Asynchronous JavaScript and XML (AJaX)

Object Computing, Inc.
Mark Volkmann
mark@ociweb.com

Topics Covered

- What is AJaX?
- JavaScript Overview
- XMLHttpRequest (XHR)
- Sarissa JavaScript Library
- REST Overview
- Demo Description
- Demo Sequence Diagrams
- Demo REST Server
- Demo XHTML
- Demo JavaScript
- Wrapup

What is AJaX?

- A name given to an existing approach to building dynamic web applications
- Web pages use JavaScript to make asynchronous calls to web-based services that typically return XML
  - allows user to continue interacting with a web page while waiting for data to be returned
  - page can be updated without refreshing browser
  - results in a better user experience
- Uses a JavaScript class called XMLHttpRequest

A Good Acronym?

- A is for "asynchronous"
  - requests can be made asynchronously or synchronously
  - both techniques allow web page to be updated without refreshing it
  - anything useful the user can do while processing request?
    - if yes then use asynchronous, otherwise use synchronous
- J is for "JavaScript"
  - typically JavaScript is used on the client-side (in the browser)
    - only programming language supported out-of-the-box by most web browsers
  - can use any language on server-side that can accept HTTP requests and return HTTP responses
    - Java servlets, Ruby servlets, CGI scripts, …
- X is for "XML"
  - request and response messages can contain XML
    - can easily invoke REST-style services
  - can really contain any text (single text value, delimited text, …)

Uses For AJaX

- Asynchronous
  - examples
    - Google Maps – `http://maps.google.com`
      - asynchronously loads graphic tiles to support map scrolling
    - Google Suggest – `http://www.google.com/suggest`
      - asynchronously updates list of possible topic matches based on what has been typed so far
- Synchronous
  - even when there is nothing useful for the user to do after a request is submitted to a server, AJaX can be used to retrieve data and update selected parts of the page without refreshing the entire page
    - better user experience

JavaScript Overview

- A programming language with syntax similar to Java
- Supported by web browsers
  - JavaScript can be downloaded from web servers along with HTML and executed in the browser
- Syntax to use from HTML
  - add `<script>` tag(s) to head section of HTML
  - can embed JavaScript code inside HTML or refer to external JavaScript files
  - embedding

```
<script type="text/javascript"> ... code ... </script>
```

  - referring

```
<script type="text/javascript" src="url"></script>
```

- JavaScript files cannot include/import others
  - HTML must use a script tag to refer to each needed JavaScript file

these notes use XHTML instead of HTML

XMLHttpRequest

- A JavaScript class supported by most web browsers
- Allows HTTP requests to be sent from JavaScript code
  - to send multiple, concurrent requests,
    use a different XMLHttpRequest instance for each
- HTTP responses are processed by "handler" functions
- Issue
  - code to create an XMLHttpRequest object differs between browsers
  - can use a JavaScript library such as Sarissa (more detail later)
    to hide the differences

XMLHttpRequest Properties

(partial list)

- `readyState`
  - 0 – UNINITIALIZED; `open` not yet called
  - 1 – LOADING; `send` not yet called
  - 2 – LOADED; `send` called, headers and status are available
  - 3 – INTERACTIVE; downloading, `responseText` only partially set
  - 4 – COMPLETED; finished downloading response
- `responseText`
  - response as text; null if error occurs or ready state < 3
- `responseXML`
  - response as DOM Document object; null if error occurs or ready state < 3
- `status` – integer status code of request
- `statusText` – string status of request

XMLHttpRequest Methods

(partial list)

- Basic methods
  - `open(`*`method`*`, `*`url`*`)` – initializes a new HTTP request
    - *method* can be `"GET"`, `"POST"`, `"PUT"` or `"DELETE"`
    - `url` must be an HTTP URL (start with `"http://"`)
  - `send(`*`body`*`)` – sends HTTP request
  - `abort()` – called after `send()` to cancel request
- Header methods
  - `void setRequestHeader(`*`name`*`, `*`value`*`)`
  - `String getResponseHeader(`*`name`*`)`
  - `String getAllResponseHeaders()`
    - returns a string where "*`header`*`: `*`value`*" pairs are delimited by carriage returns

Example return value:

```
Connection: Keep-Alive
Date: Sun, 15 May 2005 23:55:25 GMT
Content-Type: text/xml
Server: WEBrick/1.3.1 (Ruby/1.8.2/2004-12-25)
Content-Length: 1810
```

Sarissa

- An open source JavaScript library that allows the following to be done in a browser independent way
  - create XMLHttpRequest objects
  - parse XML (synchronously or asynchronously)
  - create XML (using DOM)
  - transform XML with XSLT
  - query XML with XPath
- Download from `http://sourceforge.net/projects/sarissa`
- Documentation at `http://sarissa.sourceforge.net/doc/`

Using XMLHttpObject With Sarissa

- To create an XMLHttpRequest

```
var xhr = new XMLHttpRequest();
```

- To send synchronous GET request and obtain response

```
xhr.open("GET", url, false); // false for sync
var body = null; // wouldn't be null for a POST
xhr.send(body);
var domDoc = xhr.responseXML;
var xmlString = Sarissa.serialize(docDoc);
```

`Sarissa.serialize` gets a string representation of an DOM node

- To send asynchronous GET request

```
xhr.open("GET", url, true); // true for async
var body = null; // wouldn't be null for a POST
xhr.onreadystatechange = function() {
  if (xhr.readyState == 4) {
    var domDoc = xhr.responseXML;
    var xmlString = Sarissa.serialize(docDoc);
  }
}
xhr.send(body);
```

Using XMLHttpObject With Sarissa (Cont'd)

- To set a request header

```
xhr.setRequestHeader("name", "value");
```

- To get a response header

```
var value = xhr.getResponseHeader("name");
```

REST Overview

- Stands for **RE**presentational **S**tate **T**ransfer
- Main ideas
  - a software component requests a "**resource**" from a service
    - by supplying a resource identifier and a desired media type
  - a "**representation**" of the resource is returned
    - a sequence of bytes and metadata to describe it
      - metadata is name-value pairs (can use HTTP headers)
  - obtaining this representation causes the software component to "**transfer**" to a new "**state**"

REST Overview (Cont'd)

- REST is an architectural style, not a standard or an API
  - but can use existing standards including URLs, HTTP and XML
  - can be implemented in many ways (such as Java or Ruby servlets)
  - used to build distributed applications such as Web apps. and Web services
- Good sources for further reading
  - "Building Web Services the REST Way" by Roger L. Costello
    - http://www.xfront.com/REST-Web-Services.html
  - **Roy Fielding**'s 2000 dissertation (chapter 5)
    - http://www.ics.uci.edu/~fielding/pubs/dissertation/top.htm
  - RESTwiki - http://rest.blueoxen.net/cgi-bin/wiki.pl
  - REST mailing list - http://groups.yahoo.com/group/rest-discuss/

REST Resources and Identifiers

- What is a REST **resource**?
  - a specific, retrievable thing, not an abstract concept
  - for example, instead of having a "car" resource with representations like "photo" and "sales report", those are the resources
    - **car photo** from a specific view (front, side and rear) with JPEG representations
    - **car sales report** for a specific month/year with PDF and XML representations
- What are good **resource identifiers**?

```
http://host:port/webapp/carPhoto
   ?make=BMW&model=Z3&year=2001&view=front
http://host:port/webapp/carPhoto/BMW/Z3/2001/front
http://host:port/webapp/carSalesReport
   ?make=BMW&model=Z3&year=2001&salesYear=2004&salesMonth=4
http://host:port/webapp/carSalesReport/BMW/Z3/2001/2004/4
```

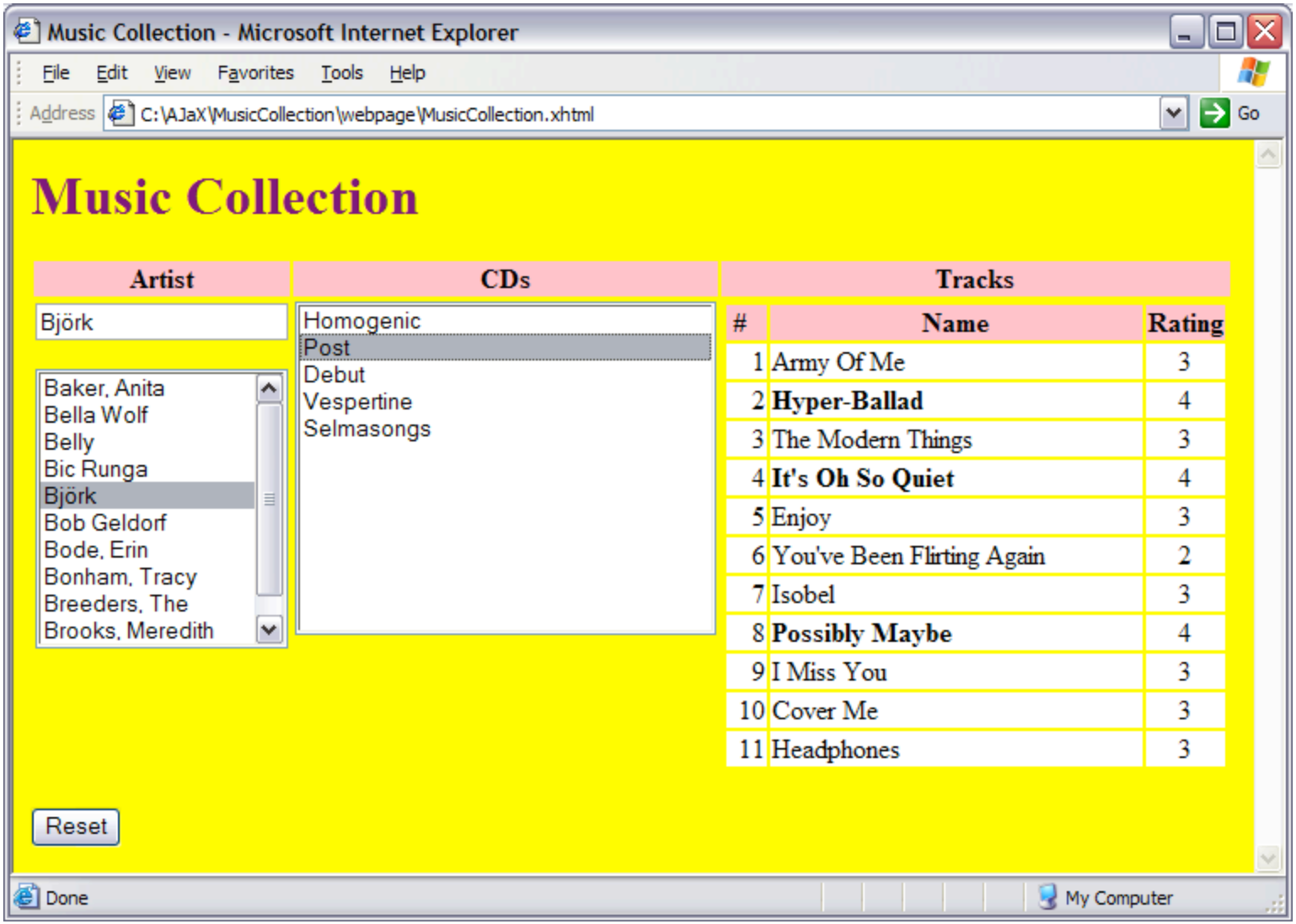
"Think of RESTful applications to consist of objects (**resources**) that **all have the same API** (PUT, DELETE, GET, POST, etc). For a component of the application to invoke a method on an object, it issues an HTTP request."
from a post on the rest-discuss by Jan Algermissen

An **underlying goal** is to make as many things as possible retrievable by an HTTP GET request. This enables **browser-based testing**.

Demo Description

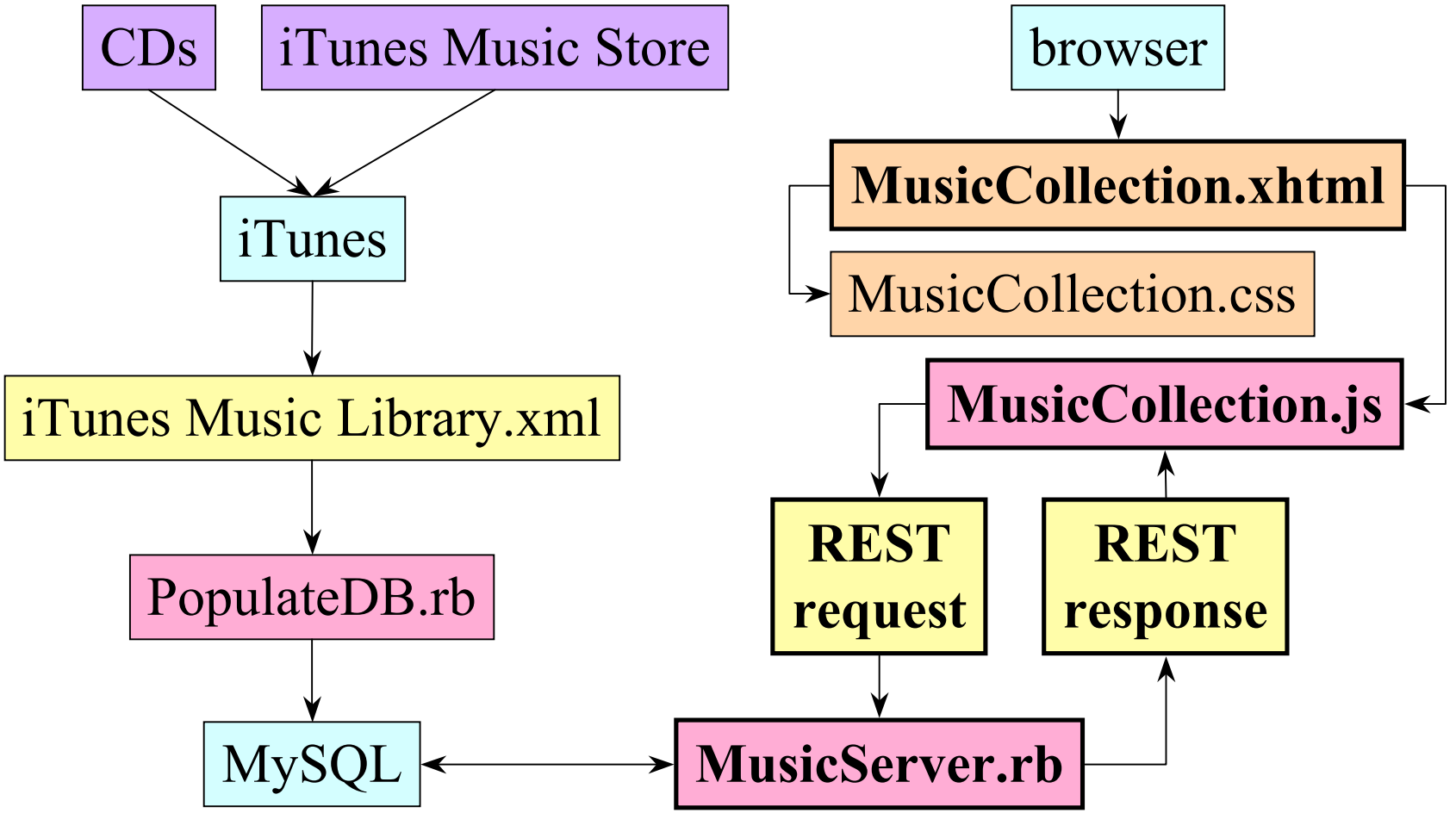
- Music collection search
  - MySQL database is populated off-line from an iTunes XML file
  - web page contains
    - text field to select artist name
      - suggests completions like Google Suggest
      - database columns include id and name
    - list of CDs by that artist
      - updated asynchronously when an artist name is entered
      - database columns include id, title and year
    - table of track data for that CD
      - updated asynchronously when CD selection changes
      - database columns include id, track number, name, time and rating
  - requests and responses follow REST style

Demo Screenshot



Demo Pieces

(we'll focus on boxes with bold text)



Getting Artists Whose Names Begin With *prefix*

- Request

```
http://localhost:2000/music/artist?starts=Co
```

- Response

```
<artists>
  <artist id="141" href="http://localhost:2000/music/artist?id=141">
    Cocteau Twins</artist>
  <artist id="72" href="http://localhost:2000/music/artist?id=72">
    Cole, Holly</artist>
  <artist id="80" href="http://localhost:2000/music/artist?id=80">
    Cole, Paula</artist>
  <artist id="111" href="http://localhost:2000/music/artist?id=111">
    Collins, Phil</artist>
  <artist id="48" href="http://localhost:2000/music/artist?id=48">
    Colvin, Shawn</artist>
  <artist id="132" href="http://localhost:2000/music/artist?id=132">
    Counting Crows</artist>
  <artist id="54" href="http://localhost:2000/music/artist?id=54">
    Cowboy Junkies</artist>
</artists>
```

Getting Artist Information

- Request

```
http://localhost:2000/music/artist?id=97&deep
```

- Response

```
<artist id="97">
  <name>Apple, Fiona</name>
  <cd artistId="97" id="163">
    <title>When The Pawn...</title>
    <track rating="3" id="767" cdId="163">On The Bound</track>
    <track rating="3" id="768" cdId="163">To Your Love</track>
    ...
  </cd>
  <cd artistId="97" id="164">
    <title>Tidal</title>
    <track rating="4" id="777" cdId="164">Sleep To Dream</track>
    <track rating="4" id="778" cdId="164">Sullen Girl</track>
    ...
  </cd>
</artist>
```

Request

```
http://localhost:2000/music/artist?id=97
```

without "deep"

Response

```
<artist id="97">
  <name>Apple, Fiona</name>
  <cd href="http://localhost:2000/music/cd?id=163" id="163" />
  <cd href="http://localhost:2000/music/cd?id=164" id="164" />
</artist>
```

Getting CD Information

- Request

```
http://localhost:2000/music/cd?id=164&deep
```

- Response

```
<cd artistId="97" id="164">
  <title>Tidal</title>
  <track rating="4" id="777" cdId="164">Sleep To Dream</track>
  <track rating="4" id="778" cdId="164">Sullen Girl</track>
  ...
</cd>
```

Request

```
http://localhost:2000/music/cd?id=164
```

without “deep”

Response

```
<cd artistId="97" id="164">
  <title>Tidal</title>
  <track href="http://localhost:2000/music/track?id=777" />
  <track href="http://localhost:2000/music/track?id=778" />
  ...
</cd>
```

Getting Track Information

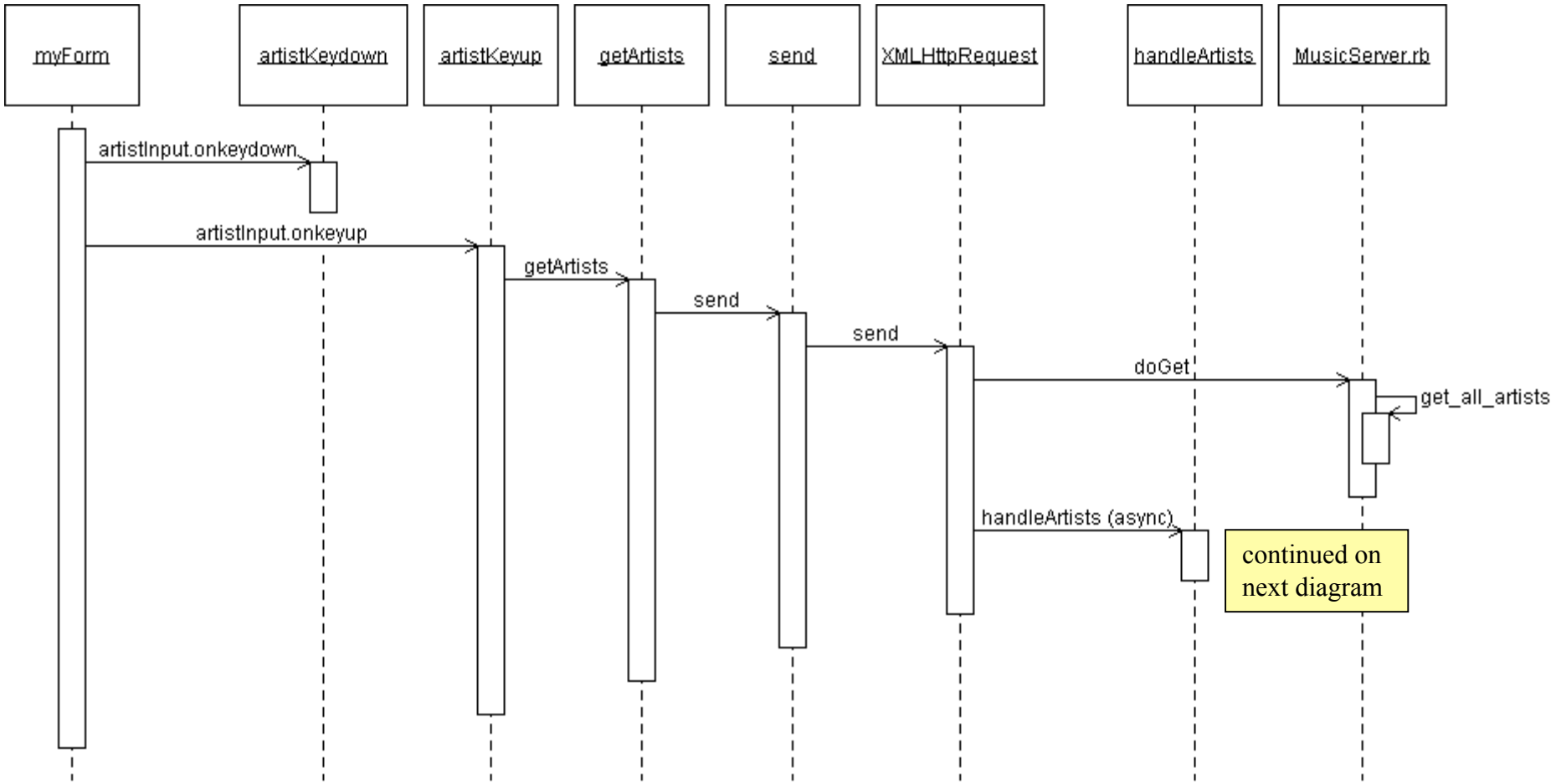
- Request

```
http://localhost:2000/music/track?id=777
```

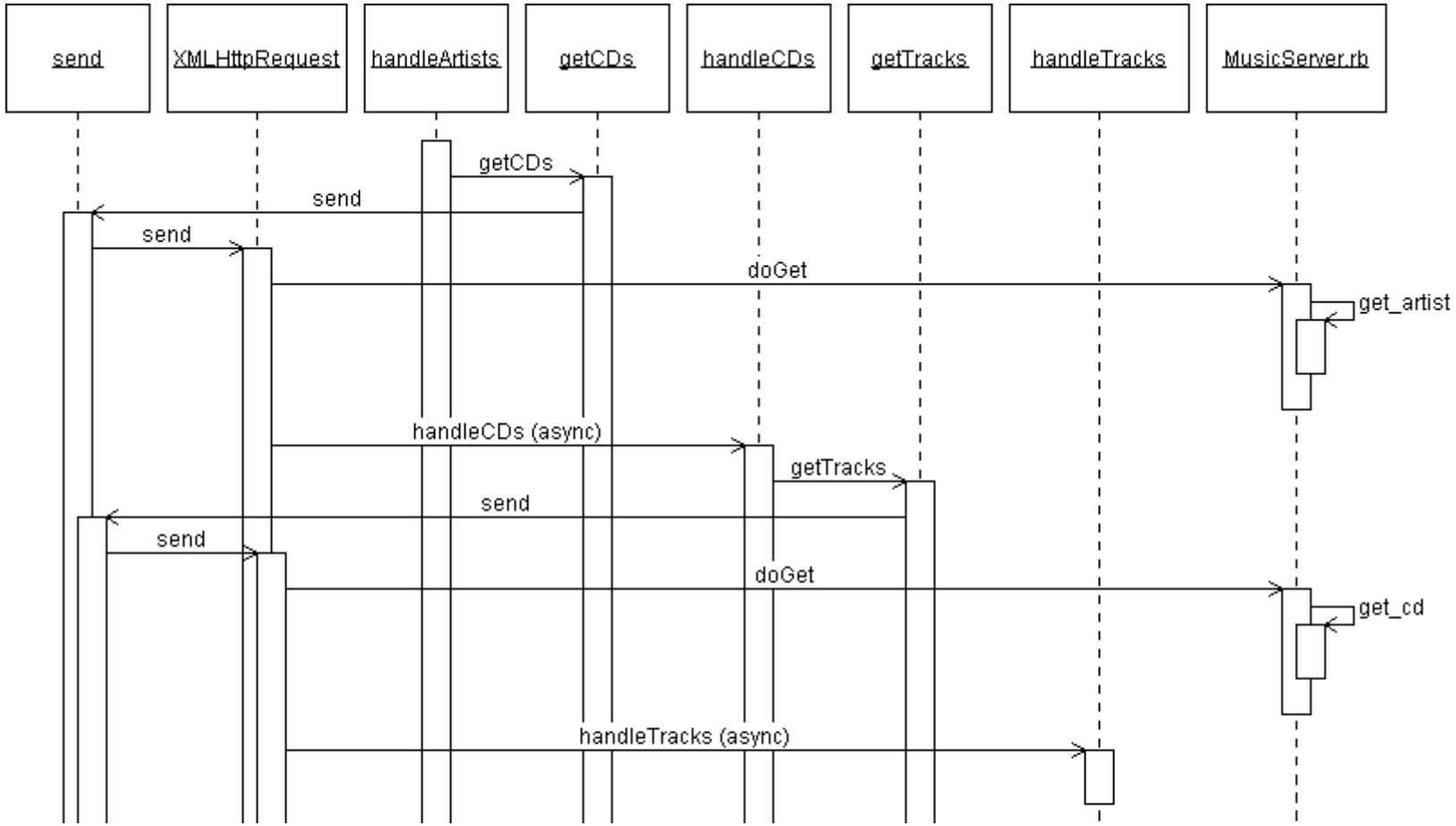
- Response

```
<track rating="4" id="777" cdId="164">Sleep To Dream</track>
```

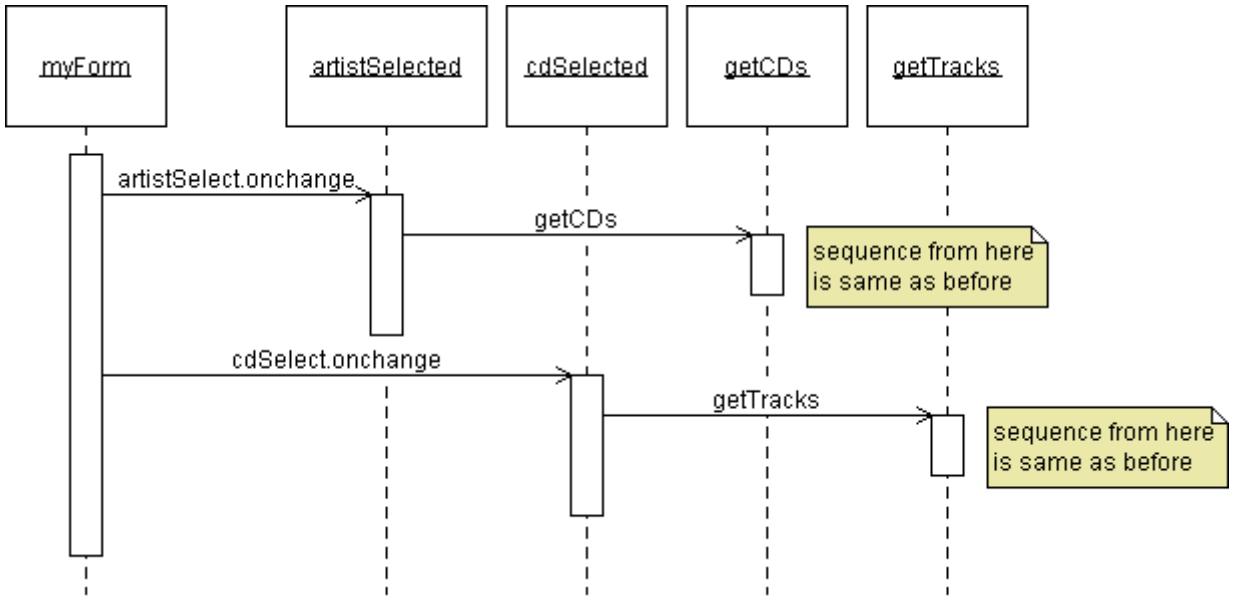
artistInput onkeydown & onkeyup Event Handling



handleArtists Function



artistSelect and cdSelect onchange Event Handling



MusicServer.rb

- Implemented in Ruby
- Uses WEBrick
  - http://www.webrick.org
  - “a Ruby library program to build HTTP servers”
  - “a standard library since Ruby-1.8.0”

MusicServer.rb (Cont'd)

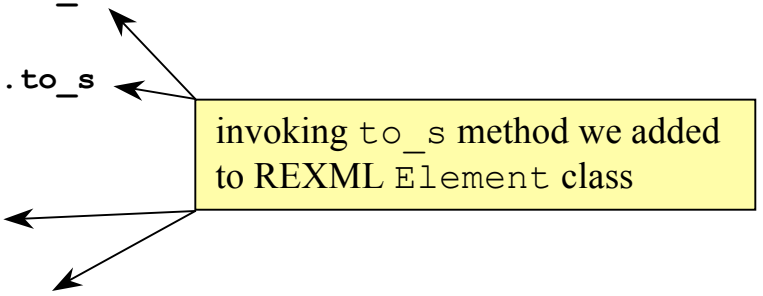
```
#!/usr/bin/ruby

require 'mysql'
require 'rexml/document'
require 'webrick'

include REXML
include WEBrick

# Add to_s method to REXML Element class.
class Element
  def to_s
    s = ''; write(s); s
  end
end
```

MusicServer.rb (Cont'd)

```
SERVLET_HOST = 'localhost'
SERVLET_PORT = 2000
SERVLET_NAME = 'music'

class MusicServlet < HTTPServlet::AbstractServlet

  DATABASE = 'music'
  DB_HOST = 'localhost'
  DB_USERNAME = 'root'
  DB_PASSWORD = ''

  # A new servlet instance is created to service each request
  # so currently a new database connection is being created for each.
  # TODO: Consider using a pool of database connections.
  # TODO: See http://segment7.net/projects/ruby/WEBrick/servlets.html
  def initialize(server)
    super(server)
    @conn = Mysql.new(DB_HOST, DB_USERNAME, DB_PASSWORD, DATABASE)
  end

  def get_resource_url(type, id)
    "http://#{SERVLET_HOST}:#{SERVLET_PORT}/#{SERVLET_NAME}/#{type}?id=#{id}"
  end
```

MusicServer.rb (Cont'd)

```
def do_GET(req, res)
  resource_type = req.path_info[1..-1] # remove first character
  resource_id = req.query['id']
  starts = req.query['starts']
  @deep = req.query['deep']

  res['Content-Type'] = 'text/xml'
  res.body = case resource_type
    when 'artist'
      if resource_id
        get_artist(resource_id).to_s
      else
        get_all_artists(starts).to_s
      end
    when 'cd'
      get_cd(resource_id).to_s
    when 'track'
      get_track(resource_id).to_s
    else
      "unsupported resource type #{resource_type}"
  end
end
```



MusicServer.rb (Cont'd)

```
def get_all_artists(starts)
  sql = "select * from artists"
  sql += " where name like '#{starts}%'" if starts
  sql += " order by name"
  rs = @conn.query(sql)

  artists = Element.new('artists') # root element

  rs.each_hash do |row|
    artist = Element.new('artist', artists) # add artist element to root element
    id = row['id']
    artist.add_attribute('id', id)
    artist.add_attribute('href', get_resource_url('artist', id))
    artist.add_text(row['name'])
  end

  artists
end
```

MusicServer.rb (Cont'd)

```
def get_artist(artist_id)
  sql = "select * from artists where id='#{artist_id}'"
  rs = @conn.query(sql)
  return "no artist with id #{artist_id} found" if rs.num_rows == 0

  row = rs.fetch_hash
  artist = Element.new('artist') # root element
  artist.add_attribute('id', artist_id)
  name = Element.new('name', artist) # add name element to root element
  name.add_text(row['name'])

  sql = "select * from cds where artistId=#{artist_id}"
  rs = @conn.query(sql)
  rs.each_hash do |row|
    cd_id = row['id']
    cd = if @deep
      artist.add_element(get_cd(cd_id)) # add cd element to artist element
    else
      Element.new('cd', artist) # add cd element to artist element
    end
    cd.add_attribute('id', cd_id)
    cd.add_attribute('href', get_resource_url('cd', cd_id)) if not @deep
  end

  artist
end
```

MusicServer.rb (Cont'd)

```
def get_cd(cd_id)
  sql = "select * from cds where id='#{cd_id}'"
  rs = @conn.query(sql)
  return "no cd with id #{cd_id} found" if rs.num_rows == 0

  row = rs.fetch_hash
  cd = Element.new('cd') # root element
  cd.add_attribute('id', cd_id)
  cd.add_attribute('artistId', row['artistId'])
  title = Element.new('title', cd) # add title element to root element
  title.add_text(row['title'])

  sql = "select * from tracks where cdId=#{cd_id}"
  rs = @conn.query(sql)
  rs.each_hash do |row|
    track_id = row['id']
    track = if @deep
      cd.add_element(get_track(track_id)) # add track element to cd element
    else
      Element.new('track', cd) # add track element to cd element
    end
    track.add_attribute('href', get_resource_url('track', track_id)) if not @deep
  end

  cd
end
```

MusicServer.rb (Cont'd)

```
  def get_track(track_id)
    sql = "select * from tracks where id='#{track_id}'"
    rs = @conn.query(sql)
    return "no track with id #{track_id} found" if rs.num_rows == 0

    row = rs.fetch_hash
    track = Element.new('track') # root element
    track.add_attribute('id', track_id)
    track.add_attribute('cdId', row['cdId'])
    track.add_attribute('rating', row['rating'])
    track.add_text(row['name'])

    track
  end

end # class MusicServlet
```

MusicServer.rb (Cont'd)

```
# Create WEBrick server, mount the servlet and start the server.
s = HTTPServer.new(:Port=>SERVLET_PORT)
s.mount("/#{SERVLET_NAME}", MusicServlet)
trap('INT') { s.shutdown } # shutdown on Ctrl-C
s.start
```

MusicCollection.xhtml

```
<?xml version="1.0"?>
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
  "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">

<html xmlns="http://www.w3.org/1999/xhtml">
  <head>
    <title>Music Collection</title>

    <link rel="stylesheet" type="text/css" href="MusicCollection.css" />

    <!-- TODO: Why can't I use shortcut element termination here? -->
    <script type="text/javascript" src="../../sarissa/sarissa.js"></script>
    <script type="text/javascript" src="DHTMLUtil.js"></script>
    <script type="text/javascript" src="StringUtil.js"></script>
    <script type="text/javascript" src="MusicCollection.js"></script>
  </head>
  <body>
    <h1>Music Collection</h1>
```

MusicCollection.xhtml (Cont'd)

```
<form id="myForm" action="">
  <table>
    <tr>
      <th id="artistHeader">Artist</th>
      <th id="cdHeader">CDs</th>
      <th id="trackHeader">Tracks</th>
    </tr>
    <tr>
      <td valign="top">
        <input type="text" id="artistInput" tabindex="1"
          onkeydown="artistKeydown(event, this)"
          onkeyup="artistKeyup(event, this)" />
      </td>
      <td valign="top" rowspan="2">
        <select id="cdSelect" tabindex="3" size="12"
          onchange="cdSelected(this)">
          <option></option> <!-- XHTML requires at least one option -->
        </select>
      </td>
```

MusicCollection.xhtml (Cont'd)

```
    <td valign="top" rowspan="2">
      <table id="trackTable">
        <tr>
          <th id="trackNumber">#</th>
          <th id="trackName">Name</th>
          <th id="trackRating">Rating</th>
        </tr>
      </table>
    </td>
  </tr>
  <tr>
    <td id="artistSelectTD">
      <select id="artistSelect" tabindex="2" size="10"
        onchange="artistSelected(this)">
        <option></option> <!-- XHTML requires at least one option -->
      </select>
    </td>
  </tr>
</table>
```

MusicCollection.xhtml (Cont'd)

```
      <!-- for debugging -->
      <!--p><textarea id="log" rows="20" cols="80"></textarea></p-->

      <p><input type="reset" /></p>
    </form>
  </body>
</html>
```

DHTMLUtil.js

```
// This contains utility functions make working with DHTML easier.

// Removes all the options from a given select component.
function clearSelect(select) {
  while (select.length > 0) {
    select.remove(0);
  }
}

// Gets the text inside a given DOM element.
// TODO: This should really concatenate the values
//       of all text nodes inside the element.
function getText(element) {
  return element.firstChild.nodeValue;
}

// Logs a message to a text area with an id of "log"
// for debugging purposes.
function log(message) {
  document.getElementById("log").value += message + "\n";
}
```

DHTMLUtil.js (Cont'd)

```
// Sends an asynchronous HTTP request to a given URL
// whose response will be sent to a given handler.
function send(xhr, url, handler) {
  async = true;
  xhr.onreadystatechange = handler;
  //log("send: opening " + url);
  xhr.open("GET", url, async);
  //log("send: sending to " + url);
  body = null;
  xhr.send(body);
}
```

MusicCollection.js

```
// Keycodes used by event handling functions.
var backspaceKeycode = 8;
var ctrlKeycode = 17;
var downArrowKeycode = 40;
var shiftKeycode = 16;

// Base URL of asynchronous HTTP requests.
var baseURL = "http://localhost:2000/music/";

// Keeps track of whether the Ctrl key is currently down.
var ctrlKeyDown = false;

// The characters of the artist name that the user typed.
var lastArtistPrefix = "";

// Used to send asynchronous HTTP requests.
var xhr = new XMLHttpRequest(); // from Sarissa
```

MusicCollection.js (Cont'd)

```
// Handles keydown events in the artist input field.
function artistKeydown(event, component) {
  if (event.keyCode == ctrlKeycode) ctrlKeyDown = true;
  if (event.keyCode == downArrowKeycode) {
    // Move focus from artistInput to artistSelect.
    document.getElementById("artistSelect").focus();
  }
}

// Handles keyup events in the artist input field.
function artistKeyup(event, component) {
  if (!ctrlKeyDown) getArtists(event, component);
  if (event.keyCode == ctrlKeycode) ctrlKeyDown = false;
}
```

MusicCollection.js (Cont'd)

```
// Handles selections of artists in the artist select component.
function artistSelected(component) {
  index = component.selectedIndex;
  value = component.options[index].text;
  document.getElementById("artistInput").value = value;
  getCDs(); // asynchronously
}

// Handles selections of CDs in the CD select component.
function cdSelected(component) {
  index = component.selectedIndex;
  cdId = component.options[index].value;
  getTracks(cdId); // asynchronously
}
```

MusicCollection.js (Cont'd)

```
// Sends an asynchronous request to obtain
// a list of artists whose name begins with
// the prefix entered in a text input component.
function getArtists(event, component) {
  if (event.keyCode == shiftKeycode) return;

  if (event.keyCode == backspaceKeycode) {
    artistPrefix = lastArtistPrefix.substring
      (0, lastArtistPrefix.length - 1);
  } else {
    artistPrefix = ltrim(component.value); // in StringUtil.js
  }
  lastArtistPrefix = artistPrefix

  if (artistPrefix.length == 0) {
    component.value = "";
    clearSelect(document.getElementById("artistSelect"));
  } else {
    url = baseURL + "artist?starts=" + artistPrefix;
    send(xhr, url, handleArtists);
  }
}
```

MusicCollection.js (Cont'd)

```
// Sends an asynchronous request to obtain
// a list of CDs by the artist selected in a select component.
function getCDs() {
  select = document.getElementById("artistSelect");
  index = select.selectedIndex;
  option = select.options[index];
  artistId = option.value
  url = baseURL + "artist?id=" + artistId + "&deep";
  send(xhr, url, handleCDs);
}

// Sends an asynchronous request to obtain
// a list of tracks on a CD selected in a select component.
function getTracks(cdId) {
  url = baseURL + "cd?id=" + cdId + "&deep";
  send(xhr, url, handleTracks);
}
```

MusicCollection.js (Cont'd)

```
// Handles the response from asynchronous requests
// for information about artists
// whose name begins with a given prefix.
function handleArtists() {
  if (xhr.readyState == 4) {
    doc = xhr.responseXML;
    //log("handleArtists: xml = " + Sarissa.serialize(doc));
    if (doc.documentElement == null) {
      alert("Is the server running?");
      return;
    }

    doc.setProperty("SelectionLanguage", "XPath");
    id = doc.selectSingleNode("/"); // from Sarissa
    nodes = doc.selectNodes("/artists/artist"); // from Sarissa

    artistSelect = document.getElementById("artistSelect");
    clearSelect(artistSelect);

    if (nodes.length == 0) return;
```

MusicCollection.js (Cont'd)

```
    // Add an option to artistSelect for each matching artist.
    for (i = 0; i < nodes.length; i++) {
      artist = nodes[i];
      name = getText(artist);
      id = artist.getAttribute('id')
      option = new Option(name, id, false, i == 0);
      artistSelect.add(option);
    }

    // Set artist text field to first choice.
    input = document.getElementById("artistInput");
    firstArtistName = getText(nodes[0]);
    input.value = firstArtistName;

    // Highlight suffix supplied by search.
    enteredLength = lastArtistPrefix.length;
    totalLength = firstArtistName.length
    range = input.createTextRange();
    range.moveStart("character", enteredLength);
    range.moveEnd("character", totalLength);
    range.select();

    getCDs();
  }
}
```

MusicCollection.js (Cont'd)

```
// Handles the response from asynchronous requests
// for information about CDs by an artist.
function handleCDs() {
  if (xhr.readyState == 4) {
    doc = xhr.responseXML;
    //log("handleCDs: xml = " + Sarissa.serialize(doc));

    doc.setProperty("SelectionLanguage", "XPath");
    id = doc.selectSingleNode("/"); // from Sarissa
    nodes = doc.selectNodes("/artist/cd"); // from Sarissa

    select = document.getElementById("cdSelect");
    clearSelect(select);
```

MusicCollection.js (Cont'd)

```
    firstId = 0;

    // Add an option to cdSelect for each CD.
    for (i = 0; i < nodes.length; i++) {
      cd = nodes[i];
      title = getText(cd.selectSingleNode("title")); // from Sarissa
      id = cd.getAttribute('id');
      if (i == 0) firstId = id;
      option = new Option(title, id, i == 0);
      select.add(option);
    }

    select.selectedIndex = 0;
    getTracks(firstId);
  }
}
```

MusicCollection.js (Cont'd)

```
// Handles the response from asynchronous requests
// for information about tracks on a CD.
function handleTracks() {
  if (xhr.readyState == 4) {
    doc = xhr.responseXML;
    //log("handleTracks: xml = " + Sarissa.serialize(doc));

    doc.setProperty("SelectionLanguage", "XPath");
    id = doc.selectSingleNode("/"); // from Sarissa
    nodes = doc.selectNodes("/cd/track"); // from Sarissa

    table = document.getElementById("trackTable");

    // Delete all the table rows except the header row.
    rowCount = table.rows.length;
    for (i = rowCount - 1; i > 0; i--) {
      table.deleteRow(i);
    }
```

MusicCollection.js (Cont'd)

```
    // Add a row to trackTable for each track.
    for (i = 0; i < nodes.length; i++) {
      track = nodes[i];
      name = getText(track);
      id = track.getAttribute('id');
      rating = track.getAttribute('rating');

      row = table.insertRow(i + 1);
      row.bgColor = "white";

      cell = row.insertCell(0); // track number
      cell.align = "right"
      cell.innerHTML = i + 1;

      cell = row.insertCell(1); // track name
      cell.innerHTML = name;
      if (rating >= 4) cell.className = "favorite";

      cell = row.insertCell(2); // track rating
      cell.align = "center"
      cell.innerHTML = rating;
    }
  }
}
```

Wrap Up

- Summary
  - don't have to refresh the browser page in order to display new data from the server
  - get data asynchronously with XMLHttpRequest
- ToDos
  - get JavaScript code to work in browsers other than IE6
  - test performance with REST server and web server running on different machines than browser
  - could improve performance by caching REST responses in client-side JavaScript
- Questions?