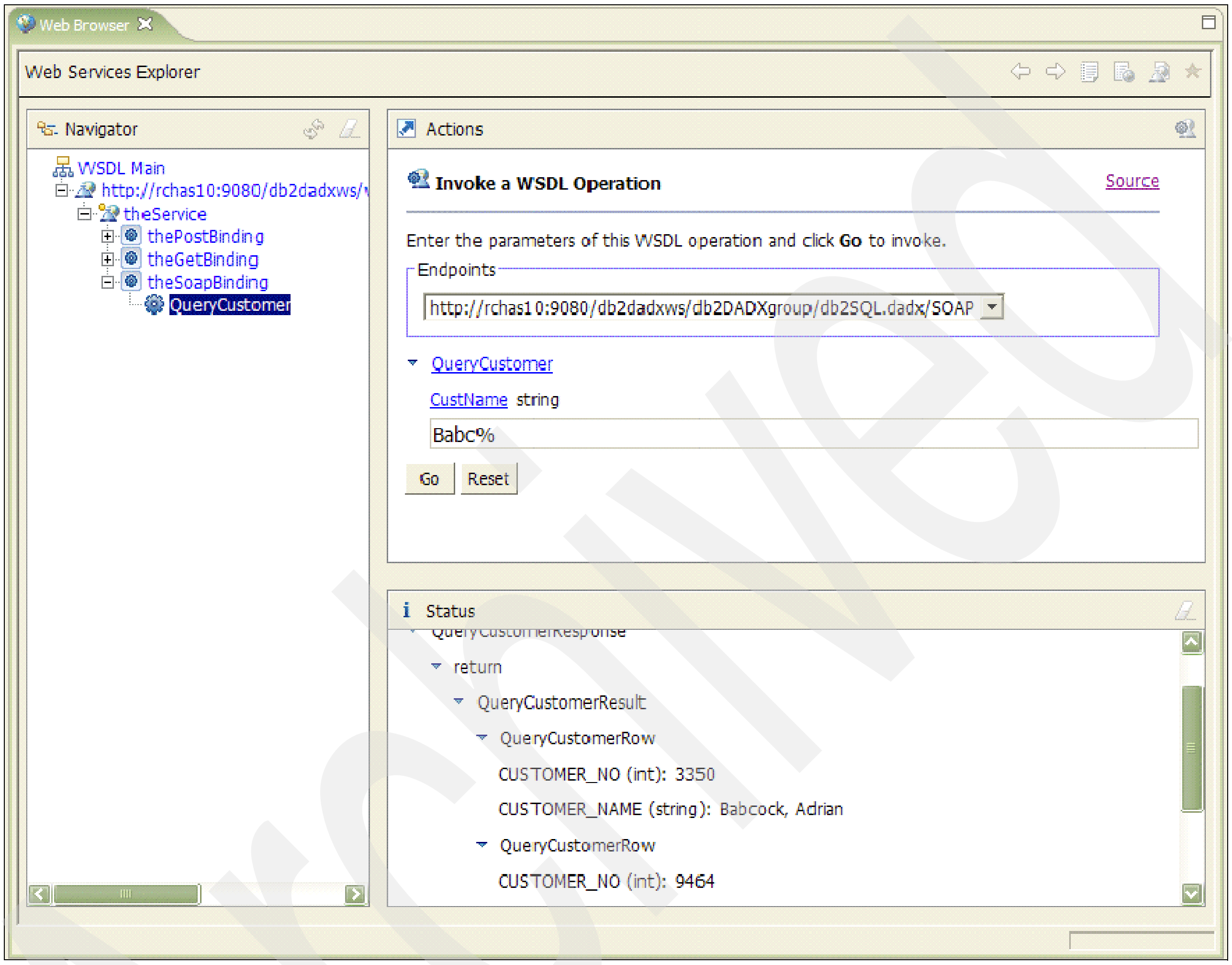
WSDL URL Browse...

http://rchas10:9080/db2dadxws/wsdl/db2DADXgroup/db2SQLService.wsdl

Figure 6-48 Accessing the WSDL file

5. In the Navigator view of the Web services Explorer expand **theService** → **theSoapBinding** and click **QueryCustomer**.
6. Enter `Babc%` in the CustName field and click **Go** (see Figure 6-49).

   You should see the results of your query in the Status frame of the view.



Enter the parameters of this WSDL operation and click **Go** to invoke.

Endpoints

http://rchas10:9080/db2dadxws/db2DADXgroup/db2SQL.dadx/SOAP

QueryCustomer

CustName string

Babc%

```
QueryCustomerResponse
  return
    QueryCustomerResult
      QueryCustomerRow
        CUSTOMER_NO (int): 3350
        CUSTOMER_NAME (string): Babcock, Adrian
      QueryCustomerRow
        CUSTOMER_NO (int): 9464
```

Figure 6-49 Testing Web service on the WebSphere Application Server profile

7

HATS Web service

This chapter describes a method to expose RPG application as a Web service using Host Access Transformation Services (HATS). It discusses the project considerations and investments for developing a Web service from traditional RPG application. Finally, the chapter demonstrates typical development steps in building such a Web service.

7.1 Project investments in developing a service

In wrappering existing business logic as a HATS Web service, you need to consider the following items for using SOA:

- Analyze the current state of the business application.
- Consider the time frame for the prototyping and production of a services application.

You need to consider also the application development, expense, and deployment for developing a Web service based application.

7.1.1 Analyzing an existing application

HATS Web service is a good solution where the existing applications can be driven using macros. With some applications, where it is not possible to drive the application using a macros, HATS Web service might not be a simple solution. You might require some modifications to the existing application flow to automate it using a macro.

Consider the following scenarios in our Flight Reservation System sample application:

1. Flight Reservation Inquiry

   This is a very simple scenario. The application window has only one input parameter and based on the input, it retrieves data from the database table. This application transaction can be driven easily with macro.

   Let us look at the transaction details and the navigation required in completing the transaction.

   a. Start personal communication session to your System i5.

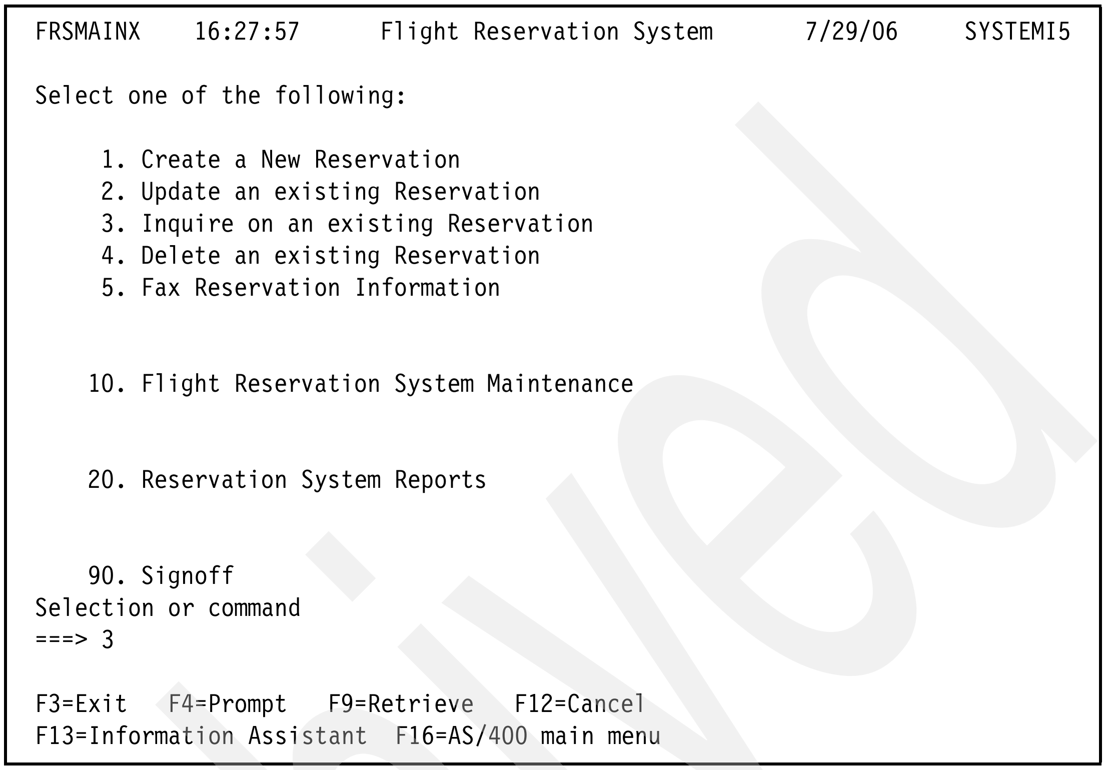
   b. Run this command to add a library to the library list:

   ```
   ADDLIBLE FLGHT400
   ```

   c. Call the Flight Reservation System application:

   ```
   GO FLGHT400/FRSMAIN
   ```

d. Enter `3 - Inquire on an Existing Reservation` on the Flight Reservation main menu panel and press Enter (see Figure 7-1).

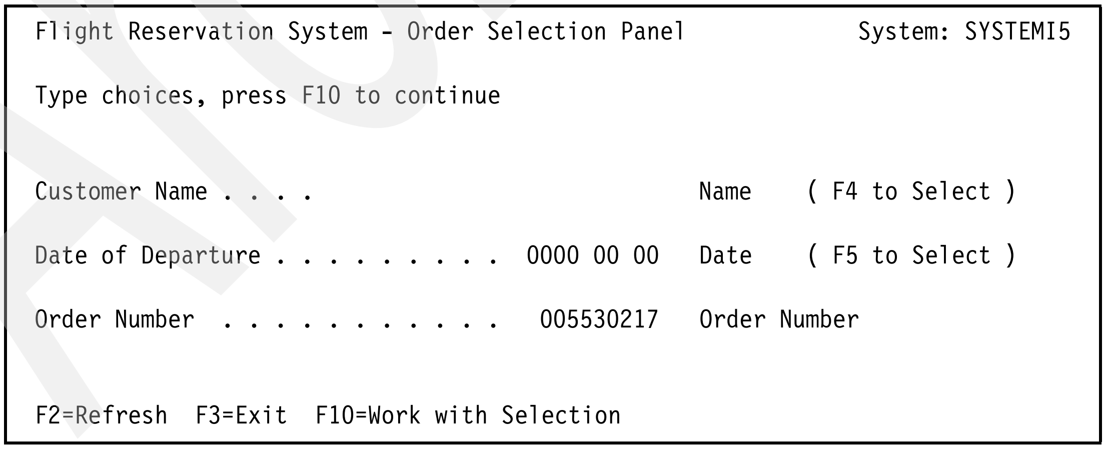


```
FRSMAINX    16:27:57      Flight Reservation System       7/29/06     SYSTEMI5

Select one of the following:

     1. Create a New Reservation
     2. Update an existing Reservation
     3. Inquire on an existing Reservation
     4. Delete an existing Reservation
     5. Fax Reservation Information


    10. Flight Reservation System Maintenance


    20. Reservation System Reports


    90. Signoff
Selection or command
===> 3

F3=Exit   F4=Prompt   F9=Retrieve   F12=Cancel
F13=Information Assistant  F16=AS/400 main menu
```

Figure 7-1 Flight Reservation System main menu

e. You should see a logon panel. Enter `Alex` as agent name and `mercury` as the password. Press F10.

f. Enter the order number `005530217` and press F10 to work with selection (see Figure 7-2).

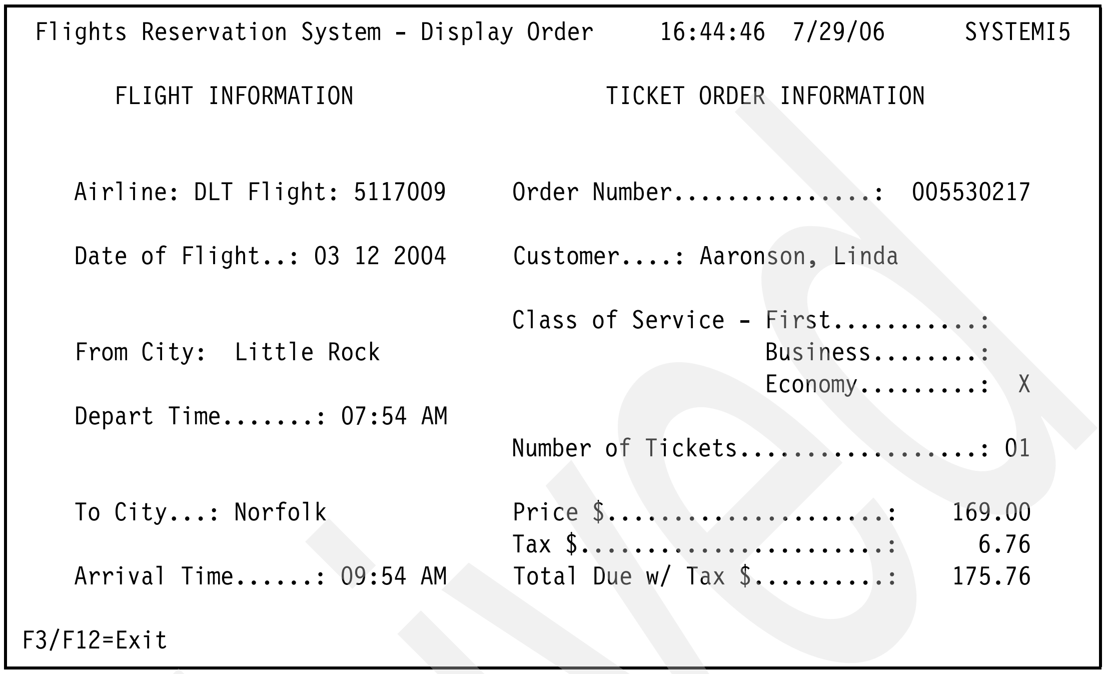


```
Flight Reservation System - Order Selection Panel             System: SYSTEMI5

Type choices, press F10 to continue


Customer Name . . . .                              Name    ( F4 to Select )

Date of Departure . . . . . . . . .  0000 00 00   Date    ( F5 to Select )

Order Number  . . . . . . . . . . .   005530217   Order Number


F2=Refresh  F3=Exit  F10=Work with Selection
```

Figure 7-2 Order Selection panel

g. Review the order and press F3 or F12 to exit the Display Order panel (see Figure 7-3).

h. Press F3 to exit from Order Selection Panel.



```
 Flights Reservation System - Display Order     16:44:46  7/29/06      SYSTEMI5

       FLIGHT INFORMATION                    TICKET ORDER INFORMATION


    Airline: DLT Flight: 5117009     Order Number..............:  005530217

    Date of Flight..: 03 12 2004     Customer....: Aaronson, Linda

                                     Class of Service - First..........:
    From City:  Little Rock                             Business........:
                                                        Economy.........:  X
    Depart Time.......: 07:54 AM
                                     Number of Tickets.................: 01

    To City...: Norfolk              Price $....................:   169.00
                                     Tax $......................:     6.76
    Arrival Time......: 09:54 AM     Total Due w/ Tax $.........:   175.76

 F3/F12=Exit
```

Figure 7-3 Display Order panel

2. Flight Selection Search and Flight Reservation Transaction

   First let us look at the Flight Reservation Transaction and learn about the data entry fields and flow of the transaction:

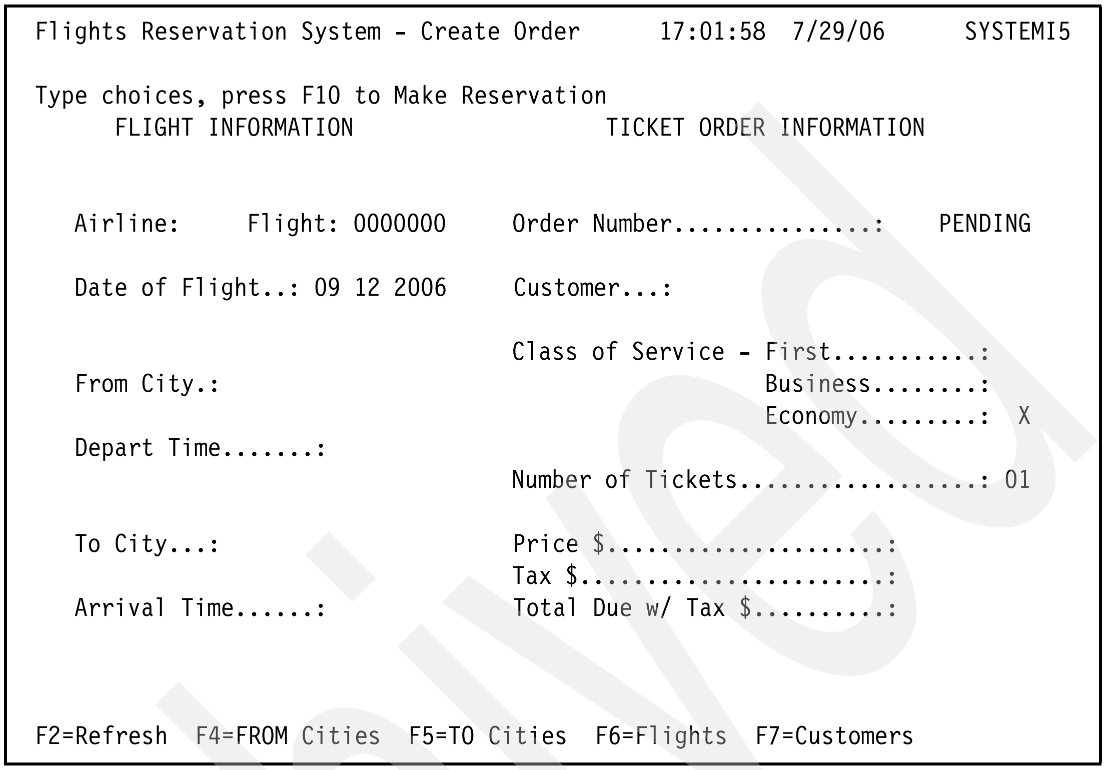
   a. Make sure that you are on Flight Reservation System main menu panel.

   b. Enter `1 - Create a new Reservation` on the Flight Reservation System main menu panel.

   c. You should see a logon panel. Enter `Alex` as agent name and `mercury` as the password. Press F10.

d. Enter the date of the flight (Figure 7-4) for example:

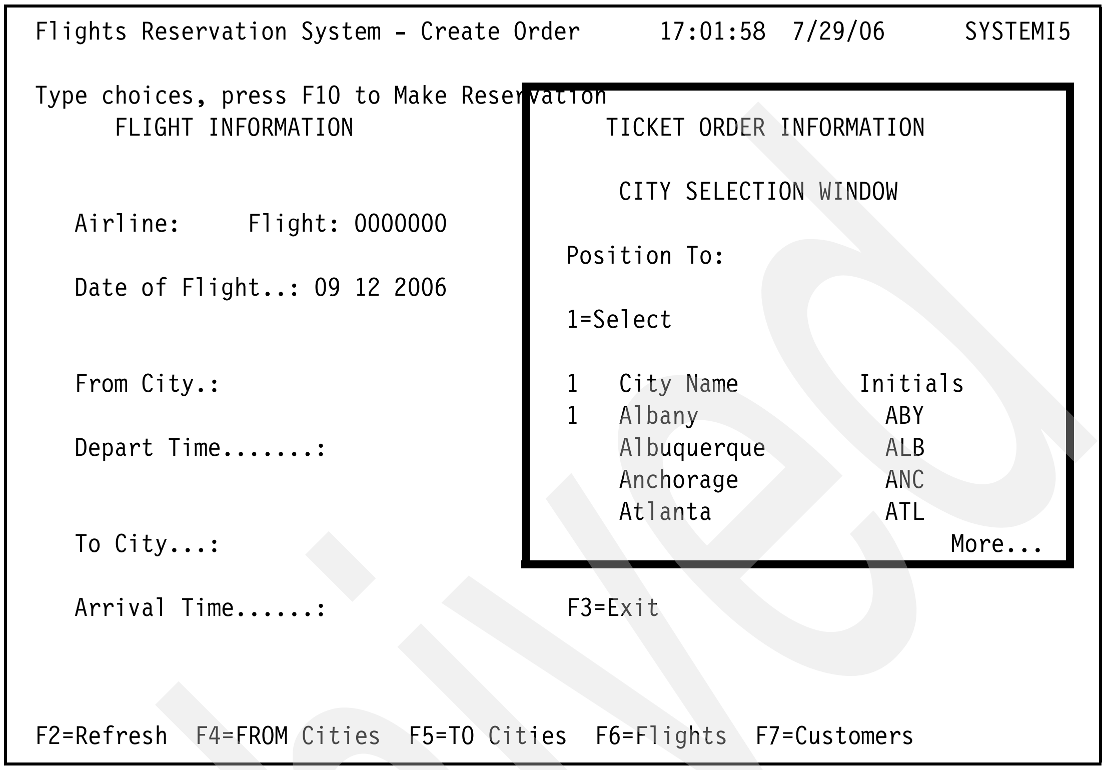
```
09 12 2006
```



```
Flights Reservation System - Create Order      17:01:58  7/29/06      SYSTEMI5

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                   TICKET ORDER INFORMATION


   Airline:     Flight: 0000000     Order Number...............:    PENDING

   Date of Flight..: 09 12 2006     Customer...:

                                    Class of Service - First...........:
   From City.:                                         Business........:
                                                       Economy.........:  X
   Depart Time.......:
                                    Number of Tickets..................: 01

   To City...:                      Price $....................:
                                    Tax $......................:
   Arrival Time......:              Total Due w/ Tax $..........:



F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-4 Create order: Date of flight

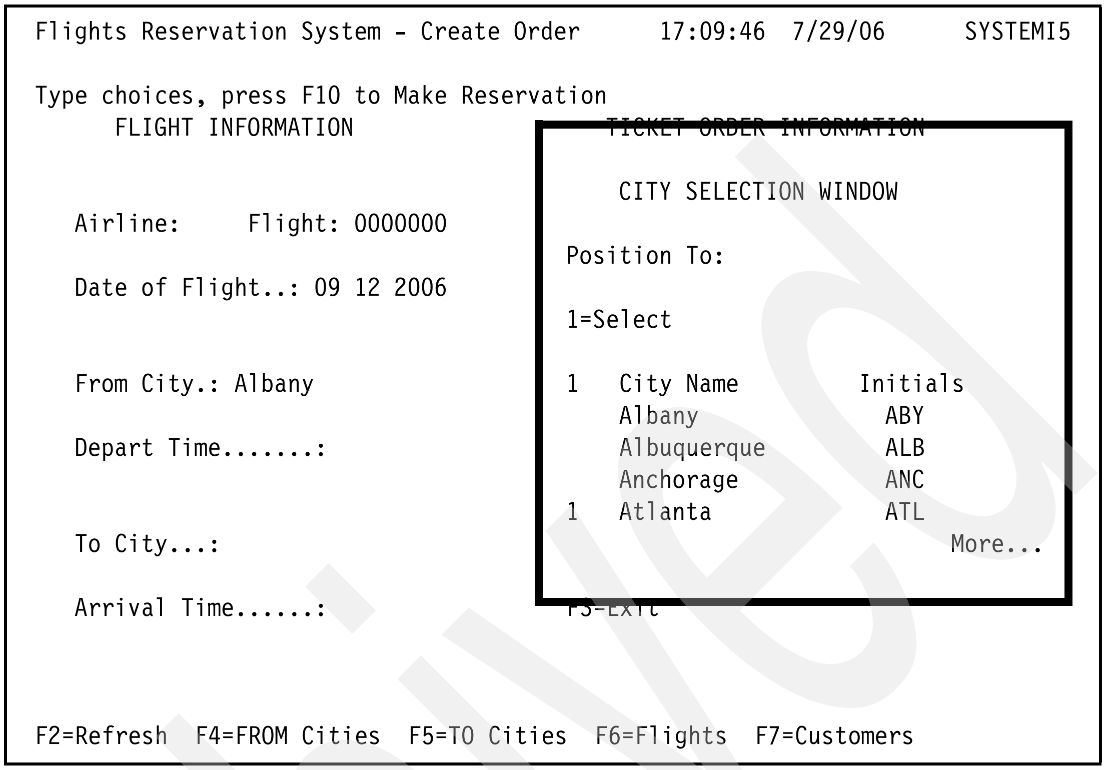
e. Press F4 to select From City. Enter 1 to select the city and press Enter (see Figure 7-5).



```
Flights Reservation System - Create Order      17:01:58  7/29/06      SYSTEMI5

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                    TICKET ORDER INFORMATION

                                             CITY SELECTION WINDOW
   Airline:     Flight: 0000000
                                         Position To:
   Date of Flight..: 09 12 2006
                                         1=Select

   From City.:                           1   City Name         Initials
                                         1   Albany              ABY
   Depart Time.......:                       Albuquerque         ALB
                                             Anchorage           ANC
                                             Atlanta             ATL
   To City...:                                                       More...

   Arrival Time......:                   F3=Exit



F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-5 Create order: From City selection

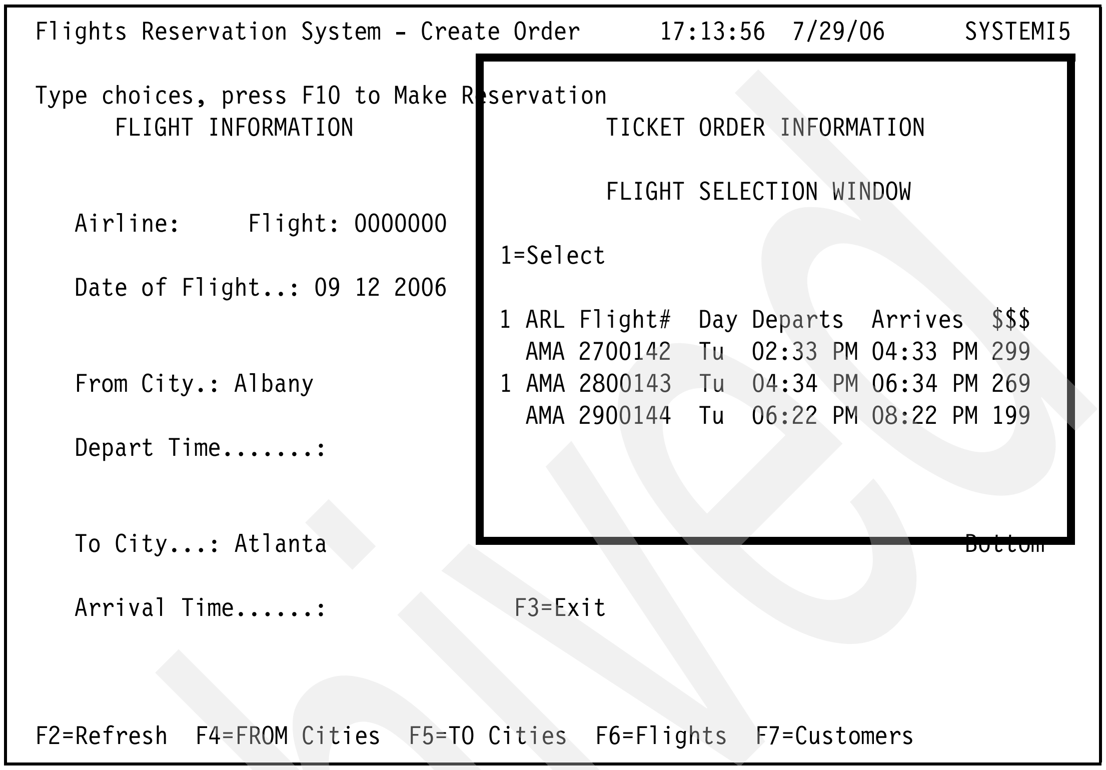
f. Press F5 to select To City. Enter 1 to select a city and press Enter (see Figure 7-6).



```
Flights Reservation System - Create Order      17:09:46  7/29/06      SYSTEMI5

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                  TICKET ORDER INFORMATION

                                              CITY SELECTION WINDOW
   Airline:     Flight: 0000000
                                          Position To:
   Date of Flight..: 09 12 2006
                                          1=Select

   From City.: Albany                     1   City Name          Initials
                                              Albany               ABY
   Depart Time.......:                        Albuquerque          ALB
                                              Anchorage            ANC
                                          1   Atlanta              ATL
   To City...:                                                          More...

   Arrival Time......:                    F3=Exit



F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-6 Create order: To City selection

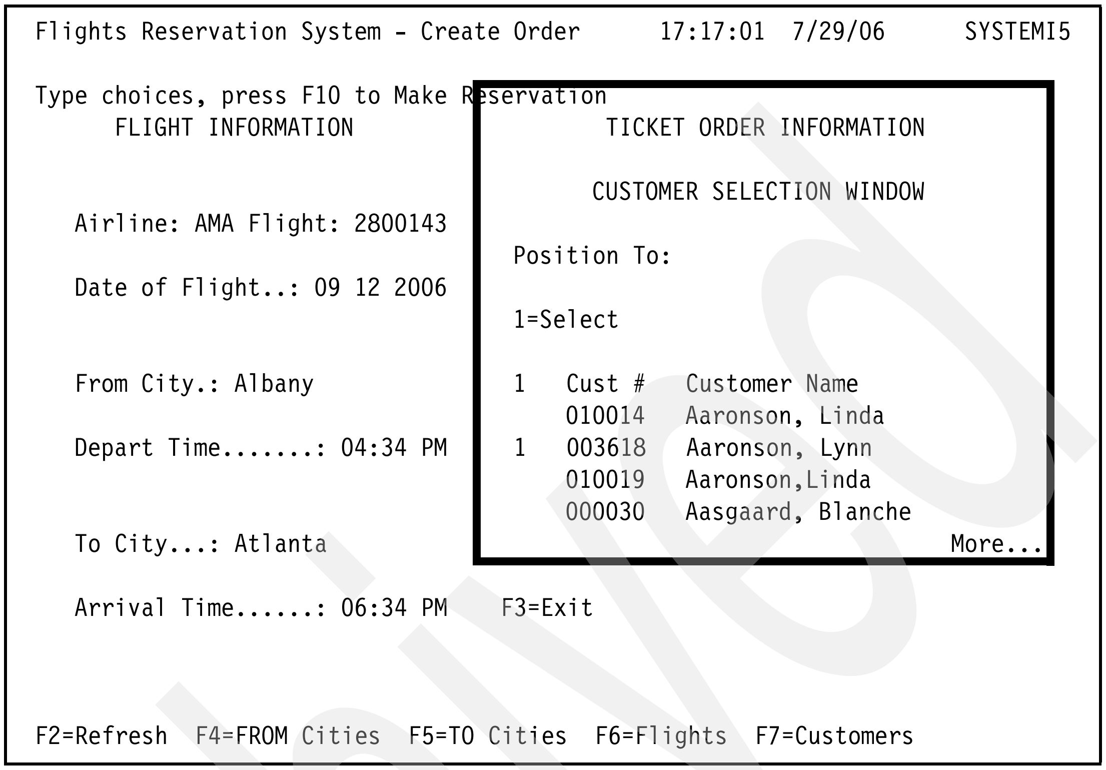
g. Press F6 to see all flights based on the date, from city, and to city that you entered earlier. Press Page Down to look at more flights. Enter 1 to select flight and press Enter (see Figure 7-7).



```
Flights Reservation System - Create Order      17:13:56  7/29/06      SYSTEMI5

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                    TICKET ORDER INFORMATION

                                            FLIGHT SELECTION WINDOW
   Airline:     Flight: 0000000
                                    1=Select
   Date of Flight..: 09 12 2006
                                    1 ARL Flight#  Day Departs  Arrives  $$$
                                      AMA 2700142  Tu  02:33 PM 04:33 PM 299
   From City.: Albany               1 AMA 2800143  Tu  04:34 PM 06:34 PM 269
                                      AMA 2900144  Tu  06:22 PM 08:22 PM 199
   Depart Time.......:


   To City...: Atlanta                                                Bottom

   Arrival Time......:            F3=Exit



F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-7 Create order: Flight selection

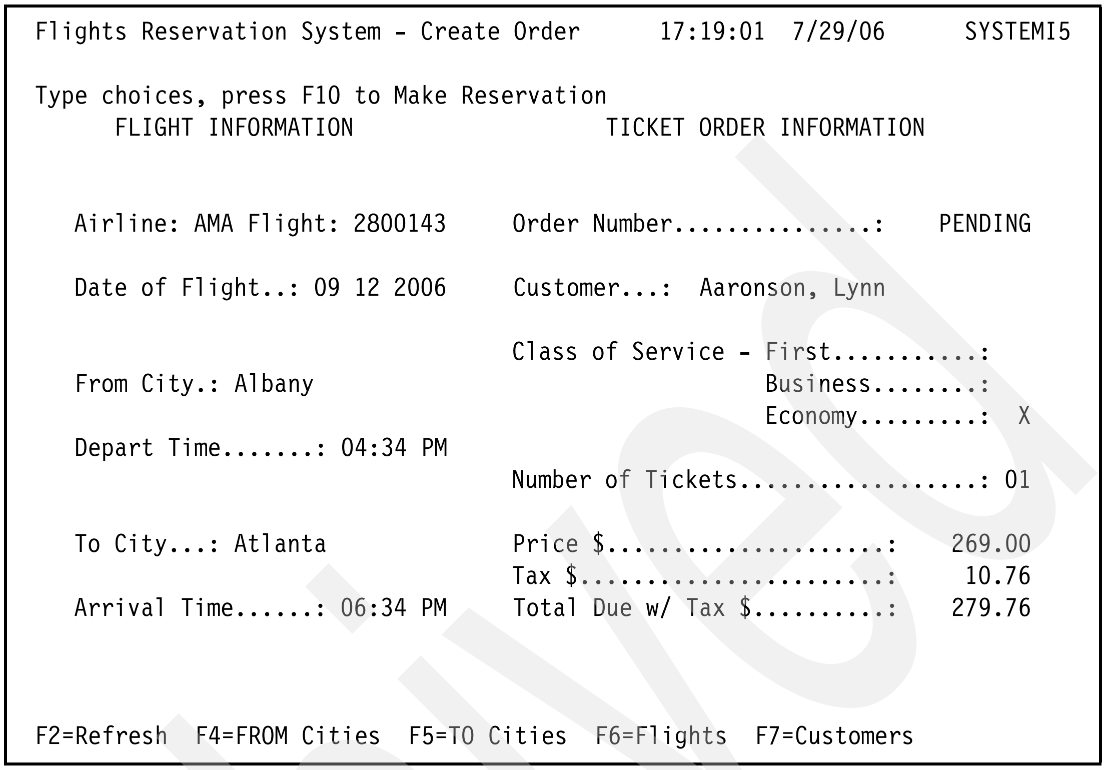
h. Press F7 to select Customer. Enter 1 to select a customer and press Enter (see Figure 7-8).



```
Flights Reservation System - Create Order      17:17:01  7/29/06      SYSTEMI5

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                        TICKET ORDER INFORMATION

                                               CUSTOMER SELECTION WINDOW
   Airline: AMA Flight: 2800143
                                          Position To:
   Date of Flight..: 09 12 2006
                                          1=Select

   From City.: Albany                     1   Cust #   Customer Name
                                              010014   Aaronson, Linda
   Depart Time.......: 04:34 PM           1   003618   Aaronson, Lynn
                                              010019   Aaronson,Linda
                                              000030   Aasgaard, Blanche
   To City...: Atlanta                                                 More...

   Arrival Time......: 06:34 PM    F3=Exit



F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-8 Create order: Customer selection

i. Enter class of service and the number of tickets (see Figure 7-9).

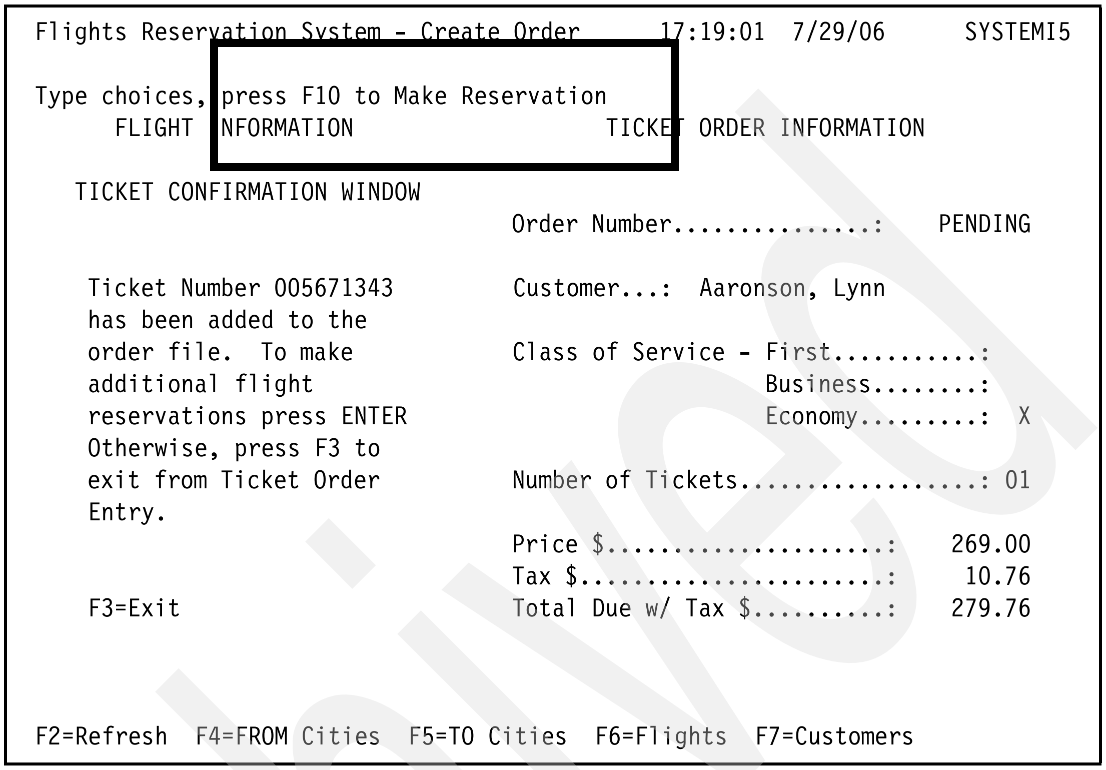


```
Flights Reservation System - Create Order      17:19:01  7/29/06      SYSTEMI5

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                    TICKET ORDER INFORMATION


   Airline: AMA Flight: 2800143     Order Number..............:    PENDING

   Date of Flight..: 09 12 2006     Customer...:  Aaronson, Lynn

                                    Class of Service - First..........:
   From City.: Albany                                  Business........:
                                                       Economy.........:  X
   Depart Time.......: 04:34 PM
                                    Number of Tickets.................: 01

   To City...: Atlanta              Price $...................:    269.00
                                    Tax $.....................:     10.76
   Arrival Time......: 06:34 PM     Total Due w/ Tax $.........:    279.76



F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-9 Create order: Class of service and number of tickets

j. Press F10 to Make Reservation (see Figure 7-10).

k. Press F3 to exit the transaction.



```
 Flights Reservation System - Create Order     17:19:01  7/29/06     SYSTEMI5

 Type choices, press F10 to Make Reservation
       FLIGHT  INFORMATION                   TICKET ORDER INFORMATION

    TICKET CONFIRMATION WINDOW
                                     Order Number...............:    PENDING

     Ticket Number 005671343         Customer...:  Aaronson, Lynn
     has been added to the
     order file.  To make            Class of Service - First...........:
     additional flight                                  Business........:
     reservations press ENTER                           Economy.........:  X
     Otherwise, press F3 to
     exit from Ticket Order          Number of Tickets..................: 01
     Entry.
                                     Price $....................:    269.00
                                     Tax $......................:     10.76
     F3=Exit                         Total Due w/ Tax $..........:   279.76



 F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers
```

Figure 7-10 Create order: Make reservation

Analyzing a transaction

We can divide the transaction that we describe in this section into two parts:

1. Flight selection

   Flight selection can be recorded as a macro which requires three input parameters:

   – Fligtht date
   – From city
   – To city

   These are input fields in the reservation transaction and allow you to add prompt action. Based on the three input parameters, the subfile displays for the flight selection. The rows in the subfile can be extracted as a table, because this part of application can be driven by macro and can be published as a Web service. We look at implementing this macro in detail in the Chapter 7.2, “Developing a HATS Web service” on page 126.

2. Complete Flight Reservation Transaction

   This transaction cannot be driven by a macro completely. As shown in this transaction, airline and flight numbers are not input fields, because they are display fields based on the flight subfile selection. Thus, display fields prompt action cannot be added. To enable prompt action, you must convert these fields to input fields, which requires some modifications to the existing flow of the transaction.

7.1.2 Naming conventions

When using HATS to create Web services, you need to follow these naming conventions:

- Macro names can begin with either an uppercase or a lowercase letter.
- Integration Object names become class names and must begin with an uppercase letter. Integration Object names are derived from macro names. So if the macro starts with a lowercase letter, then HATS converts the lowercase letter to uppercase when creating the Integration Object name.
- Macro prompt and extract names become method names and must begin with a lowercase letter.
- For any of the names mentioned here, a letter following an underscore (_)or a number must be in uppercase.

7.2 Developing a HATS Web service

You can use WebSphere Development Studio client for iSeries with HATS plug-in to develop a HATS Web service. This section explains how to create a HATS Web service based on a traditional RPG Applications.

Note: For installation requirements and instructions, see *IBM System i Application Modernization: Building a New Interface to Legacy Applications*, SG24-6671.

These are the steps to follow:

1. Create a HATS project
2. Record a HATS macros that will be used to:
   - Connect
   - Navigate through the host application
   - Extract data
   - Disconnect
3. Set Connection Properties
4. Create a HATS Integration Object
5. Create Web service support files
6. Create a Web service from the Integration Object.
7. Finally, test the Web service using the Web services Explorer

We will explain the steps in more detail in the following pages.

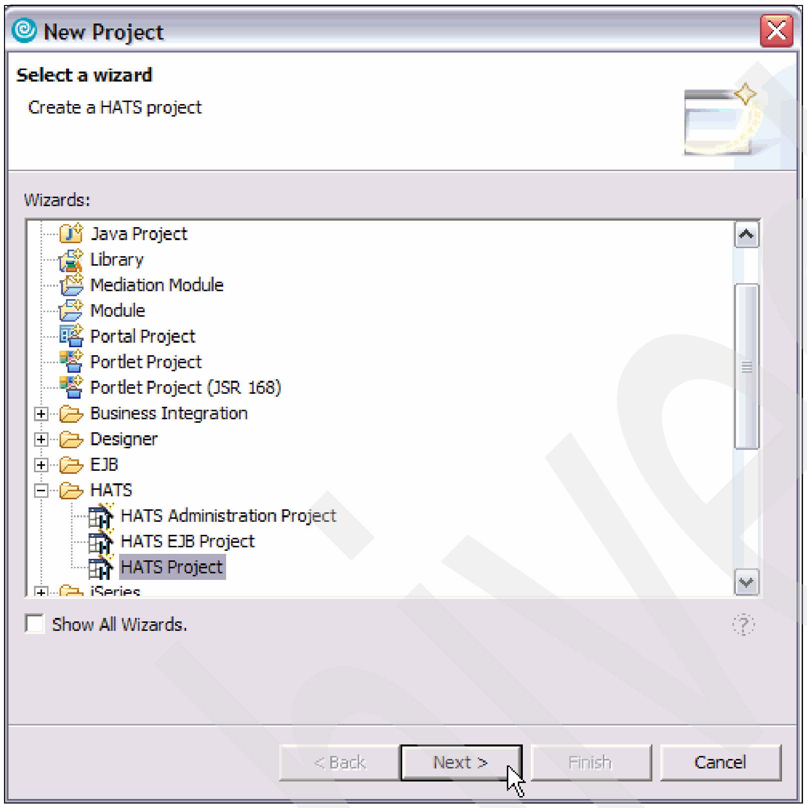
7.2.1 Creating a HATS project

The first step is to create a HATS project that includes all source code:

1. Open HATS Perspective.
   a. Click **Start** → **Programs** → **IBM WebSphere HATS 6.0** → **HATS Studio 6.0**.
   b. In the workspace launcher window, for workspace enter `c:\temp\redbook` and click **OK**.
   c. If you see a HATS Tip window, click **OK**.
   d. You should see HATS Perspective opened already. If you do not see it, select from the menu **Window** → **Open Perspective** → **Other** → **Host Access Transformation Services**.

2. Go through the New HATS project wizard:

   a. Launch the New HATS Project Wizard by clicking **File** → **New** → **Project**. Scroll down, expand **HATS** node, select **HATS Project** and click **Next** (Figure 7-11).


New Project

Select a wizard

Create a HATS project

Wizards:

- Java Project
- Library
- Mediation Module
- Module
- Portal Project
- Portlet Project
- Portlet Project (JSR 168)
- Business Integration
- Designer
- EJB
- HATS
  - HATS Administration Project
  - HATS EJB Project
  - HATS Project
- iSeries

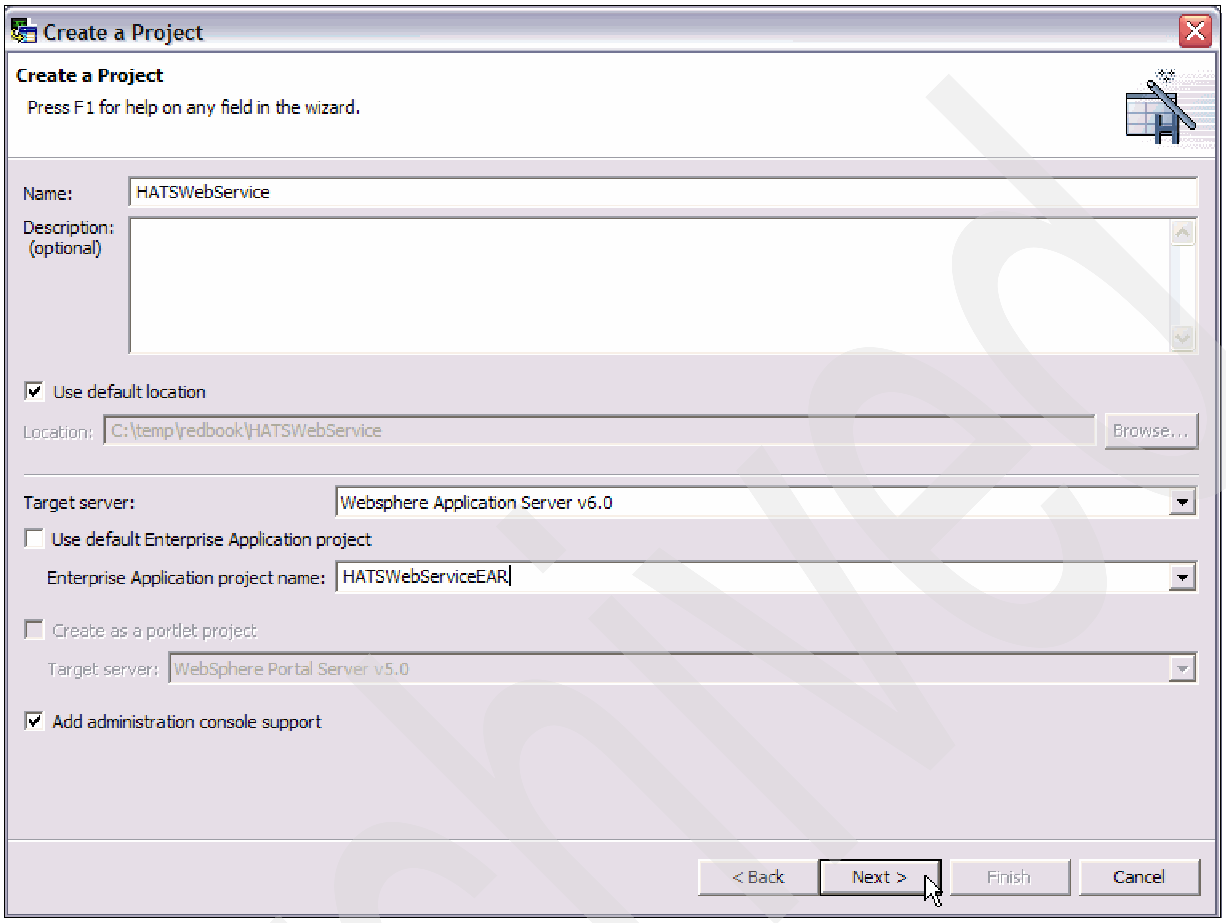
Show All Wizards.

Figure 7-11 New Project wizard

   b. In Create a Project window in the Name field, enter `HATSWebService`.

   c. In the Target server field, select **WebSphere Application Server v6.0**.

d. Deselect the **Use default Enterprise Application project** check box and enter `HATSWebServiceEAR` as the name of the Enterprise Application (EAR) project name and click **Next** (see Figure 7-12).


Create a Project

Create a Project

Press F1 for help on any field in the wizard.

Name: HATSWebService

Description: (optional)

[✓] Use default location

Location: C:\temp\redbook\HATSWebService

Target server: Websphere Application Server v6.0

[ ] Use default Enterprise Application project

Enterprise Application project name: HATSWebServiceEAR

[ ] Create as a portlet project

Target server: WebSphere Portal Server v5.0

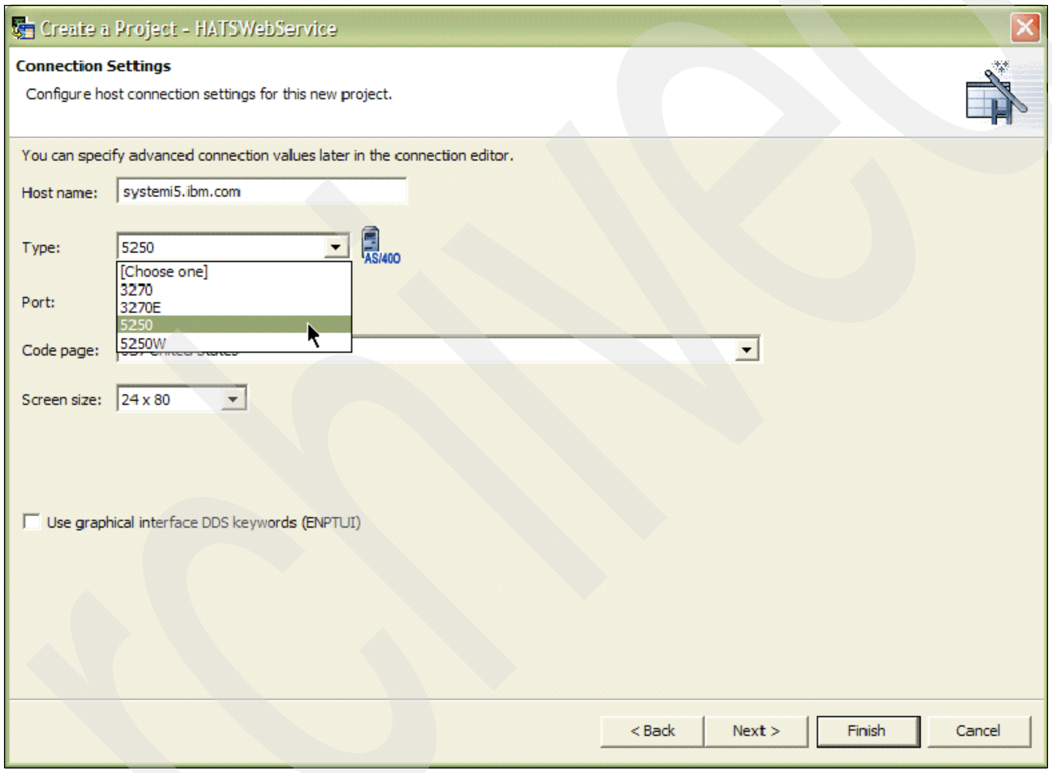
[✓] Add administration console support

Figure 7-12 Create a project: Project details

e. In the connection settings window, enter the host name or IP address of the System i5 that is running the Flight Reservation application. For example, in the Host name field, enter `systemi5.ibm.com`. Select **5250** in the Type field (see Figure 7-13). Then, click **Next**.

Note: Starting with HATS 6.0.4, the product is repackaged as *WebFacing Deployment Tool with HATS Technology* (WDHT). The new product has HATS features but no OLTP capacity requirement for System i platform running i5/OS V5R4. In HATS studio the new connection type is shown as *5250W*. To learn more about this product, see the following Web site:

`http://www-306.ibm.com/software/awdtools/wdht/about/faq.html`


Create a Project - HATSWebService

Connection Settings

Configure host connection settings for this new project.

You can specify advanced connection values later in the connection editor.

Host name: systemi5.ibm.com

Type: 5250

Port:

Code page:

Screen size: 24 x 80

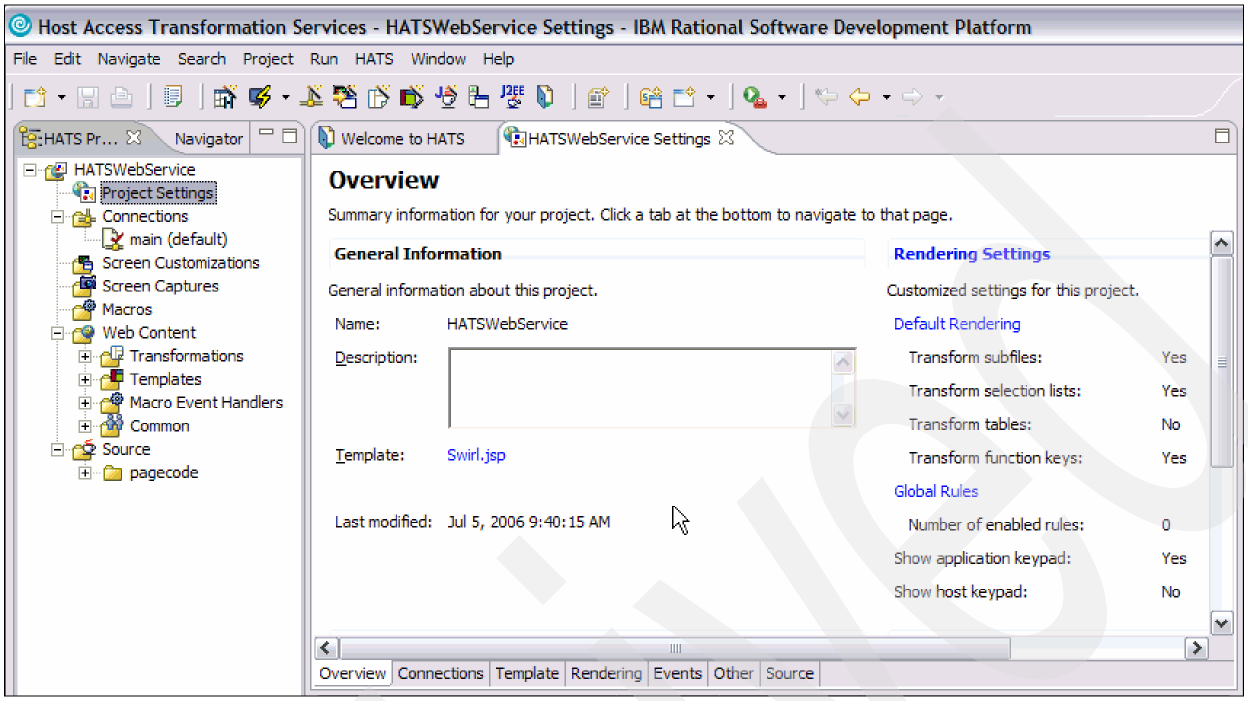
Use graphical interface DDS keywords (ENPTUI)

Figure 7-13 Create a project - Connection settings

f. Because you are not planning to use this HATS application to perform screen transformation, accept the default template and click **Finish**.

g. Click **OK** in the HATS Tip window.

The HATS Project view shows all HATS projects in the workspace. Notice it now includes the project we just created (see Figure 7-14 on page 130).


Host Access Transformation Services - HATSWebService Settings - IBM Rational Software Development Platform

Overview

Summary information for your project. Click a tab at the bottom to navigate to that page.

General Information

General information about this project.

Name:	HATSWebService
Description:	
Template:	Swirl.jsp
Last modified:	Jul 5, 2006 9:40:15 AM

Rendering Settings

Customized settings for this project.

Default Rendering

Transform subfiles:	Yes
Transform selection lists:	Yes
Transform tables:	No
Transform function keys:	Yes

Global Rules

Number of enabled rules:	0
Show application keypad:	Yes
Show host keypad:	No

Figure 7-14 Project settings

7.3 Recording macros

Next, you record a macro. A macro is a script that navigates through screens in an application. As you record the macro, you can identify which fields should be part of the input message of the eventual Web service and which fields should be part of the output message.

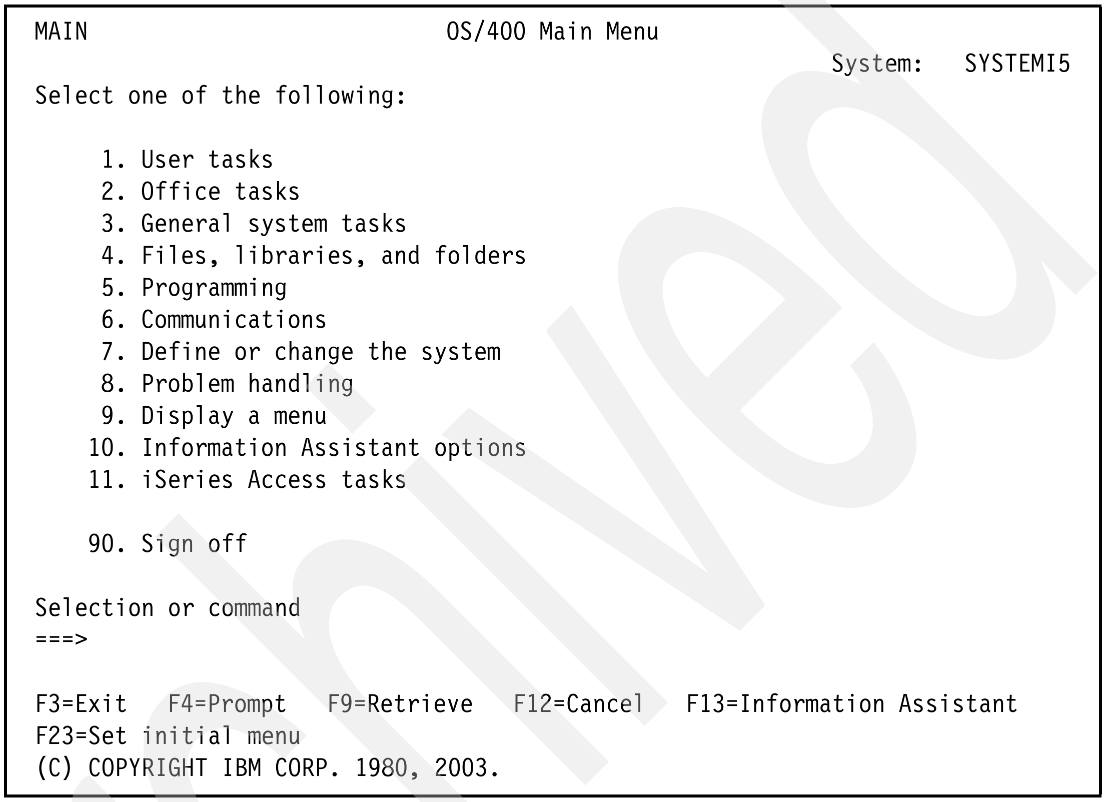
In general, it is recommended that you record three macros:

- A connect macro, which is responsible for logging onto the system and navigating to a start point
- A data macro, which performs the actual work of the transaction
- A disconnect macro which is responsible for signing off the system

Having separate macros allows for *connection pooling*. Pooling is a function in HATS that allows for a specified number of connections to be started and signed in. This specified number of connections allows for quicker transactions when a Web service request is made. Connection pooling is also more efficient because backend connections are reused, and socket connections are not being continually started to the backend system.

Recording a connect macro

Before recording your macro, use a terminal emulator, for example IBM Personal Communications (see Figure 7-15) or iSeries Access to sign on to the system using the same user profile as the one you intend to use with the macro. This forces the appearance of the Display Program Messages panel as you record your macro. Later in this section, we explain how to edit your macro to handle the case when the Display Program Messages panel does not appear.



```
MAIN                           OS/400 Main Menu
                                                            System:   SYSTEMI5
Select one of the following:

     1. User tasks
     2. Office tasks
     3. General system tasks
     4. Files, libraries, and folders
     5. Programming
     6. Communications
     7. Define or change the system
     8. Problem handling
     9. Display a menu
    10. Information Assistant options
    11. iSeries Access tasks

    90. Sign off

Selection or command
===>

F3=Exit   F4=Prompt   F9=Retrieve   F12=Cancel   F13=Information Assistant
F23=Set initial menu
(C) COPYRIGHT IBM CORP. 1980, 2003.
```

Figure 7-15 OS/400® Main Menu

Perform the following instructions to record the macro:

1. From the HATS Project view, right-click your project's folder and select **Open Host Terminal** → **main** (see Figure 7-16).

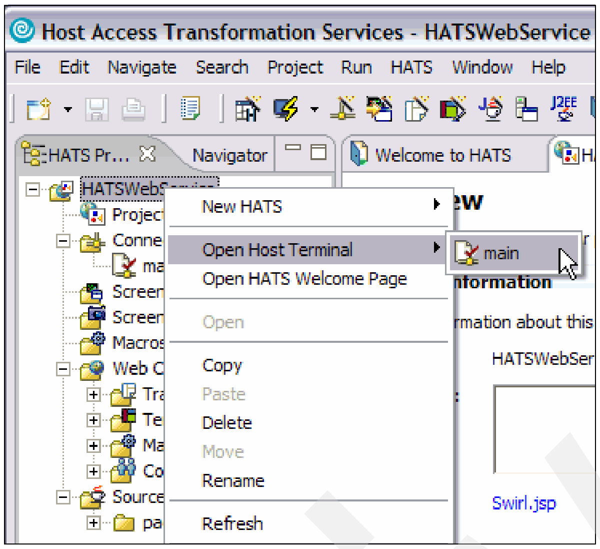
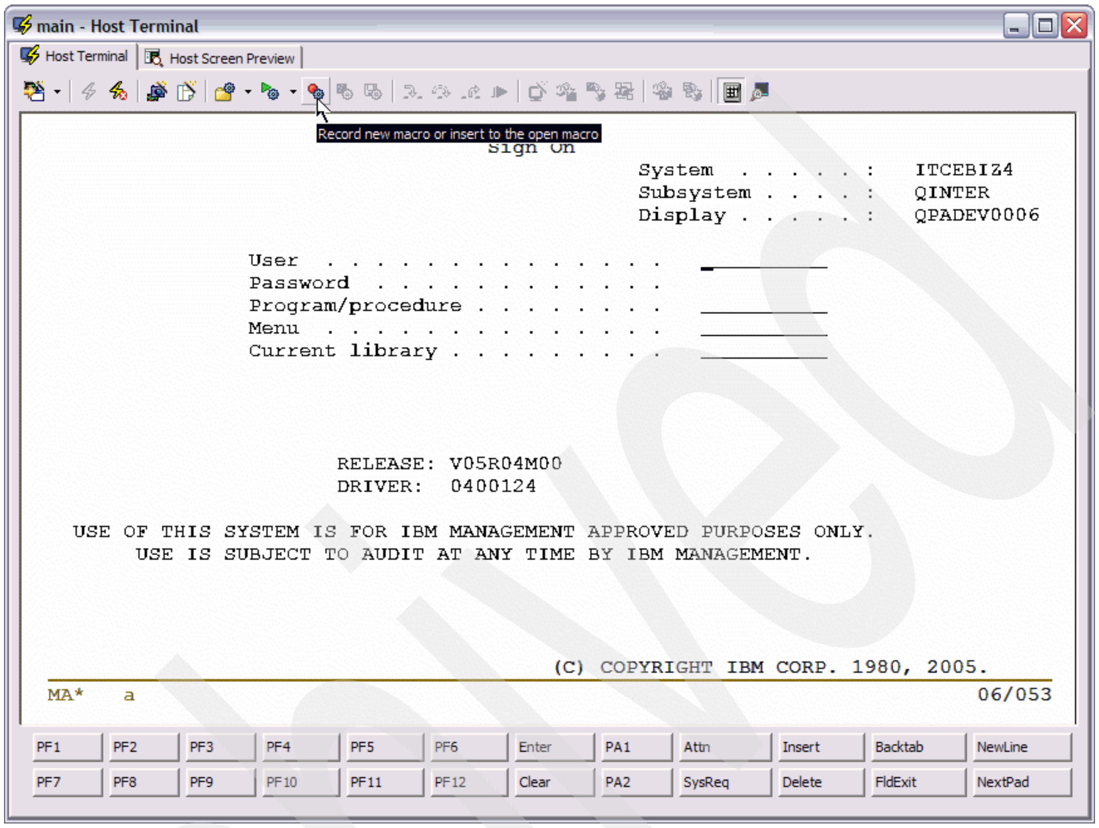


Figure 7-16 Open host terminal

2. You might see a HATS Tip window. To keep this window from opening, select **Do not show any tips** and click **OK**.

3. Here you see the Sign On window from the host system. From here you start recording the macro. To start recording your Connect macro, click the **Record Macro** button on the toolbar (see Figure 7-17).

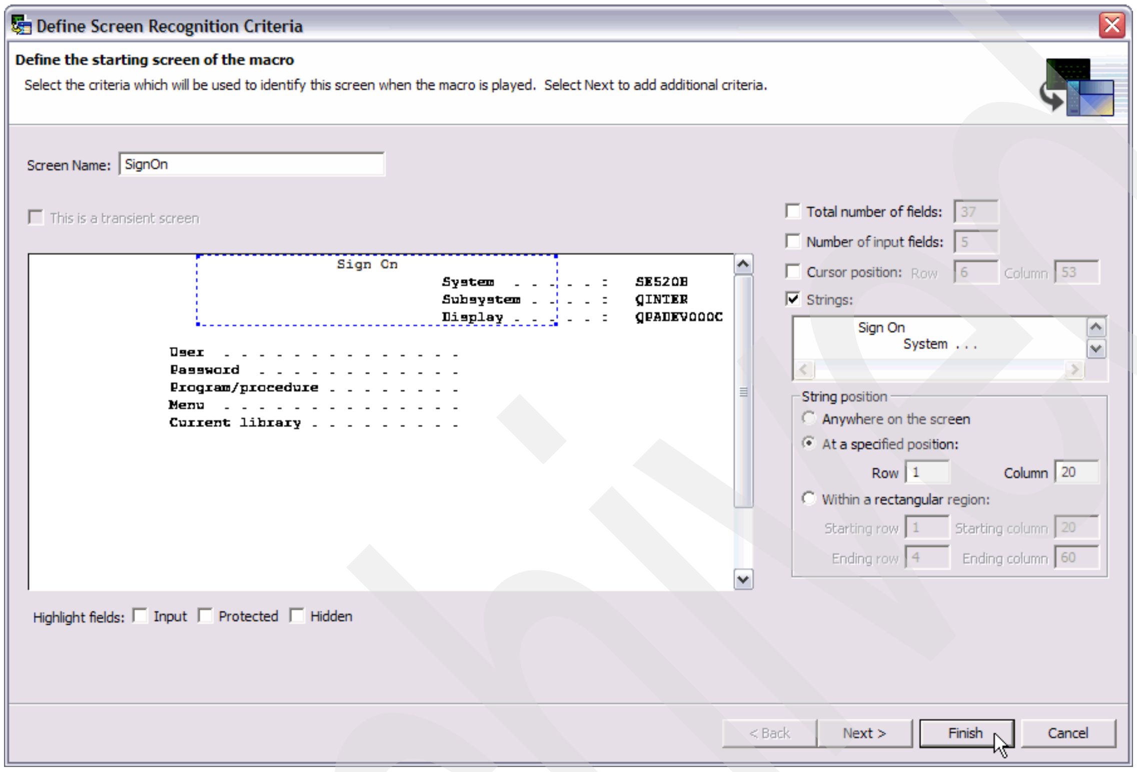


```
                                Sign On
                                             System . . . . . :   ITCEBIZ4
                                             Subsystem . . . . :   QINTER
                                             Display . . . . . :   QPADEV0006

                  User . . . . . . . . . . . . . .
                  Password . . . . . . . . . . . .
                  Program/procedure . . . . . . . .
                  Menu . . . . . . . . . . . . . .
                  Current library . . . . . . . .


                         RELEASE: V05R04M00
                         DRIVER:  0400124

    USE OF THIS SYSTEM IS FOR IBM MANAGEMENT APPROVED PURPOSES ONLY.
         USE IS SUBJECT TO AUDIT AT ANY TIME BY IBM MANAGEMENT.


                                            (C) COPYRIGHT IBM CORP. 1980, 2005.
  MA*    a                                                                06/053
```

Figure 7-17 Record macro

4. On the Record Macro panel enter `SignOn` as the name. Click **Finish**.

5. For the first panel in the macro, HATS prompts you to supply the criteria to use for recognizing the screen. On the Define the starting screen panel, enter `SignOn` for the screen name (see Figure 7-18).
6. Select the criteria within a rectangular region (notice HATS has already selected an area in the upper, middle part of the screen). You can change this area if necessary. Click **Finish**.


Define Screen Recognition Criteria

Define the starting screen of the macro

Select the criteria which will be used to identify this screen when the macro is played. Select Next to add additional criteria.

Screen Name: SignOn

☐ This is a transient screen

```
                    Sign On
                          System  . . . . . :   SE520B
                          Subsystem . . . . :   QINTER
                          Display . . . . . :   QPADEV000C

        User  . . . . . . . . . . . . . .
        Password  . . . . . . . . . . . .
        Program/procedure . . . . . . . .
        Menu  . . . . . . . . . . . . . .
        Current library . . . . . . . . .
```

☐ Total number of fields: 37
☐ Number of input fields: 5
☐ Cursor position: Row 6 Column 53
☑ Strings:

Sign On
System . . .

String position
- ○ Anywhere on the screen
- ● At a specified position: Row 1 Column 20
- ○ Within a rectangular region: Starting row 1 Starting column 20 Ending row 4 Ending column 60

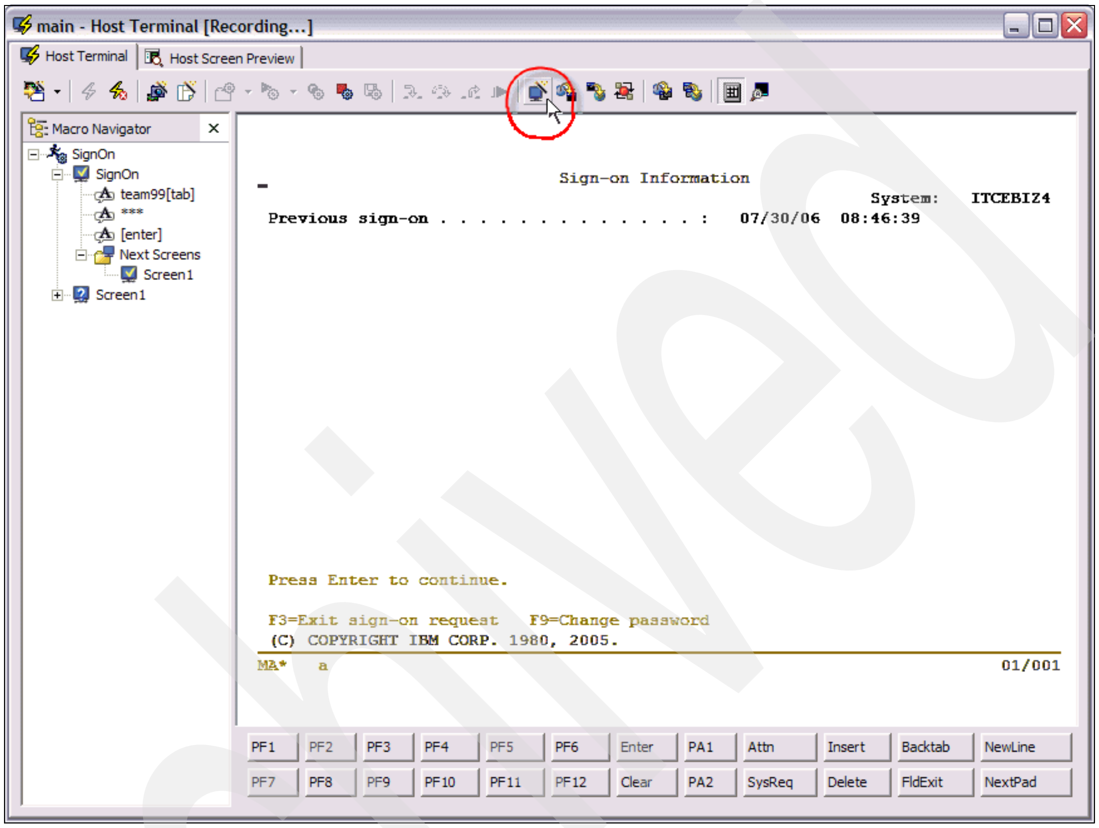
Highlight fields: ☐ Input ☐ Protected ☐ Hidden

Figure 7-18 Define screen recognition criteria

7. On the Sign On panel, enter your i5/OS user name and password and press Enter.

8. Next, you see the Previous sign on information window. This window displays if the system value `QDSPSGNINF` (sign-on display information control) is set to 1. If you do not see this window, skip to step 12 on page 136.

   From the toolbar of the host terminal window, click **Define screen Recognition Criteria** button (see Figure 7-19).



```
                             Sign-on Information
                                                          System:   ITCEBIZ4
 Previous sign-on . . . . . . . . . . . . . :   07/30/06  08:46:39












 Press Enter to continue.

 F3=Exit sign-on request   F9=Change password
 (C) COPYRIGHT IBM CORP. 1980, 2005.
MA*    a                                                             01/001
```

Figure 7-19 Screen Recognition Criteria

9. On the Select screen Recognition Criteria panel, enter `SignOnInformation`.

10. Notice this panel has a date and time on it. You should never include a date or time in a screen recognition if the date or time will change each time the screen is displayed. So, for this screen, drag your mouse around just the screen title, *Sign-on Information*, at the top. Select **At a specified position** and click **Finish** (see Figure 7-20).

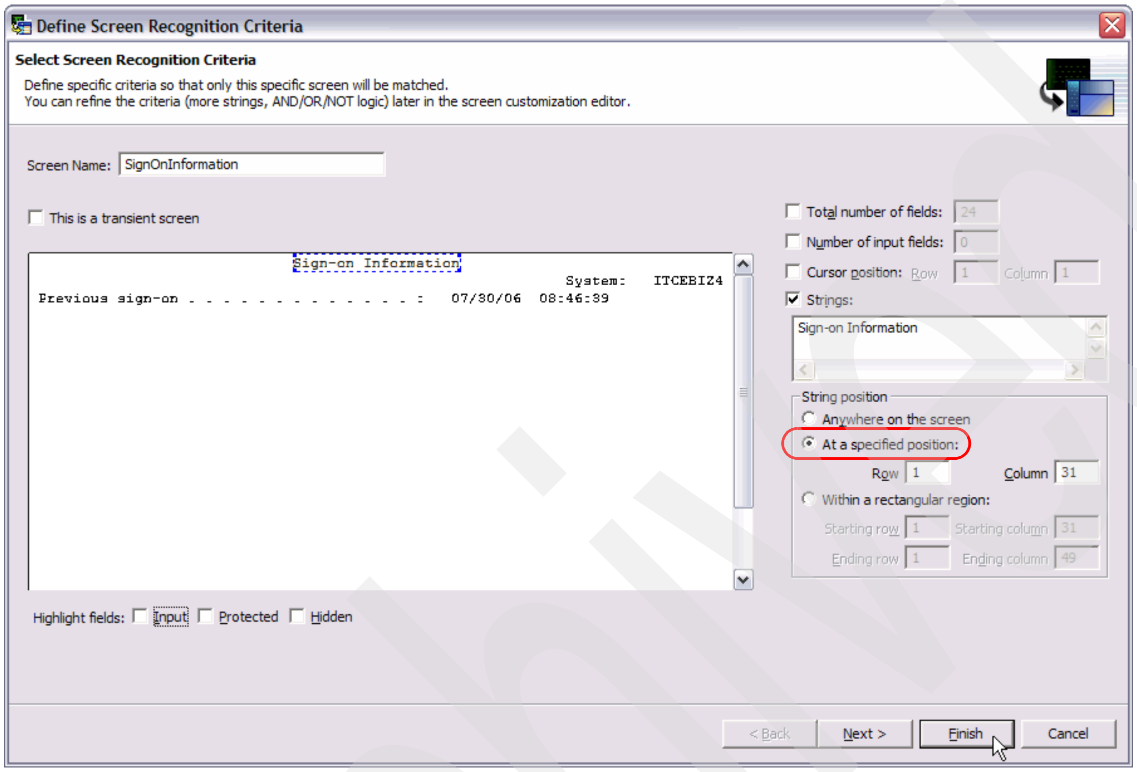

Define Screen Recognition Criteria
Select Screen Recognition Criteria
Define specific criteria so that only this specific screen will be matched.
You can refine the criteria (more strings, AND/OR/NOT logic) later in the screen customization editor.
Screen Name: SignOnInformation
This is a transient screen
Sign-on Information
System: ITCEBIZ4
Previous sign-on . . . . : 07/30/06 08:46:39
Total number of fields: 24
Number of input fields: 0
Cursor position: Row 1 Column 1
Strings:
Sign-on Information
String position
Anywhere on the screen
At a specified position:
Row 1 Column 31
Within a rectangular region:
Starting row 1 Starting column 31
Ending row 1 Ending column 49
Highlight fields: Input Protected Hidden
< Back
Next >
Finish
Cancel

Figure 7-20 Define Screen Recognition Criteria

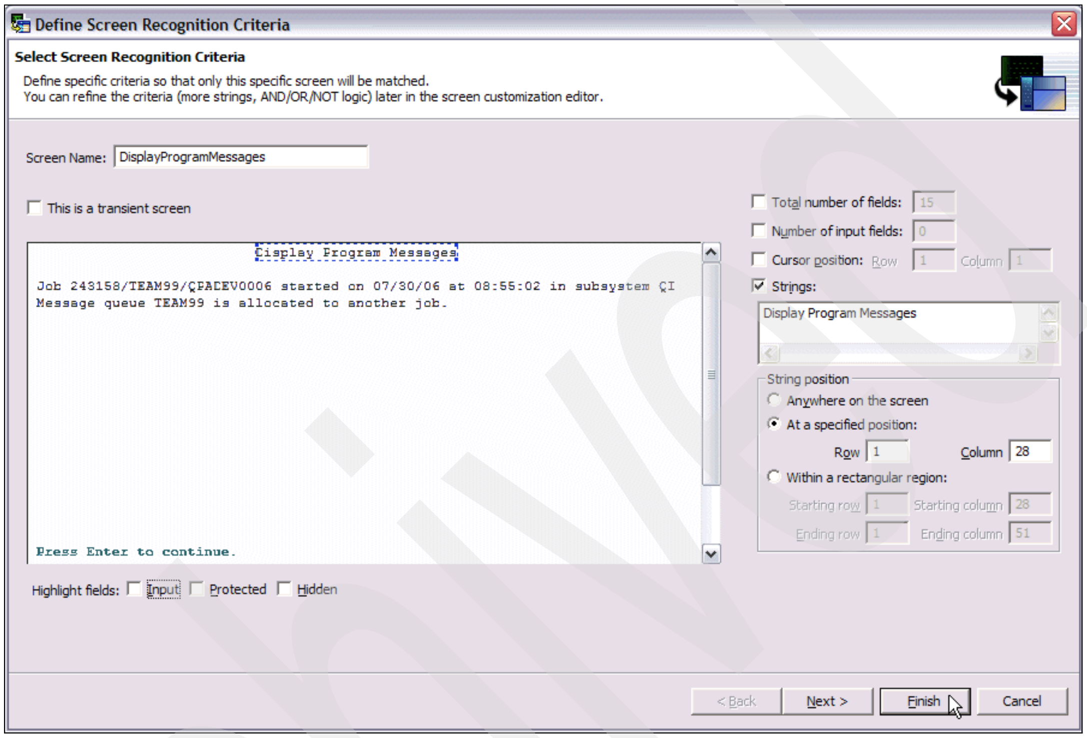
11. On the Sign-on Information panel, press Enter.

12. Next, you see the Display Program Messages window. This window displays if there is already a session started using the same user name. If you do not see this window, skip to step 17 on page 137.

13. From the toolbar of the host terminal window, click **Define screen Recognition Criteria**.

14. On the Select screen Recognition Criteria panel, enter `SignOnInformation`.

15. Notice that this screen has a date and time on it. You should never include a date or time in a screen recognition if the date or time will change each time the screen is displayed. So, for this screen, you can either resize the existing dotted box by grabbing its corner with your left mouse button (the mouse pointer should change to double arrow), or you can drag your mouse around just the screen title, *Display Program Messages*, at the top. Select **At a specified position** and click **Finish** (see Figure 7-21).



Define Screen Recognition Criteria

Select Screen Recognition Criteria

Define specific criteria so that only this specific screen will be matched.
You can refine the criteria (more strings, AND/OR/NOT logic) later in the screen customization editor.

Screen Name: DisplayProgramMessages

☐ This is a transient screen

```
                         Display Program Messages

Job 243158/TEAM99/QPADEV0006 started on 07/30/06 at 08:55:02 in subsystem QI
Message queue TEAM99 is allocated to another job.




Press Enter to continue.
```

Highlight fields: ☐ Input ☐ Protected ☐ Hidden

☐ Total number of fields: 15
☐ Number of input fields: 0
☐ Cursor position: Row 1 Column 1
☑ Strings:
Display Program Messages

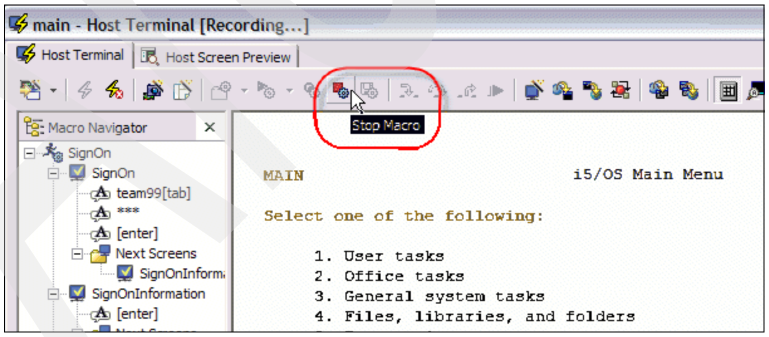
String position
○ Anywhere on the screen
● At a specified position:
Row 1 Column 28
○ Within a rectangular region:
Starting row 1 Starting column 28
Ending row 1 Ending column 51

< Back | Next > | Finish | Cancel

Figure 7-21 Define Screen Recognition Criteria

16. On the Display Program Messages panel, press Enter.

17. Next, you see the i5/OS Main Menu screen. Click **Stop Macro** to stop recording the macro (see Figure 7-22).



main - Host Terminal [Recording...]

Host Terminal | Host Screen Preview

Stop Macro

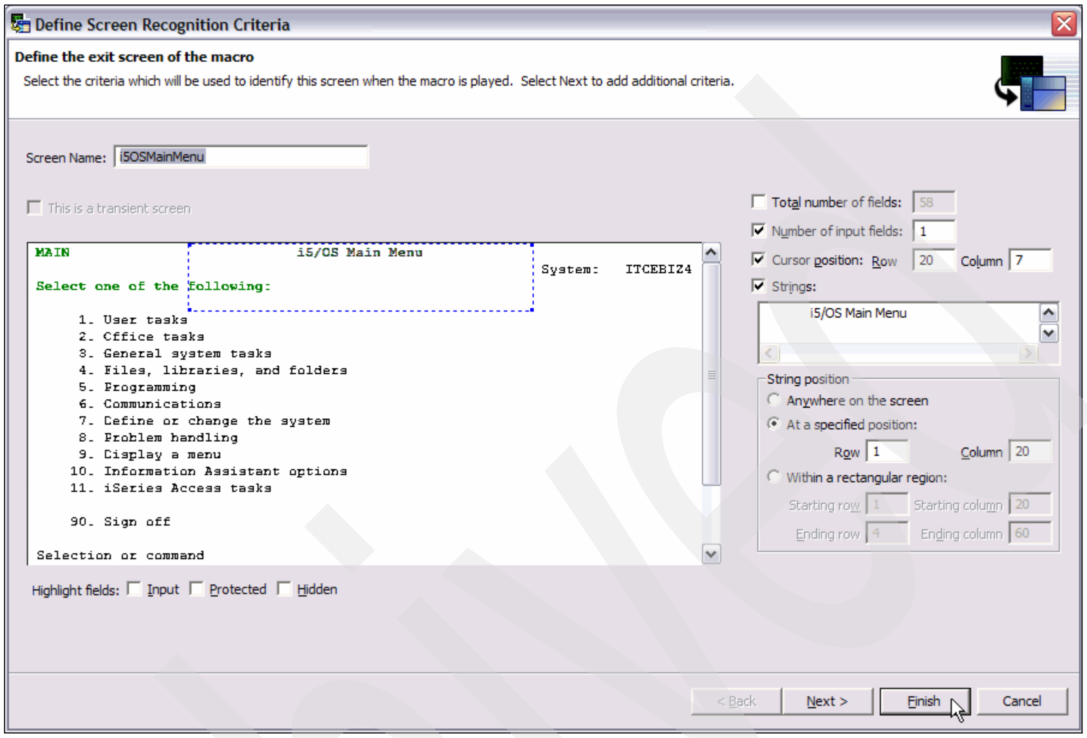
Macro Navigator
- SignOn
  - SignOn
    - team99[tab]
    - ***
    - [enter]
    - Next Screens
      - SignOnInform
  - SignOnInformation
    - [enter]

```
MAIN                                    i5/OS Main Menu

Select one of the following:

      1. User tasks
      2. Office tasks
      3. General system tasks
      4. Files, libraries, and folders
```

Figure 7-22 Stop recording

18. You see the Define the exit screen of the macro window. Enter `i5OSMainMenu`.

19.Select the criteria within a rectangular region (notice HATS has already selected an area in the upper middle part of the screen). You can change this area if necessary. Click **Finish** (see Figure 7-23).



Define Screen Recognition Criteria

Define the exit screen of the macro

Select the criteria which will be used to identify this screen when the macro is played. Select Next to add additional criteria.

Screen Name: i5OSMainMenu

☐ This is a transient screen

```
MAIN                              i5/OS Main Menu
                                                          System:   ITCEBIZ4
Select one of the following:

     1. User tasks
     2. Office tasks
     3. General system tasks
     4. Files, libraries, and folders
     5. Programming
     6. Communications
     7. Define or change the system
     8. Problem handling
     9. Display a menu
    10. Information Assistant options
    11. iSeries Access tasks

    90. Sign off

Selection or command
```

Highlight fields: ☐ Input ☐ Protected ☐ Hidden

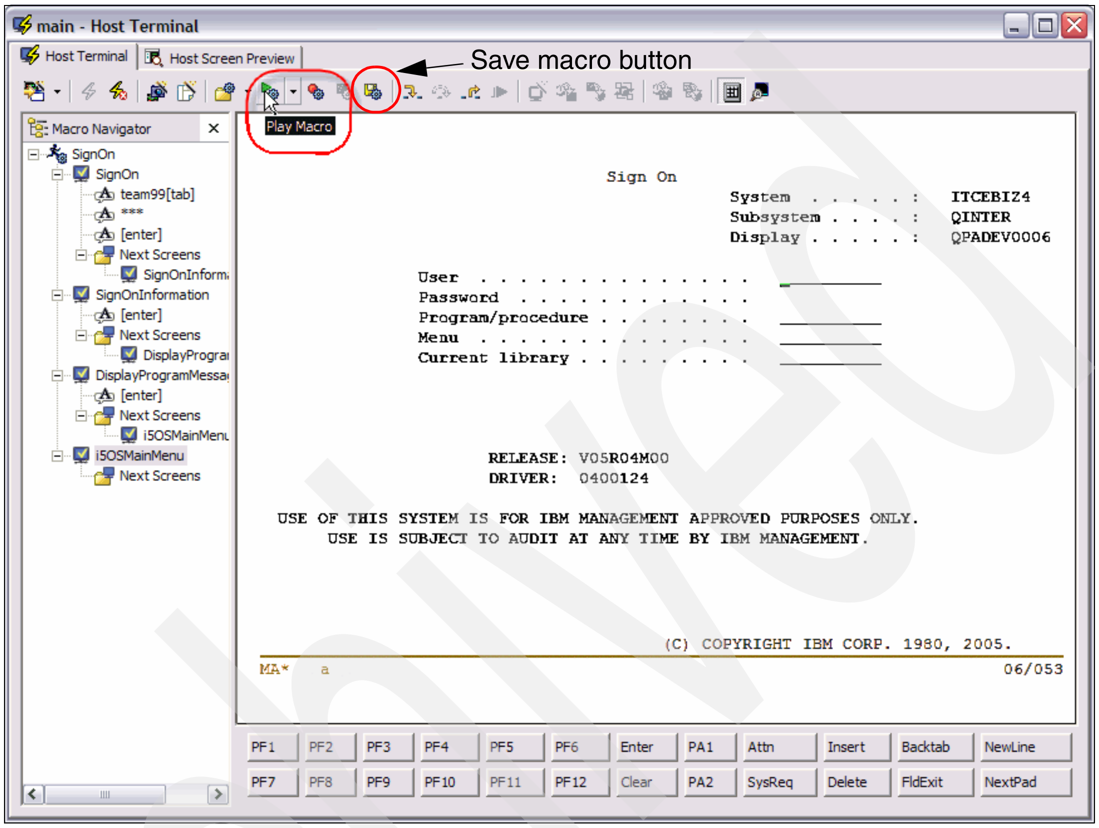
☐ Total number of fields: 58
☑ Number of input fields: 1
☑ Cursor position: Row 20 Column 7
☑ Strings:
i5/OS Main Menu

String position
○ Anywhere on the screen
● At a specified position:
Row 1 Column 20
○ Within a rectangular region:
Starting row 1 Starting column 20
Ending row 4 Ending column 60

Figure 7-23 Define exit window

20. Click the **Save macro** button to save the macro (see Figure 7-24).

21. Next you test the macro that you just recorded. First, you need to sign off by entering 90 in the host terminal window. Then, execute the macro by pressing the **Play macro** button (Figure 7-24).



```
                              Sign On
                                     System  . . . . . :   ITCEBIZ4
                                     Subsystem . . . . :   QINTER
                                     Display . . . . . :   QPADEV0006

          User  . . . . . . . . . . . . . .   __________
          Password  . . . . . . . . . . . .
          Program/procedure . . . . . . . .   __________
          Menu  . . . . . . . . . . . . . .   __________
          Current library . . . . . . . . .   __________



                 RELEASE: V05R04M00
                 DRIVER:  0400124

  USE OF THIS SYSTEM IS FOR IBM MANAGEMENT APPROVED PURPOSES ONLY.
       USE IS SUBJECT TO AUDIT AT ANY TIME BY IBM MANAGEMENT.



                                    (C) COPYRIGHT IBM CORP. 1980, 2005.
MA*    a                                                         06/053
```

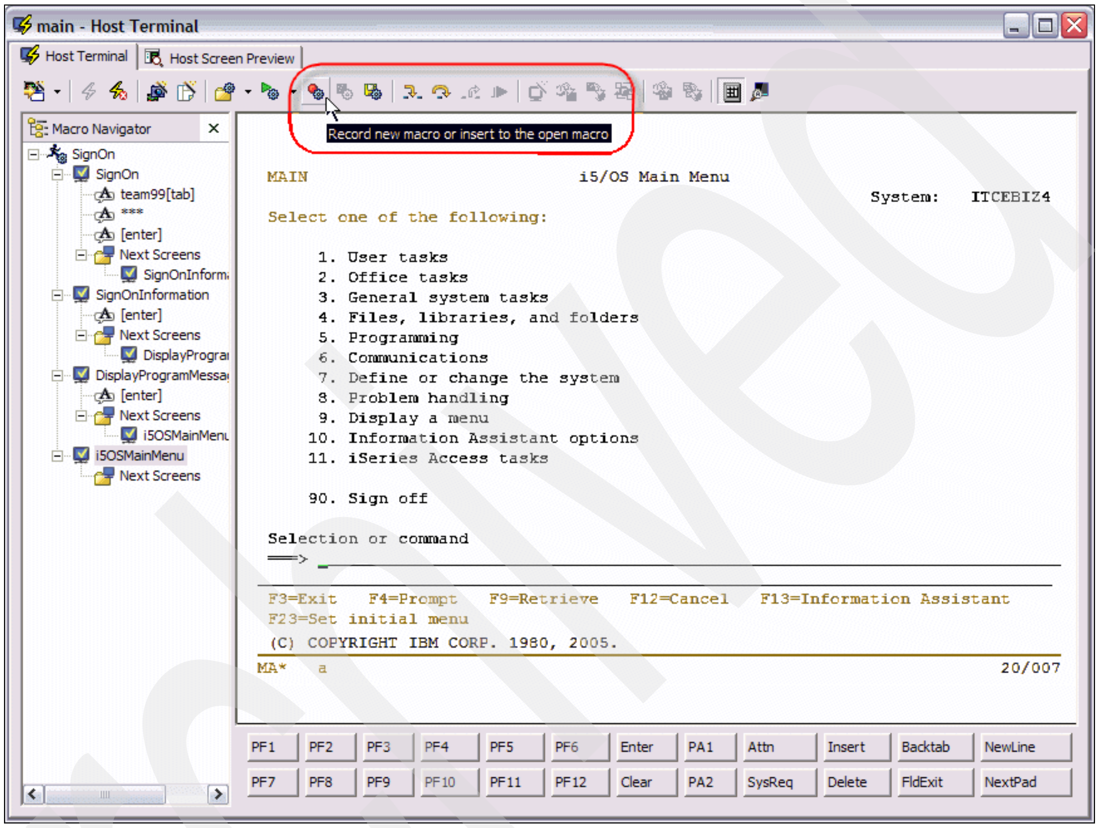
Figure 7-24   *Play macro*

You should see the macro is being executed, and finally you see the i5/OS Main Menu. You recorded the connect macro to connect to System i5. Next, you record a data macro.

Recording a data macro

In the data macro, you record the actual work of a transaction. This macro executes the application, defines the prompt actions for input fields, and defines the extract action for the output fields. To record a data macro, follow these steps:

1. Make sure that you are on i5/OS Main Menu in the host terminal window (see Figure 7-22).
2. To start recording your Data macro, click the **Record Macro** button on the toolbar.



```
MAIN                        i5/OS Main Menu
                                                    System:   ITCEBIZ4
Select one of the following:

     1. User tasks
     2. Office tasks
     3. General system tasks
     4. Files, libraries, and folders
     5. Programming
     6. Communications
     7. Define or change the system
     8. Problem handling
     9. Display a menu
    10. Information Assistant options
    11. iSeries Access tasks

    90. Sign off

Selection or command
===> _

F3=Exit   F4=Prompt   F9=Retrieve   F12=Cancel   F13=Information Assistant
F23=Set initial menu
(C) COPYRIGHT IBM CORP. 1980, 2005.
MA*    a                                                           20/007
```

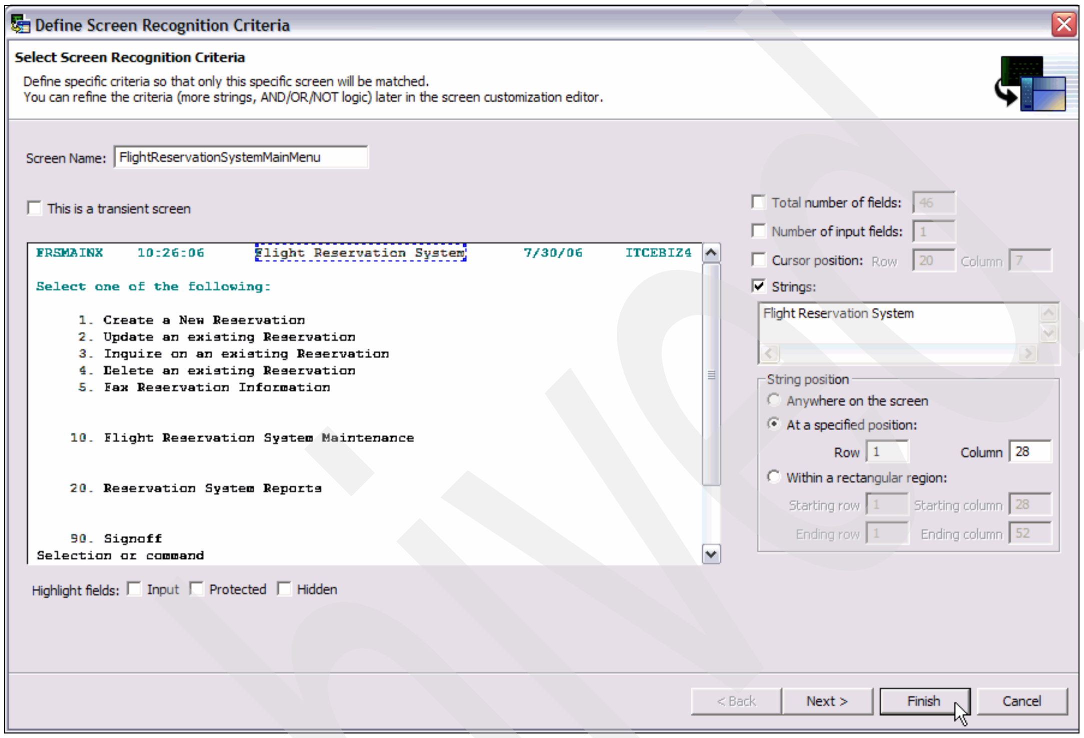
Figure 7-25 Record data macro

3. Select **New**.
4. On the Record Macro panel for Name enter `FlightSearchData`. Click **Finish**.
5. For the first screen in the macro, HATS prompts you to supply the criteria to use for recognizing the screen. On the Define the starting screen panel, enter `i5OSMainMenu` for the screen name.
6. Select the criteria within a rectangular region (notice that HATS has already selected an area in the upper, middle part of the screen). You can change this area if necessary. Click **Finish**.
7. On the i5/OS Main Menu Screen, enter following command:

   ```
   GO FLGHT400/FRSMAIN
   ```
8. Next, you see the Flight Reservation System main menu panel.
9. From the toolbar of the host terminal window, click the **Define screen Recognition Criteria** button.

10. On the Select screen Recognition Criteria panel, enter `FlightReservationSytemMainMenu` (see Figure 7-26).

11. Notice that this screen has no specific criteria selected. So for this screen, drag your mouse around just the screen title, *Flight Reservation System*, at the top. Select **At a specified position** and click **Finish**.


Define Screen Recognition Criteria
Select Screen Recognition Criteria
Define specific criteria so that only this specific screen will be matched.
You can refine the criteria (more strings, AND/OR/NOT logic) later in the screen customization editor.

Screen Name: FlightReservationSystemMainMenu

☐ This is a transient screen

```
FRSMAINX    10:26:06     Flight Reservation System      7/30/06     ITCEBIZ4

Select one of the following:

     1. Create a New Reservation
     2. Update an existing Reservation
     3. Inquire on an existing Reservation
     4. Delete an existing Reservation
     5. Fax Reservation Information


    10. Flight Reservation System Maintenance


    20. Reservation System Reports


    90. Signoff
Selection or command
```

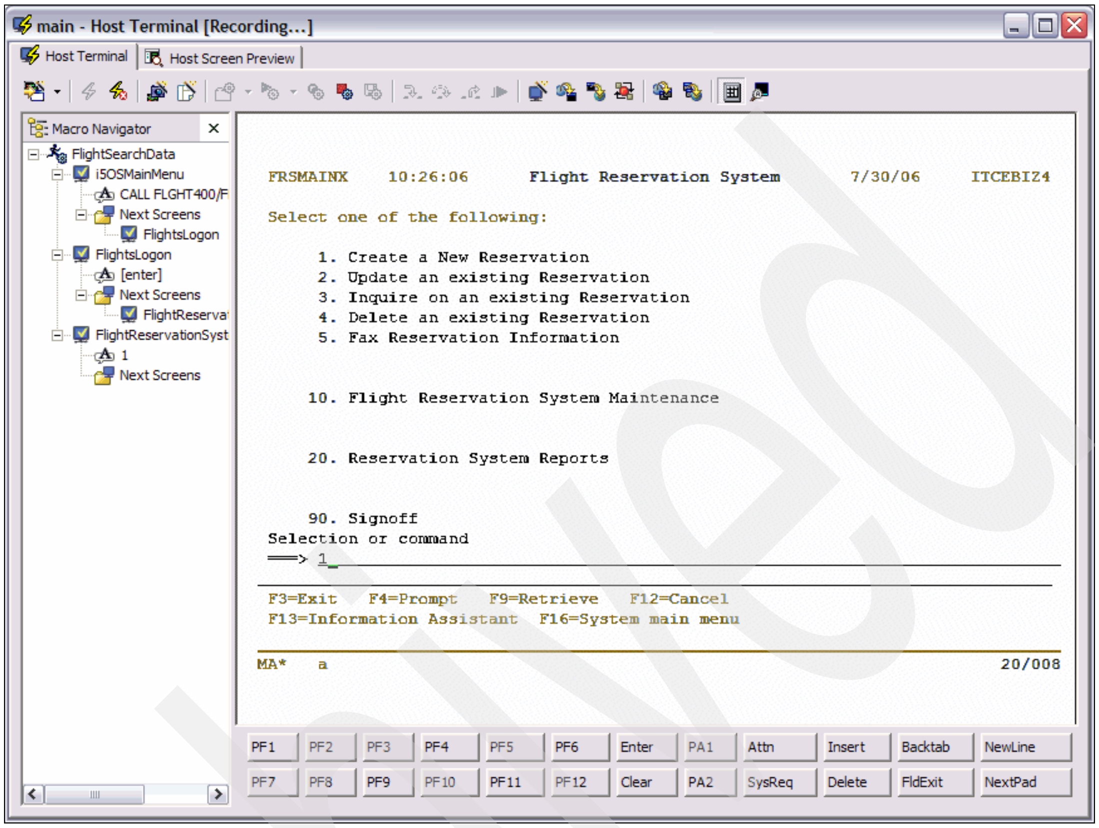
Highlight fields: ☐ Input ☐ Protected ☐ Hidden

☐ Total number of fields: 46
☐ Number of input fields: 1
☐ Cursor position: Row 20 Column 7
☑ Strings:
Flight Reservation System

String position
○ Anywhere on the screen
● At a specified position:
Row 1 Column 28
○ Within a rectangular region:
Starting row 1 Starting column 28
Ending row 1 Ending column 52

Figure 7-26 Flight Reservation System main menu screen recognition criteria

12. Type 1 on the command line to Create a new reservation and press Enter (see Figure 7-27).



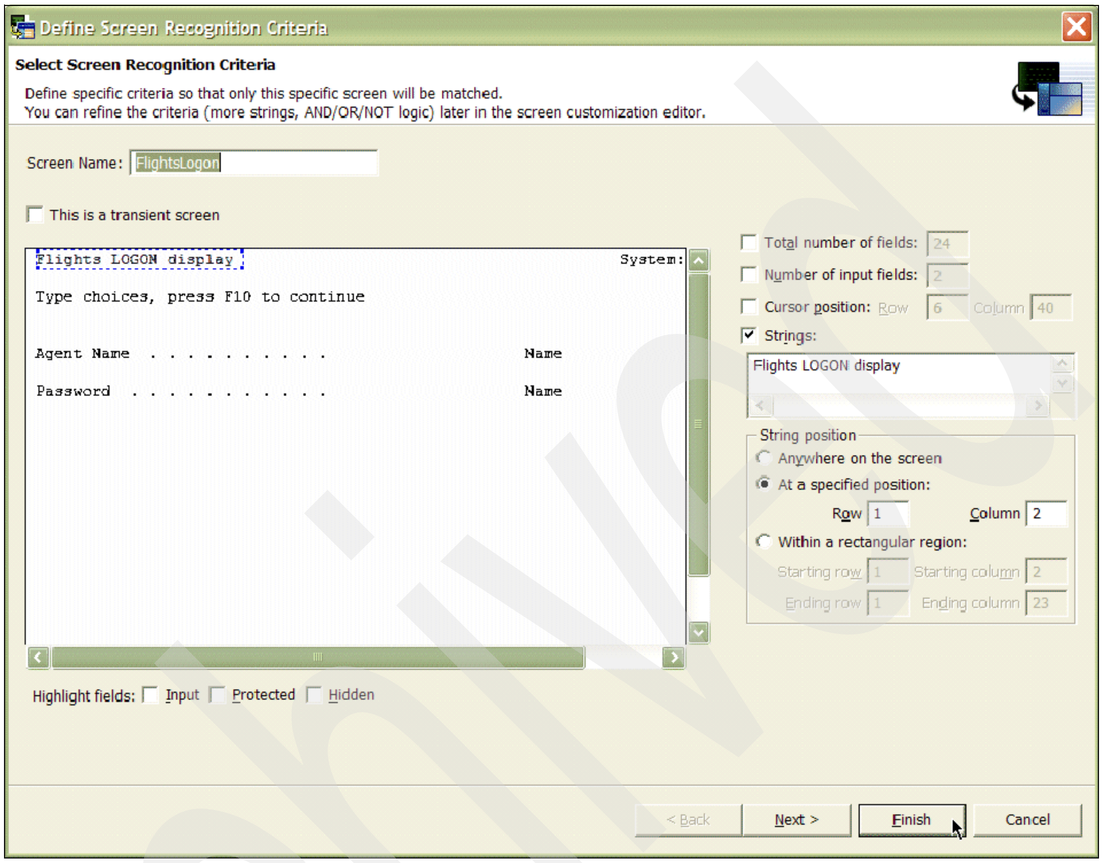
```
FRSMAINX    10:26:06       Flight Reservation System       7/30/06     ITCEBIZ4

Select one of the following:

     1. Create a New Reservation
     2. Update an existing Reservation
     3. Inquire on an existing Reservation
     4. Delete an existing Reservation
     5. Fax Reservation Information


    10. Flight Reservation System Maintenance


    20. Reservation System Reports


    90. Signoff
Selection or command
===> 1_

F3=Exit    F4=Prompt    F9=Retrieve    F12=Cancel
F13=Information Assistant  F16=System main menu

MA*    a                                                              20/008
```

Figure 7-27 Create a reservation

13. You see the Flights LOGON panel. From the toolbar of the host terminal window, click the **Define screen Recognition Criteria** button.

14. On the Select screen Recognition Criteria panel, enter `FlightsLogon` (see Figure 7-28).

15. Drag your mouse around just the screen title, *Flights LOGON display*, at the top. Select **At a specified position** and click **Finish**.



Define Screen Recognition Criteria
Select Screen Recognition Criteria
Back
Next >
Finish
Cancel

Define specific criteria so that only this specific screen will be matched.
You can refine the criteria (more strings, AND/OR/NOT logic) later in the screen customization editor.

Screen Name: FlightsLogon

[ ] This is a transient screen

```
Flights LOGON display                                              System:

Type choices, press F10 to continue


Agent Name  . . . . . . . . . .                            Name

Password  . . . . . . . . . . .                            Name
```

Highlight fields: [ ] Input [ ] Protected [ ] Hidden

[ ] Total number of fields: 24
[ ] Number of input fields: 2
[ ] Cursor position: Row 6 Column 40
[✓] Strings:
Flights LOGON display

String position
( ) Anywhere on the screen
(●) At a specified position:
Row 1 Column 2
( ) Within a rectangular region:
Starting row 1 Starting column 2
Ending row 1 Ending column 23

Figure 7-28 Flights LOGON panel recognition criteria

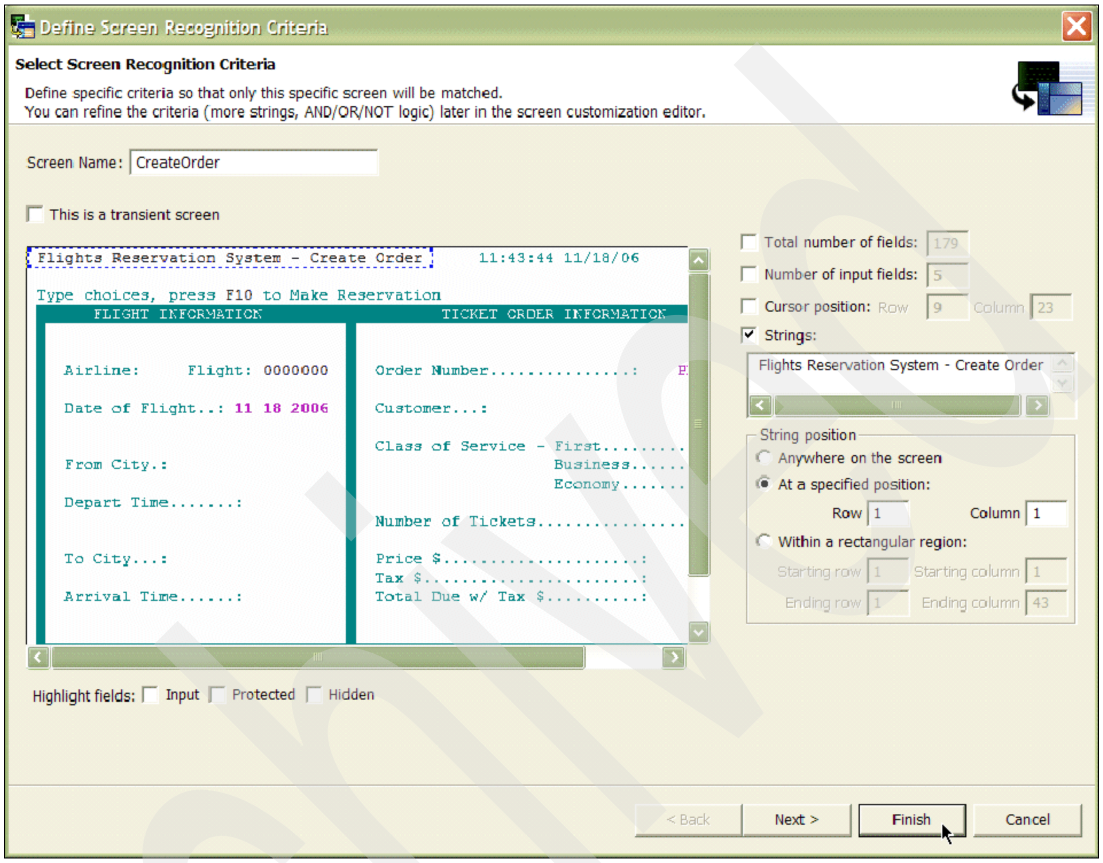
16. In the Flight LOGON dialog box:

   a. Enter `Alex` as Agent Name.

   b. Enter `mercury` as the Password.

   c. Press F10 to log on.

17. On the Flight Reservation System - Create Order panel, click the **Define Screen Recognition Criteria** button and enter `CreateOrder` as the screen name. Use your mouse to select the text **Flights Reservation System - Create Order**. Click **Finish** (see Figure 7-29).



Define Screen Recognition Criteria

Select Screen Recognition Criteria

Define specific criteria so that only this specific screen will be matched.
You can refine the criteria (more strings, AND/OR/NOT logic) later in the screen customization editor.

Screen Name: CreateOrder

☐ This is a transient screen

```
 Flights Reservation System - Create Order       11:43:44 11/18/06

 Type choices, press F10 to Make Reservation
        FLIGHT INFORMATION                   TICKET ORDER INFORMATION

    Airline:      Flight:  0000000       Order Number...............:

    Date of Flight..: 11  18  2006       Customer...:

                                         Class of Service - First........
    From City.:                                            Business......
                                                           Economy.......
    Depart Time.......:
                                         Number of Tickets...............

    To City...:                          Price $....................:
                                         Tax $.......................:
    Arrival Time......:                  Total Due w/ Tax $..........:
```

☐ Total number of fields: 179
☐ Number of input fields: 5
☐ Cursor position: Row 9 Column 23
☑ Strings:
Flights Reservation System - Create Order

String position
○ Anywhere on the screen
● At a specified position:
Row 1 Column 1
○ Within a rectangular region:
Starting row 1 Starting column 1
Ending row 1 Ending column 43

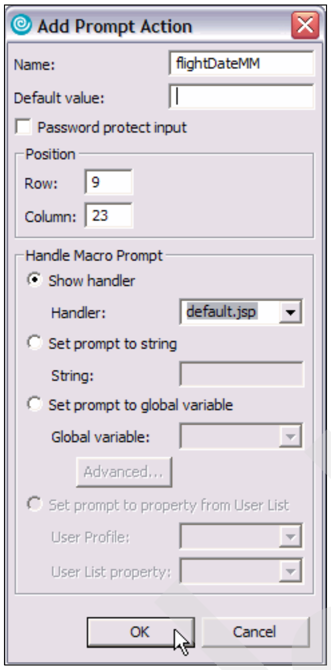
Highlight fields: ☐ Input ☐ Protected ☐ Hidden

Figure 7-29 Defining a recognition criteria for order window

18. Up to this point, all input into the macro has been supplied by the developer. You now tell HATS that the Date of flight, from city and to city, will be supplied when the macro is run. You do this by adding a macro prompt. To add a prompt, click the **Add Prompt Action** from the Host Terminal toolbar (see Figure 7-31 on page 146).

19. In the Add Prompt Action dialog box, enter `flightDateMM` as the prompt name (eventually, this parameter is the input into the Web service) and click **OK** (see Figure 7-30).

> **Note:** Make sure the prompt name starts with a *lowercase* letter.



Name: flightDateMM
Default value:
Row: 9
Column: 23
Handler: default.jsp

Figure 7-30 Define prompt action

20. HATS prompts you to supply a value for the flight month, which allows you to continue recording the macro. Enter `09` into the field and click **OK**. You notice that this value is inserted into the month field and that the cursor moves to the day field.

21. Click the **Add Prompt Action** button from the Host Terminal toolbar.

22. In the Add Prompt Action dialog box, enter `flightDateDD` as the prompt name (eventually, this parameter is the input into the Web service) and click **OK**.

> **Note:** Make sure the prompt name starts with a *lowercase* letter.

23. HATS prompts you to supply a value for the flight day, which allows you to continue recording the macro. Enter `12` into the field and click **OK**. You notice that this value is inserted into the day field and that the cursor moves to the year field.

24. Click the **Add Prompt Action** button from the Host Terminal toolbar.

25. In the Add Prompt Action dialog box, enter `flightDateYY` as the prompt name (eventually, this parameter is the input into the Web service) and click **OK**.

> **Note:** Make sure the prompt name starts with a *lowercase* letter.

26. HATS prompts you to supply a value for the flight year, which allows you to continue recording the macro. Enter `2007` into the field and click **OK**. You notice that this value is inserted into the year field and that the cursor moves to the next field.

27. Click the **Add Prompt Action** button from the Host Terminal toolbar.

28. In the Add Prompt Action dialog box, enter `fromCity` as the prompt name (eventually, this parameter is the input into the Web service) and click **OK**.

> **Note:** Make sure the prompt name starts with a *lowercase* letter.

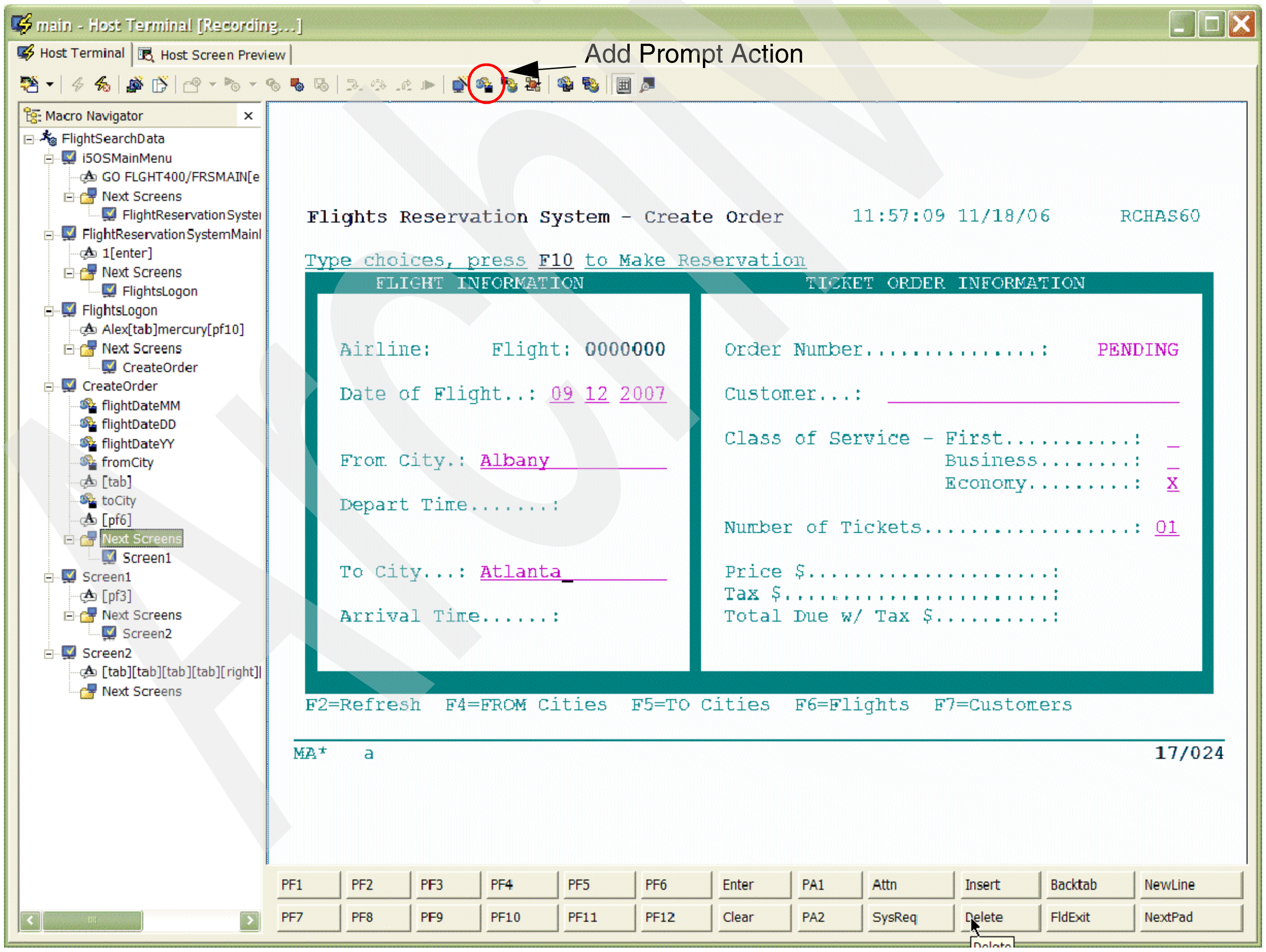
29. HATS prompts you to supply a city name, which allows you to continue recording the macro. Enter `Albany` into the field and click **OK**. You notice that this value is inserted into the From City field and that the cursor moves to the next field.

30. Click the **Add Prompt Action** button from the Host Terminal toolbar.

31. In the Add Prompt Action dialog box, enter `toCity` as the prompt name (eventually, this parameter is the input into the Web service) and click **OK**.

> **Note:** Make sure the prompt name starts with a *lowercase* letter.

32. HATS prompts you to supply a city name, which allows you to continue recording the macro. Enter `Atlanta` into the field and click **OK**. You notice that this value is inserted into the To City field (see Figure 7-31).


main - Host Terminal [Recording...]
Host Terminal
Host Screen Preview
Add Prompt Action
Macro Navigator
PF1 PF2 PF3 PF4 PF5 PF6 Enter PA1 Attn Insert Backtab NewLine
PF7 PF8 PF9 PF10 PF11 PF12 Clear PA2 SysReq Delete FldExit NextPad

```
FlightSearchData
  i5OSMainMenu
    GO FLGHT400/FRSMAIN[e
    Next Screens
      FlightReservationSyste
  FlightReservationSystemMainI
    1[enter]
    Next Screens
      FlightsLogon
  FlightsLogon
    Alex[tab]mercury[pf10]
    Next Screens
      CreateOrder
  CreateOrder
    flightDateMM
    flightDateDD
    flightDateYY
    fromCity
    [tab]
    toCity
    [pf6]
    Next Screens
      Screen1
  Screen1
    [pf3]
    Next Screens
      Screen2
  Screen2
    [tab][tab][tab][tab][right]
    Next Screens
```

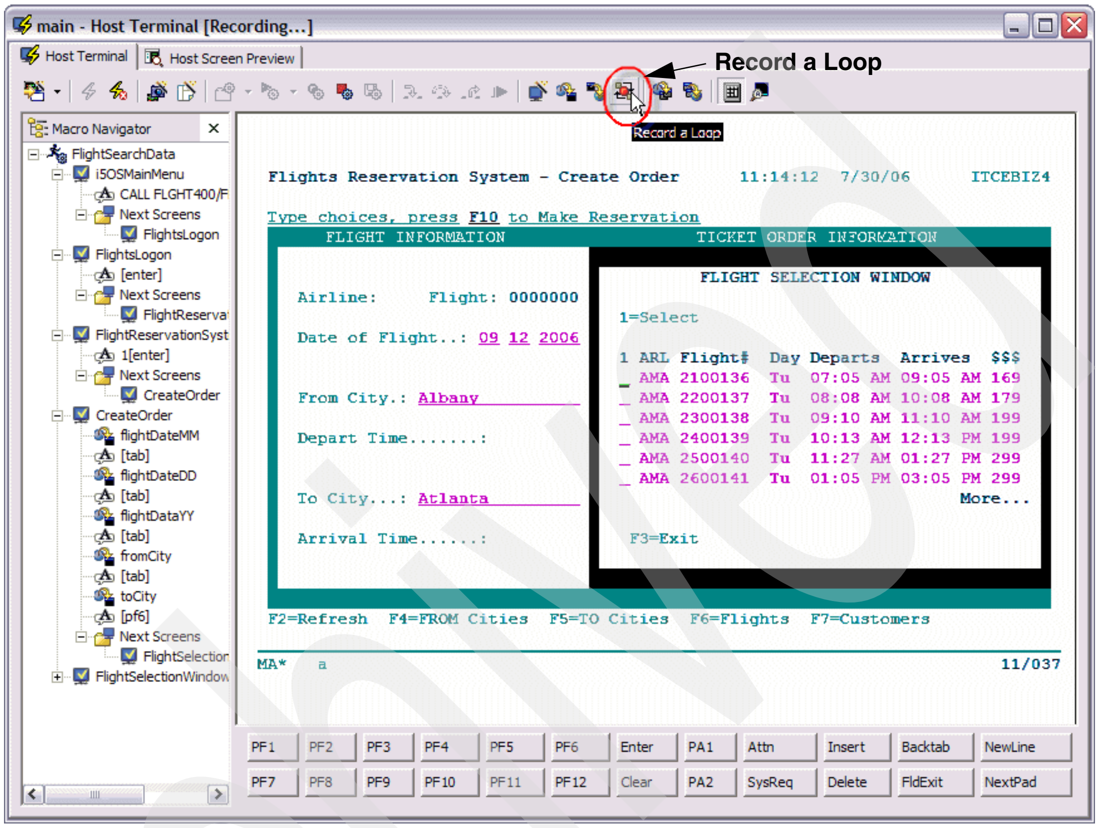
```
Flights Reservation System - Create Order     11:57:09 11/18/06     RCHAS60

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                       TICKET ORDER INFORMATION

  Airline:      Flight: 0000000        Order Number...............:    PENDING

  Date of Flight..: 09 12 2007         Customer...:  ________________________

                                       Class of Service - First...........: _
  From City.: Albany_______                              Business.........: _
                                                         Economy..........: X
  Depart Time.......:
                                       Number of Tickets..................: 01

  To City...: Atlanta_______           Price $.....................:
                                       Tax $.......................:
  Arrival Time......:                  Total Due w/ Tax $..........:

F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers

MA*   a                                                            17/024
```

Figure 7-31 Flight Search

33. In Flights Reservation System - Create Order Screen, press **F6** to display flights.

34. On the Flight Reservation System - Flight Selection window panel, click the **Define Screen Recognition Criteria** button and enter `FlightSelectionWindow` as the screen name. Use your mouse to select the text *FLIGHT SELECTION WINDOW*. Click **Finish**.

35. On the toolbar click the **Record a loop** button (see Figure 7-32).



```
Flights Reservation System - Create Order      11:14:12  7/30/06       ITCEBIZ4

Type choices, press F10 to Make Reservation
     FLIGHT INFORMATION                          TICKET ORDER INFORMATION

                                              FLIGHT SELECTION WINDOW
  Airline:      Flight: 0000000
                                         1=Select
  Date of Flight..: 09 12 2006
                                         1 ARL Flight#  Day Departs  Arrives   $$$
                                         _ AMA 2100136  Tu  07:05 AM 09:05 AM 169
  From City.: Albany                     _ AMA 2200137  Tu  08:08 AM 10:08 AM 179
                                         _ AMA 2300138  Tu  09:10 AM 11:10 AM 199
  Depart Time.......:                    _ AMA 2400139  Tu  10:13 AM 12:13 PM 199
                                         _ AMA 2500140  Tu  11:27 AM 01:27 PM 299
                                         _ AMA 2600141  Tu  01:05 PM 03:05 PM 299
  To City...: Atlanta                                                    More...

  Arrival Time......:                      F3=Exit

F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers

MA*   a                                                                 11/037
```

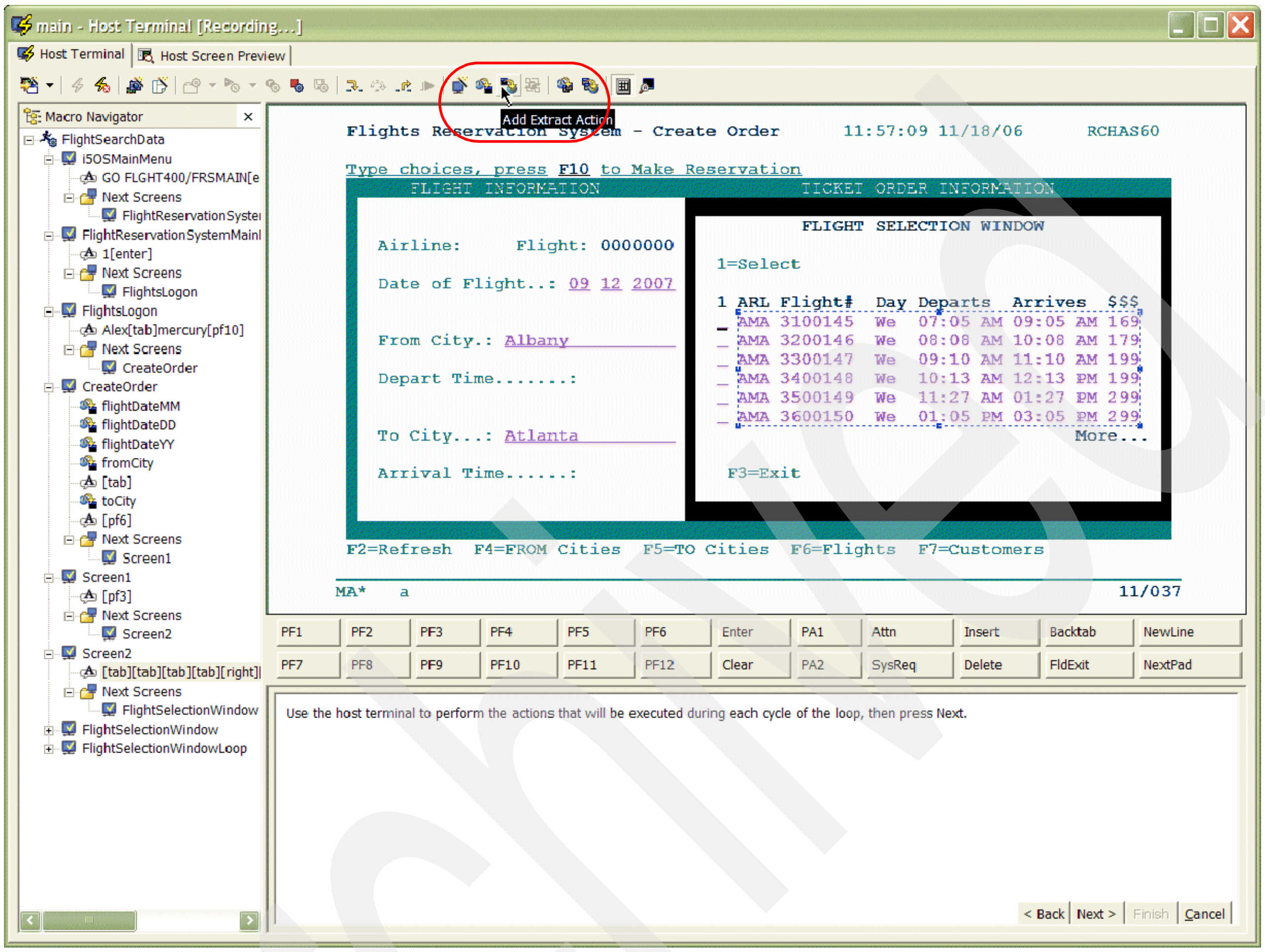
Figure 7-32   Record a loop

36. While recording your loop, pay very close attention to the instructions in the panel below the host screen.

37. You are already at the screen where the loop starts, so click **Next** at the bottom, right side of the window.

38. First, define the starting screen for the loop. Enter `FlightSelectionWindowLoop` as the screen name. Use your mouse to select the text *FLIGHT SELECTION WINDOW*. Click **Finish**.

39. Next, perform the actions that will be executed during each cycle of the loop. In the terminal window, drag your mouse around the data that you want to extract from the screen and click the **Add Extract Action** button (see Figure 7-33).

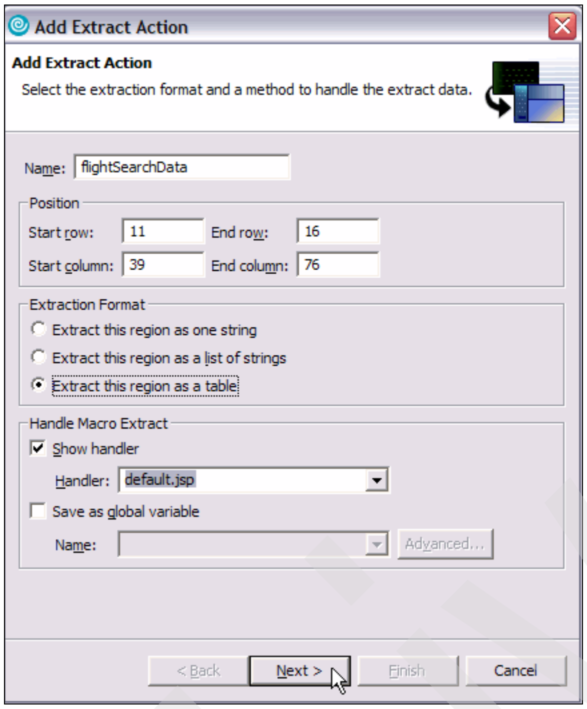


```
        Flights Reservation System - Create Order      11:57:09 11/18/06      RCHAS60

        Type choices, press F10 to Make Reservation
              FLIGHT INFORMATION                       TICKET ORDER INFORMATION

           Airline:      Flight:  0000000            FLIGHT SELECTION WINDOW

                                                 1=Select
           Date of Flight..:  09  12  2007

                                                 1 ARL Flight#  Day Departs  Arrives   $$$
                                                 _ AMA 3100145  We  07:05 AM 09:05 AM 169
           From City.: Albany                    _ AMA 3200146  We  08:08 AM 10:08 AM 179
                                                 _ AMA 3300147  We  09:10 AM 11:10 AM 199
           Depart Time.......:                   _ AMA 3400148  We  10:13 AM 12:13 PM 199
                                                 _ AMA 3500149  We  11:27 AM 01:27 PM 299
                                                 _ AMA 3600150  We  01:05 PM 03:05 PM 299
           To City...: Atlanta                                                   More...

           Arrival Time......:                     F3=Exit


        F2=Refresh  F4=FROM Cities  F5=TO Cities  F6=Flights  F7=Customers

       MA*    a                                                           11/037
```

Use the host terminal to perform the actions that will be executed during each cycle of the loop, then press Next.

Figure 7-33 Selecting the region with data

40. On the Add Extract Action panel, type `flightSearchData` as the name and select **Extract this region as a table**. Click **Next** (see Figure 7-34).


Add Extract Action

Add Extract Action

Select the extraction format and a method to handle the extract data.

Name: flightSearchData

Position

Start row: 11 End row: 16

Start column: 39 End column: 76

Extraction Format

( ) Extract this region as one string

( ) Extract this region as a list of strings

(•) Extract this region as a table

Handle Macro Extract

[✓] Show handler

Handler: default.jsp

[ ] Save as global variable

Name:

Figure 7-34 Add Extract Action - Settings

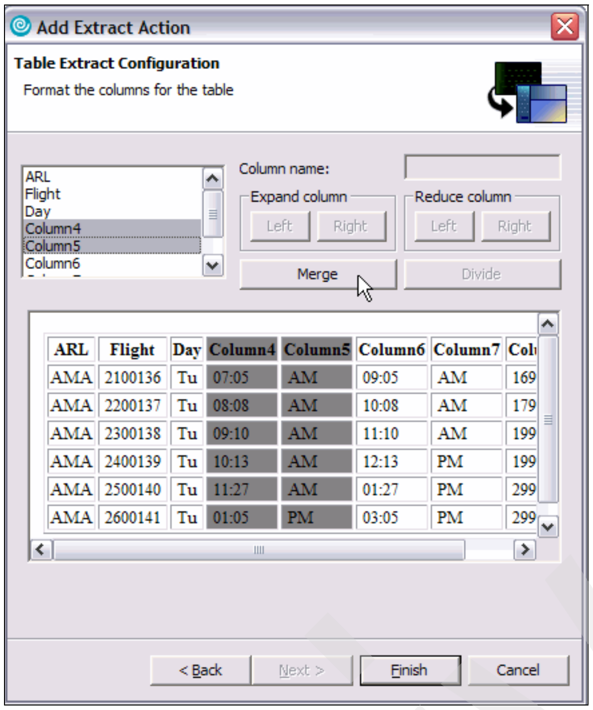
41. You see the Table Extract Configuration window. In this window, you rename the column names to match the names on the host screen. Notice that some of the columns are extracted as two fields. You use this dialog box to merge those two fields into one field. Highlight each column name and change the name in the Column name field:

a. Rename column1 to *ARL*.

b. Rename column 2 to *Flight*.

c. Rename column 3 to *Day*.

d. Select Column4. Hold the Ctrl key and select Column5. Click the **Merge** button to merge these two fields into one (see Figure 7-35).



ARL	Flight	Day	Column4	Column5	Column6	Column7	Col
AMA	2100136	Tu	07:05	AM	09:05	AM	169
AMA	2200137	Tu	08:08	AM	10:08	AM	179
AMA	2300138	Tu	09:10	AM	11:10	AM	199
AMA	2400139	Tu	10:13	AM	12:13	PM	199
AMA	2500140	Tu	11:27	AM	01:27	PM	299
AMA	2600141	Tu	01:05	PM	03:05	PM	299

Figure 7-35 Table Extract Configuration - Merge fields

e. Now rename column 4 to *Departs*.

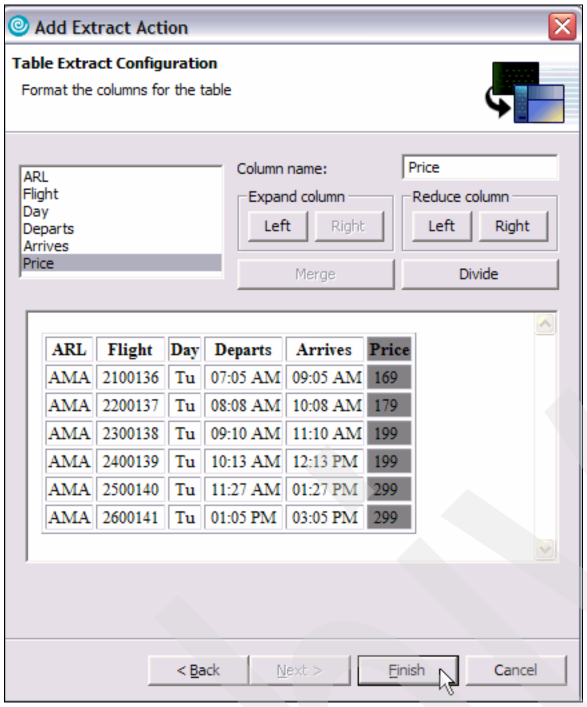
f. Select Column6. Hold the Ctrl key and select Column7. Click the **Merge** button to merge these two fields into one.

g. Now rename Column6 to *Arrives*.

h. Rename Column7 to *Price* (see Figure 7-36)

Also, notice that it allows you to expand or reduce the size of column to capture complete field from the screen.

i. Click **Finish** after you are done with all the changes.



ARL	Flight	Day	Departs	Arrives	Price
AMA	2100136	Tu	07:05 AM	09:05 AM	169
AMA	2200137	Tu	08:08 AM	10:08 AM	179
AMA	2300138	Tu	09:10 AM	11:10 AM	199
AMA	2400139	Tu	10:13 AM	12:13 PM	199
AMA	2500140	Tu	11:27 AM	01:27 PM	299
AMA	2600141	Tu	01:05 PM	03:05 PM	299

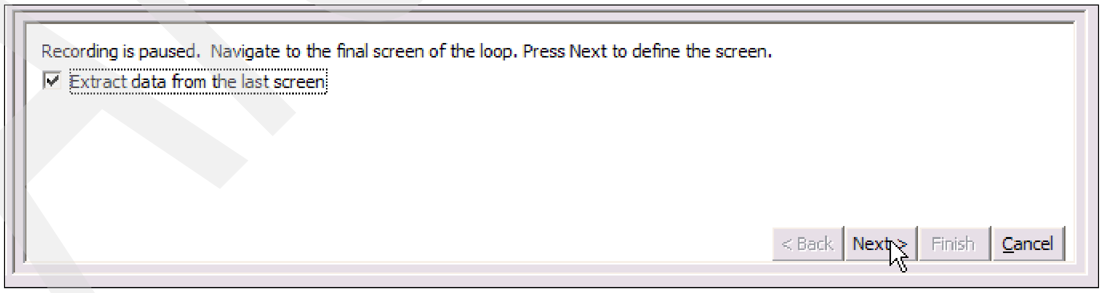
Figure 7-36 Table Extract Configuration

j. Back at the terminal window, you need to add other actions that will be executed during each cycle of the loop. In this case, press the PgDnkey just once.

42. Click **Next** in the instructions panel (bottom, right side of the window).

43. For how to end the loop, select **End when a unique screen is recognized** and click **Next**.

44. Select **Extract data from the last screen**.


Recording is paused. Navigate to the final screen of the loop. Press Next to define the screen.

☑ Extract data from the last screen

Figure 7-37 Extract data from the last window

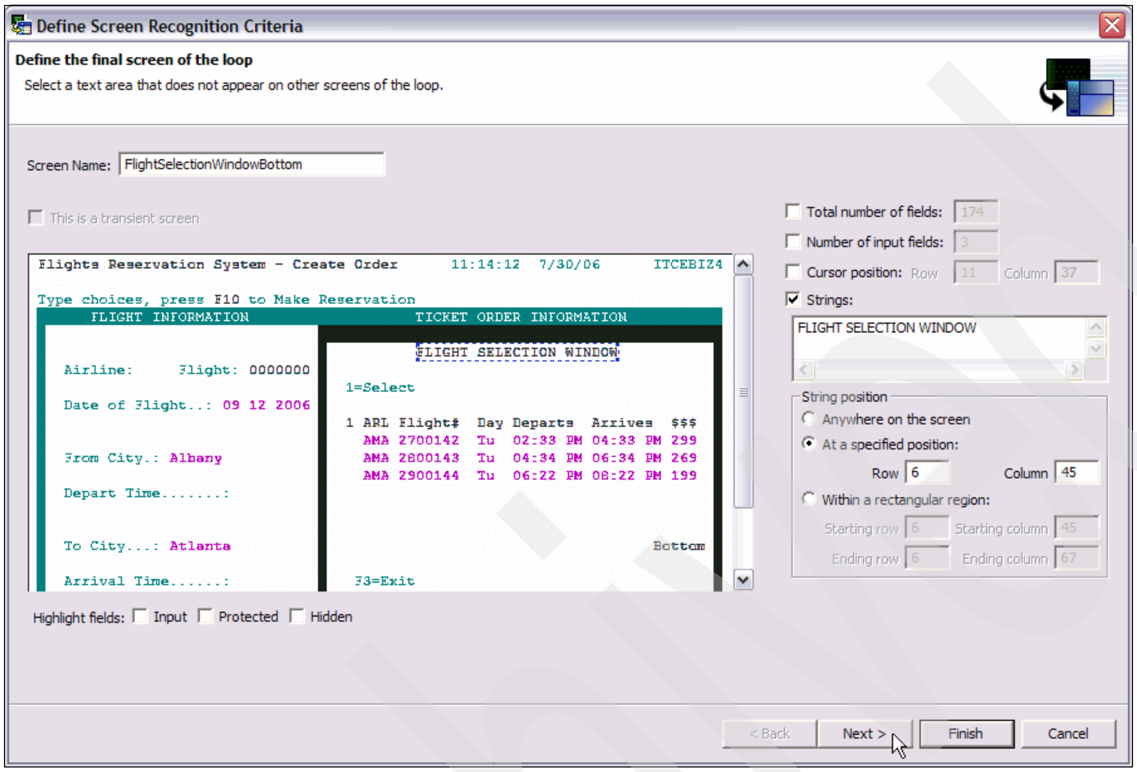
45. Next, you must navigate to the last screen. Press the PgDnkey until you get to the last panel. In this example the last panel has the text *Bottom* at the bottom of the screen.

46. Click **Next**.

47. On the Define the final screen of the loop panel, enter `FlightSelectionWindowBottom` as the name.

48. Drag your mouse around the text *FLIGHT SELECTION WINDOW* and select **At a specified position** (see Figure 7-38).

49. Click **Next**.



Define Screen Recognition Criteria

Define the final screen of the loop

Select a text area that does not appear on other screens of the loop.

Screen Name: FlightSelectionWindowBottom

This is a transient screen

```
Flights Reservation System - Create Order       11:14:12   7/30/06        ITCEBIZ4

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                       TICKET ORDER INFORMATION
                                              FLIGHT SELECTION WINDOW
   Airline:      Flight:  0000000
                                     1=Select
   Date of Flight..:  09  12  2006
                                     1 ARL Flight#  Day Departs   Arrives   $$$
                                       AMA 2700142  Tu  02:33 PM 04:33 PM 299
   From City.: Albany                  AMA 2800143  Tu  04:34 PM 06:34 PM 269
                                       AMA 2900144  Tu  06:22 PM 08:22 PM 199
   Depart Time.......:


   To City...: Atlanta                                                Bottom

   Arrival Time......:                F3=Exit
```

Highlight fields: Input Protected Hidden

Total number of fields: 174

Number of input fields: 3

Cursor position: Row 11 Column 37

[✓] Strings:

FLIGHT SELECTION WINDOW

String position

Anywhere on the screen

[✓ At a specified position:]

Row 6 Column 45

Within a rectangular region:

Starting row 6 Starting column 45

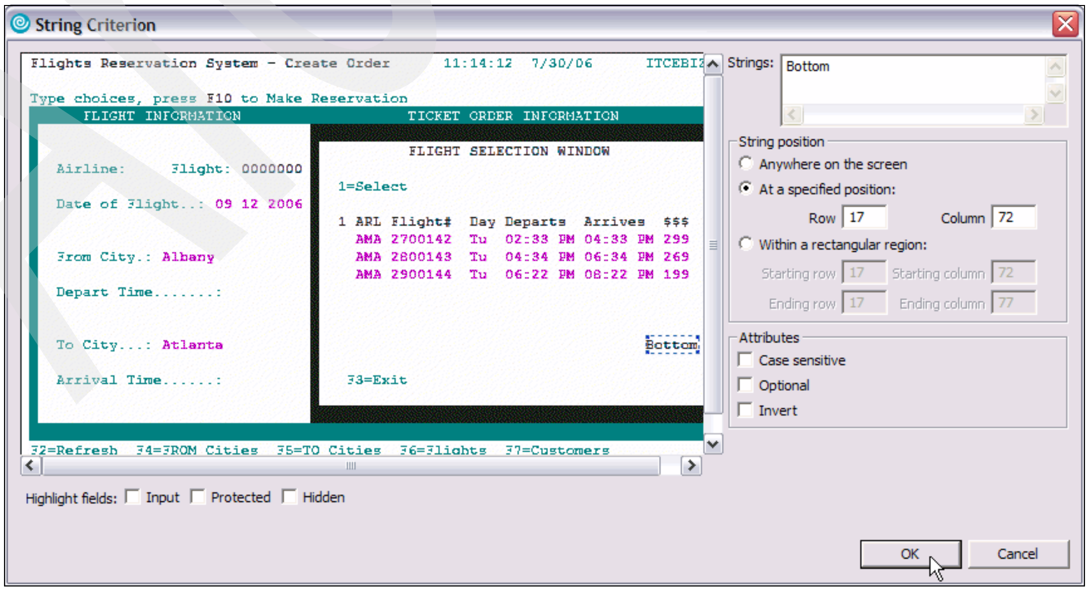
Ending row 6 Ending column 67

< Back | Next > | Finish | Cancel

Figure 7-38 Flight Selection Window Bottom

50. On the Recognition Criteria for Screen panel, click **Add** to define additional screen recognition criteria.

51. On the String Criterion panel, drag your mouse around the text *Bottom*. Select **At a specified position** and click **OK** (see Figure 7-39).



String Criterion

```
Flights Reservation System - Create Order       11:14:12   7/30/06        ITCEBIZ

Type choices, press F10 to Make Reservation
      FLIGHT INFORMATION                       TICKET ORDER INFORMATION

   Airline:      Flight:  0000000             FLIGHT SELECTION WINDOW

   Date of Flight..:  09  12  2006   1=Select

                                     1 ARL Flight#  Day Departs   Arrives   $$$
   From City.: Albany                  AMA 2700142  Tu  02:33 PM 04:33 PM 299
                                       AMA 2800143  Tu  04:34 PM 06:34 PM 269
   Depart Time.......:                 AMA 2900144  Tu  06:22 PM 08:22 PM 199


   To City...: Atlanta                                                Bottom

   Arrival Time......:                F3=Exit

F2=Refresh   F4=FROM Cities   F5=TO Cities   F6=Flights   F7=Customers
```

Highlight fields: Input Protected Hidden

Strings: Bottom

String position

Anywhere on the screen

[✓ At a specified position:]

Row 17 Column 72

Within a rectangular region:

Starting row 17 Starting column 72

Ending row 17 Ending column 77

Attributes

Case sensitive

Optional

Invert

OK | Cancel

Figure 7-39 Additional Screen Recognition Criteria

52. On the Recognition Criteria for Screen panel, click **Finish**.

53. In the terminal window instruction panel, click **Finish** to complete the loop and continue recording the macro.

54. Now finish recording your macro by either pressing F3 or clicking the PF3 button.

55. Back in Flights Reservation System - Create Order panel, click the **Define Screen Recognition Criteria** button and enter `FlightsReservationSystemCreateOrder` as the screen name. Use your mouse to select the text *Flights Reservation System - Create Order*. Click **Finish**.

56. Press F3 to go back to Flight Reservation System main menu.

57. Back in Flights Reservation System - main menu panel, click the **Define Screen Recognition Criteria** button and enter `FlightReservationSystemMain` as the screen name. Use your mouse to select the text *Flights Reservation System*. Click **Finish**.

58. Press F3 to go back to i5/OS Main Menu.

59. Back in the i5/OS main menu screen, click the **Define Screen Recognition Criteria** button and enter `i5OSMain` as the screen name. Use your mouse to select the text *i5/OS Main Menu*. Click **Finish**.

60. Click the **Stop Macro** button to stop recording the macro.

61. Next, you see the Define the exit screen of the macro window. Enter `i5OSMain`.

62. Use your mouse to select the text *i5/OS Main Menu*. Click **Finish**.

63. Click the **Save macro** button to save the macro.

64. Next, test the macro that you just recorded. Make sure that you are at the i5/OS main menu screen and execute the macro by pressing the **Play macro** button.

65. You are prompted to supply prompt values. Enter following values (see Figure 7-40):

    a. flightDateMM: `09`

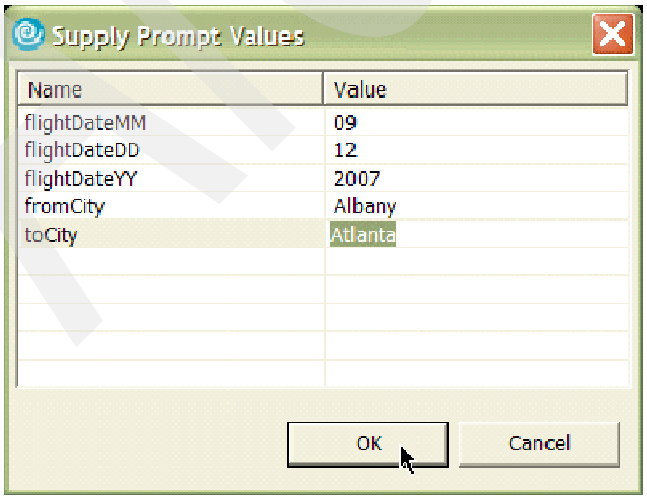
    b. flightDateDD: `12`

    c. flightdateYY: `2007`

    d. fromCity: `Albany`

    e. toCity: `Atlanta`

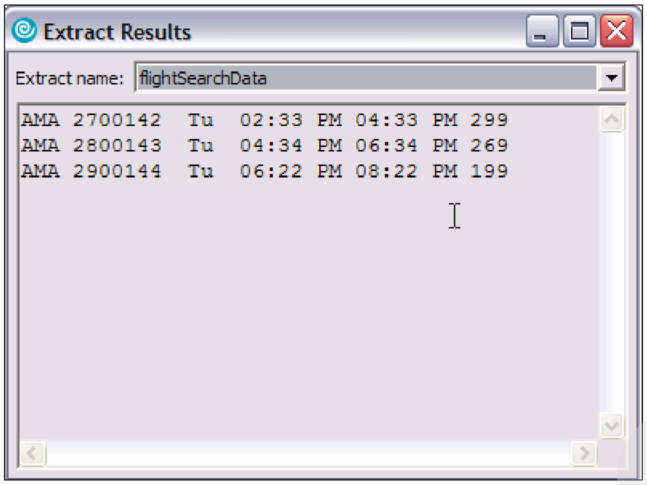
66. Click **OK**.



Name	Value
flightDateMM	09
flightDateDD	12
flightDateYY	2007
fromCity	Albany
toCity	Atlanta

Figure 7-40 Supply Prompt Values

67. You should see the results extracted in the Extract Result window (see Figure 7-41).



```
AMA 2700142  Tu  02:33 PM 04:33 PM 299
AMA 2800143  Tu  04:34 PM 06:34 PM 269
AMA 2900144  Tu  06:22 PM 08:22 PM 199
```

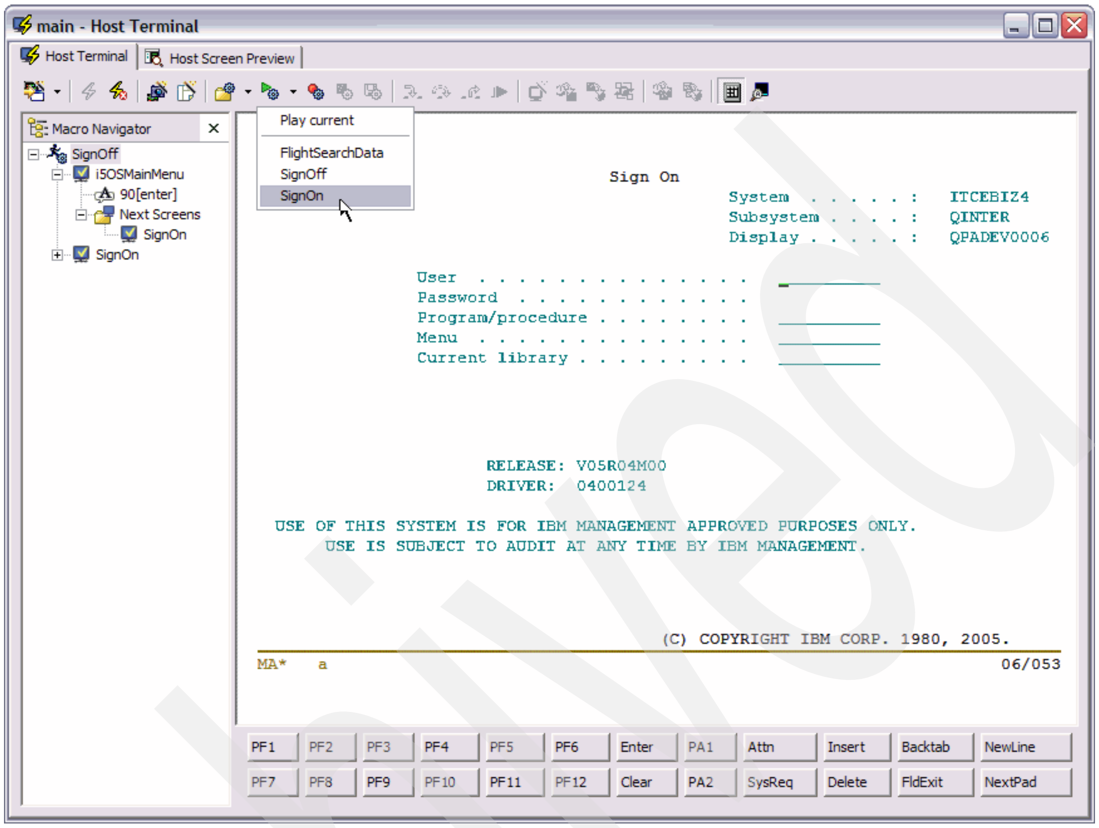
Figure 7-41 Extract Results

Recording a disconnect macro

The final step is to record a disconnect macro:

1. Make sure that you are on the i5/OS Main Menu before recording the disconnect macro.
2. To start recording your Disconnect macro, click the **Record Macro** button on the toolbar.
3. On the Record new macro or Insert window, select **New**.
4. On the Record Macro panel, for Name enter `SignOff`. Click **Finish**.
5. For the first screen in the macro, HATS prompts you to supply the criteria to use for recognizing the screen. On the Define the starting screen panel, enter `i5OSMainMenu` for the screen name.
6. Select the criteria within a rectangular region (notice HATS has already selected an area in the upper, middle part of the screen). You can change this area if necessary. Click **Finish**.
7. On the i5/OS Main Menu panel, type `90` and press Enter.
8. Click the **Stop Macro** button to stop recording the macro.
9. Next, you see the Define the exit screen of the macro window. Enter `SignOn`.
10. Use your mouse to select the text *Sign On*. Click **Finish**.
11. Click the **Save macro** button to save the macro.

12. Next, you test the macro that you just recorded. First, sign on by selecting **SignOn** from the Play button drop-down menu (Figure 7-42).



```
                                Sign On
                                        System  . . . . . :   ITCEBIZ4
                                        Subsystem . . . . :   QINTER
                                        Display . . . . . :   QPADEV0006

                 User  . . . . . . . . . . . . . .         __________
                 Password  . . . . . . . . . . . .
                 Program/procedure . . . . . . . .         __________
                 Menu  . . . . . . . . . . . . . .         __________
                 Current library . . . . . . . . .         __________




                        RELEASE: V05R04M00
                        DRIVER:  0400124

    USE OF THIS SYSTEM IS FOR IBM MANAGEMENT APPROVED PURPOSES ONLY.
         USE IS SUBJECT TO AUDIT AT ANY TIME BY IBM MANAGEMENT.




                                          (C) COPYRIGHT IBM CORP. 1980, 2005.
MA*    a                                                                06/053
```

Figure 7-42 Execute sign on screen

13. Execute the sign off macro by selecting **SignOff** from the Play button drop-down menu.

14. Close the Host terminal window.

7.4 Setting connection properties

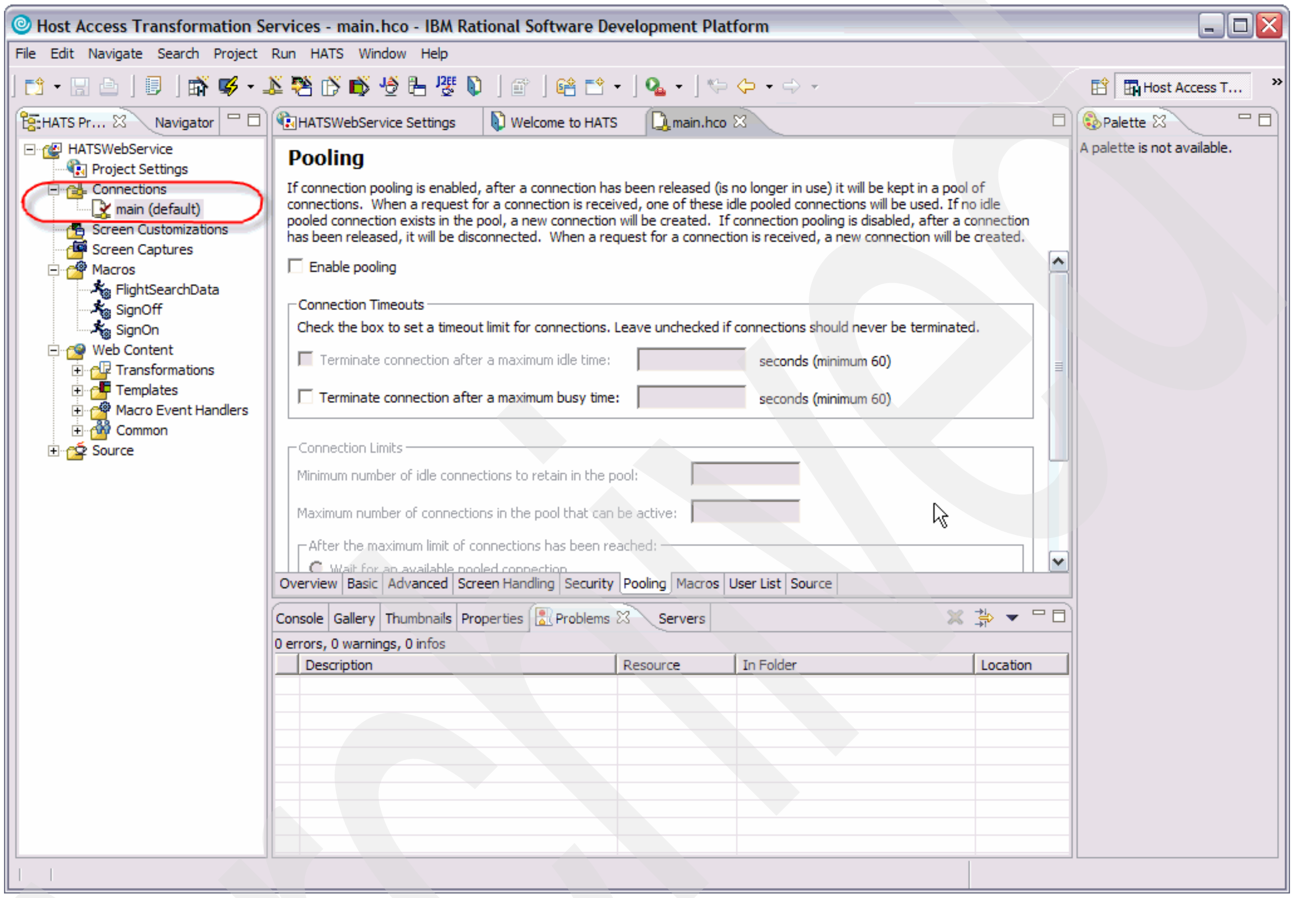
When you deploy your Web service, it uses a connection (a 5250 session) to access your System i system. You set up the basic configuration parameters for your connection when you first built your project. Now you need to define connection pooling parameters and link the macros you just built to the connection.

7.4.1 Enabling pooling

To improve performance for your Web service, it is recommended that you implement *connection pooling* for the connection that is used by the Web service. Connection pooling allows you to specify a number of connections (5250 sessions) that HATS maintains in a pool. Connection pooling avoids constant connecting and disconnecting from the host system in order to service multiple Web service requests.

The connections defined in your project are found in the *Connections* folder. HATS can support multiple connections for the purpose of collecting and combining data from multiple back end host sites. In this project you have defined just one connection, which by default is named *main*:

1. Double-click **main** under Connections (see Figure 7-43). Look through each of the tabs (at the bottom of the view) to see the different configuration settings. Click the Pooling tab.


Host Access Transformation Services - main.hco - IBM Rational Software Development Platform
File Edit Navigate Search Project Run HATS Window Help
Host Access T...
HATS Pr... Navigator
HATSWebService Settings
Welcome to HATS
main.hco
Palette
HATSWebService
Project Settings
Connections
main (default)
Screen Customizations
Screen Captures
Macros
FlightSearchData
SignOff
SignOn
Web Content
Transformations
Templates
Macro Event Handlers
Common
Source
Overview Basic Advanced Screen Handling Security Pooling Macros User List Source
Console Gallery Thumbnails Properties Problems Servers
Description Resource In Folder Location

A palette is not available.

Pooling

If connection pooling is enabled, after a connection has been released (is no longer in use) it will be kept in a pool of connections. When a request for a connection is received, one of these idle pooled connections will be used. If no idle pooled connection exists in the pool, a new connection will be created. If connection pooling is disabled, after a connection has been released, it will be disconnected. When a request for a connection is received, a new connection will be created.

☐ Enable pooling

Connection Timeouts

Check the box to set a timeout limit for connections. Leave unchecked if connections should never be terminated.

☐ Terminate connection after a maximum idle time: seconds (minimum 60)

☐ Terminate connection after a maximum busy time: seconds (minimum 60)

Connection Limits

Minimum number of idle connections to retain in the pool:

Maximum number of connections in the pool that can be active:

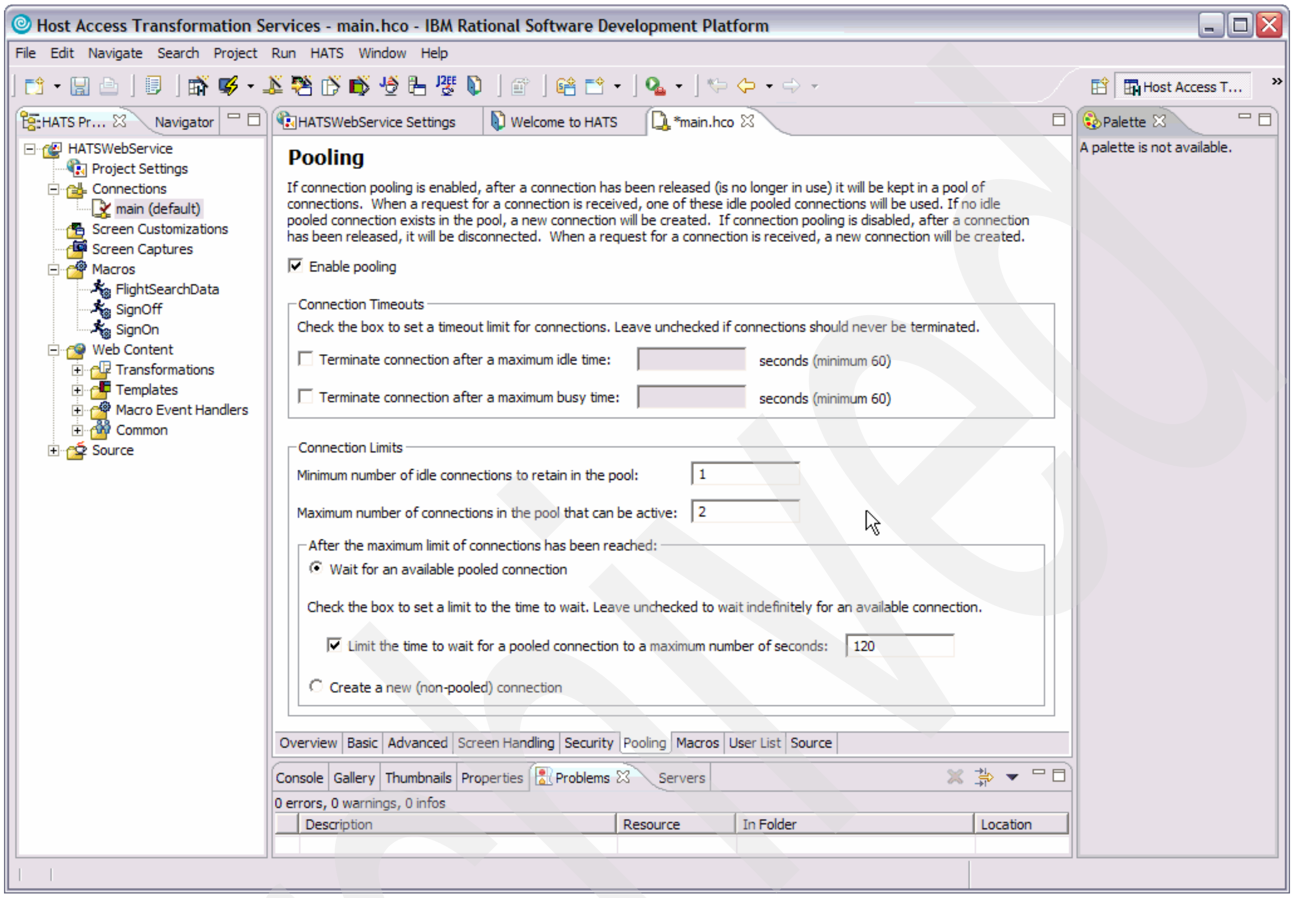
After the maximum limit of connections has been reached:

○ Wait for an available pooled connection

0 errors, 0 warnings, 0 infos

Figure 7-43 Connection Properties - pooling

2. On the Pooling tab, click **Enable Pooling** and set the Connection Limits. For testing purpose set the limits to a **Minimum of 1** and a **Maximum of 2** (see Figure 7-44). For production use, you can set the limits to higher number based on the concurrent connection being used. Then click the Macros tab.


Host Access Transformation Services - main.hco - IBM Rational Software Development Platform
File Edit Navigate Search Project Run HATS Window Help
HATS Pr... Navigator
HATSWebService
Project Settings
Connections
main (default)
Screen Customizations
Screen Captures
Macros
FlightSearchData
SignOff
SignOn
Web Content
Transformations
Templates
Macro Event Handlers
Common
Source
HATSWebService Settings
Welcome to HATS
*main.hco
Palette
A palette is not available.
Overview Basic Advanced Screen Handling Security Pooling Macros User List Source
Console Gallery Thumbnails Properties Problems Servers
0 errors, 0 warnings, 0 infos
Description Resource In Folder Location

Pooling

If connection pooling is enabled, after a connection has been released (is no longer in use) it will be kept in a pool of connections. When a request for a connection is received, one of these idle pooled connections will be used. If no idle pooled connection exists in the pool, a new connection will be created. If connection pooling is disabled, after a connection has been released, it will be disconnected. When a request for a connection is received, a new connection will be created.

[✓] Enable pooling

Connection Timeouts

Check the box to set a timeout limit for connections. Leave unchecked if connections should never be terminated.

[ ] Terminate connection after a maximum idle time: seconds (minimum 60)

[ ] Terminate connection after a maximum busy time: seconds (minimum 60)

Connection Limits

Minimum number of idle connections to retain in the pool: 1

Maximum number of connections in the pool that can be active: 2

After the maximum limit of connections has been reached:

[● Wait for an available pooled connection]

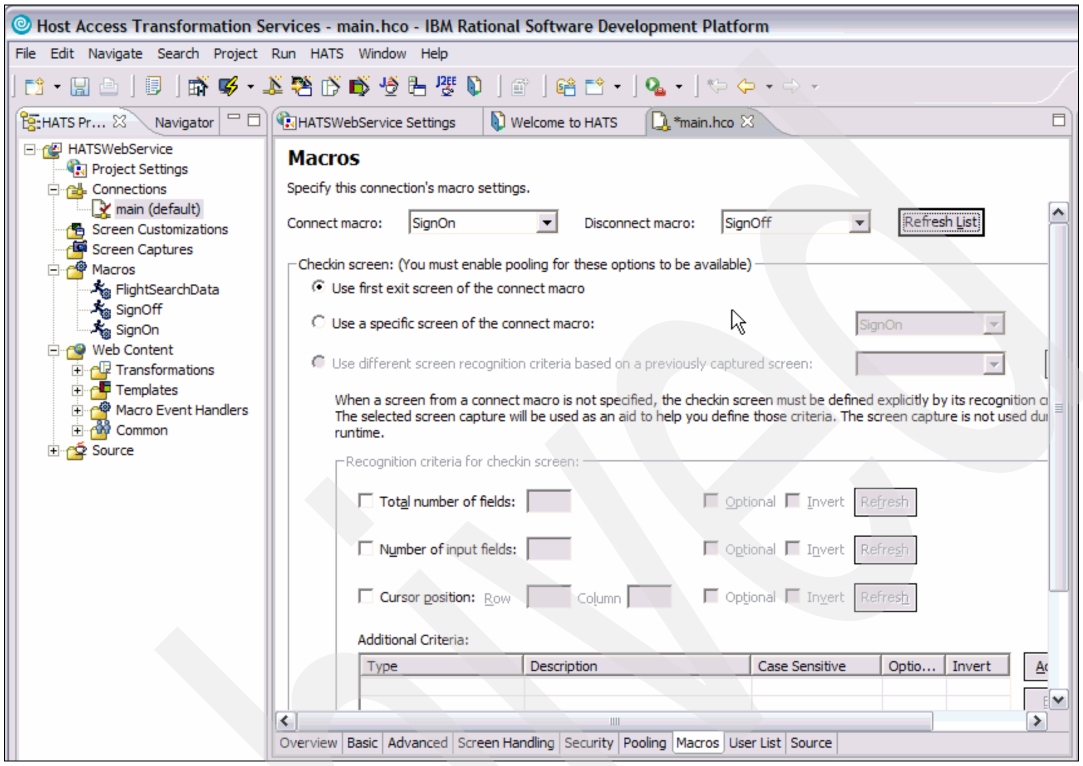
Check the box to set a limit to the time to wait. Leave unchecked to wait indefinitely for an available connection.

[✓] Limit the time to wait for a pooled connection to a maximum number of seconds: 120

○ Create a new (non-pooled) connection

Figure 7-44 Pooling - number of connections

3. On the Macros tab (see Figure 7-45):
   a. For the Connect macro use the drop-down and select your Connect macro: **SignOn**
   b. For the Disconnect macro, select your Disconnect macro: **SignOff**.



Macros

Specify this connection's macro settings.

Connect macro: SignOn   Disconnect macro: SignOff

Checkin screen: (You must enable pooling for these options to be available)

(●) Use first exit screen of the connect macro

( ) Use a specific screen of the connect macro: SignOn

( ) Use different screen recognition criteria based on a previously captured screen:

When a screen from a connect macro is not specified, the checkin screen must be defined explicitly by its recognition c
The selected screen capture will be used as an aid to help you define those criteria. The screen capture is not used du
runtime.

Recognition criteria for checkin screen:

☐ Total number of fields:

☐ Number of input fields:

☐ Cursor position: Row Column

Additional Criteria:

Figure 7-45 Connection Pooling - Macros

4. Save main connection properties by selecting **File** → **Save**. Close the editor for your main connection by clicking the **X** on the main.hco editor tab.

7.5 Creating the integration object

A HATS Integration Object is a JavaBean that encapsulates a programmed interaction with a host application. Integration Objects can be used in multiple ways to integrate interaction with a host application into new Java or Web based programs. One use of an Integration Object is to provide the interaction with a host application for a Web service. HATS macros also provide a programmed interaction with a host application. In fact, creating a HATS macro is the first step in creating an Integration Object.

The Web service you are building in this example is intended to gather flights information from the host system based on flight date, from city and to city submitted by the Web service client. You have just finished creating the HATS FlightSearchData macro that does just that. Now all you need to do is tell HATS to create an Integration Object from your Data macro and then create a Web service from the Integration Object.

Follow these steps:

1. To create an Integration Object from your Data macro, in the HATS Project View expand the Macros folder, right-click **FlightSearchData** and select **Create Integration Object** (see Figure 7-46).

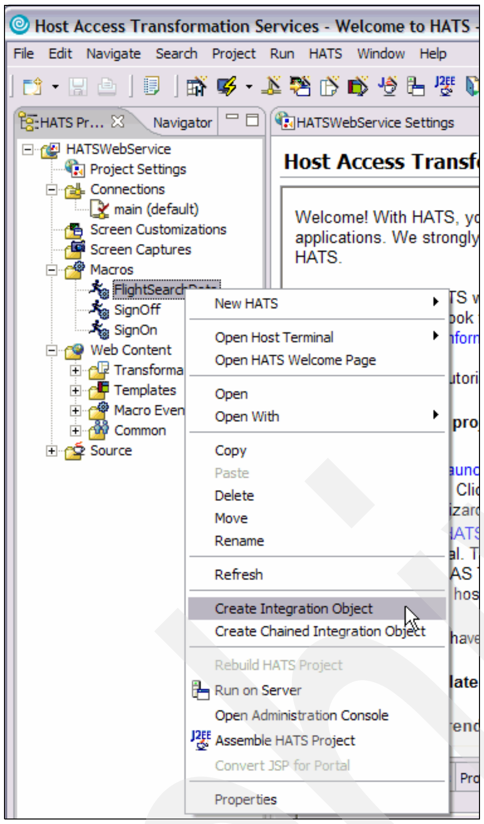


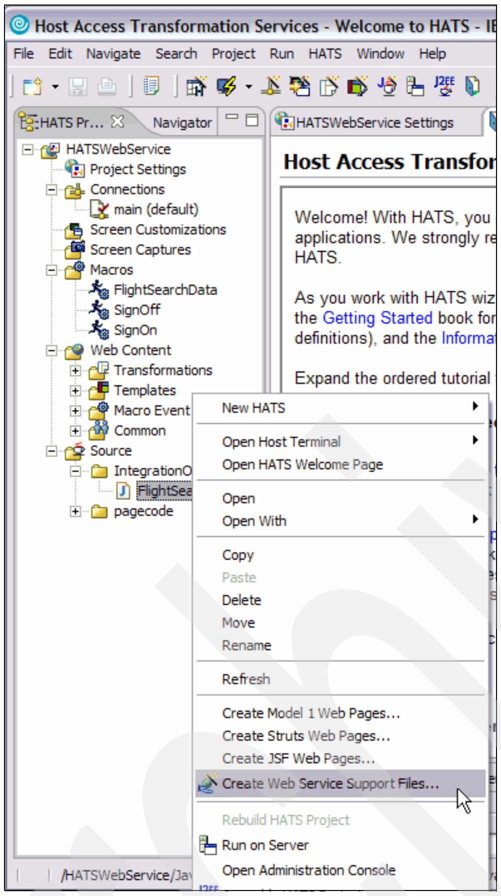
Figure 7-46 Create Integration Object

2. After HATS finishes creating the Integration Object, you find it in the **Source Integration** → **Object** folder. Notice it has the same name as the macro used to create it. Your Integration Object name is *FlightSearchData*. Due to the required naming conventions, if your macro had started with a lower case letter, HATS converts it to upper case in the Integration Object name.

7.6 Creating Web service support files

Before you create your Web service, you must first create HATS Web service support files:

1. In the HATS Project View, right-click your Integration Object **FlightSearchData** and select **Create Web service Support Files** (see Figure 7-47).



Host Access Transfor

Welcome! With HATS, you applications. We strongly re HATS.

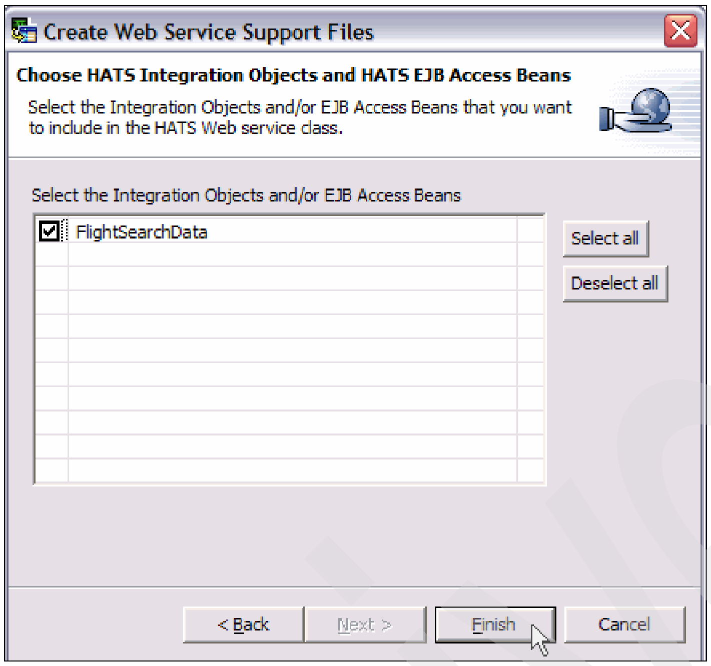
As you work with HATS wiz the Getting Started book for definitions), and the Informa

Expand the ordered tutorial

Figure 7-47 Create Web service Support Files

2. By default, the current Web project (HATSWebService) should be selected in the Project field. If it is not, select it. Enter `FlightSearchDataWS` into the Class name field. Click **Next**.

3. Place a check next to your Integration Object (FlightSearchData) to include it in the Web service class. Click **Finish** (see Figure 7-48).



Create Web Service Support Files

Choose HATS Integration Objects and HATS EJB Access Beans

Select the Integration Objects and/or EJB Access Beans that you want to include in the HATS Web service class.

Select the Integration Objects and/or EJB Access Beans

☑ FlightSearchData

Figure 7-48 Select Integration Objects

4. In the HATS Project View under *Source* notice the webserviceclasses folder. There are three classes created (see Figure 7-49):

   – FlightSearchData_Input_Properties
   – FlightSearchData_Output_Properties
   – FlightSeachDataWS

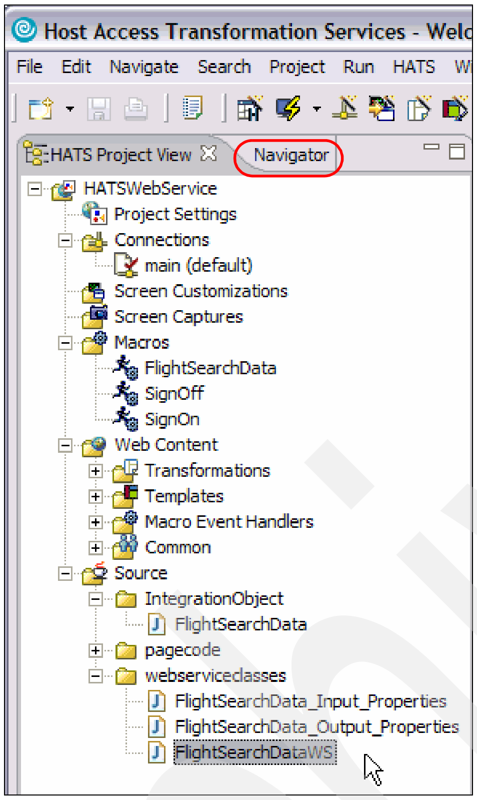
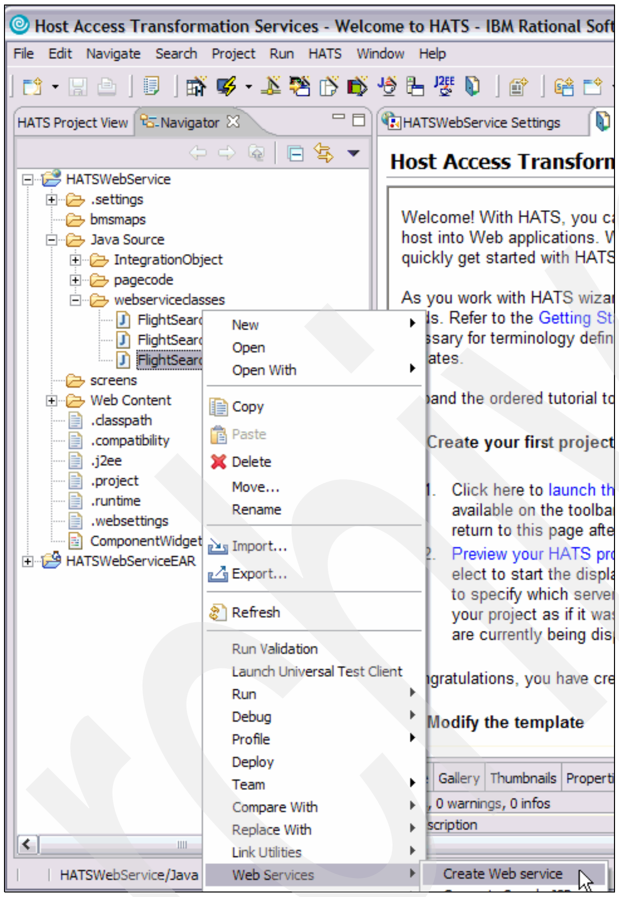


Figure 7-49 Web service Classes created

7.7 Creating Web service

Now that you have created your Web service support files, you can create your Web service and deploy it to the WebSphere Test Environment. Follow these steps:

1. Click the Navigator tab (see Figure 7-49).
2. In the Navigator view, right-click your Web service class file (FlightSearchDataWS.java) in the Java Source\webServiceClasses folder and select **Web services** → **Create Web service** (see Figure 7-50).



Welcome! With HATS, you ca
host into Web applications. W
quickly get started with HATS

As you work with HATS wizar
ls. Refer to the Getting St
ssary for terminology defin
ates.

and the ordered tutorial to

Create your first project

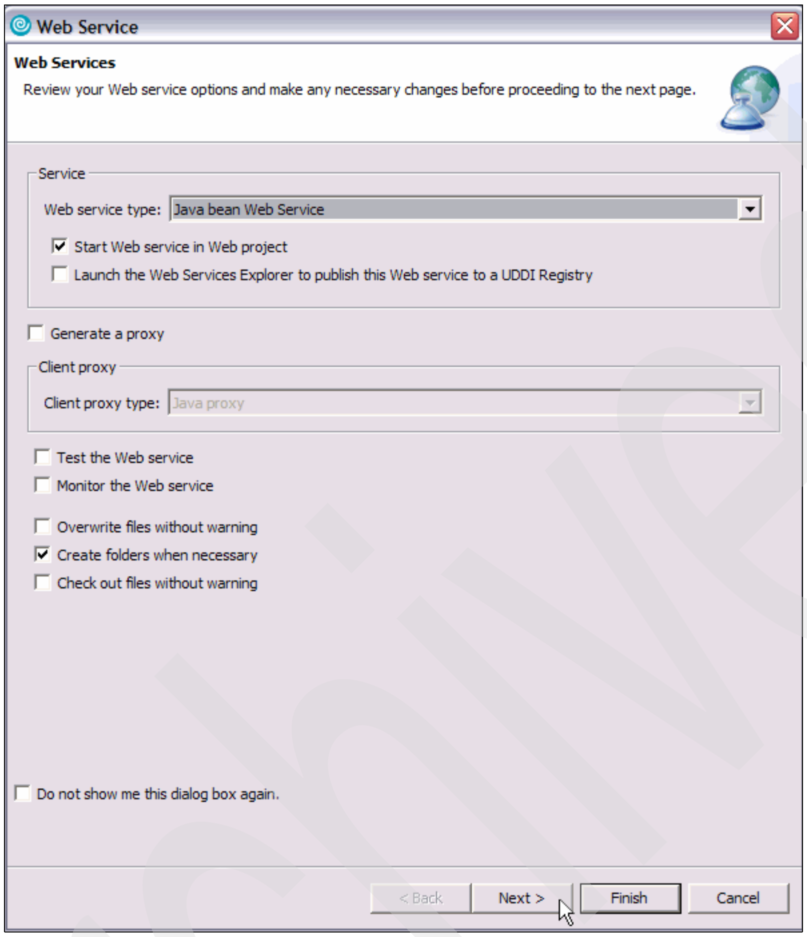
1. Click here to launch th
available on the toolbar
return to this page afte
2. Preview your HATS pro
elect to start the displa
to specify which server
your project as if it was
are currently being dis

gratulations, you have cre

Modify the template

Figure 7-50 Create Web service

3. The first panel of the wizard displays basic settings for the Web service (Figure 7-51). At this point you, could click **Finish** to take all of the defaults, but select **Next** to view the different options that are available when creating a Web service.


Web Service

Web Services

Review your Web service options and make any necessary changes before proceeding to the next page.

Service

Web service type: Java bean Web Service

[✓] Start Web service in Web project

[ ] Launch the Web Services Explorer to publish this Web service to a UDDI Registry

[ ] Generate a proxy

Client proxy

Client proxy type: Java proxy

[ ] Test the Web service

[ ] Monitor the Web service

[ ] Overwrite files without warning

[✓] Create folders when necessary

[ ] Check out files without warning

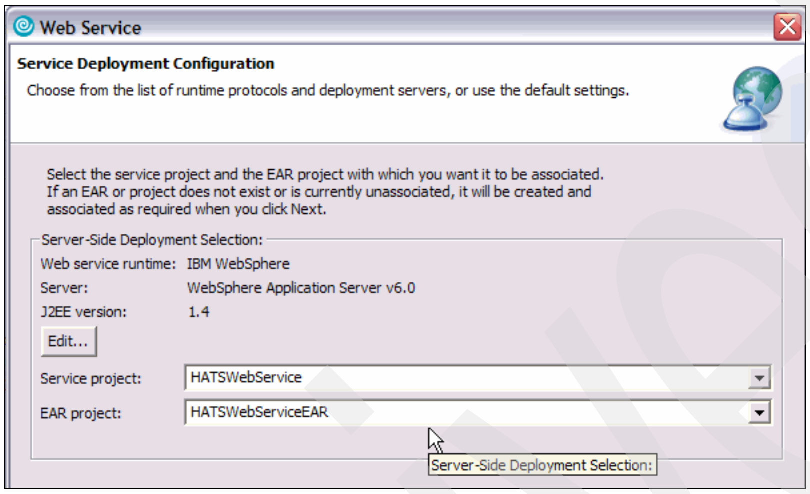
[ ] Do not show me this dialog box again.

Figure 7-51 Web service Settings

4. On the Object Selection Page panel, notice the bean name and click **Next**.

5. On the Service Deployment Configuration panel, notice that by default the server to which your Web service is deployed is WebSphere V6.0. Also notice your project name. Click **Next** (see Figure 7-52). This step can take some time; be patient.

Note: If the Web service runtime is not IBM WebSphere, click **Edit** and change the runtime.


Web Service

Service Deployment Configuration

Choose from the list of runtime protocols and deployment servers, or use the default settings.

Select the service project and the EAR project with which you want it to be associated.
If an EAR or project does not exist or is currently unassociated, it will be created and associated as required when you click Next.

Server-Side Deployment Selection:

Web service runtime: IBM WebSphere

Server: WebSphere Application Server v6.0

J2EE version: 1.4

Service project: HATSWebService

EAR project: HATSWebServiceEAR

Figure 7-52 Service Deployment Configuration

6. On the Service Endpoint Interface Selection panel, click **Next**.
7. On the Web service Java Bean Identity panel, notice all of the Web service settings. The methods correspond to the Integration Objects you included in the Web service class file. Do not change any setting on this page and click **Next**.
8. At this point, your HATS application, including the Web service, is published to the WebSphere Test Environment, and the WebSphere server is started. This operation might take a few moments. After the test server is started, the Web service Publication panel appears. Click **Finish**.

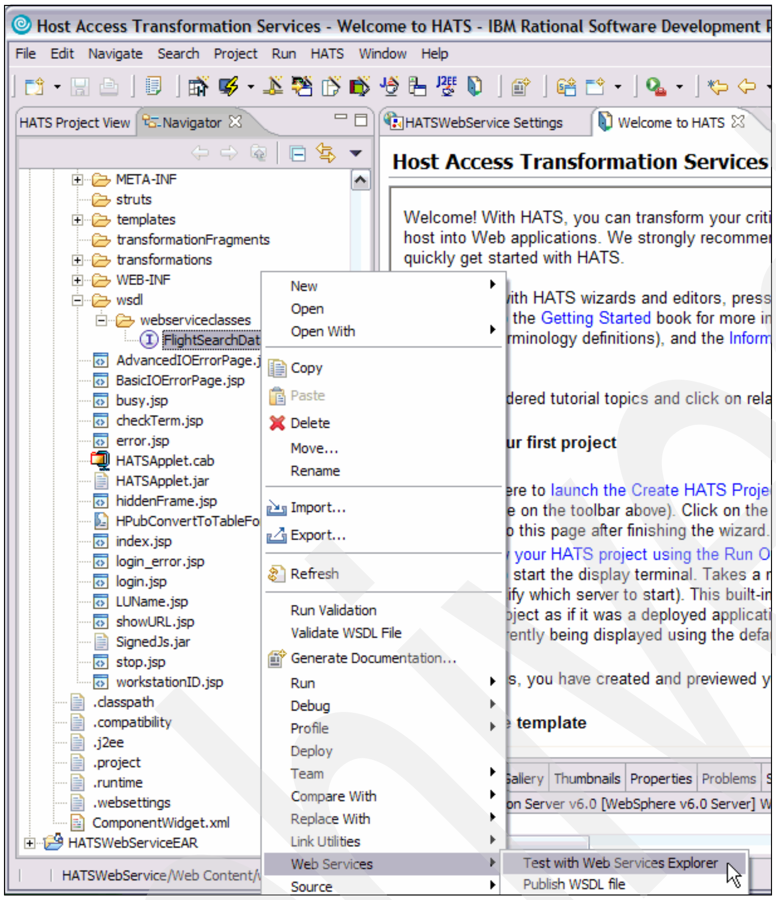
HATS Web service is now deployed, and you can test it.

7.8 Testing the Web service

One output of creating your Web service is a WSDL file. You can find this file in the Navigator view in the Web Content\wsdl\webserviceslasses folder. You can use this WSDL file to test your Web service. Follow these steps:

1. Navigate to **Web Content** → **wsdl** → **webserviceslasses** folder under HATSWebService project.

2. Right-click the WDSL file, FlightSearchDataWS.wsdl, then select **Web services** → **Test with Web services Explorer** (see Figure 7-53).



Host Access Transformation Services

Welcome! With HATS, you can transform your criti host into Web applications. We strongly recomme quickly get started with HATS.

ith HATS wizards and editors, press the Getting Started book for more i rminology definitions), and the Inform

dered tutorial topics and click on rela

ur first project

ere to launch the Create HATS Proje e on the toolbar above). Click on the o this page after finishing the wizard. your HATS project using the Run O start the display terminal. Takes a r ify which server to start). This built-in oject as if it was a deployed applicati ently being displayed using the defa

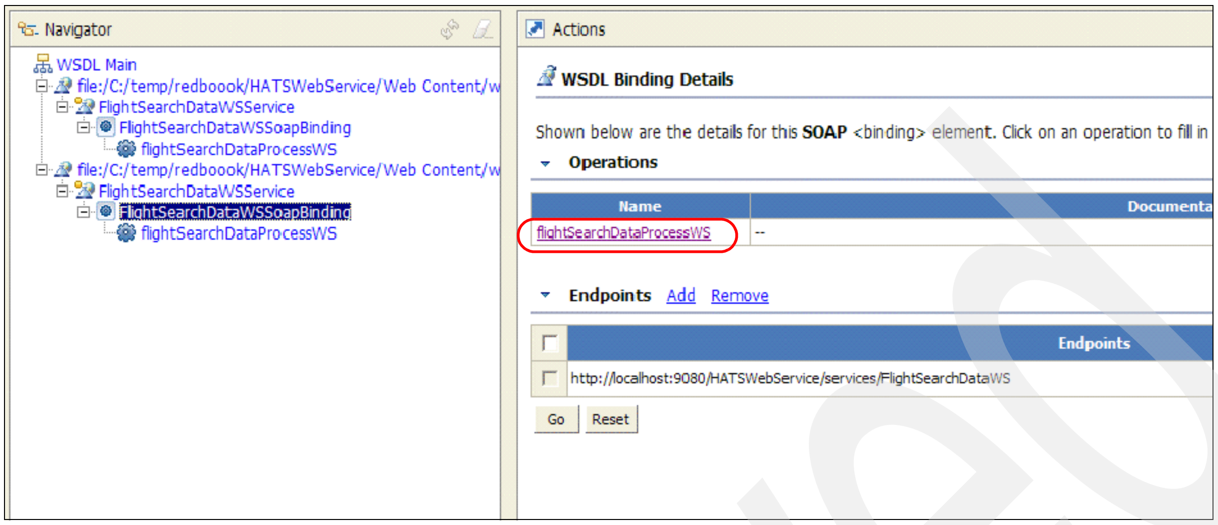
s, you have created and previewed y

template

Figure 7-53 Test with Web services Explorer

Note: Alternatively, when you created the Web service, you could have selected the option Test the Web service in the first page of the wizard (see Figure 7-51 on page 164). This would have launched the Web services Explorer after creating and publishing the Web service.

3. The Web services Explorer displays in a Web browser. In the Actions area under Operations, click the **flightSearchDataProcessWS** link (see Figure 7-54).


Navigator
WSDL Main
file:/C:/temp/redboook/HATSWebService/Web Content/w
FlightSearchDataWSService
FlightSearchDataWSSoapBinding
flightSearchDataProcessWS
file:/C:/temp/redboook/HATSWebService/Web Content/w
FlightSearchDataWSService
FlightSearchDataWSSoapBinding
flightSearchDataProcessWS
Actions
WSDL Binding Details
Operations
Endpoints Add Remove
Go
Reset

Shown below are the details for this **SOAP** <binding> element. Click on an operation to fill in

Name	Documenta
flightSearchDataProcessWS	--

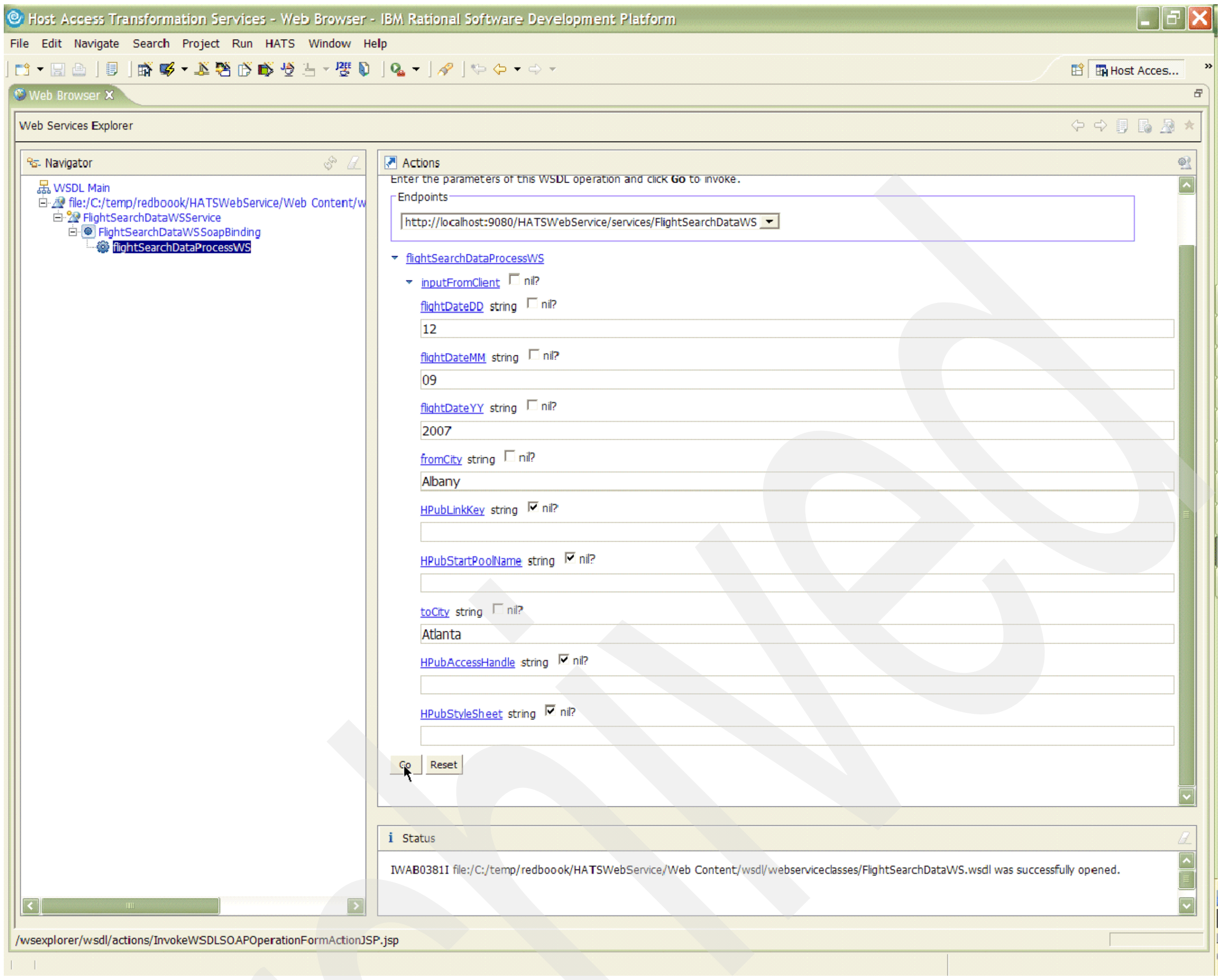
	Endpoints
☐	http://localhost:9080/HATSWebService/services/FlightSearchDataWS

Figure 7-54 Invoking a Web service

4. In the input field, s enter the following values and click **Go** (see Figure 7-55):

   a. flightDateYY: `2007`
   b. flightDateDD: `12`
   c. flightDateMM: `09`
   d. fromCity: `Albany`
   e. toCity: `Atlanta`

Note: At this point a new connection is started to your backend system. Your Integration Object is instantiated and then navigates through the host application using the supplied data. If you notice that an error has occurred, then restart the server on the Server tab by right-clicking the server and selecting **Restart**.



Host Access Transformation Services - Web Browser - IBM Rational Software Development Platform
File Edit Navigate Search Project Run HATS Window Help
Host Acces...
Web Browser
Web Services Explorer
Navigator
WSDL Main
file:/C:/temp/redboook/HATSWebService/Web Content/w
FlightSearchDataWSService
FlightSearchDataWSSoapBinding
flightSearchDataProcessWS
Actions
Status
Go
Reset

Enter the parameters of this WSDL operation and click **Go** to invoke.

Endpoints

http://localhost:9080/HATSWebService/services/FlightSearchDataWS

flightSearchDataProcessWS

inputFromClient nil?

flightDateDD string nil?

12

flightDateMM string nil?

09

flightDateYY string nil?

2007

fromCity string nil?

Albany

HPubLinkKey string [✓ nil?]

HPubStartPoolName string [✓ nil?]

toCity string nil?

Atlanta

HPubAccessHandle string [✓ nil?]

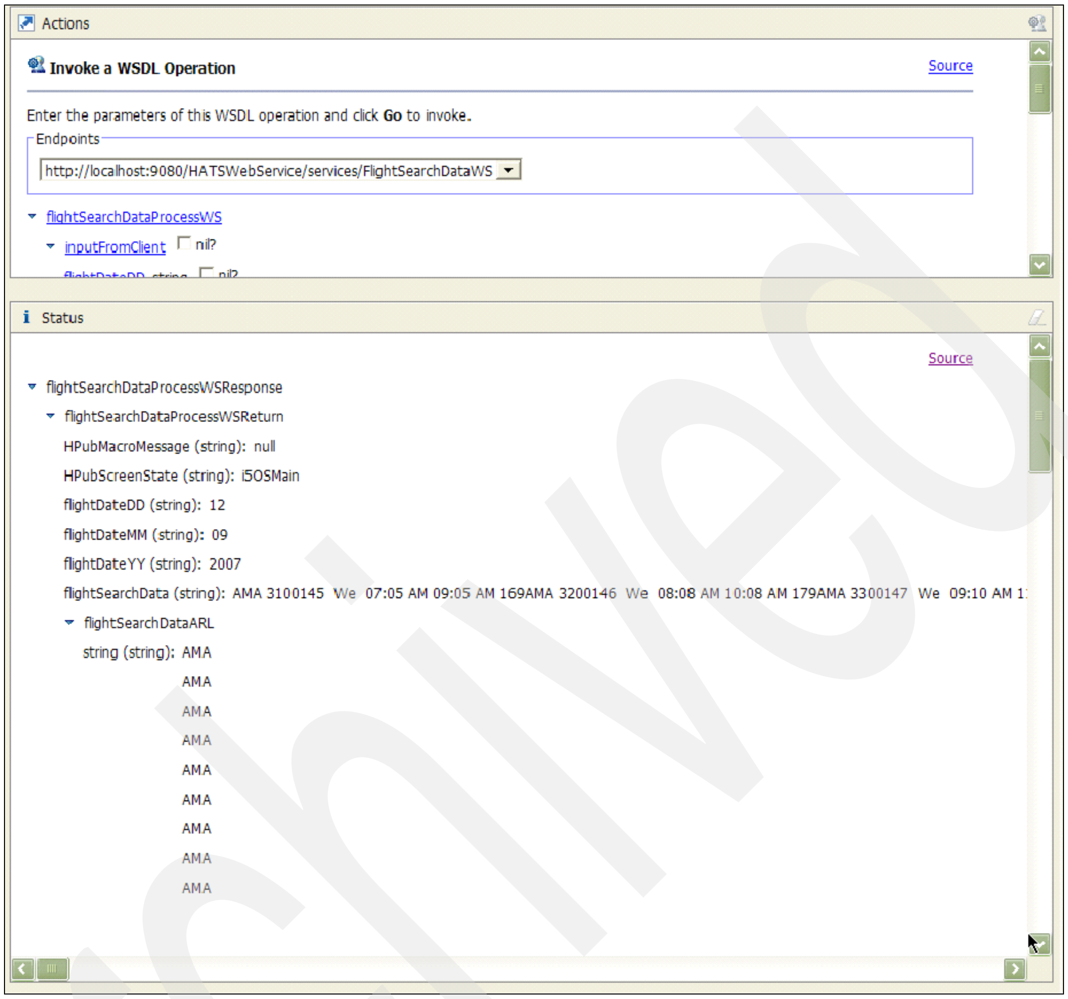
HPubStyleSheet string [✓ nil?]

IWAB0381I file:/C:/temp/redboook/HATSWebService/Web Content/wsdl/webserviceclasses/FlightSearchDataWS.wsdl was successfully opened.

/wsexplorer/wsdl/actions/InvokeWSDLSOAPOperationFormActionJSP.jsp

Figure 7-55 Entering sample input data

5. Now you should see the result of the Web service in the *Status* pane of the window (see Figure 7-56).



Actions

Invoke a WSDL Operation

Source

Enter the parameters of this WSDL operation and click **Go** to invoke.

Endpoints

http://localhost:9080/HATSWebService/services/FlightSearchDataWS

```
flightSearchDataProcessWS
  inputFromClient  nil?
```

Status

Source

```
flightSearchDataProcessWSResponse
  flightSearchDataProcessWSReturn
    HPubMacroMessage (string): null
    HPubScreenState (string): i5OSMain
    flightDateDD (string): 12
    flightDateMM (string): 09
    flightDateYY (string): 2007
    flightSearchData (string): AMA 3100145  We  07:05 AM 09:05 AM 169AMA 3200146  We  08:08 AM 10:08 AM 179AMA 3300147  We  09:10 AM 1
    flightSearchDataARL
      string (string): AMA
                       AMA
                       AMA
                       AMA
                       AMA
                       AMA
                       AMA
                       AMA
                       AMA
```

Figure 7-56   Web services output

Note: You can use the other tools within the Rational Software Development Platform to create a Java proxy, publish, or create a GUI front end for your Web service.

7.9 Next step

We demonstrated just one example of building a Web service. In real life, you need to create more than one Web service. Let us give you just one example using the Flight Reservation System application:

1. The Web service that we built returns the list of flights for certain date between two selected cities. However, your final goal is to be able to make a reservation. With HATS, your next step is to build another macro, *MakeReservation*.

2. The MakeReservation macro starts with exactly the same sequence of steps as the *FlightSearchData* macro (see “Recording a data macro” on page 140). However, you continue with the Flight Reservation System application further (as described in 7.1.1, “Analyzing an existing application” on page 116) but adding prompts for other input fields, including:
   - Flight number (select from the list)
   - Customer name
   - Class of service
   - Number of tickets

   Your final step would be to submit a reservation and return a confirmation number.
3. Next, you create an IntegrationObject and Web service from your new macro, *MakeReservation*.

Now you have two Web services that you can combine in the client application:

1. Your client application displays a Web page with the same input fields that are required for the *FlightSearchData* macro: date of the flight (day, month, and year), to and from cities. When a user submit this page, your client application invokes the *FlightSearchDataWS* Web service.
2. The client application returns the list of available flights and let a user to select one.
3. After that your client application show a page with additional input field: customer name, class of service, and number of tickets.
4. When a user enters all data, you client application invokes the second Web service, *MakeReservationWS*, and pass input data for all fields:
   - Date
   - To city
   - From city
   - Flight number
   - Customer name
   - Class of service
   - Number of tickets
5. After executing the *MakeReservationWS* Web service, your client application returns a confirmation number.

By applying this technique, you can enable many host applications through HATS Web services.

7.10 Summary

In this Web service example, a 5250 application has been externalized as a Web service. As we saw in most of the cases, there will not be any modifications required to the 5250 applications. However, in some cases you might have to modify certain application flow so that it can be driven by a macro. This Web service is accessible by any application that has access to your System i server and can communicate with SOAP/HTTP adhering to the WS-I basic profile, including applications such as Java, J2EE Web Clients, JSF, JSP, .NET, PHP, and others.

8

PHP Web service

In this chapter, we describe how to create Web services using the scripting language PHP. Before diving into the samples, we provide a short overview of PHP to help you familiarize with it, should you not already know it.

In the second part of the chapter, we build Web services.

8.1 Introducing PHP

PHP is a scripting programming language that you can use to create Web sites. The PHP acronym stands for *PHP: Hypertext preprocessor*. The open-source language is used mainly for developing Web applications, and more recently, a broader range of modern software applications, such as the production and consumption of Web services.

PHP is very popular and used on over 22 million internet domains. Zend, the company behind the Zend Engine, estimates that there are approximately 2.5 million PHP developers in the world.

The founders of Zend, Zeev Suraski and Andi Gutmans, have been key contributors to the PHP language since 1997. PHP itself was invented in 1995 by Rasmus Lerdorf. Zend invests in the development of PHP itself, as well as in significant open source projects such as the Zend PHP framework and the Eclipse PHP plug-in. In addition, Zend delivers commercial products and services that enable developers and IT personnel to deliver and operate business-critical PHP applications.

8.2 Technology overview

In this section, we first have a look at how PHP works in a typical environment to provide a general idea about how the different components of a Web server work together. Then, based on the traditional “Hello, World” sample, we show you how PHP can be used. With these short samples, we hope to demonstrate one of the strengths of PHP—its *flexibility*.

8.2.1 How PHP works

Figure 8-1 on page 173 shows a simple diagram of how PHP works in a Web environment. Here are the steps in this process:

1. A site visitor requests a URL in his browser, and the request is transmitted over the Internet to the Web server.
2. The server parses the document. If there are PHP instructions (either embedded in HTML or in a pure PHP file), the code is transmitted to the PHP module. The PHP module processes the PHP functions.
3. In this sample, PHP accesses:
   - A database to read some data
   - Other i5/OS resource, such as data queue, host program, and so on
4. The data is returned from:
   - The database to PHP
   - Other i5/OS resource
5. PHP module returns it to the Web server as simple HTML output. The server embeds the result received in the document requested.
6. Finally, the requested document is sent back to the Web site visitor.

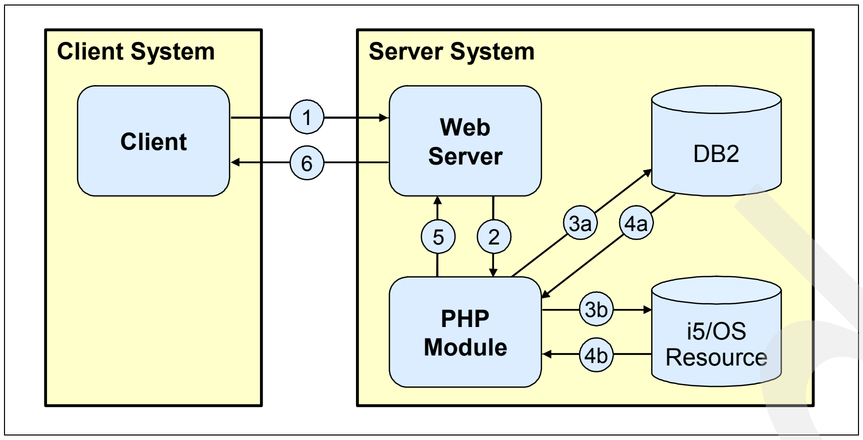


Figure 8-1 How PHP works

Of course, i5/OS access is not necessary in every case. Therefore steps 3 and 4 in Figure 8-1 might not be necessary.

8.2.2 What is needed to use PHP

There are not many requirements to start working with PHP as a Web development language. In fact, because PHP is a server-side scripting language, you only need a PHP-enabled server. PHP works with most Web server software, such as Apache or Microsoft's Internet Information Server. The source code of the PHP parser engine is the same on all operating systems, so there are no code changes required for a specific platform.

If you are interested in trying PHP for yourself on a smaller system than System i without spending to much time on installation and configuration tasks, you can search for the terms *LAMP* or *WAMP* using your favorite Internet search engine that are the abbreviations for Linux - Apache - mySQL - PHP or Windows - Apache - mySQL - PHP. Sometimes the *P* stands for *Perl* or *Python*, but these scripting languages are not the topic of this chapter. In a Macintosh environment, the terms can be *DAMP* or *MAMP* (Darwin or Macintosh, respectively). There are Web sites that offer combinations of these software packages for download. You might want to have a look at XAMPP (`http://www.apachefriends.org/en/xampp.html`), which is easy to install and quickly available to start working.

Alternatively, you can of course download the appropriate version of PHP from the site `http://www.php.net` and install it yourself. Because PHP is open source software, you can even download the source code and compile it yourself on the system of your choice.

8.2.3 There is more than one way to say "Hello, World"

Often, there is more than one way to do something, especially when it comes to programming. The sample of five programmers implementing five completely different programs to solve the very same problem has been cited often enough. PHP is no different. There probably is not *the best* or *the worst* solution. Depending on the context, one solution might be better than the other. Here we show some approaches to say "Hello, World."

We assume that you have seen an HTML page before, and for the sake of clarity we only show the relevant code in our codes examples in this chapter, leaving off everything which is not necessary, such as DOCTYPEs. So the pages do not look very nice when displayed in a browser, but they should include everything for you to see the differences. Purists might argue that this is enough anyway for a Web page.

All of the following code samples should do nothing else than display a title and the text "Hello, World" underneath. The remarks might state the obvious, but it is our goal to show the various possibilities how PHP can be used in a Web-based environment. The code is not sophisticated at all, but all samples have been tested and should work as is.

Just plain HTML

Just to be complete, Example 8-1 shows a page using static HTML.

Example 8-1 Static HTML

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<HTML>
<HEAD>
<META http-equiv="Content-Type" content="text/html; charset=ISO-8859-1">
<TITLE>IBM Redbook: Hello World</TITLE>
</HEAD>
<BODY>
<H3>Plain HTML</H3>
<p> Hello, World </p>
</BODY>
</HTML>
```

HTML with embedded PHP

Example 8-2 shows PHP code that is embedded in the HTML page. Copying and pasting the PHP code is a valid approach for smaller Web sites.

Example 8-2 HTML with embedded PHP

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN">
<HTML>
<HEAD>
<META http-equiv="Content-Type" content="text/html; charset=ISO-8859-1">
<TITLE>IBM Redbook: Hello World</TITLE>
</HEAD>
<BODY>
<H3>PHP embedded in HTML</H3>
<?php echo "Hello, World" ?></p>
</BODY>
</HTML>
```

HTML with embedded PHP, calling a self-written function

Example 8-3 shows an HTML document that includes embedded PHP. The PHP function is defined in an external PHP file (see Example 8-4 on page 175). Note that you need to reference the PHP file that includes the function using the `include_once` statement.

This approach allows you reuse the same function in many documents. If the function includes an error or needs to be modified, the change is done in one place and all documents using the function are immediately updated.

Example 8-3 HTML with embedded PHP function call

```
<?php
   // Include the PHPFunctions file
   include_once("phpfunctions.php");
?>
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1">
<title>IBM Redbook: Hello World</title>
</head>
<body>
<h3>HTML calling an externally defined PHP function</h3>
<p>
<?php HelloWorld(); ?></p>
</body>
</html>
```

The file phpfunctions.php could of course include more than one function. In this example, we included a second function called `Hello10`, which displays the text `Hello, World` 10 times and then outputs the text `Done`. Note that the functions `printf` and `echo` are used to output the text.

Furthermore, the text `Hello, World` is followed by the HTML code for a break line <br>. This shows that you can perfectly use PHP to output HTML code that is interpreted correctly by the browser. In fact, you could create a very basic HTML page that is only calling one PHP function which then outputs massive amounts of HTML. The function is not used in the HTML file in Example 8-3, but you could easily exchange the name of the function to call it.

Example 8-4 The PHP function definition (file phpfunctions.php)

```
<?php
function HelloWorld ()
{
   // Display "Hello, World"
   echo "Hello, World";
}

function Hello10 ()
{
   // Display "Hello, World" 10 times
   for ($i = 1; $i < 11; $i++)
   {
      printf("Hello, World<br>");
   }
   echo "Done.";
}
?>
```

PHP using HTML templates

The last example aims to show how to separate display from application logic by using PHP with an HTML template. The first step consists in creating a class *Template* with the appropriate functions (see Example 8-5). Our main method, `show($doc)`, receives the name of a document to be displayed as an argument. It sets the path, which is empty in our example, and then executes the template by using the PHP function `include()`.

After that it calls the function `showFooter()`, which prints a line with the current date and the current working directory.

Example 8-5 Definition of class Template (TemplateClass.php)

```
<?php
class Template {

   public $template_dir;

   function show($doc) {
      $template = $this;
      include($this->template_dir.$doc);
      $this->showFooter();
   }

   function showFooter() {
      printf("<br><br><br>Today's date: %s | Current directory: %s", date('d. M 
Y'), getcwd());}
}
?>
```

Example 8-6 defines the template file that we named `Template.tpl`. This file includes the display logic for the sample program.

Example 8-6 HTML Template file

```
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=iso-8859-1" />
<title><?php echo $template->doctitle ?></title>
</head>
<body>
<?php echo $template->contentTitle; ?>
<?php echo $template->content; ?>
</body>
</html>
```

Now, all that is needed is the main document (see Example 8-7), which first includes the PHP template class file. Then, it creates a new instance of the class Template and assigns values to the class attributes. Finally, the `show('Template.tpl')` function displays the template file (the display logic in the HTML template file), parsing and replacing the values according to what has been set in the created instance of `TemplateClass`.

Example 8-7 TemplateMain.php, our main file

```
<?php
   include('TemplateClass.php');

   $template = new Template;
   $template->doctitle = 'PHP using an HTML template';
   $template->template_dir = '';
   $template->contentTitle = '<h3>PHP using an HTML template</h3>';
   $template->content = 'Hello, World';
   $template->show('Template.tpl');
?>
```

Using the techniques in Example 8-7, you get cleaner code and more agile applications, because display and application logic are separated. This separation allows you to change either the application logic or the look-and-feel of the application without affecting the other. As always, using templates might not be the best solution for everybody. As you can see with these simple examples, a template-based solution includes more code than one without templates. We do not use templates to write less code but to keep the display and application logic separate.These techniques follow Model-View-Controller (MVC) methodology. You can learn more about MVC at:

http://en.wikipedia.org/wiki/Model-view-controller

If you are interested in templates but do not want to write a solution yourself, then you are lucky. There are dozens of free template solutions available, Smarty being one of the better known template engines. Check out the following sites for template solutions:

http://framework.zend.com/

This site is the home of Smarty. The site includes interesting information, and we recommend reading the documentation that is available online:

http://smarty.php.net

Sitepoint is a publishing company in Australia that provides information for Web developers. The following Web site points to a thread in a discussion forum where site visitors have started building up a list with all PHP template engines:

http://www.sitepoint.com/forums/showthread.php?threadid=123769

At last count there were over 70 solutions in the list.

8.3 PHP on the System i platform

On 03 April 2006, IBM and Zend announced a multi-year agreement to deliver selected Zend PHP products and solutions for i5/OS. IBM and Zend have worked together to enable Zend Core and Zend Platform for i5/OS. For development, Zend Studio provides an integrated development environment (IDE) for building and debugging PHP applications. Zend Guard provides code protection and license management tools for independent software vendors (ISVs).

8.3.1 Zend Core for i5/OS

Zend Core is a fully tested and enhanced version of the open source PHP. It provides the PHP runtime and is packaged to make the software installation easier and faster with instant PHP setup.

The Zend Core for IBM has been enhanced to take advantage of i5/OS specific resources and capabilities and provides a seamless as it is shipped PHP development and runtime environment product supported by Zend and offering tight integration with DB2. The product includes native support for XML and Web services in support of increased adoption of service-oriented architectures (SOA).

More information about the Zend Core for i5/OS is available on the following Web site:

`http://www.zend.com/products/zend_core/zend_for_i5_os`

In addition to the software, you can also find information such as datasheets and white papers on the Zend Core for IBM. For developers it is worth having a look at the Developer Zone which features tutorials, documentation, discussion forums, and much more:

`http://www.zend.com/developers.php`

There is a specific forum for the i5/OS developers, *Zend for i5/OS - Zend products for i5/OS*, which is available at:

`http://www.zend.com/forums/index.php`

8.3.2 PHP version and availability

The Zend Core and Platform for i5/OS support PHP 5.0. Zend Studio for i5/OS is available today for i5/OS customers to start developing PHP applications. You can download Zend Studio for i5/OS at no cost from:

`http://www.zend.com/products/zend_studio`

Zend Core for i5/OS is available today at no cost. You can download it from the following Web site:

`https://www.zend.com/core/oem_registration.php?access_code=IBMi5OS`

For the i5/OS version, Zend provides three years of e-mail based support. Additional support options are available for purchase.

Required i5/OS release

Zend and IBM have delivered Zend Core and Zend Platform for i5/OS V5R3 and V5R4.

8.3.3 Accessing DB2 UDB and i5/OS resources

IBM and Zend are have worked together to deliver the i5/OS toolkit enabling PHP applications to access and use data easily in DB2 UDB for i5/OS. For more information about DB2 access read *PHP: Zend for i5/OS*, SG24-7327.

Furthermore, PHP applications can access easily and use:

- RPG and COBOL OPM and ILE applications in i5/OS
- Data Queue
- User Spaces
- Spooled File
- Active Jobs

- Job Logs
- Data Area
- Object Listing
- System Value

This support is available in Zend Core for i5/OS.

8.3.4 Support for Zend products on i5/OS

Zend provides no cost e-mail based support for Zend Core for i5/OS and Zend Studio for i5/OS for three years. Zend also offers a variety of professional Support Programs for all of their products, ranging from software updates (delivery of major and minor updates, as well as bug and security hot fixes), Web-based support, business hours support, and premium 24x7 phone support.

8.4 The PHP Extension and Application Repository

The PHP Extension and Application Repository (PEAR) is a community-driven collection of open source classes that you can use to generate HTML code, make SOAP requests, create, validate and process HTML forms, send MIME mail, and much more. It was founded by Stig S. Bakken in 1999 and, since then, many people have joined the project.

8.4.1 Why PEAR important for you

PHP and the Zend Core for i5/OS provide many features, but you might find yourself in a situation where the needed functionality is not part of the core system. In general, that is the time when you start developing the missing features yourself.

Instead of doing so, you might first have a look at the PEAR Web site and browse the available categories. Every category includes one or more packages, each with a short description so that you can quickly browse through and eventually find the topic that you need. To give you just a small idea, here is a list of the top-level categories of the available PEAR modules:

- Authentication
- Date and Time
- Database
- Encryption
- Internationalization
- Logging
- Mail
- Networking
- Payment
- Web services
- XML

Again, even if this list already looks interesting, check out the PEAR Web site, because this is just an extract of the available categories. To directly access the list of available packages go to the following Web site:

`http://pear.php.net/packages.php`

8.4.2 Installing PEAR packages

One part of PEAR is a program that is called *pear* also is the PEAR package manager, which helps to download and install additional PEAR packages. i5/OS users can work with PEAR using the command line in PASE from /usr/local/Zend/Core/bin/pear.

8.4.3 Further information on PEAR

Further information on PEAR, its history, the available packages, and more is available at the following URL:

`http://pear.php.net`

If you do not know PEAR yet, we recommend that you read the *About PEAR* section at:

`http://pear.php.net/manual/en/about-pear.php`

8.5 Creating a Web service with PHP

In this section, we discuss SOAP implementations in PHP, how to create PHP Web services, and what is available in Zend Studio for i5/OS to help facilitate Web services development. The first PHP Web service example is a simple service taking a string and integer as input and returning a string as output. The second example is more complex, wrappering an i5/OS program call and returning a complex data type.

8.5.1 PHP SOAP implementations

There is more than one SOAP implementation available for PHP 5. One is *NuSOAP*. NuSOAP is provided by NuSphere and Dietrich Ayala. It is a set of PHP classes. No PHP extensions are required that allow developers to create and consume Web services. We will not discuss NuSOAP here for two reasons:

- It is not part of PEAR
- It is not part of Zend Core for i5/OS

The SOAP implementation that we focus on is the PEAR SOAP Extension. PHP 5's SOAP extension is the first attempt to implement the SOAP protocol for PHP in C. It has some advantages over the existing implementations written in PHP itself, the main one being speed. The extension is currently beta but should become more stable and reliable as time progresses. The SOAP extension implements a large subset of SOAP 1.1, SOAP 1.2, and WSDL 1.1 specifications. The key goal is to use the RPC feature of the SOAP protocol. WSDL is used where possible in order to make the implementation of Web Services more straightforward. Limited documentation is available at:

`http://us2.php.net/manual/en/ref.soap.php`

8.5.2 Zend Studio for i5/OS WSDL Generator

Zend Studio for i5/OS includes a WSDL Generator tool (see Figure 8-2). This tool is useful in the creation of WSDL files for a Web service, but it does have its limitations. The greatest limitation is that for the WSDL Generator to create the WSDL for a given PHP Web service, it needs more information than a PHP file normally includes because of the nature of PHP being a weakly-typed language. The additional needed information can be added to the code in the form of comments and additional classes with the appropriate comments.

Unfortunately, the WSDL Generator tool and the PHP syntax needed to support it are poorly documented. The PHP Web services examples in this chapter provide working examples of the format and syntax.

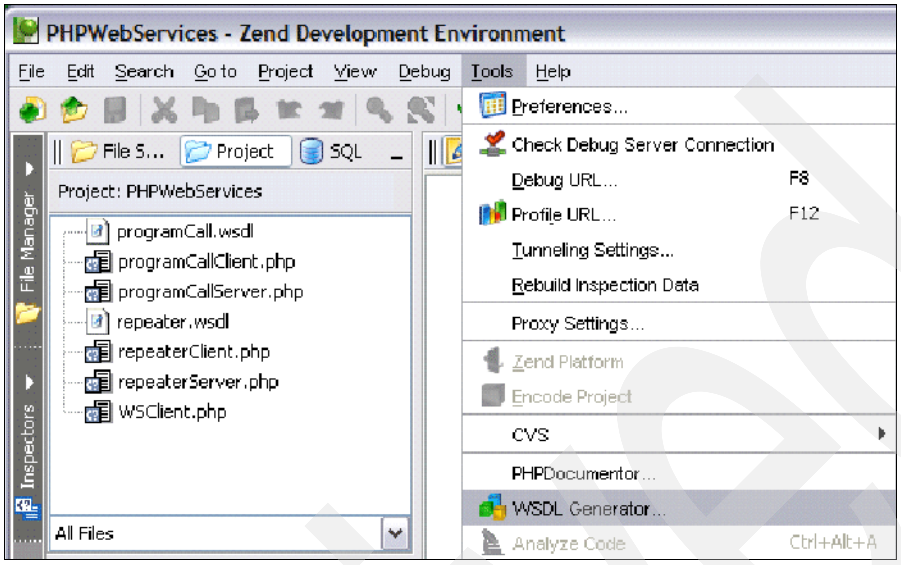


Figure 8-2 Zend Studio for i5/OS WSDL Generator is available from the Tools menu

Note: Use i5 toolkit templates (Web Service wrapper template) that are included in Zend Studio 5.5 for i5/OS to overcome limitations described in this section.

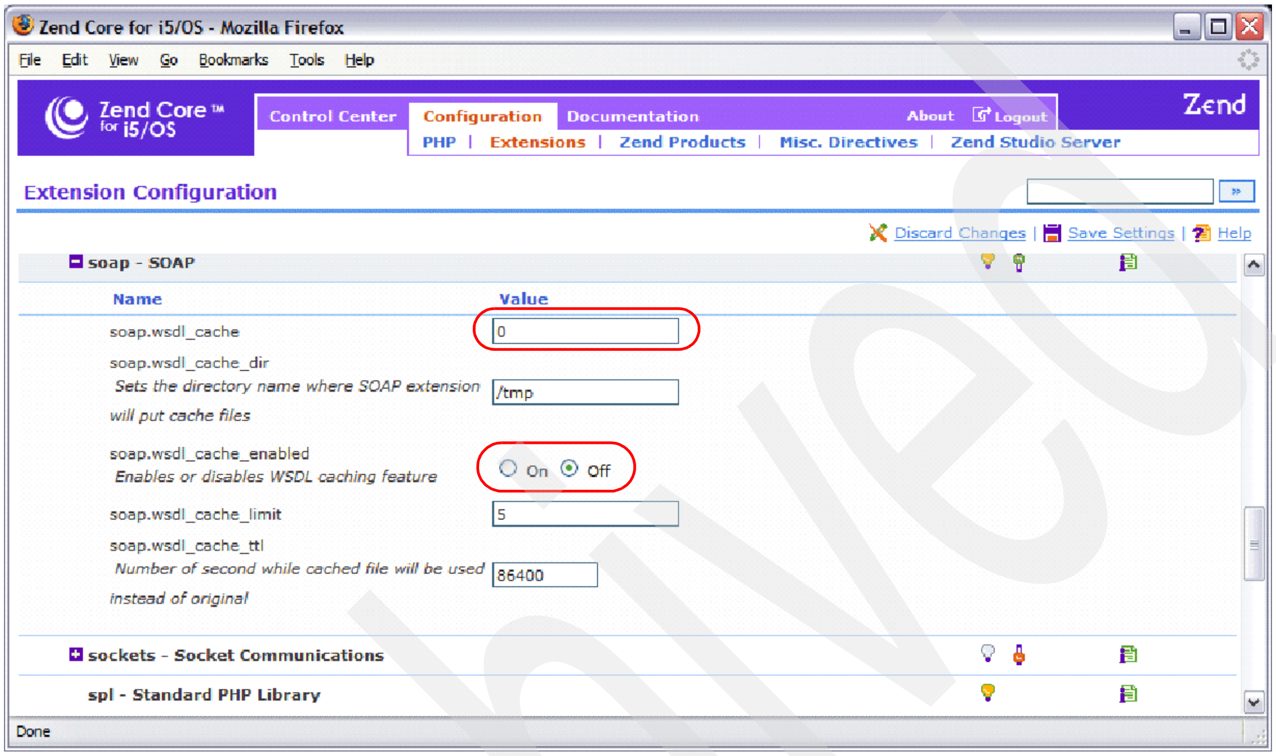
8.5.3 SOAP cache

Before developing a PHP Web service with the SOAP extension, it is important to disable the WSDL cache. If the SOAP WSLD cache is not disabled, the WSLD is cached for a period of time, even if the WSDL file is updated during development.

Go to the Zend Core Web Administration Console at (using default port number) and log in:

```
http://<host_name>:89/ZendCore
```

Click the Configuration tab and then the Extensions tab (see Figure 8-3). Find and expand the **SOAP** extension. Disabling the cache is shown in Figure 8-3 by setting `soap.wsdl_cache = 0` and `soap.wsdl_cache_enabled = off`. When development of the Web services is complete and the WSDL fill will no longer be altered, you need to re-enable the cache for better performance.


Zend Core for i5/OS - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
Zend Core for i5/OS
Control Center Configuration Documentation About Logout
Zend
PHP | Extensions | Zend Products | Misc. Directives | Zend Studio Server
Discard Changes | Save Settings | Help
Done

Extension Configuration

soap - SOAP

Name	Value
soap.wsdl_cache	0
soap.wsdl_cache_dir Sets the directory name where SOAP extension will put cache files	/tmp
soap.wsdl_cache_enabled Enables or disables WSDL caching feature	On [✓ Off]
soap.wsdl_cache_limit	5
soap.wsdl_cache_ttl Number of second while cached file will be used instead of original	86400

sockets - Socket Communications

spl - Standard PHP Library

Figure 8-3 Configuration for SOAP Extension in Zend Core for i5/OS console

8.5.4 Creating a simple Web service from PHP

We created this example using Zend Core Version 1.6.0, PHP Version 5.1.6. In this example, you create a simple PHP Web service using the SOAP extension in Zend Core for i5/OS that takes a string and an integer as input and returns a string. The Repeater Web service has two functions. The first repeats a string of text a number of times, and the second reverses a string and repeats it a number of times. Notice the syntax of the comment blocks in the `repeat` and `reverseRepeat` functions in Example 8-8. It is these comments in this specific format that the WSDL Generator needs to generate the WSDL for the Repeater Web service.

Example 8-8 repeatServer.php Web service source code

```
<?php
class Repeater{

   /**
    * Repeats a string of text a number of times
    *
    * @param string $text
    * @param integer $times
    * @return string
    */
   function repeat($text, $times){
      return str_repeat($text,$times);
   }

   /**
    * Reverses a string of text and repeats it a number of times
    *
    * @param string $text
    * @param integer $times
    * @return string
    */
   function reverseRepeat($text,$times){
      return $this->repeat(strrev($text),$times);
   }
}

//Expose as a web service
$server = new SoapServer("repeater.wsdl");
$server->setClass('Repeater');
$server->handle();
?>
```

To use file in the WSDL Generator Wizard, they must first be part of a Zend Studio for i5/OS project. You can add these files when creating a new project:

1. Select **Project** → **New Project** from the menu in Zend Studio for i5/OS (see Figure 8-4).

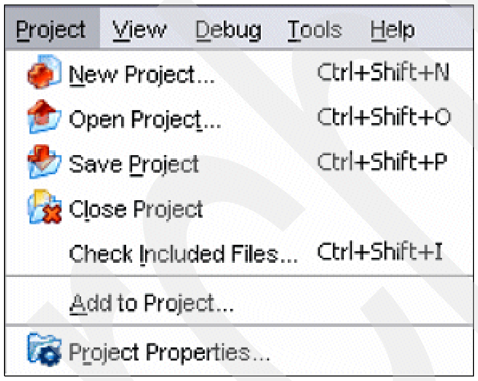

Project View Debug Tools Help
New Project... Ctrl+Shift+N
Open Project... Ctrl+Shift+O
Save Project Ctrl+Shift+P
Close Project
Check Included Files... Ctrl+Shift+I
Add to Project...
Project Properties...

Figure 8-4 Project menu in Zend Studio for i5/OS

2. In the Editor window, enter the source code for the repeatServer.php file as shown in Example 8-8 on page 182.
3. Save this file on a server where you installed Zend Core for i5/OS. When you have written the Web service and added the files to a project, you can use the WSDL Generator in Zend Studio for i5/OS to create the associated WSDL file.
4. To launch the WSDL Generator Wizard select **Tools** → **WSDL Generator** from the Zend Core for i5/OS menu (see Figure 8-5).

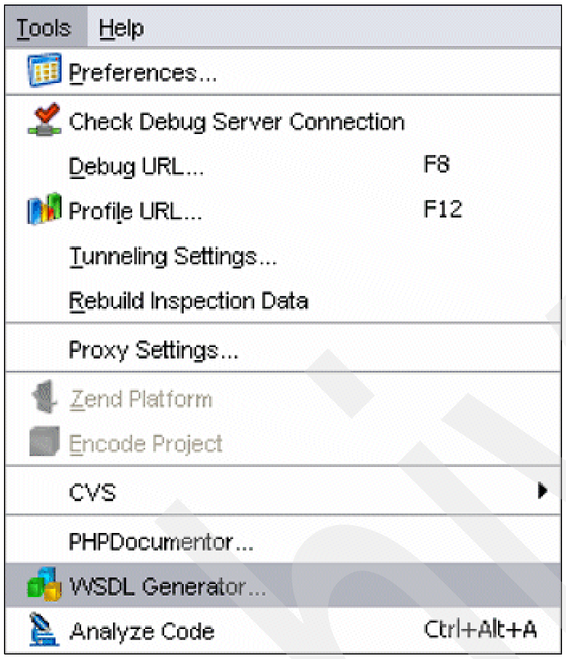
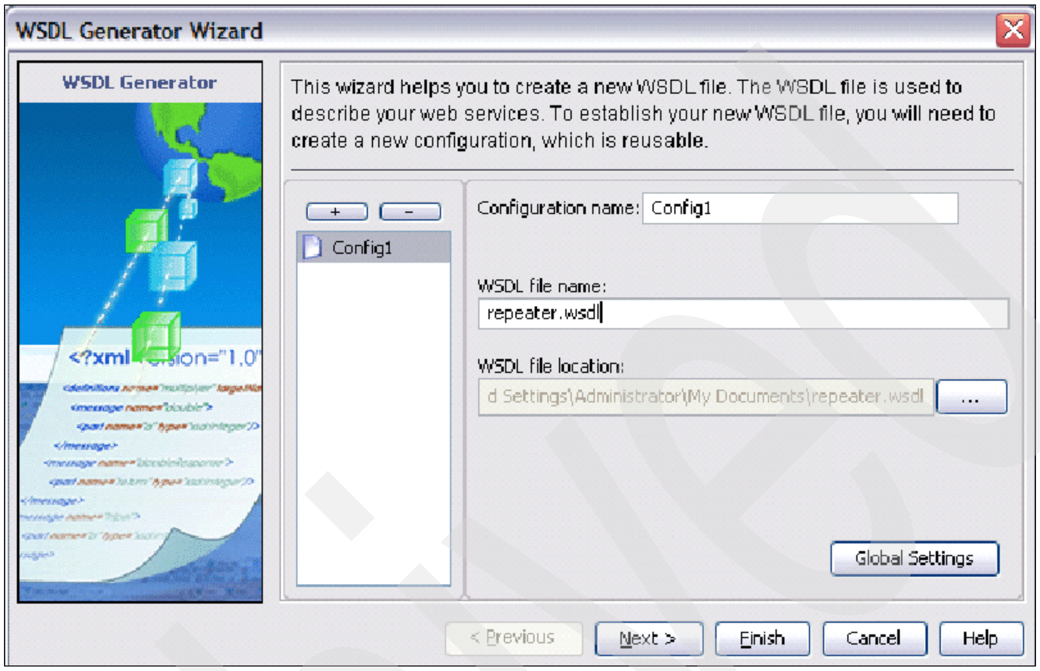


Figure 8-5 WSDL Generator on the Zend Studio for i5/OS Tools menu

5. In the first panel of the WSDL Generator Wizard, set the configuration name and the WSDL file name. For this example, we left the configuration name as the default and set the WSDL file name to `repeater.wsdl` (as shown in Figure 8-6), the same as in repeatServer.php. Click **Next**.



This wizard helps you to create a new WSDL file. The WSDL file is used to describe your web services. To establish your new WSDL file, you will need to create a new configuration, which is reusable.

Configuration name: Config1

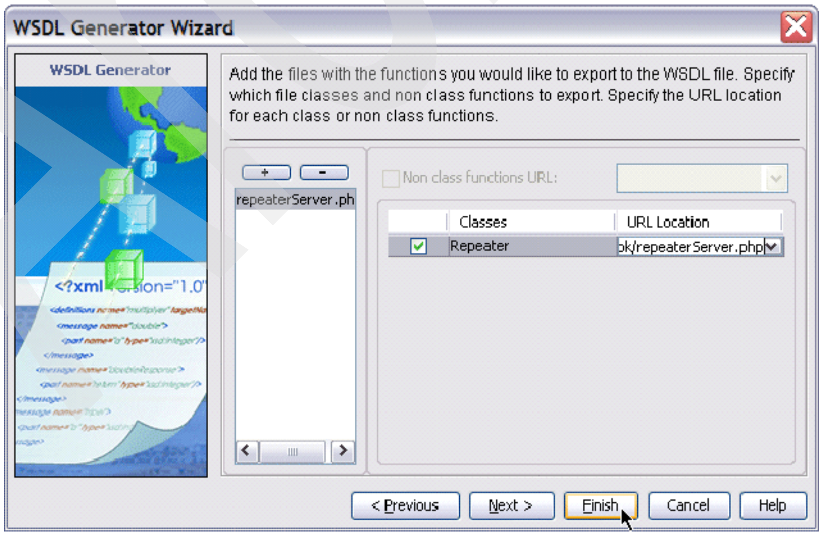
WSDL file name: repeater.wsdl

WSDL file location: d Settings\Administrator\My Documents\repeater.wsdl

Figure 8-6 WSDL Generator Wizard, setting the configuration name and the WSDL file name

6. The next window in the WSDL Generator Wizard requires that you to point it to the PHP files that include the functions and classes that you want incorporated into the WSDL file (Figure 8-7). In this example, click the plus (**+**) button and select **repeaterServer.php**. Then, select the **Repeater** class.

7. Now, you need to add the URL Location. This is the URL where the PHP file is hosted by Zend Core for i5/OS. Then, click **Finish**.



Add the files with the functions you would like to export to the WSDL file. Specify which file classes and non class functions to export. Specify the URL location for each class or non class functions.

repeaterServer.ph

Non class functions URL:

	Classes	URL Location
✓	Repeater	ok/repeaterServer.php

Figure 8-7 WSDL Generator Wizard, adding the files and classes to be exported to the WSDL

The WSDL Generator Wizard saves the WSDL file that it creates to the local drive. In these examples, the WSDL file is referenced by a relative location, assuming that it is in the same directory as the Web service and the Web service client. So, you need to save the file to the same directory as the other PHP files on the System i server, /www/zendcore/htdocs by default. In subsequent runs of the WSDL Generator Wizard the existing WSDL file can be pointed at in the WSDL file name field, in which case the new WSDL is created in the correct directory.

When you click **Finish** (see Figure 8-7), the generated WSDL file is opened in the editor window. See listing in Example 8-9. Notice that the information included in the comments of repeaterServer.php is incorporated into the WSDL. You should not have to edit the WSDL file directly. If you change your PHP file, just rerun the WSDL Generator Wizard to update the WSDL file.

The generated WSDL file also points to the location of the Web service (highlighted). This is the URL that you typed in Figure 8-7.

Example 8-9 The repeater.wsdl file

```
<?xml version='1.0' encoding='UTF-8'?>

<!-- WSDL file generated by Zend Studio. -->

<definitions name="repeater.wsdl" targetNamespace="urn:repeater.wsdl"
xmlns:typens="urn:repeater.wsdl" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/" xmlns="http://schemas.xmlsoap.org/wsdl/">
   <message name="repeat">
      <part name="text" type="xsd:string"/>
      <part name="times" type="xsd:integer"/>
   </message>
   <message name="repeatResponse">
      <part name="repeatReturn" type="xsd:string"/>
   </message>
   <message name="reverseRepeat">
      <part name="text1" type="xsd:string"/>
      <part name="times1" type="xsd:integer"/>
   </message>
   <message name="reverseRepeatResponse">
      <part name="reverseRepeatReturn" type="xsd:string"/>
   </message>
   <portType name="RepeaterPortType">
      <operation name="repeat">
         <documentation>
            Repeats a string of text a number of times
         </documentation>
         <input message="typens:repeat"/>
         <output message="typens:repeatResponse"/>
      </operation>
      <operation name="reverseRepeat">
         <documentation>
            Reverses a string of text and repeats it a number of times
         </documentation>
         <input message="typens:reverseRepeat"/>
         <output message="typens:reverseRepeatResponse"/>
      </operation>
   </portType>
   <binding name="RepeaterBinding" type="typens:RepeaterPortType">
      <soap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
      <operation name="repeat">
         <soap:operation soapAction="urn:RepeaterAction"/>
         <input>
            <soap:body namespace="urn:repeater.wsdl" use="encoded" 
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
         </input>
         <output>
            <soap:body namespace="urn:repeater.wsdl" use="encoded" 
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
         </output>
      </operation>
      <operation name="reverseRepeat">
         <soap:operation soapAction="urn:RepeaterAction"/>
         <input>
            <soap:body namespace="urn:repeater.wsdl" use="encoded" 
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
         </input>
         <output>
            <soap:body namespace="urn:repeater.wsdl" use="encoded" 
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
         </output>
      </operation>
   </binding>
   <service name="repeater.wsdlService">
      <port name="RepeaterPort" binding="typens:RepeaterBinding">
         <soap:address location="http://myServer:89/WSRedbook/repeatServer.php"/>
      </port>
   </service>
</definitions>
```

We explain the client code that uses the generated WSDL in 11.1.2, “Consuming the Repeater PHP Web service” on page 243.

8.5.5 Creating a PHP Web service to wrapper a program call

We created this example using Zend Core Version 1.6.0, PHP Version 5.1.6. In this example, you create a PHP Web service using the SOAP extension in Zend Core for i5/OS that takes three strings as input and returns a Complex Data Type. The ProgramCall Web service has one function. The function takes four parameters (first and last name, account number, and amount) as input, connects to the i5, uses i5_program_call to invoke INCRAMT (CL program). Example 8-10 shows the declaration part of the INCRAMT program.

Example 8-10 Declaration section of the INCRAMT program

```
0001.00              PGM        PARM(&FIRST &LAST &ACCOUNT &AMOUNT)
0002.00              DCL        VAR(&FIRST) TYPE(*CHAR) LEN(15)
0003.00              DCL        VAR(&LAST) TYPE(*CHAR) LEN(15)
0004.00              DCL        VAR(&ACCOUNT) TYPE(*CHAR) LEN(15)
0005.00              DCL        VAR(&AMOUNT) TYPE(*DEC) LEN(5 2)
```

To return the results of INCRAMT, you need to use a complex data type, which is accomplished with the creation of the `MyComplexDataType` {} class (see listing in Example 8-11). Notice the syntax of the comment blocks above the variables in the `MyComplexDataType` class. Also notice that `MyComplexDataType` is referenced in the comments of the function `callINCRAMT`. It is these comments in this specific format that the WSDL Generator need to generate the WSDL for the ProgramCall Web service.

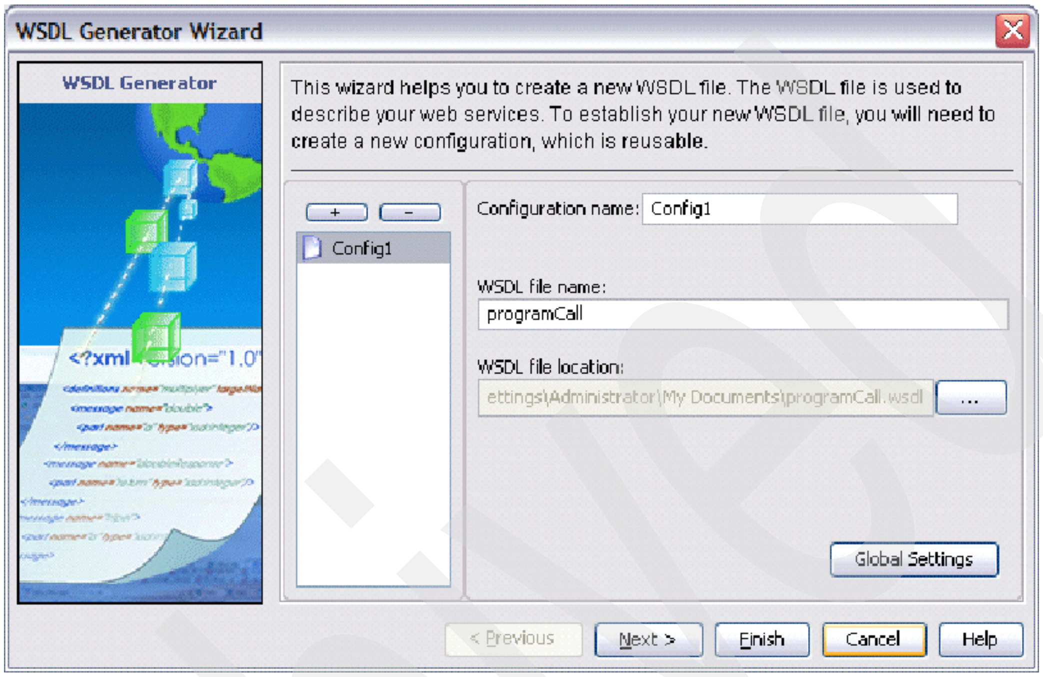
The most important parts of the PHP file are highlighted in Example 8-11.

Example 8-11 programCallServer.php source code for ProgramCall Web service

```
<?php
class MyComplexDataType {
   /**
    *
    * @var string
    */
   public $first;
   /**
    *
    * @var string
    */
   public $last;
   /**
    *
    * @var string
    */
   public $account;
   /**
    *
    * @var string
    */
   public $ammount;
}

class ProgramCall{
   /**
    * Returns a complex data type
    *
    * @param string $firstNameInput
    * @param string $lastNameInput
    * @param string $ammountInput
    * @return MyComplexDataType
    */
   function callINCRAMT($firstNameInput,$lastNameInput,$ammountInput){

      /*******************************************************/
      /* Connect to server */
      $conn = i5_connect("localhost", "PHPUSER", "SNAPPLE");
      if (!$conn) die("<br>Connection failed. Error number =".i5_errno()." msg=".i5_errormsg());

      $description = array(
      array("Name"=>"FIRST", "IO"=>I5_IN, "Type"=>I5_TYPE_CHAR, "Length"=>"15"),
      array("Name"=>"LAST", "IO"=>I5_IN, "Type"=>I5_TYPE_CHAR, "Length"=>"15"),
      array("Name"=>"ACCOUNT", "IO"=>I5_OUT, "Type"=>I5_TYPE_CHAR, "Length"=>"15"),
      array("Name"=>"AMOUNT", "IO"=>I5_INOUT, "Type"=>I5_TYPE_PACKED, "Length"=>"5.2")
      );

      $pgm = i5_program_prepare("I5SCHEMA/INCRAMT", $description);
      if (!$pgm) die("<br>Program prepare error. Error number =".i5_errno()."
msg=".i5_errormsg());
      $parmIn = array(
      "FIRST"=>$firstNameInput,
      "LAST"=>$lastNameInput,
      "AMOUNT"=>$ammountInput
      );
      $parmOut = array(
      "FIRST"=>"FIRST",
      "LAST"=>"LAST",
      "ACCOUNT"=>"ACCOUNT",
      "AMOUNT"=>"AMMOUNT"
      );

      $ret = i5_program_call($pgm, $parmIn, $parmOut);
      if (!$ret) die("<br>Program call error. Error number=".i5_errno()." msg=".i5_errormsg());

      /* Close program call */
      i5_program_close($pgm);

      /* Close connection */
      i5_close($conn);
      /***********************************************************/

      $results = new MyComplexDataType();
      $results->first = $FIRST;
      $results->last = $LAST;
      $results->account = $ACCOUNT;
      $results->ammount = $AMMOUNT;
      return $results;
   }
}

//Expose as a web service
$server = new SoapServer("programCall.wsdl");
$server->setClass('ProgramCall');
$server->handle();
?>
```

After creating the programCallServer.php the WSDL Generator Wizard, you need to create the WSDL:

1. Select **Tools** → **WSDL Generator**. For this example we use `programCall` for the WSDL file name (see Figure 8-8). Click **Next**.



This wizard helps you to create a new WSDL file. The WSDL file is used to describe your web services. To establish your new WSDL file, you will need to create a new configuration, which is reusable.

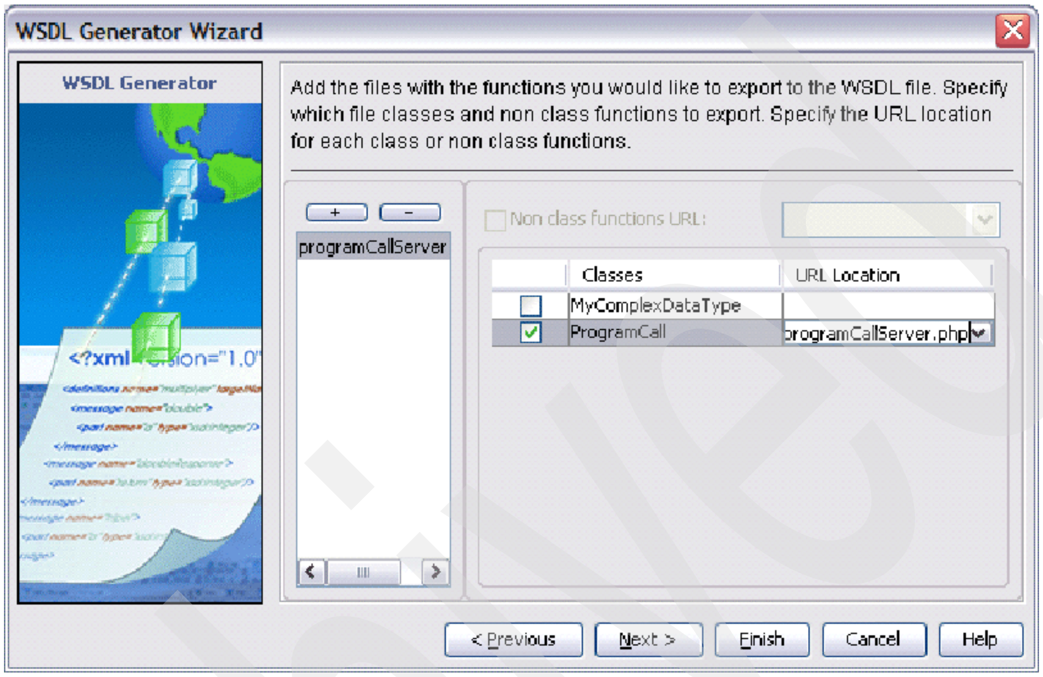
Configuration name: Config1

WSDL file name:
programCall

WSDL file location:
ettings\Administrator\My Documents\programCall.wsdl

Figure 8-8 WSDL Generator Wizard, setting the configuration name and the WSDL file name

2. When programCallServer.php is selected, two classes are available. `MyComplexDataType` was created as an object to return complex data types, not a Web service in itself. So, you should not select it. You need to select ProgramCall and enter the URL Location with the location of the Zend Core for i5/OS host (see Figure 8-9). The URL should point to the location of this PHP file on your Web server. Click **Finish**.



Add the files with the functions you would like to export to the WSDL file. Specify which file classes and non class functions to export. Specify the URL location for each class or non class functions.

programCallServer

	Classes	URL Location
☐	MyComplexDataType	
✓	ProgramCall	programCallServer.php

Figure 8-9 WSDL Generator Wizard, adding the files and classes to be exported to the WSDL

The WSDL created in programCall.wsdl is worth looking at (see Example 8-12). Notice that `MyComplexDataType` is defined in the WSDL. This is possible because of several different things. First, the class `MyComplexDataType` was created, then it was commented in the right format for the WSDL Generator Wizard to parse, and finally `MyComplexDataType` is referenced as `@return MyComplexDataType` in function `callINCRAMT` (see Example 8-11 on page 188).

Example 8-12 The programCall.wsdl file

```
<?xml version='1.0' encoding='UTF-8'?>

<!-- WSDL file generated by Zend Studio. -->

<definitions name="programCall.wsdl" targetNamespace="urn:programCall.wsdl"
xmlns:typens="urn:programCall.wsdl" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/"
xmlns:soapenc="http://schemas.xmlsoap.org/soap/encoding/"
xmlns:wsdl="http://schemas.xmlsoap.org/wsdl/"
xmlns="http://schemas.xmlsoap.org/wsdl/">
   <types>
      <xsd:schema xmlns="http://www.w3.org/2001/XMLSchema"
targetNamespace="urn:programCall.wsdl">
         <xsd:complexType name="MyComplexDataType">
            <xsd:all>
               <xsd:element name="account" type="xsd:string"/>
               <xsd:element name="ammount" type="xsd:string"/>
               <xsd:element name="first" type="xsd:string"/>
               <xsd:element name="last" type="xsd:string"/>
            </xsd:all>
         </xsd:complexType>
      </xsd:schema>
   </types>
   <message name="callINCRAMT">
      <part name="firstNameInput" type="xsd:string"/>
      <part name="lastNameInput" type="xsd:string"/>
      <part name="ammountInput" type="xsd:string"/>
   </message>
   <message name="callINCRAMTResponse">
      <part name="callINCRAMTReturn" type="typens:MyComplexDataType"/>
   </message>
   <portType name="ProgramCallPortType">
      <operation name="callINCRAMT">
         <documentation>
            Returns a complex data type
         </documentation>
         <input message="typens:callINCRAMT"/>
         <output message="typens:callINCRAMTResponse"/>
      </operation>
   </portType>
   <binding name="ProgramCallBinding" type="typens:ProgramCallPortType">
      <soap:binding style="rpc" transport="http://schemas.xmlsoap.org/soap/http"/>
      <operation name="callINCRAMT">
         <soap:operation soapAction="urn:ProgramCallAction"/>
         <input>
            <soap:body namespace="urn:programCall.wsdl" use="encoded"
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
         </input>
         <output>
            <soap:body namespace="urn:programCall.wsdl" use="encoded"
encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"/>
         </output>
      </operation>
   </binding>
   <service name="programCall.wsdlService">
      <port name="ProgramCallPort" binding="typens:ProgramCallBinding">
         <soap:address
location="http://myServer:89/WSRedbook/programCallServer.php"/>
      </port>
   </service>
</definitions>
```

Note: The Zend Studio 5.5.0 for i5/OS includes Web Service wrapper templates enabling calls to any i5/OS program.

Part 3

Implementing Service Consumer

This part demonstrates several examples of how to create a Web service consumer. A *service consumer* invokes a Web service over the Web. A big advantage of Web services is platform independence, which allows you to build a service consumer using many different technologies.

9

IBM Web Services Client for ILE (RPG, C, C++, COBOL)

In i5/OS V5R3, IBM introduced IBM Web Services Client for ILE, which is part of XML Toolkit for iSeries. Web Services Client for ILE provides a set of libraries and Java tools that enable you to build C++ Web service client applications from existing Web Service Description Language (WSDL) files.

In this chapter, we demonstrate an example of creating an RPG program that invokes the ReserveFlight Program Call Web service using Web Services Client for ILE. Using Web Services Client for ILE is one way to enable an RPG program to participate in the SOA.

9.1 RPG as a Web service Client

The opportunity to invoke Web services from ILE applications (RPG or COBOL) has provided a consumable interface with IBM Web Services Client for ILE. In this chapter, we demonstrate an RPG program acting as a Web service client using Web Services Client for ILE.

The Web service that we demonstrate in this chapter is the *ReserveFlight* Web service, which you developed in Chapter 5, "ProgramCall (RPG, Cobol) Web service" on page 35. In this example one of the artifacts of the Web service is a WSDL document. This document is used to create a C++ stub to enable an RPG client code to invoke a Web service as shown in Figure 9-1.

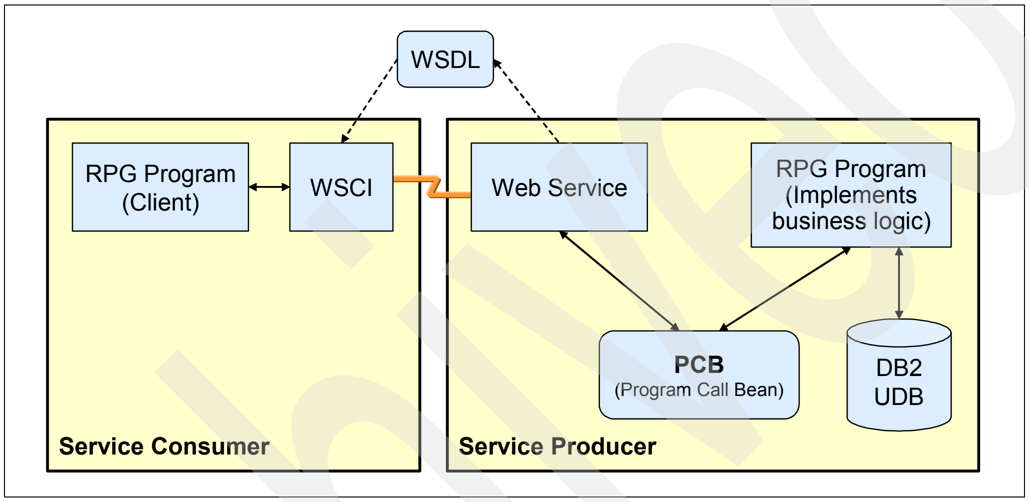


Figure 9-1 RPG as a Web service Client

9.1.1 Development environment

There are several products and PTFs that you need to install prior to running this example. Ensure that the following products are installed and running at latest PTF level.

Prerequisites

This example assumes the following products and options with the latest group PTFs are already present in the environment:

- Qshell, 5722SS1 Option 30
- Host Servers, 5722SS1 Option 12
- IBM Developer Kit for Java, 5722JV1 Options 5 and 6
- IBM Toolbox for Java, 5722JC1
- 5722WDS Option 31 Compiler - ILE RPG IV
- 5722WDS Option 34 Compiler - RPG/400
- 5722WDS, option 52 can be used to compile C and C++ stubs
- 5722WDS, option 51 can be used to compile C only
- 5733XT1, option 9 XML Parser
- 5733XT1, option 12 XML Toolkit - Web services Client for C/C++

Note: PTF's SI2445 and SI24421 for license program 5733XT1 must be installed to correctly generate the Web services C and C++ client.

In addition to the installed software, the Host Servers must be running on the target System i system.

The following products must also be installed on a development machine:

- WebSphere Development Studio Client for iSeries V6.0.1 (use Rational Product Updater to install latest fixes for V6.0.1)
- Firefox 1.0.7 or higher (or equivalent browser)

Skills assumptions

This technical reference assumes the following technical skills and knowledge:

- Experience with and basic knowledge of tools such as Rational Web Developer or WebSphere Development Studio Client
- Basic knowledge of i5/OS operating system administration
- Familiarity with the behavior and operation of the existing application that you want to modernize
- To deploy a Web service client you should possess the System i administrator skills.

Deployment environment

When you have developed an application, you need to have the following prerequisites in your deployment environment:

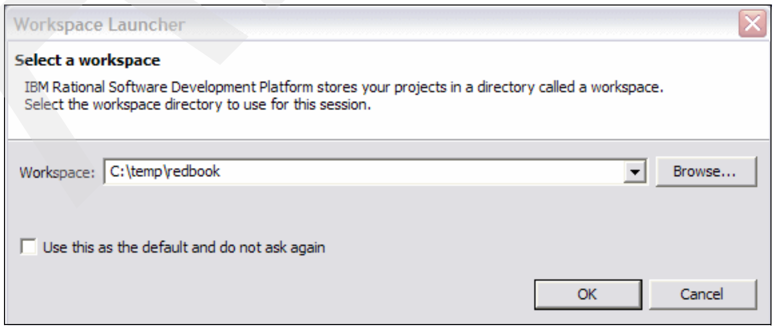
- You have installed and configured WebSphere Application Server - Express, Base, or Network Deployment (on any platform)
- System i platform on which the RPG application is deployed

9.2 ProgramCall bean example

In this example, we demonstrate Web service Client for C and C++ called from RPG and invoking the Web service *ReserveFlight* that you created in Chapter 5, “ProgramCall (RPG, Cobol) Web service” on page 35.

Follow these steps:

1. Go to **Start** → **All Programs** → **IBM Rational** → **IBM WebSphere Development Studio Client for iSeries V6.0** → **WebSphere Development Studio Client for iSeries**.
2. In the Workplace Launcher window in the Workspace field, enter `c:\temp\redbook` and click **OK** as shown in Figure 9-2.


Workspace Launcher

Select a workspace

IBM Rational Software Development Platform stores your projects in a directory called a workspace.
Select the workspace directory to use for this session.

Workspace: C:\temp\redbook

Figure 9-2 Start WebSphere Development Studio client for workspace

9.2.1 Opening the J2EE Perspective

Prepare the WebSphere Development Studio client for iSeries workspace by opening the J2EE perspective:

1. Click **Open perspective icon** on the right hand side or Go to **Window** → **Open Perspective** and select **Other** as shown in Figure 9-3.

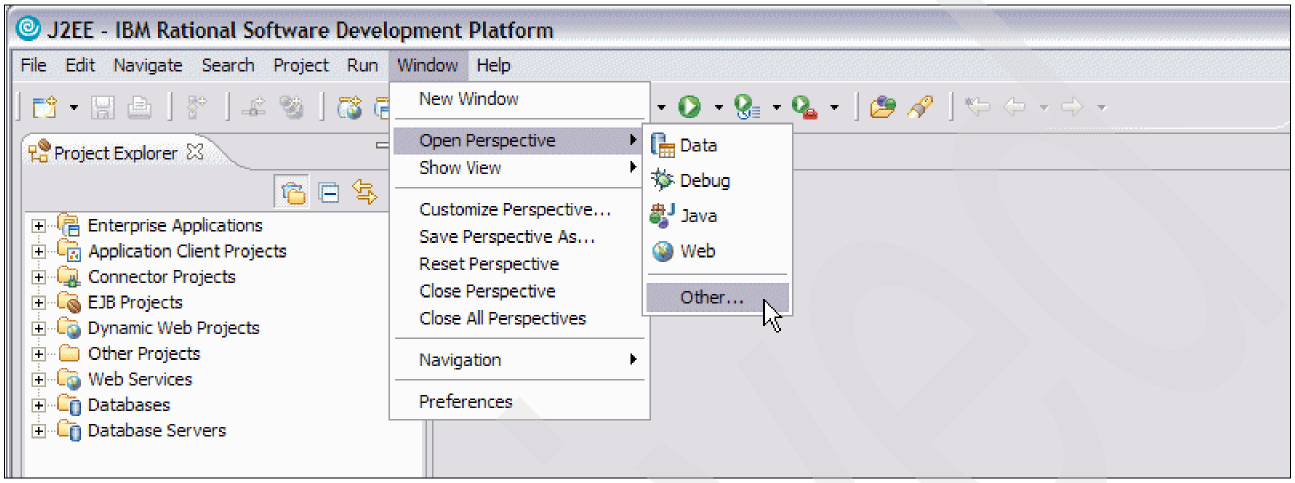


Figure 9-3 Open J2EE Perspective

2. In the Select Perspective window, select **J2EE** and click **OK**.

9.2.2 Examining the WSDL document

Important:

When reviewing the WSDL document, you have two options:

- You can complete the instructions in 5.2.13, “Testing the Web service on System i” on page 68 and then you will have the same structure as described beginning with the steps that we list here.
- Alternatively, you can follow the instructions in 5.2.13, “Testing the Web service on System i” on page 68 but for your own application. In this case, the name and structure of the project will be different.

Review the WSDL document before exporting the document:

1. In Project explorer view, expand **Dynamic web projects** → **WebServiceProject** → **WebContent** → **wsdl** → **iseries** → **wsbeans** → **reserveflight** folder.
2. Double click **RESERVEFLIGHTServices.wsdl** to open in editor window. Graph view shows various elements of WSDL document in graphical format (see Figure 9-4).

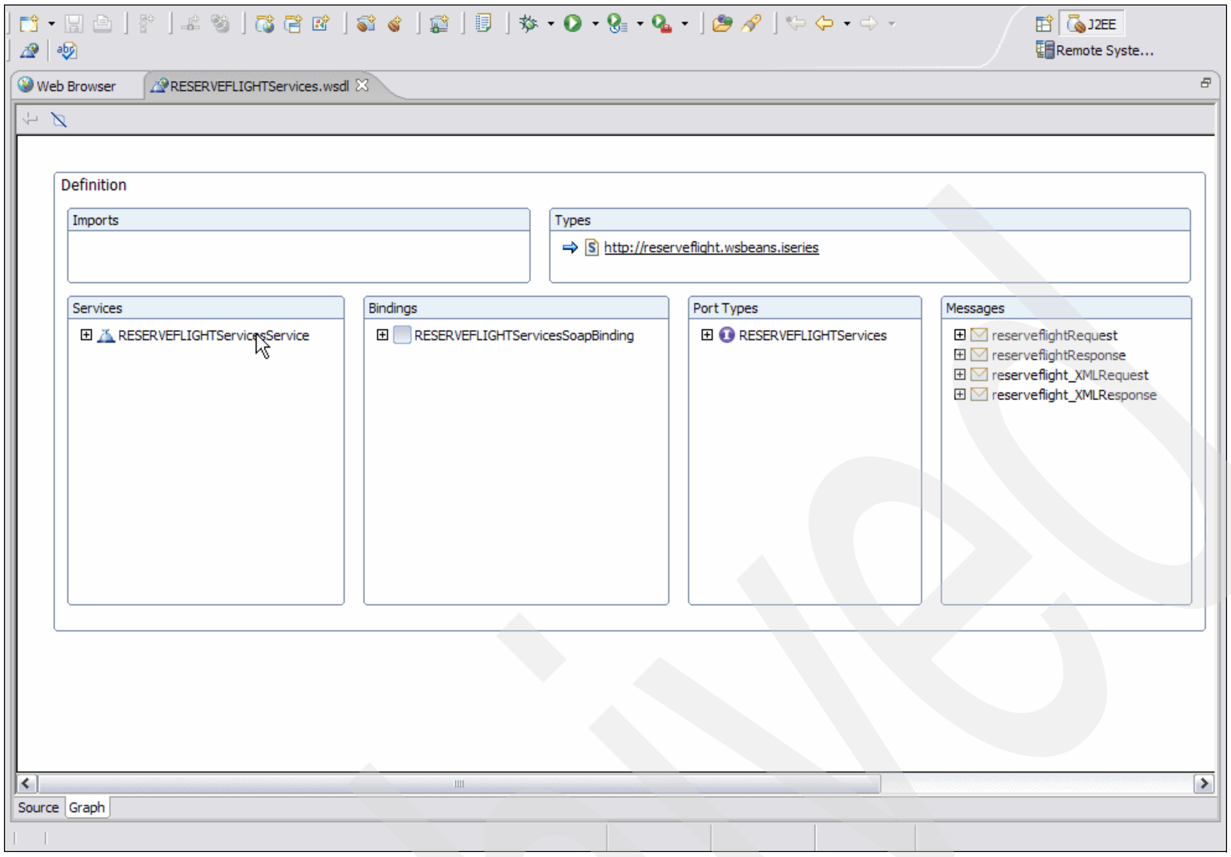
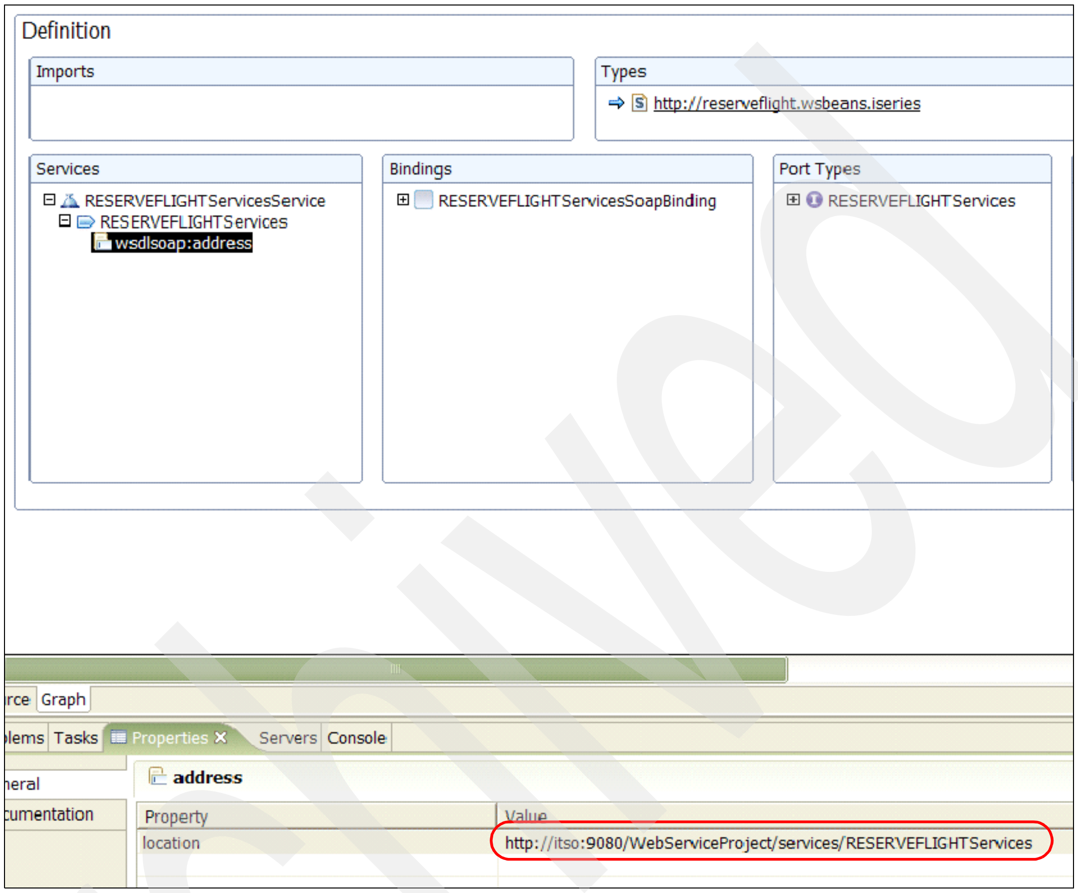


Figure 9-4   ReserveFlight WSDL

3. The WSDL document can be edited in the source view or the graph view. Under services go to **RESERVEFLIGHTServicesService** → **RESERVEFLIGHTServices** and select the **wsdlsoap:address** element. The actual property and its value is shown in the properties view (see Figure 9-5).



Property	Value
location	http://itso:9080/WebServiceProject/services/RESERVEFLIGHTServices

Figure 9-5 Web service URL

4. If you follow the steps in 5.2.8, "Deploying your Web service to WebSphere Application Server for i5/OS" on page 61, the Web service location property should display URL for your Web service deployed on the server as it's shown in our example in Figure 9-5.

   If you have not done the deployment yet, complete all steps in 5.2.8, "Deploying your Web service to WebSphere Application Server for i5/OS" on page 61 before continuing with the remainder of the instructions in this chapter.

9.2.3 Moving the WSDL file to the server

You need to move the WSDL document to System i platform to generate the C stubs and headers. You can copy the WSDL document, or you can open the Remote System Explorer perspective to move the document.

Copying the WSDL document

To copy the WSDL document, follow these steps:

1. In Project explorer view, expand **Dynamic web projects** → **WebServiceProject** → **WebContent** → **wsdl** → **iseries** → **wsbeans** → **reserveflight** folder.
2. Right-click **RESERVEFLIGHTServices.wsdl** and select **Copy** as shown in Figure 9-6.

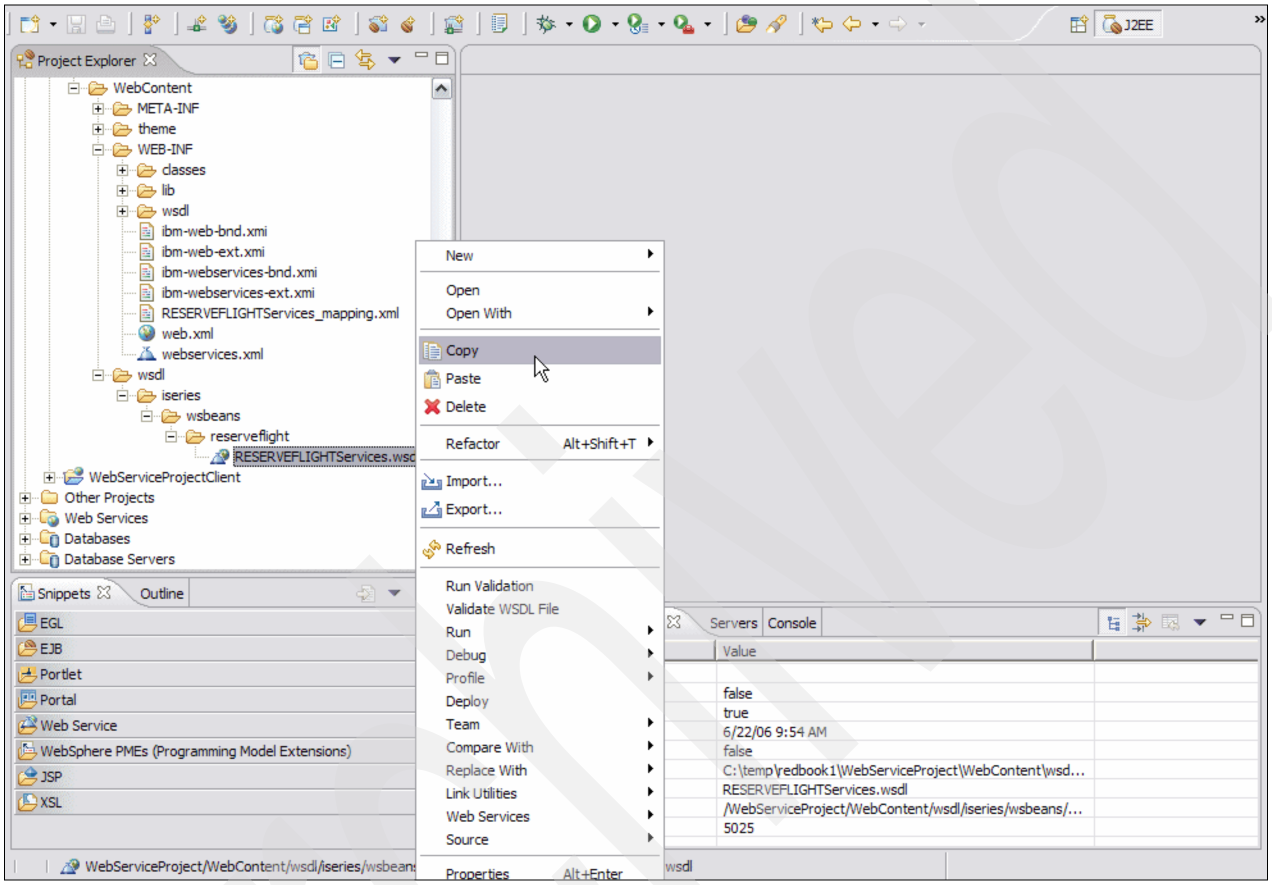


Figure 9-6 Copy WSDL document

Opening the Remote System Explorer perspective

To move the WSDL document using the Remote System Explorer perspective, follow these steps:

1. Click **Open perspective icon** on the right hand side or go to **Window** → **Open Perspective** and select **Other** as shown in Figure 9-7.

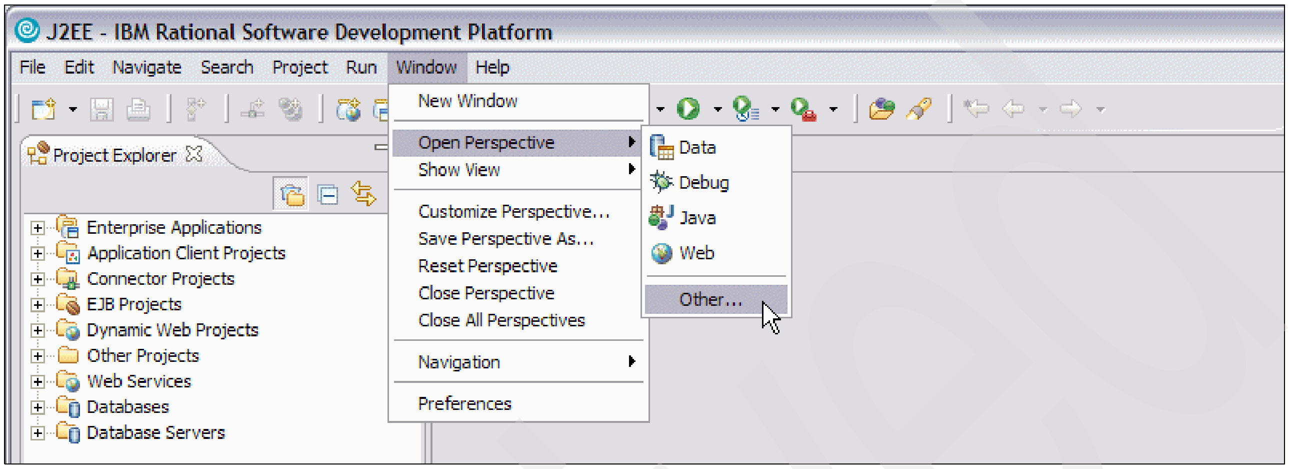


Figure 9-7 Open Remote System Explorer Perspective

2. In the Select Perspective window, select **Remote System Explorer** and click **OK**.
3. In Remote Systems view, expand **<iSeries_Server>** → **IFS Files** → **Home**.
4. Right-click **Home** and select **New** → **Folder** shown in Figure 13-8.

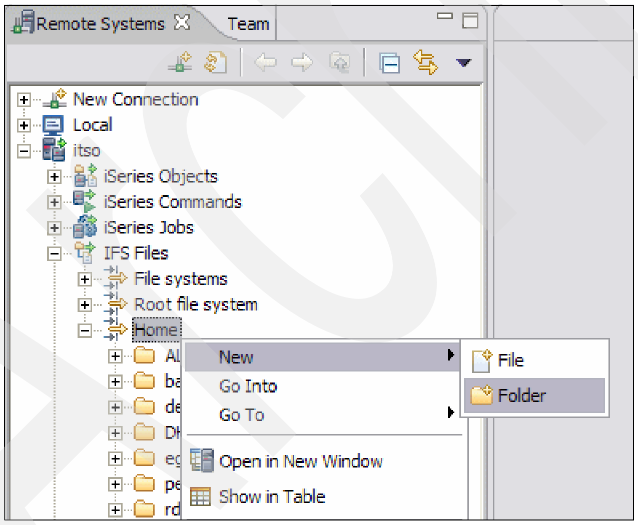
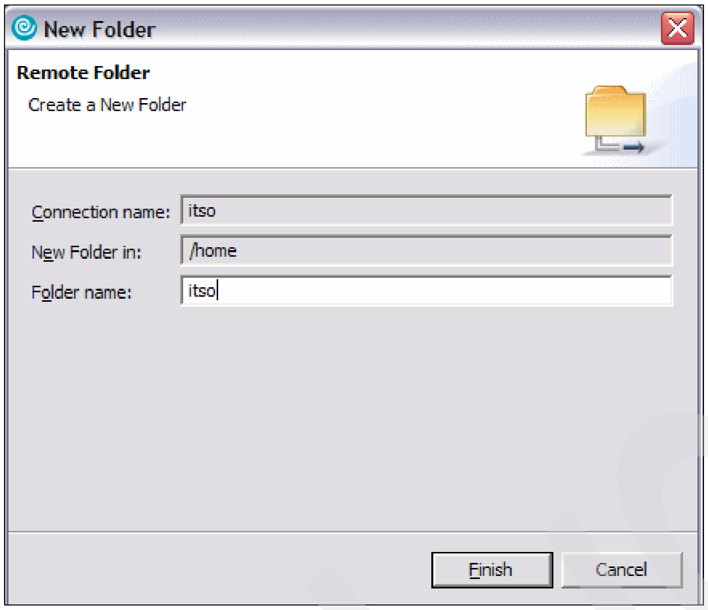


Figure 9-8 New Folder for WSDL file

5. In the Folder Name field enter `itso` and click **Finish** as shown in Figure 9-9.



Connection name: itso
New Folder in: /home
Folder name: itso

Figure 9-9 Folder Name

6. Right-click **itso** and click **Paste** as shown in Figure 9-10.

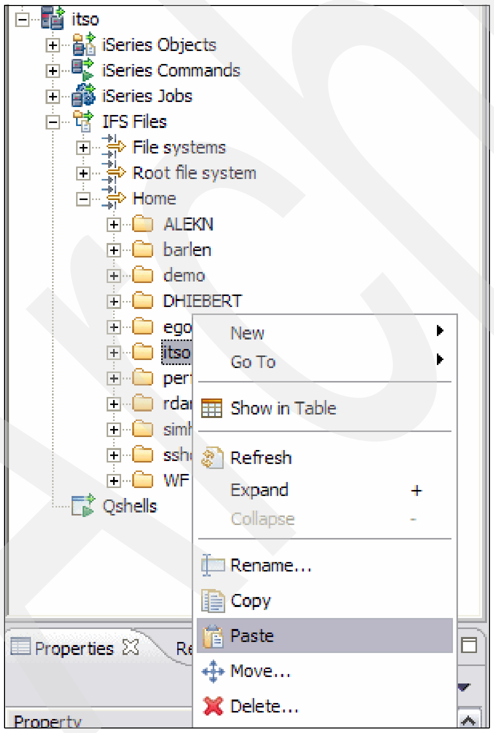


Figure 9-10 Paste WSDL document

9.2.4 Using Web Services Client for ILE to generate WSDL artifacts

The WSDL document is now located in the IFS directory /home/itso of System i server. The Web service Client for C and C++ needs to generate the stubs and headers. These files are used by an RPG program to consume a Web service:

1. Open 5250 client session to System i platform.
2. At the command prompt, enter `QSH`.
3. Run the `cd /home/itso` command.
4. Run the following command:

   ```
   /QIBM/ProdData/xmltoolkit/WSCI-1.0-OS400/bin/wsdl2ws.sh RESERVEFLIGHTServices.wsdl -lc
   ```

5. You should see some output in the terminal window. At the end, you should see the following message:

   ```
   Code generation completed.
   ```

6. Run the `ls` command. You should see generated files.

Note: You can examine the generated code more closely by refreshing the Remote System Explorer view in WebSphere Development Studio client for iSeries, **File** → **Refresh**.

9.2.5 Creating an RPG program to invoke a Web service

Using WebSphere Development Studio client for iSeries, you can now generate an RPG program that consumes the RESERVEFLIGHTServices Web service. The RPG program makes a single reservation:

1. Click **Open perspective icon** on the right hand side or go to **Window** → **Open Perspective** and select **Other** as shown in Figure 9-11.

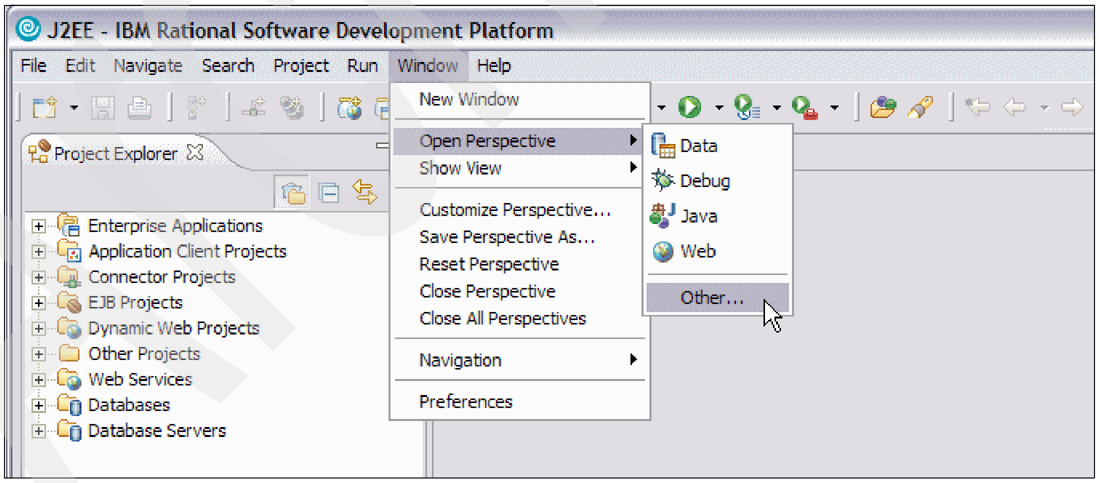


Figure 9-11 Open Remote System Explorer Perspective

2. In the Select Perspective window, select **Remote System Explorer** and click **OK**.
3. In Remote Systems view, expand **<iSeries_Server>** → **iSeries Objects**.

4. Right-click **iSeries Objects** and select **New** → **Library** (see Figure 9-12).

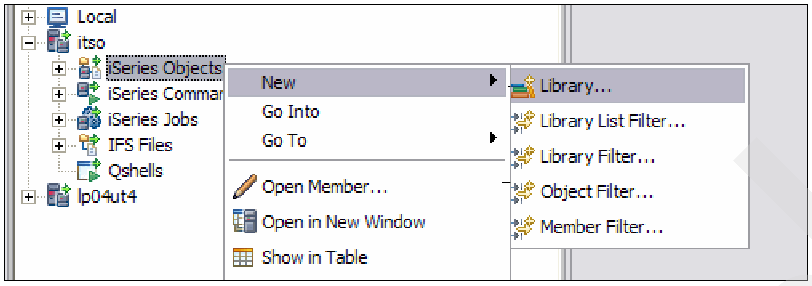
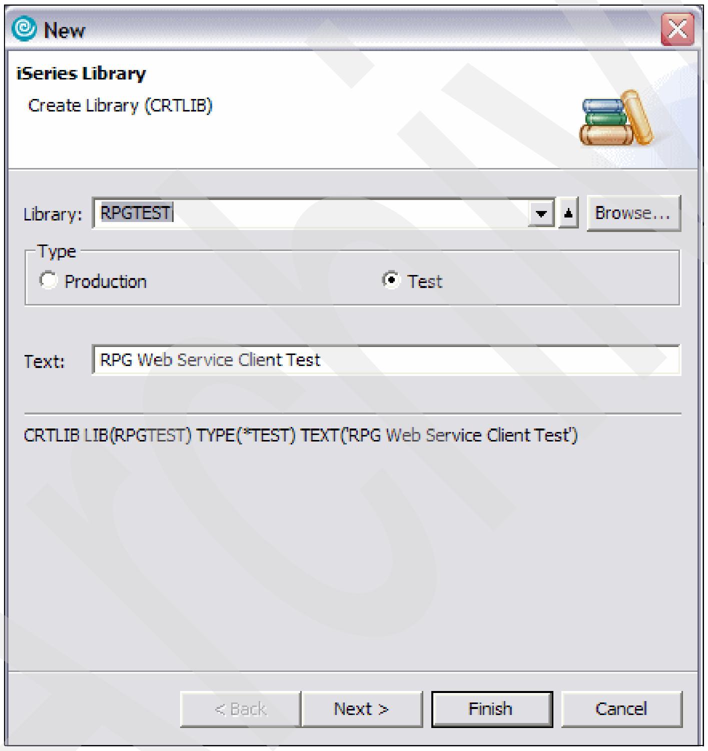


Figure 9-12 New Library

5. On the iSeries Library wizards enter the following:
   a. In Library field, enter `RPGTEST`.
   b. Select **Test**.
   c. In Text field, enter `RPG Web service Client Test`.
   d. Click **Finish** as shown in Figure 9-13.



Library: RPGTEST

Type: Production [✓ Test]

Text: RPG Web Service Client Test

CRTLIB LIB(RPGTEST) TYPE(*TEST) TEXT('RPG Web Service Client Test')

Figure 9-13 Create a New Library

6. Right-click **RPGTEST.*lib.test** and select **New** → **Source Physical File** as shown in Figure 9-14.

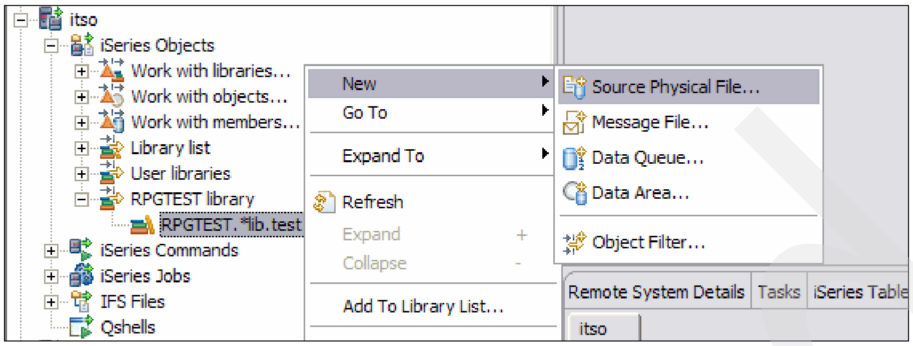
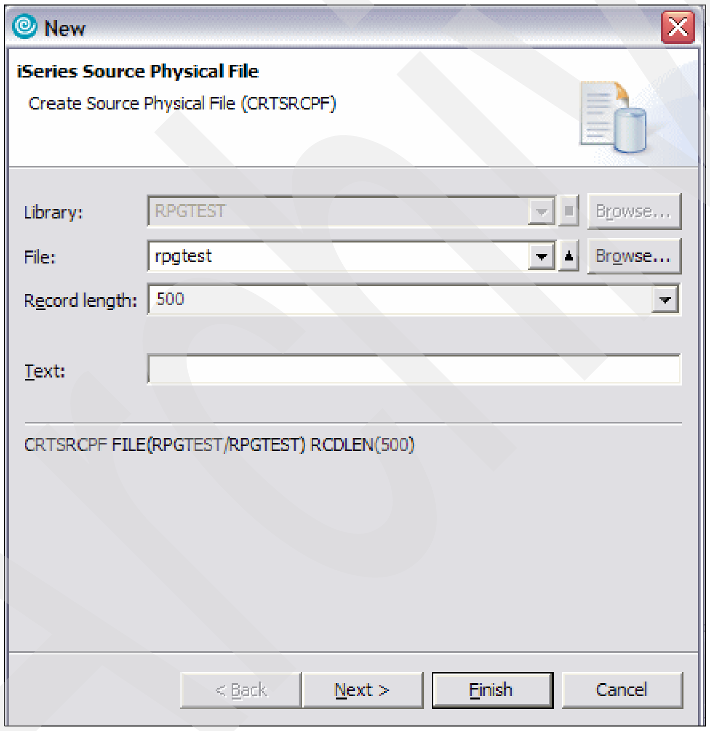


Figure 9-14 New Source Physical File...

7. On iSeries Source Physical File wizard enter the following values and click **Finish** as shown in Figure 9-15:

– File: `QRPGLESRC`
– Record Length: `500`



New

iSeries Source Physical File

Create Source Physical File (CRTSRCPF)

Library:	RPGTEST
File:	rpgtest
Record length:	500
Text:	

CRTSRCPF FILE(RPGTEST/RPGTEST) RCDLEN(500)

Figure 9-15 New source file

8. Right-click **QRPGLESRC.*file.pf-src** and select **New** → **Member** as shown in Figure 9-16.

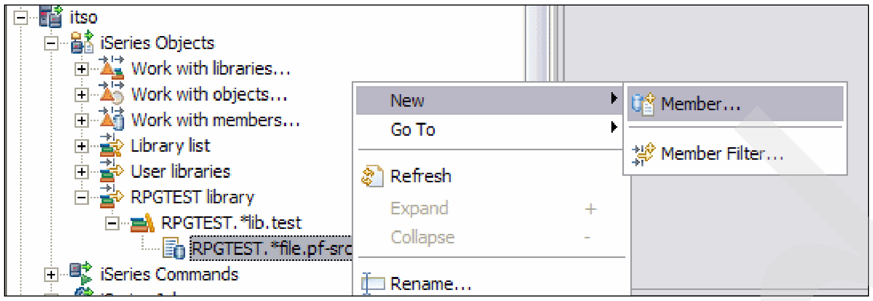
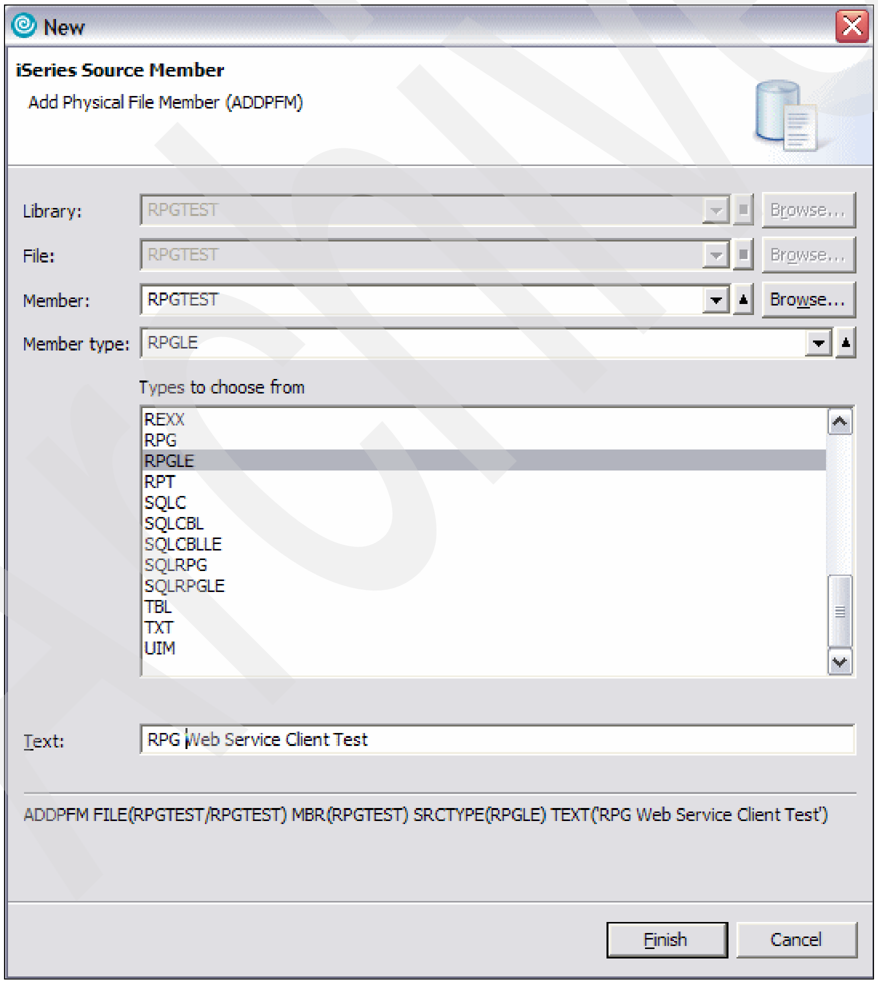


Figure 9-16 Create New Member

9. In the iSeries Source Member enter the following values and click **Finish** (see Figure 9-17):

– Member: `RPGTEST`
– Member Type: `RPGLE`
– Text: `RPG Web service Client Test`


New

iSeries Source Member

Add Physical File Member (ADDPFM)

Library:	RPGTEST
File:	RPGTEST
Member:	RPGTEST
Member type:	RPGLE

Types to choose from

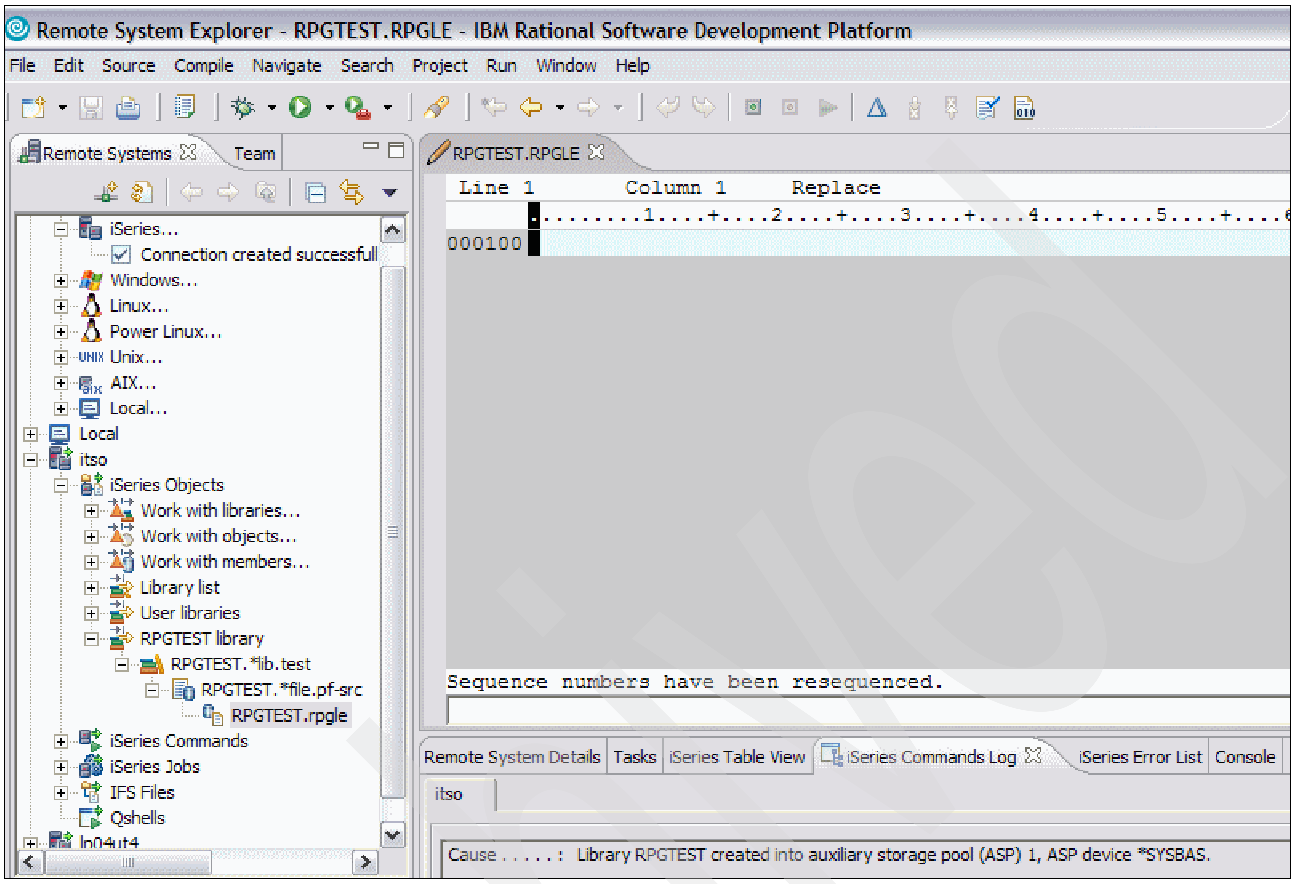
REXX
RPG
RPGLE
RPT
SQLC
SQLCBL
SQLCBLLE
SQLRPG
SQLRPGLE
TBL
TXT
UIM

Text: RPG Web Service Client Test

```
ADDPFM FILE(RPGTEST/RPGTEST) MBR(RPGTEST) SRCTYPE(RPGLE) TEXT('RPG Web Service Client Test')
```

Figure 9-17 Create RPG Source Member

10. RPGTEST.RPGLE opens in the Editor's window (see Figure 9-18).



```
 Line 1        Column 1      Replace
       ........1....+....2....+....3....+....4....+....5....+....
000100
Sequence numbers have been resequenced.
```

Cause . . . . . : Library RPGTEST created into auxiliary storage pool (ASP) 1, ASP device *SYSBAS.

Figure 9-18 RPG Source Editor open in WebSphere Development Studio Client for System i

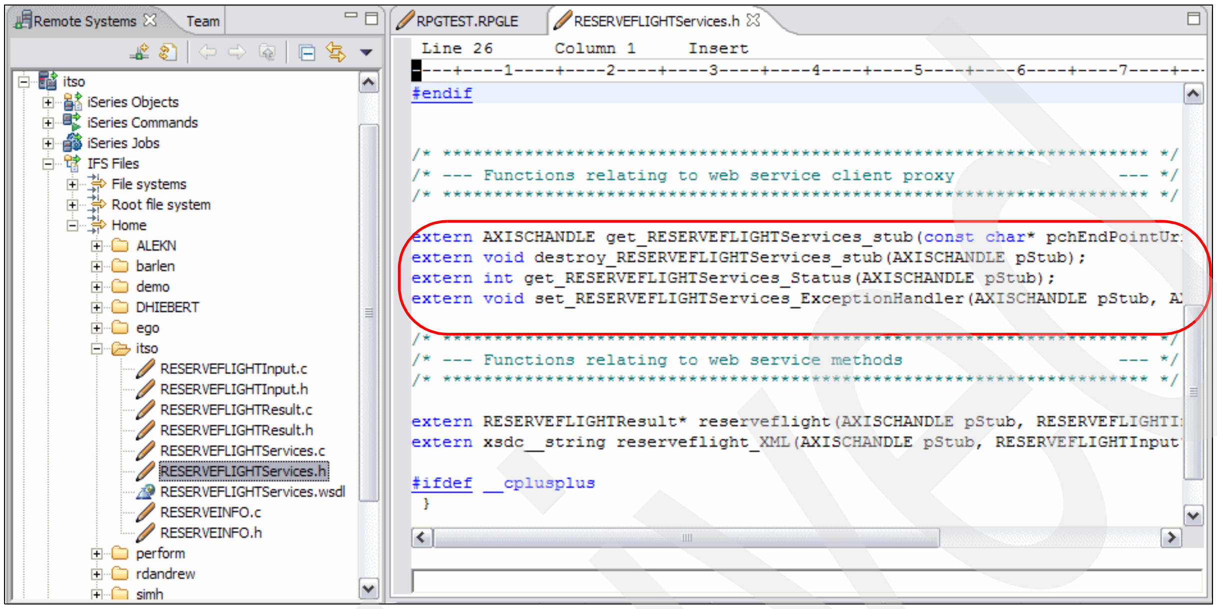
11. In Remote Systems view, expand **<iSeries_Server>** → **IFS Files** → **Home** → **itso**.

12. Double-click **RESERVEFLIGHTServices.h**.

13. Examine the generate code and note C externalized functions (see Figure 9-19):

   – Functions relating to Web service client proxy
   – Functions relating to Web service methods

   These functions will be used by an RPG program to invoke the Web service.



```
 Line 26      Column 1      Insert
-----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+---
#endif


/* ******************************************************************** */
/* --- Functions relating to web service client proxy               --- */
/* ******************************************************************** */

extern AXISCHANDLE get_RESERVEFLIGHTServices_stub(const char* pchEndPointUr
extern void destroy_RESERVEFLIGHTServices_stub(AXISCHANDLE pStub);
extern int get_RESERVEFLIGHTServices_Status(AXISCHANDLE pStub);
extern void set_RESERVEFLIGHTServices_ExceptionHandler(AXISCHANDLE pStub, A

/* ******************************************************************** */
/* --- Functions relating to web service methods                     --- */
/* ******************************************************************** */

extern RESERVEFLIGHTResult* reserveflight(AXISCHANDLE pStub, RESERVEFLIGHTI
extern xsdc__string reserveflight_XML(AXISCHANDLE pStub, RESERVEFLIGHTInput

#ifdef __cplusplus
 }
```

Figure 9-19 Generated C code for RERSERVEFLIGHTServices.h

14. Click the **RPGTEST.RPGLE** tab and copy the source code from Example 9-1. Note how the C stubs are externalized and used throughout the RPG code.

Example 9-1 RPG Source code to invoke Web Services Client for ILE

```
H DFTNAME(GETCINFORP)
      /INCLUDE RPGINCLUDE
      ********************************************
     D RFLInput        DS
      ********************************************
     D AgentNumber1                    *
     D CustNumber1                     *
     D FlightNumber1                   *
     D DepartDate1                     *
     D DepartTime1                     *
     D Tickets1                        *
     D ServiceClass1                   *
     D
      *
     D AgentNumber                   9B 0
     D CustNumber                    9B 0
     D FlightNumber                  8
     D DepartDate                    9
     D DepartTime                    9
     D Tickets                       4F
     D ServiceClass                  2
      *
     DgetStub          PR              *   ExtProc('get_RESERVEFLIGHTServices_+
     D                                     stub')
```

```
D pEndpoint                       *   Value
 *
 *
DgetRFlight       PR              *   ExtProc('reserveflight_XML')
D pRFLWS                          *   Value
D pRFLInput                       *   Value
 *
 *
DdestroyStub      PR                  ExtProc('destroy_RESERVEFLIGHTServi+
D                                     ces_stub')
D pCityInfoWS                     *   Value
 *
DdestroyParm      PR                  ExtProc('axiscAxisDelete')
D value                           *   Value
D description                    9B 0 Value
 *
 *
 *
D RFLWS           S               *
D RFLInput1       S               *
D Endpoint        S            100A
D pOrderXML       S               *
D OrderXML        S            120A
D Output          S             52A
 *
C                   eval      AgentNumber = 5
C                   eval      CustNumber = 500
C                   eval      FlightNumber = '5191135' + X'00'
C                   eval      DepartDate = '12/11/08' + X'00'

C                   eval      DepartTime = '7:12 AM' + X'00'
C                   eval      Tickets    = 3
C
C                   eval      ServiceClass   = '1' + X'00'
 *
C                   eval      AgentNumber1 = %addr(AgentNumber)
C                   eval      CustNumber1 = %addr(CustNumber)
C                   eval      FlightNumber1 = %addr(FlightNumber)
C                   eval      DepartDate1 = %addr(DepartDate)
C                   eval      DepartTime1 = %addr(DepartTime)
C                   eval      Tickets1    = %addr(Tickets)
C                   eval      ServiceClass1   = %addr(ServiceClass)
 *
C                   eval      Endpoint = 'http://itso:9080' +
C                                        '/WebServiceProject/services'+
C                                        '/RESERVEFLIGHTServices' + X'00'
C                   eval      RFLWS = getStub(%Addr(Endpoint))
C                   eval      RFLInput1 = %Addr(RFLInput)
C                   eval      pOrderXML = getRFlight(
C                                    RFLWS :
C                                    %addr(RFLInput1))
C                   eval      OrderXML = %str(pOrderXML)
C                   if        (OrderXML <> *blanks)
C                   movel     *blanks       field            52
C                   eval      Output = 'The order information: '
```

```
     C                   eval      field = %subst(OrderXML:61:7)
     C*
     C     Output        dsply
     C     field         dsply
     C                   else
     C                   eval      Output = 'There is no order information '
     C     Output        dsply
     C                   endif
     C                   callp     axiscAxisDelete(pOrderXML:XSDC_STRING)
     C                   eval      pOrderXML=*NULL
     C                   callp     destroyStub(RFLWS)
     C                   seton                                        lr
```

Important: You need to adjust the value of `itso:9080` for the correct values for your System i platform and WebSphere Application Server profile values.

Web Services Client for ILE INCLUDE file for RPG

The RPGINCLUDE file has been created to import some RPG constants and RPG functions that is common to running Web service Client in RPG Service Programs (see Example 9-2).

Note: In our example source code, we used the RPGINCLUDE file for `axiscAxisDelete(pOrderXML:XSDC_STRING)` function. The function deletes the return values after they have been processed so as not to create a memory leak for the RPG program.

Review the WSCI-1.0.pdf for memory considerations. The file is located at `/QIBM/ProdData/xmltoolkit/WSCI-1.0-OS400/docs/WSCI-1.0.pdf` and can be access using a mapped drive or FTP.

Example 9-2 RPGINCLUDE

```
* LICENSE AND DISCLAIMER
      * ----------------------
      * This material contains IBM copyrighted sample programming
      * source code ( Sample Code ).
      * IBM grants you a nonexclusive license to compile, link,
      * execute, display, reproduce, distribute and prepare derivative
      * works of this Sample Code.  The Sample Code has not been
      * thoroughly tested under all conditions.  IBM, therefore, does
      * not guarantee or imply its reliability, serviceability, or
      * function. IBM provides no program services for the Sample Code.
      *
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      * MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND
      * NON-INFRINGMENT ARE EXPRESSLY DISCLAIMED.
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      * INDIRECT, SPECIAL OR OTHER CONSEQUENTIAL DAMAGES FOR ANY USE OF
      * THE SAMPLE CODE INCLUDING, WITHOUT LIMITATION, ANY LOST
      * PROFITS, BUSINESS INTERRUPTION, LOSS OF PROGRAMS OR OTHER DATA
      * ON YOUR INFORMATION HANDLING SYSTEM OR OTHERWISE, EVEN IF WE
      * ARE EXPRESSLY ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.
```

```
 *
 * COPYRIGHT
 * ---------
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 * by GSA ADP Schedule Contract with IBM Corp.
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 * license.
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 * you may not use this file except in compliance with the
 * License.  You may obtain a copy of the License at
 *
 *      http://www.apache.org/licenses/LICENSE-2.0
 *
 * Unless required by applicable law or agreed to in writing,
 * software distributed under the License is distributed on an
 * "AS IS" BASIS, WITHOUT WARRANTIES OR CONDITIONS OF ANY KIND,
 * either express or implied.
 * See the License for the specific language governing
 * permissions and limitations under the License.
 *
 * ===================================================================
 *
 * The following interfaces define the IBM Web Services Client for ILE
 * C-stub (partial) APIs.
 *

 * ===================================================================
 * Prototypes and definitions from axis/Axis.h (partial)
 * ===================================================================

D* ----------------------------------------------------------------
D*  Delete datatype storage, required to free memory resources
D*  returned by deserializer.
D* ----------------------------------------------------------------
D axiscAxisDelete...
D                 PR            10I 0 EXTPROC('axiscAxisDelete')
D*                                    Returns return code 0=success
D  XSDPTR                         *   VALUE
D*                                    xsd type to delete
D  XSDTYPE                      10I 0 VALUE
D*                                    xsd type

D* ----------------------------------------------------------------
D*  Allocate storage for dataype.
D* ----------------------------------------------------------------
D axiscAxisNew...
D                 PR              *   EXTPROC('axiscAxisNew')
```

```
D*                                     Returns pointer to storage
D  XSDTYPE                      10I 0 VALUE
D*                                     Object type
D  LENGTH                       10I 0 VALUE
D*                                     Length (0 for non-char buffers)

D* ------------------------------------------------------------------
D*  Register exception handler routine.
D* ------------------------------------------------------------------
D axiscAxisRegisterExceptionHandler...
D                 PR                   EXTPROC('axiscAxisRegisterException+
D                                      Handler')
D  FUNCPTR                         *   VALUE
D*                                     Function pointer


 * ====================================================================
 * Prototypes and definitions from axis/GDefine.h (partial)
 * ====================================================================

D* ------------------------------------------------------------------
D*  Error codes.
D* ------------------------------------------------------------------

D AXISC_SUCCESS...
D                 C                    0
D* AXISC_FAIL...
D*                 C                    -1
D AXISC_OBJECT_ALREADY_EXISTS...
D                 C                    1
D AXISC_NO_SUCH_HANDLER...
D                 C                    2
D AXISC_NO_SUCH_SERVICE...
D                 C                    3
D AXISC_NO_REMAINING_SOAP_HEADERS...
D                 C                    4

 * ====================================================================
 * Prototypes and definitions from axis/TypeMapping.h (partial)
 * ====================================================================

D* ------------------------------------------------------------------
D*  xsd types.
D* ------------------------------------------------------------------

D XSDC_UNKNOWN...
D                 C                    1
D XSDC_INT...
D                 C                    2
D XSDC_FLOAT...
D                 C                    3
D XSDC_STRING...
D                 C                    4
D XSDC_LONG...
D                 C                    5
```

```
D XSDC_SHORT...
D                 C                   6
D XSDC_BYTE...
D                 C                   7
D XSDC_UNSIGNEDLONG...
D                 C                   8
D XSDC_BOOLEAN...
D                 C                   9
D XSDC_UNSIGNEDINT...
D                 C                   10
D XSDC_UNSIGNEDSHORT...
D                 C                   11
D XSDC_UNSIGNEDBYTE...
D                 C                   12
D XSDC_DOUBLE...
D                 C                   13
D XSDC_DECIMAL...
D                 C                   14
D XSDC_DURATION...
D                 C                   15
D XSDC_DATETIME...
D                 C                   16
D XSDC_TIME...
D                 C                   17
D XSDC_DATE...
D                 C                   18
D XSDC_GYEARMONTH...
D                 C                   19
D XSDC_GYEAR...
D                 C                   20
D XSDC_GMONTHDAY...
D                 C                   21
D XSDC_GDAY...
D                 C                   22
D XSDC_GMONTH...
D                 C                   23
D XSDC_HEXBINARY...
D                 C                   24
D XSDC_BASE64BINARY...
D                 C                   25
D XSDC_ANYURI...
D                 C                   26
D XSDC_QNAME...
D                 C                   27
D XSDC_NOTATION...
D                 C                   28
D XSDC_INTEGER...
D                 C                   29
D XSDC_ARRAY...
D                 C                   30
D C_USER_TYPE...
D                 C                   31
D XSDC_NMTOKEN...
D                 C                   32
D XSDC_ANY...
```

```
D                 C                   33
D XSDC_NONNEGATIVEINTEGER...
D                 C                   34
D XSDC_POSITIVEINTEGER...
D                 C                   35
D XSDC_NONPOSITIVEINTEGER...
D                 C                   36
D XSDC_NEGATIVEINTEGER...
D                 C                   37
D XSDC_NORMALIZEDSTRING...
D                 C                   38
D XSDC_TOKEN...
D                 C                   39
D XSDC_LANGUAGE...
D                 C                   40
D XSDC_NAME...
D                 C                   41
D XSDC_NCNAME...
D                 C                   42
D XSDC_ID...
D                 C                   43
D XSDC_IDREF...
D                 C                   44
D XSDC_IDREFS...
D                 C                   45
D XSDC_ENTITY...
D                 C                   46
D XSDC_ENTITIES...
D                 C                   47
D XSDC_NMTOKENS...
D                 C                   48
D C_ATTACHMENT...
D                 C                   49


 * ==================================================================
 * Prototypes and definitions from axis/ISoapFault.h (partial)
 * ==================================================================

D* -----------------------------------------------------------------
D*  Get complex fault object name
D* -----------------------------------------------------------------
D axiscSoapFaultGetCmplxFaultObjectName...
D                 PR              *   EXTPROC('axiscSoapFaultGetCmplxFaul+
D                                     tObjectName')
D*                                    Returns character string
D  SOAPFAULT                      *   VALUE
D*                                    ptr to soap fault object


D* -----------------------------------------------------------------
D*  Get simple fault detail
D* -----------------------------------------------------------------
D axiscSoapFaultGetSimpleFaultDetail...
D                 PR              *   EXTPROC('axiscSoapFaultGetSimpleFau+
D                                     ltDetail')
D*                                    Returns character string
D  SOAPFAULT                      *   VALUE
D*                                    ptr to soap fault object


D* ---------------------------------------------------------------
D*  Get fault code
D* ---------------------------------------------------------------
D axiscSoapFaultGetFaultcode...
D                 PR              *   EXTPROC('axiscSoapFaultGetFaultcode'
D                                     )
D*                                    Returns character string
D  SOAPFAULT                      *   VALUE
D*                                    ptr to soap fault object


D* ---------------------------------------------------------------
D*  Get fault string
D* ---------------------------------------------------------------
D axiscSoapFaultGetFaultstring...
D                 PR              *   EXTPROC('axiscSoapFaultGetFaultstri+
D                                     ng')
D*                                    Returns character string
D  SOAPFAULT                      *   VALUE
D*                                    ptr to soap fault object

D* ---------------------------------------------------------------
D*  Get fault actor
D* ---------------------------------------------------------------
D axiscSoapFaultGetFaultactor...
D                 PR              *   EXTPROC('axiscSoapFaultGetFaultacto+
D                                     r')
D*                                    Returns character string
D  SOAPFAULT                      *   VALUE
D*                                    ptr to soap fault object
```

9.2.6 Compiling RPG

Compile the RPG code from WebSphere Development Studio client for iSeries:

1. Expand **<your System i connection>** → **iSeries Objects**, right-click **Library list** and select **Add Library List Entry**.
2. In the window, enter `RPGTEST` in the Additional library field and click **OK**. This adds the RPG test library to the library list so that the compiler can access RPGINCLUDE during compilation.

3. Right-click **RPGTEST.RPGLE** and select **Compile** → **CRTRPGMOD** as shown in Figure 9-20.

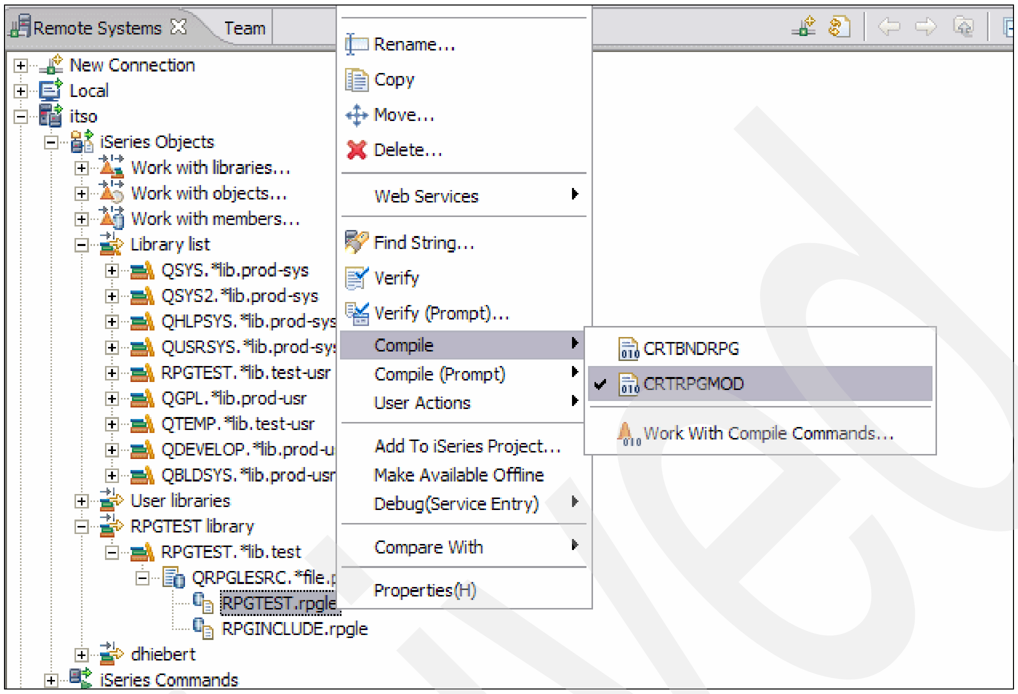


Figure 9-20 Compile RPG module

Note: Errors encountered in the compile process display in the iSeries Error List. Double-clicking an error takes you to the exact position of the error in the source code.

Important: You can ignore all informational messages with a severity of zero (0).

9.2.7 Compiling C modules and Create service program

On the 5250 session, issue the following command to create the C modules and to add all modules to a single service program:

1. On the 5250 command line issue the following commands to create the C modules:

```
CRTCMOD MODULE(RPGTEST/RPGWSC) SRCSTMF('/home/itso/RESERVEFLIGHTServices.c')
INCDIR('/qibm/proddata/xmltoolkit/WSCI-1.0-os400/include')

CRTCMOD MODULE(RPGTEST/RPGWSC1) SRCSTMF('/home/itso/RESERVEINFO.c')
INCDIR('/qibm/proddata/xmltoolkit/WSCI-1.0-os400/include')

CRTCMOD MODULE(RPGTEST/RPGWSC2) SRCSTMF('/home/itso/RESERVEFLIGHTInput.c')
INCDIR('/qibm/proddata/xmltoolkit/WSCI-1.0-os400/include')

CRTCMOD MODULE(RPGTEST/RPGWSC3) SRCSTMF('/home/itso/RESERVEFLIGHTResult.c')
INCDIR('/qibm/proddata/xmltoolkit/WSCI-1.0-os400/include')
```

Note: If you have more C programs in your /home/itso directory, it means that you selected more methods while creating a Web service (see Figure 5-23 on page 56). In this case, you need to create a C module for each C program.

In addition, you need to list all C module in the CRTPGM command in the next step.

2. Issue the following command on the 5250 command line to create the Service program:

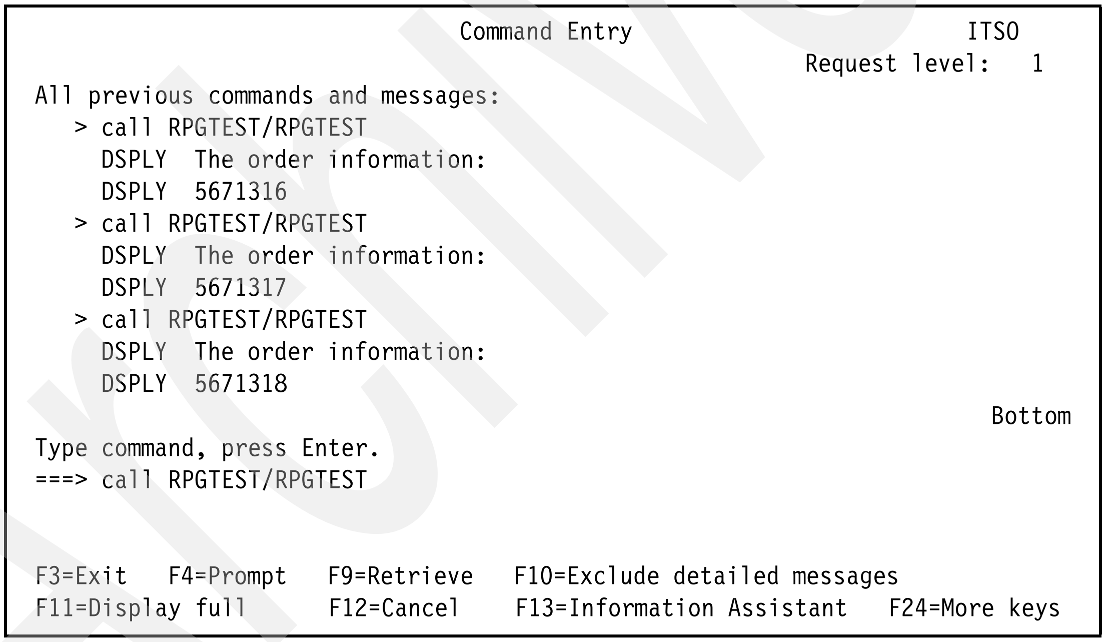
```
CRTPGM PGM(RPGTEST/RPGTEST) MODULE(RPGTEST/RPGTEST RPGTEST/RPGWSC
RPGTEST/RPGWSC1 RPGTEST/RPGWSC2 RPGTEST/RPGWSC3) BNDSRVPGM(QXMLTOOLS/QAXIS10CC)
```

9.2.8 Invoking the RPG application to make reservation

The RPG program calls Web Services Client for ILE Axis framework, which in turn calls the J2EE RPG Web service created in Chapter 5, “ProgramCall (RPG, Cobol) Web service” on page 35. To invoke the RPG program, run the following command from the 5250 command line:

```
CALL RPGTEST/RPGTEST
```

It should return results as shown in Figure 9-21.



```
                                 Command Entry                         ITSO
                                                          Request level:   1
All previous commands and messages:
   > call RPGTEST/RPGTEST
     DSPLY  The order information:
     DSPLY  5671316
   > call RPGTEST/RPGTEST
     DSPLY  The order information:
     DSPLY  5671317
   > call RPGTEST/RPGTEST
     DSPLY  The order information:
     DSPLY  5671318
                                                                        Bottom
Type command, press Enter.
===> call RPGTEST/RPGTEST


F3=Exit   F4=Prompt   F9=Retrieve   F10=Exclude detailed messages
F11=Display full      F12=Cancel    F13=Information Assistant   F24=More keys
```

Figure 9-21 CAll RPG program

Summary

In the example, we demonstrated an RPG program that uses generated code from the Web Services Client for ILE to invoke a Web service that happened to be a J2EE Web service application, which encapsulates an RPG program.

10

JSF Web service client

JavaServer Faces (JSF) technology simplifies building user interfaces for Java Web-based applications. Developers of various skill levels can quickly build Web applications by:

- Assembling reusable UI components in a page
- Connecting these components to an application data source
- Enabling Web service and wiring client-generated events to server-side event handlers

This chapter describes how to create JSF Web services client to consume existing Web services. The JSF Web service components can go out to the Internet and search existing UDDI registries, then use the WSDL file to generate the appropriate controls. The controls use the standard JAX-RPC API to invoke the Web services.

10.1 Developing a JSF client

You can use WebSphere Development Studio client for iSeries to develop a JSF client consuming the Web service. In this section, we show you how to build a sample JSF Web service client.

These are the high-level steps to follow:

1. Create a Dynamic Web Project
2. Create Page Template
3. Create JSF Web service client using Web service Component
4. Test the JSF Web service client
5. Create Web services Proxy
6. Integrate Web services Proxy with JSF page
7. Test the JSF Web service client

We explain the steps in more detail in the following sections.

10.1.1 Creating a dynamic Web project

The first step in the development process is to create a Web project that holds all artifacts of the Web service client:

1. Open Web Perspective in WebSphere Development Studio client for iSeries:
   a. Click **Start** → **All Programs** → **IBM Rational** → **IBM WebSphere Development Studio client Advanced Edition for iSeries V6.0** → **WebSphere Development Studio client Advanced Edition for iSeries**.
   b. In the workspace launcher window, for workspace enter `c:\temp\redbook` and click **OK**.
   c. To open Web perspective, select **Window** → **Open Perspective** → **Other**, select **Web** and click **OK**.
2. Create a Dynamic Web Project:
   a. Launch the New Dynamic Web Project Wizard by clicking **File** → **New** → **Dynamic Web Project**.
   b. Enter the Project Name: `JSFWSclient`.
   c. Click the **Show Advanced** button and make sure that the EAR project name is JSFWSclientEAR and that the context root is the same as the project name.
   d. Click **Finish**.
3. In the Project Explorer view, expand **Dynamic Web Projects** → **JSFWSclient project** → **WebContent**.

Before you create any Faces JSP pages, you create page template that you will use for the JavaServer Faces.

10.1.2 Creating a page template

In this section, we explore how to create a page template that you can used for the JSF pages. Before you create the page template, you need to create or import the necessary images. WebSphere Development Studio client has a built-in Web art designer tool that you can use to create the images and banner. Let us look at how to create an image file.

Creating an image file

To create image file using the Web Art Designer tool:

1. From menu select **File** → **New** → **Image file**.
2. Enter the filename `flight400banner` and click **Finish**.
3. Double-click **flight400banner** under WebContent folder to open it in WebArt designer tool.
4. In WebArt designer tool window, select **Edit** → **Canvas settings**.
5. Enter the following values:
   - Enter Width: `640`
   - Enter Height: `79`
6. Click OK.
7. In WebArt designer tool, click the Gallery tab (see Figure 10-1).

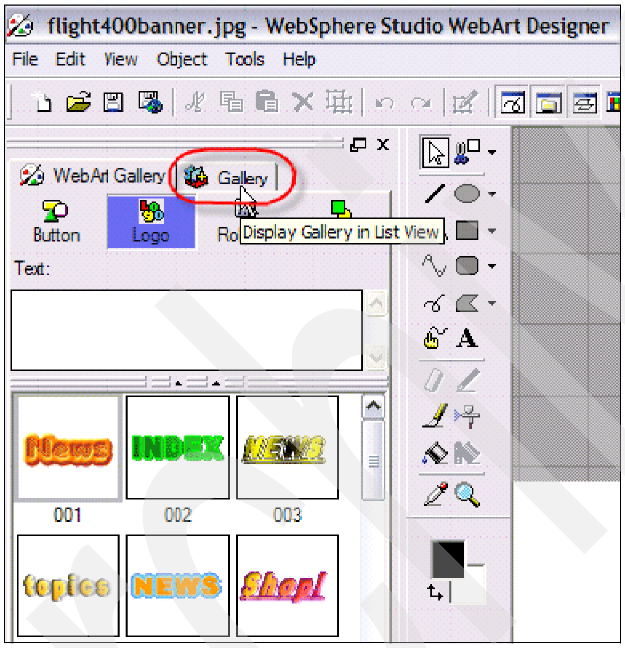
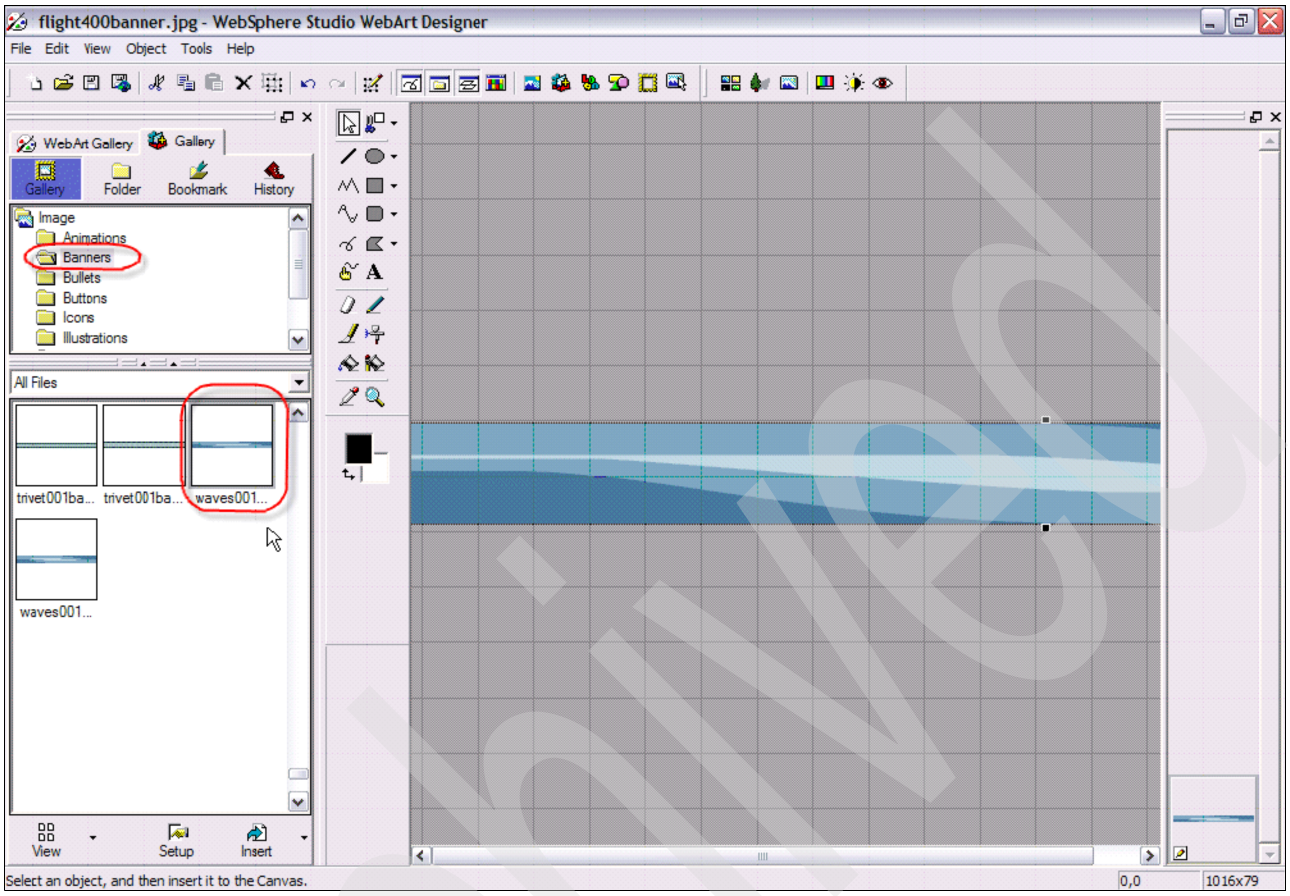

flight400banner.jpg - WebSphere Studio WebArt Designer
File Edit View Object Tools Help
WebArt Gallery
Gallery
Button
Logo
Ro
Display Gallery in List View
Text:
001
002
003

Figure 10-1 Image creation - Gallery tab

8. Click **Banners** to see the banner list. Double-click the desired banner image from the banner list view (see Figure 10-2).



Select an object, and then insert it to the Canvas.

Figure 10-2 Image creation - Select banner image

9. Next, you create a logo and place it on the banner. Click the WebArt Gallery tab. Enter the desired text in the Text input box as shown in Figure 10-3.

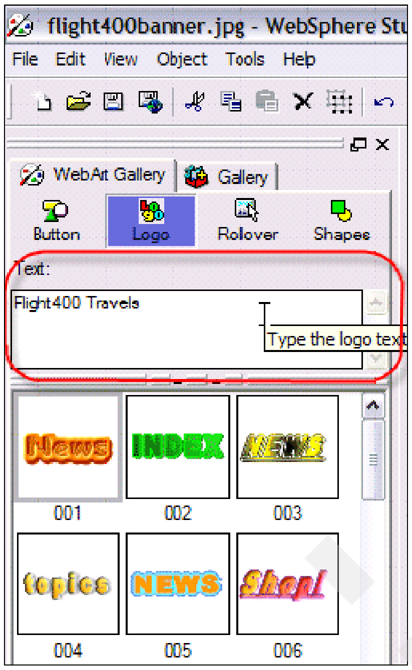


Figure 10-3 Image creation - banner text

10. Double-click desired text format.

11. Resize the logo text as desired.

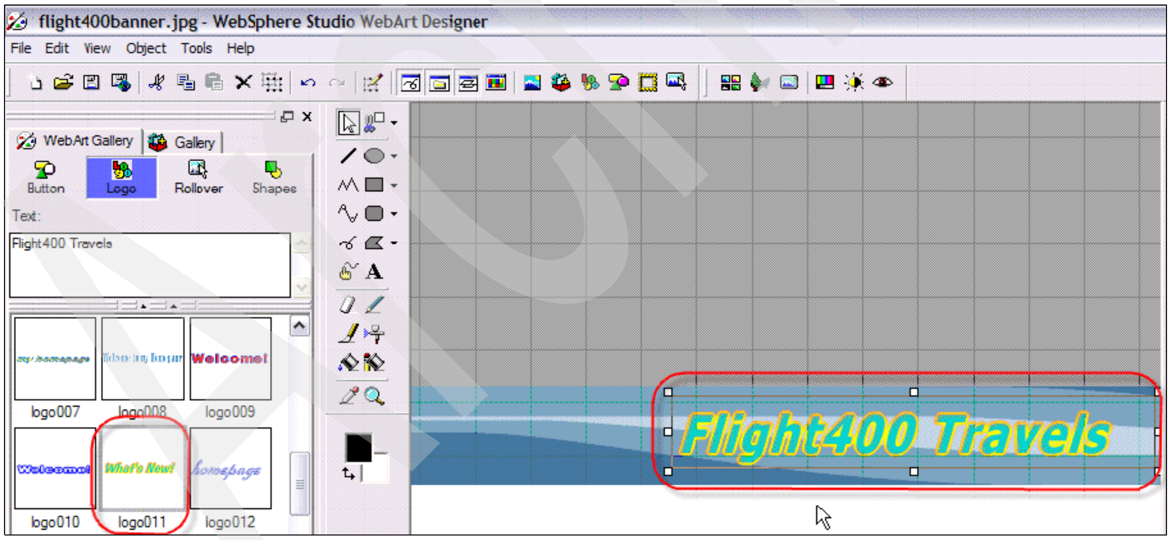


Figure 10-4 Image creation - text format

12. Select **File** → **Save Canvas** or press CTRL+S to save the JPG.

13. On the Save Canvas panel, click **Save**.

14. On the JPEG attribute settings window, click **OK**.

15. Select **File** → **Exit** to exit the WebArt Designer tool.

Importing required images

You can add additional images to your page template. Follow these steps:

1. Make sure **WebContent** → **Theme** folder is selected.
2. Select **File** → **Import** from menu. In the Import window, select **File System** and click **Next**.
3. Navigate to the location of your image files.
4. Select the desired files. (We select **plane.jpg** in this example.) Make sure that the Into folder points to the JSFWSclient/WebContent/theme folder.
5. Click **Finish**.

Creating page template

Now you have all art artifacts to create a page template. Follow these steps:

1. Make sure that the WebContent\theme folder is selected under the JSFWSclient Project.
2. Select **File** → **New** → **Page Template File**.
3. In the New Page Template File window, enter `Flight400PageTemplate` as the File Name and select **Template Containing Faces Components** in the Model drop-down box.
4. Click **Finish**.
5. Click **OK** on any informational window that displays.
6. In Page Template editor view, delete the default text *Place content here*.
7. In Page Template editor view, select **Free Layout** mode (see Figure 10-5).

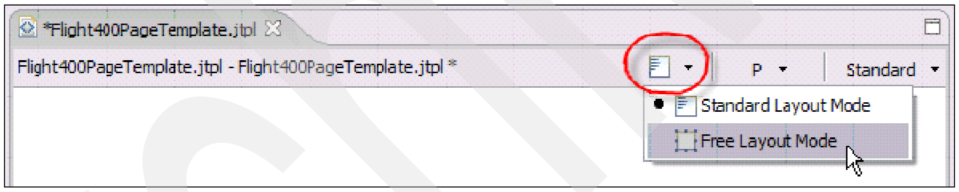

*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
P
Standard
Standard Layout Mode
Free Layout Mode

Figure 10-5 Page template - Layout mode

8. Open the **HTML tags** drawer in the palette view and drop **Free Layout Table** (see Figure 10-6). Free Layout tables create tables and cells for you automatically so that you can freely place objects on the page.

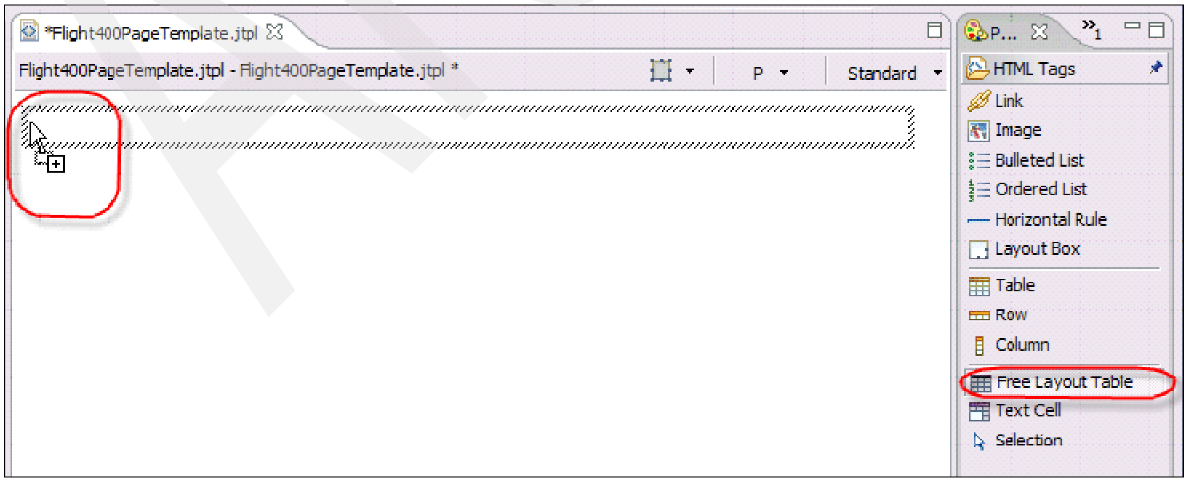


Figure 10-6 Page template - free layout table

9. Drag the corners of free layout table and increase the size.

10. Select **File** → **Save** or press CTRL+S to save your work.

11. Select **plane.jpg** from the **WebContent** → **theme** folder and drag-and-drop it in the first row of the free layout table as shown in Figure 10-7.

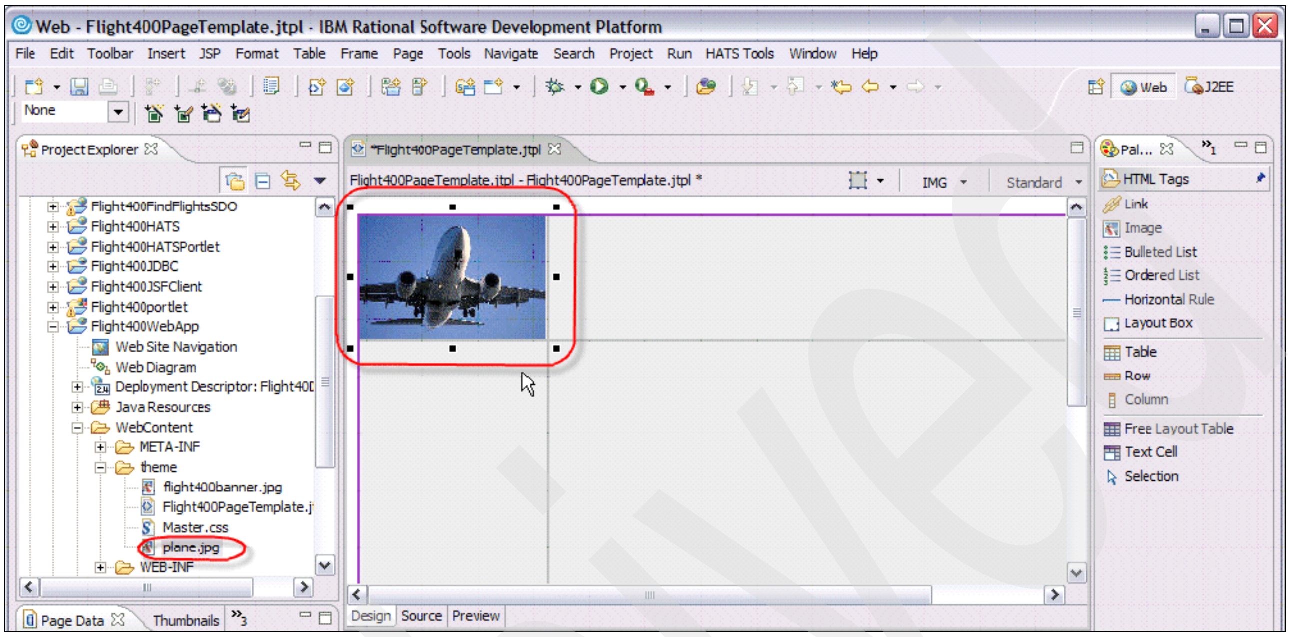


Figure 10-7 Page template - insert image

12. Open the Web Site Navigation drawer under Palette. Drag **Navigation Trail** and drop it in the second row on the right-hand side as shown in Figure 10-8.

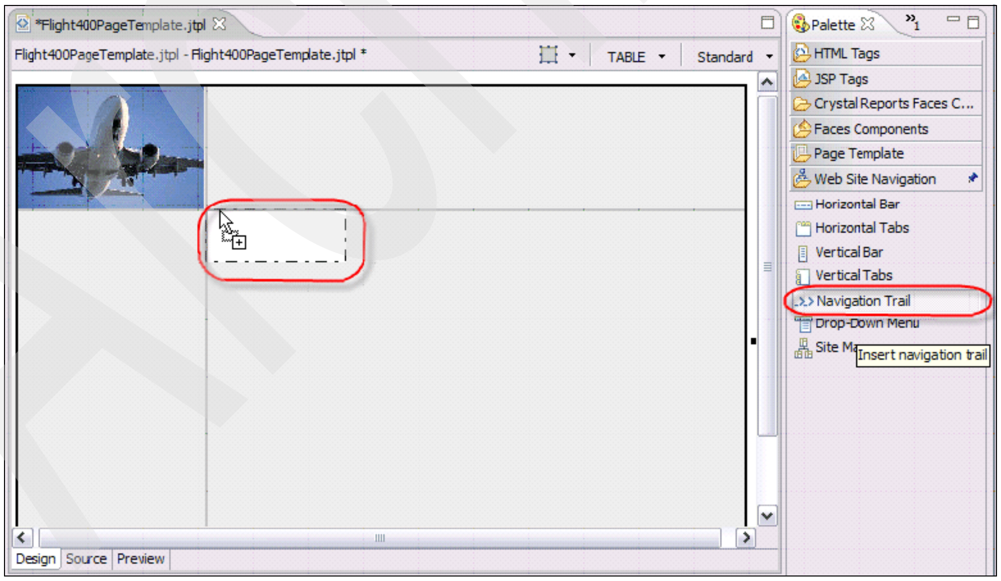


Figure 10-8 Page template - navigation trail

13. In Select a navigation specification file, select **trail_horizontal.jsp** and click **Finish**.

14. Select the cell where navigation trail is placed. Use the guides to expand the cell across the layout area (see Figure 10-9).

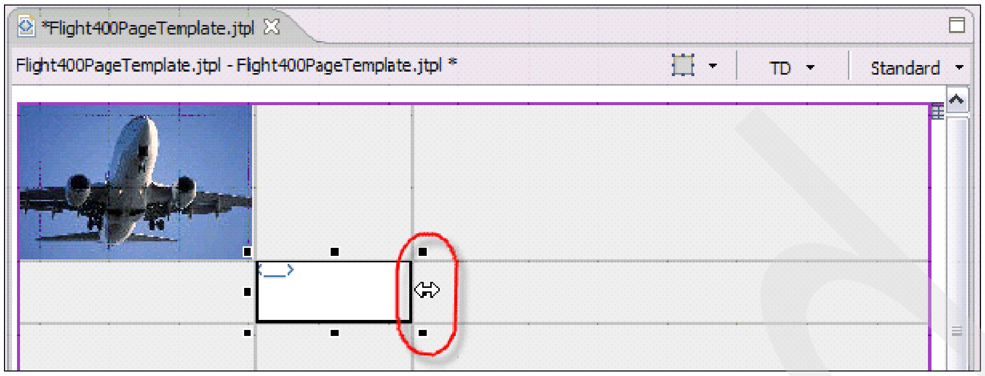

*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
TD
Standard

Figure 10-9 Page template - expand navigation trail

15. Drag **Vertical Tabs** from the Web Site Navigation drawer under Palette and drop it below the plane image (see Figure 10-10).

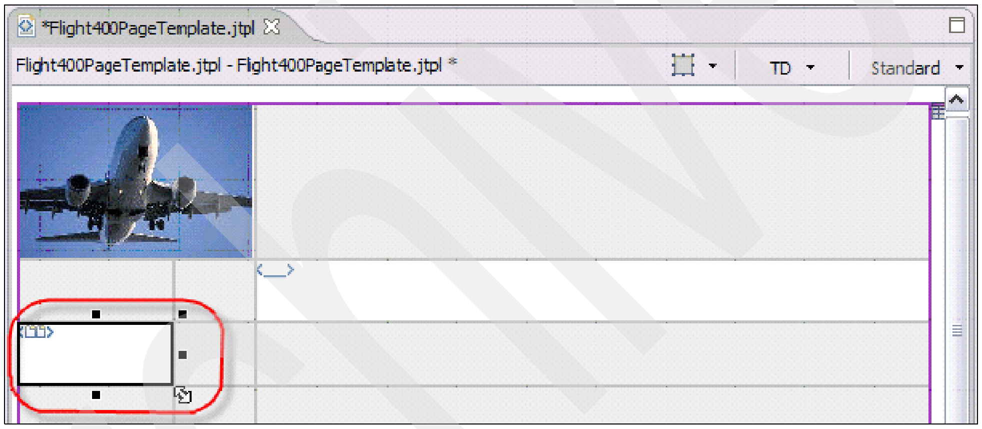

*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
TD
Standard

Figure 10-10 Page template - vertical tabs

16. In Select a Navigation Specification file window click **Next**.

17. In Select Links Destination window:

 a. Select **Children of top page** so that your navigation bar has links to the child pages of the home page.

 b. Then select **Sibling pages** to create navigation links between pages at the same level in the site hierarchy.

 c. Click **Finish**.

18. Select the cell where Vertical Tabs is placed. Use the guides to expand the cell across the next column and rows below as shown in Figure 10-11.

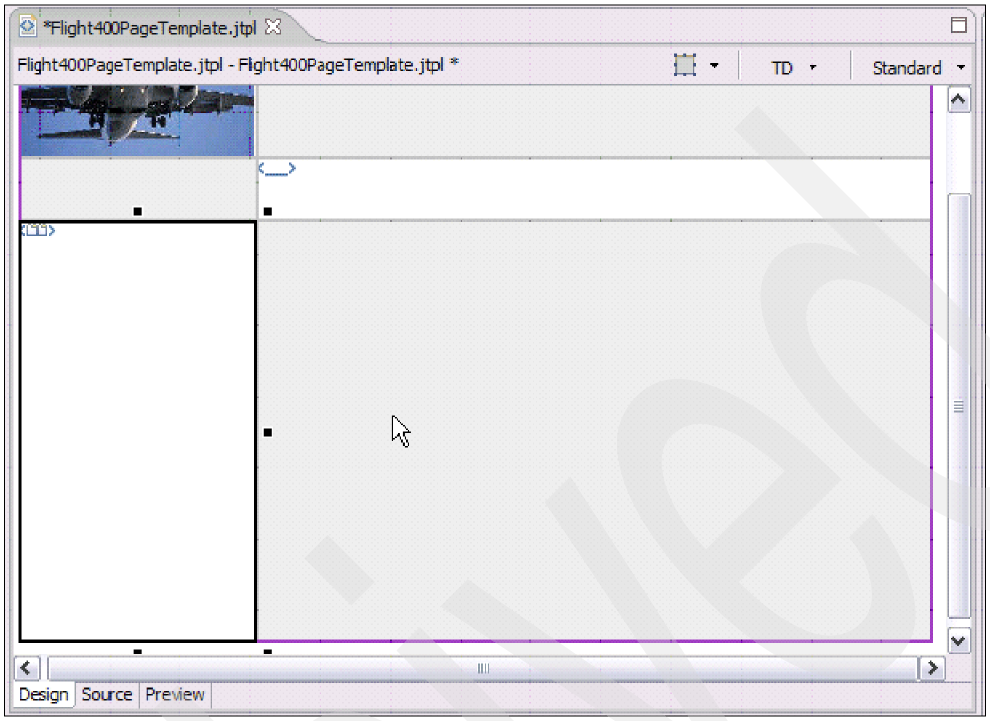

*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
TD
Standard
Design
Source
Preview

Figure 10-11 Page Template - Vertical Tabs expanded

19. Open Page template drawer. Drag **Content Area** and drop it below the navigation trail (see Figure 10-12).

20. In the Insert Content Area pop-up click **OK**.

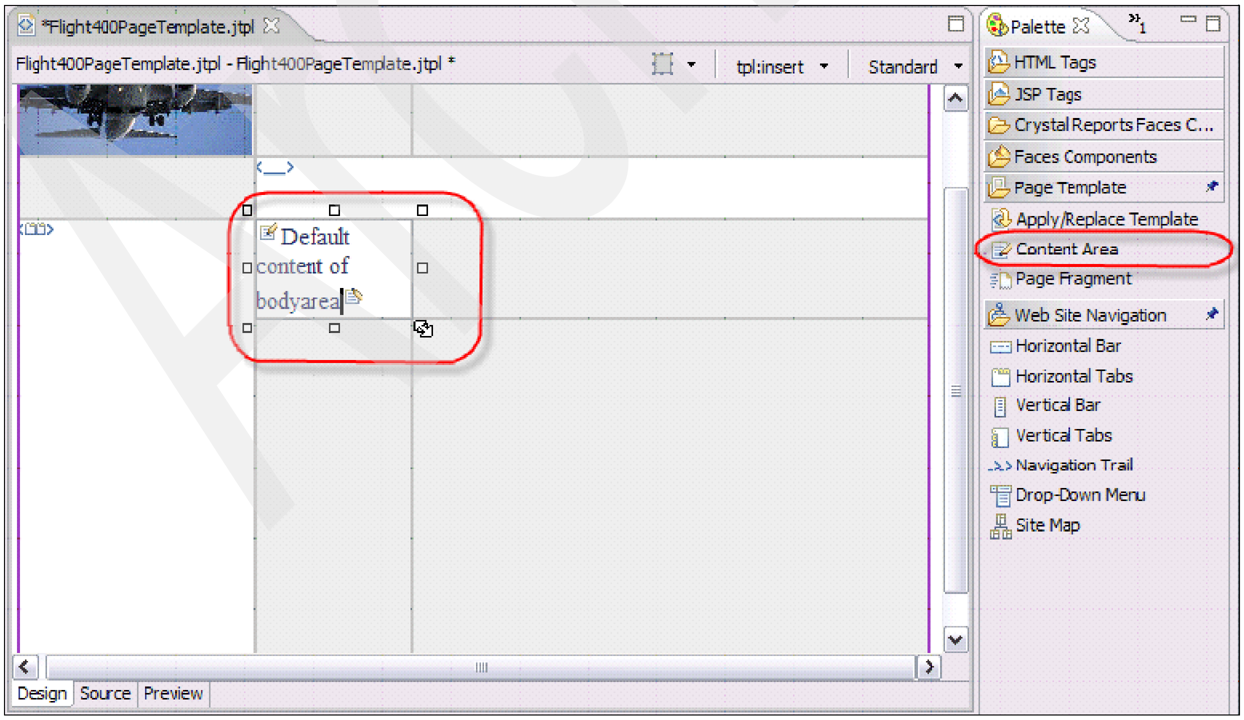
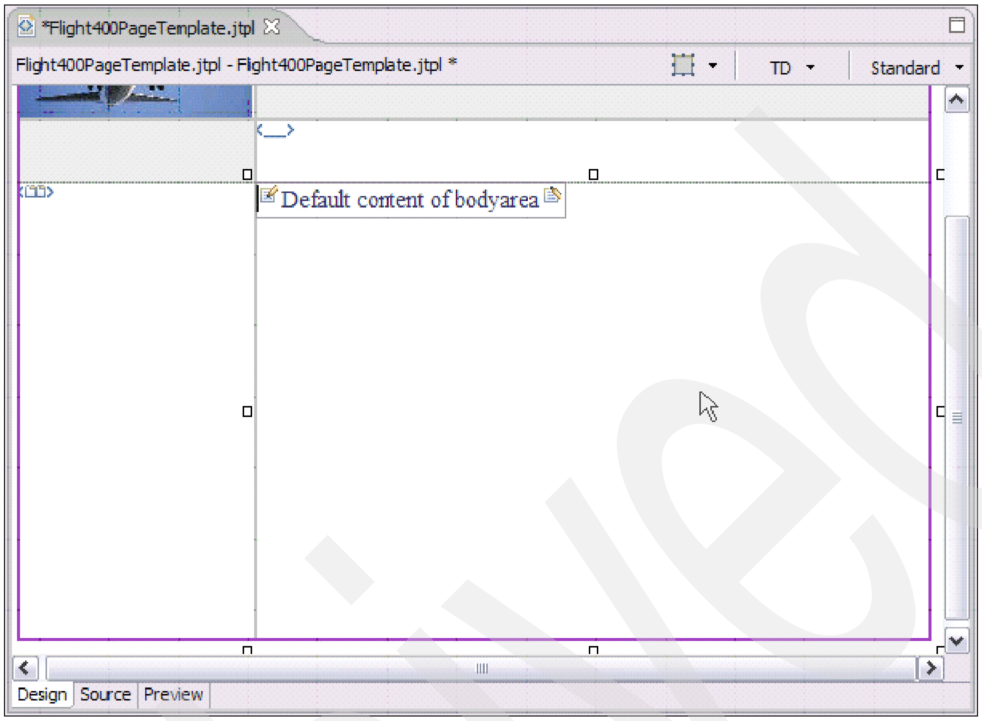


Figure 10-12 Page Template - Content Area

21. Expand the content area using guides to occupy next column and row below as shown in Figure 10-13.


*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
TD
Standard
Design
Source
Preview

Default content of bodyarea

Figure 10-13 Page Template - Content Area Expanded

22. Select **File** → **Save** or press CTRL+S to save your work.

23. Select **flight400banner.jpg** from the WebContent folder in Project Explorer. Drag and drop it in the first row next to plane.jpg (see Figure 10-14).

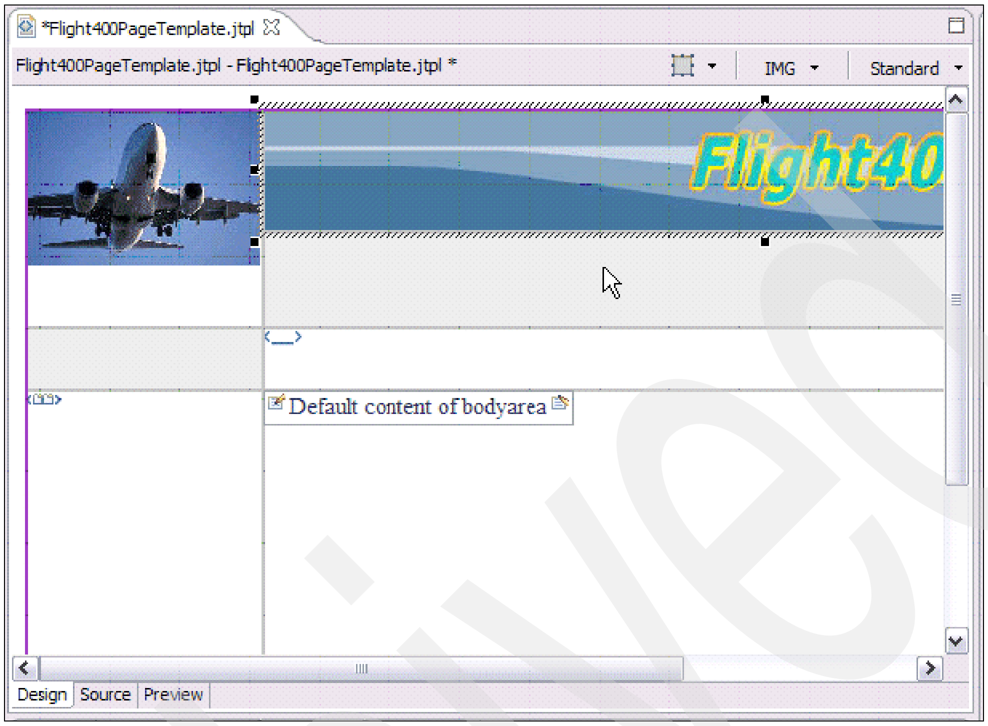
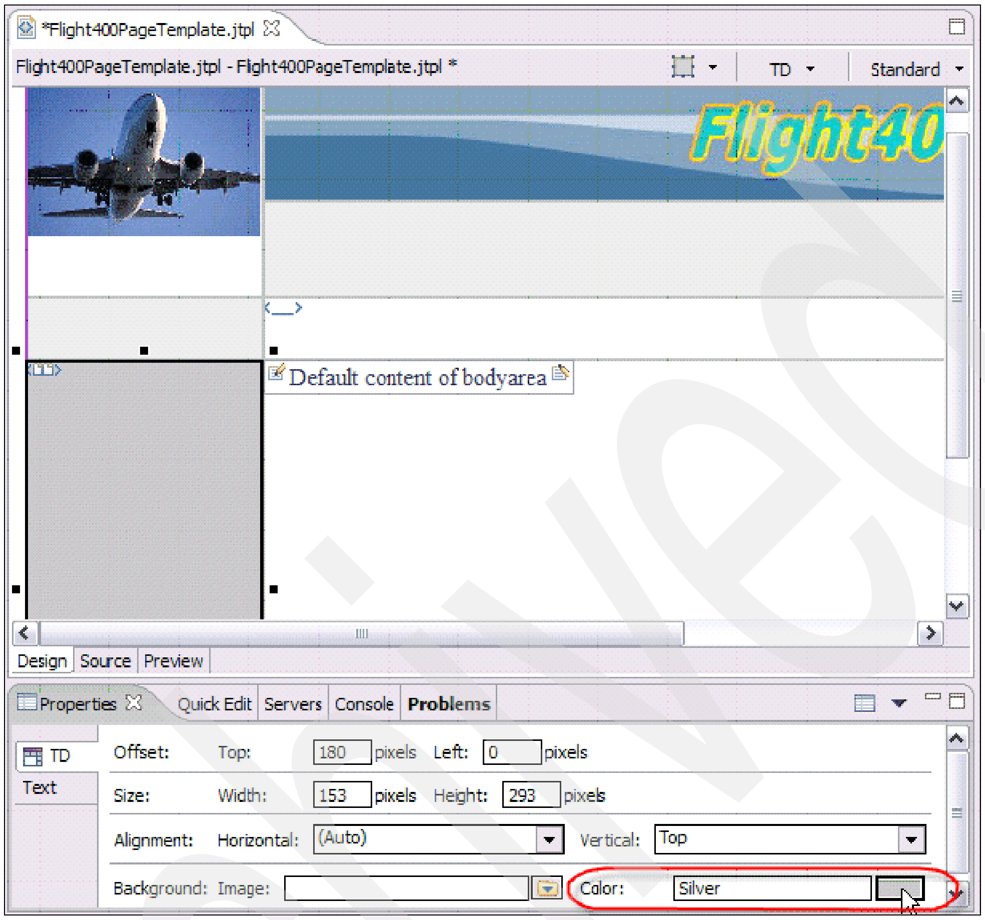

*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
IMG
Standard
Flight40
Default content of bodyarea
Design
Source
Preview

Figure 10-14 Page Template - banner image

24. Select **File** → **Save** or press CTRL+S to save your work.

25. Change the background color. Select the left navigation pane in the page template. Choose the desired color in the Color field in the properties view (see Figure 10-15).


*Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl *
TD
Standard
Flight40
Default content of bodyarea
Design
Source
Preview
Properties
Quick Edit
Servers
Console
Problems
TD
Text

Offset: Top: 180 pixels Left: 0 pixels
Size: Width: 153 pixels Height: 293 pixels
Alignment: Horizontal: (Auto) Vertical: Top
Background: Image: Color: Silver

Figure 10-15 Page Template - background color

26. Select **File** → **Save** or press CTRL+S to save your work.

27. Preview your page template by selecting the Preview tab (see Figure 10-16).

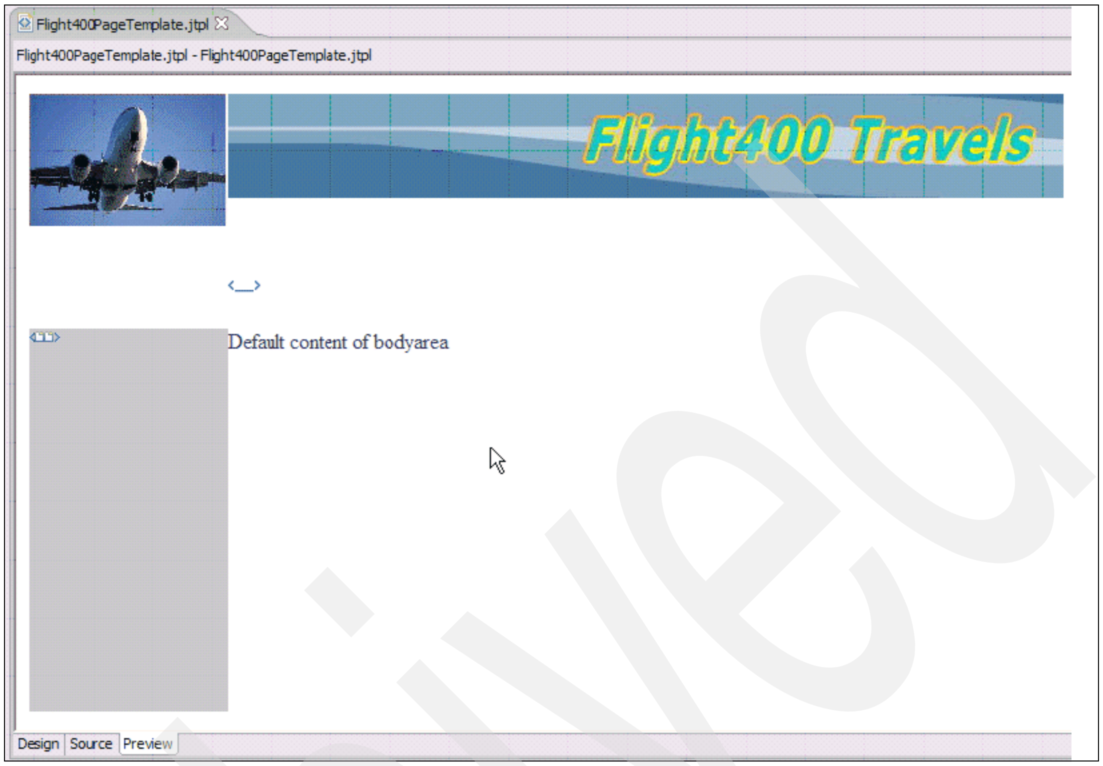

Flight400PageTemplate.jtpl
Flight400PageTemplate.jtpl - Flight400PageTemplate.jtpl
Flight400 Travels
Default content of bodyarea
Design
Source
Preview

Figure 10-16 Page Template - preview

28. Select **File** → **Close** to close the page template editor window.

10.1.3 Creating JSF Web service client using Web Service Component

In this section, you use the page template and existing Web service that you created earlier to create a JavaServer Faces Web service client. You use some of the JSF editing features to drag-and-drop components.

Reviewing a WSDL document

Verify that you still can access a Web service:

1. Type the path for the WSDL document URL in an Internet Explorer window and press Enter. In our example, the URL is:

   ```
   http://<System_i>:<port>/WebServiceProject/wsdl/com/ibm/flight400/beans/GETFLIG
   HTINFOServices.wsdl
   ```

   You should see the content of the WSDL file.

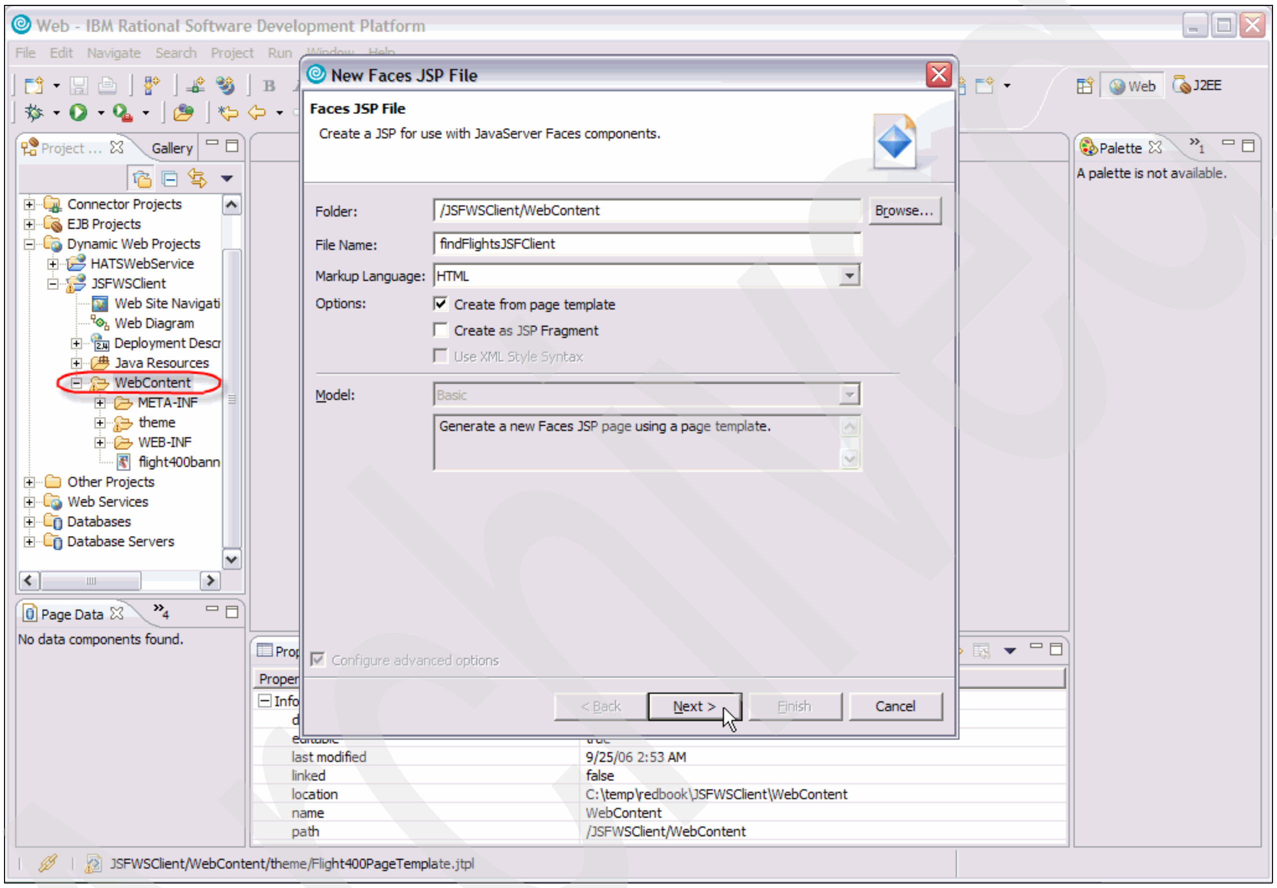
2. The file shows different methods implemented within the Web service with the input and output parameters. In our example, we have two methods: findFlights and findFlights_XML. The methods have three input parameters (FROMCITY, TOCITY, and FLIGHTDATE) and two output parameters (FLIGHTCOUNT and FLIGHTS data structure).

3. We use this WSDL document to build the JSF Web service client to consume the Web service.

Creating a Faces JSP page

It is time to build a JSF based on the page template that you developed earlier in this chapter. Follow these steps:

1. Expand **Dynamic Web Projects** → **JSFWSclient** → **WebContent**.
2. From the menu bar select **File** → **New** → **Faces JSP file**.
3. Enter the filename `findFlightsJSFclient`.
4. Select **Create from page template** and click **Next** (see Figure 10-17).



New Faces JSP File

Faces JSP File

Create a JSP for use with JavaServer Faces components.

Folder: /JSFWSClient/WebContent

File Name: findFlightsJSFClient

Markup Language: HTML

Options: [✓ Create from page template] Create as JSP Fragment Use XML Style Syntax

Model: Basic

Generate a new Faces JSP page using a page template.

[✓ Configure advanced options]

No data components found.

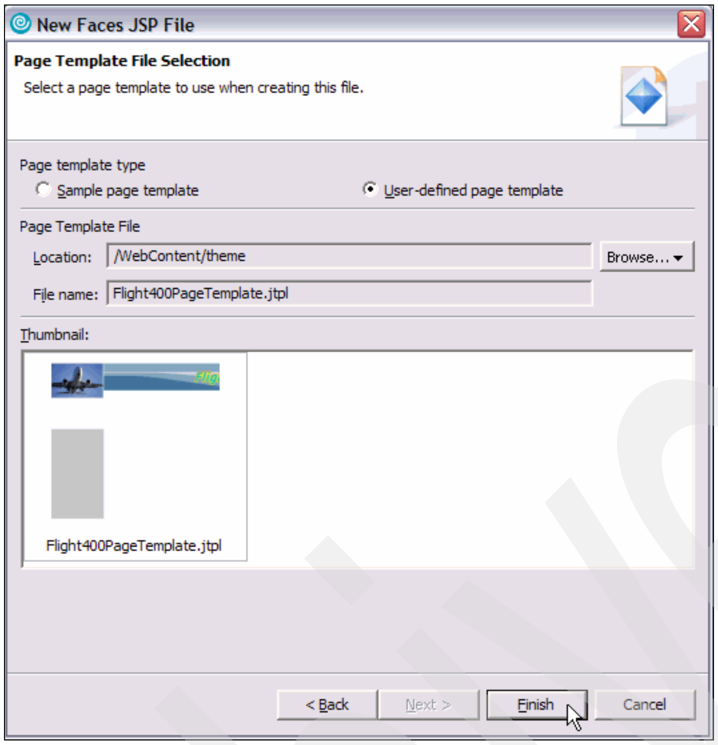
A palette is not available.

last modified	9/25/06 2:53 AM
linked	false
location	C:\temp\redbook\JSFWSClient\WebContent
name	WebContent
path	/JSFWSClient/WebContent

JSFWSClient/WebContent/theme/Flight400PageTemplate.jtpl

Figure 10-17 Faces JSP properties

5. On Page template file selection panel, select **User-defined page template**, select the previously created **Flight400PageTemplate**, and click **Finish** (see Figure 10-18).


New Faces JSP File

Page Template File Selection

Select a page template to use when creating this file.

Page template type

Sample page template [✓ User-defined page template]

Page Template File

Location: /WebContent/theme

File name: Flight400PageTemplate.jtpl

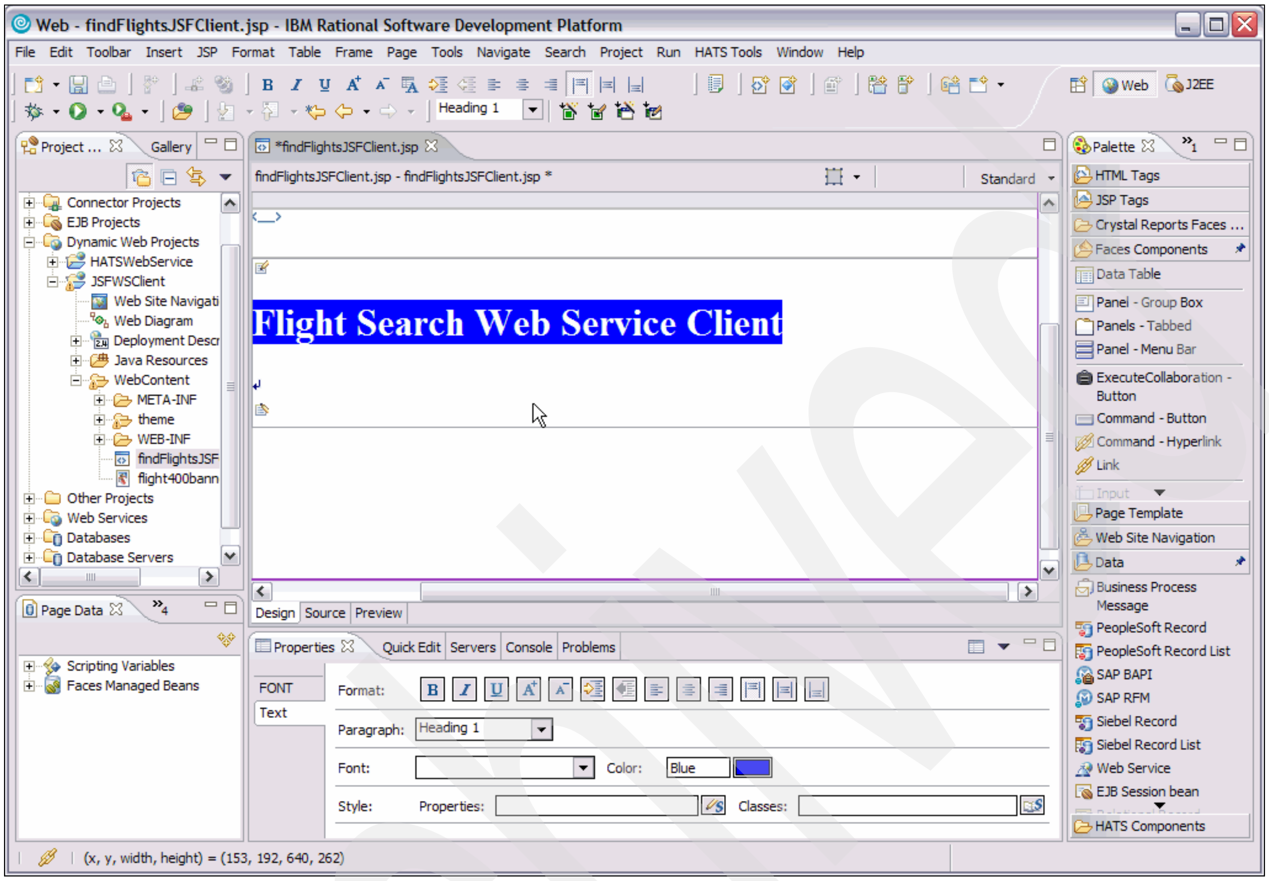
Thumbnail:

Flight400PageTemplate.jtpl

Figure 10-18 User-defined page template

6. Select the default text *Default content of bodyarea* and replace it with *Flight Search Web service client*.
7. Press Enter next to Flight Search Web service client.
8. Select **Flight Search Web service client** and click the Properties tab at the bottom of the window.

9. The properties view shows the properties for the selected component in the edit window. Select **Heading 1** in paragraph field (see Figure 10-19). You can also change the color and the font. Press the down arrow to keep the cursor below the heading.



Format:
Paragraph: Heading 1
Font:
Color: Blue
Style: Properties: Classes:

(x, y, width, height) = (153, 192, 640, 262)

Figure 10-19 Page Heading

10. Save you work by selecting **File** → **Save** from the menu bar or by pressing CTRL+S on the keyboard.

11. Make sure your cursor is just below the heading. In the *Palette* view (on the right-hand side), expand **Data** drawer.

12. From Data drawer, select **Web service** and drop it onto the JSF page at the cursor position (see Figure 10-20).

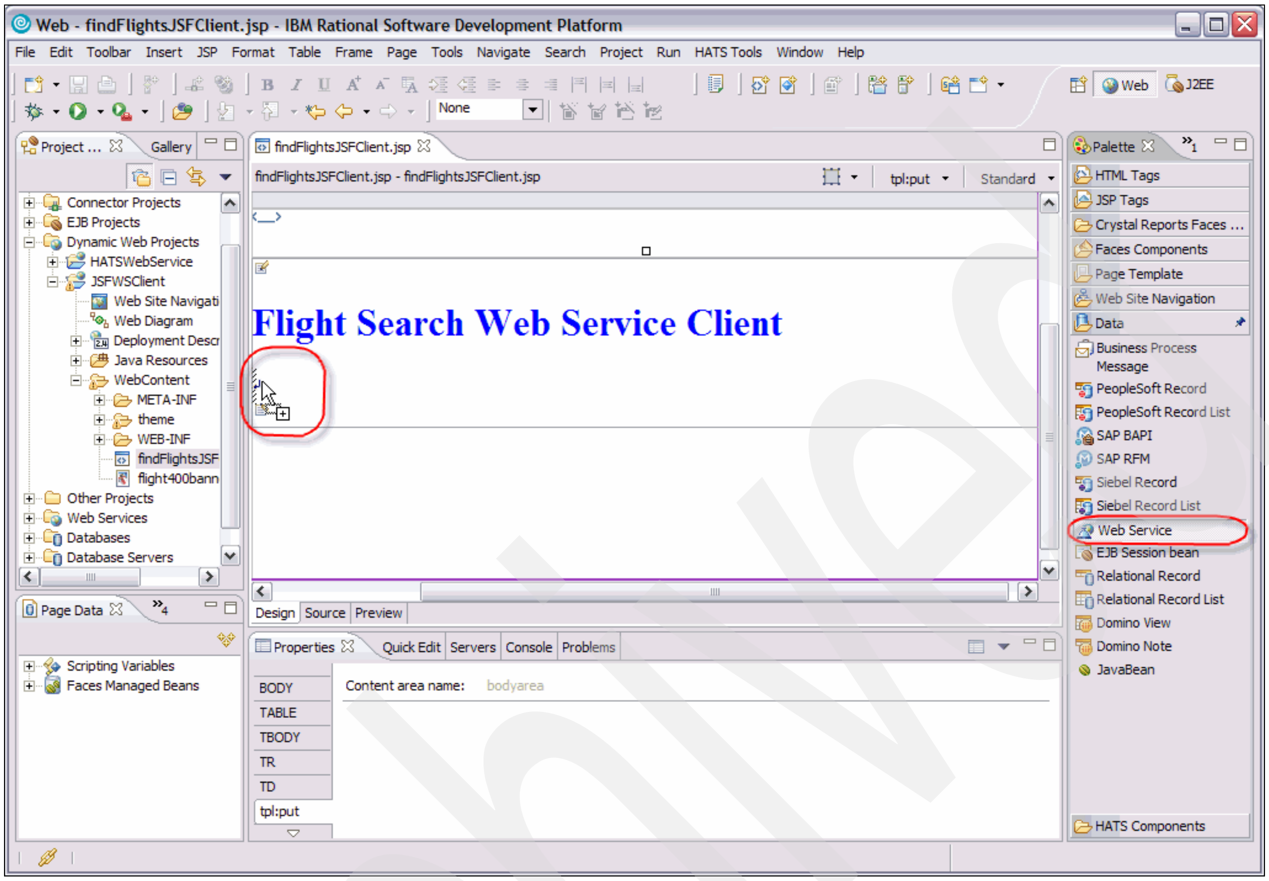


Figure 10-20 Drop Web service component

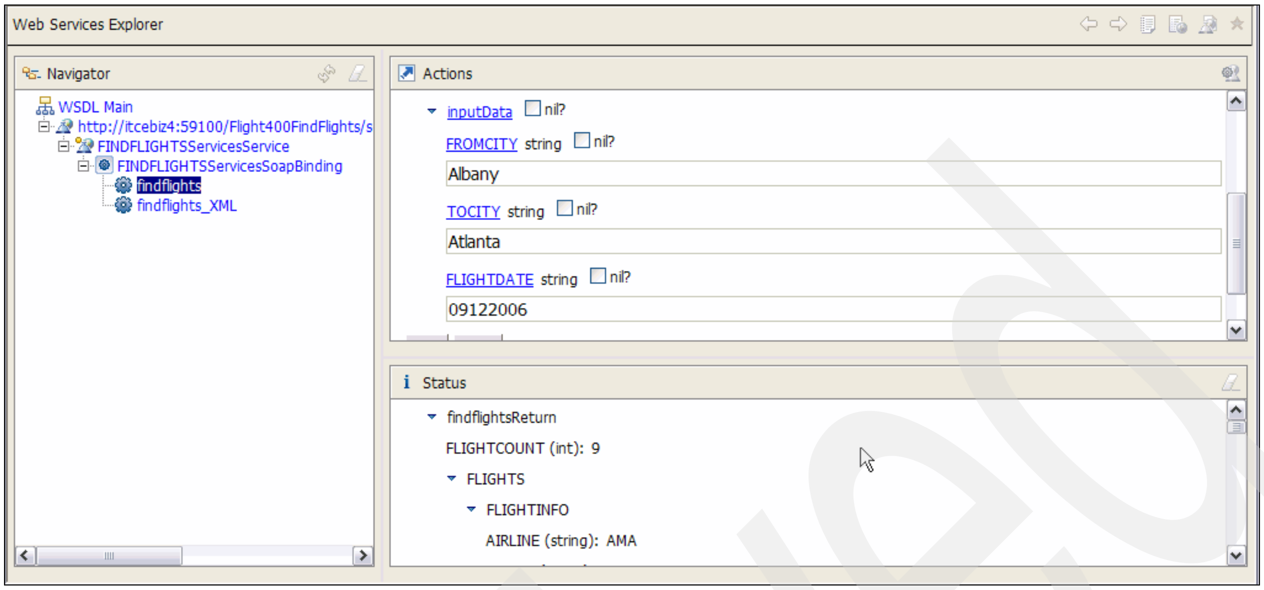
13. The Web services discovery dialog box displays. Click the **Web services from a known URL** link. Also, you can search Web services deployed and running in your current workspace.

14. Enter the WSDL URL (see step 1 on page 231) and click **Go**.

15. You should see Web services details with port information. To explore the Web service click **Details**. This launches Web Services Explorer in the browser. You should see the methods and endpoint information. Click **findFlights** to test that method. On Invoke a WSDL operation screen, enter following inputs:

   – FROMCITY: `Albany`
   – TOCITY: `Atlanta`
   – FLIGHTDATE: `09122006`

16. Click **Go**. It shows the result in the Status pane (Figure 10-21).


Web Services Explorer

Navigator

WSDL Main
http://itcebiz4:59100/Flight400FindFlights/s
FINDFLIGHTSServicesService
FINDFLIGHTSServicesSoapBinding
findflights
findflights_XML

Actions

inputData nil?
FROMCITY string nil?
Albany
TOCITY string nil?
Atlanta
FLIGHTDATE string nil?
09122006

Status

```
findflightsReturn
FLIGHTCOUNT (int): 9
FLIGHTS
FLIGHTINFO
AIRLINE (string): AMA
```

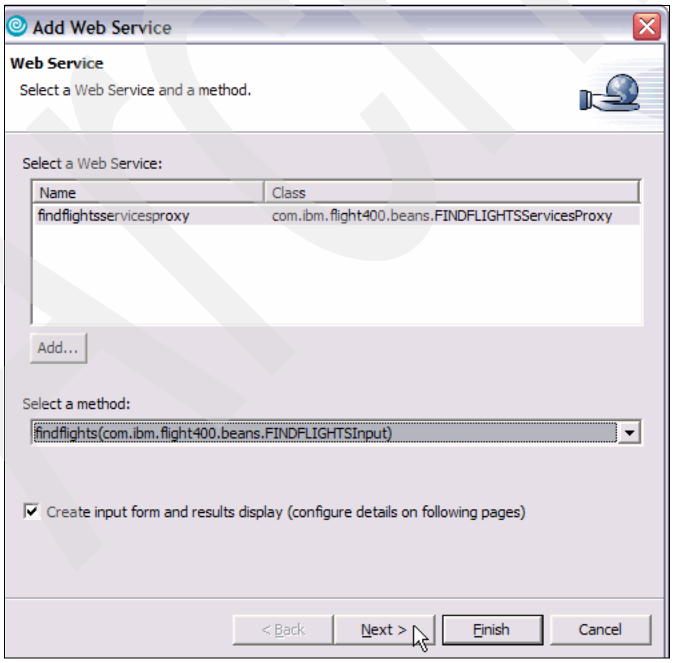
Figure 10-21 Web services Explorer

17. You can also test the `findFlights_XML` method to see the output in XML document form. Close the Web services Explorer browser window.

18. Back in Web Services Discovery dialog box, click **Add to Project**.

19. Click the **Yes All** button on the Warning dialog box.

20. Select the `findflights()` method on the Web services wizard page. Make sure that **Create input form and result display** selected. Click **Next** (see Figure 10-22).


Add Web Service

Web Service

Select a Web Service and a method.

Select a Web Service:

Name	Class
findflightsservicesproxy	com.ibm.flight400.beans.FINDFLIGHTSServicesProxy

Add...

Select a method:

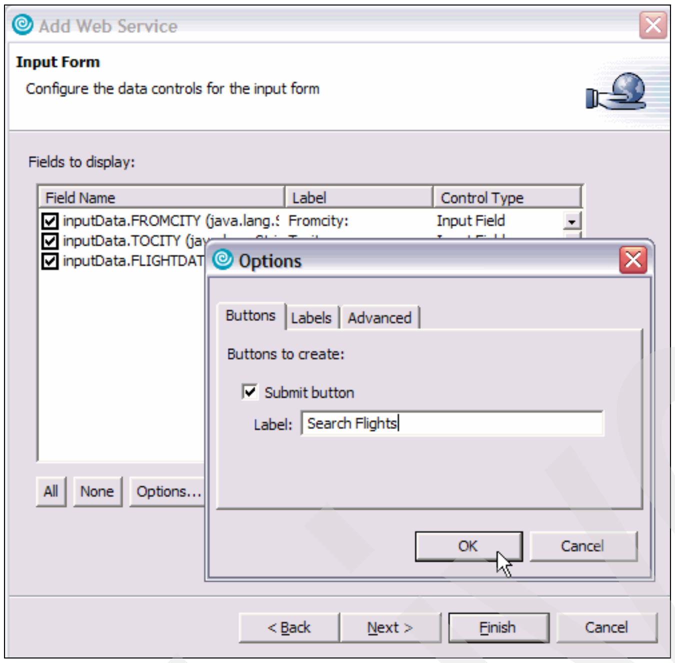
findflights(com.ibm.flight400.beans.FINDFLIGHTSInput)

☑ Create input form and results display (configure details on following pages)

< Back | Next > | Finish | Cancel

Figure 10-22 Select a method

21. On the Input form page, it shows the input fields that are placed on the Input form. Click **Options**. Enter `Search Flights` in the Submit button field and click **OK** (see Figure 10-23). The options dialog lets you select input field properties for the Input form.



Field Name	Label	Control Type
☑ inputData.FROMCITY (java.lang.S	Fromcity:	Input Field
☑ inputData.TOCITY (ja		
☑ inputData.FLIGHTDAT		

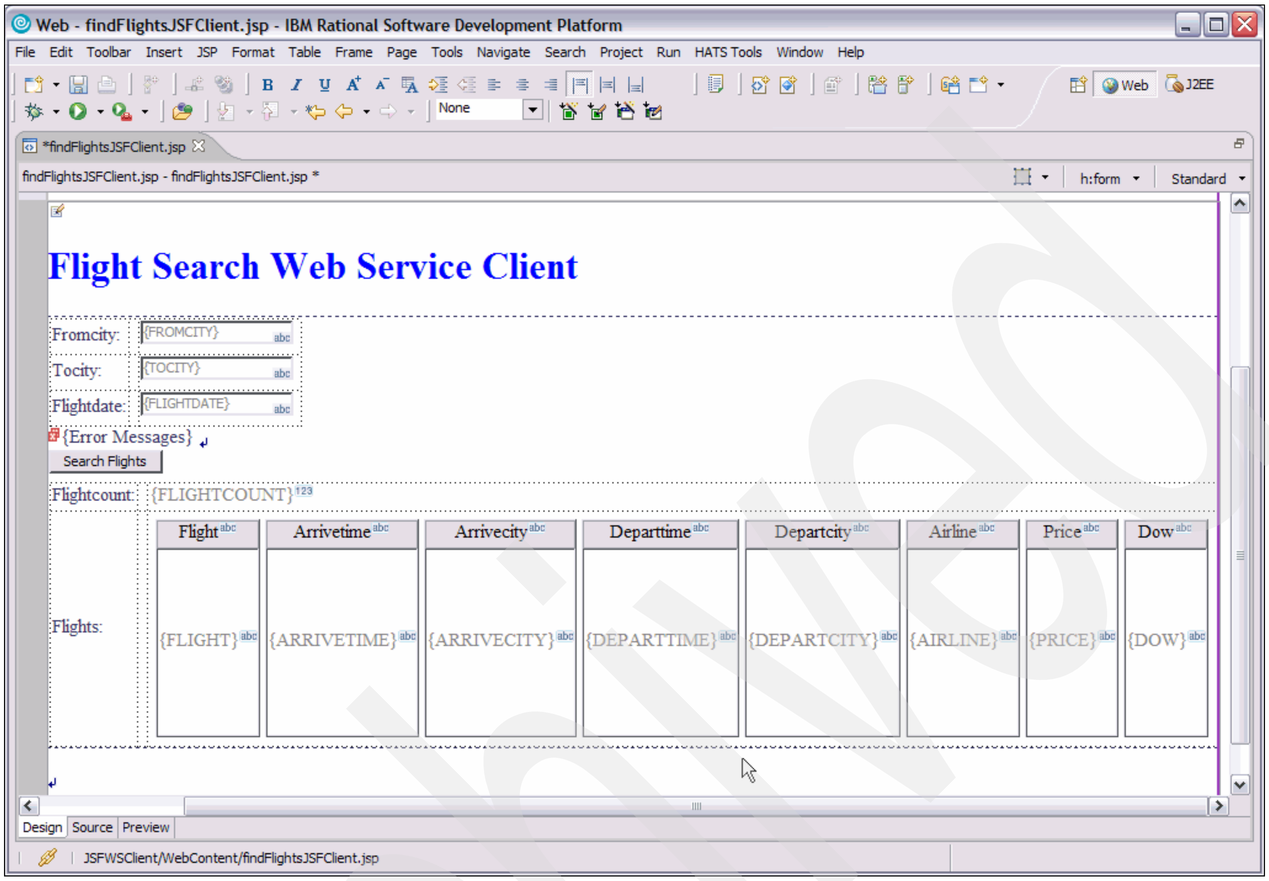
Label: Search Flights

Figure 10-23 Input Form - options

22. Back in Input Form dialog box, click **Next**.

23. The Result form shows the output fields. Click **Finish**.

24.JSF Web services wizard generates input and output fields on the JSF page as shown in Figure 10-24.


Web - findFlightsJSFClient.jsp - IBM Rational Software Development Platform
File Edit Toolbar Insert JSP Format Table Frame Page Tools Navigate Search Project Run HATS Tools Window Help
*findFlightsJSFClient.jsp
findFlightsJSFClient.jsp - findFlightsJSFClient.jsp *
h:form
Standard
Design Source Preview
JSFWSClient/WebContent/findFlightsJSFClient.jsp

Flight Search Web Service Client

Fromcity: {FROMCITY}
Tocity: {TOCITY}
Flightdate: {FLIGHTDATE}
{Error Messages}
Search Flights
Flightcount: {FLIGHTCOUNT}

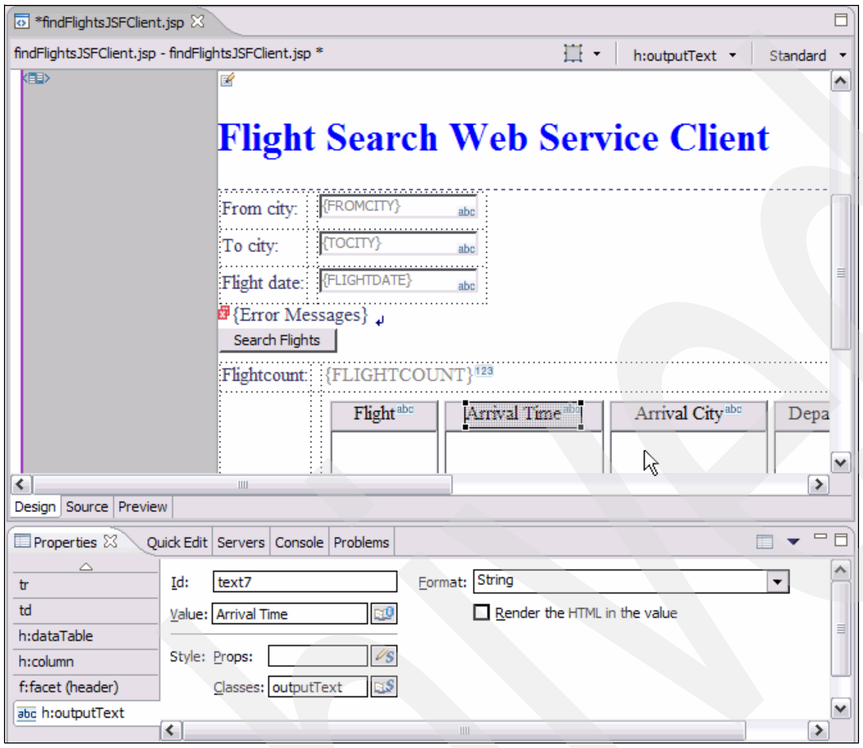
Flight	Arrivetime	Arrivecity	Departtime	Departcity	Airline	Price	Dow
{FLIGHT}	{ARRIVETIME}	{ARRIVECITY}	{DEPARTTIME}	{DEPARTCITY}	{AIRLINE}	{PRICE}	{DOW}

Figure 10-24 Input and Output Components

25.Save you work by selecting **File** → **Save** in the menu bar or by pressing CTRL+S on the keyboard.

26. Update labels next to the input fields to make them readable. You can also select the text and change the properties like format, font, color, and so on in the Properties view.

    Update the labels on the output table. Select the column heading and change the value in the properties view. The updated page is shown in Figure 10-25.



Id: text7
Value: Arrival Time
Format: String
Style: Props:
Classes: outputText

Figure 10-25 Input and Output fields

27. Save you work by selecting **File** → **Save** from the menu bar or by pressing CTRL+S on the keyboard.

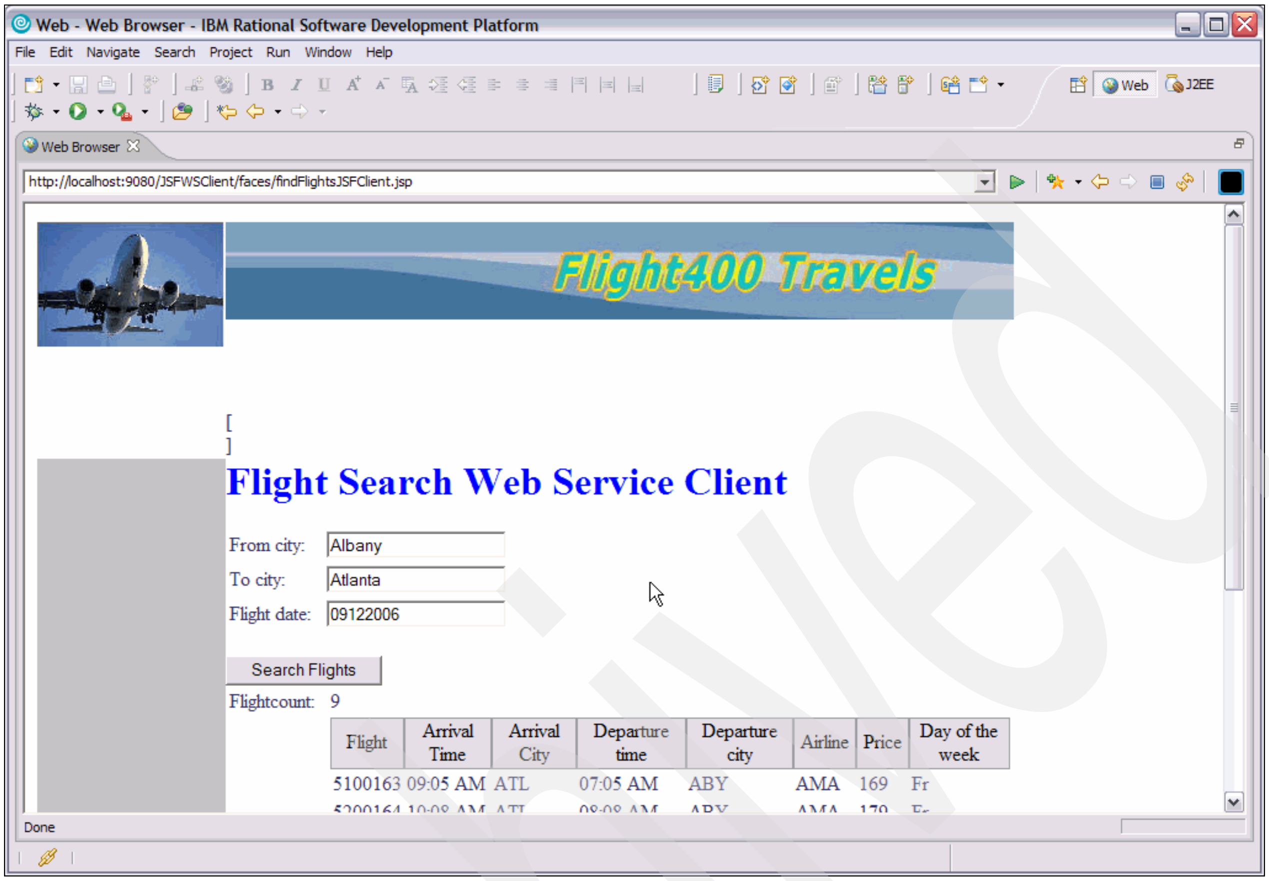
Now you are ready to the test the Web service client in WebSphere Application Server Test environment in WebSphere Development Studio client for iSeries.

10.1.4 Testing the JSF Web service client

To test the JSF Web service client:

1. Right-click **findFlightsJSFclient.jsp** in the Project Explorer view under **JSFWSclient** → **WebContent** folder and select **Run** → **Run on Server** option.
2. In the Server selection window, click **Choose an existing server** and select **WebSphere Application Server V6.0** under localhost and click **Finish**.
3. After a while, you should see a browser displaying the findFlights page with input form. Enter following inputs:
   - From City: `Albany`
   - To City: `Atlanta`
   - Date: `09122006`
   - Click `Search Flights`

4. Double-click a Web browser window title to expand the window (see Figure 10-26).


Web - Web Browser - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Web
J2EE
Web Browser
Flight400 Travels
Done

http://localhost:9080/JSFWSClient/faces/findFlightsJSFClient.jsp

[
]

Flight Search Web Service Client

From city: Albany
To city: Atlanta
Flight date: 09122006

Search Flights

Flightcount: 9

Flight	Arrival Time	Arrival City	Departure time	Departure city	Airline	Price	Day of the week
5100163	09:05 AM	ATL	07:05 AM	ABY	AMA	169	Fr

Figure 10-26 Test the JSF Web service client

10.2 Summary

In this chapter, we demonstrated an example of building a JSF Web service client. WebSphere Development Studio client for iSeries provides a great deal of tools to make this task as easy as possible. You can now design, build, and test a JSF client without leaving the WebSphere Development Studio client for iSeries environment.

11

PHP Web service client

In this chapter, we describe how to consume Web services using the scripting language PHP. The three examples demonstrate Web services clients from simple to more complex. The first two examples are the clients for the Web services created in Chapter 8, “PHP Web service” on page 171, and the third is a client that is designed to consume the GETFLIGHTINFOServices Web service that you built in 5.2.14, “Adding additional Web services: GetFlightInfo and FindCustomers” on page 70.

11.1 Consuming a Web service with PHP

This section explains how to consume the following Web services:

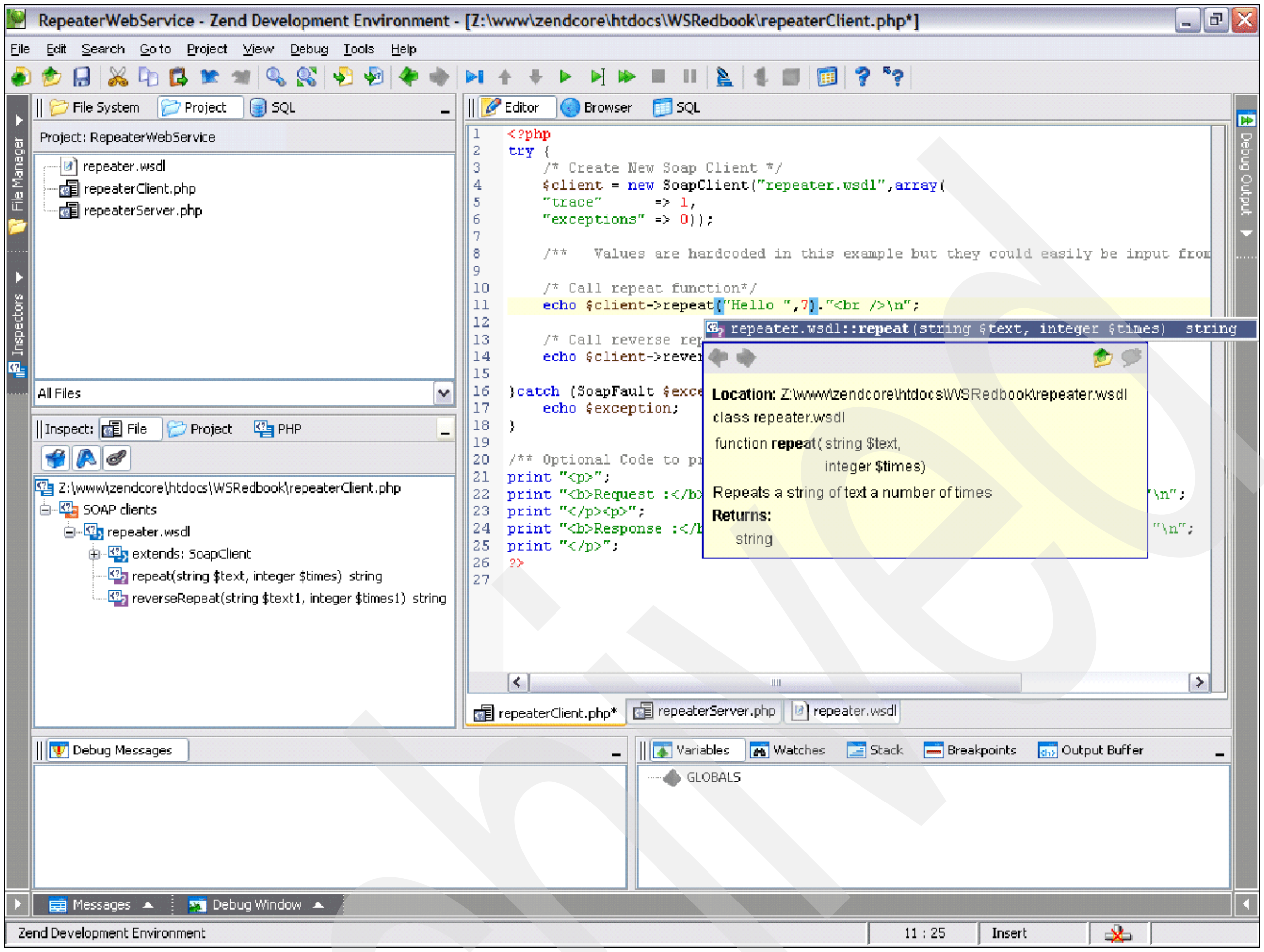
- The first Web service, *Repeater***,** is a PHP Web service with two functions. It takes in a string and an integer. The function `repeat` repeats a string of text a number of times and the function `reverseRepeat` reverses a string of text and repeats it a number of times (see Example 8-8 on page 182).
- The second Web service, *ProgramCall*, uses a PHP Web service with one function. It takes first name, last name, and an initial amount as input. The Web Service wrappers an `i5_program_call` to the `INCRAMT` CL program that sets the account name to the last name, increments the balance by specified amount, and returns the results (see Example 8-11 on page 188).
- The third Web service *GETFLIGHTINFOServices* is a WebSphere Web service that wrappers FLGHT400M/NSF404(FINDFLIGHTS). It takes the departure and destination cities and the date of the flight as input. It returns the number of available flights and available flight information.

11.1.1 Using Zend Studio for i5/OS to create Web services clients

Zend Studio for i5/OS can simplify the task of writing PHP Web services clients. For the examples in this chapter, we use the PHP SOAP extension to create the Web services client. To create the SOAP Client, you need the WSDL file. It can reside on a system where you run a PHP client, you can specify it as a URL.

After you create the SOAP client, two useful features become available in Zend Studio for i5/OS. The first is the *Inspectors* view of available SOAP clients. The new SOAP Client is visible in the File and Project Inspector view. With this view, you can expand the SOAP client to reveal the name of the WSDL, the class it extends, the available functions, what they take for input, and what they return for output. The second feature that is available in Zend Studio for i5/OS after you create the SOAP client is the code completion feature. It analyzes dynamically the WSDL file that is associated with the SOAP client and displays information that is relevant to the function as you type.

Figure 11-1 illustrates both features.


RepeaterWebService - Zend Development Environment - [Z:\www\zendcore\htdocs\WSRedbook\repeaterClient.php*]
File Edit Search Goto Project View Debug Tools Help
File System Project SQL
Project: RepeaterWebService
repeater.wsdl
repeaterClient.php
repeaterServer.php
All Files
Inspect: File Project PHP
Z:\www\zendcore\htdocs\WSRedbook\repeaterClient.php
SOAP clients
repeater.wsdl
extends: SoapClient
repeat(string $text, integer $times) string
reverseRepeat(string $text1, integer $times1) string
Editor Browser SQL
repeaterClient.php* repeaterServer.php repeater.wsdl
Debug Messages
Variables Watches Stack Breakpoints Output Buffer
GLOBALS
Messages Debug Window
Zend Development Environment 11 : 25 Insert
File Manager
Inspectors
Debug Output

```
<?php
try {
    /* Create New Soap Client */
    $client = new SoapClient("repeater.wsdl",array(
    "trace"       => 1,
    "exceptions" => 0));

    /**   Values are hardcoded in this example but they could easily be input from

    /* Call repeat function*/
    echo $client->repeat("Hello ",7)."<br />\n";

    /* Call reverse rep
    echo $client->rever

}catch (SoapFault $exce
    echo $exception;
}

/** Optional Code to pr
print "<p>";
print "<b>Request :</b>                              "\n";
print "</p><p>";
print "<b>Response :</b                              "\n";
print "</p>";
?>
```

repeater.wsdl::repeat (string $text, integer $times)   string

Location: Z:\www\zendcore\htdocs\WSRedbook\repeater.wsdl
class repeater.wsdl
function **repeat**(string $text,
integer $times)
Repeats a string of text a number of times
Returns:
string

Figure 11-1 Zend Studio for i5/OS Web services client features

The technique for creating a PHP client code in Zend Studio for i5/OS is the same as for creating a PHP server code. You need to have a project to which you add your PHP files. Use the **File** → **New File** menu option to create a new PHP file.

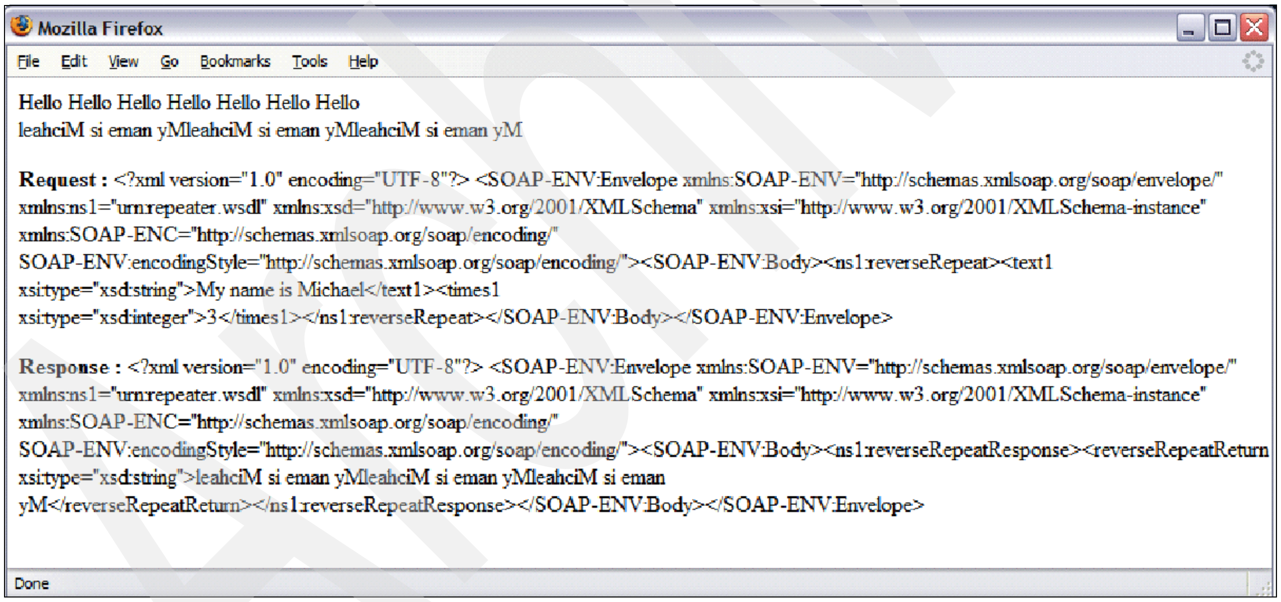
11.1.2 Consuming the Repeater PHP Web service

Example 11-1 was created using Zend Core Version 1.6.0, PHP Version 5.1.6. In this first example, we show you how to consume the PHP Repeater Web service (see Example 8-8 on page 182). Notice that near the bottom of repeaterClient.php, there is the optional code to print the last SOAP request and response. It is not commented out so when the code is run in addition to the Web service reply, the actual last SOAP request and response is displayed also.

Example 11-1 repeaterClient.php source code

```
<?php
try {
   /* Create New Soap Client */
   $client = new SoapClient("repeater.wsdl",array(
   "trace"       => 1,
   "exceptions" => 0));
   /**   Values are hardcoded in this example but they could easily be input from
the user **/

   /* Call repeat function*/
   echo $client->repeat("Hello ",7)."<br />\n";

   /* Call reverse repeat function*/
   echo $client->reverseRepeat("My name is Michael",3);

}catch (SoapFault $exception) {
   echo $exception;
}

/** Optional Code to print the last SOAP Request & Response **/
print "<p>";
print "<b>Request :</b>\n".htmlspecialchars($client->__getLastRequest()) ."\n";
print "</p><p>";
print "<b>Response :</b>\n".htmlspecialchars($client->__getLastResponse())."\n";
print "</p>";
?>
```

Figure 11-2 shows a sample output from the `repeaterServer` Web service.



```
Hello Hello Hello Hello Hello Hello Hello
leahciM si eman yMleahciM si eman yMleahciM si eman yM

Request : <?xml version="1.0" encoding="UTF-8"?> <SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:ns1="urn:repeater.wsdl" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"><SOAP-ENV:Body><ns1:reverseRepeat><text1
xsi:type="xsd:string">My name is Michael</text1><times1
xsi:type="xsd:integer">3</times1></ns1:reverseRepeat></SOAP-ENV:Body></SOAP-ENV:Envelope>

Response : <?xml version="1.0" encoding="UTF-8"?> <SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/"
xmlns:ns1="urn:repeater.wsdl" xmlns:xsd="http://www.w3.org/2001/XMLSchema" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
xmlns:SOAP-ENC="http://schemas.xmlsoap.org/soap/encoding/"
SOAP-ENV:encodingStyle="http://schemas.xmlsoap.org/soap/encoding/"><SOAP-ENV:Body><ns1:reverseRepeatResponse><reverseRepeatReturn
xsi:type="xsd:string">leahciM si eman yMleahciM si eman yMleahciM si eman
yM</reverseRepeatReturn></ns1:reverseRepeatResponse></SOAP-ENV:Body></SOAP-ENV:Envelope>
```

Figure 11-2 The repeaterClient.php run in Web browser

11.2 Consuming the ProgramCall PHP Web service

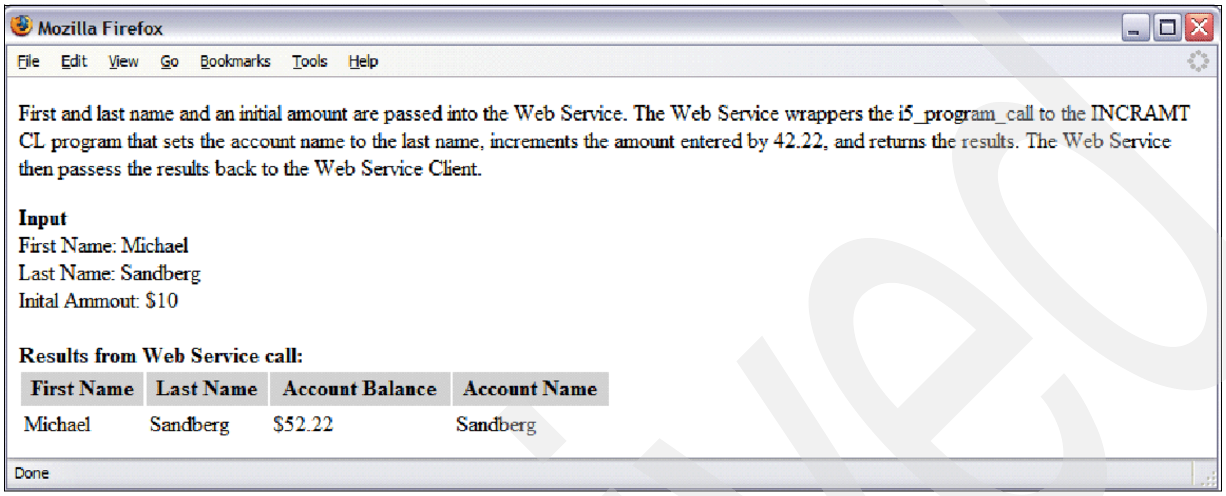
Example 11-2 was created using Zend Core Version 1.6.0, PHP Version 5.1.6. This example shows how to consume the PHP ProgramCall Web service (see Example 8-11 on page 188). This Web service client is more complex than Example 11-1 in that it works with the complex data type returned by the Web service, working with it as an object.

Example 11-2 programCallClient.php source code

```
<?php
/**   Values are hardcoded in this example but they could easily be input from the
user **/
$first = "Michael";
$last = "Sandberg";
$amount = "10";

/** Create SOAP Client **/
try {
   $client = new SoapClient("programCall.wsdl",array(
   "trace"      => 1,
   "exceptions" => 0));

   print "<p>";
   $results = $client->callINCRAMT($first,$last,$amount);
   /** Optional Code to print the $results object **/
   //var_dump($results);
   print "</p>";
}catch (SoapFault $exception) {
   echo $exception;
}

echo "<p>First and last name and an initial amount are passed into the Web
Service. The Web Service wrappers the
i5_program_call to the INCRAMT CL program that sets the account name to the last
name, increments the amount
entered by 42.22, and returns the results. The Web Service then passess the
results back to the Web Service Client.</p>";
echo "<b>Input</b><br>";
echo "First Name: ".$first."<br>";
echo "Last Name: ".$last."<br>";
echo "Inital Amount: $".$amount."<br><br>";

echo "<b>Results from Web Service call:</b>";
print("<table width='50%' border='0' cellpadding='2' cellspacing='2'>");
print("<tr bgcolor='#CCCCCC'><th>First Name</th><th>Last Name</th><th>Account
Balance</th><th>Account Name</th></tr>");
print("<tr>");
printf("<td>%s</td>",$results->first);
printf("<td>%s</td>",$results->last);
printf("<td>$%s</td>",$results->amount);
printf("<td>%s</td>",$results->account);
print("</tr>");

/** Optional Code to print the last SOAP Request & Response **/
//print "<p>";
//print "<b>Request :</b>\n".htmlspecialchars($client->__getLastRequest()) ."\n";
```

```
//print "</p><p>";
//print "<b>Response :</b>\n".htmlspecialchars($client->__getLastResponse())."\n";
//print "</p>";
?>
```

Figure 11-3 shows a sample output from the programCall PHP Web service.



First and last name and an initial amount are passed into the Web Service. The Web Service wrappers the i5_program_call to the INCRAMT CL program that sets the account name to the last name, increments the amount entered by 42.22, and returns the results. The Web Service then passess the results back to the Web Service Client.

Input
First Name: Michael
Last Name: Sandberg
Inital Ammout: $10

Results from Web Service call:

First Name	Last Name	Account Balance	Account Name
Michael	Sandberg	$52.22	Sandberg

Figure 11-3 The programCallClient.php run in Web browser

11.2.1 Consuming the GETFLIGHTINFOServices WebSphere Web service

Example 11-3 was created using Zend Core Version 1.5.0, PHP Version 5.1.6. It shows how to consume the GETFLIGHTINFOServices WebSphere Web service (see 5.2.14, “Adding additional Web services: GetFlightInfo and FindCustomers” on page 70). This example is the most complex of the three examples in this chapter. The Web service client passes in a complex data type and also receives back another complex data type. To pass in the required parameters to the Web service, an object is created that matches the design of the expected complex data type. The results are passed back as an object with a variable number of flights. This is handled by retrieving the number of flights value from the results object and then using it in a `for` loop to walk through the results object printing the values.

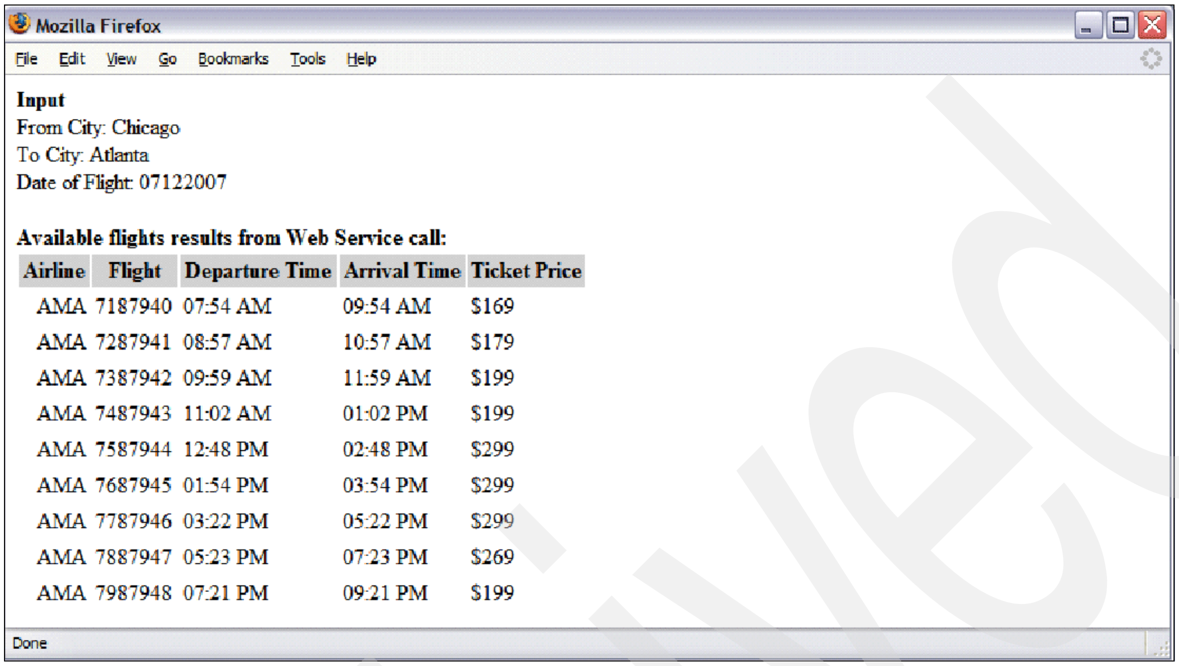
Also notice that this example points to the WSDL file that is located on a remote server (the highlighted text in the example). We use the file’s URL. Another way of using remote WSDL file is to copy it to the system where you run your PHP client code. In the latter case, you would point to the WSDL file in the same way as we show in the Example 11-1 and Example 11-2.

Example 11-3 WSClient.php source code

```
<?php
 /**
 * WSClient is a PHP Web services client designed to consume the Web service described
 * by GETFLIGHTINFOServices.wsdl
 **/

/** Build the Object that will be passed in the call to the Web service
*   Values are hardcoded in this example but they could easily be input from the user
**/
$params -> inputData -> FROMCITY = 'Chicago';
$params -> inputData -> TOCITY = 'Atlanta';
```

```
$params -> inputData -> FLIGHTDATE = '07122007';

/** Create SOAP Client **/
try {
   $client = new
SoapClient("http://remoteServer:9080/WebSvc/wsdl/com/ibm/flight400/beans/GETFLIGHTINFOServices.w
sdl",array(
   "trace"      => 1,
   "exceptions" => 0,));
}catch (SoapFault $exception) {
   echo $exception;
}

/** Call Web service described in GETFLIGHTINFOServices.wsdl passing $params **/
try {
   $results = $client->findflights($params);
   /** Optional Code to print the $results object **/
   //print "<p>";
   //var_dump($results);
   //print "</p>";
}catch (SoapFault $exception) {
   echo $exception;
}

echo "<b>Input</b><br>";
echo "From City: ".$params -> inputData -> FROMCITY."<br>";
echo "To City: ".$params -> inputData -> TOCITY."<br>";
echo "Date of Flight: ".$params -> inputData -> FLIGHTDATE."<br><br>";

echo "<b>Available flights results from Web Service call:</b>";

/** Retrieve number of flights returned by the Web service **/
$re = $results->findflightsReturn->FLIGHTCOUNT;

/** Create table and then print flight information **/
print("<table width='50%' border='0' cellpadding='2' cellspacing='2'>");
print("<tr bgcolor='#CCCCCC'><th>Airline</th><th>Flight</th><th>Departure Time</th><th>Arrival
Time</th><th>Ticket Price</th></tr>");
for ( $i = 0; $i < $re; $i += 1){
   print("<tr>");
   printf("<td><div
align='right'>%s</div></td>",$results->findflightsReturn->FLIGHTS->FLIGHTINFO[$i]->AIRLINE);
   printf("<td>%s</td>",$results->findflightsReturn->FLIGHTS->FLIGHTINFO[$i]->FLIGHT);
   printf("<td>%s</td>",$results->findflightsReturn->FLIGHTS->FLIGHTINFO[$i]->DEPARTTIME);
   printf("<td>%s</td>",$results->findflightsReturn->FLIGHTS->FLIGHTINFO[$i]->ARRIVETIME);
   printf("<td>$%s</td>",$results->findflightsReturn->FLIGHTS->FLIGHTINFO[$i]->PRICE);
   print("</tr>");
}

/** Optional Code to print the SOAP Request & Response **/
//print "<p>";
//print "<b>Request :</b>\n".htmlspecialchars($client->__getLastRequest()) ."\n";
//print "</p><p>";
//print "<b>Response :</b>\n".htmlspecialchars($client->__getLastResponse())."\n";
//print "</p>";
?>
```

Before attempting to execute the PHP client code, make sure that your Web service on the remote system has been started. Figure 11-4 shows sample output from the PHP Web service client.



Input
From City: Chicago
To City: Atlanta
Date of Flight: 07122007

Available flights results from Web Service call:

Airline	Flight	Departure Time	Arrival Time	Ticket Price
AMA	7187940	07:54 AM	09:54 AM	$169
AMA	7287941	08:57 AM	10:57 AM	$179
AMA	7387942	09:59 AM	11:59 AM	$199
AMA	7487943	11:02 AM	01:02 PM	$199
AMA	7587944	12:48 PM	02:48 PM	$299
AMA	7687945	01:54 PM	03:54 PM	$299
AMA	7787946	03:22 PM	05:22 PM	$299
AMA	7887947	05:23 PM	07:23 PM	$269
AMA	7987948	07:21 PM	09:21 PM	$199

Figure 11-4 WSClient.php run in browser

A

Setting the connection to WebSphere Application Server V6.0

You can use the SOAP connector or remote method invocation (RMI) to make JMX™ connections with the server. These ports are used for communication between the development environment and the server. The RMI (ORB bootstrap) port is designed to improve performance and communication with the server. The SOAP connector port is designed to be more firewall compatible. It is used by an HTTP transport for incoming SOAP requests.

This chapter explains how to set the connection to WebSphere Application Server V6.0 using a JMX option.

Important: If there is a firewall between the development environment and the server, use the SOAP connector port rather than the ORB bootstrap port.

Important: In a lab environment where a single image is ghosted to multiple PCs, the master image host name is ghosted to the WebSphere Application Server - Test Environment runtime configuration files. To resolve the TCP issue, use SOAP.

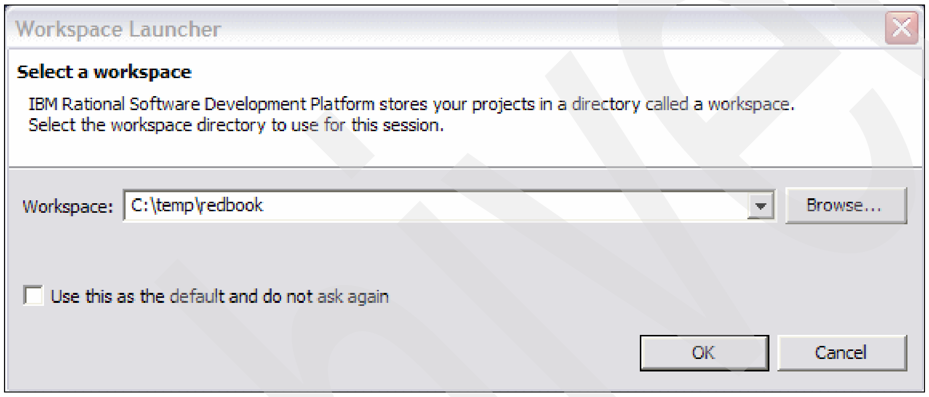
Changing a JMX connection with a server

Follow these steps to view and change, if needed, a JMX connection to your server in WebSphere Development Studio client for iSeries:

1. In your Windows workstation go to **Start** → **All Programs** → **IBM Rational** → **IBM WebSphere Development Studio Client Advanced Edition for iSeries V6.0** → **WebSphere Development Studio Client Advanced Edition for iSeries**.

   Note: In the event that WebSphere Development Studio client for iSeries is already started, proceed to step 4 on page 251.

2. In the workplace launcher window, enter `c:\temp\redbook` in the workspace field and press **OK** as shown in Figure A-1. (Make sure that you deselect the check box **Use this as a default and do not ask again**.)



IBM Rational Software Development Platform stores your projects in a directory called a workspace.
Select the workspace directory to use for this session.

Workspace: C:\temp\redbook

☐ Use this as the default and do not ask again

Figure A-1 Specifying a workspace location

3. If the WebSphere Development Studio client for iSeries workspace was not used before, you see a Welcome page. Click **X** to close the Welcome page (see Figure A-2).

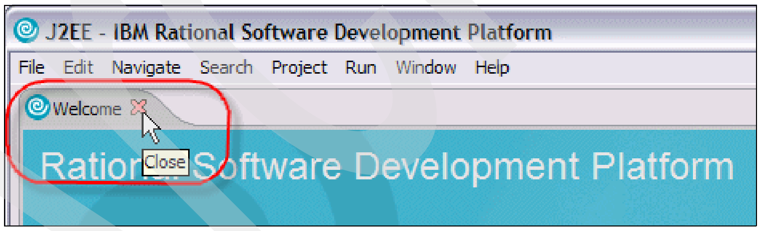

J2EE - IBM Rational Software Development Platform
File
Edit
Navigate
Search
Project
Run
Window
Help
Welcome
Close
Rational Software Development Platform

Figure A-2 Closing a Welcome page

4. Click the **Open perspective** icon on the right-hand side (see Figure A-3) or go to **Window → Open Perspective**.

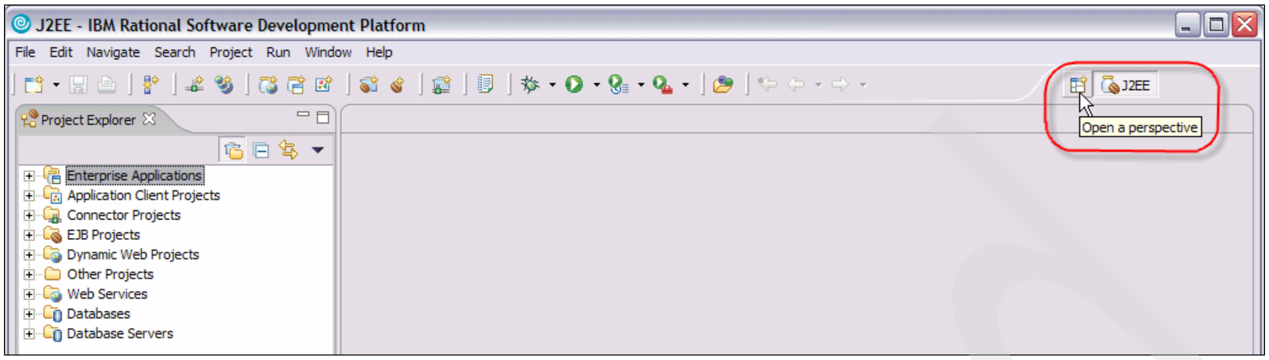


Figure A-3

5. Select **Other**.
6. In the Select Perspective window, select **Web** and click **OK**.
7. In Web Perspective, select the **Servers** view as shown in Figure A-4.

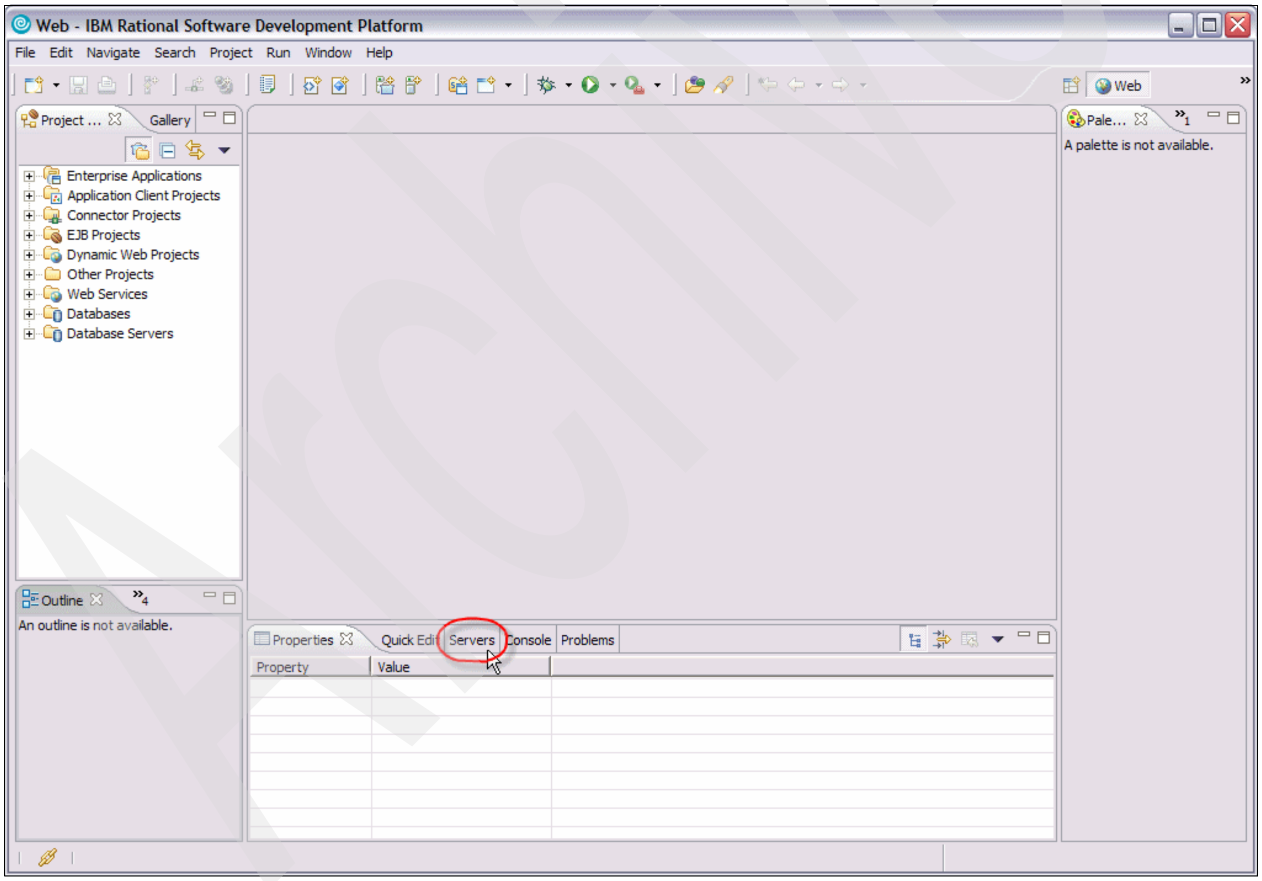
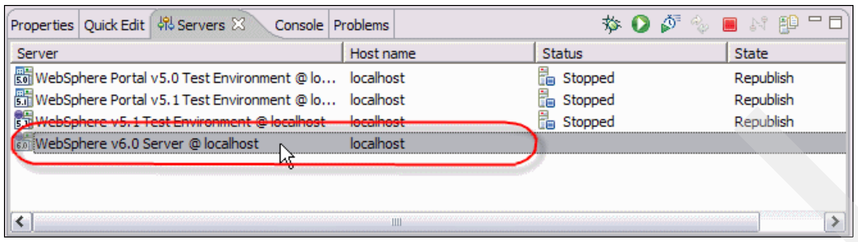


Figure A-4 Selecting the Servers view

8. In the Servers view, double-click **WebSphere Application Server v6.x** to open the server editor (see Figure A-5).

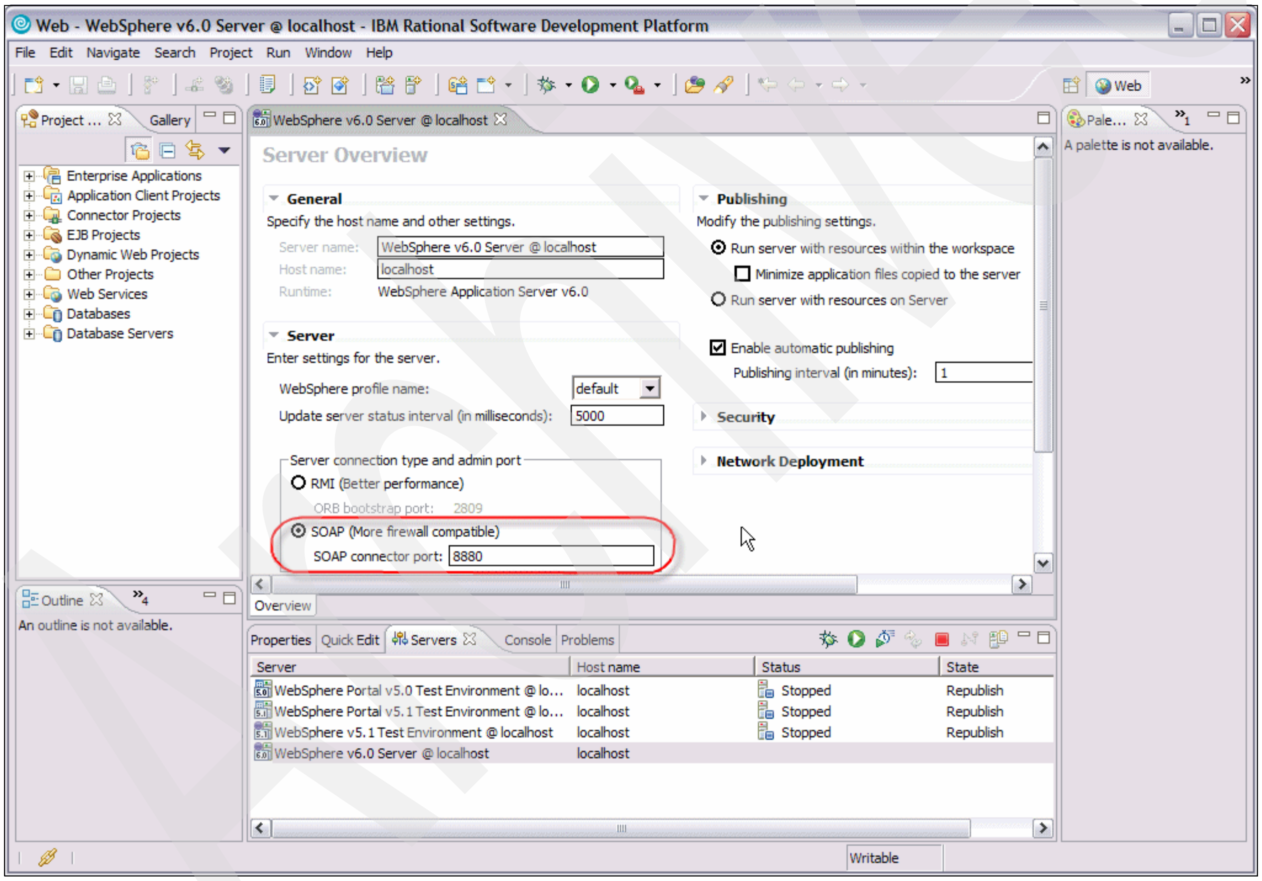


Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
~~WebSphere v5.1 Test Environment @ localhost~~	~~localhost~~	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost		

Figure A-5 Double-clicking your server

9. Click the Overview tab. Expand the **Server** section if it is not expanded already.

10. Under the Server connection type and admin port, select **SOAP (more firewall compatible)** (see Figure A-6). For a SOAP connection, in the SOAP connector port field, we use the default port number 8880.



A palette is not available.

An outline is not available.

Server Overview

General

Specify the host name and other settings.

Server name: WebSphere v6.0 Server @ localhost
Host name: localhost
Runtime: WebSphere Application Server v6.0

Server

Enter settings for the server.

WebSphere profile name: default
Update server status interval (in milliseconds): 5000

Server connection type and admin port
- ○ RMI (Better performance)
  ORB bootstrap port: 2809
- [✓ SOAP (More firewall compatible)]
  SOAP connector port: 8880

Publishing

Modify the publishing settings.

- [✓ Run server with resources within the workspace]
  - ☐ Minimize application files copied to the server
- ○ Run server with resources on Server

☑ Enable automatic publishing
Publishing interval (in minutes): 1

Security

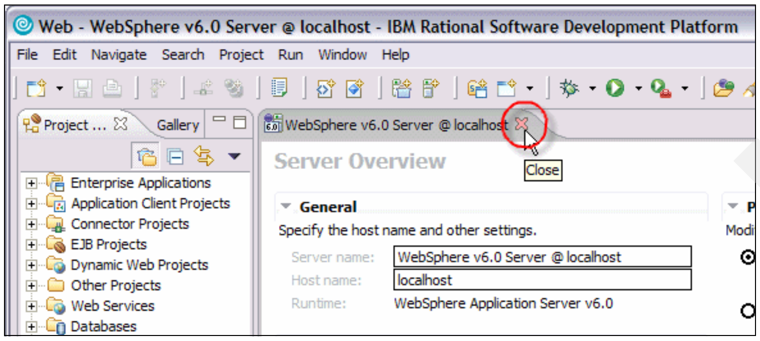
Network Deployment

Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere v5.1 Test Environment @ localhost	localhost	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost		

Figure A-6 Selecting the SOAP connector

11. Select **File** → **Save** from the menu bar or press CTRL+S to save the configuration changes.

12. Click **X** to close the WebSphere 6.0 Server Configuration view (see Figure A-7).

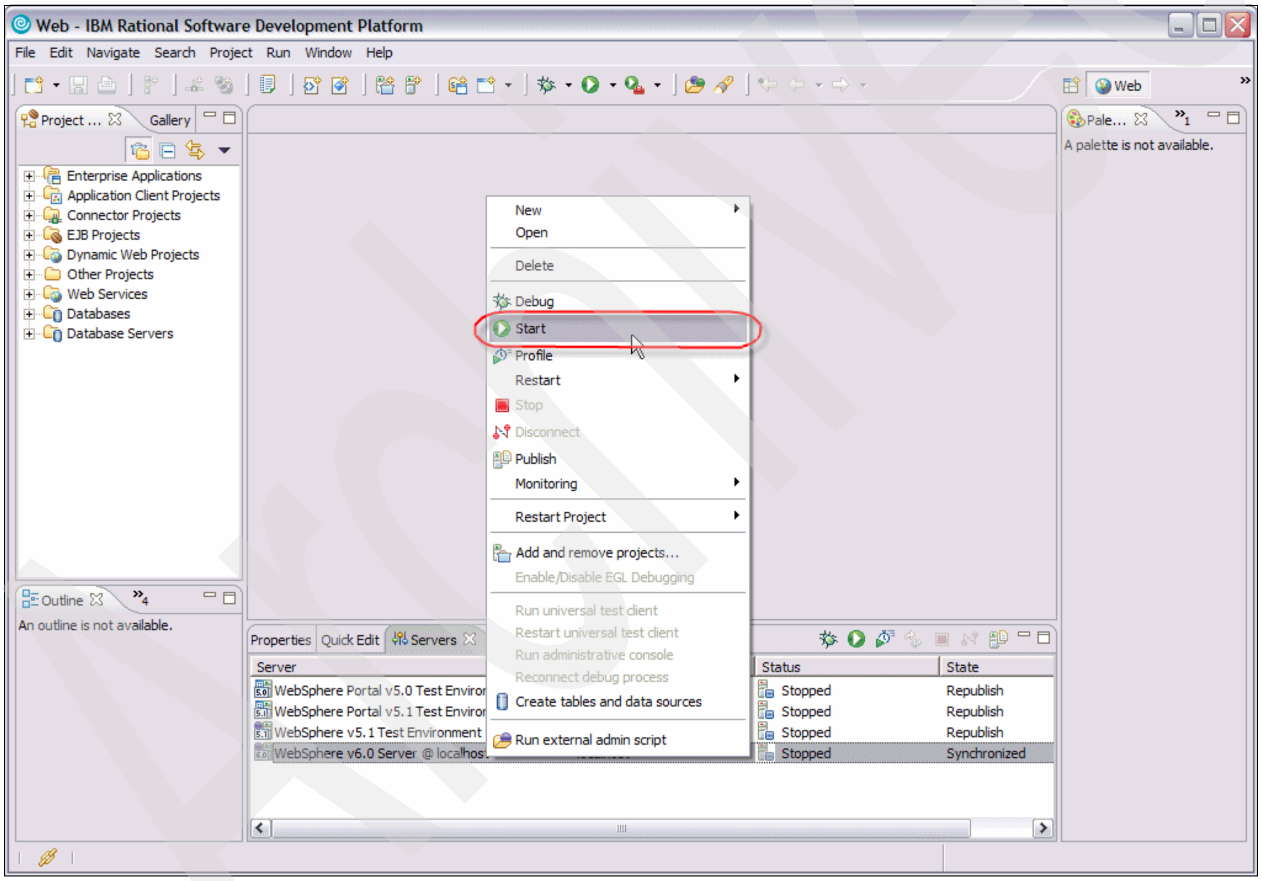

Web - WebSphere v6.0 Server @ localhost - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Project ... Gallery
Enterprise Applications
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
Other Projects
Web Services
Databases
WebSphere v6.0 Server @ localhost
Close
Server Overview
General

Specify the host name and other settings.

Server name: WebSphere v6.0 Server @ localhost
Host name: localhost
Runtime: WebSphere Application Server v6.0

Figure A-7 Closing the server properties file

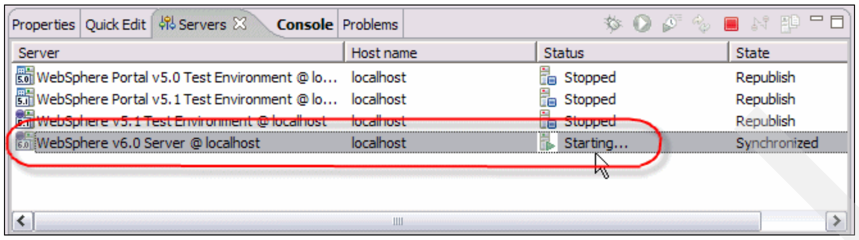
13. In the Servers view, right-click the **WebSphere 6.0 server** (you might see a different name in your environment) and select **Start** (see Figure A-8).


Web - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Web
Project ... Gallery
Enterprise Applications
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
Other Projects
Web Services
Databases
Database Servers
Outline
An outline is not available.
Pale...
A palette is not available.
New
Open
Delete
Debug
Start
Profile
Restart
Stop
Disconnect
Publish
Monitoring
Restart Project
Add and remove projects...
Enable/Disable EGL Debugging
Run universal test client
Restart universal test client
Run administrative console
Reconnect debug process
Create tables and data sources
Run external admin script
Properties Quick Edit Servers

Server	Status	State
WebSphere Portal v5.0 Test Enviror	Stopped	Republish
WebSphere Portal v5.1 Test Enviror	Stopped	Republish
WebSphere v5.1 Test Environment	Stopped	Republish
WebSphere v6.0 Server @ localhost	Stopped	Synchronized

Figure A-8 Starting the server

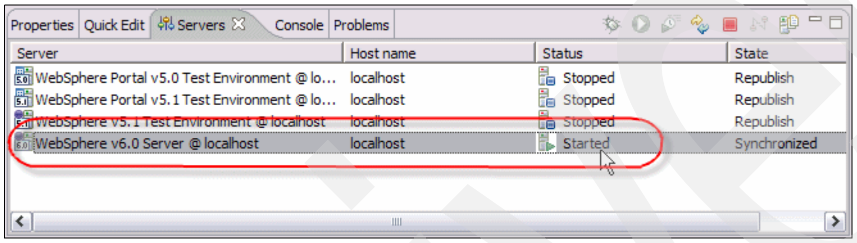
14. In the Servers view, you should see the *Starting* message for 3 to 5 minutes as shown in Figure A-9.



Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere v5.1 Test Environment @ localhost	localhost	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost	Starting...	Synchronized

Figure A-9 The server is starting

15. After the WebSphere Application Server is started, you should see the *Started* status in the Servers view as shown in Figure A-10.



Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere v5.1 Test Environment @ localhost	localhost	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost	Started	Synchronized

Figure A-10 The server is started

B

URI length limit of 259 characters on Windows

This appendix describes the details of the workaround for WebSphere Development Studio client for iSeries in a case when a path to a resource in WebSphere Development Studio client for iSeries exceeds 259 characters.

Issue

An error such as that shown in Example B-1can occur when you are deploying an application to the WebSphere Test Environment using WebSphere Application Server V6.0.

Example: B-1 Error message

```
[11/14/05 13:04:26:114 EST] 00000042 SystemErr R java.io.IOException:
URI length is greater than Windows limit of 259 characters. C:\Program
Files\IBM\Rational\SDP\6.0\runtimes\base_v6\profiles\default1\wstemp\1079040961d\w
orkspace\cells\sandygmobNode05Cell\applications\MyProjectWithaLongPathNameEAR.ear\
deployments\MyProjectWithaLongPathNameEAR\MyProjectWithaLongPathNameWeb.war\wsdl\a
\very\exceptionallylong\nameusedforthepackagename\MyTestForWS.wsdl
```

Cause

The length limit on Windows is imposed by the Java SDK 1.4.

Solution

Here are a few different suggestions to try for resolving this issue:

- Shorten the names of the Enterprise Application Project (EAR) and Web Project
- Shorten the length of the package used
- Shorten the temp directory used by WebSphere Application Server by following the steps we describe in this section.

Important: In this section, the solution to shorten the temp directory is shown in detail for WebSphere Development Studio client for iSeries, because this is the most complete resolution to the problem.

Follow these steps to resolve the issues with a path length:

1. Create a directory with a short name, for example `C:\A`, on the C drive. Using Windows Explorer select **File** → **New Folder** as shown in Figure B-1.

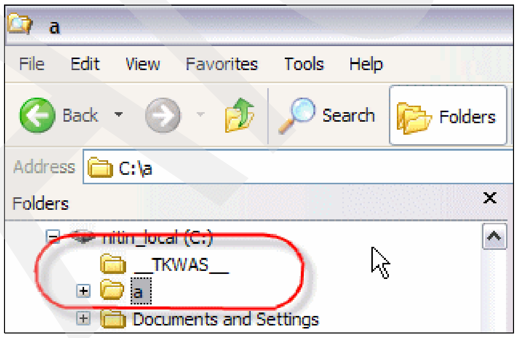
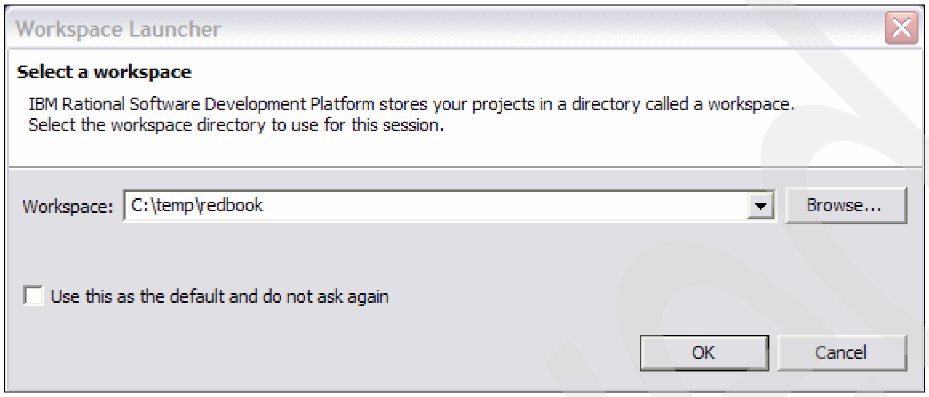


Figure B-1 Creating a new directory

2. Start WebSphere Development Studio client for iSeries by going to **Start** → **All Programs** → **IBM Rational** → **IBM WebSphere Development Studio Client Advanced Edition for iSeries V6.0** → **WebSphere Development Studio Client Advanced Edition for iSeries**.

3. In the workplace launcher window, enter `c:\temp\redbook` in the workspace field and click **OK** (see Figure B-2).

> **Note:** In the event that WebSphere Development Studio client for iSeries is already started, proceed to step 5 on page 257.


Workspace Launcher

Select a workspace

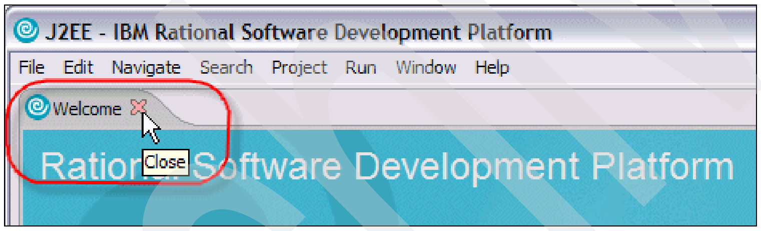
IBM Rational Software Development Platform stores your projects in a directory called a workspace.
Select the workspace directory to use for this session.

Workspace: C:\temp\redbook

☐ Use this as the default and do not ask again

Figure B-2 Specifying a workspace location

4. If you have not used WebSphere Development Studio client for iSeries before, you should see a Welcome page. Click **X** to close the Welcome page as shown in Figure B-3.



J2EE - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Welcome
Close
Rational Software Development Platform

Figure B-3 Closing a Welcome page

5. Click the **Open perspective** icon on the right-hand side (see Figure B-4) or go to **Window** → **Open Perspective**.

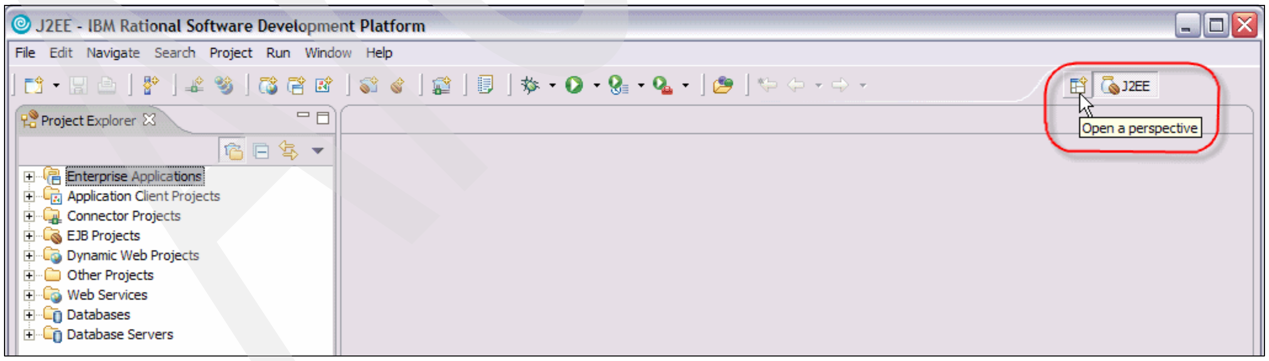
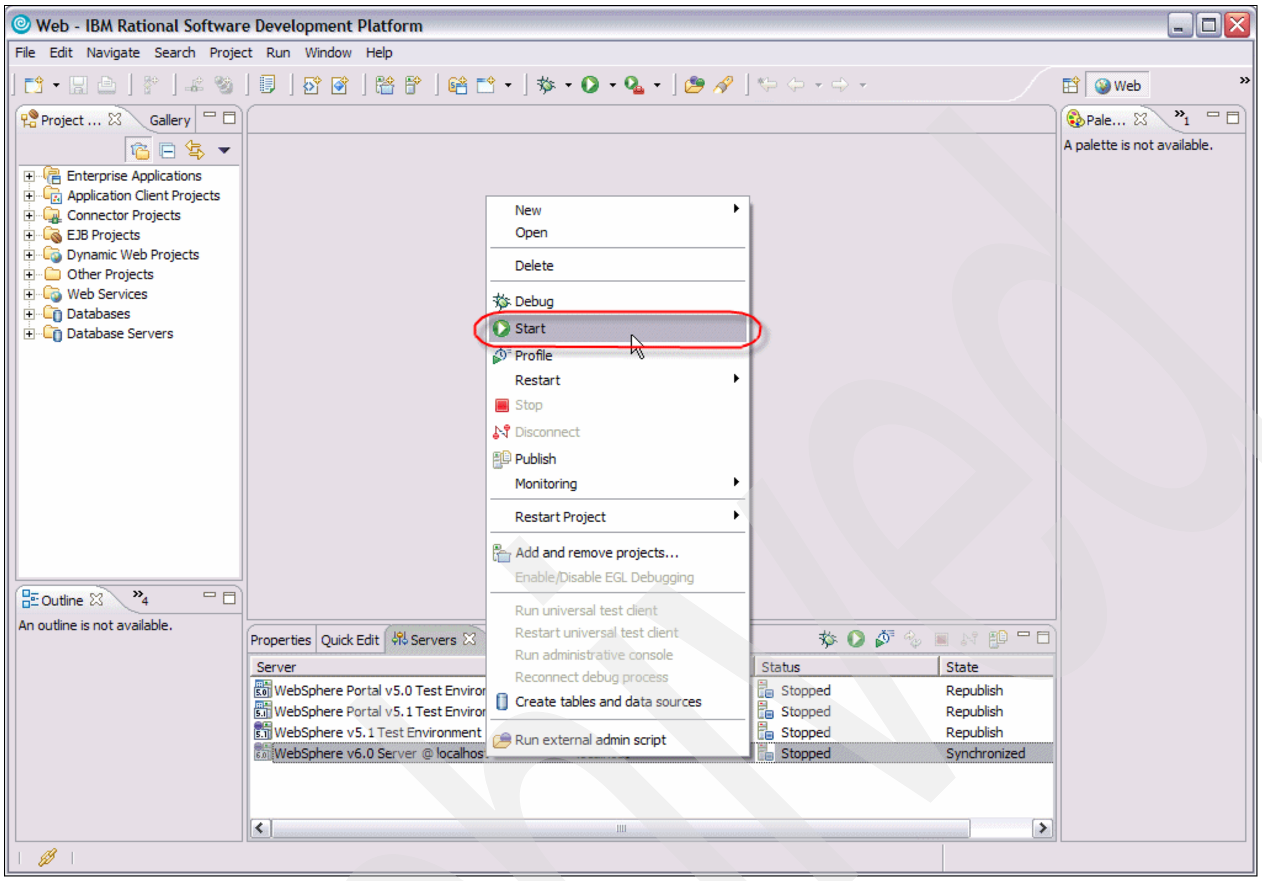


Figure B-4

6. Select **Other**.
7. In the Select Perspective window, select **Web** and click **OK**.

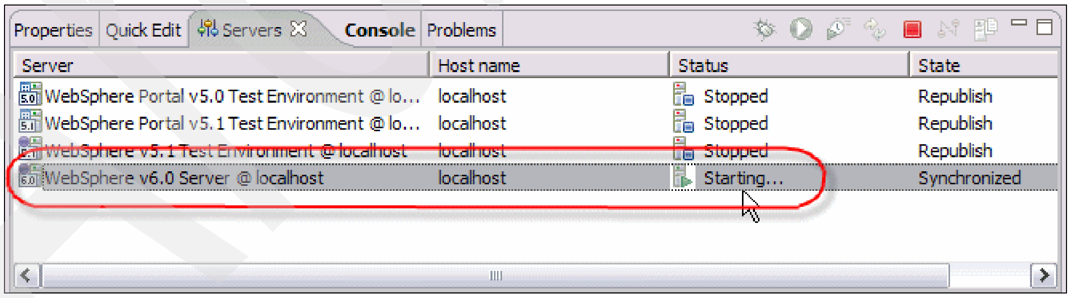
8. In the Servers view, right-click the **WebSphere 6.0 server** (you might have a different name in your environment) and select **Start** as shown in Figure B-5.


Web - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Web
Project ... Gallery
Enterprise Applications
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
Other Projects
Web Services
Databases
Database Servers
Outline
An outline is not available.
Pale...
A palette is not available.
New
Open
Delete
Debug
Start
Profile
Restart
Stop
Disconnect
Publish
Monitoring
Restart Project
Add and remove projects...
Enable/Disable EGL Debugging
Run universal test client
Restart universal test client
Run administrative console
Reconnect debug process
Create tables and data sources
Run external admin script
Properties Quick Edit Servers

Server	Status	State
WebSphere Portal v5.0 Test Enviror	Stopped	Republish
WebSphere Portal v5.1 Test Enviror	Stopped	Republish
WebSphere v5.1 Test Environment	Stopped	Republish
WebSphere v6.0 Server @ localhos	Stopped	Synchronized

Figure B-5 Starting the server

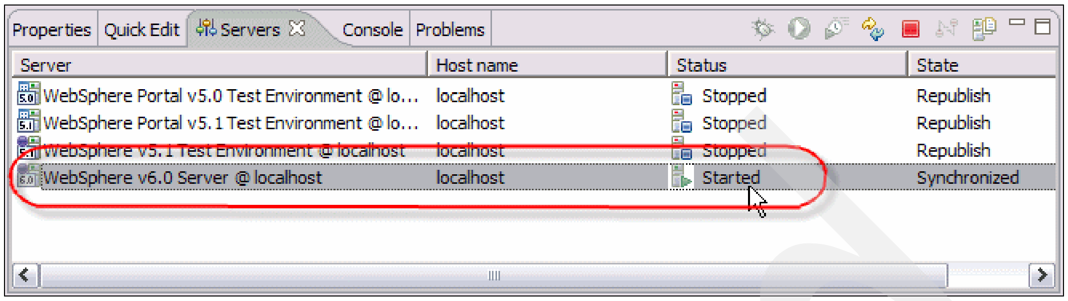
9. In the Servers view, you should see the Starting message for 3 to 5 minutes (see Figure B-6).



Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere v5.1 Test Environment @ localhost	localhost	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost	Starting...	Synchronized

Figure B-6 The server is starting

10. After the WebSphere 6.0 Server is started, you should see the *Started* status in the server view (see Figure B-7).



Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere v5.1 Test Environment @ localhost	localhost	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost	Started	Synchronized

Figure B-7 The server is started

11. In the Server view, right-click the **WebSphere 6.0 server** and select **Run administrative console** (see Figure B-8).

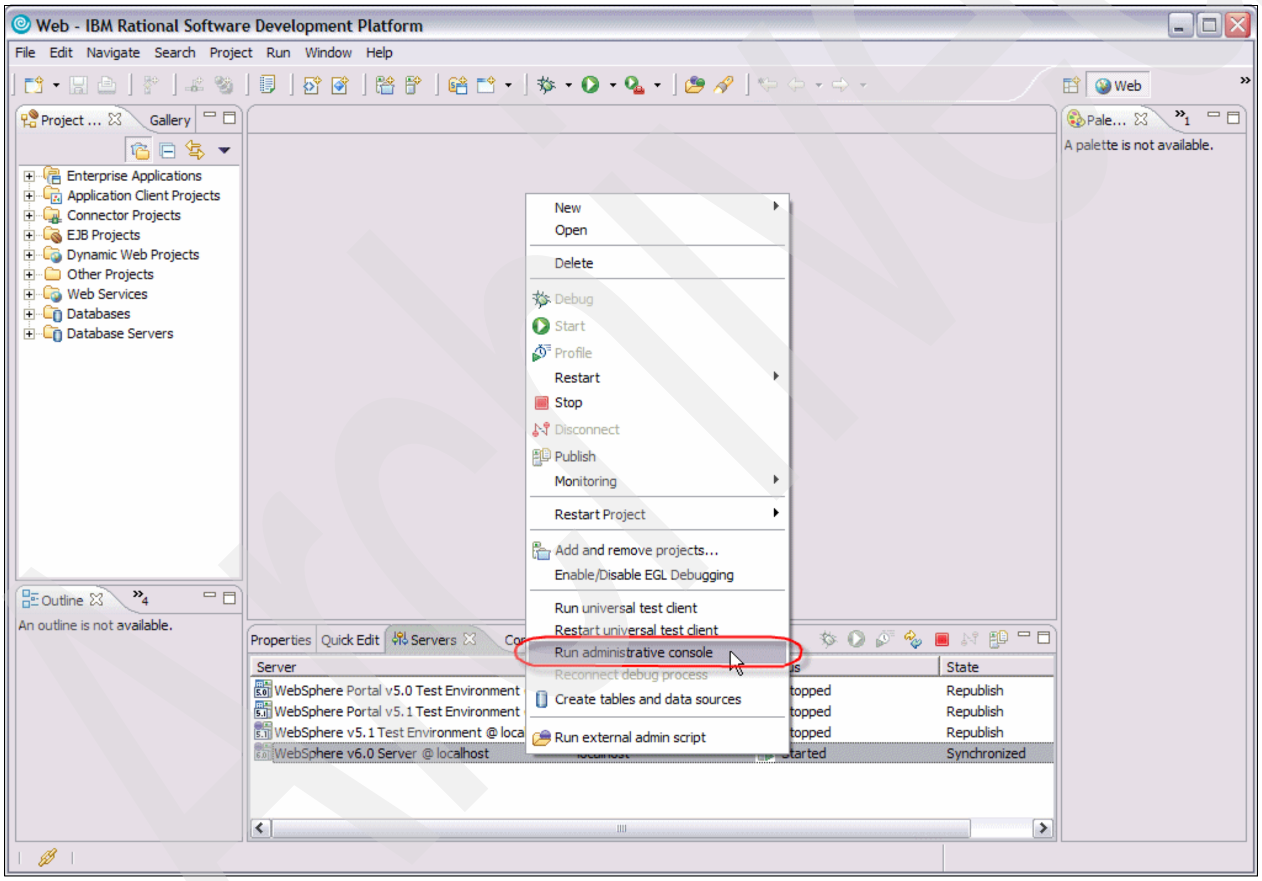
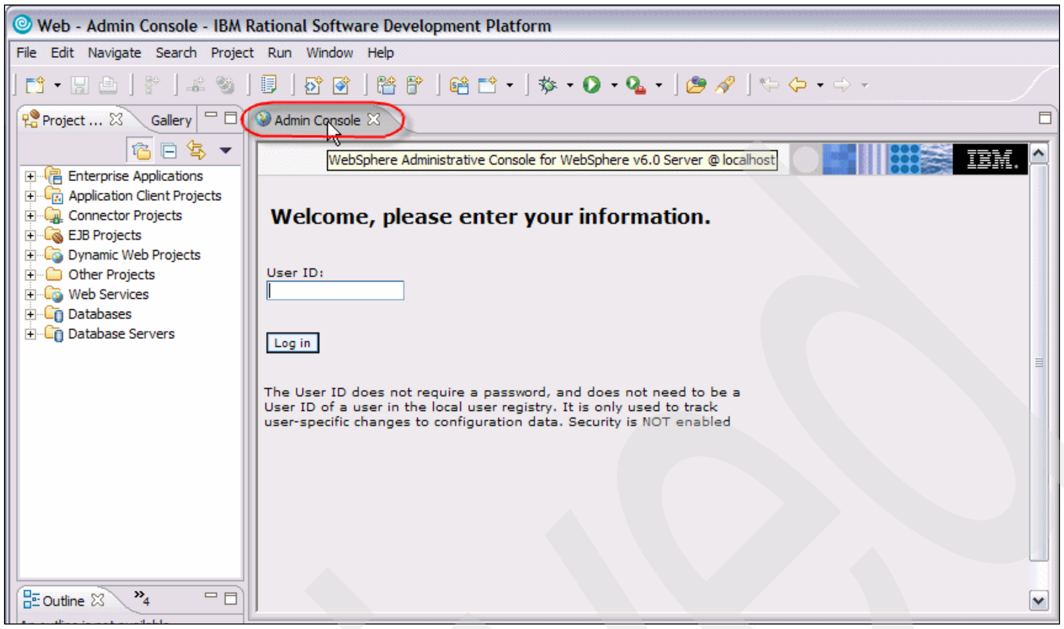

Web - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Web
Project ...
Gallery
Enterprise Applications
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
Other Projects
Web Services
Databases
Database Servers
Outline
An outline is not available.
Pale...
A palette is not available.
New
Open
Delete
Debug
Start
Profile
Restart
Stop
Disconnect
Publish
Monitoring
Restart Project
Add and remove projects...
Enable/Disable EGL Debugging
Run universal test client
Restart universal test client
Run administrative console
Reconnect debug process
Create tables and data sources
Run external admin script
Properties
Quick Edit
Servers
Server
State
WebSphere Portal v5.0 Test Environment
WebSphere Portal v5.1 Test Environment
WebSphere v5.1 Test Environment @ loca
WebSphere v6.0 Server @ localhost
topped
topped
topped
tarted
Republish
Republish
Republish
Synchronized

Figure B-8 Opening the administrative console

12. Double-click **Admin Console** window to expand it (see Figure B-9).


Web - Admin Console - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Project ... Gallery
Admin Console
Enterprise Applications
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
Other Projects
Web Services
Databases
Database Servers
Outline
WebSphere Administrative Console for WebSphere v6.0 Server @ localhost
IBM.
Log in

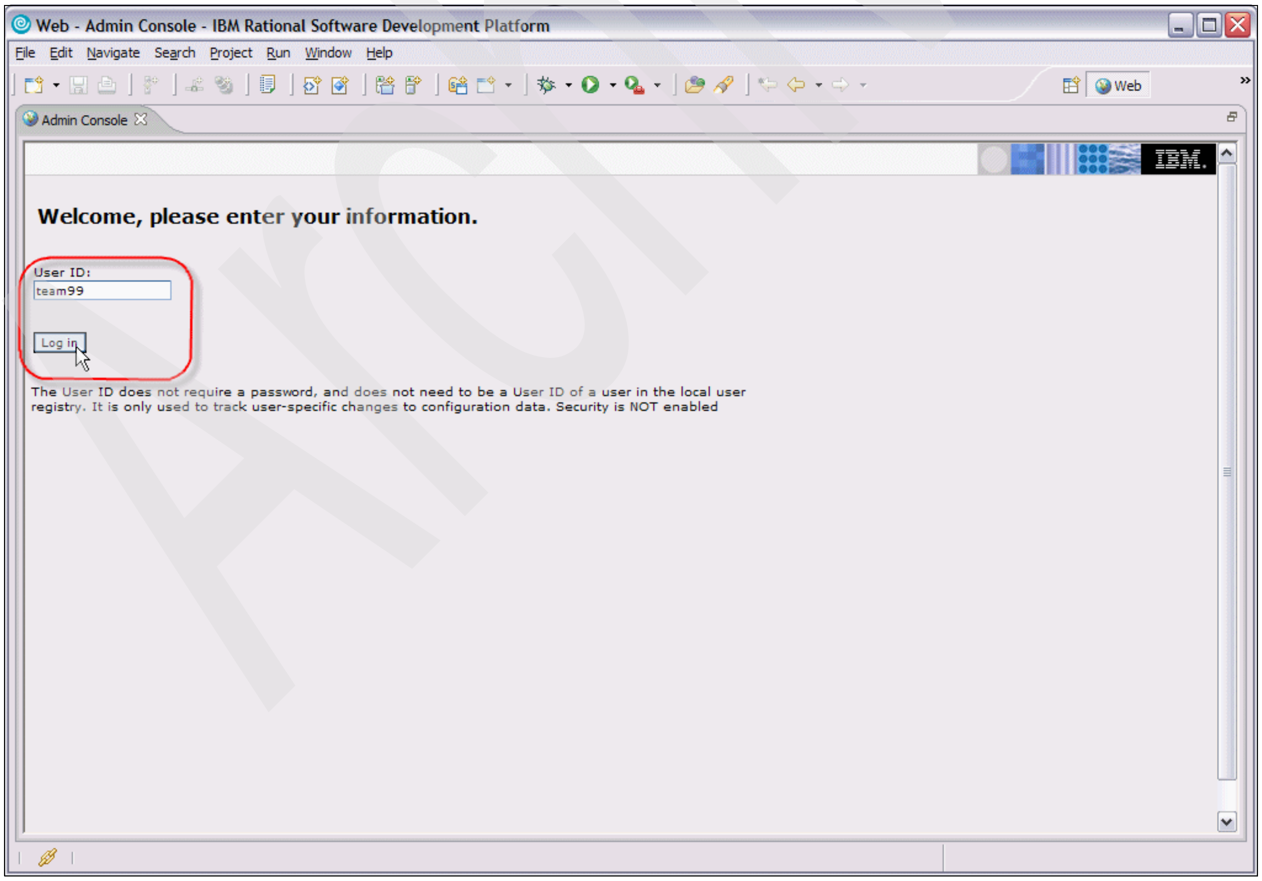
Welcome, please enter your information.

User ID:

The User ID does not require a password, and does not need to be a User ID of a user in the local user registry. It is only used to track user-specific changes to configuration data. Security is NOT enabled

Figure B-9 Expanding the window

13. In the Admin Console window, enter a user name (any name will work) and click **Log in** (see Figure B-10).


Web - Admin Console - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Web
Admin Console
IBM.
Log in

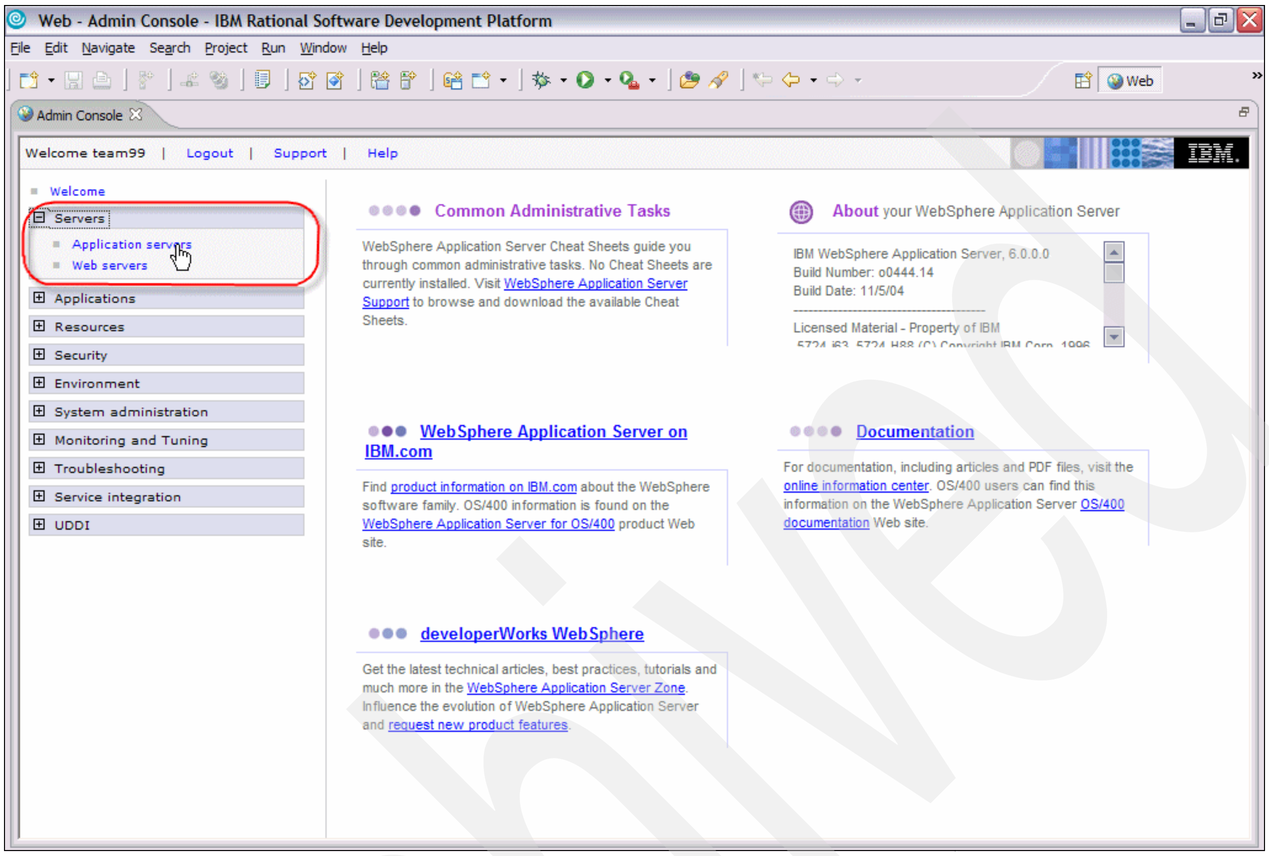
Welcome, please enter your information.

User ID: team99

The User ID does not require a password, and does not need to be a User ID of a user in the local user registry. It is only used to track user-specific changes to configuration data. Security is NOT enabled

Figure B-10 Logging in

14. Expand **Servers** by clicking the plus (**+**) sign and select **Application Servers** (see Figure B-11).



Common Administrative Tasks

WebSphere Application Server Cheat Sheets guide you through common administrative tasks. No Cheat Sheets are currently installed. Visit WebSphere Application Server Support to browse and download the available Cheat Sheets.

About your WebSphere Application Server

IBM WebSphere Application Server, 6.0.0.0
Build Number: o0444.14
Build Date: 11/5/04

Licensed Material - Property of IBM
5724-I63, 5724-H88 (C) Copyright IBM Corp. 1996

WebSphere Application Server on IBM.com

Find product information on IBM.com about the WebSphere software family. OS/400 information is found on the WebSphere Application Server for OS/400 product Web site.

Documentation

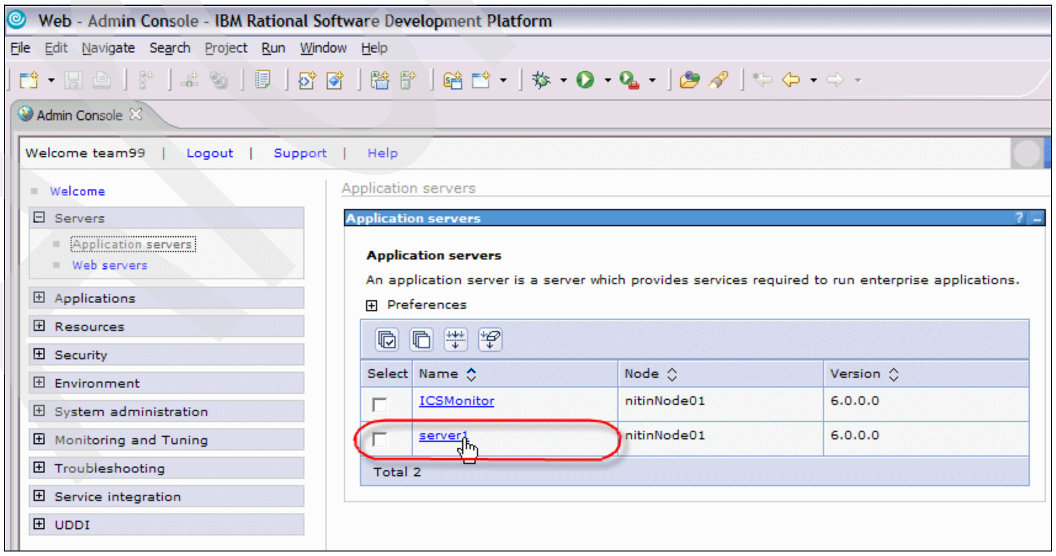
For documentation, including articles and PDF files, visit the online information center. OS/400 users can find this information on the WebSphere Application Server OS/400 documentation Web site.

developerWorks WebSphere

Get the latest technical articles, best practices, tutorials and much more in the WebSphere Application Server Zone. Influence the evolution of WebSphere Application Server and request new product features.

Figure B-11 Accessing your server configuration

15. Select **server1** under Application Servers as shown in Figure B-12.



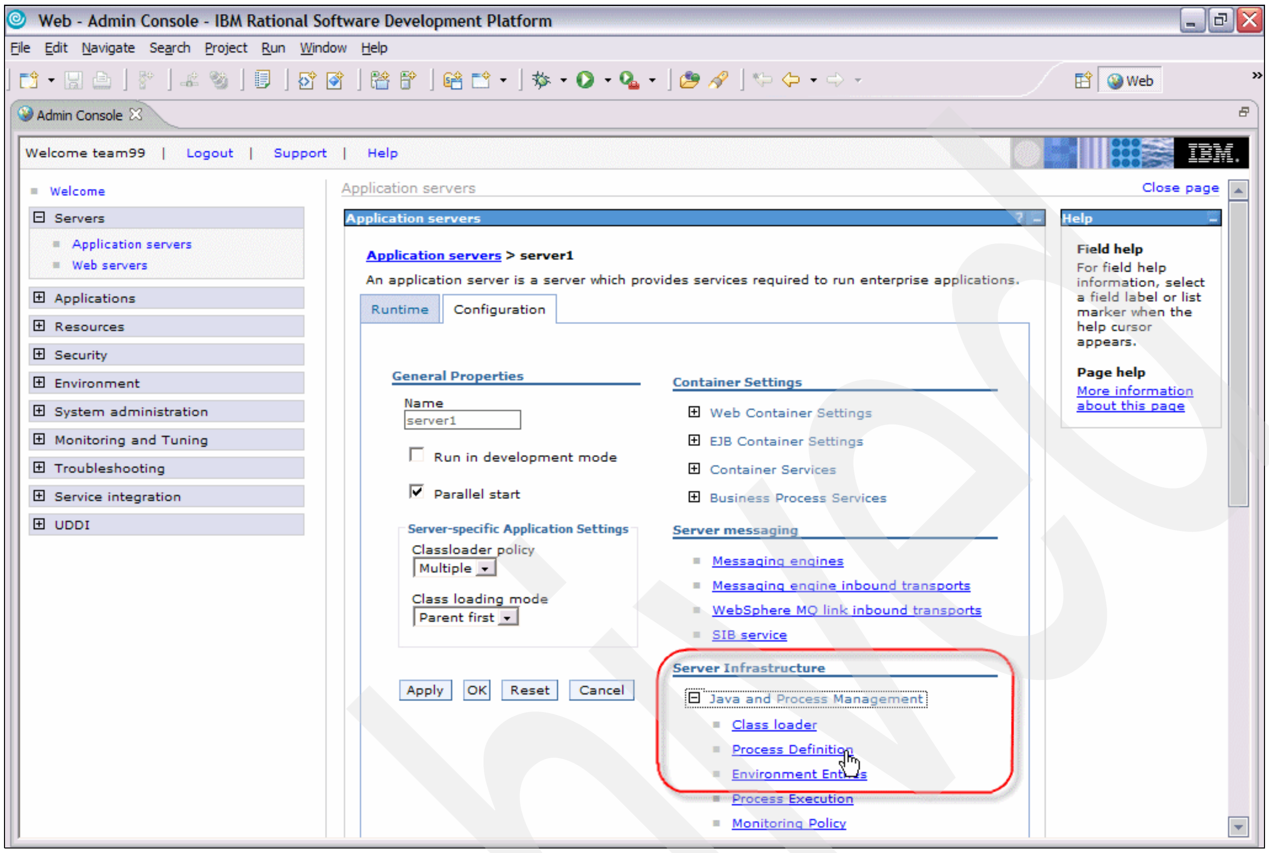
Application servers

An application server is a server which provides services required to run enterprise applications.

Select	Name	Node	Version
☐	ICSMonitor	nitinNode01	6.0.0.0
☐	server1	nitinNode01	6.0.0.0
Total 2			

Figure B-12 Selecting server1

16. Expand **Java and Process Management** by clicking the plus sigh (**+**) under Server Infrastructure. Click **Process Definition** (see Figure B-13).



Application servers > server1

An application server is a server which provides services required to run enterprise applications.

Name: server1

☐ Run in development mode

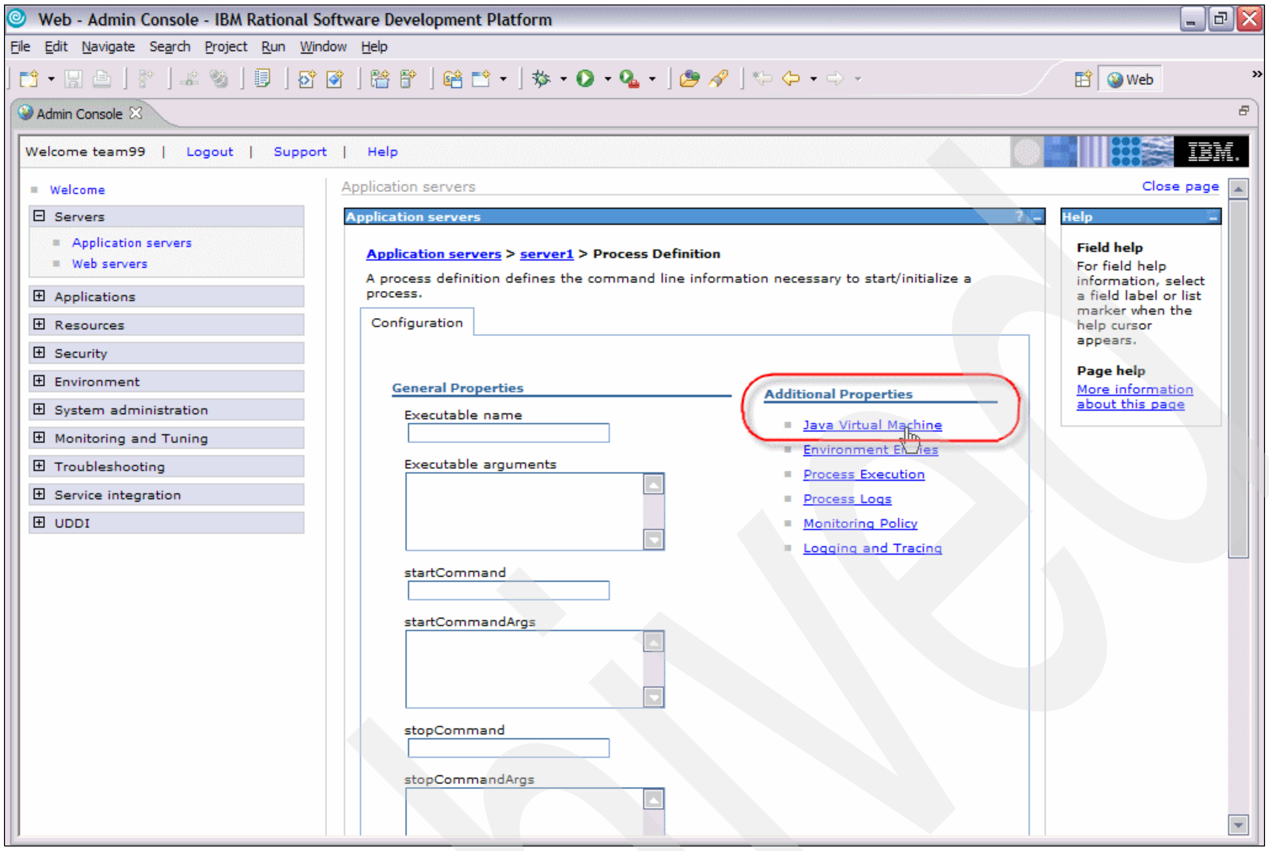
☑ Parallel start

Classloader policy: Multiple

Class loading mode: Parent first

Figure B-13 Opening Process Definition

17.Select **Java Virtual Machine** under Additional Properties as shown in Figure B-14.

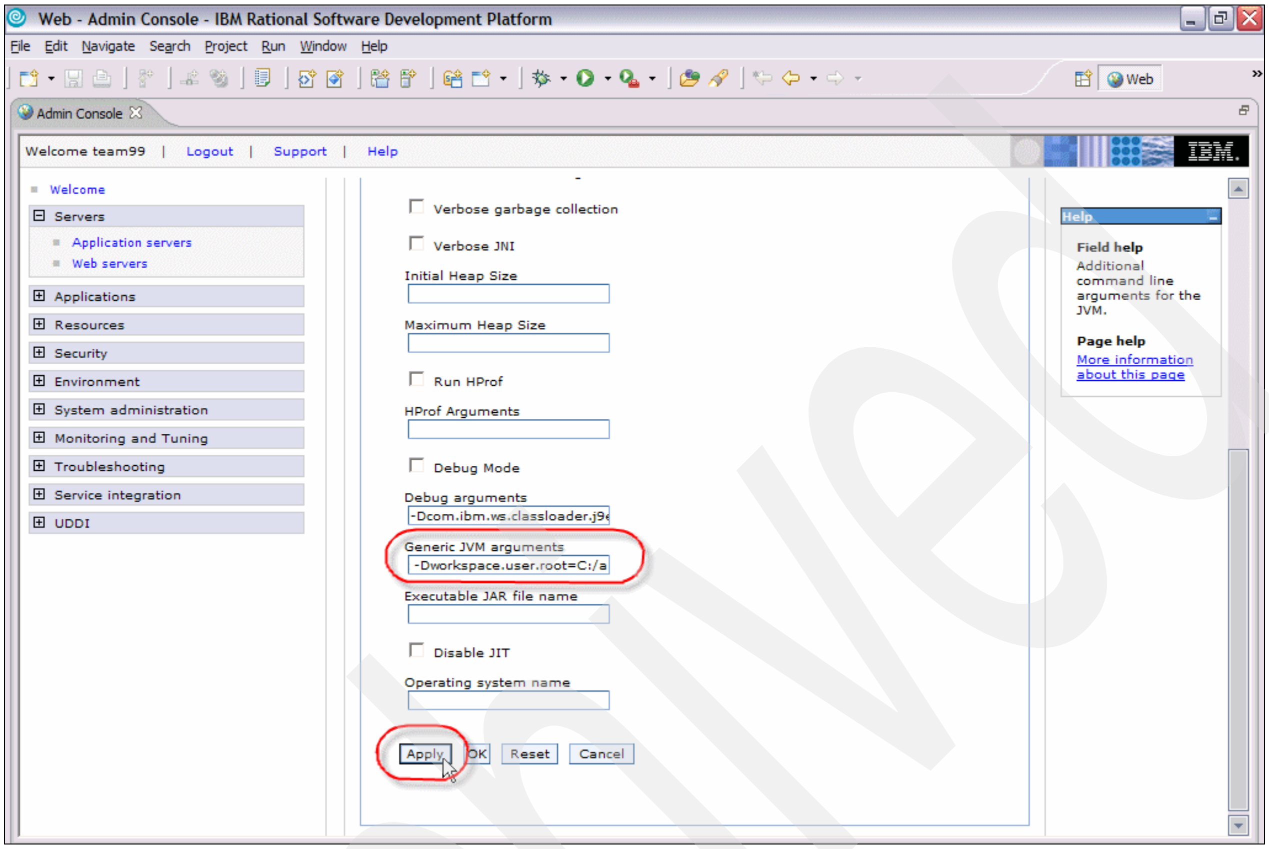


A process definition defines the command line information necessary to start/initialize a process.

For field help information, select a field label or list marker when the help cursor appears.

Figure B-14 Opening JVM™ properties

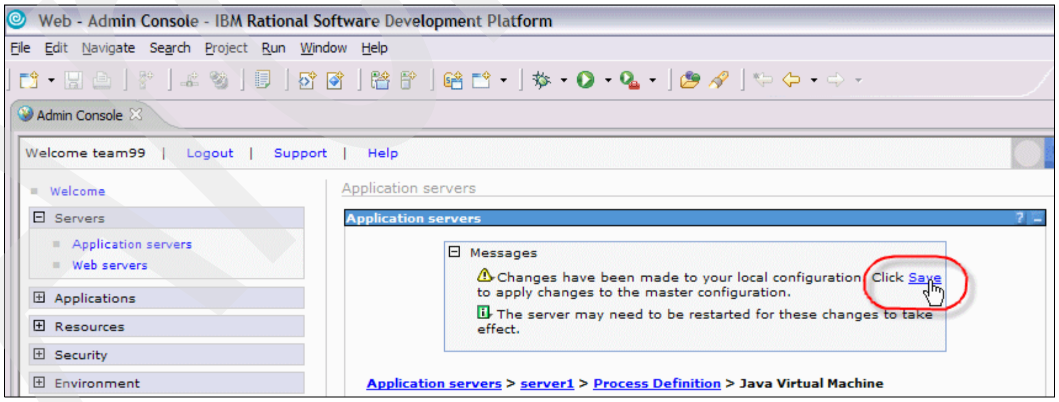
18.In the Generic JVM arguments, enter `-Dworkspace.user.root=C:/a` and click **Apply** as shown in Figure B-15. The directory you specify must match the directory that you created in step 1 on page 256.


Web - Admin Console - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Admin Console
Welcome team99 | Logout | Support | Help
Welcome
Servers
Application servers
Web servers
Applications
Resources
Security
Environment
System administration
Monitoring and Tuning
Troubleshooting
Service integration
UDDI
Help
Field help
Additional command line arguments for the JVM.
Page help
More information about this page
Apply
OK
Reset
Cancel

Verbose garbage collection
Verbose JNI
Initial Heap Size
Maximum Heap Size
Run HProf
HProf Arguments
Debug Mode
Debug arguments: -Dcom.ibm.ws.classloader.j9e
Generic JVM arguments: -Dworkspace.user.root=C:/a
Executable JAR file name
Disable JIT
Operating system name

Figure B-15 Changing JVM arguments

19.Click **Save** on the next window to save the changes (see Figure B-16).


Web - Admin Console - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Admin Console
Welcome team99 | Logout | Support | Help
Welcome
Servers
Application servers
Web servers
Applications
Resources
Security
Environment
Application servers
Application servers

Messages

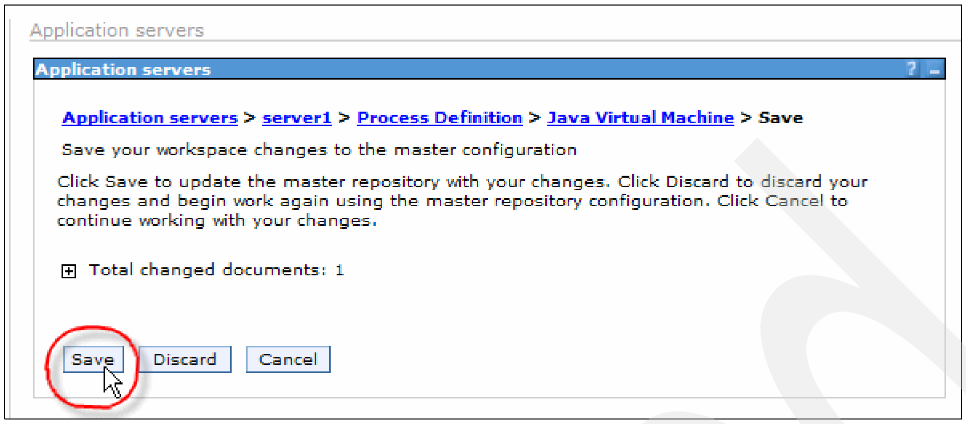
Changes have been made to your local configuration. Click Save to apply changes to the master configuration.

The server may need to be restarted for these changes to take effect.

Application servers > server1 > Process Definition > Java Virtual Machine

Figure B-16 Saving WebSphere profile configuration

20. Click **Save** on the next panel (see Figure B-17).


Application servers

Application servers

Application servers > server1 > Process Definition > Java Virtual Machine > Save

Save your workspace changes to the master configuration

Click Save to update the master repository with your changes. Click Discard to discard your changes and begin work again using the master repository configuration. Click Cancel to continue working with your changes.

Total changed documents: 1

Figure B-17

21. Click **Logout** to exit the Admin Console window as shown in Figure B-18.

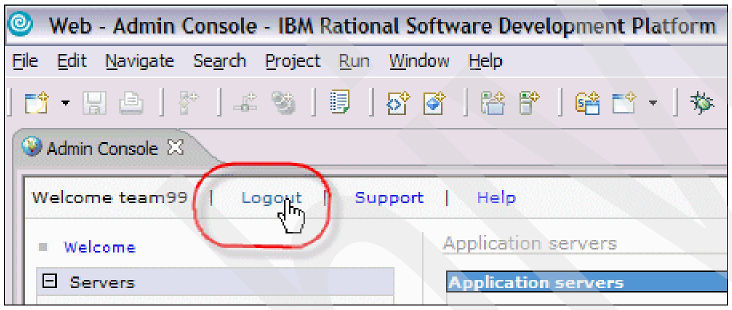
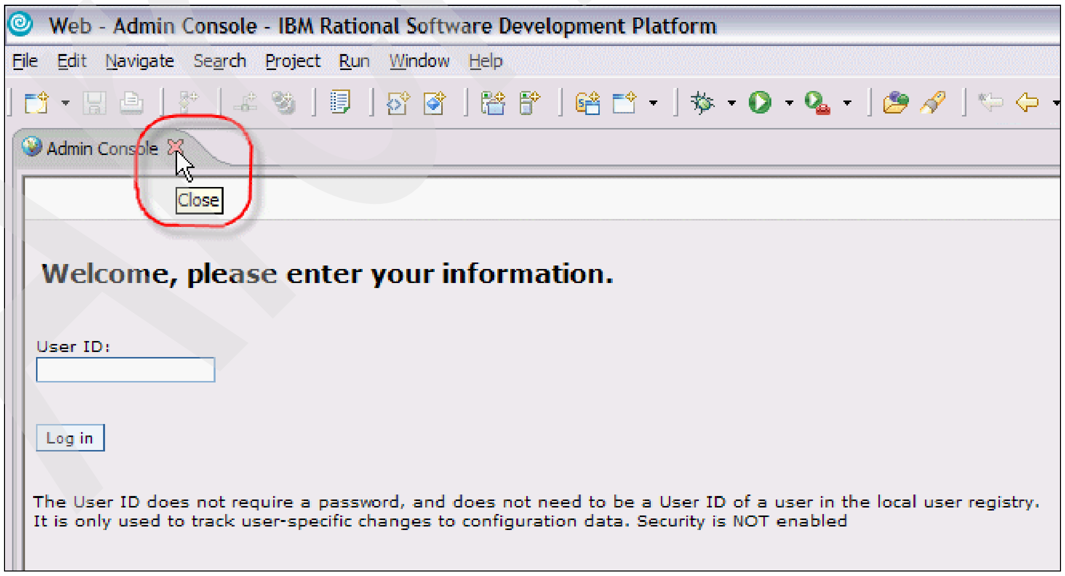

Web - Admin Console - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Admin Console
Welcome team99 | Logout | Support | Help
Welcome
Servers
Application servers
Application servers

Figure B-18 Logging out

22. Click **X** to close the Admin Console window (see Figure B-19).


Web - Admin Console - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Admin Console
Close

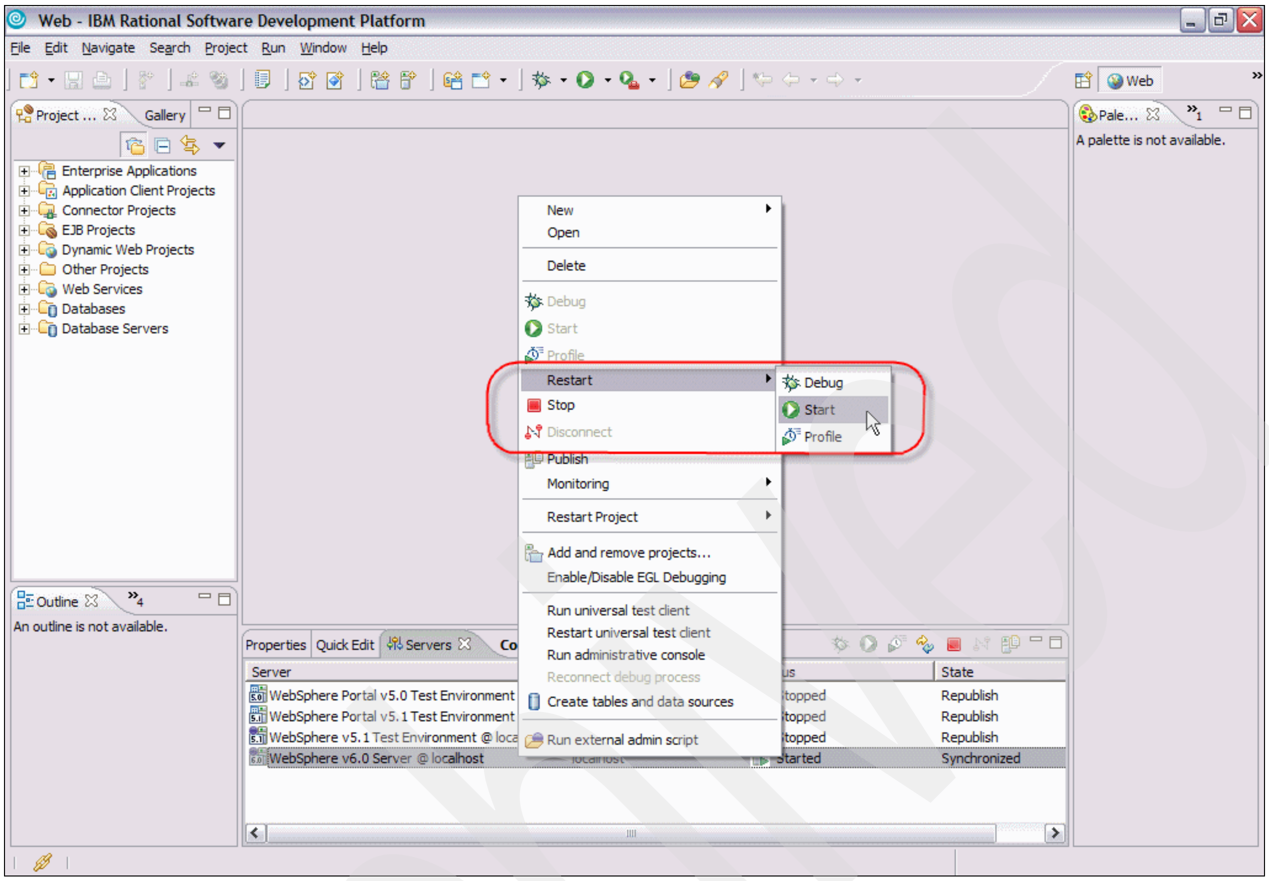
Welcome, please enter your information.

User ID:

The User ID does not require a password, and does not need to be a User ID of a user in the local user registry. It is only used to track user-specific changes to configuration data. Security is NOT enabled

Figure B-19 Closing the window

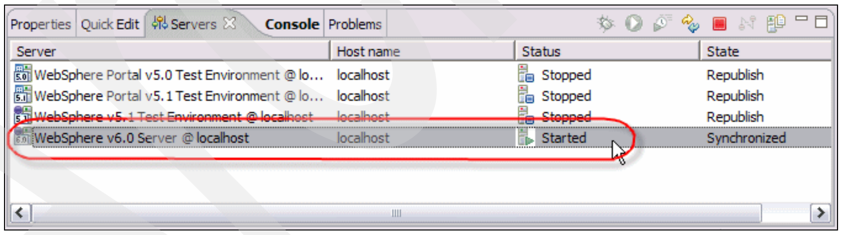
23. In the Servers view, right-click **WebSphere 6.0 server** and select **Restart** → **Start** (see Figure B-20).


Web - IBM Rational Software Development Platform
File Edit Navigate Search Project Run Window Help
Web
Project ... Gallery
Enterprise Applications
Application Client Projects
Connector Projects
EJB Projects
Dynamic Web Projects
Other Projects
Web Services
Databases
Database Servers
Outline
An outline is not available.
Pale...
A palette is not available.
New
Open
Delete
Debug
Start
Profile
Restart
Stop
Disconnect
Publish
Monitoring
Restart Project
Add and remove projects...
Enable/Disable EGL Debugging
Run universal test client
Restart universal test client
Run administrative console
Reconnect debug process
Create tables and data sources
Run external admin script
Debug
Start
Profile
Properties Quick Edit Servers Co

Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment		topped	Republish
WebSphere Portal v5.1 Test Environment		topped	Republish
WebSphere v5.1 Test Environment @ loca		topped	Republish
WebSphere v6.0 Server @ localhost	localhost	tarted	Synchronized

Figure B-20 Restarting the server

24. Wait until the server status changes to `Started` (see Figure B-21).



Server	Host name	Status	State
WebSphere Portal v5.0 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere Portal v5.1 Test Environment @ lo...	localhost	Stopped	Republish
WebSphere v5.1 Test Environment @ localhost	localhost	Stopped	Republish
WebSphere v6.0 Server @ localhost	localhost	Started	Synchronized

Figure B-21 The server is restarted

C

Useful tools

This chapter examines some of the advanced topics for application debugging on System i. It includes the following topics:

- SOAP monitoring utility
- Security testing for Web services
- WebSphere Development Studio client for iSeries debugger

SOAP monitoring utility

In the previous chapters, we showed how to generate the Service Provider or Service Consumer. While testing the interaction, nothing happens between the services or, worse yet, you get exceptions or Web services faults. In this section, we articulate a sequence of steps to help with problem determination of the service interaction. This problem determination should prove helpful for both the Service Consumer or Service Provider scenarios.

In the course of the development of Web services, it became apparent that seeing the messages exchanged between the Service Provider and Service Consumer is necessary to assist in debugging technical problems.

There are several SOAP utilities that you can use to monitor the messages between service provider and service consumer. In the next sections, we focus on the TCPMON utility offered as a free download from:

http://www.apache.org

You can use the TCPMON utility for the following issues:

- Response timeout
- Web service faults that seem network related
- Service end-point interface that seems incorrect
- Examine the SOAP message being exchanged between the Consumer/Provider
- Determine if encryption of messages are occurring within the SOAP packet

Download Apache TCPMON binary

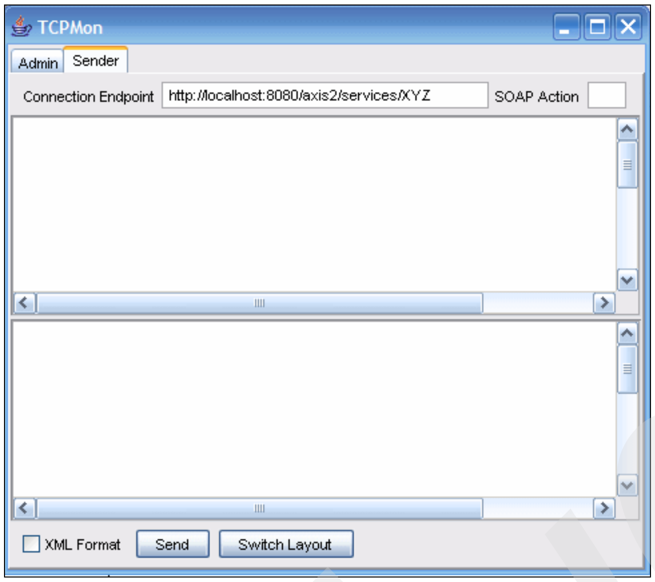
TCPMON is a java based utility that can be downloaded from the following location:

http://ws.apache.org/commons/tcpmon/download.cgi

You do not need to run the utility on the Consumer or the Provider. You can run it on any GUI-based client and use it as mediator to examine the exchanging of the messages. TCPMON requires a version of JDK™ to run the utility. Follow these steps:

1. Extract the contents of the compressed file to a temporary directory.

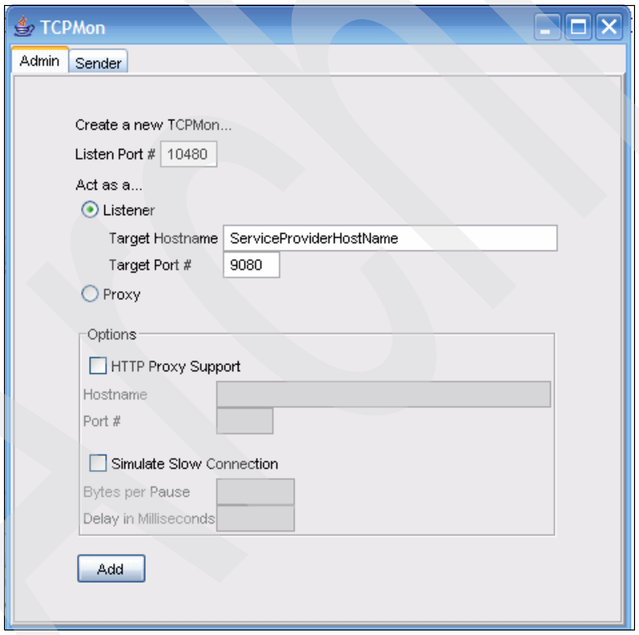
2. Select to execute `..\tcpmon-1.0-bin\build\tcpmon.bat` (see Figure C-1).



Connection Endpoint: http://localhost:8080/axis2/services/XYZ

Figure C-1 TCPMON Utility

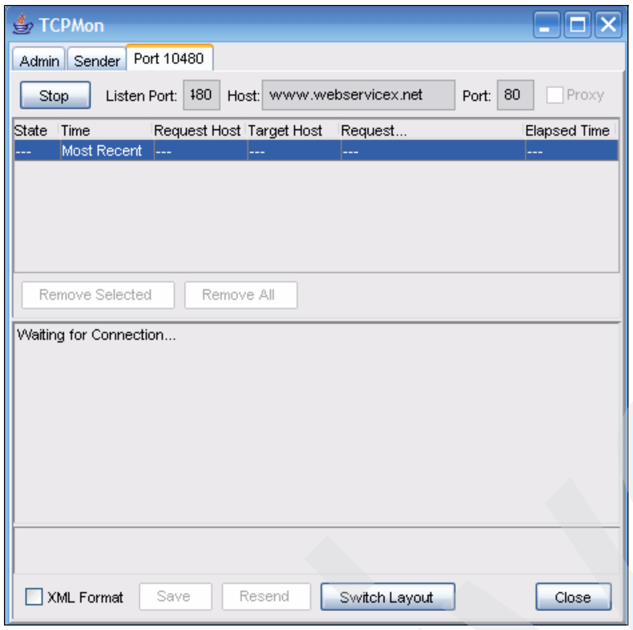
3. Click the Admin tab. Enter the values Target Hostname and Target Port # which can be determined from the WSDL file (For further information about Service Endpoint review 5.2.9, “Modifying the Web service Client URI” on page 62). Click **Add** (see Figure C-2).



Create a new TCPMon...
Listen Port # 10480
Act as a...
(●) Listener
Target Hostname ServiceProviderHostName
Target Port # 9080
( ) Proxy

Figure C-2 TCPMON Admin tab

4. Select the new listener tab (see Figure C-3) that was created to monitor SOAP packets as they are routed through the TCPMON SOAP utility.



State	Time	Request Host	Target Host	Request...	Elapsed Time
---	Most Recent	---	---	---	---

Waiting for Connection...

Figure C-3 TCPMON SOAP Listener

5. Adjust any Web service client service endpoint interface to point at the listener port and server that you defined in the previous step. (You should use the host name of the system where you run TCPMON and the port number that you specify on the Admin tab. In our example, it is 10480.)
   - JSP test client - 10.1.3, “Creating JSF Web service client using Web Service Component” on page 231
   - RPG Client - 9.2.2, “Examining the WSDL document” on page 198
   - Web Services Explorer on WebSphere Development Studio client for iSeries as shown in the next steps

6. Using WebSphere Development Studio client, right click any WSDL document and select **Web services** → **Test with Web services Explorer** (see Figure C-4).

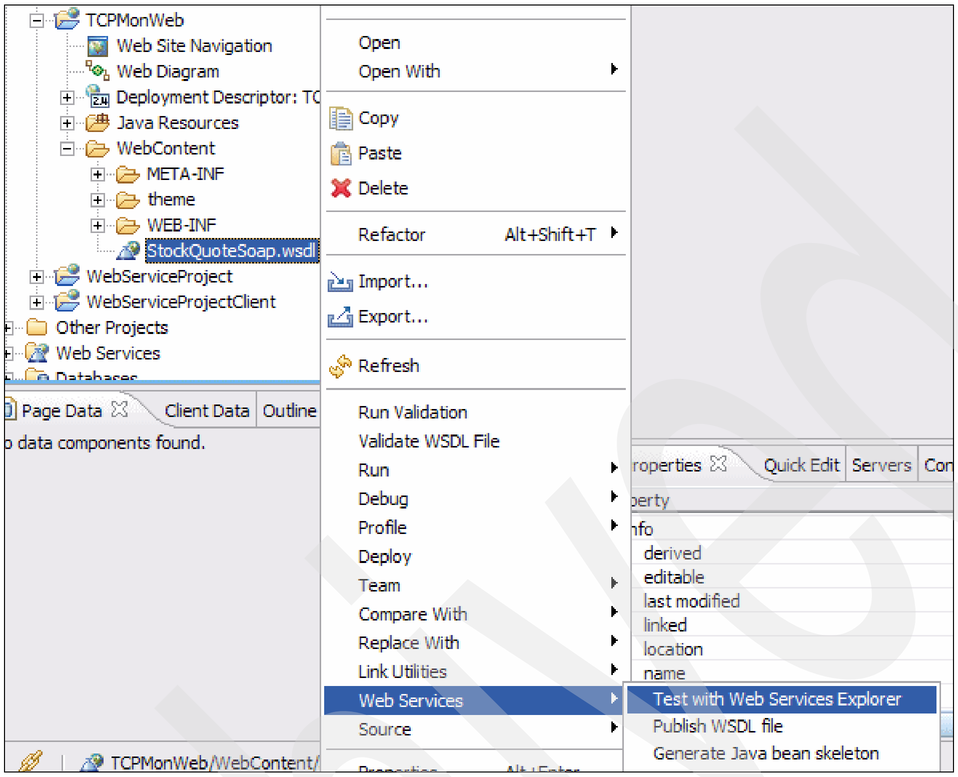
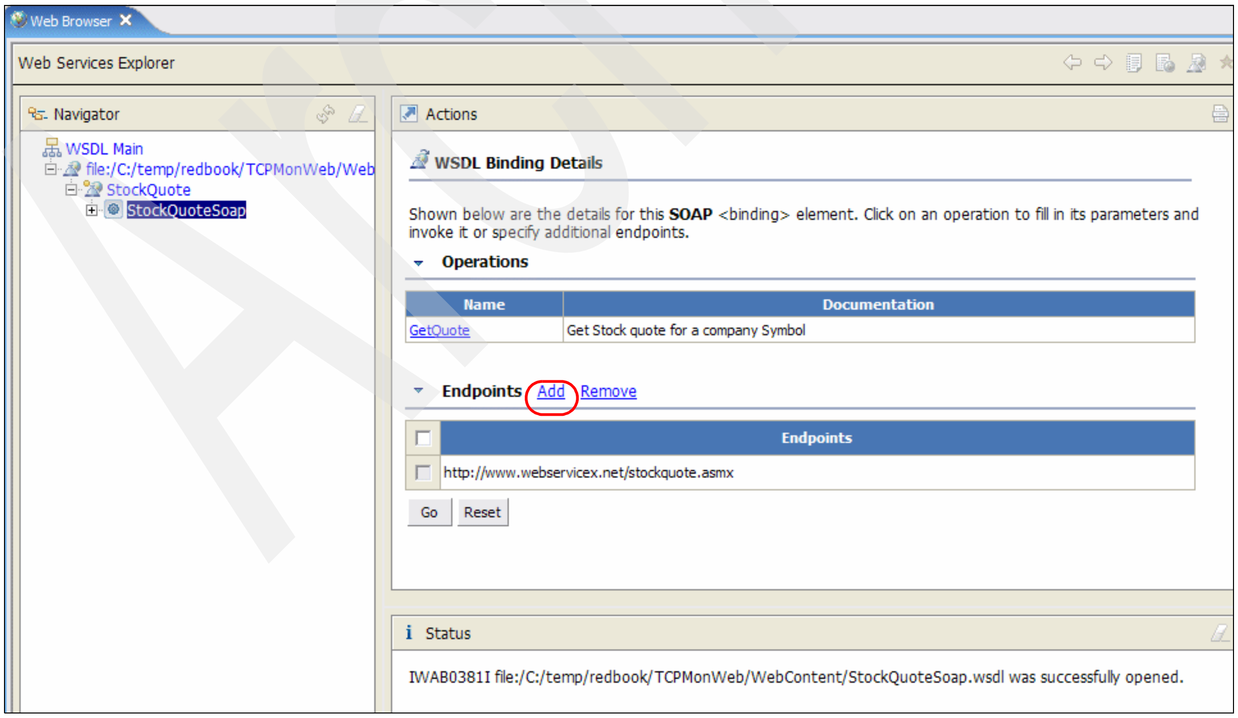


Figure C-4 Web services Explorer

7. On Web services Explorer select **Add** (see Figure C-5).



Shown below are the details for this **SOAP** <binding> element. Click on an operation to fill in its parameters and invoke it or specify additional endpoints.

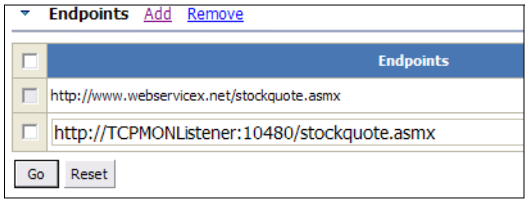
Name	Documentation
GetQuote	Get Stock quote for a company Symbol

	Endpoints
☐	http://www.webservicex.net/stockquote.asmx

IWAB0381I file:/C:/temp/redbook/TCPMonWeb/WebContent/StockQuoteSoap.wsdl was successfully opened.

Figure C-5 Web services Explorer

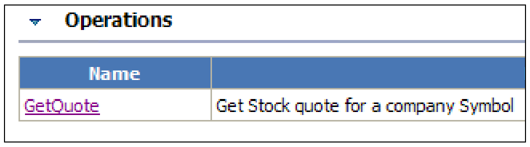
8. Enter the URL to route though TCPMON Listener and click **Go** (see Figure C-6).



http://www.webservicex.net/stockquote.asmx
http://TCPMONListener:10480/stockquote.asmx

Figure C-6 Configure TCPMON as EndPoint for Web service

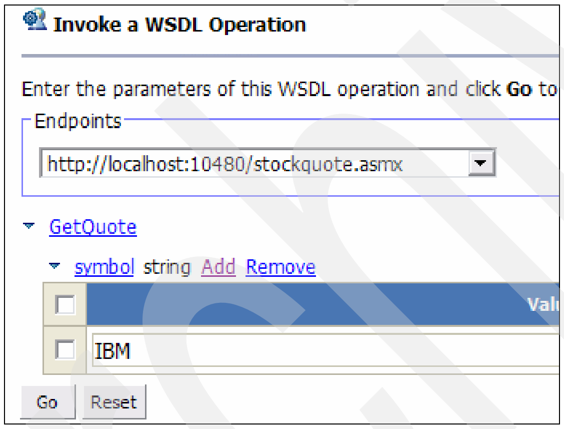
9. Select the Web service operation in the Operations tab as shown in Figure C-7.



Name	
GetQuote	Get Stock quote for a company Symbol

Figure C-7 Service Operations

10.Enter the appropriate values as required for your Web service operation and click **Go** (see Figure C-8).



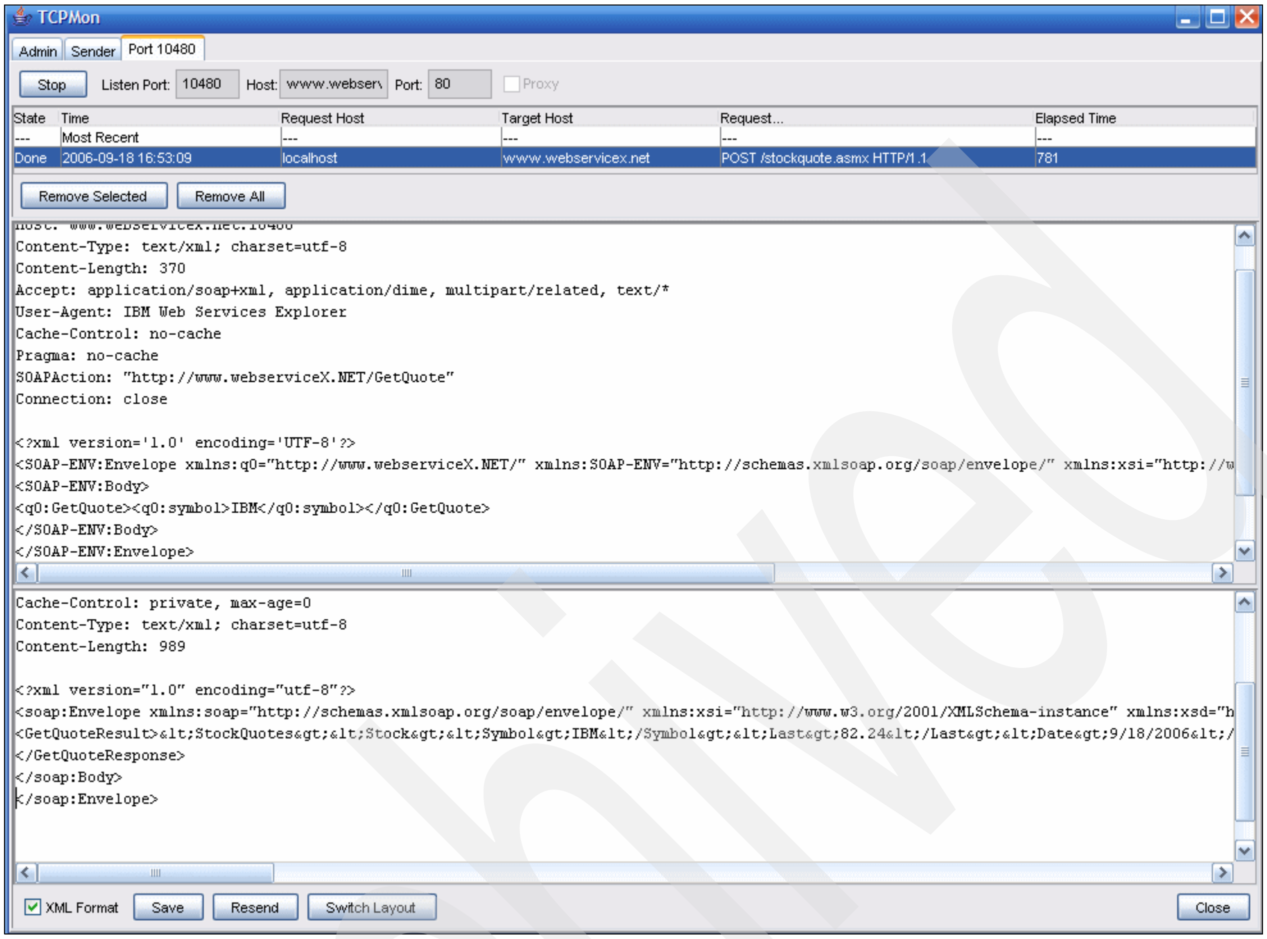
Enter the parameters of this WSDL operation and click **Go** to

Endpoints: http://localhost:10480/stockquote.asmx

IBM

Figure C-8 Invoking Web service

11. Examine the TCPMON Trace for details (see Figure C-9).



State	Time	Request Host	Target Host	Request...	Elapsed Time
---	Most Recent	---	---	---	---
Done	2006-09-18 16:53:09	localhost	www.webservicex.net	POST /stockquote.asmx HTTP/1.1	781

```
Content-Type: text/xml; charset=utf-8
Content-Length: 370
Accept: application/soap+xml, application/dime, multipart/related, text/*
User-Agent: IBM Web Services Explorer
Cache-Control: no-cache
Pragma: no-cache
SOAPAction: "http://www.webserviceX.NET/GetQuote"
Connection: close

<?xml version='1.0' encoding='UTF-8'?>
<SOAP-ENV:Envelope xmlns:q0="http://www.webserviceX.NET/" xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/" xmlns:xsi="http://w
<SOAP-ENV:Body>
<q0:GetQuote><q0:symbol>IBM</q0:symbol></q0:GetQuote>
</SOAP-ENV:Body>
</SOAP-ENV:Envelope>
```

```
Cache-Control: private, max-age=0
Content-Type: text/xml; charset=utf-8
Content-Length: 989

<?xml version="1.0" encoding="utf-8"?>
<soap:Envelope xmlns:soap="http://schemas.xmlsoap.org/soap/envelope/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="h
<GetQuoteResult>&lt;StockQuotes&gt;&lt;Stock&gt;&lt;Symbol&gt;IBM&lt;/Symbol&gt;&lt;Last&gt;82.24&lt;/Last&gt;&lt;Date&gt;9/18/2006&lt;/
</GetQuoteResponse>
</soap:Body>
</soap:Envelope>
```

Figure C-9 TCPMON SOAP Listener Information

TCPMON uses in debugging services problems

A TCPMON trace information is actually hitting the wire, and this is helpful if you are unsure whether the service client is getting to the provider. It also responds back through the TCPMON utility indicating the complete flow of Web service interaction.

TCPMON can also be used in a case where some Service Clients are working and other Service Clients are not working. For example, say a new RPG Web service Consumer was generated with the IBM Web Services Client for ILE and the generated code is not working. However, the JSP or Web services Explorer client is working successfully. Capturing TCPMON packets for both clients might indicate why one service is working and the other service is failing.

TCPMON uses for security

Security is a concern in an SOA implementation. Many times message and information within the message might need to be encrypted or authenticated. Much the security discussions are beyond the scope of this book. However, if you need to verify that your message has been encrypted, use the same steps as described in “TCPMON uses in debugging services problems" on page 273. You can view the packets to determine whether the information was indeed encrypted.

WebSphere Development Studio client - debugger

In the development of existing applications including RPG and COBOL acting as service provider or service consumer a useful tool is the debugger built into WebSphere Development Studio client. The debugger allows you to step line by line through the RPG code as it is interacted within a services model.

Note: In this section we use RPGCODE/RPGTEST program to demonstrate debugging technique. You need to replace this name with your program's name as you perform debugging activity.

Using the WebSphere Development Studio client debugger

In this section, we demonstrate how to use the host application debugger. We show this using the Web services client RPG application that we described in Chapter 9, "IBM Web Services Client for ILE (RPG, C, C++, COBOL)" on page 195, a service client written in RPG was demonstrated in detail. Follow these steps:

1. Open the Remote Systems Explorer perspective with **Window** → **Open Perspective** → **Other** (see Figure C-10).

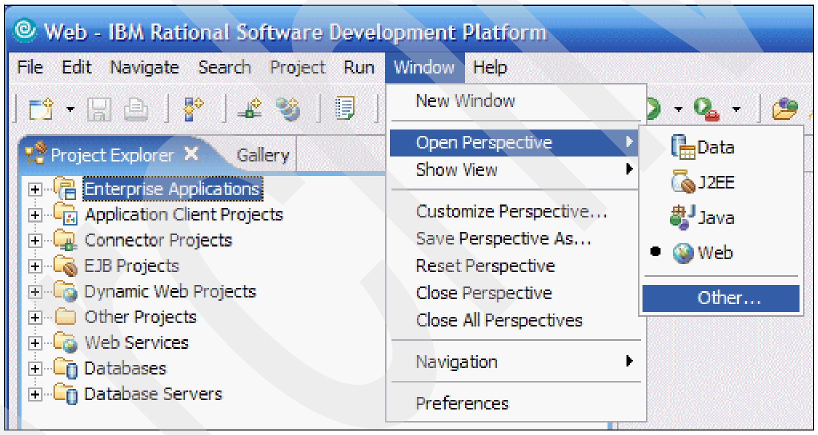


Figure C-10 Switch perspective

2. Select **Remote System Explorer** and click **OK** (see Figure C-11).

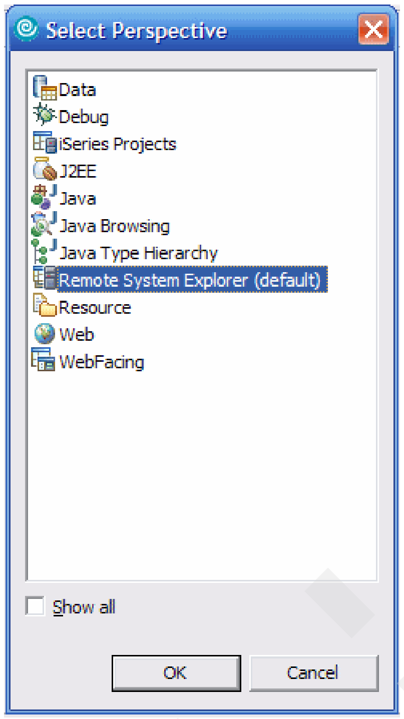


Figure C-11 Remote System Explorer

3. Expand **System i** → **iSeries Objects,** right-click **Library list**, and select **Add Library List Entry** (see Figure C-12).

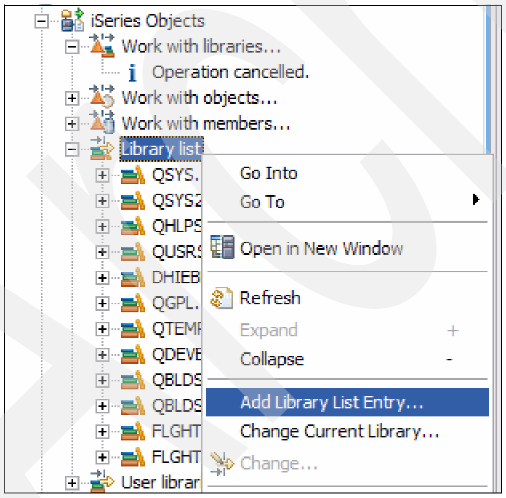
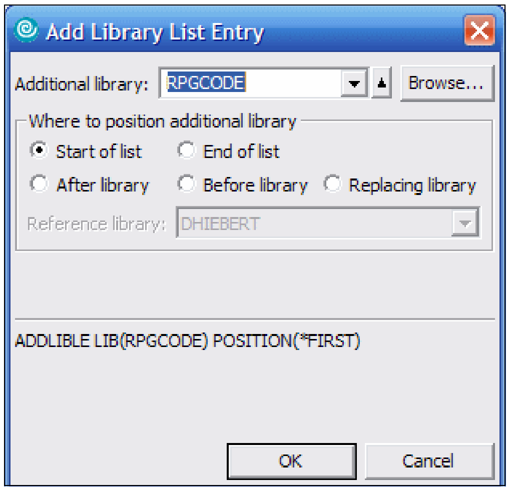


Figure C-12 Add Library List

4. On the Add Library List Entry frame, enter the library of source code in the Additional Library field (see Figure C-13) and click **OK**.



ADDLIBLE LIB(RPGCODE) POSITION(*FIRST)

Figure C-13 Library List Entry

5. In Remote Systems Explorer frame expand into the library that contains, in our example, the QRPGLESRC source file. This file includes the RPG source code member.
6. Right-click the RPG source member and select **Compile (Prompt)** → **CRTRPGMOD** (see Figure C-14).

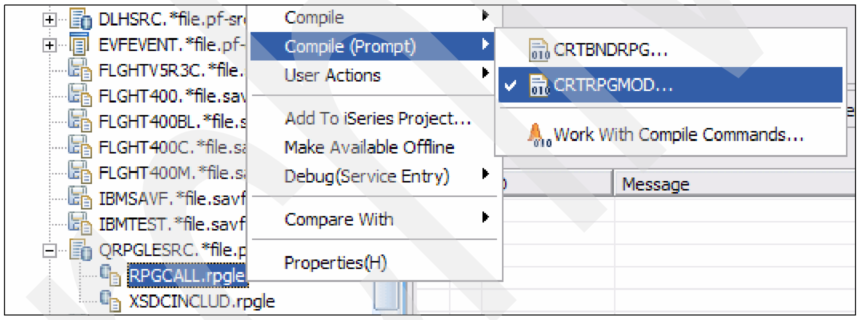
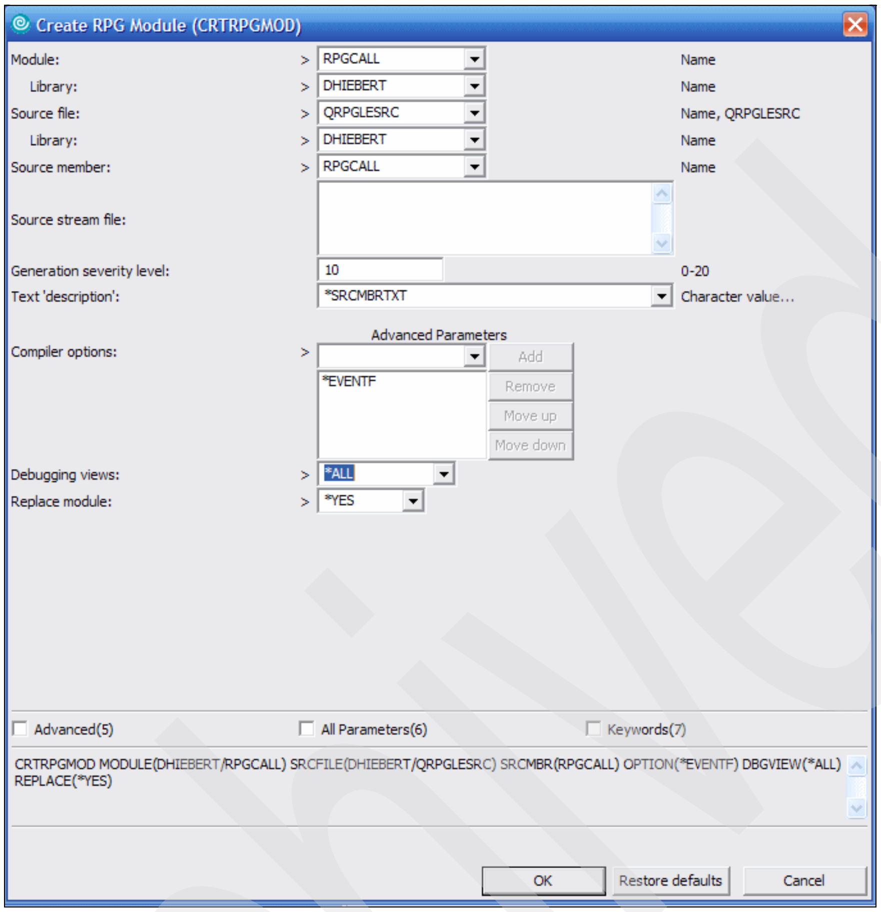


Figure C-14 Compile RPG

7. Select ***ALL** in the Debugging views field and click **OK** (see Figure C-15).



Module:	>	RPGCALL	Name
Library:	>	DHIEBERT	Name
Source file:	>	QRPGLESRC	Name, QRPGLESRC
Library:	>	DHIEBERT	Name
Source member:	>	RPGCALL	Name
Source stream file:			
Generation severity level:		10	0-20
Text 'description':		*SRCMBRTXT	Character value...
Compiler options:	>	*EVENTF	
Debugging views:	>	*ALL	
Replace module:	>	*YES	

```
CRTRPGMOD MODULE(DHIEBERT/RPGCALL) SRCFILE(DHIEBERT/QRPGLESRC) SRCMBR(RPGCALL) OPTION(*EVENTF) DBGVIEW(*ALL)
REPLACE(*YES)
```

Figure C-15 Include Debug Code

8. Repeat the steps 9.2.7, “Compiling C modules and Create service program” on page 217 to complete the generating the client code.

9. Using WebSphere Development Studio client, right-click the source code library and select **Refresh**.

10. Right-click **RPGTEST** → **Debug (Service Entry)** → **Set Service Entry Point** (see Figure C-16).

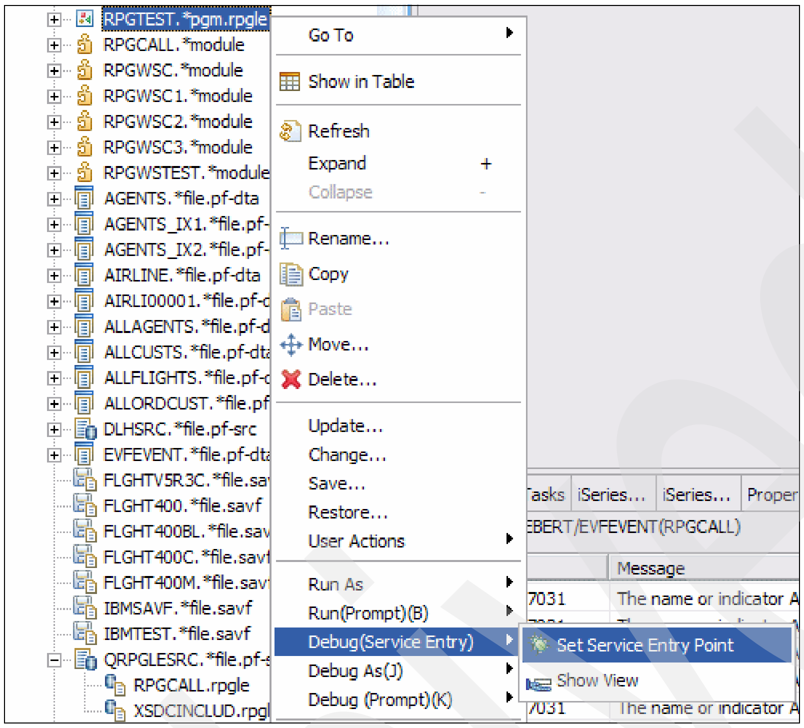
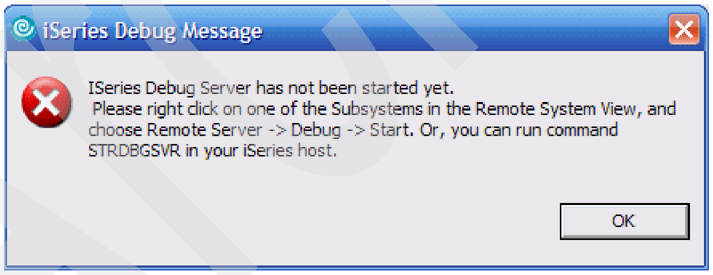


Figure C-16 Set Service Entry Point

Attention: A warning might appear indicating that you need to start the debug server on the System i host (Figure C-17). Open a 5250 session your System i platform and issue the command STRDBGSVR. After Debug Server starts repeat the previous step.

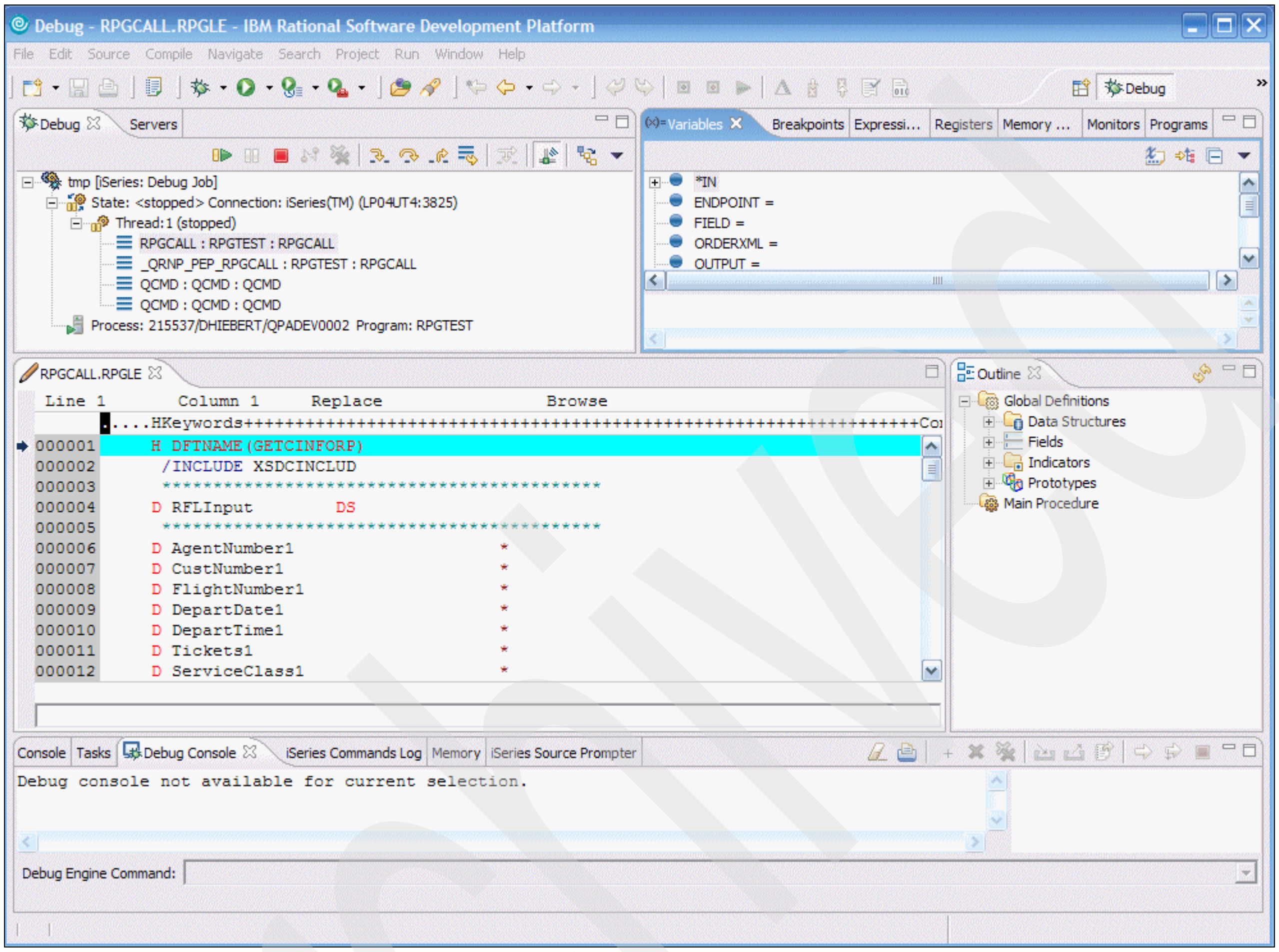


ISeries Debug Server has not been started yet.
Please right click on one of the Subsystems in the Remote System View, and choose Remote Server -> Debug -> Start. Or, you can run command STRDBGSVR in your iSeries host.

Figure C-17 STRDBGSVR

11. On the 5250 panel in which the debug server is running, issue the command CALL RPGTEST/RPGTEST.

12. Immediately switch back to WebSphere Development Studio client. The application will switch to the debugger perspective after the application is called from 5250 (see Figure C-18).


Debug - RPGCALL.RPGLE - IBM Rational Software Development Platform
File Edit Source Compile Navigate Search Project Run Window Help
Debug
Debug Servers
Variables Breakpoints Expressi... Registers Memory ... Monitors Programs
RPGCALL.RPGLE
Outline
Console Tasks Debug Console iSeries Commands Log Memory iSeries Source Prompter

```
tmp [iSeries: Debug Job]
  State: <stopped> Connection: iSeries(TM) (LP04UT4:3825)
    Thread: 1 (stopped)
      RPGCALL : RPGTEST : RPGCALL
      _QRNP_PEP_RPGCALL : RPGTEST : RPGCALL
      QCMD : QCMD : QCMD
      QCMD : QCMD : QCMD
  Process: 215537/DHIEBERT/QPADEV0002  Program: RPGTEST
```

```
*IN
ENDPOINT =
FIELD =
ORDERXML =
OUTPUT =
```

```
 Line 1        Column 1     Replace                Browse
       ....HKeywords++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++Co
             H DFTNAME(GETCINFORP)
              /INCLUDE XSDCINCLUD
              *******************************************
             D RFLInput          DS
              *******************************************
             D AgentNumber1                  *
             D CustNumber1                   *
             D FlightNumber1                 *
             D DepartDate1                   *
             D DepartTime1                   *
             D Tickets1                      *
             D ServiceClass1                 *
```

```
Global Definitions
  Data Structures
  Fields
  Indicators
  Prototypes
Main Procedure
```

```
Debug console not available for current selection.

Debug Engine Command:
```

Figure C-18 Debugger for System i - RPG

13. Use the buttons shown in Figure C-19 to debug the application (there are Play, Terminate, Step Into, Step Over, and Step Return buttons).

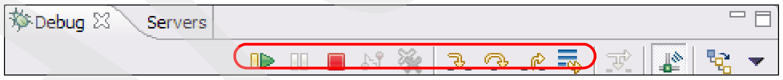


Figure C-19 Debugger buttons

D

Additional material

In this appendix, we describe the additional material that we refer to in this book which you can download from the Internet.

Locating the Web material

The Web material that is associated with this book is available in softcopy on the Internet from the IBM Redbooks Web server. Point your Web browser at:

ftp://www.redbooks.ibm.com/redbooks/SG247284

Alternatively, you can go to the IBM Redbooks Web site at:

ibm.com/redbooks

Select the **Additional materials** and open the directory that corresponds with the IBM Redbooks form number, SG247284.

Using the Web material

The additional Web material that accompanies this book includes the following files:

File name	*Description*
flght400.zip	zipped 2 SAVF files

How to use the Web material

Create a subdirectory (folder) on your workstation, and decompress the contents of the Web material zipped file into this folder. FTP the two SAVF files to your i5/OS server, using binary transfer.

Use RSTLIB commands on your i5/OS server to create two libraries:

```
RSTLIB SAVLIB(FLGHT400) DEV(*SAVF) SAVF(<your LIB name>/FLGHT400)
RSTLIB SAVLIB(FLGHT400M) DEV(*SAVF) SAVF(<your LIB name>/FLGHT400M)
```

Related publications

We consider the publications that we list in this section particularly suitable for a more detailed discussion of the topics that we cover in this book.

IBM Redbooks publications

For information about ordering these publications, see "How to get IBM Redbooks publications" on page 284. Note that some of the documents that we reference here might be available in softcopy only.

- *Web Services Handbook for WebSphere Application Server 6.1*, SG24-7257
- *WebSphere Version 6 Web Services Handbook Development and Deployment*, SG24-6461
- *Patterns: SOA Foundation Service Connectivity Scenario*, SG24-7228
- *Patterns: SOA Foundation Service Creation Scenario*, SG24-7240
- *Patterns: SOA Foundation - Business Process Management Scenario*, SG24-7234
- *Enabling SOA Using WebSphere Messaging*, SG24-7163
- *Patterns: SOA Client - Access Integration Solutions*, SG24-6775

Other publications

These publications are also relevant as further information sources:

- *Web services Platform Architecture*, by Sanjiva Weerawarana, Francisco Curbera, Frank Leymann, Tony Storey, Donald F. Ferguson, ISBN 0-13-148874-0 (Pearson Education)
- *Real World Web services*, by Will Iverson, ISBN 0-596-00642-X (O'Reilly Media)
- *Understanding SOA with Web services*, by Eric Newcomer, Greg Lomow, ISBN 0-321-18086-0 (Pearson Education)

Online resources

These Web sites and URLs are also relevant as further information sources:

- SOA introduction

  `http://www-128.ibm.com/developerworks/architecture/roadmap/#2`
- developerWorks: SOA and Web services

  `http://www-128.ibm.com/developerworks/webservices`
- Wikipedia: Service-oriented architecture

  `http://en.wikipedia.org/wiki/Service-oriented_architecture`
- System i Developer Roadmap: End to End Demo

  `http://www-03.ibm.com/servers/enable/site/ideveloper_j2ee/etoe/index.html`

- WebFacing Deployment Tool with HATS Technology

  http://www-306.ibm.com/software/awdtools/wdht/about/faq.html

- Web Services Client for ILE introduction

  http://publib.boulder.ibm.com/infocenter/iseries/v5r3/index.jsp?topic=/rzamj/rzamjwebservicesintro.htm

- PHP Web site

  http://www.php.net/

- i5/OS PHP Enabling Technology

  http://www.zend.com/products/zend_core/zend_for_i5_os

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Index

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0.475”<->0.873”
250 <-> 459 pages

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This environment is based on service-oriented architecture (SOA) and solutions that support business process automation.

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- Host Access Transformation Services (HATS)
- DB2 Web services
- PHP
- IBM Web Services Client for ILE
- Java-Server Faces (JSF)

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