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| Developing JAX-RS Web Applications Utilizing Server-Sent Events and WebSocket  Martin Matula  Sr. Development Manager |

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# Introduction

In this lab we are going to demonstrate some of the new up-coming features of JavaEE 7 as well as value-add features we are working on for GlassFish, the JavaEE reference implementation. We will develop a web application that allows users to collaboratively draw simple pictures.

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* architektura aplikace (font-end nad angularjs, na serveru grizzly, na nem websocket, jersey a moxy)

# Exercise 1: Exposing RESTful API

In this first exercise, we are going to create and expose a simple RESTful API for CRUD (create, retrieve update, delete) operations on top of drawings. To save time, instead of starting from scratch, there is an existing project in the <lab\_root>/exercise1 we are going to add this functionality to.

## Step 1: Exploring the Initial Project

Let’s first look at what’s already in the project:

1. Start NetBeans and open the project **drawingboard** from **<lab\_root>/exercise1** directory.
2. Expand “Drawing Board Web Application”/”Web Pages” folder in the project view. This folder contains the front-end of our application. It utilizes AngularJS JavaScript framework. The main entry point to the application is the index.html, which loads the framework scripts and style sheets. We define two views – main.html for working with the list of drawings and drawing.html for working with a single drawing. Most of the application-specific front-end logic is implemented in controller.js file, where we define controllers for these two views. The controllers take care of interacting with the backend, receiving the server-sent events as well as opening WebSocket connections. Detailed description of the JavaScript part of the application is beyond the scope of this hands-on-lab, as we are focusing on building the back-end part in Java.
3. Expand “Source Packages” node of the project. You can see the project currently has one Java package with two classes. DataProvider class is a simple utility class serving as an in-memory data store for drawings. It defines operations for creating, retrieving, updating and deleting the drawings. The second class in the package defines Java representation of a drawing.
4. Let’s run the project to see how the initial page looks like. To do that, first rightclick on the project node and choose “Clean and Build” in the pop-up menu, then right-click again and choose “Run”. The NetBeans will start GlassFish, deploy our application and open a web browser at the application URL (in this case <http://localhost:8080/drawingboard/>).
5. The initial screen of the application has a text field where you can enter a name for a new drawing and hit Enter or click the New button to issue a command to create a new drawing with that name. This will not work at the moment, as we haven’t exposed the RESTful API the front-end tries to use to create a new drawing.
6. You can confirm that the front-end makes HTTP requests to the back-end by enabling the network monitoring in Chrome browser. To do that, choose View->Developer->Developer Tools in the Chrome application menu. The Developer Tools will show up at the bottom of the browser window. Switch to the Network tab.
7. Now, type something into the Drawing Name text field of our application (e.g. “test”) and hit Enter. In the Network tab of Developer Tools you should see the frond-end made HTTP POST request to /drawingboard/api/drawings URL, but the server responded with “404 – Not Found” status code, since we haven’t exposed anything at that URI yet.
8. Once done, close the Developer Tools pane.

## Step 2: Adding JAX-RS Resources

Now we are going to expose the RESTful API. Here is how we want the API to look like:

|  |  |  |
| --- | --- | --- |
| URI | HTTP Method | Description |
| <app\_context>/api/drawings | POST | Creates a new drawing |
| <app\_context>/api/drawings | GET | Retrieves the list of all drawings |
| <app\_context>/api/drawings/{id} | DELETE | Deletes a drawing with id = {id} |

1. First, we need to add a dependency on Jersey libraries to our project. Double-click “Project Files”->pom.xml file to open it and add the following dependencies just before the closing </project> tag:

<dependencies>

<dependency>

<groupId>org.glassfish.jersey.core</groupId>

<artifactId>jersey-server</artifactId>

<version>${jersey.version}</version>

<scope>provided</scope>

</dependency>

<dependency>

<groupId>org.glassfish.jersey.media</groupId>

<artifactId>jersey-media-moxy</artifactId>

<version>${jersey.version}</version>

<scope>provided</scope>

</dependency>

</dependencies>

The dependency on jersey-server is needed so that we can use the JAX-RS and Jersey server-side API in our application. We are going to use MOXy to map Java objects (particularly the Drawing bean) to/from JSON, hence the dependency on jersey-media-moxy. Both dependencies have the scope set to "provided", which means the respective jars won't be bundled in the application war file. This is because GlassFish (our target deployment server) already contains these libraries out of the box, so no need to include them in the war.

1. Let’s rebuild the project (right-click on the project, click on “Clean and Build” in the pop-up menu) to get these new dependencies downloaded from maven.
2. Now, create a new DrawingsResource class (right-click on the com.mycompany.drawingboard package and choose New->Java Class in the pop-up menu).
3. We will expose this class at “drawings” URI (relative to the JAX-RS application URI). To do that, annotate the class with @Path(“drawings”) (add import for javax.ws.rs.Path).
4. Attach also @Consumes and @Produces annotations to the class to indicate the class expects/returns JSON messages:

@Path("drawings")

@Consumes(MediaType.APPLICATION\_JSON)

@Produces(MediaType.APPLICATION\_JSON)

public class DrawingsResource {

}

1. Let’s add a method named “create()” that will be used to create new drawings. We’ll map it to HTTP POST. The method will return "201 – Created" response with "Location" HTTP header set to the URI of the newly created drawing:

@POST

public Response create(@Context UriInfo uriInfo, Drawing drawing) {

return Response.created(uriInfo.getBaseUriBuilder()

.path(DrawingsResource.class, "getDrawing")

.build(DataProvider.createDrawing(drawing))

).build();

}

Note, we are using JAX-RS @Context annotation to inject UriInfo, which provides contextual request-specific information about the request URI. The class provides us with the base URI of our application. We use it to construct the full URI of the newly created drawing. The second method parameter will receive the content of the HTTP request converted to an instance of Drawing object (using JSON un-marshaller provided by MOXy library).

1. Now, add a "get()" method that returns the list of all drawings (mapped to HTTP GET):

@GET

public List<Drawing> get() {

return DataProvider.getAllDrawings();

}

As you can see, the method simply returns List<Drawing> - this is possible thanks to the concept of JAX-RS message body writers/readers that you can plug in to implement mapping to/from a specific media type to a java type (in this case we will be utilizing MOXy message body writer that knows how to convert Java objects into JSON strings).

1. The third resource method we are going to add is the "delete()" method. It is actually going to be what we call a **sub-resource** method, because it will be exposed at a URI containing one additional path element – the drawing ID. So the method itself is going to be annotated with @Path annotation:

@Path("{id:[0-9]+}")

@DELETE

@Consumes("\*/\*")

public void delete(@PathParam("id") int drawingId) {

if (!DataProvider.deleteDrawing(drawingId)) {

throw new NotFoundException();

}

}

As you can see, we are utilizing so called path parameter in this method. We use regular expression in the definition of the path parameter named "id" to indicate the parameter should only match path elements that contain numbers. So, a HTTP DELETE request to a URI like "…/drawings/1234" would match this resource method taking "1234" as the value of the "id" path parameter, however "…/drawings/abc" will not match.

Also note that the method utilizes NotFoundException() which is new to JAX-RS 2.0 and when thrown, produces "404 – Not Found" response code. Our method throws it when no drawing with the given ID was found.

1. Finally we need to add a JAX-RS application class to our project that encapsulates the JAX-RS runtime configuration for our project. Add a new class named "JaxrsApplication", annotate it with @ApplicationPath("api"), make it extend "ResourceConfig" class, which is a Jersey API class that provides some useful functionality additional to what the default JAX-RS API Application class provides (such as package scanning, notion of properties, etc.). The resulting class should look as follows:

@ApplicationPath("api")

public class JaxrsApplication extends ResourceConfig {

public JaxrsApplication() {

super(DrawingsResource.class);

addBinders(new MoxyJsonBinder());

}

}

As you can see, in the constructor of the class we are passing the resource class to the constructor of the super class – this tells the JAX-RS application what classes it should recognize as resources or providers. We are registering the JSON-related MOXy providers by a single call addBinders() – binder is a Jersey proprietary concept that can be used for registering a set of co-related JAX-RS providers as a single "feature".

1. We are done with the implementation part, let's rebuild and run the application to try it out (right-click on the project, do Clean and Build and then Run).
2. Once the application page opens in the browser, try entering some text into the Drawing Name text field and hit Enter. It will still look like nothing happened, since we haven't implemented the server-sent events part that would notify the JavaScript front-end that a new drawing was added, however, if you hit Refresh in your browser, you should see the new drawing is there. This confirms our RESTful API works and the front-end is able to use it to create and retrieve drawings. You can try clicking the "x" next to the drawing to delete it and refresh again to see the changes.
3. We can also test the API directly (instead of using the front-end of our application). To retrieve the list of drawings in JSON format, you can enter the URI of our DrawingsResource (<http://localhost:8080/drawingboard/api/drawings>) directly into the address bar of the browser and hit enter. That will send an HTTP GET request to our resource and you should see the JSON string representing the list of drawings.
4. To directly make POST and DELETE requests to our REST API you can utilize the Postman Chrome add-on that's installed on your machine. To try adding a new drawing, you can enter <http://localhost:8080/drawingboard-api/drawings> address into the request URL field of Postman, switch the method to POST, click on the Headers button and add "Content-Type" header set to "application/json", switch to "raw" view of the message entity to be able to enter a JSON string and type in the following for example:

{"name" : "my drawing"}

After you click the Send button, this will create a new drawing named "my drawing". Feel free to try DELETE as well and to experiment further.

This concludes the first exercise where you learned how to expose simple RESTful API from your application using JAX-RS and Jersey. In the following exercise we are going to add support for change notifications using Jersey's implementation of the HTML5 concept called Server-Sent Events.

# Exercise 2: Adding Server-Sent Events

Now that we have the basic REST API working, it is time to add the SSE notifications, so that the front-end gets automatically updated whenever someone adds/removes a drawing.

1. The SSE support for Jersey resides in jersey-media-sse maven module, so let's add this dependency to our application pom.xml file by copy-pasting the following into the <dependencies> section of that file:

<dependency>

<groupId>org.glassfish.jersey.media</groupId>

<artifactId>jersey-media-sse</artifactId>

<version>${jersey.version}</version>

<scope>provided</scope>

</dependency>

1. Rebuild the project so that the dependency gets downloaded (right-click the project and choose Build).
2. Jersey defines a class named SseBroadcaster, that can be used for broadcasing server-sent events. Let's add a broadcaster instance to the DataProvider class and use it to send events whenever any changes are made to the collection of drawings. Open the DataProvider class and the following field declaration:

private static SseBroadcaster sseBroadcaster

= new SseBroadcaster();

1. Now, find the createDrawing() method and instert the following just before the line with the return statement:

sseBroadcaster.broadcast(new OutboundEvent.Builder()

.name("create")

.data(Drawing.class, result)

.mediaType(MediaType.APPLICATION\_JSON\_TYPE)

.build());

This will create a new event named "create", sending the newly created drawing object as JSON in the data field of the event, and broadcasts it to all the clients registered in the broadcaster instance (we'll add the client registration shortly).

1. Next, we are going to add event notification to DataProvider.deleteDrawing() method. Add the following code before the return statement:

sseBroadcaster.broadcast(new OutboundEvent.Builder()

.name("delete")

.data(String.class, String.valueOf(drawingId))

.build());

As you can see, this generates an event named "delete" and data field containing the ID of the drawing being deleted.

1. We've just added the event notification code, but how is the client registration to the broadcaster going to work? Jersey has a concept of an "event channel", which is essentially a long running connection established by the client the server uses to send the event data to. Events sent from the server are a long response (typically to a HTTP GET request made by a client) being sent from the server in "chunks". EventChannel is a class in the Jersey API that represent this SSE connection. Let's add a method to the DataProvider class for registering a new EventChannel to the broadcaster:

static void addEventChannel(EventChannel ec) {

sseBroadcaster.add(ec);

}

1. Now we have to add a resource method to our DrawingsResource class responding to HTTP GET request, establishing the SSE EventChannel connection. Open the DrawingsResource class and add the following method to it:

@GET

@Path("events")

@Produces(EventChannel.SERVER\_SENT\_EVENTS)

public EventChannel getEvents() {

EventChannel ec = new EventChannel();

DataProvider.addEventChannel(ec);

return ec;

}

As you can see, this method adds another sub-resource mapped to …/drawings/events URI, it produces a response of type text/event-stream (EventChannel.SERVER\_SENT\_EVENTS constant value), which is the standard media type for SSE and all it does is creating a new EventChannel instance, registering it to our broadcaster (through the DataProvider.addEventChannel() method we added in the previous step), and returning it. Jersey keeps the connection open, and releases the container thread for processing other requests (i.e. open SSE connections don't block container threads).

1. Finally we need to add the special MessageBodyWriter for SSE to our JaxrsApplication (so that Jersey knows how to convert the event objects to the stream of data sent on the wire). Doing that is simple – just go to the JaxrsApplication class constructor and add OutboundEventWriter.class to the list of classes passed to the super constructor, so now the call to super() should look like this:

super(DrawingsResource.class, OutboundEventWriter.class);

1. Let's run the project to see if it works (right-click on the project and click Run). Once the browser opens, try adding a new drawing again – this time you should see the new drawing is displayed in the list of drawings right away. Since the front-end now receives the events.
2. Try opening another browser window, so that you have the application in two windows side-by-side. Try adding/deleting drawings in one window and watch how the list of drawings gets automatically updated in both.
3. Before we move on to the next exercise, let's quickly look at how the event listening is implemented on the JavaScript side. Open controller.js file in the Web Pages folder of the project. Between lines 22 and 35 you can see the following code:

// listens to server-sent events for the list of drawings

$scope.eventSource = new EventSource("/drawingboard/api/drawings/events");

var eventHandler = function (event) {

$scope.drawings = DrawingService.query();

};

$scope.eventSource.addEventListener("create", eventHandler, false);

$scope.eventSource.addEventListener("delete", eventHandler, false);

// clean up

$scope.$on("$destroy", function (event) {

$scope.eventSource.close();

});

As you can see, on the JavaScript side, EventSource object (available in HTML5-compliant browsers) is used to establish an SSE connection – it makes an HTTP GET request to the URI passed to it in the constructor. The request hits our DrawingsResource.getEvents() resource method, which keeps the connection open and registers the stream (EventChannel) to the broadcaster. You can register event handlers on the EventSource object based on the event name. In the code above we are adding listeners for the two types of events we are firing (create and delete) – both use the same event handler which simply reads an updated list of drawings from the server.

This concludes the second exercise. You've learned how you can leverage Jersey API to enable server-sent events in your server-side application. In the following exercise we are going to look at how to utilize another HTML5 technology – web sockets – to do bi-directional communication between the server and the clients.

# Exercise 3: Adding Web Sockets

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* pridat coding
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* spustit a hrat si

# Exercise 4: Writing a Simple Java Client

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* rict, ze websocket client api neni v tuto chvili uplne ready

# Summary

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# Appendix: Setting up the Lab Environment

This lab was developed and tested with the following configuration:

* JavaSE 7 (<http://www.oracle.com/technetwork/java/javase/downloads/index.html>)
* Chrome web browser (<https://www.google.com/intl/en/chrome/browser/>)
* Postman REST Client extension for Chrome (<https://chrome.google.com/webstore/detail/fdmmgilgnpjigdojojpjoooidkmcomcm>)
* NetBeans 7.2 (<http://netbeans.org/downloads/index.html>)
* GlassFish 4.0 nightly build from Sept. 28 (<http://dlc.sun.com.edgesuite.net/glassfish/4.0/nightly/glassfish-4.0-b57-09_28_2012.zip>)

To be able to easily deploy and run the application project from NetBeans, you need to register the GlassFish 4.0 nightly build in NetBeans as follows:

1. Click on the Services tab in NetBeans.
2. Right-click on Servers, choose Add Server… in the pop-up menu.
3. Select GlassFish Server 3+ in the Add Server Instance wizard and click Next.
4. Browse to where you installed the GlassFish build, click Next.
5. Click Finish on the next screen.