1 Front-end Technologies - Historical Overview

1.1 Web Applications

Web Applications

- `http://www.evolutionoftheweb.com/`

1.2 Java World

Servlet API

- (HTTP-specific) classes for request/response processing,
- Response written directly into output stream sent to the client,
- Able to process requests concurrently.

```
public class ServletDemo extends HttpServlet{

  public void doGet(HttpServletRequest request, HttpServletResponse response)
  throws IOException{
    PrintWriter out = response.getWriter();
       out.println("<html>");
       out.println("<body>");
       out.println("<h1>Hello World!</h1>");
       out.println("</body>");
       out.println("</html>");
  }
}
```

Java Server Pages

- JSPs are text-based files containing:
  - Static data, usually HTML markup or XML,
  - JSP technology elements for creating dynamic content,
- JSPs are compiled into Servlets and returned to the client in response,
- JSP Standard Tag Library (JSTL) - a library of common functionalities – e.g. forEach, if, out.

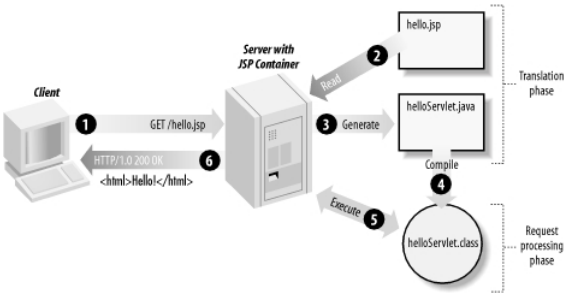


Figure 1: JSP processing. From `http://www.onjava.com/2002/08/28/graphics/Jsp2_0303.gif`

JSP Example

```
<html>
<head>
  <title>JSP Example</title>
</head>
<body>
  <h3>Choose a hero:</h3>
  <form method="get">
    <input type="checkbox" name="hero" value="Master Chief">Master Chief
    <input type="checkbox" name="hero" value="Cortana">Cortana
    <input type="checkbox" name="hero" value="Thomas Lasky">Thomas Lasky
    <input type="submit" value="Query">
  </form>

  <%
  String[] heroes = request.getParameterValues("hero");
  if (heroes != null) {
  %>
    <h3>You have selected hero(es):</h3>
    <ul>
  <%
      for (int i = 0; i < heroes.length; ++i) {
  %>
        <li><%= heroes[i] %></li>
  <%
      }
  %>
    </ul>
    <a href="<%= request.getRequestURI() %>">BACK</a>
  <%
  }
  %>
</body>
</html>
```

Java Server Faces

- Component-based framework for server-side user interfaces,
- Two main parts:
  - An API for representing UI components and managing their state; handling events, server-side validation, and data conversion; defining page navigation; supporting internationalization and accessibility; and providing extensibility for all these features,
  - Custom JSP tag libraries for expressing UI components.
- Components make it easier to quickly develop complex applications,

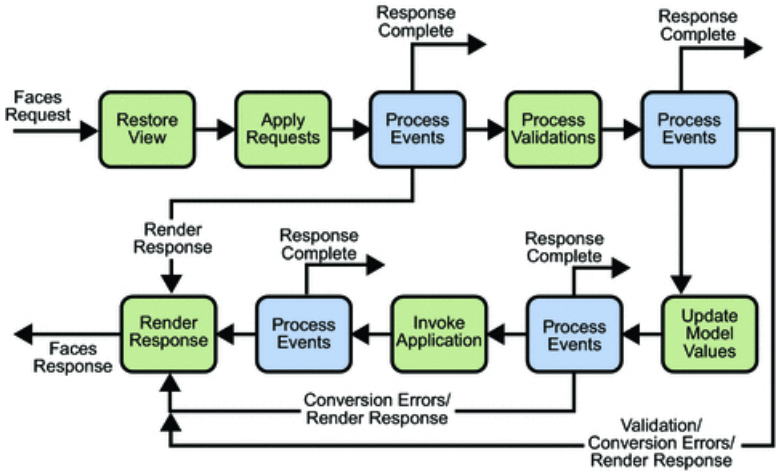


Figure 2: JSF lifecycle. From `http://docs.oracle.com/javaee/5/tutorial/doc/figures/jsfIntro-lifecycle.gif`

- Many component libraries - PrimeFaces, RichFaces, IceFaces.

JSF Lifecycle

JSF Example

```
<f:view>
    <h:head>
        <title>Book store – Users</title>
    </h:head>
    <h:body>
        <h1 class="title ui-widget-header ui-corner-all"><h:outputText value="#{msg['user-list.title']}"/></h1>
        <p:panel>
            <h:form>
                <p:growl />
                <p:dataTable var="user" value="#{usersBack.users}">
                    <p:column headerText="User">
                        <p:commandLink action="#{selectedUser.setUserById('user')}" ajax="false">
                            <h:outputText value="#{user.userName}" />
                            <f:param name="userid" value="#{user.id}" />
                        </p:commandLink>
                    </p:column>
                    <sec:ifAllGranted roles="ROLE_ADMIN">
                        <p:column headerText="Delete User">
                            <p:commandButton value="Delete" actionListener="#{usersBack.deleteUser(user.id)}"
                              update="@form" />
                        </p:column>
                    </sec:ifAllGranted>
                    <p:column headerText="Age">
                        <h:outputText value="#{user.age}"/>
                    </p:column>
                </p:dataTable>
                <p:link outcome="book-store-welcome-page" value="Home"/>
            </h:form>
        </p:panel>
        <p:commandLink action="#{loginBean.logout()}" value="Logout" />
    </h:body>
</f:view>
```

JSF Example II

```
@Component("usersBack")
@Scope("session")
```

```
public class UsersBack {

    @Autowired
    private UserService userService;

    public List<UserDto> getUsers() {
        return userService.findAllAsDto();
    }

    public void deleteUser(Long userId) {
        userService.removeById(userId);
        FacesContext.getCurrentInstance().addMessage(null, new FacesMessage("User was sucessfully deleted"));
    }
}
```

Other Popular Frameworks

Google Web Toolkit (GWT) Write components in Java, GWT then generates JavaScript from them,

Vaadin Built on top of GWT,

Wicket Pages represented by Java class instances on server.

Why are we moving away from JSF?

- JSP, JSF are based on request/response, which requires frequent page reloads,
- Very limited support for AJAX,
- Limited support for mobile devices,
- Difficult to add new or extend existing components.

2 JavaScript-based UI

JavaScript-based UI

- Client-side interface generated completely or partially by JavaScript,
- Based on AJAX,
  - Dealing with asynchronous processing,
  - Events – user, server communication,
  - Callbacks,
  - When done wrong, it is very hard to trace the state of the application,
- Enables dynamic and fluid user experience.

No jQuery

- We will not be using jQuery,

- It is a collection of functions and utilities for dynamic page manipulation/rendering,
- But building a complex web application solely in jQuery is difficult and the code easily becomes messy.

JS-based UI Classification

Declarative HTML templates with bindings for JS framework. E.g. Angular.

```
<html ng-app="appname">

  <head>
    <script src="js/angular.min.js"></script>
    <link href="style.css" rel="stylesheet"/>
    <script src="js/script.js"></script>
  </head>

  <body>
    <div ng-controller="appCtrl">
      <p>{{greeting.text}}, world </p>
    </div>
  </body>

</html>
```

JS-based UI Classification

"Procedural" DOM tree is completely generated by JS. E.g. ReactJS.

```
var HelloMessage = React.createClass({
  render: function () {
    return <h1>Hello {this.props.message}!</h1>;
  }
});

ReactDOM.render(<HelloMessage message="World" />, document.getElementById('root'));
```

2.1 Principles

JS-based UI Principles

- Application mostly responds by manipulating the DOM tree of the page,
- Fewer refreshes/page reloads,
- Server communication happens in the background,
- Single-threaded (usually),
- Asynchronous processing.

3 Integrating JavaScript-based Frontend with Backend

Frontend – Backend Communication

- JS-based frontend communicates with REST web services of the backend,

```javascript
'use strict';

var Reflux = require('reflux');

var Actions = require('../actions/Actions');
var Ajax = require('../utils/Ajax');

var SearchStore = Reflux.createStore({
    init: function () {
        this.listenTo(Actions.fullTextSearch, this.onFullTextSearch);
    },

    onFullTextSearch: function (expr) {
        Ajax.get('rest/search?expression=' + encodeURIComponent(expr)).end((data) => {
            this.trigger({
                action: Actions.fullTextSearch,
                data: data
            });
        });
    }
});

module.exports = SearchStore;
```

```java
@RestController
@RequestMapping("/search")
public class SearchController {

    static final String EXPRESSION_PARAM = "expression";

    @Autowired
    private SearchService searchService;

    /**
     * Runs a full-text search for the specified expression.
     *
     * @param expression The expression to search for
     * @return Search results
     */
    @RequestMapping(method = RequestMethod.GET, produces = MediaType.APPLICATION_JSON_VALUE)
    public RawJson fullTextSearch(@RequestParam(value = EXPRESSION_PARAM, defaultValue = "") String expression) {
        if (expression.isEmpty()) {
            throw new BadRequestException("Cannot search for an empty string.");
        }
        return searchService.fullTextSearch(expression);
    }
}
```

- Usually using JSON as data format,
- Asynchronous nature,
  - Send request,
  - Continue processing other things,
  - Invoke callback when response received.

Frontend – Backend Communication Example

↓

```
GET /inbas-reporting-tool-refactoring/rest/search?expression=drahy HTTP/1.1
Host: www.inbas.cz
Connection: keep-alive
Accept: application/json
User-Agent: Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/54.0.2840.71 Safari/537.36
```

Frontend – Backend Communication Example II

↓

```
HTTP/1.1 200 OK
Date: Sat, 29 Oct 2016 16:44:15 GMT
Server: Apache/2.4.10 (Debian)
Content-Type: application/json

{
  // JSON response body
}
```

```
'use strict';

var Reflux = require('reflux');

var Actions = require('../actions/Actions');
var Ajax = require('../utils/Ajax');

var SearchStore = Reflux.createStore({
    init: function () {
        this.listenTo(Actions.fullTextSearch, this.onFullTextSearch);
    },

    onFullTextSearch: function (expr) {
        Ajax.get('rest/search?expression=' + encodeURIComponent(expr)).end((data) => {
            this.trigger({
                action: Actions.fullTextSearch,
                data: data
            });
        });
    }
});

module.exports = SearchStore;
```

Frontend – Backend Communication Example III

↓

4 Single Page Applications

Single vs. Multi Page JS-based Web Applications

Multi Page Web Applications Individual pages use a lot of JS, but browser navigation still occurrs – browser URL changes and page reloads. Example: GitHub.

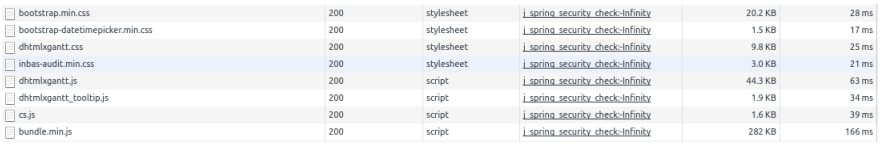
Single Page Web Applications No browser navigation occurrs, everything happens in one page using DOM manipulation. Example: Gmail.

Single Page Applications

- Provide more fluid user experience,
- No page reloads, only URL hash usually changes,
- View changes by modifications of the DOM tree,
- Most of the work happens on the client side,
- Communication with the server in the background,
- Client architecture becomes important – a lot of code on the client.

Single Page Application Specifics

- Everything has to be loaded when page opens,
  - Framework,
  - Application bundle,



bootstrap.min.css	200	stylesheet	j spring_security_check-Infinity	20.2 KB	28 ms
bootstrap-datetimepicker.min.css	200	stylesheet	j spring_security_check-Infinity	1.5 KB	17 ms
dhtmlxgantt.css	200	stylesheet	j spring_security_check-Infinity	9.8 KB	25 ms
inbas-audit.min.css	200	stylesheet	j spring_security_check-Infinity	3.0 KB	21 ms
dhtmlxgantt.js	200	script	j spring_security_check-Infinity	44.3 KB	63 ms
dhtmlxgantt_tooltip.js	200	script	j spring_security_check-Infinity	1.9 KB	34 ms
cs.js	200	script	j spring_security_check-Infinity	1.6 KB	39 ms
bundle.min.js	200	script	j spring_security_check-Infinity	282 KB	166 ms

  - Most of CSS,
- Different handling of security,
- Different way of navigation,
- Difficult support for bookmarking.

Single Page Application Drawbacks

- Navigation and *Back* support,
- Scroll history position,
- Event cancelling (navigation),
- Bookmarking,
- SEO,
- Automated UI testing.

4.1 Client Architecture

Client Architecture

- JS-based clients are becoming more and more complex,
  - $\rightarrow$ neccessary to structure them properly,
- Plus the asynchronous nature of AJAX,
- Several ways of structuring the client.

Model View Controller (MVC)

- Classical pattern applicable in client-side JS, too,
- Controller to control user interaction and navigation, **no business logic**,
- Frameworks often support MVC.

Client Architecture II

Model View View-Model (MVVM)

- Originally developed for event-driven programming in WPF and Silverlight,
- View-Model is an abstraction of the View,
- Let the framework bind UI components to View-Model attributes (two-way binding),
- Controllers still may be useful.

Flux

- Unidirectional flow,
- Originated in ReactJS,
- Simplifies reasoning about application state.

The End

Thank You

Resources

- M. Fowler: Patterns of Enterprise Application Architecture,
- `https://dzone.com/articles/java-origins-angular-js`,
- `https://msdn.microsoft.com/en-us/magazine/dn463786.aspx`,
- `http://singlepageappbook.com/index.html`,
- `http://adamsilver.io/articles/the-disadvantages-of-single-page-applications/`,
- `http://www.oracle.com/technetwork/articles/java/webapps-1-138794.html`.