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CZECH TECHNICAL UNIVERSITY IN PRAGUE  
FACULTY OF INFORMATION TECHNOLOGY  
DEPARTMENT OF THEORETICAL COMPUTER SCIENCE



Master's thesis

**Admission procedure  
Automatic processing of applications  
for master's study program**

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7th June 2012



# Acknowledgements

I would like to thank my family and friends for support during writing this thesis.



# Declaration

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In Prague 7th June 2012

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# Abstract

Primary aim of this thesis is to analyse Conditions for admission and Dean's directive for admission process to master's study programme at CTU FIT. Implement RESTful API, which exposes backend functionality for admission processing using Business Process Management.

**Keywords** Admission procedure, RESTful API, BPM, jBPM, Spring, Spring Roo

# Abstrakt

Primárnym cieľom tejto diplomovej práce je analyzovať Řád přijímacího řízení ČVUT a Směrnici děkana pro přijímací řízení na ČVUT Fakultě informačních technologií. Implementovat RESTful API, ktoré vystaví funkcionality backendu pre prijímací proces s použitím Business Process Management stroja.

**Klíčová slova** Spracovanie prihlášok, RESTful API, BPM, jBPM, Spring, Spring Roo



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# Prologue

## Motivation and objectives

Every year, hundreds of high school graduates apply for studies at Czech Technical University, Faculty of Informatics. This raises certain requirements, including managing, storing, analysing and processing of all these applications. Each application has its own life cycle, which begins with filling out an on-line form and continues through various steps which an applicant has to pass. The life cycle ends when a decision of acceptance is delivered to the applicant and he either enrolls in the studies or not.

We live in the world of new era of the Internet. Everything goes on-line, web and the latest trend - everything goes mobile. People want things to happen very quickly. They want to access all the information fast, now.

Students and applicants are no different. They expect from this prestigious University, especially from Faculty of Informatics, the most modern and useful gadgets when it comes to software and web.

## How do things work now

Currently all applications are processed rather manually. Many man days of administrative work are consumed during the process. Although an electronic form is filled in and submitted by an applicant, the rest of actions almost exclusively fall into the hands of Study Department staff. Some of the work is handled by simple scripts or other utilities. The question is: Why don't we do most of the work automatically?

This work is monotonous and can even lead to men's frustration.

## What should be achieved - the goals

Courses at Faculty of Informatics teach its students to handle various programming languages, web technologies and techniques. We all know what to expect from a working web application and good looking one is a bonus. This is why knowledge of faculty's students should be used for good of their suc-

cessors. Fast, reliable, informative and functional system will make them feel more comfortable and perhaps could even save some precious time.

Ideal state would be to accept on-line applications and automatically generate invitations for applicants, that should attend a test. After the test, process all results and generate a decision of acceptance letter for all who passed the test or are accepted without it. The only manual interventions that will remain is to accept apology, appeal and insert the letters into the envelopes.

Pragmatically goals of this thesis could be summarized as follows:

- familiarise with RESTful best practices, patterns and anti-patterns
- familiarise with Business process management (BPM) with main focus on jBPM
- implement RESTful Application Programming Interface (API) (back-end) according to functionality requested by Android and Web UI teams
- implement admission processing using Java and jBPM processing machine
- explore new and modern Java (JEE) technologies
- follow modern development methodologies
- perform tests during and after development
- use exclusively Open Source software and tools

## Let's make things better

Taking the above written into account, this might be a good idea for a master's or bachelor's thesis. However if we want to use all available technologies that have become popular in past years and automatize the majority of admission processing, it turns out to be a very complex project. So why not to create several teams and split necessary work into multiple, both bachelor's and master's, thesis?

This is how project Příříz was born. It includes web interface for both students and Study Department staff, native Android application and RESTful API with BPM processing machine, which is the subject of my master's thesis.

## Structure of this work

Basically, I could divide my work into these main parts, which are then further split into chapters:

- Theoretical introduction is covered by chapters 1 and 2. Following parts will largely draw on the information contained here.
- Analytical part talks about architecture of the whole ecosystem with main focus on RESTful API. Describes technologies used, methodologies applied and tools commonly used during development and testing phases.
- Implementation and unit testing
- Integration and regression testing
- Results and conclusion

Appendices at the end of the document are referred directly from the text within the chapters. Smaller figures, tables or other objects are put directly into the content.



# RESTful API with JAX-RS

Nowadays, Internet consumers demand fast growth of various services and integration of their favourite ones. As an example I can point out synchronization of contact list between very popular social networks, e-mail providers and phone contact lists.

Other example may be growing amount of `mashups`<sup>1</sup> and uncountable number of `startups`<sup>2</sup>, who often provide RESTful or different type of public API.

## 1.1 Talking about REST, what is it?

REpresentational State Transfer (REST) or RESTful programming is not defined by any official standard and there are no official guidelines or rules for it. So what is it then? It is an architectural and programming style for Web, where a set of constraints is defined. Lots of text has been written about it during past years and describing the whole idea of REST is out of scope of this master's thesis. I can however try to point out the most significant, important and basically, what I personally managed to adopt.

### 1.1.1 Main principles of REST, RESTful web service

There are several architectural principles, that one should keep in mind when thinking of REST [1, p. 3]:

---

<sup>1</sup>Applications that are created via combination of multiple different services. Such application, almost exclusively web based, can be created very quickly by consuming several APIs. Not necessarily from the same provider.

<sup>2</sup>Constantly rising amount of web applications, that focus on fast growth of attracted users. They offer various services, which are often very innovative and experimental. One successful example is popular social network and my favorite information channel - Twitter.

- **Addressable resources** The key abstraction of information and data in REST is a resource, and each resource must be addressable via a Uniform Resource Identifier (URI). A uniform, constrained interface Use a small set of well-defined methods to manipulate your resources.
- **Representation-oriented** You interact with services using representations of that service. A resource referenced by one URI can have different formats. Different platforms need different formats. For example, browsers need HTML, JavaScript needs JSON (JavaScript Object Notation), and a Java application may need XML.
- **Communicate statelessly** Stateless applications are easier to scale. Hypermedia As The Engine Of Application State (HATEOAS) Let your data formats drive state transitions in your applications.

HATEOAS is often understood as a core principle of REST. It carries an idea of resource representation via links and stateless implementation of services.

RESTful web services are the result of applying these constraints to services that utilize web standards such as URIs, Hypertext Transfer Protocol (HTTP), Extensible Markup Language (XML), and JavaScript Object Notation (JSON).

### 1.1.2 Back to the roots, HTTP is reborn

Service-oriented architecture (SOA) has been in this world for a long time. Many different approaches and technologies exist to implement it. From those worth to mention: DCE, CORBA, Java RMI, ... They offer robust standards, one can build large, complex and scalable systems on top of it, but there is a cost. They often bring huge complexity and maintenance requirements into place.

Currently, when one says SOA, it often evokes Simple Object Access Protocol (SOAP) in a mind, that spent several years using technologies mentioned above. This however is not a bad thing. SOAP is used very widely and is perfectly suitable for developing services and APIs. But it is definitely not a lightweight technology and it is not ideal for everything. Its most common use case is for server-server communication in enterprise systems.

Nowadays, we need something quickly adoptable, widely spreadable, platform and technology independent and client oriented. This needs a completely different approach and new way of thinking when it comes to SOA. It is about Web, so why not to start with something that is Web, as we see it today, based on? Yes, it is HTTP.

Although REST is not protocol specific, when saying REST it usually automatically means REST + HTTP. No wonder. HTTP is perfectly suitable for client-server SOA, it is just about the way of thinking. It offers transport

layer, request-response mechanism, descriptive responses, caching mechanism and many more. It is true, that in past years, when various types of web applications started to appear, many web developers limited their thinking and use of HTTP to two basic cases:

- GET a page with URI, perhaps containing a few query parameters
- POST a form

---

**Code 1** HTTP GET request/response example of a standard web page

---

```
GET /index.html HTTP/1.1
User-Agent: curl/7.24.0 (i686-pc-cygwin) ...
Host: www.google.sk
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,*/*;q=0.8
Accept-Language: sk-sk,en;q=0.5

HTTP/1.1 200 OK
Date: Thu, 07 Jun 2012 11:25:15 GMT
Expires: -1
Cache-Control: private, max-age=0
Content-Type: text/html; charset=ISO-8859-2
Set-Cookie: ... expires= ...; path=/; domain=.google.sk
Set-Cookie: ... expires= ...; path=/; domain=.google.sk; HttpOnly
Server: gws
X-XSS-Protection: 1; mode=block
X-Frame-Options: SAMEORIGIN
Transfer-Encoding: chunked

<!doctype html><html ...><head> ... <body> ...
```

---

The example above 1 shows most common HTTP request and response, when browsing the web via standard web browser. It requests object **/index.html** using **GET** method placed on host **www.google.sk**. My client also put several HTTP headers into the request:

- **Accept:** text/html,application/xhtml+xml,application/xml;q=0.9,\*/\*;q=0.8
- **Accept-Language:** sk-sk,en;q=0.5

Also the request does not contain any request body, as it is GETting information from the server.

The response of the message received is 200, which means OK - success. An overview of all available HTTP response codes can be found on-line at

[3]. **Content-type** header of the response message tells us, that the body received it of type HTML.

RESTful web service needs more than that and luckily HTTP offers much more. It will be better to point out its features in a relationship to each of REST's architectural principles.

### 1.1.3 Addressable resources, URIs and links

Each **resource** in a system should be reachable through a **unique identifier**. When reflected to the idea of REST and HTTP, URIs will automatically come to mind. The format of a URI looks like this [2]:

```
<scheme>://<authority><path>?<query>
```

The above is a citation directly from RFC, but for purposes of this master's thesis should be rewritten into more detailed form:

```
<scheme>://<host>:<port>/<path>?<queryString>#<fragment>
```

Where in the RESTful world these parts usually mean:

- **scheme** typically **http** or **https**
- **host** aka server name, e.g. **fit.cvut.cz** and **port**
- **path** to the resource on server, e.g. **/admission/123-456-01**
- **queryString** after the **?** is typically used for a set of resources and can be a page number, number of items in the set, or a filter definition and many more, e.g. **?page=1&limit=10**
- **fragment** after the **#** usually points to a certain place in a document

An example of such URI pointing to a set of resources may be:

```
http://pririz.is.fit.cvut.cz:9090/admission/services/admission  
?page=2&count=20
```

An example of URI pointing to a concrete single resource:

```
http://pririz.is.fit.cvut.cz:9090/admission/services/admission  
/123-456-01
```



1.1.4 A uniform, constrained interface, HTTP methods

1.1.5 Communicate statelessly, (no)sessions

1.1.6 HATEOAS

1.2 Why not SOAP?

1.3 REST vs. SOAP

1.4 REST, Java and JAX-RS



## CHAPTER 2

# BPM and jBPM



CHAPTER 3

# Chosen technologies



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## Content of CD

readme.txt	- the file with CD content description
data/	- the data files directory
graphs/	- the directory of graphs of experiments
*.eps	- the B/W graphs in PS format
*.png	- the color graphs in PNG format
*.dat	- the graphs data files
exe/	- the directory with executable WBDCM program
wbdcmm	- the WBDCM program executable (UNIX)
wbdcmm.exe	- the WBDCM program executable (MS Windows)
src/	- the directory of source codes
wbdcmm/	- the directory of WBDCM program
Makefile	- the makefile of WBDCM program (UNIX)
thesis/	- the directory of $\text{\LaTeX}$ source codes of the thesis
figures/	- the thesis figures directory
*.eps	- the figures in PS format
*.pdf	- the figures in PDF format
*.tex	- the $\text{\LaTeX}$ source code files of the thesis
text/	- the thesis directory
thesis.pdf	- the Diploma thesis in PDF format
thesis.ps	- the Diploma thesis in PS format