Eclipse Corner Article

We Have Lift-off: The Launching Framework in Eclipse

Summary
The ability to launch (run or debug) code under development is fundamental to an IDE. But because Eclipse is more of a tools platform than a tool itself, Eclipse's launching capabilities depend entirely on the current set of installed plug-ins. This article describes the API available to build launching plug-ins and works through developing an example launcher using this API.

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Prerequisites

To get the most out of this article, the reader should have a basic understanding of the Eclipse plug-in architecture and the structure of `plugin.xml` files. In addition, some knowledge of Java and Java terminology (VM, classpath, etc.) is helpful, though not necessary.

In the beginning, there was nothing

For purposes of this article, *launching* is defined as running or debugging a program from within Eclipse, and a *launcher* is a set of Java classes that live in an Eclipse plug-in that performs launching. As with most things in Eclipse, there is no 'built-in' launching functionality. The base Eclipse workbench can't launch a thing. It is only through plug-ins that Eclipse gains the ability to launch. The Eclipse SDK does ship with a set of useful launchers for launching local Java applications & Java applets, connecting to remote Java applications, launching JUnit test suites and starting an Eclipse workbench, but if none of these satisfy your needs and you can't find a plug-in someone else has written to do the job, you will need to write your own launcher.

A little history

Prior to 2.0, launching in Eclipse was somewhat inflexible and decentralized. For these reasons and many others, the launching framework was overhauled for 2.0. The primary issues addressed were:

- Allow developers to easily contribute launchers that are tightly integrated with the platform.
- Break the launcher/resource dependency. Previously, launchers only worked on workspace resources.
- Centralize the collection of launch-related attributes.
- Allow users to save sets of launching attributes for reuse.

The downside of all these improvements is that there is no backward compatibility. Eclipse 1.0 plug-ins that do launching will have to be reworked for 2.0. However, such conversions are relatively painless, and should result in much improved functionality.

Let there be framework

If you've decided to write your own launcher, you're in luck. Eclipse 2.0 plug-in developers have a rich API at their disposal to build plug-ins with launching behavior. In 2.0, launching is centered around two main entities, **LaunchConfigurations** and **LaunchConfigurationTypes**. At the simplest level, LaunchConfigurationTypes are cookie cutters, and LaunchConfigurations are the cookies made from these cookie cutters. When you as a plug-in developer decide to create a launcher, what you are really doing is creating a specific kind of cookie cutter that will allow your users to stamp out as many cookies as they need. In slightly more technical terms, a LaunchConfigurationType (henceforth, a 'config type') is an entity that knows how to launch certain types of launch configurations, and determines what the user-specifiable parameters to such a launch may be. Launch configurations (henceforth, 'configs') are entities that contain all information necessary to perform a specific launch. For example, a config to launch a HelloWorld Java application would contain the name of the main class ('HelloWorld'), the JRE to use (JDK1.4.1, for example), any program or VM arguments, the classpath to use and so on. When a config is said to be 'of type local Java Application', this means that the local Java application cookie cutter was used to make this config and that only this config type knows how to make sense of this config and how to launch it.

Configs and working copies

Plug-in developers don't need to directly concern themselves with the launch configuration lifecycle. Once you've implemented a config type, the launching infrastructure contributed by the Debug core plug-in (`org.eclipse.debug.core`) takes care of creating and persisting configs on behalf of the config type, and infrastructure provided by the Debug UI plug-in (`org.eclipse.debug.ui`) provides a dialog to manage configs (the 'LaunchConfigurationDialog'), as well as other launching-related UI.

However, plug-in developers do need to know how to interact with configs. All config objects implement the `org.eclipse.debug.core.ILaunchConfiguration` interface which defines methods for retrieving information about the config, but no methods for changing the config. This is because objects implementing `ILaunchConfiguration` are immutable and cannot be changed. If you wish to change a config, you must have a reference to an object that implements the `org.eclipse.debug.core.ILaunchConfigurationWorkingCopy` interface. This interface extends `ILaunchConfiguration`, but adds methods for changing the contents of the config. The contents of a config consist of name/value pairs called 'attributes'. An attribute specifies one discrete piece of information about a config, for example the JRE to use when launching a Java-oriented config. By looking at the API defined by `ILaunchConfiguration` and `ILaunchConfigurationWorkingCopy`, you can see that attribute values must be one of 5 types:

- **boolean**
- **int**
- `java.lang.String`
- `java.util.List` (all elements must be of type `java.lang.String`)
- `java.util.Map` (all keys & values must be of type `java.lang.String`)

This may seem limiting, but in practice, developers create `String` mementos for complex data types and store these.

tip *When referencing attribute names in code, you should always use publicly available constants. This allows other developers to access your attributes.*

Separating model and UI

To use the launcher API, your plug-in must make some import declarations in its `plugin.xml` file. If your plug-in declares a config type, it **must** import `org.eclipse.debug.core`, and if your plug-in declares anything related to launching UI, it **must** import `org.eclipse.debug.ui`. In general, it is recommended that the UI and non-UI aspects of your launcher be handled by two *different* plug-ins. Note that it is not required for a launcher to have *any* associated UI. In this case, the launcher can only be used programmatically from within code, not by a user (see the forthcoming related article "How to Launch Java Applications Programmatically" by Darin Wright). Even if your launcher has an associated UI, there may be times when you or someone else wants to use your launcher programmatically. Without a clean separation between UI & non-UI code, a plug-in wishing to use your launcher programmatically would have to import the standard UI plug-ins, which may be inconvenient, inefficient or impossible.

The Java applet example

The rest of this article is concerned with developing a launcher for Java applets. This launcher is actually part of the Eclipse SDK (as of version 2.1), so all of the source code presented here can be viewed by downloading the SDK. The non-UI parts of this launcher live in the `org.eclipse.jdt.launching` plug-in, and the UI parts are contained in the `org.eclipse.jdt.debug.ui` plug-in. Each XML declaration that follows is marked as being UI or non-UI in nature. This is to help you separate out the UI components in launchers you create.

Declaring a launch configuration type

The first step in creating our applet launcher is declaring a config type, as shown in the following snippet of XML from our plug-in's `plugin.xml` file:

Non-UI declaration

```
<extension point="org.eclipse.debug.core.launchConfigurationTypes">
    <launchConfigurationType
        name="Java Applet"
        delegate="org.eclipse.jdt.internal.launching.JavaAppletLaunchConfigurationDelegate"
        modes="run, debug"
        id="org.eclipse.jdt.launching.javaApplet">
    </launchConfigurationType>
</extension>
```

The most important part of this declaration is the `delegate` attribute which specifies the fully-qualified name of a class that implements the interface `org.eclipse.debug.core.model.ILaunchConfigurationDelegate`. The delegate is the brains of the launcher, and implements the `launch()` method which launches a specified config.

The `modes` attribute specifies one or both of `run` & `debug`. The debug infrastructure only supports these two modes of launching, and to be useful, your config type must support at least one of these. Among other things, this value tells the workbench where configs of your type may appear in the UI. For example, if the launch configuration dialog is opened in run mode, but your config type is for debug mode only, then your config type and any associated configs will not appear. Note that if your config type declares both modes, it is your delegate's responsibility in the `launch()` method to handle both modes.

An optional attribute not present in the above declaration is `private`. This is a boolean attribute that indicates whether the config type should appear in the UI, if there is one. Setting this attribute to `true` effectively makes your launcher usable for programmatic launching only. The default value, if this attribute is omitted, is `false`.

Another optional attribute not shown above is `category`. This string-valued attribute will be discussed later in the section on launch groups.

Implementing a launch configuration type

Source: org.eclipse.jdt.internal.launching.JavaAppletLaunchConfigurationDelegate

As noted above, the work of implementing a config type boils down to creating a delegate class that implements the interface `org.eclipse.debug.core.ILaunchConfigurationDelegate`. The only method on this interface is:

```
public void launch(ILaunchConfiguration configuration,
                   String mode,
                   ILaunch launch,
                   IProgressMonitor monitor) throws CoreException;
```

The first argument, `configuration`, is the most important. This specifies the config to be launched. The Debug UI framework ensures that your delegate is never asked to launch a config of the wrong type, however there is no such guarantee for programmatic launching, so you may want to verify the type of the `config` argument. In simple terms, the job of the `launch()` method is to extract all of the pertinent information from this config and then act upon it. For our applet launcher, this information includes things such as the name of the Applet class, the JRE to use, the width & height of the applet panel viewing area, the classpath to use and so on. Once this information has been extracted from the config and checked for validity, it is used to first generate an HTML file and then to launch an instance of the `appletviewer` utility on this HTML file.

The `mode` attribute has a value of either '`run`' or '`debug`'. Once again, the Debug UI framework makes sure your delegate is not asked to launch in a mode it can't handle, but with programmatic launching, any developer can ask your delegate to do anything, so some sanity checking is a good idea.

tip *When specifying a launch mode in code, you should never use a hard-coded `String`. Instead, use one of the constants defined in `org.eclipse.debug.core.ILaunchManager`.*

The third argument, `launch`, is the top-level debug model artifact that represents a launch. This object is created before the `launch()` method is called. The delegate's responsibility with respect to this argument is to add the debug targets and/or processes that result from launching to it. In our applet launcher, this is done inside the `IVMRunner.run()` call.

The last argument, `monitor`, is the progress monitor you should update during any long-running operations you perform. In addition, you should periodically check this monitor to see if the user has requested that the launch be canceled. This can be done via `monitor.isCanceled()`. Doing this allows your users the chance to change their minds, which makes your launcher much friendlier. Note that `monitor` may be `null` (for example, during a programmatic launch).

The implementation of the `launch()` method for our applet launcher delegate is made easier by that fact that the delegate extends `org.eclipse.jdt.launching.AbstractJavaLaunchConfigurationDelegate`. This class provides common functionality that most Java-oriented launchers will need. For example, it has methods to retrieve and verify Java-related config attributes such as the main type, classpath, bootpath and VM. In addition, our applet launcher takes advantage of some Java launching infrastructure in the form of `org.eclipse.jdt.launching.IVMRunner`. The VMRunner's job is simply to build a command line to launch the Java program, call `Runtime.exec()` on this command line and add the resulting debug targets/processes to the ILaunch object. The reason `IVMRunner` is an interface with several implementors is that each VM type (1.1.x, 1.3/1.4, J9, etc.) has its own idiosyncrasies. Also, there are different VMRunners for run & debug modes.

tip *If you are writing a launcher that fires up a JVM, you should seriously consider making your delegate extend `AbstractJavaLaunchConfigurationDelegate`. Also, you should take advantage of the `IVMRunner` infrastructure as much as possible.*

The following code fragment is taken from the `beginning of the launch()` method of `JavaAppletLaunchConfigurationDelegate`:

```
String mainTypeName = verifyMainTypeName(configuration);
IJavaProject javaProject = getJavaProject(configuration);
IType type = JavaLaunchConfigurationUtils.getMainType(
    mainTypeName, javaProject);
ITypeHierarchy hierarchy = type.newSupertypeHierarchy(
    new NullProgressMonitor());
IType javaLangApplet = JavaLaunchConfigurationUtils.getMainType(
    "java.applet.Applet", javaProject);
if (!hierarchy.contains(javaLangApplet)) {
    abort("The applet type is not a subclass of java.applet.Applet.");
}
IVMInstall vm = verifyVMInstall(configuration);
IVMRunner runner = vm.getVMRunner(mode);
```

This code snippet is typical of the verification done by the `launch()` method:

1 Use a framework method to verify & return the name of the 'main type', which in our case is the class that extends `java.applet.Applet`.
2 Use a utility method to return the `org.eclipse.jdt.core.IType` object for the Applet class.
3 Make sure that the specified applet class really does extend `java.applet.Applet`.
4 Verify & return the `org.eclipse.jdt.launching.IVMInstall` object that corresponds to the JRE specified in the configuration.
5 Ask the installed VM for a VMRunner appropriate to the specified mode.

Further along in the `launch()` method is this snippet of code:

```
// Create VM config
VMRunnerConfiguration runConfig = new VMRunnerConfiguration(
    "sun.applet.AppletViewer", classpath);
runConfig.setProgramArguments(new String[] {buildHTMLFile(configuration)});
String[] vmArgs = execArgs.getVMArgumentsArray();
String[] realArgs = new String[vmArgs.length+1];
System.arraycopy(vmArgs, 0, realArgs, 1, vmArgs.length);
realArgs[0] = javaPolicy;
runConfig.setVMArguments(realArgs);

runConfig.setWorkingDirectory(workingDirName);

// Bootpath
String[] bootpath = getBootpath(configuration);
runConfig.setBootClassPath(bootpath);

// Launch the configuration
this.fCurrentLaunchConfiguration = configuration;
runner.run(runConfig, launch, monitor);
```

This is the code that actually performs the launch:

1 Create a `VMRunnerConfiguration`, which is just a convenience holder of various launch parameters. Notice the program being launched is the `appletviewer` utility.
2 Resolve the VM arguments and set them on the VMRunnerConfiguration.
3 Set the Java bootpath on the VMRunnerConfiguration.
4 Ask the VMRunner to launch. All information necessary to perform the launch is now contained in `runConfig`. This method call will result in building a command line and passing it to `Runtime.exec()`. If the launch mode was 'run', the resulting process is registered with the debug infrastructure. If the launch mode was 'debug', the resulting process is used to create a 'debug target', which is also registered.

On a Win32 machine, the command line built by the VMRunner to run a HelloWorld applet with our applet launcher might look like:

```
C:\Java\jdk1.4.1\bin\javaw.exe
       -Djava.security.policy=java.policy.applet
       -classpath C:\TargetWorkspaces\eclipse\MyApplets
               sun.applet.AppletViewer HelloWorldApplet1030633365864.html
```

Debugging the same applet would result in the following command line:

```
C:\Java\jdk1.4.1\bin\javaw.exe
       -Djava.security.policy=java.policy.applet
       -classpath C:\TargetWorkspaces\eclipse\MyApplets
       -Xdebug -Xnoagent
```

```
        -Djava.compiler=NONE
        -Xrunjdwp:transport=dt_socket,suspend=y,address=localhost:14983
                sun.applet.AppletViewer HelloWorldApplet1030634748522.html
```

tip *You can always see the command line used to initiate a launch by right-clicking the resulting process in the Debug View and selecting Properties. This is useful for debugging your delegate.*

To summarize, implementing a config type (Java or otherwise) means implementing the `launch()` method on your launch configuration delegate. This method has 2 main tasks to perform:

1. Construct a command line and pass it to `Runtime.exec()`
2. Create debug targets/processes and add these to the ILaunch object

Note that the first task may sometimes *not* involve calling `Runtime.exec()`. For example, the Remote Java Debug delegate does not need to execute anything in the OS because the program to be debugged is already running (possibly on another machine). In general though, if your delegate is launching something under development in the Eclipse workspace, you will probably want to use `Runtime.exec()`.

Declaring a launch configuration type icon

Now that we have a declared and implemented a config type, the next step is to flesh out the various UI elements associated with the config type. First up is an icon for the applet config type:

UI declaration

```
<extension point="org.eclipse.debug.ui.launchConfigurationTypeImages">
    <launchConfigurationTypeImage
        icon="icons/full/ctool16/java_applet.gif"
        configTypeID="org.eclipse.jdt.launching.javaApplet"
        id="org.eclipse.jdt.debug.ui.launchConfigurationTypeImage.javaApplet">
    </launchConfigurationTypeImage>
</extension>
```

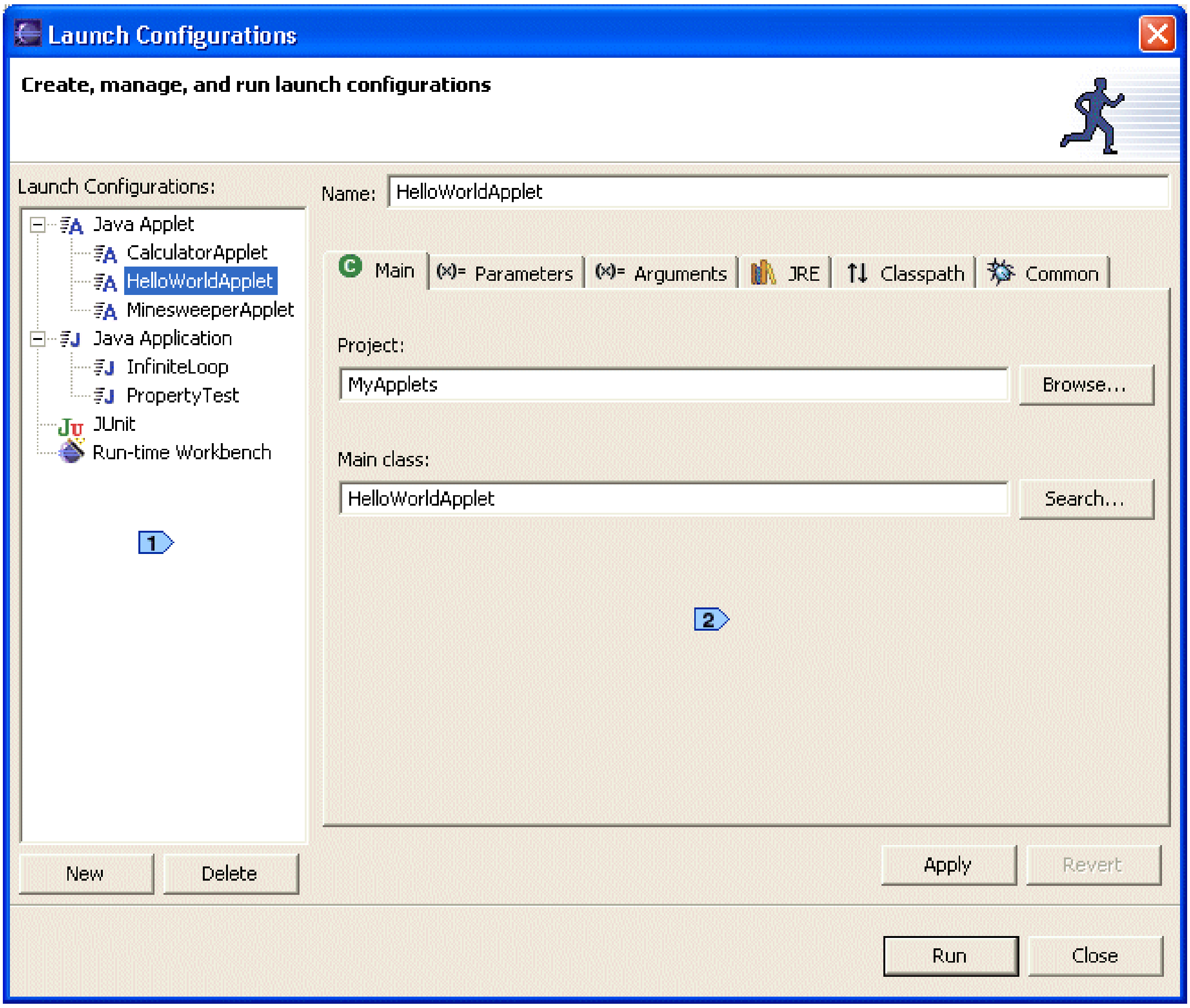
Note that the `id` attribute is just a unique identifier, whereas the `configTypeID` attribute should have the same value as the `id` attribute for our config type declaration. Notice that the icon is declared via a separate extension point instead of just being an attribute on the config type declaration. This is in keeping with the goal of not forcing launcher contributors to provide a UI.

Implementing a launch configuration type icon

There is no code to write when implementing a config type icon, you simply need to create the icon. The icon should be 16x16, contain no more than 256 colors, and have a transparent background.

Declaring a tab group

The most important piece of UI to consider when developing a new launcher is the 'tab group'. To understand how tab groups work, we need a little background on the LaunchConfigurationDialog provided by the Debug UI plug-in. This dialog (henceforth known as the 'LCD') is a central point for creating, managing, deleting and launching configs of any config type. If you have used any 2.0 or later version of Eclipse, you have probably seen the LCD:



The LCD is broken into two main regions:

1 The config tree shows all configs currently defined in the workspace, grouped by config type.

2 The tabbed folder lets users edit attributes of the config currently selected in the tree. The contents of this tabbed folder are specified when you declare a tab group.

The 6 tabs in the above figure show the launching attributes for **HelloWorldApplet**. These same 6 tabs would appear if either of the other two configs of type **JavaApplet** were selected, though of course they would show different values. If **InfiniteLoop** were selected, it would show a *different* set of tabs because this config is of a different config type. When you declare a tab group, you are telling the LCD to use the tabs specified in your tab group for configs of your config type. This makes perfect sense because if your config type requires width & height attributes (for example) in order to launch properly, the only way to get values for these attributes is via a set of tabs that appear when a config of your type is selected in the LCD. Another way to look at this is that if your config type requires some attribute X in order to function, then somewhere on a tab specified in your tab group, there better be some UI widget that collects a value for X.

Here is the XML for declaring a tab group:

UI declaration

```
<extension point="org.eclipse.debug.ui.launchConfigurationTabGroups">
    <launchConfigurationTabGroup
        type="org.eclipse.jdt.launching.javaApplet"
        class="org.eclipse.jdt.internal.debug.ui.launcher.JavaAppletTabGroup"
        id="org.eclipse.jdt.debug.ui.launchConfigurationTabGroup.javaApplet">
    </launchConfigurationTabGroup>
</extension>
```

All that this declaration really does is associate a tab group implementation (a class that implements the interface `org.eclipse.debug.ui.ILaunchConfigurationTabGroup`) with a config type. Any time a config of the specified type is selected in the LCD, the class named by the `class` attribute will be used to provide the content of the tabbed folder.

Implementing tab groups

Source: [org.eclipse.jdt.internal.debug.ui.launcher.JavaAppletTabGroup]()

The main job of a tab group is to specify the tabs that will appear in the LCD and set their order. These tabs may have been specially written for the particular config type in question, or they may be general purpose tabs that appear for multiple config types. The tab group for our applet launcher creates 6 tabs, of which 4 already existed (`JavaArgumentsTab`, `JavaJRETab`, `JavaClasspathTab`, `CommonTab`) and 2 which were written just for our applet launcher (`AppletMainTab` and `AppletParametersTab`):

```
public void createTabs(ILaunchConfigurationDialog dialog, String mode) {
        ILaunchConfigurationTab[] tabs = new ILaunchConfigurationTab[] {
                        new AppletMainTab(),
                        new AppletParametersTab(),
                        new JavaArgumentsTab(),
                        new JavaJRETab(),
                        new JavaClasspathTab(),
                        new CommonTab()
        };
        setTabs(tabs);
}
```

A tab group is free to mix & match any combination of existing and custom-written tabs. The only proviso is that tabs you wish to reuse must be in public (not internal) packages. In the simplest case, *all* of the tabs would be preexisting tabs and the work of providing a UI for our config type in the LCD would be done once we had defined a class similar to `JavaAppletTabGroup`.

tip *If you are implementing a tab group for a Java-oriented config type, you should consider reusing some or all of the Java tabs in the `org.eclipse.jdt.debug.ui.launchConfigurations` package.*

tip *<u>All</u> tab groups should include `org.eclipse.debug.ui.CommonTab`. This tab contains UI that allows users to make their configs 'local' or 'shared', mark configs as 'favorites' and control perspective switching when launching. By convention, this tab is the last tab in the tab group.*

If you decide that you need to write one or more of your own tabs, you need to understand the tab lifecycle defined by `org.eclipse.debug.ui.ILaunchConfigurationTab`, an interface which all tabs must implement. There is a convenience abstract class, `org.eclipse.debug.ui.AbstractLaunchConfigurationTab` that implements this interface and provides useful implementations of many of its methods. Whenever possible, you should extend this abstract class.

The first two events in a tab's life cycle are calls to `setLaunchConfigurationDialog(ILaunchConfigurationDialog)` and `createControl()` in that order. The first simply notifies the tab of the LCD object that owns it. Tabs make frequent calls to methods on the LCD, so a tab needs to have a reference to it. The second method creates the GUI widgetry for the tab and lays it out.

[Source: org.eclipse.jdt.debug.ui.launchConfigurations.AppletParametersTab]()

To illustrate the rest of the methods on `ILaunchConfigurationTab`, the `AppletParametersTab` implementation will be discussed. This class makes three field declarations you need to be aware of:

- `private Text widthText;`
- `private Text heightText;`
- `private Text nameText;`

where `Text` is the SWT text-field widget.

The three most important methods on a tab are the following 'value copying' methods:

- `public void setDefaults(ILaunchConfigurationWorkingCopy configuration);`
- `public void performApply(ILaunchConfigurationWorkingCopy configuration);`
- `public void initializeFrom(ILaunchConfiguration configuration);`

In general terms, the first two methods copy values from the tab to a working copy, while the third method copies values from a working copy to the tab. The `setDefaults()` method is called when a new config is created. This method sets default values for all attributes it understands on the working copy argument. This is done differently depending on the nature of the attributes collected by the tab. The `AppletMainTab` checks the current workbench selection or active editor to determine default values for the Project & Applet class attributes. The `CommonTab` sets hard-coded defaults, and the `JavaJRETab` sets the default JRE to be the JRE marked as the workbench default in the Java preferences.

The `performApply()` method reads current values from the GUI widgets on the tab and sets the corresponding attribute values on the working copy argument:

```
public void performApply(ILaunchConfigurationWorkingCopy configuration) {
```

```
        configuration.setAttribute(
           IJavaLaunchConfigurationConstants.ATTR_APPLET_WIDTH,
           (String)widthText.getText());
        configuration.setAttribute(
           IJavaLaunchConfigurationConstants.ATTR_APPLET_HEIGHT,
           (String)heightText.getText());
        configuration.setAttribute(
           IJavaLaunchConfigurationConstants.ATTR_APPLET_NAME,
           (String)nameText.getText());
        configuration.setAttribute(
           IJavaLaunchConfigurationConstants.ATTR_APPLET_PARAMETERS,
           getMapFromParametersTable());
}
```

The `initializeFrom()` method does the opposite of the `performApply()` method. It reads attribute values out of the config argument, and sets these values in the corresponding GUI widgets:

```
public void initializeFrom(ILaunchConfiguration config) {
    try {
1       fWidthText.setText(Integer.toString(config.getAttribute(
            IJavaLaunchConfigurationConstants.ATTR_APPLET_WIDTH, "200")));
    } catch(CoreException ce) {
        fWidthText.setText(Integer.toString(DEFAULT_APPLET_WIDTH));
    }
    try {
2       fHeightText.setText(Integer.toString(config.getAttribute(
            IJavaLaunchConfigurationConstants.ATTR_APPLET_HEIGHT, "200")));
    } catch(CoreException CE) {
        fHeightText.setText(Integer.toString(DEFAULT_APPLET_HEIGHT));
    }
    try {
3       fNameText.setText(config.getAttribute(
            IJavaLaunchConfigurationConstants.ATTR_APPLET_NAME, ""));
    } catch(CoreException CE) {
        fNameText.setText("");
    }
    updateParametersFromConfig(config);
}
```

1 Extract the value of the width attribute from the config and put it in the corresponding `Text` widget.
2 Extract the value of the height attribute from the config and put it in the corresponding `Text` widget.
3 Extract the value of the name attribute from the config and put it in the corresponding `Text` widget.
In all cases, if there is an error retrieving the attribute value, the `Text` widget is filled with a default value.

Both `performApply()` and `initializeFrom()` are called frequently, for example, whenever the user selects a new tab. Thus, they should not perform long-running operations.

The remaining methods on `ILaunchConfigurationTab` are also fairly straightforward. The `isValid(ILaunchConfiguration)` method returns `true` if all of the attributes in the tab currently have values that permit launching, within the context of the specified config:

```
public boolean isValid(ILaunchConfiguration launchConfig) {
    setErrorMessage(null);
    try {
1       Integer.parseInt(fWidthText.getText().trim());
    } catch(NumberFormatException nfe) {
2       setErrorMessage("Width is not an integer");
        return false;
    }
    try {
1       Integer.parseInt(fHeightText.getText()Trim());
    } catch(NumberFormatException nfe) {
2       setErrorMessage("Height is not an integer");
        return false;
    }
3   return true;
}
```

1 The config can be launched only when both the `width` & `height` attributes have valid integer values.

2 The appropriate response to a validation failure is calling `AbstractLaunchConfigurationTab.setErrorMessage(String)` with a description of the failure and returning `false`.
3 The other attribute values this tab is responsible for cannot be checked for validity, so at this point we declare the tab valid.

The `canSave()` method is similar to `isValid()`, and returns `true` if all of the attributes in the tab have values that permit saving.

tip *If you implement your own tab, consider making it public API so that others can reuse it.*

If you compare the API on `ILaunchConfigurationTabGroup` and `ILaunchConfiguration`, you will see a number of similarities. In particular, the following methods are common:

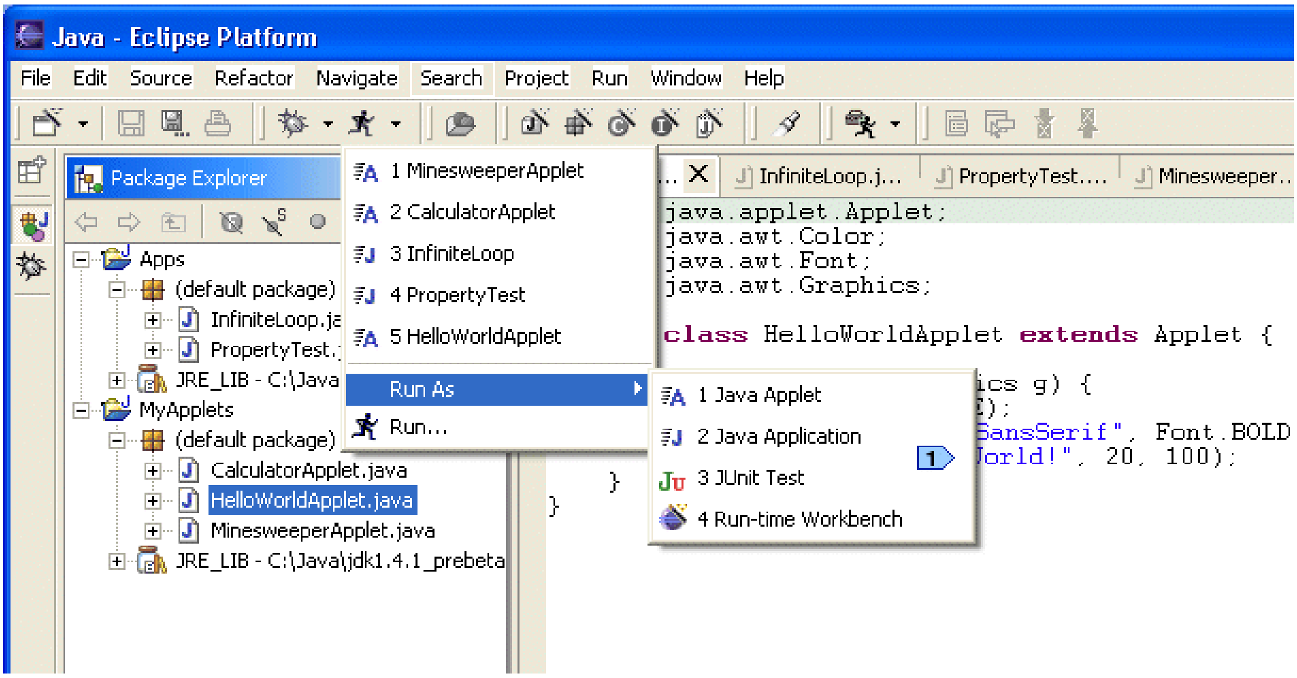
- `public void initializeFrom(ILaunchConfiguration configuration);`
- `public void performApply(ILaunchConfigurationWorkingCopy configuration);`
- `public void setDefaults(ILaunchConfigurationWorkingCopy configuration);`
- `public void launched(ILaunch launch);`

You will recognize the 3 'value copying' lifecycle methods for tabs, along with `launched(ILaunch)` which is simply a callback that happens when a successful launch has occurred. In most cases, the tab group is not interested in these calls and simply forwards them on to its tabs. When this is true, you should make your tab group extend `org.eclipse.debug.ui.AbstractLaunchConfigurationTabGroup`. This abstract class implements these 4 methods to simply loop through all owned tabs and make the corresponding call on each. The applet launcher tab group extends this abstract class. However, there are situations when you might want to implement some of these methods at the tab group level. Suppose you are reusing someone else's tab that specifies a default value for an attribute you don't like. You can change this default value and still reuse the tab by implementing the `setDefaults()` method on your tab group to first call `setDefaults()` on the tab in question (which sets the undesirable default value), then directly set the attribute in question to the value you prefer. In this way, you 'override' the one value you care about, while leaving the others as specified in the tab.

Declaring launch shortcuts

As useful as the LCD is, there are many times when users don't want to bother with it. They simply want to launch a program. This is where 'launch shortcuts' come in. A launch shortcut allows users to identify a resource in the workbench (either via selection or the active editor) and launch that resource with a single click *without* bringing up the LCD. Launch shortcuts are *not* useful when a user needs to tweak launch configuration attributes because the user gets no chance to set these. Launch shortcuts *are* useful when the user is happy with default values for all config attributes and wants to launch in a hurry.

The following figure shows how launch shortcuts appear in the UI:



1 The 'Run As' sub-menu of the 'Run' drop-down menu shows all config types that have registered a launch shortcut in the current perspective. Selecting one of the 'Run As' sub-menu choices activates the corresponding launch shortcut.

This is the XML to declare the applet launch shortcut:

UI declaration

```
<extension point="org.eclipse.debug.ui.launchShortcuts">
```

```
    <shortcut
        id="org.eclipse.jdt.debug.ui.javaAppletShortcut"
        class="org.eclipse.jdt.internal.debug.ui.launcher.JavaAppletLaunchShortcut"
        label="Java Applet"
        icon="icons/full/ctool16/java_applet.gif"
        modes="run, debug">
            <perspective id="org.eclipse.jdt.ui.JavaPerspective"/>
            <perspective id="org.eclipse.jdt.ui.JavaHierarchyPerspective"/>
            <perspective id="org.eclipse.jdt.ui.JavaBrowsingPerspective"/>
            <perspective id="org.eclipse.debug.ui.DebugPerspective"/>
    </shortcut>
</extension>
```

Though the screenshot showed only the 'Run' shortcuts, launch shortcuts apply equally to both modes. The `modes` attribute specifies which of the drop-down menus include the shortcut. In addition to being mode sensitive, launch shortcuts can also be configured to only appear in certain perspectives. The `perspective` sub-elements list each perspective in which the shortcut will be available. Only those perspectives that make sense for a particular shortcut should be specified. For example, specifying a C++ perspective for the Java applet launcher wouldn't be generally useful. Following this rule of thumb leads to better UI scalability.

Implementing launch shortcuts

Source: org.eclipse.jdt.internal.debug.ui.launcher.JavaAppletLaunchShortcut

The first step in implementing a launch shortcut is determining if you even need to. Launch shortcuts are strictly conveniences that make user's lives easier by allowing them to create a config, set all attributes to default values and launch that config in a single mouse click. If you don't provide a shortcut for your config type, users can always bring up the LCD 'manually', create a config of the desired type and launch it.

tip *There are two ways to bring up the LCD: (1) Choose Run... or Debug... from the drop-down menus to bring up the LCD on the last launched config or (2) As of 2.1, you can Ctrl click a favorite or history item in the drop-down menus to bring up the LCD on the corresponding config.*

Launch shortcut classes must implement the `org.eclipse.debug.ui.ILaunchShortcut` interface. This interface defines two `launch()` methods:

- `public void launch(ISelection selection, String mode);`
- `public void launch(IEditorPart editor, String mode);`

The only difference between them is how the entity to be launched is specified. In the first method, it's via a workbench selection, in the second it's as an editor part. Typically, both of these methods will defer the real work of creating a config and launching it to a helper method once the entity to be launched has been resolved:

```
    public void launch(IEditorPart editor, String mode) {
        IEditorInput input = editor.getEditorInput();
        IJavaElement javaElement =
            (IJavaElement) input.getAdapter(IJavaElement.class);
        if (javaElement != null) {
1           searchAndLaunch(new Object[] {javaElement}, mode);
        }
    }

    public void launch(ISelection selection, String mode) {
        if (selection instanceof IStructuredSelection) {
1           searchAndLaunch(((IStructuredSelection)selection).toArray(), mode);
        }
    }


    protected void searchAndLaunch(Object[] search, String mode) {
        IType[] types = null;
        if (search != null) {
            try {
2               types = AppletLaunchConfigurationUtils.findApplets(
                        new ProgressMonitorDialog(getShell()), search);
            } catch (Exception e) {
               /* Handle exceptions */
            }
            IType type = null;
```

```
3           if (types.length == 0) {
                MessageDialog.openInformation(
                    getShell(), "Applet Launch", "No applets found."};
4           } else if (types.length > 1) {
                type = chooseType(types, mode);
5           } else {
                type = types[0];
            }
            if (type != null) {
6               launch(type, mode);
            }
        }
    }

    protected void launch(IType type, String mode) {
        try {
            ILaunchConfiguration config = findLaunchConfiguration(type, mode);
            if (config != null) {
7               config.launch(mode, null);
            }
        } catch (CoreException e) {
            /* Handle exceptions*/
        }
    }
```

1 Both `launch()` methods from the `ILaunchShortcut` interface defer the real work to `searchAndLaunch()`. Notice that in the first `launch()` method, we have to resolve the entity to launch from the editor, whereas in the second, the selection contains the candidate entities to launch.
2 Since there may be more than one candidate entity to launch, we first filter out any that aren't applets.
3 We handle the case of no applets to launch by showing an informational dialog.
4 If there is more than one applet available to launch, ask the user to choose one.
5 Otherwise, there's exactly one applet.
6 If there's an applet to launch, do so.
7 Launch a config corresponding to the applet. The `findLaunchConfiguration()` method first attempts to find an existing config for the applet. Failing this, a new config is created and returned. Note that the actual launching happens by just calling `launch()` on the config.

In most cases, a launch shortcut is maximally useful if it performs the following steps:

1. Resolve something to launch from the specified selection or editor
2. Check to see if there is an existing config based on the resolved entity, if there is launch it
3. Otherwise, create a new config and populate it with default attribute values, except for those directly related to the resolved entity
4. Launch the new config

However, there is nothing in the `ILaunchShortcut` interface that requires you to follow these steps. For example, you could create a launch shortcut implementation that skipped step 2. This way, *every* time the shortcut was invoked, a new config would be created. This would normally lead to a flood of duplicate configs, however if the default value for an attribute was somehow time-dependent, this could be useful. Another variation might be to open the LCD on the newly created config. This might be necessary if some attribute has no reasonable default value and must be specified by the user. Note that even in this case, the shortcut saves time and keystrokes by creating a config and populating most of its attributes with appropriate values. The user only has to supply the required attribute(s), then click Run or Debug.

In summary, launch shortcuts are optional. If you choose to implement one, you should consider making it as useful as possible to your users. This might mean avoiding duplicate configs, or saving as many keystrokes as possible. In the end though, the `ILaunchShortcut` contract is very flexible and just provides a way to insert an action into a particular place in the UI.

Declaring a launch group

tip *Most developers writing launchers will not need to worry about 'launch groups', but they are covered here for completeness.*

Launch groups (introduced in Eclipse 2.1) are an organizational construct for config types whose primary purpose is to provide a way to filter configs & configs types in the UI. Standard UI components supplied by the launching framework such as the LCD are set up to always filter their contents with a single active launch group. In addition, the workbench tracks separate launch histories for each launch group. The Eclipse SDK provides two default launch groups, a standard 'Run' launch group and a standard 'Debug' launch group. When you open the LCD by choosing 'Debug...' from the debug drop-down menu, you are actually asking the LCD to open and display only configs that satisfy the filtering criteria specified by the standard 'Debug' launch group.

The filtering criteria of a launch group are specified in two pieces, a `mode` attribute (run or debug) and an optional `category` attribute. Remember that the config type declaration also included an optional `category` attribute. The purpose of this attribute is now clear - it serves to associate config types with launch groups. If a launch group specifies a value for its `category` attribute, then only config types that specify the same value for their `category` attributes are considered to belong to that launch group. The `mode` attribute serves to further refine which configs & config types belong to a specific launch group. Recall that config types declare their support for one or both of the allowable modes, run and debug. A launch group must specify exactly one of these modes in its declaration. We can now specify the complete filtering algorithm used to apply launch groups to UI elements such as the LCD:

- A config type is visible if it supports the mode of the currently active launch group ***and*** specifies the same category as the currently active launch group.
- A config is visible if its config type is visible.

This is the XML declaration of the standard 'Run' & 'Debug' launch groups:

UI declaration

```
<extension point = "org.eclipse.debug.ui.launchGroups">
        <launchGroup
                id = "org.eclipse.debug.ui.launchGroup.debug"
                mode = "debug"
                label ="Debug"
                image = "icons/full/ctool16/debug_exc.gif"
                bannerImage = "icons/full/wizban/debug_wiz.gif">
        </launchGroup>
        <launchGroup
                id = "org.eclipse.debug.ui.launchGroup.run"
                mode = "run"
                label = "Run"
                image = "icons/full/ctool16/run_exc.gif"
                bannerImage = "icons/full/wizban/run_wiz.gif">
        </launchGroup>
</extension>
```

Notice that neither declaration specifies a `category`. This means that only config types that also do not specify a category attribute will be visible when one of these launch groups is active in the UI. All of the standard launchers included in the SDK fall into this category: Java Application, Java Applet, Remote Java Application, JUnit & Run-time Workbench.

The rest of the available options for a launch group declaration are straightforward. The `id`, as always, is merely a unique identifier for the launch group, `label` is a human-readable description of the launch group, and `image` and `bannerImage` are a 16x16 icon and a larger image suitable for placing at the top of a wizard or dialog. Not shown above is an optional `public` attribute that controls whether the launch group's history is editable by the user in the workbench Debug preferences. The default value if this attribute is not specified is `true`.

Given that the standard toolbar drop down actions always open the LCD with one of the two default launch groups active, you might wonder about the usefulness of launch groups. In other words, if all of the standard SDK launchers belong to the empty category, and the LCD always opens on either the empty debug or empty run launch group, what is the point? The answer is that unless you are trying to use the launch config framework in new and clever ways, launch groups aren't of much interest. However, if you want to use the launch config framework to do things other than launch code under development, launch groups can be useful.

As an example of a *useful* application of launch groups, we will look at the external tools plug-ins. The purpose of the external tools plug-ins is to allow developers to run things *other* than the code they are currently developing. Sometimes these programs are tangential to the development process, such as an MP3 player or a mail client. Other times, developers might want to launch Ant scripts that build or deploy projects. This type of launching is different from the launching discussed so far in this article, but it does have many similarities. Because of the similarities, the launch config framework was used as the basis of the launching-related pieces of the external tools plug-ins.

Below is the declaration of two launch groups associated with external tools:

UI declaration

```
<extension point = "org.eclipse.debug.ui.launchGroups">
        <launchGroup
                id = "org.eclipse.ui.externaltools.launchGroup"
                mode = "run"
                category = "org.eclipse.ui.externaltools"
                label = "&External Tools"
                image = "icons/full/obj16/external_tools.gif"
```

```
                bannerImage = "icons/full/wizban/ext_tools_wiz.gif">
        </launchGroup>
        <launchGroup
                id = "org.eclipse.ui.externaltools.launchGroup.builder"
                mode = "run"
                category = "org.eclipse.ui.externaltools.builder"
                label = "&External Tools"
                image = "icons/full/obj16/external_tools.gif"
                bannerImage = "icons/full/wizban/ext_tools_wiz.gif"
                public = "false">
        </launchGroup>
</extension>
```

Notice that each launch group specifies its own `category`. This is so that UI components don't display 'regular' external tool configs and 'builder' external tool configs at the same time. It also means that there are two different launch histories for these configs (though the 'builder' history is not public so it does not appear in the Debug preferences). In addition, this means that the external tools plug-ins are free to create launch configs as they see fit, without fear that these configs might show up in the LCD when the user is trying to run code they are developing. Finally, this means that the external tools plug-ins can implement their own relaunching actions and not worry about accidentally launching a program under development.

Implementing a launch group

Source: org.eclipse.debug.ui.DebugUITools

Implementing a launch group does not require implementing any API. A launch group exists simply as an XML declaration with no associated classes. However, there is some launch group-related API you should be aware of. This API allows developers to bring up the LCD with a specified launch group actively filtering its contents. It is worth repeating that this is ***not*** something most launcher developers need to worry about. It is only useful if you have a need to show configs of a specific config type and mode separately from all other configs.

The `DebugUITools` class defines the following two launch group-related methods:

```
1 public static int openLaunchConfigurationDialogOnGroup(
        Shell shell, IStructuredSelection selection, String groupIdentifier);
2 public static int openLaunchConfigurationPropertiesDialog(
        Shell shell, ILaunchConfiguration configuration, String groupIdentifier);
```

Both of these methods are used to bring up UI components subject to filtering provided by the specified launch group. In both cases, `groupIdentifier` is the value of the `id` attribute in a launch group XML declaration, and `shell` is just the SWT Shell that will be the parent of the new UI component.

1 This method opens the LCD and sets the tree selection to the specified selection, which may contain any combination of `ILaunchConfigurationType`s and `ILaunchConfiguration`s.
2 While the previous method opens the entire LCD, this method opens just the tabbed folder properties area for the specified config; the tree is not shown. This is useful for allowing the user to edit a single config without any extraneous UI.

One other related method on `DebugUITools` is:

```
public static int openLaunchConfigurationDialog(
        Shell shell, IStructuredSelection selection, String mode);
```

This method opens the LCD much as method 1 did above, except that the launch group used for filtering is based on the value of `mode`. If `mode` is '`debug`', the LCD is opened on the empty 'Debug' launch group, otherwise it is opened on the empty 'Run' launch group. This can be useful even if you aren't defining launch groups, since it allows developers to pop up the LCD with an arbitrary selection.

To summarize, most launcher developers will never need to concern themselves with launch groups. They are a technique for filtering configs and config types in the UI that is hidden from the user, in other words, the user has no way to control which launch group is active in the UI. Launch groups are useful when a developer uses the launch configuration framework to do something *other* than write a launcher that launches user code under development.

Declaring a launch configuration comparator

The following discussion of launch configuration comparators is somewhat more advanced than the previous sections, and the implementation example requires a bit more knowledge of Java and the Eclipse JDT plug-ins (however launch configuration comparators are ***not*** Java-specific and can be implemented for any debug model). Launch configuration comparators are an entirely optional feature of launchers, so this section and the following section on implementation can be safely skipped.

Because all attributes on a config are defined by the developer, the Debug core & Debug UI infrastructures have no knowledge of attribute semantics. They know only that there is a `String`-valued attribute named JRE, not that this String is a memento that specifies the installed name and type of the JRE. This gets to be a problem when the debug infrastructure needs to perform comparisons with configs, for example, determine if two config objects actually represent the same underlying configuration, or in the LCD, determine if a config has been modified by the user. Without help from the developer, the best the infrastructure can do is call `Object.equals(Object)` on attribute values (or use == for primitive types). This may be fine for some attributes, but you can imagine situations in which this would be incorrect. For example, suppose your tab group collects a list of `String`s as an attribute value, and suppose that order is not significant. Left to its own devices, the Debug infrastructure would determine that two configs containing the same list of Strings in their attribute values but in different orders, were not equal. The solution to this problem lies in declaring a launch configuration comparator. This is an entity that the Debug infrastructure will use to perform all comparisons for attributes with a specified name. The Java Applet launcher doesn't declare any comparators, but the standard Java Application launcher does:

Non-UI declaration

```
<extension point="org.eclipse.debug.core.launchConfigurationComparators">
        <launchConfigurationComparator
                id="org.eclipse.jdt.launching.classpathComparator"
                class="org.eclipse.jdt.internal.launching.RuntimeClasspathEntryListComparator"
                attribute="org.eclipse.jdt.launching.CLASSPATH"/>
</extension>
```

This declaration tells the Debug infrastructure to use the class `RuntimeClasspathEntryListComparator` any time it performs a comparison involving an attribute named "`org.eclipse.jdt.launching.CLASSPATH`". Note that this comparator will be used for *all* attributes with this name, regardless of config type. This allows you to reuse comparators that have already been implemented by other developers, but requires caution in attribute naming.

tip *When creating names for config attributes, you should always prefix them with the fully qualified name of your plug-in. This avoids potential collisions down the road if someone else extends your launcher. It also avoids unintentionally using someone else's comparator.*

Implementing a launch configuration comparator

Source: org.eclipse.jdt.internal.launching.RuntimeClasspathEntryListComparator

To implement a launch configuration comparator, you simply need to implement the standard Java library interface `java.util.Comparator`. This interface defines a single method, `public int compare(Object o1, Object o2)` that returns a negative value if `o1` is less than `o2`, zero if `o1` equals `o2` and a positive value if `o1` is greater than `o2`:

```
    public int compare(Object o1, Object o2) {
        List list1 = (List)o1;
        List list2 = (List)o2;
        if (list1.size() == list2.size()) {
            for (int i = 0; i < list1.size(); i++) {
                String memento1 = (String)list1.get(i);
                String memento2 = (String)list2.get(i);
                try {
                    IRuntimeClasspathEntry entry1 =
                       JavaRuntime.newRuntimeClasspathEntry(memento1);
                    IRuntimeClasspathEntry entry2 =
                       JavaRuntime.newRuntimeClasspathEntry(memento2);
1                   if (!entry1.equals(entry2)) {
                        return -1;
                    }
                } catch (CoreException e) {
                    LaunchingPlugin.log(e);
                    return -1;
                }
            }
            return 0;
        }
            return -1;
    }
```

1 This method simply reconstructs `IRuntimeClasspathEntry` objects from the `String` mementos stored in the `List` arguments, then calls `equals(Object)` on these. The implementation of `equals()` on the `IRuntimeClasspathEntry` objects will do an intelligent comparison.

Another use for comparators is disambiguating default values for attributes. Consider an integer-valued attribute named 'address' whose default value is zero. If the debug infrastructure is asked to compare two configs, one of which has an address value of zero, and the other which has no address attribute, it would normally declare these to be not equal. However the absence of an address value should in most cases mean the same thing as a default address value. The solution is to implement a comparator that encapsulates this logic.

tip *In the LCD, if you select a config, then without making any changes to it select a different config and are asked if you wish to save changes, the problem is probably due to a mismatch between a default attribute value and no attribute value. Implement a comparator to fix the problem.*

Putting it all together

There are a couple of things to keep in mind while developing a launcher:

- Putting your UI code in one plug-in and everything else in another plug-in makes your launcher easier to maintain, facilitates programmatic launching, and allows you or someone else to provide an alternate UI for your launcher.
- If your delegate requires some attribute to function properly, there must be UI somewhere in your tab group to collect it
- The 3 main 'value copying' methods on tabs are called frequently and must execute quickly. If you need to perform some sort of lengthy validation, consider waiting until launch time to do it.

Work smarter, not harder

The first rule of implementing a launcher is to reuse as much as possible. If you are implementing a Java-oriented launcher, there is a large amount of code that is part of the Eclipse SDK, is public API and ready to be reused. This article has pointed the opportunities for Java-oriented reuse. Non-Java launchers can also take advantage of reuse. For example, consider extending language-independent abstract API classes like:

- `org.eclipse.debug.ui.AbstractLaunchConfigurationTabGroup`
- `org.eclipse.debug.ui.AbstractLaunchConfigurationTab`.

To get further reuse outside of Java, you need to identify plug-ins that contain code you wish to reuse. Encourage other plug-in developers to make their launching related classes public so that you can reuse them, and consider making your own launching-related classes public for the same reason.

Source code

The Java Applet launcher discussed in this article is part of the Eclipse SDK, as of release 2.1. All UI code for this launcher is found in the `org.eclipse.jdt.debug.ui` plug-in, while the non-UI code lives in the `org.eclipse.jdt.launching` plug-in.

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