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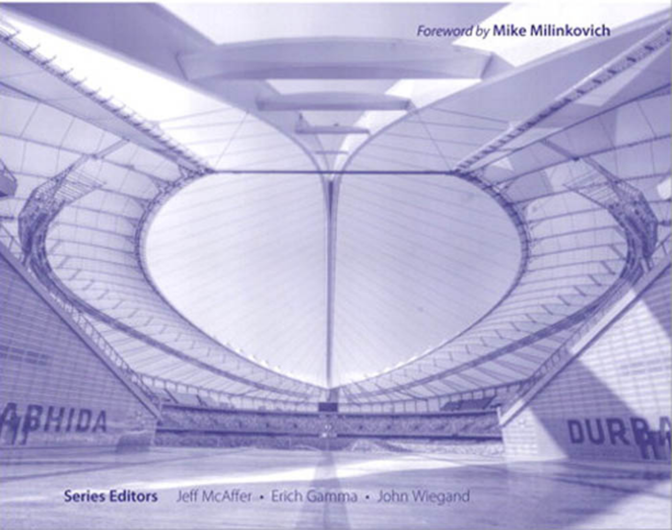
Integrating and Extending BIRT

Third Edition

Jason Weathersby • Tom Bondur • Iana Chatalbasheva



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Integrating and Extending BIRT

Third Edition

The Eclipse Series

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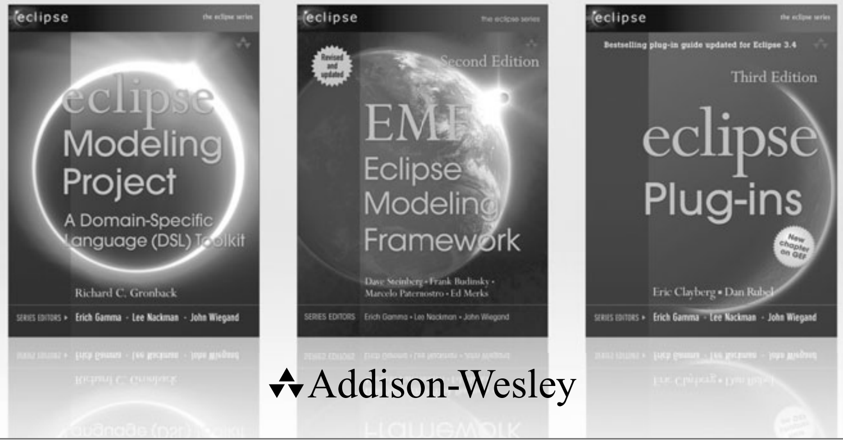
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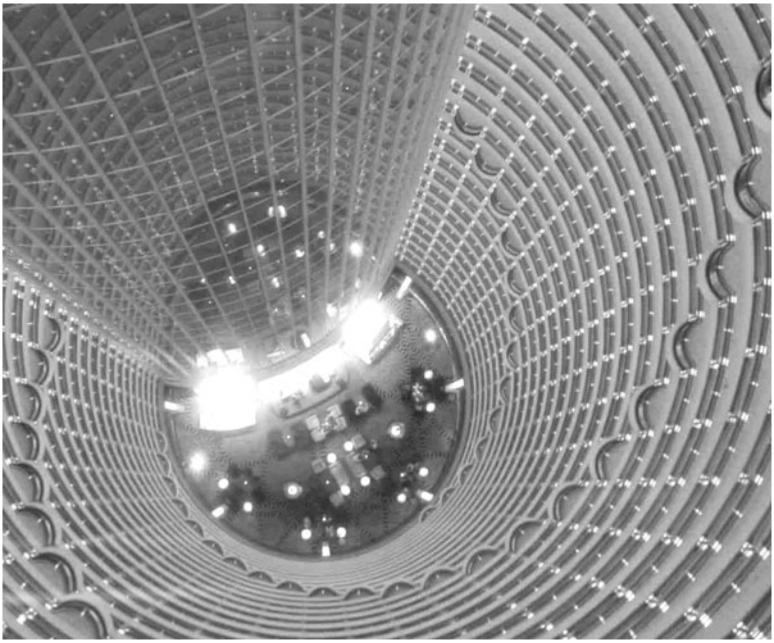

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Foreword

It is a common misconception that Eclipse projects are focused on simply providing great tools for developers. Actually, the expectations are far greater. Each Eclipse project is expected to provide both frameworks and extensible, exemplary tools. As anyone who has ever tried to write software with reuse and extensibility in mind knows, that is far more difficult than simply writing a tool.

"Exemplary" is one of those handy English words with two meanings. Both are intended in its use above. Eclipse projects are expected to provide tools that are exemplary in the sense that they provide an example of the use of the underlying frameworks. Eclipse tools are also intended to be exemplary in the sense that they are good and provide immediate utility to the developers who use them.

Since its inception, the BIRT project has worked hard to create both reusable frameworks and extensible tools. This book focuses primarily on how to extend BIRT and how to use BIRT in your own applications and products. As such, it illustrates BIRT's increasing maturity and value as an embedded reporting solution.

As Executive Director of the Eclipse Foundation, I'm pleased with the tremendous progress the BIRT team has made since the project's inception in September of 2004, and I'm equally pleased with the vibrant community that has already grown up around it. As you work with BIRT and the capabilities that are described in this book, I'd encourage you to communicate your successes back to the community, and perhaps consider contributing any interesting extensions you develop. The BIRT web site can be found here:

```
http://www.eclipse.org/birt
```

It includes pointers to the BIRT newsgroup, where you can communicate and share your results with other BIRT developers, and pointers to the Eclipse installation of Bugzilla, where you can contribute your extensions. If you like BIRT—and I am sure this book will help you learn to love it—please participate and contribute. After all, it is the strength of its community that is the true measure of any open source project's success.

Mike Milinkovich
Executive Director, Eclipse Foundation

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About this book

The second of a two-book series on business intelligence and reporting technology, *Integrating and Extending BIRT*, introduces programmers to BIRT architecture and the reporting framework. Its companion book, *BIRT: A Field Guide*, shows report developers how to create reports using the graphical tools of BIRT Report Designer. Built on the open-source Eclipse platform, BIRT is a powerful reporting system that provides an end-to-end solution, from creating and deploying reports to integrating report capabilities in enterprise applications.

BIRT technology makes it possible for a programmer to build a customized report using scripting and BIRT APIs. This book informs report developers about how to write scripts that:

- Customize the report-generation process
- Incorporate complex business logic in reports

This book also informs application developers about how to:

- Debug and deploy reports
- Integrate reporting capabilities into other applications
- Extend BIRT functionality

A programmer can extend the BIRT framework by creating a new plug-in using the Eclipse Plug-in Development Environment (PDE). This book provides extensive examples that show how to build plug-ins to extend the features of the BIRT framework. The source code for these examples is available for download at http://www.actuate.com/birt/contributions.

The topics discussed in this book include:

- Installing and deploying BIRT
- Deploying a BIRT report to an application server
- Understanding BIRT architecture

- Scripting in a BIRT report design
- Integrating BIRT functionality into applications
- Working with the BIRT extension framework

This revised BIRT 2.6 edition adds the following new content:

- Updated architectural diagrams
- Expanded scripting examples
- Debugging Event Handlers
- Developing an advanced report item with data binding
- Developing a Data Extraction Extension
- Developing a Charting Extension

Who should read this book

This book is intended for people who have a programming background. These readers can be categorized as:

- Embedders and integrators

  These individuals work with the software to integrate it into their current application infrastructure.

- Extenders

  These individuals leverage APIs and other extension points to add capability or to establish new interoperability between currently disparate components or services.

To write scripts in report design, you need knowledge of JavaScript or Java. More advanced tasks, such as extending BIRT's functionality, require Java development experience and familiarity with the Eclipse platform.

Contents of this book

This book is divided into several parts. The following sections describe the contents of each of the parts and chapters.

Part 1, Installing and Deploying BIRT

Part 1 introduces the currently available BIRT reporting packages, the prerequisites for installation, and the steps to install and update the packages. Part 1 includes the following chapters:

- *Chapter 1. Introducing BIRT Report Designers.* BIRT provides a number of separate packages as downloadable archive (.zip) files on the Eclipse web site. Some of the packages are stand-alone modules, others require an existing Eclipse environment, and still others provide additional functionality to report developers and application developers. This chapter describes the prerequisites for each of the available packages.

- *Chapter 2. Installing a BIRT Report Designer.* BIRT provides two report designers as separate packages, which are downloadable archive (.zip) files on the Eclipse web site. This chapter describes the steps required to install each of the available report designers.
- *Chapter 3. Installing Other BIRT Packages.* This chapter describes the steps required to install and update each of the available packages.
- *Chapter 4. Deploying a BIRT Report to an Application Server.* This chapter introduces the distribution of reports through an application server such as Apache Tomcat, IBM WebSphere, or BEA WebLogic. The instructions in the chapter provide detailed guidance about deploying a BIRT report to Apache Tomcat version 6.0. From those instructions, a developer can infer how to deploy to other versions.

Part 2, Understanding the BIRT Framework

Part 2 introduces the BIRT architecture and the Report Object Model (ROM) and provides background information that helps programmers design or modify reports programmatically, instead of using the graphical tools in BIRT Report Designer. Part 2 includes the following chapters:

- *Chapter 5. Understanding the BIRT Architecture.* This chapter provides an architectural overview of BIRT and its components, including the relationships among the BIRT components and BIRT's relationship to Eclipse and Eclipse frameworks. Architectural diagrams illustrate and clarify the relationships and workflow of the components. The chapter also provides brief overviews of all the major BIRT components.
- *Chapter 6. Understanding the Report Object Model.* This chapter provides an overview of the BIRT ROM. ROM is a specification for a set of XML elements that define both the visual and non-visual elements that comprise a report design. The ROM specification includes the properties and methods of those elements, and the relationships among the elements.

Part 3, Scripting in a Report Design

Part 3 describes how a report developer can customize and enhance a BIRT report by writing event handler scripts in either Java or JavaScript. Part 3 includes the following chapters:

- *Chapter 7. Using Scripting in a Report Design.* This chapter introduces the writing of a BIRT event handler script in either Java or JavaScript, including the advantages and disadvantages of using one language over the other. BIRT event handlers are associated with data sets, data sources, and report items. BIRT fires specific events at specific times in the processing of a report. This chapter identifies the events that BIRT fires and describes the event firing sequence.

- *Chapter 8. Using JavaScript to Write an Event Handler.* This chapter discusses the coding environment and coding considerations for writing a BIRT event handler in JavaScript. This chapter describes several BIRT JavaScript objects that a developer can use to get and set properties that affect the final report. The BIRT JavaScript coding environment offers a pop-up list of properties and functions available in an event handler. A JavaScript event handler can also use Java classes. This chapter includes a tutorial that describes the process of creating a JavaScript event handler.
- *Chapter 9. Using Java to Write an Event Handler.* This chapter discusses how to write a BIRT event handler in Java. BIRT provides Java adapter classes that assist the developer in the creation of Java event handlers. The report developer uses the property editor of the BIRT Report Designer to associate a Java event handler class with the appropriate report element. This chapter contains a tutorial that steps through the Java event handler development and deployment process. This chapter also describes the event handler methods and their parameters.
- *Chapter 10. Working with Chart Event Handlers.* This chapter describes the BIRT event handler model for the Chart Engine. The model is similar to the model for standard BIRT report elements and supports both the Java and JavaScript environments. This chapter provides details on both environments. The Chart Engine also supports this event model when used outside of BIRT.
- *Chapter 11. Using Scripting to Access Data.* This chapter describes how to access a data source using JavaScript code. A data source that you access using JavaScript is called a scripted data source. With a scripted data source, you can access objects other than an SQL, XML, or text file data source. A scripted data source can be an EJB, an XML stream, a Hibernate object, or any other Java object that retrieves data.
- *Chapter 12. Debugging Event Handlers.* This chapter describes how to use the BIRT report debugger to debug BIRT reports and event handlers written in JavaScript and Java. The BIRT report debugger enables users to run reports step by step, set breakpoints, inspect instance properties, and watch and evaluate variable values in certain contexts. The debugger supports advanced report developers in spotting the errors in report designs quickly, and makes it easy to understand and identify exceptions during run time. The chapter provides a tutorial with step-by-step instructions about debugging Java and JavaScript report event handlers.

Part 4, Integrating BIRT into Applications

Part 4 describes the public APIs that are available to Java developers, except the extension APIs. Part 4 includes the following chapters:

- *Chapter 13. Understanding the BIRT APIs.* This chapter introduces BIRT's public API, which are the classes and interfaces in three package hierarchies:
  - The report engine API, in the org.eclipse.birt.report.engine.api hierarchy, supports developers of custom report generators.
  - The design engine API, in the org.eclipse.birt.report.engine.api hierarchy, supports the development of custom report designs.
  - The chart engine API, in the org.eclipse.birt.chart hierarchy, is used to develop a custom chart generator.
- *Chapter 14. Programming Using the BIRT Reporting APIs.* This chapter describes the fundamental requirements of a reporting application and lists the BIRT API classes and interfaces that are used to create a reporting application. This chapter describes the tasks that are required of a reporting application and provides an overview of how to build a reporting application. The org.eclipse.birt.report.engine.api package supports the process of generating a report from a report design. The org.eclipse.birt.report.model.api package supports creating new report designs and modifying existing report designs.
- *Chapter 15. Programming Using the BIRT Charting API.* This chapter describes the requirements of a charting application, either in a stand-alone environment or as part of a reporting application. The org.eclipse.birt.chart hierarchy of packages provides the charting functionality in BIRT. By describing the fundamental tasks required of charting applications, this chapter introduces the API classes and interfaces that are used to create a chart. This chapter also describes the chart programming examples in the chart examples plug-in.

Part 5, Working with the Extension Framework

Part 5 shows Java programmers how to add new functionality to the BIRT framework. By building on the Eclipse platform, BIRT provides an extension mechanism that is familiar to developers of Eclipse plug-ins. This part also provides information about how to build the BIRT project for developers who need access to the complete BIRT open source code base. Part 5 includes the following chapters:

- *Chapter 16. Building the BIRT Project.* This chapter explains how to download BIRT 2.6 source code and build the BIRT project for development. This chapter describes how to configure an Eclipse workspace, download BIRT source code, and build the BIRT report and web viewers.
- *Chapter 17. Extending BIRT.* This chapter provides an overview of the BIRT extension framework and describes how to use the Eclipse Plug-in Development Environment (PDE) and the BIRT extension points to create, build, and deploy a BIRT extension.

- *Chapter 18. Developing a Report Item Extension.* This chapter describes how to develop a report item extension. The rotated text extension example is a plug-in that renders the text of a report item as an image. The extension rotates the image in the report design to display the text at a specified angle. This chapter describes how to build the rotated text report item plug-in and add the report item to the BIRT Report Designer using the defined extension points.
- *Chapter 19. Developing a Report Rendering Extension.* This chapter describes how to develop a report rendering extension using the Eclipse PDE with sample CSV and XML report rendering extensions as the examples. The chapter describes how to extend the emitter interfaces using the defined extension points to build and deploy a customized report rendering plug-in that runs in the BIRT Report Engine environment.
- *Chapter 20. Developing an ODA Extension.* This chapter describes how to develop several types of DTP ODA extensions. The CSV ODA driver example is a plug-in that reads data from a CSV file. The Hibernate ODA driver example uses Hibernate Query Language (HQL) to provide a SQL-transparent extension that makes the ODA extension portable to all relational databases. This chapter shows how to develop an ODA extension to the BIRT Report Designer 2.6.0 user interface that allows a report designer to select an extended ODA driver.
- *Chapter 21. Developing a Data Extraction Extension.* This chapter describes how to develop a report data extraction extension using the Eclipse PDE. The data extraction example exports report data to XML format. The Eclipse PDE provides the basis for the extension.
- *Chapter 22. Developing a Fragment.* This chapter describes how to build a fragment. The BIRT Report Engine environment supports plug-in fragments. A plug-in fragment is a separately loaded package that adds functionality to an existing plug-in, such as a specific language feature in a National Language Support (NLS) localization application. The example in this chapter creates a Java resource bundle that adds translations to the messages defined in the messages.properties files for the org.eclipse.birt.report.viewer plug-in.
- *Chapter 23. Developing a Charting Extension.* This chapter discusses the process of adding a new chart type to the BIRT chart engine. BIRT provides a radar chart type with the chart engine as an example of how to build new chart types. This chapter describes how to create this radar chart example.

The *Glossary* contains a glossary of terms that are useful to understanding all parts of the book.

Typographical conventions

Table P-1 describes the typographical conventions that are used in this book.

Table P-1 Typographical conventions

Item	Convention	Example
Code examples	Monospace font	`StringName = "M. Barajas";`
File names	Initial capital letter, except where file names are case-sensitive	SimpleReport.rptdesign
Key combination	A + sign between keys means to press both keys at the same time	Ctrl+Shift
Menu items	Capitalized, no bold	File
Submenu items	Separated from the main menu item with a small arrow	File➛New
User input	Monospace font	`2008`
User input in Java code	Monospace font italics	`chkjava.exe` *`cab_name`*`.cab`

Syntax conventions

Table 3-1 describes the symbols that are used to present syntax.

Table 3-1 Syntax conventions

Symbol	Description	Example
[ ]	Optional item	int count [= <value>];
	Array subscript	matrix[ ]
< >	Argument that you must supply	<expression to format>
	Delimiter in XML	<xsd:sequence>
{ }	Groups two or more mutually exclusive options or arguments when used with a pipe	{TEXT_ALIGN_LEFT | TEXT_ALIGN_RIGHT}
	Defines array contents	{0, 1, 2, 3}

(continues)

Table 3-1 Syntax conventions (continued)

Symbol	Description	Example

{ }	Delimiter of code block	if (itemHandle == null)
		{
		  // create a new handle
		}

|	Separates mutually exclusive options or arguments in a group	[public | protected | private] <data type> <variable name>;
	Java bitwise OR operator	int newflags = flags |4

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`http://reusablereporting.blogspot.com/`

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Chapter

7

Using Scripting in a Report Design

BIRT provides a powerful scripting capability that enables a report developer to create custom code to control various aspects of report creation. This chapter provides an overview of scripting in BIRT. Subsequent chapters focus on implementing script event handlers in JavaScript and Java, writing event handlers for charts, and accessing data using scripted data sources.

Overview of BIRT scripting

BIRT Report Designer supports writing custom event handlers in both Java and JavaScript. BIRT RCP Report Designer supports writing custom event handlers only in JavaScript.

Choosing between JavaScript and Java

Both JavaScript and Java have advantages and disadvantages when writing an event handler. For a developer who is familiar with only one of the two languages, the advantage of using the familiar language is obvious, but for others the decision depends on the report requirements.

The advantages of using JavaScript to write an event handler include:

- Ease of adding a simple script for a particular event handler

  Adding a JavaScript event handler to a report is less complicated than adding an event handler written in Java. To write a JavaScript event handler, there is no need to create a Java environment in Eclipse or to learn the Eclipse Java development process. There is no requirement to specify a package, implement an interface, or know the parameters of the event handler you write.

To add a JavaScript event handler, first select the name of the event handler from a drop-down list on the Script tab. Then, type the code.

- Simpler language constructs, looser typing, and less strict language rules

  JavaScript is less demanding to code than Java due to its more relaxed requirements.

The advantages of using Java to write an event handler include:

- Availability of the Eclipse Java development environment

  The Eclipse Java development environment is very powerful and includes such features as autocompletion, context sensitive help, keyboard shortcuts, and parameter hints.

- Ease of finding and viewing event handlers

  All the Java event handlers for a report exist in readily viewable Java files. By contrast, the JavaScript event handlers are embedded in the design and you can view only one handler at a time.

Using both JavaScript and Java

There is no requirement to write all event handlers in one language. You can write some in JavaScript and others in Java. If both a JavaScript and a Java event handler for the same event are available, BIRT uses the JavaScript handler.

Events overview

When writing event handlers, understanding the event order is imperative. The order in which events fire depends on several factors. These factors include which BIRT processing phase is executing, the engine task executing the process, and what event type is processing.

Engine task processes

The scripting chapters make continuous reference to engine task processes. This section provides an overview of what these processes are and how they affect scripting.

The Report Engine that executes reports is task-oriented and provides three tasks related to the execution and rendering of reports. These tasks are RunAndRenderTask, RunTask, and RenderTask.

The RunAndRenderTask uses one process to open the report design and produce a specific output, such as PDF. The RunTask opens a report design and executes the report producing a report document file with a

.rptdocument extension. This report document is an intermediate binary file that can then be used by a RenderTask to produce a report output type, such as HTML, PDF, PPT, PS, Word, or XLS. The RenderTask opens a report document (.rptdocument) and renders the appropriate output format. This task can be executed any time after a RunTask. This task can even occur on a separate system.

BIRT Report Designer uses the report engine to show a preview of a report. Selecting Preview in the Editor launches a RunAndRenderTask to produce the report. Selecting any other previewing option in BIRT Report Designer toolbar launches a RunAndRenderTask to produce the output, with the exception of the Run report in BIRT Web Viewer, which produces the report using a RunTask followed by a RenderTask.

The tasks RunTask and RenderTask can be used when the tasks need to occur at separate times or on separate systems. Using separate run and render tasks therefore requires two processes to run and render a report to a particular output format.

When RunAndRenderTask processes a report, the event firing order is different from the RunTask and RenderTask are used as two separate processes. The differences in processing are discussed throughout these chapters.

The following sections describe how the report engine processes reports in the BIRT Report Designer environment.

BIRT Web Viewer

The example BIRT Web Viewer application is a J2EE application that encapsulates the report engine to produce reports. This viewer contains three Servlet mappings used to generate reports. These are the frameset, run, and preview mappings.

In the example web viewer, two processes, RunTask and RenderTask, generate and render to the output format to create a report document. Selecting the Export report icon in the Web Viewer toolbar initiates a RenderTask to execute on the current report document.

BIRT processing phases

The BIRT services for generating and presenting report data create a report during the following processing phases:

- Preparation

  RunTask or RunAndRender Task prepare the report items for execution.

- Generation

  RunTask or RunAndRender Task create an instance of each report item, connect to the data source, execute the data sets, and process the data to produce the report.

- Presentation

  RenderTask or RunAndRender Task select the correct emitters to produce the output specified for the report.

The RunTask handles the preparation and generation phases and the Render Task handles the presentation phase. RunAndRenderTask handles all phases of report processing. The types of events and the order in which these events fire depends on the processing phase currently executing in an engine task.

BIRT event types

BIRT supports the following types of events:

- Parameter
- Report design
- Data source and data set
- Report item

Each event type has a series of events that fire during report processing.

Parameter events

BIRT currently supports two parameter level events that can be used to customize the parameter selection choices and default values before the parameter entry box is displayed. In addition, BIRT supports one parameter level event that is called after the parameters have been selected. These events are summarized in Table 7-1. These events are currently available only in JavaScript. Parameter events fire only if the report contains parameters.

Table 7-1 Parameter events

Event	Description
getDefaultValueList	Sets the parameter's default value. If the parameter is set to allow multiple values, this script should return an array of values that will then be pre-selected in the parameter entry box. This event fires first.
getSelectionValue List	Returns a single value or an array of values. This event fires before the parameter entry box displays for parameters presenting a list of values. Simple text parameters do not call this event.
validate	This event fires after the user selects the report parameters and before the initialize event. This event fires for each parameter and returns a value of true or false. Returning false throws an exception that states which parameter failed validation. Returning true processes the report normally.

Listing 7-1 provides an example of getDefaultValueList and getSelectionValueList event handlers for a parameter formatted as a list box. The array dSLArray contains four values that a report user can select. The array dVLArray contains two values that are the default values of the parameter. These values are selected in the list of available values when the user runs the report.

Listing 7-1 Example event handlers for a parameter formatted as a list box

```
//getDefaultValueList
var dVLArray = [];
dVLArray[0]= "10104";
dVLArray[1] = "10108";
dVLArray;
```

```
//getSelectionValueList
var dSLArray = [];
dSLArray[0]= "10101";
dSLArray[1]= "10104";
dSLArray[2]= "10105";
dSLArray[3] = "10108";
dSLArray;
```

The getDefaultValueList can be useful to provide date parameters as well.

If changes to the parameter are necessary after a user enters a parameter or if extra parameter validation is required, write an event handler for the validate event. The following example shows a validate script for a string parameter:

```
params["MyParameter"].value = "Something Else";
true;
```

Report design events

Report design events fire for all reports. Table 7-2 describes these events. The events support event handlers to provide additional processing of the report.

Table 7-2 Report design events

Event	Description
initialize	Fires every time a task accesses the report design (.rptdesign) or the report document (.rptdocument). This event occurs once when using RunAndRenderTask. When the processing phases run separately, RunTask triggers once for the generation phase and RenderTask triggers once for every render operation. Displaying the first page of a report in the presentation phase and using the page navigation control to access a new page also triggers this event handler.

(continues)

Table 7-2 Report design events (continued)

Event	Description
beforeFactory	Fires just prior to the generation phase after the elements in the report have been prepared in the preparation phase. This event handler fires only once. Use beforeFactory( ) when modifications to the report design are required before execution.
beforeRender	Fires just prior to the presentation phase and is called for every render operation. In the RunAndRender task, this event occurs once just after the beforeFactory event.
afterFactory	Fires at the conclusion of the generation phase and fires only once. If using a RunTask or RunAndRenderTask, this event is the last one fired. If using a RenderTask, this event does not execute.
afterRender	Fires at the conclusion of the presentation phase for a specific render operation. If using a single RunAndRenderTask process, this event is called only once. If using separate RunTask and RenderTask processes, this event fires for every render operation.
onPageStart	Fires prior to placing content on a specific page and supports the use of page-level variables to modify the page. This event fires only when processing phases run separately, for example, a RunTask followed by a RenderTask. This event fires prior to the onPageBreak events for the individual elements to be placed on the page. This event is also available on the master page.
onPageEnd	Fires after all the onPageBreak events have fired for the content to be placed on a page and prior to evaluating the autotext items for the page. This event is also available on the master page.

Types of data source and data set events

There are several kinds of data sources and data sets. A data source can be a flat file, a JDBC data source, a scripted data source, a web services data source, or an XML data source. All data sources have a common set of event handlers. A scripted data source has two additional event handlers.

Data set events can be called multiple times to support multipass aggregation and data set sharing. It is not advisable to write event handlers that rely on the data set event firing order. An additional issue is that data set event handlers may only be called once because of data set caching.

Table 7-3 describes the data source events.

Table 7-3 Data source events

Event	Description
beforeOpen	This event is most often used to modify public properties of the data source, including database URL, username, password, driver class and JNDI URL. This event fires only once, before the connection to the data source opens event, when the connection uses multiple data sets. Fires prior to opening a connection to a data source.
afterOpen	Fires after the connection to the data source opens.
beforeClose	Fires at the conclusion of the generation phase, just prior to closing the data source connection.
afterClose	Fires after the data source connection closes.
open	Fires only for a scripted data source, providing a location for the developer to set up a connection to an external source.
close	Fires only for a scripted data source, providing a location for the developer to close a connection to an external source.

Data source and data set events fire in the generation phase prior to the onCreate event of the report item that uses them. Data set events can fire several times. The event order is covered in more detail later in this chapter. Table 7-4 describes the data set events.

Table 7-4 Data set events

Event	Description
beforeOpen	Fires prior to opening a data set and used most often to modify public properties of the data set. For example, when using a JDBC data set, the query text can be altered using this event. This event fires for every report item bound to the data set. If two tables use the same data set, the data set is called twice, resulting in this event firing twice. BIRT 2.6 allows report items to be bound to other report items, in which case the data set is called only once, resulting in the event triggering only once. Data set caching options continue to be added which affect how often data source and data set events fire.
afterOpen	Fires after the data set opens.

(continues)

Table 7-4 Data set events (continued)

Event	Description
onFetch	Fires as the data set retrieves each row of data. This event fires for all rows of data before the onCreate event for the particular report item that uses the data set.
beforeClose	Fires before closing the data set after creating the report item that uses the data set.
afterClose	Fires after the data set closes.
open	Fires for a scripted data set, providing a location for the developer to set up a data set.
fetch	Fires for a scripted data set, providing a location for the developer to populate rows from the scripted data set.
close	Fires for a scripted data set, providing a location for the developer to close the set.

Data source and data set events fire prior to being used on a data bound item. If the data set is never used in the report, the data source and data set are never called. A scripted data set is a data set that accesses a scripted data source. A non-scripted data set is one that accesses a standard data source. Use the scripted data source and data set to write custom code to retrieve data values.

Scripted data source events

A scripted data source contains the afterOpen, afterClose, beforeOpen, and beforeClose events common to all data sources, and open and close events. Use the event handlers for the open and close events to perform the actions of opening and closing the data source.

Scripted data set events

A scripted data set contains the afterOpen, afterClose, OnFetch, beforeOpen, beforeClose, open, close, and fetch events. Use the event handlers for the open and close events to perform the actions of opening and closing the data set. Use the fetch method to fetch a row from the data source. Using a scripted data set requires an event handler to be written for the fetch event.

ReportItem events

ReportItem events trigger for report items that are placed in the report. Most items support writing event handlers for the events listed in Table 7-5.

Table 7-5 Report item events

Event	Description
onPrepare	Fires at the beginning of the preparation phase before data binding or expression evaluation occurs. This event is useful for changing the design of the item prior to generating the item instance.
onCreate	Fires at the time the generation phase creates the element. This event is useful when a particular instance of a report item needs alteration.
onRender	Fires in the presentation phase. This event is useful for operations that depend on the type or format of the output document.
onPageBreak	Fires for all report items currently on the page when the page break occurs. Not all report items support the onPageBreak event.

Event order sequence

Table 7-6 summarizes which engine task is responsible for a particular phase. The following sections describe the order of event firing for each phase in more detail.

Table 7-6 Engine task by phase

Report engine task	Preparation phase	Generation phase	Presentation phase
RunTask	Yes	Yes	No
RenderTask	No	No	Yes
RunAndRenderTask	Yes	Yes	Yes

Preparation phase operation

The preparation phase includes parameter validation as well as initialization and report element preparation for every element in the report. The preparation phase is identical for all reports. Table 7-7 lists the event types for RunTask and RunAndRenderTask in the order in which the events execute.

The RenderTask does not have a preparation phase. In a RunAndRenderTask, the preparation phase triggers a beforeRender event.

Table 7-7 Preparation phase events

Element type and event	RunTask	RunAnd RenderTask
Parameter getDefaultValueList	Yes	Yes
Parameter getSelectionValueList	Yes	Yes
Parameter validate	Yes	Yes
ReportDesign Initialize	Yes	Yes
ReportItem onPrepare (iterative)	Yes	Yes
ReportDesign beforeFactory	Yes	Yes
ReportDesign beforeRender	No	Yes

The parameter events fire first for each parameter. Before the parameter entry box is displayed, the getDefaultValueList is called for each parameter. This script returns either a single value or a list of values, depending on the parameter type.

Next, each parameter that provides a list of choices to the user calls the getSelectionValueList. If running reports using the API for RunTask or RunAndRenderTask, the getDefaultValueList script event fires for only parameters that have no value passed. The getSelectionValueList is not called. If using createGetParameterDefinitionTask to build your own parameter entry screen, these events fire much like the example Viewer.

After a user enters values for the parameters, the next event is the validate event, which fires for each parameter. The ReportDesign event, initialize, follows. The initialize event fires once when using only one engine task. Using a separate engine task triggers the initialize event at least two times, one time for the preparation phase, and a second time for the render phase. Additional render tasks or phases also trigger the initialize method.

After the initialize event, the preparation phase triggers the onPrepare event for every element in the report. This process starts with the master page content and proceeds from left to right and top to bottom in the report body. All nested elements process before proceeding to the next element.

The beforeFactory event fires next. This event signals that report creation is about to occur and provides a location for altering a running report.

The beforeRender event fires when using a RunAndRenderTask. When using two tasks, this event does not fire until a render operation occurs.

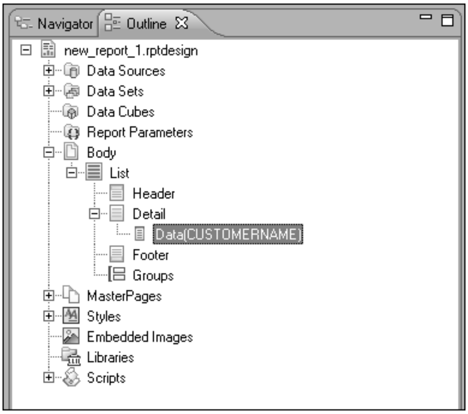
Generation phase operation

The generation phase includes connecting to data sources, executing data sets and data cubes, evaluating data bindings, and creating all the report items in the report. The data source and data set events fire before the creation of data-bound items, but this processing may not occur before the creation of other report items. For example, if a table is bound to a data set and the report uses a master page with only a label in the footer, the master page content onCreate event fires before the data source and data set events for the data set bound to the table.

This phase triggers the onCreate event for every report item. BIRT processes the report body after processing content on the master page. The report body contains all the report items to be created and rendered. BIRT processes all items at all levels in an iterative fashion, following the same process at each level as it does for the top-level items. A report item that is not contained in another report item is called a top-level report item. BIRT processes the top-level items, going from left to right and proceeding a row at a time toward the bottom right. Every report has at least one top-level report item, usually a grid, list, or table. All nested elements complete OnCreate processing before the next element's onCreate fires.

For each top-level item, BIRT processes all the second-level items before proceeding to the next top-level item. A second-level report item is a report item that is contained within a top-level item. For example, a table contained in a grid is a second-level report item.

There can be any number of levels of report items. To see the level of a particular report item, examine the structure of the report design in Outline, in the BIRT Report Designer, as shown in Figure 7-1.



- new_report_1.rptdesign
  - Data Sources
  - Data Sets
  - Data Cubes
  - Report Parameters
  - Body
    - List
      - Header
      - Detail
        - Data[CUSTOMERNAME]
      - Footer
      - Groups
  - MasterPages
  - Styles
  - Embedded Images
  - Libraries
  - Scripts

Figure 7-1 Outline showing the level of a report item

If a RunAndRenderTask process executes the generation phase, each element is created and immediately rendered, which fires the onRender event before proceeding to the next element. If a RunTask process executes the generation phase, the onRender events do not fire.

Table 7-8 lists the events triggered in the generation phase for each major report component in the order in which these events execute. The data source, data set, and onPageBreak events are optional.

Table 7-8 Generation phase events

Report component	RunTask	RunAndRenderTask
Master Page content	Data source and data set events (optional) onCreate onPageBreak (optional)	Data source and data set events (optional) onCreate onRender onPageBreak (optional)
Body (iterative)	Data source and data set events (optional) onCreate onPageBreak (optional)	Data source and data set events (optional) onCreate onRender onPageBreak (optional)

Data source and data set events do not fire if a report item is not data bound or if the report item is bound to another report item that executed previously. The onPageBreak event fires only when an actual page break occurs.

The next three sections describe the data source, data set, data binding, and page break events in more detail.

About data source and data set events

Events for data source and data set elements fire just prior to creating the report item bound to the data set. This sequence occurs for every report item bound to a data set with the exception of the data source beforeOpen and afterOpen events. These events do not fire if a data source has already been used. When a report item is bound to another report item, none of these events fire for the bound report item, supporting two data-bound items sharing one data set without re-executing the data set.

The data source beforeClose and afterClose events fire at the end of the generation phase just before the afterFactory event fires. In the generation phase, there is no difference in data source or data set processing in RunTask and RunAndRenderTask.

BIRT supports data set caching, by which data sets execute only once and are used multiple times. In this case, the data set events fire on only the first use. If a data set is parameterized and the actual parameter value is changed within a report item, the query executes again using the new parameter value. This query execution causes the data set events to fire again. Table 7-9 lists the data source and data set types and events in the order in which these events execute.

Table 7-9 Data source and data set events

Event type and event	RunTask	RunAnd RenderTask
Data source beforeOpen	Yes	Yes
Data source afterOpen	Yes	Yes
Data set beforeOpen	Yes	Yes
DataSet afterOpen	Yes	Yes
DataSet onFetch for all rows of data	Yes	Yes
Process the data-bound Report Item	Yes	Yes
DataSet beforeClose	Yes	Yes
DataSet afterClose	Yes	Yes

About data binding

Data binding in BIRT makes a logical separation between BIRT data sets and data-bound elements, such as tables and lists. Selecting a table or list and then the Binding tab in the Property Editor displays the current bindings for the item. A report developer can create bound columns that use external objects to calculate a specific column value. The bound data set continues to determine the number of rows that are processed for a given table or list.

In a table or list, evaluation of the data bindings for the detail rows occurs before the onCreate event on the current row. This approach supports the onCreate event handler retrieving the appropriate values for the row.

The bindings are evaluated for each detail row in a bound data set. Table footers containing data elements that use a binding are evaluated before the last onCreate event for the final detail row.

Trying to alter a bound column using the onCreate script is discouraged. For example, it is possible to concatenate a column value for a row with all previous rows for the given column using the onCreate script with a JavaScript variable. If this value is in the expression of a bound column, the last value is excluded from the bound column. To display the last value, use a computed column, an aggregation report item, or the dynamic text <VALUE-OF> tag in a text element to display the JavaScript value.

A report developer must not assume any particular evaluation order of binding expressions relative to the various table item events, except that a binding evaluates before the onCreate event of an item that uses it. Best practice is to perform any required manipulation of the data in a data set script or the binding expression.

Data binding evaluation for a group evaluates the bound column many times before creating the table or list item. BIRT performs multiple passes over the data to support grouping. Any script in a group-bound column expression is called every time the data binding evaluates, affecting report performance.

All bindings of a table are always calculated, whether or not these bindings are used by the table. For performance reasons, check the binding list and remove any unused items from the report design.

Report items can share data bindings. For example, two tables can share the same set of bindings. The second table does not re-evaluate the data bindings. To use this feature in the BIRT Report Designer, select the second table, choose Binding in Property Editor, select Report Item, and select the appropriate report item from the list. The list supports only named data-bound report items.

The above scenarios affect any BIRT expression that uses the Available Column Bindings category.

About page break events

Many report items support page breaks. Setting a page break interval on a table instructs the table to process a certain number of rows and then apply a page break. Setting a page break on a group section applies a page break both before and after or only after the group processes. A page break can be applied before many other report items. For example, applying a page break before a row in a table instructs the engine to apply a page break before every row of data that a table processes.

Page events are based on the paginated HTML emitter. If a report generates 5 HTML pages but has 20 PDF pages, the page events fire only 5 times.

The general order of the events is as follows.

- The engine creates the page.
- The onPageStart event fires for the report.
- The onPageStart event fires for the selected master page.
- For items that are to appear on the page, the onPageBreak event fires.
- The onPageEnd event fires for the selected master page.
- The onPageEnd event for the report fires.
- The engine evaluates the Master Page Auto Text fields.

The onCreate events for all items that are to appear on a page fire before the report's onStart event. Some items have their onCreate triggered but do not appear on a page because of the keep together flag. Such items appear on the following page.

The page-level scripts are used when the Run and Render tasks are separated.

About chart event order

Chart events are handled by the chart engine and execute within the presentation phase. These events are covered in a later chapter.

About table and list event order

The BIRT engine fires the onCreate event for report items iteratively. When processing report items that iterate over data rows, such as a table or list, the event order changes to add additional events for each row of data. Row containers process data rows.

Row execution sequence

Tables, lists, and groups have rows. BIRT processes all rows identically. There are three kinds of rows:

- Header
- Detail
- Footer

Figure 7-2 illustrates the execution sequence for a row. A list or table can contain multiple elements, such as detail rows or table header rows.

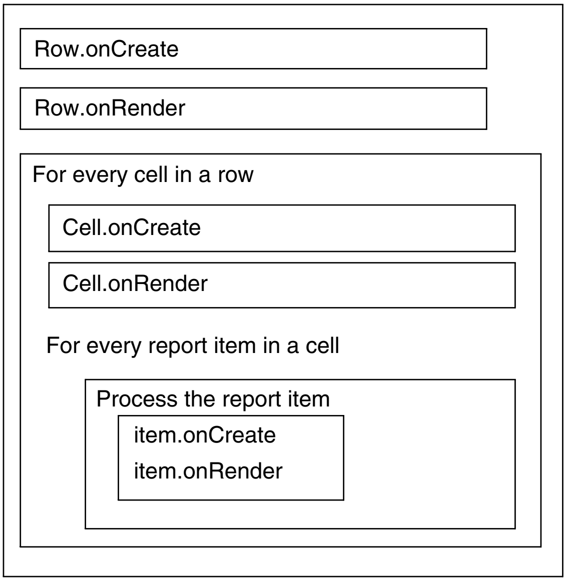


Figure 7-2 Row execution sequence

Table and list method execution sequence

A list is equivalent to a table that has only a single cell in every row. BIRT processes tables and lists identically, except that for a list, BIRT does not iterate through multiple cells. BIRT processes tables in three steps, the setup, detail, and wrap-up processing steps.

The following sections describe the table and list execution sequence steps.

Table and list setup step

The pre-table processing step is the same for all tables, both grouped and ungrouped.

Figure 7-3 illustrates the execution sequence for the pre-table processing step. This illustration shows the event order when using a RunAndRenderTask in the generation phase.

A RunTask does not fire onRender events. A RenderTask does not fire onCreate, data source, and data set events. The data source and data set events are optional.

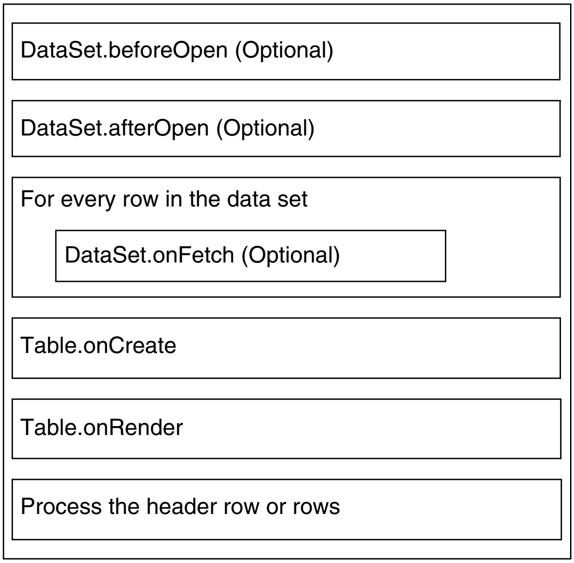

DataSet.beforeOpen (Optional)
DataSet.afterOpen (Optional)
For every row in the data set
DataSet.onFetch (Optional)
Table.onCreate
Table.onRender
Process the header row or rows

Figure 7-3 Table and list setup execution sequence

Table and list processing step

The sequence for the table and list processing step depends on whether the table or list is grouped. A table or list having no grouping has a different sequence from one that has grouping.

Figure 7-4 illustrates the execution sequence for a table or list without grouping.

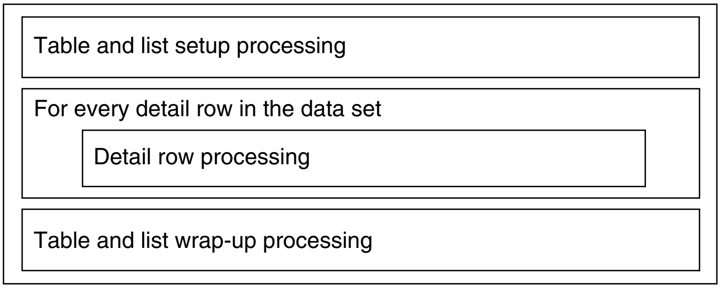


Table and list setup processing
For every detail row in the data set
Detail row processing
Table and list wrap-up processing

Figure 7-4 Ungrouped table or list detail execution sequence

For a table having grouping, BIRT creates one ListingGroup item per group.

A ListingGroup is similar to a table in that it has one or more header rows and one or more footer rows. BIRT processes grouped rows in the same way that it processes a table row.

In addition to the standard onPrepare, onCreate, and onRender events for these rows, the ListingGroup fires the onPageBreak and onPrepare events for the group. To access the script location for these event handlers, locate the group in the outline view and select the script tab. Use code in the onPrepare event handler to modify grouping behavior, such as changing the sort order.

Figure 7-5 illustrates the method execution sequence for a table that has groups.

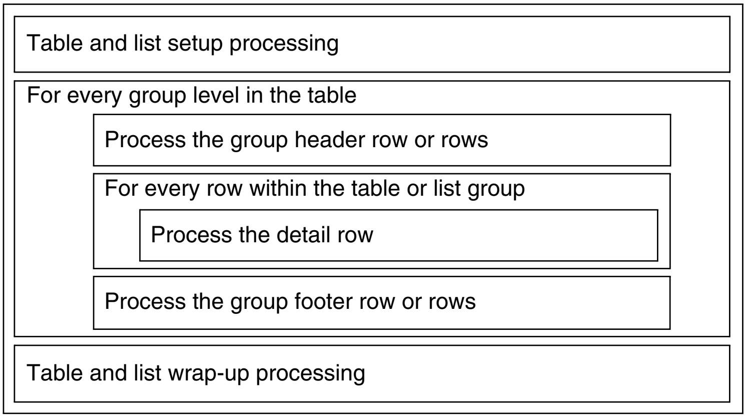


Table and list setup processing
For every group level in the table
Process the group header row or rows
For every row within the table or list group
Process the detail row
Process the group footer row or rows
Table and list wrap-up processing

Figure 7-5 Grouped table execution sequence

To verify the execution sequence of event handlers for a specific report, add logging code to the event handlers.

Table and list wrap-up step

The post-table processing step is the same for all tables, both grouped and ungrouped.

Completion of the generation phase

On completion of the generation phase, all data sources, beforeClose and afterClose events fire, followed by the afterFactory event. If using the RunAndRenderTask, the afterRender event fires before closing the data sources. Table 7-10 describes the events available at completion of the generation phase.

Table 7-10 Completing the generation phase

Element type and event	RunTask	RunAndRenderTask
afterRender	No	Yes
Data Source(s) beforeClose	Yes	Yes
Data Source(s) afterClose	Yes	Yes
afterFactory	Yes	No

Presentation phase operation

The presentation phase launches the appropriate emitter and produces report output based on the generated report. This phase fires the onRender events for all items as they are created. If using the RenderTask to render an existing report document, the initialize event triggers first and then each rendered report item's onRender event fires.

If the RenderTask renders pages individually, the onRender event fires only for items that are rendered. For example, BIRT Web Viewer uses a RunTask to create a report document. The web viewer uses a RenderTask to render the first page. This action fires the initialize event first and the onRender event for each item that appears on the page. Selecting a new page and using the pagination controls results in a new RenderTask that calls the initialize event again and triggers the onRender event for each item on the new page.

Event order summary

Table 7-11 summarizes the report design and report item events triggered in each processing phase. The events are listed in the order they are fired for a particular task. Page break, getDefaultValueList, getSelectionValueList, data source, and data set events are not shown for brevity.

Table 7-11 Event order summary

Element type and event	RunTask	RunAnd Render Task	Render Task	Notes
Parameter validate	Yes	Yes	n/a	Only available in JavaScript.

Table 7-11 Event order summary

Element type and event	RunTask	RunAnd Render Task	Render Task	Notes
Report initialize	Yes	Yes	Yes	Called multiple times using the RenderTask.
MasterPage Content onPrepare	Yes	Yes	n/a	
Body Iterate onPrepare	Yes	Yes	n/a	
Report beforeFactory	Yes	Yes	n/a	
Data source and data set beforeOpen and afterOpen	Yes	Yes	n/a	
Report beforeRender	n/a	Yes	Yes	
MasterPage Content onCreate	Yes	Yes	n/a	
Body Iterate onCreate	Yes	Yes	n/a	
Page Events	Yes	Yes	n/a	
Body Iterate onRender	n/a	Yes	Yes	RunAndRenderTask triggers this event immediately after onCreate for a report item.
Report afterRender	n/a	Yes	Yes	
Data source and data set beforeClose and afterClose	Yes	Yes	n/a	
Report afterFactory	Yes	Yes	n/a	

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