The Google Web Toolkit:
Using GWT RPC to Access Server-Side Data
(GWT 2.5 Version)

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Topics in This Section

- Idea of RPC
- Development process
  - Defining main data service interface
  - Defining callback version of data service interface
  - Making a data service servlet
  - Creating a service proxy
  - Defining client-side callback objects
- Examples
  - Getting simple data from server
  - Getting complex types from server
  - Getting serializable custom classes from server
  - Sending serializable custom class to server
- Handling asynchronous methods
  - Performing server-dependent ops only in callback methods
- Testing

RPC: Big Idea

- Write regular methods on server; don’t write servlet methods
  - Methods take arbitrary arguments
    - Not HttpServletRequest and HttpServletResponse
  - Methods return arbitrary results
    - Strings, arrays, lists, custom classes, etc.
- Call methods directly from client; don’t make explicit HTTP requests
  - Call server methods almost as though they were local
    - No need to create or parse query parameters
  - Pass arbitrary arguments and get arbitrary results
    - Custom form of serialization handles all the parsing
RPC: Notes

• Online RPC documentation is good
  – GWT RPC tutorial
    • https://developers.google.com/web-toolkit/doc/latest/tutorial/RPC
  – Client-Server development guide

• GWT does not require RPC
  – It is a tremendous simplification, and should be used for all new GWT projects. However, if you already have a server-side resource that uses JSON, you can access it.
    • See client-server dev guide listed above
    • However, this approach is much lower-level, and it requires JSNI. We will cover JSNI in a later section.

RPC Data Types

• Server methods can accept & return complex types
  – Packing and unpacking handled automatically
    • Even though client-side code is JavaScript (not Java) at runtime

• Legal types
  – Primitives
    • int, double, boolean, etc.
  – Wrappers
    • Integer, Double, Boolean, etc.
  – A subset of standard Java types
    • ArrayList, Date, HashMap, HashSet, String, etc.
  – For full list, see the JRE Emulation Reference at https://developers.google.com/web-toolkit/doc/latest/RefJreEmulation
  – Custom classes that implement Serializable
  – Arrays containing any of the above types
GWT-RPC Development Steps

- **Define main service interface**
  - Must be under .client package
  - Implement RemoteService interface
  - Define regular methods without explicit HTTP
  - Use @RemoteServiceRelativePath to point at servlet

- **Define callback version of service interface**
  - Must be under .client package
  - If main interface is FooService, define FooServiceAsync
  - Eclipse automates this for you
    - Once you define the main service interface, Eclipse will create the Async version.
    - And, every time you add or change a method to main interface, Eclipse will add or update the Async version

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GWT-RPC Development Steps (Continued)

- **Make service servlet**
  - Must be outside of the .client package
  - Extend RemoteServiceServlet, implement service interface
  - Supply url-pattern in web.xml that matches relative path

- **Create service proxy**
  - Must be under .client package (usually in onModuleLoad)
  - Call GWT.create(YourServiceInterfaceName.class)

- **Define client-side callback objects**
  - Must be under .client package
  - With onSuccess and onFailure
Example 1: Getting a Random Number from the Server

Example Overview

• Goal
  – Press button, call method on server that returns String
  – Display String on client inside table cell

• Point
  – General process of calling server

• Assumed project setup already done
  – Clicked “g” to create new Web Application Project
  – Deleted extraneous files as described in last section
  – In auto-generated HTML file, removed everything except script tag and replaced with custom HTML
  – In auto-generated Java class, removed everything except class definition and signature of onModuleLoad
Step 1: Define Main Service Interface

- **Interface**
  - Must be under the .client package
  - Must implement RemoteService interface
    - This is just a marker interface: no required methods

- **Methods**
  - Regular methods that accept and return normal Java types
  - Remember: Only a subset of Java 6 types are supported

- **Annotation**
  - Use @RemoteServiceRelativePath("some-path")
  - Gives relative URL of servlet that implements interface
    - Relative to GWT “appname” subfolder. So, url-pattern of servlet (in web.xml) would be /appname/some-path
      - “appname” comes from <module> element’s ‘rename-to’ attribute from AppName.gwt.xml file

Main Service Interface: Example

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

@RemoteServiceRelativePath("data-service")
public interface DataService extends RemoteService {
    public String getButton1Data();
    public String[] getButton2Data();
    public RandomNumber getButton3Data(String range);
    public void logAjaxRandom(RandomNumber clientRandom);
}
```

This is relative to GWT appname subfolder. So, by default, if main URL is http://hostname/AppName/, the URL of the data service servlet will be http://hostname/AppName/appname/data-service. Thus, the url-pattern of the servlet should be /appname/data-service to match this.

Will look at this method in this section. Next sections cover the other three methods.
Step 2: Define Callback Version of Service Interface

- **Interface organization**
  - Name: `OriginalInterfaceAsync`, under `.client` package
  - Return types: always void
  - Arguments
    - Same as in main data service interface, except with `AsyncCallback<OriginalReturnType>` as last arg

- **Example methods**
  - Main service interface (BlahService)
    - `public double getSomeValue();`
    - `public String[] findLastNames(int n, String firstName);`
  - Callback version of interface (BlahServiceAsync)
    - `public void getSomeValue(AsyncCallback<Double> callback);`
    - `public void findLastNames(int n, String firstName, AsyncCallback<String[]> callback);`

Callback Version of Service Interface: Example

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc *

public interface DataServiceAsync {
    public void getButton1Data(AsyncCallback<String> callback);
    public void getButton2Data(AsyncCallback<String[]> callback);
    public void getButton3Data(String range, AsyncCallback<RandomNumber> callback);
    public void logClientRandom(RandomNumber clientRandom, AsyncCallback<Void> callback);
}
```

Changed return type from String to void.

None of this code was written by hand. Given the main service interface, Eclipse automates creating this Async interface and defining each of the methods.
Step 3: Make Service Servlet

- **Extend RemoteServiceServlet**
  - Put in server package (or any package other than “client”)
- **Implement service interface from step 1**
  - Implement the methods in that interface
    - Normal methods with the arguments and return types exactly as listed in the interface definition
    - May use any Java features in method body
      - Whatever Java version your server is running
        - You can even use lambdas if your server is running Java 8!
      - No restriction to use GWT-client subset of Java types
  - Remember the interface is in client package
    - So you need to import mainPackage.client.MainInterface
- **Define url-pattern in web.xml**
  - Should be /appname/path-given-in-annotation

Service Servlet: Example

```java
package coreservlets.server;

import com.google.gwt.user.server.rpc.*;
import coreservlets.client.*;

public class DataServiceImpl
    extends RemoteServiceServlet
    implements DataService {

    public String getButton1Data() {
        String result =
            String.format("Number: % .2f", Math.random() * 10);
        return(result);
    }

    ...
```

All Java features permitted. GWT does not support `String.format`, but server-side code can still use it. Code in "server" package does not get compiled into JavaScript.

No code outside the ..client.* package gets compiled into JavaScript.
Data Service Servlet: web.xml

```
...  
  <servlet>
    <servlet-name>
      Servlet that Provides DataService
    </servlet-name>
    <servlet-class>
      coreservlets.server.DataServiceImpl
    </servlet-class>
  </servlet>
</servlet>
<servlet-mapping>
  <servlet-name>
    Servlet that Provides DataService
  </servlet-name>
  <url-pattern>/gwtrpc/data-service</url-pattern>
</servlet-mapping>
...  
  "gwtrpc" is the lowercase version of project name.  
  This folder created automatically by GWT within "war".  
  "data-service" matches @RemoteServiceRelativePath 
  annotation from the DataService interface.
```

Step 4: Create Service Proxy

- **Idea**
  - Must be under .client package (usually in onModuleLoad)
  - Create instance of callback (Async) version of interface
  - Call server methods, passing in a callback handler
  - The callback handler gets invoked with server data

- **Steps**
  - Main code
    - YourServiceInterfaceAsync serviceProxy = 
      GWT.create(YourServiceInterface.class);
    - serviceProxy.someServerMethod(arg1, arg2, 
      new CallbackHandler());
  - Callback handler
    - Implements AsyncCallback<MethodReturnType>
    - Has onSuccess and onFailure

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Creating Service Proxy: Example

```java
public class GwtRpc implements EntryPoint {
    private DataServiceAsync serviceProxy;
    private HTML label1, label2, label3, label4;
    private TextBox rangeBox;

    public void onModuleLoad() {
        serviceProxy = GWT.create(DataService.class);
        Button button1 = new Button("Show Random Number");
        label1 = new HTML("<i>Num will go here</i>");
        button1.addClickHandler(new Button1Handler());
        RootPanel.get("button1").add(button1);
        RootPanel.get("label1").add(label1);
        ...
    }
    ...
}
```

Step 5: Define Client-Side Callback Objects

- **Make a class that implements AsyncCallback<OrigMethodReturnType>**
  - Must be under .client package
  - onSuccess
    - Invoked when call to server is successful. Returns whatever type the original service method returns
  - onFailure
    - Invoked when call to server fails
  - As with event handling in Swing, SWT, or AWT, you often use inner classes so that the methods can easily access data from main app

- **Call interface method on service proxy**
  - Pass the expected args *plus the callback object*
  - You usually do this from a GUI event handler
Defining Client-Side Callback Objects: Details

- Main data service interface
  - public String getMessage(int level);

- Callback version of data service interface
  - public void getMessage(int level, AsyncCallback<String> callback);

- Callback class
  - private class SomeCallback implements AsyncCallback<String> {
    public void onSuccess(String result) {...}
    public void onFailure(Throwable caught) {...}
  }

- Invoking service proxy
  - serviceProxy.getMessage(someInt, new SomeCallback());

Defining Client-Side Callback Objects: Example

```java
class GwtRpcApplication implements EntryPoint {
    ...

    private class Button1Handler implements ClickHandler {
        public void onClick(ClickEvent event) {
            serviceProxy.getButton1Data(new Button1Callback());
        }
    }

    private class Button1Callback implements AsyncCallback<String> {
        public void onSuccess(String result) {
            label1.setHTML(result);
        }

        public void onFailure(Throwable caught) {
            Window.alert("Unable to get data from server.");
        }
    }
}
```
Using GWT RPC

Server-Side Data

<table>
<thead>
<tr>
<th>Button</th>
<th>Range</th>
<th>Server Result</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1, 10, 100, 1000</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2011</td>
<td></td>
</tr>
</tbody>
</table>

The ids are referenced in GwtRpc.java.
Testing in Development Mode

- R-click project name and Run As → Web Application
  - Or, click project name in Eclipse. Press Run button at top

 When first brought up.

After pressing button (String comes from server).

Testing in Production Mode

- **Idea**
  - Running in a regular browser with all client-side Java code converted to JavaScript
  - Do most testing/debugging in development mode, but use Web mode occasionally to check browser support
  - Uses embedded version of Jetty

- **Steps**
  - Run the application in development mode
  - R-click project, then Google → GWT Compile
    - Or, click project, then click red toolbox at top
    - Creates JavaScript files in war/appname folder
  - Change URL by removing ?gwt.codesvr=…
    - Can copy URL to other browsers to test cross-browser compatibility
Testing in Production Mode

- Did Google → GWT Compile, then changed URL

When first brought up.

After pressing button (String still comes from server).

Testing in Deployed Mode

- Idea
  - Deployed mode is similar to production mode
    - Running in a regular browser with all client-side Java code converted to JavaScript
    - However, uses normal Web App structure running on a Java server of your choice on any machine
    - Do initial debugging in development mode, do occasional testing in production mode, test in deployed mode at end

- Steps
  - Run the application in development mode
  - Do Google → GWT Compile (or click red toolbox at top)
  - Find the “war” folder on filesystem
    - Copy/rename and deploy as exploded WAR
    - Or, copy contents (not “war” folder itself) into file.zip, then rename file.zip to file.war and deploy as WAR file
Testing in Deployed Mode

- **Copied workspace/GwtRpc/war folder**
  - Renamed to GwtRpc to keep similar-looking URL
  - GwtRpc.html is welcome-file, so name can be omitted
- Deployed to Apache Tomcat on localhost
  - Could have used any Java-capable server

Example 2:
Getting an Array of Numbers from the Server
Example Overview

• Goal
  – Press a button, call a method on the server that returns an array of Strings.
  – On the client, build a bulleted list out of the array

• Points
  – Returning complex data types to client
    • Nothing extra is required, unlike with JSON-RPC.
    • GWT will automatically package and parse arrays.
  – Building HTML on the client
    • In many GWT apps, you manipulate GWT widgets based on the server data. But you are also allowed to explicitly build HTML strings. Simpler than in many Ajax tools
    – You are dealing with a normal array instead of JSON or XML
    – Can use Java-style loops & String methods (but not String.format)

Step 1: Main Service Interface

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

@RemoteServiceRelativePath("data-service")
public interface DataService extends RemoteService {
    public String getButton1Data();
    public String[] getButton2Data();
    public RandomNumber getButton3Data(String range);
    public void logClientRandom(RandomNumber clientRandom);
}
```
Step 2: Callback Version of Service Interface

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

public interface DataServiceAsync {
    public void getButton1Data(AsyncCallback<String> callback);
    public void getButton2Data(AsyncCallback<String[]> callback);
    public void getButton3Data(String range,
                                  AsyncCallback<RandomNumber> callback);
    public void logClientRandom(RandomNumber clientRandom,
                                  AsyncCallback<Void> callback);
}
```

- **Changed return type from String[] to void.**
- **Added AsyncCallback<String[]> to end of argument list.**
  String[] is return type of original (non-callback) version of getButton2Data.

Step 3: Service Servlet

```java
public class DataServiceImpl extends RemoteServiceServlet implements DataService {
    public String getButton1Data() {
        String result =
            String.format("Number: %.2f", Math.random()*10);
        return(result);
    }

    public String[] getButton2Data() {
        String[] results =
            { String.format("%.2f", Math.random()),
              String.format("%.2f", Math.random() * 10),
              String.format("%.2f", Math.random() * 100),
              String.format("%.2f", Math.random() * 1000) };  
        return(results);
    }

    ...  
```

- **As before:**
  - Wrote normal method with normal arguments and return values (not servlet method)
  - Used String.format even though it is not supported by GWT on the client
  - Gave url-pattern of "data-service" in web.xml
Step 4: Service Proxy

public class GwtRpc implements EntryPoint {
    private DataServiceAsync serviceProxy;
    private HTML label1, label2, label3, label4;
    private TextBox rangeBox;

    public void onModuleLoad() {  // Main entry point
        serviceProxy = GWT.create(DataService.class);
        ...
        label2 = new HTML("List will go here</i>");
        button2.addClickHandler(new Button2Handler());
        RootPanel.get("button2").add(button2);
        RootPanel.get("label2").add(label2);
        ...
    }
    ...
}

Service proxy definition unchanged from previous examples.
But code above also shows GUI controls specific to this example.

---

Step 5: Client-Side Callback Objects

public class GwtRpcApplication implements EntryPoint {
    ...
    private class Button2Handler implements ClickHandler {
        public void onClick(ClickEvent event) {
            serviceProxy.getButton2Data(new Button2Callback());
        }
    }
}
Step 5: Client-Side Callback Objects (Continued)

```java
private class Button2Callback
    implements AsyncCallback<String[]> {
    public void onSuccess(String[] listItems) {
        String result = "<ul>
        for(String item: listItems) {
            result = result + "<li>" + item + "</li>\n";
        }
        result = result + "</ul>";
        label2.setHTML(result);
    }

    public void onFailure(Throwable caught) {
        Window.alert("Unable to get data from server.");
    }
}
```

Testing in Development Mode

- R-click project name and Run As → Web Application
- Or, click project name in Eclipse. Press Run button at top

When first brought up:
- After pressing button (String array comes from server, then client-side code builds `<ul>` list from array).
Testing in Production Mode

- Did Google \(\rightarrow\) GWT Compile, then changed URL

When first brought up.

After pressing button (String array comes from server, then client-side code builds <ul> list from array).

Testing in Deployed Mode

- Deployed to Tomcat on localhost
  - Copied “war” folder and renamed to “GwtRpc”
  - Or, made GwtRpc.zip, put contents of “war” (not “war” itself) inside it, and then renamed to GwtRpc.war.
    - Either way, deployed result to Web apps folder of server
Example 3: Getting a Serialized Object from the Server

Example Overview

• Goal
  – Press a button, pass a value to a server-side method
  – Server method returns a custom RandomNumber object
  – On the client, extract data from the RandomNumber by calling accessor methods
    • I.e., use normal Java approach. No parsing required.

• Points
  – Passing data to server-side methods
  – Returning Serializable data types to client
    • You implement Serializable
    • GWT manages the network marshalling/unmarshalling
      – Even though client-side code is really in JavaScript!
Step 1: Main Data Service Interface

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

@RemoteServiceRelativePath("data-service")
public interface DataService extends RemoteService {
    public String getButton1Data();
    public String[] getButton2Data();
    public RandomNumber getButton3Data(String range);
    public void logClientRandom(RandomNumber clientRandom);
}
```

Step 2: Callback Version of Service Interface

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

public interface DataServiceAsync {
    public void getButton1Data(AsyncCallback<String> callback);
    public void getButton2Data(AsyncCallback<String[]> callback);
    public void getButton3Data(String range,
                                 AsyncCallback<RandomNumber> callback);
    public void logClientRandom(RandomNumber clientRandom,
                                 AsyncCallback<Void> callback);
}
```

- Changed return type from RandomNumber to void.
- Added AsyncCallback<RandomNumber> to end of argument list. RandomNumber is return type of original (non-callback) version of getButton3Data.
Step 3: Service Servlet

```java
public class DataServlet extends RemoteServiceServlet implements DataService {
    public String getButton1Data() {
        String result =
            String.format("Number: %.2f", Math.random()*10);
        return(result);
    }

    public String[] getButton2Data() {
        String[] results =
            { String.format("%.2f", Math.random()),
              String.format("%.2f", Math.random() * 10),
              String.format("%.2f", Math.random() * 100),
              String.format("%.2f", Math.random() * 1000) };
        return(results);
    }

    public RandomNumber getButton3Data(String rangeString) {
        return(new RandomNumber(rangeString));
    }
}
```

Serializable Classes

- Classes implement java.io.Serializable
  - Or com.google.gwt.user.client.rpc.IsSerializable
  - This interface is just a marker
    - No required methods
    - Must have zero-argument (default) constructor.
      - Of course, if you define no constructors, Java gives you a 0-arg one.
    - Property types must also follow Serializable rules
- Server-side code uses this class normally
  - Normal Java class, but class must restrict itself to the Java subset supported by GWT (no printf or String.format, etc)
- Client-side code declares argument to onSuccess to be of this type
  - Then uses it like a normal Java class, even though in production or deployed mode it really becomes JavaScript
package coreservlets.client;  
import java.io.*;

import java.io.*;

public class RandomNumber implements Serializable {
    private double range = 0;
    private double value;
    private boolean isRangeLegal;

    public RandomNumber(String rangeString) {
        try {
            range = Double.parseDouble(rangeString);
            isRangeLegal = true;
        } catch (NumberFormatException nfe) {} 
        if (range <= 0) {
            range = 1.0;
            isRangeLegal = false;
        }
        value = Math.random() * range;
    }

    public RandomNumber() {
        this("-1");
    }

    public double getRange() {
        return (range);
    }

    public double getValue() {
        return (value);
    }

    public boolean isRangeLegal() {
        return (isRangeLegal);
    }
}

Code for RandomNumber (Continued)

The Serializable interface contains no methods, so classes that implement Serializable need no special methods. Subclasses of serializable classes are automatically serializable.
Step 4: Service Proxy

```java
public class GwtRpc implements EntryPoint {
    private DataServiceAsync serviceProxy;
    private HTML label1, label2, label3, label4;
    private TextBox rangeBox;

    public void onModuleLoad() { // Main entry point
        serviceProxy = GWT.create(DataService.class);
        ...
        Button button3 = new Button("Show Random Number");
        rangeBox = new TextBox();
        label3 = new HTML("<i>Num will go here</i>");
        button3.addClickHandler(new Button3Handler());
        RootPanel.get("button3").add(button3);
        RootPanel.get("rangeBox").add(rangeBox);
        RootPanel.get("label3").add(label3);    ...
    } ...
}
```

Service proxy definition unchanged from previous examples.
But code above also shows GUI controls specific to this example.

Step 5: Client-Side Callback Objects

```java
public class GwtRpcApplication implements EntryPoint {
    ...
    private class Button3Handler implements ClickHandler {
        public void onClick(ClickEvent event) {
            String range = rangeBox.getText();
            serviceProxy.getButton3Data(range,
                new Button3Callback());
        }
    }
    ...
}
```
Step 5: Client-Side Callback Objects (Continued)

private class Button3Callback implements AsyncCallback<RandomNumber> {
    public void onSuccess(RandomNumber number) {
        String range = "Range: " + number.getRange();
        if (!number.isRangeLegal()) {
            range = range + " (default due to illegal range)";
        }
        String value = "Value: " + number.getValue();
        String result = "<ul>
            <li>" + range + "</li>
            <li>" + value + "</li>
        </ul>";
        label3.setHTML(result);
    }
    public void onFailure(Throwable caught) {
        Window.alert("Unable to get data from server.");
    }
}

In main service interface (DataService), getButton3Data returns RandomNumber. So, use RandomNumber here.

Testing in Development Mode

- R-click project name and Run As ➔ Web Application
  • Or, click project name in Eclipse. Press Run button at top

When first brought up.

After entering number and pressing button (String goes to server; RandomNumber comes back. Client-side code calls RandomNumber accessor methods, extracts data, and builds <ul> list).
Testing in Production Mode

- Did Google → GWT Compile, then changed URL

When first brought up.

After entering number and pressing button (String goes to server; RandomNumber comes back. Client-side code calls RandomNumber accessor methods, extracts data, and builds <ul> list).

Testing in Deployed Mode

- Deployed to Tomcat on localhost
  - Copied “war” folder and renamed to “GwtRpc”
  - Or, made GwtRpc.zip, put contents of “war” (not “war” itself) inside it, and then renamed to GwtRpc.war.
    - Either way, deployed result to Web apps folder of server
Example 4: Sending Serialized Object to the Server

Example Overview

- **Goal**
  - Press a button, construct a custom RandomNumber on the client, send it to the server
  - Server method returns ‘void’ and logs number
    - Uses regular servlet logging capabilities
  - On the client, use onSuccess as acknowledgement of receipt and display client-side value

- **Points**
  - Passing data to server-side methods
    - GWT manages the network marshalling/unmarshalling
      - Even though client-side code is really in JavaScript!
  - Returning Void data type to client
Step 1: Main Service Interface

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

@RemoteServiceRelativePath("data-service")
public interface DataService extends RemoteService {
    public String getButton1Data();
    public String[] getButton2Data();
    public RandomNumber getButton3Data(String range);
    public void logClientRandom(RandomNumber clientRandom);
}
```

Step 2: Callback Version of Service Interface

```java
package coreservlets.client;

import com.google.gwt.user.client.rpc.*;

public interface DataServiceAsync {
    public void getButton1Data(AsyncCallback<String> callback);
    public void getButton2Data(AsyncCallback<String[]> callback);
    public void getButton3Data(String range,
                                AsyncCallback<RandomNumber> callback);
    public void logClientRandom(RandomNumber clientRandom,
                                AsyncCallback<Void> callback);
}
```

- Return type of void stays the same
- Added AsyncCallback<Void> to end of argument list.
- void is return type of original (non-callback) version of logClientRandom.
**Step 3: Service Servlet**

public class DataServlet extends RemoteServiceServlet
    implements DataService {

    public RandomNumber getButton3Data(String rangeString) {
        return (new RandomNumber(rangeString));
    }

    public RandomNumber getButton3Data(String rangeString) {
        return (new RandomNumber(rangeString));
    }

    public void logClientRandom(RandomNumber clientRandom) {
        log("Random number sent from client is: " +
            clientRandom.getValue());
        System.out.println("Random number '" +
            clientRandom.getValue() + '" was logged.');
    }
}

**Step 4: Service Proxy**

public class GwtRpc implements EntryPoint {

    private DataServiceAsync serviceProxy;
    private HTML label1, label2, label3, label4;
    private TextBox rangeBox;

    public void onModuleLoad() { // Main entry point
        serviceProxy = GWT.create(DataService.class);

        Button button4 = new Button("Log Client Random");
        label4 = new HTML("<i>Confirmation will go here</i>");

        RootPanel.get("button4").add(button4);
        RootPanel.get("label4").add(label4);
        button4.addClickHandler(new Button4Handler());
    }
}

*Service proxy definition unchanged from previous examples.*
*But code above also shows GUI controls specific to this example.*
public class GwtRpcApplication implements EntryPoint {
    ...
    private class Button4Handler implements ClickHandler {
        public void onClick(ClickEvent event) {
            String range = RootPanel.get("range4")
                .getElement().getInnerText();
            RandomNumber clientRandom = new RandomNumber(range);
            serviceProxy.logClientRandom(clientRandom,
                new LogCallback(clientRandom));
        }
    }
}

private class LogCallback implements AsyncCallback<Void> {
    RandomNumber clientRandom;
    public LogCallback(RandomNumber clientRandom) {
        this.clientRandom = clientRandom;
    }
    public void onFailure(Throwable caught) {
        Window.alert("Unable to log message to the server.");
    }
    public void onSuccess(Void result) {
        String message = "Random number sent to server was: "
            + clientRandom.getValue();
        label4.setHTML(message);
    }
}
Testing in Development Mode

- R-click project name and Run As → Web Application
  - Or, click project name in Eclipse. Press Run button at top

When first brought up.
After pressing the button
(Client-generated Random Number is sent to server;
since server returns ‘void’, serves as confirmation).

Testing in Production Mode

- Did Google → GWT Compile, then changed URL

When first brought up.
After pressing the button
(Client-generated Random Number goes to server;
since server returns ‘void’, serves as confirmation).
Testing in Deployed Mode

- Deployed to Tomcat on localhost
  - Copied “war” folder and renamed to “GwtRpc”
  - Or, made GwtRpc.zip, put contents of “war” (not “war” itself) inside it, and then renamed to GwtRpc.war.
- Either way, deployed result to Web apps folder of server

Handling Asynchronous Methods
• **Service proxy methods are automatically asynchronous**
  – Even though you see no explicit threading code, `serviceProxy.someMethod` returns immediately and runs in the background

• **So, onSuccess must do all the work directly**
  – This is obvious to JavaScript programmers who do normal Ajax programming.
    • But, Java programmers can be confused because they don’t see multithreading cues like Runnable or Thread.

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**Example: Shared Code**

```java
public class SomeApp implements EntryPoint {
    private SomeServiceAsync serviceProxy;
    private HTML label;
    private String message = "no message yet";

    public void onModuleLoad() {
        serviceProxy = GWT.create(SomeService.class);
        Button button = new Button("Click Me");
        label = new HTML("<i>Message will go here</i>");
        ...
        button.addClickHandler(new ButtonHandler());
        ...
    }
}
```
**Example: Wrong Approach**

```java
private class ButtonHandler implements ClickHandler {
    public void onClick(ClickEvent event) {
        serviceProxy.getMessage(new ButtonCallback());
        label.setHTML(message);
    }
}
```

```java
private class ButtonCallback implements AsyncCallback<String> {
    public void onSuccess(String message) {
        this.message = message;
    }
    public void onFailure(Throwable caught) {
        Window.alert("Unable to get data from server.");
    }
}
```

Example: Right Approach

```java
private class ButtonHandler implements ClickHandler {
    public void onClick(ClickEvent event) {
        serviceProxy.getMessage(new ButtonCallback());
    }
}
```

```java
private class ButtonCallback implements AsyncCallback<String> {
    public void onSuccess(String message) {
        label.setHTML(message);
    }
    public void onFailure(Throwable caught) {
        Window.alert("Unable to get data from server.");
    }
}
```
Wrap-Up

Summary

- **Define main service interface**
  - Extend RemoteService, use @RemoteServiceRelativePath

- **Define Async version of service interface**
  - BlahServiceAsync: add AsyncCallback<Type> to end of args

- **Make data service servlet**
  - Extend RemoteServiceServlet, implement service interface
  - Supply url-pattern in web.xml that matches relative path

- **Create service proxy**
  - Call GWT.create(YourServiceInterfaceName.class)

- **Define client-side callback objects**
  - With onSuccess and onFailure

- **Test**
  - Development mode, production mode, deployed mode
Questions?

Customized Java EE Training: http://courses.coreservlets.com/
GWT, Java 7 and 8, JSF 2, PrimeFaces, HTML5, Servlets, JSP, Ajax, jQuery, Spring, Hibernate, REST, Hadoop, Android. Developed and taught by well-known author and developer. At public venues or onsite at your location.