Lesson 16

Consuming Web Services Using SOAP and REST Apps

Victor Matos
Cleveland State University

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Overview

- A WebService is a Consumer_Machine-to-Provider_Machine collaboration schema that operates over a computer network.

- The data exchanges occur independently of the OS, browser, platform, and programming languages used by the provider and the consumers.

- A provider may expose multiple EndPoints (sets of WebServices), each offering any number of typically related functions.

- WebServices expect the computer network to support standard Web protocols such as XML, HTTP, HTTPS, FTP, and SMTP.

- Example: Weather information, money exchange rates, world news, stock market quotation are examples of applications that can be modeled around the notion of a remote data-services provider surrounded by countless consumers tapping on the server’s resources.
Under the **WebService** strategy the invoked functions are *implemented once* (in the server) and *called many times* (by the remote users).

Some advantages of this organization are:
- Elimination of redundant code,
- Ability to transparently make changes on the server to update a particular service function without clients having to be informed.
- Reduced maintenance and production costs.
Why should the Android developer learn how to create a WebService?

- Simple apps are usually self-contained and do not need to collaborate with other parties to obtain additional data or services (for instance, think of a scientific calculator).

- However, there are many cases in which the data needed to work with is very extensive, or changes very often and cannot (should not) be hard-coded into the app. Instead, this kind of data should be requested from a reliable external source (for instance, what is the Euro-to-Dollar rate of change right now?)

- Another class of apps requires a very high computing power perhaps not available in the mobile device (think of problems such as finding the shortest/fastest route between mapped locations, or best air-fare & route selection for a traveler).

- It is wise for an Android developer to learn how to solve typical problems that exceed the capacities of the handheld devices. Understanding the possibilities offered by the client-server computing model will make the developer be a more complete and better professional.
### WebService Architecture

An ideal Web service provider is designed around four logical layers which define the ways in which data is to be transported, encoded, exposed and discovered by the users.

<table>
<thead>
<tr>
<th>Layers</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transport</td>
<td>Move messages through the network, using HTTP, SMTP, FTP, ...</td>
</tr>
<tr>
<td>Messaging</td>
<td>Encoding of data to be exchanged (XML)</td>
</tr>
<tr>
<td>Description</td>
<td>WSDL (Web Service Desc. Lang) used for describing public methods available from the endpoint</td>
</tr>
<tr>
<td>Discovery</td>
<td>UDDI (Universal Description &amp; Discovery Integration) facilitates location and publishing of services through a common registry</td>
</tr>
</tbody>
</table>
There are two widely used forms of invoking and consuming WebServices:

**Representational State Transfer (REST)**

Closely tie to the HTTP protocol by associating its operation to the common methods: GET, POST, PUT, DELETE for HTTP/HTTPS. This model has a simple invocation mode and little overhead. Service calls rely on a URL which may also carry arguments. Sender & receiver must have an understanding of how they pass data items from one another. As an example: Google Maps API uses the REST model.

**Remote Procedure Call (RPC).**

Remote services are seen as coherent collections of discoverable functions (or method calls) stored and exposed by EndPoint providers. Some implementations of this category include: Simple Object Access Protocol (SOAP), Common Object Request Broker Architecture (CORBA), Microsoft's Distributed Component Object Model (DCOM) and Sun Microsystems's Java/Remote Method Invocation (RMI).
Example: Using REST.

The following URL is used to make a call to the **Google Search** service asking to provide links to the subject “Cleveland State University”

https://www.google.com/search?q=cleveland+state+university

**Figure 1.** Example of a REST web-service called with a URL that includes arguments
Although SOAP and REST technologies accomplish the same final goal, that is request and receive a service, there are various differences between them.

- **REST** users refer to their remote services through a conventional **URL** that commonly includes the location of the (stateless) server, the service name, the function to be executed and the parameters needed by the function to operate (if any). Data is transported using HTTP/HTTPS.

- **SOAP** requires some scripting effort to create an XML envelop in which data travels. An additional overhead on the receiving end is needed to extract data from the XML envelope. SOAP accepts a variety of transport mechanisms, among them HTTP, HTTPS, FTP, SMTP, etc.

- SOAP uses **WSDL** (WebService Description Language) for exposing the format and operation of the services. REST lacks an equivalent exploratory tool.
Figure 2. A WebClient consuming services using REST & SOAP

**REST**
- Using common URL
  - **Request**: http://provider.org?op=function&arg1=val1&arg2=val2
  - **Response**: Free format. Options include: Plain-text, HTML, XML, JSON...

**SOAP**
- **Request**: XML envelope holding function-name, arguments.
- **Response**: XML formatted results

**WSDL Exploration Tool**
Examples of Android Apps Using REST and SOAP

In the next sections we will present three examples showing how an Android web-client typically interacts with a remote server requesting and consuming WebServices.

Example 1. SOAP client / .NET provider
An Android app uses a XML KSOAP envelope to call a Windows IIS server. WebServices are implemented as a set of C#.NET functions.

Example 2. REST client / PHP provider
A REST Android client invokes remote PHP services which consult a database on behalf of the client. The response is formatted using JSON.

Example 3. REST client / Servlet provider
Our Android app communicates with an Tomcat Server in which its WebServices are implemented as Java Servlets. As in the previous example, the results of a database query are returned as a JSON string.
Windows Communication Foundation (WCF)

BACKGROUND

WCF is a Microsoft technology that provides a framework for writing code to communicate across heterogeneous platforms [1, 2].

1. An IIS WebServer may host various EndPoints (WebServices).

2. Each of those EndPoints uses WSDL to provide a way of exposing its composition and behavior to clients wishing to find and communicate with the services.

3. Each endpoint includes:
   • address (URL - where to send messages),
   • binding (how to send messages ), and a
   • contract (an explanation of what messages contain)

References:
Example: The link http://www.webservicex.net/uszip.asmx?WSDL takes us to a WCF EndPoint useful for finding locations in the US based on zip code (only a few lines are shown). This view –written in WSDL- is known as the service contract.

```xml
<wSDL:definitions xmlns:soap="http://schemas.xmlsoap.org/wsdl/soap/" ... targetNamespace="http://www.webserviceX.NET">
  <wsdl:types>
    <s:schema elementFormDefault="qualified" targetNamespace="http://www.webserviceX.NET">
      <s:element name="GetInfoByZIP">
        <s:complexType>
          <s:sequence>
            <s:element minOccurs="0" maxOccurs="1" name="USZip" type="s:string"/>
          </s:sequence>
        </s:complexType>
      </s:element>
      <s:element name="GetInfoByZIPResponse">
        <s:complexType>
          <s:sequence>
            <s:element minOccurs="0" maxOccurs="1" name="GetInfoByZIPResult" mixed="true">
              <s:complexType>
                . . .
              </s:complexType>
            </s:element>
          </s:sequence>
        </s:complexType>
      </s:element>
    </s:schema>
  </wsdl:types>
</wSDL:definitions>
```

Method’s name, Argument, Type

Returned result
Remove the fragment ?WSDL from the previous link. The shorter URL http://www.webservicex.net/uszip.asmx exposes the endpoint service functions as shown in the figure below.

Figure 3. A .NET WebService providing USA ZIP-code information
Figure 4. WSDL Service Contracts & SOAP Envelopes

Outgoing Envelope (Request)

Incoming Envelope (Response)
Figure 5.

The **Response** data is sent by the WebService to the client as an **XML** encoded string.
This example consists of two parts. First we construct an **EndPoint** offering a set of **Windows IIS web-services**, in the second part we build an Android SOAP client that requests and consumes the previous web-services.

**Server Side Software:**
- The following document is a step-by-step tutorial describing how to create a simple web-service running on a Windows IIS-Server [http://support.microsoft.com/kb/308359](http://support.microsoft.com/kb/308359)

**Client Side:**
- We use the **KSOAP 2.0** [1] library to send requests and receive results to/from the IIS server.
- KSOAP offers various access methods such as: .getProperty(...), .getPropertyAsString(...), .getPropertyCount() and so on, to dissect the data tokens sent back in the composite **response** object.

Example 1: Android SOAP Web-Client & .NET WebServices

Envelope holding REQUEST
XML Package containing:
URL, Namespace, Method,
<Argument, Value> set

Envelope with RESPONSE
XML <tag>.....</tag>

Windows Machine
IIS Server

C#.NET
Web-Services

SOAP

MySql
Database
Android & WebServices

Example1: KSOAP API

BACKGROUND
Android does not supply a native mechanism to handle SOAP exchanges; therefore we have to use external software such as the KSOAP API.

- **KSOAP** is a communication support library designed for limited hardware devices.

- **KSOAP** can exchange simple Java types (**SoapPrimitive**), as well as serialized complex objects (**SoapObject**).

**KSOAP API**

<table>
<thead>
<tr>
<th><strong>SoapEnvelope</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Holds the encoded object’s head and body. Includes a <code>parse()</code> method to pull the supplied XML data.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SoapObject</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Generic container that travels inside the XML envelope transporting app’s data. Custom objects must implement the <code>KvmSerializable</code> interface.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>HttpTransport</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>This method uses a URL to place an HTTP call and allow SOAP exchange using the JME generic connection framework.</td>
</tr>
</tbody>
</table>

**KSOAP download link:** [http://code.google.com/p/ksoap2-android/](http://code.google.com/p/ksoap2-android/)
Example 1: Android SOAP Web-Client Consuming .NET WebServices

This Windows IIS EndPoint offers three remote methods. Click on any entry to see contract details regarding its requests & responses.
Example1: A Sample of C#.NET Webservices

namespace WebServiceDemo1
{
    [WebService(Namespace = "http://MyHostNameOrIPAddress/")]  
    [WebServiceBinding(ConformsTo = WsiProfiles.BasicProfile1_1)]  
    [System.ComponentModel.ToolboxItem(false)]  
    {
        // add two numbers
        [WebMethod]
        public double addValues(int var1, float var2)
        {
            return (var1 + var2);
        }
    }
}

The C#.NET methods acting as webservices are marked with the [WebMethod] annotation. Public WebMethods are added to the end-point’s WSDL contract, so their input/output structures can be exposed.
// Return a list of Person objects

[WebMethod]
public List<Person> getPersonList(String home)
{
    List<Person> lst = new List<Person>();
    // partial list of the "Winterfel Castle" characters
    if (home.Equals("Winterfel Castle")) {
        lst.Add(new Person("Catelyn Stark", 40));
        lst.Add(new Person("Sansa Stark", 14));
        lst.Add(new Person("Jon Snow", 22));
    }
    return lst;
}

// accept name & age, return a 'younger' Person object

[WebMethod]
public Person rejuvenatePerson(string name, int age)
{
    return new Person(name, age - 1);
}

} // class
} // namespace
namespace WebServiceDemo1
{
    [Serializable]
    public class Person
    {
        private string _personName;
        private int _personAge;

        public Person( String personNameValue, int personAgeValue )
        {
            this._personName = personNameValue;  this._personAge = personAgeValue;
        }
        public Person( )
        {
            this._personName = "NA";  this._personAge = 0;
        }
        public string personName
        {
            get { return this._personName; } 
            set { this._personName = value; }
        }
        public int personAge
        {
            get { return this._personAge; } 
            set { this._personAge = value; }
        }
    }
}
1. Our IIS webservice is implemented in C#.Net; however any .NET language could be used. The entry called Namespace identifies the IIS workspace hosting the WebMethods to be called by the Android client app. The literal value of this namespace is important as it will be referenced later by the client app as part of its request object.

2. In our example the .NET service **getPersonList** accepts a string naming a location (such as ‘**Winterfel Castle**’) and returns a list of its fictional inhabitants (**Person** objects made according to the definition shown by Bullet 3). An answer encoded in XML format is sent back to the client. For instance in our example, the returned string is as follows (only a few lines are shown):

```xml
  <Person>
    <personName>Catelyn Stark</personName>
    <personAge>40</personAge>
  </Person>
  <Person>
    <personName>Sansa Stark</personName>
    <personAge>14</personAge>
  </Person>
</ArrayOfPerson>
```
3. **Important Note**: Remember to modify the .NET application’s properties as follows: On the ‘Solution Explorer’ look for the application, Right-Click > Properties > Web > Use Local IIS server > Create Virtual Directory.
Example 1: Android SOAP Web-Client + .NET WebServices

Figure 4. Android WebClient App

The figure shows the decoded response for the request: `getPersonList (home)` which returns a partial list of the fictional inhabitants of a given home location (e.g. “Winterfell Castle”).

```
RESPONSE
anyType{Person=anyType{personName=Catelyn Stark; personAge=40; }; Person=anyType{personName=Sansa Stark; personAge=14; }; Person=anyType{personName=Jon Snow; personAge=22; }; }

PERSON-LIST
Row-0
KSOAP
anyType{personName=Catelyn Stark; personAge=40; } JAVA:
→ Person [name=Catelyn Stark, age=40]
Row-1
KSOAP
anyType{personName=Sansa Stark; personAge=14; } JAVA:
→ Person [name=Sansa Stark, age=14]
Row-2
KSOAP
anyType{personName=Jon Snow; personAge=22; } JAVA:
→ Person [name=Jon Snow, age=22]
```

NOTE: You need to place a copy of the KSOAP jar file in the app’s /libs folder. The KSOAP download link is: http://code.google.com/p/ksoap2-android/
Example 1: Android SOAP-Client Consuming .NET Web services

```java
public class SoapTestActivity extends Activity {
    TextView result;

    // use handler to keep GUI update on behalf of background tasks
    Handler handler = new Handler() {
        @Override
        public void handleMessage(Message msg) {
            // TODO Auto-generated method stub
            super.handleMessage(msg);
            String text = (String) msg.obj;
            result.append("\n" + text);
        }
    };

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_soap_test);
        result = (TextView) findViewById(R.id.result);
    }
}
```
//do slow calls to remote server in a background thread
Thread slowJob = new Thread() {
    @Override
    public void run() {
        // IP address at home
        final String URL = "http://192.168.1.66/WebServiceDemo1/Service1.asmx";
        final String NAMESPACE = "http://MyHostNameOrIPAddress/";
        final String METHOD_NAME = "getPersonList";
        String resultValue = "";

        try {
            //prepare SOAP REQUEST (namespace, method, arguments)
            SoapObject request = new SoapObject(NAMESPACE, METHOD_NAME);
            //passing primitive (simple) input parameters
            request.addProperty("home", "Winterfel Castle");

            //prepare ENVELOPE put request inside
            SoapSerializationEnvelope envelope = new SoapSerializationEnvelope(SoapEnvelope.VER11);
            envelope.dotNet = true;
            envelope.setOutputSoapObject(request);

            //tell the type of complex object to be returned by service
            envelope.addMapping(NAMESPACE, METHOD_NAME,
                    new ArrayList<Person>().getClass());
        } finally {
            slowJob = null;
        }
    }
};
// TRANSPORT envelope to destination set by URL (call & wait)
HttpTransportSE androidHttpTransport = new HttpTransportSE(URL);
androidHttpTransport.call(NAMESPACE + METHOD_NAME, envelope);

// receiving a complex response object (list of Person objects)
SoapObject response = (SoapObject) envelope.getResponse();

if (response == null) {
    resultValue = "NULL response received";
} else {
    // get ready to show rows arriving from the server
    resultValue = "RESPONSE\n" + response.toString();

    resultValue += "\n\nPERSON-LIST";

    // use KSOAP access methods to parse and extract data from response
    for (int i = 0; i < response.getPropertyCount(); i++) {
        resultValue += "\nRow-" + i;
        resultValue += "\n\tKSOAP\n\t" + response.getProperty(i);

        SoapObject personObj = (SoapObject) response.getProperty(i);
        Person p = new Person(personObj);

        resultValue += "\n\tJAVA:\n" + p.toString();
    }
}
Example1: Android SOAP-Client Consuming .NET Webservices

```java
} catch (Exception e) {
    resultValue = "\nERROR: " + e.getMessage();
}
// send message to handler so it updates GUI
Message msg = handler.obtainMessage();
msg.obj = (String) resultValue;
handler.sendMessage(msg);

// onCreate
slowJob.start();
```
Example 1: Java Person Class & KSOAP Serialization

```java
import org.ksoap2.serialization.SoapObject;

public class Person {
    private String name;
    private int age;
    // constructors
    public Person() {
        this.name = "na";
        this.age = -1;
    }
    public Person(String name, int age) {
        this.name = name;
        this.age = age;
    }
    // create a local Java Person object using the KSOAP response (C#) object
    public Person(SoapObject obj) {
        this.name = obj.getProperty("personName").toString();
        this.age = Integer.parseInt(obj.getProperty("personAge").toString());
    }
    // accessors (get/set) omitted for brevity...

    @Override
    public String toString() {
        return "Person [name=" + name + ", age=" + age + "]";
    }
}
```
1. The Android webclient uses a background Thread to offload the task of communicating with the (possibly slow) webserver while keeping the app’s GUI responsive. Updates to the app’s GUI are made by the main thread from the messages sent by the worker thread through a Handler object.

2. The client prepares its request SoapObject indicating the Namespace and WebMethod in that workspace that needs to be executed. Then, each parameter (and its value) sent to the invoked method is added with the .addProperty clause.

3. A SoapSerializationEnvelope is made to carry the user’s request to the server. The envelope’s dotNet property indicates that it expects results to be generated by the Windows server. The .addMapping method is used to identify the Java type of the data returning inside the SOAP envelope. In this example, the clause

   ```java
   new ArrayList<Person>().getClass()
   ```

   tells the response consists of a list of user-defined Person objects.
4. The SOAP envelope is finally transported to the server designated by the given URL. After that, the Android app waits for a response.

5. The `envelope.getResponse()` clause eventually sends to the Android client a collection of Person objects encoded in XML format (the formal structure of the XML dataset is available in the endpoint’s WSDL contract). The statement `response.toString()` converts the XML string into equivalent KSOAP notation. For instance, in our example we obtain:

```anyType{
    Person=anyType{
        personName=Catelyn Stark; personAge=40; }
    Person=anyType{
        personName=Sansa Stark; personAge=14; }
    Person=anyType{
        personName=Jon Snow; personAge=22; }
}
```

6. The method `response.getPropertyCount()` is used to determine the size of the returned array. The `response.getProperty(i)` extracts the i-th row from the response object. Each row (representing a .NET serialized person) is passed to the local Java Person-class constructor (see Bullet 8).
7. A message is sent from the background worker thread to the main app so its GUI could be updated with the data received from the webservice.

8. The Java Person constructor is given (Bullet 5) a **SoapObject** holding encoded Person data, for instance, **obj** looks like the following string:

   Person=anyType{personName=Catelyn Stark; personAge=40; }

This string is dissected using the KSOAP parsing methods **obj.getProperty("personName")** and **obj.getProperty("personAge")**. These values are then used to make the equivalent Java object **Person[name=Catelyn Stark, age=40]**
In this second example an Android client uses **REST** protocol to interact with an **IIS server**. WebServices in the Windows machine are implemented as a set of **PHP** programs. We use **JSON** encoding for the client-server data exchange.

**Example 2:**
Using an Android REST-based Client + PHP Webservices

REQUEST string (Post / Get)

```plaintext
http://www.abc.com
?key1=value1&key2=value2
```

RESPONSE formatted as:

- JSON {......}
- XML `<tag>......</tag>`
- HTML `<html>....</html>`
- CSV “aaa”,111,,333
- Plain-Text ...

*Windows or Linux/Unix Machine*

- **PHP**
- **Json**
- **MySql**
**Example 2: Using an Android REST-based Client + PHP services**

<table>
<thead>
<tr>
<th>REST-JSON</th>
</tr>
</thead>
</table>

**Client Request (URL)**

**Server Response (JSON)**
```json
[{
    "name": "Tiryion Lannister", "age": 30,
    "name": "Cersei Baratheon", "age": 32
}
```

**Decoded Response (Java)**
```java
[Person[name=Tiryion Lannister, age=30]
 , Person[name=Cersei Baratheon, age=32]
]
"Tiryion Lannister" - - 30
"Cersei Baratheon" - - 32
```

The remote PHP WebService allows the retrieving of people from a given castle.

Response from the server arrives in **JSON** notation, later it is translated to an equivalent Java collection.
<?php

// METHOD: getPeopleNoSql.php
// retrieves people by castle location (eg.?castle=winterfel castle)
// data comes from associative arrays (noSql)

// create anonymous Person-like objects
$person0 = array('name' => 'Daenerys Targaryen', 'age' => 18);
$person1 = array('name' => 'Tiryion Lannister', 'age' => 30);
$person2 = array('name' => 'Arya Stark', 'age' => 11);
$person3 = array('name' => 'Jon Snow', 'age' => 20);
$person4 = array('name' => 'Hodor', 'age' => 40);

// create lists of people-by-HomeCastle
$winterfelPeople = array($person2, $person3, $person4);
$otherPeople = array($person0, $person1);

// select list to be returned (only winterfel in this abbreviated example)
if( strtolower($_REQUEST['castle']) == 'winterfel castle' )
    $people = $winterfelPeople;
else
    $people = $otherPeople;

// respond with JSON-encoded list
echo json_encode($people);
<?php
// METHOD: getPeopleMySql.php - Use MySql database 'gameofthrones' to
// retrieve people by castle location (eg.?castle=winterfel). URL is
// ---------------------------------------------------------------
// attribute 'castle' arrives via POST or GET call (default: Winterfel)
if( $_REQUEST[ 'castle' ] ) {
    $arg1 = $_REQUEST[ 'castle' ];
} else {
    $arg1 = 'Winterfel';
}
$link = mysqli_connect("192.168.1.66", "csuperson", "euclid", "gameofthrones");
// test connection
if (mysqli_connect_errno()) {
    echo "<h1>Connect failed</h1>" . mysqli_connect_error();
    exit();
}
// create a prepared statement
$stmt = mysqli_prepare($link,
    'SELECT name, age FROM person where castle LIKE ? ;');
if (!$stmt) {
    echo "<h1>Statement failed</h1>" . mysqli_error($link);
    exit;
}
// bind parameter to local variable. The 2nd arg (TYPE spec) 'is' indicates:
// (i)nteger, (s)tring input types, etc
$arg1 = $arg1 . '%';  //allow SQL partial matching
mysqli_stmt_bind_param($stmt, 's', $arg1);
// execute query
mysqli_stmt_execute($stmt);

// bind sql result to local variable
mysqli_stmt_bind_result($stmt, $name, $age);

$personList = array();
$i = 0;
while (mysqli_stmt_fetch($stmt)) {
    $person = array('name' => $name, 'age' => $age);
    $personList[] = $person;
}
// close prepared statement, connection
mysqli_stmt_close($stmt);
mysqli_close($link);

//respond with encoded person-list
$jsondata = json_encode($personList);
echo $jsondata;
?>

The Person dataset is retrieved from a MySQL database
Example 2: MySQL Database

Example based on characters from HBO Series - Game of Thrones © by G. R.R. Martin
http://www.hbo.com/game-of-thrones#/game-of-thrones

# script to create a mySql database
drop database if exists GameOfThrones;
create database GameOfThrones;
use GameOfThrones;
drop table if exists person;
create table person (name varchar(80), age int, castle varchar(40) );
insert into person values("Arya Stark",11, "Winterfel Castle");
insert into person values("Jon Snow",20, "Winterfel Castle");
insert into person values("Hodor",40, "Winterfel Castle");
insert into person values("Daenerys Targaryen",18, "Dragonstone");
insert into person values("Tiryion Lannister",30, "King's Landing");
insert into person values("Cersei Baratheon",32, "King's Landing");
select * from person;
Example 2: PHP Webservices - Comments

1. The remote PHP method `getPeopleNoSql` returns a list of people grouped according to their corresponding home location. The request parameter ‘castle’ carries the site to be selected (in our example we use ‘Winterfel Castle’). The server prepares a list from a dataset stored as an associative array. The list is encoded using JSON notation and is finally returned to the calling Android web-client app (discussed later). The PHP methods `json_encode( ...)and json_decode(...)` are part of the language and do not require additional APIs to be installed on the server’s side.

2. The method `getPeopleMySql` is functionally similar to the method above however; its output is constructed from data stored in a relational MySql database.

3. As in the first method, the resultset is also encoded using JSON format.

4. The script provides a way to implement a small MySql database called ‘gameofthrones’ to be used with the optional service `getPeopleMySql`.

MySql Download:  http://dev.mysql.com/downloads/
Example 2: Android REST-based Client

```java
public class MainActivity extends Activity {
    TextView txtRequestUrl, txtResponseJson, txtResponseJava;

    @Override
    public void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);
        txtRequestUrl = (TextView) findViewById(R.id.txtRequestUrl);
        txtResponseJson = (TextView) findViewById(R.id.txtResponseJson);
        txtResponseJava = (TextView) findViewById(R.id.txtResponseJava);

        // WebServer REQUEST consists of URL?arguments (args: spaces replaced by +)
        // You must use actual IP addresses, do not enter "localhost:8080"
        // ---------------------------------------------------------------------

        txtRequestUrl.setText(SERVER_URL);

        // Use AsyncTask to execute potential slow task without freezing GUI
        new LongOperation().execute(SERVER_URL);
    }
}
```
private class LongOperation extends AsyncTask<String, Void, Void> {
    private String jsonResponse;
    private ProgressDialog dialog = new ProgressDialog(MainActivity.this);

    protected void onPreExecute() {
        dialog.setMessage("Please wait..");
        dialog.show();
    }

    protected Void doInBackground(String... urls) {
        try {
            // Use URL to reach remote service-method. Parameters (if any) are
            // added to the URL as an '& ' separated list of key=value tokens.
            // An example of arguments: ?castle=King's+Landing&age>=20
            String url = urls[0];

            HttpClient client = new DefaultHttpClient();
            HttpGet methodGet = new HttpGet(new URI(url));
            HttpResponse response = client.execute(methodGet);

            // wait for incoming response stream, place data in a buffer
            InputStream isResponse = response.getEntity().getContent();
            InputStreamReader instream = new InputStreamReader(isResponse);
            BufferedReader responseBuffer = new BufferedReader(instream);
// move buffered data lines into a StringBuilder storage
StringBuilder strBuilder = new StringBuilder();
String line = null;
while (true) {
    line = responseBuffer.readLine()
    if (line == null) break;
    strBuilder.append(line);
}

// done. Requested data is now available
jsonResponse = strBuilder.toString();

} catch (Exception e) {
Log.e("Error-Background", e.getMessage());
} finally {
try {
    responseBuffer.close();
} catch (Exception e) {
    Log.e("Closing-Background", e.getMessage());
}
return null; // needed to gracefully terminate Void method
protected void onPostExecute(Void unused) {

    try {
        dialog.dismiss();
        // update GUI with JSON Response
        txtResponseJson.setText(jsonResponse);

        // prepare to decode JSON response and create Java list
        Gson gson = new Gson();

        // set (host) Java type of encoded JSON response
        Type listType = new TypeToken<ArrayList<Person>>(){}.getType();

        // decode JSON string into appropriate Java container
        ArrayList<Person> personList = gson.fromJson(jsonResponse, listType);

        // update GUI with Java version of retrieved list
        txtResponseJava.setText(personList.toString());

        // This strategy is other option to interpret the returned JSON response. 
        // Here you parse the nodes of the underlying data structure using GSON 
        // classes. A JsonElement could be either a: JsonObject, JSONArray, or 
        // JsonPrimitive
String result = "\n";
try {

JsonElement jelement = new JsonParser().parse(jsonResponse);
JsonArray jarray = jelement.getAsJsonArray();

for (int i = 0; i < jarray.size(); i++) {
    JsonObject jobject = jarray.get(i).getAsJsonObject();
    result += jobject.get("name").toString() + " -- "
    + jobject.get("age").toString()
    + "\n";
}

} catch (Exception e) {
    Log.e("PARSING", e.getMessage());
}
txtResponseJava.append( result );

} catch (JsonSyntaxException e) {
    Log.e("POST-Execute", e.getMessage());
}

} //asynckttask

} //class
Example 2: Android REST-based Client - Comments

1. The client app uses an **AsyncTask** object to call the remote WebService. This practice is functionally equivalent to running a background thread but offers more options (such as showing progress messages).

2. **doInBackground** takes the supplied URL to reach the server and request its assistance. The **org.apache.http.client.HttpClient** class is responsible for establishing the asynchronous HTTP client-server exchange. In our example an HTTP GET operation is invoked using the URL:


   the called PHP method **getPersonMySQL** extracts its result from a MySql database. Observe that URL arguments appear after the ? symbol. You may also replace spaces with + symbols as in castle=King’s+Landing

3. The client app collects the **JSON** encoded result in a StringBuilder. In our example the returned string is: 

   ```json
   [{"name":"Tiryion Lannister","age":30},{"name":"Cersei Baratheon","age":32}]
   ```

HTTPClient Ref:
Example 2: Android REST-based Client - Comments

4. The **onPostExecute** portion of the AsyncTask decodes the JSON response string into a Java ArrayList<Person> collection.

   We have chosen **Google’s GSON API** for processing the incoming JSON string. The example shows two approaches for decoding JSON data:

   (a) The first invokes the `fromJson(data, type)` method,

   (b) the second alternative parses the JSON string looking for the occurrence of JsonElement, JSONArray, and JsonObject tokens.

   For more details on this issue see Lecture 14

Google’s GSON API Download:  
[https://code.google.com/p/google-gson/downloads/list](https://code.google.com/p/google-gson/downloads/list)
Example 3: Android REST consuming Servlet WebServices

This problem is similar to Example-2. An Android REST-based client supplies a location and a webservice retrieves all inhabitants of that place.

As before we divide the problem in two parts, first we discuss step-by-step how to create the **Tomcat hosted Servlet**, then we build an Android client using REST to communicate with it.

REQUEST string (Post / Get)

http://www.abc.com
?key1=value1&key2=value2

RESPONSE formatted as:

**JSON** 
{}

**XML**
<tag>......</tag>

**HTML**
<html>....</html>

**CSV** "aaa",111,,333

**Plain-Text** ...

Tomcat Server download:
[http://tomcat.apache.org/download-70.cgi](http://tomcat.apache.org/download-70.cgi)
Example 3: Android REST consuming Servlet Services

• An **HttpServletRequest** is a Java class used to extend the functionality of a web server. It is commonly used to provide dynamic web content in a manner similar to the ASP, .NET and PHP technologies.

• A **Servlet** primarily operates on two distinct objects:
  
  o **HttpServletRequest**: Represents a client's request. This object gives a servlet access to incoming information such as HTML form data and HTTP request headers.

  o **HttpServletResponse**: Represents the servlet's response. The servlet uses this object to return data to the client such as HTTP errors, response headers (Content-Type, Set-Cookie, and others), and output data by writing to the response's output stream or output writer.

Reference:
Example 3: Create a ServLet

We assume you are using **Eclipse EE** and Apache **Tomcat 7.0** (or newer).

1. In **Eclipse** - create a new **Dynamic Web project**.
   - Set project name to: **GameOfThrones**.
   - On ‘Target runtime’ pane, click ‘New runtime’. From the drop-down list choose **Tomcat Server v7.0** (or a newer version). Click ‘Next’ button.
   - In textbox ‘Tomcat Installation directory’ enter the location where your Tomcat software is placed (usually: C:\Program Files\Apache Software Foundation\Tomcat 7.0). Click button ‘Finish’ > ‘Finish’.

2. Add new package **csu.yourlastname** to the folder **/JavaResources/src**

3. Place inside the package a new **Servlet**. In the ‘Class name’ box enter: **GetHeroes**. Click the button ‘Finish’.

4. Add to the package the **Person** class (*code to be shown shortly*)

5. Copy to the folder: **WebContent/WEB-INF/lib** the **GSON** and **MySQL-JConnector** jars. They are needed to support JSON encoding and access to a MySql database.
Example 3: Create a Servlet

6. Create inside the folder `WebContent/META-INF/` an XML file called `context.xml` globally indicating how to access the MySql database (*code to be shown shortly*).

7. Create inside the folder: `WebContent/WEB-INF` an XML file called `web.xml` explaining the parts of the service and its mapping of symbolic names to Java classes (*shown ahead*).

The structure of your Java Servlet should be as indicated in the figure. Add pending code, and test your app. *Make sure that only the Eclipse developer’s web server is running.*
Example 3: Create a Servlet - Test Results

http://localhost:8080/GameOfThrones/GetHeroes?castle=winterfell


http://localhost:8080/GameOfThrones/GetHeroes?castle=dragonstone

Example 3: Create a Servlet

**context.xml**
This file indicates how to connect to a MySql database. It includes the user’s name, password, driver name, connection parameters, and database connection string. It must be placed in the WebContent/META-INF/ folder.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<Context>
   <!-- comments removed -->

   <Resource
      name="jdbc/mysqlResourcegameofthrones"
      auth="Container"
      type="javax.sql.DataSource"
      maxActive="100" maxIdle="30" maxWait="10000"
      username="cuseron"
      password="euclid"
      driverClassName="com.mysql.jdbc.Driver"
      url="jdbc:mysql://192.168.1.66:3306/gameofthrones"/>

</Context>
```
Example 3: Create a Servlet

**web.xml**
This file lists the parts of the servlet, its resources, and indicates how to map the Servlet’s java classes to webService names passed in the request object. It must be placed in the **WebContent/WEB-INF** folder.

```xml
<?xml version="1.0" encoding="UTF-8"?>
<web-app xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  
  <display-name>GameOfThrones</display-name>

  <welcome-file-list>
    <welcome-file>index.html</welcome-file>
    <welcome-file>index.htm</welcome-file>
  </welcome-file-list>

  <servlet>
    <description></description>
    <display-name>GetHeroes</display-name>
    <servlet-name>GetHeroes</servlet-name>
    <servlet-class>csu.matos.GetHeroes</servlet-class>
  </servlet>
</web-app>
```
Example 3: Create a Servlet

web.xml

```xml
<servlet-mapping>
    <servlet-name>GetHeroes</servlet-name>
    <url-pattern>/GetHeroes</url-pattern>
</servlet-mapping>

<resource-ref>
    <description>MySQL Datasource – GameOfThrones Example</description>
    <res-ref-name>jdbc/mysqlresourcegameofthrones</res-ref-name>
    <res-type>javax.sql.DataSource</res-type>
    <res-auth>Container</res-auth>
</resource-ref>

</web-app>
```
Example 3: Create a Servlet - GetHeroes Servlet

GetHeroes is the actual servlet. It does all its work inside the `doGet` method. The incoming request string is examined looking for the `argument=value` pairs it may carry. Once the `castle` value is known a list of its associated people is assembled. The servlet redundantly extracts its data from two sources, first it uses an in-memory collection of datasets, then it repeats the same type of retrieval querying a mySql database.

```java
@WebServlet("/GetHeroes")
public class GetHeroes extends HttpServlet {

    private static final long serialVersionUID = 1L;

    public void doGet(HttpServletRequest request, HttpServletResponse response)
            throws ServletException, IOException {

        PrintWriter output = response.getWriter();
        output.println(" [0] NEW TEST: " + new Date());

        Map<String, String[]> requestMap = request.getParameterMap();
        if (requestMap.isEmpty()) {
            output.println(" [1] <<<< SERVLET CALLED - Empty Request >>>> ");
        }
        for (String key : requestMap.keySet()) {
            String[] value = requestMap.get(key);
            output.println(" [2] >>> " + key + " " + value[0]);
        }
    }
```
// setup memory resident datasets (fake core database)
ArrayList<Person> winterfelPeople = new ArrayList<Person>();
winterfelPeople.add(new Person("Arya Stark", 11, "Winterfel Castle"));
winterfelPeople.add(new Person("Jon Snow", 20, "Winterfel Castle"));
winterfelPeople.add(new Person("Hodor", 40, "Winterfel Castle"));

ArrayList<Person> dragonPeople = new ArrayList<Person>();
dragonPeople.add(new Person("Daenerys Targaryen", 18, "Dragonstone"));

ArrayList<Person> kingsPeople = new ArrayList<Person>();
kingsPeople.add(new Person("Tiryion Lannister", 30, "King's Landing"));
kingsPeople.add(new Person("Cersei Baratheon", 32, "King's Landing"));

String castle = "";
castle = request.getParameter("castle");
output.println(" [3]PARAMETER castle: " + castle);

// Part1. add to peopleResult data from memory-held lists
// if no castle is supplied, include all characters
ArrayList<Person> peopleResult = new ArrayList<Person>();
if (castle==null){
castle = "";
peopleResult.addAll(winterfelPeople);
peopleResult.addAll(dragonPeople);
peopleResult.addAll(kingsPeople);
} else if ("winterfell castle".startsWith(castle)) {
    peopleResult = winterfelPeople;
}

} else if ("dragonstone".startsWith(castle)) {
    peopleResult = dragonPeople;
}

} else if ("king's landing".startsWith(castle)) {
    peopleResult = kingsPeople;
}

// prepare to do GSON encoding of selected people
Gson gson = new Gson();
String jsonData = gson.toJson(peopleResult);
output.println(" [4] TAKEN FROM MEMORY-DB: " + jsonData);

// Part2. Redo peopleResult now retrieving from mySQL db.
try {
    peopleResult = getDbRecord(castle);
    jsonData = gson.toJson(peopleResult);
    output.println(" [5] TAKEN FROM MYSQL-DB: " + jsonData);
} catch (Exception e) {
    output.println("NO DATA");
}

output.flush();

}// doPost
@Override
protected void doPost(HttpServletRequest request, HttpServletResponse response)
    throws ServletException, IOException {
    doGet(request, response);
}

// Retrieve designated people this time from a mySql database
private ArrayList<Person> getDbRecord(String castle) throws Exception {

    ArrayList<Person> result = new ArrayList<Person>();
    try {
        javax.naming.Context initContext = new InitialContext();
        Context envContext = (Context)initContext.lookup("java:/comp/env");

        javax.sql.DataSource ds = (DataSource) envContext.lookup("jdbc/mythronessqlresource");
        java.sql.Connection cnn = ds.getConnection();

        String mySQL = " select name, age, castle "
            + " from person where castle LIKE '%" + castle + "%'";

        java.sql.Statement stm = cnn.createStatement();

        java.sql.ResultSet rs = stm.executeQuery(mySQL);
while ( rs.next() ){
    String pname = rs.getString("name");
    int page = Integer.parseInt(rs.getString("age"));
    String pcastle = rs.getString("castle");

    Person pers = new Person(pname, page, pcastle);
    result.add(pers);
}

} catch (java.sql.SQLException e) {
    throw new Exception (" *[Problems1 ]* " + e.getMessage());

} catch (javax.naming.NamingException e) {
    throw new Exception (" *[Problems2 ]* " + e.getMessage());

} return result;

}//getDbRecord

}// class
public class Person {

    private String name;
    private int age;
    private String castle;

    public Person(String name, int age, String castle) {
        this.name = name;  this.age = age;  this.castle = castle;
    }

    public Person() {
        this.name = "na";  this.age = -1;  this.castle = "na";
    }

    public String getName() { return name; }
    public void setName(String name) { this.name = name; }
    public int getAge() { return age; }
    public void setAge(int age) { this.age = age; }

    @Override
    public String toString() {
        return "Person [name=" + name + ", age=" + age + ", castle=" + castle + "]";
    }
}
Example 3: Servlet - Comments

1. This servlet only implements its **doGet** method in which a **request** URL string is accepted and a **response** object is sent back to the caller.

2. For demonstration purposes the servlet returns twice the result-set. First data is selected from an in-memory (ArrayList-based) collection, the second time data comes from a relational database.

3. The incoming **castle** argument is extracted from the request URL, it indicates what group of people should be retrieved.

4. After a resultset consisting of Person objects held in an ArrayList is assembled, the collection is converted to a JSON string (we use GSON library, see Lecture 14).

5. The method **getDbRecord** redundantly retrieves a version of the resultset from a MySql database. **DataSource** specs for reaching the database are taken from the global server’s **context** file.

6. A select-statement adds the **castle** argument to its **where** clause to find the tuples satisfying the search condition.

7. Database rows are scanned one at the time. From each selected tuple a Person object is created and added to a growing ArrayList. After all rows are processed the ArrayList is returned.
Example 3: Transfer your Servlet to the Production Server

1. In Eclipse Workspace, navigate to the build directory.
2. Copy the GameOfThrones project folder to the Tomcat Server's webapps directory.
3. Paste the context.xml file from the build directory into the GameOfThrones folder in the Tomcat Server's webapps directory.
4. Place the necessary jars and libraries in the Tomcat Server's lib directory.
Preliminary Steps

- Stop the Eclipse Tomcat server instance (no other webserver should be running).
- Locate the Tomcat production server in your system (usually at `c:\Program Files\Apache Software Foundation\Tomcat 7.0`). If needed create a folder called `/webapps/GameOfThrones`. Add The subdirectories `META-INF` and `WEB-INF`.

Transfer Files From Eclipse Workspace to the Tomcat Production Server

1. Modify the production server’s file `\conf\context.xml`. Add to it a copy of the `<resource... />` XML entry from your Eclipse `WebContent\META-INF\context.xml` file. Observe that you may end-up with more than one global `<resource>` entry.

2. Use your Windows Explorer to find and copy the Eclipse’s `build\classes` folder. Paste this copy in the server’s `webapps\GameOfThrone\WEB-INF\` folder.

3. Copy each of the `jars` used by the servlet into the server’s `\lib\` folder.

4. Place a copy of the `\WEB-INF\web.xml` file in the corresponding `\WEB-INF\` server’s folder.

5. Restart the server.
Run/Restart the Tomcat service (Control Panel > Administrative Tools > Services > Locate Apache Tomcat > Start). Run a browser with the following URL:

http://localhost:8080/GameOfThrones/GetHeroes?castle=winterfel

The returned page is shown below
Use the same Android client from the previous example. Change the URL to the desired destination. For this example, test the client-app with the URL values:

- http://localhost:8080/GameOfThrones/GetHeroes?castle=king’s+landing
Producing & Consuming Web Services

< Questions />
REST Protocol – Android & Apache's Tomcat Server

This replaces Step 8 in Example 2C. Multitier Application

Add the following `DataSource` to the application’s `context.xml` file. Add the file to the `/WebControl/META-INF/` folder of your Eclipse workspace solution (later, this fragment will be copied to the Tomcat’s `/conf/context.xml` file)

```xml
<?xml version="1.0" encoding="UTF-8"?>
<context>
  <Resource name="jdbc/myoracle" auth="Container"
    type="javax.sql.DataSource" driverClassName="oracle.jdbc.OracleDriver"
    url="jdbc:oracle:thin:@sancho.csuohio.edu:1521:ORCL"
    username="CSUPERSON" password="EUCLID" maxActive="20" maxIdle="10"
    maxWait="-1"/>
</context>
```

The above `DataSource` helps the JDBC connection identify the involved server and user. Other users could reuse the data-source and provide individual credentials.

Reference:
http://tomcat.apache.org/tomcat-5.5-doc/jndi-datasource-examples-howto.html
http://tomcat.apache.org/tomcat-5.5-doc/jndi-resources-howto.html
Appendix B. JDBC Architecture

JDBC™ 4.0 Specification. JSR 221
Sun Microsystems
Lance Andersen, Specification Lead
November 7, 2006

FIGURE 5-1 Relationships between major classes and interface in the java.sql package