

Rational® QualityArchitect

User's Guide

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WINDOWS

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Preface

This manual provides conceptual information and task-oriented guidelines for using Rational® QualityArchitect. QualityArchitect is a collection of integrated tools for testing middleware components built with technologies such as Enterprise JavaBeans and COM.

Audience

This guide is intended for all members of the development team who design, write, edit, or execute test scripts for testing Enterprise JavaBeans and COM components. A solid foundation in the target test script language is assumed.

Other Resources

This guide is available as a printed manual and in electronic form as HTML and PDF files.

To access the HTML version:

- Click **Start > Programs > <Rational ...> Rational Test > Rational Online Manual**.
- Or start Rose and click **Tools > QualityArchitect > Online Manual**.

The PDF version of this manual is available on the *Rational Solutions for Windows* Online Documentation CD.

Context-sensitive Help is available for QualityArchitect from within Rational Rose®.

To access the online Help:

- 1 Click **Tools > QualityArchitect > Console**.
- 2 When the toolbar is displayed, press **F1**.

The Help will appear after several seconds.

Integrations Between Rational Testing Tools and Other Rational Products

Rational TestManager Integrations		
Integration	Description	Where it is Documented
Rational TestManager–Rational Administrator	Use Rational Administrator to create and manage Rational projects. A Rational project stores software testing and development information. When you work with TestManager, the information you create is stored in Rational projects. When you associate a RequisitePro project with a Rational project using the Administrator, the RequisitePro requirements appear automatically in the Test Inputs window of TestManager.	<ul style="list-style-type: none"> ▪ <i>Rational Suite Administrator's Guide</i> ▪ <i>Rational TestManager User's Guide</i> ▪ Rational TestManager Help
TestManager–Rational ClearQuest	Use ClearQuest with TestManager to track and manage defects and change requests throughout the development process. With TestManager, you can submit defects directly from a test log in ClearQuest. TestManager automatically fills in some of the fields in the ClearQuest defect form with information from the test log and automatically records the defect ID from ClearQuest in the test log.	<ul style="list-style-type: none"> ▪ <i>Rational TestManager User's Guide</i> ▪ Rational TestManager Help
TestManager–Rational Rational Unified Change Management (UCM)	Use UCM with TestManager to: <ul style="list-style-type: none"> ▪ Archive test artifacts such as test cases, test scripts, test suites, and test plans. ▪ Maintain an auditable and repeatable history of your test assets. ▪ Create baselines of your test projects. ▪ Manage changes to test assets stored in the Rational Test datastore. 	<ul style="list-style-type: none"> ▪ <i>Rational TestManager User's Guide</i> ▪ Rational TestManager Help ▪ <i>Rational Suite Administrator's Guide</i> ▪ Rational Administrator Help ▪ <i>Using UCM with Rational Suite</i>

Rational TestManager Integrations		
Integration	Description	Where it is Documented
TestManager– Rational RequisitePro	<p>Use RequisitePro to reference requirements from TestManager so that you can ensure traceability between your project requirements and test assets.</p> <p>Use requirements in RequisitePro as test inputs in a test plan in TestManager so that you can ensure that you are testing all the agreed-upon requirements.</p>	<ul style="list-style-type: none"> ▪ <i>Rational TestManager User’s Guide</i> ▪ Rational TestManager Help ▪ <i>Rational Suite Administrators Guide</i>
TestManager– Rational Robot	<p>Use TestManager with Robot to develop automated test scripts for functional testing and performance testing. Use Robot to:</p> <ul style="list-style-type: none"> ▪ Perform full functional testing. Record test scripts that navigate through your application and test the state of objects through verification points. ▪ Perform full performance testing. Record test scripts that help you determine whether a system is performing within user-defined response-time standards under varying workloads. ▪ Test applications developed with IDEs (Integrated Development Environments) such as Java, HTML, Visual Basic, Oracle Forms, Delphi, and PowerBuilder. You can test objects even if they are not visible in the application’s interface. ▪ Collect diagnostic information about an application during test script playback. Robot is integrated with Rational Purify, Rational Quantify, and Rational PureCoverage. You can play back test scripts under a diagnostic tool and see the results in the test log in TestManager. 	<ul style="list-style-type: none"> ▪ <i>Rational TestManager User’s Guide</i> ▪ Rational TestManager Help ▪ <i>Rational Robot User’s Guide</i> ▪ Rational Robot Help ▪ <i>Getting Started: Rational PurifyPlus, Rational Purify, Rational PureCoverage, Rational Quantify.</i> ▪ Rational PurifyPlus Help

Rational TestManager Integrations

Integration	Description	Where it is Documented
TestManager–Rational Rose	<p>Use Rose model elements as test inputs in TestManager. A test input can be anything that you want to test. Test inputs are defined in the planning phase of testing.</p> <p>You can use Test Manager to create an association between a Rose model (called a test input in TestManager) and a test case. You can then create a test script to ensure that the test input is met. In TestManager, you can view the test input (the Rose model element) associated with the test case.</p>	<ul style="list-style-type: none"> ▪ <i>Rational TestManager User's Guide</i> ▪ Rational TestManager Help
TestManager–Rational SoDA	<p>Use SoDA to create reports that extract information from one or more tools in Rational Suite. For example, you can use SoDA to retrieve information from different information sources, such as TestManager, to create documents or reports.</p>	<ul style="list-style-type: none"> ▪ <i>Rational SoDA User's Guide</i> ▪ Rational SoDA Help ▪ <i>Rational TestManager User's Guide</i>
TestManager–Rational Unified Process (RUP)	<p>Use Extended Help to display RUP tool mentors for TestManager. RUP tool mentors provide practical guidance on how to perform specific process activities using TestManager and other Rational testing tools.</p> <p>Start Extended Help from the TestManager Help menu.</p>	<ul style="list-style-type: none"> ▪ <i>Rational TestManager User's Guide</i> ▪ Rational TestManager Help ▪ Rational Extended Help

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- Your name, telephone number, and company name
- Your computer's make and model
- Your operating system and version number
- Product release number and serial number
- Your case ID number (if you are following up on a previously reported problem)

Rational® QualityArchitect is a powerful collection of integrated tools for testing middleware components built with technologies such as Enterprise JavaBeans (EJB) and COM.

QualityArchitect, in conjunction with Rational Rose®, allows users to generate test scripts for components and interactions in your Rose model. Once generated, the test scripts can be edited and executed from your development environment or from Rational® TestManager.

With QualityArchitect, you can:

- Generate test scripts that unit test individual methods or functions in a component-under-test.
- Generate test scripts that drive the business logic in a set of integrated components. Scripts can be generated directly from Rose interaction diagrams or, in the case of EJBs, from live components using the EJB Session Recorder.
- Generate stubs that allow you to test components in isolation, apart from other components called by the component-under-test.
- Track code coverage through Rational® PureCoverage® and model-level coverage through TestManager.

What You Need to Get Started

To develop tests with QualityArchitect, you need:

- A workstation running Microsoft NT 4.0, Windows 2000, Windows 98, or Windows Me.
- Rational Rose
- A project for storing your test assets (created with Rational® Administrator)
- TestManager or an IDE for executing test scripts

Supported Environments

QualityArchitect supports the environments listed in the following sections:

If You Are Testing Enterprise JavaBeans

- Version 1.2.x or later of a Sun-compliant Java Developer Kit (JDK)
- Version 3.5 or later of IBM Visual Age for Java, or Version 4.x or later of Visual Cafe, Enterprise Edition
- One of the following application servers:
 - Versions 3.5 or 4.x of IBM WebSphere, Advanced Edition
 - Version 5.1 or later of BEA WebLogic
 - The Sun J2EE Reference Server

If You Are Testing COM, DCOM, and COM+ Components

QualityArchitect can test components in any language that realizes COM interfaces. Microsoft Visual Basic 6.0 is required to compile and run test scripts.

Installing Rational QualityArchitect

QualityArchitect can be installed as part of Rational Suite® DevelopmentStudio, Rational Suite Enterprise, or Rational Rose Enterprise. For information about the Rational Suite installations, see the *Rational Suite Installation Guide*. For information about the Rose installation, see the *Installing Rational Rose* manual.

The installation process adds a QualityArchitect subdirectory to your Rational Test directory.

Quick Start

Use the procedures in this section to get started with QualityArchitect.

Step 1: Working in the Rational Administrator

Before you generate test scripts, use the Administrator to create a project and test datastore. The test datastore contains test assets, such as datapools, lookup tables, and log files.

For details, see the *Rational Suite Administrator's Guide* or the Administrator Help.

Step 2: Working in Rose

- 1 If you have an existing component, reverse engineer it into your Rose model. (Skip this step if you are already modeling your system and components in Rose.)

For EJBs, a good way to do this is with the Rose/Java Add-in. Simply make a jar file and drop the jar file on a class diagram. Be sure to include only the source (.java) files for the Remote interface, the Home interface, and the Bean itself, and the deployment descriptors. Do not import any .class files compiled from the source files because these are not properly reverse-engineered with parameter names. For more information, see *Reverse Engineering a Deployed EJB into Rose* on page 50 and the Rose J online Help.

- 2 Choose a template for the test generation process. This template contains replacement variables that become populated when you generate the test script. (A template is provided for you by default.) For more information, see *Templates* on page 7 and *Template Replacement Variables* on page 119.

In Rose, right-click a model element to test and click **QualityArchitect > Select Unit Test Template**.

- 3 To create a unit test and datapool, right-click the item to test and click **QualityArchitect > Generate Unit Test**.

For information about testing your business logic, see *Using EJB Scenario Tests to Test Transactions* on page 70 or *Using COM Scenario Tests to Test Transactions* on page 109. For information about generating EJB test scripts with the Session Recorder, see *Using the EJB Session Recorder* on page 82. For information about datapools, see *Datapools* on page 23.

- 4 If this is your first time generating a test script, you are prompted to select a test script source directory in which to store your scripts. For more information, see *Storing Your Tests Scripts* on page 6.

- 5 Populate the datapool.

For information about populating datapools for EJB test scripts, see *Populating the Datapool* on page 54. For information about populating datapools for COM test scripts, see *Populating the Datapool* on page 105.

Step 3: Working in Your IDE

After you generate your test assets, you must add them to a project in your IDE, where you can run the tests.

If you are using IBM Visual Age for Java (VAJ), you need to import test assets into the VAJ repository. For details, see *Importing Test Assets into Your IDE* on page 58.

If you are working in a Visual Cafe/WebLogic environment, you need to add your test scripts to a Visual Cafe project and update the class path in Visual Cafe. For details, see *Visual Cafe/WebLogic Requirements* on page 36.

Working In Visual Basic

Every generated test of a COM component results in the creation of a Visual Basic project and several other files. For a list and description of these generated files, see *Programming in Visual Basic* on page 100.

To run your test in Visual Basic:

- 1** Open the Visual Basic project file.
- 2** Edit the .cls file as needed.
- 3** Click **Run > Start with Full Compile**.

This section discusses several basic concepts that will help you take advantage of the features provided with QualityArchitect.

Topics include:

- Test script basics
- Templates
- Scenario tests
- Stubs
- Test script services

For information about concepts that apply to specific component models, see the sections that describe each particular model.

Test Script Basics

QualityArchitect allows users to generate *test scripts* that drive and validate the component-under-test. Test scripts are generated in various languages, depending on the type of component you are testing. The following table lists the test script languages for each component type:

Component Type	Language
Enterprise JavaBeans	Java
COM components	Visual Basic

Test Types

There are two types of test scripts that QualityArchitect can generate from Rose:

- Unit tests
- Scenario tests

A *unit test* tests the behavior of an individual method or operation.

A *scenario test* tests the behavior of components as specified in an interaction diagram. These tests are intended to replicate the sequence of events in a transaction, and as such, test the implementation of the transaction. You can use interaction diagrams to construct simple scenario tests involving a single component or complex tests involving multiple components.

In addition, you can generate complex scenario tests by directly interacting with deployed EJBs using the EJB Session Recorder. For details, see *Using the EJB Session Recorder* on page 82.

Storing Your Tests Scripts

Projects for storing test assets are created in the Rational Administrator. Each project can contain several datastores—for example, a datastore for test assets, a datastore for requirements, and a datastore for change requests.

Certain test assets for QualityArchitect, such as datapools, lookup tables, and log files are stored in the test datastore. Test scripts, however, can be stored independently of the test datastore, in a location of your choice, where they can be placed under source control. When you generate your first test script, you will be prompted to log in to a project and to select a directory for storing your test scripts. QualityArchitect maintains an association between this directory and the project's test datastore, making it possible to execute test scripts directly from TestManager. You can change this location afterwards by clicking the Rational Options button on the Rational Console and then clicking either the VB Options or Java Options tabs.

Unit test scripts are stored in the `unittests` subfolder within your specified test script folder. Scenario tests are stored in the `scenariotests` subfolder. Tests recorded with the EJB Session Recorder are stored in the `recordedtests` subfolder. Stubs are stored in the `Stubs` folder.

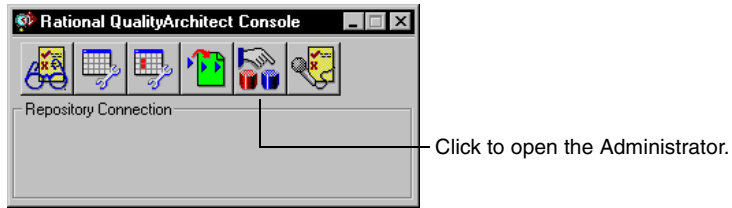
Note: If you want to share your test scripts with a team, be sure to use a UNC path (`\\server-name\directory-path`) to create the project and a UNC path to specify your script source directory. Failure to do both of these will result in a project and script source that cannot be used in a group environment.

To create a new project with the Administrator:

- 1 Click **Start > Programs <Rational ...> Rational Test > Rational QualityArchitect Console**.

where `<Rational ...>` is the name of the Rational product you have installed—for example, `Rational Suite DevelopmentStudio`.

- 2 When the Rational console appears, click the **Administrator** icon on the console.



- 3 Click **File > New Project**.

For more details, see the *Rational Suite Administrator's Guide*.

Templates

QualityArchitect uses templates to provide structure and common code to generated scripts and stubs. *Templates* are simply ASCII text files with replacement variables. The code generators supplied with QualityArchitect replace the variables in the templates with real code derived from Rose model elements.

All of the Rational templates can be customized. To create your own template, simply copy one of the supplied templates and edit it as needed. For example, to provide more logging information in your scripts, copy one of the supplied templates, add logging code, and generate tests with the new template.

Templates also provide a means for supporting additional environments, such as application servers. Generally, to add support for a new environment, you adjust a standard template, primarily in the initialization code, and then generate your test scripts using the new templates.

Rational has included several templates for your use. These templates can be logically grouped into the following general categories:

- Templates for unit test generation
- Templates for scenario test generation
- Templates for stub generation
- Template for the EJB Session Recorder

Within each general category there are several templates for the various component models. You can browse through the Rational Test\QualityArchitect\Template directory to view the list of templates that are installed.

The following table lists the templates QualityArchitect uses for unit test generation:

Template	Description
weblogic_home.template	Template for testing the methods in the home interface of EJBs on a WebLogic server. Use this template: <ul style="list-style-type: none"> ▪ To ensure that the remote interface can be created successfully ▪ As a check before writing or running method-level tests
weblogic_remote.template	Template for testing the methods in the remote interface of EJBs on a WebLogic server.
websphere_home.template	Template for testing the methods in the home interface of EJBs in the WebSphere environment.
websphere_remote.template	Template for testing the methods in the remote interface of EJBs in the WebSphere environment.
sunj2ee_home.template	Template for testing the methods in the home interface of EJBs in the Sun J2EE environment.
sunj2ee_remote.template	Template for testing the methods in the remote interface of EJBs in the Sun J2EE environment.
TestNameScript.cls	Template for the Visual Basic .cls file that is generated to test a COM component. The .cls file is the template for the actual test program.
TestName.vbp	Template for the Visual Basic project file that is generated to test a COM component.
TestNameMain.bas	Template for the main program that calls the test program in the .cls file. Visual Basic requires a <i>main</i> program to begin execution.
TestName.res	Template for the resource file that is created to support datapools.

For more information about templates, see *Templates for Scenario Test Generation* on page 13, *Templates for Stub Generation* on page 21, and *Template Replacement Variables* on page 119.

Scenario Tests

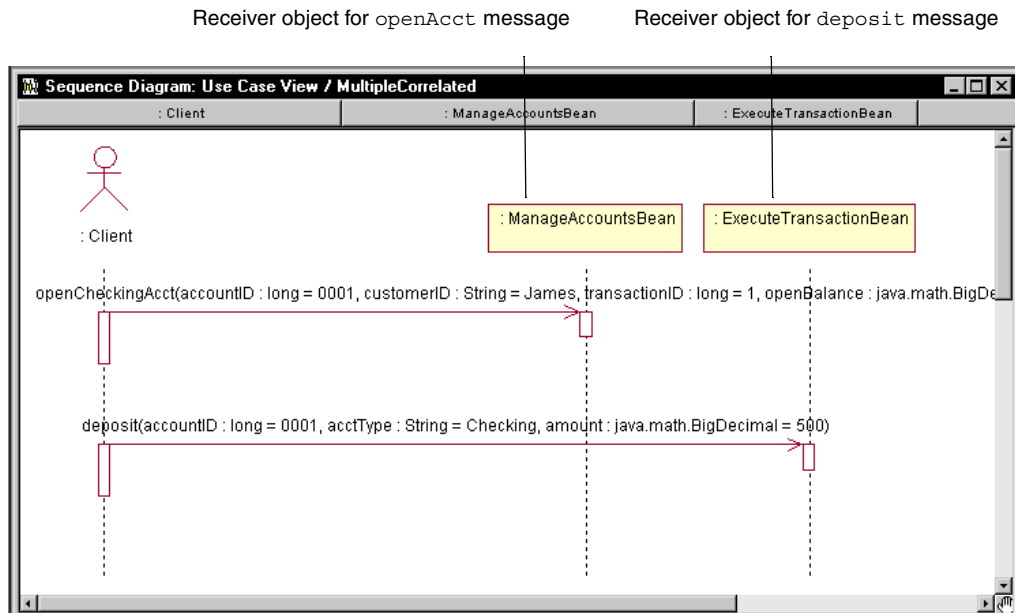
Scenario tests can be used to test transactions. Scenario tests can be generated from Rose interaction diagrams—that is, sequence and collaboration diagrams—or by direct interaction with the EJBs using the EJB Session Recorder.

This section discusses scenario test script generation from Rose. For information about generating scenario test scripts from the EJB Session Recorder, see *Using the EJB Session Recorder* on page 82.

QualityArchitect interprets the messages in the interaction diagram and generates test scripts for one or more receiver objects in the diagram. (The *receiver object* is the object that receives the message.)

Each message in a diagram corresponds to an operation of a class, either by direct linkage through the diagram or by name. Each argument in a message maps to a corresponding parameter object attached to the operation object of the class.

As it generates the test script, QualityArchitect allows you to insert an optional verification point for each message in the diagram. (A *verification point* is a functional testing construct used by a test script to verify specific behavior. For more information, see *Verification Points* on page 25.)



Scenario test scripts include support for datapools, logging, and verification points. (A *datapool* is a set of records that you can use to drive a test script. For details, see *Datapools* on page 23.) The scenario test templates provide automatic support for datapools and logging, while verification points can be added during script generation.

The basic steps for creating a scenario test from Rose are as follows:

- 1 Create a sequence or collaboration diagram in Rose.
- 2 Select the objects involved in the transaction and add them to the diagram.
- 3 Add messages for the operations that implement the transaction.
- 4 Add parameter names and data to the messages (optional).

In this step, you can modify message syntax to permit automated data correlation. For more information, see *Message Signatures and Data Correlation* on page 13.

- 5 Select a scenario test template.
- 6 Generate the scenario test and optionally insert verification points.

For more information, see *Using the Java Query Builder to Add Database Verification Points* on page 72 and *Using the OLE DB Query Builder to Add Database Verification Points* on page 112.

- 7 Edit datapool data.

For more information, see *Datapools in Scenario Tests* on page 23. For information about creating datapools for EJB unit tests, see *Generating EJB Unit Test Scripts and Datapools from a Rose Model* on page 52. For information about creating datapools for COM unit tests, see *Generating COM Unit Test Scripts and Datapools from a Rose Model* on page 102.

Support for Performance Testing

In addition to using scenario test scripts for functional testing, you can use these scripts to evaluate the performance of your components under a load of multiple simulated users. To capture performance data, you need to:

- 1 Modify the default template to create an object for measuring performance.
- 2 Modify your generated test scripts to capture performance data.
- 3 Execute your test scripts from Rational TestManager.

The following examples are for EJB test scripts, but the same procedures apply for COM test scripts as well.

Modifying the Template

To create test scripts that capture performance data during test script execution, you need to first create a modified version of the default scenario test template for your application server. You will find this template in `<RQA Home>\templates\ejb\Scenario Test Templates\ejb\appserver*_scenario.template`.

To modify the template for performance testing, uncomment the line in the template that calls the constructor for the `TSSMeasure` class, as shown in the following EJB example:

```
public void testMain(String[] args) {
    boolean fRetVal = false;
    TSSMeasure tss = new TSSMeasure(); // used for measuring performance
    TSSDataPool dp = new TSSDataPool();
    int idPCount = 0;
```

Be sure to use this modified template whenever you want to create a test script for capturing performance data.

For more information about the `TSSMeasure` class, see the documentation for the `TSSMeasure` class in the *Rational Test Script Services for Java* manual and the *Rational Test Script Services for Visual Basic* manual.

Modifying a Generated Test Script

Each generated test script must be edited to capture performance data. Typically, you need to insert measurement calls around each remote method call that you want to measure. To do this:

- 1 Insert a `TSSMeasure.commandStart()` call before and a `TSSMeasure.commandEnd()` call after the invocation of each method-under-test.

By placing `commandStart()` and `commandEnd()` calls around each remote method call, you can measure the time required to complete these calls under load. The following code example shows some typical parameters to the `commandStart()` and `commandEnd()` methods.

```
tss.commandStart("deposit", "deposit", MST_WAITRESP);
retdeposit_double = Accountremote.deposit(amt);
tss.commandEnd(TSS_LOG_RESULT_PASS);
```

- 2 Optionally, you can use the `TSSMeasure.think()` method to insert a think-time delay before any method call that would typically follow a user interaction or other pause.

For further information about these methods, see the *Rational Test Script Services for Java* manual. For information about the corresponding Visual Basic operations, see the *Rational Test Script Services for Visual Basic* manual.

Executing the Load Test

After you have modified the template and the generated test script, you can execute the test script. For information about how to execute a performance testing script, see the *Running Test Scripts* topics in the Rational TestManager Help and in the *Rational Test Script Services* manuals.

Support for Verification Points

Typically, components tested with QualityArchitect are transactional, and as such they make updates to a database. Therefore, verification must include a way to verify these database transactions. Because scenario tests specifically test these transactions, QualityArchitect provides database verification points to verify any changes to the underlying database. When you generate a scenario test from Rose, QualityArchitect prompts you to insert a database verification point for each message in your interaction diagram.

In addition, the verification point framework is extensible, allowing you to create your own verification point types. For overview information about verification points, see *Verification Points* on page 25. For information about inserting database verification points using the EJB Session Recorder, see *Inserting a Verification Point* on page 97.

For more detailed information about verification points, see the following topics in the *Rational Test Script Services for Java* and *Rational Test Script Services for Visual Basic* manuals:

- Reference pages for the `VerificationPoint` and `DatabaseVP` classes
- *Implementing a New Verification Point*

These manuals are available in print and also online, in both HTML and PDF format.

Templates for Scenario Test Generation

QualityArchitect includes several templates that are used to generate scenario tests for each supported component model or application server. The templates shown in the first row in the following table are the ones you can select for test script generation. The other templates are called by the template that you select.

Template	Description
websphere_scenario.template weblogic_scenario.template sunj2ee_scenario.template com_scenario_script.template	Top-level templates for testing the sequence of methods specified in an interaction diagram. Each top-level template contains substitution variables for the method calls listed in the interaction diagram.
websphere_scenario_constructor.template weblogic_scenario_constructor.template sunj2ee_scenario_constructor.template com_scenario_constructor.template	Templates for building the constructor. For EJBs, the constructor builds the remote interface. For COM, the constructor builds the COM object.
scenario_java_method1.template scenario_java_method2.template com_scenario_operation.template	Templates for generating the method calls. These templates include functions for calling individual methods within the sequence and for calling functions such as <code>tssCommandStart</code> and <code>tssCommandEnd</code> , which are used for performance testing.
com_scenario_project	Template for the Visual Basic project file that is generated to test a COM scenario.
com_scenario_basmain.template	Template for the main Visual Basic program that calls the test program in the <code>.cls</code> file. Visual Basic requires a <i>main</i> program to begin execution.

Message Signatures and Data Correlation

Message signatures include all of the message text that appears in parentheses in a Rose interaction diagram.

In the following message, for example, the message signature is shown in bold:

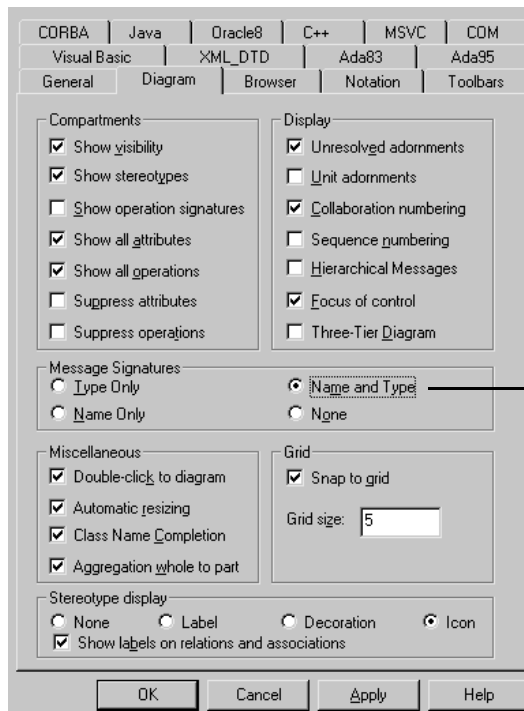
```
openCheckingAcct(accountID : long, customerID : String, transactionID  
: long, openBalance : java.math.BigDecimal)
```

Signature Options

Rose supports the following options for displaying message signatures:

- Type Only
- Name Only
- Name and Type
- None

You set these options in Rose by clicking **Tools > Options > Diagram** and clicking one of the check boxes inside the Message Signatures box.



Set message signatures here.

You can use message signatures for several purposes. For example, you can:

- Change parameter names to force the correlation results that you want.
- Add assignments to give initial values to parameters.
- Add assignments to give names to function results correlated with parameters.

Warning: If you change message signature options from one style to another in Rose—for example, from Name and Type to Type Only—every modification made to a manually edited message name is erased. Therefore, decide early on how you want message signatures displayed and do not change the options after you have modified the messages.

Message Syntax

When you generate a scenario test from Rose, QualityArchitect parses the diagram to determine the name, type, and initial data for each parameter (argument) in a message signature.

- **Parameter name.** For each parameter in the message signature, QualityArchitect uses the name from the message signature in the diagram. If no name is included in the message, QualityArchitect uses the name property of the associated parameter.
- **Parameter type.** For each parameter in the message signature, QualityArchitect uses the type from the associated parameter object, regardless of what is in the diagram.
- **Parameter's initial data.** For each parameter in the message signature, QualityArchitect uses the value to the right of the equals sign. If no initial data is included in the signature, QualityArchitect uses the Initial Data property of the associated parameter. If no Initial Data property is set and no initial data is specified in the diagram, then NULL or some other suitable value for the data type is used. Thus, you can select the **None** option in the Message Signatures box and still get a valid test script.

Note: When only the name or type of a parameter is present in the message, QualityArchitect compares this name or type to the actual type in the corresponding parameter object. If they are the same, QualityArchitect uses the name from the parameter object as the script variable name for the parameter. If they are different, QualityArchitect uses the name used in the message and takes the type from the parameter object.

Message syntax for the Name and Type option is as follows:

Result = operation([parameter₁ : type₁ = value₁, parameter_n : type_n = value_n, etc])

Item	Description
Result	The value (if any) returned by the operation. It is used by QualityArchitect for correlation with parameters of the same name later in the transaction. Result is optional.
Operation	The name of the operation as defined in a UML class.
Parameter Type Value	Parameter, type, and value define a parameter of the operation and its initial value. Parameter and type are both optional, because QualityArchitect examines the parameter object. The syntax that separates them with a colon is the UML syntax for separating parameter name and type. In QualityArchitect, you can add the assignment syntax (= value) to allow the initial value of a parameter to be specified in the sequence diagram.

Editing Message Signatures

You edit message signatures to tell QualityArchitect three things, all of which are optional:

- Parameter names that are different from their parameter specification
- Initial data
- The name and type of the return value

QualityArchitect generates a variable in the test script to hold the return value (result) if you do not supply one.

How Message Signatures Correlate to Datapool Fields

When you generate a scenario test from Rose, QualityArchitect also generates a corresponding datapool (see *Datapools in Scenario Tests* on page 23). QualityArchitect first examines the arguments in the message signatures to determine how many datapool fields to create. If no argument names are included in the signature, QualityArchitect supplies the names by searching the parameter (object) of the corresponding operation of the class.

For example, if QualityArchitect finds an argument named `accountID` in multiple messages, it creates a single datapool field for `accountID`. If you want to have multiple datapool fields for `accountID`, you need to assign `accountID` different names in the diagram, regardless of the Rose Message Signature Option that you have picked.

Message Signature Examples

This section provides several samples of message signatures.

Example 1 – the Name-Only Option

In this example, there is a `getBalance` operation in the `ExecuteTransaction` class. This operation takes one argument—`accountID`. If you want to generate a test script with two calls to this operation, with each call operating on different `accountID`s, you need to code your message signatures as follows:

```
getBalance(accountID1)
getBalance(accountID2)
```

In this example, two datapool fields will be created—one for `accountID1` and one for `accountID2`.

If you want these operations to go against the same account, driven from a datapool, you need to code your message signatures as follows:

```
getBalance(accountID)
getBalance(accountID)
```

The fact that both operations use the same argument name ensures that they are assigned to the same datapool field.

If you want to initialize these operations with data and assign them different names, code the message signatures as follows:

```
getBalance(accountID1 = 1)
getBalance(accountID2 = 5)
```

Example 2 – the Type-Only Option

If you use the Type-Only option, code your message signatures as follows to get the same datapool field for both calls:

```
getBalance( : Long)
getBalance( : Long)
```

In this case, the name of the datapool field will be taken from the parameter name of the parameter object.

If you want different datapool fields for each call, you must add the name to the signature, as in the following example, even if you have set Rose Options to Type-Only.

```
getBalance(accountID1 : long = 1)
getBalance(accountID2 : long = 5)
```

Example 3 – Name and Type

This example shows the message signature when you display name and type without including parameter values or assignment statements.

```
getBalance(acctountID : long, acctType : java.lang.String, amount : double)
```

Example 4 – Name and Type with Parameter Values

This example shows the message signature after you add the initial data assigned to each parameter.

```
getBalance(accountID : long = 1, acctType : java.lang.String = "checking", amount : double = 50)
```

Example 5 – Name and Type with Assignment Statement

Finally, if the message returns a value and you want to establish a variable in the test script to hold this value, possibly for use as a parameter of data in a subsequent message, you need to convert the message name into an assignment statement. In this example, the variable named `result` is declared and used in the test script to hold the value returned by the `getBalance()` function.

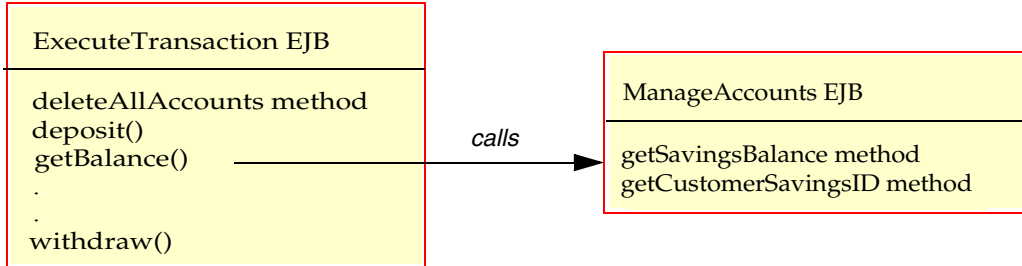
```
result = getBalance(accountID : long = 1, acctType : java.lang.String = "checking", amount : double = 50)
```

Stubs

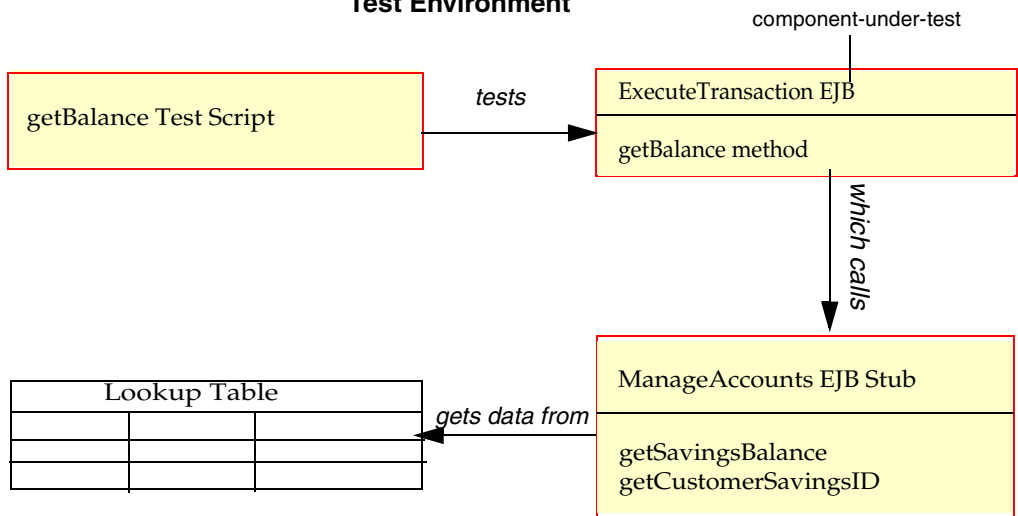
Stubs are components that can be used for testing purposes in place of actual components. A stub can be either a pure “dummy” component that just returns some predefined value, or it can simulate more complex behavior. With *QualityArchitect*, the simulated behavior for stubbed operations is specified in a lookup table. Through the use of stubs, you can control the results returned from components that interact with the component-under-test and create a simulated, controlled test environment.

Consider the sample EJB application that is described in the chapter on *Testing Enterprise JavaBeans*. In this chapter, you create a test script to test the `getBalance` method that is included with the `ExecuteTransaction` interface. Because the `getBalance` method calls several methods in the `ManageAccount` EJB, such as `getSavingsBalance` and `getSavingsCustomerID`, you would need to control access to the `ManageAccount` EJB to thoroughly test the `getBalance` method. As an alternative, you can create a stub for the `ManageAccount` EJB and control the results returned when `getBalance` calls the methods in the `ManageAccount` EJB.

Sample Application



Test Environment



In a stub, any method that is called by the component-under-test requires a lookup table consisting of rows and columns of expected results and exceptions for the method, as in the following example. (Although the lookup table is generated automatically when you generate the stub, you must use the datapool manager to populate the lookup table.)

AccountID	expectedReturn	expectedException
012 34 5678	012 34 5678	
123 45 6789	123 45 6789	
234 56 7890		java.rmi.RemoteException

The lookup table contains one or more columns for each parameter of the operation being stubbed. QualityArchitect uses the values in the columns to determine how the operation should behave. If the operation is supposed to return a value, the value is shown in the `expectedReturn` column. If the operation is supposed to throw an exception, the type of exception is shown in the `expectedException` column. Any Java class that extends `java.lang.Throwable` is a valid value for the `expectedException` column.

The stub looks up the row containing the inputs matching the parameter values passed in by the component-under-test—that is the caller of the stub—and either returns the value in the `expectedReturn` column or throws the exception in the `expectedException` column.

To generate stubs:

- 1 In the Rose browser, right-click the implementation class you are testing and click **QualityArchitect > Generate Stubs**.

Note: COM stubs are generated from classes stereotyped as `<<coclass>>` from the COM Type Library.

- 2 Select a directory for storing the stubs.

For more information about stubs for EJBs, see *Generating Stubs and Lookup Tables for the Unit Test* on page 56. For more information about stubs for COM components, see *Generating Stubs and Lookup Tables for the Unit Test* on page 106.

A lookup table is created automatically, with the name `ClassName_OperationName_L`—for example `ExecuteTransaction_getBalance_L`.

- 3 Use the datapool manager to populate the lookup table with data.

For information about populating lookup tables for EJBs, see *Populating the Lookup Tables* on page 57. For information about populating lookup tables for COM components, see *Populating the Lookup Tables* on page 107.

Note: Stubs must be deployed on the same computer as the test script. Otherwise, playback will fail.

Templates for Stub Generation

EJB

The following table lists the templates used to generate stubs for the home interface, remote interface, and implementation class.

Template	Description
Session_Home.template	Template used to generate the stub for an EJB home interface.
Session_Remote.template	Template used to generate the stub for an EJB remote interface.
Session_Bean.template	Template used to generate the stub for an EJB implementation class.

The following table lists the templates used to build the method body in the EJB's implementation class. The template that is used depends on the particular method.

Template	Description
MethodBodyWithoutLookUp.template	Template used when lookup code cannot be generated, either because: <ul style="list-style-type: none">▪ The method has no parameters▪ The method has no return value or exceptions▪ The method contains at least one complex parameter and lookup code cannot be generated automatically.
MethodBodyWithoutExceptions.template	Template used when the method throws no exceptions.
MethodBodyWithoutReturnValue.template	Template used when the method has no return value (for example, returns void).
MethodBody.template	Template used for all other methods.

COM/VB

The following table lists the template used to generate the stub code that defines the Visual Basic class.

Template	Description
VBCOMClass.template	Template used in all cases to generate the code that defines the Visual Basic class.

The following table lists the templates that are used to create the method bodies for the COM/VB stub. Different templates are used depending on the type of method being stubbed.

Template	Description
FunctionBody.template	Template used for functions. (Functions are methods that have return values.)
FunctionBodyWithoutLookUp.template	Template used for functions without parameters. (No look up code is generated when a method has no parameters.)
PropertyGetBody.template	Template used for "Property Get" methods.
PropertyGetBodyWithoutLookUp.template	Template used for "Property Get" methods without parameters. (No lookup code is generated when a method has no parameters.)
PropertyLetBody.template	Template used for "Property Let" methods.
SubBody.template	Template used for subroutines. (Subroutines are methods that have no return value.)
SubBodyWithoutLookUp.template	Template used for subroutines without parameters. (No lookup code is generated when a method has no parameters.)

Test Script Services

Rational Test Script Services provide datapool, logging, verification, synchronization, measurement, and monitoring capabilities to various Rational applications, including QualityArchitect.

Datapools

A *datapool* is a set of records that you can use to drive a test script. Typically, each record in the datapool represents a test case and includes the test inputs and the expected results. With a datapool, a single script can iterate through multiple test cases. If you want to add a new test case, such as the result of invalid input, you only need to add another record to the datapool.

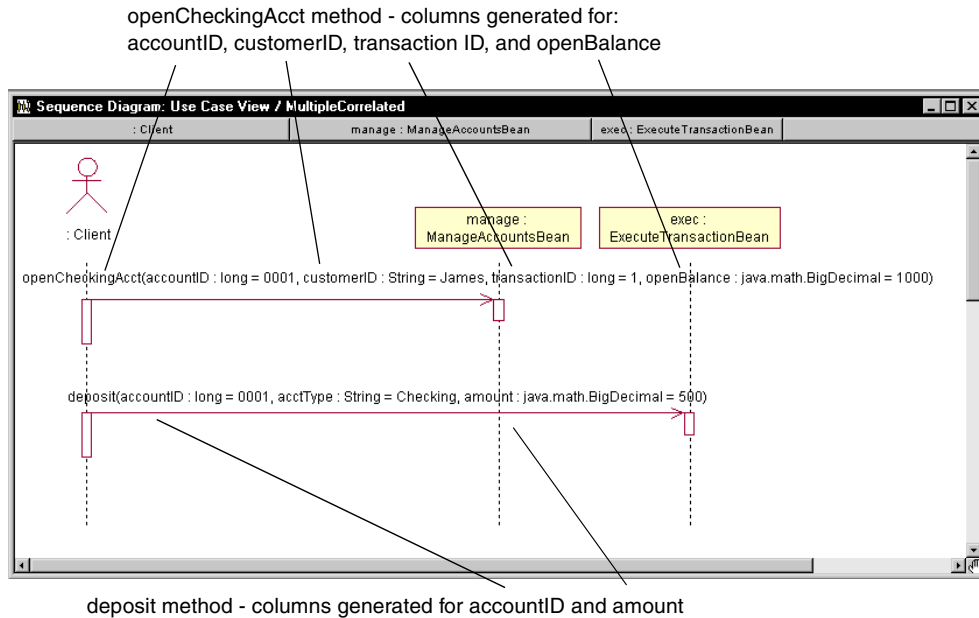
For example, suppose you want to test an `add()` operation that takes two integers as parameters. If you want to test what happens when you pass it two negative integers, you can simply add another record to the datapool. Include negative integer values in each of the two parameter columns, and populate the expected result or expected exception columns accordingly.

Datapools greatly reduce the number of test scripts that are required and minimize script maintenance.

Datapools in Scenario Tests

When you generate a scenario test from Rose, QualityArchitect creates a datapool automatically. It examines each message in an interaction diagram and populates one datapool row with data based on the parameter values in the messages. If no parameter values are found in the messages, QualityArchitect attempts to populate the row with initial values found in the parameter specification.

QualityArchitect creates a datapool column for each unique parameter in each message in the diagram. For example, as shown in the following figure, if the first message included in the script has four unique parameters, and the second message has two unique parameters, the datapool will have at least six columns. In addition, each verification point contributes several columns of data to the datapool. The initial data for these verification point columns is extracted from the values entered into the Query Builder wizard.



By default, QualityArchitect assigns the datapool a name of *ModelName_DiagramName__D*.

You can access and edit the datapool from the QualityArchitect console. To display the console, click **Tools > QualityArchitect > Console**.

Datapools in Unit Tests

When you generate a unit test, QualityArchitect creates a datapool automatically. QualityArchitect creates the new datapool and presents you with a dialog box in which you can add rows of data. QualityArchitect uses the operation's parameters as datapool columns and names the datapool *ClassName_OperationName__D*.

Note: Because the datapool name and its column names are embedded in the script, you will need to modify your script if you change the datapool name.

For an EJB example, see *Generating EJB Test Assets* on page 51. For a COM example, see *Generating COM Test Assets* on page 102.

For detailed information on the use of datapools with other Rational Test products, see the Help for TestManager and Rational® Robot.

Data Types

Data types are used to define datapool columns. You assign data types to datapool columns when you define the columns in the Datapool Specification dialog box.

For Java, QualityArchitect supports all native data types plus `String` and `BigDecimal`.

For Visual Basic, values are retrieved as variants containing strings.

For a complete list of available data types, see the TestManager Help.

Note: Complex data types are not currently supported in datapools. However, you can construct complex data types at runtime based on the primitive data types that the datapool supplies.

Verification Points

A verification point (VP) is a functional testing construct used by a test script to verify specific behavior in the application or component-under-test. In QualityArchitect, a verification point compares an *expected* data object with an *actual* data object. The result of this comparison is logged, allowing for analysis of overall functional correctness and test case coverage.

How Data Is Verified

A verification point operates on two different types of data:

- Data that is known to be correct.

For example, this data might be captured when the component is known to be functioning correctly, or from a source that is known to contain the correct data. Data that is known to be correct is called the *expected* data.

- Data whose validity is unknown and must be verified.

This data is captured at test runtime and is called the *actual* data.

A verification point compares expected data and actual data. If the data matches (or optionally, satisfies some other condition, such as falling within an accepted range), the verification point passes. Otherwise, the verification point fails. Verification point results are automatically logged and viewed in the Rational Test Log window.

Static, Dynamic, and Manual Verification Points

In QualityArchitect, verification points can operate in three different modes—static, dynamic, and manual—depending on how the verification point is invoked.

Static Verification Points

With a static verification point, the expected data object is captured the first time the verification point is executed and is stored in the datastore as the verification point's baseline. The expected data object does not change during subsequent executions of the test script. When the verification point is executed again:

- The baseline data object is retrieved from the datastore.
- An actual data object is captured from the system-under-test.
- The two objects are compared, and the result is logged.

Static verification points are regression-style tests in that the successful behavior of the system is implicitly defined by the system's behavior the first time the verification point executes. In other words, static verification points assume that the system-under-test is functionally correct the first time you run the verification point.

QualityArchitect contains a user-acknowledgement flag that lets you interactively accept or reject data as a baseline for a static verification point. With the flag enabled, QualityArchitect will prompt you with the baseline data that you can accept or reject. For details, see *Verification Point classes* in the online *Rational Test Script Services for Java* and *Rational Test Script Services for Visual Basic* manuals.

To access the online documentation:

- Click **Start > Programs <Rational ...> Rational Test > API > TSS for Java** or
- Click **Start > Programs <Rational ...> Rational Test > API > TSS for Visual Basic**.

where *<Rational ...>* is the name of the Rational product you have installed—for example, Rational Suite DevelopmentStudio.

Dynamic Verification Points

With a dynamic verification point, the expected data object is passed to the verification point at execution time. This expected data object is not managed by the verification point infrastructure and may be hard coded into the script, driven by values in a datapool, or built using any other method chosen by the test script author. When a dynamic verification point is executed, an expected data object is passed to the verification point by the test script. The verification point captures an actual data object from the system-under-test, compares the expected and actual data objects, and logs the result. Dynamic verification points differ from static verification points in that the successful behavior of the system under test is explicitly defined by the test script author, not implicitly defined by a previous behavior of the system-under-test.

Manual Verification Points

With manual verification points, you as the scripter are responsible for providing both the expected and the actual data objects. The verification point framework simply compares the data objects that you provide and logs the results.

Database Verification Point

In this release, Rational has implemented a single verification point: the database verification point. This verification point is used to validate the changes made to a data source by the component-under-test.

With a static database verification point, the first time that you run a test, the data is captured and stored in the datastore, thus establishing a baseline. Subsequent runs will show a pass in the Rational Test Log window if the returned values are the same as the values in the baseline. With a dynamic database verification point, the test script itself constructs the expected value.

The Query Builder

QualityArchitect provides a Query Builder wizard that lets you build and execute queries for use with a database verification point. Wizards are available for both EJB and COM. The wizards let you connect to a data source and interactively build a query.

The Query Builder appears automatically in the following situations:

- When you insert a database verification point while generating a scenario test from Rose
- When you insert a database verification point from the EJB Session Recorder (EJB only)
- When you run a test containing an incompletely-specified database verification point

For more information, see *Using the Java Query Builder to Add Database Verification Points* on page 72 and *Using the OLE DB Query Builder to Add Database Verification Points* on page 112.

Extensibility

QualityArchitect provides you with the ability to implement your own verification points by extending the verification point framework classes. For details, see *Implementing a New Verification Point in the Rational Test Script Services for Java* and *Rational Test Script Services for Visual Basic* manuals.

This section contains the information you need to use QualityArchitect to test Enterprise JavaBeans (EJBs).

Topics include:

- Overview
- Requirements for EJB testing
- The Rational Bank Account Sample Application
- Reverse engineering a deployed EJB into Rational Rose
- Generating test assets
- Importing test assets into your IDE
- Deploying stubs to a WebLogic application server
- Deploying stubs to the Sun J2EE Reference Server
- Executing test scripts
- Using EJB scenario tests to test transactions
- Using the Java Query Builder to add database verification points
- Using the EJB Session Recorder

Overview

This section provides a brief overview of EJB development and test.

For each EJB that you develop, you must define two interfaces and either one or two classes—the home interface, the remote interface, the implementation class, and the primary key class.

- The *remote interface* defines all of the bean's business methods.
- The *home interface* defines lifestyle methods for the bean—that is, methods for creating, removing, and finding beans.

- The *implementation* or *bean class* implements the business methods defined by the remote interface.
- The *primary key class* provides a pointer into a database. Only *entity beans* require a primary key.

Because client applications interact directly with the home and remote interfaces and not with the implementation class, and because test scripts emulate client applications, EJB testing needs to test only the methods defined in the remote and home interfaces.

EJB TestScripts

All test scripts that are generated or constructed manually extend `com.rational.test.tss.TestScript`, an abstract class that contains the code necessary to connect to a project, initialize log information, and look up the name of the script.

All EJB test scripts that extend the `TestScript` class must implement a `main` method and a `testMain` method.

- The `main` method is the entry point for the class.
- The `testMain` method is the entry point for the testing code. `testMain` includes all of your test logic. All calls to other test scripts must reside within `testMain`.

In addition, all EJB test scripts must call `tms.startTestServices` and `tms.endTestServices`.

- `tms.startTestServices` initializes logging and other test services and should be the first method called in `testMain` (within a try block).
- `tms.endTestServices` turns off logging, writes the log file, and performs various cleanup functions and should be the last method called in `testMain` (in your finally block).

Packages Imported Into EJB Test Scripts

EJB test scripts must also import the following packages:

- `com.rational.test.ct.*`
- `com.rational.test.tss.*`
- `com.rational.test.vp.*`
- `com.rational.test.vp.ui.*`
- `java.util.*`

- `javax.naming.*`
- `javax.rmi.PortableRemoteObject`

For more information about the `TestScript` class, see the online *Rational Test Script Services for Java* manual. (`Rational Test\Api\TssJava\Rational TSS for Java.htm`).

Documentation Conventions

The following table lists some conventions used in this chapter:

Product	Convention	Default Location
J2EE	<J2EE Home>	C:\j2sdkee1.2.1
WebLogic 5.1	<WebLogic Home>	C:\weblogic
WebLogic 6.1	<BEA Home>	C:\bea
WebSphere	<WebSphere Home>	C:\websphere\appserver
Rational Test	<Rational Test Home>	C:\Program Files\Rational\Rational Test
Rational Quality Architect	<RQA Home>	C:\Program Files\Rational\Rational Test\QualityArchitect

Requirements for EJB Testing

This section describes the following configuration requirements for EJB testing:

- Supported JDKs
- Application server classpath requirements
- Rational test script playback requirements
- EJB Session Recorder requirements
- TestManager playback requirements
- VAJ/WebSphere requirements
- Visual Cafe/WebLogic requirements

Supported JDKs

The following table lists the JDKs supported for each IDE/application server combination:

IDE and Application Server	Recommended JDKs
Sun J2EE Reference Application Server v.1.2.1	Sun JDK 1.3.1_02
Visual Cafe 4.x/WebLogic 6.x	Sun JDK 1.3.x or later
Visual Cafe 4.x/WebLogic 5.1	Sun JDK 1.2.x or later
VAJ 3.5/WebSphere Runtime Environment/WebSphere 3.5x	IBM JDK 1.2.x or later
VAJ 4.x/WebSphere Runtime Environment/WebSphere 4.0	IBM JDK 1.3.x or later

Application Server Classpath Requirements

QualityArchitect requires that the appropriate application server classes be included in your classpath. These classes can be included in either your user or system classpath, or for the EJB Session Recorder, in the Additional Class path field on the QualityArchitect Options dialog box.

These requirements must be met in order to play back test scripts from TestManager or to successfully launch the EJB Session Recorder.

Classpath Requirements for the Sun J2EE Reference Server

The Sun J2EE Reference Server requires the following entry on your classpath:

- `<J2EE_Home>\j2sdkee<version>\lib\j2ee.jar`

Classpath Requirements for WebLogic 5.1

The following entries must be added to your classpath if you are operating in a WebLogic 5.1 environment:

- `<WebLogic Home>\license`
- `<WebLogic Home>\lib\weblogicaux.jar`
- `<WebLogic Home>\classes`
- `<J2EE Home>\lib\j2ee.jar` (Even if you're working in a WebLogic 5.1 environment `j2ee.jar` is required.)

Classpath Requirements for WebLogic 6.1

The following entries must be added to your classpath if you are operating in a WebLogic 6.1 environment:

- `<BEA Home>\lib\weblogic.jar`
- `<J2EE_Home>\lib\j2ee.jar` (Even if you're working in a WebLogic 6.1 environment `j2ee.jar` is required.)

Classpath Requirements for Remote WebSphere 3.5

The following entries must be added to your classpath if you need to connect to a remote WebSphere application server or the WebSphere test environment from another IDE besides VAJ:

- `<WebSphere Home>\websphere3.5\appserver\lib\ejbs.jar`
- `<WebSphere Home>\appserver\lib\ibmjndi.jar`
- `<WebSphere Home>\appserver\lib\ibmwebas.jar`
- `<WebSphere Home>\appserver\lib\jns.jar`
- `<WebSphere Home>\appserver\lib\ujc.jar`

These classpath entries are not required if you are working within the WebSphere test environment.

Note: For the sample application, the `ratlbankacctwsclient.jar` file is required if the sample application client that is installed with QualityArchitect needs to connect to the remote version of WebSphere from another IDE besides VAJ. This file can be found in the `<RQA Home>\Samples\ejb\bankacct\vaj` directory.

Rational Test Script Playback Requirements

The installation procedure includes several JAR files that are required for test script playback. These JAR files must be added to your IDE's classpath to enable script playback from your IDE. These JAR files include:

Package Description	File Name	Default Installation Path
Rational Test Script Services	<code>rational_ct.jar</code> <code>rttssjava.jar</code>	<code>C:\Program Files\Rational\Rational Test\QualityArchitect</code> <code>C:\Program Files\Rational\Rational Test</code>
Rational Test Script Execution Adapter	<code>rttseajava.jar</code>	<code>C:\Program Files\Rational\Rational Test\tsea</code>

EJB Session Recorder Requirements

The EJB Session Recorder requires:

- The JAR files listed in the section *Rational Test Script Playback Requirements* on page 33, plus the following JAR files:

Package Description	File Name	Default Installation Path
XML Script Generator	scriptgen_ct.jar	C:\Program Files\Rational\Rational Test\QualityArchitect
Xerces XML parser v.1.2	xerces.jar	C:\Program Files\Rational\Rational Test\QualityArchitect
Java Collections v.1.1	collections.jar	C:\Program Files\Rational\Rational Test\QualityArchitect
JavaHelp v.1.1	jh.jar	C:\Program Files\Rational\Rational Test\QualityArchitect
EJB Session Recorder	EJBSessionRecorder_ct.jar	C:\Program Files\Rational\Rational Test\QualityArchitect

- JDK version 1.2.2 and later

In addition, before you can start the EJB Session Recorder from the QualityArchitect console, several required classes must be referenced either in the additional classpath for the EJB Session Recorder or in the user classpath. These classes and the order in which they must be listed are as follows:

- The home and remote interface classes for the deployed EJBs. These classes can be referenced in a directory or in a JAR file. For the sample application, you will need one of the following, depending on your application server:
 - `<RQA Home>\Samples\ejb\bankacct\vc\ratlbankacct51.jar`
 - `<RQA Home>\Samples\ejb\bankacct\vc\ratlbankacct61.jar`
 - `<RQA Home>\Samples\ejb\bankacct\j2ee\ratlbankaccteclient.jar` (For Sun J2EE)
- The required application server classes (See *Application Server Classpath Requirements* on page 32.)
- The path to the installed J2EE SDK. This path must appear in the J2EE_HOME system environment variable.

For information about configuring your IDE to work with the EJB Session Recorder, see *Starting the EJB Session Recorder from Visual Cafe* on page 84 and *Starting the EJB Session Recorder from Visual Age for Java* on page 85.

Modifying the Additional Classpath Field

To modify the Additional Classpath field:

- 1 Click **Tools > QualityArchitect > Console** to display the RQA Console.
- 2 Click the **RQA Options** icon.
- 3 Click the **Java Options** tab.
- 4 Type the required classes in the additional classpath field.

Rational TestManager Playback Requirements

To play back EJB test scripts directly from TestManager, your system must meet the following requirements:

- You must have either a Sun JDK or Sun JRE installed. (To play back test scripts on an Agent machine, a JRE is sufficient. To play back test scripts on the Master machine, a JDK is required.)

When TestManager executes Java (EJB) test scripts, it must first locate the currently installed Java Virtual Machine (JVM), which it finds by looking at the following registry key:

```
HKEY_LOCAL_MACHINE\SOFTWARE\JavaSoft\Java Runtime  
Environment\CurrentVersion
```

This registry key is created by the installation programs of both the Sun JDK and the Sun JRE.

To override the most recently installed JDK/JRE, you can create an environment variable called `RATL_JVM_LOCATION` and assign it to the fully qualified path of the JVM library (`jvm.dll` for JDK 1.2 and above, `javai.dll` for JDK.1.x).

- You must have the full path to a Java compiler (`javac.exe`) included in your Path.
- You must include the following in your classpath:
 - The home and remote interface classes for the deployed EJBs. (See *EJB Session Recorder Requirements* on page 34 for a list of required client JAR files for the sample application.)

- Any required application server classes (see *Application Server Classpath Requirements* on page 32)

Note: If your scripts contain static verification points, the baseline must be captured outside TestManager by running the script once from an IDE or from the command line. TestManager assumes that the baseline already exists. If this is not done, the script run will fail. For further information about baselines and static verification points, see *Verification Points* on page 25.

Visual Age/WebSphere Requirements

If you are working in a VAJ/WebSphere Test Environment, QualityArchitect requires:

- Visual Age for Java 3.5 (VAJ) with patch 2 or VAJ 4.x
- The VAJ WebSphere Test Environment and VAJ EJB Development Environment

For details about how to load these features, see the VAJ online Help.

- DB2 version 6.1 with fix pack 2 (For applications using a database for container or bean managed persistence)

You can download FixPak 2 from the following location:

<http://www.ibm.com/DB2>.

For further information about working with VAJ and WebSphere, see *Classpath Requirements for Remote WebSphere 3.5* on page 33, *Setting Up the Sample Application for VAJ/WebSphere* on page 39, *Importing Test Assets into Your IDE* on page 58, *Executing Test Scripts from VAJ* on page 68, and *Starting the EJB Session Recorder from Visual Age for Java* on page 85.

Visual Cafe/WebLogic Requirements

If you are working in a Visual Cafe/WebLogic environment, QualityArchitect requires:

- Visual Café 4.x or newer
- WebLogic 5.1.x or newer

In addition, to run the sample application, you need the `ratlbankacct51.jar` file (`ratlbankacct61.jar` if you are in a WebLogic 6.1 environment) and the Cloudscape BankAcct database, located in the `<RQA Home>Samples\ejb\bankacct\vc\data` directory.

Note: The minimum required JDK for WebLogic 6.1 is v.1.3.

For further information about working with Visual Cafe and WebLogic, see *Classpath Requirements for WebLogic 5.1* on page 32, *Classpath Requirements for WebLogic 6.1* on page 33, *Adding WebLogic to the Global Classpath in Visual Café* on page 37, *Deploying the Sample Application to a WebLogic Application Server* on page 45, *Deploying the Sample Application to WebLogic 6.1* on page 47, *Configuring Visual Cafe to Run the Sample Application* on page 49, *Executing Test Scripts from Visual Cafe* on page 69, and *Starting the EJB Session Recorder from Visual Cafe* on page 84.

Adding WebLogic to the Global Classpath in Visual Café

If you are working in a Visual Cafe/WebLogic environment, you must add WebLogic to the classpath in Visual Cafe if it is not already present. This is required for running the sample application, the EJB Session Recorder, and any generated test scripts in a Visual Cafe/WebLogic environment.

To add WebLogic to the global classpath in Visual Cafe:

- 1 Launch Visual Café 4.x.
- 2 Click **Tools > Environment Options**.
- 3 Click the **Internal VM** tab.

You should see the classpath settings at the bottom.

- 4 Add the WebLogic classpath.

For WebLogic 5.1:

- a If you do not see `<WebLogic Home>\classes` in the classpath settings, click **New**.
- b Navigate to the `<WebLogic Home>\classes` folder.
- c Click **Open** to insert the directory into the classpath settings.
- d Click **New**.
- e Navigate to the `<WebLogic Home>\lib` folder.
- f Select the `weblogicaux.jar` file and click **Open** to insert the file into the classpath settings.

For WebLogic 6.1:

- a If you do not see the `<BEA Home>\lib\weblogic.jar` file in the classpath settings, click **New**.
- b Navigate to the `<BEA Home>\lib\weblogic.jar` file.
- c Click **Open** to insert the file into the classpath settings.

5 Click **OK** to close the **Environment Options** dialog box.

Note: The settings do not take effect until you exit and restart Visual Cafe.

The Rational Bank Account Sample Application

The Rational Bank Account sample application is an EJB-based application that you can use to try out the features in QualityArchitect. With the Rational Bank Account sample application, you can set up bank accounts and make deposits and withdrawals. The application consists of the following items:

- A Java-based client application
- A set of six EJBs—four entity beans and two session beans

Each entity bean corresponds to a different table in a database and uses *container managed persistence*. The session beans are stateless and are used to interact with the client; the entity beans are used to manage transactions with the database.

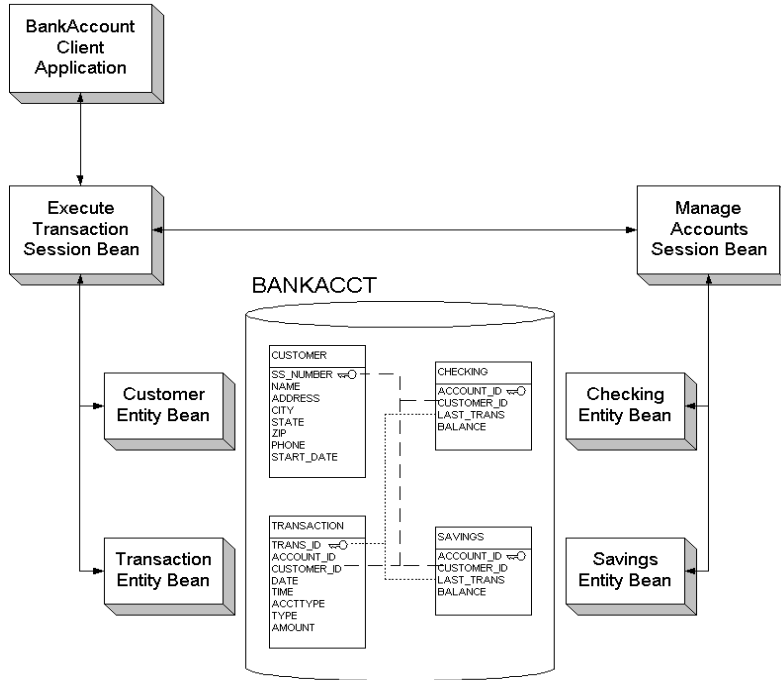
- A Rose model—`ratlbankacct.mdl`—that you can use to generate test scripts and stubs against the sample EJBs that are provided.

This model is populated with objects derived from reverse engineering the sample application's deployed JAR file. It uses the J2EE modeling support built into Rose J to model the beans in the sample application and implements a standard profile for stereotypes and associations for modeling EJBs in UML. For more information about J2EE modeling support, see *How Rational Rose Supports the Java Platform Enterprise Edition (J2EE)* in the Rose J Online Help.

Note: The procedures that are used to demonstrate EJB testing with QualityArchitect are all based on the sample application. For example, one procedure shows you how to generate a unit test for the `getBalance` method in the `ExecuteTransaction` remote interface, while another procedure shows you how to create a stub for the methods that are called by `getBalance` method.

The following figure shows the structure of the Rational Bank Account sample application.

Enterprise JavaBeans Bank Account Sample



Setting Up the Sample Application for VAJ/WebSphere

This section shows you how to set up the sample application to run in a VAJ/WebSphere test environment.

Importing the Sample into VAJ

Before you can run the sample application, you must import it into VAJ, as follows:

- 1 Start IBM Visual Enterprise for Java (VAJ).
- 2 Within the VAJ Workbench window, click the **Projects** tab.
- 3 Right-click the empty space in the window and click **Import**.

- 4 When the SmartGuide dialog box appears, select **Repository** as the import source and click **Next**.
- 5 Select **Local Repository**, click the **Browse** button, and navigate to the `<RQA Home>\Samples\ejb\bankacct\vaj` directory.
- 6 Select `RatlBankAcct.dat` and click **Open**.
- 7 Make sure **Projects** is selected in the 'What do you want to import?' section.
- 8 Click **Details**.
- 9 Select **Rational Bank Account Sample** in the Projects list and make sure **1.2.2** is selected in the Versions window.
- 10 Click **OK**.
- 11 Make sure **Add most recent project edition to workspace** is checked.
- 12 Click **Finish** to import the sample into the repository.

If you cannot see the Rational Bank Account Sample project in the Projects window:

- 1 Right click in the window and select **Add > Project**.
- 2 Select **Add projects from the repository**.
- 3 Select **Rational Bank Account Sample** from the Available project names list and make sure **1.2.2** is selected in the Versions window.
- 4 Click **Finish**.

You should now see the Rational Bank Account Sample project in the Projects window.

Creating the Database

To run the sample, you must first create a database in DB2 and then configure VAJ to use the database.

To create the database:

- 1 From the Start menu, click **Programs > Db2 for Windows NT > Command Line Processor** to launch the DB2 Command Line Processor.
- 2 At the `db2=>` prompt, type **create database <database name>**, where *<database name>* is the actual name of the database that will be used for the sample—for example, **create database bankacct**.

You should see a return message in the window that states the database was created successfully.

- 3 Close the Command Line Processor window by typing **quit** and then **exit** at the `db2=>` prompt.

Configuring VAJ to Use the New Sample Database

To configure VAJ to use the new sample database:

- 1 Launch VAJ.
- 2 Specify the location of the DB2 JDBC driver to use.
 - a From the Workbench, click **Window > Options**.
 - b In the Options dialog box, select **Resources** and enter the following information in the Workspace class path text box:
`<DB2 Path>\java\db2java.zip`
where *<DB2 Path>* is the full DB2 installation path and `db2java.zip` contains the DB2 JDBC driver. The default DB2 installation directory is `SQLLIB`.
If you do not know where DB2 is installed, search for the file name `db2java.zip` to determine the full file path. The following is an example of the JDBC driver path:
`D:\SQLLIB\java\db2java.zip`
 - c Click **Apply** to save the selected DB2 JDBC driver information, and then click **OK**.

Adding EJB Support

To add EJB support:

- 1 Launch VAJ.
- 2 Click **File > QuickStart** from the main VAJ menu.
- 3 Click **Features** in the left-hand box and **Add Features** in the right-hand box.
- 4 Click **OK**.

A dialog box appears with a list of features.

- 5 Click **IBM EJB Development Environment** and **IBM WebSphere Test Environment** and click **OK**.

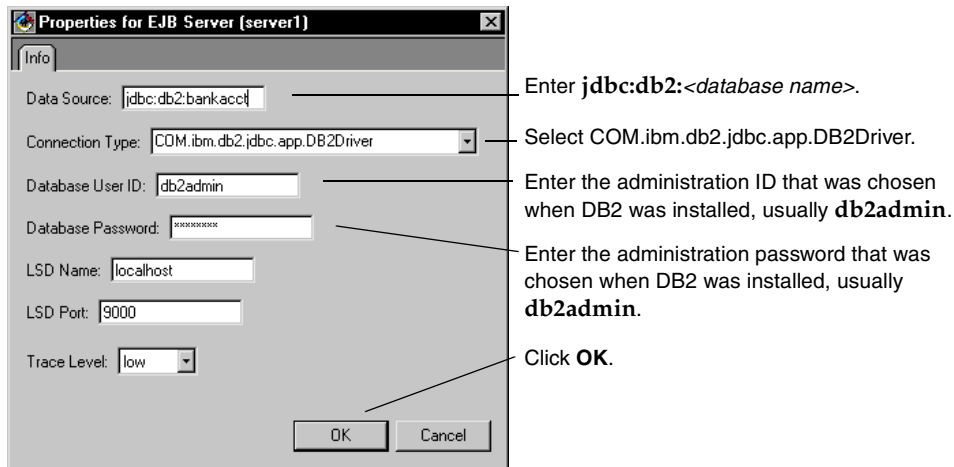
To make sure that these features were added successfully, make sure that the EJB tab is visible in the Workbench window.

Deploying the Sample Application in the VAJ Test Environment

This section describes how to deploy the sample application in the VAJ Test Environment.

Creating Database Tables

- 1 In VAJ, click the **EJB** tab to view the EJB window.
You should now see the RationalBankAcctSampleEJBs group in the window.
- 2 Right-click **RationalBankAcctSampleEJBs** and click **Add To > Server Configuration**.
- 3 Right-click **EJB Server (server 1)** and click **Properties**.



- 4 Right-click **EJB Server (server 1)** again and choose **Create Database Table**.
This creates the database tables that are required for the sample.

Starting the Persistent Name Server

- 1 From the Workbench window, click **Workspace > Tools > WebSphere Test Environment**.

This opens the WebSphere Test Environment Control Center.

- 2 Click **Persistent Name Server** and click **Start Name Server**.

The Persistent Name Server is the JNDI server that is required for the naming service.

You know that the server has been started when the following message appears at the bottom of the WebSphere Test Environment Control Center:

```
Persistent Name Server is Started
```

Starting the EJB Server

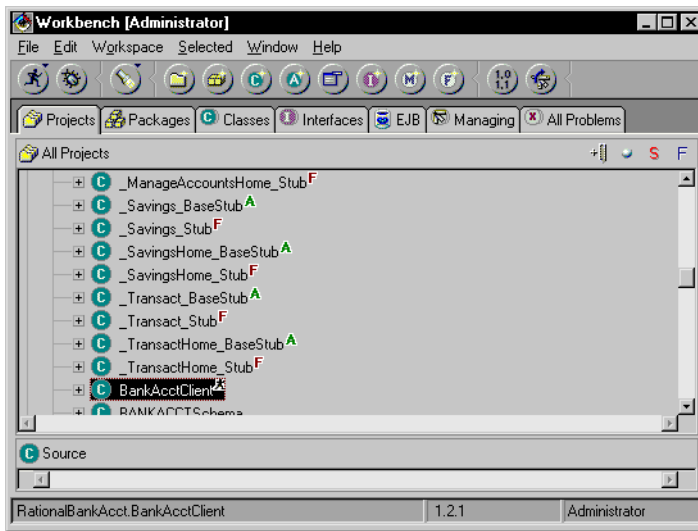
- 1 Back in the EJB Server Configuration window, right-click **EJB Server (server 1)** and click **Start Server**.
- 2 Click the Console window to bring it to the front.
Note: It might take a moment for the Console window to be brought to the front.
- 3 In the **All Programs** box, click the last EJB Server entry.

You know that the server has been successfully started when the following line appears in the Output box:

```
EJServer E Server open for business
```

Starting the Rational Bank Account Sample Application

- 1 Click the **Projects** tab in the VAJ Workbench window.
- 2 Find the Rational Bank Account Sample in the window and expand it by clicking on the **+** box.
If there is a **-** in the box, it is already expanded.
- 3 Expand the RationalBankAcct package by clicking the **+** box.
If there is a **-** in the box, it is already expanded.
- 4 Scroll until you see the BankAcctClient class. (On the right side of the class there should be a picture of a running man.)



- 5 Right-click on this class and click **Run > Check Classpath**.

- 6 Click **Compute Now**.
- 7 If you plan to use the WebSphere Test Environment, click the **Edit** button to the right of the Project path and make sure the IBM WebSphere Test Environment package is checked. Click **OK**.
- 8 Click the Program tab.
In the Command line arguments box, enter the following text:
`appserver=websphere`
- 9 Click **OK**.
- 10 Right-click on this class and click **Run > Run main**.

At this point, the Rational Bank Account window appears in the upper left corner of your screen. Use this client application to add database entries that you can use for testing purposes. For details, see *Adding Account Information to the Rational Bank Account Sample* on page 50.

Importing the Required JAR Files

Before importing generated test scripts into VAJ, you must import the Rational support classes (`rational_ct.jar` and `rttssjava.jar`), the Rational Test Script Execution Adapter (`rttseajava.jar`), and the JavaHelp classes, and add these JAR files to the IDE's classpath. The Rational classes provide support for verification points, datapools, stub generation, script playback, logging, and other services. The JavaHelp classes are required to display the Help for the EJB Query Builder and the EJB Session Recorder. You can find these files in the following locations:

- `<RQA Home>\rational_ct.jar`
- `<Rational Test Home>\tsealrttseajava.jar`

- <Rational Test Home>\rttssjava.jar
- <RQA Home>\jh.jar

To import the required JAR files into VAJ:

- 1 Right-click the Rational Bank Account Sample project and click **Import**.
- 2 Make sure that the JAR file option is selected and click **Next**.
- 3 Under **What types of files do you want to import**, make sure that the **.class** option and the **resource** option are checked.
- 4 Under **Options**, make sure that **Create new/scratch editions of versioned projects/packages** is checked.
- 5 Click the **Browse** button and navigate to the installation directory for QualityArchitect (Rational\Rational Test\QualityArchitect).
- 6 Select rational_ct.jar and click **Open** in the File Open dialog box.
- 7 Click **Finish**.

All of the class files from the JAR file are then imported into the VAJ repository.
- 8 Repeat these steps for <RQA Home>\jh.jar, <Rational Test Home>\tsea\rttseajava.jar, and <Rational Test Home>\rttssjava.jar.

Deploying the Sample Application to a WebLogic Application Server

WebLogic provides two deployment modes:

- A temporary, development mode in which you can stage or hot deploy EJBs for testing purposes without shutting down the WebLogic server
- A permanent, production mode in which you must load EJBs and configure the server offline

This section describes how to permanently deploy the sample application to WebLogic 5.1 and WebLogic 6.1 servers. For information about how to permanently deploy stubs to a WebLogic application server, see *Deploying Stubs to a WebLogic Application Server* on page 59. For information about hot deploying the sample application, stubs, and other EJBs, see *Deploying Stubs to a Running WebLogic Server (Hot Deployment)* on page 61.

Deploying the Sample Application to WebLogic 5.1

To deploy the sample application to WebLogic 5.1:

- 1 Create a subdirectory within the <WebLogic Home>\myserver directory called RatlBankAcct.

- 2 Copy the RatlBankAcct51.jar file from the <RQA Home>\Samples\ejb\bankacct\vc directory to the <WebLogic Home>\myserver\RatlBankAcct directory that was created in Step 1.
- 3 Copy the bankacct directory from <RQA Home>\Samples\ejb\bankacct\vc\data to <WebLogic Home>\eval\cloudscape\data.

These directories contain the Cloudscape databases for the sample. (For details, see the Cloudscape readme file.)

- 4 Open the weblogic.properties file, found in <WebLogic Home>, for editing. Uncomment (by removing the # symbol from the beginning of the line) the following lines found in the WEBLOGIC DEMO CONNECTION POOL PROPERTIES section:

```
weblogic.jdbc.connectionPool.demoPool=\
url=jdbc:cloudscape:demo,\
driver=COM.cloudscape.core.JDBCdriver,\
initialCapacity=1,\
maxCapacity=2,\
capacityIncrement=1,\
props=user=none;password=none;server=none
weblogic.allow.reserve.weblogic.jdbc.connectionPool.demoPool=everyo
ne
```

- 5 Change the following lines:

From	To
url=jdbc:cloudscape:demo,\	url=jdbc:cloudscape:bankacct,\
weblogic.jdbc.connectionPool.demoPool=\	weblogic.jdbc.connectionPool.rqaPool=\
weblogic.allow.reserve.weblogic.jdbc.conn ectionPool.demoPool=everyone	weblogic.allow.reserve.weblogic.jdbc.conne ctionPool.rqaPool=everyone

- 6 Add the following lines right after WEBLOGIC EJB DEMO PROPERTIES section and then save the weblogic.properties file:

```
weblogic.ejb.deploy=\
  <weblogic directory>/myserver/RatlBankAcct/RatlBankAcct51.jar
```

For example:

```
weblogic.ejb.deploy=\
```

c:/weblogic/myserver/Rat1BankAcct/Rat1BankAcct51.jar

7 Launch the WebLogic server:

Click **Start > Programs > WebLogic 5.1 > WebLogic Server**.

If the Rational Bank Account sample was successfully deployed, you should see the following lines in the WebLogic Server window:

```
<EJB> 1 EJB jar files loaded, containing 6 EJBs
```

```
<EJB> 6 deployed, 0 failed to deploy.
```

Note: If the EJBs do not deploy, check the following log files for any errors:

- `<WebLogic Home>\myserver\weblogic.log`
- `<WebLogic Home>\eval\cloudscape\data\cloudscape.log`

Deploying the Sample Application to WebLogic 6.1

To deploy the sample application to WebLogic 6.1:

- 1 Verify that you have installed the examples that come with the WebLogic 6.1 Application Server. If the examples are not installed, be sure to install them. To verify, navigate to the `<BEA Home>\wlsrver6.1\config\examples` directory.

The default `<BEA Home>` directory is `C:\bea`.

- 2 Copy the `Rat1BankAcct61.jar` file from the `<RQA Home>\Samples\ejb\bankacct\vc` folder to the `<BEA Home>\wlsrver6.1\config\examples\applications` folder.
- 3 Copy the whole `bankacct` folder from the `<RQA Home>\Samples\ejb\bankacct\vc\data` folder to the `<BEA Home>\wlsrver6.1\Samples\eval\cloudscape\data` folder.
- 4 Open the `<BEA Home>\wlsrver6.1\config\examples\config.xml` file in a text editor and locate the section that contains the `JDBCConnectionPool` entries. This section should be located near the top of the file.
- 5 After the very last `JDBCConnectionPool` entry, insert the following lines exactly as shown:

```
<JDBCConnectionPool CapacityIncrement="1"
  DriverName="COM.cloudscape.core.JDBCdriver" InitialCapacity="1"
  MaxCapacity="1" Name="rqaPool"
  Properties="user=none;password=none;server=none"
  Targets="examplesServer" URL="jdbc:cloudscape:bankacct"/>
```

- 6 Save the file and exit the text editor.

- 7 Launch the WebLogic 6.1 Application Server that includes the deployed sample:
Click **Start > Programs > BEA Weblogic E-Business Platform > WebLogic Server 6.1 > Examples > Start Examples Server**.

Deploying the Sample Application to the Sun J2EE Reference Server

To deploy the sample application to the Sun J2EE Reference Server, you must first have the latest J2EE SDK v1.2.1 installed along with the required matching JDK (For details about required JDKs see *Supported JDKs* on page 32.). Throughout this section, `<J2EE_HOME>` is used to represent the currently installed location for the J2EE SDK.

To deploy the sample application to the Sun J2EE Reference Server:

- 1 Configure the data source that the J2EE SDK will use for the Bank Account sample.
 - a Open the `<J2EE_HOME>\config\default.properties` file.
 - b Find the line for the property `jdbc.datasources`. At the end of the line, append the following text:

```
| jdbc/BankAcctDB | jdbc:cloudscape:rmi:CloudscapeDB;create=true
```

- 2 Start the Cloudscape database server.

In a separate command prompt window, change the directory to `<J2EE_HOME>\bin` and type the following text:

```
cloudscape -start
```

- 3 Start the J2EE Reference Server.

In a separate command prompt window, change the directory to `<J2EE_HOME>\bin` and type the following text:

```
j2ee -verbose
```

- 4 Launch the Sun Deployment tool that is used to deploy the sample application to the Sun J2EE Reference Server.
 - a In a separate command prompt window, change the directory to `<J2EE_HOME>\bin` and type the following text:

```
deploytool
```
 - b In the Sun Deployment tool application window, click **File > Open Application**.
 - c In the Open File dialog box, browse to the `<RQA_Home>\Samples\EJB\BankAccount\J2EE` directory and select the `RatBankAcctEE.EAR` file.
 - d Click **Tools > Deploy Application**.

- e Continue through the dialog boxes and accept all of the default settings by clicking **Next**.
- f When you reach the last dialog box, click **Finish**.

The sample EJB application will now be deployed to the Sun J2EE Reference Server.

Configuring Visual Café to Run the Sample Application

To run the Rational Bank Account sample EJB application in Visual Café:

- 1 Launch Visual Café 4.x if it is not currently running.
- 2 Create a new Empty Project:
 - a Click **File > New Project**.
 - b Select **Empty Project**.
 - c Click **OK**.
- 3 Click **Project > Options** and then click the **Directories** tab.
- 4 Click **New**, the button furthest to the left.
- 5 Click **file**.
- 6 For WebLogic 5.1, navigate to
<RQA_Home>\Samples\ejb\bankacct\vc\RatIBankAcct51.jar
and click **Open**.

For WebLogic 6.1, navigate to
<RQA_Home>\Samples\ejb\bankacct\vc\RatIBankAcct61.jar
and click **Open**
- 7 Click the **Project** tab and enter the following text in the **Main Class** text box:
`RationalBankAcct.BankAcctClient`
- 8 In the Program Arguments box, enter the following text:
`appserver=weblogic`
- 9 Click **OK**.

After this point, you can add account information and configure datapools and stub lookup tables.

Adding Account Information to the Rational Bank Account Sample

After the Rational Bank Account window opens, you need to create a few savings accounts and make deposits to each account. Be sure to keep track of the generated account numbers and the balance in each account. You will need this information later when you create the datapool.

To create a new account:

- 1 Click **Open New Account**.
- 2 Enter the required account information and click **Execute Transaction**.
- 3 Write down the number of the new account.

To make a deposit:

- 1 Click **Deposit**.
- 2 Enter the account number that was returned when the account was created.
- 3 Enter the amount you want to deposit.
- 4 Select **Savings**.
- 5 Click **Execute Transaction**.

Be sure to keep track of the account balance.

Reverse Engineering a Deployed EJB into Rose

The sample model that is included with the Rational Bank Account sample application is populated with objects derived from reverse engineering the sample application's deployed JAR file. You can use this model to generate test assets to test the sample application. For details, see *Generating EJB Test Assets* on page 51.

If you already have your own deployed EJBs that you want to test, you can reverse engineer them into Rose. When you reverse engineer the deployed JAR file, Rose parses the deployment descriptors in the JAR file and sets up the associations and stereotypes automatically.

Associations between the various elements in the EJB—the implementation class, the home interface, the remote interface, and the primary key—are displayed graphically in the Class diagram.

Special icons are used in the Logical View of the Rose browser to display the various elements in the EJB.

There are two ways to reverse engineer EJBs:

- You can drag and drop an EJB JAR file onto a class diagram.
- You can use the filter field on the Reverse Engineering dialog box (**Java > Reverse Engineer Java**) to reverse engineer a JAR file or to reverse engineer the .class or .java files and the .xml files that comprise an EJB.

When you use the Reverse Engineering dialog box to select the .class or .java files that are part of an EJB, you must also select the XML deployment descriptor (the .xml file) in the same reverse engineering operation. The deployment descriptor defines the associations that make up an EJB. Without the deployment descriptor, Rose J cannot recreate an accurate view of your EJB classes.

Also, in order for Rose J to resolve references to J2EE API classes, you will need to update your classpath setting with a path to the j2ee.jar file (for example, d:\j2sdkee1.2.1\lib\j2ee.jar). For information about extending the classpath within Rose, see the Classpath Help topic in the Rose J Help. For additional information and requirements, see *About Reverse Engineering* in the Rose J Help.

Generating EJB Test Assets

This section explains how to generate the various test assets you need to test EJBs with QualityArchitect. Test assets include test scripts, datapools, stubs, and lookup tables.

Generating EJB Test Scripts

QualityArchitect provides two ways to create EJB test scripts. The method you choose depends on the processes in place on your development and testing team and on the state of the component-under-test.

The recommended way to create test scripts is to model the component-under-test in Rational Rose and generate test scripts from the Rose model. However, if you have already built or partially built a component, you can do the following:

- Reverse engineer the component into Rose and generate test scripts from the model.
- Use the EJB Session Recorder to interactively generate test scripts from the log file.

Generating EJB Unit Test Scripts and Datapools from a Rose Model

To try out the QualityArchitect unit test generation feature, you can use the sample model that is included with the Rational Bank Account Sample Application. For example, try generating a unit test for the `getBalance` method, which is part of the remote interface named `ExecuteTransaction`. This method is used to obtain the current balance from the specified account.

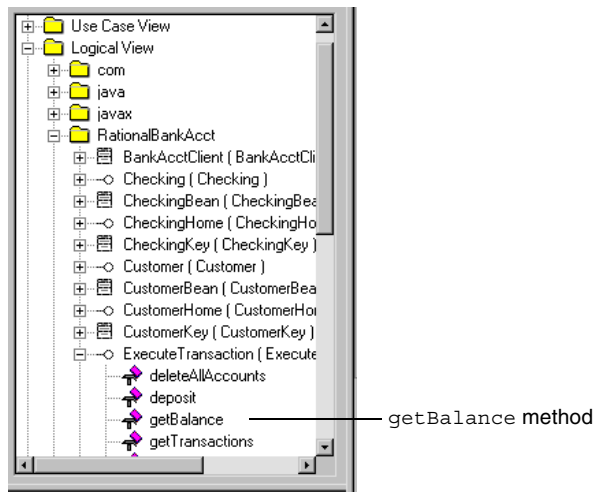
The `getBalance` method calls three methods from the `ManageAccounts` session bean. The three methods are `getSavingsCustomerID`, `getSavingsBalance`, and `getCheckingBalance`. All of these methods take noncomplex objects as parameters.

To generate the unit test:

- 1 If you haven't already done so, create a project with the Administrator for maintaining your test assets.

For details, see *Adding a Project* in the Administrator Help.

- 2 Start Rose and open the `ratlbankacct.mdl` model.
- 3 In Rose, right-click the `getBalance` method and click **QualityArchitect > Select Unit Test Template**.



- 4 Do one of the following:
 - Select the **websphere_remote.template** and click **Open** if you are working in a WebSphere environment.

- Select **weblogic_remote.template** and click **Open** if you are working in a WebLogic environment.
- Select **sunj2ee_remote.template** and click **Open** if you are working in a Sun J2EE environment.

QualityArchitect defaults to the last template chosen, so in the future you can skip this step if you plan to use the same template. For more information about templates, see *Templates* on page 7.

- 5 In Rose, right-click the `getBalance` method again and click **QualityArchitect > Generate Unit Test**.

A message appears, indicating that code generation is in progress, after which you will be prompted to log in to a Rational project.

The screenshot shows a 'Login' dialog box with the following fields and values:

- User Name:** Admin
- Password:** (empty)
- Project:** Mlfinal1 (selected in a dropdown menu)
- Location:** F:\Repos\Mlfinal1\Mlfinal1.rsp

Buttons: OK, Cancel, Browse (next to Project dropdown)

- 6 Log in to the project and click **OK**.

Each project contains a datastore for storing test assets, such as datapools, lookup tables, and log files.

If this is the first time you have generated a script for a particular datastore, you will be prompted to select a directory in which to store your scripts.

QualityArchitect maintains an association between the test script directory that you have chosen and the test assets that are stored in the project's test datastore. As a result of this association, you can execute your test scripts directly from TestManager.

- 7 Select a directory location and click **OK**.

QualityArchitect creates a directory hierarchy under the location you have chosen and saves the test script. The test script itself is assigned a name of the format *InterfacenameMethodname*. Thus, a script generated to test `getBalance` in the `ExecuteTransaction` interface would be named `ExecuteTransactiongetBalance.java`.

Populating the Datapool

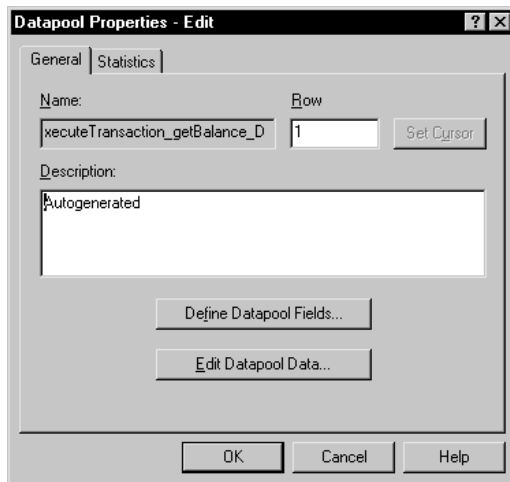
After it generates the test script, QualityArchitect autogenerated a datapool named `ExecuteTransaction_getBalance_D`, using the parameters in the `getBalance` method (`accountID` and `acctType`) for the column names. It also creates a column for the expected return value of the method and the expected exception. The expected exception column should only be populated for rows containing input that elicits an exception from the method-under-test.

(A *datapool* is a set of records that you can use to drive a test script.)

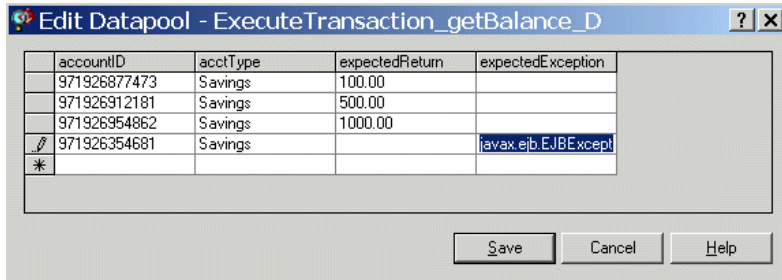
Although QualityArchitect generates the datapool automatically, it is up to you to populate the datapool with records.

To populate the datapool:

- 1 When QualityArchitect asks if you want to edit the datapool that it created, click **Yes** to display the Datapool Properties dialog box.
- 2 In the Datapool Properties dialog box that is displayed, click **Edit Datapool Data** and populate the datapool with several rows using the generated account numbers (IDs). Specify `Savings` as the account type, and enter the actual account balance in the `expectedReturn` column.



- 3 Click **Save** and then **Close** when you are finished.



- 4 Click **OK** to close the Datapool Properties dialog box.
- 5 Click **Close** to close the progress bar.

The following code fragment shows the datapool name and the parameter (column) names embedded in the test script:

```
String sDPName = "ExecuteTransaction_getBalance_D";
dp.open(sDPName);
fRetVal = dp.fetch();
while (fRetVal)
{
    iDPCount = iDPCount + 1;

    // Retrieve values from Datapool for datatypes that we understand.
    accountID = dp.value("accountID").longValue();
    acctType = dp.value("acctType").toString();
    ExpectedReturn = dp.value("expectedReturn").getBigDecimal();
    sExpectedException = dp.value("expectedException").toString();
}
```

_____ Datapool name

|
Column names are displayed here in boldface.

For more information about datapools, see *Datapools* on page 23, the *Test Script Services for Java* manual, and the Help for Rational TestManager.

For information about using scenario testing to test your business logic, see *Using EJB Scenario Tests to Test Transactions* on page 70.

Generating Test Scripts with the EJB Session Recorder

If you have already built or partially built a component, you can use the EJB Session Recorder to interact with the component and generate test scripts. For details, see *Using the EJB Session Recorder* on page 82.

Generating Stubs and Lookup Tables for the Unit Test

With QualityArchitect, you can create stubs for session beans and test any component that calls that session bean.

When you generate stubs for session beans, QualityArchitect creates Java source files for the home interface, the remote interface, and the implementation class itself. After generating stubs, you can deploy them on your application server, where they replace the real session beans.

Note: Stubs must be deployed on the same computer as the test script.

Templates used for generating EJB session stubs include:

- Session_Bean.template
- Session_Home.template
- Session_Remote.template
- MethodBodyWithoutLookUp.template
- MethodBodyWithoutExceptions.template
- MethodBodyWithoutReturnValue.template
- MethodBody.template

Because the `getBalance` method calls methods in the `ManageAccounts` EJB, you can either generate a stub or run the tests directly against the actual `ManageAccounts` EJB.

To generate the stubs:

- 1 Right-click the **ManageAccountsBean** class in the Rose browser and click **QualityArchitect > Generate Stub**.
- 2 Select a directory for storing the stubs.
- 3 Click **OK**.

QualityArchitect generates stubs for:

- The remote interface, `ManageAccounts.java`
- The home interface, `ManageAccountsHome.java`

- The implementation class, `ManageAccountsBean.java`

QualityArchitect also creates a lookup table for each method in the stub called by the method-under-test. In this case, QualityArchitect creates two lookup tables because `ExecuteTransaction.getBalance`, when called against a Savings account, calls two methods in the `ManageAccounts` bean—`getSavingsBalance` and `getSavingsCustomerID`.

Note: Lookup tables are based on Rational datapool technology. Whereas a datapool is used to test inputs and expected behavior, a lookup table is used with stubs to simulate the behavior of an actual component.

After generating the lookup tables, QualityArchitect asks you if you want to edit the newly created lookup tables.

Populating the Lookup Tables

To populate the lookup tables:

- 1 When QualityArchitect asks if you want to edit the lookup tables that it created, click **Yes**.
- 2 Select the lookup table to edit, for example, `ManageAccountBean_getSavingsBalance_L`, and click **Edit** to display the Datapool Properties dialog box.
- 3 In the Datapool Properties dialog box, click **Edit Datapool Data** and populate the lookup table with several rows of data, for example:

AccountID	expectedReturn	expectedException
<i>Generated ID 1</i>		
<i>incorrect AccountNo</i>		<code>java.rmi.RemoteException</code>

- 4 Click **Save** and then **Close** when you are finished.
- 5 Click **OK** to close the Datapool Properties dialog box.
- 6 Repeat Step 2, through Step 5 for the `getSavingsCustomerID` method.
- 7 Click **Close** to close the Manage Datapools dialog box.

At this point, you should be finished creating your tests assets, and you can start setting up your development environment in order to run the tests.

Importing Test Assets into Your IDE

After you generate your test assets, you must add them to a project in your IDE, where you can run the tests.

If you are using IBM Visual Age for Java (VAJ), this means importing the test into the VAJ repository.

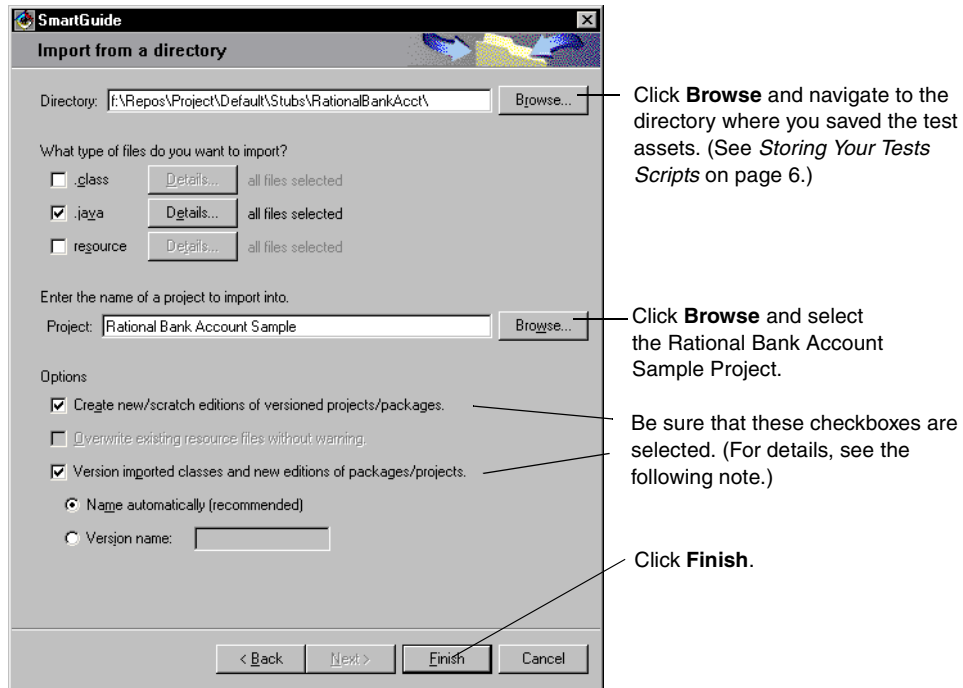
Importing Test Assets into VAJ

To import generated test assets into the RationalBankAccount project in the VAJ repository:

- 1 Start VAJ if it is not already started.
- 2 Within the VAJ Workbench window, click the **Projects** tab.
- 3 Right-click anywhere in the window and click **Import**.

Note: When you import a test asset into VAJ, the test asset is compiled automatically.

- 4 When the SmartGuide dialog box appears, select **Directory** as the input source and click **Next**.



Note: To save previous versions of your test assets, be sure to select the following check boxes: **Create new/scratch editions of versioned projects/packages** and **Version imported classes and new editions of versioned projects/packages**. Doing so lets you roll back to a known previous version of the test asset.

To roll back to a previous version:

- 1 Shut down the EJB servers.
- 2 Right-click the RationalBankAcct package and click **Replace with > Another Edition menu**.

Importing Test Assets into Visual Cafe

To import test assets into Visual Cafe:

- 1 Start Visual Cafe.
- 2 Create a new, empty project or open an existing project.
- 3 Click the **Files** tab under the Project window.
- 4 Right-click in the Project window and click **Insert Files**.
- 5 Navigate to the directory that contains the test assets you want to import.
See *Storing Your Tests Scripts* on page 6 for information on where the various test assets are stored.
- 6 Select the test assets that you want to import, click **Add**, and then click **OK**.
- 7 Save the new project.

Deploying Stubs to a WebLogic Application Server

If you are working in a WebLogic environment, deploy the stubs that you generate before you actually execute your test scripts.

WebLogic provides two deployment modes:

- A permanent, production mode in which you must load EJBs and configure the server offline
- A temporary, development mode in which you can stage or hot deploy EJBs for testing purposes without shutting down the WebLogic server

This section provides instructions for both permanent and hot deployment modes.

Deploying Stubs Permanently to a WebLogic Server

To deploy stubs permanently to a WebLogic server:

- 1 Shut down the WebLogic application server if it is currently running.
- 2 Generate the stubs from Rose. For details, see *Generating Stubs and Lookup Tables for the Unit Test* on page 56.
- 3 Launch Visual Café 4.x if it is not currently running and create a new empty project.
- 4 Use **Insert > Files into project** to add the three stub source files into the project. For example, add the three stub files that were created in *Generating Stubs and Lookup Tables for the Unit Test* on page 56. These three stub files include:
 - The remote interface, `ManageAccounts.java`
 - The home interface, `ManageAccountsHome.java`
 - The implementation class, `ManageAccountsBean.java`
- 5 Add the required JAR files to the project.
 - a Click **Project > Options** and then click the **Directories** tab.
 - b Click **New**, the button furthest to the left.
 - c Click **file**.
 - d Add the required JAR files for test script playback. (See *Rational Test Script Playback Requirements* on page 33.)
 - e For WebLogic 5.1, browse to `<RQA Home>\Samples\ejb\bankacct\vc\ratlbankacct51.jar` and click **Open**.
For WebLogic 6.1, browse to `<RQA Home>\Samples\ejb\bankacct\vc\ratlbankacct61.jar` and click **Open**.
 - f Click **OK**.
- 6 Save the project and specify a name.
- 7 Click **Project > Rebuild all** to compile the project.
- 8 Copy the three compiled class files into a directory named after the package name, for example, `RationalBankAcct`.
- 9 Launch a zip utility such as WinZip and open the sample JAR file.
 - Open `ratlbankacct51.jar` if you are working in a WebLogic 5.1 environment.
 - Open `ratlbankacct61.jar` if you are working in a WebLogic 6.1 environment.

- 10 Delete the .class files from the JAR file.
- 11 Add the stubbed .class files to the JAR file:
 - a Click the **Add** icon on the Winzip toolbar.
 - b Navigate to the stub directory and make sure that **Save full path info** is checked. (It's in **Folders** options.)
 - c Select all three .class files and then click **Add**.
 - d Close the archive file.
- 12 Copy the modified JAR file to the appropriate WebLogic directory, for example:
 - <WebLogic Home>\myserver\RatIBankAcct, for WebLogic 5.1.
 - <BEA Home>\wlsrver6.1\config\examples\applications, for WebLogic 6.1.
- 13 Before executing any test scripts and stubs, be sure that you have met the requirements discussed in *Requirements for EJB Testing* on page 31, particularly the classpath requirements for WebLogic and the classpath requirements for playback from TestManager.
- 14 Restart the WebLogic application server to deploy the stubs.

Deploying Stubs to a Running WebLogic Server (Hot Deployment)

After you generate stubs and lookup tables (see *Generating Stubs and Lookup Tables for the Unit Test* on page 56), you need to deploy the stubs to the WebLogic server before you can actually run the test script associated with the stub.

With WebLogic, it is possible to deploy these stubs to a WebLogic server without stopping the server. This is known as *hot deployment*. With this feature, you can deploy your generated stubs and test your deployed EJBs right away, before they are deployed permanently to the WebLogic server. Any EJBs that you hot deploy to the WebLogic server are only deployed temporarily for staging and testing purposes. Once you stop and restart the server, the EJBs will no longer be deployed.

The following procedures use the Rational Bank Account sample application as an example. For information about how to permanently deploy the Rational Bank Account sample application to a WebLogic server, see *Deploying the Sample Application to a WebLogic Application Server* on page 45. For information about permanently deploying stubs to a WebLogic server, see *Deploying Stubs Permanently to a WebLogic Server* on page 60.

The wl_deploy Build Folder

Included with the QualityArchitect installation is a build folder called `wl_deploy`. This build folder contains the build scripts required to build and deploy the Rational Bank Account sample application to a WebLogic server that is already up and running. The `wl_deploy` build folder is located in the `<RQA_HOME>\Samples\ejb\bankacct\vc` folder on the computer where you installed QualityArchitect.

This build folder contains two command script files—`setbuildenv.cmd` and `wl_build.cmd`.

- The `setbuildenv.cmd` file is a command script that is used to set the required environment variables for the build and hot deployment process.
- The `wl_build.cmd` file is a command script that is used to actually build the EJBs and hot deploy them to a WebLogic server.

The `wl_deploy` folder also contains two subfolders: `RationalBankAcct` and `META-INF`.

- The `RationalBankAcct` folder contains the source code for each of the EJBs required for the Rational Bank Account sample.
- The `META-INF` folder contains the XML deployment descriptors for each of those EJBs.

Building and Hot Deploying the Sample Application and Stubs

To build and hot deploy the Rational Bank Account sample EJBs and stubs to a WebLogic server:

- 1 Execute steps 3, 4, 5, and 6 from *Deploying the Sample Application to WebLogic 5.1* on page 45 if you are working with a WebLogic 5.1 server, or steps 3, 4, 5, and 6 from *Deploying the Sample Application to WebLogic 6.1* on page 47 if you are working with a WebLogic 6.1 server. These steps only need to be executed once.
- 2 Open the `setbuildenv.cmd` file and set the required environment variables.

To do this, find the SET command for each of the required environment variables and make sure that the value after the '=' sign is the correct value for the variable. The required environment variables and their description follow:

- `JAVA_HOME` contains the full path to the directory where the JDK/JRE was installed.
- `WL_HOME` contains the full path to the WebLogic home directory. The default WebLogic home directory for version 5.1 is `C:\WebLogic`. The default WebLogic home directory for version 6.1 is `C:\bea\wlserver6.1`.
- `WL_HOST` contains the host server name for the running WebLogic server. The default value is `localhost` for a local machine.

- WL_PORT contains the port number for the running WebLogic server. The default value is 7001.
- WL_PASSWORD contains the system password for the WebLogic server. This is required for the hot deployment process.
- WL_DEPLOYMODE contains the WebLogic deployment mode to use when processing the built EJBs. Possible options are deploy, undeploy, and update.

Note: If you have already hot deployed EJBs to a WebLogic server, you cannot hot deploy them again. You either have to undeploy or update the deployed EJBs. For directions, see *Undeploying the Sample Application* on page 64.
- WL_DEPLOYNAME contains the label name to use for EJBs deployed to the WebLogic server.
- BUILD is a flag variable used to turn build mode on or off. Use 1 for on and 0 for off.
- DEBUG is a flag variable used to turn debug mode on or off. Use for on and 0 for off.

- 3 Back up the actual EJB files in the `<RQA HOME>\Samples\ejb\bankacct\vc\wl_deploy\RationalBankAcct` folder to a separate directory so you can restore the original EJBs, if necessary.

The RationalBankAcct folder contains the source code for each of the EJBs required for the Rational Bank Account sample.

- 4 Copy the generated stubs to the `<RQA HOME>\Samples\ejb\bankacct\vc\wl_deploy\RationalBankAcct` folder, essentially replacing the actual EJB files contained there.

- 5 Execute the `wl_build.cmd` command script to build the EJB code for the Rational Bank Account sample and to deploy the EJBs to a running WebLogic server.

The `wl_build.cmd` command script:

- a Calls the `setbuildenv.cmd` script and sets the required environment variables.
- b Compiles the EJB source code.
- c Generates the container code for the EJBs.
- d Puts the EJB classes and container classes in a JAR file and hot deploys the EJB JAR file to a WebLogic server.

Once you successfully execute the `wl_build.cmd` script, you can immediately start testing the deployed EJBs on the running WebLogic server.

Undeploying the Sample Application

If you have already deployed the Rational Bank Account EJB sample to the WebLogic server using the instructions in *Deploying the Sample Application to a WebLogic Application Server* on page 45 or *Deploying the Sample Application to WebLogic 6.1* on page 47, you must undeploy the sample before the hot deployment process will work.

To undeploy the sample application:

- 1 Open the `setbuildenv.cmd` file.
- 2 Set the `WL_DEPLOYNAME` variable to the deployment name for the Rational Bank Account EJBs.

If you deployed the Rational Bank Account EJB sample to a WebLogic 5.1 server, set `WL_DEPLOYNAME` to `<WL_HOME>\myserver\RatlBankAcct\RatlBankAcct51.jar`.

If you deployed the Rational Bank Account EJB sample to a WebLogic 6.1 server, set `WL_DEPLOYNAME` to `RatlBankAcct61`.

- 3 Set the `BUILD` variable to 0.
- 4 Set the other required environment variables with the appropriate values.
- 5 Make sure that the WebLogic Server is running.
- 6 Execute the undeployment process by running the `wl_build` command script.

This process undeploys the deployed Rational Bank Account EJBs from the running WebLogic server.

Deploying Your Own Stubs

To deploy stubs of your own EJBs:

- 1 Create a new staging environment for your EJBs.

In this staging environment you will need a directory hierarchy containing your EJB source files, XML deployment descriptors, and the command scripts. Be sure that your source file directory matches the package structure of your EJBs. Also be sure that your deployment descriptor directory is `META-INF`.

- 2 Copy your EJB source files to the EJB source file directory.
- 3 Copy your deployment descriptors to the deployment descriptor directory.
- 4 Copy the `setbuildenv.cmd` file and the `wl_build.cmd` file to your staging environment and then modify the environment variables in those files for your particular EJBs.
- 5 Run the `wl_build.cmd` file.

Deploying Stubs to the Sun J2EE Reference Server

If you are working in a Sun J2EE Reference Server environment, you will need to deploy any stubs that you generate (see *Generating Stubs and Lookup Tables for the Unit Test* on page 56) before you can actually execute your test scripts.

To deploy stubs to the Sun J2EE Reference Server:

- 1 Verify that you have `JAVA_HOME` in your system or user classpath. If not, create a `JAVA_HOME` environment variable that points to the root of your JDK 1.3.x installation, for example `C:\jdk1.3.1`.

Note: Sun JDK 1.3.x is the minimum required JDK for the Sun J2EE Reference Server.

- 2 Start the Cloudscape database.

For example:

- a Open a Command Prompt window.
- b Type `<J2EE HOME>\bin\cloudscape -start`.

- 3 In a new Command Prompt window, change the default security settings for the Sun J2EE Reference Server.

The default security settings for the Sun J2EE Reference Server prevents native libraries (DLLs) from being loaded. Because stubs require DLLs for logging and lookup tables, the default security settings will prevent stubs from working. To enable DLLs, add the following lines to the `server.policy` file found in the `<J2EE HOME>\lib\security` directory:

```
grant {  
    permission java.lang.RuntimePermission "loadLibrary.*";  
};
```

Note: You can add these lines anywhere in the file as long as the lines are not inside another `grant { }` block.

- 4 Start the Sun J2EE Reference Server.

For example, type `<J2EE HOME>\bin\j2ee`.

- 5 Start the deployment tool.

For example, type `<J2EE HOME>\bin\deploytool`.

- 6 Using the deployment tool, click **File > Open Application**. For example, to open the Rational Bank Account sample application, select *<RQA Home>\Samples\ejb\bankacct\j2ee\ratlbankacctee.ear*.
- 7 Add the Rational support class library files to the EAR file.
 - a In the Local Applications pane, click on the **RationalBankAccount** package.
 - b On the General Tab, click **Add Library JAR**.
 - c Navigate to *<RQA Home>*, select *Rational_ct.jar*, and click **Add Library JAR**.
 - d Navigate to *<Rational Test Home>*, select *rtssjava.jar*, and click **Add Library JAR**.
 - e Navigate to *<Rational Test Home>tsea*, select *rtseajava.jar*, and click **Add Library JAR**.
- 8 Expand the *BankAcctEJBJar* folder and select the folder that matches the EJBs you will be replacing with the stub code. You should see the classes associated with that EJB in the list box.
- 9 Remove the EJB classes that you will be replacing with the stub code. Normally there are three classes for each generated stub: the Home Interface class, the Remote Interface class, and the Implementation class.

In the Contents list box of the General tab, select the existing bean classes to be removed—*RationalBankAcct\ManageAccountsBeans.class*, *RationalBankAcct\ManageAccountsHome.class*, and *RationalBankAcct\ManageAccounts.class*, and click **Delete** button.
- 10 Once all of the classes are removed, add the stubbed classes to the currently selected EJB.
 - a On the General tab, click the **Add** button in the Contents list box.
 - b Using the Browse button, navigate to the directory that contains the stubs, for example *C:\RatlBankAcct\RatlBankAcct*, select the stubs—for example, *ManageAccounts.class*, *ManageAccountsBean.class*, and *ManageAccountsHome*— and click **Choose Root Directory**.
 - c Choose the directory name where the class files exist, click **Add**, and then click **OK**.
- 11 In the Local Applications pane, click on the **RationalBankAccount** package.
- 12 Change Application Display Name to a new name, such as *RatlBankAcctEE_stubbed*, click **Save > As**, and assign a new file name.

13 Deploy the application by clicking **Tools- > Deploy Application**.

Note: The application will be changed when you deploy or when you explicitly save the application. Therefore, it is best to save your changes under a different name.

Executing Test Scripts

This section describes how to execute your test scripts from VAJ, Visual Cafe, and TestManager.

Editing Host Name and Port Number Variables

Before you can execute a test script, you may need to edit the `hostName` and `portNumber` variables for your particular, remote application server. These variables are declared as part of the URL string in each template used to generate the script.

The default settings are as follows:

Server	URL Format	Default Setting
WebLogic	t3://<HostName>:<PortNumber>	String url = "t3://localhost:7001";
Sun J2EE	IIOP://<HostName>:<PortNumber>	String url = "iiop://localhost:1050";
WebSphere	IIOP://<HostName>:<PortNumber>	String url = "IIOP:///";

Note: `localhost` is used if your application server is installed locally.

For WebLogic and Sun J2EE Application Servers

If you need to edit the `hostName` and `portNumber` variables for a WebLogic or Sun J2EE application server, simply replace the host and port number with your own host and port number.

For WebSphere

For WebSphere, `String url="IIOP:///";` expands to `"IIOP://localhost:900/`. To edit, simply replace `"IIOP:///"` with your own host and port number, for example, `"IIOP://MyHost:MyPortNum/`.

Executing Test Scripts from VAJ

To execute the test script from VAJ:

- 1 Import the test script into VAJ. (For details, see *Importing Test Assets into Your IDE* on page 58.)

- 2 Start the EJB servers to deploy the Rational Bank Account sample EJBs.

For details about starting the EJB servers, see *Deploying the Sample Application in the VAJ Test Environment* on page 42.

- 3 Right-click the generated test script `ExecuteTransactiongetBalance` in the VAJ Project window and click **Run > Check Classpath**.

- 4 Click **Compute Now** to add the path of the generated test script to the ClassPath.

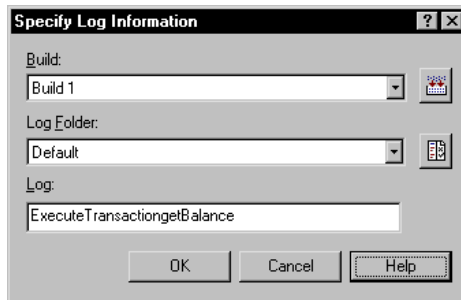
- 5 If you plan to use the WebSphere Test Environment, click the **Edit** button to the right of the Project path and make sure the IBM WebSphere Test Environment package is checked. Click **OK**.

- 6 Click **OK** to accept the generated class path.

- 7 Right-click on the generated test script `ExecuteTransactiongetBalance` in the VAJ Project window and click **Run > Run main**.

- 8 If necessary, log in to a project and click **OK**.

The Specify Log Information dialog box appears:



- 9 Accept the defaults in the Specify Log Information dialog box and click **OK**.

Click **Help** for more information about the Specify Log Information dialog box.

- 10 View the test results in the Rational Test Log window.

The log should contain entries from the stub, indicating the parameters received and the values returned.

For more information about the Test Log window, click **Help**.

Executing Test Scripts from Visual Cafe

To execute a test script from Visual Cafe:

- 1 Open the project that contains your test assets (see *Importing Test Assets into Visual Cafe* on page 59).
- 2 Modify your project options by specifying the Main Class and the project classpath.

a Click **Project > Options**.

b Enter the Main Class of the test script that you want to execute in the **Main Class** text box. You can only execute one test script at a time.

c Be sure that you have added the required Rational test asset JAR files to the project classpath. (See *Rational Test Script Playback Requirements* on page 33 for a list of these files.)

To modify your project classpath, click the **Directories** tab and add the required JAR files and/or directories to the Directories list.

d Be sure you have added the required application server JAR files and/or directories to the project classpath. (See *Application Server Classpath Requirements* on page 32.)

e Be sure you have added the required client JAR file(s) for the EJBs you are testing. If you are testing the Rational Bank account sample EJBs, you will need the following JAR file:

- For WebLogic 5.1, you will need
<RQA_Home>\Samples\ejb\bankacct\vc\RatlBankAcct51.jar
- For WebLogic 6.1, you will need
<RQA_Home>\Samples\ejb\bankacct\vc\RatlBankAcct61.jar

f Click **OK** to save the project options.

- 3 Click **Project > Execute** to build and run the test assets.

Executing Test Scripts from TestManager

Essentially, if you can run your client application from a command prompt, you should be able to execute your test scripts from TestManager. When running a Java test script, TestManager calls whatever Java compiler you are using to compile the test script. For a list of prerequisites, see *Rational TestManager Playback Requirements* on page 35.

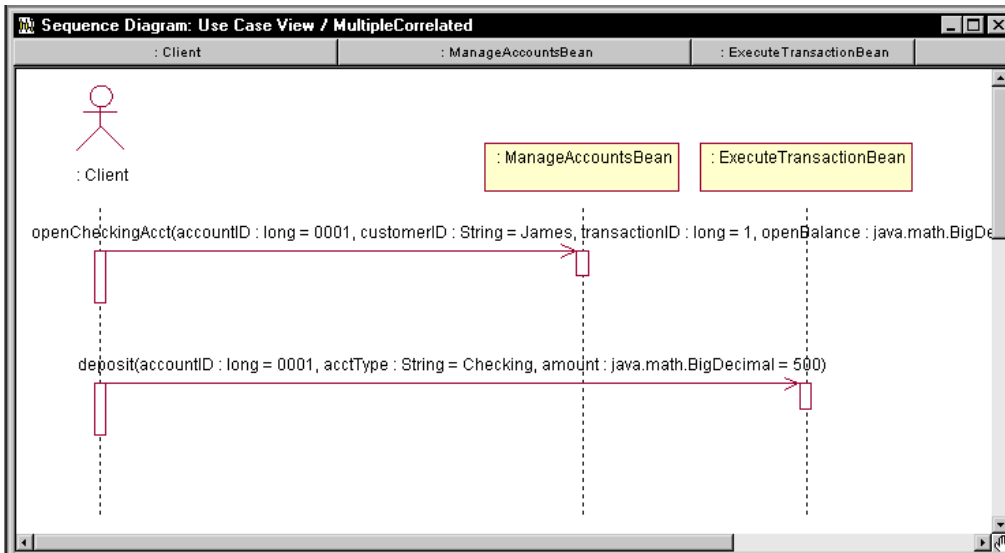
To execute an RQA Java test script in TestManager:

- 1 Start TestManager.
- 2 Click **File > Run Test Script > RQA Java Test Scripts**.
- 3 Select the script and click **Open**.
- 4 From the Run Script dialog box, click **OK**.

For additional information about other ways to run test scripts from TestManager, see the *Rational TestManager User's Guide* or the TestManager Help.

Using EJB Scenario Tests to Test Transactions

Scenario tests use Rose interaction diagrams to test transactions. To try out this feature, you can generate a scenario test for one of the sequence diagrams that are included with the Rational Bank Account sample application. For example, the following figure shows the Multiple Correlated sequence diagram that is included with the sample application

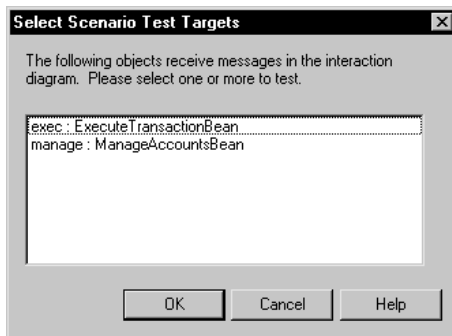


When you generate a scenario test, QualityArchitect prompts you to insert a verification point for each message in your interaction diagram. To add a database verification point, you need a database and you need to know the fully qualified path of your JDBC driver and the JDBC URL, which also includes the name of the database. For information about setting up the database for the sample application, see *The Rational Bank Account Sample Application* on page 38.

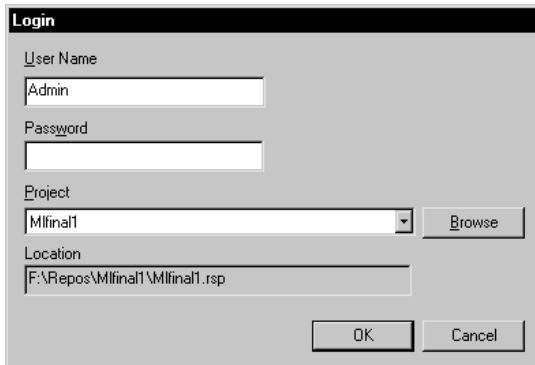
To generate a scenario test:

- 1 Right-click in an active interaction diagram and click **QualityArchitect > Select Scenario Test Template**.
- 2 Expand either the WebSphere folder, the WebLogic folder, or the Sun J2EE folder, and select the appropriate scenario template for your environment.
- 3 Click **Open**.
- 4 Right-click in the interaction diagram and click **QualityArchitect > Generate Scenario Test**.
- 5 In the Select Scenario Test Targets dialog box, select the scenario test targets—that is, the receiver objects (where the arrows are pointing).

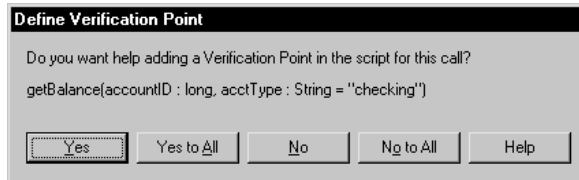
You can select one or more objects to test.



- 6 Click **OK**.
- 7 If prompted, log in to a project and click **OK**.



- 8 In the Define Verification Points dialog box, click **Yes** to add a verification point for the first message in the diagram—`getBalance`.



- 9 In the Select Verification Point Type dialog box, select a verification point type and click **OK**.

For this release, select the database verification point type—`DatabaseVP`.

- 10 At this point, the Query Builder wizard starts. Use the Query Builder to connect to the database and to define a Select statement that can be used to query the database. For more information about the Query Builder, see *Using the Java Query Builder to Add Database Verification Points* on page 72.
- 11 Repeat Steps 8 and 9 for each message in the diagram.
- 12 After the last message, you are prompted to add a verification point at the end of the scenario. Click **Yes**.
- 13 Select a directory to store the tests in and click **OK**.

Note: You can also start the scenario test generator by right-clicking a diagram in the Rose browser and then clicking **QualityArchitect > Generate Scenario Test**.

Using the Java Query Builder to Add Database Verification Points

The QualityArchitect Java Query Builder is a tool that helps you connect to and interact with JDBC data sources for the purpose of defining database verification points. The Query Builder uses a wizard-like interface that lets you build a query one step at a time. Once built, the query is used with a database verification point.

To understand more about the Query Builder, consider what happens if you generate a scenario test for the Multiple Correlated sequence diagram in the sample application. (See *Using EJB Scenario Tests to Test Transactions* on page 70.) This sequence diagram contains the following messages:

- `openCheckingAcct`
- `deposit`

In testing this scenario, you could choose to create a verification point for each message. The first verification point could be used to verify that an account was opened and that the opening balance is as expected. The second verification point could be used to verify the results of a deposit to this account.

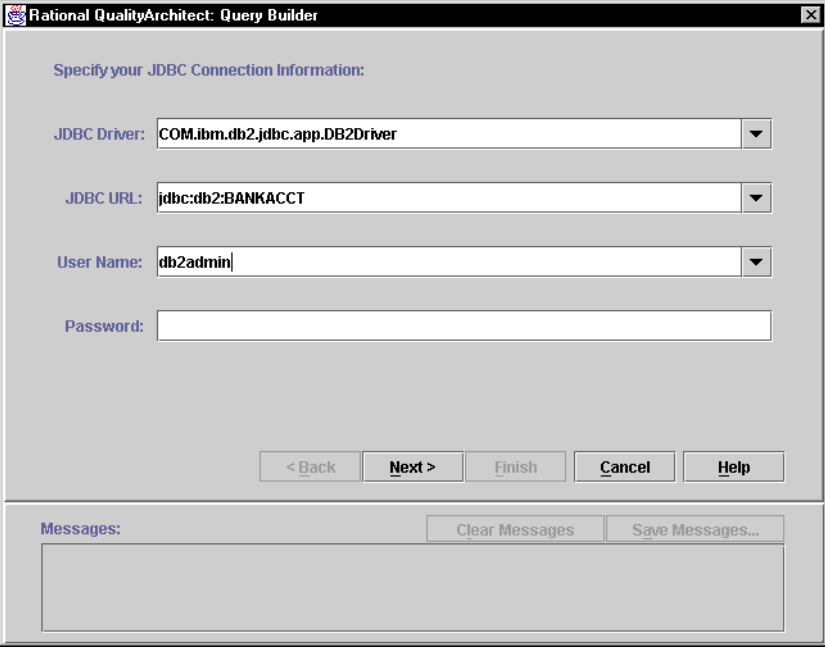
To design the query, you must:

- Connect to a database via JDBC.
- Design a SQL statement.
- Verify the specified SQL query settings.

Connecting to the Database via JDBC

The first step involved in building a custom SQL query is to connect to the database and enter the required JDBC information.

When the Query Builder starts, specify the JDBC Driver, the JDBC URL, a user name, and password, and then click **Next**.



The screenshot shows a dialog box titled "Rational QualityArchitect: Query Builder". The main area is titled "Specify your JDBC Connection Information:" and contains four input fields:

- JDBC Driver:** A dropdown menu with the selected value "COM.ibm.db2.jdbc.app.DB2Driver".
- JDBC URL:** A dropdown menu with the selected value "jdbc:db2:BANKACCT".
- User Name:** A text input field containing "db2admin".
- Password:** An empty text input field.

At the bottom of the dialog, there are five buttons: "< Back", "Next >", "Finish", "Cancel", and "Help". Below the main input area is a "Messages:" section with a "Clear Messages" button and a "Save Messages..." button, and a large empty text area for displaying messages.

JDBC Driver

The JDBC Driver text is the fully qualified class name of the Java JDBC driver class that was written for the specific DBMS that you would like to connect to. The following table lists some examples of JDBC Driver text for some common environments:

Environment	JDBC Driver Text
WebSphere/DB2	COM.ibm.db2.jdbc.app.DB2Driver
WebLogic/SQL Server	weblogic.jdbc.mssqlserver4.Driver
WebLogic/CloudScape	COM.cloudscape.core.RmiJdbcDriver
Any ODBC data source	sun.jdbc.odbc.JdbcOdbcDriver

JDBC URL

The JDBC URL provides a way of identifying a database to the driver. The standard syntax for JDBC URLs is as follows:

```
jdbc:<subprotocol>:<subname>
```

The three parts of a JDBC URL are broken down as follows:

Part of URL	Description
jdbc	The jdbc protocol. The protocol is always jdbc.
subprotocol	Contains the name of the driver or the name of a database connectivity mechanism, which may be supported by one or more drivers. A prominent example of a subprotocol name is "odbc", which has been reserved for URLs that specify ODBC-style data source names.
subname	Used to identify the database. The subname can vary, depending on the subprotocol, and it can have a subsubname with any internal syntax that the driver writer chooses.

The following table lists some examples of JDBC URLs for some common environments:

Environment	JDBC Driver Text
WebSphere/DB2	jdbc:db2:BANKACCT
WebLogic/SQL Server	jdbc:weblogic:mssqlserver4:CQSMV

Environment	JDBC Driver Text
WebLogic/CloudScape	<code>jdbc:cloudscape:rmi://<hostname:<port>/<Cloudscape database></code>
Any ODBC data source	<code>jdbc:odbc:nwind</code>

User Name

The User Name text is the name of the user who has access rights to the specified database.

Password

The Password text is the password that is associated with the database user.

Designing a Custom Query Statement

After you connect to the JDBC data source, you can design the custom SQL query statement that will be used to retrieve specific data from the database. You can enter the SQL query statement manually or design one interactively using the Query Design Wizard.

For example, in testing `openCheckingAcct`, you could construct a Select statement that returns an account ID, a customer ID, and a balance from the Checking table.

If you are familiar with SQL syntax and are familiar with the schema of the data source that you are connecting to, you can simply enter your custom SQL query statement in the SQL Text box.

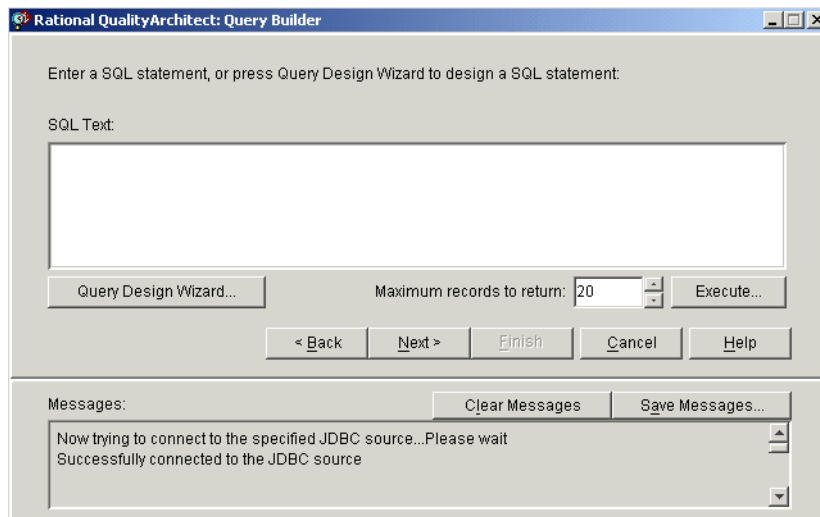
Once you are satisfied with your custom SQL query statement, click **Next** to apply the SQL query to the connected data source.

Using the Query Design Wizard

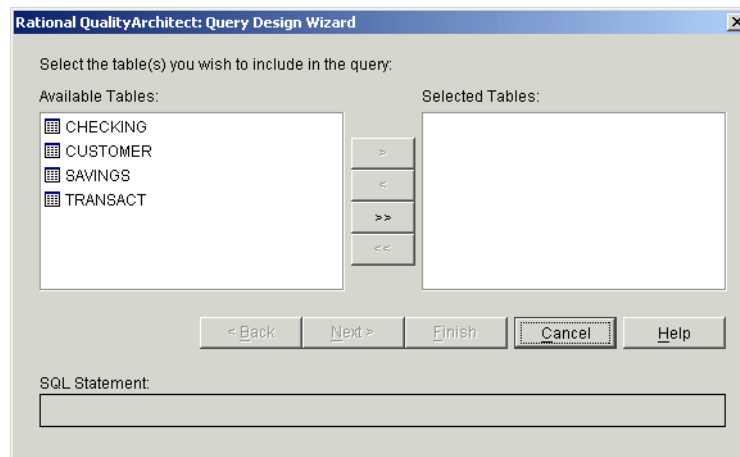
If you are not familiar with SQL syntax or are not familiar with the schema of the data source that you are connecting to, you can use the Query Design Wizard to interactively walk through the design of your custom SQL query statement. The Query Design Wizard helps you easily create complex SQL query statements by taking you step-by-step through the design process.

To use the Query Design Wizard:

- 1 Click the **Query Design Wizard** button.

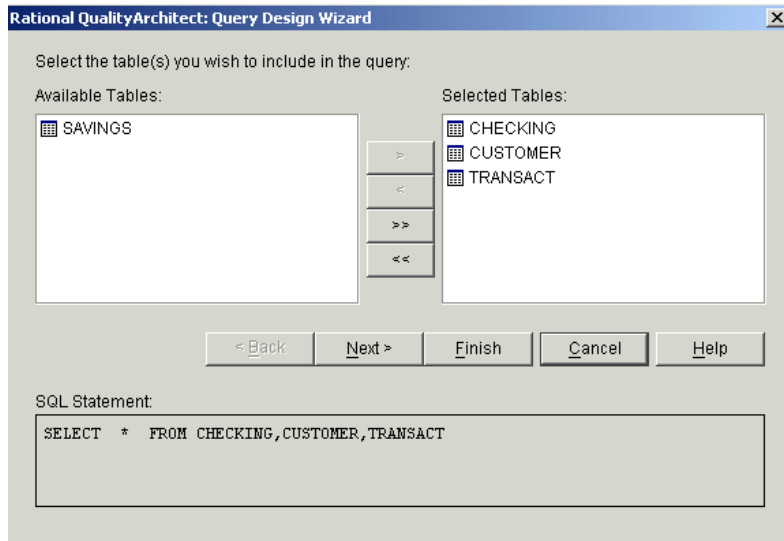


- 2 Select the tables that you want to query and click **Next**.



To select specific tables, click the table names in the Available Tables list and click >. As an alternative, simply double-click a table name from the Available Tables list. To select all of the tables in the list, click >>.

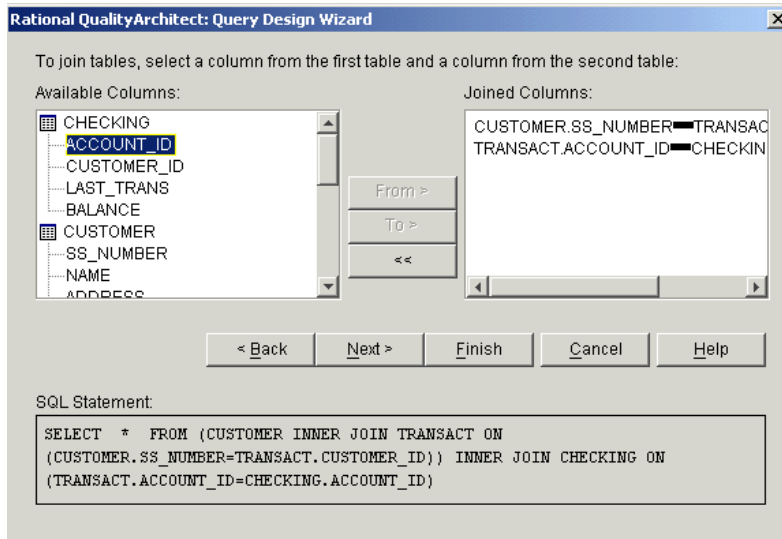
For our purposes, select the Checking, Customer, and Transact tables.



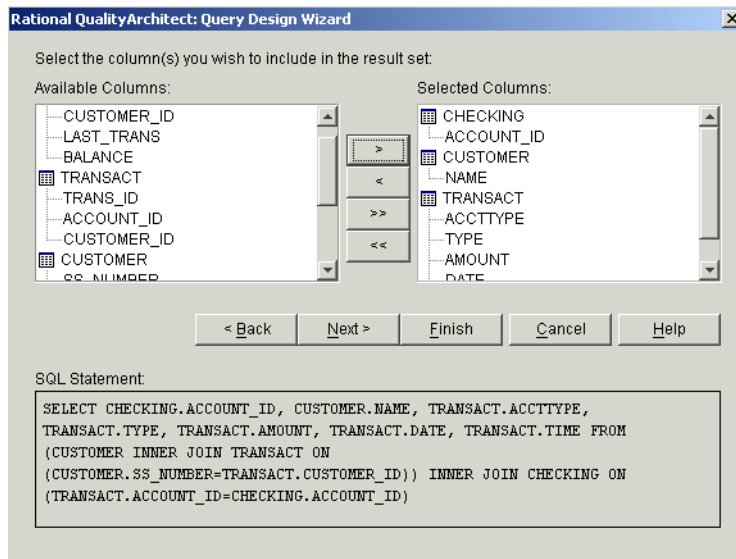
- 3 With the Query Design wizard, you can visually join a column from one table with a column from another table. For example:
 - a Click the SS_NUMBER column in the CUSTOMER table and click **From**.
 - b Click the CUSTOMER_ID column in the TRANSACT table and click **To**.
This creates an Inner Join between the two columns.
 - c Click the ACCOUNT_ID column in the TRANSACT table and click **From**.
 - d Click the ACCOUNT_ID column in the CHECKING table and click **To**.
 - e Click **Next**.

This creates an Inner Join between these two columns.

Note: Column names are listed in *TableName.ColumnName* format.

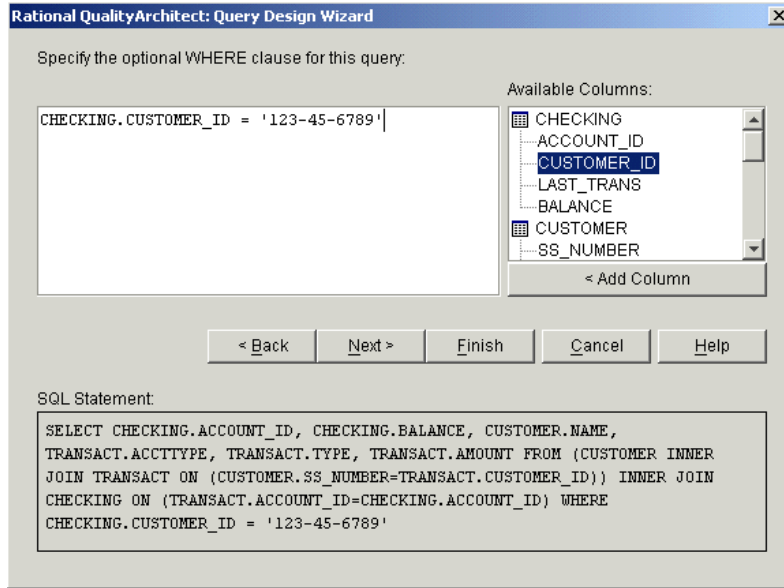


- 4 Select the columns to include in the result set, and then click **Next**:

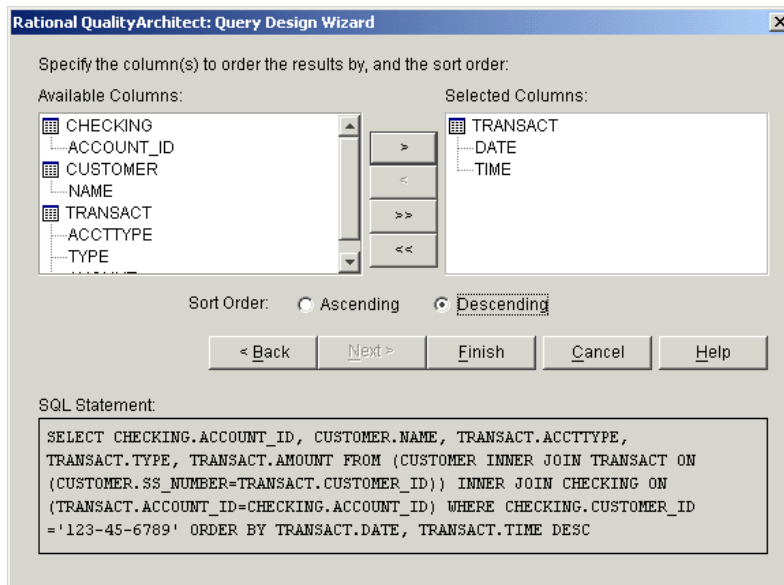


- 5 Enter a WHERE clause for the query and click **Next**.

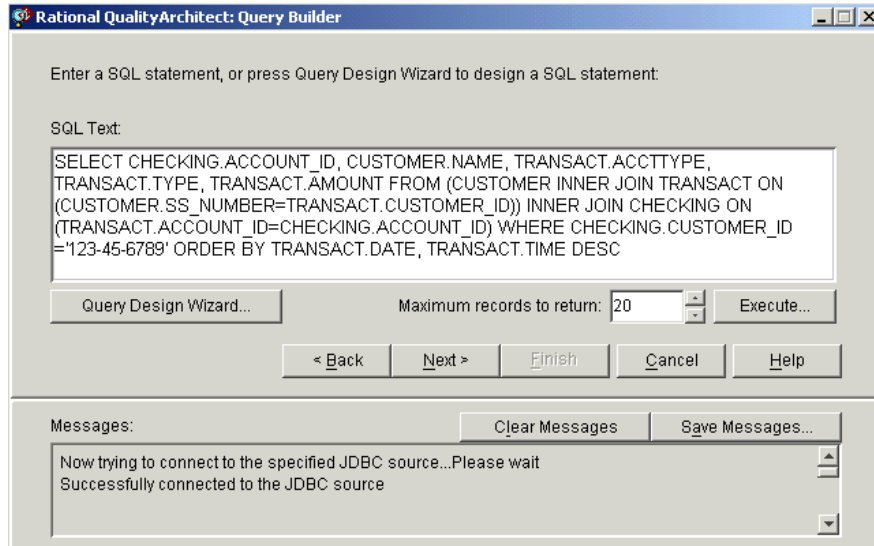
The WHERE clause allows you to specify a search condition that restricts the returned query results.



- Specify the columns to order the results by, set the sort order to Descending, and then click **Finish**.



- 7 Verify the SQL Text, make any edits as needed, and click **Next** to exit the Query Design Wizard.



- 8 Click **Next** to verify the connection information and the SQL Text and then click **Finish** if you are satisfied with the information.

To make changes, click **Back**.

The screenshot shows the 'Rational QualityArchitect: Query Builder' dialog box. At the top, it says 'Press Finish to accept this query information or press Back to make changes:'. Below this are four input fields: 'JDBC Driver' with the value 'COM.ibm.db2.jdbc.app.DB2Driver', 'JDBC URL' with 'jdbc:db2:BANKACCT', 'User Name' with 'db2admin', and 'Password' with 'db2admin'. A large text area contains the following SQL query:

```
SELECT CHECKING.ACCOUNT_ID, CUSTOMER.NAME, TRANSACT.ACCTTYPE, TRANSACT.TYPE, TRANSACT.AMOUNT FROM (CUSTOMER INNER JOIN TRANSACT ON (CUSTOMER.SS_NUMBER=TRANSACT.CUSTOMER_ID)) INNER JOIN CHECKING ON (TRANSACT.ACCOUNT_ID=CHECKING.ACCOUNT_ID) WHERE CHECKING.CUSTOMER_ID = '123-45-6789' ORDER BY TRANSACT.DATE, TRANSACT.TIME DESC
```

 Below the SQL text is an 'Advanced Options...' button. At the bottom of the dialog are five buttons: '< Back', 'Next >', 'Finish', 'Cancel', and 'Help'. Below the dialog is a 'Messages' section with 'Clear Messages' and 'Save Messages...' buttons. The message list contains two entries: 'Now trying to connect to the specified JDBC source...Please wait' and 'Successfully connected to the JDBC source'.

To set advanced database verification point options, click **Advanced Options**.

The screenshot shows the 'Set Advanced Database VP Options' dialog box. It contains four unchecked checkboxes: 'Trim leading and trailing whitespace in captured result set', 'Perform case insensitive comparison', 'VP succeeds only if comparison fails (negative test)', and 'Prompt for validation of captured baseline data on first execution'. At the bottom are three buttons: 'OK', 'Cancel', and 'Help'.

See the Query Builder Help for a description of the advanced Database VP Options

Viewing and Verifying the SQL Query Results

When the custom SQL query has been successfully executed on the connected data source, the query results are displayed in the Query Results table. The columns of the table correspond to the columns that you included in the SQL query in the SELECT clause.

After you finish creating the query for a scenario test, the script generator asks if you want to create verification points for each additional message in the diagram. If you choose to do so, create a database verification for the deposit message.

After you finish entering database verification points, the scenario test script is generated. The values specified in the Query Builder are placed into a datapool, and the generated code retrieves these datapool values, allowing the verification point to be data driven.

A sample verification point is listed in the script as follows:

```
// A verification point may be automatically inserted below.
String svp1JDBCdriver = dp.value("svp1JDBCdriver").toString();
String svp1JDBCurl = dp.value("svp1JDBCurl").toString();
String svp1JDBCuser = dp.value("svp1JDBCuser").toString();
String svp1JDBCpassword = dp.value("svp1JDBCpassword").toString();
String svp1SQL = dp.value("svp1SQL").toString();
String svp1VPname = dp.value("svp1VPname").toString();

DatabaseVP vp1openCheckingAcctVP = new DatabaseVP("svp1VPname",
svp1SQL, svp1JDBCuser, svp1JDBCpassword, svp1JDBCdriver,
svp1JDBCurl);

vp1openCheckingAcctVP.performTest(null);
```

For more information about coding verification points, see the *Rational Test Script Services for Java* manual.

Using the EJB Session Recorder

The EJB Session Recorder is a tool that lets you visually connect to and interact with EJBs. As you execute transactions against the component, interaction data is recorded and stored in an external XML file. The XML file is then converted to a scenario test script that can be used for testing the EJBs.

Before working with the EJB Session Recorder, see *EJB Session Recorder Requirements* on page 34.

The basic steps for using the EJB Session Recorder are:

- 1 Start the EJB Session Recorder.
- 2 Connect to the JNDI (Java Naming and Directory Interface) Naming Service and select a deployed EJB.

This returns the EJB's home interface.

- 3 Select a method on the home interface and enter parameter names and values for the method.
- 4 Invoke the method.

This returns the EJB's remote interface.

- 5 Select a method on the remote interface and enter parameter names and values for the method.

For example, to enter parameter names and values for the EJBs installed with QualityArchitect, you will need to examine the Method Specifications in Rose or review the EJB's methods in your IDE.

- 6 Invoke the method.
- 7 View the XML log by clicking **View > Current XML Log**.
- 8 Generate a test script from the XML log.

Setting Up the Java Runtime Environment (JRE)

To choose the JRE that the Session Recorder runs in:

- 1 Click **Tools > QualityArchitect > Console** to display the RQA Console.
- 2 Click the **RQA Options** icon.
- 3 Click the **Java Options** tab.
- 4 Specify the desired JRE executable file in the Java Runtime Environment box.

Note: In order to connect to a WebSphere application server outside of the WebSphere test environment, you must choose the IBM JRE, which is located by default in the JDK\JRE\bin directory under the WebSphere installation directory. You must also include the JDK\JRE\bin directory in your system path.

Starting the EJB Session Recorder

There are several ways to start the EJB Session Recorder:

- From the QualityArchitect console
- From Visual Cafe
- From IBM Visual Age for Java

Note: We recommend that you start the EJB Session Recorder from the console or the command line, because it is more complicated to set up and configure the EJB Session Recorder from the IDE. In addition, performance of the EJB Session Recorder is best if run outside an IDE.

Starting the EJB Session Recorder from the Console

To start the EJB Session Recorder from the console:

- 1 Set up the classpath. (See *EJB Session Recorder Requirements* on page 34.)
- 2 Click the **EJB Session Recorder** icon on the QualityArchitect console.

Starting the EJB Session Recorder from Visual Cafe

In order to start the EJB Session Recorder from Visual Cafe, several entries must be included in the Visual Cafe classpath.

To start the EJB Session Recorder from Visual Cafe:

- 1 Create a new, empty project in Visual Cafe.
- 2 After the new project is created, click **Project > Options** from the main menu.
- 3 Click the **Project** tab and enter the following text in the **Main Class** text box:
`com.rational.test.ejbclient.EJBSessionRecorder`
- 4 Click the **Directories** tab and verify that **Input class files** is selected in the **Show directories for** box.
- 5 Click the **New** button (the button furthest to the left) in the Directories area.
- 6 Click the **file** button.
- 7 In the File Open dialog box, navigate to the installation directory for QualityArchitect (by default, C:\Program Files\Rational\Rational Test\QualityArchitect), select Rational_ct.jar and click **Open**.

The imported JAR file appears in the **Directories** list.

- 8 Repeat the JAR import instructions for the rest of the required JAR files. You can find all of these files, except `rtssjava.jar`, in the `<RQA Home>` directory (by default, `C:\Program Files\Rational\Rational Test\QualityArchitect`). You can find `rtssjava.jar` in `C:\Program Files\Rational\Rational Test`.
 - `Xerces.jar`
 - `collections.jar`
 - `Jh.jar`
 - `Scriptgen_ct.jar`
 - `Ejbsessionrecorder_ct.jar`
 - `rtssjava.jar` (located under Rational Test, not QualityArchitect)
- 9 Click **Project > Execute** from the main menu to launch the EJB Session Recorder.

Passing in Command Line Parameters (optional)

As an added feature, the JNDI Provider URL and Initial Context Factory can be passed in as command line parameters for the EJB Session Recorder.

To specify these parameters for the EJB Session Recorder:

- 1 Click **Project > Options** from the main menu.
- 2 When the Project Options dialog box opens, enter the command line parameters in the Program Arguments text box.

An example for Visual Cafe would be:

```
providerurl=t3://localhost:7001
contextfactory=weblogic.jndi.WLInitialContextFactory
```

Note: The JNDI Provider URL and the Initial Context Factory can also be set in the Options dialog box, which can be accessed from the Rational QualityArchitect console. (To access the console, click **Tools > QualityArchitect > Console**.)

Starting the EJB Session Recorder from Visual Age for Java

Before you start setting up the EJB Session Recorder in VAJ (v.3.5 or v. 4.x), make sure that the IBM EJB Development Environment feature and IBM WebSphere Test Environment feature have been added. You will know that they have been added because you will see an EJB tab in the Workbench window. For details, see *Adding EJB Support* on page 41.

Creating a New Project

From the VAJ Workbench window, create a new project.

After you create the project, you will see the name of the new project in the current projects list.

Importing JavaHelp

- 1 Right click on the name of the project that you just created and click **Import**.
- 2 Make sure the Jar file option is selected and click **Next**.
- 3 Under **What types of files do you want to import**, make sure that the **class** and **resource** options are checked.
- 4 Under **Options**, make sure **Create new/scratch editions of versioned projects/packages** is checked.
- 5 Click the **Browse** button and navigate to the installation directory for QualityArchitect (By default, C:\Rational\Rational Test\QualityArchitect).
- 6 Select jh.jar and click **Open** in the File Open dialog box.
- 7 Click **Finish**.

All of the class files from the JAR file are then imported into the VAJ repository.

- 8 Click **OK** to close the problems dialog box.

The Modify Palette dialog box now appears. This dialog box lets you specify which Swing classes you want to add to the visual palette.

- 9 Click **Cancel** to close this dialog box.

Importing Xerces

The next JAR file to import is xerces.jar. Follow the steps in *Importing JavaHelp* on page 86. Be sure to select xerces.jar.

When you click **Finish**, all of the class files from the JAR file are imported into the VAJ repository.

Note: A problems dialog box appears stating that **One or more classes were imported into pre-existing packages in other projects**. Three of the packages found in xerces.jar are shared by the IBM XML Parser. Ignore these problems because they will not affect the EJB Session Recorder. Click **OK** to close this dialog box.

Importing the Remaining Jar Files from the QualityArchitect Directory

Follow the steps in *Importing JavaHelp* on page 86 to import the following JAR files from the QualityArchitect directory:

- collections.jar
- scriptgen_ct.jar
- rational_ct.jar
- Ejbssessionrecorder_ct.jar

Importing rtssjava.jar

The next JAR file to import is `rtssjava.jar`, which is part of Rational Test Services. Follow the steps in *Importing JavaHelp* on page 86. Be sure to select `rtssjava.jar`, which is located in the Rational Test directory, one directory above the QualityArchitect directory.

Importing Deployed EJBs

In order for the EJB Session Recorder to successfully connect to deployed EJBs in VAJ, you must import the home and remote interface classes for those EJBs into VAJ.

Checking the Classpath and Launching the EJB Session Recorder

- 1 Expand the package named `com.rational.test.ejbclient` under the project you created by clicking the + box next to the package name.
- 2 Right-click the `EJBSessionRecorder` class and click **Run > Check Class Path**.
- 3 Click the **Compute Now** button to fill in all of the package dependencies for the EJB Session Recorder.
- 4 If you plan to use the WebSphere Test Environment, click the **Edit** button to the right of the Project path and make sure that the IBM WebSphere Test Environment package is checked. Then, click **OK**.
- 5 Click **OK**.
- 6 Right-click the `EJBSessionRecorder` class again and click **Run > Run main** to launch the EJB Session Recorder.

Passing in Command Line Parameters (optional)

As an added feature, the JNDI Provider URL and Initial Context Factory can be passed in as command line parameters for the EJB Session Recorder.

To specify these parameters for the EJB Session Recorder:

- 1 Right-click the `EJBSessionRecorder` class and click **Run > Check Class Path**.
- 2 When the project properties dialog box opens, click the **Program** tab.
- 3 Enter the command line parameters in the Command line arguments text box.

An example for VAJ would be:

```
providerurl=iiop:///
contextfactory=com.ibm.ejs.ns.jndi.CNInitialContextFactory
```

Using the EJB Session Recorder with the Sample Application

You can use the EJBs that have been installed with the sample application to try out the EJB Session Recorder.

In this section, you:

- 1 Start a recording session.
- 2 Connect to an EJB.
- 3 Interact with the home interface.
- 4 Interact with the remote interface.
- 5 Insert a verification point.
- 6 View the XML log.
- 7 Generate a test script.

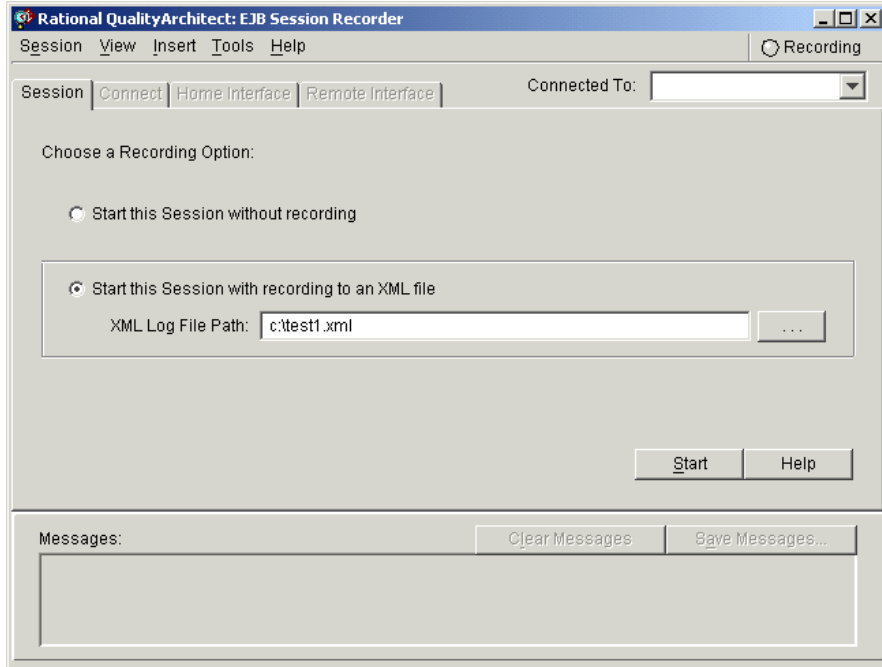
Before starting the EJB Session Recorder, be sure to start your application server.

Starting a Recording Session

To start a recording session:

- 1 Start the EJB Session Recorder, using one of the methods listed in *Starting the EJB Session Recorder* on page 84.

When you start the EJB Session Recorder, the first screen that appears is the Session panel.



- 2 Click **Start this Session with Recording to an XML file**.
- 3 Specify a path in which to store the XML log file.
- 4 Click **Start**.

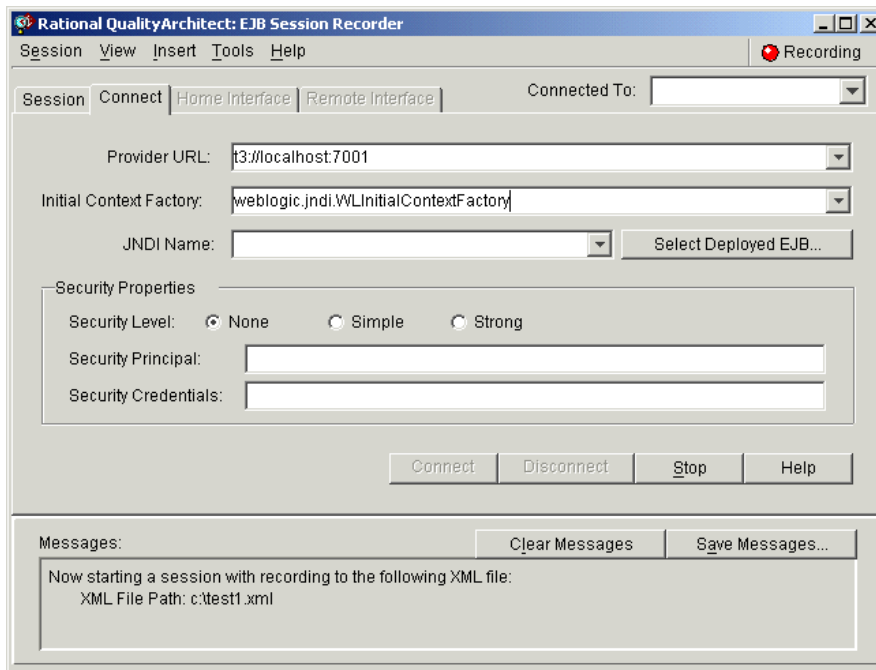
The Connect Panel appears.

Connecting to an EJB

Use the Connect Panel to enter the settings required to connect to JNDI, to find the EJB stored in the Naming Service, and to return the home interface.

Application servers, such as IBM WebSphere and BEA WebLogic, may utilize a completely different Naming Service architecture. In most cases, you should be able to accept the default settings for your application server.

A sample Connect Panel appears in the following figure:



To connect to a deployed EJB and return its home interface:

1 Specify the **Provider URL**.

The **Provider URL** is used to specify the location of the server that is used to provide the Naming Service.

- The default URL for the WebSphere Naming Service server is `iiop://`.
- The default URL for the WebLogic Naming Service server is `t3://localhost:7001`.
- The default URL for the Sun J2EE Naming Service server is `iiop://localhost:1050`.

The general format for the **Provider URL** is:

service://host:port/

where

- *service* refers to the name given to the Naming Service for the Application Server.
- *host* is the host machine that the Naming Service is running on.
- *port* refers to the specific port on the host machine that the Naming Service is listening to for requests.

2 Specify the **Initial Context Factory** for your application server.

To access a JNDI service provider, you need to create an initial context and pass it a context factory, which creates a context for a particular provider. The *context factory* is essentially a Java object that contains the JNDI information required by the Naming Service. Once the context is created, it provides client access to the Naming Service.

The default context factory for WebSphere is:

`com.ibm.ejs.ns.jndi.CNInitialContextFactory`

The default context factory for WebLogic is:

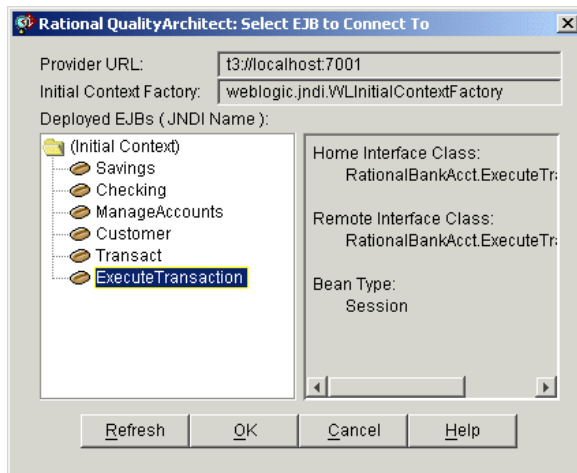
`weblogic.jndi.WLInitialContextFactory`

The default context factory for the Sun J2EE reference platform is:

`com.sun.jndi.cosnaming.CNctxFactory`

3 Click the **Select Deployed EJB** button.

This retrieves the list of deployed EJBs from the application server. In this case, select the `ExecuteTransaction` bean and click **OK**.



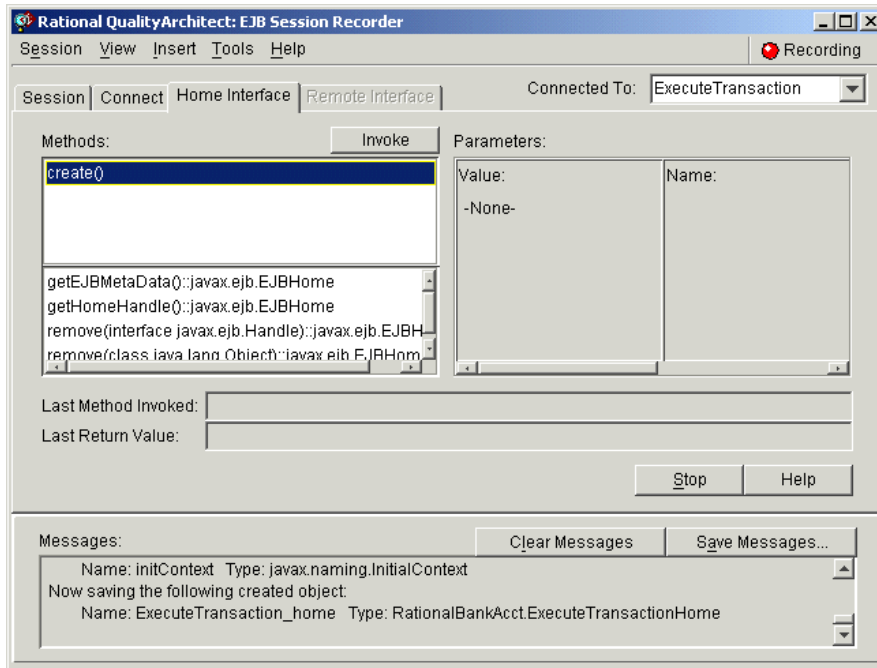
4 Click **Connect**.

This connects you to the JNDI services, which returns the deployed bean's home interface and displays the Home Interface panel.

Note: If there is a problem connecting to JNDI or retrieving the home interface, view the error information that appears in the Messages panel.

Interacting with the Home Interface

The Home Interface panel displays the public methods for the EJB's home interface.



The Home Interface panel displays methods, parameters, and messages.

- The Methods list displays all of the public methods in the EJB's home interface class.
- The Parameters pane displays all the required parameters for the selected home interface method.
- The Messages pane is used to display status information for invoked methods.

Invoking a Method on the Home Interface

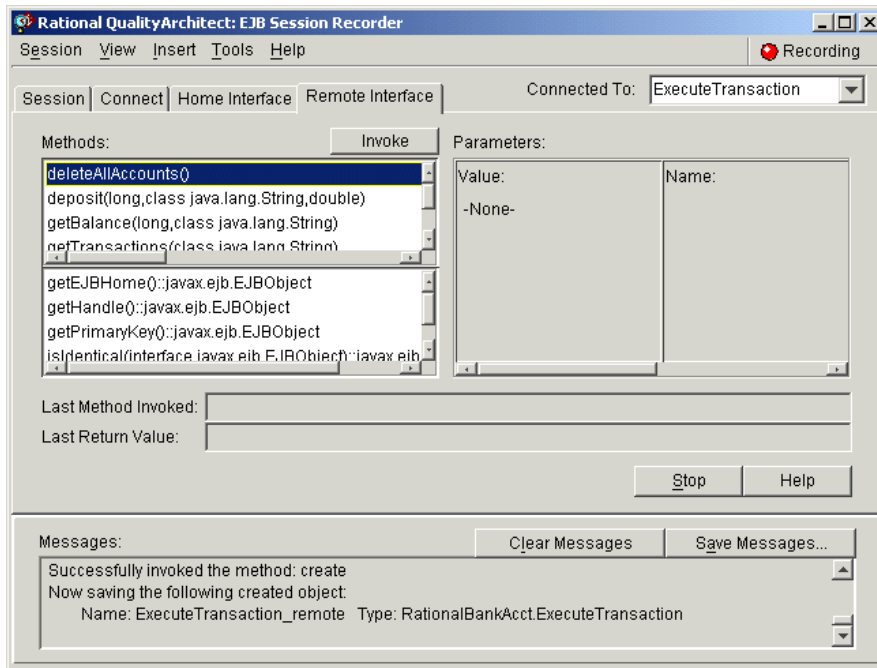
To invoke a method on the home interface:

- 1 Verify that the `create()` method is selected in the **Methods** list.
There are no required parameters for the `create()` method.
- 2 Click **Invoke**.

When you invoke the `create()` method on the home interface, the remote interface is returned and the Remote Interface panel appears.

Interacting with the Remote Interface

This panel is very similar to the Home Interface panel in that it displays methods, parameters, and messages.



- The Methods list contains all of the public methods for the EJB's remote interface. The declared methods are displayed in the top section, and the inherited methods are displayed in the bottom section.
- When you select a method, its required parameters are displayed in the Parameters pane.
- The Messages pane is used to display status information for invoked methods.

To invoke a method on the remote interface, select the method from the Methods list. If there are any parameters required to invoke the method, enter the desired values for the parameters in the Parameters pane. Then, click the **Invoke** button to execute the method.

Note: To invoke methods for the sample application's remote interface, you will need to know the arguments for each method. One way to obtain this information is to examine one of the supplied Rose models.

Invoking the openAccount() Method

For example, to invoke the `openAccount()` method on the `ExecuteTransaction` remote interface:

- 1 Click the `openAccount()` method from the **Methods** list.
- 2 Enter values for the required parameters—for example:

Values	Names
987-56-1234	ssNumber
Joseph Zenga	name
1959 Wright Way	address
Burbank	city
CA	state
98765	zip
(512) 399-5678	phone

Optionally, you can also enter names for these values. Names are necessary only if you plan to reuse parameters during the session.

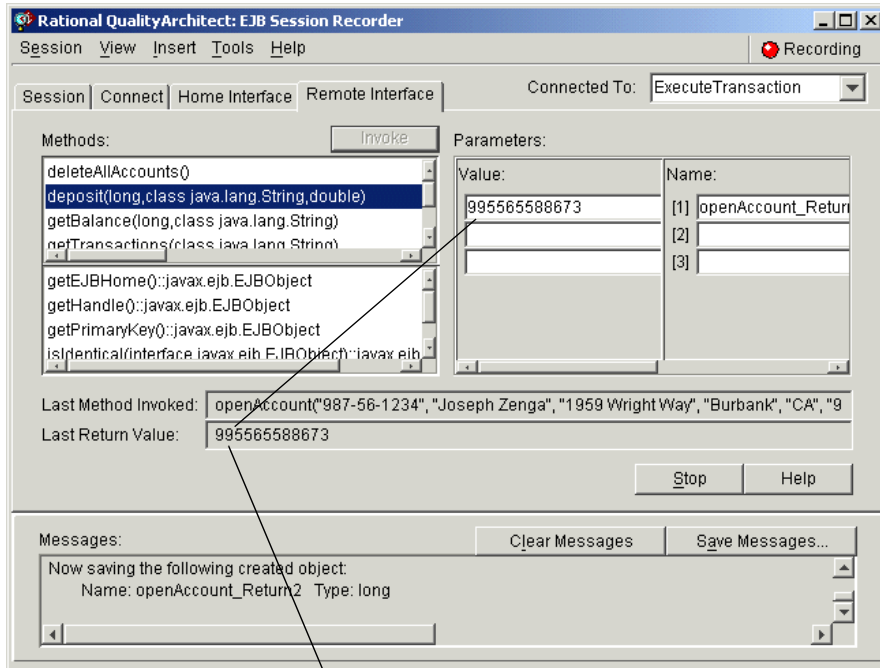
- 3 Click **Invoke**.

This operation returns an account ID in the **Last Return Value** box. The return value for `openAccount` is stored in a named variable called `openAccount_Return`.

Invoking the deposit() Method

To invoke the `deposit()` method:

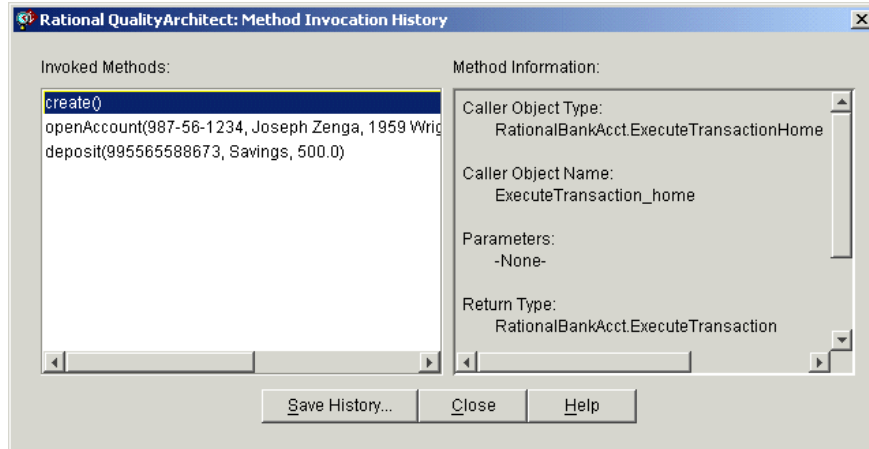
- 1 Click the `deposit()` method from the **Methods** list.
- 2 Click the value displayed in the **Last Return Value** box. Drag and drop the value on to the first **Parameter Value**.



Drag and drop the **Last Return Value** on to the first **Parameter Value**.

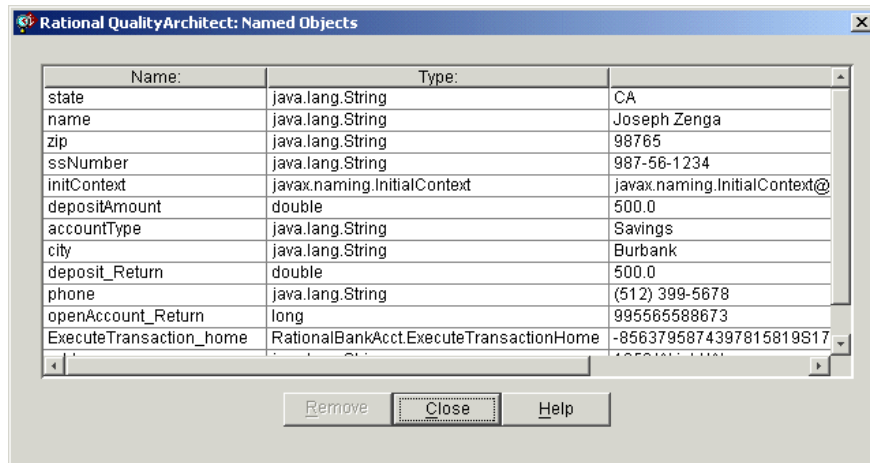
- 3 Type **Savings** for the second **Parameter Value** and then type **accountType** in the **Name** box.
- 4 Type **500** for the third **Parameter Value** and then type **depositAmount** in the **Name** box.
- 5 Click **Invoke** to deposit the specified amount into the account.
- 6 Click **View > Method History** to see a history of the invoked methods.

The history includes methods that are successful, as well as those that have failed to execute.



When you finish viewing the Method History, click **Close**.

- 7 Click **View > Objects** to see a list of the named objects that were created. The named objects are the ones that can be reused during the session.



When you finish viewing the objects, click **Close**.

Invoking the `getBalance()` method

To invoke the `getBalance()` method:

- 1 Click the **`getBalance()`** method from the **Methods** list.
- 2 Right-click the first Value box in the Parameters pane and select `openAccount_Return`.

The `openAccount_Return` object was created automatically when the `openAccount` method was invoked.

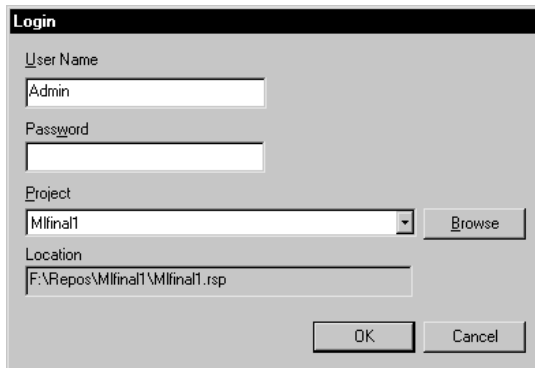
- 3 Right-click the second Value box in the Parameters pane and select **`accountType`**.
- 4 Click **Invoke**.

The current account balance should now appear in the **Last Return Value** box.

Inserting a Verification Point

To insert a verification point:

- 1 Click **Insert > Verification Point**.
- 2 If prompted, log in to a project and click **OK**.



A screenshot of a 'Login' dialog box. It contains the following fields and controls:

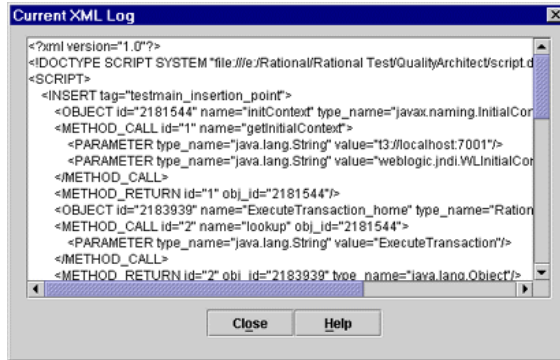
- User Name:** A text input field containing the text 'Admin'.
- Password:** A text input field that is currently empty.
- Project:** A dropdown menu showing 'Mlfinal1' and a 'Browse' button to its right.
- Location:** A text input field containing the path 'F:\Repos\Mlfinal1\Mlfinal1.rsp'.
- Buttons:** 'OK' and 'Cancel' buttons at the bottom.

- 3 When the Select Verification Point Type dialog box appears, select **DatabaseVP**, or another type of verification point that you have implemented.
- 4 Type a name for the Verification Point and click **OK**.
- 5 At this point, the Query Builder wizard starts. Use the Query Builder to connect to the data source and to define a Select statement that can be used to query the database. For more information about the Query Builder, see *Using the Java Query Builder to Add Database Verification Points* on page 72.

Viewing the XML Log

To view the XML log of the current session:

- 1 Click **View > XML Log**.



- 2 When you finish viewing the log, click **Close**.

Generating a Test Script from the XML Log

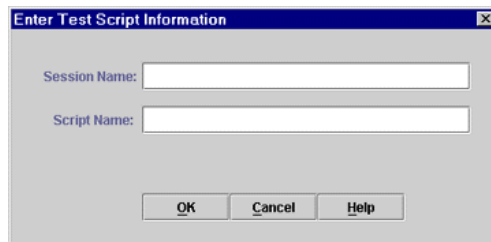
To stop the session and generate a test script:

- 1 Click **Stop**.

You are asked whether or not you want to generate a test script from the XML log.

- 2 Click **Yes** to generate the test script.

Note: If you are not already logged into a project, you are now prompted to log in. Then, you are prompted to enter a Session Name and a Script Name.



- 3 Enter a name for the current session in the **Session Name** box.
- 4 Enter a name for the generated script in the **Script Name Box** and click **OK**.

The script is saved in Test DataStore under recordedtests*<session name>*\<i>scriptname.java</i>.

This section contains the information you need to use Rational QualityArchitect to test COM-based component applications.

Topics include:

- Overview
- Requirements for testing COM components
- Working with the sample model
- Executing test scripts
- Using COM scenario tests to test transactions
- Using the OLE DB Query Builder to add verification points

Overview

With QualityArchitect, you can test COM components after they have been built, or you can test iteratively during the development process.

Testing Existing Objects

To test completed COM components, you can use the type library import tool in Rose. The type library import tool defines the appropriate interfaces, coclasses, and classes and the relationships among them. The structure for each COM object created in the model by the imported type library is the same as the structure created with the Rose ATL (ActiveX Type Library) object creation wizard.

By default, the import tool does not capture the methods on each interface. You can capture the methods afterwards in one of two ways:

- By doing a full import from the Rose Component view
- By doing a full import of selected interfaces from the Logical view

Note: The methods must be imported into the model in order to model method messages in sequence diagrams.

For more information about testing completed COM components, see the topic *Importing Type Libraries Into the Model* in the Rose Help.

Testing with Iterative Development

To test iteratively, you can use the Update Code feature of Rose to create new classes for your component and then round-trip the code that you add to these classes into the model as you develop.

When you are ready to test, you import the type library for your component and then model the transactions in interaction diagrams using the interfaces imported from the type library.

When you change your code, either by updating it from the model or directly, you simply refresh the type library information in the model by re-importing it.

Programming in Visual Basic

When you program in Visual Basic, VB masks the complexity of dealing with interfaces and coclasses. You use the class name both to instantiate objects and to call methods on those objects. VB creates a hidden interface, using your class name preceded by a leading underscore character.

QualityArchitect treats each test script generated for COM as a Visual Basic project. Each project consists of several files, as follows:

- *test.vbp* – The project file. This is what you open in Visual Basic.
- *test.bas* – The main program that calls the test script program in the *.cls* file. Visual Basic requires a main program to begin execution.
- *test.cls* – The actual test script.
- *test.res* – A standard Visual Basic resource file used to store datapool configuration information. This file is required in order to run test scripts from TestManager and can be edited with the Visual Basic 6 resource file editor add-in.

Note: A temporary *test.rc* file is also generated and converted to *test.res* by the resource compiler.

Every time you generate a unit test or a scenario test, QualityArchitect uses templates to produce these files.

Requirements for Testing COM Components

To test COM components with QualityArchitect, you need the following:

- Visual Basic 6.0
- A model that represents your COM interfaces and coclasses

You can obtain this model by importing a type library.

In addition, QualityArchitect must be able to find the Visual Basic resource compiler file, *rc.exe*. QualityArchitect searches for it on the System or User path and then looks in one of the following typical installation locations:

- *<Visual Studio Directory>\Common\MSDev98\Bin*
- *<Visual Studio Directory>\VB98\Wizards*

If QualityArchitect fails to find *rc.exe*, you are prompted to supply the path.

You can also specify the path to *rc.exe* in the Rational QualityArchitect Options dialog box. To do so:

- 1 In Rose, click **Tools > QualityArchitect > Console**.
- 2 Click the **Edit Rational QualityArchitect Options** button.
- 3 Click the **VB Options** tab.
- 4 Specify the location of *rc.exe* in the Resource Compiler text box.

Working with the Sample Model

The installation procedure installs a sample Rose model—*rqacomsample*—that you can use to try out QualityArchitect. This model reflects a traditional transaction processing system that allows users to credit or debit their accounts on a server.

The *rqacomsample* model already contains an imported type library and a component associated with a Visual Basic source project.

Understanding the Component View

The Rose component view shows the physical pieces of software that are included in the model, for example:

- A COM object (RQACOMSample Ver 1.0) that is associated with the imported type library

- An optional ActiveX DLL (RQACOMSample) that is associated with the Visual Basic source project

This DLL is used for round-trip engineering.

Other components, such as Stdole and DAO, are included with COM.

Understanding the Logical View

The Logical View shows the packages, classes, interfaces, and operations in the model, such as:

- RQACOMSample (from COM)

The package that is created when the type library is imported. (In the sample model, the type library has already been imported.) This package contains several COM interfaces—`_Account`, `_UpdateReceipt`, `_GetReceipt`, and `_MoveMoney`.

- RQACOMSample (from Reverse Engineered)

The package containing objects used in round-trip engineering of the source code.

For script generation, QualityArchitect uses the COM package.

Generating COM Test Assets

This section shows you how to generate the test scripts, stubs, datapools, and lookup tables that you need to test COM components with QualityArchitect.

Note: In a model it is possible to have more than one coclass that realizes the same interface. In this case, when you generate a unit test script, QualityArchitect displays a dialog box that prompts you to specify the coclass that you want to use.

Generating COM Unit Test Scripts and Datapools from a Rose Model

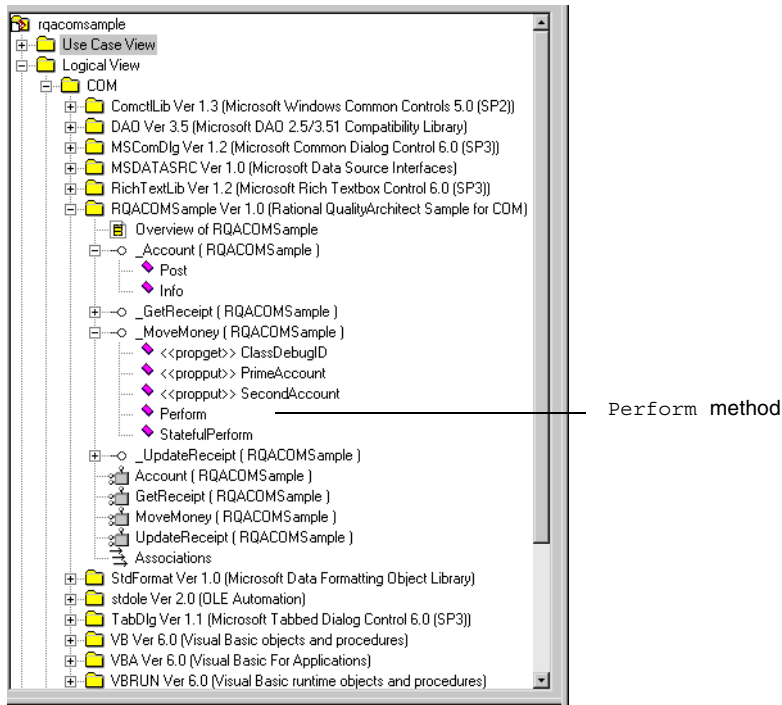
To try out the QualityArchitect unit test generation feature, you can use the `rqacomsample` sample model that is installed with QualityArchitect. For example, you can generate a unit test script for the `Perform` method, which is part of the `_MoveMoney` interface.

To generate the unit test and datapool:

- 1 If you haven't already done so, create a project with Administrator for maintaining your test assets.

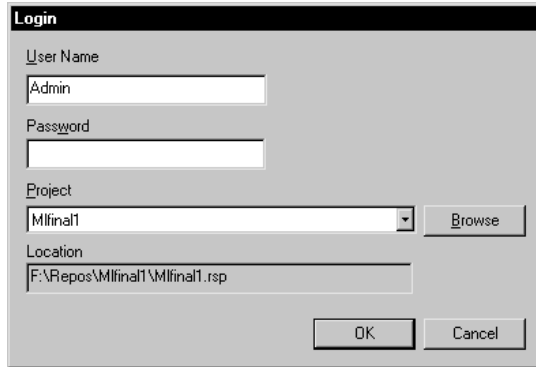
For details, see *Adding a Project* in the Administrator Help.

- 2 Start Rose and open the `rqacompsample.mdl` model.
- 3 Optionally, right-click the `Perform` method and click **QualityArchitect > Select Unit Test Template**.



- 4 Optionally, select the **TestName.vbp** template and click **Open**.
For more information about templates, see *Templates* on page 7.
- 5 In Rose, right-click the `Perform` method again and click **QualityArchitect > Generate Unit Test**.

A message appears, indicating that code generation is in progress, after which you will be prompted to log in to a Rational project.



- 6 Log in to the project and click **OK**.

Each project contains a datastore for storing test assets, such as datapools, lookup tables, and log files.

If this is the first time generating a script for a particular datastore, you are prompted to select a directory in which to store your scripts. QualityArchitect maintains an association between this test script directory and any test assets, such as datapools, that are stored in the project's test datastore. As a result of this association, you can execute your test scripts directly from Rational TestManager.

- 7 Select a directory location and click **OK**.

QualityArchitect creates a directory hierarchy under the location you have chosen and saves several files, as follows:

- MoveMoneyPerform.vbp
- MoveMoneyPerformMain.bas
- Perform.cls
- MoveMoneyPerform.res

The Visual Basic project file that is created (MoveMoneyPerform.vbp) is assigned a name of the format *InterfacenameMethodname*.

Note: You can change the directory location for future test scripts in the VB tab of the RQA Options dialog box.

Populating the Datapool

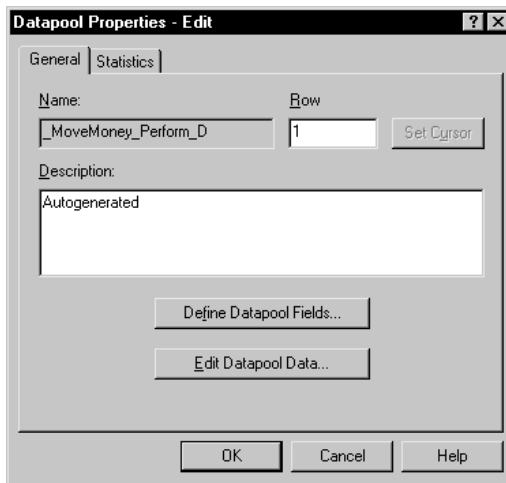
Next, QualityArchitect autogenerated a datapool named `_MoveMoney_Perform_D`, using the parameters in the `Perform` method (`IPrimeAccount`, `ISecondAccount`, `IAmount`, `ITranType`, `expectedReturn`, `expectedError`) for the datapool columns.

(A *datapool* is a set of records that you can use to drive a test script.)

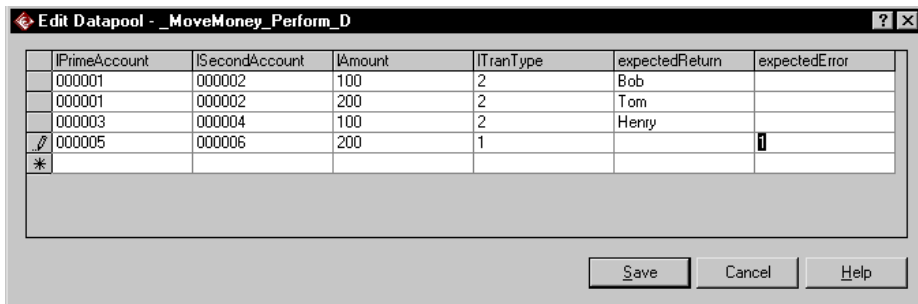
Although QualityArchitect generates the datapool automatically, it is up to you to populate the datapool with records.

To populate the datapool:

- 1 When QualityArchitect asks if you want to edit the datapool that it created, click **Yes** to display the Datapool Properties dialog box.
- 2 In the Datapool Properties dialog box, click **Edit Datapool Data** and populate the datapool with several rows of data.



- 3 Click **Save** and then **Close** when you are finished.



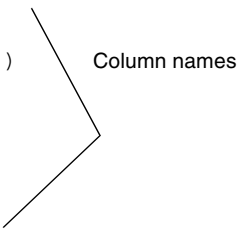
- 4 Click **OK** to close the Datapool Properties dialog box.
- 5 Click **Close** to close the progress bar.

The following code fragment shows the datapool name and the parameter (column) names embedded in the test script:

```

dp.Open "_MoveMoney_Perform_D" ----- Datapool name
'Loop over datapool and perform test.
While dp.Fetch
    'Keep counter of number of rows fetched.
    NumRows = NumRows + 1
    'Get the column data from the datapool.
    lPrimeAccount = dp.Value("lPrimeAccount")
    lSecondAccount = dp.Value("lSecondAccount")
    lAmount = dp.Value("lAmount")
    lTranType = dp.Value("lTranType")
    expRet = dp.Value("expectedReturn")
    expErr = dp.Value("expectedError")

```



Note: For more information about datapools, see *Datapools* on page 23, the *Test Script Services for Visual Basic* manual, and the online Help for Rational TestManager.

Generating Stubs and Lookup Tables for the Unit Test

With QualityArchitect, you can create stubs for any component called by the method-under-test. COM stubs are generated from classes that are stereotyped as coclasses.

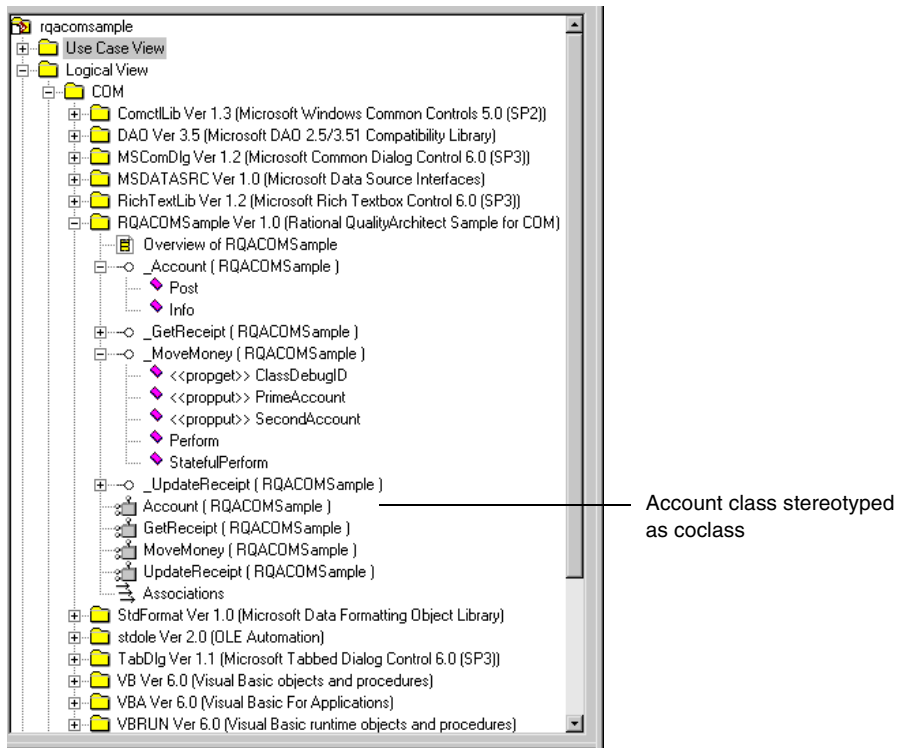
When you generate stubs, QualityArchitect creates Visual Basic class files that you can copy into your Visual Basic project and use in place of actual components. Simply replace the actual component with the stub and recompile the project.

Stub generation also creates a lookup table for each method in the stub called by the method-under-test. Lookup tables are based on Rational datapool technology. Whereas a datapool is used to test inputs and expected behavior, a lookup table is used with stubs to simulate the behavior of an actual component.

Because the MoveMoney method calls methods in the Account class, you can either generate a stub or run the tests directly against the actual Account class.

To generate the stubs:

- 1 In the Rose browser, right-click the **Account** class that is stereotyped as coclass and click **QualityArchitect > Generate Stub**.



- 2 Select a directory for storing the stubs.
- 3 Click **OK**.

QualityArchitect creates a Visual Basic class file for the `Account` class and also creates a lookup table for each method in the stub called by the method-under-test (in this case, the `Post` and `Info` methods). It then asks you if you want to edit the newly-created lookup tables.

Populating the Lookup Tables

To populate the lookup tables:

- 1 When QualityArchitect asks if you want to edit the lookup tables that it created, click **Yes**.
- 2 Select the lookup table to edit, for example, `_Account_Post_L`, and click **Edit** to display the Datapool Properties dialog box.

- 3 In the Datapool Properties dialog box, click **Edit Datapool Data** and populate the lookup table with several rows of data, for example:

IAccountNo	IAmount	expectedReturn	expected Error
<i>Generated ID 1</i>	<i>amount of Post</i>		
<i>incorrect AccountNo</i>			1003

- 4 Click **Save** and then **Close** when you are finished.
- 5 Click **OK** to close the Datapool Properties dialog box.
- 6 If necessary, click **Close** to close the Manage Datapools dialog box.

Recompiling with the Stub

After populating the lookup tables:

- 1 Make a copy of the `Account` class.
- 2 Replace the real `Account` class in the `RQACOMSample` application with the stubbed version.
- 3 Add a reference to “Rational QualityArchitect Playback Type Library” in the `RQACOMSample` project in Visual Basic.
- 4 Comment out any lines in the code for complex objects.
- 5 Recompile `RQACOMSample`.

Note: Stubs must be deployed on the same computer as the test script.

For a high-level overview of stubs, see *Stubs* on page 18.

Executing Test Scripts

To execute your test script in Visual Basic:

- 1 Open the Visual Basic project file.
- 2 Edit the test script (the `.cls` file) as needed.
- 3 Click **Run > Start with Full Compile**.

You can also execute test scripts from TestManager. Before doing so, be sure that Visual Basic 6.x is included on your system path.

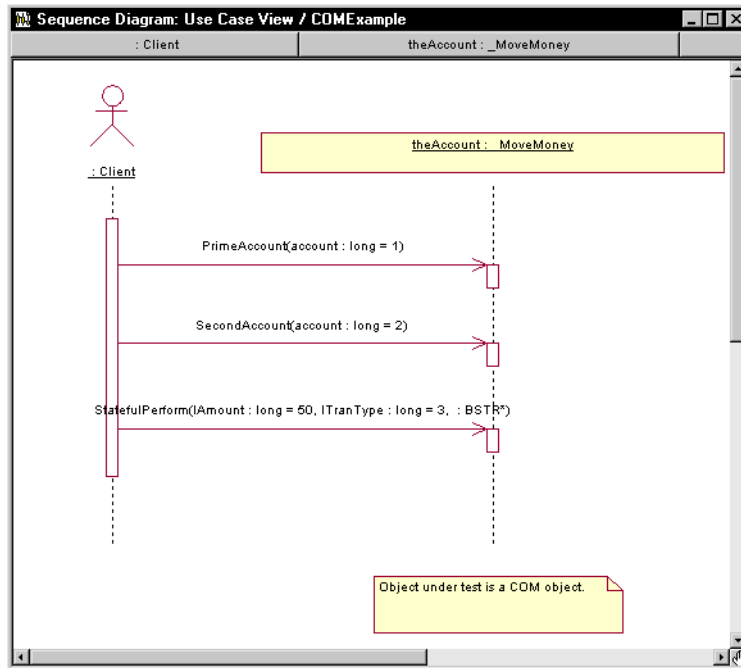
To execute your test script in TestManager:

- 1 Start TestManager.
- 2 Click **File > Run Test Script > RQA VB Scripts**.
- 3 Select the script and click **Open**.
- 4 From the Run Script dialog box, click **OK**.

Note: If your scripts contain verification points, the baseline must be captured outside TestManager by running the script once from the IDE or from command line. TestManager assumes that the baselines already exists. If this is not done, the script run will fail. For further information about baselines and verification points, see *Verification Points* on page 25.

Using COM Scenario Tests to Test Transactions

Scenario tests use Rose interaction diagrams to test transactions. To try out this feature, you can generate a scenario test for the COMExample sequence diagram (see the following figure) that is included in the rqaconsample model.



When you generate a scenario test, QualityArchitect prompts you to insert a verification point for each message in your interaction diagram.

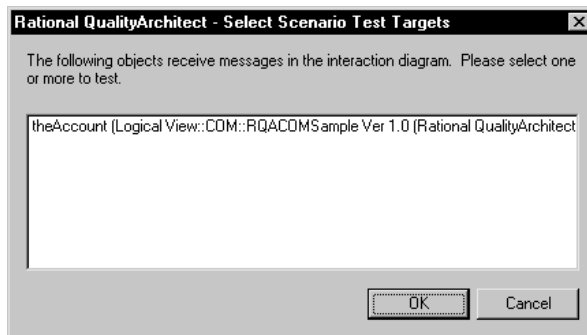
To generate a scenario test:

- 1 Open the COMExample sequence diagram in Rose.
- 2 Right-click in the diagram and click **QualityArchitect > Select Scenario Test Template**.
- 3 Verify that com_scenario_script_template appears in the File Name box, and then click **Open**.

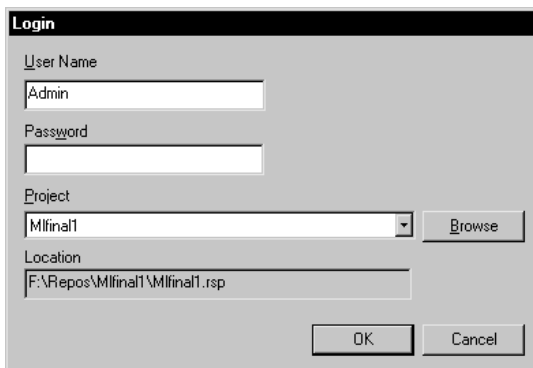
This template resides in the QualityArchitect\Templates\Scenario Test Templates\COM VB directory.

- 4 Right-click in the interaction diagram and click **QualityArchitect > Generate Scenario Test**.
- 5 In the Select Scenario Test Targets dialog box, select the scenario test targets—that is, the objects you want to test—and click **OK**.

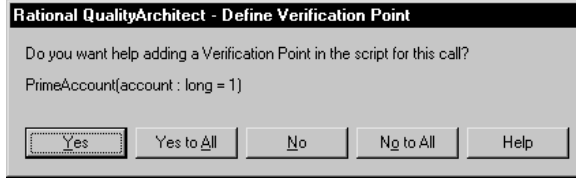
You can select one or more objects to test.



- 6 If prompted, log in to a project and click **OK**.

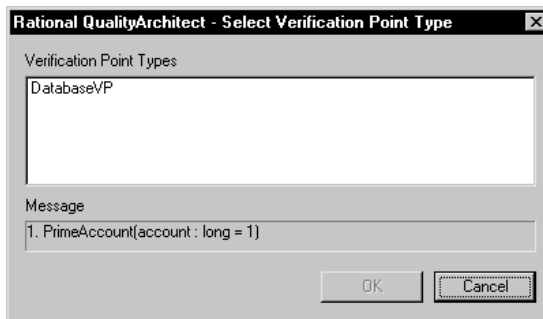


- 7 In the Define Verification Points dialog box, click **Yes** to add a verification point for the first message in the diagram—getBalance.



- 8 In the Select Verification Point Type dialog box, select a verification point type and click **OK**.

For this release, select the database verification point type—DatabaseVP.

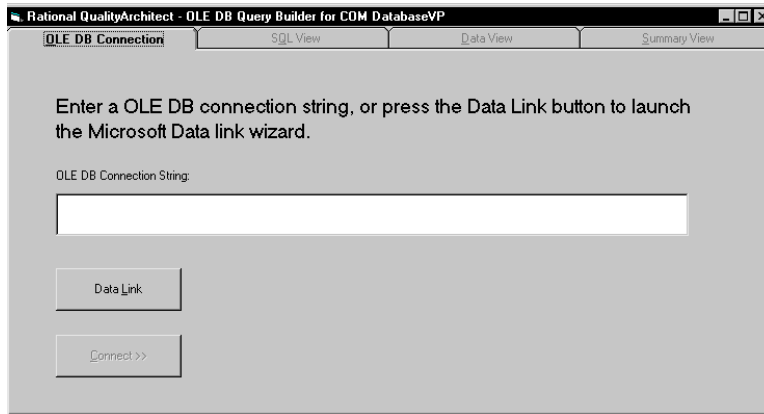


- 9 At this point, the OLE DB Query Builder wizard starts. Use the Query Builder to connect to the database and to define a Select statement that can be used as a query. For more information about the Query Builder, see *Using the OLE DB Query Builder to Add Database Verification Points* on page 112.
- 10 Repeat Steps 8 and 9 for each message in the diagram.
- 11 After the last message, you are prompted to add a verification point at the end of the scenario. Click **Yes**.
- 12 Select a directory to store the tests in and click **OK**.

Note: You can also start the scenario test generator by right-clicking on a diagram in the Rose browser and then clicking **QualityArchitect > Generate Scenario Test**.

Using the OLE DB Query Builder to Add Database Verification Points

The OLE DB Query Builder is a tool that helps you connect to and interact with databases for the purpose of defining database verification points.



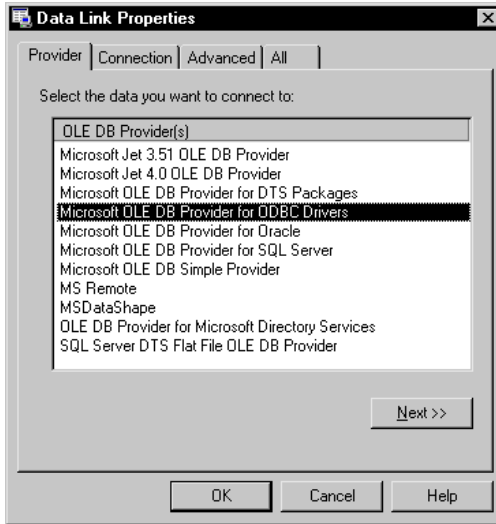
Connecting to the Database via OLE DB

The first step involved in building a custom SQL query is to enter an OLE DB connection string, which allows you to connect to a database.

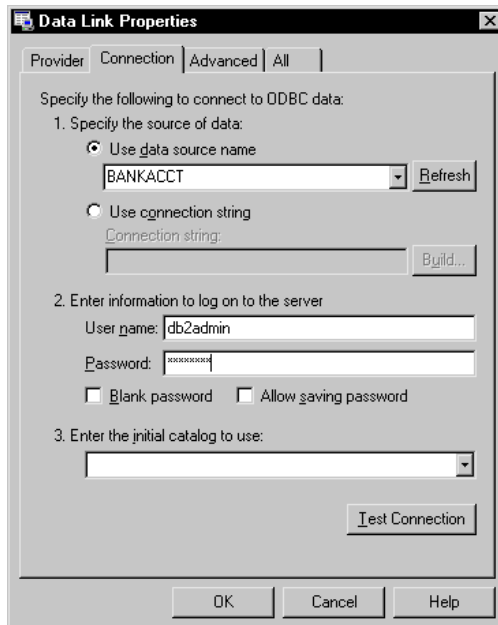
When the OLE DB Query Builder starts, you can either type the connection string manually or click the **Data Link** button to display the Data Link Properties wizard, a graphical user interface that assists you in building the connection string.

To use the Data Link Properties wizard:

- 1 Click the **Data Link** button to display the Provider page of the Data Link Properties wizard. (Click **Help** at any point to view online Help for the wizard.)
- 2 On the Provider page, select the appropriate OLE DB provider and click **Next**.



- 3 On the Connection page, select a data source name and enter a user name and password, if these are required to log in to the server.



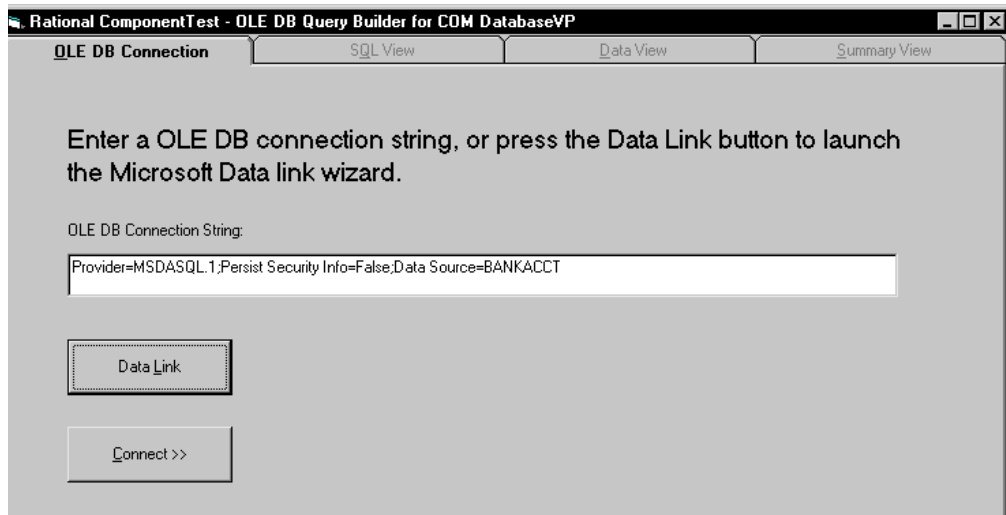
- 4 Also, on the Connection page, check **Allow Saving Password** to allow the password to be included in the connection string.

Note: If saved, the password is not encrypted.

- 5 Click **Test Connection**.

In most cases, it should not be necessary to change any of the default settings on the **Advanced** or **All** pages. Click the **Help** button for details.

- 6 Click **OK** to save the OLE DB Connection String and redisplay the Query Builder.



- 7 Click **Connect** to connect to the database.

Designing a Custom SQL Statement

After you connect to the database, you can design the custom SQL query statement to be used to retrieve specific data from the database.

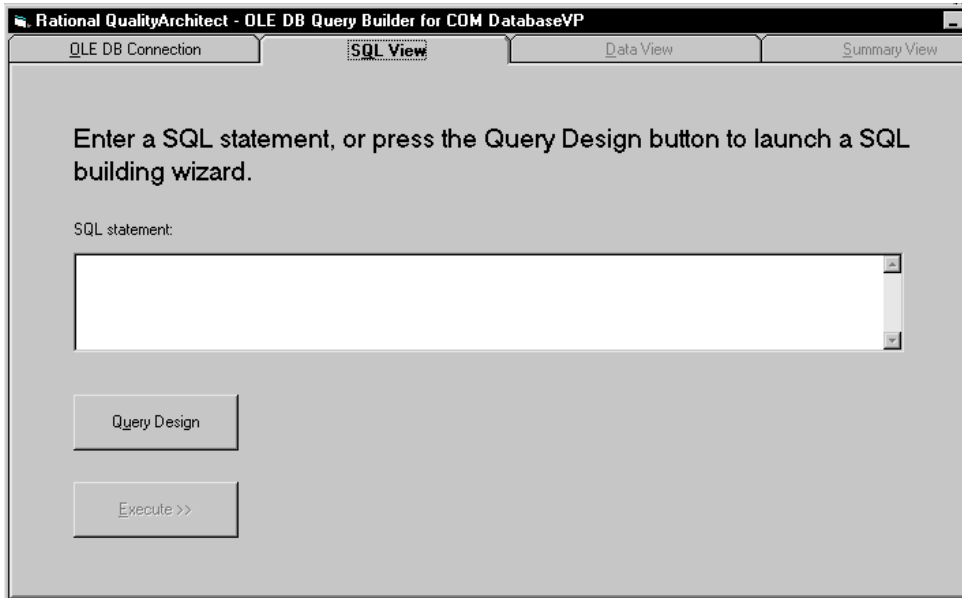
If you are familiar with SQL syntax and are familiar with the schema of the database you are connecting to, you can simply enter your custom SQL query statement in the SQL text box.

Using the Query Design Wizard

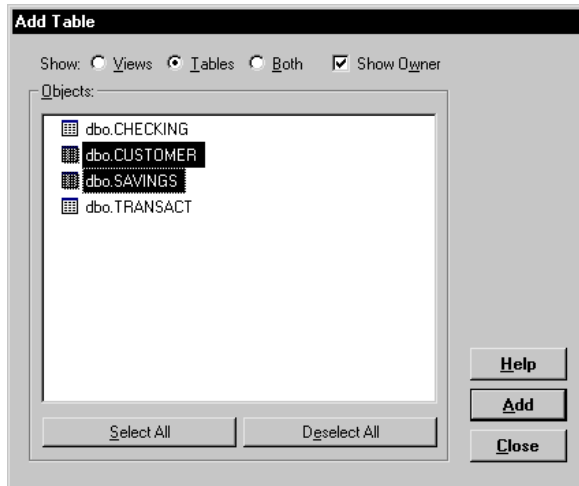
Alternatively, you can use the Query Design wizard to interactively walk you through the design of your custom SQL query statement. The Query Design wizard helps you easily create complex SQL query statements by taking you step-by-step through the design process.

To use the Query Design wizard:

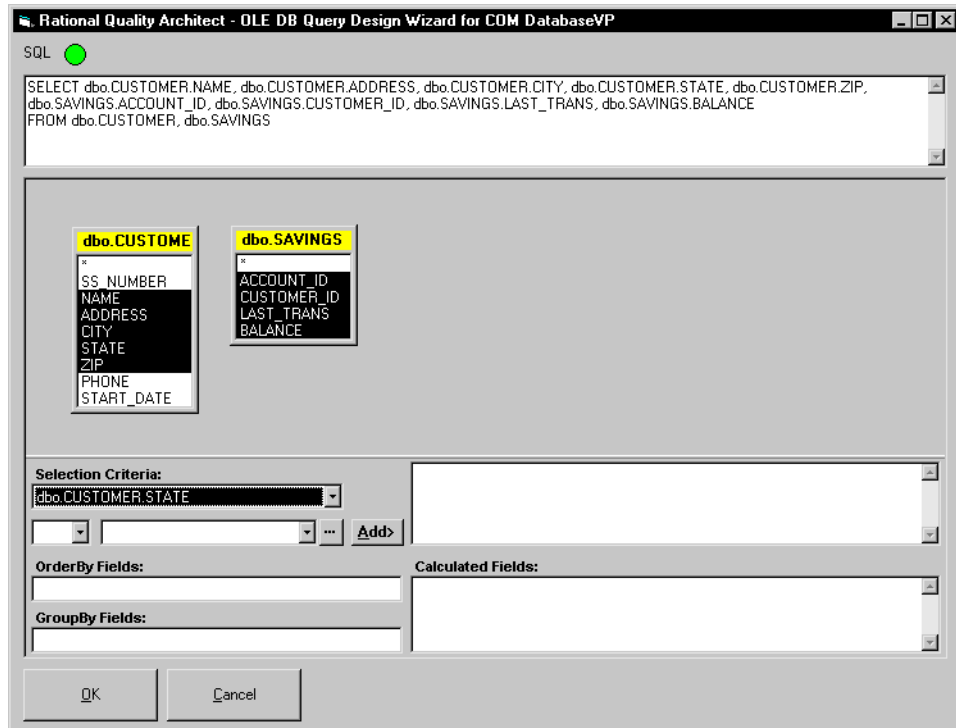
- 1 Click the **Query Design** button.



- 2 Select the tables you want to query and click **Add**.



3 Select the columns to include in the result set.



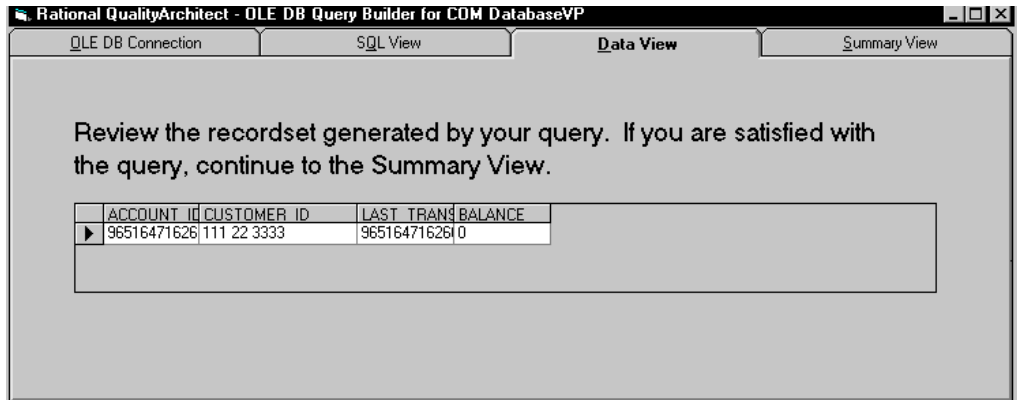
Column names are listed in *TableName.ColumnName* format so that you can easily identify the columns in each table.

- 4 Enter selection criteria that will restrict the returned query results (optional).
- 5 Enter a sort order in the **OrderBy Fields** box (optional).
- 6 Enter a GroupBy order in the **GroupBy Fields** box (optional).
- 7 Enter any calculated fields.
- 8 Click **OK**.
- 9 Verify the SQL statement, make any edits as needed, and click **Execute**.

Note: The round SQL button turns green if the SQL statement is syntactically correct. Otherwise, the button turns red.

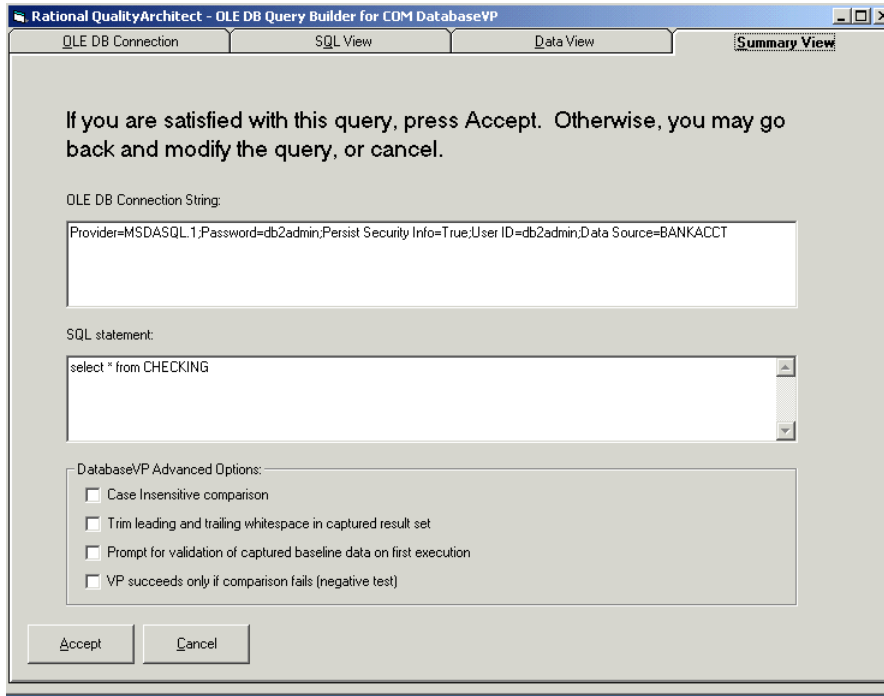
Reviewing the Record Set

The next step in building the query is to review the record set returned by the SQL statement. If you are satisfied with the results, click the **Summary View** tab. Otherwise, click the **SQL View** tab and redesign the query.



Accepting the Query

The Summary View shows the OLE DB Connection String and the SQL statement that you have created. Click **Accept** to generate the query and complete the verification point.



DatabaseVP Advanced Options

The Summary View also includes a number of advanced options that you can set for the database verification point. These options include:

Option	Description
Case Insensitive comparison	Specifies that the verification should be case insensitive. By default, text comparisons are case sensitive.
Trim leading and trailing whitespace in captured result set	Specifies that captured values should have whitespace trimmed from the right and left sides
Prompt for validation of captured baseline data on first execution	Specifies that the first run of a static verification point should display the captured data for the tester to validate before storing it as the expected (baseline) data object.
VP succeeds only if comparison fails (negative test)	Specifies that the verification point's expected result is failure. If the comparison fails and this option is set, the verification point succeeds.

Template Replacement Variables

A

This section describes the replacement variables that are used in the various templates used by QualityArchitect. The code generators supplied with QualityArchitect replace the variables in the templates with real code and data derived from Rose model elements.

These replacement variables can be logically grouped into the following general categories:

- Replacement variables for unit test generation templates
- Replacement variables for scenario test generation templates
- Replacement variables for stub generation templates

Replacement Variables for Unit Test Generation Templates

The replacement variables for the unit test generation templates can be logically divided into the following categories:

- Variables used in all languages
- Variables used only in Visual Basic and COM
- Variables used only with Enterprise JavaBeans (EJBs)

For a list of the unit test generation templates, see *Templates* on page 7.

Variables Used in All Unit Test Generation Templates

The following table lists the replacement variables that are used in all of the unit test generation templates:

Variable	Description and Example
<generation_date>	Shows when the script was generated. <generation_date> in the template becomes Date: 9/19/00 2:56:32 PM in the script.
<root_package>	Root directory location for all generated unit test scripts. The <root-package> is always unittests. <root_package> in the template becomes unittests in the script.
<author_name>	Login ID supplied when you connect to a test datastore project.
<package_name>	The package hierarchy in the Rose model, excluding the class and the top-level package name. For example, the Rose Item Fully Qualified Name := Logical View::COM::MyComponent::MyClass::MyOperationUnderTest" TestName := MyClassMyOperationUnderTest tms.StartTestServices "<root_package>\<package_name>\<test_name>" becomes unittests\COM\MyComponent\MyClassMyOperationUnderTest" in the script.
<operation_name>	The name of the operation selected for generation. Class=<operation_name>; TestNameScript.cls becomes Class=MyOperationUnderTest; TestNameScript in the script.
<class_name>	The name of the class selected for generation. Template: <class_name> Script: MyInterface
<test_name>	The name of the test script, calculated as follows: ClassNameOperationName QualityArchitect may modify <test_name> to conform to the target generation language. Example: ClassName := "_Account", OperationName := "Post", Language := "VB" Before: ExeName32="<test_name>.exe" After: ExeName32="AccountPost.exe" Note: In VB an object name cannot begin with "_" character, so the "_" is removed at generation time.

Variable	Description and Example
<datapool_name>	<p>The name of the datapool, calculated as follows: ClassName_OperationName_CTD_DATAPOOL</p> <p>The DataStore understands that datapool names are limited to 40 characters, so it takes two parameters and tries to figure out the best name, such as "ClassNameOperationName", that fits within the 40 character limit. CTD_DATAPOOL causes "_D" to be appended to the end of the name and CTD_LOOKUPTABLE causes "_L" to be appended to the end of the name.</p> <p>Example: ClassName := "_Account", OperationName := "Post", Language := "VB" Before: dp.Open("<datapool_name>") After: dp.Open("_Account_Post_D")</p>
<index>	<p>Unique index, calculated as follows: ScriptSource\PackagePath\TestName</p> <p>CTD_SCRIPTTYPE_VB - Uses the "RQA VB Test Scripts" script source for the index calculation. CTD_SCRIPTTYPE_JAVA - Uses the "RQA Java Test Scripts" script source for the index calculation.</p> <p>Example: TestName := "AccountPost", PackagePath := "unittests\COM\MyComponent", ScriptType := CTD_SCRIPTTYPE_VB</p> <p>If no files exist with the name <ScriptSourceDirectory>\<PackagePath>\TestName Before: ExeName32="<test_name><index>.exe" After: ExeName32="AccountPost.exe"</p> <p>If <ScriptSourceDirectory>\<PackagePath>\AccountPost.vbp exists Before: ExeName32="<test_name><index>.exe" After: ExeName32="AccountPost1.exe"</p>

Variable	Description and Example
<check_expected_result>	<p>The code generated here depends on the target language for generation and the return value of the operation. If the operation return type is void, or if VB is marked as a "Sub", then the actual code that is inserted is as follows:</p> <pre> If (operation does NOT have a return value) Then <check_expected_result> := 'Log message indicating success. Else <check_expected_result> := 'If statement to compare the expected return with the actual return for equivalence. 'If equal, then log success, otherwise log error. </pre>
<method_declaration>	<p>The code that is generated here depends on the target language for generation and the operation that is selected. The result is a string that can be used to declare a method. No newline characters are added to this variable.</p>
<parameter_declarations>	<p>The code that is generated here depends on the target language for generation and the operation that is selected. The result is a string that can be used to declare all of the variables that will be used as arguments to the operation that has been selected for generation. Newline characters are added to this string so that each variable is declared on a new line.</p>
<parameter_initialization>	<p>The code that is generated here depends on the target language for generation and the operation that is selected. The result is a string that can be used to initialize all of the variables that are declared in <parameter_declarations> to be values from a datapool. Each parameter type is checked to see if it can be driven using a datapool value. If not, a comment is inserted in place of the datapool assignment.</p>
<return_val>	<p>The code that is generated here depends on the target language for generation and the operation that is selected. The result is an empty string if the operation does NOT return a value, or "actRet = " if it does.</p>

Variable	Description and Example
<operation_arglist>	<p>The code that is generated here depends on the target language for generation and the operation that is selected. The result is a string that can be used in the function invocations string.</p> <p>Example</p> <pre> TestClass::TestShort(ByVal Arg1 As Integer, ByRef Arg2 As Integer) As Integer Before: Dim tc As TestClass Dim actRet As Integer <parameter_declarations> ' Invoke: <method_declaration> of TestClass <return_value> tc.<operation_name> (<operation_arglist>) After: Dim tc As TestClass Dim actRet As Integer Dim arg1 As Integer Dim arg2 As Integer ' Invoke: TestShort(ByVal Arg1 As Integer, ByRef Arg2 As Integer) As Integer of TestClass actRet = tc.TestShort (arg1,arg2) </pre>

Variables Used Only with the COM/Visual Basic Templates

The following table lists the replacement variables that are used only with the COM/VB unit test generation templates:

Variable	Description and Example
<interface_name>	<p>Interface name of the operation selected for generation.</p> <p>Example: Rose Item Fully Qualified Name := "Logical View::COM::MyComponent::_MyInterface::MyOperationUnderTest"</p> <p>Before: <Interface_name> After: _MyInteface</p> <p>Note: Same as <class_name> for VB scripts generated from COM interfaces.</p>
<library_name>	<p>Library name that contains the class that is implementing this operation, calculated as:</p> <pre>Dim rsModule As RoseModule rsModule = cls.GetAssigendModules(1) Dim rsProp As RoseProperty rsProp = rsModule.FindProperty("COM", "library") <library_name> = rsProp.Value</pre> <p>Example: Rose Item Fully Qualified Name := "Component View::COM::MyComponent"</p> <p>Before: Set obj = CreateObject("<library_name>.Foo") After: Set obj = CreateObject("MyComponent.Foo")</p>
<coclass_name>	<p>CoClass that implements the interface that the operation belongs to. If more than one coclass implements the interface, the user is prompted to choose a CoClass.</p> <p>Example: Rose Operation := "Logical View::COM::MyComponent::_Account::Post" Rose Interface := "Logical View::COM::MyComponent::_Account" Rose CoClass := "Logical View::COM::MyComponent::Account"</p> <p>Before: Set obj = CreateObject("MyComponent.<coclass_name>") After: Set obj = CreateObject("MyComponent.Account")</p>

Variable	Description and Example
<coclass_guid>	<p>CoClass GUID that implements the interface that the operation belongs to. If more than one coclass implements the interface, the user is allowed to select the coclass to use.</p> <p>Example: Rose Operation := "Logical View::COM::MyComponent::_Account::Post" Rose Interface := "Logical View::COM::MyComponent::_Account" Rose CoClass := "Logical View::COM::MyComponent::Account"</p> <p>Before: Set obj = createObject(<coclass_guid>) After: Set obj = createObject(87DD307A-01DD-42BD-997D-967E5CBB3281)</p>
<coclass_progid>	<p>Coclass_progid, or programmatic identifier, is a registry entry that is associated with a CLSID. Like the CLSID, the coclass_progid identifies a class, but with less precision.</p> <p>Example: Rose Operation := "Logical View::COM::MyComponent::_Account::Post" Rose Interface := "Logical View::COM::MyComponent::_Account" Rose CoClass := "Logical View::COM::MyComponent::Account"</p> <p>Before: Set obj = CreateObject("<prog_id>") After: Set obj = CreateObject("MyComponent.Account")</p>
<project_reference>	<p>Project reference allows you to add an object or type library or project references to your project. This makes another application's objects available in your code. Once a reference is set, the referenced objects are displayed in the Object Browser.</p> <p>Before: <project_reference> After: Reference=*\\G{F6E99F53-33E7-4478-A5F7-E2801010E673}#1.0#0#RQACOMSample.dll#Rational Quality Architect Sample for COM</p>

Variables Used Only with the EJB Templates

The following table lists the replacement variables that are used only with the EJB unit test generation templates:

Variable	Description and Example
<remote_interface_name>	<p>Name of the EJB Remote Interface</p> <p>Rose Item Fully Qualified Name := Logical View::RationalBankAcct::Checking::getBalance</p> <p>Before: Object o = initContext.lookup("<remote_interface_name>"); After: Object o = initContext.lookup("Checking");</p>

Variable	Description and Example
<home_interface_name>	<p>Name of the EJB Home Interface Rose Item Fully Qualified Name := Logical View::RationalBankAcct::CheckingHome::create</p> <p>Before: <home_interface_name> home = (<home_interface_name>) PortableRemoteObject.narrow(o, <home_interface_name>.class); After: CheckingHome home = (CheckingHome) PortableRemoteObject.narrow(o, CheckingHome.class);</p>
<primary_key_class_name>	<p>Name of the EJB Primary Key class Rose Item Fully Qualified Name := Logical View::RationalBankAcct::CheckingKey</p> <p>Before: <primary_key_class_name> key = new <primary_key_class_name>(<key_params>); After: CheckingKey key = new CheckingKey(<key_params>)</p>
<createparam_declaration>	<p>String that declares all of the parameters for the EJB Home Interface Create method that is associated with the operation's class selected for generation.</p> <p>Example: Before: // Declare arguments to the create method <createparam_declaration> After: // Declare arguments to the create method long accountID = 0; String customerID = null; long lastTrans = 0; java.math.BigDecimal openBalance = null;</p>
<createparam_init>	<p>String that will initialize all of the create parameters for the EJB Home Interface Create method using a datapool initialization.</p> <p>Before: // Declare arguments to the create method <createparam_declaration></p> <p>After: Initialize arguments for the create method AccountID = dp.value("accountID").longValue(); customerID = dp.value("customerID").toString(); lastTrans = dp.value("lastTrans").longValue(); openBalance = dp.value("openBalance").getBigDecimal();</p>

Variable	Description and Example
<create_params>	String that can be used as an arglist for the create method invocation. Before: Invoke the create method. <remote_interface_name> remote = home.create(<create_params>); After: Invoke the create method. Checking remote = home.create(accountID, customerID, lastTrans, openBalance);
<keyvalue_declaration>	Same as <createparam_declaration> but for the Key class constructor method that is associated with the operation class selected for generation.
<keyvalue_init>	Same as for the <createparam_init> but for the key class constructor's parameters.
<key_params>	Same as for the <create_params> but for the key class constructor's parameters.
<datapool_init>	Same as the <parameter_initialization> that is indicated above for COM/VB. This is provided only for EJB and NOT for COM, whereas <parameter_initialization> is provided for both.

Replacement Variables for Scenario Test Generation Templates

The replacement variables for the scenario test generation templates can be logically divided into the following categories:

- Variables used in both the COM/VB and EJB templates
- Variables used only in the COM/VB templates
- Variables used only in the EJB templates

For a list of the scenario test generation templates, see *Templates for Scenario Test Generation* on page 13.

Variables Used in Both the COM/VB and EJB Templates

The following table lists the replacement variables that are used in both COM/VB and EJB templates for scenario test generation:

Variable	Description	Template
<DIAGRAM_NAME>	Rose diagram name	Com_scenario_project Com_scenario_basmain Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario
<QUALIFIED_DIAGRAM_NAME>	Fully-qualified diagram name including the package hierarchy containing the diagram. Example: Use Case View::MyPackage::MyDiagram The template processor typically removes embedded blanks and changes the double-colons to either backslashes, "\", or periods, ".", depending on the usage (Java package or file path).	Com_scenario_basmain Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario
<AUTHOR_NAME>	Login ID supplied when you connect to a test datastore project.	Com_scenario_basmain Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario
<GENERATION_DATE>	System time	Com_scenario_basmain Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario
<DATAPOOL_NAME>	System assigned name of a datapool for the diagram.	Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario
<VARIABLE_INITIALIZATIONS>	Generated code for initializing script program variables used in datapools and as parameters in operations.	Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario

Variable	Description	Template
<OPERATIONS>	Generated code to call all of the operations implied by the user's selection of test targets.	Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario
<RETURN_VARIABLE>	If the operation returns a value, then this is a variable name generated by concatenating "retval_" with the Operation Name. May or may not be present in generated code.	Com_scenario_operation Scenario_java_method1
<CLASS_NAME>	Name of the Rose interface class.	Com_scenario_constructor Com_scenario_operation Scenario_java_method1 Scenario_java_method2 Weblogic_scenario_constructor Websphere_scenario_constructor sunj2ee_scenario_constructor
<VERIFICATION>	Generated code for handing a verification point inserted at the user's option by the code generator.	Com_scenario_operation Com_scenario_script Scenario_java_method1 Scenario_java_method2 Weblogic_scenario Websphere_scenario sunj2ee_scenario
<DIAGRAM_NAME>	Rose diagram name	Com_scenario_project Com_scenario_basmain Com_scenario_script Weblogic_scenario Websphere_scenario sunj2ee_scenario
<QUALIFIED_DIAGRAM_NAME>	Fully-qualified diagram name including the package hierarchy containing the diagram. Example: Use Case View::MyPackage::MyDiagram The template processor typically removes embedded blanks and changes the double-colons to either backslashes, "\", or periods, ".", depending on the usage (Java package or file path).	Com_scenario_basmain Com_scenario_script Weblogic_scenario Websphere_scenario Sunj2ee_scenario

Variables Used Only in the COM/VB Scenario Test Templates

The following table lists the replacement variables that are used only in the COM/VB templates for scenario test generation:

Variable	Description	Template
<VARIABLE_DECLARATIONS>	Generated code for declaring script program variables used in datapools and as parameters in operations.	Com_scenario_script
<SCRIPT_DIRECTORY>	The directory path where this script lives, relative to directory "root" where RQA scripts are stored. Example: \scenariotests\ratlbankacct\usecaseview	Com_scenario_script
<MODEL_NAME>	The name of the model with the file path and file extension removed. For example, given "C:\TEMP\mymodel.mdl", the <MODEL_NAME> is "mymodel".	Com_scenario_basmain
<INDEX>	If used, this is a monotonically increasing integer used to uniquely identify instances of like-named things. Typically not used in code generated for scenarios.	Com_scenario_basmain
<OPERATION_NAME>	Name of an operation. This corresponds to the Rose operation name.	Com_scenario_operation
<OPERATION_ARGLIST>	The argument list for an operation. Derived from the Rose parameters collection associated with an operation.	Com_scenario_operation
<COCLASS_NAME>	Name of the coclass implementing the Interface object referenced in the diagram.	Com_scenario_constructor
<COCLASS_GUID>	CoClass GUID that implements the interface that the operation belongs to. If more than one coclass implements the interface, the user is allowed to select the coclass to use.	Com_scenario_constructor

Variable	Description	Template
<COCLASS_PROGID>	Coclass_progID, or programmatic identifier, is a registry entry that is associated with a CLSID. Like the CLSID, the coclass_progID identifies a class, but with less precision. Example: Rose Operation := "Logical View::COM::MyComponent::_Account::Post" Rose Interface := "Logical View::COM::MyComponent::_Account" Rose CoClass := "Logical View::COM::MyComponent::Account" Before: Set obj = CreateObject("<prog_id>") After: Set obj = CreateObject("MyComponent.Account")	Com_scenario_constructor
<LIBRARY_NAME>	Name of the COM Library associated with the Rose Interface Class associated with the operation.	Com_scenario_constructor
<OBJECT_NAME>	Variable that gets populated with the name of the object instance (target object) in the interaction diagram. If the name of the target object is not present (it is not required), then the variable is populated with a concatenation of the COM library name and the coclass name.	Com_scenario_constructor

Variables Used Only in the EJB Scenario Test Templates

The following table lists the replacement variables that are used only in the EJB templates for scenario test generation:

Variable	Description	Templates Used In
<OPERATION_SIGNATURE>	In Java/EJB this is the entire signature of an operation call including the concatenation of the operation name and its argument list.	Scenario_java_method1 Scenario_java_method2
<HOME_INTERFACE_NAME>	The name of the home interface.	Weblogic_scenario_constructor Websphere_scenario_constructor sunj2ee_scenario_constructor

Replacement Variables for Stub Generation Templates

The replacement variables for the stub generation templates can be logically divided into the following categories:

- Variables used only in Visual Basic and COM
- Variables used only with Enterprise JavaBeans (EJBs)

For a list of the stub generation templates, see *Templates for Stub Generation* on page 21.

Replacement Variables for the COM/VB Stub Templates

The following table lists the replacement variables that are used in the COM/VB templates for stub generation:

Variable	Description	Template
<<!VBClassName!>>	Class name for the stub. Example: Account	VBCOMClass FunctionBody PropertyGetBody PropertyLetBody SubBody.template
<<!ImplementsBlock!>>	Adds code to the top of the CLS file listing the interfaces implemented by the coclass.	VBCOMClass
<<!MethodBodyTemplate!>>	Causes the stub generator to use one of the seven method body templates to generate the declaration and definition for each public method in the stub. For more information, see <i>Templates for Stub Generation</i> on page 21.	VBCOMClass
<<!Modifier!>>	Access modifier for the method. Will evaluate to either "Public" or "Private."	FunctionBody FunctionBodyWith outLookUp PropertyGetBody PropertyGetBodyW ithoutLookUp PropertyLetBody SubBody SubBodyWithoutLo okUp

Variable	Description	Template
<<!MethodName!>>	Name of the method. Example: Post	FunctionBody FunctionBodyWith outLookUp PropertyGetBody PropertyGetBodyW ithoutLookUp PropertyLetBody SubBody SubBodyWithoutLo okUp
<<!ParameterDeclarations!>>	Comma-separated list of parameter types and names to be included as part of the method declaration. Example: ByVal lAccountNo As Long, ByVal lAmount As Long	FunctionBody PropertyGetBody PropertyLetBody SubBody
<<!ReturnType!>>	Return type for the method. Example: String	FunctionBody FunctionBodyWith outLookUp PropertyGetBody PropertyGetBodyW ithoutLookUp
<<!ParameterNamesAsStrings!>>	Comma-separated list of parameter names as strings. Example: "lAccountNo", "lAmount"	FunctionBody PropertyGetBody PropertyLetBody SubBody
<<!ParameterNames!>>	Comma-separated list of parameter names. Example: lAccountNo, lAmount	FunctionBody PropertyGetBody PropertyLetBody SubBody
<<!ParameterValuesAsStrings!>>	Comma-separated list of parameter values converted to strings. Example: "CStr(lAccountNo), CStr(lAmount)" NOTE: For complex data types such as arrays, the generated code will need to be modified to compile and work.	FunctionBody PropertyGetBody PropertyLetBody SubBody
<<!LookupTableName!>>	Name of the lookup table to be used for the method. Example: _Account_Post_L	FunctionBody PropertyGetBody PropertyLetBody SubBody

Variable	Description	Template
<<!ParameterValuesAsSumofStrings!>>	Parameter values converted to String and concatenated. NOTE: For complex data types such as arrays, the generated code will need to be modified to compile and work. Example: CStr(lAccountNo) + ", " + CStr(lAmount)	FunctionBody PropertyGetBody PropertyLetBody SubBody
<<!ReasonForNoLookupCodeGeneration!>>	Describes why lookup code was not generated. Example: This Method does not have parameters. Lookup code cannot be generated. Insert code here to add logic.	FunctionBodyWithoutLookup PropertyGetBodyWithoutLookup SubBodyWithoutLookup

Replacement Variables for the EJB Stub Templates

The following table lists the replacement variables that are used in the EJB templates for stub generation:

Variable	Description	Template
<<!JavaPackage!>>	Package name of the EJB. Example: RationalBankAcct	Session_Home Session_Remote Session_Bean
<<!HomeInterfaceName!>>	Class name for the home interface. Example: ManageAccountsHome	Session_Home
<<!HomeMethods!>>	Method declarations for methods in the home interface. For example, RationalBankAcct.ManageAccounts create() throws javax.ejb.CreateException, java.rmi.RemoteException.	Session_Home
<<!RemoteInterfaceName!>>	Class name for the remote interface. Example: ManageAccounts	Session_Remote MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue.

Variable	Description	Template
<<!RemoteMethods!>>	<p>Method declarations for methods in the remote interface.</p> <p>Example:</p> <pre>void deleteAllCheckingAccts() throws java.rmi.RemoteException; void deleteAllSavingsAccts() throws java.rmi.RemoteException; ... java.math.BigDecimal withdrawFromChecking(long accountID, java.math.BigDecimal amount) throws java.rmi.RemoteException, javax.naming.NamingException, javax.ejb.EJBException; java.math.BigDecimal withdrawFromSavings(long accountID, java.math.BigDecimal amount) throws java.rmi.RemoteException, javax.naming.NamingException, javax.ejb.EJBException;</pre>	Session_Remote
<<!ImplementationClassName!>>	<p>Class name of the EJB implementation class.</p> <p>Example:</p> <pre>ManageAccountsBean</pre>	Session_Bean

Variable	Description	Template
<<!MethodBodyTemplate!>>	<p>This variable causes the stub generator to use one of the four methodbody templates to generate the declaration and definition for each public method in the implementation class.</p> <p>The method body templates are chosen via the following criteria:</p> <p>MethodBodyWithoutLookUp – Used when lookup code cannot be generated either because the method has no parameters, or method has neither a return value nor exceptions, or one of the parameters is complex and lookup code cannot be generated automatically.</p> <p>MethodBodyWithoutExceptions – Used when the method does not throw exceptions.</p> <p>MethodBodyWithoutReturnValue – Used when method does not have a return value (for example, returns void).</p> <p>MethodBody – Used for all other methods.</p>	Session_Bean
<<!ReturnType!>>	<p>Return type for the method</p> <p>Example: java.math.BigDecimal</p>	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutLookUp
<<!MethodName!>>	<p>The Method Name</p> <p>Example: depositToChecking</p>	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutLookUp MethodBodyWithoutReturnValue
<<!ParameterDeclarations!>>	<p>Comma-separated list of parameter types and names to be included as part of the method declaration.</p> <p>Example: long accountID, java.math.BigDecimal amount</p>	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutLookUp MethodBodyWithoutReturnValue

Variable	Description	Template
<<!Exceptions!>>	Comma-separated list of exceptions that the method throws to be included as part of the method declaration. Includes the word "throws". Example: throws java.rmi.RemoteException,javax.naming.NamingException,javax.ejb.EJBException	MethodBody MethodBodyWithoutLookUp MethodBodyWithoutReturnValue
<<!ParameterCount!>>	Number of parameter for the method Example: 3	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue
<<!ParameterNamesAsStringArray!>>	Code to turn parameter names into array of strings. Example: ParamNames[0] = "accountID"; ParamNames[1] = "amount";	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue
<<!Return!>>	The word "Return" + a space Example: Return	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutLookUp
<<!ParameterNames!>>	Comma-separated list of parameter names, for example accountID, amount	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue
<<!InitialReturnValue!>>	Initial value assigned to the return value—for example null. Zero for numeric types false for boolean null for String and Objects	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutLookUp
<<!LookupTableName!>>	Name of the lookup table to be used for the method—for example ManageAccountsBean_depositToChecking_L	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue
<<!ParameterValuesAsStringArray!>>	Code to turn parameter values into array of strings. For example: values[0] = Long.toString(accountID); values[1] = amount.toString();	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue

Variable	Description	Template
<<!ParameterValuesAsSumofStrings!>>	Parameter values are converted to sum of strings. Example: values[0] + " " + values[1] + " "	MethodBody MethodBodyWithoutExceptions MethodBodyWithoutReturnValue
<<!ConvertStringValueToReturnType!>>	Converts the expected return value read from the lookup table to the return value type. Example: retval = new java.math.BigDecimal(sRetval);	MethodBody MethodBodyWithoutExceptions
<<!CatchBlocks!>>	Catch block for the exception (any class extending java.lang.Throwable) that the method throws. It is used to throw the exception that lookup table instructs. Example: catch (java.rmi.RemoteException e) { throw e; } catch (javax.naming.NamingException e) { throw e; }	MethodBody MethodBodyWithoutReturnValue
<<!ReasonForNoLookupCodeGeneration!>>	Describes why lookup code was not generated. For example: //This Method does not have parameters. Lookup code cannot be generated. //Insert code here to add logic.	MethodBodyWithoutLookupUp

This section provides troubleshooting techniques that you can use when running QualityArchitect.

Resource File Not Found

Symptom

The following message appears when you open a Visual Basic project after generating a script:

```
File not found: FileName.Res
```

Explanation

During script generation, QualityArchitect compiles the resources for datapool configuration using the Microsoft Visual Studio resource compiler—`rc.exe`. The end result is a resource file—`test.res`.

If this fails for any reason, the original source file, `test.rc`, is left in the directory with the script. However, you need to specify where the `rc.exe` resides using the RQA Options dialog box. For more information, see *Requirements for Testing COM Components* on page 101.

COM Test Scripts Fail to Run from TestManager

Symptom

A COM test script cannot be run from TestManager, and an error message such as the following is displayed:

```
Compiling Test Scripts ...
Error GetFile Timestamp() from ...
.
.
.
0 warning(s), 1 error(s)
Fatal compiler error, run terminated
```

Explanation

COM test scripts cannot be run from TestManager without the existence of a .RES file.

To run the test script from TestManager, you must convert the .RC file to a .RES file. To do this, you can run the resource compiler (rc.exe) from the command line. Typically, the resource compiler can be found in one of the following two directories:

- *<Visual Studio Directory>*\Common\MSDev98\Bin
- *<Visual Studio Directory>*\VB98\Wizards

Command Line Example

```
rc.exe test.rc
```

See *Resource File Not Found* on page 139 for further information.

EJB Class or Interface Not Found Messages

The following messages indicate that there are missing dependency relationships in the model between the bean implementation class, the home interface, the remote interface, and the primary key class. If you have the Rose J addin enabled, reverse engineering an EJB or creating a new EJB will create the necessary dependency relationships automatically. To enable script generation, be sure to insert the dependency relationships in your class diagram.

The messages are as follows:

- EJB remote interface not found
- EJB entity bean implementation class not found
- EJB home interface not found
- EJB session bean implementation class not found
- EJB primary key class not found
- Cannot find home, remote or key interface from implementation class. Check possible missing relationship in model.
- Cannot find implementation class for home, remote or key interface class. Check possible missing relationship in model.

Java Query Builder Failing to Connect to Cloudscape Database

The Java Query Builder is a tool that helps you connect to and interact with databases so you can define database verification points. The Rational Bank Account Sample Application comes with a sample Cloudscape database that the Java Query Builder can connect to.

If the Query Builder fails to connect to the Cloudscape database with a message such as “Database Not Found,” it is because WebLogic is already using the default Cloudscape JDBC driver. To connect to the database, choose another JDBC driver and JDBC URL, such as:

JDBC Driver

```
weblogic.jdbc.rmi.Driver
```

JDBC URL

```
jdbc:weblogic:rmi?weblogic.jdbc.datasources=CShopDataSource&weblogic.server.url=t3://localhost:7001
```

The argument `CShopDataSource` in the JDBC URL is a datasources created via the BEA WebLogic Server Console. You can access the console from the following URL:

```
HTTP://localhost:7001/console
```

From there, click **JDBC > Data Sources** and create a data source that points to the correct WebLogic connection pool.

java.naming.communication Error in Test Log Window

If you have previously connected to a WebLogic 5.1 server by running RQA Java test script(s) from TestManager on one machine and then attempt to run the same test script(s) on a remote Test Agent machine, you might see the following error in the Test Log window:

```
java.naming.Commuincation error
```

This error can occur if you only have one license for your WebLogic server. To work around this problem, shut down your WebLogic server and reboot before proceeding with Test Agent testing.

Glossary

application-under-test. The software being tested. See also *system-under-test*.

baseline results. A persistent snapshot of data that is assumed to be correct and is used as the expected data object in a static verification point.

bean class. Class that actually implements the bean's business methods.

black-box testing. Tests that rely on a requirements definition or functional description of the application-under-test. A record and playback tool, such as Robot, is an example of a black-box testing tool.

class invariant. A set of rules that hold true when an object is in a stable state. The class invariant consists of a list of requirements on the data in a class. See also *Design by Contract*, *precondition*, and *postcondition*.

collaboration diagram. An interaction diagram that shows the sequence of messages that implement an operation or a transaction. Collaboration diagrams and sequence diagrams are alternate representations of an interaction. Collaboration diagrams show objects, their links, and their messages. They can also contain simple class instances and class utility instances. Each collaboration diagram provides a view of the interactions or structural relationships that occur between objects and object-like entities in the current model.

container-managed persistence. With container-managed persistence, the container is responsible for synchronizing the fields in an entity bean with data in a database.

context factory. A Java object that contains the JNDI information required by a naming service.

data-driven testing. A type of software testing that tests code with specific input and output values. With data-driven testing, test code is separated from test data. Data-driven tests are often used to compare expected and actual output values. See also *functional testing*.

database verification point. A type of verification point used with Rational Quality Architect. The database verification point tests the results of a SQL statement.

datapool. A source of test data that test scripts can draw from during playback. You can generate datapools using the Datapool Manager, or you can derive datapools from other sources such as your database.

Design By Contract. A programming methodology based on three important concepts: preconditions, postconditions, and a class invariant.

entity bean. An object representation of persistent data that is maintained in a permanent data store, such as a database. A primary key identifies each instance of an entity bean. Entity beans typically model business concepts that can be expressed as nouns, such as a customer or a bank account. Entity beans are transactional, and they are recoverable following a system crash.

functional test. A test to determine whether a system, application, or component functions as intended. Functional tests often compare how the application-under-test behaves in the current build against its behavior in previous builds.

Grid Comparator. The Rational Test component for reviewing, analyzing, and editing data files for text and numeric verification points in grid formats. The Grid Comparator displays the differences between the recorded baseline data and the actual data captured during playback.

home interface. An interface class for an enterprise bean that defines life-cycle methods for the bean—that is, methods for creating, removing, and finding beans.

IDE. Integrated Development Environment. This environment consists of a set of integrated tools that are used to develop a software application. Examples of IDEs supported by Rational QualityArchitect include Visual Age and Visual Cafe.

interaction diagram. See *collaboration diagram* and *sequence diagram*.

log. A file that contains the record of events that occur during test script play back.

LogViewer. See Rational LogViewer.

playback. The process of executing a script.

postcondition. A requirement that a method, routine, or function has on its result. The requirement is checked after the method executes.

precondition. A requirement that a method, routine, or function has on the values supplied to its parameters. The requirement is checked before the method executes.

Rational Administrator. The Rational Test component that you use to create and maintain repositories, projects, users, groups, computers, and SQL Anywhere servers.

Rational LogViewer. The Rational Test component for displaying log files, which contain the record of events that occur while playing back a script or running a schedule. Also, the component from which you start the four Comparators.

Rational TestManager. The Rational Test product for managing the overall testing effort. You use it to define and store information about test documents, requirements, scripts, schedules, and sessions.

receiver object. The object that receives the messages in a Rose interaction diagram.

regression testing. Testing that occurs over successive builds of an application.

remote interface. An interface class for an enterprise bean that defines all of the bean's business methods.

requirements-based testing. A testing strategy based on test requirements. Requirements-based testing measures the number of test requirements that have been verified compared to all of the requirements that have been identified.

script. See *test script*.

sequence diagram. A graphical view of a scenario that shows object interaction in a time-based sequence—that is, what happens first, what happens next. Sequence diagrams establish the roles of objects and help provide essential information to determine class responsibilities and interfaces. This type of diagram is best used during early analysis phases in design because they are simple and easy to comprehend. Sequence diagrams are normally associated with use cases. Sequence diagrams are closely related to collaboration diagrams and both types of diagrams are alternate representations of an interaction. There are two main differences between sequence and collaboration diagrams: sequence diagrams show time-based object interaction while collaboration diagrams show how objects associate with one another.

session bean. A session bean typically models business concepts that can be expressed as a verb, such as managing an account or executing a transaction. A session bean is created by a client and in most cases exists only for the duration of a single client/server session. Session beans can be transactional, but (normally) they are not recoverable following a system crash. Session beans can be stateless or stateful.

stub. The minimum set of interfaces for a component that interacts with the component-under-test. Stubs can be used to control the results returned from components that are dependent on the component-under-test.

test case. A set of test inputs, execution conditions, and expected results developed for a particular objective, such as to exercise a particular program path or to verify compliance with a specific requirement.

test script. Test scripts are the computer-readable instructions that automate the execution of a test procedure. Test scripts can be generated automatically using test automation tools, programmed using a programming language, or can result from a combination of recording, generating, and programming. With Rational test generation tools, the test script also includes a repository object. EJB test scripts, in particular, are generated in Java, and all generated Java test scripts extend the TestScript class.

test log. See log.

TestManager. See *Rational TestManager*.

verification point. A functional testing construct used by a test script to verify a specific behavior of the application or component-under-test. Static verification points capture information about the application-under-test and store it as the baseline. During playback, a verification point recaptures the object information and compares it to the baseline. Results of the verification point are maintained in a log, allowing for analysis of overall functional correctness and test case coverage.

white-box testing. Tests that rely on knowledge of the code, specifications, or other source material to perform the test. White-box testing is also called Structural testing. Rational QualityArchitect is an example of a white-box testing tool.

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