

# Service-Oriented Architectures and Web Services: Course Tutorial and Lab Notes

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## Abstract

This document presents a number of quick-step instructions to get started on writing mini-service-oriented web services-based applications using OpenESB 2.31, Tomcat 6, GlassFish 2.x/3.0.1 with BPEL support, and Java 1.6+ primarily in Scientific Linux 6.6 with user quota restrictions. While the tutorial notes are oriented towards the students taking the SOEN487 on service-oriented architectures (SOA) at Computer Science and Software Engineering (CSE) Department, Faculty of Engineering and Computer Science (ENCS), other may find some of it useful as well outside of CSE or Concordia. The notes are compiled mostly based on the students' needs and feedback.

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## 1 Introduction

**NOTE:** these notes are undergoing an update for the current term.

**NOTE:** A copy these notes may also be released more frequently on course web page, SourceForge while pending approval of updates on arXiv. Thus, available “mirrors” for these are:

- course web page (most up-to-date)
- <https://sourceforge.net/projects/atasm/files/SOEN%20WS/Winter%202015/>
- <http://arxiv.org/abs/0907.2974>

## 2 Tentative Lab and Tutorial Schedule

In the tutorials the tutor demonstrates the environment, tools, etc. (1 hour). In the lab, the students reproduce the tutorial material with the assistance of the lab instructor. The hands-on aspect is primarily in the lab. Including assistance with the project and assignments.

**Week 2** Lab environment, see Section 10.

**Week 3** Explicit XML parsing using DOM, xpath, JAXB as well as HTTP processing with Java; see references in Section 2.1.

**Weeks 4–5** SOAP services, see Section 3. Project support.

**Weeks 6–7** REST services, see Section 4. Project support.

**Weeks 9–11** BPEL, see Section 5. Project support.

**Weeks 12–15** Project support.

### 2.1 Prerequisites

Basic knowledge and prerequisite skills required to grasp in order to do the introductory assignments and have a deeper knowledge of the subject include:

1. Understanding the concepts behind web services (WS) in the context of distributed system and distributed computing. How WS came to be and what are its major advantages and disadvantages.

Introductory notes on WS can be found in the NetBeans and Oracle tutorials [Net11c, Sun06b].

2. Understanding HTTP POST and GET in general is important. More specifically programmability of HTTP POST and GET with Java, as e.g. given in [Mor08].
3. Manual XML parsing with Java is important to understand especially when dealing with parsing a custom application’s XML files to extract or represent the data.

A simple example is available at [Gag11], and more realistic application-specific examples in [The14]’s `NeuralNetwork` implementation and its testing application `TestNN` [CMt14]:

<http://marf.cvs.sf.net/viewvc/marf/apps/TestNN/>

<http://marf.cvs.sf.net/viewvc/marf/marf/src/marf/Classification/NeuralNetwork/>

4. JAXB and Java [Net11a]
5. Programming in Java [Fla97], JSP [Sun05b], Servlets [Sun05a], JavaScript

## 2.2 Related Work and Reading

This section compiles a set of related work and reading references.

1. Reference texts:  
SOA and WS: [EAA<sup>+</sup>04, CT08, SH05]  
JavaScript, AJAX, WWW: [Seb10]
2. Why not CORBA?  
[Hen06]
3. BPEL, WSC problem modeling and overview, algorithms, SOAP routing, and AI planning:  
[YPZ10, YABCZ10, YLRD09, Koe07, BBW<sup>+</sup>08, VL08, OL09, Pee05, OLK05, OLK07, YKLO08, PBB<sup>+</sup>04, GNT04, NKL08, YXG08, YZ08, BT08]
4. Formal methods in WS:  
[Yan08, YDPC09, vdAMSW09, Vir04, SBS04, OvdAB<sup>+</sup>05, FFK04, YBWM08]
5. Applications:  
[JY08, HMLW08, ML08, MJ08]
6. Lecture notes and slides:  
[Yan11d, Yan11g, Yan11i, Yan11f, Yan11a, Yan11j, Yan11k, Yan11c, Yan11e, Yan11h, Yan11b]

## 3 Preparatory Notes on Web Services

### 3.1 Create a Web Service with NetBeans, test Web Service, Observe SOAP Messages

Reading and practice:

- Build: `ManufacturerService.processP0` as Exercise 1 as illustrated in [Net11c].
- Knowledge: Chapter 1 in [Sun06b].
- One can create a Web Service as *Java Web Application* or as *Maven Web Application*. Maven [Mav12] is a project management tool on top of Ant [Ant12].
- One needs to compile and deploy the service before you testing it.

### 3.2 Consume Web Service with Java classes, JSP and Servlet

Use the referenced tutorial [Net11c] as well as see the login example in Section 11.

Table 1: JAXB Mapping of XML Schema Built-in Data Types [Sun06a]

XML Schema Type	Java Data Type
xsd:string	java.lang.String
xsd:integer	java.math.BigInteger
xsd:int	int
xsd:long	long
xsd:short	short
xsd:decimal	java.math.BigDecimal
xsd:float	float
xsd:double	double
xsd:boolean	boolean
xsd:byte	byte
xsd:QName	javax.xml.namespace.QName
xsd:dateTime	javax.xml.datatype.XMLGregorianCalendar
xsd:base64Binary	byte[]
xsd:hexBinary	byte[]
xsd:unsignedInt	long
xsd:unsignedShort	int
xsd:unsignedByte	short
xsd:time	javax.xml.datatype.XMLGregorianCalendar
xsd:date	javax.xml.datatype.XMLGregorianCalendar
xsd:g	javax.xml.datatype.XMLGregorianCalendar
xsd:anySimpleType	java.lang.Object
xsd:anySimpleType	java.lang.String
xsd:duration	javax.xml.datatype.Duration
xsd:NOTATION	javax.xml.namespace.QName

### 3.3 Complex Data Types Used in Web Services, JAXB Binding

Consult the two tables (Table 1, Table 2) are from [Sun06b] as a reference, more specifically from [Sun06a].

**JAXBElement.** When XML element information can not be inferred by the derived Java representation of the XML content, a `JAXBElement` object is provided. This object has methods for getting and setting the object name and object value.

**Java-to-Schema.** The referenced Table 2 shows the default mapping of Java classes to XML data types.

1. Binding WSDL with JAXB [Net11a]:
  - The class of a complex type should have a non-argument default constructor.
  - The WSDL contains a `schemaLocation` to indicate an xml that describes the complex data type.
2. Given a WSDL file, ask for implementing such a Web service:

Table 2: JAXB Mapping of XML Data Types to Java Classes [Sun06a]

Java Class	XML Data Type
<code>java.lang.String</code>	<code>xs:string</code>
<code>java.math.BigInteger</code>	<code>xs:integer</code>
<code>java.math.BigDecimal</code>	<code>xs:decimal</code>
<code>java.util.Calendar</code>	<code>xs:dateTime</code>
<code>java.util.Date</code>	<code>xs:dateTime</code>
<code>javax.xml.namespace.QName</code>	<code>xs:QName</code>
<code>java.net.URI</code>	<code>xs:string</code>
<code>javax.xml.datatype.XMLGregorianCalendar</code>	<code>xs:anySimpleType</code>
<code>javax.xml.datatype.Duration</code>	<code>xs:duration</code>
<code>java.lang.Object</code>	<code>xs:anyType</code>
<code>java.awt.Image</code>	<code>xs:base64Binary</code>
<code>javax.activation.DataHandler</code>	<code>xs:base64Binary</code>
<code>javax.xml.transform.Source</code>	<code>xs:base64Binary</code>
<code>java.util.UUID</code>	<code>xs:string</code>

- Method 1: at the “Web Service” folder, right click, select “Web service from WSDL”. This creates a JAX-WS service. Or you can find “Web service from WSDL” when you right click the project node.
- Method 2: (1) first create an xml (i.e. the WSDL) to Java binding. (2) create an empty Web Service. (3) add operations described in the WSDL to the Web service, with the required inputs and outputs. If the inputs and the outputs are complex types, JAXB binding is useful. One needs to use the classes generated by JAXB binding (step 1). If the service has only simple types, you do not need step (1). Example: `CreditReportService` [Net11a].

### Exercises for key points:

1. Create a WS with simple and complex XML data types
2. Develop a SOAP WS with top-down and bottom-up approaches

Related tutorials:

1. Top-down and bottom-up approaches tutorial e.g. in [Net11b]
2. Passing binary data in SOAP: a five-part tutorial in [Net11d]
3. Develop Web service with complex XML data type with JAXB binding [Net11a]

## 4 RESTful Web Services

*REpresentational State Transfer (REST)*. Follow NetBeans tutorial [Net15]. The lecture notes are in [Yan11e]. Delicious restful service demo at <http://jmvidal.cse.sc.edu/talks/rest/delicious.html>: use JavaScript to call a RESTful service and use JavaScript process the results in JSON (*JavaScript Object Notation*) is a lightweight data-interchange format, [www.json.org](http://www.json.org)).

# RESTful Architecture

Hammad Ali

## ReST - Representational State Transfer

Architectural style for designing networked applications.

Instead of using **S**imple **O**bject **A**ccess **P**rotocol, **H**ypertext **t**ransfer **p**rotocol is used to make calls between machines.



## ReST - Representational State Transfer

To perform Create, Read, Update, Delete operations ReSTful Applications use HTTP requests to post (create/update), read, and delete data.

1. POST (Create/Insert Record)
2. PUT (Update/Edit Record)
3. GET (Read Data e.g. make queries)
4. DELETE (Delete Record)

ReST uses above 4 Http requests to perform all CRUD operations.

## Web services and SOAP VS ReST

### SOAP Request

```
<?xml version="1.0" encoding="UTF-8"?><S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/" xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
  <SOAP-ENV:Header/>
  <S:Body>
    <ns2:inventory xmlns:ns2="http://warehouse/">
      <qty>10</qty>
    </ns2:inventory>
  </S:Body>
</S:Envelope>
```

<http://localhost:8080/HelloWorld2/resources/helloWorld/test1>

### SOAP Response

```
<?xml version="1.0" encoding="UTF-8"?><S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/" xmlns:SOAP-ENV="http://schemas.xmlsoap.org/soap/envelope/">
  <SOAP-ENV:Header/>
  <S:Body>
    <ns2:inventoryResponse xmlns:ns2="http://warehouse/">
      <return>96</return>
    </ns2:inventoryResponse>
  </S:Body>
</S:Envelope>
```

`<html><body><h1>Hello Hammad!</h1></body></html>`

## SAMPLE PROJECT

New Project → Samples → Web Services → REST: Hello World (Java EE 6)

```
@Singleton
public class NameStorageBean {

    // name field
    private String name = "Name
Storage World";

    public String getName() {
        return name;
    }

    public void setName(String name) {
        this.name = name;
    }
}
```

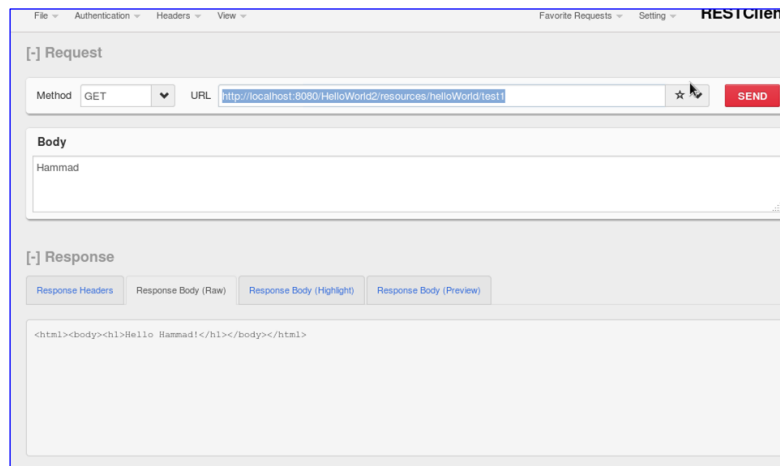
Project Name → Source Packages → pkgName →  
NameStorageBean.Java

Project Name → Source Packages → pkgName → HelloWorldResource.Java

```
@GET
@Path("/test")
@Produces("text/html")
public String getsample(String sample) {
    return "<html><body><h1>Hello ...
"+nameStorage.getName()+"!</h1></body></html>";
}

@PUT
@Path("/put")
@Consumes("text/plain")
public String putXml(String content) {
    //return content;
    nameStorage.setName(content);
    return "Variable changed";
}
```

Use ReST client plugin for testing in your browser.



## 4.1 Exercises

### 4.1.1 HelloWorld

Test the sample REST service `HelloWorld`, where one can set and get the resource value in the resource `HelloWorld`. Use HTTP GET/PUT to get and change the resource values. Resource end point:

`http://localhost:8080/HelloWorld/resources/helloWorld`

### 4.1.2 CustomerDB

CustomerDB is a more elaborate example. We'd use Derby, the default NetBeans's internal database engine.

## 4.2 Optional Exercise

What would be required to convert your Exercise 4 from Assignment 1 to become RESTful services? Try doing it.

## 5 BPEL

Reading and resources: [IBM<sup>+</sup>07, OAS07, Koe07, Ope09, Wik09, Yan11b, OvdAB<sup>+</sup>05, FFK04]

## 5.1 OpenESB 2.3.1



# OpenESB

CONFIGURATION GUIDE

HAMMAD ALI

## Changing user directory for opensesb to write IDE files in your group directory.

```
Cd /groups/e/eg_soen487_4/hammad  
opensesb - -userdir `pwd` &
```

OR

```
Opensesb - -userdir /groups/e/eg_soen487_4/hammad &
```

- Use backtick/ backquote `` for pwd – Print Working Directory to pass value to.
- Everything in backtick is executed before the main command, and output of that execution is fed to main command.

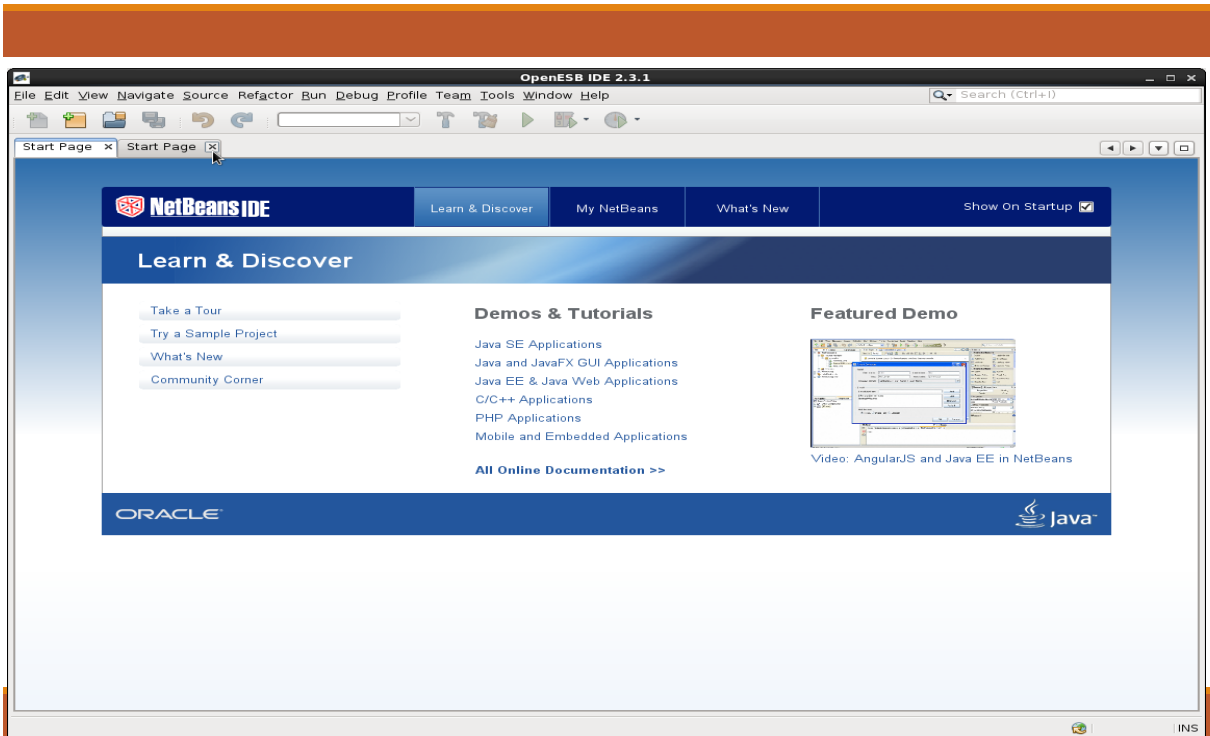
# Success and Error



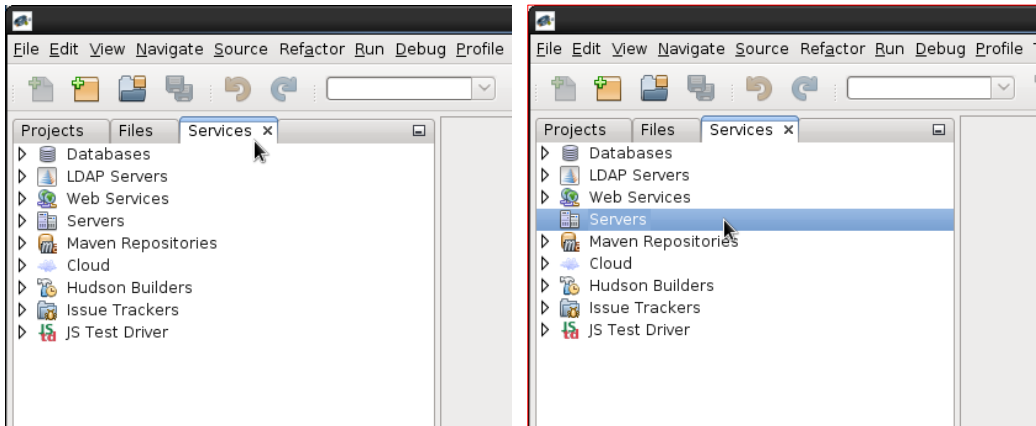
if you have pointed out esb to the directory where you have permission to write files, you will see openesb loading up.

else you will get a warning message if you try to load it in a directory where you don't have permission to write files to.

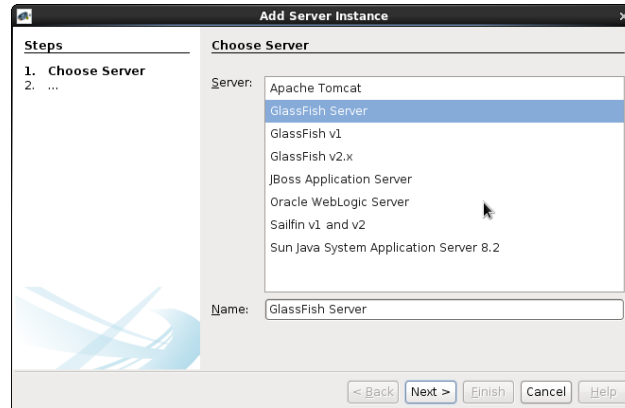
for instance your /home directory



## Adding a server

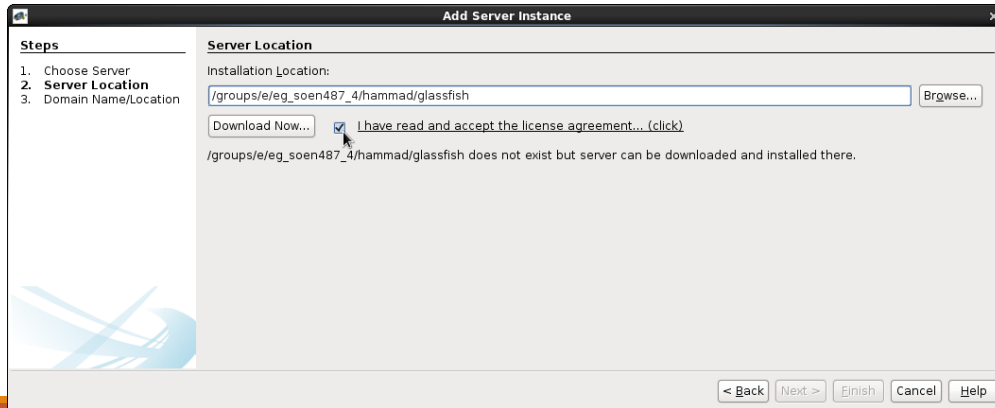


## GlassFish Server



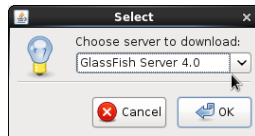
## GlassFish Server

Select Installation location for server, and click on download button.



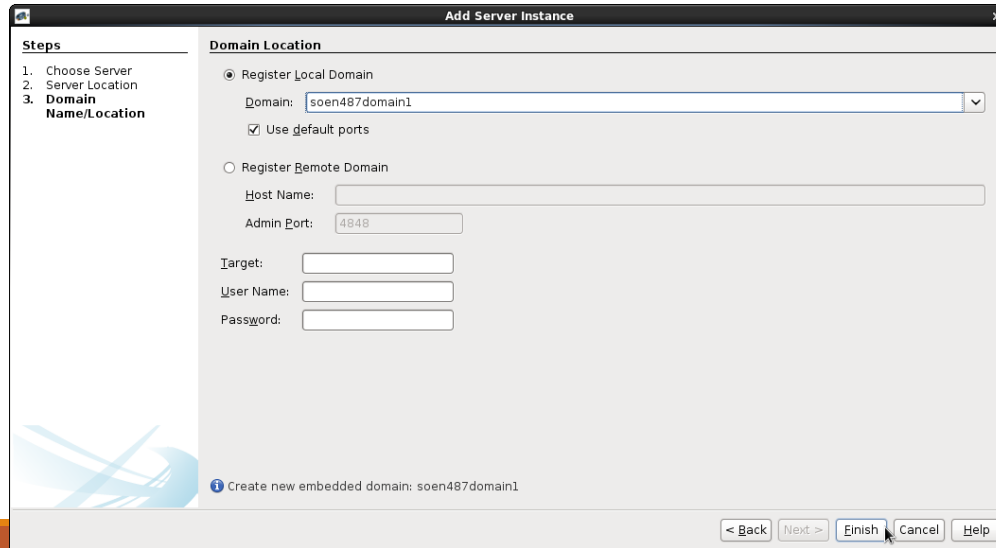
## GlassFish Server

From the dropdown menu select server version 4.0 and click ok.



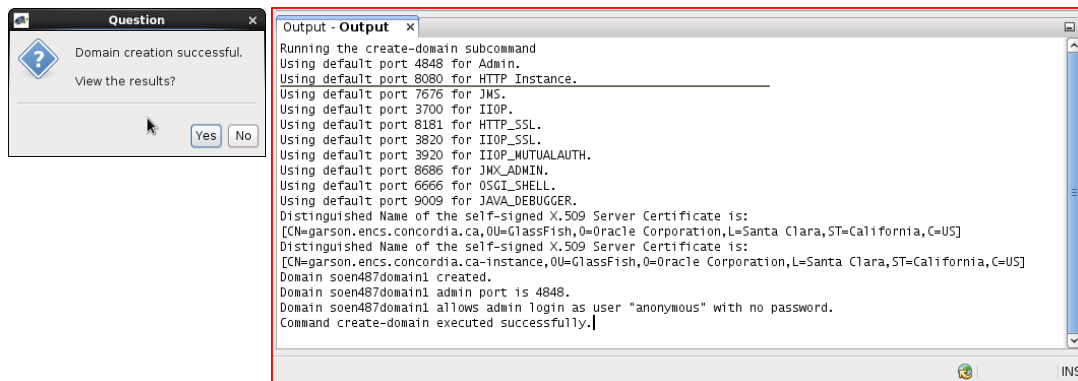
# GlassFish Server

Specify domain name for your server. and click on finish



# GlassFish Server

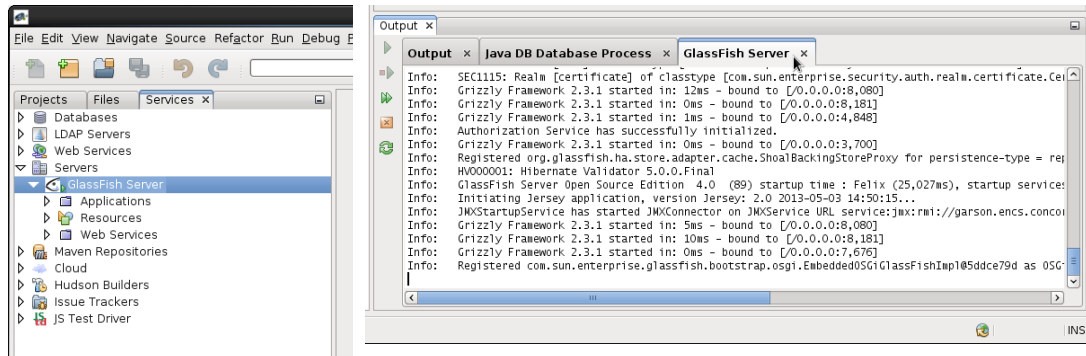
Upon successful installation you will see the dialog box asking if you want to see results.



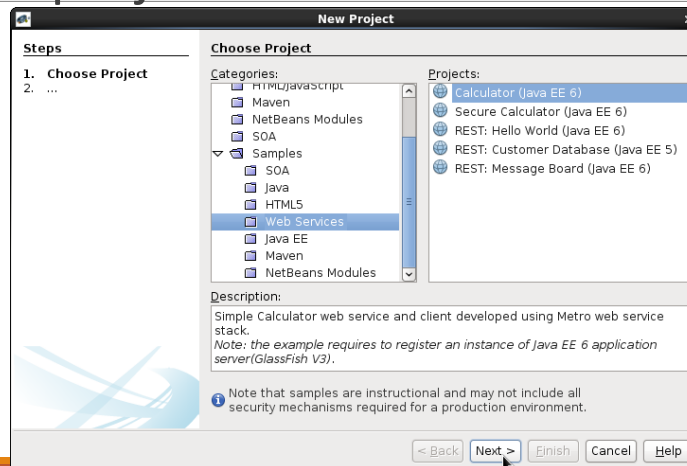


## Starting GlassFish Server

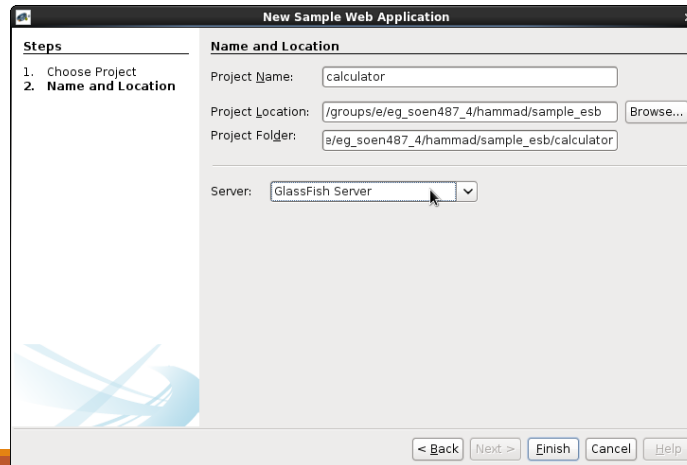
Right click on the glassfish server from the sidebar and click on Start.



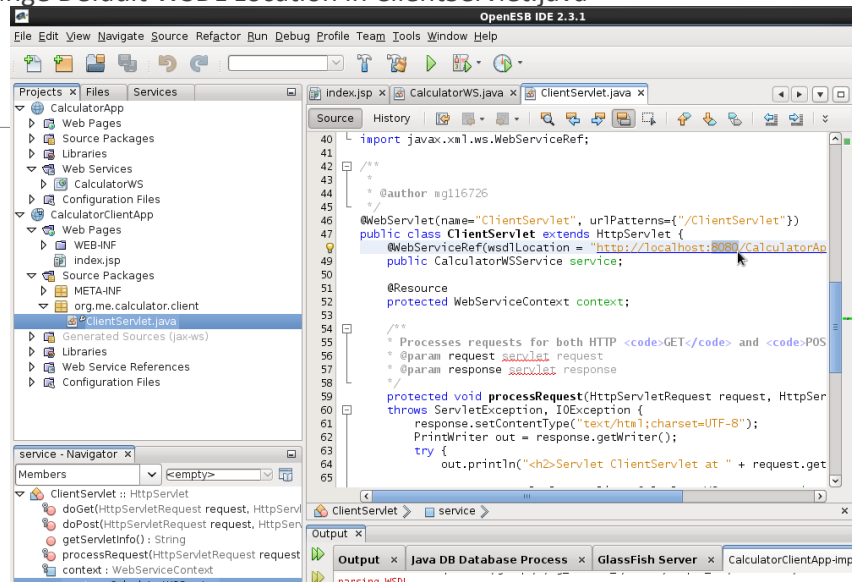
## Loading a sample calculator web service project



## Project Location & Server



## Change Default WSDL Location in ClientServlet.java



Build and deploy the project.  
Test the Project,  
Run the project in browser.

## 5.2 NetBeans 6.9.1 and Eclipse

There is some chance BPEL would be available for the newer platforms, but we are not holding our breath for it presently, so for now we'll stick with the legacy setup in Section 5.3.

## 5.3 Legacy

BPEL plugins (GUI and the service engine) for now are known to work “out-of-the-box” with NetBeans 6.5.1 [Sun09b] (labs) and 6.7.1 [Sun10] (download). See notes about Linux commands

and project directories in Section 10.3.

Tools, resources and their locations:

- NetBeans 6.5.1 [Sun09b] path in Linux in labs  
32-bit systems:  
`/encs/pkg/netbeans-6.5.1/root/bin/netbeans`  
Remote login to `computation.encs.concordia.ca` (64-bit):  
`/encs/ArchDep/i686.linux26-RHEL5/pkg/netbeans-6.5.1/root/bin/netbeans`
- NetBeans 6.5.1 download:  
`http://netbeans.org/downloads/6.5.1/index.html`
- NetBeans 6.7.1 download:  
`http://netbeans.org/downloads/6.7.1/index.html`
- BPEL Guide and Tutorials:  
`http://netbeans.org/projects/usersguide/downloads/download/NB61-SOAdocs.zip`  
`http://www.youtube.com/watch?v=a76RxxkzB4Bg`
- BPEL Lecture Notes [Yan11b]

### 5.3.1 Configuring NetBeans and GlassFish for BPEL

The ALL option typically installs GlassFish 2.1 [Sun09a] as well as Tomcat 6 bundled by default with NetBeans, as well as some of the components. This includes some of the BPEL [Wik09] components as well. To complete all the needed extensions for BPEL for GlassFish you'd need to download WSDL extensions and Saxon shared libraries and deploy them within your running GlassFish instance. Download libraries for BPEL SE [Ope09], specifically: `wsdlexlib.jar` and `saxonlib.jar`; these should go under "Shared Libraries". That's all you need for your setup in the lab. For your home computer you may need to download and install the actual BPEL service engine component from the same web page [Ope09], called `bpelserviceengine.jar`, which should go under "Service Engines" and NOT "Shared Libraries".

### 5.3.2 BPEL Composite Applications

GlassFish 2.1 is needed for legacy BPEL. E.g. see the tutorial from NetBeans referenced above.

Similarly, there are good application samples available in the netbeans to start the process of a BPEL composite application: "New" → "Samples" → "SOA"; specifically "Travel Resevation Service" and "BPEL BluePrint 1".

**NOTE:** The referenced tutorial works best with NetBeans 6.5.1 and was found to have difficulties in NetBeans 6.7 (e.g. empty `Output.xml` file is not being prompted for or produced). If you insist on using NetBeans 6.7 be extra careful to the warning notes in the tutorial web page.

## 6 WS Reliability and Security

*TODO*

## 7 Packaging and Deployment

- NetBeans
- Ant [Ant12]
- Maven [Mav12]

*TODO*

## 8 GlassFish

### 8.1 Starting GlassFish as a Standalone Service

This is to startup GlassFish outside of the NetBeans environment as a standalone service for application deployment:

<http://download.oracle.com/docs/cd/E19798-01/821-1757/gglog/index.html>

#### 8.1.1 Windows

GlassFish and configuration

1. GlassFish installation directory: `C:\Program Files\glassish-3.0.1`. Use `%GF%` to represent this path.  
You may need to make `%GF%` editable (change security) in order to be able to log events, run modules, etc.
2. NetBeans runs GlassFish from the specified domain, e.g.  
`C:\users\USERNAME\.netbeans\6.9\config\GF3\domain1`. Use `%NG%` to represent this path.
3. To start GlassFish from `%GF%` (not inside NetBeans), run from command line:  

```
asadmin start-domain --verbose
```

## 9 Marking Schema for the Assignments and Project

Please refer to the project document.

## 10 Lab Environment

### 10.1 Windows

On ENCS Windows the software was not made readily available (in particular more recent NetBeans with the ALL option).

## 10.2 Linux

We are using Scientific Linux 6.6 during the labs. For your own work you can use any platform of your choice, e.g. Windows or MacOS X on your laptops. You will have to do the installation and configuration of NetBeans, Java, GlassFish, or Tomcat and so on there yourself.

### 10.2.1 Accounts

Under UNIX, disk space (for a sample account `kos691a2`) would be accessible under e.g. `/groups/k/ko_soen691a_2`. Under Windows (in case you need to access files from that OS), that path would be `\\filer-groups\v_groups\groups_unix\k\ko_soen691a_2` (the “S:” drive). There is a 1GB quota space available there and your in-school work related to the assignments and courses can be put there, as the generated data files can be large at times.

To figure out what is your group account, type the `id` command in a terminal, e.g.:

```
addams.mokhov [ko_soen691a_2] % id
uid=X(mokhov) gid=X(mokhov) groups=...,8896(kos691a2),...,X(mokhov)
```

### 10.2.2 Java 1.6

Java 1.6 is not a default Java in ENCS at this moment. You need to make it default. In order to use this version all you need to do is prepend:

```
/encs/pkg/jdk-6/root/bin
```

to your `PATH` (the environment variable). To do so there are simple instructions:

People using `tcsh` (the default):

```
addams.mokhov [~] % setenv PATH /encs/pkg/jdk-6/root/bin:$PATH
addams.mokhov [~] % rehash
addams.mokhov [~] % java -version
java version "1.6.0_29"
Java(TM) SE Runtime Environment (build 1.6.0_29-b11)
Java HotSpot(TM) Server VM (build 20.4-b02, mixed mode)
```

People using `bash`:

```
bash-2.05b$ export PATH=/encs/pkg/jdk-6/root/bin:$PATH
bash-2.05b$ java -version
java version "1.6.0_29"
Java(TM) SE Runtime Environment (build 1.6.0_29-b11)
Java HotSpot(TM) Server VM (build 20.4-b02, mixed mode)
```

You can avoid typing the above commands to set the `PATH` each time you open a terminal under Linux by recording it in `~/.cshrc`. If you do not have this file in your home directory you can create one with the following content (e.g. using `vim` [MC09]):

```
set path=( /encs/pkg/jdk-6/root/bin $path )
```

or copy an example from [Mok09] and update the `path` to include the above directory to be the first on the list. Thus, next time when one logs in and opens a terminal, Java 1.6 will always be the default. The same applies to the Java used when one clicks on the NetBeans or Eclipse shortcuts in the graphical menu.

### 10.2.3 NetBeans

NetBeans [Net14] is a major IDE of the supported for the course.

**NetBeans 6.9.1** NetBeans 6.9.1 [Net12] is accessible as a simple command `netbeans` or from the “Applications” → “Programming” → “NetBeans” menu with a corresponding icon. This version of NetBeans does not have support plug-ins for SOA and BPEL at the time of this writing.

**NetBeans 6.5.1** This material is for legacy versions of NetBeans 6.5.1 and GlassFish 2 under Scientific Linux 5.6 environment that support SOA, BPEL Designer and a run-time service engine. The legacy version NetBeans 6.5.1 [Sun09b] is accessible as a command from `/encs/pkg/netbeans-6.5.1/root/bin/netbeans` on lab desktops, is used for legacy SOA and BPEL exercises. The rest of the section describes this version of NetBeans as needed to be set up for the exercises. You can create an alias for yourself and place it e.g. in your `.cshrc`, to shorten it:

```
addams.mokhov [~] % alias netbeans651 /encs/pkg/netbeans-6.5.1/root/bin/netbeans
addams.mokhov [~] % netbeans651
```

## 10.3 Step-by-Step Environment Setup

1. Login to Linux. If you never did before likely your default window manager is GNOME.
2. Open up the terminal: “Applications” → “Accessories” → “Terminal”. The window similar to Figure 1 should pop-up.
3. Configure your Java 1.6 to be the default as outlined in Section 10.2.2, and an example is shown in Figure 2.
4. In *the same terminal window*, change your `HOME` environment variable to that of your 1GB group directory. This will allow most portions of NetBeans to write the temporary and configuration files there by default instead of your main Unix home directory. I use an equivalent directory of mine `/groups/k/ko_soen691a_2`, *as an example* – and you should be using the directory assigned to you with your group 1GB quota. An example to do so is very similar as to set up `PATH`, except it is a single entry. It is exemplified in Figure 3. Unlike `PATH`, `HOME` is *not* recommended to be hardcoded to change your `HOME` in `.cshrc`.
5. Create the following directories in your new group `HOME` (your 1GB group directory):

```
mkdir .netbeans .netbeans-derby .netbeans-registration
chmod g+rwsx .netbeans .netbeans-derby .netbeans-registration
ls -al
```

These directories will hold all the configuration and deployment files pertaining to NetBeans, the Derby database, and the domains for GlassFish’s operation. The overall content may easily reach 80MB in total disk usage for all these directories just to start up.

6. Disk usage, quota, and big files (in case running out of space) can be checked for using the following commands:

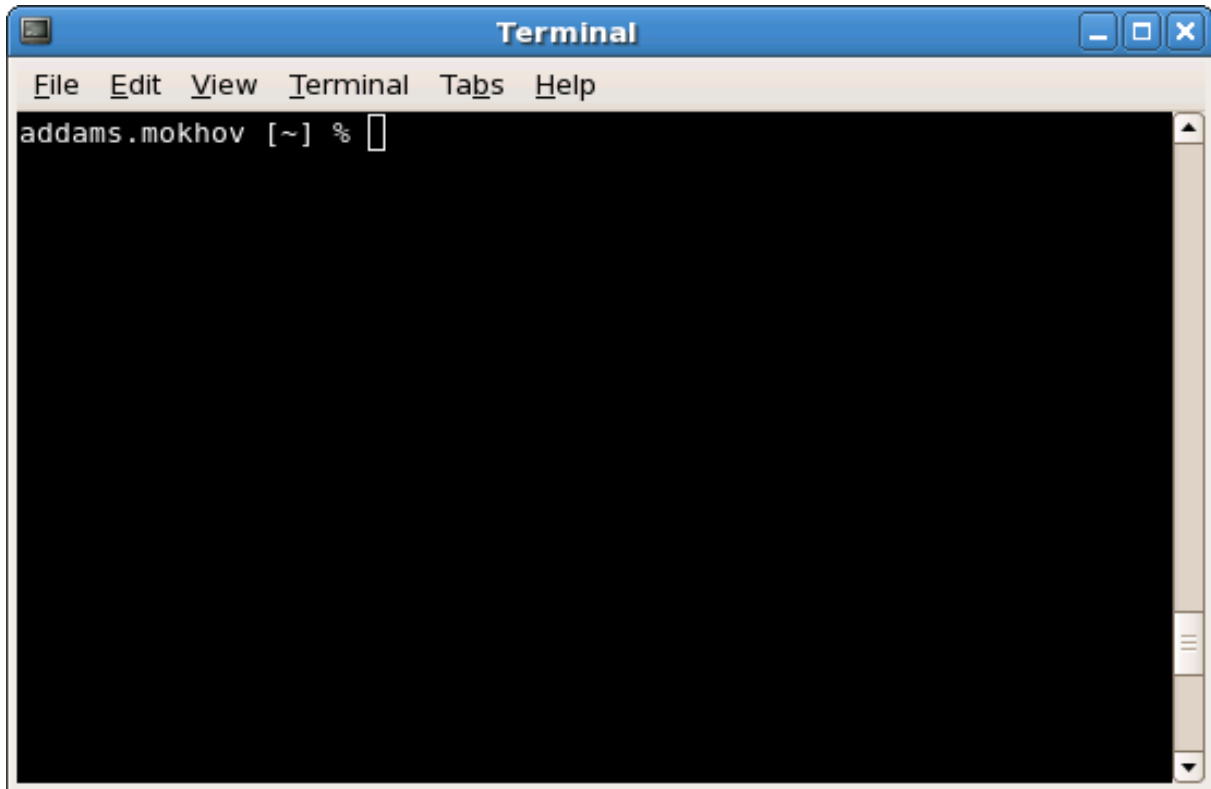


Figure 1: Terminal Window

```
quota
du -h
bigfiles
```

7. In your *real home directory* (open another Terminal), remove any previous NetBeans et co. setup files you may have generated from the previous runs:

```
.asadminpass
.asadmintruststore
.netbeans*
.personalDomain*
```

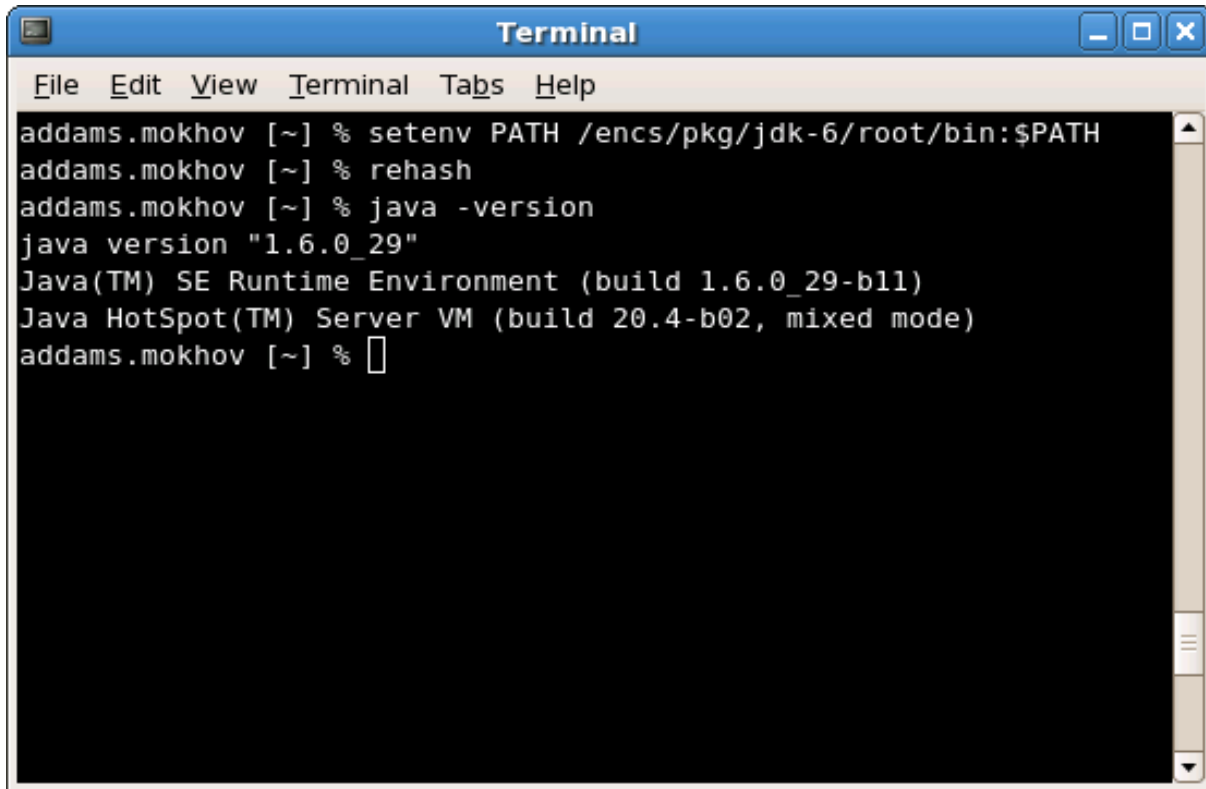
(assuming no important data for you are saved there):

```
\rm -rf .netbeans* .personalDomain* .asadmin*
```

8. In your *real home directory* create symbolic links (“shortcuts”) to the same NetBeans directories now found in your group directory you made earlier. This is just in case you launch NetBeans without redirecting the HOME, it still goes to the group directory without impeding your main quota:

```
addams.mokhov [~] % pwd
/nfs/home/m/mokhov
```





```

Terminal
File Edit View Terminal Tabs Help
addams.mokhov [~] % setenv PATH /encs/pkg/jdk-6/root/bin:$PATH
addams.mokhov [~] % rehash
addams.mokhov [~] % java -version
java version "1.6.0_29"
Java(TM) SE Runtime Environment (build 1.6.0_29-b11)
Java HotSpot(TM) Server VM (build 20.4-b02, mixed mode)
addams.mokhov [~] % 

```

Figure 2: Setting up Java 1.6 as a Default in the Terminal

```

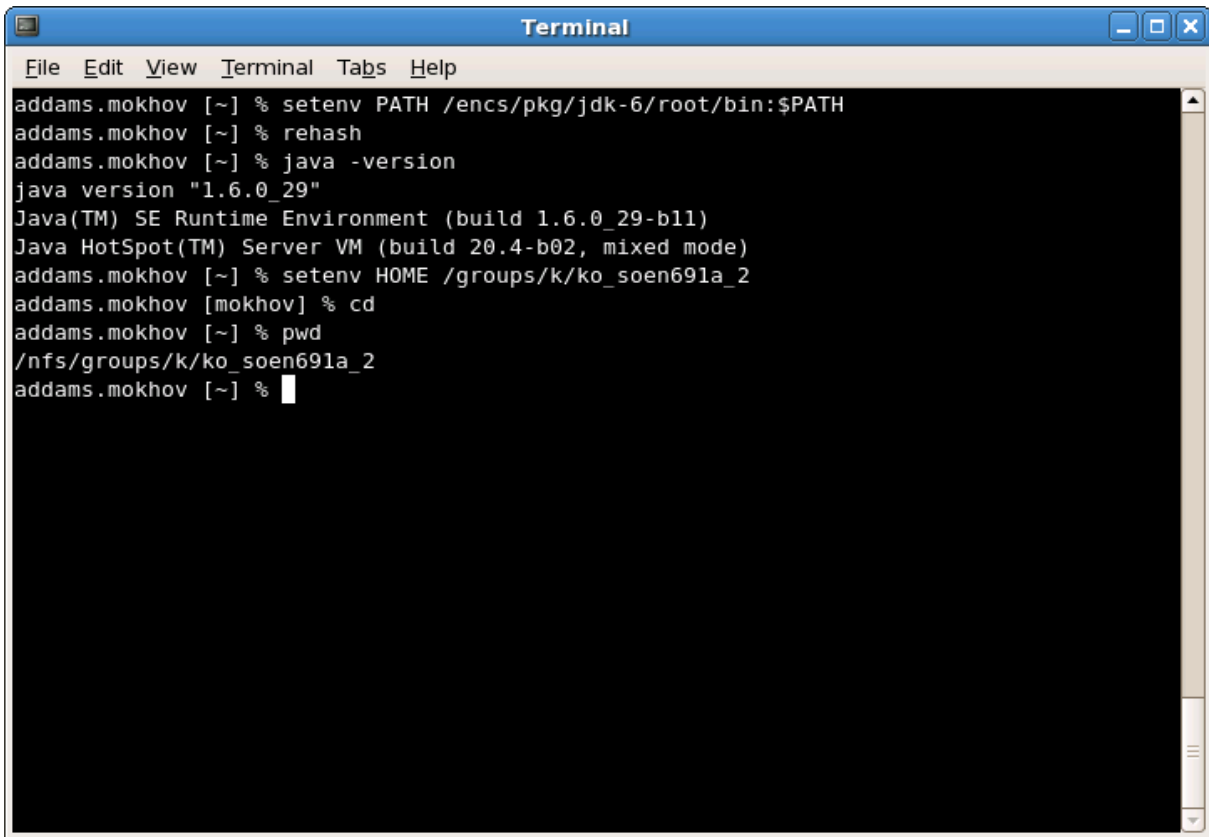
addams.mokhov [~] % ln -s /groups/k/ko_soен691a_2/.netbeans* .
addams.mokhov [~] % ls -ld .netbeans*
lrwxrwxrwx 1 mokhov mokhov 33 Oct 31 18:37 .netbeans -> /groups/k/ko_soен691a_2/.netbeans
lrwxrwxrwx 1 mokhov mokhov 39 Oct 31 18:37 .netbeans-derby
-> /groups/k/ko_soен691a_2/.netbeans-derby
lrwxrwxrwx 1 mokhov mokhov 46 Oct 31 18:37 .netbeans-registration
-> /groups/k/ko_soен691a_2/.netbeans-registration
addams.mokhov [~] %

```

9. In the *group home* terminal window launch NetBeans, by executing the command `netbeans &`, and after some time it should fully start up *without* of any errors.
10. This is NetBeans 6.9.1, the 6.5.1 will look slightly different in some places. It is covered at step 11.

You will be prompted to allow Sun/Oracle to collect your usage information and register; it is recommended to answer “No” to both. And then you will see a left-hand-side (LHS) menu, the main editor page with the default browsed info, and the top menu of the NetBeans, as shown in Figure 6.

- (a) A: screenshot-warning-gf301-domain-mpass-691.png (8 OK)
- (b) B: screenshot-warning-gf3-prelude-651.png
- (c)
- (d)
- (e)



```
Terminal
File Edit View Terminal Tabs Help
addams.mokhov [~] % setenv PATH /encs/pkg/jdk-6/root/bin:$PATH
addams.mokhov [~] % rehash
addams.mokhov [~] % java -version
java version "1.6.0_29"
Java(TM) SE Runtime Environment (build 1.6.0_29-b11)
Java HotSpot(TM) Server VM (build 20.4-b02, mixed mode)
addams.mokhov [~] % setenv HOME /groups/k/ko_soen691a_2
addams.mokhov [mokhov] % cd
addams.mokhov [~] % pwd
/nfs/groups/k/ko_soen691a_2
addams.mokhov [~] %
```

Figure 3: Setting up HOME to the Group Directory

- (f)
- (g)
- (h)
- (i)
- (j)
- (k)

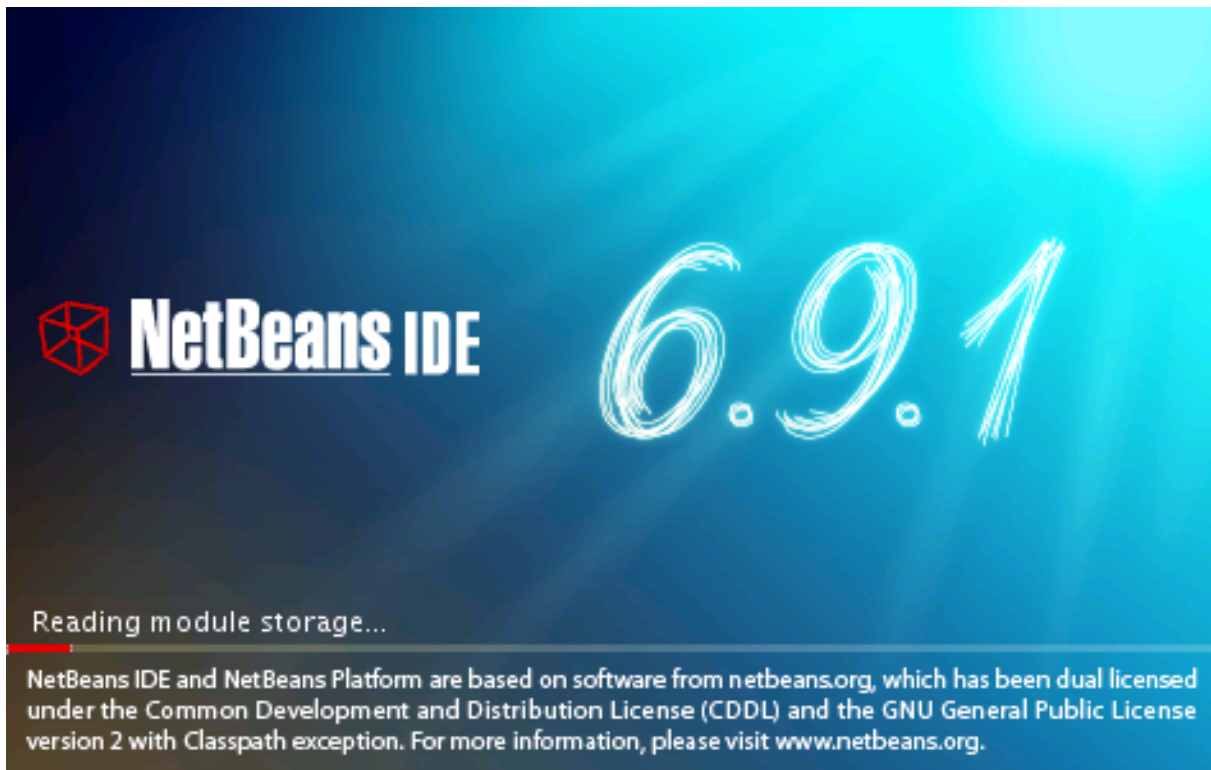


Figure 4: NetBeans 6.9.1 Starting Up

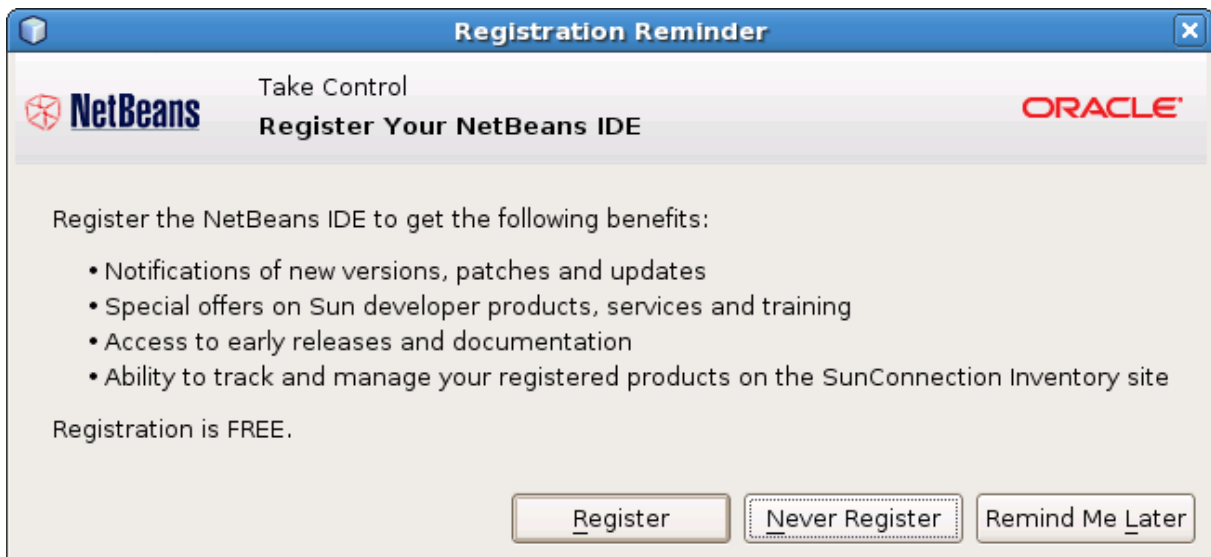


Figure 5: NetBeans 6.9.1 Registration

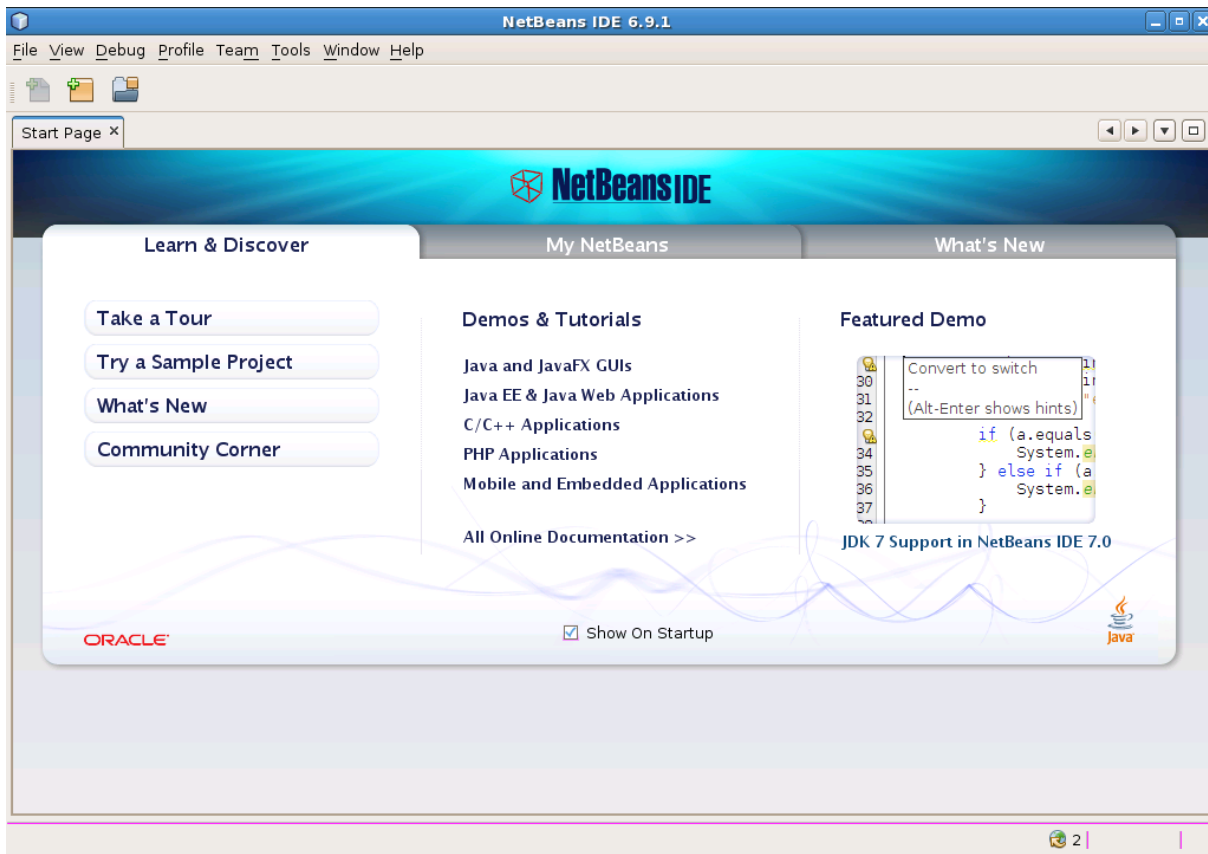


Figure 6: NetBeans 6.9.1 Start-up Screen



Figure 7: screenshot-warning-gf301-domain-mpass-691



Figure 8: screenshot-warning-gf3-prelude-651

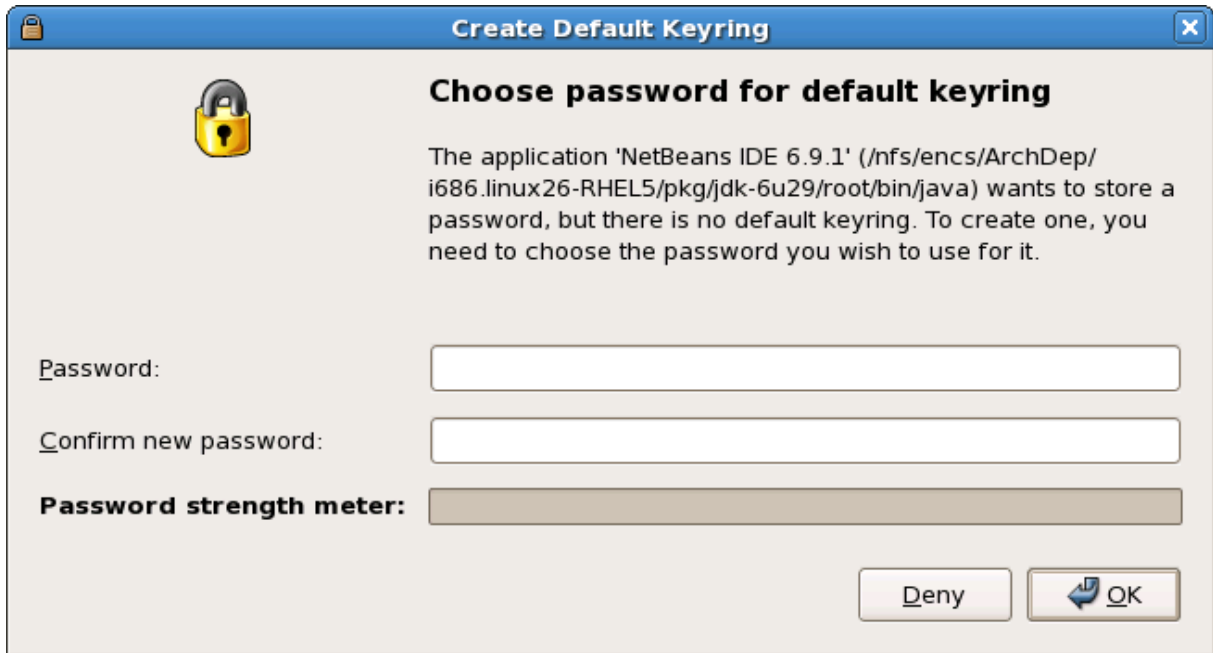


Figure 9: screenshot-create-default-keyring

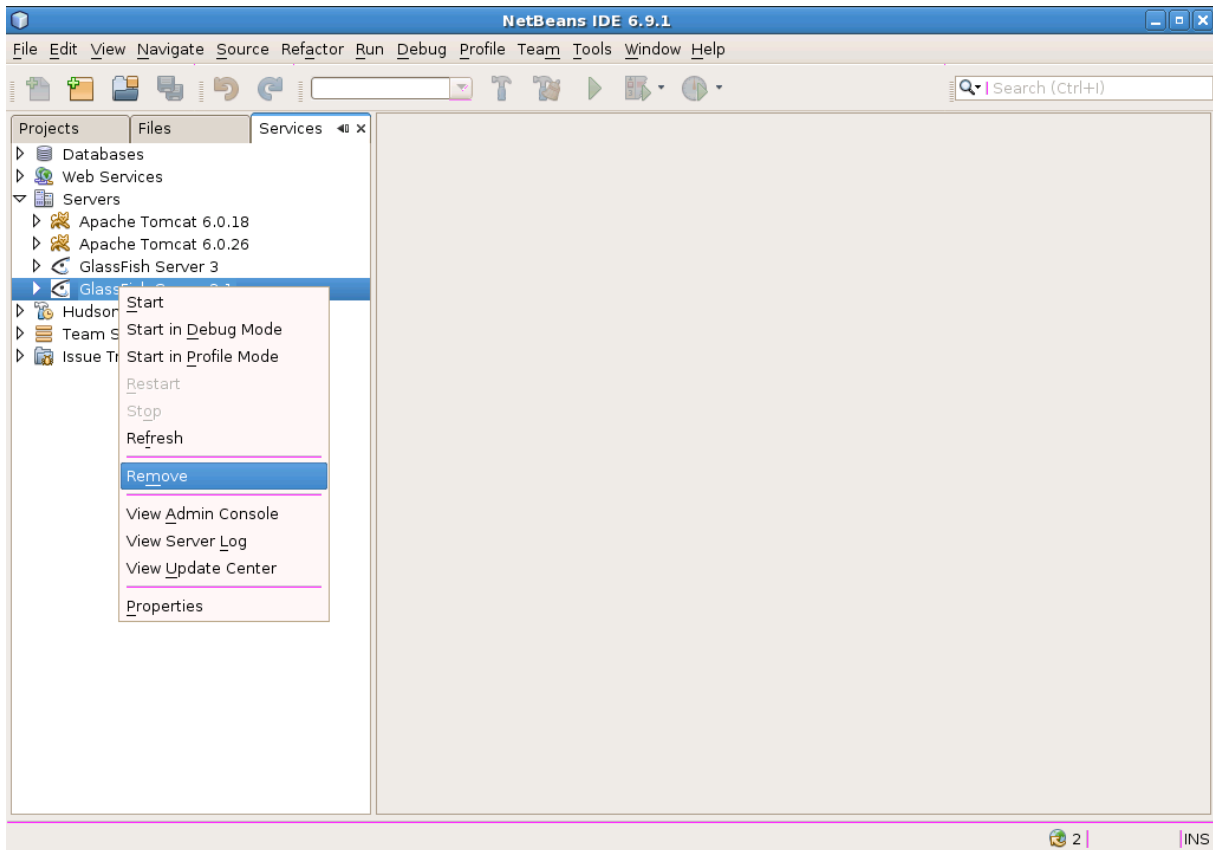


Figure 10: screenshot-netbeans691-remove-gf31



Figure 11: screenshot-remove-server-instance-gf31

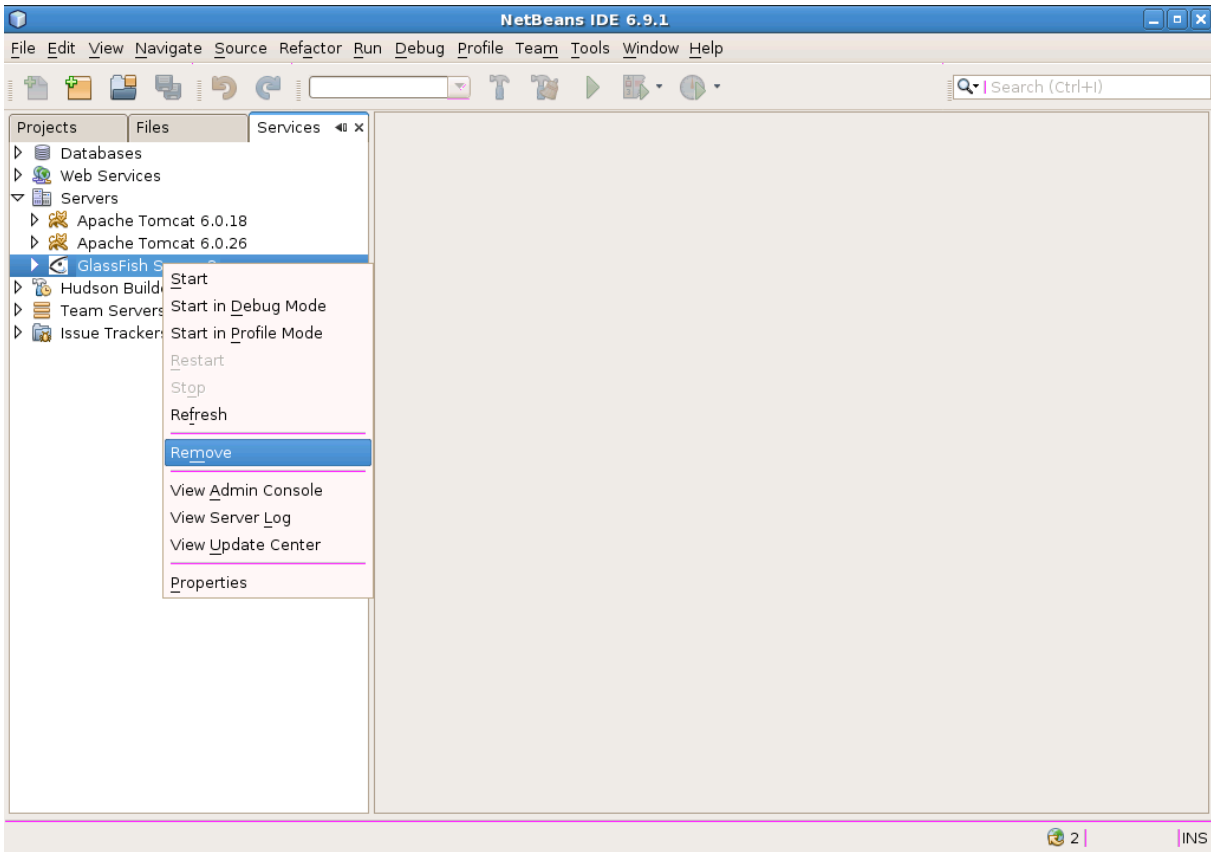


Figure 12: screenshot-netbeans691-remove-gf3

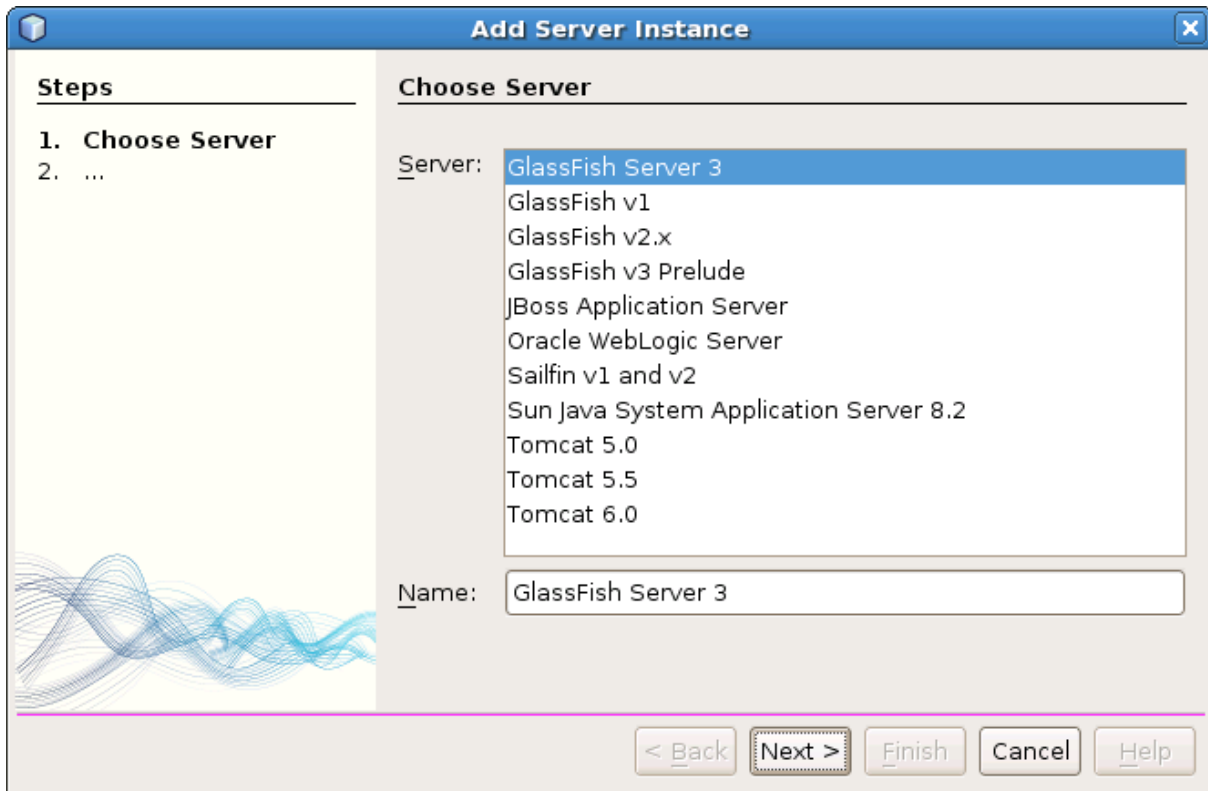


Figure 13: screenshot-add-server-instance-gf3

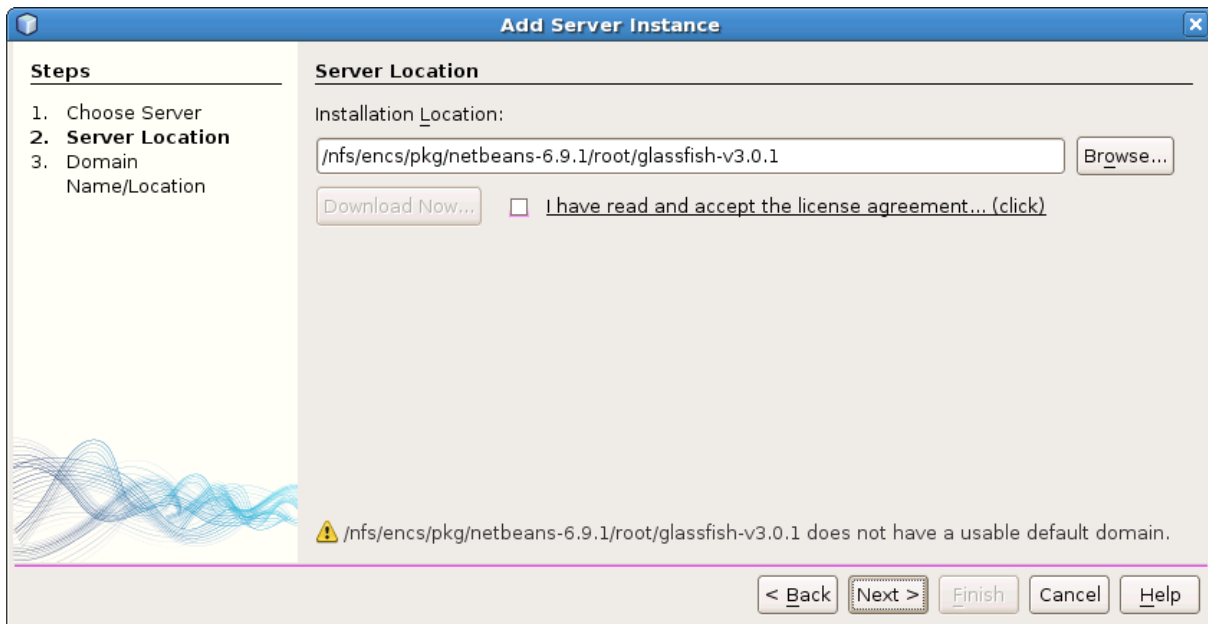


Figure 14: screenshot-add-server-instance-gf301-path

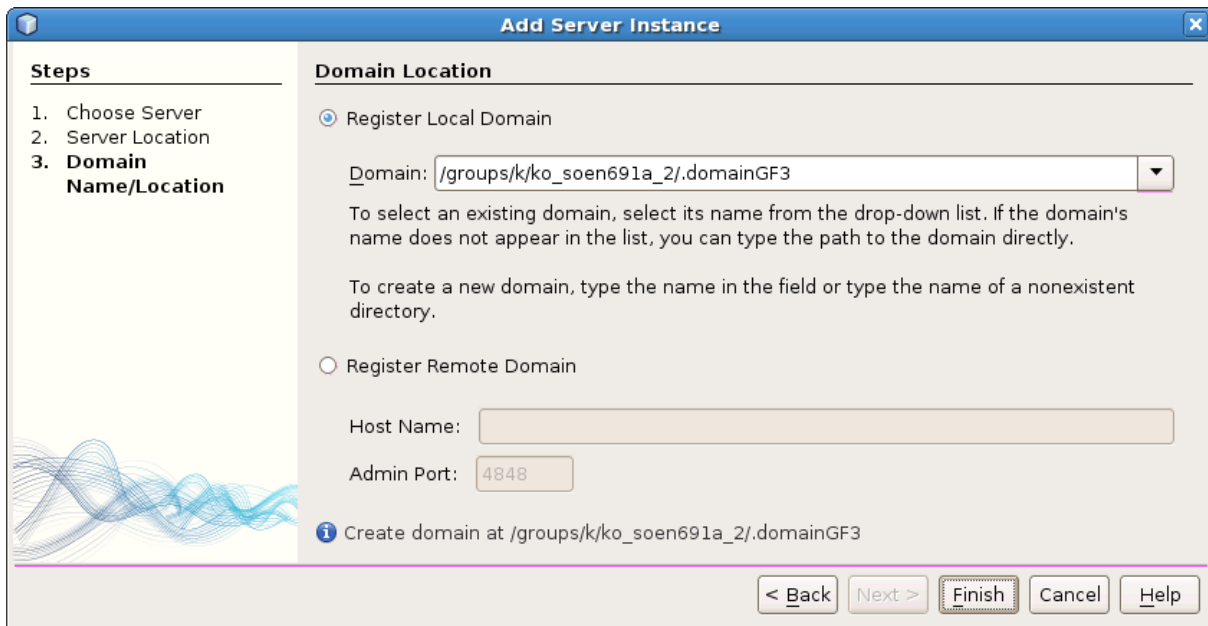


Figure 15: screenshot-add-server-instance-gf3-domain

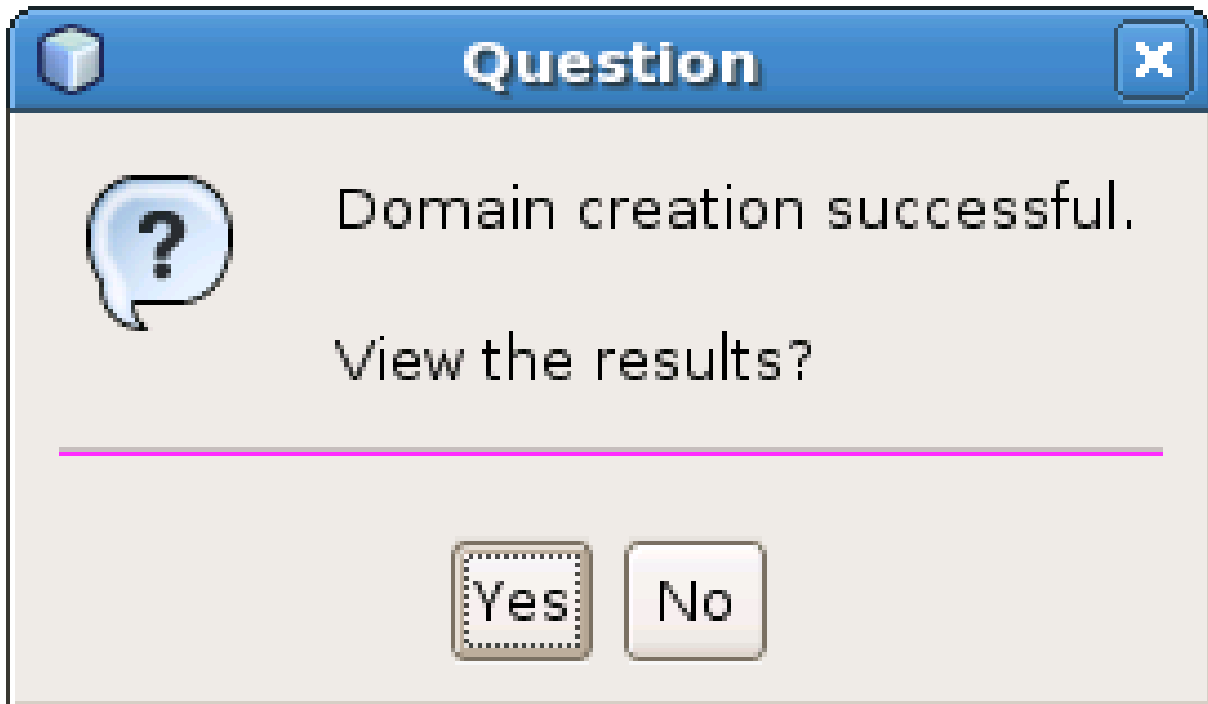


Figure 16: screenshot-domain-creation-results



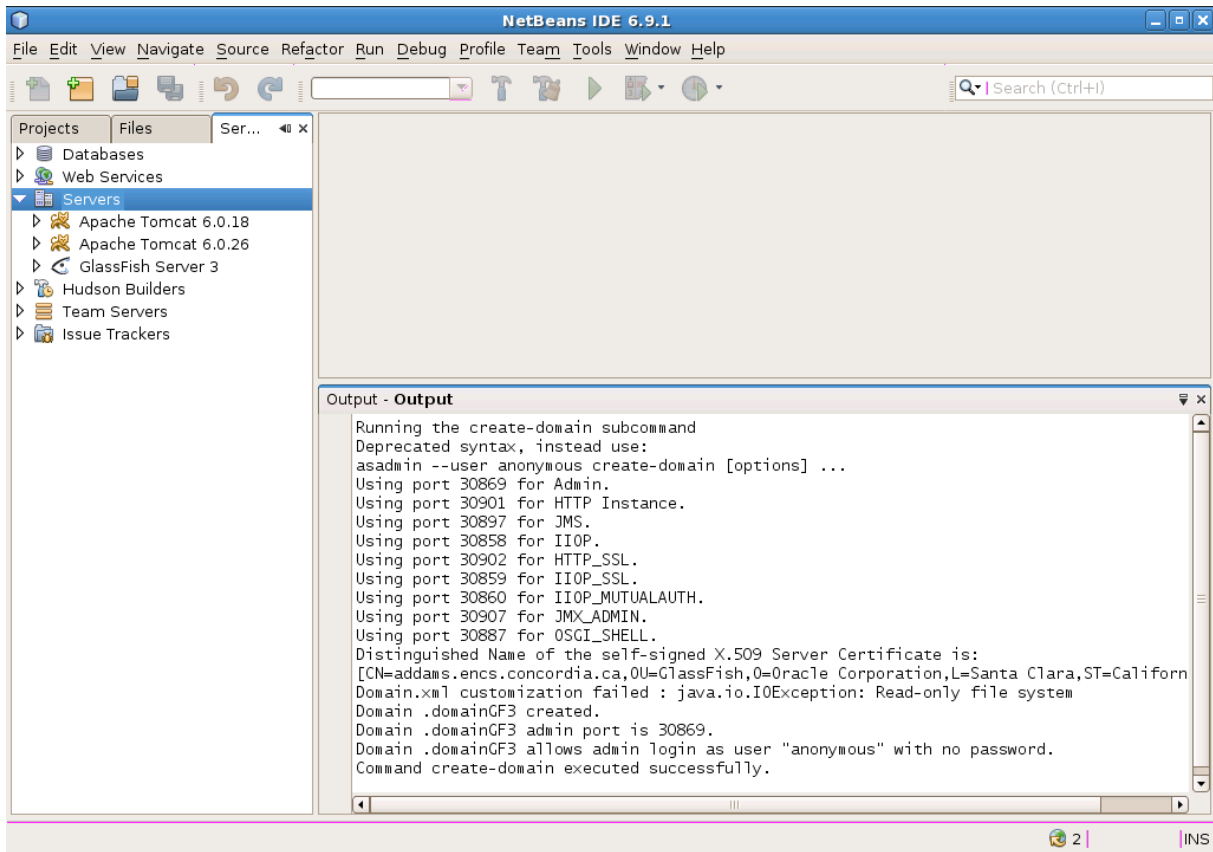


Figure 17: screenshot-netbeans691-gf3-created

11. This is NetBeans 6.5.1, the 6.9.1 will look slightly different in some places. It is covered at step 10.

You will be prompted to allow Sun/Oracle to collect your usage information and register; it is recommended to answer “No” to both. And then you will see a left-hand-side (LHS) menu, the main editor page with the default browsed info, and the top menu of the NetBeans, as shown in Figure 18.

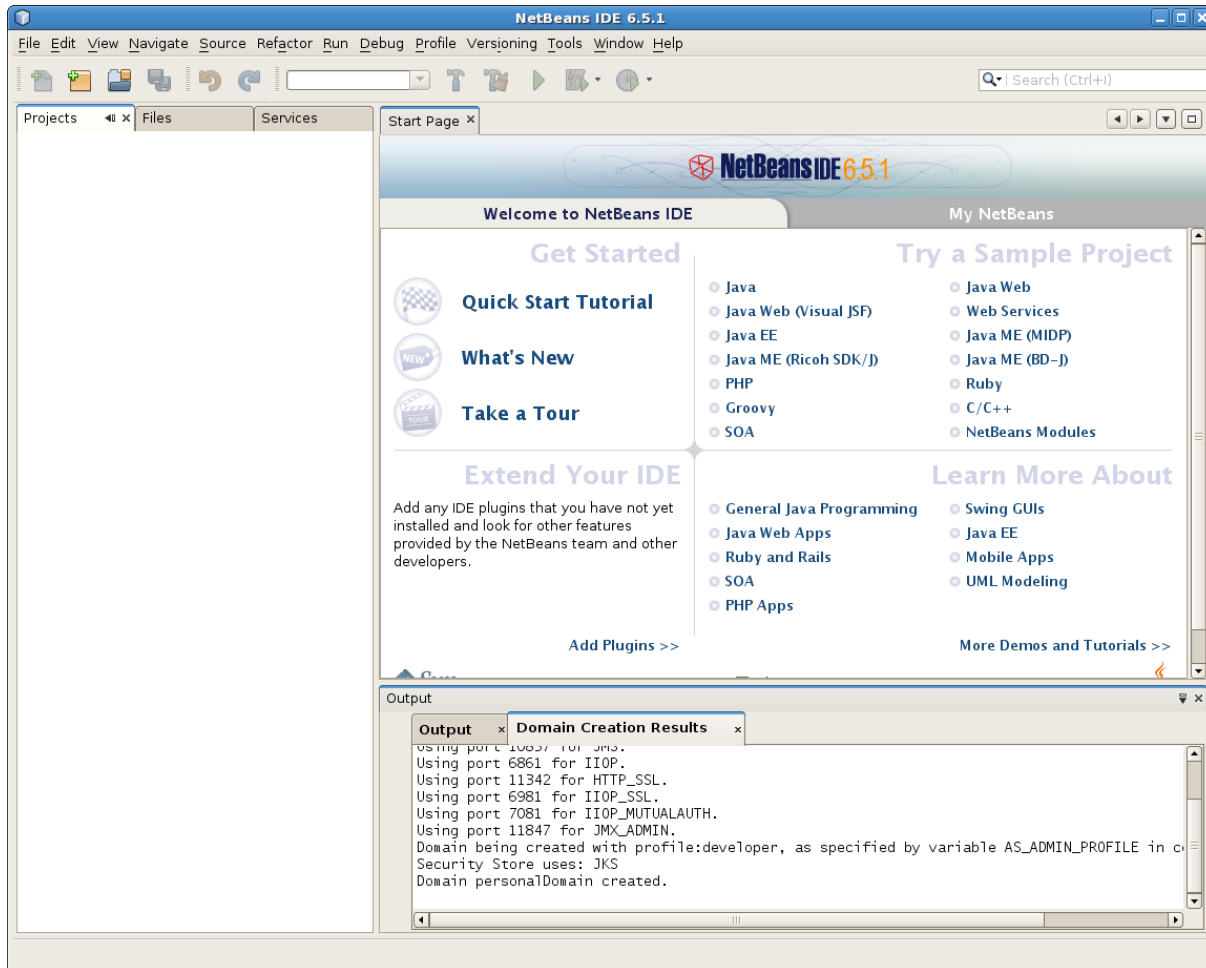


Figure 18: NetBeans 6.5.1 Start-up Screen

- (a) Navigate to the “Services” tab and expand the “Server” tree in the LHS menu. You should be able to see a “GlassFish V2” entry there (among other things), as shown in Figure 19.
- (b) Right-click on “GlassFish V2” and then “Properties”, as in Figure 20. Observe the “Domains folder” and “Domain Name”. If the folder points within your normal home directory, you have to change it as follows (and then remove it from your personal home directory):
  - i. Close the properties window.
  - ii. Right-click on “GlassFish V2” and then “Remove”. Confirm the removal with “Yes”. (You may as well remove “Personal GlassFish V3”).

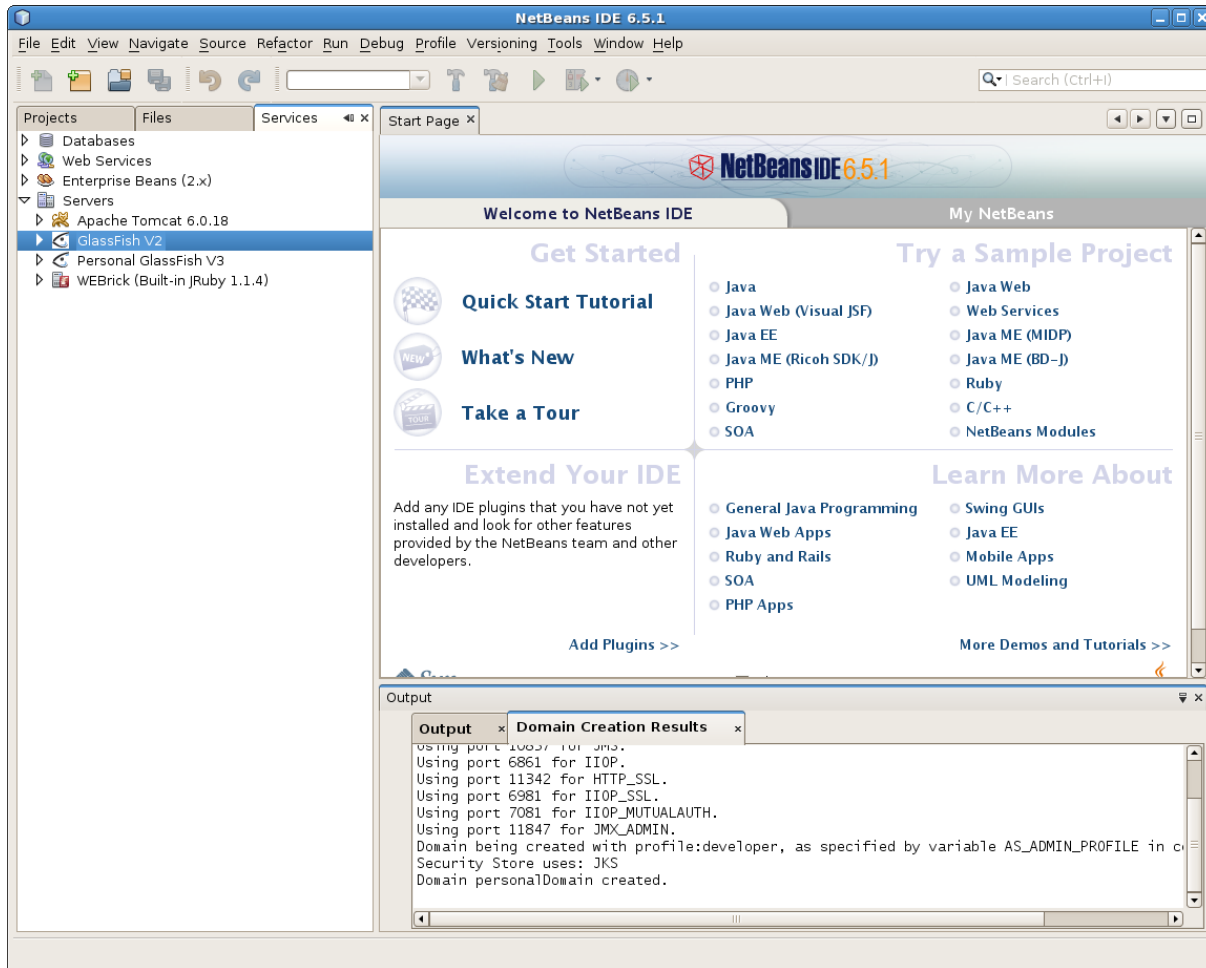


Figure 19: NetBeans: Services → Server → GlassFish V2

- iii. Right-click on “Servers” and then “Add Server...”.
  - iv. Select “GlassFish V2” and then “Next”, and “Next”.
  - v. Then, for the “Domain Folder Location” “Browse” or paste your group directory followed by an appended domain name, e.g. `/groups/r/rm_soen691a_4/domainGF2` in my case, notice where `domainGF2` is an arbitrary name of a directory under your group directory that is not existing yet, give it any name you like, and then press “Next”.
  - vi. Pick a user name and a password for the admin console (web-based) of GlassFish. The NetBeans default (of the GlassFish we removed) is ‘admin’ and ‘adminadmin’. It is *strongly* suggested however you do *NOT* follow the default, and pick something else. Do *NOT* make it equal to your ENCS account either.
  - vii. “Next” and “Finish”. Keep the ports at their defaults **EXCEPT** set HTTP port to 8085 and HTTPS to 8185. Notice it may take time to restart the new GlassFish instance and recreate your domain you indicated in the group folder.
- (c) Right-click on “GlassFish V2” again and select “Start”. It may also take some time to actually start GlassFish; watch the bottom-right corner as well as the output window for the startup messages and status. There should be no errors. Apache Derby service

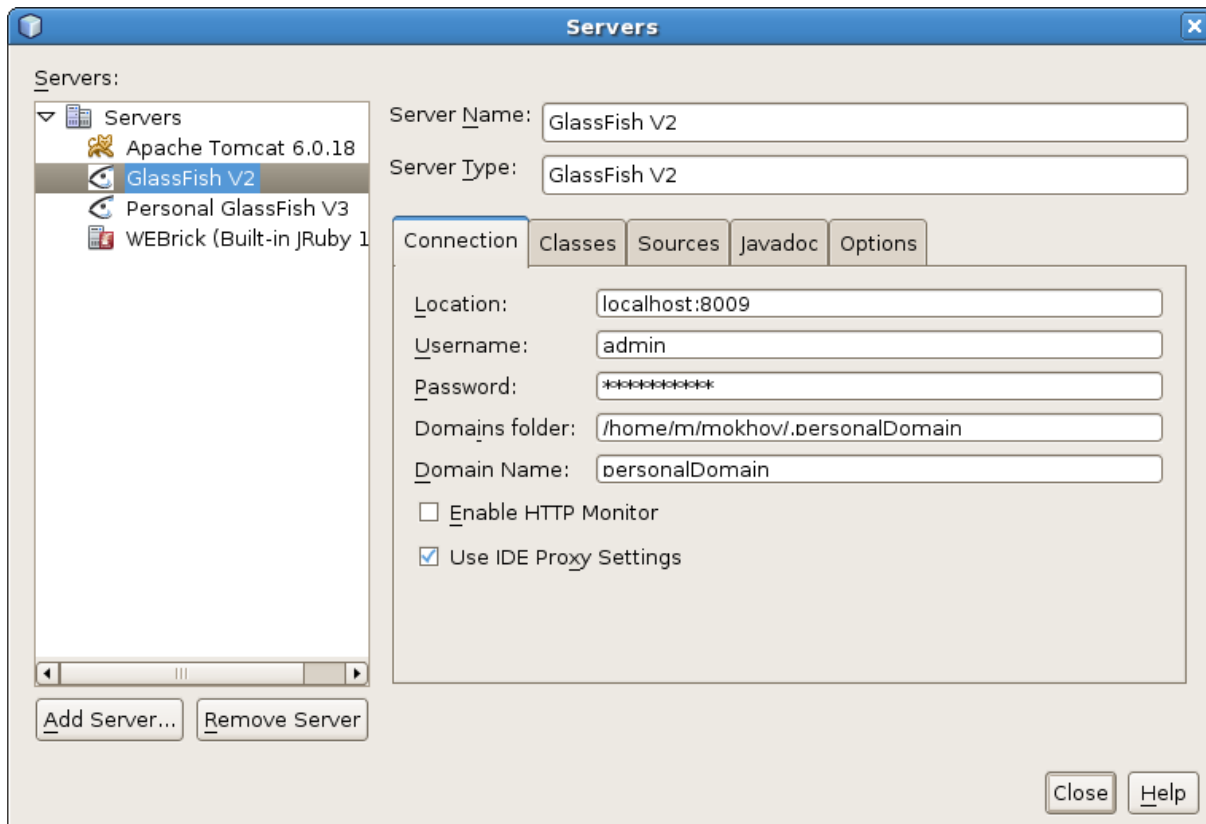


Figure 20: Right-click GlassFish V2 → Properties

should have started.

- (d) Once started, right-click on “GlassFish V2” again, and select “View Admin Console”. You should see the GlassFish login window pop-up in the Firefox web browser, looking as shown in Figure 21.
- (e) To log in, use the username and password you created earlier in Step 11(b)vi.
- (f) In your *group home* terminal, download additional libraries from course web page (formerly from [Ope09]). In the lab, you will only need 2 (`wsdl-ext-lib.jar` and `saxon-lib.jar`) out of typical 3, because the version installed in ENCS already includes the 3rd (`bpel-service-engine.jar`). You will likely need the 3rd file however, for your laptop or home desktop in Windows.
- (g) In your GlassFish console web page, under “Common Tasks” → “JBI” → “Shared Libraries” you need to install the two libraries we downloaded (3 for your Windows laptop or home desktop) by clicking “Install” and following the steps by browsing to the directory where you downloaded the files and installing them. Then, once installed `sun-saxon-library` and `sun-wsdl-ext-library` should be listed under the “Shared Libraries”.

You can also perform this step within NetBeans itself, by expanding the “GlassFish V2” tick, and then “JBI”, then right-clicking on “Shared Libraries” → “Install”.

It is *imperative* if you are using NetBeans 6.7.1 on your own systems, to install these libraries first before moving onto the next step and installing the BPEL engine.

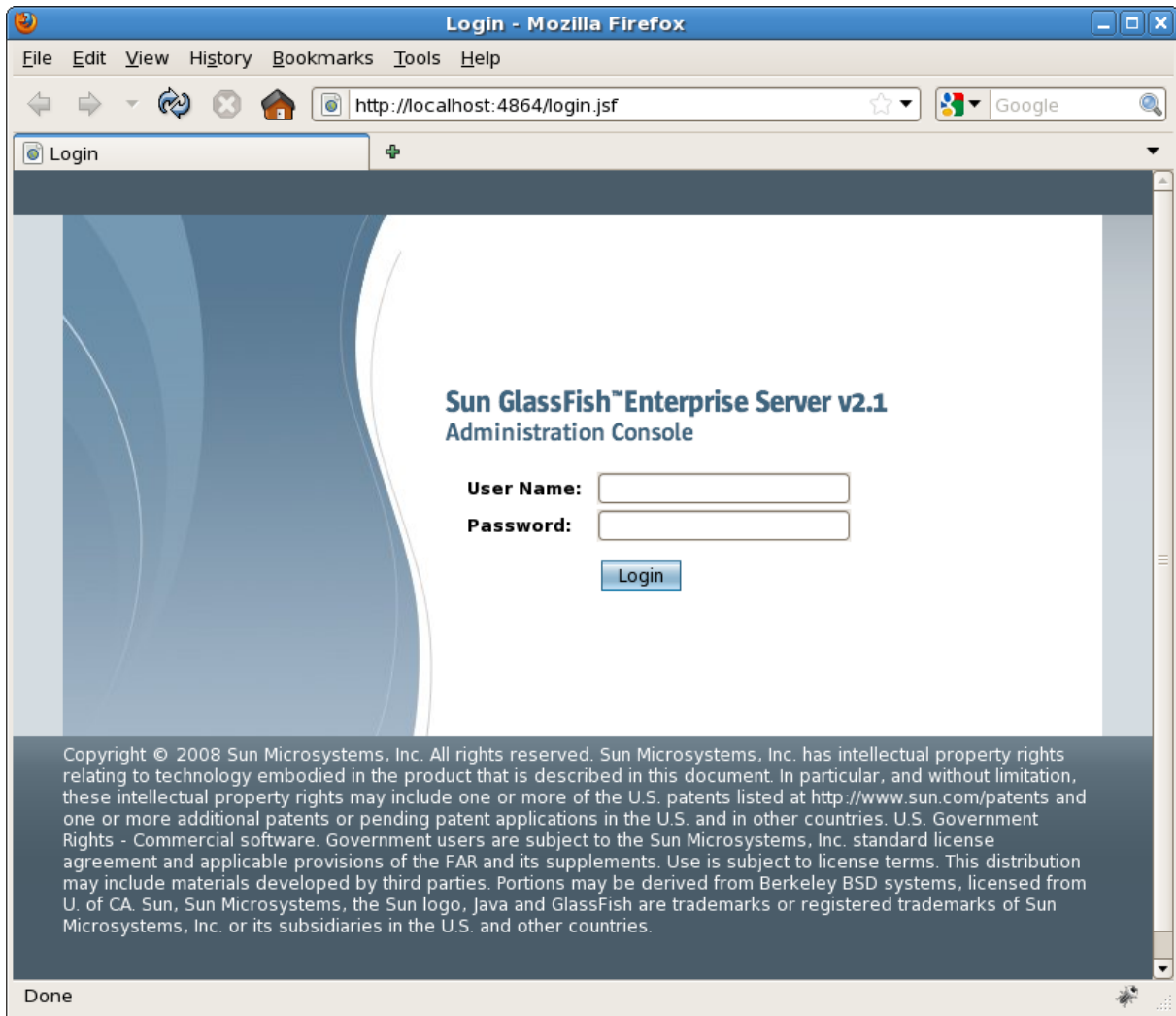


Figure 21: GlassFish Admin Console Login Screen

- (h) Make sure under “Components” you have `sun-bpel-engine`. Linux boxes in the labs should have it installed with the NetBeans, at home it’s the 3rd file – `bpel-service-engine.jar`, that may need to be installed using the similar procedure as in the previous step. Roughly, how your “Components” and “Shared Libraries” should look like is in Figure 22.

Similarly to the previous step, the installation of this jar can be done within NetBeans under the “Service Engines” subtree instead of “Shared Libraries”.

On this the NetBeans environment setup should be complete. You will technically not need to repeat except if you remove all the files from your group directory.

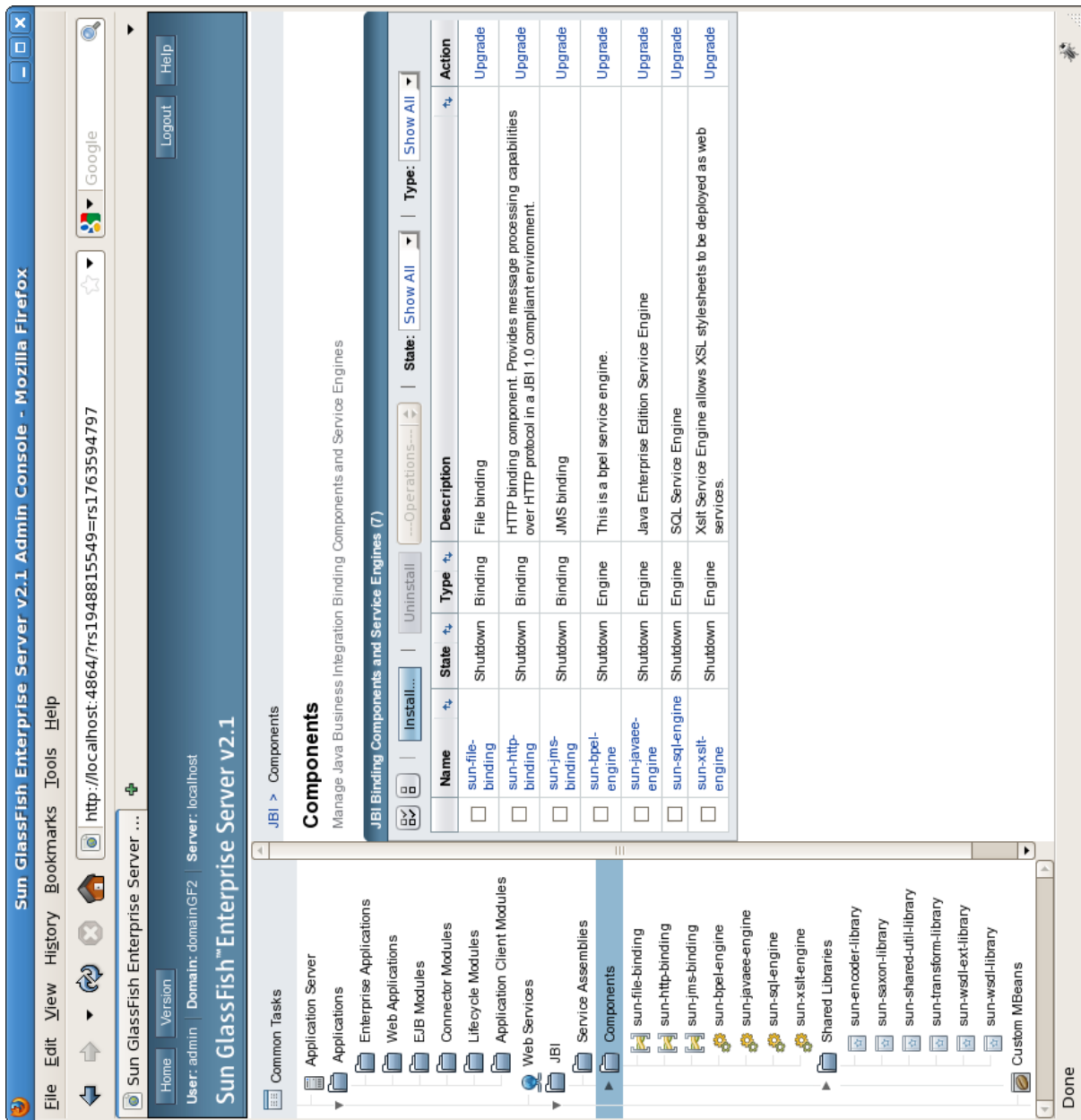


Figure 22: List of Components and Shared Libraries Installed in GlassFish

## 11 Step-by-Step Simple Application and Web Service Creation and Testing

### 11.1 NetBeans 6.5.1

1. Go to the "Projects" tab in NetBeans.
2. Then "File" → "New Project".
3. Choose "Java EE" → "Enterprise Application", as shown in Figure 23, and then "Next".

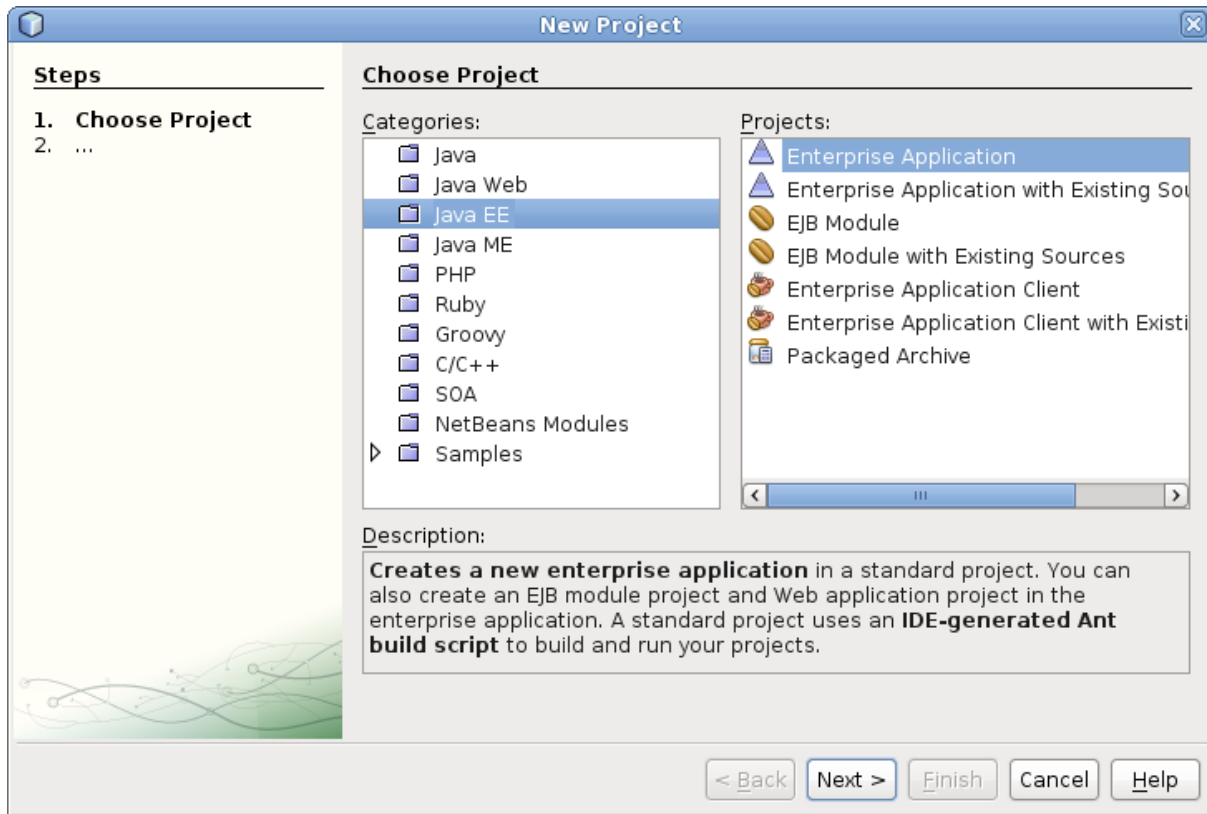


Figure 23: “Java EE” → “Enterprise Application”

4. Give the project properties, like Project Name to be “A1”, project location somewhere in your group directory, e.g. as for me shown in Figure 24, and then “Next”.
5. In the next tab, you can optionally enable “Application Client Module” for an example, and keep the rest at their defaults, e.g. as shown in Figure 25. Notice, I altered the client package `Main` class to be in `soen691a.a1.Main`. It is not strictly required in here as you can test your web services using web service unit testing tools built-into the IDE.
6. Click “Finish” to create your first project with the above settings. You should see something that looks like as shown in Figure 26, after some of the tree elements expanded.
7. Under `A1-war`, create a package, called `soen691a` by right-clicking under “A1” → “Source Packages” → “New” → “Java Package” → “Package Name”: `soen691a`. Then “Finish”.
8. Create a “Web Service” under that package, by right-click on the newly created package → “New” → “Web Service” → “Web Service Name” → `Login`, as shown in Figure 27.
9. The LHS project tree if expanded would look like shown in Figure 27.
10. Right-click on `Login WS`, and select “Add Operation...” and create a web method `login()`, as shown in Figure 29.
11. After the web method `login()` appears as a stub inside the `Login` class with `return false;` by default. For quick unit testing of the new method, implement it with some test

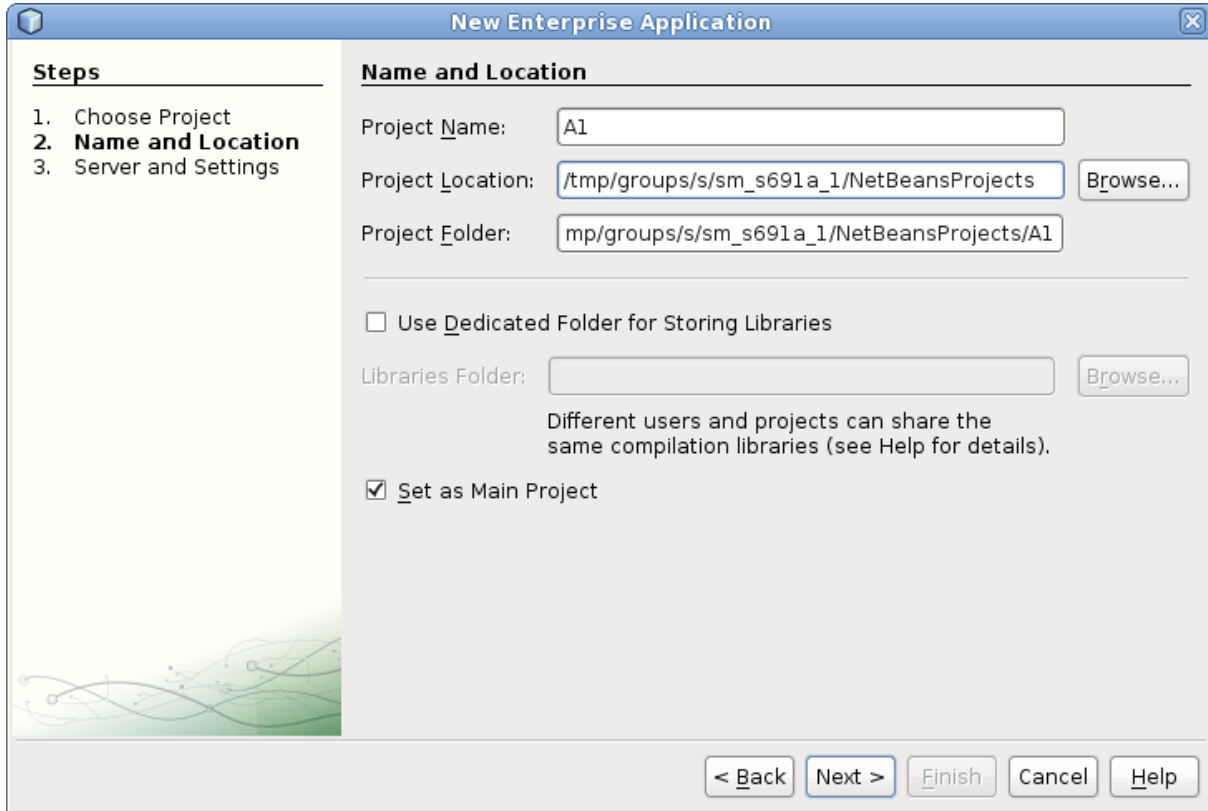


Figure 24: NetBeans Programming Projects Location

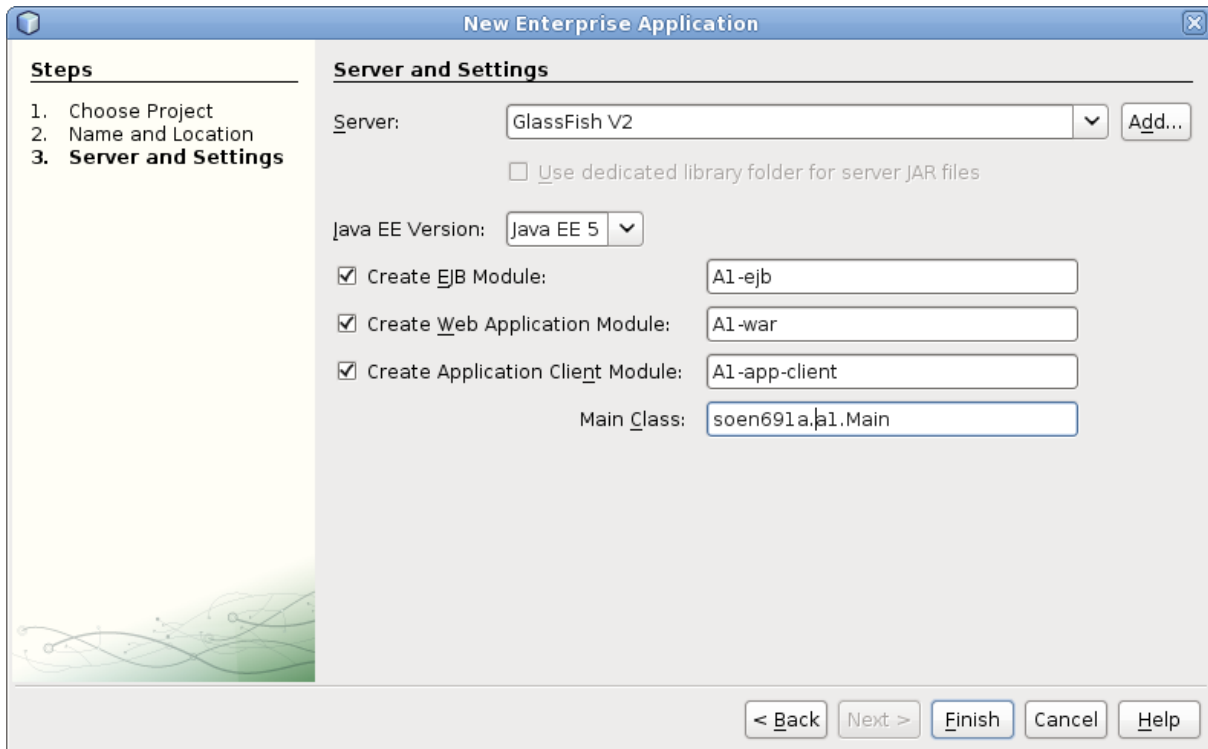


Figure 25: A1's Example Server and Client Settings



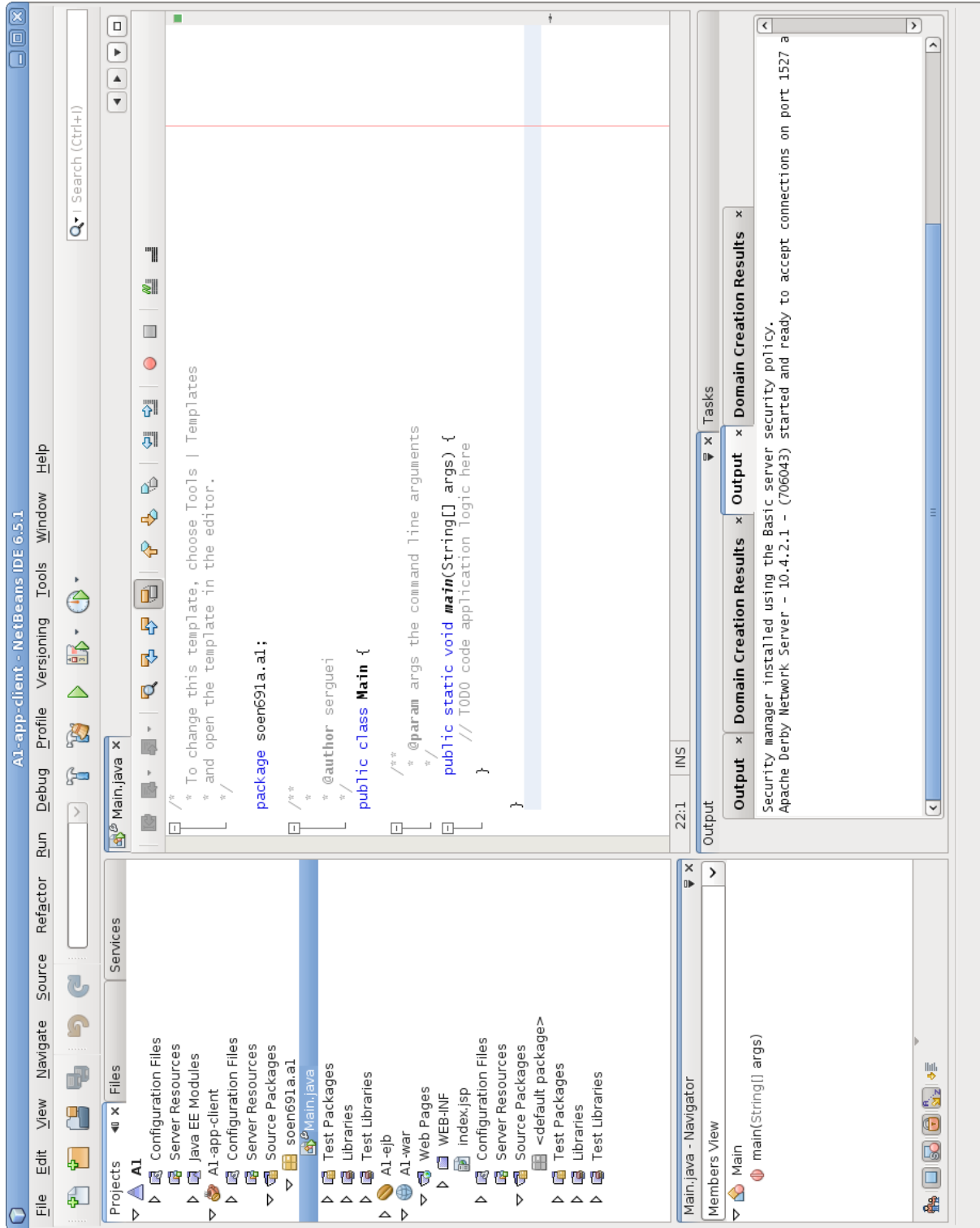


Figure 26: A1 Project Tree

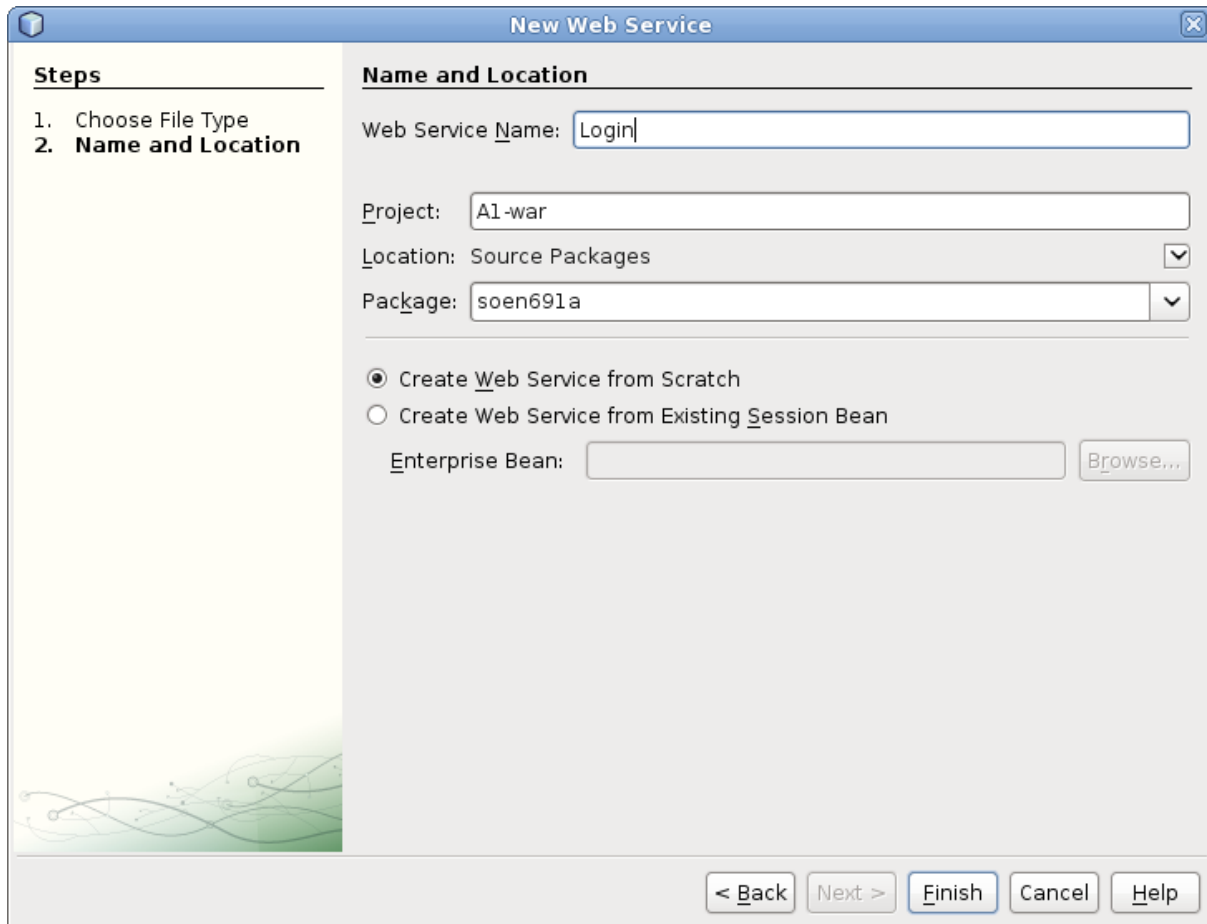


Figure 27: New Login Web Service

user name and password as shown in Figure 30, which will later be replaced to be read from the XML file.

12. Perform a simple unit test for the web method. Your GlassFish must be running and you have to “start” your project by deploying – just press the green angle “play” button. You should see a “Hello World” page appearing in your browser.
13. Then, under “A1-war” → “Web Services” → “Login” right-click on **Login** and select “Test Web Service”. It should pop-up another browser window (or tab) titled something like “LoginService Web Service Tester” with a pre-made form to test inputs to your web method(s), as shown in Figure 31.
14. Fill-in the correct test values that we defined earlier for login and press the “login” button. Observe the exchanged SOAP XML messages and the **true** value returned as a result, as shown in Figure 32.

Then try any wrong combination of the username and password and see that it returns **false**. This completes basic verification of your web service – that is can be successfully deployed and ran, and its method(s) unit-tested on the page.

15. Java-based callee of a web service has to be defined e.g. as a WS client, as shown

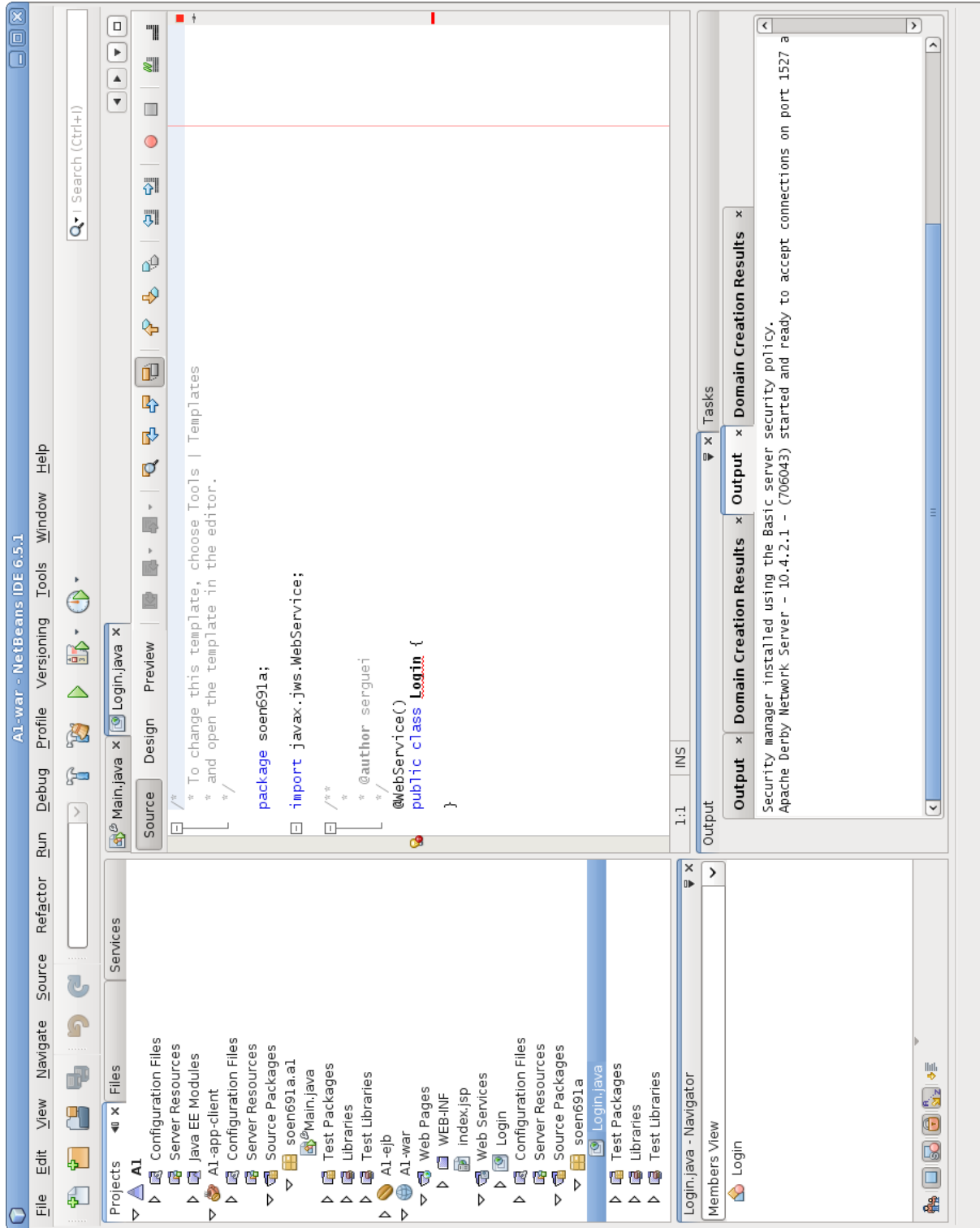
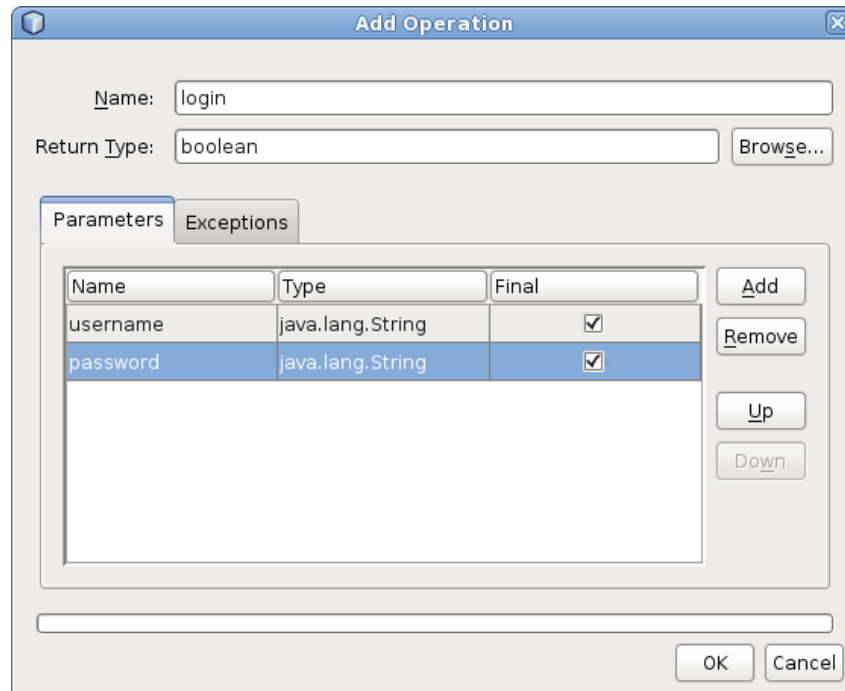


Figure 28: A1 Project Tree after Login Web Service Creation

Figure 29: Adding a Web Method `login()`

in earlier screenshots as “A1-app-client”, which has a `Main.main()` method. In that method you simply invoke the desired service by calling its web method after a number of instantiations. It may look like you are calling a local method of a local class, but, in fact, on the background there is a SOAP message exchange, marshaling/demarshaling of data types, etc. and actually connection to a web service, posting a request, receiving and parsing HTTP response, etc. all done by the middleware.

Steps:

- Right-click “A1-app-client” → “New” → “Web Service Client”. A dialog shown in Figure 33 should appear. Click “Browse”.
- Select your web service to generate a reference client for, as e.g. shown in Figure 34 and click “OK”.
- Having selected the service to generate the WS client code for, you should see the URL, as shown in Figure 35 “Finish”, re-deploy (green “Play” button).
- Then, in `Main`, import the generated code classes to invoke the service, as shown in Listing 1.

See also an example from DMARF [Mok06].

- Sometimes your ports for HTTP and HTTPS can be different from your home machine or multiple installations and a lab machine. You can synchronize the ports in the client side by expanding “Web Service References” and the first node of a service in question, e.g. “LoginService”, then doing right-click it → “Edit Web Service Attributes” → “Wsimport Options” → “wsdlLocation” – and fix the port number in the URL. Then click “OK”, and “Clean and Build” (and “Deploy” if necessary) the whole client project.

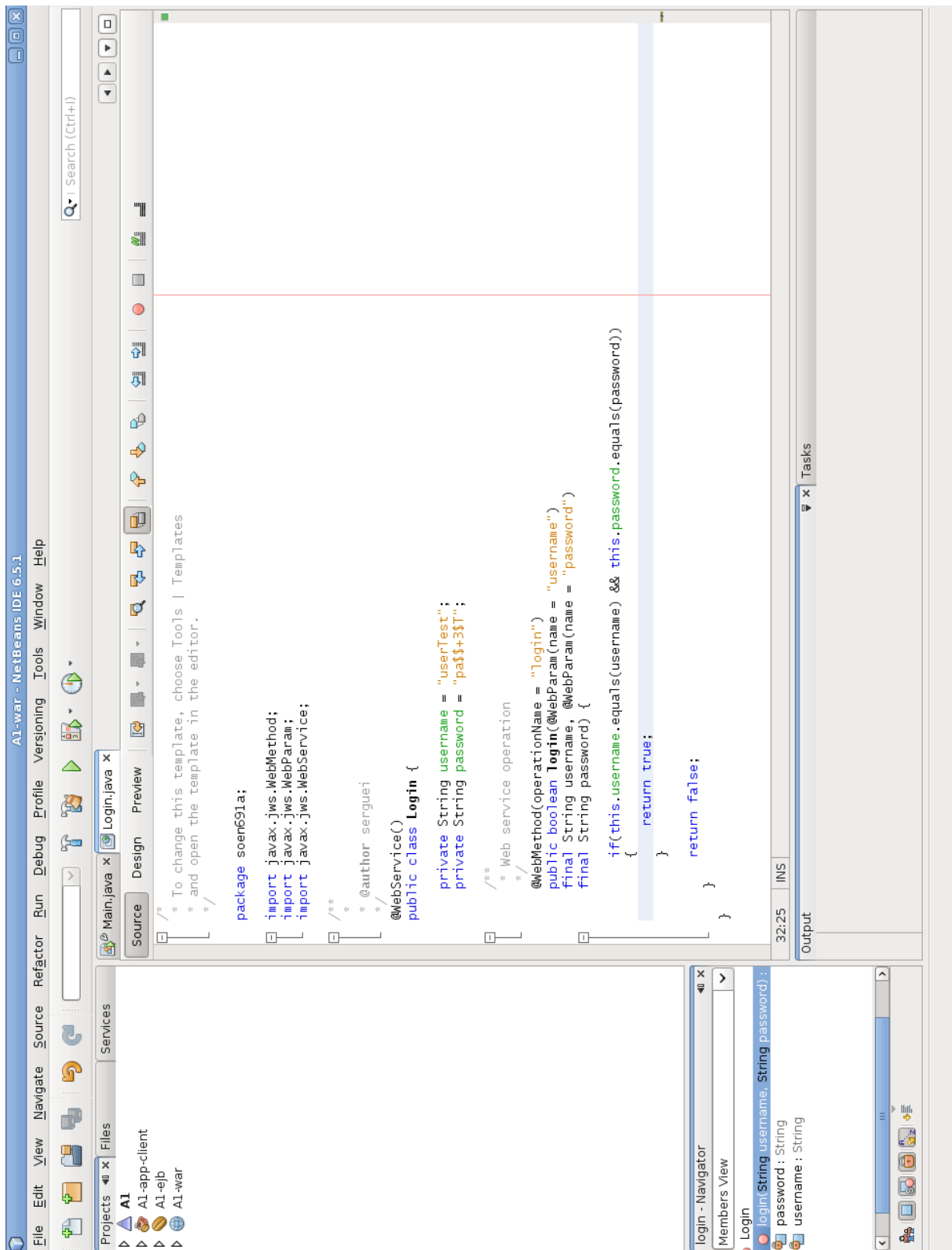


Figure 30: Implementing a Simple Web login() Method for Quick Unit Testing



Figure 31: Unit-testing Page for the Login WS

```

package soen691a.a1;

import soen691a.Login;
import soen691a.LoginService;

/**
 * @author serguei
 */
public class Main {

    /**
     * @param args the command line arguments
     */
    public static void main(String[] args) {
        LoginService service = new LoginService();
        Login login = service.getLoginPort();

        //...
        // Must be false
        boolean success = login.login("wrongusername", "wrongpassword");
        // Must be false
        success = login.login("wrongusername", "pa$$+3$T");
        // Must be false
        success = login.login("userTest", "wrongpassword");
        // Must be true
        success = login.login("userTest", "pa$$+3$T");
        //...
    }
}

```

Listing 1: Invoking a Web Service from a Plain Java Class

Method invocation trace - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://localhost:8107/A1-war/LoginS

## login Method invocation

---

### Method parameter(s)

Type	Value
java.lang.String	userTest
java.lang.String	pa\$\$+3\$T

---

### Method returned

boolean : "true"

---

### SOAP Request

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Header/>
  <S:Body>
    <ns2:login xmlns:ns2="http://soen691a/">
      <username>userTest</username>
      <password>pa$$+3$T</password>
    </ns2:login>
  </S:Body>
</S:Envelope>
```

---

### SOAP Response

```
<?xml version="1.0" encoding="UTF-8"?>
<S:Envelope xmlns:S="http://schemas.xmlsoap.org/soap/envelope/">
  <S:Body>
    <ns2:loginResponse xmlns:ns2="http://soen691a/">
      <return>true</return>
    </ns2:loginResponse>
  </S:Body>
</S:Envelope>
```

Done

Figure 32: login() Web Method Invocation Trace

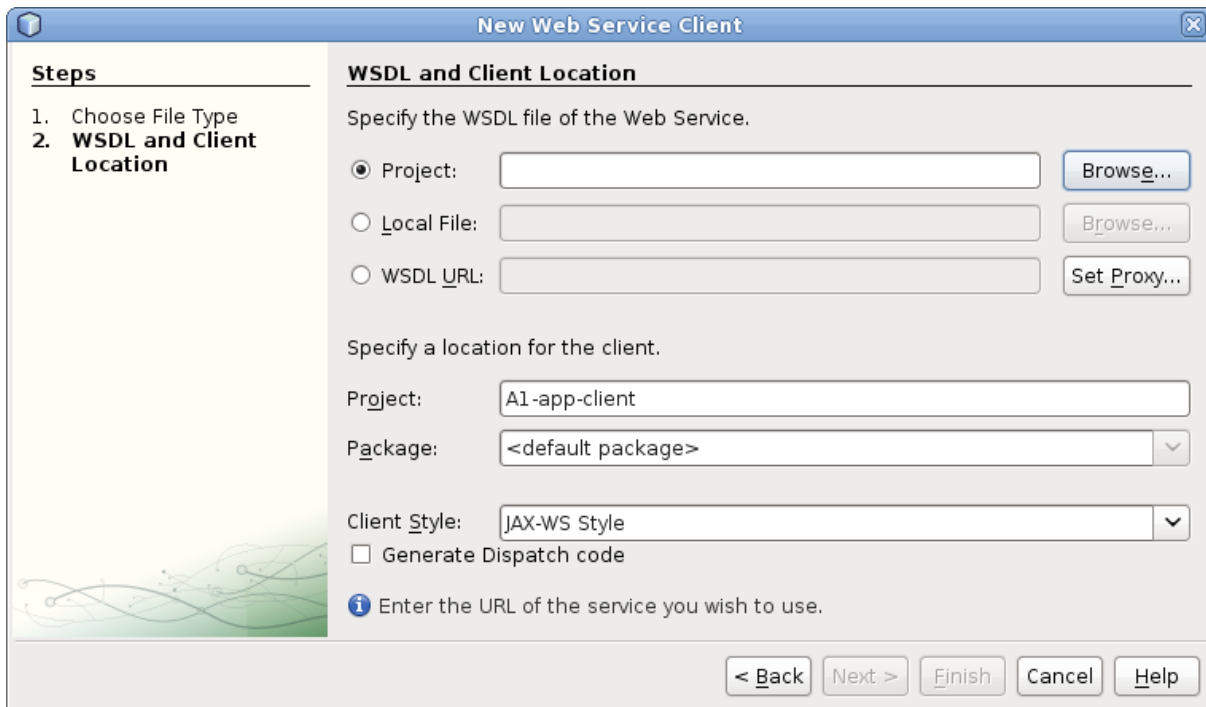


Figure 33: Creating a New Web Services Client in the Client Application Package from a Project

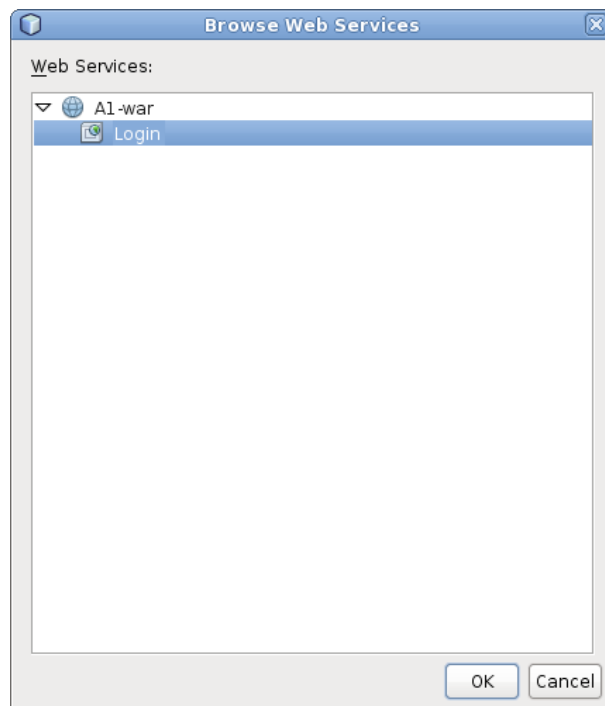


Figure 34: Selecting the Service to Create a Client For from the Project



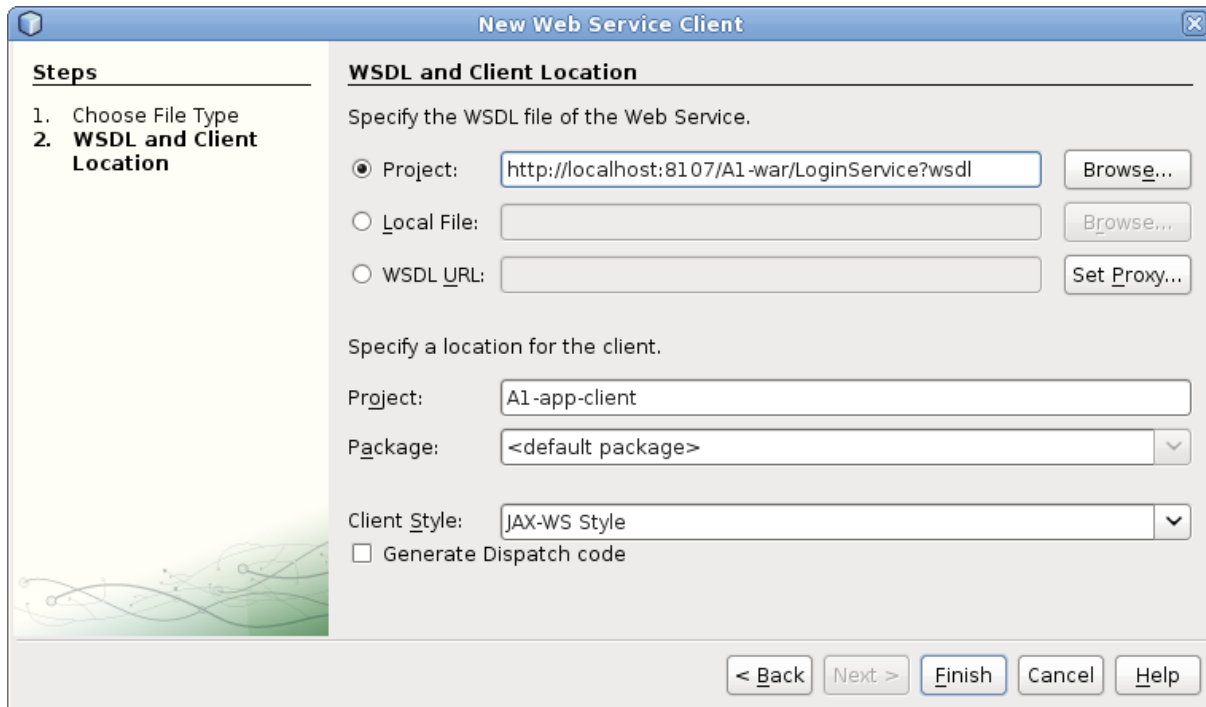


Figure 35: Creating a New Web Services Client Nearly Done. Notice the URL

17. Relative path for loading XML can be found using `System.getProperty("user.dir")` to find out your current working directory of the application, which is actually relative to the `config/` subdirectory in your personal domain folder, so it would be based on your deployment, but roughly:

```
System.getProperty("user.dir") + "../generated/...../users.xml"
```

where “.....” is the path leading to where your `users.xml` and others actually are. You can configure Ant’s `build.xml` (actually `build-impl.xml` and other related files for deployment to copy your XML data files into `config/` automatically.

18. Loading and querying XML with SAX is exemplified in `TestNN` with MARF [CMt14, The14], specifically at these CVS URLs:

```
http://marf.cvs.sf.net/viewvc/marf/apps/TestNN/
```

```
http://marf.cvs.sf.net/viewvc/marf/marf/src/marf/Classification/NeuralNetwork/
```

Do not validate your XML unless you specified a DTD schema (not necessary here), just make sure your tags are matching, properly nested, and closed.

## 12 Conclusion

Please direct any problems and errors with these notes or any other constructive feedback to [mokhov@cse.concordia.ca](mailto:mokhov@cse.concordia.ca).

## 12.1 See Also

- GlassFish website [Sun09a].
- Unix/Linux commands [Mok05].
- ENCS help: <http://www.encs.concordia.ca/helpdesk/>.
- An example of the XML parsing application, TestNN with MARF [CMt14, The14] using the built-in SAX parser.

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