

Enterprise Architectures

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Contents

- 1 Information about the course
- 2 Enterprise Applications
- 3 Java EE
- 4 Servlets
 - HTTP Basics
 - Servlet Basics
 - Managing State
 - Filters



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Information about the course

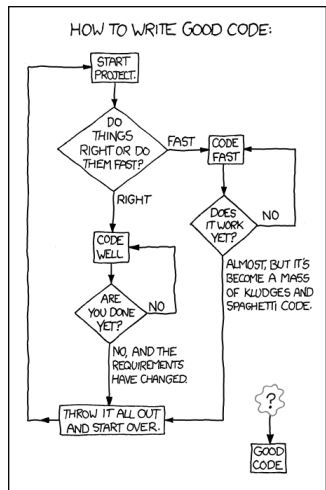


You will learn how to

design enterprise applications using Java web technologies, including pieces of the Java EE stack

implement the applications in Java, Spring, EclipseLink

think about high-availability, clustering, security, and other stuff ...



source: <https://techcodegeek.wordpress.com>



Teachers

Lecturers:

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Course Organization

- **Go through**

**<https://cw.fel.cvut.cz/wiki/courses/b6b33ear>
carefully, including subsections:**

- Lectures

<https://cw.fel.cvut.cz/wiki/courses/b6b33ear/lectures>

- Seminars

<https://cw.fel.cvut.cz/wiki/courses/b6b33ear/seminars>

- Assessment

<https://cw.fel.cvut.cz/wiki/courses/b6b33ear/hodnoceni>

- Materials

<https://cw.fel.cvut.cz/wiki/courses/ear/materials>

- The course will be split into two parts:

Basic topics – lectures 1-7

Advanced topics – lectures 8-13

- 14th week – Panel Discussion with people from commercial sector

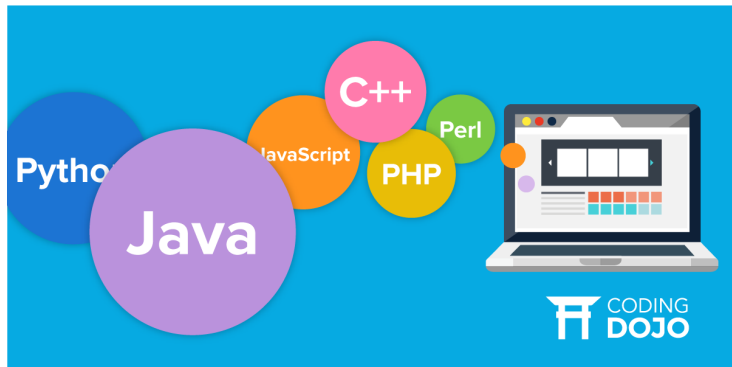


Enterprise Applications



Why Java ?

Answer #1: Usage of programming languages in 2018



source: <https://www.codingdojo.com/blog/7-most-in-demand-programming-languages-of-2018/>



Why Java ?

Answer #2:

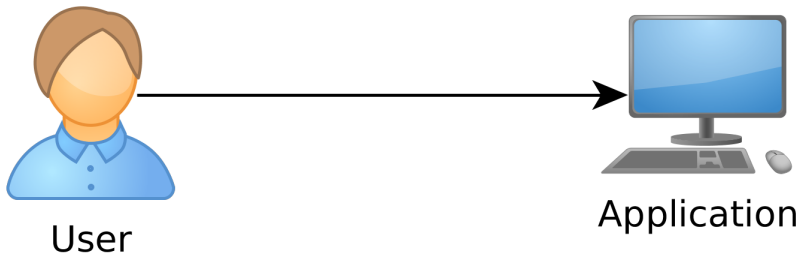
- well-established
- portable (bytecode)
- optimized in runtime
- public specifications JSR based on community discussion
- editions

Java Editions

- Java ME – micro edition (Java ME 8.3)
- Java SE – standard edition (Java SE 10)
- Java EE – enterprise edition (Java EE 8)
- (Android), ...



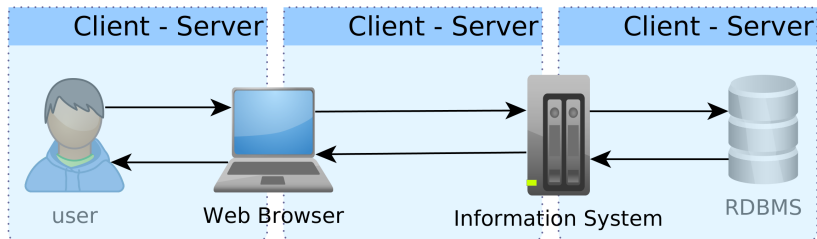
Desktop Application



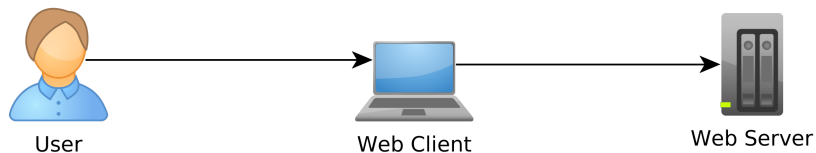
Desktop Application. Single-user access.



Client - Server Paradigm



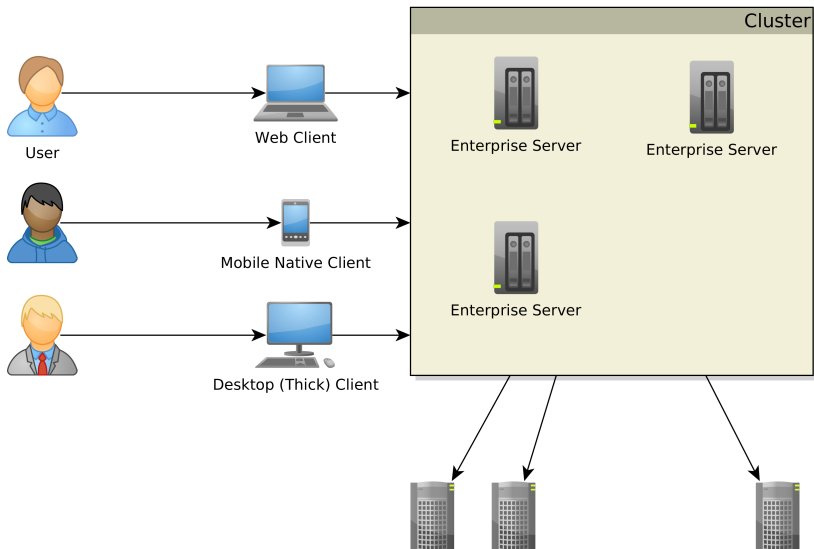
Web Application



Web Application. Multi-user access, single client (web), no integration with other systems.



Enterprise Application (EA)



Multi-tier Architecture

Typically three-tier – presentation logic, business logic, data storage.

Separation of tiers to

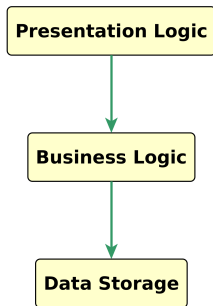
- 1 presentation
- 2 service
- 3 business logic
- 4 data access
- 5 data storage
- 6 ...

Each tier can access only a tier right below (**strict**), or all lower tiers (**relaxed**).

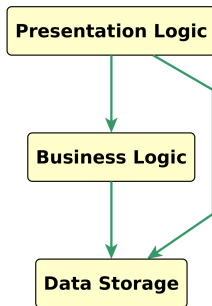


Multi-tier Architecture

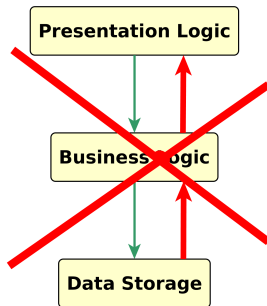
Strict



Relaxed



Spaghetti Code



Enterprise Application Architecture

Martin Fowler: Patterns of Enterprise Application Architecture

“... display, manipulation and storage of large amounts of complex data and the support or automation of business processes with that data.”



Enterprise Applications - Requirements

Persistent Data using relational databases, graph databases, NoSQL databases, RDF triple stores,

Complex Data Integration of different volume, accuracy, update frequency, quality and meaning → data integration,

Concurrent Data Access by many users at once with different scenarios (writing, reading different parts of data),

Multiple Input Interfaces involving complex user interfaces (many forms, web pages), (sensoric) data sources, operational data,

Process Automation involving integration with other enterprise applications, batch processing, etc.

Performance, Robustness involving (horizontal/vertical) scalability, load balancing, high-availability



Data Integration

Enterprise Conceptual Models – produces among others **shared vocabularies (ontologies)** to avoid data ambiguity

Master Data¹ – data spanning the whole enterprise, like *customers, products, accounts, contracts* and *locations*

¹source: <http://www.ibm.com/developerworks/data/library/techarticle/dm-0804oberhofer>



Ontology Management – Is It Worth ?

9/11 – One or Two Events ?

... matter of billions of USD

DID YOU KNOW



Just months before 9/11, the World Trade Center's lease was privatized and sold to Larry Silverstein.

Silverstein took out an insurance plan that 'fortuitously' covered terrorism.

After 9/11, Silverstein took the insurance company to court, claiming he should be paid double because there were 2 attacks.

Silverstein won, and was awarded \$4,550,000,000.

source:<https://www.metabunk.org/larry-silversteins-9-11-insurance.t2375>



Integration with other EA

Messaging systems for asynchronous messaging

- JMS (JSR 343)

Remote Procedure Calls for synchronous calls

- RPC
- RMI
- CORBA
- Web Services



Performance Testing²

Metrics

response time – server-side request processing time,

latency – client-side request processing time for NOP operation (i.e. for zero response time),

throughput – transactions per seconds,

scalability – sensitivity to resource (hardware) addition/removal,

scaling up (vertical) – add resource (RAM) to one server

scaling out (horizontal) – add more servers

Contextual Information

load – number of requests/transactions

load sensitivity – sensitivity of a metric w.r.t load

²<https://nirajrules.wordpress.com/2009/09/17/measuring-performance-response-vs-latency-vs-throughput-vs-load-vs-scalability-vs-stress-vs-robustness>



Use Case – External B2C System

like e-shops, social networks

characteristics

- Many Concurrent Users
- Web Client
- Relational Database with a simple model
- Enterprise Data Store Integration



Use Case – Internal Enterprise System

like Car Insurance System

characteristics

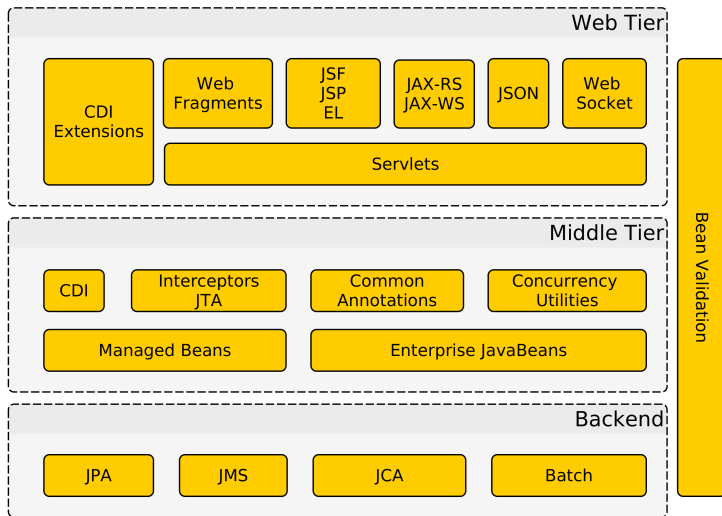
- (Not so many) Concurrent Users – mainly company employees
- Thick client for company employees
- Relational Database, complex domain model capturing enterprise know-how
 - e.g. conditions for obtaining an insurance contract
- ERP, CRM Integration



Java EE



Java EE = Java Enterprise Edition



Java EE Principles

- single specification, more implementations
- bunch of technologies integrated in a single Java EE platform
 - Application server** – full Java EE stack (e.g. Glassfish, WildFly (RedHat),...)
 - Web Container** – only Java EE web profile (e.g. Apache Tomcat, Jetty, ...)



Technologies Used in This Course

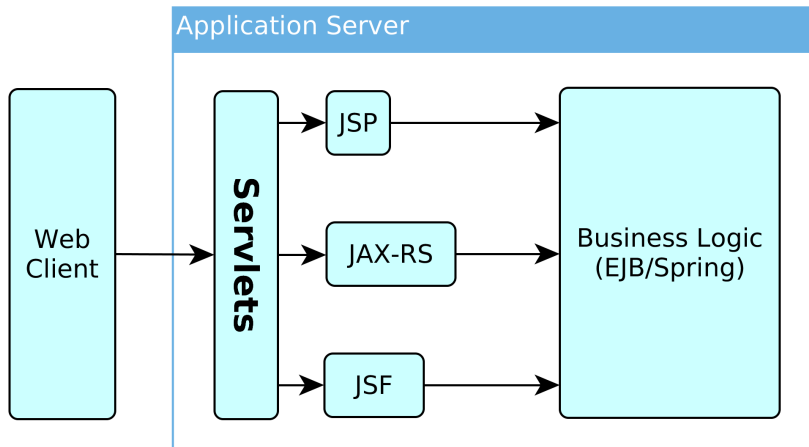
Technology	Java EE	Description
JPA (EclipseLink)	✓	object persistence layer, alternative to Hibernate, OpenJPA, etc.
Spring	×	alternative to Java EE Session Beans, CDI
Spring Web Services	×	web service layer, alternative to JAX-RS
Websockets	✓	client-server bidirectional communication
Servlets	✓	basic HTTP request processing



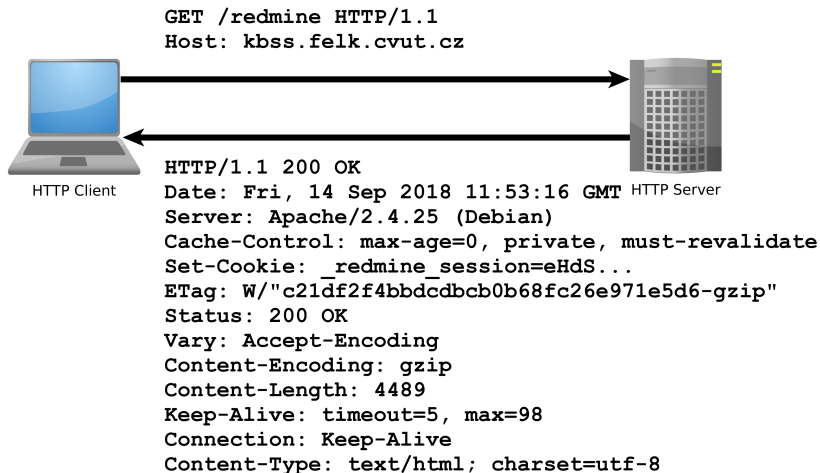
Servlets



Context



HTTP Protocol



HTTP Response

```
HTTP/1.1 200 OK
Date: Fri, 14 Sep 2018 12:07:38 GMT
Server: Apache
X-Content-Type-Options: nosniff
X-Frame-Options: sameorigin
X-XSS-Protection: 1; mode=block
Referrer-Policy: same-origin
Allow: GET, POST
Access-Control-Allow-Origin: https://www.fel.cvut.cz
Set-Cookie: PHPSESSID=5ccksgfok3f75o08tq9jdt8405; path=/, ;HttpOnly;
    Secure;samesite=strict
Expires: Thu, 19 Nov 1981 08:52:00 GMT
Cache-Control: no-store, no-cache, must-revalidate, post-check=0, pre-
    check=0
Pragma: no-cache
Set-Cookie: lang=cz; expires=Sun, 14-Oct-2018 12:07:38 GMT; path=/
Connection: close
Transfer-Encoding: chunked
Content-Type: text/html; charset=UTF-8
```



HTTP methods

HTTP 1.0

GET – requests a **representation** of a resource,

POST – requests the server to accept the entity enclosed in the request as a **new subordinate** of the web resource identified by the URI,

HEAD – same as GET, but **no response body** is expected,

HTTP 1.1 (rfc2616, rfc5789)

OPTIONS – returns the HTTP methods supported for URL,

PUT – requests that the enclosed entity is **stored** under the supplied URI,

DELETE – requests deletion of the specified resource,

TRACE – echoes the received request (to see the changes made by intermediate servers)

CONNECT – converts the connection to a transparent TCP/IP tunnel (for HTTPs)

PATCH – applies partial modifications to a resource.



HTTP GET

- parameters embedded in the URL
- requests can be cached
- requests remain in the browser history
- requests can be bookmarked
- requests should never be used when dealing with sensitive data
- requests have length restrictions
- requests should be used only to retrieve data

Example

```
http://example.org/test/demo?name1=val1&name2=val2
```



HTTP POST

Query strings (name/value pairs) sent in the message body:

Example

```
POST /test/demo HTTP/1.1
Host: example.org
name1=val1&name2=val2
```

- requests are **never** cached
- requests **do not remain** in the browser history
- requests **cannot** be bookmarked
- requests **have no restrictions** on data length



First Servlet

```
package cz.cvut.kbss.ear.servlet;
import java.io.IOException;
import javax.servlet.annotation.WebServlet;
import javax.servlet.http.*;

@WebServlet(urlPatterns = {"/hello/*"})
public class HelloWorldServlet extends HttpServlet {

    protected void doGet (HttpServletRequest req,
        HttpServletResponse resp) throws IOException {
        resp.setContentType("text/plain");
        resp.getWriter().write("HELLO");
    }
}
```



Servlet

- Java runtime is running (no need to run it)
- thread pool for request processing
- memory sharing
- jSessionId in cookies
- local/remote debugging
- might be a singleton or not



Servlet Container ensures

- TCP/IP connection
- HTTP protocol processing
- parameter processing
- resource management (thread pools)

General servlets are in `javax.servlet.*` package, but we will deal with HTTP servlets (`javax.servlet.http.*` package)



GET vs. POST

often processed the same way ...

```
public class AServlet extends HttpServlet
{
    public void doGet (HttpServletRequest request,
        HttpServletResponse response)
    { processRequest (request, response); }

    public void doPost (HttpServletRequest request,
        HttpServletResponse response)
    { processRequest (request, response); }

    public void processRequest (HttpServletRequest
        request, HttpServletResponse response)
    { _processRequest (request, response); }
}
```



web.xml

```
@WebServlet(urlPatterns = {"/hello/*"})
public class HelloWorldServlet extends HttpServlet {
    ...
}
```

can be alternatively expressed in web.xml as

```
<servlet>
  <servlet-name>HelloWorldServlet</servlet-name>
  <servletclass>cz.cvut.kbss.ear.
    servlet.HelloWorldServlet</servlet-class>
</servlet>
<servlet-mapping>
  <servlet-name>HelloWorldServlet</servlet-name>
  <url-pattern>/hello/*</url-pattern>
</servlet-mapping>
```

XMLs are an “old-style” solution, but they are more expressive and *override annotations*.



Init parameters

java.lang.Object

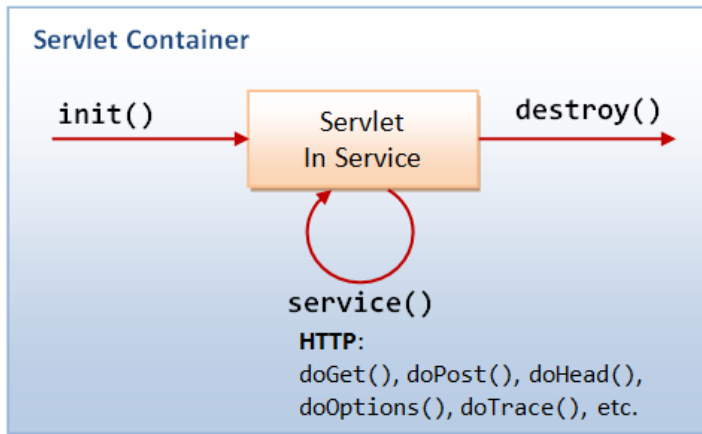
javax.servlet.GenericServlet

javax.servlet.http.HttpServlet

```
public class HelloWorldServlet extends HttpServlet {
    public void init(ServletConfig config) throws
        ServletException {
        super.init(config);
        System.out.println("Created by " +
            getInitParameter("brand"));
    }
    public void destroy() {
        super.destroy();
        System.out.println("Closing down.");
    }
    ...
}
```



Servlet Lifecycle



taken from <http://idlebrains.org/tutorials/java-tutorials/servlets-init-service-destroy/>



How to share data between requests ?

- application-wide – `request.getServletContext()`
- session-wide – `request.getSession()`
- request-wide – `request`

example

```
String product_id =  
    request.getParameter("product_id");  
User login = (User)  
    request.getSession().getAttribute("currentuser");
```



Client Session State

HTTP is stateless and the session state might be huge ... Web client can store the session using

URL parameters – but the URL length is limited, problems with bookmarking, parameters shown to the user

Hidden input fields – not shown to the user

Cookies – might be banned by the client; cookies might become mixed up when two apps from the same domain use the same cookie ...



HTTP Cookies

```
GET/index.html HTTP/1.0  
Host: www.example.org
```

request



response



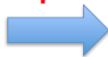
```
HTTP/1.0 200 OK  
Content-type: text/html  
Set-Cookie: name=value  
Set-Cookie: name2=value2; Expires=Wed, 09 Jun 2021 10:18:14 GMT  
...
```



HTTP Cookies

```
GET/index.html HTTP/1.0  
Host: www.example.org
```

request



response



```
HTTP/1.0 200 OK  
Content-type: text/html  
Set-Cookie: name=value  
Set-Cookie: name2=value2; Expires=Wed, 09 Jun 2021 10:18:14 GMT  
...
```

request



```
GET /spec.html HTTP/1.1  
Host: www.example.org  
Cookie: name=value; name2=value2  
Accept: */*
```



Client Session State

- state management on the client helps in clustering (stateless failover)
- should be encrypted for sensitive data → extra time
- server should check the incoming data to ensure their consistency



Server Session State

- the client state contains only server session identifier – `JSESSIONID`. **Beware of Session stealing – the user modifies sessionID in order to get someone else's session.**
- the server session is represented either as a BLOB (binary object) or as a text (e.g. XML)
 - locally** – in the application server (AS) memory, in AS filesystem, in AS local DB. *Failover problematic.*
 - unstructured shared DB** – in a database as BLOBs, session expiration needs to be handled
 - structured shared DB** – in a database tables (e.g. sessionId column)



Connection Info

The `HttpServletRequest` offers many information about the HTTP connection

- client

- `request.getRemoteAddr()`
- `request.getRemoteHost()`

- server

- `request.getServerName()`
- `request.getServerPort()`
- `request.getContextPath()`

E.g., for authorization (`isSecure`, `isUserInRole`, `getAuthType`, `getCookies`, `getHeaderNames`).



Filters

The `HttpServletRequest` offers many information about the HTTP connection

- client

- `request.getRemoteAddr()`
- `request.getRemoteHost()`

- server

- `request.getServerName()`
- `request.getServerPort()`
- `request.getContextPath()`

E.g., for authorization (`isSecure`, `isUserInRole`, `getAuthType`, `getCookies`, `getHeaderNames`).



Servlets 4.0

- HTTP/2 Support
- Client requests an HTML file `page.html`
 - Server finds out that `page.html` links other resources, say `page.css` and `page.js`
 - Server pushes `page.css` and `page.js` to the client
 - Server responds with `page.html` and closes the request

