JSON-RPC

Sending Complex Data to and from the Server

Originals of Slides and Source Code for Examples:
http://courses.coreservlets.com/Course-Materials/ajax.html

Topics in This Section

- **Using the jsabsorb JSON-RPC implementation**
  - Calling server methods synchronously
    - Very useful for testing, but not for real projects
  - Calling server methods asynchronously
    - For real projects
  - Passing and returning strings and primitives
  - Returning JSON objects
- **Other JSON-RPC utilities**

Intro and Setup

RPC and JSON

- **Idea**
  - Let client code act as though it is calling a method on the server (not accessing a URL)
- **Advantages**
  - Simpler client syntax
    - No explicit use of XmlHttpRequest object
  - Simpler server syntax
    - Regular methods, not server doGet methods
  - Can pass and return data directly
    - Instead of indirectly sending strings in (via request params) and printing to generate output data
- **Disadvantages**
  - Requires extra code on both client and server
  - Ties server code to Java (instead of to arbitrary URL)

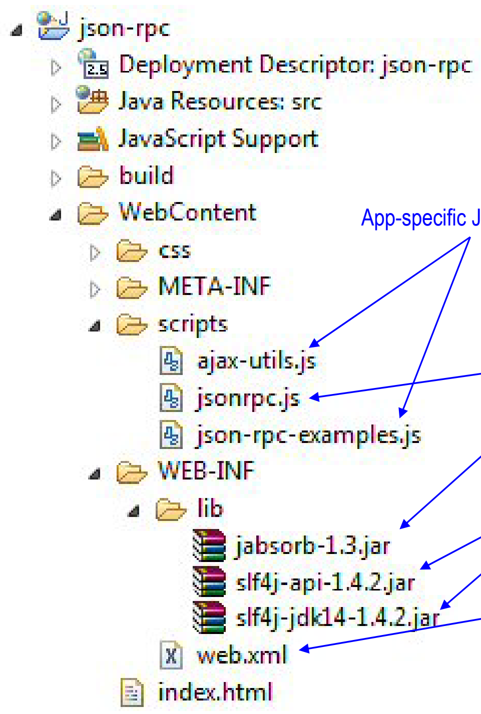
JSON-RPC

- **JSON-RPC**
  - Standard for remote calls with JSON data
  - http://json-rpc.org/
- **jabsorb**
  - Popular JSON-RPC implementation
    - "JavaScript to Java Object Request Broker"
  - Simple to use; limited power
  - Installation and setup poorly documented
- **Other JSON-RPC implementations**
  - http://json-rpc.org/wiki/implementations
- **Alternative RPC-to-Java toolkits**
  - Google Web Toolkit (covered later in this tutorial)
  - Direct Web Remoting (http://directwebremoting.org/)

Installation and Setup

- **Download jabsorb**
  - http://jabsorb.org/Download
    - Get “minimal” version to get jabsorb-1.*x*.jar and jsonrpc.js
    - Get “src” version to get slf4j-*xxxx*.jar (two files)
- **Installation**
  - Server
    - Put three JAR files in WEB-INF/lib
      - jabsorb-1.x.jar, two JAR files for slf4j
    - Edit web.xml for JSON-RPC mapping (see later slide)
  - Client
    - Load jsonrpc.js into page
- **Documentation**
  - http://jabsorb.org/Manual
  - http://jabsorb.org/Tutorial

Example Eclipse Project



```
json-rpc
  Deployment Descriptor: json-rpc
  Java Resources: src
  JavaScript Support
  build
  WebContent
    css
    META-INF
    scripts
      ajax-utils.js
      jsonrpc.js
      json-rpc-examples.js
    WEB-INF
      lib
        jabsorb-1.3.jar
        slf4j-api-1.4.2.jar
        slf4j-jdk14-1.4.2.jar
      web.xml
    index.html
```

Note: you can also download the json-rpc-blank Eclipse project from http://courses.coreservlets.com/Course-Materials/ajax.html#JSON-RPC. This is an Eclipse project with all the necessary pieces for jabsorb, but nothing else (no Java code, no app-specific JavaScript). You can use that project as a starting point for your own jabsorb projects.

App-specific JavaScript

From jabsorb-minimal.zip

From jabsorb-src.zip

Needs servlet-mapping for /JSON-RPC.
If you use ServletContextListener to register handler, then you also need <listener> entry.

Server-Side Configuration

Servlet Mapping

```
<servlet>
   <servlet-name>org.jabsorb.JSONRPCServlet</servlet-name>
   <servlet-class>org.jabsorb.JSONRPCServlet</servlet-class>
 </servlet>
 <servlet-mapping>
   <servlet-name>org.jabsorb.JSONRPCServlet</servlet-name>
   <url-pattern>/JSON-RPC</url-pattern>
 </servlet-mapping>
```

- **Note**
  - There is also a web.xml entry that tells JSON-RPC to gzip the response whenever possible. This improves performance in real life, but should be omitted in testing so that you can use Firebug to trace the return data. Online docs show how to enable gzipping.

Registering Handler Object on Server

- **Idea**
  - You instantiate a server-side object and register it (give a name). E.g., give it the name objName.
    - Use init of servlet with load-on-startup or context listener
  - For synchronous class, client code calls rpcClient.objName.methodName(args)
    - Very useful for interactive testing; do *not* use for final app.
  - For asynchronous calls, client code calls rpcClient.objName.methodName(callbackFunction, args)
- **Alternatives**
  - If you have static methods only, you can register class
  - If methods have state, you can make a user-specific handler object that is stored in the user's session
    - There is good documentation on this at jabsorb.org

Sample Handler Object

```
public class JsonRpcTester {
  public double getRandomNumber() {
    return(Math.random());
  }

  public double getRandomNumber(double range) {
    return(range * Math.random());
  }

  public City getCity(String cityName) {
    return(CityUtils.getCity(cityName));
  }
}
```

- **Note**
  - This is normal object with normal methods, not a servlet

Registering Handler Object on Server: Servlet Context Listener

```
package coreservlets;

import javax.servlet.*;
import org.jabsorb.*;

public class JsonRpcInitializer
    implements ServletContextListener {
  public void contextInitialized(ServletContextEvent event) {
    JsonRpcTester rpcTester = new JsonRpcTester();
    JSONRPCBridge globalBridge =
      JSONRPCBridge.getGlobalBridge();
    globalBridge.registerObject("rpcTester", rpcTester);
  }

  public void contextDestroyed(ServletContextEvent event) {
  }
}
```

Registering Handler Object on Server: web.xml Entry

```
<!--  Run JsonRpcInitializer when app starts up. -->
 <listener>
   <listener-class>
     coreservlets.JsonRpcInitializer
   </listener-class>
 </listener>
```

Client-Side Configuration

Registering RPC Client in Browser

- **Idea**
  - Client loads jsonrpc.js in page
  - Client does
    - rpcClient = new JSONRpcClient("address");
      - Address is from the URL pattern that you set in web.xml (e.g., /JSON-RPC)
  - For synchronous calls
    - rpcClient.serverObjName.methodName(args)
      - Never deploy real apps with synchronous calls, but this is tremendously useful for interactive testing in Firebug. You can directly type in remote method calls and make sure everything works before hooking it up to callback handler for the real app.
  - For asynchronous calls
    - rpcClient.serverObjName.methodName(callback, args)

Registering RPC Client in Browser: Example

```
var rpcClient;

window.onload = function() {
  rpcClient = new JSONRpcClient("JSON-RPC");
}
```

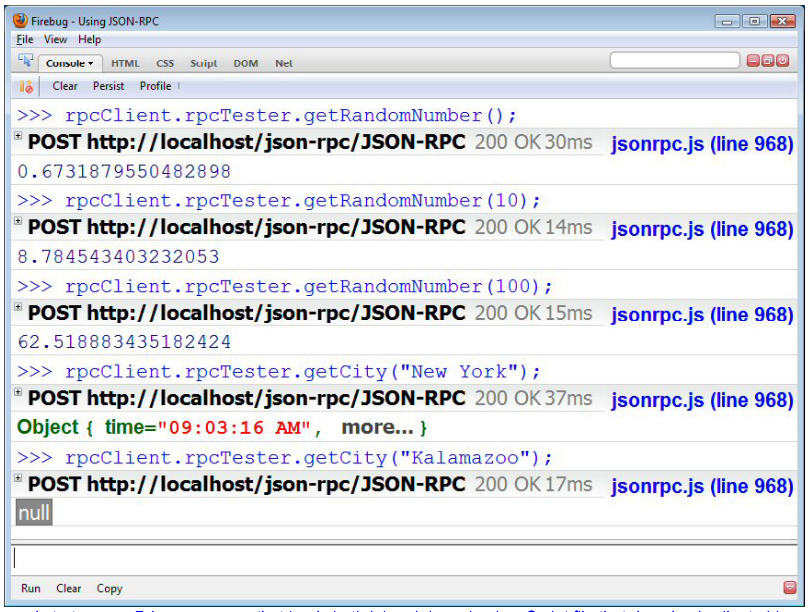
This is relative URL. This example assumes that page is in top level of Web application. If it was in subfolder, you would use ../JSON-RPC. If you used this from pages scattered in various subfolders at different levels, you could do /appName/JSON-RPC.

Making Synchronous Remote Calls

Synchronous RPC Calls

- **Idea**
  - Make normal function call
    - var result = rpcClient.serverObj.methodOfServerObj(…);
- **Arguments to method and return value**
  - You can pass numbers, strings, arrays, or objects.
  - You do not need to escape Strings you pass to server
  - Beans that are returned *from* server are automatically JSONified as in previous lecture
  - Passing objects *to* server is trickier (but not done often). Server-side code should expect JSONObject.
- **Important: use asynchronous calls**
  - Synchronous calls are only for practice and testing of the server-side code.
  - *Always use asynchronous calls in real life*, otherwise JavaScript will be frozen until server returns.

Synchronous Calls: Example of Interactive Testing



```
>>> rpcClient.rpcTester.getRandomNumber();
POST http://localhost/json-rpc/JSON-RPC 200 OK 30ms   jsonrpc.js (line 968)
0.6731879550482898
>>> rpcClient.rpcTester.getRandomNumber(10);
POST http://localhost/json-rpc/JSON-RPC 200 OK 14ms   jsonrpc.js (line 968)
8.784543403232053
>>> rpcClient.rpcTester.getRandomNumber(100);
POST http://localhost/json-rpc/JSON-RPC 200 OK 15ms   jsonrpc.js (line 968)
62.518883435182424
>>> rpcClient.rpcTester.getCity("New York");
POST http://localhost/json-rpc/JSON-RPC 200 OK 37ms   jsonrpc.js (line 968)
Object { time="09:03:16 AM",  more... }
>>> rpcClient.rpcTester.getCity("Kalamazoo");
POST http://localhost/json-rpc/JSON-RPC 200 OK 17ms   jsonrpc.js (line 968)
null
```

First, deploy app and start server. Bring up a page that loads both jabsorb.js and a JavaScript file that does basic client-side setup as just described. Then bring up Firebug and interactively try out remote method calls. To add a new remote method, just add a method to the class in Eclipse and save file. Then R-click on server and choose "Restart". Then go to HTML page and hit reload button. Then go back to Firebug and try the new method.

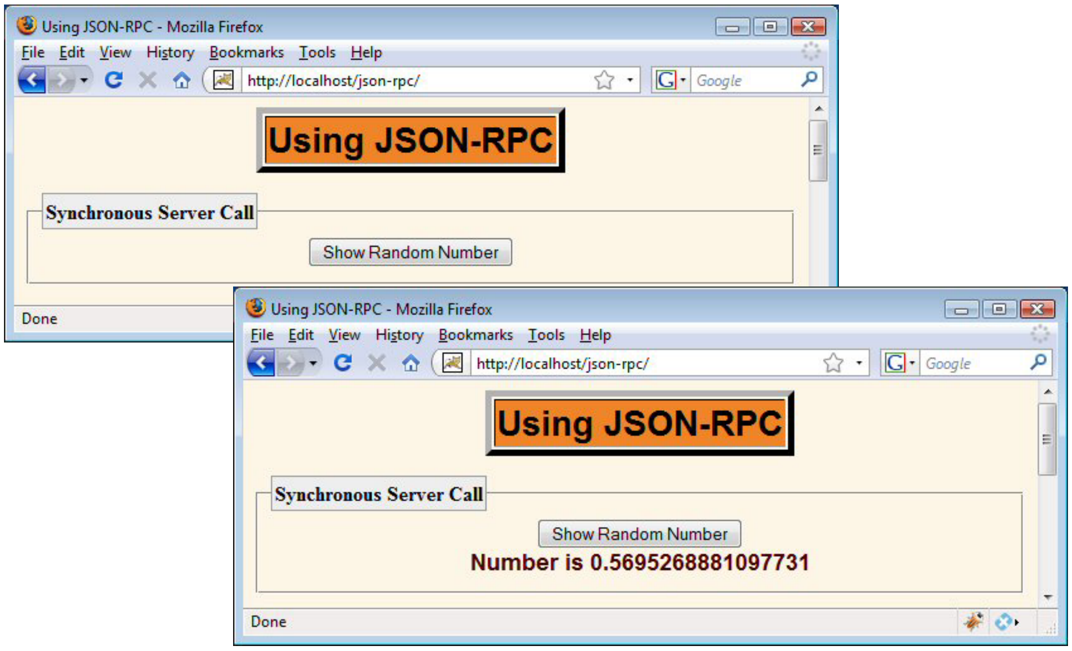
Synchronous Call: Example (JavaScript)

```
function showRandomNumber1(resultRegion) {
  var randomNumber =
    rpcClient.rpcTester.getRandomNumber();
  htmlInsert(resultRegion,
             "Number is " + randomNumber);
}
```

Synchronous Call: Example (HTML)

```
<script src="./scripts/ajax-utils.js"
        type="text/javascript"></script>
<script src="./scripts/json-rpc-examples.js"
        type="text/javascript"></script>
<script src="./scripts/jsonrpc.js"
        type="text/javascript"></script>
…
<fieldset>
  <legend>Synchronous Server Call</legend>
  <form action="#">
   <input type="button" value="Show Random Number"
          onclick='showRandomNumber1("ran-num-result-1")'/>
  </form>
  <div id="ran-num-result-1" class="ajaxResult"></div>
</fieldset>
```

Synchronous Call: Example (Result)


Using JSON-RPC - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/json-rpc/
Using JSON-RPC
Synchronous Server Call
Show Random Number
Done

Number is 0.5695268881097731

Making Asynchronous Remote Calls

Asynchronous RPC Calls

- **Idea**
  - When calling remote function, pass JavaScript callback function as the first argument to the call
  - The callback function should take two arguments
    - The real data that will come from the server
    - An exception
  - Callback will be invoked on readyState 4.
    - No freezing browser until response come in
    - The exception will be undefined if everything was ok
- **Arguments and return values**
  - Same as in previous example. Numbers and strings passed directly. Objects have type conversion rules.
    - You do not escape strings. Done automatically.

Making Asynchronous Calls: Example (JavaScript)

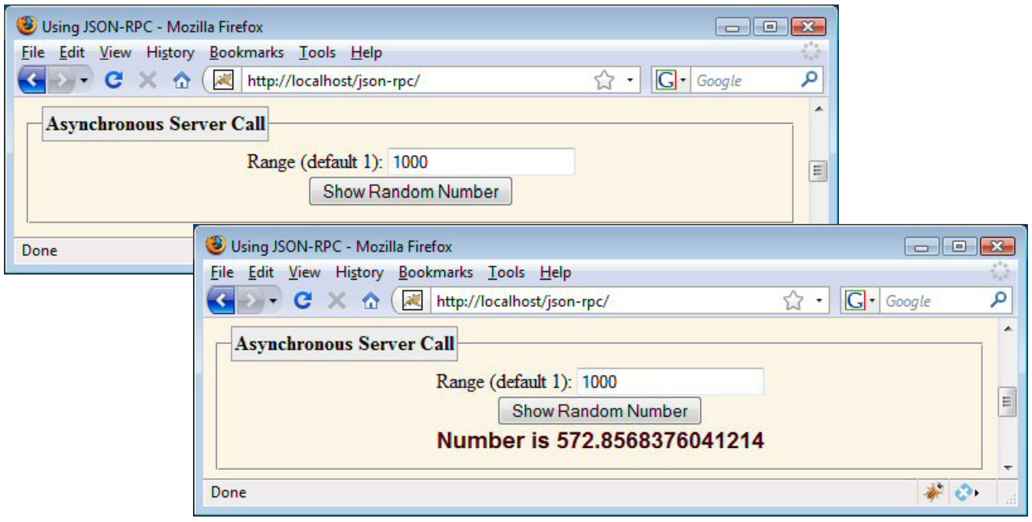
```
function showRandomNumber2(inputField, resultRegion) {
  var range = parseInt(getValue(inputField));
  if (isNaN(range)) {
    range = 1;
  }
  var callback = function(randomNumber, exception) {
    if(exception) {
      alert(exception.msg);
    } else {
      htmlInsert(resultRegion, "Number is " + randomNumber);
    }
  };
  rpcClient.rpcTester.getRandomNumber(callback, range);
}
```

Note: http://jabsorb.org/Manual says to use "exception.message". However, debugging with Firebug shows that it is "exception.msg" in the current release.

Making Asynchronous Calls: Example (HTML)

```
<fieldset>
  <legend>Asynchronous Server Call</legend>
  <form action="#">
   <label for="ran-num-range">Range (default 1):</label>
   <input type="text" id="ran-num-range"/><br/>
   <input type="button" value="Show Random Number"
          onclick='showRandomNumber2("ran-num-range",
                                     "ran-num-result-2")'/>
  </form>
  <div id="ran-num-result-2" class="ajaxResult"></div>
</fieldset>
```

Making Asynchronous Calls: Example (Result)


Using JSON-RPC - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/json-rpc/
Google
Show Random Number
Done

Asynchronous Server Call

Range (default 1): 1000

Number is 572.8568376041214

Passing or Returning Complex Data

Complex Data

- **Data sent to server**
  - Numbers and strings need no special handling
    - Do not escape strings.
    - This is done automatically.
  - Objects can be sent only if server expects JSONObject
- **Data returned from server**
  - Numbers and strings need no special handling
  - Returned objects are automatically passed to JSONObject constructor
    - Which means you can easily return beans *without explicit conversion*

Aside: Reading Textfield Values

- **Done previously**

```
function getValue(id) {
  return(escape(document.getElementById(id).value));
}
```

- **Done here**

```
function getRawValue(id) {
  return(document.getElementById(id).value);
}
```

Returning Complex Data: Example (JavaScript)

```
function showCity(inputField, resultRegion) {
  var cityName = getRawValue(inputField);
  var callback = function(city, exception) {
    if(exception) {
      alert(exception.msg);
    } else {
      var result;
      if (city) {
        result = "<ul>" +
                 "<li>Name: " + city.name + "</li>" +
                 "<li>Time: " + city.time + "</li>" +
                 "<li>Population: " + city.population + "</li>" +
                 "</ul>";
      } else {
        result = "Unknown City";
      }
      htmlInsert(resultRegion, result);
    }
  };
  rpcClient.rpcTester.getCity(callback, cityName);
}
```

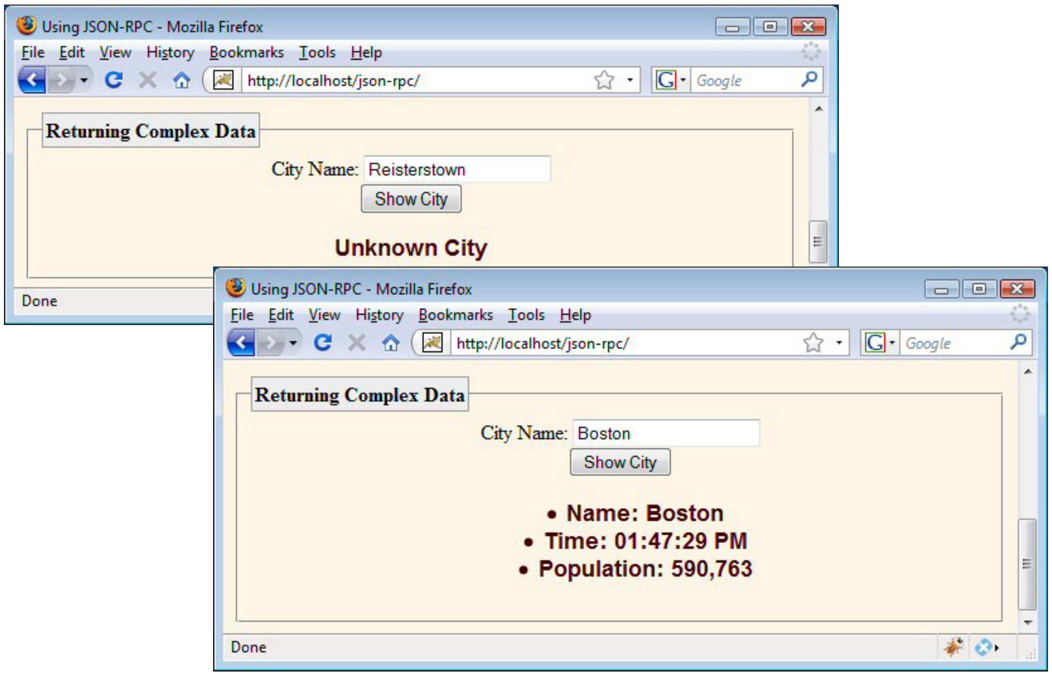
Returning Complex Data: Example (Server Code)

```
package coreservlets;

public class JsonRpcTester {
  public double getRandomNumber() {
    return(Math.random());
  }

  public double getRandomNumber(double range) {
    return(range * Math.random());
  }

  public City getCity(String cityName) {
    return(CityUtils.getCity(cityName));
  }
}
```

Returning Complex Data: Example (HTML)

```
<fieldset>
  <legend>Returning Complex Data</legend>
  <form action="#">
   <label for="city-name">City Name:</label>
   <input type="text" id="city-name"/>
   <br/>
   <input type="button" value="Show City"
          onclick='showCity("city-name", "city-result")'/>
  </form>
  <p/>
  <div id="city-result" class="ajaxResult"></div>
</fieldset>
```

Returning Complex Data: Example (Results)


Using JSON-RPC - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://localhost/json-rpc/
Google
Done

Returning Complex Data

City Name: Reisterstown

Show City

Unknown City

Returning Complex Data

City Name: Boston

Show City

- Name: Boston
- Time: 01:47:29 PM
- Population: 590,763

Complex Data: Returning Lists or Arrays

- **Server-side code**
  - Specify return type as List<Type> or Type[]
- **Client-side code**
  - Get the "list" property (not the direct return value)
  - This is an array (probably of JSONified beans)
- **Example**

```
var callback = function(cityList, exception) {
  if(exception) {
    alert(exception.msg);
  } else {
    doSomethingWith(cityList.list);
  }
};
```

Note: http://jabsorb.org/Manual says to use "exception.message". However, debugging with Firebug shows that it is "exception.msg" in the current release.

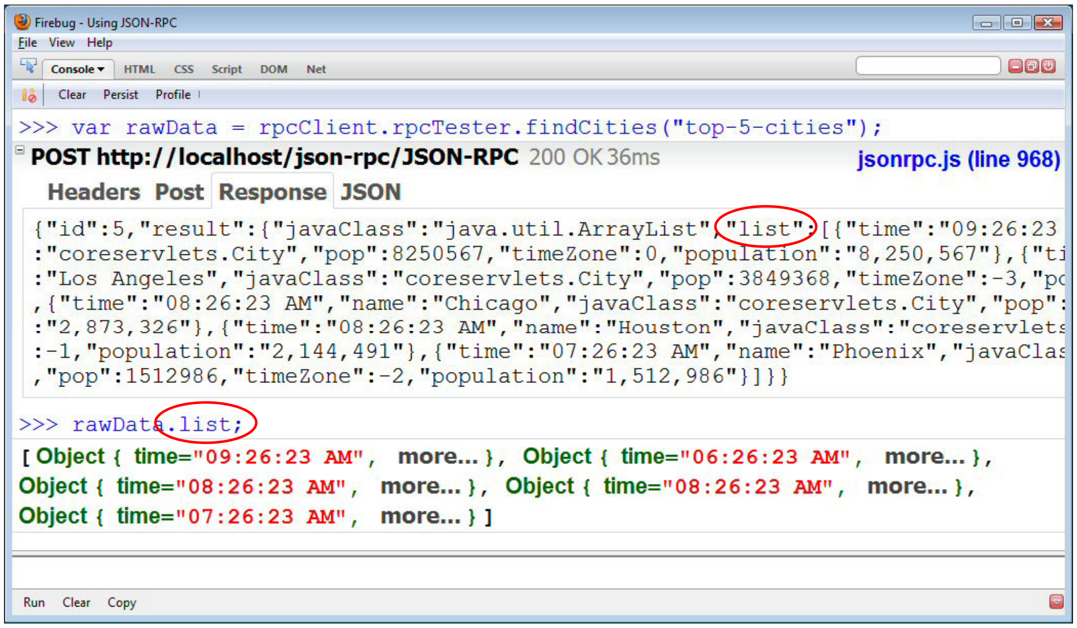
Even though remote method returns List, the converted List (array) does not go into the top-level variable (cityList). Instead, it gets put into an automatically-created property called "list".

Update to JsonRpcTester

```
public class JsonRpcTester {
  public double getRandomNumber() {
    return(Math.random());
  }

  public double getRandomNumber(double range) {
    return(range * Math.random());
  }

  public City getCity(String cityName) {
    return(CityUtils.getCity(cityName));
  }

  public List<City> findCities(String description) {
    return(CityUtils.findCities(description));
  }
}
```

Eclipse process: added this new method to class, hit Control-S to save it, then R-clicked on server and chose "Restart". Then went back to HTML page shown earlier and hit reload button. Then went to Firebug to try this method out (see next page).

Testing the Update



```
>>> var rawData = rpcClient.rpcTester.findCities("top-5-cities");
POST http://localhost/json-rpc/JSON-RPC 200 OK 36ms                jsonrpc.js (line 968)
{"id":5,"result":{"javaClass":"java.util.ArrayList","list":[{"time":"09:26:23
:"coreservlets.City","pop":8250567,"timeZone":0,"population":"8,250,567"},{"ti
:"Los Angeles","javaClass":"coreservlets.City","pop":3849368,"timeZone":-3,"pc
,{"time":"08:26:23 AM","name":"Chicago","javaClass":"coreservlets.City","pop":
:"2,873,326"},{"time":"08:26:23 AM","name":"Houston","javaClass":"coreservlets
:-1,"population":"2,144,491"},{"time":"07:26:23 AM","name":"Phoenix","javaClas
,"pop":1512986,"timeZone":-2,"population":"1,512,986"}]}}

>>> rawData.list;
[ Object { time="09:26:23 AM", more... }, Object { time="06:26:23 AM", more... },
Object { time="08:26:23 AM", more... }, Object { time="08:26:23 AM", more... },
Object { time="07:26:23 AM", more... } ]
```

When you do a remote call, the rpcClient automatically evals the network data and passes you the "result" property. Normally, this is the actual return value of the method. But in the case of lists and arrays, this contains a "list" subproperty that is actual return value.

Wrap-up

Summary

- **Register server handler object**
  - JSONRPCBridge.getGlobalBridge(name, object);
- **Make browser RPC client**
  - rpcClient = new JSONRpcClient("address");
- **Make synchronous call (testing only!)**
  - rpcClient.serverObj.methodName(args)
- **Make asynchronous call**
  - rpcClient.serverObj.methodName(callback, args)
- **Returning bean from server**
  - Return it directly. Converted automatically with JSONObject as shown in previous tutorial section.

Questions?