



@enterprise 11.0

Application Development Guide

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1. Overview

This guide explains the creation of workflow applications with *@enterprise* that also offers a set of demos combined in the file *demos.zip* within the *doc/examples* folder of *@enterprise* base folder (either *base* in a standalone installation or *WEB-INF* in an application server installation). Within this compressed file an MS Word file called *Demos.docx* is available which gives an overview about the demo programs.

2. Servlet Methods

This chapter contains the description how to write methods for Web applications - receiving input from the browser and writing out to it. Moreover the authorization mechanism is discussed and some utilities for building HTML components are presented. *@enterprise* is a Web-based system with an integrated Web-server. The interface between the Web server and the rest of the system is a set of servlets.

For the application programmer a convenient interface is provided to write "servlet methods". These methods must have one of the two following signatures:

```
public void methodX (HttpServletRequest req, HttpServletResponse res)
    throws Exception;
```

```
public Page methodY (HttpServletRequest req) throws Exception;
```

`HttpServletRequest` and `HttpServletResponse` are interfaces from the package `javax.servlet.http` (see the Documentation of J2EE [1]). The return value `Page` represents a page sent to the browser and is described below.

The methods are called from the dispatcher servlet of *@enterprise* via reflection. The URL schema is as follows:

```
http://<host>:<port>/<contextpath>/servlet.method/appclass.appmethod?params
```

`appclass` is the fully qualified name of the class containing the method `appmethod`.

`appmethod` is a method having one of the two above signatures.

What is the reason for two interfaces to write servlet methods? The first interface is the more general, because it allows to write directly onto the output stream of the response. It is the same as writing a `doGet` or `doPost` method of a servlet. However, the second method signature has some advantages:

- It is explicit, that a return value (the page sent to the browser) is necessary.
- The page is sent to the browser, after the method has been completed, and a commit has been performed. This prevents sending half pages when an error occurs.
- `Page` is an interface which can have several implementations with extended functionality, read below about `HTMLPage`, `ActionPage`, and `XHTMLPage`.

The limitation of this approach is that you cannot set Header-Fields of the HTTP-Response, for example Cookies. The following section contains a more detailed description of the *@enterprise* Dispatcher.

2.1 The Dispatcher Servlet

The Dispatcher servlet handles all requests starting with `"/<contextpath>/servlet.method/"`. `<contextpath>` is the context where you have installed *@enterprise* when using an application server, in standalone mode it is the constant `wf`. The Dispatcher performs the following steps:

1. Load the session of this request.
2. If there is no session and the method is not public, call the `sendLoginRequest` method of the authorization class.
3. Call the method specified in the URL by loading the class and calling the method using reflection.
4. If the method terminates normal (without exception) the user transaction associated with this thread is committed and the page together with a HTTP header is sent to the browser.

If the method terminates with an exception, a rollback is performed on the user transaction and an error page is sent to the browser.

The distinction of public, nonpublic and administration methods works via the annotation `com.groiss.servlet.Access` (see section [Defining the access mode](#) for more information).

It can be attached to a package, class or method. The `Access.mode` is either public (everybody has access), or user (logged in users have access), or admin (= part of the administration). When using public methods the internationalization is done with the settings of the *@enterprise* user *guest*.

2.2 Mapping of URLs to files or methods

In this section we explain how an HTTP request is interpreted by *@enterprise*. But let us first briefly step over the components of an URL:

`<protocol>://<host>:<port>/<path>?<query>`

e.g.:

`http://www.groiss.com:80/wf/servlet.method/a.b.c?oid=24323&time=3254777`

The protocol (http) states the set of rules which govern the communication between client and server place. The host is the name or ip-address of the machine (www.groiss.com). The port (80) is a specific transport endpoint within the machine. Together these three components specify a service, which is an *@enterprise* installation in our case.

The path (`/wf/servlet.method/a.b.c`) refers to a resource within the service. By interpreting this path, the service searches for resources internal to the service. Typical resources are static files and dynamic content generated by program code. The parameters (`oid=24323&time=3254777`) can be used by the service to customize the resource.

Using and referencing URLs

We do not deal with the protocol, host and port components of a URL, since we should never reference to them within the same *@enterprise* installation. Further, in *@enterprise* as well as in application servers, all URL paths start with the context root. In a standalone installation this is always `"/wf"`. When *@enterprise* runs within an application server the context root is specified during deployment.

When specifying URLs, adhere to the following rule:

Do not use an absolute URL when you are referring to resources within the same engine (deployment context). In other words:

- do not include the protocol (`http://`)
- do not include the host name
- do not include the port
- do not include the context root
- do not include the slash following the context root

in your URLs.

By obeying this rule, we gain deployment transparency within the server. The browsers are responsible for constructing the absolute URL from the relative ones. In case of doubt, use the status line of the browser to determine the constructed path.

Mapping of the URL path to a resource within *@enterprise*

When the part of the path after the context root is `/servlet.method`, then the Dispatcher servlet is responsible for dealing with the URL. This is described in the section [The Dispatcher Servlet](#).

Any string different from `/servlet.method` is handled by the FileServlet, which is responsible for locating the file specified in the URL path and for proper internationalization of those files.

Since there may be files which are independent of the language, the FileServlet distinguished two cases:

a) language independent files

For addressing language independent files, the string `/alllangs` follows the context root. The files are searched in the classpath including the `alllangs` prefix.

Example: The classpath consists of two components:

- a directory `/home/firstappl/classes`
- followed by a jar file `lib/secondappl.jar`

When resolving the URL

`http://myhost:8000/wf/alllangs/dir/text.html`

the FileServlet first tries to locate the file by accessing `alllangs/dir/text.html` starting from the directory `/home/firstappl/classes`. If successful, the file is returned. If the file could not be found in the first component of the class path, then the next component is searched, and so on. In the example the FileServlet tries to locate the file by searching for `alllangs/dir/text.html` within the jar file `lib/secondappl.jar`.

Hint: Since *@enterprise* version 8.0 images are stored in the `lang` instead of the `alllangs` folder.

b) language dependent files

When a string different from `"/alllangs"` follows the context root, the FileServlet interprets the file as language dependent, for which the FileServlet supports two mechanisms:

1. The file has already been translated for the different locales, and the translations have been stored in separate directories.
2. There is just one file (a template containing special labels) which is translated on-the-fly when the file is loaded.

Because a locale can contain language, country and variant, the search path is implicitly extended by

1. `lang/<language>_<country>_<variant>/`
2. `lang/<language>_<country>/`
3. `lang/<language>/`
4. `lang/default`

in this order.

If the file can not be found, an untranslated template is searched by extending the path with

5. `alllangs/`

If the file is found in steps 1, 2, 3 or 4 it is sent to the browser unchanged, if it is found during step 5 it is translated on-the-fly (see following subsection).

Note that each of the steps means to search within all the components of the classpath.

Example: The classpath consists of two components:

- a directory `/home/firstappl/classes`
- followed by a jar file `lib/secondappl.jar`

When resolving the URL

`http://myhost:8000/wf/dir/text.html`

and the locale is `en_US`, the file is searched in the following locations (since the locale has no variant, the search starts at step 2):

2. Servlet Methods

2. `/home/firstappl/classes/lang/en/US/dir/text.html`
`lib/secondappl.jar!lang/en/US/dir/text.html`
3. `/home/firstappl/classes/lang/en/dir/text.html`
`lib/secondappl.jar!lang/en/dir/text.html`
4. `/home/firstappl/classes/lang/default/dir/text.html`
`lib/secondappl.jar!lang/default/dir/text.html`
5. `/home/firstappl/classes/alllangs/dir/text.html`
`lib/secondappl.jar!alllangs/dir/text.html`

Because the files are searched in all the components of the classpath, it is highly advisable to use different prefixes for the files of different applications.

2.3 Page

The interface `com.groiss.gui.Page` describes a page sent to the browser with the following defined methods:

```
public String show();  
public String getContentType();  
public List<Pair<String, Object>> getHeaders();
```

The method `show` returns a `String` representation of the page and is normally called by the `Dispatcher`.

The method `getContentType()` returns the mime-type of the page, for example `"text/html"`.

The method `getHeaders()` returns the list of `http-response-headers` to be set on the `javax.servlet.http.HttpServletResponse`.

The interface is implemented by the following classes:

HTMLPage: Used for HTML pages where a fixed template is loaded and the dynamic parts are substituted from a Java method. See section [HTMLPage](#) for details.

ActionPage: The action page is used for HTML pages containing JavaScript code only, for example a command for closing the browser window.

XHTMLPage: The `XHTMLPage` is used for XHTML and XForm pages. XHTML is a reformulation of HTML in XML. The advantage of using XML is that substitutions of XML structures are possible, see section [XHTMLPage](#). An example how an `XHTMLPage` is used in XForms is shown in section [9.2](#).

VelocityPage: Implementation which can handle Velocity-templates. See section [Velocity Page](#) for details.

JSONPage: This implementation is used to send JSON data to the client, e.g.

```
JSONPage p = new JSONPage(new JSONObject(new HashMap(){{ put("a","b");}}));
```

Of course, application programmers can define their own implementations of the Page interface. In this case please ensure that the following imports are available within the HEAD-tags:

```
<link rel="stylesheet" type="text/css"
      href="../../servlet.method/com.groiss.gui.css.StyleConf.loadCSS" />
<script src="../../scripts/dojo/dojo.js" djConfig="parseOnLoad: true">
</script>
```

2.4 HTMLPage

When showing HTML pages with dynamically generated content, it is useful to separate the fixed HTML code and the parts generated by the program.

Different approaches exist here. The most popular are Active Server Pages (ASP) from Microsoft and Java Server Pages, part of the Java 2 Enterprise Edition (J2EE). In both frameworks you have to write the code into the HTML pages. Whereas this mechanism is nice for prototyping it has some drawbacks:

- Long HTML/code pages are developed, where the design of the page is hard to see and maintain.
- The placement of utility methods, constants or static variables is unclear.
- Development in an IDE.
- Internationalization of code and HTML text.

In *@enterprise* a different approach is used. The HTML pages contain placeholders that are replaced with actual data at run-time. Replacements are done with the class `HTMLPage` which provides the following constructors and methods:

Constructors:

- `public HTMLPage()`
No parameters: An empty page is generated, set the content of the page with `setPage(String)`.
- `public HTMLPage(String resource)`
The parameter is the name of a resource, normally a file in the class path.
- `public HTMLPage(String resource, Resource res)`
The parameter *resource* is the name of a resource, normally a file in the class path.
The parameter *res* is an explicit resource bundle.

Methods:

- `setPage(String s)`: Allows to set the content of the page.
- `substitute(String field, Object value)`: The placeholder field is substituted by the given value.

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- `substEncoded(String field, String value)`: Analog to `substitute`, but the value will be HTML encoded.
- `showPage()`: Returns the page as string.
- `getContentType()`: Returns the content type and if not set, the value "text/html" is returned.
- `setContentType(String type)`: Allows to set the content type of the page.
- `getHeaders()`: Returns the HTTP headers of the page.
- `addHeader(String header, Object value)`: Allows to set a header field in the response before writing the page.

The class `HTMLPage` is normally used in the following steps:

1. Use the constructor to load the mask,
2. make multiple calls of `substitute` to replace the placeholders,
3. return the page to the Dispatcher.

Example: The method `showNLSDate` can be rewritten using `HTMLPage`.
HTML-mask:

File **classes/demo/masks/date.html**

```
<html><body>
Date in %format% format in %language%:<br>
%date%
</body>
</html>
```

Placeholders start and end with a "%" character. The Java-method now looks like:

File **classes/com/groiss/demo/HttpDemo.java**

```
public Page showNLSDate2(HttpServletRequestResponse res) throws Exception {
    String language = req.getParameter("language");
    String format = req.getParameter("format");
    Locale l = new Locale(language, language);
    HTMLPage p = new HTMLPage("demo/masks/date.html");
    SimpleDateFormat df = new SimpleDateFormat(
        ("long".equals(format) ?
         "EEEE, MMMM dd, yyyy" : "EEE, MMM dd, yyyy"), l);
    p.substitute("format", format);
    p.substitute("language", language);
    p.substitute("date", df.format(new Date()));
    return p;
}
```

2.5 XHTMLPage

XHTML is a reformulation of HTML in XML, it has been defined and published by the W3C (World Wide Web Consortium), see their Web page [2] for details.

Analogous to the `HTMLPage` an additional class `XHTMLPage` has been defined based on XHTML with extended functionality:

- Every XML element with an "id" can be substituted. Therefore, whole parts of the page can be substituted, for example a table element. Making an element invisible is performed by substituting with `null`.
- It is possible to change elements by setting attributes, for example the background color or the value in an input field.
- It is possible to make the substitutions more than once or not at all. In the page there is a default value (element). A substitution is done when necessary. Multiple substitutions can be performed, because the result of the substitution is again an XML tree.

However, the usage of the XML components has some drawbacks. Only XML elements can be substituted or changed: It is not possible to substitute a part of a URL (for example to fill in an object's oid). Note, that the templates must be syntactically correct XML. For example, a "<" (less) character in JavaScript must be written as `<`;

Hint: Since *@enterprise 8.0* it is not possible to write HTML code directly on a page, but sometimes it is necessary that HTML code should be interpreted. For this purpose the class *ProcessingInstruction* can be used like in following example:

XHTML-mask snippet:

```
<table class="simple" width="100%">
  <tr><td width="120px">Name: </td><td><span id="name"/></td></tr>
  <tr><td valign="top">Description: </td><td><span id="descr"/></td></tr>
</table>
```

Java method snippet:

```
XHTMLPage page = new XHTMLPage("mask/MyXHTMLPage.xhtml");
page.get("name").setContent("MyText");
ArrayList l = new ArrayList();
l.add(new org.jdom2.ProcessingInstruction(Result.PI_DISABLE_OUTPUT_ESCAPING, ""));
l.add("<b>This text</b> should be displayed in bold letters");
l.add(new org.jdom2.ProcessingInstruction(Result.PI_ENABLE_OUTPUT_ESCAPING, ""));
page.get("descr").setContent(l);
```

2.6 Velocity Page

Velocity is a Java-based template engine. It permits web page designers to reference methods defined in Java code. Web designers can work in parallel with Java programmers to develop web sites according to the Model-View-Controller (MVC) model, meaning that web page designers can focus solely on creating a well-designed site, and programmers can focus solely on writing top-notch code. For more details take a look on [page](#).

For this purpose *@enterprise* provides the class *com.groiss.gui.VelocityPage* (see *@enterprise* API Doc for details).

Example: Using and setting variables in a velocity page.

First an HTML page (template) should be created (it is also possible to use ordinary text-files):

```
...
<h4>Current Threaduser of reserved variable and set by JAVA</h4>
Threaduser: $user / $username_by_java

<p/>

<h4>List all users</h4>
#foreach($u in $users)
    $u<br/>
#end

<p/>

<h4>Simple IF-selection for variable str</h4>
#if($str != 'str')
    $str
#end

<p/>

<h4>Read request parameter</h4>
$request.getParameter('vpparam')

<p/>

<h4>Read configuration parameter</h4>
$Configuration.get().getProperty('avw.license')
...
```

Afterward a JAVA method must be written to fill template variables:

```
public Page getVelocityPage(HttpServletRequest req) throws Exception {
    VelocityPage vp = new VelocityPage("masks/velocitypage.html");
    //set current thread user
    vp.set("username_by_java", ThreadContext.getThreadPrincipal());
    //list all users
}
```

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```
vp.set("users",Store.getInstance().list(User.class));
//set variable
vp.set("str","MyString");
return vp;
}
```

Finally call the JAVA method by entering following URL:

```
http://<host>:<port>/<contextpath>/servlet.method/
myClass.getVelocityPage?vpparm=myreqparam
```

2.7 File Upload

On the client side, the client's browser must support form-based upload (most modern browsers do).

File **classes/alllangs/demo/fileform.html**

```
<!DOCTYPE html>
<html>
<head>
<link href="../../../servlet.method/com.groiss.gui.css.StyleConf.loadCSS"
rel="stylesheet" type="text/css"></link>

<script type="text/javascript" src="../../../scripts/dojo/dojo.js"
data-dojo-config="parseOnLoad: true,async:true"></script>
<script>
require(
["dojo/ready","dojo/parser","ep/widget/FileInput"],
function(ready) {}
);
</script>
</head>
<body class="claro">
<form enctype="multipart/form-data" method="post"
action="../../../servlet.method/com.groiss.demo.HttpDemo.viewFile">
<div data-dojo-type="ep/widget/FileInput" name="mptest"></div><br/>

<input type="submit" class="ep_button">
</form>
</body>
</html>
```

The DOJO widget "FileInput" brings up a button for a file select box on the browser together with a text field that takes the file name once selected.

When the user clicks the "Submit" button, the client browser locates the local file and sends it using HTTP POST, encoded using the MIME-type multipart/form-data. When it reaches your servlet, your servlet must process the POST data in order to extract the encoded file. You can learn all about this format in RFC 1867, [3].

There is no method in the Servlet API to do this. The *@enterprise* API provides the class `com.groiss.servlet.MultipartRequest` to handle multipart/form-data requests.

The file(s) are stored in temporary files in the file system of the server. The following method shows how to access to these files:

File `demo/com/groiss/demo/HttpDemo.java`

```
public void viewFile(HttpServletRequest req, HttpServletResponse res)
    throws Exception {
    MultipartRequest r = MultipartRequest.createInstance(req);
    File tmpfile = r.getFile("mptest");
    String str = FileUtil.getContent(tmpfile);
    int i = 1;
    PrintWriter w = res.getWriter();
    w.println("<html><body>remote name: " + r.getRemoteFileName("mptest") + "<pre>");
    for (StringTokenizer st = new StringTokenizer(str, "\r\n"); st.hasMoreTokens();) {
        w.println(Integer.toString(i++) + st.nextToken());
    }
    w.println("</pre></body></html>");
}
```

The method writes the content of the file to the browser together with a line number. The class `MultipartRequest` is a wrapper around the `HttpServletRequest` and provides some other useful methods (see *@enterprise* APIDoc for more details) like the following most important:

```
public abstract void addParameter(String name, String value);
public abstract void removeParameter(String name);
public abstract Cookie getCookie(String id);
```

`addParameter` adds a parameter name-value pair to the request; this can be used when calling servlet methods from other servlet methods.

`removeParameter` removes a parameter.

`getCookie` allows direct access to a cookie without iterating over the cookie array.

Note, that you have to call the `createInstance` method of `MultipartRequest` before you call any method of the `ServletRequest` that reads the parameters or content of the request.

2.8 Authorization

@enterprise allows the implementation of customer defined authorization schemes. The authorization class must implement the following interface:

```
public interface HttpAuth {
    public void sendLoginRequest(HttpServletRequest req,
        HttpServletResponse res) throws Exception;
    public Principal checkUser(String user, String passwd,
        String clientAddr) throws Exception;
```

2. Servlet Methods

```
default public void logoutRedirect (HttpServletRequest req,  
    HttpServletResponse res) throws Exception;  
}
```

Figure 2.1 shows the interaction during the authorization phase.

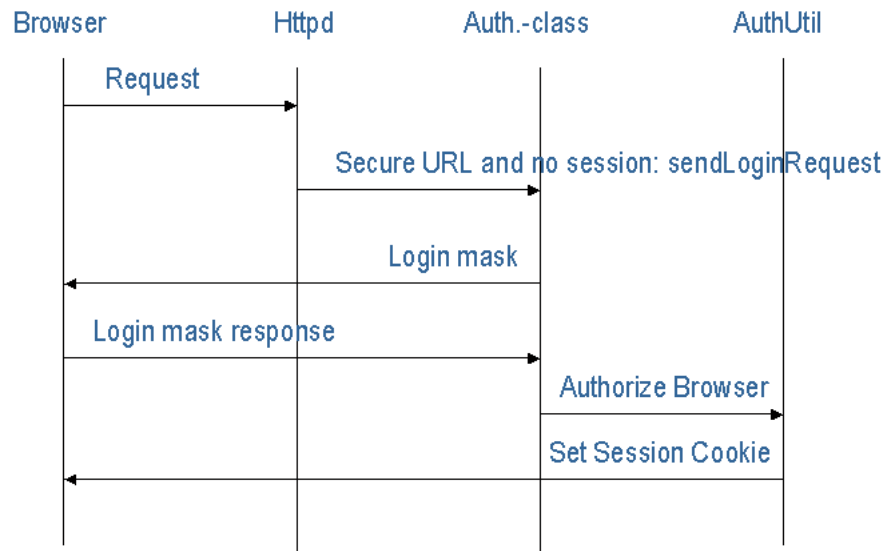


Figure 2.1: **Authorization**

As described in section [The Dispatcher Servlet](#), the Dispatcher calls the `sendLoginRequest` method of the authorization class. This class either sends a login page to the browser or performs another action for finding out the user of the client. After it found out the user it should call the method `authorizeBrowser` of `AuthUtil` which sends the session cookie to the browser.

The following examples show two implementations of the interface. The first one - `BasicPasswdAuth` - uses the basic Authorization of the HTTP protocol:

File **com/groiss/demo/BasicPasswdAuth.java**

```

public class BasicPasswdAuth implements HttpAuth {

    private static final Logger logger = LoggerFactory
        .getLogger(BasicPasswdAuth.class);

    public void sendLoginRequest(HttpServletRequest req, HttpServletResponse res)
        throws Exception {
        String auth= req.getHeader("Authorization");
        if (auth != null && auth.startsWith("Basic ")) {
            auth = auth.substring(6);
            auth = new String(Base64.decode(auth));
            String userId = auth.substring(0,auth.indexOf(':'));
            String passwd = auth.substring(auth.indexOf(':')+1);
            try {
                User u = (User)checkUser(userId,passwd,req.getRemoteAddr());
                AuthUtil.authorizeBrowser(req, res, u, req.getRequestURI() +"?" +
                    req.getQueryString());
                return;
            } catch (Exception e) {
                logger.error(null,e);
            }
        }
    }
}
  
```

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```
        }
    }
    res.setStatus(401);
    res.addHeader("WWW-Authenticate", "Basic realm=\"%enterprise\"");
    res.getWriter().println();
}

public Principal checkUser(String userId, String passwd, String clientAddr)
    throws Exception {
    return AuthUtil.checkUser(userId, passwd, clientAddr);
}
}
```

The method `sendLoginRequest` sends the status 401 (Not Authorized) to the client, which will open a login window and sends the login information to the server (base64 encoded user name and password). This information is used for checking the user and generating the session cookie.

The second example uses the login mask from the default `com.groiss.org.PasswdAuth` class, but rewrites the user checking mechanism. The method `checkWinPassword` connects to a host with an FTP server and tries to login there. If it succeeds, the user is also authorized in *@enterprise*.

File `com/groiss/demo/WinPasswdAuth.java`

```
public class WinPasswdAuth extends PasswdAuth {
    static String winhost = Configuration.get().getProperty("windows.server");

    @Override
    public Principal checkUser(String userId, String passwd, String clientAddr)
        throws Exception {
        User user;
        // don't connect to the database when sysadm
        if (AuthUtil.equalUserIds(userId, "sysadm")) {
            return AuthUtil.checkUser(userId, passwd, clientAddr);
        } else {
            user = OrgData.getInstance().getById(User.class, userId);
            if (user == null) {
                throw new ApplicationException(122);
            }
            checkWinPassword(userId, passwd);
        }
        return user;
    }

    /** Try to make a ftp connection to auth host
     */
    private void checkWinPassword(String userId, String passwd) throws Exception {
        try {
            URL url = new URL("ftp://" + userId + ":" + passwd + "@" + winhost + "/");
        }
    }
}
```


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```
URLConnection urlc = url.openConnection();
try (InputStream is = urlc.getInputStream()) {
    //no need to read from stream - no exception indicate
    //that credentials are correct
}
} catch (Exception e) {
    throw new ApplicationException(
        "Authentication on host "+winhost+" failed for user "+userId);
}
}
```

An alternative is the function `AuthUtil.authorizeBrowser(req, res, user)` which does not send a redirect to the browser. It creates a session and returns it to the caller. A null return value indicates success, a non-null value is a page that should be written back to the browser of the caller. It is the caller which is responsible for initiating the appropriate method after the `authorizeBrowser` call, e.g. like in the following sketch to use within a `sendLoginRequest` method:

```
String answer = AuthUtil.authorizeBrowser(req, res, u);
if (answer != null) { // might produce an error message
    res.getWriter().println(answer);
    return;
} else {
    String p = req.getServletPath()+req.getPathInfo();
    RequestDispatcher dispatcher = req.getRequestDispatcher(p);
    dispatcher.forward(req, res);
}
```

@enterprise provides an API for `UserSession` specific assignments of roles, c.f. methods in `OrgData` interface:

- `public void addRoleToSession(Role r, OrgUnit ou);`
- `public void removeRoleFromSession(Role r, OrgUnit ou);`
- `public boolean hasRoleInSession(Role r, OrgUnit ou);`
- `public void removeAllRolesFromSession();`

The additional roles are taken into account by these methods and by the permission checking system. The roles assigned to a user in the usual way are not altered in any way. To use this feature during login, the authorization class must implement the interface `com.groiss.org.LoginListener` as shown in following example. In this example the user agent is read from request and depending on it the appropriate role is assigned in method `afterLogin`. In a production environment instead of a user agent other criteria are more reasonable to determine which role should be assigned (e.g. the IP address). Furthermore 2 methods are part of the example to check, if role is part of user session or to remove it (or all roles) from user session.

```
public class TestAuth extends PasswdAuth implements LoginListener {

    private final static Logger logger = LoggerFactory.getLogger(TestAuth.class);
```

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```
private final OrgData od;
private final Role firefox;
private final Role ie;
private final OrgUnit ou;
private final Role sys;

public TestAuth() {
    od = OrgData.getInstance();
    firefox = od.getById(Role.class, "firefox");
    ie = od.getById(Role.class, "ie");
    sys = od.getById(Role.class, "sys");
    ou = od.getById(OrgUnit.class, "GI");
}

@Override
public Principal checkUser(String userId, String passwd, String clientAddr)
    throws Exception {
    return AuthUtil.checkUser(userId, passwd, clientAddr);
}

@Override
public void afterLogin(IUserSession us){
    logger.info("##### afterLogin #####");
    HttpServletRequest req = ThreadContext.getRequest();
    String userAgent = StringUtil.noNull(req.getHeader("User-Agent"));
    logger.info("User agent: " + userAgent);
    if(userAgent.contains("Firefox")){
        od.addRoleToSession(firefox, null);
    } else if(userAgent.contains("Trident")) { //IE11
        od.addRoleToSession(ie, ou);
    } else {
        od.addRoleToSession(sys, null);
    }
}

@Override
public void afterLogout(IUserSession us){
    logger.info("##### afterLogout #####");
    logger.info("Login-Date: " + us.getLoginDate());
    logger.info("Logout-Date: " + us.getLogoutDate());
    logger.info("Session ID: " + us.getSessionId());
    logger.info("IP: " + us.getIP());
    logger.info("Is role " + firefox + " in session? " +
        od.hasRoleInSession(firefox, null));
    logger.info("Is role " + ie + " in session? " +
        od.hasRoleInSession(ie, ou));
    logger.info("Is role " + sys + " in session? " +
        od.hasRoleInSession(sys, null));
}
```

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```
/* Servlet method to check, if role is still part of session */
public void checkRoleInSession(HttpServletRequest req,
    HttpServletResponse res) throws Exception {
    PrintWriter pw = res.getWriter();
    String roleid = StringUtil.notNull(req.getParameter("role"));
    Role r = od.getById(Role.class, roleid);
    if(r != null) {
        pw.println("Is role " + r + " in session? ");
        if(r.getType() == Role.GLOBAL && od.hasRoleInSession(r, null)) {
            pw.println("YES<br/>");
        } else if(r.getType() == Role.LOCAL && od.hasRoleInSession(r, ou)) {
            pw.println("YES<br/>");
        } else {
            pw.println("NO<br/>");
        }
    }
}

/* Servlet method to remove roles from session */
public void removeRoleFromSession(HttpServletRequest req,
    HttpServletResponse res) throws Exception {
    PrintWriter pw = res.getWriter();
    String roleid = StringUtil.notNull(req.getParameter("role"));
    if("allroles".equals(roleid)) {
        od.removeAllRolesFromSession();
        pw.println("Removed all roles from session");
    } else {
        Role r = od.getById(Role.class, roleid);
        if(r != null) {
            pw.println("Is role " + r + " in session? ");
            if(r.getType() == Role.GLOBAL && od.hasRoleInSession(r, null)) {
                pw.println("YES<br/>");
                od.removeRoleFromSession(r, null);
                pw.println("Removed role " + r + " from session");
            } else if(r.getType() == Role.LOCAL && od.hasRoleInSession(r, ou)) {
                pw.println("YES<br/>");
                od.removeRoleFromSession(r, ou);
                pw.println("Removed role " + r + " from session");
            } else {
                pw.println("NO<br/>");
            }
        }
    }
}
```

2.9 Demo Package

The *@enterprise* installation contains a demonstration file `demos.zip` that contains some examples for writing servlet methods. Install the demos by using the "Install/Upgrade

2. Servlet Methods

application" link in the *@enterprise* system administration (see [System Administration Guide](#) for more details). After successful installation, you can view the index page of the demos within the demo GUI configuration. Simply navigate to the Demo links/List of Demos section.

The first of the four examples of the Java class `HttpDemo` simply writes out the current date to the browser:

File `classes/com/groiss/demo/HttpDemo.java`

```
public void showDate(HttpServletRequest req, HttpServletResponse res)
    throws IOException {
    res.getWriter().println("<html><body>" + new Date() + "<body></html>");
}
```

The second example uses a form to give some values to the servlet method. The form looks as follows:

File `classes/alllangs/demo/dateform.html`

```
<!DOCTYPE html>
<html>
<head>
<link href="../../servlet.method/com.groiss.gui.css.StyleConf.loadCSS"
    rel="stylesheet" type="text/css"></link>
<script src="../../scripts/dojo/dojo.js"></script>
</head>
<body class="claro">
<form action="../../servlet.method/com.groiss.demo.HttpDemo.showNLSDate1">
Language:
<select name="language">
    <option value="de">German
    <option value="en">English
    <option value="es">Spanish
    <option value="fr">French
</select><br>

Format
long: <input type="radio" name="format" value="long">
short: <input type="radio" name="format" value="short">
<br>

<input type="submit" class="ep_button">
</form>
</body>
</html>
```

The form contains two form fields. The `language` field to select one of four languages, the `format` field to select either a long or short date format. The form action is the method `showNLSDate1` of the class `HttpDemo`:

File `classes/com/groiss/demo/HttpDemo.java`

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```
public void showNLSDatel(HttpServletRequest req, HttpServletResponse res)
    throws Exception {
    String language = req.getParameter("language");
    String format = req.getParameter("format");
    Locale l = new Locale(language, language);
    SimpleDateFormat df = new SimpleDateFormat(
        ("long".equals(format) ? "EEEE, MMMM dd, yyyy" : "EEE, MMM dd, yyyy"), l);
    res.getWriter().println("<html><body>Date in " + format + " format in " + language +
        " :<br>" + df.format(new Date()) + "</body></html>");
}
```

The values from the form fields are retrieved with the method `getParameter()` of the request object. The result is written to the writer of the response object.

3. Persistence Layer

The persistence layer of *@enterprise* has been defined to hide the complexities of reading and updating objects in a relational database. The underlying mechanism uses the Java Database Connection, the standard interface between Java and Relational Database Management Systems.

The classes and interfaces described in this chapter belong to the package `com.groiss.store`.

3.1 Database Connection Pool

The management of the database connections is done by the class `DBConnPool`. On startup the system initializes a pool of connections to the relational database. The number of connections and some other settings are specified in the system configuration.

Normally you don't have to deal explicitly with database connections. When an API call needs a database connection, it reserves one for the thread. As long as the transaction lasts, this connection is used.

If you want to get a database connection to perform JDBC operations directly, you get one with the method call `DBConnPool.getConnection`. Multiple calls of this method in the same transaction will return the same connection.

Some words about transactions: Every servlet method in *@enterprise* is executed in a transaction context. Before the method is called a transaction is started and after the method has completed, the transaction is committed - on error a rollback is performed. When methods perform database operations, operations in the same thread use the same transaction and the same database connection.

3.2 Persistent Objects

For making Java objects persistent we have defined the interface `Persistent` and the corresponding abstract class `PersistentObject` implementing the interface. A member of a class implementing this interface has a corresponding tuple in a database table. The fields of the class have a corresponding column value in the database tuple. For reading objects from and writing to the database the service `Store` is used. This is an interface, with the call `Store.getInstance` you get an instance of it.

Let's first take a closer look at the `Persistent` interface:

```
public interface Persistent extends KeyValuePair<String, String>, Serializable {  
    public long getOid();  
}
```

3. Persistence Layer

```
public void setOid();
public void setOid(long oid);

public String getTableName();

public List<Field> dbFields();

public void beforeInsert();
public void afterInsert();
public void beforeUpdate();
public void afterUpdate();
public void beforeDelete();
public void afterDelete();
public void afterRead();

public void setFilled(boolean f);
public boolean isFilled();

public String getKey();
public String getValue();

public String getLocalObjectName();
public String getLocalClassName();

public String toListString();

public void isValid();

public String[][] getKeys();
}
```

Every object has a unique object id (`oid`), the getter `getOid` retrieves this oid. The setter `setOid` should be used by the persistence mechanism only.

The object is filled, when the field values are set to the corresponding values in the database.

Each object knows its store and the store can be set. This is not necessary, if your program uses one database.

The method `getTableName` returns the name of the database table. This is the only method not implemented by `PersistentObject`, therefore you have to implement it in your class.

The method `dbFields` returns a list of `Field` objects, containing the class' fields which have corresponding fields in the database. The default implementation returns all fields which are neither `static`, `volatile`, `transient`, nor annotated with `com.groiss.store.NonPersistent`.

The columns of the database table must have the same names as the fields of the Java class and the types must be compatible. The column `oid` is used for the object identifier. Its type is `decimal(20)` and it should be defined as primary key.

Compatible types are shown in the following table:

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SQL Type	Java Type
char	String
varchar	String
decimal(x)	int,long
decimal(x,y)	float,double
longvarchar	String, char[]
longvarbinary	byte[]
date	Date
time	Date
timestamp	Date
decimal(20)	Persistent

The entry in the last row shows that you can define fields which refer to other persistent objects. The type of the field must be a class or interface implementing (or extending) the Persistent interface. If the objects for this field are not all from the same class, you must add a database field for the name of the objects class. This field is named like the Java class field with "_class" appended.

The store uses the following rule to decide whether a "_class" field is present: If the type is an interface or is an abstract class or is directly annotated with `HasSubclasses`, a "_class" field is expected.

The methods `beforeInsert`, `afterInsert`, `beforeUpdate`, `afterUpdate`, `beforeDelete`, `afterDelete` and `afterRead` are called when the respective database operations are performed. They allow to add custom code to these operations.

The store interface provides, among others, the following methods for manipulation of persistent objects:

- `void insert(Persistent o)`: inserts the object into the database, assigns a unique oid, creates no log entries, does not consider permissions in any way,
- `void update(Persistent o)`: stores the (changed) object in the database, creates no log entries, does not consider permissions in any way,
- `void delete(Persistent o)`: deletes the object from the database, creates no log entries, does not consider permissions in any way,
- `Persistent get(Class c, long oid)`: reads an object from the database, where the oid is known.
- `Persistent get(Class c, String cond)`: The cond String is an SQL expression, the method returns the object matching the query where the cond argument is used as *where* clause.
- `Persistent fill(Persistent o)`: fills the object with the values from the database, the oid must be already set.
- `List<P> list(Class c)`: return all members of the class stored in the database; does not consider permissions in any way.
- `List<P> list(Class c, String cond)`: cond is again a where clause, the method returns all matching objects; does not consider permissions in any way.

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- `List<P> list(Class c, String cond, String order)`: like above, the second argument contains one or more order attributes (separated by commas); does not consider permissions in any way.
- `List<P> list(Class c, String cond, String order, Object... bindVars)`: The additional parameter `bindVars` contains bind variables, each question mark in the condition string is substituted by a value from parameter; does not consider permissions in any way

Example: For a reservation system we define the class `Item`, which contains some information about reservable items:

```
public class Item extends PersistentObject {
    private String name;
    private String description;
    private int maxuse;

    public String getTableName() { return "res_item"; }
```

The class contains some fields for storing details about the item and the method `getTableName`, which returns the name of the database table.

The table must be generated using an SQL statement like this (in Oracle syntax):

```
create table demo_address (
    oid decimal(20) primary key,
    name varchar(100),
    description varchar(100),
    maxuse decimal(10)
);
```

A second class, `ItemRelation`, describes the user-reserves-item relation:

```
public class ItemRelation extends PersistentObject {
    private Item item;
    private User userid;
    private Date fromDate;
    private Date toDate;

    public ItemRelation() {}

    public ItemRelation(Item res, User user, Date from, Date to) {
        this.item = res;
        this.userid = user;
        this.fromDate = from;
        this.toDate = to;
    }

    public Item getItem() { return item; }

    public User getUser() { return userid; }

    public Date getFromDate() { return fromDate; }
```

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```
public Date getToDate() { return toDate; }

public String getTableName() { return "res_itemrel"; }
}
```

The database table for this class:

```
create table res_itemrel (
    oid decimal(20) primary key,
    item decimal(20),
    userid decimal(20),
    userid_class varchar(100),
    fromDate date,
    toDate date
);
```

Note that the fields `item` and `userid` hold the oids of an item object and a user object respectively. Because the field `userid` is of type `com.groiss.org.User` and this is an interface, we need the additional table column `userid_class`.

3.3 Lazy filling

When reading an object from the database, using one of the `get` or `list` methods of the store, the fields of the objects are filled with the values from the database. For fields containing persistent objects, the objects are created with the given `oid`, but the other fields have default values and the method `isFilled` will return `false`.

If, for example, we read an object of the class `ItemRelation` from the database, the method `getItem` applied to this object would return an object containing the `oid` but other fields will have their default values (0 or null). Calling `fill` on this object will set the values.

This behavior is important if you have nested object hierarchies. If you navigate through the objects you have to fill them after calling getter methods. However, it belongs to the developer to insert the fill methods into the getters, like in the following example:

```
public String toString() {
    try {
        Store.getInstance().fill(this);
    } catch (ApplicationException e) {
        throw new ApplicationRtException(e);
    }
    return name;
}
```

The `toString` method returns the name and ensures that the object is filled.

3.4 Optimistic Locking

If two threads want to change an object at the same time, one thread will overwrite the change the other thread made. To prevent these "lost updates", we implemented the optimistic locking mechanism: With each object a `transactionid` is stored, every update increases this `transactionid` and checks if it has the correct `transactionid`. If it does not have the correct id, an update occurred since it read the object from the database. In this case an error is thrown.

For using optimistic locking with your objects you must do two things: First, your class must implement the interface `OptimisticLocking`, secondly your database table must contain the decimal field `transactionid`.

3.5 PersistentEventHandler

This interface provides a hook for some action when an object is inserted, updated or deleted. The methods `beforeInsert`, `beforeUpdate` and `beforeDelete` are called before the database operation is performed but after the corresponding methods of `Persistent` are called. The methods `afterInsert`, `afterUpdate` and `afterDelete` are called after database operation. The method `isValid` is called after `beforeInsert` and `beforeUpdate`. Register your event handler using `StoreUtil.addEventHandler`.

3.6 Additional aspects

Permission checks are necessary to ensure, if an agent is allowed to apply an operation to an object. The insert, update, delete and list operations of `Store` do not consider permissions in any way.

The `OrgData` facade, obtainable via `OrgData.getInstance` provides appropriate methods for this:

```
OrgData.insert(Persistent p),  
OrgData.update(Persistent p) and  
OrgData.delete(Persistent p)
```

check, if the current user is permitted to execute the operation on the object. If the check fails, an `Exception` is thrown. The method `OrgData.listWithRightCheck` can be used to retrieve a list of objects, the current user is allowed to see according to his permissions (see chapter [Organizational Data](#) for more details).

3.6.1 PermissionMapping

By using the `PermissionMapping` it is possible to change the behaviour of the permission system. For this purpose you have to write a own class which extends the class `com.groiss.accesscontrol.PermissionMapping` and add the new permission rule e.g. at startup of an application to the permission system. An example how this can be handled is available in our demo package:

- **com.groiss.demo.SupplierPermissionMapping:** Defines a permission rule for the supplier form.

- **com.groiss.demo.DemoApplication:** In `startup` method of the Application-Adapter the permission rule is added to the permission system with following call of `OrgData` interface:

```
OrgData.getInstance().addRule(SupplierPermissionMapping.class);
```

3.6.2 DeferredChanges

Some master data instances can have changes that are "deferred" till a later point in time. For this purpose the marker interface `HasDeferredChange` is available which designates that an instance may have outstanding changes. This interface is checked during update and delete operation via the `Store`.

3.6.3 HasPermissionList

Some objects can have `PermissionList`s attached to them. Objects implementing `HasPermissionList` have an `acl` field of type `PermissionList`. On insert, update and delete of such objects, the `Store` applies appropriate actions on the permission list. A `OrgUnit` can be set as default for purposes of right checks. The abstract `com.groiss.org.CheckedPersistent` class provides implementations for those methods and is a convenience class combining `com.groiss.org.HasPermissionList` and `OptimisticLocking`.

3.6.4 HasLog

The insert, update, delete and operations of `Store` do not consider semantic versioning in any way. The corresponding `OrgData` methods are responsible for semantic versioning, if the object implements the `com.groiss.org.HasLog` interface. The semantic versions have the type `com.groiss.org.LogEntry` and are stored in the `avw_log` table.

3.6.5 PersistentAspect

Allows to change certain aspects of the behavior of the `Store` and `OrgData` operations on Persistent objects. The values can be set on a global (thread/transaction level) or on an object level. Deviations from standard behavior are reset at the end of the transaction.

Hint: Detailed information about the mentioned interfaces are available in *@enterprise APIDoc*.

4. Utilities and Data Structures

@enterprise provides some utility classes for working with files, strings or date objects as well as some data structures.

4.1 Data Structures

The data structures belong to the package `com.groiss.ds`.

4.1.1 KeyValuePair

The interface `KeyValuePair` is implemented by some classes like `com.groiss.store.PersistentObject` which have a unique key (object id) and a value - the object itself or a string representation. We use it, for example, for representing objects in select lists.

4.1.2 Pair

The `Pair` is a simple class containing two objects. The class also implements the interface `KeyValuePair`, where the first object is returned with `getKey`, the second with `getValue`.

4.1.3 MultiMap

`MultiMap` is like a `java.util.HashMap`, but can map a key to more than one value.

4.1.4 KeyedList

This class implements an ordered map. A list of keys is mapped to a list of values. The values can be accessed by the key or the position in the list. A small example should demonstrate the usage:

```
List l1 = Arrays.asList(new String[]{"a", "b", "c"});
List l2 = Arrays.asList(new String[]{"v1", "v2", "v3"});
KeyedList kl = new KeyedList(l1, l2);
// get the second value v2
Object x = kl.get(1);
// or get v2 by its key
Object y = kl.get("b");
```

4.1.5 CountedSemaphore

A counted Semaphore is used for controlling the number of threads entering a critical section. When constructing the semaphore object you specify two bounds:

The first value defines how many threads can enter the critical section concurrently, the second value defines how many threads will wait for the resource until an exception is thrown (`QueueFullException`).

The clients call two methods: the method `P` for entering the critical section and the method `V` for leaving it. The waiting threads are handled in FIFO order.

Example:

```
// create a semaphore for two concurrent threads and three waiting threads.
static CountedSemaphore s = new CountedSemaphore(2,3);

public void foo() throws Exception {
    s.P();
    try {
        // make some complicated computations
    } finally {
        s.V(); // call V in finally guarantees that it is called
    }
}
```

4.1.6 Caching

It is often quite advantageous to access persistent data with a high referencing rate and a relatively low modification rate via some caching mechanism. *@enterprise* provides a convenient caching API for such purposes. `Caches` of arbitrary objects can be constructed via the `com.groiss.cache.CacheFactory`. Cluster wide caches should be constructed via calling `Caches.getClusteredCache`.

While cache loading and cache access operations must be explicitly provided by the user, the `com.groiss.cache.CacheFactory` provides a range of options to parametrize the more technically involved cache aspects like size limits, expiration lifetime or context and cluster awareness.

The `Cache` instances returned by the factory can be used like ordinary `java.util.Map` objects to a large extent.

A comprehensive usage example can be found in *@enterprise* demo package in class `com.groiss.demo.Supplier`.

If you want to see how the example works, load gui configuration `demo.xml`, open table *Supplier Custom persistent, old table* within subtree *Master data* in block *Demo links* and activate the toolbar function *Test supplier cache* (create a supplier object before!).

4.2 StringUtil and FileUtil

The class `StringUtil` provides some convenient methods for Strings and the class `FileUtil` for files. See the API for details.

4.3 Date/Time Handling

4.3.1 CalUtil

Whenever the system reads and writes a date, the class `com.groiss.cal.CalUtil` is used. The format for conversions is defined in the system administration. Two formats exist: one for date only, one for date and time. The method `parse` converts a `String` to a `Date` object, trying both formats. The method `showDate` shows the date, `showDateTime` the date and time of the given `Date` object.

The class `CalUtil` allows you to get instances of *SimpleDateFormat*. These instances are cached per Thread, are localized and adapted to ThreadContext-timezone (excepting some default patterns, e.g. ISO, RFC, etc.). For further information about patterns see this [link](#).

4.3.2 Holidays

In the system administration a class specifying the holidays can be defined. It must implement the following interface:

```
public interface com.groiss.cal.Holidays {
    public String isHoliday(GregorianCalendar d);
}
```

The method `isHoliday` returns null when the day represented by the `Calendar` object is a holiday, otherwise it returns the name of the holiday, for example "Easter Sunday".

The implementing class is used in the `com.groiss.cal.CalUtil` methods `addWorkdays`, `isHoliday`, and `workdaysBetween`. Additionally, it is used in calendar for entering dates, for example when setting a deadline.

The distribution contains the class `com.groiss.cal.impl.AustrianHolidays` with the following implementation of `isHoliday`:

```
public String isHoliday(GregorianCalendar d) {
    int day = d.get(d.DAY_OF_YEAR);
    int year = d.get(d.YEAR);
    switch ( d.isLeapYear(year) ? day - 1 : day ) {
        case 121: return "Staatsfeiertag";
        case 227: return "Maria Himmelfahrt";
        case 299: return "Nationalfeiertag";
        case 305: return "Allerheiligen";
        case 306: return "Allerseelen";
        case 342: return "Maria Empfängnis";
        case 359: return "Christtag";
        case 360: return "Stephanitag";
    }
    int easter = CalUtil.easterDay(year);
    if (day == easter) return "Ostersonntag";
    else if (day == easter + 1) return "Ostermontag";
    else if (day == easter + 39) return "Ch. Himmelfahrt";
    else if (day == easter + 49) return "Pfingsten";
}
```

```
else if (day == easter + 50) return "Pfingsmontag";
else if (day == easter + 60) return "Fronleichnam";
else if (day == 1) return "Neujahr";
else if (day == 6) return "Hl. 3 Könige";
return null;
}
```

The floating holidays depend on the date of Easter, the method `easterDay` in `CalUtil` can be used here. We use the formula from Gauss, note that the result does not match the Greek-orthodox Easter.

For Germany use the implementation `com.groiss.cal.impl.GermanHolidays`.

4.3.3 Application dependent calendar-events

The *@enterprise* calendar-component can be extended to fetch events from custom sources. To specify your own calendar source, please use the *@enterprise* configuration parameter located under *Calendar* → *Calendar sources*. This property contains a comma separated list of classes implementing the `com.groiss.cal.CalInfo`-interface. Please note that it's recommended to extend `com.groiss.cal.CalInfoAdapter`.

The following default implementations are shipped with *@enterprise*:

- `com.groiss.calendar.CalendarAppl`: returns custom events inserted by a user
- `com.groiss.calendar.wf.DueTasks`: returns all tasks which have to be finished at the given date
- `com.groiss.calendar.wf.FinishedTasks`: returns all finished workflow tasks

If you want to register your `CalInfo`-implementations programmatically, use `com.groiss.cal.CalRegistry`.

4.4 ThreadContext

The `com.groiss.util.ThreadContext` class contains some `ThreadLocal` variables, which are set by the `Dispatcher` servlet and can be retrieved from any method:

- `getThreadPrincipal` returns the user of this thread. The method returns a `java.security.Principal` object, which can be casted to a `com.groiss.org.User` object.
- `getThreadLocale` returns the locale of the thread: This is either the locale of the user, or if the thread is not assigned to a user, the default locale defined in the system configuration.
- `getSessionId` returns the id of the user session.
- `isPrivileged` returns true if the session is privileged. Privileged sessions are allowed to open additional database connections, if all connections are used. A thread belonging to the user `sysadm` is privileged.

- `getThreadRequest` returns the `HttpServletRequest` object from the thread.
- The methods `setAttribute`, `getAttribute`, `removeAttribute`, and `getAttributeKeys` can be used to add arbitrary attributes to the `ThreadContext` object.
- The method `getSessionType` returns the type of the session, either HTTP, RMI¹, or internal.
- Client Certificates: The `ThreadContext` holds the client certificates, if the communication is encrypted and requires client authentication. The certificates of the client are set automatically and can be read from the attributes with the key `java.security.cert.X509Certificate` (returns an array of `X509Certificates`).

The following method from `HttpDemo` can be called to check the environment:

File **classes/com/groiss/demo/HttpDemo.java**

```
public void showThreadContext(HttpServletRequest req, HttpServletResponse res)
    throws Exception {
    PrintWriter w = res.getWriter();
    w.println("<html><pre>"+
        "\nUser: " + ThreadContext.getThreadPrincipal() +
        "\nLocale: " + ThreadContext.getThreadLocale() +
        "\nSession: " + ThreadContext.getSessionId() +
        "\nPrivileged: " + ThreadContext.isPrivileged() +
        "\nRequest: " + ThreadContext.getThreadRequest() +
        "</pre></html>");
}
```

4.5 Logging

@enterprise uses the *slf4j* logging framework by default and writes the logging output to a log file.

The format of each output line is as follows:

- log level
- thread name
- date and time
- ip address
- your message

The configuration options are described in the *@enterprise* [Installation and Configuration](#) guide.

Output example:

¹RMI Sessions are deprecated.

INFO [JHttp-48] 2013-08-07 08:30:58.375 10.205.112.10 - GET /wf/html/avw.css

Example in Java:

```
private static final Logger logger = org.slf4j.LoggerFactory
    .getLogger(MyClass.class);
logger.info("This is a log info");
```

Hint: More information about the `org.slf4j.Logger` interface is available in the *SLF4J API* documentation.

4.6 Timer

One of the services *@enterprise* provides is the timer service. You can schedule your tasks and specify the interval, thread, etc.

Your timer task must implement the `com.groiss.timer.TimerTask` interface. It contains the methods `run` and `abort`. The `run` method is called when the timer task should be executed, `abort` is never called and for future use.

4.7 BeanManager

The `com.groiss.component.BeanManager` is a component that controls transactional behavior. It can be used to commit or rollback transactions and offers the possibility to execute code at various points in the transaction life cycle.

For simple cases, the registration of callbacks is supported like described in the following section. More complex requirements can be met via Beans which will be elaborated afterwards.

4.7.1 Callback registration

This can be achieved via the registration of callbacks with a simple functional interface `com.groiss.functional.VoidCallable` with a `call` method which can throw an exception.

The callbacks can be registered via the following static methods of `BeanManager`:

- `beforeCompletion`: will be called before commit. Exceptions lead to a rollback of the transaction.
- `afterCommit`: will be called after commit of the transaction, Exceptions will be ignored.
- `afterRollback`: will be called after rollback of the transaction, Exceptions will be ignored.
- `executeDeferred`: will be called after commit in the `EventDispatcher Thread`. Each callback is executed in its own transaction. Exceptions lead to rollback of this separate transaction.

An arbitrary number of callbacks can be registered, they will be executed in the order of registration.

Example for such a call :

```
BeanManager.afterCommit(() -> {
    myLogger.trace("Called after successful commit.");
});
```

4.7.2 Beans

In *@enterprise* it is possible to implement Beans which are handled by `com.groiss.component.BeanManager`.

The Bean must implement the interface `javax.ejb.SessionSynchronization`.

Following 3 steps are necessary for the integration and usage in *@enterprise*:

1. Write your own Bean: Following *DemoBean* has a method to store DMS documents in a temporary folder. At the end of transaction (could be initiated by the call `BeanManager.commit`) the methods `beforeCompletion` and `afterCompletion` are called. In our *DemoBean* we delete all files created in temporary folder after successful transaction.

```
public class DemoBean implements SessionSynchronization{

    private String TMP_FOLDER_PATH = Settings.getLocalDir() + "/files";
    private final Logger logger =
        LoggerFactory.getLogger(DemoBean.class);

    /**
     * Method to store document in temporary folder
     * @param doc the DMS document to store
     * @throws Exception
     */
    public void storeDocument(DMSDocForm doc) throws Exception {
        File folder = new File(TMP_FOLDER_PATH);
        if(!folder.exists()) {
            folder.mkdir();
        }

        String filename = doc.getName() + "." + doc.getExtension();
        logger.info("DemoBean.storeDocument: {}", filename);

        File f = new File(TMP_FOLDER_PATH, filename);
        if(!f.createNewFile()) {
            throw new ApplicationException("File " +
                filename + " could not be created!");
        }
        FileOutputStream out = new FileOutputStream(f);
        out.write(doc.getContent());
        out.close();
    }
}
```

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```
@Override
public void beforeCompletion()
    throws EJBException, RemoteException { /* empty */ }

@Override
public void afterBegin()
    throws EJBException, RemoteException { /* empty */ }

/**
 * Delete all files which were created in temporary folder
 */
@Override
public void afterCompletion(boolean arg0)
    throws EJBException, RemoteException {
    logger.info("DemoBean.afterCompletion");
    File folder = new File(TMP_FOLDER_PATH);
    File [] files = folder.listFiles();
    for(int i = 0; i < files.length; i++) {
        files[i].delete();
    }
}
```

2. Register the Bean: This could be done e.g. at application startup (see section [Application Adapter](#) for more details) by using following call:

```
BeanManager.addBean("DemoBean", DemoBean.class);
```

3. Use the Bean: Our *DemoBean* has the method `storeDocument` which allows to store a DMS document on file system. Before we could call this method we have to get the Bean with the `BeanManager` like in following way. A possibility to finish a transaction is the usage of `BeanManager.commit`:

```
DemoBean db = (DemoBean) BeanManager.getBean("DemoBean");

//code to get DMS document(s)
...
db.storeDocument(doc); //store document on file system
...

try {
    //code to handle file(s)
    ...
    BeanManager.commit(); //calls beforeCompletion() + afterCompletion()
} catch (Exception ex) {
    BeanManager.rollback();
}
```

More details about the `com.groiss.component.BeanManager` could be found in the *@enterprise* API!

4.8 Resource Files

@enterprise uses the mechanism of JAVA "ResourceBundles" for translating language-dependent texts. See the Java documentation of `java.util.ResourceBundle` for details on how this works. *@enterprise* uses two ResourceBundles:

```
<ephome>/classes/com/dec/avw/resource/Errors for error messages and  
<ephome>/classes/com/dec/avw/resource/Strings for label, messages  
and other texts.
```

The default versions contain the texts in English, the German versions, with the suffix "_de" contain the German texts. Other languages are French ("_fr") and Italian ("_it").

You can define resource files for country dependent locales, for example a file `Strings_de_AT` and overwrite selectively the labels you want to change.

For this purpose it is recommended to use the function *New language* of the *@enterprise* resource editor (see the [System Administration Guide](#), chapter [Workflow modeling](#), section [Resource Editor](#)).

If the desired language option is not available, you have to define it in section Configuration/Localization with parameter List of locales. This new column appears in resource editor spreadsheet and is editable. When saving the spreadsheet a new file *Strings_XX.properties* on file system will be created (file is located in `classes/com/dec/avw/resource`).

Finally assign the appropriate language to the users. If no appropriate translation is found in the overwritten language file, the default translation is used.

For application specific translations please read section [Internationalization of Applications](#).

4.9 Error Handling

If your servlet code throws an Exception or Error, an error page will be displayed. This page contains the following message:

- The message from the exception itself, if the exception is an instance of `com.groiss.util.TopLevelException`.
- The standard message "An internal error occurred. Please contact the system administrator!" is shown otherwise.

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The `com.groiss.util.ApplicationException` implements the `com.groiss.util.TopLevelException` and extends the `java.lang.RuntimeException`.

All *@enterprise* errors have an error number as key, the key for the standard message is "unknown". You can change the text by defining a resource file for the Errors bundle for your Locale (see section [Resource Files](#)).

If you want to change the error page as a whole, you can implement an own error formatter by using following interface:

```
public interface ErrorFormatter {  
    public Page format(Throwable e);  
    public JSONObject formatJSON(Throwable e);  
}
```

Afterwards set your error formatter class in the *@enterprise* configuration in section *Classes*.

The default implementation is `com.groiss.gui.DefaultErrorFormatter`.

The class `com.groiss.util.ApplicationException` has the method `setErrorFormatter` that allows you to set your own formatter class for a single exception.

5. Structure of Applications in *@enterprise*

The integration of applications is one of the main tasks of workflow systems. In this chapter we show how *@enterprise* applications should be structured to make installation and maintenance easy.

Our design goals were:

- Simple installation/un-installation of applications
- Support for upgrade of applications
- Independence of applications and *@enterprise* versions
- Support of startup and shutdown functions

5.1 Organization of Files

The resources of applications can be placed under the *@enterprise* directory, the `appls` directory is provided for this purpose (in `local` and `var` folders). In any case, a different directory should be used for each application within `appls`. Typically, an application contains:

- jar files for application classes and additional libraries,
- static HTML pages, probably language dependent,
- HTML masks, loaded from the code,
- configuration file(s), styles
- other: export files, documentation, database scripts.

The structure of applications is partially predefined, for example the configuration file is searched in the root directory of the application, jar files must be placed in the `lib` directory. In the following table we show the structure of an application. The bold parts are required, non bold parts are conventions only. “applid” denotes the id of the application.

installation.properties	configuration file
classes/	Java classes and all resources loaded from classpath
classes/applid_guid.xml	gui configuration with id guid
classes/applid/properties.xml	property-file for application- and user-parameter
classes/applid/import.xml	import-definition for file importer (see System Administration Guide - section File Import)
classes/applid/reporting.xml	Reporting definition containing needed information about the pool of data which can be used in reports (see XML Configuration)
classes/applid/styles.less	The <i>@enterprise</i> styleloader loads the file (depending on startup sequence of the application) and appends it to the main less-file
classes/applid/styles_mobile.less	Analog to <i>styles.less</i> , but for mobile GUI. This file is optional, if styles for mobile GUI should not be stored in <i>styles.less</i>
classes/applid/strings.xls	Resource file for internationalization
classes/applid/masks/	HTML masks
classes/applid/forms/	Forms (templates for formtypes)
classes/applid/exports/	Export files; needed for import via admin-shell (see System Administration Guide - chapter Administration Shell)
classes/lang/default/applid/	defaults for language dependent files, including images
classes/lang/<language>/applid/	language specific files
classes/alllangs/applid/	language independent files (HTML, ..)
classes/alllangs/scripts/applid/	JavaScript files and DOJO widgets
java/	Java source files
lib/	Needed libraries (jar files) can be placed here
lib/applid_forms.jar	<i>@enterprise</i> puts the form interfaces in this jar file
doc/	Folder for documentation (e.g. user guide, etc.)

HTML masks used in servlet functions are loaded from the classpath and are located either in the `lib` or the `classes` directory. In the classloader the jar-files are sorted alphabetically for each path.

When you specify the application path in the corresponding field of the application entry in the system configuration, the `classes` directory and the jar files in the `lib` directory are added to the classpath. The `classes` directory is in the classpath before the jar files, so you can shadow classes in the jar files.

We recommend to build a jar file containing application classes and HTML masks and putting this jar file in the `lib` directory of your application. Thus, future application upgrades can be done by simply exchanging one single file. The `classes` directory is useful during application development, because you don't need to build and replace a jar file every time you compile your code.

5.2 The Configuration Files

The configuration files contain key-value pairs in the syntax of a Java property file and represent two kinds of parameters: First, *@enterprise* reads some parameters when an appli-

cation is installed. These parameters are stored in a file named `installation.properties`. The second group of parameters is only used within the application and stored in file `appl.prop`.

5.2.1 The installation properties

The configuration file `installation.properties` is located in the application's installation directory which is typically located in the `<local>` area of your *@enterprise* installation. It may contain the following parameters:

avw.application.id: The id of the application,

avw.application.name: A name for the application,

avw.application.description: A description for the application,

avw.application.docu: Location of application documentation (see section [Documentation of Applications](#) for details).

avw.application.docu.html: Location of application's html documentation (see section [Documentation of Applications](#) for details).

avw.export.file: The name of the export file (e.g. `export.xml`).

This file is considered as part of the delivered software and therefore will not be changed when running the *@enterprise* server.

Additionally to the parameters mentioned above this file may contain application specific parameters. Those parameters will be copied to the application properties file when installing the application, but only if no such file already exists, which should be the case in this situation. This behavior can be used to deliver default values for application properties without defining them in file `properties.xml` of this application.

5.2.2 The application properties

The configuration file `appl.prop` is located in directory `<ep_base>/<var>/appls/<applid>` and will be created (if missing) when installing the application.

On startup, *@enterprise* reads the configuration file and keeps it in memory. With the configuration API the parameters can be read and set. A `com.groiss.component.Configuration` object holds the parameter values of an application. To get this object call:

```
Configuration conf = Configuration.get("appl-id");
```

The parameter values are then retrieved and set with the following calls:

```
conf.getProperty(name);
```

```
conf.setProperty(name, value);
```

5. Structure of Applications

If parameter values have been changed in file *appl.prop* without using the GUI, the function *Reload Configuration* (can be found under *Administration* → *Admin-Tasks* → *Server* → *Server Control*) allows to load the changes and transfer the changed values into the `com.groiss.component.Configuration` object. After loading the method *reconfigure()* is called for each service (and each application where application class implements the interface `com.groiss.component.Service`). The name of the changed properties can be retrieved by using the method `ThreadContext.getAttribute("changedParams")` which returns a list of strings.

The second group of parameters can be pre-defined in a XML-file called *properties.xml*. This file contains the properties, which are displayed in *Configuration* or (User-) *Settings* of *@enterprise*. The values of *Configuration* are stored in *appl.prop*, the user-settings in database-table *avw_userprops*.

For creating and editing the file *properties.xml* the property-editor of *@enterprise* can be used, which is available in tab *Properties* of the application-object (see [System Administration Guide](#) - section [Applications](#)).

Example for *properties.xml*:

```
<?xml version="1.0" encoding="UTF-8"?>
<application>
  parametergroup name="ITSM" helpctx="itsm/configuration" visible="true">
    <property label="@@@mail.sender@" type="String" name="mail.sender"
      needsrestart="false" defaultvalue="">
      <tooltip>
        <div>The mail sender address in the FROM field of an email.</div>
      </tooltip>
    </property>
  </parametergroup>
  <userprops>
    <property label="@@@signature@" name="sig" allowOnClient="true"
      needsrestart="false" type="String">
      <components type="textarea" />
    </property>
  </userprops>
  <resource strings="itsm.Strings" />
  <upgrade>
    <step to="10.2" groovy="false">
      com.groiss.itsm.ITSMUpdater.upgradeTestResultFormTypes</step>
    <step to="11.0" groovy="false">
      com.groiss.itsm.ITSMUpdater.upgradeToV11</step>
    <step to="11.0.1" groovy="false">
      com.groiss.itsm.ITSMUpdater.upgradeV11ToV1101</step>
    </upgrade>
  </application>
```

After the xml tag the property-file starts and ends with an *application*-tag. Between this tag you can define

- *parametergroup* (displayed as section in *Administration* → *Configuration*)
- *userprops* (displayed as group in *User profile* → *Settings*)

5. Structure of Applications

- resources (applications do not support error resources)
- upgrade (Upgrade path for the application)

A `parametergroup` should contain a `name`-attribute which represents the link in the navigation-tree of *Configuration*. Within the `parametergroup` and `userprops` the `property`-tags can be set, which indicates the property.

The keywords `name` and `type` must be defined, `label` is optional (only for representation in GUI).

Defaults can be specified either via a `defaultvalue` attribute within the `property`-tag, or (for multi-line defaults) by a nested `default`-tag.

The attribute `needrestart` defines, if the server has to be restarted or not when property is set via GUI.

The attribute `allowOnClient` defines, if the parameter is accessible on client too (see section [Implementing own widgets](#) for more details). The `components`-tag allows to define other HTML-elements like password-fields, select-lists, text-areas, links, etc.

Hint: The *Duration* type uses the `java.time.Duration` and can be inserted in the following formats:

- `dD hH mM s .f S` (e.g. `2d 1h 2m 3.5s`)
- as number (will be interpreted as seconds)
- as ISO-8601 string

Following example shows, how to define different HTML-elements with the `components`-tag (snippet of a `parametergroup`):

```
<property label="Textfield" name="example.textfield">
  <components type="textfield" size="40" />
</property>
<property label="Password" name="example.password">
  <components type="password" />
</property>
<property label="Textarea" name="example.textarea">
  <components type="textarea" />
</property>
<property label="Dropdown-List"
  name="example.dropdownlist" type="Integer"
  defaultvalue="0">
  <restriction>
    <enumeration value="0" name="v1" />
    <enumeration value="1" name="v2" />
    <enumeration value="2" name="v3" />
  </restriction>
</property>
<property label="Select-List" name="example.selectlist">
  <components type="selectlist" multiselect="true" />
  <restriction>
    <enumeration value="1" name="sunday" />
    <enumeration value="2" name="monday" />
  </restriction>
</property>
```

5. Structure of Applications

```
<enumeration value="3" name="tuesday" />
<enumeration value="4" name="wednesday" />
<enumeration value="5" name="thursday" />
<enumeration value="6" name="friday" />
<enumeration value="7" name="saturday" />
</restriction>
</property>
<property label="Class Checker" name="example.classchecker">
  <components>
    <a href="javascript:ep.admin.checkClass('example.classchecker',
      'aimg','instanceof java.lang.Object')">
      
    </a>
  </components>
</property>
```

Please note that the upgrade path (*<upgrade>*) follows the order as defined in the properties file, from top to bottom, with the lowest version listed first and the latest version listed last.

@enterprise uses also a default property-file (stored in *conf*-folder of *ep-impl.jar*), where you can see the definition of all *@enterprise* properties (values stored in *ep.conf*), but: **DO NOT CHANGE THIS FILE!**

5.3 The Application Class

The application class contains methods for startup, shutdown, and other control operations of the application. The interface `com.groiss.component.Service` (a sub-interface of `com.groiss.component.Lifecycle`) contains the following methods:

```
public void startup();

public void shutdown();

public boolean isRunning();

public void reconfigure() {}
```

The first two methods are called on startup respective shutdown of the server.

The method `isRunning` can be called to find out whether the application is running or not (whatever this means in the context of the application).

The method `reconfigure` can explicitly be used to reconfigure the service.

We recommend to implement this interface, if an own `Service` implementation is needed - do not extend `com.groiss.component.ServiceAdapter`!

The class `com.groiss.wf.DefaultApplicationAdapter` provides a default implementation of the `com.groiss.wf.ApplicationAdapter` interface, which contains some methods to tailor the behavior of an application. You can define such a class and register it in the application administration (field application class).

5.4 Documentation of Applications

You can add documentation pages to your application by specifying a property with the key `avw.application.docu` and/or `avw.application.docu.html` in the application's `installation.properties` file. *@enterprise* will search for the documentation in the classpath, so you must add it to the folder `lang/<language>` either within `classes` directory or to the application jar file in the `lib` directory. Here comes an example for the properties:

```
avw.application.docu=demodoc/demo.pdf
avw.application.docu.html=demodoc/html/index.html
```

When a user clicks on **Help** and **Content**, the system searches for *@enterprise* and application documentation. If at least one application documentation is found, a selection page will be shown, where the user can choose either the system documentation or an application documentation. The application documentation links to the location specified in the above mentioned properties. There you can provide HTML help pages or links to pdf-files or whatever you prefer.

5.4.1 Using context sensitive help in applications

@enterprise offers the possibility to add a pdf or html version of application's help (parameter `avw.application.docu` and `avw.application.docu.html`). This can be used as context sensitive help on application masks which is opened when key **F1** is pressed. For this purpose the PDF file or HTML help-pages must contain anchors to get the correct relation between mask and help page. When PDF is opened, the anchor is found via the parameter `nameddest`; the anchor in HTML-pages is determined by the `id`-attribute.

For defining anchors in PDFs multiple ways are offered, e.g. by using the Adobe Acrobat tool, MS Word bookmarks or special plugins, Latex with `hypertarget`, etc. The following steps describe a simple and facile possibility to define anchors in PDFs by using MS Word and LibreOffice:

- Create a document in MS Word.
- Define the anchors by using MS Word bookmarks; ensure that the bookmarks do not contain special characters according to PDF restrictions.
- Save the MS Word document and open it with LibreOffice Writer tool.
- Change to toolbar and open the dropdown list *File*; click on entry *Print as PDF*.
- In dialog *PDF options* change to tab *Links* and activate checkbox *Export bookmarks as named destination*.
- Activate button *Export* to create a PDF version of the document.

The following example shows the anchor definition for HTML help pages:

5. Structure of Applications

```
<h1 id="problems">Problem Management</h1>
...
<h2 id="startProblem">Start problem</h2>
  For starting a problem the agent ...

<h1 id="config">Configuration</h1>
...
```

After the PDF file or HTML help pages are defined, the next step is to set the context on HTML masks, in widgets or in GUI-XML in *@enterprise*. The context consists of the application-id and the anchor defined in help-page.

On HTML mask, in an *html* tag you have to set the correct context in an attribute `data-ep-helpcontext` as shown in following example:

```
<html data-ep-helpcontext="sysadm/cacheadministration">
```

Please note that following the `dojo.js` must be imported on HTML mask where context sensitive help should be used (see section [The @enterprise JavaScript library](#) for details):

```
<script src="../../scripts/dojo/dojo.js"></script>
```

In case of DOJO widgets (see section [Implementing own widgets](#)) the attribute `helpContext` can be used to set the context. The following example should demonstrate how the context can be set:

```
...
var dlg = new Dialog({
  title:"@@@startProb@@",
  content:thePane,
  helpContext:"itsm/startProblem",
  showOk: true
});
...
```

If a help context for own defined tables or worklists is needed, you have to add the attribute `helpContext` in your GUI-configuration file (see section [Configuring the Worklist Client](#)). Examples:

```
<table id="mytable1">
  <name>My table 1</name>
  <classname>com.dec.avw.appl.my_table_1</classname>
  <helpContext>itsm/mytable1</helpContext>
</table>
```

For the configuration parameter page created with data of *properties.xml* (see section [The Configuration Files](#)) an attribute called `helpctx` must be added with the context `appl-id/anchor`, if context sensitive help should work for this page, e.g.:

```
<parametergroup name="ITSM" helpctx="itsm/config">
...
</parametergroup>
```

5. Structure of Applications

In addition to these possibilities the user manual of *@enterprise* can be overwritten. This could be necessary, if the context help of *@enterprise* dialogs/masks should not point to the *@enterprise* user manual. For this purpose following parameters in *@enterprise* configuration section *Other parameters* are available:

- `ep.user.docu`: Path to PDF version of user manual. If an own user manual should be used for the *@enterprise* default dialogs, use a path analog to parameter `avw.application.docu` defined in file *installation.properties* of your application (see section [The Configuration Files](#) for details).
- `ep.user.docu.html`: Path to HTML version of user manual. If an own user manual should be used for the *@enterprise* default dialogs, use a path analog to parameter `avw.application.docu.html` defined in file *installation.properties* of your application (see section [The Configuration Files](#) for details).
- `ep.user.docu.shadowall`: If value is set to *true*, the fallback to default user manual will be disabled, i.e. the paths are used which are entered in `ep.user.docu` and `ep.user.docu.html`. If this parameter is *false*, the *@enterprise* user manual will be used as default, e.g. if in case of context sensitive help the help page in an own defined user manual could not be found.

Please note, if an own user manual should be used, the anchor-ids in your HTML help pages must contain the same anchor-ids as in the *@enterprise* [user manual](#) HTML files! Example: The dialog of task function *Set priority* has the helpcontext 'user/setpriority'. In this case your help page must contain a HTML-tag with id *setpriority*.

5.5 Internationalization of Applications

@enterprise offers the possibility to add your own resource bundles to your applications. For internationalizing your application following steps are necessary:

1. **Definition:** A resource bundle for the strings (and error) messages of the application must be defined (see section [Resource Files](#)).
2. **Configuration:** The resource bundle must be added to the application (see [System Administration Guide](#) - section [Applications](#)).
3. **Usage:** There are different ways to use the resource bundle:
 - Resources loaded by *@enterprise*: Use the placeholders "###" e.g. in forms or gui-configuration (see section [Internationalization](#) for using placeholders in GUI-configuration). All strings (= keys) starting with "###" and ending with "@@" are interpreted as translation labels. If the string "###" is needed in HTML/JavaScript files (= should not be internationalized), you have to write following string: @@@@

Example for forms:

```
<input type="button" value="@@@close@@">
in locale en_US: <input type="button" value="Close">
in locale de_AT: <input type="button" value="Schließen">
```

- Resources loaded by `FileServlet` (images, scripts, HTML pages):
This resources are loaded from `alllangs` directory in classpath or from language specific directory (see section [Mapping of URLs to files or methods](#)). Use the placeholders "===" as described above.
- Java Code: In JAVA code use `com.groiss.wf.ApplicationAdapter` to get the `com.groiss.component.Resource` object (see section [Application Adapter](#) for more details). If the keys of a HTML-page should be translated, load the `HTMLPage` object like in following example (see section [HTMLPage](#) for more details):

```
Application myAppl = OrgData.getInstance()
    .getById(Application.class, "applid");
ApplicationAdapter applclass = ApplicationAdapter.of(myAppl);
Resource res = applclass.getResource();
String key = res.getString("key"); //translation key without ===
HTMLPage p = new HTMLPage("masks/mypage.html", res);
...
```

If standard *@enterprise* resources should be used, the key must contain a leading `ep:`, e.g. `@@@ep:role@@`

It is also possible to use resources of other applications. In this case the application-id is the prefix instead of `ep:`, e.g. `@@@applid:abortandarchive@@`

5.6 Startup and Shutdown

During the startup of an application the system performs the following steps:

- Add the jar files to the `lib` directory and the classes directory to the classpath.
- Load the configuration file.
- Execute the startup method of the application class.

5.7 Installation

The installation of an application is done in two steps:

1. Copy the files to the destination directory.
2. Create an application object, specify the id, name and installation directory of the application.

When inserting the application object, the classpath is altered, the application loaded and the application is started.

The second and recommended possibility to add an application is to pack the application into a zip file and load it onto the server. This is done via the "Install/Upgrade Application" function in the administration (see [System Administration Guide](#) for more details).

5.8 Upgrading

Detailed information on how to apply an upgrade to an application can be found in the [Installation and Configuration Guide](#) of *@enterprise*.

5.9 Making the web application secure

The architecture of the Dispatcher servlet makes it possible that every method with signature

```
m(HttpServletRequest req) and
```

```
m(HttpServletRequest req, HttpServletResponse req)
```

can be accessed directly via a browser. Therefore the application programmer must secure EACH of these methods in the following way:

First, it must be decided for what group of users the method should be accessible.

Second, it must be checked whether the rights of the user are sufficient for performing the requested operation.

5.9.1 Defining the access mode

The access to a method can be classified as follows:

- Public: Accessible without authorization
- User: Accessible for authorized users only
- Admin: Accessible for administration users only - in a dedicated administration session

In your code, the classification can be done in two ways:

(a) A class that implements the interface `com.groiss.servlet.Public` has public access.

(b) The Annotation class `com.groiss.servlet.Access` has an enum type with the above three values defined.

Methods, classes and packages can be annotated. In the following example the class `HTMLFunctions` is restricted to administration users:

```
import com.groiss.servlet.Access;

@Access(Access.mode.Admin)
public class HTMLFunctions {
    ...
}
```

Note that the most specific classification is used, i.e. method annotation overwrites class annotation overwrites package annotation. However, overwriting annotations is not recommended.

5. Structure of Applications

Methods with annotation `Admin` are accessible only in an *admin session*. In the configuration an extra port can be defined for admin sessions for making it possible to restrict access to administration functions using a firewall. A session becomes an admin session, if the user opens the administration - an extra login is necessary.

The class `com.groiss.servlet.ServletUtils` provides some methods to check for an admin session:

- `isAdminSession(HttpServletRequest req)`
- `checkAdminSession(HttpServletRequest req)`

The method `checkAdminSession()` throws an exception, if the current session is no admin session.

5.9.2 Checking rights

The `com.groiss.org.OrgData` interface offers methods to perform checks, if current user has the permission to perform the intended operation:

- `public boolean hasRight(User u, Right r, Object o)`
- `public void checkRight(Right r, Persistent o)`

The method `checkRight()` throws an `ApplicationException`, if the current thread user does not have the right `r` for object `o` (exception number is 521 if `o` is null, else 520). The object argument may be null in both methods, if "global" rights are checked (e.g. check for configuration right).

5.9.3 Common security pitfalls

This section describes some common security problems of web applications and how to avoid them.

SQL Injection

This vulnerability happens when user input is embedded in SQL statements. In *@enterprise* SQL injection can be avoided by using prepared statements like in the following example:

WRONG:

```
Store.getInstance().list(User.class, "id='" + req.getParameter("user")+"'");
```

RIGHT:

```
Store.getInstance().list(User.class, "id=?", null, req.getParameter("user"));
```

In the wrong statement the following value of the user parameter can be used to get the full list of users: `' or '1'='1`

Cross-site scripting

Cross-site scripting (XSS) enables attackers to inject client-side scripts into Web pages viewed by other users. A cross-site scripting vulnerability may be used by attackers to bypass access controls such as the same origin policy. In *@enterprise* XSS could be avoided by always encoding user input if it is replaced in HTML pages like in the following example:

```
<input name="formtarget" value="%target%">
```

WRONG:

```
page.substitute("target", req.getParameter("formTarget"));
```

RIGHT:

```
page.substEncoded("target", req.getParameter("formTarget"));
```

Note that the XHTMLPage implementation is not vulnerable against this attack. Substitutions always encode special characters.

Access to local resources

The file servlet is the default servlet in the *@enterprise* web application and gives unrestricted access to resources in the classpath that have the following prefixes: `alllangs` or `lang`.

Other resources in the classpath or file system are not exposed to the client.

Don't use file names or resource paths as parameters in requests, as these parameters can be manipulated and give access to secure information.

6. Organizational Data

The package `com.groiss.org` contains the API for the organizational data in *@enterprise*. See the *@enterprise Administration Guide* for a description of the objects for representing organizational data.

The interfaces `Application`, `OrgUnit`, `Role`, `Right`, and `User` have been defined to access information about the organization.

The interface `OrgData` is a service-interface for retrieving objects and make changes in the organizational database.

If you have the id of one of the objects of the organizational data, you get the object with the method `getById`.

6.1 Users, their Roles and Rights

The interface `User` represents a person known to the system. The `toString` methods returns the title, first name and surname, separated with spaces.

The `toListString` method returns the same in another order: the surname, the first name and then the title. It is more suitable for showing lists of users sorted by surname.

Use the methods `getRoles` and `hasRole` for finding out whether a user has a role.

Example: The following example shows the roles a selected user has in the - optionally - selected department.

File `classes/com/groiss/demo/OrgDataDemo.java`

```
public class OrgDataDemo {
    public Page showUserSelection(HttpServletRequest req) {
        HTMLPage p = new HTMLPage();
        p.setPage("<html><head>\r\n" +
            "<link href=\"../servlet.method/com.groiss.gui.css.StyleConf.loadCSS\" "
            "rel=\"stylesheet\" type=\"text/css\"></link>\r\n" +
            "<script src=\"../scripts/dojo/dojo.js\"></script>\r\n" +
            "</head><body class=\"claro\">\r\n" +
            "<form action=\"com.groiss.demo.OrgDataDemo.showUserRoles\"> "
            "%user% %org% <input type=\"submit\" class=\"ep_button\">\r\n" +
            "</form></body></html>");
        Store store = Store.getInstance();
        p.substitute("user", new DropDownList("user",
            store.list(User.class, null, null)).show());
    }
}
```

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```
p.substitute("org", new DropDownList("dept",
    store.list(OrgUnit.class, null, null), true).show());
return p;
}

public Page showUserRoles(HttpServletRequest req) {
    HTMLPage p = new HTMLPage();
    p.setPage("<html>%roles%</html>");
    User u = HTMLUtils.getObject(req, "user");
    OrgUnit ou = HTMLUtils.getObject(req, "dept");
    OrgData od = OrgData.getInstance();
    p.substitute("roles", od.getRoles(u, ou));
    return p;
}
}
```

The first method shows a HTML page with two select lists for selecting a user and an organizational unit. The second method reads the corresponding `User` and `OrgUnit` objects and shows the roles of the user (optionally in the org.-unit).

The home department - the department where the user has the `home` role can be retrieved with the method `getHomeOrg`.

For checking whether a user has a right, use the methods `hasRight(User, Right, Object)` or `checkRight(Right r, Persistent o)` of interface `OrgData`.

6.2 Database operations

The `OrgData` methods `insert`, `update`, `delete` perform the corresponding actions of the `com.groiss.store.Store` service with the following additional functions:

- checking permissions: The methods `insert`, `update`, and `delete` call the corresponding `mayXX` methods before performing the operation. As user argument the thread user is used.
- making log entries: If the class implements the interface `com.groiss.org.HasLog` a log entry is written to the database.

You can get the log entries for an object with the method `getLogEntries` of `OrgData`.

6.3 Password Policies

To write a special password checker, you have to implement the interface `com.groiss.passwd.Checker` and enter it in the password policy configuration in administration under *Configuration* → *Password policy* → *Checker class*.

```
public interface Checker {
    public List<String> getReasons();
    public boolean isCompliant(String password);
}
```

The method `isCompliant` checks the password, if it is compliant to the specific policy. The method `getReasons` returns a list of Strings representing the reasons, why the password is not compliant.

6.4 Adding tab Additional Info

In *@enterprise* it is possible to attach forms to master data objects, for example users, org-units, process definitions. For maintaining these objects there is an API and a user interface. It is necessary to define the relation in one of your GUI configurations files: Add a node `objectExtension` to the `<nodes>` section of the file (see section [Non tree nodes \(<nodes>\)](#)), for example:

```
<config>
  <tree>
    ...
  </tree>
  <nodes>
    .....
    <objectExtension id="your_id">
      <name>a_label</name>
      <classname>com.dec.avw.appl.myxform_1</classname>
      <form>myxform.xhtml</form>
      <attachedTo>com.groiss.org.User</attachedTo>
      <editable>true</editable>
      <position>1</position>
    </objectExtension>
    .....
  </nodes>
</config>
```

The configuration file **must** be referenced in a GUI configuration object. On startup, *@enterprise* reads these files and registers the object-extension nodes. In the above example you will now get an additional tab in the user detail mask, where you can edit the attached form. Enter the *classname* and - if class is not a form class, but any `com.groiss.store.Persistent` - the location where *form* (template) is available on file system. In the example above the form is located in *forms* directory of *@enterprise*. The attribute *editable* defines, if the content of *Additional info* tab can be saved with save buttons or if the content is just read-only. The attribute *position* can be used to define the position of the *Additional info* tab in the tab-list (must be a positive integer).

Hint: If any `com.groiss.store.Persistent` is defined as *classname* (excepting a form class), only XForms are allowed as template (= parameter *form*)! In case of a form class, it is possible to use xhtml forms and XForms as template.

The `OrgData` interface has the method `getObjectExtension` for accessing the attached object:

```
OrgData ord = OrgData.getInstance();
User u = od.getById(User.class, "testuser_id");
```

6. Organizational Data

```
DMSForm f = (DMSForm)od.getObjectExtension(u,  
                                             "com.dec.avw.appl.myxform_1",true);  
//further handling with DMSForm  
....
```

The method `getObjectExtension` has following parameters:

- Persistent obj: The object, where the extension is added (e.g. User)
- String formclass: The form-class of the additional form
- boolean create: create the extension, if it does not exist
- Return value: the `com.groiss.store.Persistent` object (e.g. a form)

7. HTML Components

The following section describes the API to build HTML components with Java. We have defined Java Classes for most HTML elements, like forms, input fields, etc. You find the classes in the package `com.groiss.gui.component`.

The use of them is simple: call the constructor with the necessary arguments. The method `show` returns a string representation of the component.

The internal representation of the elements is a JDOM tree representing the XML structure of the element. The method `getRoot` returns this tree.

The following method contains three examples for using the components:

File **`com/groiss/demo/HTMLComponents.java`**

```
public class HTMLComponents {
    static String[][] arr = { { "a11", "a12", "a13" }, { "a21", "a22", "a23" } };
    static String[] headers = { "col1", "col2", "col3" };

    /** Show a select list of users.
     */
    public Page showMask(HttpServletRequest req) {
        HTMLPage result = new HTMLPage();
        List<User> l = OrgData.getInstance().listWithRightCheck(
            ThreadContext.getThreadPrincipal(),
            User.class, OrgData.Rights.VIEW, null,
            false, null, "surname");

        SelectList sl = new SelectList("user", l, 10);
        DropDownList dl = new DropDownList("user", l);
        TableContainer tc1 = new TableContainer(new DefaultTableModel(arr, headers));
        tc1.setRowAttribute(1, "bgcolor", "red");

        List<Pair<String, String>> style = new ArrayList<>();
        style.add(new Pair<>("bgcolor", "grey"));

        TableContainer tc2 = new TableContainer();
        tc2.setAttribute("border", "1");
        for (User u: l) {
            List<Object> row = new ArrayList<>();
            row.add(u.getSurname());
            row.add(u.getFirstName());
            if (u.isActive()) {
                tc2.addRow(row);
            } else {
```


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```
        tc2.addRow(row, style, null);
    }
}

result.setPage("<html><head>\r\n" +
    "<link href=\"../servlet.method/com.groiss.gui.css.StyleConf.loadCSS\" " +
    "rel=\"stylesheet\" type=\"text/css\"></link>\r\n" +
    "<script src=\"../scripts/dojo/dojo.js\"></script>\r\n" +
    "</head>" +
    "<body class=\"claro\">" +
    "\n<br>" + sl.show() +
    "\n<br>" + dl.show() +
    "\n<br>" + tc1.show() +
    "\n<br>" + tc2.show() +
    "</body></html>");
return result;
}
}
```

First, a select list of length 10 with name `user` containing a list of users is constructed. This works, because a `com.groiss.org.User` object implements the interface `com.groiss.ds.KeyValuePair`: The value of the select list option is the `toString` method, the key is the `oid` (as `String`). A `DropDownList` with the same content is the next element.

An HTML table is build using the `com.groiss.gui.component.TableContainer` class. One constructor takes a `TableModel` object, we use the `javax.swing.table.DefaultTableModel` to generate such a model. Another table is build using the `com.groiss.gui.component.TableContainer` by adding rows in a loop. When adding rows one can set additional attributes of the row and the row columns.

8. Document Management

@enterprise offers powerful mechanisms for managing documents, either attached to processes or located within a document tree. The key features of this component are:

- **typed documents and folders:** each document or folder belongs to a type which may have its own set of meta data
- **flexible storage of document content:** storage of document content is independent from storage of meta data and can be changed via interface implementation (standard implementation: content will be stored in the database)
- **storage of meta data:** meta data are stored in the database (as known from process forms)
- **permission control:** individual permissions or permission lists (if activated) may be attached to documents and folders
- **adaptability:** own documents or folders may be integrated and the mechanisms for storing the document content and archiving documents may be changed

In the following sections we will see which classes and interfaces exist in *@enterprise* Document Management System (DMS) and how they are related and we will see some examples using the DMS API.

The data structures belong to the package `com.groiss.dms`.

8.1 Objects of the DMS

The most important interface in the DMS is the interface `DMSObject`. The DMS can manage all objects that implement this interface. `DMSObject` provides methods for retrieving and setting information of an object in the DMS, like the name of an object or when it was lastly changed. But because we have various types of objects in the DMS which differ in their characteristics one interface would not be sufficient. Fig. 8.1 shows the schema of all the various types of objects (all represented by their own specific interface) which can be used within the Document Management System of *@enterprise*. In a DMS usually thousands of objects will exist, which have to be organized in some way so that users can handle their set of DMS objects. Therefore the interface `DMSFolder` exists. The concept should be well known from file systems where each file is located within a folder. `DMSFolder` defines such a folder. You can add DMS objects to

@enterprise: DMS

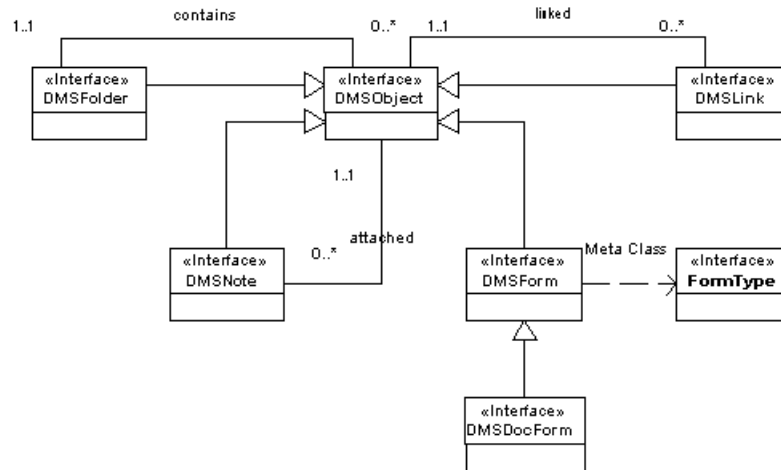


Figure 8.1: Schema of DMS

it, retrieve them later and you can remove them again. Because any object implementing **DMSObject** can be added to a **DMSFolder** you can build hierarchic folder structures by adding one folder to another folder.

Although **DMSObject** provides already a set of properties these are all system defined and of limited use. So we need objects which can hold additional, user defined data. This can be achieved using **DMSForm** that is an interface which provides access to structured data, i.e. data with a specific key and value. Related to a **DMSForm** is the interface **FormType** which provides more information about forms.

Beside structured data we also want to manage unstructured data like a text file or something else. Therefore the DMS provides the interface **DMSDocForm**, which can handle structured data (because it extends **DMSForm**) and unstructured data. Another different type of object in the DMS is defined by the interface **DMSLink** that holds a reference to another **DMSObject** of any type (except a **DMSLink** again).

At last we have the interface **DMSNote** which is a special kind of **DMSForm** in the way that it has two predefined fields (a subject and a content) and it is used to annotate other **DMSObject**. Therefore you can attach one or more **DMSNote** objects to any type of **DMSObject** (you can think about it as a kind of an electronic Post-it ®).

8.2 Life Cycle of a DMSObject

The life cycle of a `DMSObject` is quite simple and straight forward as you can see in Fig. 8.2. When a `DMSObject` is created it already exists within the DMS but it is in an inconsistent state (from the DMS point of view) because it is not added to a folder. The DMS requires all DMS objects to be assigned to a folder (except `DMSNote`, they can be attached to a `DMSObject`). Only after adding the object to a folder the whole functionality of the DMS is available to manage and edit this object. Moving it from one folder to another folder is possible, but deleting the assignment is not. As expected the life cycle of a `DMSObject` ends with its deletion. In the case of deletion interface `DMSArchiver` is invoked which can be used to archive some relevant data. The default implementation does nothing but the implementation of this interface can be replaced by the system administration in configuration section *DMS*).

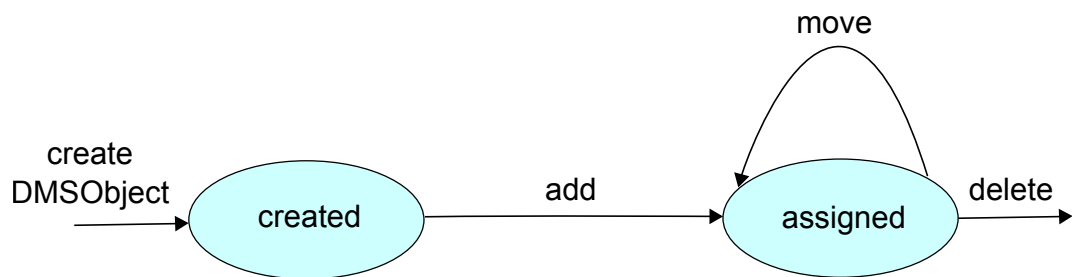


Figure 8.2: **DMSObject Life Cycle**

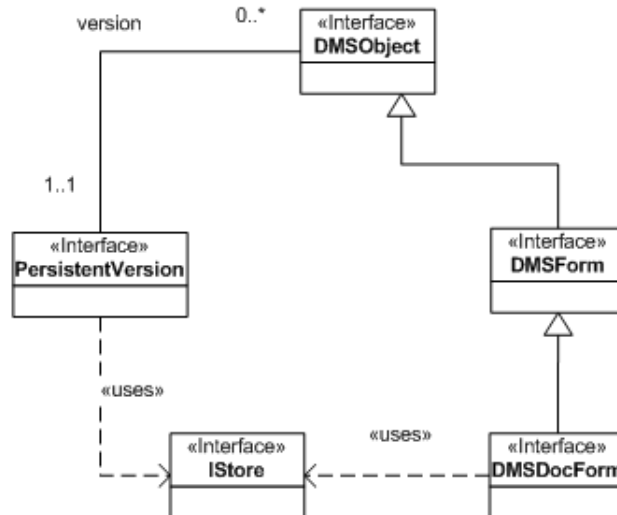
8.3 Storage and Versioning

For managing the data of the various DMS objects we need to store these data in a persistent storage. The DMS handles the storage of structured and unstructured data in different ways. Making the structured data persistent lies in the responsibility of the DMS objects themselves. But for storing the unstructured data the DMS uses the interface `IStore`. This interface provides a small set of simple methods for storing and retrieving these data.

The concrete implementation of this interface can be specified via the system administration of the *@enterprise* sever (in section *DMS*). The default implementation stores these data in the data base¹.

Although we mentioned that the structured data have to be handled by the DMS objects themselves they store their data also in the database, but they do not use the `IStore` interface for doing that.

¹An exemplary implementation of a store which stores the data as files in a file system can be found in the demo package of *@enterprise* (classes `com.groiss.demo.dms.FileStore` and `com.groiss.demo.dms.FileStoreBean`).

@enterprise: Storage and VersionsFigure 8.3: **Storage and Versions**

In the DMS beside managing the actual data of DMS objects we have also the possibility to make versions of DMS objects. These versions must be managed too which lies in the responsibility of interface `com.groiss.org.PersistentVersion` that holds information about the version itself (i.e. when it was created and by whom) and it manages the versioned content of the various DMS objects. Here we have the same strategy as in managing the actual data: versions of structured data are stored in the database, versions of unstructured data are stored via `IStore`.

Whether a version is written, depends on the settings of the version strategy, globally in the system configuration and per form type in the form type definition mask.

A special case is the **versioning of process forms**: if the form is changed, a version is created for the "current" activity instance. This version is overwritten by subsequent changes in the same activity instance. Form updates in the user interface set the context activity instance automatically. If you make a form update using the API, it is necessary to set the context with `form.setActivityContext(ai)` to the right activity instance.

8.4 The @enterprise DMS API

All the interfaces of the DMS API are located in the package `com.groiss.dms`. Apart from the interfaces already mentioned in the above sections this package contains another important interface called `DMS`. This interface offers a powerful set of methods for creating and manipulating DMS objects and provides also some other useful utility methods for programmers working with the DMS. You can retrieve an implementation of this interface by calling `DMS.getInstance`.

The methods of interface DMS are arranged in the following groups:

- Create DMS related objects
- Manage the relations between these objects
- Manipulate the objects
- Navigate within the DMS
- Permissions on the objects
- other utility methods

Each group will be explained in the following section, but for a more detailed description of the mentioned methods see the *@enterprise* API Documentation.

8.4.1 Create DMS objects

Each kind of DMS object has its own creation method in interface `DMS`. For most of them you need the following data:

- the type of the object which should be created
- the name of the object
- a template if the new object should be a copy of this template
- the user who wants to create the object
- a permission list if wanted

The type can be retrieved with following method:

- `FormType getFormType(String id, int version)`

Or you can get all the types a user may create via method `listCreateableFormTypes`. If you want to use a template you have to specify one which is of the same type as the passed one.

When all arguments are available you can use one of these creation methods:

- `DMSFolder createFolder(FormType ft, String name, DMSFolder template, PermissionList acl)`
- `DMSDocForm createDocForm(FormType ft, String name, String extension, DMSDocForm template, PermissionList acl)`
- `DMSForm createForm(FormType ft, DMSForm template, PermissionList acl)`
- `DMSNote createNote(String subject, String content, PermissionList acl)`

As you can see we don't have a creation method for `DMSLink`. This is because links are created by method `move` which will be explained in section [Managing Relations](#).

Best practice for creating subforms via API

The *@enterprise* API offers different ways to create (sub)forms and their relations. This section demonstrates how to use the available API methods to

- avoid unnecessary log entries and
- ensure that adding of a subform is done in the right context in log history of the main form.

For this purpose use following skeleton:

```
FormType subformFormtype = ...; //get subform formtype
DMSForm subform = subformFormtype.newInstance();
//set fields of subform
...
DMS.getInstance().addSubform(mainform, subform);
OrgData.getInstance().insert(subform);
```

If the subform is added in the context of some process instance, you have to set this context on the subform with `subform.setActivityContext(ai)` to ensure correct versioning.

8.4.2 Managing Relations

There are three groups of relationship in DMS and for each group DMS offers a set of methods for managing those relationships. The first group is for managing the relations between a `DMSFolder` and its contents:

- `DMSObject add(DMSFolder f, DMSObject o)` throws `Exception`
adds the object to the folder
- `void remove(DMSFolder f, DMSObject o)`
removes the object from the folder
- `void delete(DMSFolder f, DMSObject o)`
removes the object from the folder and then deletes the object
- `DMSObject move(DMSFolder src, DMSFolder dest, DMSObject doc, short type)`
depending on the value of parameter `type` you can achieve the following goals:
 - `DMS.MOVE`: move the object from one folder to another
 - `DMS.COPY`: add a copy of the object to another folder
 - `DMS.LINK`: add a link to the object to another folder

The second group of methods is provided for managing the relationship between a `DMSObject` and its attached notes:

- `void attachNote(DMSObject target, DMSNote note)`
attaches the note to the target

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- `void removeNote(DMSObject target, DMSNote note)`
removes the note from the target and deletes the note
- `List<DMSNote> listNotes(DMSObject target)`
returns the list of notes which are attached to the target and for which the user has at least view right

And last but not least we have methods for managing the relationship between a `DMSObject` and its versions:

- `PersistentVersion makeVersion(DMSObject obj, String description)`
makes a version of the passed object
- `void deleteVersion(PersistentVersion dv)`
delete the passed version
- `void DMSForm deleteVersions(DMSForm form)`
delete all versions of the passed form
- `List<PersistentVersion> listVersions(DMSObject obj)`
returns a list of the versions of the passed object

8.4.3 Manipulate DMS Objects

Beside the manipulation methods offered already by `DMSObject` and their sub-interfaces, interface `DMS` provides the following methods:

- `DMSObject renameDocument(DMSFolder folder, DMSObject obj, String newName, String newExtension)`
renames the passed `DMSObject`
- `DMSDocForm reloadDocument(DMSFolder folder, DMSDocForm document, String newExtension, InputStream is)`
replaces the content of the passed `DMSDocForm` with the content held by the passed `InputStream`
- `DMSForm changeType(DMSForm obj, FormType newType, DMSFolder folder)`
changes the `FormType` of the passed `DMSForm`
- `void update(DMSObject o)`
updates the `DMSObject`

8.4.4 Navigate within the DMS

Because objects in DMS are hierarchically organized we need some methods to navigate in this hierarchy. Therefore the following methods are available:

- `DMSFolder getRootFolder(User user)`
returns the root of the DMS tree of the specified user
- `DMSFolder getFolder(DMSObject obj)`
returns the folder the passed object belongs to

- `List<DMSFolder> listSubfolders(DMSFolder startFolder)`
returns a list of all the folders within the tree of which `startFolder` is the root (inclusive the root itself)
- `DMSForm getMainForm(DMSForm f)`
returns the main form if there is one
- `List<DMSForm> listSubforms(DMSForm f, int id)`
returns the subforms with the passed id (if there are some)
- `List<DMSForm> listSubforms(DMSForm f, int id, String cond, String order, Object... vals)`
returns the subforms with the passed id which match the passed condition
- `List<DMSForm> listForms(FormType ft, String cond, String order, Object... vals)`
returns a list of objects of the specified type which match the passed condition
- `List<DMSObject> listContents(DMSFolder folder, FormType ft, boolean recursive, String cond, String order, Object... vals)`
returns a list of objects of the specified type which belong to the passed folder and match the passed condition

8.4.5 Permissions in DMS

The interface `com.grois.org.OrgData` offers some methods to check if a specific user may view or edit a `DMSObject`, but the checks in DMS context are a little bit different. The differences are:

- DMS objects which are attached to a process are bound to the rights the user has for this process (i.e. their own right relations are ignored)
- DMS notes which are attached to a `DMSObject` are bound to the rights of their `DMSObject`, and it is also interpreted if they are private (visible only to their creator) or public (visible to all that may view the `DMSObject`)

8.4.6 Utility Methods

Last but not least interface `DMS` provides some utility methods, e.g.:

- `DMSObject getDMSObject(String classname, long oid)`
returns the DMS object with the passed oid which is an instance of the passed class
- `void checkValidName(DMSObject target, String name, String extension)`
throws an exception if the passed name or extension contain an invalid character. Invalid characters are all characters which are considered as invalid by the Windows® file system. By now these are the following characters: `/ \ : * ? " < > |`

- `void checkDuplicateNames(DMSFolder targetFolder, DMSObject targetObject, String name, String extension)`
throws an Exception if the target folder already contains an object with the passed name and extension
- `boolean isDuplicateName(DMSFolder targetFolder, DMSObject targetObject, String name, String extension)`
returns true if the target folder already contains an object with the passed name and extension

8.5 Using the DMS API

Knowing now all relevant interfaces and classes of the *@enterprise* DMS this chapter will show you some examples for the usage of the DMS API, especially for cases which we assume being most likely to be implemented by application programmers. But before describing those examples we will get to know a few additional utility classes of the DMS.

8.5.1 Utilities for DMS related HTML Interface

Additionally to the classes and interfaces mentioned in the sections above the DMS provides other classes and interfaces which should simplify the life of an API programmer building a specific HTML interface to the DMS. These are:

- `DMSTableHandler`
- `XHTMLFolderFormEventHandler`

DMSTableHandler

This interface gives the application programmer the possibility to change the table view and toolbar used to represent the contents of a folder in the HTML client. An implementation of that interface may be set globally (i.e. for all folders) via System Configuration (section DMS) or for each form type representing a folder via administration for form types.

The methods provided by this interface are:

- `void init(HttpServletRequest req, DMSFolder folder, User u, int mode)`
Gives you the possibility to initialize the implementation class.
- `List<DMSObject> getList(List<DMSObject> objects)`
Your chance to modify the list of the table entries and to collect additional data for them.
- `void modifyColumns(List<ColumnDescription> colDescs)`
The descriptions (i.e. column header) for the table columns may be changed here.
- `void modifyTableLine(DMSObject obj, Map<String, Object> line)`
The table line representing on folder entry can also be modified.

- `void modifyActions(List<Pair<String, Object>> actions)`
This is your chance to modify the set of provided actions for the folder and its entries.
- `String lineStyle(DMSObject obj, String style)`
By implementing this method you change the style of the line for the specified folder item by returning the name of the style class which should be used.

Additional information about this interface and its methods can be found in the API documentation.

In section [Adapting Folder and Table View](#) we will see an example for an implementation of `DMSTableHandler`.

XHTMLFolderFormEventHandler

This interface is an extension of interface `XHTMLFormEventHandler` which is only useful for form types representing folders because it provides methods which will be called when an item will be added or removed from a folder.

- `void onAdd(T f, DMSObject o) throws Exception`
This method will be called immediately before a new item will be added to a folder.
- `void onRemove(T f, DMSObject o) throws Exception`
This method will be called immediately before a item will be removed from its folder.

You can register an implementation of this interface as you would register any other type of form event handler. It is also possible to register it for non-folder form types, in that case methods `onAdd` and `onRemove` will never be called.

8.5.2 Adding a Document to a Process

Although adding a document to a process is a default functionality of the *@enterprise* worklist it may sometimes be necessary to perform this action automatically within some program code. Or imagine the case that some external user which may not see the *@enterprise* worklist should be able to add documents to processes. The following example will show how to create a HTML mask which allows you to select a process and add a document to this process. Method `showMask` creates a simple HTML page in which a process can be selected and a file can be specified. As form action method `addDoc` is defined, which takes the users input (without checking the input for correctness) and makes a new document which is added to the specified process.

File `com/groiss/demo/dms/DMSDemo.java`

```
public Page showAddDocMask(HttpServletRequest req) throws Exception {
    List<ActivityInstance> ais =
        WfEngine.getInstance().getWorklist(null, false);
    DropDownList l = new DropDownList("process");
    for (ActivityInstance ai : ais) {
        ProcessInstance pi = ai.getProcessInstance();
        l.addOption("" + pi.getOid(), pi.toString());
    }
}
```

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```
}
HTMLPage page = new HTMLPage();
page.setPage(
    "<form method=\"post\" enctype=\"multipart/form-data\" \" +
    "action=\"com.groiss.demo.dms.DMSDemo.addDoc\">" +
    "Process:" + l.show() +
    "<br>File: <input type=\"file\" name=\"file\">" +
    "<br>Name: <input type=\"text\" name=\"name\">" +
    "<br><input type=\"submit\">" +
    "</form>");
return page;
}

public Page addDoc(HttpServletRequest re) throws Exception {
    //transform the req. because we need a MultipartRequest when handling files
    MultipartRequest req = MultipartRequest.createInstance(re);
    //get the current user
    User user = (User)ThreadContext.currentThread().getPrincipal();
    //get the selected process
    WfEngine e = WfEngine.getInstance();
    ProcessInstance process = e.getProcess(Long.parseLong(
        req.getParameter("process")));

    //get the specified name and divide it into the name and the extension
    //(e.g. doc for Word files)
    String tmpName = req.getParameter("name");
    int idx = tmpName.lastIndexOf(".");
    String name = tmpName.substring(0, idx);
    String extension = tmpName.substring(idx+1);

    //get the file
    File file = req.getFile("file");

    //create a new standard document and add it to the process
    DMS dms = DMS.getInstance();
    FormType ft = Store.getInstance().get(
        FormType.class, FormType.STANDARD_DOCUMENT);
    DMSDocForm newDoc = dms.createDocForm(ft, name, extension, null, null);
    dms.add(process.getDMSFolder(), newDoc);

    //check in the content of the file
    dms.setContent(newDoc, new FileInputStream(file));

    //return an answer
    HTMLPage page = new HTMLPage();
    page.setPage("<html>Upload done.</html>");
    return page;
}
```

Creating the document and adding it to the process is done using the utility class `DMS` from package `com.groiss.dms` which contains a set of DMS related utility methods (for

more details see *@enterprise* API documentation).

This example works also for adding a document to a folder. The only difference is that you have to find the correct folder instead of the correct process. As you can see in the class diagram `com.dec.avw.core.StepInstance` and `FolderForm` (the base class for all folder implementations) implement the same interface `DMSFolder`, so all folder related API methods may be applied to processes and folders.

Adding other DMS objects to a folder or process works quite similar as in the example above. You only have to choose the corresponding creation method in class `DMS` and collect the necessary parameters. After that again call method `add` to add it to the process or folder.

8.5.3 Adapting Folder and Table View

In this example we will implement a table handler and an event handler for a folder to solve the following tasks:

1. add an additional column determining if a bill has already been paid or not
2. at the bottom of the table we want to display the total amount of bills within the current folder
3. change the folders behavior so that it allows only bills or bill folders in its content
4. define a function 'paid' which marks a bill as paid

Adding a Column

If we want to add a column to the table of contents of a folder there are two different ways for doing that:

1. If the additional column is a meta data field of the objects within the content you can add this column via configuration of the folders table representation (either for one specific folder or for all folders of a specific folder type). How this can be done is explained in the [User manual](#).
2. If the additional column is not a column of the contained objects or we don't want to configure it (or cannot because of format problems) we must implement a table handler.

In our case here we could just only configure the additional column but this would not be sufficient because it would display the values `0` for unpaid and `1` for paid (because the meta data field `paid` is a checkbox with these values in the meta data form) which is not very useful. Instead we want the text `No` for unpaid and `Yes` for paid.

So what we will do here is to implement a table handler by creating a class named `OrderFolderTableHandler` which implements `DMSTableHandler`.

File `com/groiss/demo/dms/OrderFolderTableHandler.java`

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```
private Resource applResource;

@Override
public void modifyColumns(List<ColumnDescription> colDescs){
    for(ColumnDescription cd : colDescs){
        if("form.checked".equals(cd.getId())){
            //in this case no additional column must be added
            return;
        }
    }

    //here we know that the column has not already been added
    //via configuration so we do it now
    colDescs.add(new ColumnDescription("form.checked",
        new Image("../images/check.gif")));
}

@Override
public void modifyTableLine(DMSObject obj, Map<String, Object> line) {
    String value = "";
    if (obj instanceof DMSDocForm) {
        if (((DMSDocForm) obj).getFormType().getId()
            .equals("demo_deliverynote")) {
            if ((Boolean) ((DMSForm) obj).getField("checked")) {
                value = getResource().getString("yes");
            } else {
                value = getResource().getString("no");
            }
        }
    }
    line.put("form.paid", value);
}

@Override
private Resource getResource(){
    if(applResource == null){
        applResource = ApplicationAdapter.of("demo").getResource();
    }
    return applResource;
}
```

We have to override method `modifyColumns` to add an additional column for the field `paid` if not already done via configuration. This is only done here to show the programmatic way of adding a column, normally the column should be added via configuration. Then we must override method `modifyTableLine` which will add the value that should be displayed in column "form.paid".

At last we have a private helper method which will return the correct resource for I18N support of our demo application (see the configuration of application 'demo').

When we have finished our implementation we must register our new table handler for our new folder type via administration.

Changing Folder Behavior

In this section we will see how we can change the default behavior of a folder. In our example we will ensure that only one delivery note is attached.

File **com/groiss/demo/dms/OrderFolderEventHandler.java**

```
public void onAdd(DMSFolderForm f, DMSObject o) {
    if (o instanceof DMSDocForm) {
        FormType formType = ((DMSDocForm)o).getFormType();
        if (formType.getId().equals("demo_orderconfirmation") &&
            !DMS.getInstance().listContents(f, formType, true, null, null).isEmpty()) {
            throw new ApplicationException("Only one order confirmation in process");
        }
    }
}
```

Function 'checkDelivery'

Now we have reached the last step in our example. We will write a function with which we can check the delivery. To achieve this goal we have to:

1. write this function
2. make this function available to the user

The next code snippet will show the method for writing this function.

File **com/groiss/demo/dms/DMSDemo.java**

```
public Page checkDelivery(HttpServletRequest req) throws Exception {
    //get the form
    DMSForm deliverynote = HTMLUtils.getObject(req);
    //set it to be checked
    deliverynote.setField("checked", Boolean.TRUE);
    OrgData.getInstance().update(deliverynote);
    JSONObject jso = ClientUtil.getAsJSON(req, deliverynote);
    return new ActionPage(ActionPage.EP_SCRIPTS, "ep.util.refreshParent(" +
        StringUtil.escapeJavaStyleString(jso.toString(), true) + ");");
}
```

Now we must make this function available to the user. This can again be done by overriding method `modifyActions` in our table handler.

File **com/groiss/demo/dms/OrderFolderTableHandler.java**

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```
public void modifyActions(List<Pair<String, Object>> actions){
    for(Pair<String, Object> action : actions){
        if("demo.checkDelivery".equals(action.first)) {
            //in this case no additional action is needed
            return;
        }
    }
    //here we know that the action has not already been added
    //via configuration so we do it now
    actions.add(new Pair<String, Object>("space", "space"));
    actions.add(new Pair<String, Object>("demo.checkDelivery",
        "demo.checkDelivery"));
}
```

The concrete method for that action must be defined in an XML file which must be loadable via the class path. As an example here is our snippet of our demo file:

File **demos/classes/demo.xml**

```
...
<actions>
    ...
    <action id="checkDelivery">
        <name>@@@paid@@</name>
        <href>com.groiss.demo.dms.DMSDemo.checkDelivery</href>
        <apply>ONE</apply>
        <target>HIDDEN</target>
    </action>
</actions>
...
```

As you can see the name of our action has three leading and two trailing '@' signs. This is used when the name of the function should be translated into different languages at runtime (needed in a multi-language environment). The system will interpret this markup and will use the application's resource for translation (see the application's configuration for the defined resource).

8.5.4 Further Examples

In this section we show further examples which do not use the DMS Java API directly but other ways of customizations.

Start at a specific subfolder

Normally the 'Documents' tab of an activity instance initially shows the content of the root folder of that instance. But there may be situations in which you want to display a folder that fits better to the current context, e.g. in case of parallel branches where for each branch a dedicated subfolder should be used. This can be easily achieved by implementing the following method in your `com.groiss.wf.ApplicationAdapter`:

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```
public void modifyDetailPanels(KeyedList<String,NavigationTreeNode> nodes,
String title, ProcessInstance pi, ActivityInstance ai){
    NavigationTreeNode node = nodes.get("documents");
    if(node != null){
        //calculate the folder which content shall be displayed initially
        DMSFolder folder = calculate_the_desired_folder(pi, ai);
        if(folder != null){
            //add the information which folder should be displayed
            node.setAttrib("navigateToFolder", StoreUtil.toJsonAsReference(folder));
        }
    }
}
```

The main clue here is the setting of attribute 'navigateToFolder' which will then be interpreted as the start folder by documents tab.

Tab showing the folder's content

In projects forms are often used to define master data which are maintained using a 'table' node in the GUI configuration file. If those forms represent folders you may want to integrate a view of the content of such a folder. To achieve this goal you need to specify the following nodes in your GUI configuration:

In the tree section you need to define the navigation link that will show the list of your folders as follows:

```
<table id="myfolders">
  <name>My Folders</name>
  <columns>
    <column name="@@@ep:name@@ " id="name" />
  </columns>
  <actions>
    <action id="new" />
    <action id="edit" />
    <action id="delete" />
  </actions>
  <classname>com.groiss.forms.MyFolder_1</classname>
  <defaultAction>edit</defaultAction>
  <detail>com.groiss.storegui.TabbedWindow.showDialog</detail>
  <model>com.groiss.storegui.FormTable</model>
  <version>2</version>
  <tabs>/,myconfig.myfoldercontent</tabs>
</table>
```

As you can see in element 'tabs' we are referencing 'myconfig.myfoldercontent' where 'myconfig' represents the Id of your GUI configuration and 'myfoldercontent' is an action in the nodes section of your configuration:

```
<action id="myfoldercontent">
  <name>Folder content</name>
  <href>com.groiss.dms.html.DMSUtil.showDMSFolder?
    showToolBar=true&disableUpNav=true&
    hideCloseButton=true
```

```
</href>  
</action>
```

The semantics of the parameters in 'href' are as follows:

- `showToolBar`: if set to true the DMS toolbar will be visible in your page, otherwise it will not
- `disableUpNav`: if set to true the user will not be able to navigate to a parent of the current folder
- `hideCloseButton`: as the used URL is designed to be used in its own window it will provide a 'Close' button. This button is of no use in this context therefore it can be hidden by setting this parameter to true

8.6 Office Templates

@enterprise offers many mechanism to manage documents. Such an mechanism is the definition of Office templates with placeholders in XPath syntax which will be replaced by the *@enterprise* engine (see section [XPath-Conditions](#) for more details). Section [Example](#) shows a whole example how Office templates could be used.

8.6.1 Requirements

The templates can be created with OpenOffice (LibreOffice) and must be stored in file format ***.odt**. On the server where *@enterprise* is running an installation of OpenOffice 3 (LibreOffice) or higher must be available. Under *@enterprise Configuration* → *DMS* the path to the OpenOffice directory should be set (see [Installation- and Configuration Guide](#) for more details). The standard communication between *@enterprise* and OpenOffice is the recommended *Named Pipes* communication. In some cases it could be necessary to use the socket connection (e.g. with Windows 64 bit versions) instead of *Named Pipes*.

8.6.2 Placeholder elements

As mentioned before the placeholders in templates are XPath expressions. Placeholders are indicated with `${}`. Within the brackets one of the following elements can be used:

Property replacement

This is the simplest element which is an ordinary XPath expression (see section [XPath-Conditions](#)). It is also possible to use any method to change the values. Following examples should demonstrate the property replacement:

```
Formfield of given form (= context):  
${$form/formfield}  
Id of given process instance (= context):  
${$pi/id}  
Usage of method to get formatted process instance start date:  
${com.groiss.cal.CalUtil.showDate(value($pi/started))}
```

Hint: If methods are called with parameters, the keyword *value* must be used for the parameter!

Loops (Repeats)

Sometimes it is necessary to use one placeholder for many replacements. For this purpose loops can be used which are indicated by the keyword *REPEAT*. The syntax is:

```
${REPEAT $loopvar in $xpaththcollection}content_to_repeat${END}
```

The variable `$loopvar` is the variable that is used within the loop and is one element of the collection. The variable `$xpaththcollection` contains the (XPath to) collection which should be iterated over. The loop must be closed with `${END}`. Examples about the usage of loops are shown in section [Example](#).

Hint: If unnecessary blank lines should be avoided, use SHIFT+RETURN instead of ordinary RETURN before `${END}`!

Conditions (IF)

In addition to loops conditions are also available for template replacement. A condition is indicated by the keyword *IF* and has following syntax:

```
${IF $xpaththcondition>true_handling${ELSE>false_handling${END}
```

As known from loops conditions must be closed with `${END}`. Examples about the usage of conditions are shown in section [Example](#).

Images

The template also allows the definition of placeholders for images. For this purpose the method `com.groiss.office.OdtUtil.insertImage()` is needed. *@enterprise* offers 4 possibilities to replace images:

- *Image from context:* The file is read in a JAVA method and must be set as context for the replacement (see example in section [Example](#)). The placeholder has to be defined in following way:

```
${com.groiss.office.OdtUtil.insertImage($myimg,$document)}
```

- *Image from classpath:* If an image of the *@enterprise* classpath should be replaced, the keyword *cp* is needed and the appropriate classpath as shown in following example:

```
${com.groiss.office.OdtUtil.insertImage(  
  "cp://lang/default/images/img.jpg", $document)}
```

- *Image from filesystem:* It is also possible to get an image from filesystem for replacement. For this purpose you need the keyword *file* and the appropriate path to the image as in following example:

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```
${com.groiss.office.OdtUtil.insertImage(
    "file://C:/img.jpg", $document)}
```

- *Image from DMS*: Images also could be load from DMS for replacement. For this purpose the keyword *dms* is needed and the appropriate DMS path to the image. The keyword *COMMON* indicates that the public root folder is read. This keyword is necessary, because the public root folder has a language depended name which is set during setup of *@enterprise*. The keyword *USER* indicates the user folder of current thread user.

```
${com.groiss.office.OdtUtil.insertImage("dms://COMMON/img.jpg", $document)}
${com.groiss.office.OdtUtil.insertImage("dms://USER/img.jpg", $document)}
```

The parameter `$document` is used by the engine only (no user interaction needed!) and must be set as shown in the examples.

Formatted form field text

Sometimes it is necessary to get the formatted value of a form field (e.g. the display string of dropdown fields / fields referencing value lists). For this purpose the following method is provided:

```
${com.groiss.office.OdtUtil.formatField($form/formdropdownfield)}
```

8.6.3 Creating documents from templates

The *@enterprise* API class `com.groiss.office.DocCreator` offers a simple way for creating documents. The methods of this class can be used in context of a (task) function or in context of system steps/postconditions. For more details please read the APIDoc.

If more flexibility is needed, you have to use the class `com.groiss.office.DocumentManager` which is responsible to replace placeholders and convert it to appropriate format. Following two methods (with different parameters) are available and important for these actions:

- *mixin*: These methods replace the placeholders with values of given context. This could be for example a form, the activity instance or a Map with different elements.
- *convert*: These methods convert the replaced template file (*.odt) to the target file format (e.g. PDF).

More details about the different *DocumentManager* methods can be found in *@enterprise* APIDoc.

8.6.4 Example

This example should demonstrate how Office templates can be used in *@enterprise*. The first step is that we need a form called *myform* which contains following fields:

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```
field1 - String
field2 - String
ufield - com.groiss.org.User
formtxtfield - String
```

This form also contains a subform with *subformid=1* and a field called *subformfield1*. Create instances of *myform* with subform entries in any DMS folder whereby in one instance the value of field *field1* has to be *F1*.

After creation of instances the template file (*.odt) should be created:

Property substitution:

```
-----
Field1+2: ${form/field1} ${form/field2}
Date: ${date}
String: ${string}
Persistent field: ${form/ufield/surname}
```

Activity Instance:

```
-----
Application: ${ai/application/name}
Process: ${ai/process/name}
ID: ${ai/id}
Started: ${com.groiss.cal.CalUtil.showDateTime(value(ai/started))}
```

ThreadUser:

```
-----
${user/firstName} ${user/surname}
```

Repeats:

```
-----
Repeat (1): ${REPEAT $ff in $collection}${ff/field1}, ${END}
Repeat (2): ${REPEAT $subform in $form/subform[@id='1']/form}
            ${subform/subformfield1},${END}
```

Conditions:

```
-----
Has subforms (1): ${IF count($form/subform[@id='1']/form)>0}yes${END}
                  ${IF count($form/subform[@id='1']/form)<0}no${END}
Has subforms (2): ${IF count($form/subform[@id='1']/form)<0}false
                  ${ELSE}true${END}
```

Images:

```
-----
From context: ${com.groiss.office.OdtUtil.insertImage($img,$document)}
From classpath: ${com.groiss.office.OdtUtil.insertImage(
                  "cp://lang/default/images/new.gif",$document)}
From dms (public): ${com.groiss.office.OdtUtil.insertImage(
                  "dms://COMMON/officetemplate.jpg",$document)}
From dms (user): ${com.groiss.office.OdtUtil.insertImage(
                  "dms://USER/officetemplate.jpg",$document)}
From filesystem: ${com.groiss.office.OdtUtil.insertImage(
```

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```
"file://C:/new.gif",$document) }
```

Hint: Please note that the XPath syntax should not contain spaces or line breaks!

For image replacement a document with name *officetemplate.jpg* must be added to public root folder and user root folder of DMS.

After template creation put the template file into *@enterprise* classpath and call following JAVA method to replace placeholders and create a PDF:

```
public void createPDF(HttpServletRequest req, HttpServletResponse resp)
    throws Exception {
    resp.setContentType("application/pdf");
    String source = req.getParameter("file");
    if(StringUtil.isEmpty(source)) {
        source="template.odt";
    }

    //collect values for replacement
    Map<String,Object> context = new HashMap<String, Object>();
    //set form context of given DMS form
    context.put("form",
        Store.getInstance().get(
            "com.dec.avw.appl.myform_1","field1 = ?", "F1")
        );
    //set current date
    context.put("date", CalUtil.showDate(new Date()));
    //set any string
    context.put("string", "Test");
    //set a list of forms for repeats
    context.put("collection",
        Store.getInstance().list("com.dec.avw.appl.myform_1"));
    //set image of given DMS document
    FormType ft = Store.getInstance().get(
        FormType.class, com.groiss.dms.FormType.STANDARD_DOCUMENT);
    context.put("img",
        Store.getInstance().list(ft.getClassName(),
            "name=?", null, "officetemplate").get(0)
        );
    //get any active activity instance and set it
    Application appl = Store.getInstance().get(
        Application.class, Application.DEFAULT);
    ActivityInstance ai = WfEngine.getInstance().getWorklist(
        appl, true).get(0);
    context.put("ai", ai);

    //replace placeholders, convert to PDF and write it on screen
    resp.getOutputStream().write(
        DocumentManager.convert(
            new ByteArrayInputStream(DocumentManager.mixin(
                Settings.getClassLoader().getResourceAsStream(source),
                context)
```

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```
        ), "odt", "pdf"));  
    }
```

9. Forms

9.1 General

When defining a form type, the following elements are created:

- a form type object in the database
- a database table
- a Java interface extending `DMSForm` as and an implementation class as Java representation of the form.
- an HTML file for the GUI representation

The name of the Java interface is the form id followed by "_" and the version of the form, the package is `com.groiss.forms.interfaces` (the implementation classes have the same name and are in the package `com.groiss.forms`).

When referencing forms in your Java code you have two possibilities:

- use the general interface `com.groiss.dms.DMSForm` and the methods `getField` and `setField` for accessing the form fields.
- use the generated interfaces, with getter and setter methods for each field. The form interfaces are packaged in a jar file named *application-id_forms.jar*, which is placed into the lib directory of the application directory. The source is also included in the jar file, providing the form type and field descriptions as Javadoc comments. If you use the interfaces, add this jar file into the build path of your project. It is not necessary to add this jar to the project deliverables - *@enterprise* has copies in the *forms* directory.

Hint: Please note that the *application-id_forms.jar* is generated and updated if the configuration parameter *ep.forms.generate.jar* is set to *generate* (default value). If you don't want to generate and update this file, set the parameter value to *don't generate*. This setting is recommended for production use. If the jar file cannot be (over)written in your installation, you can choose the value *ignore error*.

The interfaces

- `com.groiss.org.OrgData`,

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- `com.groiss.store.Store`,
- `com.groiss.wf.WfEngine` and
- `com.groiss.dms.DMS`

can be used for retrieving and storing forms.

We distinguish three types of forms:

- (process) forms: for storing structured data, can be used as process forms or in the DMS
- document forms: allow additional storage of a document (text, image, etc.)
- folder forms: can be used as folder in DMS

For the GUI representation, there are also three flavors:

- HTML with embedded form elements (not recommended to use it anymore).
- XHTML for better navigation and replacement of elements and attributes (see section [XHTML forms](#) for more details).
- XForms uses the XForms standard, where XForms elements are embedded into XHTML. This is the standard in *@enterprise* (see section [XForms](#) for more details). The form editor creates such files.

In the next sections we show the different APIs for forms, first the form event handler, then the form table handler. The details of XForms and the API is shown thereafter. Finally, the handling of subforms in XHTML is described.

9.2 The Form Event Handler

The form event handler for a form is defined in the administration mask of the form type (see [System Administration Guide](#) for details). One event handler can be used for several form types. Depending on the type and template type of a form, the interfaces for callback methods differ slightly:

- HTML (not recommended to use it anymore): `com.groiss.dms.FormEventHandler`
- XHTML and XForms: `com.groiss.dms.XHTMLFormEventHandler`
- Document form: `com.groiss.dms.DocumentEventHandler`
- Folder form: `com.groiss.dms.XHTMLFolderFormEventHandler`

The common methods of `FormEventHandler`, `XHTMLFormEventHandler` and `XHTMLFolderFormEventHandler` are:

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```
public void beforeInsert(T f) throws Exception;
public void beforeUpdate(T f) throws Exception;
public void beforeDelete(T f) throws Exception;
public void afterInsert(T f) throws Exception;
public void afterUpdate(T f) throws Exception;
public void afterDelete(T f) throws Exception;
public String getName(T f) throws Exception;
```

T is defined as `extends DMSForm`. The first three methods `beforeXX` are called before the respective database actions are performed. The next three methods `afterXX` are called after the respective database actions are performed. The `beforeShow` method is called before the page of the form is built. With `getName` you may overwrite the `toString` method of a form.

Hint: If a form event handler is specified for a form and this form will be imported by *@enterprise* import-function, the form event handler(s) will be called.

The callback methods for showing HTML forms (`com.groiss.dms.FormEventHandler`):

```
public void beforeShow(T f, FormContext ctx, HttpServletRequest req)
    throws Exception;
public void onShow(T f, ActivityInstance ai, HTMLPage p,
    HttpServletRequest req) throws Exception;
```

For XHTMLForms and XForms (`com.groiss.dms.XHTMLFormEventHandler`):

```
public void beforeShow(T f, FormContext ctx, HttpServletRequest req)
    throws Exception;
public void onShow(T f, FormContext ctx, XHTMLPage p,
    HttpServletRequest req) throws Exception;
public void modifyModel(T f, Element formElement, FormContext ctx);
```

Method `beforeShow` is called before the (X)HTML page is built.

Method `onShow` is called after the (X)HTML is generated, so you can make additional replacements.

Method `modifyModel` is only applicable for XForms, see below.

Example: In the following example the `beforeShow` and `onShow` methods are used:

```
@Override
public void beforeShow(TestAddress_1 f, FormContext ctx, HttpServletRequest req) {
    if (f.getCountryField() == null) {
        f.setCountryField("AT");
    }
}

@Override
public void onShow(TestAddress_1 f, FormContext ctx, XHTMLPage p,
    HttpServletRequest req) {
    p.get("name").setStyle("background-color:red");
}
```

In `beforeShow` a default value is set for a form field, in `onShow` we set the style of an element.

Example: Using Form Event Handler with XForms

```
public void onShow(
    DMSForm form, FormContext ctx, XHTMLPage p, HttpServletRequest req) {
    Element root = p.getRoot();
    Element f = XMLUtil.getElement(
        "//xf:textarea[@ref='/data/form/texti']", root, XForm.xformNS);
    f.setAttribute("style", "color:red");
}
```

In this example we use XPath to get the *textarea* with the identification `[@ref='/data/form/texti']` and set a new text-color. The following code shows the text-area within the XForm:

```
....
<xf:textarea ref="/data/form/texti" rows="" cols="">
    <xf:label class="label100">MyTextarea</xf:label>
</xf:textarea>
...
```

If your form is of type folder form, the interface `com.groiss.dms.XHTMLFolderFormEventHandler` can be implemented, providing two additional methods:

```
public void onAdd(T f, DMSObject o) throws Exception;
public void onRemove(T f, DMSObject o) throws Exception;
```

T is defined as extends `DMSFolder` & `DMSForm`. If your form is of type document form the interface `com.groiss.dms.DocumentEventHandler` provides the following method which is called when the content of a DMS document will be initially set or changed:

```
public InputStream onSetContentAsStream(T document, InputStream content);
```

9.3 The Form Table Handler

A subform table or configured table (see GUI configuration) can be customized by using a table handler. The class must implement the interface `com.groiss.dms.FormTableHandler`. The class is registered in the `tablefield` tag (of a subform) as attribute `tablehandler` or in the XML GUI configuration file by using the element `tableHandler` (which is the recommended way). The interface contains the following methods:

```
public void init(HttpServletRequest req, FormContext ctx);
public List getList(List<T> list);
public void modifyColumns(List<ColumnDescription> colDescs);
public void modifyTableLine(T f, Map<String, Object> line);
public String lineStyle(T f, String style);
```

The first method is useful to initialize your class with the request. With the second method you have the possibility to modify the delivered list and return it. The third method allows to modify the table header. With the fourth method you can modify each table line. The last method is for changing the style of the table lines by returning a new css class.

9.4 XForms

XForms is a standard defined by the W3C consortium for the definition of web forms. In *@enterprise* XForms can be used as an alternative to HTML forms. The advantages of XForms make this technology an excellent choice for all further web form implementations. This section describes how XForms can be used in *@enterprise*.

Following the functional principle for displaying a XForm is described:

- The XForm template is loaded and parsed.
- Within the `model` element an `instance` element with instance- and context-data is added. The form fields are accessible via the path `data/form/fieldname`.
- The `bind` element with visibilities is added to the `model`.
- Depending on the kind of representation the appropriate submit-buttons and their actions are added.
- The XForm is converted to a XHTML page: Each XForm control is converted to a HTML equivalent which is filled with the data of the `model` and displayed with the appropriate visibility.

The following example shows the *model* of a form with the form fields *name*, *country* and *amount*:

```
<xf:model>
  <xf:instance>
    <data xmlns="">
      <form object="com.groiss.forms.wiztest_1:1000074412" task="1000074417">
        <transactionId>73</transactionId>
        <avwcreatedby>roland eisenberg</avwcreatedby>
        <avwcreatedat>2009-04-06T07:05:22Z</avwcreatedat>
        <avwchangedby>roland eisenberg</avwchangedby>
        <avwchangedat>2009-04-07T08:28:22Z</avwchangedat>
        <name>John Doe</name>
        <country>GB</country>
        <amount>40011</amount>
      </form>
    <context>
      <viewmode>view_text</viewmode>
      <activityinstance oid="1000042420">Process 158</activityinstance>
      <processinstance oid="1000042417">158</processinstance>
      <task oid="1000000185" id="wiztest_request" version="0">
        Request</task>
      <processdefinition oid="1000000090" id="wiztest" version="1">
        Test Process </processdefinition>
      ...
    </context>
  </data>
</xf:instance>
<xf:bind nodeset="/data/form/name" required="false()" type="string" />
```

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```
<xf:bind nodeset="/data/form/country" required="false()" type="string" />
<xf:bind nodeset="/data/form/amount" required="false()" type="decimal" />
<xf:submission action="com.groiss.storegui.FormWrapper.updateNoAction"
  replace="instance" method="post" markempty="true" validate="false" id="submit0" />
<xf:submission action="com.groiss.storegui.FormWrapper.finish?afterSubmit=
  com.groiss.storegui.FormWrapper.afterFinish"
  method="post" replace="instance" markempty="true" id="submit1" />
<xf:submission action="com.groiss.storegui.FormWrapper.updateAndAction?afterSubmit=
  com.groiss.storegui.FormWrapper.gotoComeFrom"
  method="post" replace="instance" markempty="true" id="submit2" />
</xf:model>
```

Hint: Form data are written in first model of a XForm which represents the default model!

In addition to the form fields the following context data are included in default model:

- `activityinstance`: The oid and toString of the current activity
- `processinstance`: The oid and Id of the process instance
- `task`: The oid, Id, version and the name of the task
- `processdefinition`: The oid, Id, version and the name of the process definition
- `viewmode`: The view mode with one of the following values: update, insert, search, view, view_version, view_text

Hint: On log level TRACE the whole XForm is written into log (before converting into HTML).

In the following some examples should illustrate the usage of XForms.

Example 1: Setting a field to read-only: The fields *curefrom* and *cureto* are editable only, if the field *reason* is set to value *cure*.

```
<xf:bind nodeset="/data/form/curefrom" readonly="/data/form/reason != 'cure'"/>
<xf:bind nodeset="/data/form/cureto" readonly="/data/form/reason != 'cure'"/>
```

Example 2: Usage of value lists: The different types of a vacation are stored in a value list. XForms use an own model element for value lists.

```
<xf:model id="valuelist">
  <xf:instance src="com.groiss.wf.html.ValueList.show?id=holidaytype"/>
</xf:model>
```

For the `src` attribute the represented URL must be entered. The attribute `id` references the Id of the value list. If more than one value list should be used, the id's must be separated by commas. The body of a XForm contains an element with reference to the value list:

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```
<xf:select1 ref="/data/form/type"><xf:label>Vacation type</xf:label>
  <xf:itemset model="valuelist" nodeset="/valuelists/list[@id='holidaytype']/item">
    <xf:label ref="label"/>
    <xf:value ref="value"/>
  </xf:itemset>
</xf:select1>
```

Example 3: Configuration data: The form should use the currency symbol defined in the configuration (of an application). If configuration parameter should be used within the XForm, the `configuration` element is needed which defines all parameters as `property` element with their names. The name consists of the application-id as prefix and the parameter-name. *@enterprise* parameters do not need a prefix. The values are inserted at runtime:

```
<xf:instance>
  <data xmlns="">
    <configuration>
      <property name="myappl:currency.symbol" />
    </configuration>
  </data>
</xf:instance>
...
<xf:bind id="currency" nodeset="//property[@name='myappl:currency.symbol']"/>
```

Example 4: Usage of subtable (subform): The element `xf:repeat` is needed. Within this element the `formtype` of subform and a `subformid` must be specified. The created HTML structure is the same as described in section [XHTML forms with Sub-tables](#) and it is also possible to define the same attributes:

```
<xf:repeat formtype="com.groiss.forms.subform_1" subformid="1">
  <xf:label class="label100">Subtable</xf:label>
</xf:repeat>
```

Example 5: Calculate sum from subforms: A billing form contains a subform which represents the items. The main form should display the sum of the items. For this purpose a `bind` element can be used which computes the sum with the attribute `calculate`:

```
<xf:bind nodeset="/data/form/totalamount"
  calculate="sum(/data/form/subform/form/total)"/>
```

Example 6: Embedded subtable: With XForms it is possible to embed subtables with the attribute `xf:repeat-nodeset` (for any element). The attribute value (called `nodeset` for element `repeat`) is a XPath expression which selects the subforms. The content of the `repeat` element is repeated for each subform. The buttons *Delete* and *New line* are XForm triggers which resolve the XForm actions "delete" and "insert". It is necessary for *@enterprise* to add a `subformid` and `formtype` to the `repeat` element:

```
<xf:group class="xformscontrol" ref="/data/form/subform[@id='1']/form">
  <label>Time item:</label>
  <div class="scEditableSubform">
    <table class="subformtable">
```

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```
<tr>
  <th class="subformtable-column-itemdate">itemdate</th>
  <th class="subformtable-column-costcenter">costcenter</th>
  <th class="subformtable-column-description">description</th>
  <th class="subformtable-column-timefrom">timefrom</th>
  <th class="subformtable-column-timeto">timeto</th>
  <th class="subformtable-column-lunchbreak">lunchbreak</th>
  <th class="subformtable-column-homeoffice">homeoffice</th>
  <th class="subformtable-column-minutes">minutes</th>
</tr>
<tbody xf:repeat-nodeset="/data/form/subform[@id='1']/form[position() !=last()]"
  formtype="com.dec.avw.appl.hr_timeitem_1" subformid="1" id="repeat_1">
  <tr>
    <td>
      <xf:input ref="itemdate" />
    </td>
    <td>
      <xf:input ref="costcenter" />
    </td>
    <td>
      <xf:input ref="description" />
    </td>
    <td>
      <xf:input ref="timefrom" />
    </td>
    <td>
      <xf:input ref="timeto" />
    </td>
    <td>
      <xf:input ref="lunchbreak" />
    </td>
    <td>
      <xf:input ref="homeoffice" />
    </td>
    <td>
      <xf:input ref="minutes" />
    </td>
  </tr>
</tbody>
</table>
<xf:trigger ref="/data/form/subform[@id='1']/buttons">
  <xf:label>@@@ep:new_line@@</xf:label>
  <xf:insert position="after"
    nodeset="/data/form/subform[@id='1']/form" at="index('repeat_1')" />
</xf:trigger>
<xf:trigger ref="/data/form/subform[@id='1']/buttons">
  <xf:label>@@@ep:delete@@</xf:label>
  <xf:delete nodeset="/data/form/subform[@id='1']/form" at="index('repeat_1')" />
</xf:trigger>
</div>
</xf:group>
```

9.5 The XForms API

This section will show you some useful examples for the usage of the XForms API.

9.5.1 Using the form event handler

Your handler should implement `com.groiss.dms.XHTMLFormEventHandler`, the same as for XHTML forms (see section [The Form Event Handler](#) for details). Note the specifics in two methods:

- `onShow`: The method is called before the XForms elements are replaced with HTML elements.
- `modifyModel`: enables the manipulation of the XForms model before it is mixed into the form. The difference to the manipulation of the form in the `beforeShow` method is that this method is also called when the form data are sent to the client after an update.

9.5.2 View a form

Sometimes it is necessary to view the form with specific visibilities or buttons. The following method can be used for all types of forms:

```
com.groiss.wf.html.HTMLUtils.showForm
```

For XForms the action parameter is ignored, set the `submitAction` in the `SubmitButton`. Example:

```
public Page showForm(HttpServletRequest req) throws Exception {
    // get the formtype
    FormType ft = Store.getInstance().get(FormType.class, "id=?", "appl_fid");
    // create a new form
    DMSForm form = ft.newInstance();
    // setting field(s)
    form.setField("field1", "text-from-server");
    // add a submit button
    SubmitButton sb = new SubmitButton("Insert");
    sb.setSubmitAction("test.Xformtest.update");
    return HTMLUtils.showForm(form, Arrays.asList(sb), null, new FormContext(req));
}
```

This method shows an empty form, one field value is set, and a submit button is added. Visibilities and modes can be modified with the `com.groiss.dms.FormContext`.

Note that XForms submit buttons have two modes:

- `replace=instance`: the response from the server replaces the instance data
- `replace=all`: this is the default, the response from the server replaces the page (as normal HTML form submit does)

You can set the replace mode on the submit button.

9.5.3 Implement the submit action

The action is implemented as a servlet method with a `HttpServletRequest` parameter.

- First get an instance of the XForms implementation:

```
XFormImpl xFormImpl.getInstance (HttpServletRequest req);
```

- The request contains an object parameter containing `classname:oid`, so you can get the right form from the database (if `oid` is null, you get an empty form):

```
DMSForm f = HTMLUtils.getObject (req);
```

- To save the values from the request into the form, use:

```
void XFormImpl.setValues (DMSForm form, HttpServletRequest req);
```

- The complete XForms model is also accessible, get the `com.groiss.xforms.XFormInstance` object:

```
XFormInstance xFormImpl.getFormInstance (HttpServletRequest req);
```

The `com.groiss.xforms.XFormInstance` interface has several methods, for example getting and setting form fields:

```
XFormInstance.getFieldValue(String path);  
XFormInstance.setField(String path, Object value);
```

The `path` in the first method is an XPath to the field, the `Object` in the second method is either an XML (JDOM) Element or Attribute.

The following example method illustrates a form update:

```
public Page updateForm(HttpServletRequest req) throws Exception {  
    DMSForm f = HTMLUtils.getObject(req);  
    // for accessing the form, first get the implementation  
    XFormImpl xformImpl = XFormImpl.getInstance(req);  
    // set the values to a form  
    xformImpl.setValues(f, req);  
    // then update the form  
    OrgData.getInstance().update(f);  
    // send back a page  
    HTMLPage p = new HTMLPage();  
    p.setPage("<html>Done.</html>");  
    return p;  
}
```

If the submission mode is `replace=all`, the method is completed by returning an `HTMLPage`.

Sometimes it is necessary to resend the changed form to the client (for example if you have changed subforms in a non-editable table). In this case you can use `refreshForm`:

```
HttpServletResponse HTMLUtils.refreshForm(HttpServletRequest req)
```

If the submission mode is `replace=instance`, send back the changed instance data using this method:

```
impl.sendFormInstance(XFormInstance inst, HttpServletResponse res)
```

9.5.4 XForms buttons in the form

For defining submission buttons in the form, use the form editor. You can define the `id`, the server url (`action`), the `replace` mode and the validation. If you don't want a button, but invoke the submit action from JavaScript, use the following:

```
ep.xforms.xformSubmitLocal2(  
    {modelid: "model", replace: "instance",  
    action: "test.Xformtest.compute", validate: false});
```

The parameter `modelid` is always `"model"`, `replace` can be defined as `"instance"`, `"none"` or `"all"`, the `action` is a servlet method and if `validate` is specified as `true`, an error message will be shown if the form is not filled correctly.

9.5.5 Client side event handling

According to the XForms definition, it is possible to define event handlers for the following XForms events:

- | | | |
|------------------------|-------------------------------|-------------------------|
| • xforms-value-changed | • xforms-invalid | • xforms-model-destruct |
| • xforms-enabled | • xforms-refresh | • xforms-ready |
| • xforms-disabled | • xforms-recalculate | • xforms-help |
| • xforms-readonly | • xforms-revalidate | • xforms-next |
| • xforms-readwrite | • xforms-rebuild | • xforms-previous |
| • xforms-required | • xforms-model-construct | • xforms-submit |
| • xforms-optional | • xforms-model-construct-done | • xforms-submit-done |
| • xforms-valid | | • xforms-submit-error |

As an example, the following event handler for the XForms-submit event shows a confirm dialog before form submission:

```
require(["ep/Utils", "dojo/on", "dojo/domReady!"], function(Utils, on) {  
    on(window, "xforms-submit", function(evt) {  
        var submission = evt.xformSubmission;  
        if(submission) {  
            if(!submission.resumed) { //this is the original action  
                evt.preventDefault(); //stop original submission  
                //let the user decide  
                Utils.yesNoCancel("Confirm first...").then(function(result) {  
                    //flag to identify second submission and avoid check  
                    submission.resumed = true;  
                    ep.xforms.xformSubmitLocal2(submission); //retry submission  
                });  
            }  
        }  
    });  
});
```

9.5.6 Subform handling

When using editable subforms tables, the subforms can be manipulated in a form submission with mode `replace=instance`. In the following example a subform is added:

```
XFormInstance instance = impl.getFormInstance (req);
Element root = instance.getInstanceElement();
Element formdata = root.getChild("form");
// there may be more than one subform element, subformid is attribute id
Element subformelement = formdata.getChild("subform");
// list of subforms
List<Element> subformelements = subformelement.getChildren("form");
// the last subform is the prototype
Element prototype = subformelements.get(subformelements.size() - 1);
// the new subform
Element clone = prototype.clone();
// set some fields
clone.getChild("amount").setText("123");
// add it as last element before the prototype
Element parent = prototype.getParentElement();
int index = parent.indexOf(toClone);
parent.addContent(index, clone);

// send result to the server
xfimpl.sendFormInstance(instance,
    new String[] { "/data/form/subform[@id='1']/form" }, res);
```

Note, that we use a different signature of the `sendFormInstance` method: the client must be informed, which subform tables have to be refreshed.

9.5.7 Evaluate the bindings

The XForms bindings may contain constraints and mandatory checks, which are evaluated when submitting a form. However, you can perform these checks without client interaction. The following piece of code shows the principle:

```
XFormInstance instance = xfimpl.getFormInstance(form, ctx);
instance.processBindings(true);
return instance.isValid();
```

The code calls `getFormInstance` from the XForms implementation object with a form and a `FormContext`. Then, it evaluates the bindings and returns the validity of the model

9.6 XHTML forms

This section will show you some useful examples for the usage of XHTML forms.

9.6.1 XHTML forms with Sub-tables

@enterprise allows the definition of master-detail relations between forms. Master-detail (or 1:n) relations are common in many application areas. Consider the relation of an "order" and the order items as an example.

To model such a relation using *@enterprise* forms you define first the "detail" form (the "order item" in the previous example) and load it into *@enterprise*. Next, you define the master-form with a reference to the detail-form.

This reference is defined with the HTML-Tag `tablefield`, which has the following attributes:

- **formtype:** The name of the Java class of the subform.
- **subformid:** An integer value as identification of the subform. There can be more than one subform in a form and they must have different numbers.
- **configid:** Reference to a table defined in GUI configuration XML (see chapter [Configuring the Worklist Client](#) for more details defining a table). The reference consists of the XML-id (created by the *@enterprise GUI-Configuration*) and the node-id, i.e. `<xmlid>.<nodeid>`. Following an example of a subform table in XML:

```
<table id="jobform_subtable">
  <name>Jobform subtable</name>
  <actions>
    <action id="new" />
    <action id="edit" />
    <action id="delete" />
  </actions>
  <sortable>true</sortable>
  <selection>ROWMULTI</selection>
</table>
```

In case of subforms only some attributes are possible for a subform table:

- **actions:** Defines the toolbar actions; *new*, *edit* and *delete* are the default actions. Own actions can be defined within `<nodes>` block as described in chapter [Non tree nodes \(<nodes>\)](#). If an own function is called following parameters are important for subform tables:
 - * **object:** Contains all selected subform entries depending on *selection*.
 - * **_src:** The `<classname>:<oid>` of the mainform
 - * **id:** The id of the subform (= attribute *subformid*)
- **selection:** ROWMULTI, ROWONE or NONE; defines the selection mode of table entries.
- **sortable:** true or false; if true, the subtable is sortable.
- **class:** A CSS class can be defined for the subform. By entering CSS class *balloon* and calling `ep.resize.initBalloonResizing()` in a DOJO onLoad handler it allows the subtable to resize automatically.

9.6.2 The attribute *epblock* in XHTML-Forms

Elements with an `epblock` attribute can be used to set the visibility of a section in a form. All *div* tags, which have this special attribute, will be displayed in the mask *Visibility of Forms*. The `id` attribute of the `div` tag is necessary for unique identification.

Example:

```
<div id="thefield_div" epblock="true">
  <table>
    <tr>
      <td class="tdb"><label for="thefield">FieldName:</label></td>
      <td><input type="text" id="thefield" name="thefield" dbtype="VARCHAR"
        maxlength="30" size="20" /></td>
    </tr>
  </table>
</div>
```

10. The Workflow Engine

In this chapter we first present the function of the *@enterprise* workflow engine. After this, the API of the engine is explained. Examples will show the possibilities of the API.

10.1 Process definition and execution

The definition of a process can be represented as graph. The activities are the nodes, the edges represent the flow of control. The graph of the process definition is either generated from a WDL script or graphically defined using the process editor.

The nodes of the graph can belong to the following types:

- *task*: interactive task (done by the user)
- *system*: automatic step, call of a program
- *process*: call of a sub process
- *condition*: labeled as *if*, *while*, *exit_when*: branch with condition
- *andjoin* and *orjoin*: join node after a split to parallel branches
- *nop*: structural nodes labeled as *par*, *begin*, *end*, and *goto*

The edges are directed and can have one of the following types:

- *normal*
- *then*: The edge is followed, when the condition in the previous node evaluates to true.
- *else*: The edge is followed, when the condition in the previous node evaluates to false.

Fig. 10.1 shows the same process in WDL notation and as graph produced from the process editor. This graph is structurally equivalent to the internal structure of the process definition.

```

process iftest()
  version 1;
  name "iftest";
  forms f Jobform;
  application default;
  begin
    if (f.recipient = null) then
      all right();
    else
      r1 left();
    end;
    while (f.subj = "1") do
      r2 while1();
      r3 while2();
    end;
  end;
end;

```

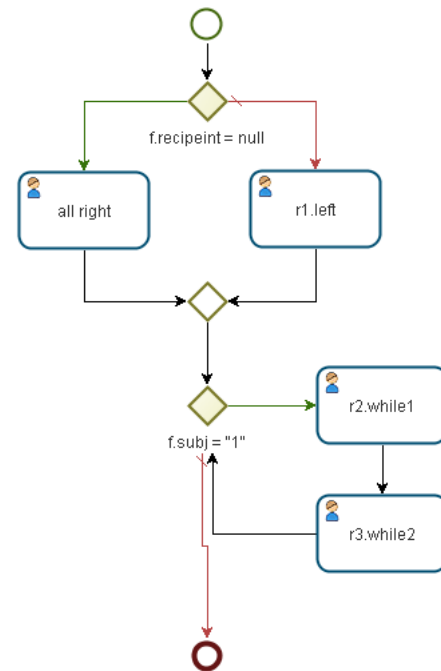


Figure 10.1: **Process graph**

The workflow engine is an interpreter for the process definition graph. Its responsibility is to change the state of the process instances according to the process definition graph. The behavior of this interpreter can be described with the two procedures `start_activity` and `finish_activity` shown in Fig. 10.2.

When a workflow is initiated, the procedure `start_activity` is called, it selects the initial activity of the process and calls the procedure recursively. The behavior of this procedure depends on the type of the node currently processed. If the type is *nop* (*par*, *loop*, *endif*, or *end*) no action is performed and the execution proceeds with the successor nodes. If the type of the node is *condition* (*if*, *while*, or *exit_when*) the expression defined with the node is executed and depending on the result the branch marked with *then* or the branch marked with *else* is followed. The two node types closing a parallel execution - *andjoin* and *orjoin* - are handled in the following way: When processing an *orjoin* node, the successor is started when the first branch reaches the *orjoin* node. When processing *andjoin* nodes, the successor is started when the last branch reaches the node. If the node is a *task* node, the following steps are performed: the (optional) procedure defined for this activity is executed, then the agent is assigned. At this point the procedure terminates.

When the user finishes an activity, the procedure `finish_activity` is invoked (the button complete in the worklist client) with the activity. In the procedure `finish_activity` the successors of the node are started. The second argument defines the type of edge to

10. The Workflow Engine

```
procedure start_activity(act)
  if type_of(act) = condition then
    if execute_expression(act)
      then finish_activity(act, "then");
      else finish_activity(act, "else");
    end if;

  elsif type_of(act) = nop then
    finish_activity(act, "normal");

  elsif type_of(act) = orjoin then
    if this is the first finished branch then
      finish_activity(act, "normal");
    end if;

  elsif type_of(act) = andjoin then
    if this is the last finished branch then
      finish_activity(act, "normal");
    end if;

  elsif type_of(act) = process then
    start_activity(init_activity(act));

  elsif type_of(act) = activity then
    execute_procedure(act);
    assign_agent(act);

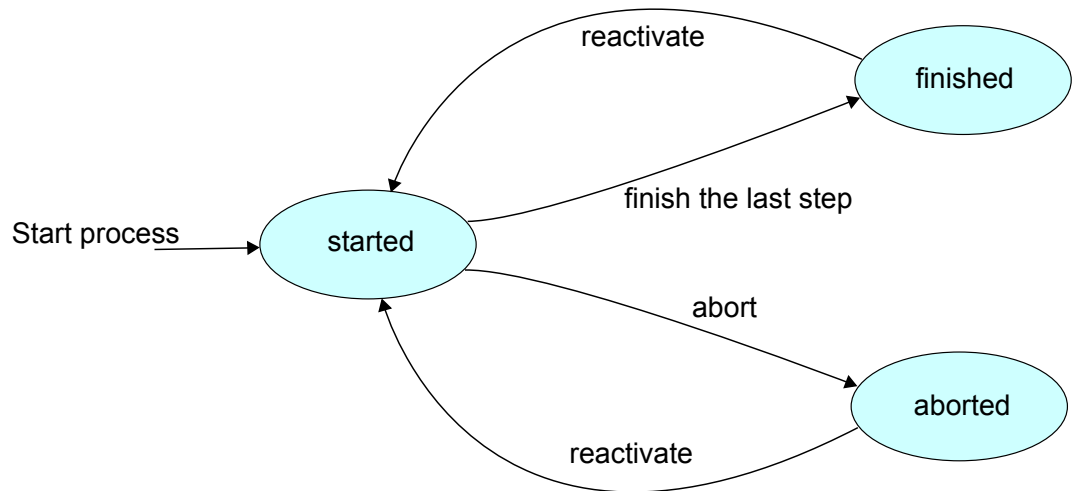
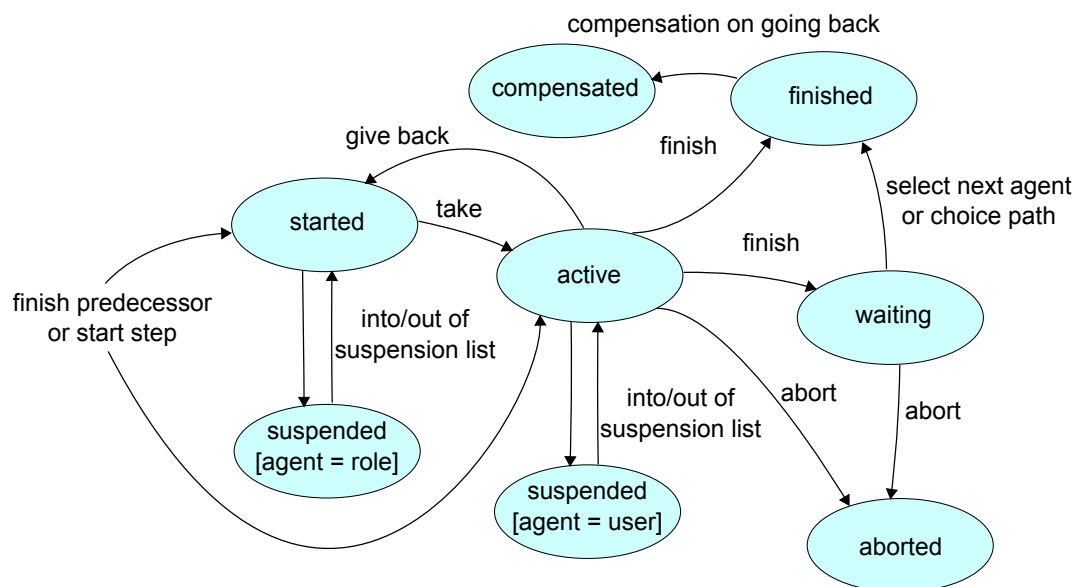
  elsif type_of(act) = system then
    execute_procedure(act);
    finish_activity(act, "normal");
  end if;
end;

procedure finish_activity(act, b)
  if no successors of act then
    finish_activity(parent(act));
  else
    for all successors succ of act in branch b do
      start_activity(succ);
    end do;
  end if;
end;
```

Figure 10.2: Interpreting the process definition

follow.

States of process instances and activity instances are shown in Fig. 10.3 and Fig. 10.4. The process is either running (state *started*) or not running - when it has been finished normally (state *finished*) or when it has been aborted (state *aborted*). When an interactive activity is started, it is assigned to a role (state *started*) or to a user

Figure 10.3: **Process States**Figure 10.4: **Activity States**

(state *active*). Taking the activity from the role-worklist to the personal worklist changes the state to *active*. Putting it in the suspension list changes the state to *suspended*. When the process is aborted, the active activities afterwards have the state *aborted*. Finishing an activity normally leads to state *finished*. When the agent of the following task or a choice path have to be selected, the state of the activity is *waiting*, until this action has been done. The action "go back" compensates the activities lying on the path to the previous activity, this activities have then the state *compensated*. The constants for this states are defined in the interface `com.groiss.wf.ActivityInstance`.

10.1.1 Structure of run-time data

Whenever a process or activity is started, some objects are created and stored in the database. We call these objects run-time data, because they are created at run-time (of the engine) in opposition to the build-time data (for example the process definition).

Fig. 10.5 shows the relationship between the process graph and the run-time data. The process structure shown in the left part of the figure is composed of nodes and edges. Nodes of type *task* have a reference to a `com.groiss.wf.Task` object. When the process is started, for each node the engine processes an `com.groiss.wf.ActivityInstance` object is created. These objects have references to the corresponding node of the process graph. More than one `com.groiss.wf.ActivityInstance` can be generated for one node in the process graph in one process instance: The functions "set agent" or "give back" create additional `com.groiss.wf.ActivityInstance` objects, so that the history of the process instance can be seen when listing the `com.groiss.wf.ActivityInstance` objects.

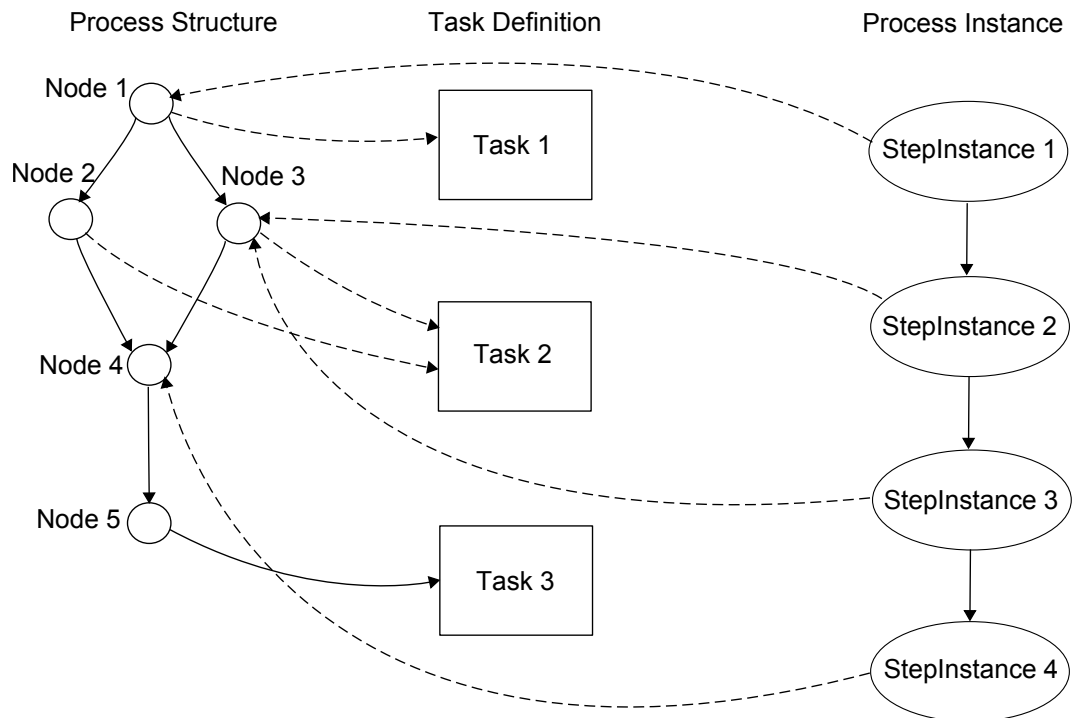


Figure 10.5: Process graph and run-time data

If the node in the process graph is of type *process* the corresponding `com.groiss.wf.ActivityInstance` object represents the execution of a subprocess and also implements the interface `com.groiss.wf.ProcessInstance`.

The `com.groiss.wf.ActivityInstance` objects representing the execution of the subprocess are children of this object.

Fig. 10.6 shows such a graph of `com.groiss.wf.ActivityInstance` objects. The object *p0* represents the execution of a process instance *p0*. In this process instance four

steps have been executed, the tasks $t1, t2, t3$, and the process $p1$. The execution of $p1$ contained the steps $t4, t5$, and $t6$.

The API provides the methods `getParent` in `com.groiss.wf.ActivityInstance` and `getActivityIntsance` in `com.groiss.wf.WfEngine`, for navigating through this hierarchy. A process instance has always at least one root node (`com.groiss.wf.ProcessInstance` object) and one or more leaf nodes.

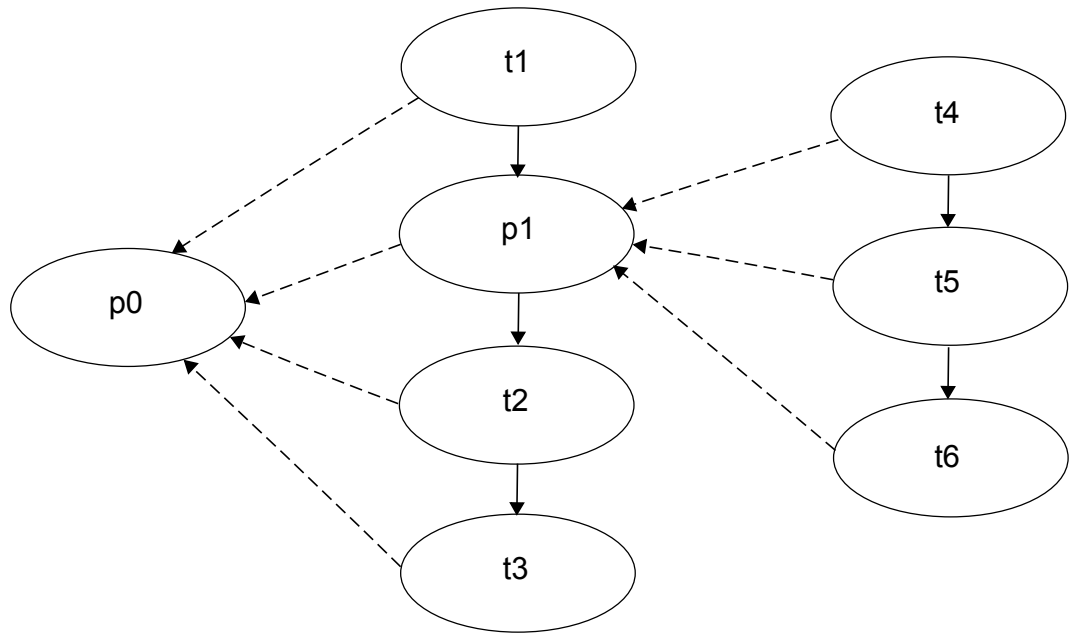


Figure 10.6: **Graph of ActivityInstance objects**

10.2 The *@enterprise* workflow API

The classes and interfaces for accessing the workflow engine are located in the package `com.groiss.wf`. The objects of the process definition and the run-time data can be accessed with the following interfaces:

- `ProcessDefiniton` representing the definition of a process
- `Task` the interactive steps of a process definition
- `ProcessInstance` the instance of a process
- `ActivityInstance` the instance of a step of a process

The methods for manipulating process instances are executed using the interface `WfEngine`. The method `getInstance` of interface `WfEngine` returns an `WfEngine` object. The methods are arranged in four groups:

- Create a process instance
- Find process instances
- Get information about process instances
- Change the state of process instances

10.2.1 Create a process instance

To create a process instance we must specify the following data:

- The process definition
- The user who starts the process
- The organizational unit, where the process is started
- The date when the process should be finished (optional)

See the chapter [Organizational Data](#) for information how to get users and org.-units. The process definition can be retrieved with one of the methods of WfEngine:

```
ProcessDefinition getProcessDefinition(String id);  
ProcessDefinition getProcessDefinition(String id, int version);
```

Additionally, `listProcessDefinitions` returns the process definitions of an application, `getStartableProcesses` the processes a user can start.

When the arguments are collected, the process can be started using:

```
ProcessInstance startProcess(ProcessDefinition p, User u, OrgUnit d,  
                             Date duedate, String id)
```

The last argument is the process instance id. If you leave it null, the system assigns an id.

10.2.2 Find process instances

The following methods are used to find a process instance:

```
public List<ActivityInstance> getWorklist(Application a, boolean withRepr);  
public List<ActivityInstance> getRoleWorklist(Application a);  
public List<ActivityInstance> getSuspensionList(Application a);  
public List<ActivityInstance> getRoleSuspensionList(Application a);  
public ProcessInstance getProcess(String id);  
public ProcessInstance getProcess(long oid);  
public ProcessInstance getProcess(DMSForm f);
```

The first four methods retrieve the worklist, role-worklist, suspension list and role-suspension list of the current user. You can call the methods with application null, for getting the items for all applications. An alternative way is to use the methods

```
public List<ActivityInstance> getWorklist(WorklistKind wlKind, Application a);  
public List<ActivityInstance> getWorklist(Set<WorklistKind>  
                                         wlKinds, Application a);
```

If you know the id or the oid of a process, call one of the `getProcess` methods.

10.2.3 Get information about a process instance

The interface `ActivityInstance` has getter methods for all the information stored in the underlying object: the agent, start time, end time, status, organizational unit, process definition, process instance, type, and task.

The interface `ProcessInstance` has additional methods for getting the subject and the id.

In the `WfEngine` interface the following methods are available:

- `public List<ActivityInstance> getActiveTasks(ProcessInstance process)`
returns all active (state started, active, or suspended) tasks of a process
- `public List<ActivityInstance> getActiveTasks(ProcessInstance process, User u)`
like above, restricted to a user.
- `public List<? extends ActivityInstance> getAllInteractiveTasks(ProcessInstance pi)`
returns all interactive tasks of a `ProcessInstance`, even if they are children of a `parfor`, `par` or `scope`.
- `public List<ActivityInstance> getActivityInstances(ProcessInstance process)`
all activity instances of a process instance (all children).
- `public DMSForm getForm(ActivityInstance ai, String id)`
a form of the process, identified by the id; if ai is part of a `parfor` or subprocess without form, the form of the next parent (process instance) will be returned in case of availability or otherwise the next parent process form (until the root process instance is reached). The structure of the process instance hierarchy is shown in section [Methods for process instances](#).
- `public List<DMSForm> getForms(ProcessInstance process)`
all forms of the process.
- `public ProcessInstance getMainProcess(ActivityInstance ai)`
the root of the tree of activity instances.
- `public ProcessInstance getParent(ActivityInstance ai)`
the parent of an activity instance.
- `public List<DMSObject> getDocuments(ProcessInstance process)`
a list of documents attached to the process
- `public List<DMSNote> getNotes(ProcessInstance process)`
the notes attached to a process instance.

10.2.4 Manipulation of process instances

The API provides methods for all actions you can do from the worklist client: finish, take, untake, goBack, seeLater, seeAgain, setAgent, gotoTask, copyTo, makeBranch, setOrgUnit, setDescription. See there for details.

The following methods apply to process instances:

```
public void abort(ProcessInstance process);
public void reactivate(ProcessInstance process)
public void archive(ProcessInstance process);
public void setSubject(ProcessInstance process);
public void setSubjectToString(ProcessInstance process, String str);
```

10.2.5 Getting the context

In conditions and system steps the method defined by the application can retrieve the current activity instance with the following code:

```
WfEngine e = WfEngine.getInstance();
ActivityInstance ai = e.getContext();
```

Hint: In case of a take hook `getContext` returns that `ActivityInstance` which is created **after** the take operation. In case of an untake hook `getContext` returns the `ActivityInstance` that is created **before** the untake operation will be performed. To get the "untaken" `ActivityInstance` use `ThreadContext.getAttribute("untakenActivity")`.

10.2.6 Methods for process instances

There are several methods with process instance as arguments and how they perform needs some clarification.

The structure of a process instance is as follows:

```
activityInstance -> [ parfor_1 .. -> [subprocess_1 ...->]] main_process
```

The relation shown as arrow is a parent relation between activity instances. The `getParent` method returns the target of this relation. If we start at a leaf node (`ActivityInstance`) the first call returns the parfor node if existing. After other nested parfors the node of the current subprocess will be found and finally, after other possible parfor and process nodes, the main process. Any of these nodes except the first implements the process instance interface. The method `getProcessInstance` returns the next activity instance with type `PROCESS` (not parfor) that can be found when calling `getParent` repeatedly.

The methods on process instances behave as following:

- `archive`: This is the only method applicable only on the main process.
- `abort`, `reactivate`: Normally applicated on the main process, but it is possible to perform this operations on intermediate nodes.

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- `getDocuments`, `getNotes`, `hasDocuments`, `hasNotes`, `setPriority`: These methods first navigate to the main process, then perform like called with it.
- `makeBranch`, `setSubject`, `getForms`, `getActivities`, `getActiveTasks`: The result depends on the argument. For example, to get the local forms inside a parfor, the method `getForms` must be called with the parent of the activity instance

11. Using the Workflow API

The programming of a workflow application contains several different tasks, which we will describe in this chapter:

- Methods that are part of workflow execution: expressions, postconditions, preprocessing, system steps.
- Interactive functions: called on user request as extension to the standard worklist functions.
- Enhancing the functionality of forms.
- Setting the default behavior of some actions in the application class
- Internationalization of applications.
- Appearance of the client: configuration of the main screen and the worklists. Programming of application specific worklists.

11.1 Application Methods Called by the Engine

The application programmer can define several types of methods which are executed by the workflow engine:

- system step in the process definition,
- preprocessing: executed before the StepInstance is visible in the worklist,
- compensation: executed when compensating this step (function go back),
- postcondition: executed when user completes the task,
- take- and untake-hook: executed when the user takes the activity instance or gives it back.
- condition: condition evaluation in if, while, exit when, choice.

In each case a Java method can be specified. In the first and last case the name of the method is specified in the process definition, the other method names are specified in the task declaration. The methods can have zero to n String parameters. The return value must be `boolean` for conditions and postconditions and is ignored otherwise. The following example shows two methods, `foo` and `fee`. The method `foo` can be used as system step or postcondition, the second for all above cases.

11. Using the Workflow API

```
class Test {
    public void foo(String a, String b) {
        ...
    }

    public boolean fee() {
        ...
        return true;
    }
}
```

The value of the string parameters are constants, in the process definition and task declaration the method call must be specified with the parameters, for example:

```
Test.foo("first", "second")
```

Note, that you also have to specify the package together with the class name if the class belongs to a package. The class file must be in the class path of the server or the `classes` directory of an application.

The following example shows a method which is called, when an activity instance is taken:

```
public void setFieldApproval() {
    WfEngine e = WfEngine.getInstance();
    ActivityInstance ai = e.getContext();
    DMSForm f = e.getForm(ai, procFormId); //form id defined in process editor
    User u = (User)ai.getAgent();

    //set the field in the form
    f.setField("approvedBy", u);
    e.updateForm(f);
}
```

The methods first gets the activity instance, the process instance, and then a form of this process. The field `approvedBy` of this form is set to the agent of this activity instance.

11.1.1 Usage of script-language GROOVY

@enterprise also offers the possibility to enter a GROOVY-script instead of a method-call (preprocessing, compensation, etc.) in tasks and task-functions. GROOVY is an object-oriented programming language for the Java platform. It is a dynamic language with features similar to those of Python, Ruby, Perl, and Smalltalk. More information can be found [here](#).

For using GROOVY in *@enterprise* you have to start with the keyword `groovy:` and a following groovy-script in one of the method-fields as shown in the following example:

```
groovy:
form_procFormId.setField("approvedBy", ai.getAgent());
engine.updateForm(form_procFormId);
```

Hint: Groovy must be activated via the hidden parameter *ep.scripts.enable* in *@enterprise* configuration-file!

The context for tasks is:

- engine is the object `com.groiss.wf.WfEngine`
- ai is the object `com.groiss.wf.ActivityInstance`
- pi is the object `com.groiss.wf.ProcessInstance`
- store is the object `com.groiss.store.Store`
- dms is the object `com.groiss.dms.DMS`
- orgdata is the object `com.groiss.org.OrgData`
- user is the object `com.groiss.org.User`
- form_<procFormId> is the corresponding form

The context for task-functions is:

- request is the object `HttpServletRequest`
- response is the object `HttpServletResponse`
- context is the object `ServletContext`
- session is convenient for `request.getSession(false)` - can be null
- params is a map of all form parameters - can be empty
- headers is a map of all request header fields
- out is equal to `response.getWriter()`
- sout is equal to `response.getOutputStream()`
- ai is the object `com.groiss.wf.ActivityInstance`
- pi is the object `com.groiss.wf.ProcessInstance`

These context-variables are defined in `com.groiss.groovy.WFBinding`, but can be configured via the hidden parameter *ep.groovy.binding.class* in configuration-file.

The following example shows a groovy-script which is called before activity instance is visible in worklist (preprocessing):

```
groovy:
form = engine.getForm(pi, "inputform");
form.description = form.description + "Method call activated by task2.";
engine.updateForm(form);
```

In this example the field "description" of the "inputform" is extended by the string "Method call activated by task2". The form-fields are accessible directly without `getField` and `setField` calls.

In the next example a groovy-script is entered in a task-function which is assigned to all tasks:

```
groovy:
u = com.groiss.util.ThreadContext.getThreadPrincipal();
out.println("Logged on User: " + u.getFirstName() + " " +
    u.getSurname() + "<BR/>");
out.println("Instance Details: " + request.getParameterMap());
```

If this task-function is called via worklist, the current user and information about the selected instance will be displayed.

11.1.2 XPath-Conditions

The XML Path Language (XPath) is developed by the W3-consortium for addressing parts of an XML-document (considered as tree). The access on *@enterprise* process data is done with following variables:

- **Forms**: The access on a form and its elements is possible with variable `$form_<fid>`. The several fields are subelements, e.g.:

```
<transactionId>2</transactionId>
<avwcreatedby>Frank Mansdorf</avwcreatedby>
<avwcreatedat>2010-01-29T09:34:29Z</avwcreatedat>
```

The task-field, OID and the class are defined as attributes at the form-element:

```
<form object="com.dec.avw.appl.hr_recruiting_1:1000002101"
    task="1000098715">
</form>
```

Objects are defined as follows:

```
<selectagent object="com.dec.avw.core.User:12345">
...object attributes...
</selectagent>
```

The access to subforms is done via the:

```
<subform id="1">
  <form object="com.dec.avw.appl.hr_evaluation_1:1000099042"
    task="1000098715">
    <transactionId>0</transactionId>
    ....
  </form>
</subform>
```

- **Current process instance**: The access is possible by using the variable `$pi`. The XML-structure of a process instance is defined as follows:

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```
<pi object="com.dec.avw.core.StepInstance:12345">
  <agent object="com.dec.avw.core.User:12345">
    <firstName>Frank</firstName>
    ...
  </agent>
</pi>
```

- Current activity instance (`engine.getContext()`): The access is possible by using the variable `$ai`. The behavior is analog to process instance.
- User of current step: The access is possible by using the variable `$user`. In process conditions this user is always the `ThreadUser`. The XML-structure of a user object is defined as follows:

```
<user object="com.dec.avw.core.User:12345">
  <firstName>Frank</firstName>
  ...
</user>
```

- Current date: The variable `$now` contains the current date.
- Java method: `XPathCheckClass.echo('arg') = 'arg'`
Any JAVA methods can be called, whereas String parameter are allowed only. The API programmer is responsible for the RETURN value, but *String* is recommended.
- Configuration: There are 2 different kinds of configuration and their access possibilities:
 - Application: `$configuration_<appl_id>/property[@name='km']/text()`
 - System: `$configuration/property[@name='avw.servername']/text()`

An other possibility to define XPath conditions is the usage of method `com.groiss.wf.SystemAction.evaluateXPath`.

Examples for XPath-Conditions:

```
//check, if form field value of type com.groiss.org.User
//is the same as the current thread user:
xpath:$form_f/recipient = $user
//check for com.groiss.org.User attribute "firstName":
xpath:$form_f/recipient/firstName = 'Frank'
//check a date field against current date:
xpath:$form_f/effectiveDateField = $now
//checks the value of the form field "status" in subform with subform-id 1:
xpath:$form_f/subform[@id='1']/form/status = 'ok'
//checks is the agent of the current process instance the thread user:
xpath:$pi/agent = $user
// checks the agent's id of the current activity instance:
xpath:$ai/agent/id = 'frank'
//evaluates the given XPath expression:
xpath:com.groiss.wf.SystemAction.evaluateXPath("$form_f/finished = '1'")
//check against configuration parameter "avw.servername"
//stored in ep.conf:
xpath:$configuration/property[@name='avw.servername']/text() = 'ep_o'
```

11.1.3 Adding methods to the system step editor

The system step editor is a tool in the process editor that allows adding and editing of chosen methods in a system step. These are, by default, useful standard methods of *@enterprise*.

To add own methods (e.g. part of an application) to the editors list, the desired methods must be annotated with *@com.groiss.wf.CallableMethod*. A scanner searches in the system- and the application classpath when the editor is opened for the first time after a server start and looks for methods with that specific annotation. All found methods are added to the list of methods in the editor.

Example:

```
@CallableMethod(group="@@@ep:forms@@",
                params={"{id:'id',type:'formfield'}", "{id:'id',}"})
public void methodName (String parameter1, String parameter2) {

    ...

}
```

The first two parameters of the annotation support the usage of resource keys, if they are marked with @ signs (e.g. @@@ key @@). It is also possible that both - the group and the description of the method - are automatically found in the resources. For this purpose, they must not be described in the annotation and the key must have the following syntax: `<fully qualified class name>.<method name>_`

Example:

```
com.groiss.wf.SystemAction.addFolder_
```

A `desc` must be added for the description key and for the group the `group` key. However, the ID of the parameter (the same one that was assigned in the annotation) must be specified first, followed by `_label` (for the label) or `_desc` (for the description). It looks like this:

```
com.groiss.wf.SystemAction.addFolder_parameter1_label
com.groiss.wf.SystemAction.addFolder_parameter1_desc
```

More details about the annotation itself and how to describe the methods and their parameters for the editor can be found in the API documentation of *com.groiss.wf.CallableMethod*.

11.2 Interactive Functions

The set of standard functions applicable in the worklist client can be extended with the so called Task-Functions. The functions can be used for arbitrary application specific tasks, for example sending mails, filling forms with some initial data, or anything else. We differentiate between four types of functions:

- Functions applicable in the worklist in certain tasks. These functions can be attached to task definitions in the system administration.
- Functions applicable in the worklist with every task of an application,
- task-independent functions,
- functions for viewing additional information for users, organizational units, and process instance history.

In the user interface only these tasks are shown, where the user has the execute right. Task-independent functions are reached with the link "Functions" in the navigation tree of the client.

The signature of the Java methods is as follows:

```
public void foo(HttpServletRequest req, HttpServletResponse resp)
public Page foo(HttpServletRequest req)
```

See chapter [Servlet Methods](#) for a discussion of these two method signatures.

After you wrote the Java method you have to define a Task-Function object with the name of your method in the system administration.

File **com/groiss/demo/DemoFunctions.java**

```
/** function in worklist: approve one or more orders with task-function */
public Page approve(HttpServletRequest req) throws Exception {
    User u = ThreadContext.getThreadPrincipal();
    WfEngine e = WfEngine.getInstance();
    String[] tasks = req.getParameterValues("functionTask");
    for (String aistr: tasks) {
        ActivityInstance ai = e.getActivityInstance(Long.parseLong(aistr));
        if (!u.equals(ai.getAgent())) {
            throw new ApplicationException("You are not the agent of this task.");
        }
        DMSForm f = e.getForms(ai.getProcessInstance()).get(0);
        f.setField("approvedby", u);
        f.setField("approved", "1");
        e.updateForm(f);
        e.propagateChange(ai);
    }
    JSONObject result = ClientUtil.getChangesAsJSON(
        req.getParameter("nodeid"), true);
    return new ActionPage("parent.require(['ep/Utils'], function(Utils) {" +
        "Utils.refreshWorklists(" + result + ", true);});");
}
```

11.3 Application Adapter

For each application you can define a Java class where some characteristics of the application can be defined. This class must implement the interface `com.groiss.wf.ApplicationAdapter`.

There exists a default implementation `com.groiss.wf.DefaultApplicationAdapter` which is used when no application specific class is defined. You can either write a subclass of `com.groiss.wf.DefaultApplication` or implement the interface `com.groiss.wf.ApplicationAdapter`. The first alternative is preferred, because it is more stable against changes of the default implementation or enhancements of the interface.

11.4 Utilities for building an HTML interface

In this section some utility methods of the class `com.groiss.wf.html.HTMLUtils` are described.

11.4.1 Show the form

Two methods can be used for showing a process form:

```
public static Page showForm(HttpServletRequest req) throws Exception;
public static Page showForm(HttpServletRequest req, ActivityInstance ai,
    String formid, int mode) throws Exception;
```

The first method calls the second, where the additional parameters `ai`, `formid`, and `mode` are taken from the equally named `ServletRequest` parameters. The mode is one of the following:

0	update mode
9	view mode without buttons

Create a PDF version of form/page

By using following methods in class `com.groiss.wf.html.HTMLUtils` a PDF version of a given form can be created. The form is first created in `VIEW_TEXT` mode (with the permissions of the current activity if parameter `task` contains its oid).

```
public void showPdfForm(HttpServletRequest req, HttpServletResponse res)
    throws Exception;
public void showPdfForm(DMSForm form, FormContext ctx, OutputStream os,
    String addr, Locale l) throws Exception;
```

Example how `showPdfForm()` could be called from a `XForm`:

```
<a class="nonprint" href="javascript:window.open(
    'com.groiss.wf.html.HTMLUtils.showPdfForm/form.pdf?object='+
    document.getElementById('object').value+
    '&task='+document.getElementById('task').value,'xx');void(0)">
    Print
</a>
```

If you need to mix-in HTML elements (input, textarea, select, etc. e.g. in `onShow` of form event handler) that are not part of the form type definition, i.e. these fields are not stored in the database, it is on your own to convert these fields manually as shown in the following example:

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```
Component c = p.get("myfield");
// set some value in onShow
c.setAttribute("value", "Non-DB Input-Field val");
// change input to span for PDF
if (ctx.getMode() == FormContext.VIEW_TEXT) {
    c.getRoot().setName("span");
    c.getRoot().setText(c.getAttribute("value"));
}
```

If you need to manipulate the `com.groiss.gui.XHTMLPage` object before converting to PDF, use following method:

```
public void convertToPDF(XHTMLPage p, OutputStream os, String addr,
    Locale l) throws Exception;
```

The `addr` parameter can be determined with

```
com.groiss.servlet.ServletUtils.getServerAddress
```

and the locale e.g. from `com.groiss.util.ThreadContext`.

Hint: Please note that the [Flying Saucer](#) library is used for PDF conversion. It's important to note its adherence to CSS 2.1, which means that certain CSS features may not be fully supported. Some commonly used styles beyond CSS 2.1, such as CSS Grid Layout, Flexbox, and CSS Variables, may not render as expected. Additionally, note that certain properties like `font-weight` with numerical values (e.g., `font-weight: 400;`) are not compatible. Prioritize CSS 2.1-compliant styles for optimal rendering results.

11.4.2 Show a form table

Following method allows to open form-tables in own window/iframe:

```
public Page showFormTable(HttpServletRequest req);
```

The request must contain the parameter `nodeid` which consists of the `xml-id` (= gui-configuration) and the `node-id` (= table node), i.e. `xmlid.nodeid`

Additionally the boolean parameters `showToolbar` and `hideCloseButton` can be added to the request.

11.4.3 Link to forms and documents

For customizing the links to forms and documents the class `com.groiss.wf.html.HTMLUtils` contains the following methods:

- `getDocumentsLink` returns a link to the documents of the process,
- `getNotesLink` returns a link to the notes of the process,
- `getFormLinks` returns the links to the process forms concatenated to a string. The mode is either `UPDATE` or `VIEW`, `comingFrom` is the URL shown after a form submit and `target` is the target frame of the submit action.

11.4.4 Object Selection

The class `com.groiss.wf.html.HTMLUtils` provides the method `selectList` for selecting objects from a list. The method is useful when you want to select an object and get the selected object in the opener document. The `ServletRequest` can have the following parameters:

Parameter	
<code>classname</code>	Java class of objects
<code>title</code>	The title of the window
<code>field</code>	The name of the field in the caller form: The classname and oid of the object is written to the field. The string representation of the object is written to the field with the specified name followed by <code>"_display"</code> .
<code>searchid</code>	If a condition (where clause) is needed, the attributes <code>searchid</code> and <code>parameters</code> must be used and an action node must be created in the appropriate xml-file. An example how to define parameterized conditions (it is always the same procedure) can be found in chapter Object selection - ep/widget/ObjectSelect .
<code>noClass</code>	instead of <code>< classname >: < oid ></code> only the oid is written to the field
<code>attribs</code>	Normally the <code>toString()</code> method is used to display the objects. With the <code>attribs</code> parameter you can specify a comma-separated list of attributes you want to see.
<code>searchAttr</code>	If the list is very long a search can be used to restrict the number of elements shown. Specify a list of attributes where you want to search. An input field will appear on the mask. If the given string is a prefix of one of the attributes of an object, the object will appear in the list.

The entries are sorted alphabetically.

When selecting an object, two values are written to the opener form. The object class-name and oid, concatenated with a colon (:) is written to the given field. The objects String representation is written to the field named `field_display`.

Example: The following url is used to show a window for user selection:
The HTML code shows a button opening a window for selecting users:

```
<script>
function selectUser(){
    window.open("../servlet.method/com.groiss.wf.html.HTMLUtils.selectList?" +
        "classname=com.dec.avw.core.User&title=User&field=customer"+
        "&attribs=surname,firstName,id&searchAttr=surname,id",
        "search", 'width=500,height=500,directories=0,toolbar=0,scrollbars=1');
}
</script>
...

<input type="hidden" name="customer" value=""/>
<input type="text" name="customer_display" value="" style="width:180"/>
<input type="button" class="ep_button" value=" ? " onclick="selectUser()">
<input type="button" class="ep_button" value=" X "
    onclick="form.customer.value=' ';form.customer_display.value=' ';"></td>
```

11.5 Task-Functions in forms

@enterprise allows to place buttons for task-functions in forms. For this purpose you have to write the following placeholder

- in HTML forms: "%taskfunction:fid%"
- in XHTML forms and XForms: `<script id="toolbarfunctions">fid1,...,fidn</script>`

fid is the id of a task-function.

To sum up, there are several possibilities to place task-functions:

1. in the submenu appearing when you click on the cog-wheel in the worklist. the "Show in worklist" checkbox must be clicked.
2. in the toolbar: add the key "taskfunction:fid" to the list of actions.
3. in the form: add the key "%taskfunction:fid%" in the html form; add the line `<script id="toolbarfunctions">fid1,...,fidn</script>` in the XHTML form or XForm
4. in the toolbar when the form is shown in the frame of the worklist. Add the key "%toolbarfunctions:fid1,...,fidn%" into the HTML form and the key `<script id="toolbarfunctions">fid1,...,fidn</script>` into xhtml forms / XForms. *fid₁* and *fid_n* are ids of task-functions. If you specify no task-function at all, only the standard buttons are shown.

Hint: The necessary task functions have to be assigned to the corresponding tasks in administration, otherwise no functions are visible.

In any case the parameter `functionTask` contains the oid of the activity instance where the task function was invoked. In case 2, if more than one worklist entries have been selected, this parameter appears for every selected entry.

In the target field of the task-function, you can specify the target window. You can also add window properties if you want to create a new window. Add the properties after the target name and a "," (comma), for example: `_blank,toolbars=0,width=300,height=200`

Hint: If a target window is specified, the form will not be saved when activating the save button.

11.6 Batch Processing

In @enterprise two types of automated steps exist:

- synchronous: this is specified in WDL by the keyword `system` followed by a method call. The method is executed in the same thread and within the transaction context of the operation which started the step. After execution of the method, the step is finished.

- **asynchronous:** specified by the keyword `batch` followed by a class name. Some methods of this class are executed after the step has been started - in their own transaction and thread.

Use the first method (synchronous) whenever possible, i.e. if the execution time of the method is not too long (it executes in the same transaction as the finish action of the previous interactive step) and if you don't need to wait for an external event or system to finish the step.

The specific behavior of batch jobs can be influenced via a class implementing the interface `com.groiss.batch.BatchAdapter`:

```
public interface BatchAdapter {
    void startup() throws Exception;
    void afterCreation(BatchJob job) throws Exception;
    void doStart(BatchJob job) throws Exception;
    void doPoll(BatchJob job) throws Exception;
    void beforeCompletion(BatchJob job) throws Exception;
    void afterCompletion(BatchJob job, boolean commit) throws Exception;
    void doCompensate(BatchJob job) throws Exception;
    Pair<Integer, String> getErrorCode(BatchJob bj, Throwable ex);
}
```

The `com.groiss.wf.batch.NullAdapter` class can be used as an extension point for specific adapter implementations. The `NullAdapter` provides method implementations which just log the call (at log level `DEBUG`).

The workflow-engine will generate a single instance of the adapter class, the `startup` method of the class is called once. The other methods are called on this single instance per batch job with the current batch job as a parameter.

There are several variations in the life cycle of a batch job (initiated via flagging of the job, see below), but the general scenario is as follows:

When the workflow engine reaches a batch step, it creates a

`com.groiss.wf.batch.BatchJob` object and writes it to the database, this batch job contains control data and state information.

The `com.groiss.wf.BatchManager` timer is responsible for starting batch jobs and for finishing the steps after the batch job has completed. The flow of control is as follows:

1. When the batch job is created, the `startup` method of the specified `BatchAdapter` class is called (this is done only once for each class, not for each batch job). Then the batch job state is set to `CREATED` and the `afterCreation` method is called. In the `afterCreation` method no explicit `ROLLBACK` is done if an error occurs.
2. The `BatchManager` timer starts the batch job by calling the `doStart` method. After successful completion the state of the batch job is `STARTED`. If an exception is thrown in `doStart`, the state of the batch job changes to `STARTERROR` and a `ROLLBACK` will be performed. No further action is taken by the batch system.
3. Next the batch job must be finished. This can be triggered from an internal or external event (for example via reception of an email). Via calling the method `BatchManager.markJobFinished`, the state of the `BatchJob` object will be `FINISHED`.

4. When the `BatchManager` detects finished jobs during its next timer controlled run, it completes them. First it calls `beforeCompletion`. If there is an exception, the job is placed in state `FINISHERROR`. No further action is taken by the batch system. If `beforeCompletion` was executed successfully, `afterCompletion` is called with a boolean parameter which indicates if the job is now in state `COMPLETED` (`commit = true`) or in state `FINISHERROR` (`commit = false`). If an exception is thrown in `afterCompletion`, a `ROLLBACK` will be performed.
5. On going back via the batch job step, the method `doCompensate` is called.

As mentioned above, the life cycle of a batch job can be modified by appropriate flagging with respect to six aspects, which can be combined (almost) arbitrarily.

- **startnow:** A batch job where `startnow` is set is started immediately after the end of the current transaction and not during the next timer triggered run of the `BatchManager`.
- **newthread:** By specifying `newthread`, the start of the job takes place in a thread created newly for this batch job instance. The original thread creates the batch job and calls `afterCreation`, but the start of the job is done in the new thread. This feature could be used when the start of the batch job itself takes significant time.
Any number of threads could be working concurrently, each on one individual batch job step instance. The workflow engine does not limit thread creation by e.g. using a bounded thread pool. Its is questionable practice to have the threads linger in the system for a long time, e.g. by periodically polling for results and going to sleep in between.
- **retrystart:** When using `retrystart`, an exception in `doStart` does not set the state of the batch job to `starterror`. Instead, the batch job stays in state `CREATED` and a new start attempt will be made during the next timer run. Such further attempts can be avoided, if the `doStart` method explicitly marks the batch job as erroneous via calling `BatchManager.markJobError`.

To suspend further start attempts without changing the batch jobs state, `doStart` can call `BatchManager.markJobSuspendRetry`. Start attempts can be commenced by a later call to `BatchManager.markJobRetry`.

- **autofinish:** Setting `autofinish` means that immediately after the `doStart` method has terminated in a normal manner, the job is marked as finished and then completed by the system itself. Could be used for "fire and forget" batch jobs.
- **pollfinish:** When using `pollfinish`, the timer will actively check if the batch job is finished via a call to the `doPoll` method of the adapter.

The polling will take place in the thread of the timer, unless the `newthread` modifier is specified, then polling will take place in a dedicated thread for each job.

If the check implemented in `doPoll` determines that the batch jobs is not yet finished, it does not need to do anything. If the check determines that the job is

finished, it must mark it explicitly by calling `BatchManager.markJobFinished`.

An exception in `doPoll` does not change the state of the batch job. To "give up" on this job, the `doPoll` method should explicitly mark the batch job as erroneous via calling `BatchManager.markJobError`.

To suspend further poll attempts without changing the batch jobs state, `doStart` can call `BatchManager.markJobSuspendPoll`. Poll attempts can be commenced by a later call to `BatchManager.markJobPoll`.

- `gobackonerror`: Setting `gobackonerror` to true means that in case of an unhandled exception during execution of the `doStart` method, engine tries to goBack to the last interactive step.

The behavioral modification flags can be checked at the batch step dialogue in the process editor or by adding them literally after the class name in the WDL batch statement, e.g.:

```
batch com.groiss.demo.DemoBatchAdapter() startnow newthread;
```

The defaults for the life cycle modifications are:

```
startnow=false, newthread=false, retrystart=false,  
autofinish = false, pollfinish=false, gobackonerror=false.
```

The following table deals with aspects of the life cycle modification flags concerning threads:

newthread	startnow	thread in which <code>doStart</code> is called
false	false	batch manager (timer) thread (during its next run)
false	true	event dispatcher thread (after successful completion of the current transaction)
true	false	new thread for this batch job instance (during the next run of the batch manager timer)
true	true	new thread for this batch job instance (via the event dispatcher after successful completion of the current transaction)

The following examples illustrate the usage of this framework. We will first provide a simple implementation and then illustrate the usage of `retrystart` and `pollfinish`.

File `wdl/batchproc.wdl`

```
process batchproc()  
  application default;  
  version 1;  
  
  forms f Jobform;  
  subject f.subj;  
  begin  
    <order_start> all order(f);
```

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```
repeat
  order_start:user a_task(f);
  batch com.groiss.demo.DemoBatchAdapter() newthread;
until xpath:"$form_f/finished = 'true'";
end
```

The process is a slight variation of the well-known jobproc example. We introduce an additional batch step, the processing logic is implemented in the class

`com.groiss.demo.DemoBatchAdapter`.

The general notion of the batch job we want to implement is to write a file with some process data to a process specific location in the file system. Then we trigger some external entity to process the file. The external entity will place a second file in the same directory (the result of its processing). The batch job will be finished through invocation of an URL and some of the contents of the result file are transferred into the form.

The `com.groiss.demo.DemoBatchAdapter` implements the interface `com.groiss.wf.batch.BatchAdapter`, imports the needed things and defines some utility methods, which state the location of the directories where the files will be placed. Under a subdirectory `batchdemo` in the server's temporary directory, we will place one directory for each process, named like the process id.

File `java/com/groiss/demo/DemoBatchAdapter.java`

```
public class DemoBatchAdapter implements BatchAdapter {

    private static final Logger logger = LoggerFactory.getLogger(
        DemoBatchAdapter.class);

    public static final String FORMID = "f";
    public static final String FIELDID = "description";

    protected File getMainDir() {
        return new File(Settings.getTempDir(), "batchdemo");
    }

    protected File getProcDir(BatchJob job) {
        return new File(getMainDir(), getProcId(job));
    }

    protected String getProcId(BatchJob job) {
        return job.getContext().getProcessInstance().getId();
    }

    protected DMSForm getForm(BatchJob job) {
        return WfEngine.getInstance().getForm(
            job.getContext().getProcessInstance(), FORMID);
    }

    @Override
    public void startup() {
        File mainDir = getMainDir();
        mainDir.mkdir();
        logger.debug("{} startup: mainDir={}, ", getClass().getName(), mainDir);
    }
}
```

```
}

@Override
public void afterCreation(BatchJob job) {
    File procDir = new File(getMainDirName(), getProcId(job));
    procDir.mkdir();
    logger.debug("{}afterCreation() for job {}: procdir={},",
        getClass().getName(), job, procDir);
}

@Override
public void doStart(BatchJob job) {
    logger.debug("{}doStart() in Thread {} for job {}",
        getClass().getName(), Thread.currentThread().getName(), job);
    try {
        File outFile = new File(getProcDir(job), getProcId(job) + ".html");
        String fieldContent = getForm(job).getField(FIELDID);
        try (PrintWriter out = new PrintWriter(new FileWriter(outFile))) {
            out.println("Output File " + new java.util.Date());
            out.println("<html>" + fieldContent);
            String url = Admin.getInstance().getServerURL() +
                "servlet.method/com.groiss.demo.DemoBatchAdapter.notifyFinish?" +
                "bjOid=" + job.getOid();
            out.println(new Link(url, "continue...").show() + "</html>");
        }
        logger.debug("{}doStart() for job {}: " +
            "wrote filed content({}) to outfile={},",
            getClass().getName(), job, fieldContent, outFile);
    } catch (Exception ex) {
        throw new ApplicationException("doStart", ex);
    }
}

@Override
public void beforeCompletion(BatchJob job) {
    logger.debug("{}beforeCompletion for job {}:", getClass().getName(), job);
    try {
        File inFile = new File(getProcDir(job), getProcId(job) + ".in");
        try (BufferedReader in = new BufferedReader(new FileReader(inFile))) {
            String line = in.readLine();
            DMSForm f = getForm(job);
            f.setField(FIELDID, line);
            Store.getInstance().update(f);
            logger.debug("{}beforeCompletion for job {}: " +
                "set formfield to :{} from infile={},",
                getClass().getName(), job, line, inFile);
        }
    } catch (Exception ex) {
        throw new ApplicationException("beforeCompletion", ex);
    }
}

@Override
```

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```
public void afterCompletion(BatchJob job, boolean commit) {
    logger.debug("{}afterCompletion for job {}: ", getClass().getName(), job);
    if (commit) {
        File procDir = getProcDir(job);
        FileUtil.deleteDir(procDir);
    }
}

public void notifyFinish(HttpServletRequest req, HttpServletResponse res)
    throws Exception {
    long bjOid = Long.parseLong(req.getParameter("bjOid"));
    BatchJob bj = Store.getInstance().get(BatchJob.class, bjOid);
    BatchManager.markJobFinished(bj);
    res.getWriter().println("Done");
}

@Override
public void doCompensate(BatchJob job) { /* implements interface */
}
```

The `startup` method creates the `batchdemo` directory. It is called by the `BatchManager` the first time the `DemoBatchAdapter` is used. We could establish a communications channel with some external entity here (e.g. a connection to a database or a JMS system).

The `afterCreation` method creates the appropriate subdirectory for the process. We use the `getContext` method of the `BatchJob` object to retrieve the current `ActivityInstance`.

The `doStart` method creates a file (`<processid>.html`) and writes some process specific data into it. The "real" start would take place instead of the comment.

The `beforeCompletion` method checks for the result file (`<processid>.in`)¹ and transfers the first line of this file into the description field of the form attached to the process.

After successful completion, we delete the files and directories in the `afterCompletion` method.

For finishing, we provide the servlet method `notifyFinish` which expects the oid of the batch job as parameter `bjOid`. There is also the `<processid>.html` file where a link is provided which can be clicked to trigger the finish notification.²

The compensation method `doCompensate` does nothing in this simple example.

This completes the simple example. In the following example, we use `retrystart` and `pollfinish`, together with an extended version of the batch adapter.

¹It is assumed that the file has been created by some external system (or that it was created manually for the sake of the example).

²Please ensure that the "Check Referer header" parameter is turned off for the link and the entire example to function as intended.

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The `BatchManager` timer will periodically check an (externally imposed) condition to determine if the start of the job has been successful and will also periodically poll to determine if the jobs has ended.

For the start condition, we will use the existence of a subdirectory with the id of the process as its name; for the termination condition we will use the existence of an response file in this very directory.

File `wdl/batchproc2.wdl`

```
process batchproc2()
  application default;
  version 1;

  forms f Jobform;
  subject f.subj;
  begin
    <order_start> all order(f);
    repeat
      order_start:user a_task(f);
      batch com.groiss.demo.DemoBatchAdapter2() newthread retrystart pollfinish;
    until xpath:"$form_f/finished = 'true'";
  end
```

The adapter class extends the class of the previous example:

File `java/com/groiss/demo/DemoBatchAdapter2.java`

```
public class DemoBatchAdapter2 extends DemoBatchAdapter {

  private static final Logger logger =
    LoggerFactory.getLogger(DemoBatchAdapter2.class);
```

The `afterCreation` method does nothing besides logging. In particular, the process instance specific subdirectory is not created.

```
@Override
public void afterCreation(BatchJob job) {
  logger.debug("{} afterCreation() for job {}: uncreated procdir={},",
    getClass().getName(), job, getProcDir(job));
}
```

The `doStart` checks for the existence of the process instances specific subdirectory. Since the `retrystart` modifier is being used, the batch adpters `doStart` method will be called repeatedly until this directory has been created³.

If it exists, the `doStart` method of the super class is called (see above). If it does not exist, an exception is thrown. But since we specified `retrystart`, the batch jobs state is still `CREATED` and further start attempts will be made by the timer. After the directory is created (e.g. manually), the start will be successful.

³By an external system or manually for the sake of the example

```
@Override
public void doStart(BatchJob job) {
    File procdir = getProcDir(job);
    if (procdir.exists()) {
        logger.debug("{}doStart() for job {} start o.k.",
            getClass().getName(), Thread.currentThread().getName(), job);
        super.doStart(job);
    } else {
        throw new ApplicationException(getClass().getName() +
            ".doStart() dir not found: " + procdir);
    }
}
```

The `doPoll` method checks for the existence of an *.in file. If it is found, the job is marked as being FINISHED. If the file is not found, no action takes place (and the polling will be repeated later on).

Since the `pollfinish` modifier is being used, no explicit marking of the job is needed (especially, there is no need to click the link in the `<processid>.html` file).

```
@Override
public void doPoll(BatchJob job) {
    logger.debug("{}doPoll() in Thread {} for job {}",
        getClass().getName(), Thread.currentThread().getName(), job);
    try {
        File inFile = new File(getProcDir(job), getProcId(job) + ".in");
        if (inFile.exists()) {
            logger.debug("{}doPoll() for job {}: infile({}) found,",
                getClass().getName(), job, inFile);
            BatchManager.markJobFinished(job);
        } else {
            logger.debug("{}doPoll() for job {}: infile({}) not found,",
                getClass().getName(), job, inFile);
        }
    } catch (Exception ex) {
        throw new ApplicationException("doPoll", ex);
    }
}
```

11.6.1 Batch jobs and concurrency

Batch job objects may be modified concurrently. This could be the case if a process instance currently executes a batch job, and the process is being aborted (or reactivated afterwards). Batch jobs can also be aborted via the process history or from the admin GUI.

The batch mechanism will always get a fresh copy of the batch job from the database after executing a `BatchAdapter.doXX()` callback. Therefore, it is not wise to call any setter methods on (possibly outdated) batch job instances directly, especially without updating

batch job via the store afterwards. We recommend to use the `BatchManager.mark*` methods, they take care of this aspect.

If you nevertheless must use the setters because you need fine-granular changes, then adhere to the following pattern:

```
@Override
public void doStart(BatchJob job) {
    ... // may take quite some time
    job = BatchManager.getFreshBatchJob(job); // get the current state
    job.setResultValues("myresult");
    store.update(job); // explicitly update the job
}
```

The `BatchManager.mark*` methods always fetch the latest batchJob from the database. This copy is being changed and returned to the caller. If you need to make any changes to a `BatchJob` object after calling one of the `BatchManager.mark*`, you can and should use this returned copy. Nevertheless, it is recommended to abstain from modifying a batch job after calling `BatchManager.mark*`;

```
@Override
public void doPoll(BatchJob job) {
    ... // may take quite some time
    job = BatchManager.markJobFinished(job); // note the assignment to the original object
    job.setResultValues("myresult");
    store.update(job); // explicitly update the job;
}
```

11.7 Event Mechanism

The event mechanism is used for raising and handling events inside the workflow engine. An event can be raised from the process execution or via API from another program. The event will be received from all process instances which have registered for the event and the event handler, specified by the receiver, will be called.

The event is identified by a name and an optional context object. If the raiser specifies such an object, a handler registration matches only when the same context object is given or when the handler registered without a context object. The context object itself is either a `com.groiss.store.PersistentObject` or a `String`.

11.7.1 WDL event elements

The following extensions have been made to our process definition language WDL to define the event mechanism:

```
registerForEvent =
    "registerForEvent" "(" eventname [ "," eventhandler [ "," context ] ] ")".

unregister =
    "unregister" "(" eventname ")".

sync =
    "sync" "(" eventname [ "," eventhandler [ "," context ] ] ")".

raiseEvent =
    "raiseEvent" "(" eventname "," "current_tx" [ "," context ] ")".

context =
    "parent" | "processInstance" | "mainProcess" | formid [ "." fieldname ].
```

registerForEvent register to receive events with the given name (first parameter). The second parameter is the name of an eventhandler (a Java class implementing the interface `com.groiss.event.IEventHandler` or extending `com.groiss.event.EventHandler`). The optional third parameter designates a context object (see below).

unregister Removes the registration of all events with this name from nodes below the parent of the current node.

sync waits for receiving an event. The parameters have the same meaning as in `registerForEvent`.

raiseEvent The first argument is the name of the event. The next argument must be `current_tx` at the moment. The third argument defines the context object.

context There are several different types of context.⁴

⁴The traditional keyword `process` is deprecated. It has the same (unchanged) semantics as the new `parent` keyword, but the naming gave the wrong impression that it always is a process instance.

parent : the context is the oid of the immediate parent of the current activity instance (can be a process instance or a parfor node)

processInstance : the oid of the innermost (sub-)process instance reachable from the current activity instance

mainProcess : the oid of the top level process instance for the current activity instance

formid : the form object with id `formid` reachable from the current activity instance

formid.fieldname : the object from field `fieldname` of the form with id `formid` reachable from the current activity instance

11.7.2 The Event API

All operations (except sync) defined in WDL can be performed from the API. The interface `Event` defines the methods an event must have:

```
public interface Event {
    public String getName();
    public ActivityInstance getRaiser();
    public Object getContext();
    public Object getField(String name);
    public Date getRaiseDate();
    public void afterDispatch();
    public void onNotDispatched();
    public int getTxType();
    public boolean isAbort();
}
```

The implementation `com.groiss.event.BasicEvent` can be used as implementation (and is used for events raised from the WDL statements above).

The `com.groiss.event.EventHandler` is a class containing the following methods:

```
public boolean handle(Event e, ProcessInstance handlerProc, EventRegistry reg)
public boolean onRegister()
public void onUnRegister(EventRegistry reg)
```

Before the event handler is actually registered, the method `onRegister` is called. If `onRegister` returns false, there will be no registration and the calling activity instance (sync or registerEvent) will be finished immediately.

When the registration matches a raised event the `handle` method is called. And `unRegister` is called when the eventhandler is unregistered. You will make subclasses of this class for doing some actions in the `handle` method. The `com.groiss.event.EventHandler` class itself writes a log file entry when `handle` is called and does nothing in `onRegister`.

The utility class `com.groiss.event.EventManager` is used to raise events and to register and unregister for events:

```
public class EventManager {
    public static void raiseEvent(Event e);
    public static long register(String name, Class eh, Object context);
}
```

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```
public static void unregister(long oid);
public static void unregister(String name, ProcessInstance registrant);
public static void unregisterAll(ProcessInstance registrant);
}
```

Events are submitted using `raiseEvent`. With `register` you can register an event handler, the method returns the `oid` for the registration. Use this `oid` for the method `unregister`. Alternatively, there is a `unregister` method for deleting registrations for a given event name and process instance.

`unregisterAll` removes all registrations made by a process instance.

11.7.3 Event Processing

The WDL statement `registerForEvent` or the API call `EventManager.register` writes the event name, event handler, the registrant, and the context object into the registration table.

When `raiseEvent` is called, all "matching" event handlers are executed (in undefined order). For each event handler a new instance is created and the `handle` method is called. Matching is defined as: same event name, and when a context object has been defined on `register`, the context object of the event must be the same (means equal for `String`, same `oid` for `com.groiss.store.PersistentObject`). The following table subsumes this behavior (Y means handler is fired, N means handler is not fired, = means firing depends on object or string equality).

		register		
		null	object	string
raise	null	Y	N	N
	object	Y	=	N
	string	Y	N	=

The handling of raised events is performed synchronous in the same thread as the raising. The event raiser does not know how many handlers have been invoked. If the handling of an event throws an (uncaught) exception, the transaction is rolled back.

In log level "debug" or higher raising and handling of events is logged.

After an event for a sync is executed, the sync-step is finished if the `handle` method returns true.

If `unregister` is not called explicitly, the handlers are removed at the end of the process (the outermost main process in case of subprocesses).

Example:

```
process p1
forms f Jobform;

begin
  all task1(f);
  registerForEvent("personChange", PersonEventHandler, f.agent);
  ...
end
```

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```
end;

process p2
forms f Person;
begin
    all changeData(f);
    raiseEvent("personChange", current_tx, f.pers);
    ...
end;
```

It an instance of process p1, we call it pi1, reaches the line `registerForEvent`, the following record is added to the event registry:

client	eventname	context	eventclass
pi1	personChange	hugo	PersonEventHandler

Process instance pi1 waits for personChange events, which apply to the object "hugo" ("hugo" is the value of `f.agent`). When an instance of process p2 - pi2 - reaches the line `raiseEvent` and `f.pers` has the value "hugo", then an event is raised with the following properties:

```
getName: personChange
getRaiser: pi2
getContext: hugo
```

The event manager looks in the registry after matching registrations and finds the above entry, because event name and context object matches. An instance of `PersonEventHandler` is created and the `handle` method is called with the events and process instance pi2 as arguments.

11.7.4 Cluster

Event handlers are executed on the node where the event has been raised.

11.7.5 Administration

In the administration you can view the list of registrations and you can add and remove registrations.

Processes waiting in a sync can be finished manually from the process history.

11.8 Examples

11.8.1 Start a Process

The first example in this section starts a process using the API. This is an often needed task: Either you have to start processes from a program or want to fill the forms with initial values.

In this example the process `jobproc` is started and the form of the process is initialized. The start form is static and resides in the `serverarea` directory:

File **classes/alllangs/demo/StartJob.html**

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```
<!DOCTYPE html>
<html>
<head>

    <script src="../../scripts/dojo/dojo.js"
        data-dojo-config="parseOnLoad: true"></script>
    <link href="../../servlet.method/com.groiss.gui.css.StyleConf.loadCSS"
        rel="stylesheet" type="text/css"></link>
    <title>StartJob</title>
</script>
require(["ep/widget/DateField", "ep/widget/ObjectSelect"]);
</script>
</head>
<body class="claro" >
Start invoice processing:

<p/>
<form action="../../servlet.method/com.groiss.demo.StartJob.start">
<table>
    <tr>
        <td>@@@invoice_number@@</td>
        <td><input name="num" type="text"></td>
    </tr>
    <tr>
        <td>@@@supplier@@</td>
        <td><input name="supplier" data-dojo-type="ep/widget/ObjectSelect"
            classname="com.dec.avw.appl.demo_supplier_1">
        </td>
    </tr>
    <tr>
        <td>@@@order@@</td>
        <td><input name="srmorder" data-dojo-type="ep/widget/ObjectSelect"
            searchid="demo.OrderSelect">
        </td>
    </tr>
    <tr>
        <td>@@@ep:comment@@</td>
        <td><textarea name="comment"></textarea></td>
    </tr>
    <tr>
        <td>@@@ep:duedate@@</td>
        <td><input name="duedate" showTime="false"
            data-dojo-type="ep.widget.DateField"/>
        </td>
    </tr>
</table>
<input type="submit" value="Start Process" class="ep_button"></form>
</body>
</html>
```

The method `start` in the class `StartJob`:

File **com/groiss/demo/StartJob.java**

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```
public class StartJob {

    public Page start(HttpServletRequest req) {
        // get parameters
        String num = req.getParameter("num");
        Persistent supplier = HTMLUtils.getObject(req, "supplier");
        Persistent order = HTMLUtils.getObject(req, "srmorder");
        String comment = req.getParameter("comment");
        String duedatestr = req.getParameter("duedate");
        Date duedate = com.groiss.cal.CalUtil.parseDate(duedatestr);

        User user = ThreadContext.getThreadPrincipal();
        WfEngine e = WfEngine.getInstance();
        OrgData od = OrgData.getInstance();
        OrgUnit dept = od.getHomeOrg(user);

        ProcessDefinition pd = e.getProcessDefinition(
            "demo_incoming_invoice_processing");
        if (!e.getStartableProcDefs(null).stream()
            .map(p -> p.first).toList().contains(pd)) {
            throw new ApplicationException(
                "The user is not allowed to start this process.");
        }
        ProcessInstance pi = e.startProcess(pd, user, dept, duedate, null);

        DMSForm form = e.getForm(pi, "invoice");
        form.setField("num", num);
        form.setField("supplier", supplier);
        form.setField("srmorder", order);
        form.setField("comments", comment);
        form.setField("duedate", duedate);
        e.updateForm(form);

        /* variant 1: just write a text.
        HTMLPage p = new HTMLPage();
        p.setPage("<html><body>Process " + pi.getId() + " started.</body></html>");
        return p; */

        /* variant 2: refresh the worklist and optionally show the details. */
        boolean showDetails = Configuration.get().getBoolean("avw.start.with.form");
        JSONObject result = ClientUtil.getChangesAsJSON("demo.wl", true);
        return new ActionPage("parent.require(['ep/Utils','dojo/topic'],
            function(Utils,topic) {" +
                "Utils.refreshWorklists(" + result + ",
                    true," + showDetails + ",true);});");

        /* variant 3: send it to another agent, worklist has not changed, just bring it t
        ActivityInstance ai = e.getActiveTasks(pi).get(0);
        e.changeAgent(ai, OrgData.getInstance().getById(User.class, "hugo"), null, null);
        return new ActionPage("parent.require(['ep/Utils'], function(Utils) {" +
            "Utils.showWorklist('demo.wl');});");
        */
    }
}
```

```
}
```

11.8.2 Find running Processes

The following example, a simple process instance monitor, shows the work items assigned to a selected user.

A dynamically created form lets you select a user, on submit the list of work items belonging to this user is shown.

11. Using the Workflow API

```
public class Monitor {

    /** Show a select list of users.
    */
    public Page showMask(HttpServletRequest req) {
        HTMLPage result = new HTMLPage();
        List<User> l = Store.getInstance().list(
            User.class, "\"ACTIVE\"=1", "surname");
        result.setPage("<form action=" + "'com.groiss.demo.Monitor.showList'>Benutzer:" +
            new SelectList("user", l, 10).show() +
            "<br><input type=submit>" +
            "</form>");
        return result;
    }

    /** Show the worklist of a selected user.
    */
    public Page showList(HttpServletRequest req) {
        HTMLPage result = new HTMLPage();
        long user = Long.parseLong(req.getParameter("user"));
        StringBuilder p = new StringBuilder("<html>");
        WfEngine e = WfEngine.getInstance();
        ThreadContext.setThreadPrincipal(
            (User)Store.getInstance().get(User.class, user));
        List <ActivityInstance> l = e.getWorklist(null, false);
        for (ActivityInstance ai:l) {
            p.append(ai.getProcessInstance().getId() + ", " + ai.getStarted() +
                ", " + ai.getProcessDefinition().getId() + "<br>");
        }
        result.setPage(p.toString());
        return result;
    }
}
```

12. Configuring the Worklist Client

12.1 Introduction

The appearance of the Worklist Client of *@enterprise* is fully configurable. Use the *GUI Configuration* editor described in [System Administration](#) manual. Different clients can be built by defining configuration files ¹.

The next sections describe the syntax of such configuration files and then the implementation of a worklist class is presented.

12.2 The Elements of the Configuration File

The configuration file contains the structure of the navigation tree. The tree consists of nodes of different types. Depending on the type, different attributes or child nodes are available.

The standard configuration file resides in the file *ep-impl-`<versionnr>`.jar* in `classes/standard.xml`

Hint: Do not change, manipulate or shadow the file `standard.xml`!

More often you want to create application or user group specific clients. In such a case you define your own configuration file and put it into the classpath. For this purpose the Configuration Editor in the *@enterprise* Administration is recommended to use. The URL for a client based on such a configuration file is:

```
http://<host>:<port>/<contextpath>/servlet.method/  
com.groiss.smartclient.Main.showMainPage?id=<gui_id>
```

`<gui_id>` stands for the name of the configuration file, (without the ".xml" suffix).

The configuration is described in XML format, the XSD (XML Schema Definition) is in the file `guiconfig.xsd` in the `conf` directory of the file *ep-impl-`<versionnr>`.jar*.

The structure of the navigation tree is:

```
<?xml version="1.0" encoding="UTF-8"?>  
<config version="2.0">  
  <userProfile>
```

¹The configuration files are read from the classpath. Due to preprocessing and caching, changes in such a file are **not** effective immediately. A configuration is reread from the file if the main URL has the suffix `&reload`.

12. Configuring the Worklist Client

```

...
</userProfile>
<standardActions>
...
</standardActions>
<tree>
...
</tree>
<nodes>
....
</nodes>
</config>

```

The root element `config` contains the whole tree configuration in the element `tree` (no other child elements of `config` is applicable for the HTML client). The elements `userProfile` and `standardActions` are also needed, but it is possible to change the actions inside these elements. The tree can contain a various number of elements.

When a user logs in, the navigation tree is built using the following rules: For the structure of nodes in the `tree` a corresponding tree of HTML labels and links is built.

The tree is then composed of node elements (e.g. type *node*, *worklist*, *dms*, etc.). Before we look at the possible types of nodes we present the possibilities to customize the main tree. The table 12.1 gives you an overview about the most important attributes and in which context they can be used.

Table 12.1: Overview about most important GUI configuration attributes

Attribute	label	node	worklist	structuredWorklist	dms	table	processStart	functionList	function	report	query	action	objectExtension	Description
target		x										x		Target window of link or action
href		x										x		URL of link or action
onClick		x										x		JavaScript subclass of <code>_Action</code> . If this is present, href and target are ignored.
widget		x										x		JavaScript subclass of <code>widget</code> . In new GUI this defines the appearance and function of the action or node. Either <code>onClick</code> or <code>widget</code> is specified.
columns			x	x	x	x								List of table columns, contains column elements
columnPicker			x	x	x	x								TRUE, if picker should be displayed
actions			x	x	x	x								List of action elements
toolbarShape			x	x	x	x								ICON, TEXT or BOTH

12. Configuring the Worklist Client

Attribute	label	node	worklist	structuredWorklist	dms	table	processStart	functionList	function	report	query	action	objectExtension	Description
toolbarSize			x	x	x	x								Number of functions shown in the toolbar
selection			x	x	x	x								Selection type: HIDDEN (NONE), ONE, MULTI, ROWONE, ROW-MULTI
useFilter			x	x	x	x								Show filter menu
paging			x	x	x	x								Show paged table: only TableRenderer tables
pageSize			x	x	x	x								Page size in paged mode
defaultSortColumn			x	x		x								Initial sort, syntax: ("+" "-") <colid>
type			x	x										Worklist type: USER, ROLE, SUSP, ROLESUSP, SUBST_USER, ROLE_NO_SUBST, SUSP_NO_SUBST, ROLE-SUSP_NO_SUBST, SUSP_ONLY_SUBST, AUGMENTED, NONE
tablehandler			x	x		x								Table adapter for worklist, DMS or form table
formhandler						x								Form event handler for form tables
classname						x					x		x	Name of Java class
editTargetProps						x						x		Properties of the detail window suitable for Javascript method window.open()
detail						x								URL for toolbar actions
model						x								Model class implementing TableAdapter
applications							x	x						List of applications
targetId							x		x	x				ID of process,function or report
mode							x							Mode for process start: DUE DATE, FORM, DIRECT, ALL (= default)
orgUnit							x							Id of organizational unit for process start in mode DIRECT
worklistId							x							Id of worklist to show after process start (only old gui)
searchAttrs											x			List of search attributes
condition						x					x			SQL condition string which can contain placeholders (?)

12. Configuring the Worklist Client

Attribute	label	node	worklist	structuredWorklist	dms	table	processStart	functionList	function	report	query	action	objectExtension	Description
allowModifications						x					x			Allows insert, update, delete using JSONLoader
types						x					x			Types for placeholders in condition string
allowFormTypes					x									List of formtypes allowed in the DMS
defaultAction			x	x		x								Double-click action
application			x	x										Application restriction for worklist
attribs											x			List of shown attributes
form													x	If the extension class is not a form (i.e. a Persistent), a form (html mask) can be specified for displaying the data
attachedTo													x	Object class where this object is attached
apply												x		Apply to NONE, ONE, MULTI objects
params			x	x					x					Additional parameter added to the URI, not used in <i>@enterprise</i> itself
filterId			x	x										Reference to an id of a worklist for sharing filters
links			x	x		x								Parameter compatibility / tabs / tabsWithoutForms, only in old GUI
printable			x	x	x	x								Print function for table
helpContext			x	x	x	x								Context sensitive help
fetchAttrs						x					x			Allow to (pre-)fetch dependent objects from the database by efficient operations

Table 12.1: Overview about most important GUI configuration attributes

12.2.1 Own layout of main page in smartclient

With element `layoutWidget` it is possible to define a (template) widget (ideally a `di-jit/layout/xx` widget - e.g. `BorderContainer`). This element is placed within the `<tree>` element, e.g.:

```
<?xml version="1.0" encoding="UTF-8"?>
<config version="2.0">
  <userProfile>
    <widget>ep/widget/smartclient/UserProfile</widget>
    <action id="setContext" />
    <action id="admin" />
    <action id="roles"></action>
    <action id="substitutions"></action>
    <action id="organization"></action>
    <action id="useMobileGui"></action>
    <action id="settings"></action>
    <action id="changePassword"></action>
    <action id="aboutInfo"></action>
    <action id="logout" />
  </userProfile>
  <standardActions>
    <action id="help" />
  </standardActions>
  <tree>
    <layoutWidget>ep/widget/smartclient/demo/MainLayoutContainer</layoutWidget>
    <navigationType>COLLAPSIBLE</navigationType>
    <title>{counter} {config} - {context}</title>
    <collapsed>false</collapsed>
    <label id="tasks">
      ....
    </label>
  </tree>
</config>
```

12.2.2 Tree Nodes

The `tree` is described using nested node elements. A Node can have the following common elements:

id: An id which identifies the element.

ref: With this attribute it is possible to define a reference to another node in another XML file, e.g.

```
<node id="mycalendar" ref="standard.calendar">
  <name>My calendar</name>
</node>
```

In the example above all attributes are merged from node *calendar* of standard gui configuration (= *standard.xml*) into current node *mycalendar*. Only the attribute *name* should not be taken from *standard.xml*. This results in following (internal) structure:

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```
<node id="mycalendar" ref="standard.calendar">
  <name>My calendar</name>
  <!--resolved: ref="standard.calendar"-->
  <widget>ep/calendar#ep/widget/smartclient/calendar/CalendarPane</widget>
  <helpContext>user/calendar</helpContext>
</node>
```

Non-node elements missing in the referencing node are always copied. Node elements are copied only, if *withChildren="true"*.

withChildren: In addition to the *ref* attribute the attribute *withChildren="true"* can be used to refer to whole subtrees and not only single (pruned) nodes, e.g.

```
<label id="mysearch" ref="standard.search" withChildren="true"/>
```

name: This name is visible in the tree. Within *<name>* the definition of e.g. images or Java Scripts are possible (see example [Function \(<function>\)](#)).

default: If this element is present and its value is true, the node is the default node. The page represented by this node will be shown when the user navigates to this client the first time.

rightsMayExecute: Visibility of this node is restricted to users having one of the rights in the list (comma separated list of id's)

rolesMayExecute: Visibility of the node is restricted to users having one of the roles in the list (comma separated list of id's). Restrictions to roles within org-units are also possible with following syntax: [deptid "!"] roleid

The attributes *rightsMayExecute* and *rolesMayExecute* are just for controlling the visibility in the tree. There is no checking or granting of permissions involved. The called functions must apply their own permission checks.

Please note that for the node to be visible when both *rightsMayExecute* and *rolesMayExecute* are specified, the current user must at least be granted one of the rights **and** be assigned to one of the roles.

collapsible: Defines, if the tree is collapsible or not (true/false).

default: One of the links in the tree can be the default-Link. This page is then loaded initially (after login). The value is TRUE or FALSE.

widget: A widget can be defined here which is used by smartclient. An example for such a widget are the DMS-Tree in Navigation, the calendar pane, etc.

reloadOnShow: This boolean parameter should be used for tabs only which are reloaded on each click. A meaningful example is an additional process instance tab which should be reloaded every time via servlet request. Example configuration:

```
<action id="linkedItems"> <!-- itsm linked items-node -->
  <href>com.groiss.itsm.ITSMFunctions.showLinkedItemsTab</href>
  <name>Incidents / Changes</name>
  <reloadOnShow>true</reloadOnShow>
</action>
```

In the following sections the available node types are described.

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Label (<label>)

Defines a simple label, e.g.

```
<label id="mylabel">
  <name>Simple Text</name>
</label>
```

Node (<node>)

Defines a hyperlink; `href` defines the link (opens a page in an iframe) or it is possible to define an `onClick` action (defining a widget for example). With element `target` the target of the link can be defined (value *right* is the default).

Examples:

```
<node>
  <name>Current Date</name>
  <href>../servlet.method/com.groiss.demo.HttpDemo.showDate</href>
</node>

<node>
  <name>@@@ep:stored_queries@@</name>
  <onClick>ep/widget/smartclient/reporting/actions/ShowStoredQueries</onClick>
</node>
```

Worklist (<worklist>)

The node element `worklist` defines the class implementing the interface `com.groiss.wf.html.Worklist` and represents a link to the worklist.

With the element `application` you can restrict the worklist items to a given application. If this element is not present and the worklist node is not inside an application node, the worklist for all applications is retrieved.

The element `tableHandler` defines the class implementing the interface `com.groiss.wf.html.Worklist`. We recommend to implement this interface.

The type of the worklist (user worklist, role worklist, etc.) is specified within the element `type`, table 12.2 shows the possible values. You may specify almost any combinations of these types. The `id` attribute is used to refer to this worklist description from the API.

A special type is `AUGMENTED` which is for situations when the `WorklistHandlers` do not just filter/restrict the precalculated worklists but also augment the lists with additional tasks. Worklist adapter classes must fill the list for themselves in the case of full worklist construction (initial worklist fetch and complete refresh). In the case of delta computation (partial worklist building for notifications) the list contains all changes (even irrelevant ones) and must be filtered appropriately.

To differentiate between the cases, the `com.groiss.wf.html.WorklistDescription`

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parameter (which is part of the init call) provides the method `isDelta` which returns true in case of partial worklist building and false otherwise. For notifications to work in such a scenario, the property `ep.notification.sendto.augmented.worklists` must also be checked under *@enterprise Administration/Configuration/Other* parameters.

In the case of partial worklist building for augmented worklists, `WorklistHandler.getList` will be called with a list of `ActivityInstances` which contains

- items that origin from the unaugmented part of the worklist and therefore should be kept in the result and
- items that origin from the augmented part of the worklist. According to the intended semantics of the augmentation, such items might or might not be relevant for the worklist. It is the responsibility of the `getList()` implementation to remove irrelevant augmented items from the result.

To differentiate between the two cases, `WorklistDescription.isAugmentedItem` can be used.

Another special type is `NONE`. Worklists of this type are not part of the active notification mechanism on the client. They will refresh when they are opened, or when an explicit refresh action is triggered in the client. `Worklist.getList` will always be called with an empty list, the `Worklist` implementation must calculate the list itself and return it. The worklisttype `NONE` should not be combined with other types (then it would have no effect).

It is also possible to define a `defaultAction` which is executed when a table entry is double-clicked. Especially for worklists the action `showWIDetails` can be defined to display the detail tabs of an entry.

With element `showInlineDetailsAt` it is possible to define where the detail view of an worklist entry should be displayed. With value `row` the details can be shown in worklist table directly (an own area appears beneath the selected row). Alternatively a column can be defined as value in following way: `column:<colid>` whereby `<colid>` is the id of the column defined in XML (see section with `columns` beneath).

The element `dndHandle` allows to configure the drag & drop (DnD) behavior of a worklist. The value `off` means that no DnD is possible for this worklist. The value `handle` allows DnD in principle, but only a small area on the left side of a worklist entry can be used for DnD actions. The value `row` is the default behavior and allows DnD for a worklist entry as known. If text selection in worklist rows is needed, only the modes `handle` and `off` can be used.

The element `actions` defines the applicable functions from the table 12.3. Actions can be combined like in the example below (actions `finish` and `finishAndSelect`). Additional actions can be defined in block `<nodes>` described in section [Non tree nodes \(<nodes>\)](#) which are accessed by using `<xmld>.<action_id>`.

Furthermore, the following elements are available for customizing worklists:

- `columns`: a set of `<column>` elements can be defined with following attributes (example see below):

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USER	the personal worklist: agent is the user
ROLE	the role worklist plus the role worklists of the substituted users
SUSP	the suspension list of the user plus the suspension list of the substituted users
ROLESUSP	the suspended item where the agent is a role the user has or substitutes
SUBST_USER	the personal worklists of the substituted users
ROLE_NO_SUBST	like ROLE without the substitutions
SUSP_NO_SUBST	like SUSP without the substitutions
ROLESUSP_NO_SUBST	like ROLESUSP without the substitutions
SUSP_ONLY_SUBST	suspension list of the substituted users only
AUGMENTED	for situations when the WorklistHandlers do not just filter/restrict the precalculated worklists but also augment the lists with additional tasks
NONE	WorklistHandler must calculate the list. No active notification on the client.

Table 12.2: **Worklist Types**

Id	Description
finish	complete one or more tasks
untake	put item back into role worklist
finishAndSelect	finish and select next agent
finishAndComment	finish and comment for next agent (+ select next agent)
goBack	go back to one of previous steps
seeLater	put work item into suspension list
makeVersion	make a version of the process instance
take	take an item from the role worklist
recall	recall an item from the suspension list
recallAndTake	take an item form the role suspension list
setAgent	set a new agent
newFolder	new userfolder
editFolder	edit userfolder
cut	cut selected item and put it into clipboard
insert	insert item from clipboard
adHoc	adhoc-functionality for worklist
loadDoc	load a DMS object and attach it to process instance
taskfunction:functionid	functionid is the id of a task-function
space	separator

Table 12.3: **Actions**

- id: from table 12.4 or self defined id, the worklist implementation must provide the value.

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Id	Description
role	role the work-item belongs to
order	manual order for the worklist content by using drag & drop; this column cannot be used for worklist type AUGMENTED
id	process id
orgUnit	department name
pd	process name
task	task name
subject	process subject
documents	links to the forms and documents
functions	link to the functions (icon)
started	when the work item has been created
received	when the work item has been received
dueDate	the due date of the task
processDueDate	the due date of the main process
finished	in the suspension list till ...
currentEditor	the current editor (only displayed, if AUTO-TAKE)
priority	priority of the process instance
origin	symbolizes, if user sees the instance via substitution or not
application	the application where the process belongs to
lastAction	the last action of the task (name: triggering_action)
hasSeen	column for displaying seen/unseen entries (name: has_seen)

Table 12.4: **Columns of Worklist**

- name: the name of the column
- formFields: the definition of a form field could be done with following syntax:

```
process-definition-id ":" process-version ":" form-path  
{ ";" process-definition-id ":" process-version ":" form-path }
```

Where the following variants of form-path are allowed:

- * form-id ":" field-id1 :
display the value of the field field-id1 of the form
- * form-id ":" field-id1 ":" field-id2 :
display the value of field field-id2 of the field field-id1 of the form
- * form-id ":" subform-number ":" field-id1 :
display a comma separated list of values of field field-id1 of the subforms with number subform-number of the form
- * form-id ":" subform-number ":" field-id1 ":" field-id2 :
display a comma separated list of values of field field-id2 of field field-id1 of the subforms with number subform-number of the form

This syntax defines for every process instance which form field is shown. Please note that the definition of only one form-path per process definition/version is allowed, i.e.:

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`myproc:1:myf:field1;myproc:1:myf:field2` is **not** possible, because field1 and field2 are read from the same process definition/version.

`myproc:1:myf:field1;mypproc2:1:myf:field2` is possible, because field1 and field2 are read from different process definitions/versions.

If the worklist contains an instance of a process not listed in the field specification the column will remain empty.

- **visible**: if set to true, the column is displayed automatically without using the columnpicker.
- **rowSpan**: a positive integer could be defined for rowspan (analog to HTML)
- **colSpan**: a positive integer could be defined for colspan (analog to HTML)
- **unhideable**: defines, if column could be hidden via column picker
- **localizeValue**: translates value (depending on resource bundle), if set to *true*
- **icon**: path to an icon; it is displayed instead of the name
- **jsClass**: enter a path to a widget which handles this column (see e.g. in `demo.xml`
`ep/widget/smartclient/wl/columns/CombinedSubject`)
- **filterable**: if *true*, the column can be used for filter mechanism
- **type**: defines the type of a column; possible values are: string, date, dateTime, UTCdate, UTCdateTime, number (for numbers without comma) or decimal (for numbers with comma + appropriate representation according to decimal formatter configuration).
- **sortable**: if *true*, column is sortable
- **shortcut**: an arbitrary shortcut can be defined here by entering the appropriate keys. A list of keys is listed [here](#).

Example: CTRL+SHIFT+W

If these keys are pressed at once, this worklist-node will be displayed.

- **defaultSortColumn**: This parameter allows to define a column which is sorted by default. If a user is changing the order in table, the new order is stored in the user properties table (and read from there). The element *defaultSortColumn* must contain the sort direction (+ or -) and the column-id as value (see example below). The sort direction + defines ascending order, descending order is -. If one attribute is missing, the first (or given) column will be sorted (by default in ascending order).
- **defaultGroupColumn**: This parameter allows to define a column which is taken as default group-by-column. If a user is changing the group-by-column in table, the new setting is stored in the user properties table (and read from there). The element *defaultGroupColumn* must contain the column-id as value and optional the descending sort direction (see example below). The sort direction - defines descending order, the column-id without sort-direction defines ascending order.
- **selection**: the selection mode of worklist-entries can be modified.

- NONE or HIDDEN: no selection possible in worklist (NONE works in smart-client only!)
 - ONE: checkboxes will be displayed, but only one checkbox simultaneously can be selected
 - MULTI: checkboxes will be displayed
 - ROWONE: one row can be selected only
 - ROWMULTI: multiple rows can be selected
- **toolbarShape:** This parameter allows to set the representation of toolbar functions in following ways:
 - ICON: Function representation as icon
 - TEXT: Function representation as text
 - BOTH: Function representation as text and icon (only in smartclient usable)
- **folderActions:** Allows the definition of actions which are displayed in a dropdown menu beside the worklist node. A well-known example is the creation/adaption of user folders of a worklist (action-id: newUserFolder, deleteUserFolder, editUserFolder, etc.). The definition of *folderActions* is equal to the element *actions* (the *Example of a worklist node* shows how folderActions can be defined). The action *inheritTableSettings* allows to inherit table settings (sorting/grouping/column hiding/column widths) to subfolders.
- **params:** It is possible to add additional parameters to worklist requests, e.g. `x=1&y=2`
- **filterId:** Reference to an id of a worklist for sharing filters.
- **printable:** If this element is set to *true*, in GUI a printer icon is displayed and allows to print the displayed worklist (only in smartclient!).

With following attributes it possible to increase the performance of the worklist table:

- `<avoidDocsAndNotes>true</avoidDocsAndNotes>` avoids selection of documents and notes; should only be set if neither documents nor notes are needed in the application!
- `<avoidUserFolderFilter>true</avoidUserFolderFilter>` avoids filtering by userfolder contents; should only be set if user folders are not used in the application!

Example of a worklist node:

```
<worklist id="myworklist">
  <name>@@@ep:worklist@@</name>
  <type>USER</type>
  <application>default</application>
  <printable>true</printable>
  <dndHandle>handle</dndHandle>
  <actions>
```

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```
<action id="finish">
  <action id="finishAndSelect" />
</action>
<action id="goBack" />
</actions>
<folderActions>
  <action id="newUserFolder" />
</folderActions>
<columns>
  <column filterable="false" visible="true" sortable="true" name="#"
    groupable="true" id="order" jsClass="ep/widget/smartclient/wl/columns/Order"/>
  <column colSpan="1" sortable="true" name="@@@ep:id@" groupable="true" id="id"/>
  <column filterable="true" visible="true" unhideable="true" name="@@@ep:subject@"
    groupable="true" id="subject" />
  <column name="@@@ep:origin_path@" groupable="true" id="origin"/>
  <column type="dateTime" name="@@@ep:finish_till@" groupable="true" id="dueDate"/>
  <column id="process" name="@@@ep:process@" visible="true" />
  <column id="task" name="@@@ep:task@" visible="true" colSpan="2" />
</columns>
<defaultSortColumn>-id</defaultSortColumn>
<defaultGroupColumn>dueDate</defaultGroupColumn>
</worklist>
```

This node describes a link to the user worklist (type=USER) with 5 columns defined in 2 rows, four of them are visible, the other can be selected using the column selection menu on the right edge of the table header. The column with name *id* is sorted by default in descending order.

Structured worklist (<structuredWorklist>)

The structured worklist is a special kind of worklist and allows to structure it. This could be necessary, if a user folder or a worklist with substitutions should be used. Structured worklists must contain an *id* and supports following types (<type>): *USER* for user folder and *SUBST_USER* for substitutions. For *SUBST_USER* also the element *structure* is needed with following values:

- *perFolder*: Only the/all user folder trees of substituted persons are displayed without top level folder (= worklist). For each person a user folder tree is displayed.
- *perUserAndFolder*: For each substituted user a tree with its worklist items (worklist and user folder) is displayed.
- *perUser*: Only the worklists of substituted users are displayed without user folder items (for each person a worklist node is displayed).

In *standard.xml* the attribute *filterId* with value *wl* means, that all stored filters are inherited from the standard-worklist depending on attribute *id* in worklist description node.

Hint: In structured worklists it is also possible to define the tuning attributes *avoidDocsAndNotes* and *avoidUserFolderFilter* which are described in worklist section!

Start process (<processStart>)

Defines a link for starting processes. Following modes are available, the mode is specified via the element `mode`:

DUEDATE: On click on the link a form is shown where the due date and the start department can be entered.

DIRECT: On click on the link the process is started immediately.

FORM: On click on the link the process form is shown before process is started. This option is usable in smartclient only! The button label for starting the process can be configured by adding the following element: `<params>buttonlabel=Name of button</params>`

ALL: The list of startable processes of the application is shown.

The Attribute `targetId` denotes the id of the process (only for mode DUEDATE, DIRECT and FORM). The system uses the active process with this id and the highest version number. With attribute `orgUnit` (only for DIRECT and FORM) you can define, in which organizational unit the defined process (`targetId`) should be started. In mode **ALL** (default-mode) the element `applications` can contain a list of application ids.

Example:

```
<processStart id="myprocstart">
  <name>Start</name>
  <applications>default,myappl</applications>
  <worklistId>standard.wl</worklistId>
</processStart>
```

Function (<function>)

Shows a link to a global task function, parameters can be specified.

Example: A link to the function `note_global` will appear for all users with the role `r1`. The function will be called with the arguments $x = 1$ and $y = 2$. Left of the function name the specified icon is shown.

```
<function id="myfunction">
  <name>My function</name>
  <targetId>note_global</targetId>
  <rolesMayExecute>r1</rolesMayExecute>
  <params>x=1&y=2</params>
</function>
```

Function list (<functionList>)

Shows a link to all global task functions of an application.

The attribute `applications` can contain a list of application ids.

```
<functionList id="myfunctions">
  <name>My functions</name>
  <applications>default,itsm,crm</applications>
</functionList>
```

Report (<report>)

A node can be configured to link to a stored query.

```
<report id="id_22">
  <name>My report</name>
  <targetId>bsp_03</targetId>
</report>
```

The node `report` contains the element `targetId` of the report (see [Reporting](#) manual).

DMS (<dms>)

Shows the DMS of *@enterprise*. Following additional attributes can be defined:

- **actions:** Analog to node type worklist description.
Examples:
 - **createVersion:** A version of the currently selected DMS object can be created by activating this function in toolbar.
 - **taskfunction:<function_id>:** The function with the specified id is displayed in toolbar.
- **columns:** Analog to node type worklist description.
- **allowFormTypes:** This attribute can contain a list of forms, which are allowed or denied depending on attribute *allow*. This attribute can contain the values *true/false* whereby *false* means that the entered form types are not allowed. All other form types of *@enterprise* can be used.

More common table attributes can be found in section *Table*.

Example:

```
<dms id="mydms">
  <name>DMS folder</name>
  <actions>
    <action id="new" />
    <action id="delete" />
    <action id="space" />
    <action id="cut" />
    <action id="copy" />
    <action id="link" />
    <action id="paste" />
    <action id="space" />
    <action id="replace" />
    <action id="sendTo" />
    <action id="startProcess" />
    <action id="space" />
    <action id="changeType" />
    <action id="createVersion" />
    <action id="attachNote" />
  </actions>
</dms>
```

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```
<action id="signDoc" />
<action id="download" />
<action id="space" />
<action id="folderProps" />
<action id="clipboard" />
</actions>
<columns>
  <column id="name" name="@@@ep:name@"
    visible="true" icon="" />
  <column id="form" name="@@@ep:additional_data@"
    visible="true" icon="images/form.gif" />
  <column id="type" name="@@@ep:docType@"
    visible="true" icon="" />
  <column id="size" name="@@@ep:docSize@"
    visible="true" icon="" />
  <column id="changed" name="@@@ep:changed_at@"
    visible="true" icon="" />
  <column id="status" name="@@@ep:locked_by@"
    visible="false" icon="" />
  <column id="info" name="@@@ep:properties@"
    visible="false" icon="images/info.gif" />
  <column id="versions" name="@@@ep:versions@"
    visible="false" icon="images/version.gif" />
  <column id="attachedNotes" name="@@@ep:notes@"
    visible="false" icon="images/dms/attachednotes.gif" />
  <allowFormTypes allow="false">f_mainform(1)</allowFormTypes>
</dms>
```

Table (<table>)

A table can be created whereas the table should be a form table, but can be a persistent table. Following most needed attributes are:

- **classname**: The classname of the object (a `com.groiss.store.Persistent`).
- **tableHandler**: The tablehandler to manipulate the table (see section [The Form Table Handler](#)).
- **model**: Here you can define the table model (default: `com.groiss.storegui.FormTable`).
- **condition**: Possibility to enter a SQL condition for restricting table result. The parameters are represented by question marks (?).
- **allowModifications**: If true, insert, update and delete using `com.groiss.smartclient.JSONLoader` is allowed.
- **types**: Allows to define the datatypes of the given parameters defined in the *condition*. For each parameter in condition a type is needed (comma-separated list). Possible values are:
 - Persistent
 - Date

- Long
- Double
- Integer
- String
- OIDList

A parameter with type *OIDList* has to be a nested JSON array (double square brackets are needed!), e.g. `[[oid1,oid2,oid3]]`. The condition has only one question mark (e.g. "oid not in (?)").

- **columns**: Analog to node type worklist description.
- **actions**: Analog to node type worklist description. A special action for (form) tables is *formExportToExcel* which allows to export the displayed table as XLSX-file (Microsoft Excel).
- **editTargetProps**: The window properties can set here by adding several parameters separated by semicolon. The syntax is the same as using the JavaScript method *window.open()*.
- **columnPicker**: If set to true, the column picker is displayed.
- **useFilter**: If set to true, the filter mechanism of *@enterprise* for tables is provided.
- **paging**: If set to true, the paging mechanism of *@enterprise* for tables is used (for v1 tables only!).
- **pagesize**: Individual paging size for this table. If not set, the user parameter is used and as default the configuration parameter (for v1 tables only!).
- **defaultSortColumn**: This parameter allows to define a column which is sorted by default. If a user is changing the order in table, the new order is stored in the user properties table (and read from there). The element *defaultSortColumn* must contain the sort direction (+ or -) and the column-id as value. The sort direction + defines ascending order, descending order is -. If one attribute is missing, the first (or given) column will be sorted (by default in ascending order).
- **defaultGroupColumn**: This parameter allows to define a column which is taken as default group-by-column. If a user is changing the group-by-column in table, the new setting is stored in the user properties table (and read from there). The element *defaultGroupColumn* must contain the column-id as value and optional the descending sort direction. The sort direction - defines descending order, the column-id without sort-direction defines ascending order.
- **selection**: checkboxes on the left side of table-entries can be modified.
 - NONE or HIDDEN: no selection possible in table
 - ONE: checkboxes will be displayed, but only one checkbox simultaneously can be selected

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- MULTI: checkboxes will be displayed
 - ROWONE: one row can selected only
 - ROWMULTI: multiple rows can be selected
- `toolbarShape`: This parameter allows to set the representation of toolbar functions in following ways:
 - ICON: Function representation as icon
 - TEXT: Function representation as text
 - BOTH: Function representation as text and icon
- `admin`: If set to *true*, table can be used as *@enterprise* admin only.
- `noSearch`: If set to *true*, whole table is displayed (e.g. if more table entries are available than allowed to display) by default and no search is possible.
- `noWarning`: If set to *true*, no warning is displayed, if more table entries are available than allowed to display.
- `subformid`: If table is used as subform table, it is possible to enter the subform id (integer value) here which identifies the relation between mainform and subform.
- `printable`: If this element is set to *true*, in GUI a printer icon is displayed and allows to print the displayed table.
- `fetchAttrs`: Allow to (pre-)fetch dependent objects from the database by efficient operations. The content is a comma separated list of names of java fields of the corresponding class. The field names must denote persistent objects! Usually one BulkQuery per field is executed instead of a (single record) select-statement per record and field.

Example:

```
<table id="myformtable">
  <name>MyForm table</name>
  <model>com.groiss.storegui.FormTable</model>
  <classname>com.dec.avw.appl.MyForm_1</classname>
  <searchAttrs>str</searchAttrs>
  <columns>
    <column id="str" name="str" visible="true" />
    <column id="dt" name="dt" visible="false" />
    <column id="deci" name="deci" visible="false" />
    <column id="pb_art" name="pb_art" visible="false" />
  </columns>
  <columnPicker>true</columnPicker>
  <useFilter>false</useFilter>
  <actions>
    <action id="new" />
    <action id="edit" />
    <action id="delete" />
    <action id="searchfield" />
  </actions>
</table>
```

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```
<action id="search" />
</actions>
<paging>true</paging>
<columnPicker>true</columnPicker>
<printable>true</printable>
<defaultSortColumn>+str</defaultSortColumn>
<defaultGroupColumn>-dt</defaultGroupColumn>
/table>
```

It is also possible to define tabbed views shown in the following example. The master-view must contain the element `tabs`. The slash at the first position indicates that the master-view is shown as tab *Common*. The second position indicates the detail page (= second tab) which is defined as own node - named *detail* in this example - in the XML named *myxml* within the *nodes* block (see section [Non tree nodes \(<nodes>\)](#) for more details about this block). A further necessary attribute in master-view is `detail` to get a tabbed window view. In our example the detail-view is a table (displayed in *page*) with columns *Id* and *Name* which represents the history of the master-view. If an entry is double-clicked (= element `defaultAction`) or selected and the toolbar function *view* is activated, the detail-view of the selected entry is opened. The attribute `toolbarTarget` indicates that a toolbar (frame with id *tbframe*) is displayed as vertical toolbar (= element `toolbarAlign`).

```
<table id="master">
  <name>Master</name>
  <model>com.groiss.storegui.FormTable</model>
  <classname>com.dec.avw.appl.master_1</classname>
  <detail>com.groiss.storegui.TabbedWindow.showDialog</detail>
  <actions>
    <action id="new" />
    <action id="edit" />
    <action id="delete" />
    <action id="searchfield" />
    <action id="search" />
    <action id="allsearch" />
  </actions>
  <searchAttrs>master_id</searchAttrs>
  <tabs>/,myxml.detail</tabs>
  <paging>true</paging>
  <useFilter>true</useFilter>
  <editTargetProps>width=850,height=500</editTargetProps>
  <columnPicker>true</columnPicker>
</table>

<nodes>
  <table id="detail">
    <name>Detail</name>
    <model>com.groiss.storegui.FormTable</model>
    <tableHandler>com.groiss.test.DetailTableHandler</tableHandler>
    <classname>com.dec.avw.appl.detail_1</classname>
    <actions>
      <action id="view"/>
    </actions>
  </table>
</nodes>
```

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```
<defaultAction>view</defaultAction>
<toolbarTarget>tbframe</toolbarTarget>
<toolbarAlign>v</toolbarAlign>
<page>mask/TabTB.html</page>
<tableTarget>parent</tableTarget>
<columnPicker>true</columnPicker>
<columns>
  <column id="detail_id" name="Id" visible="true" />,
  <column id="detail_name" name="Name" visible="false" />
</columns>
<editTargetProps>width=800,height=500</editTargetProps>
</table>
</nodes>
```

An alternative way for a detail view is the usage of a `com.groiss.store.Persistent` instead of forms. For this purpose the attributes `tabs` and `formHandler` are needed like in following example. An example of such an `formHandler` can be found in our demo application.

File `demos/classes/demo.xml`

```
<table id="supplier2">
  <name>@@@supplier@@ Custom persistent, old table</name>
  <version>1</version>
  <classname>com.groiss.demo.Supplier</classname>
  <tableHandler>com.groiss.demo.SupplierTableHandler</tableHandler>
  <formHandler>com.groiss.demo.SupplierFormHandler</formHandler>
  <tabs>/demo/masks/supplier.xhtml</tabs>
  <useFilter>true</useFilter>
  <actions>
    <action id="new" />
    <action id="edit" />
    <action id="delete" />
    <action id="demo.testCache" />
  </actions>
  <columns>
    <column id="name" name="@@@ep:name@@> visible="true" />
    <column id="description" name="@@@ep:description@@> visible="true" />
    <column id="street" name="@@@street@@> visible="true" />
    <column id="city" name="@@@city@@> visible="true" />
    <column id="zip" name="@@@zip@@> visible="true" />
    <column id="country" name="@@@country@@> visible="true" />
  </columns>
  <columnPicker>true</columnPicker>
</table>
```

XML fragment (APP_TREE)

This node allows to load application specific GUI-XML fragments into the tree. The attribute `fragmentName` defines the name of the XML file containing the tree fragment, for example:

```
<APP_TREE fragmentName="fileName"/>
```

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For each application *@enterprise* searches in the classpath for a resource using the following path: `<applid>/<fragmentName>.xml`, `applid` is the id of an application. If such a file is found, the `APP_TREE` node is replaced with the contents of the top-level XML-element of the fragment file. The top level element must be a `<fragment>`.

For example, a fragment file contains two nodes:

```
<fragment>
  <node id="node1">...</node>
  <node id="node2">...</node>
</fragment>
```

After the substitution, the two nodes `node1` and `node2` are inserted into the GUI-configuration instead of the `APP_TREE` node.

If there is more than one application containing a file with the given name, the contents of all files are inserted, ordered by the application startup sequence. If there is no file for replacement found, the `APP_TREE` node is just removed.

Hint: Note that there is a predefined fragment in *@enterprise* Administration:

```
<APP_TREE fragmentName="admin_tasks_fragment"/>
```

For all applications that have a fragment file with the name *admin_tasks_fragment.xml* the content is displayed after the *Dashboard* node in the section *Admin tasks*.

12.2.3 Non tree nodes (<nodes>)

If elements should not be displayed in tree, they must be defined within `<nodes>` block and outside of block `<tree>`. For non tree nodes the attribute *ref* is possible too as mentioned in section [Tree Nodes](#). Following elements are allowed:

Actions (<action>)

Sometimes it is necessary to define own functions. For this purpose the `<action>` element can be used like in following example:

```
<nodes>
  <action id="print">
    <name>@@@print@@</name>
    <href>javascript:window.print()</href>
  </action>
</nodes>
```

This new defined action is referenced in the worklist actions block, e.g.:

```
<worklist id="myworklist">
  <name>Worklist</name>
  <actions>
    ...
    <action id="xmlfilename.print">
    ...
  </actions>
</worklist>
```


Following attributes for actions are available:

- **name:** The name of the action. Within *<name>* the definition of e.g. images or Java Scripts are possible (see example [Function \(<function>\)](#)).
- **href:** Defines the link which opens an iframe
- **onClick:** Analog to href, but does not open an iframe; possibility to enter a path to a widget
- **target:** The target of the link can be defined, value *right* is the default. With value *ajax* a AJAX servlet method can be called which could be necessary e.g. for subform tables.
- **editTargetProps:** The window properties can set here by adding several parameters separated by semicolon. The syntax is the same as using the JavaScript method *window.open()*.
- **apply:** Defines, if action should be applied for a table entry or could be executed without selection. Following modes are available:
 - **NONE:** action can be executed without selecting a table entry
 - **ONE:** action can be executed only, if one table entry is selected
 - **MULTI:** action can be executed, if one or more table entries are selected
- **shortcut:** an arbitrary shortcut can be defined here by entering the appropriate keys. A list of keys is listed [here](#).

Example: CTRL+SHIFT+A

If these keys are pressed at once in appropriate context, the action will be performed. The appropriate context depends on the availability/visibility of the function, e.g. if function is a toolbar function of the worklist, the worklist must be displayed first (and maybe a worklist entry must be selected) before the shortcut can be used.

Object extension (<objectExtension>)

With help of this element an object extension can be created. For more information please read chapter [Adding tab Additional Info](#).

Object selection (<query>)

This element allows the definition of an object selection. Such a selection is needed for DOJO selection which are explained in chapter [Usage of customized DOJO controls](#).

(Sub-)tables (<table>)

Ordinary tables are defined normally within `<tree>` block. Subtables should be defined within `<nodes>` block. A description how to do this is available in section [XHTML forms with Sub-tables](#). In case of XHTML forms changing the subforms normally does not refresh the main-form. If a refresh is desired, add the element `<params>refreshForm</params>` to the configuration of the subform table.

12.2.4 Internationalization

Use `@@@key@@` like in `HTMLPage`. The resource must reside in classpath of the application. If standard `@enterprise` resources should be used, the key must contain a leading `ep;`, e.g. `@@@ep:role@@`. It is also possible to use resources of other applications. In this case the application-id is the prefix instead of `ep;`, e.g. `@@@itsm:abortandarchive@@`.

12.2.5 Adding HTML Code Between the Links

Arbitrary HTML Code can be put between the links in the navigation tree, for example a horizontal rule (`<hr>`). You specify a node with the HTML code as name and no other attributes. Example:

```
<label>
  <name><hr/></name>
</label>
```

12.2.6 Configure user parameters

The user properties in the configuration file contains an attribute with the following value, where you can add parameters in form of a list to show or hide options on the settings page of the users. These properties are accessible via the User profile / Settings dialog.

A summary of these properties is given in the following table (parameter and meaning):

- `ep.notification.condition`: When to be notified about new or removed entries
- `ep.notification.type`: Type of the notification
- `locale`: Language
- `avw.timezone`: Time zone
- `mail.composew.mode`: E-mail format for compose window
- `ep.style.theme`: Theme selection
- `ep.gui.tree.persist_expansionstate`: Restore tree view (e.g. DMS)
- `dms.show_hidden_docs`: Display hidden documents

Example: Define an own settings node in section `nodes`

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```
<action id="mySettings">
  <name>@@@ep:settings@@</name>
  <onClick>ep/widget/smartclient/ShowUserProperties</onClick>
  <params>list=ep.notification.condition,ep.notification.type,locale</params>
</action>
```

In this example the options *Email notification* and *Language* are visible on the settings page of the users only. Make a reference to this action within the `userProfile` node as following:

```
<userProfile>
  ...
  <action id="mygui.mySettings" />
</userProfile>
```

12.2.7 Change style and logos/icons

If you want to use your own style for your application, create a file *styles.less* within the *classes* folder of your application (see section [Organization of Files](#) for file structure). The *@enterprise* styleloader loads this file (depending on startup sequence of the application) and appends it to the main less-file. More information concerning styling is available in section [Styling](#).

If you want to change the *@enterprise*-logos, you have to do following steps manually:

1. Create the directory *lang/default/images* in *classes* directory
2. Create a file named *enterprise.svg* in the *images* folder to replace the logo at the login-page and in the top left corner above the navigation frame

Hint: If you create your own theme via style configurator, it is easily to set up the *@enterprise*-logos. Just enter an image path in the *Application logo* and *Application logo inverse* (for example: *../images/new_enterprise_logo.svg*).

@enterprise uses icons from icomoon library (see [Icomoon Ultimate](#)). These icons are available in file *ep-icomoon-repackaged-*.jar* within the lib-directory of *@enterprise* and can be also used by API developers!

12.3 Customizing the Worklist

For achieving full flexibility in worklist layouts, it is possible to write a Java class defining the appearance of the worklist. You can mix information from *@enterprise* (user, task name) with application specific data from forms or other database tables.

Define your class as implementor of `com.groiss.wf.html.Worklist` and specify the class in the XML configuration file as additional attribute of the worklist description:

```
<tableHandler>com.groiss.demo.DemoWorklist</tableHandler>
```

The `com.groiss.wf.html.Worklist` interface contains the following methods:

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```
public void init(HttpServletRequest req, WorklistDescription wl, User u);
public Object getTitle();
public List<ActivityInstance> getList(List<ActivityInstance> l);
public void getAdditionalData(List<ActivityInstance> instances);
public void modifyColumns(List<ColumnDescription> colDescs);
public void modifyTableLine(ActivityInstance ai,
    Map<String, Object> line);
public String lineStyle(ActivityInstance ai, String style);
public List<Pair<String, String>> listFilters();
```

The interface `com.groiss.wf.html.WorklistDescription` used in the `init` method consists of:

```
public interface WorklistDescription {
    public int getType();
    public String getId();
    public Application getApplication();
    public List<ColumnDescription> getColumns();
    public int getLinkType();
    public void needForm(String processid, int version, String formid);
    public DMSForm getForm(ProcessInstance pi, String formid);
    public Set<DMSForm> getForms(String formid);
    public boolean isFillCounter();
    public boolean isDelta();
    public boolean isAugmentedItem(ActivityInstance item);
    public String getAttrib(String key);
}
```

The `WorklistDescription` contains getters for the definitions from the XML file. The list retrieved from the method `getColumns` can be modified to change the displayed columns.

The method `needForm` is used to define which forms will be needed in the worklist construction. You must call this method in the `init` method of your worklist implementation. The system will then retrieve the forms in an efficient manner. The method `getForm` retrieves these forms from the temporary cache.

The methods of the `Worklist` interface are called in the written order and do the following:

- `init`: You can init your class with the request. For your convenience, we give you the type of the worklist, the application, and the user. The `init` method is called once for the creation of a worklist.
- `getTitle`: non null overwrites the title.
- `getList`: non null overwrites the list, should return list of activity instances,
- `getAdditionalData`: Your chance to collect data. See the next section for details.
- `modifyColumns`: You get the header as we suggest it (i.e. the default), a list of `com.groiss.gui.table.ColumnDescription`. A `ColumnDescription` contains an id and a name. The id is the column-id and the name is the value which is displayed. The id's can be found in table [12.4](#).

12. Configuring the Worklist Client

You can change this header as you like. The resulting header is used to build the table lines: for the keywords the system adds the corresponding column, for other names we add "null" elements.

- `modifyTableLine`: Your chance to modify the line, called for each table line. Returning null will filter out this line.
- `lineStyle`: Finally you can change the style of the line, return the name of a table-row style class.
- `listFilters`: Define a list of customized filters. See below.

The worklist implementation can be used to define filters, two steps are necessary: First, the method `listFilters` defines the available filters:

```
public List<Pair<String, String>> listFilters() {
    List<Pair<String, String>> result = new ArrayList<>();
    // filter processes order
    result.add(new Pair<>("demo_order", "Process order"));
    // filter tasks start order
    result.add(new Pair<>("demo_request_order", "Task start order"));
    return result;
}
```

Next, you must remember the selected filter in a local variable:

```
String filter;
public void init(HttpServletRequest req, WorklistDescription wl, User u) {
    // custom filter step 1: remember filter parameter
    if (ThreadContext.getRequest() != null) {
        filter = ThreadContext.getRequest().getParameter("filter_s");
    }
}
```

In the method `modifyTableLine` you can filter out lines with the method `clear`:

```
public void modifyTableLine(ActivityInstance ai, Map<String, Object> line) {
    if ("demo_order".equals(filter) &&
        !(ai.getProcessDefinition().getId()).equals("demo_order") ||
        "demo_request_order".equals(filter) &&
        !(ai.getTask().getId()).equals("demo_request_order")) {
        line.clear();
        return;
    }
}
```

The *@enterprise* class `com.groiss.wf.html.FilteredWorklist` offers a simple way to filter worklists by tasks, roles, or processes. Specify the class in the xml configuration file in the `tableHandler` element of the worklist configuration and define a filter using the `params` element. The worklist in the following example shows only instances of `process1` and `process2`:

```
...
<tableHandler>com.groiss.wf.html.FilteredWorklist</tableHandler>
<params>{filter: "process", include: ["process1","process2"]}</params>
...
```

For more details about this implementation of `com.groiss.wf.html.Worklist` please read the APIDoc.

12.4 Displaying Additional Data

When displaying the worklist, data can be read from different places, which affects the performance of the table. Consider a scenario where a database table `demo_supplier` may hold additional data about a process in DMS. The simplest approach to display this data in the worklist would be to define a method `getAdditionalData`, which gets a list of activity instances as parameter and to use this information in method `modifyTableLine`.

```
...
line.put("invoice",addProcData.get(pi));
...
```

As an example, we define a class `AdditionalProcDataWL` which contains some arbitrary data.

File **java/com/groiss/demo/AdditionalProcDataWL.java**

```
public class AdditionalProcDataWL implements Worklist {

    protected HashMap<ProcessInstance, DMSObject> addProcData = new HashMap<>();

    @Override
    public void getAdditionalData(List<ActivityInstance> list) {
        BulkQuery bq = new BulkQuery(list);
        String query = "folder " + BulkQuery.IN;
        bq.execute(FolderItemRelation.class, query).stream()
            .forEach(rel ->
                addProcData.put((ProcessInstance)rel.getFolder(), rel.getItem()));
    }

    /**
     * build header for personal and role worklist
     * @see com.groiss.wf.html.Worklist#modifyTableHeader(java.util.List)
     */
    @Override
    public void modifyColumns(List<ColumnDescription> colDescs) {
        colDescs.add(new ColumnDescription("invoice", "Invoice"));
    }

    /**
     * build line of personal and role worklist
     * @see com.groiss.wf.html.Worklist#modifyTableLine(
```

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```
        com.groiss.wf.ActivityInstance, com.groiss.ds.KeyedList)
    */
    @Override
    public void modifyTableLine(ActivityInstance ai, Map<String, Object> line) {
        ProcessInstance pi = ai.getProcessInstance();
        line.put("invoice", addProcData.get(pi));
    }
}
```

The table must be generated using an SQL statement like this:

File **sql/addprocdataschema.sql**

```
create table demo_supplier(
    oid %OIDTYPE% not null primary key,
    transactionId %OIDTYPE%,
    name VARCHAR(100),
    description VARCHAR(1000),
    street VARCHAR(100),
    zip VARCHAR(10),
    city VARCHAR(100),
    country VARCHAR(100)
)
```

To sum up, this approach might be somewhat more intensive implementation wise, but in general it does pay off well in terms of increased performance and diminished server load.

13. Communication with other Systems

13.1 E-Mail

13.1.1 Sending E-Mails

The `com.groiss.messaging.MessageTemplate` interface can be used to create and send e-mail messages. Message templates can be created in the system administration user interface. You may specify recipients, subject, message body, etc. The most simple method to send a message is the following:

```
com.groiss.wf.SystemAction.sendMessage(templateid);
```

`templateid` is the id of a message template. However, there are several methods to manipulate the template, see the following example:

```
MessageTemplate mt = Admin.getInstance().getMessageTemplate("myid");
mt.addRecipient(
    new Recipient().setAgentString("test@frequentis.com")
        .setRecType(javax.mail.Message.RecipientType.CC))
    .setSubject("test")
    .setBody("<b>Good morning</b>")
    .send();
```

First, the template is read from the database. Then, it is manipulated by adding a recipient, a subject, and a message body. Finally, the message is sent using the `send` method.

Alternatively to get a template from the database, a new template can be created with:

```
Admin.getInstance().createMessageTemplate();
```

Variable substitution can be used in mail body and subject, for the syntax see section [Office Templates](#), but control structures are not implemented here. The message template has some methods for setting the context, depending on these the following variables are set:

- `setProcessInstance: pi`
- `setActivityInstance: pi, ai`

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- `setDocument`: `form` - the form associated with the document, `folder` - the folder the document is in

You can add extra variables with the method `setVariableValue`.

The template for the message body can be taken from a string (like in the above example) or from a resource in the classpath using the method `setBodyUrl`.

The properties of mail sending can be defined by setting a `MailSender` object using `setMailSender`. If this method is not used, a default mail-sender is created using the properties from the configuration (Communication group). Several communication properties can be set using the `MailSender`. One property, the queuing, can also be set directly using `setQueueAction`, the following options are possible:

- **QUEUE**: With this action the mail is tried to send immediately. If an error occurs, the mail will be added to the mail queue.
- **DEFERRED**: With this action the mail is added to the mail queue and will be sent automatically later. If an error occurs, the mail will be kept a predefined time in the mail queue (see parameter *Max. time for mail queue item (in hours)* in handbook *Installation- and Configuration*). If this time is exceeded, the administrator will be informed.
- **NO_QUEUE**: With this action the mail is sent immediately without using mail queue.

13.1.2 Receiving E-Mails

Receiving mails is a more complicated task. *@enterprise* contains a mail handler which is able to read mails from an IMAP mail box. In the system administration you can define such a mail box and a handler class for processing the incoming mails.

The mail handler class must implement the following interface:

```
package com.groiss.mail;

public interface MailHandler2 {
    public boolean receive(javax.mail.Message msg, MailBox mb);
}
```

The following example takes the incoming mails and returns a mail with the server info.

File `com/groiss/demo/MailGetter.java`

```
public class MailGetter implements MailHandler2 {

    @Override
    public boolean receive(Message msg, MailBox mb) throws Exception {
        Admin admin = Admin.getInstance();
        String from = msg.getFrom()[0].toString();
        String body = admin.serverInfo();
    }
}
```

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```
        admin.createMessageTemplate()  
            .addRecipient(from)  
            .setSubject("Server info")  
            .setMimeType("text/plain")  
            .setBody(body)  
            .send();  
        return true;  
    }  
}
```

13.1.3 Tab *Emails*

This section treats the configuration of the tab *Emails* and the ways to manipulate it.

In *@enterprise* this tab is defined as XML node with id "mails" in admin.xml. So it is possible to use it e.g. for a process by adding this id to field *Detail tabs* on process detail mask (see [Administration Guide](#), section [Processes](#) and subsection [Tab: General](#) for details).

For making manipulations you need to define an own XML node in your GUI configuration XML by adding a class which implements the interface `com.groiss.smartclient.mail.MailActionsHandler` as shown in following example:

```
<action id="custommails" ref="admin.mails">  
  <params>{mailhandler: "package.to.my.MailActionsHandler"}</params>  
  <href>com.groiss.mail.MailFunctions.showMailPane?  
    mailhandler=package.to.my.MailActionsHandler  
  </href>  
</action>
```

This node extends the *@enterprise* default Emails tab (admin.mails) with the toolbar functions

- Compose (admin.composeSC),
- Reply (admin.replySC),
- Reply all (admin.replyallSC),
- Forward (admin.forwardSC),
- Edit as new (admin.editasnewSC),
- Edit draft (admin.editDraftSC),
- Delete draft (deleteDraftSC) and
- Refresh (admin.refresh).

These toolbar functions are also defined in the API as `com.groiss.mail.MailFunctions.DefaultMailFunction`.

In elements `params` and `href` an own implemented `MailActionsHandler` class is defined. The interface `com.groiss.smartclient.mail.MailActionsHandler` provides some methods for manipulating the standard behavior of the Compose window, the mail sending action and the mail list. Detailed information for each method can be found in the APIDoc.

The `params` element of the XML node is used, if the Emails tab is shown in context of the (DOJO-)Smartclient (e.g. as tab of a process).

The `href` element of the XML node is used, if the Emails tab is shown e.g. in a Browser popup window or in context of a `com.groiss.storegui.TabbedWindow` implementation as shown in following example:

```
<table id="myfolders">
  <name>My Folders</name>
  <columns>
    <column name="@@@ep:name@" id="name" />
  </columns>
  <actions>
    <action id="new" />
    <action id="edit" />
    <action id="delete" />
  </actions>
  <classname>com.groiss.forms.MyFolder_1</classname>
  <defaultAction>edit</defaultAction>
  <detail>com.groiss.storegui.TabbedWindow.showDialog</detail>
  <model>com.groiss.storegui.FormTable</model>
  <version>2</version>
  <tabs>/,myconfig.custommails</tabs>
</table>
```

This table shows all forms of form type `MyFolder`. By editing a table entry a popup window will be opened with 2 tabs: The form itself and the Emails tab as defined in the XML node above (id "custommails").

If these manipulations are not sufficient and you need additional toolbar functions, you have to define a list of toolbar actions in a XML node as shown in following example:

```
<action id="custommails2" ref="myconfig.custommails">
  <params>{mailhandler: "package.to.my.MailActionsHandler",
    toolbar: "myconfig.myCompose,replySC,replyallSC,editDraftSC,
    deleteDraftSC,refresh"}
  </params>
</action>
...
<action id="myCompose">
  <href>compose</href>
  <apply>NONE</apply>
  <name>@@@ep:compose@@</name>
</action>
```

In this example we have defined the toolbar as parameter that contains some default functions and an own compose function with id "myCompose". By adding the `href` value

"compose" the client implementation knows that the compose window should be opened when activating this toolbar function. On server side in your `MailActionsHandler` class you are able to get the XML node action id of the executed toolbar function with parameter "actionId" which allows you to react appropriately.

Hint: If an other href value is entered, you have to extend the widget `ep/widget/smartclient/wl/MailPane` and overwrite JS-function `performAction` to handle the appropriate action. In this case you have to modify the XML node in the following way:

- You have to define the widget in your Emails tab node with the `widget` element as shown in following example:

```
<widget>myappl/MailPane</widget>
```

- For the `href` element you have to add the request parameter `mailpane` as shown in following example:

```
<href>
  com.groiss.mail.MailFunctions.showMailPane?
  mailhandler=package.to.my.MailActionsHandler&
  mailpane=myappl/MailPane
</href>
```

Attention: Because of the definition in the XML file, the `&` in the URL is intended!

13.2 Remote Method Invocation

Please note that this functionality is **deprecated** and that RMI-related components will be removed in a future version.

You can connect to *@enterprise* from other Java programs using Remote Method Invocation (RMI). The class `com.groiss.wf.SessionFactory` is used as root object to get a session from a client to the *@enterprise* server. Write the following lines to connect to a server:

```
DefaultResource.init("com.dec.avw.resource.Strings",
    "com.dec.avw.resource.Errors");
Properties props = new Properties();
props.put("url", url); // host:port
props.put("userid", userid);
props.put("password", password);
Session ss = SessionFactory.createSession(
    "com.groiss.avw.RMISessionFactory", props);
Store s = ss.getStore();
WfEngine e = ss.getWfEngine();
OrgData od = ss.getOrgData();
DMS dms = ss.getDMS();
...
```

The interfaces `Store`, `WfEngine`, `OrgData`, and `DMS` provide you the necessary API calls of *@enterprise*.

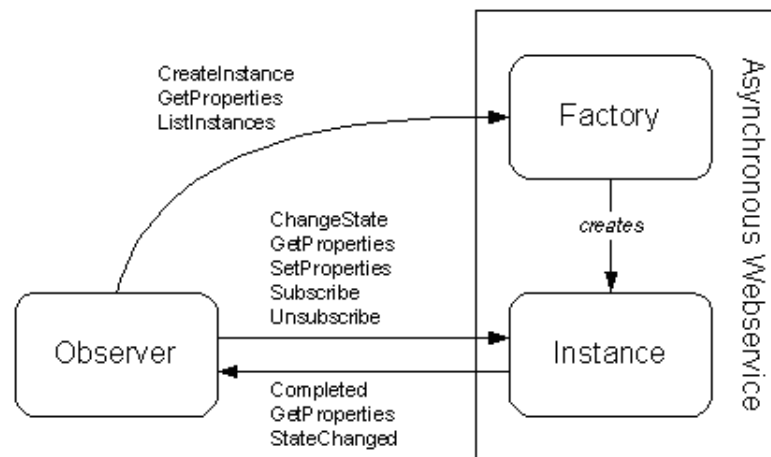


Figure 13.1: **Resource types of an asynchronous web service and the methods they use.**

13.3 Wf-XML 2.0

Wf-XML is a protocol for process engines that makes it easy to link engines together for interoperability. Wf-XML 2.0 is an updated version of this protocol, built on top of the Asynchronous Service Access Protocol (ASAP), which is in turn built on Simple Object Access Protocol (SOAP).

@enterprise contains an implementation of the standard. *@enterprise* can receive Wf-XML messages to start a process, get the current state of a process and change a process' state; and the system can also send all types of messages.

13.3.1 ASAP Overview

ASAP is a protocol that is needed for integration of asynchronous services across the Internet and their interaction defined by Oasis ASAP Committee. The integration and interactions consist of control and monitoring of the services. *Control* means creating the service, setting up the service, starting the service, stopping the service, being informed of exceptions, being informed of the completion of the service and getting the results of the service. *Monitoring* means checking on the current status of the service and getting an execution history of the service.

For the support of an asynchronous web service, three types of endpoints are defined to match the three roles of the interaction: Instance, Factory, and Observer. An endpoint type is distinguished by the group of operations it supports, and so there are three groups of operations (see Fig. 13.1).

Typical use of this protocol would be as follows:

- A Factory endpoint receives a CreateInstanceRq message that contains Context-Data and an EPR of an Observer

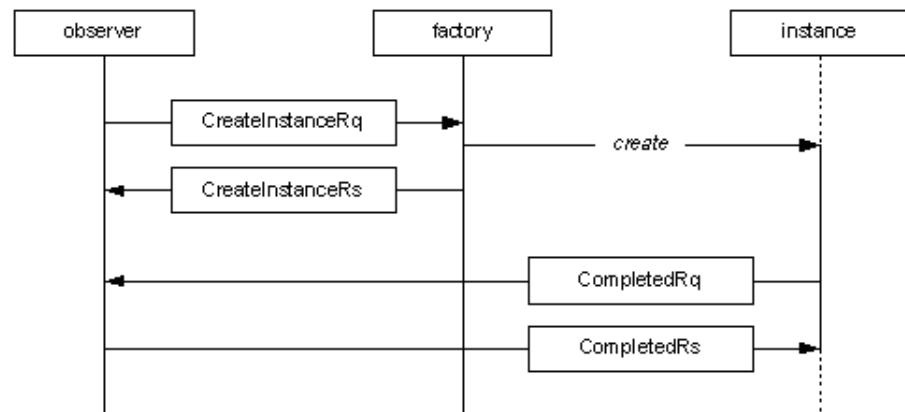


Figure 13.2: **Typical usage scenario of ASAP.**

- The Factory service creates an Instance service (with associated Instance endpoint).
- The Factory responds with a CreateInstanceRs message that contains an EPR for the Instance
- The Instance service eventually completes its task and sends a CompletedRq message that contains the ResultsData to the Observer endpoint

13.3.2 Wf-XML Overview

ASAP offers a way to start an instance of an asynchronous web service (AWS), monitor it, control it, and be notified when it is complete. This service instance can perform just about anything for any purpose. Wf-XML extends this in the special case that the asynchronous service is being invoked on a process engine.

The Service Factory maps to a Process Definition; the Service Instance maps to a Process Instance. Process engines provide some additional capabilities for monitoring the process. First of all, because it is a process, and not simply an opaque service, there is a process diagram. This diagram can be retrieved for introspection. Second, since the process is composed of activities, one can ask the activities for their current values. An activity may itself represent an invocation of a yet another remote service, and the address of that service instance may be retrieved. Thirdly, the process definitions can be edited, removed, or added.

Service registry resource is workflow system itself, or some application within this system, it manages factory resources, that are kind of process definitions, that can create in turn an operation instances, each of such instances can have one or more running activities. Each resource has common properties like name, description, and few specific properties, that will be returned back to *GetProperties* call. Some of this properties read-only, other can be modified with *SetProperties* call.

Container resources like Service registry, Factory, Instance have additionally methods for container introspection (see corresponding *listXXX* calls).

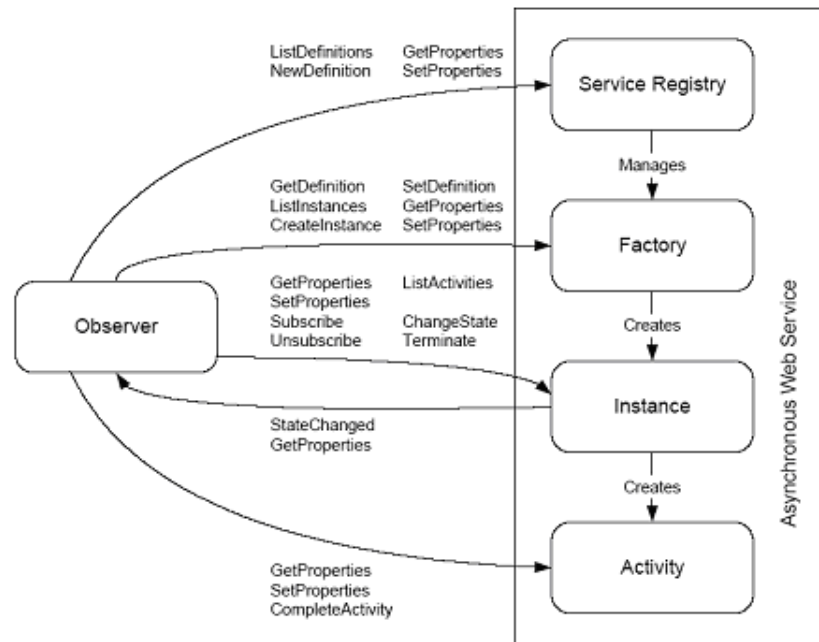


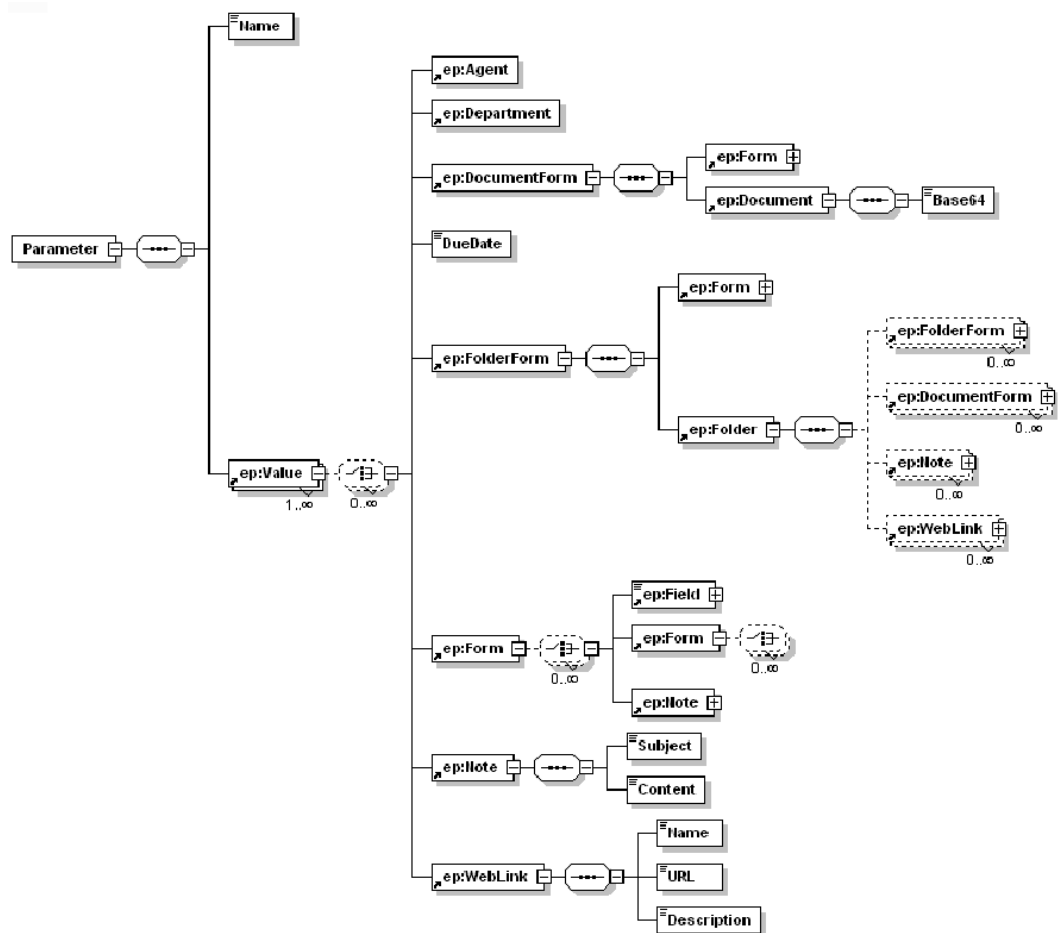
Figure 13.3: **Resource types of a process engine web service and the methods they use.**

Typical use of this protocol would be as follows:

- A Service registry resource receives ListDefintionsRq message, and returns list of process definitions
- A Client pick up required Factory resource from list and send CreateInstanceRq
- A Factory endpoint receives a CreateInstanceRq message that contains Context-Data and an EPR of an Observer
- The Factory service creates an Instance service (with associated Instance endpoint).
- The Factory responds with a CreateInstanceRs message that contains an EPR for the Instance
- The Instance service eventually completes its task and sends a CompletedRq message that contains the ResultsData to the Observer endpoint

Context/Result data

As defined in ASAP specification the service factory should provide a schema for the ContextData element and ResultData elements. The schema may be XML Schema or Relax NG.



@enterprise WfXML implementation defines common XML Schema for both Context and Result data, the only difference between them is that Context data may contain additionally start parameter with optional start-up options (see Fig. 13.4).

Context and result data elements contains zero or more *Parameter* elements, each parameter has name and value. Value of Name could be one of the following:

- StartParameter (considered only for createInstance request)
- ProcessForms
- DMSFolder
- Notes

Content of Value element is dependent from value of Name element.

StartParameter

Value element contains start-up properties for createInstance call, inside it can be *Agent*, *Department* and *DueDate* elements.

Value of Agent element is an agent id, that will be assigned with a new process. Agent Id should be known for *@enterprise*.

The *Department* element will contain id of organization unit, that will be assigned with new process. If department element is missing, then WfXML Engine will take default WfXML organization unit. This value will be taken from configuration properties of *@enterprise*.

The date value in *DueDate* element will affect corresponding property of process. If no DueDate element is specified, then process will be started without this restriction. Format of date should be in following format: yyyy-MM-dd'T'HH:mm:ss'Z'.

ProcessForms

Value element contains zero or more *Form* elements. Each Form has a name that is unique for the process, this value will be encoded in content of Field element with attribute name='name'. Form contains also one or more Field elements and zero or more Form and attached Notes elements.

DMSFolder

Value element of DMSFolder parameter could contain zero or more of following elements:

- Form
- FolderForm
- DocumentForm
- Note
- WebLink

FolderForm is a folder object, that could contain some additional fields with meta information. Content elements allowed in FolderForm are the same as for the Value element of DMSFolder parameter.

DocumentForm is a file document, that could contain some additional fields with meta information. Content of file is encoded in *base64*.

Notes

This parameter contains zero or more Note elements.

WfXML2Timer

WfXML2Timer component is an *@enterprise* timer that will track status of observed processes, once status change detected appropriate method of `com.groiss.wfxml2.engine.IWfXMLEngine` will be called. The engine will then lookup all remote observers and send them notifications. `WfXMLTimer` will also check expiration of local observers and once expired observer detected timeout method of corresponding handler class will be called.

Partner communication

WfXML itself does not require explicit partnership between communicating parts, but in some situation there is need to define it. These are advantages of communication on partnership basis:

- Accept only authenticated incoming requests from trusted partners
- Support one-way communications (e.g. through firewall)
- Configurable communication settings
- Automatic and reliable initiation of remote processes through application configuration

Wf-XML Client API

This layer provide easy to use API for communication with external part and dealing with Wf-XML/ASAP resource properties. This API will be used by *@enterprise* application classes and WfXMLEngine layer (see Fig. 13.5).

Example

Lets take a look how these classes can be used on short example.

```
WfXMLFactory factory;  
WfXMLInstance instance;  
WfXMLActivity activity;  
  
factory = new WfXMLFactory(
```

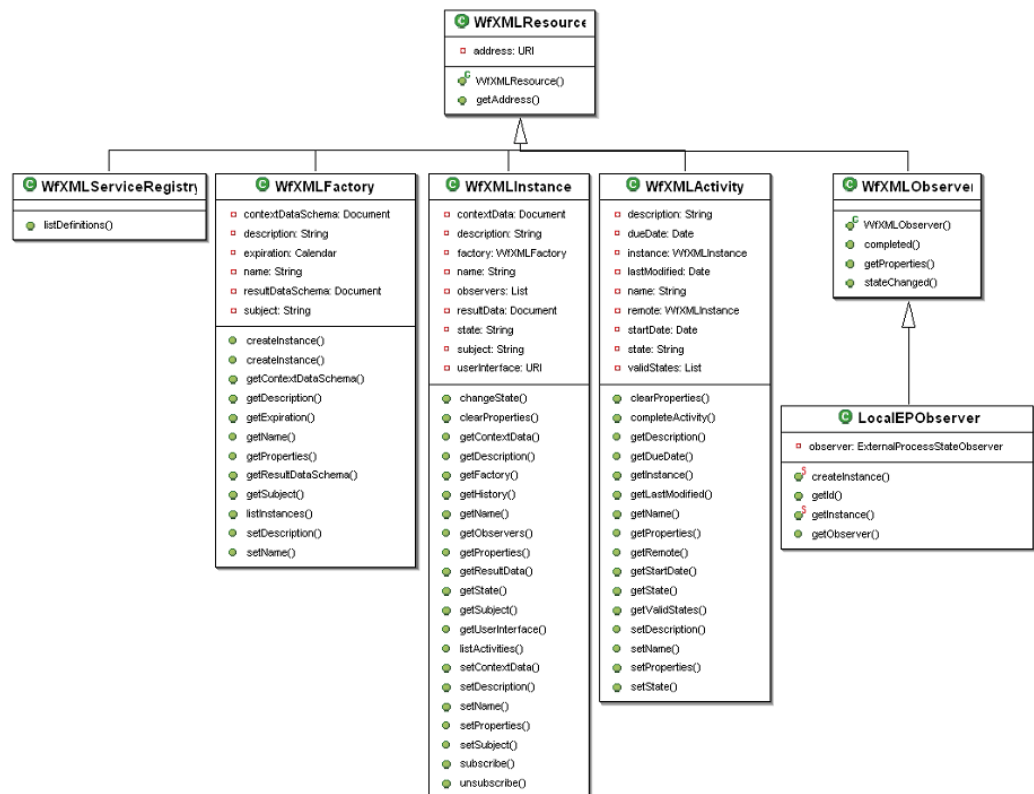


Figure 13.5: Overview of WfXML client classes.

13. Communication with other Systems

```
new URI("http://myserver.com/factory/jobproc"));
instance = factory.createInstance();

List activities = instance.listActivities();
activity = activities.get(0);
activity.completeActivity();

instance.getProperties();
if(instance.getStatus().equals("open.running")) {
    instance.setName("job process 1");
    instance.setProperties();
}
instance.changeState("closed.abnormalCompleted.aborted");
```

First of all we get access to factory resource with `WfXMLFactory`, this can be done either:

- through use of service registry method `listDefinitions`,
- or simply by call to constructor of `WfXMLFactory` with exact URL to external factory resource.

After that we get access to instance resource. This can be done in following ways:

- By call to factory method `listInstances` if we want to get existing instance
- By call to factory method `createInstance` if we want to start new process
- By call to constructor of `WfXMLInstance` object with exact URL to existing instance resource, and reference to factory object

Once we got instance object we can list activities, get and set properties, and also change instance state.

Access to activity resource can be gained from:

- instance resource object, by calling `listActivities` method
- or by call to constructor of `WfXMLActivity` class, with exact URL to external activity resource.

Activity object can be used by clients to get/set properties and to complete activity.

Observer resource can be used if client wants to subscribe/unsubscribe itself for process instance state notifications. The following short example show us how this could be done:

```
LocalEPObserver observer = LocalEPObserver.createInstance(null,
    MyObserver.class, null, null);

instance.subscribe(observer);
observer.getObserver().setProcess_url(
    instance.getAddress().toString());
observer.getObserver().update();
```

13. Communication with other Systems

`LocalEPObserver` is special kind of `WfXMLObserver`, that will use *@enterprise* `ObserverService` for accepting of incoming notifications. Alternatively client can specify any other observer resource by call to instance `subscribe` with URL parameter.

To unsubscribe itself from notifications, client should call instance method `unsubscribe` with reference to `WfXMLObserver` object that should be taken off subscription. Access to existing observer object can be gained from:

- instance observers property
- or simply by call to constructor of `WfXMLObserver` class with exact URL that points to observer resource.

Local observers should be first taken from database, and only after that they can be passed to call to `unsubscribe` method. Client should remember value of observer id property, if sooner unsubscribe is possible.

```
long observerId = observer.getId();  
  
...  
  
LocalEPObserver observer = LocalEPObserver.getInstance(observerId);  
  
instance.unsubscribe(observer);
```

13.3.3 Administration

Installation

There are few steps required before Wf-XML interface of *@enterprise* can be used. First of all Axis2 Web-service container should be installed either as part of *@enterprise*, or as standalone web-app inside *@enterprise* web-server. Implementation classes are dependent from runtime context of *@enterprise*, and cannot be launched out of it.

Once Axis distribution is installed and verified, we can overwrite generic axis configuration file (`server-config.wsdd`) located in `WEB-INF` directory with prepared configuration from `com/groiss/wfxml/server/impl`.

Configuration

Wf-XML components relies on few configuration properties, that should be configured by administrator, before it can be used. The following properties can be set via the GUI under *Administration* → *Configuration* → *Communication*.

First of all we have to specify relative location of Web-service classes on *@enterprise* web-server:

```
wfxml2.serviceregistry.path=/services.axis2/WfXML2ServiceRegistryService  
wfxml2.factory.path=/services.axis2/WfXML2FactoryService  
wfxml2.instance.path=/services.axis2/WfXML2InstanceService
```

13. Communication with other Systems

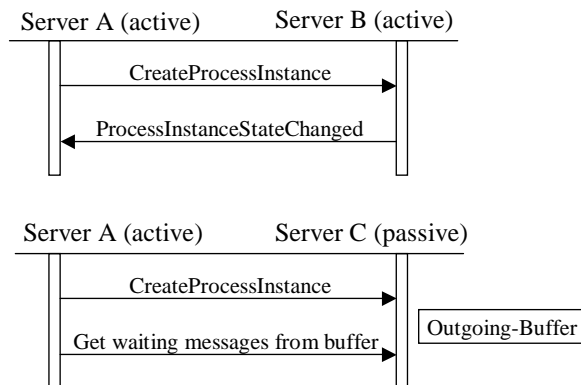


Figure 13.6: **Active-active and active-passive Wf-XML communication.**

```
wfxml2.activity.path=/services.axis2/WfXML2ActivityService  
wfxml2.observer.path=/services.axis2/WfXML2ObserverService
```

Also default organization unit and user id for default agent should be configured:

```
wfxml2.orgunit=gi  
wfxml2.user=wfxml_user
```

An *@enterprise* server can be configured to run with three different operating modes:

- **Off:** Wf-XML is turned off. The server does not send messages and it also does not accept incoming messages.
- **Active:** An active server sends messages to other servers and accepts messages. This is the 'normal' operating mode, like it is used in the specification.
- **Passive:** A passive server does not send messages itself, it only receives incoming messages. Active servers can request outgoing messages from passive servers, but a passive server never sends messages itself. The passive server stores outgoing message in a buffer and keeps them until the target server requests them. This might be useful for security reasons where you want to allow connections to be established just in one direction. Figure 13.6 shows a diagram with active-active and active-passive server communication. The direction of the arrows always indicates the direction in which the connection is established. Responses are sent back through the same connections.

For proper work of WfXML Engine layer in *@enterprise* timer task should be registered under *Administration* → *Applications* → *Default* → *Timer*:

- **Timer class name:** com.groiss.wfxml2.engine.timertask.WfXMLTimer
- **Period:** By default 60 seconds. Lower value will decrease status notification delays, higher will save system time resources.

By default the timer entry *WfXML2Task* is available.

The following additional settings must be applied to an *@enterprise* server in order to use Wf-XML:

You have to define communication partners in *Admin-Tasks* → *Communication* → *WfXML* → *Partner list*. You must set the following data for each Wf-XML partner server:

- **Id:** The ID of the server. In case of *@enterprise* servers, this must be the server id of the partner.
- **Operating mode:** Operating mode of the partner server. If you set it to 'passive', the local server will try to request messages from this server, because it doesn't expect the partner server to send any messages. Mind: this works only, if the local server is active! Two passive servers cannot communicate with each other.
- **Protocol:** Either HTTP or HTTPS can be selected here.
- **Hostname:** The host name of the partner server (without http(s) at the beginning).
- **HTTP(S) Port:** The port on which the partner server is listening for HTTP(S) requests (value is linked with/depends on selected Protocol)
- **Path:** The context path, e.g. wf (= the default context path of *@enterprise*).

Here you can also get a quick overview of your local server with the *Local status* link. If you click on *Partner status*, your server sends a test message to the other server and displays information about the partner server. Mind that this works only if both servers are *@enterprise* servers.

13.3.4 Wf-XML Web client

For quick test of functional state of Wf-XML *@enterprise*, or any other Wf-XML implementations - administrator has possibility to use web client interface, that can be reached with following URL or find under *Administration* → *Admin-Tasks* → *Communication* → *WfXML* → *Web client*.

On first page location of ServiceRegistry Service should be specified, and list of definitions managed by ServiceRegistry can be obtained (see Fig. 13.7) by using following URL:

`http://<host>:<port>/<context-root>/services.axis2/WfXML2ServiceRegistryService`

It is also possible to restrict the definition list by adding an application id with parameter *?application_id=<applid>*.

After successful connection to ServiceRegistry service user will be able to browse list of definitions managed there (see Fig. 13.8).

After selection one of definitions, which are Factory resources following actions are possible:

- **Show properties** will display available properties of Factory resource

13. Communication with other Systems

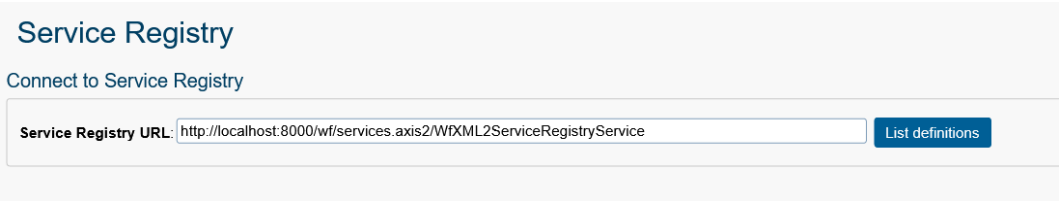
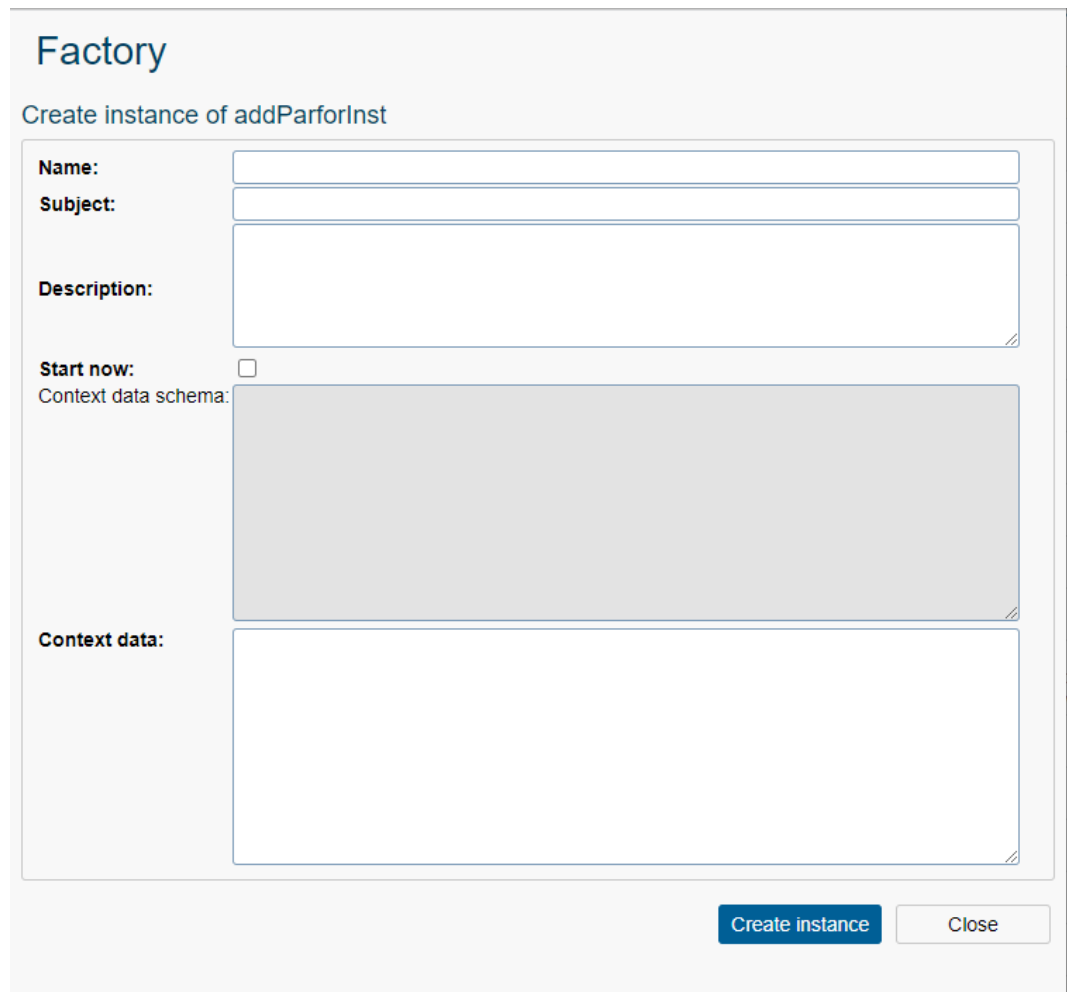


Figure 13.7: Connect to service registry screen.

The screenshot shows a web interface titled 'Administration ep11_postgres - Logged in: Nikola Lagic'. On the left is a sidebar with navigation options: Organization, Applications, Search, Admin tasks, Cluster, DMS, Reorganize, Communication, Mail-Queue, Mail journal, Authorizers, LDAP, External Stores, WIXML, Local status, Partner list, Remote-Process Registry, Access log, Internal processes, Scheduled processes, Web client, Local services, Decision support, Cache information, Evaluation information, and Configuration. The main area displays a table with the following columns: Name, Version, Subject, and Instance URL. The table contains 15 rows of data, including services like AddParforBranch, addParforInst, AdHoc, All Steps Process, App A Proc, applA Process, batchproc, batchproc2, Beauftragungen managen, Blinds and Formfield Visibilities, change_req, Choice, copy_of_App A Proc, and copy_of_TSM 31654. At the bottom, it says 'Number of entries: 123 | 0 selected'.

Name	Version	Subject	Instance URL
AddParforBranch	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=addparforbranch&factory_version=1
addParforInst	1	ITSM #7819	http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=addParforInst&factory_version=1
AdHoc	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=AdHoc&factory_version=1
All Steps Process	5	A Process that have all steps.	http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=all_steps_proc&factory_version=5
All Steps Process	4	A Process that have all steps	http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=all_steps_proc&factory_version=4
All Steps Process	3	A Process that have all steps.	http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=all_steps_proc&factory_version=3
App A Proc	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=app_a_proc&factory_version=1
applA Process	1	xx	http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=applAProc&factory_version=1
batchproc	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=batchproc&factory_version=1
batchproc	2		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=batchproc&factory_version=2
batchproc2	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=batchproc2&factory_version=1
batchproc2	2		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=batchproc2&factory_version=2
Beauftragungen managen	1	<div>Der Beschaffungsprozess der FFG, der von der Bedarfsdefinition, über die Erhaltung und Bewerzung der Angebote bis zur Vertragsanstellung und Zustellung sowie ggfs. Änderung der Verträge reicht. </div>	http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=sm_order&factory_version=1
Blinds and Formfield Visibilities	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=bindings&formfield&factory_version=1
change_req	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=iban_change_request&factory_version=1
Choice	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=coice&factory_version=1
copy_of_App A Proc	1		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=copy_of_app_a_proc&factory_version=1
copy_of_TSM 31654	2		http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?factory_id=direct_parl&factory_version=2
			http://montevideo:11000/wf/services.axis2/WFXML2FactoryService?

Figure 13.8: List of definitions screen.



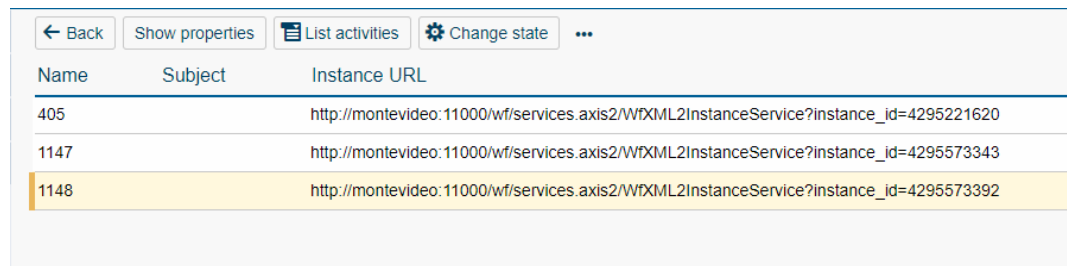
The image shows a web-based form titled "Factory" with the subtitle "Create instance of addParforInst". The form contains several input fields: "Name:" (a single-line text box), "Subject:" (a single-line text box), "Description:" (a multi-line text area), "Start now:" (a checkbox), "Context data schema:" (a large, empty rectangular box), and "Context data:" (a multi-line text area). At the bottom right of the form, there are two buttons: "Create instance" (in blue) and "Close" (in light gray).

Figure 13.9: **Create instance screen.**

- **List instances** action will show the list of running processes that belong to the selected Factory resource
- **Create instance** action will provide form where initial process properties can be specified (see Fig. 13.9). In this form name, subject, description fields can be specified. Additionally context data can be specified in XML format. Schema specified for factory is also displayed to make easy for client XML validation. After *Create* action successfully processed new screen with short information about created instance will be presented.

From this point we can operate on instance resource level. On this level we have following actions available for use:

- **Show properties** action will display form with available properties, observers and context/result data for selected instance. This form allows to perform modifications on some instance properties.



<div>← Back Show properties List activities Change state ...</div>		
Name	Subject	Instance URL
405		http://montevideo:11000/wf/services.axis2/WfXML2InstanceService?instance_id=4295221620
1147		http://montevideo:11000/wf/services.axis2/WfXML2InstanceService?instance_id=4295573343
1148		http://montevideo:11000/wf/services.axis2/WfXML2InstanceService?instance_id=4295573392

Figure 13.10: **Activity list screen.**

- **List activities** action allows to browse list of active activities for this process instance. From this point we can operate on activity resource level.
- **Change state** action will display a form where required state can be specified. After successful change of instance state the instance properties page will be displayed.
- **Subscribe** action will display a form observer URL can be specified. After successful observer subscription the page with instance properties will be displayed.

On the activity resource level we have following actions available for use (see Fig. 13.10):

- **Complete activity** action will provide form where option path can be specified. After successful completion of activity user will be redirected back on instance level (instance properties screen).
- **Show properties** action will display form with available properties for selected activity, this form also can be used to perform modification of instance properties or context data.

13.4 LDAP

The organizational data of *@enterprise* can be synchronized with directory services (LDAP-servers). With the administrative interface, one can define a set of LDAP-servers for the purposes of either importing (part of) their directory data and incorporate it in the *@enterprise* organizational data or to export this organizational data into an LDAP server.

In most cases, an installation wanting to synchronize with directory services will define exactly one LDAP server and employ a unidirectional synchronization. Technically it is possible to have a single LDAP server and to bidirectionally import from this server as well as export to this server. But on an administrative level it is strongly recommended to use either *@enterprise* as the source and the LDAP server as the target or vice versa, but not at the same time.

Please note that LDAPv3 must be supported by the LDAP-Servers.

13.4.1 Basic Aspects of the Synchronization Mechanism

The synchronization can be characterized by the following aspects:

- **Directory Service:** Comprises the technical aspects of the directory server. Needed are the hostname or IP-address, the port, the path in the directory tree to use as a search root, a filter which can be applied to the entire tree, and credentials in the form of a user name and a password.
- **Direction:** Each LDAP-Server can act as source of imported data or as destination of exported data.
- **Timer Involvement:** The synchronization can be carried out manually or executed by the *LDAPDirSyncTask* timer (the system takes care that at most one LDAP synchronization operation takes place at one point of time).
- **Scope:** The following organizational entities of *@enterprise* are subject to LDAP synchronization:
 - Rights
 - Organizational Units
 - Organizational Hierarchies
 - Roles with associated permissions
 - Users with associated roles and permissions

While all of these entities can be synchronized by a default mechanism, most installations will probably restrict themselves to a subset, e.g. import of user data (see the [System Administration guide](#) for a description of a basic implementation for this).

- **Schema Mapping** The default synchronization mechanism uses a fixed directory schema at this moment. But since each organization employs its specific schema to structure the information in the directory, the default mapping mechanisms can be replaced by a customer specific one in the form of a Java class.

13.4.2 Default Schema Mapping

Since we strive for a possibly complete mapping of all the *@enterprise* organizational data, we defined a specific LDAP schema. It is provided as *ldap/schema.ldap* in the *epimpl.jar* file in the lib directory of *@enterprise* installations. This schema comprises appropriate definitions for LDAP attributetypes and objectclasses and uses an officially registered enterprise number (see [PENs](#)).

The schema must be deployed onto the LDAP server using the proprietary means of the product. In OpenLDAP, the file must be included in the master schema file (which can usually be found in */etc/openldap/slapd.conf*). For other products, your mileage will vary. Since the schema is not trivial, it might be advisable to export some organizational data using the default mechanism and to browse the resulting LDAP directory to gain a better understanding of the following description.

Under the searchroot, there are the five subdivisions (People, Departments, DeptTree, Roles, Rights), each implemented as organizational unit:

- **Rights:** Each right is of objectClass `entRight`, it is identified (RDN) by the attribute **entId** which contains the *@enterprise* id of the right. For the other attributes, the mapping is as follows:
 - `entName`: name (mandatory)
 - `entApplication`: application (id of application the right is associated with, mandatory)
 - `entOid`: oid
 - `entXid`: transactionid
 - `description`: description
 - `entActive`: active
- **Departments:** Each department is of objectClass `entDepartment` which is a subclass of class `organizationalUnit`. It is identified (RDN) by the attribute **ou** which contains the *@enterprise* id of the department. Other attributes are:
 - `entName`: name
 - `entOid`: oid
 - `entXid`: transactionid
 - `description`: description
 - `entActive`: active
 - `entOrderAttr`: orderattr
 - `mail`: email
 - `entOrgType`: orgtype
 - `entOrgClass`: orgclass (id of the departments orgclass)
 - `telephoneNumber`: telnr
 - `postalAddress`: address
- **Department Trees:** Each department tree is of objectClass `entDeptTree`. It is identified (RDN) by the attribute **entId** which contains the *@enterprise* id of the depttree. Other attributes are:
 - `entName`: name (mandatory)
 - `entOid`: oid
 - `entXid`: transactionid
 - Under each department tree node, there is a flat collection of directory entries which represent the edges of the department tree (Java class `DeptHierarchy`). Each `DeptHierarchy` object is mapped to one LDAP entry of objectClass `entDeptHierarchy`. It is identified by attribute `cn`. The value of `cn` is the id of the subDepartment of the edge, optionally concatenated with the id of the superDepartment of the edge. In concatenated RDNs, we use the `#` as a component separator. The other attributes are:
 - * `entOid`: oid

- * entXid: transactionid
- * entSubDept: subdepartment (full LDAP DN of the subdepartment, mandatory)
- * entSuperDept: superdepartment (full LDAP DN of the superdepartment)

By using DN's as the value for the subdepartment and superdepartments entries, we enable quick navigation in the LDAP-directory.

- **Roles:** Each role is of objectClass entRole which is a subclass of organizationalRole. It is identified (RDN) by the attribute **cn** which contains the *@enterprise* id of the role. Other attributes are:
 - entName: name
 - entOid: oid
 - entXid: transactionid
 - description: description
 - entActive: active
 - entRoleType: type
 - entReferenceRole: reference role (full LDAP DN of the referred role)
 - entApplication: application (id of application the role is associated with)
 - Below each role node, there is an organizationalUnit with RDN **ou=ACLEnties** which contains a flat collection of directory entries which represent the permissions given to the role (Java class ACLEnt). Each ACLEnt object is mapped to one LDAP entry of objectClass entACLEnt. It is identified by attribute **cn**. The value of cn is concatenation of the following fields: id of the right, id of the department, name of the object class, oid of the object. The other attributes are:
 - * entOid: oid
 - * entXid: transactionid
 - * entRight: avwright (full LDAP DN of the right, mandatory)
 - * entDept: dept (full LDAP DN of the department)
 - * entTargetClass: target_class
 - * entTarget: oid of the object to which this permission applies
 - * entOrgScope: orgscope (mandatory)
 - * entObjScope: objscope (mandatory)
 - * entPositive: positive (mandatory)
- **People:** Each user object is of objectClass entPerson which is a subclass of inetOrganizationalPerson. It is identified (RDN) by the attribute **uid** which contains the *@enterprise* id of the user object. Other attributes are:
 - title: title
 - givenName: firstName
 - sn: surname

- description: description
- mail: email
- telephoneNumber: telnr
- userPassword: password
- entOid: oid
- entXid: transactionid
- entServer: server (id of the users server)
- entActive: active
- entOrderAttr: orderattr
- entLocale: locale
- entPWneverExpires: pwdneverexpires
- entPWmustChange: changepwdnext
- entPWunchangeable: cantchangepwd
- Below each user node, there is organizationalUnit with RDN **ou=ACLEntries** exactly like in the case of Roles.
- Under each user node, there is als an organizationalUnit with RDN **ou=UserRoles** which contains a flat collection of directory entries which represent the roles given to the user(Java class UserRole). Each UserRole object is mapped to one LDAP entry of objectClass entUserRole. It is identified by attribute **cn**.The value of cn is a concatenation of the id of the role, optionally followed by the id of the department. The other attributes are:
 - * entOid: oid
 - * entXid: transactionid
 - * entActive: active
 - * entDept: department (full LDAP DN of the department)
 - * entRole: role (full LDAP DN of the role, mandatory)

Exporting to LDAP

Exporting an *@enterprise* object to the LDAP directory is done like this:

1. Lookup the LDAP entry by its RDN
2. If not found, search it via the entOid Attribute
3. if still not found, create the LDAP entry and export all its subobjects
4. else if the RDN changed (attributes which form the RDN in *@enterprise* were updated), delete the entire LDAP-subtree below the entry and export the object
5. else if RDN unchanged but Xid changed, then update the LDAP entry

Importing from LDAP

The import algorithm for one LDAP entry can be sketched as follows:

1. If the entry has an entOid attribute, then search in the database based on this oid
2. If not found, search by its RDN
3. If still not found, create a new database object with the attributes of the LDAP entry
4. else check if an update is needed (Xid changed), and update the SQL object as needed

13.4.3 Customizing the Synchronization

The default schema is clearly much more complicated than needed in typical installations which usually just want to import user data from the directory service.

As already mentioned, one installation can use its own schema mapping semantics by providing a Java Class which implements `com.groiss.ldap.DirectorySyncer`. The interface consists of just one method `synchronize` which receives two parameters. The first one is the `com.groiss.ldap.DirectoryServer` entry as entered in the administrative interface. It can be used to parametrize the synchronization process or can be ignored altogether. The second parameter of `synchronize` is a `DirContext` (found in the `javax.naming.directory` package). The `DirContext` represents an established connection to the LDAP-server and serves as a main entry point for all following operations in the LDAP server (using the the LDAP-Provider of JNDI).

The following class realizes a simple mapping and can be used as a starting point for ones one implementations:

File `com/groiss/demo/SimpleDirectorySyncer.java`

```
public class SimpleDirectorySyncer implements DirectorySyncer {

    private static final Logger logger =
        LoggerFactory.getLogger(SimpleDirectorySyncer.class);

    private static String[][] attMap = {
        { "cn", "id" },
        { "sn", "surname" },
        { "givenName", "firstName" },
        { "title", "title" },
        { "description", "description" },
        { "mail", "email" },
        { "telephoneNumber", "telNr" }
    };

    private static String[] ldapAttNames = Arrays.stream(attMap)
        .map(elem -> elem[0]).toArray(String[]::new);

    private static final String LDAPKEYATTNAME = attMap[0][0];

    @Override
```

```
public void synchronize(DirectoryServer ds, DirContext baseContext)
    throws Exception {
    SearchControls sc = new SearchControls();
    sc.setReturningObjFlag(false);
    sc.setReturningAttributes(ldapAttNames);
    sc.setSearchScope(SearchControls.ONELEVEL_SCOPE);
    NamingEnumeration<SearchResult> ne = baseContext.search("", ds.getFilter(), sc);
    while (ne.hasMoreElements()) {
        syncObject(ne.next().getAttributes());
    }
}

private void syncObject(Attributes attribs) throws Exception {
    Object ldapKey = attribs.get(LDAPKEYATTNAME).get();
    OrgData od = OrgData.getInstance();
    User u = od.getById(User.class, (String)ldapKey);
    if (u != null) { // object exists in @enterprise
        logger.info("SimpleDirectorySyncer: user {} already present", ldapKey);
        setFields(u, attribs);
        od.update(u);
    } else { // create user object
        u = od.createUser();
        setFields(u, attribs);
        u.setActive(true);
        logger.info("SimpleDirectorySyncer: Creating User {},{}", ldapKey, u);
        od.insert(u);
    }
}

private void setFields(User u, Attributes attribs) throws Exception {
    for (String[] mapping: attMap) {
        Attribute att = attribs.get(mapping[0]);
        if (att != null) {
            Object attVal = att.get();
            if (attVal != null) {
                Field ff = StoreUtil.getField(u, mapping[1]);
                LDAPUtils.setField(ff, u, attVal);
            }
        }
    }
}
}
```

13.5 Accessing external databases

In order to access SQL databases (other than the primary *@enterprise* data store), we provide the notion of external stores (`com.groiss.store.external.XStore`).

13.5.1 External database setup

An `XStore` is configured via *Administration/Admin tasks/Communication/External Stores* (see [System administration guide](#), section [External Stores](#)). Each `XStore` must have a unique id and has to be configured with the proper settings for the JDBC framework. The driver class, the JDBC URL, the username and the password for the remote database must be given. Some entries might not be needed for special constellations. Please make sure that the appropriate jar file for the driver is in the class path. After saving the `XStore` form, a connection check can be performed. Upon success, some product and version info of the target database will be displayed.

13.5.2 Basic assumptions and underlying principles

This feature is meant to provide easy access and manipulation of external data without refraining to low-level JDBC constructs.

The external data is not in an appropriate form to deal with it in the standard way of *@enterprise* for internal objects, but rather structured in an arbitrary way.

It is meant to be used rather sparingly for occasional lookups or updates, not for high volume, high frequency performance critical operations.

There is no connection pool, connections are created on the fly. Auto-commit is disabled for the connections and the isolation level is set to read committed. Statements are executed with the configured query timeout.

All the artifacts are in the *com.groiss.store.external* package.

13.5.3 Getting an XStore

An `XStore` can be obtained via the `XStoreFactory`:

```
XStore xs = XStoreFactory.getXStore(id);
```

An instance of the `xstore` is associated with the current `UserTransaction`. No connection is yet opened; this will automatically occur on the first time the connection is needed. At `Beanmanager.commit` or `BeanManager.rollback`, the connection of the `XStore` is either committed and closed or roll backed and closed.

The `XStore` class also implements `AutoCloseable`, upon `close()` the connection is committed and closed, so it can also be used in the following manner:

```
try(XStore xs = XStoreFactory.getXStore(id)) {  
    ...  
}
```

13.5.4 Transactional operations of an XStore

- `getConnection` returns the underlying JDBC connection. Will usually not be needed.

- `commit` commits the connection, but does not close it.
- `rollback` rolls back the connection, but does not close it.
- `close` commits the connection and closes it.

13.5.5 Data manipulation operation

The following method allows to execute arbitrary statements (DML or DDL):

```
int executeStatement(String statement, Object... bindVars);
```

For DDL statements, it returns the number of records affected by the statement. The statement can contain placeholders in the form of question marks. The *bindVars* are assigned to the placeholders in the order given.

```
int count = xs.executeStatement(
    "update mytable set mycolumn=? where key=?",
    newValue, keyValue);
```

13.5.6 Data access operations

- `getValue(String query, Object... bindVars)` allows to get a single value from the database.
The query is a select statement that can contain placeholders in the form of question marks. The *bindVars* are assigned to the placeholders in the given order. The first column of the first row of the result set from the database is returned. The value is obtained internally by using the universal `rs.getObject` method.

```
String s = (String) xs.getValue("select mystring from mytable
                                where key=?", keyValue);
```

- `getValue(int sqlType, String query, Object... bindVars)` allows to get a single value from the database. The `sqlType` hints what type to assume for the column.

```
Date d = (Date) xs.getValue(java.sql.Types.DATE,
    "select mydate from mytable where key=?", keyValue);
```

- `getRow(String query, Object... bindVars)` allows to get the first row of a query from the database. The following rows are ignored.

```
DataRow dr = xs.getRow("select * from mytable where key=?", keyValue);
```

- `getList(String query, Object... bindVars)` allows to get the resulting records as a query in the order received.

```
List<DataRow> drl = xs.getList(
    "select * from mytable where acolumn=? order by bcolumn",
    aValue);
```

13.5.7 DataRow interface

A `com.groiss.store.external.DataRow` is a simple interface representing one tuple of a query result. It provides one method:

- `getObject(String columnName)` returns the object associated with the given column name. The column names must always be given in lowercase.

See the Java documentation of the `com.groiss.store.external` package for more details.

14. Web services

@enterprise application classes can use external web services, and provide own web service interfaces for external use. Administration console provides easy management of own web services, and allows generation of client classes for external web service from corresponding WSDL.

@enterprise provides support for web service oriented development in a broad variety of use cases.

14.1 Components

14.1.1 WS-Framework

@enterprise uses the Apache Axis2 Web service engine [7]. It used to ship with support for several WS-standards like WS-Security, WS-Policy, WS-Trust etc.

The currently used Axis2-version (1.8.x), doesn't provide any compatible Rampart implementation. Therefore, the WS-X standards are currently not supported. We aim to re-integrate Rampart as soon as it's publicly available.

Axis2 provides code generation capabilities to generate client and service stubs and implementations from or into WSDL-files. (see: [8]).

14.1.2 EP-Context

This component provides an invocation context for local service implementations, in way similar as the `com.groiss.servlet.Dispatcher` class for servlet methods.

The component is implemented as an Axis2 module. The module defines handlers for InFlow, OutFlow, InFaultFlow, and OutFaultFlow. If a service wants to use this functionality, it must engage this module in the *services.xml* file:

```
<service>
  ...
  <module ref="epcontext" />
  ...
</service>
```

When a service specifies the use of this module, a transaction handling mechanism takes place (cf. `com.groiss.servlet.Dispatcher`):

- If the web service throws no exception, a commit is performed automatically.

- If the web service signals an error by throwing an exception, a rollback is performed.

If a different behavior is desired, then the web service implementation must take care of it.

Additionally, the module allows BasicAuth and WS-Security UsernameToken-based authentication against *@enterprise* users. Make sure to use transport-security (HTTPS) to avoid leaking information. The module doesn't provide full WS-Security compliance, but it can be used as a temporary substitute until a compatible Rampart implementation is available.

14.1.3 Partner Links

Partner links provide a mechanism to obtain location transparency for the addressing of remote service links.

A partner link maps a logical id of a remote web service to a specific physical transport address. Changes in the address do not require any changes in the clients, because they reference just the partner IDs. The mapping of partner IDs to addresses can be accomplished via the administrative GUI of *@enterprise*.

14.2 Providing web services

To provide a web service via *@enterprise*, the Axis2 standard ways of creating web services should be used.

Code-first write your service-implementation first and generate the WSDL

Contract-first write your WSDL to specify the service, generate the service skeletons and add your business logic

We recommend you to use the "contract-first" approach, because of better interoperability to other systems.

14.2.1 Contract-first with Axis2

1. Specify the WSDL
2. Generate your service skeletons with the Axis2 CLI or Ant-Task [9]
3. Compile the generated sources
4. Package the generated sources
5. Add the new library to your application classpath
6. Subclass the service-skeleton and implement your business logic
7. Modify the services.xml to change the implementation class. This step is required, because it's not recommended to modify the generated source files.
8. Package your services.xml and your WSDL as an Web service archive (.aar)

14. Web services

9. Upload the archive to the server

10. Deploy the service

An example contract-first-service can be found in the *@enterprise* demos at *demos/webservices*. Instructions on how to run the demo can be found in the *readme.txt* file.

14.3 Demos

Examples for the various scenarios can be found in the demo package *demos.zip*.

15. XWDL

15.1 Introduction

This chapter presents the XWDL, an extensible XML based dialect of WDL. The classic approach to define process types in *@enterprise* was to use the Workflow Description Language (WDL) or to draw the process with the process editor. WDL is designed as a kind of structured, human-readable process programming language. It is not mainly targeted for the exchange of process type information with other systems. In order to semantically analyze the WDL-scripts, those third-party systems would have to make use of conventional parsing techniques. The export/import format of *@enterprise* allows one to transfer application definitions (which contain process definitions) between *@enterprise* systems. While this format is XML based, the process information is still sent along as a WDL-Script.

Hint: Defined process escalations are not available in XWDL!

The formulation of WDL in a structure-rich XML has the following aims / benefits:

- third-party applications can generate XWDL-Scripts on the grounds of a well understood formalism
- use a plain DTD-driven XML editor to write XWDL-Scripts with automatic syntactical correctness
- verification of the syntax using solely an out of the box XML-parser.
- third party extensions could be accommodated using an extension approach for the DTD

15.2 Usage

15.2.1 HTML-Client

XWDL-Processes can be loaded into the system exactly like WDL Processes. There are two new links on the Process / Script page for viewing (IE6 needed) or downloading the XWDL-Code of a process.

15.3 API

A simple API is provided to insert XWDL-Processes into the system.

```
package com.groiss.wf.xwdl;
public class ProcessParser implements IProcessParser{

    public ProcessDefinition loadProcess(InputStream is, boolean genRoles,
        boolean genTasks) throws Exception;

    public ProcessDefinition loadProcess(String fileName, boolean genRoles,
        boolean genTasks) throws Exception;

    public String getErrors();
```

A XWDL-Process can be loaded from an `InputStream` or from a `File` which is specified via its filename. The booleans `genRoles` and `genTasks` state whether roles and tasks should be generated. When the process could be loaded without errors, no `Exception` is thrown and the `getErrors` method will return the empty string.

A typical usage would be like this:

```
ProcessParser pp = new com.groiss.wf.xwdl.ProcessParser;
try {
    ProcessDefinition pd = pp.loadProcess(fileName, true, true);
} catch (Exception ex) {
    //rollback;
}
if (pp.getErrors().length() != 0) {
    // error occurred;
    // rollback;
} else {
    // commit;
}
```

15.4 The basic DTD

The DTD uses ENTITY definitions for the content of each element. This allows for extensions of the DTD in a modular manner. The extension mechanism is described in the next section. The DTD resides in the file `conf/xwdl.dtd` which is part of the distribution in file `ep-impl-<versionnr>.jar`.

15.5 An Example

We will now present a rendering of WDL in XWDL by means of an example.

15.5.1 WDL

The example in WDL is:

```
process some_control_structures()
version 1;
name "some control structures";
description "Show control structures";
maxtime 10 days;
forms form Jobform;
subject "form.subject";

begin
  <first>
  all start_task(form);
  repeat
    choice
      "first choice: an if":
        if (form.type = "hw") then
          all hw_task(form);
        elsif (form.type = "sw") then
          form.recipient sw_task(form);
        elsif (form.type = "adm") then
          first:user adm_task(form);
        else
          first:user none_task(form);
        end;

      "second choice: a while":
        while (form.type="hw") do
          form.recipient while_task1(form);
          <in_while>
          form.recipient while_task2(form);
          form.recipient while_task3(form);
        end;

      "third choice: a loop":
        loop
          form.recipient loop_task(form);
          exit when (form.type="hw");
        end;

      "fourth choice: system steps":
        system com.groiss.wf.SystemAction.nop();
        form.recipient between_task(form);
        system com.groiss.wf.SystemAction.nop();
        system com.groiss.wf.SystemAction.nop();
        <label_10>
        form.recipient aftersys_task(form);

      "fifth choice: andpar":
        andpar
          form.recipient andpar1_task(form);
```

```
        |
        all andpar2_task(form);
        |
        form.recipient andpar3_task(form);
    end;

    "sixth choice: orpar":
    orpar
        form.recipient orpar1_task(form);
        |
        form.recipient orpar2_task(form);
        |
        form.recipient orpar3_task(form);
    end;

    "seventh choice: branch":
    branch
        form.recipient a_branch();
    end;

    "eight choice: subprocesses":
    call subflow1(form);

    "ninth choice: goto (into the while)":
    goto in_while;
end;
until xpath: "$form_form/finished = 'true'";

end
```

15.5.2 XDWL

The corresponding formulation in XWDL would look like this:

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE process SYSTEM "../conf/xwdl.dtd">
<process id="some_control_structures" version="1" name="some control structures"
application="default" description="show the control structures">
    <forms>
        <formdecl id="form" typ="Jobform"/>
    </forms>
    <label id="first" />
    <activity id="start_task">
        <agent string="all" />
        <form name="form" />
    </activity>
    <loop>
        <choice>
            <case name="first choice: an if">
                <if condition="form.type = &quot;hw&quot;;">
                    <then>
                        <activity id="hw_task">
```

```
        <agent string="all" />
        <form name="form" />
    </activity>
</then>
<elseif condition="form.type = &quot;sw&quot;;">
    <then>
        <activity id="sw_task">
            <agent string="form.recipient" />
            <form name="form" />
        </activity>
    </then>
</elseif>
<elseif condition="form.type = &quot;adm&quot;;">
    <then>
        <activity id="adm_task">
            <agent string="first:user" />
            <form name="form" />
        </activity>
    </then>
</elseif>
<else>
    <activity id="none_task">
        <agent string="first:user" />
        <form name="form" />
    </activity>
</else>
</if>
</case>
<case name="second choice: a while">
    <while condition="form.type = &quot;hw&quot;;">
        <activity id="while_task1">
            <agent string="form.recipient" />
            <form name="form" />
        </activity>
        <label id="in_while" />
        <activity id="while_task2">
            <agent string="form.recipient" />
            <form name="form" />
        </activity>
        <activity id="while_task3">
            <agent string="form.recipient" />
            <form name="form" />
        </activity>
    </while>
</case>
<case name="third choice: a loop">
    <loop>
        <activity id="loop_task" >
            <agent string="form.recipient" />
            <form name="form" />
        </activity>
        <exit condition="form.type = &quot;hw&quot;;" />
    </loop>
```

```
</case>
<case name="fourth choice: system steps">
  <system methodcall="com.groiss.wf.SystemAction.nop()" />
  <activity id="between_task">
    <agent string="form.recipient" />
    <form name="form" />
  </activity>
  <system methodcall="com.groiss.wf.SystemAction.nop()" />
  <system methodcall="com.groiss.wf.SystemAction.nop()" />
  <activity id="aftersys_task">
    <agent string="form.recipient" />
    <form name="form" />
  </activity>
</case>
<case name="fifth choice: andpar" >
  <andpar>
    <parallel>
      <activity id="andpar1_task" >
        <agent string="form.recipient" />
        <form name="form" />
      </activity>
    </parallel>
    <parallel>
      <activity id="andpar2_task">
        <agent string="all" />
        <form name="form" />
      </activity>
    </parallel>
    <parallel>
      <activity id="andpar3_task">
        <agent string="form.recipient" />
        <form name="form" />
      </activity>
    </parallel>
  </andpar>
</case>
<case name="sixth choice: orpar">
  <orpar>
    <parallel>
      <activity id="orpar1_task">
        <agent string="form.recipient" />
        <form name="form" />
      </activity>
    </parallel>
    <parallel>
      <activity id="orpar2_task">
        <agent string="form.recipient" />
        <form name="form" />
      </activity>
    </parallel>
    <parallel>
      <activity id="orpar3_task">
        <agent string="form.recipient" />

```

```
        <form name="form" />
      </activity>
    </parallel>
  </orpar>
</case>
<case name="seventh choice: branch">
  <branch>
    <activity id="a_branch">
      <agent string="form.recipient" />
    </activity>
  </branch>
</case>
<case name="eight choice: subprocesses">
  <call id="subflow1">
    <form name="form" />
  </call>
</case>
<case name="nineth choice: goto (into the while)">
  <goto label="in_while" />
</case>
</choice>
<exit condition="xpath:$form_form/finished = 'true'" />
</loop>
</process>
```

Versioning: If -1 is specified as the version of the process, it gets a new version number. If there are already process definitions with this id in the system, the new process gets the highest version number of those processes plus one. If there are no processes with this id, version number 1 is assigned.

15.6 The extension model

15.6.1 The extension DTD

The extension mechanism follows the spirit of the formulation of Modular XHTML [5] without introducing any unneeded complexity.

The main idea is to leave the basic XWDL DTD untouched and to define a specific extension DTD which would include the original DTD like this:

```
<![ INCLUDE [
<!ENTITY % xwdl.mod SYSTEM "../xwdl.dtd">
%xwdl.mod;]]>
```

Before the inclusion, one would define a name for the extension like this:

```
<!ENTITY % adonis.name "adonis">
<!ENTITY % adonis.pfx "%adonis.name;:">
```

Further a namespace for the extension is to be defined:

```
<!ENTITY % xwdl.process.xmlns.extra 'xmlns:%adonis.name;
CDATA #FIXED "http://www.woanders.com"'>
```

The `xwdl.process.xmlns.extra` entity was included in the attributes for the process element in the main `xwdl.dtd` file. By defining the namespace here, we can annotate the specific elements with the name prefix (adonis in this case).

Additional attributes would be declared via stand alone attribute lists like in the following example. We add an extra attribute to the element `if` with an attribute name which is prefixed by the namespace in the extension DTD. It is defined as implied, so it is not mandatory

```
<!ENTITY % adonis.if.condition.qname "%adonis.pfx;condition">
<!ATTLIST if
    %adonis.if.condition.qname;          CDATA          #IMPLIED
>
```

Changes in the element structure are implemented by defining the new elements in the extension DTD and then by defining the corresponding ... content entity from the `xwdl.dtd` file. The example declares a new element `adonis:followingProcess` with four attributes and states the new content model for the activity. Thereby we can use the new element within activity elements after the original content (agents and forms).

It is a requirement, that the original content of the elements like described in the `xwdl.dtd` file is not altered but merely augmented.

```
<!ENTITY % adonis.followingProcess.qname "%adonis.pfx;followingProcess">
<!ELEMENT %adonis.followingProcess.qname; EMPTY>
<!ATTLIST %adonis.followingProcess.qname;
    id CDATA #REQUIRED
    name CDATA #IMPLIED
    version CDATA #IMPLIED
    gs CDATA #IMPLIED
>
```

```
<!ENTITY % xwdl.activity.content
    "(agent*,form*,%adonis.followingProcess.qname;*)" >
```

System steps can be extended as follows:

```
<!ENTITY % adonis.varout.qname "%adonis.pfx;varout">
<!ELEMENT %adonis.varout.qname; EMPTY>
<!ATTLIST %adonis.varout.qname;
    task CDATA #REQUIRED
>
<!ENTITY % xwdl.system.content "(%adonis.varout.qname;)?">
```

The whole extension dtd looks like this:

```
<!ENTITY % adonis.name "adonis">
<!ENTITY % adonis.pfx "%adonis.name;:">
<!ENTITY % xwdl.process.xmlns.extra 'xmlns:%adonis.name;
    CDATA #FIXED "http://www.woanders.com"'>

<!ENTITY % adonis.if.condition.qname "%adonis.pfx;condition">
<!ATTLIST if
```

15. XWDL

```
        %adonis.if.condition.qname;          CDATA          #IMPLIED
    >

<!ENTITY % adonis.followingProcess.qname "%adonis.pfx;followingProcess">
<!ELEMENT %adonis.followingProcess.qname; EMPTY>
<!ATTLIST %adonis.followingProcess.qname;
    id CDATA #REQUIRED
    name CDATA #IMPLIED
    version CDATA #IMPLIED
    gs CDATA #IMPLIED
>

<!ENTITY % adonis.varout.qname "%adonis.pfx;varout">
<!ELEMENT %adonis.varout.qname; EMPTY>
<!ATTLIST %adonis.varout.qname;
    task CDATA #REQUIRED
>

<!ENTITY % xwdl.activity.content
    "(agent*,form*,%adonis.followingProcess.qname;*)" >

<!ENTITY % xwdl.system.content "(%adonis.varout.qname;)?">

<![ INCLUDE [
<!ENTITY % xwdl.mod SYSTEM "../xwdl.dtd">
%xwdl.mod;]]>
```

15.6.2 An Example

An extended XDWL file using the above extension dtd could look like this:

```
<?xml version="1.0" encoding="ISO-8859-1"?>
<?xwdl extensionHandler="com.groiss.wf.xwdl.NullExtensionHandler"?>
<!DOCTYPE process SYSTEM "../conf/adonis.dtd">
<process xmlns:xwdl='https://www.frequentis.com'
    xmlns:adonis="http://www.woanders.com" id="some_control_structures" version="1"
    name="some control structures" description="Show the control structures"
    application="default">
    <forms>
        <formdecl id="form" typ="Jobform" />
    </forms>
    <label id="first" />
    <activity id="start_task">
        <agent string="all" />
        <form name="form" />
    </activity>
    <loop>
        <choice>
            <case name="first choice: an if">
                <if condition="(form.type = &quot;hw&quot;)" adonis:condition="cc">
                    <then>
                        <activity id="hw_task">
                            <agent string="all" />
                        </activity>
                    </then>
                </if>
            </case>
        </choice>
    </loop>
</process>
```

```
<form name="form" />
<adonis:followingProcess id="ididid" gs="gsgsgs"/>
<adonis:followingProcess id="ididid2" gs="gsgsgs2"/>
</activity>
</then>
<elseif condition="(form.type = &quot;sw&quot;)">
<then>
  <activity id="swx_task" name="the name of this task">
    <agent string="form.recipient" />
    <form name="form" />
  </activity>
</then>
</elseif>
<elseif condition="(form.type = &quot;adm&quot;)">
<then>
  <activity id="adm_task">
    <agent string="first:user" />
    <form name="form" />
  </activity>
</then>
</elseif>
<else>
  <activity id="none_task">
    <agent string="first:user" />
    <form name="form" />
  </activity>
</else>
</if>
</case>
<case name="second choice: a while">
  <while condition="(form.type = &quot;hw&quot;)">
    <activity id="while_task1">
      <agent string="form.recipient" />
      <form name="form" />
    </activity>
    <label id="in_while" />
    <activity id="while_task2">
      <agent string="form.recipient" />
      <form name="form" />
    </activity>
    <activity id="while_task3">
      <agent string="form.recipient" />
      <form name="form" />
    </activity>
  </while>
</case>
<case name="third choice: a loop">
  <loop>
    <activity id="loop_task">
      <agent string="form.recipient" />
      <form name="form" />
    </activity>
    <exit condition="(form.type = &quot;hw&quot;)" />
  </loop>
</case>
```



```
    </loop>
  </case>
  <case name="fourth choice: system steps">
    <system methodcall="com.groiss.wf.SystemAction.nop()">
      <adonis:varout task="something"/>
    </system>
    <activity id="between_task">
      <agent string="form.recipient" />
      <form name="form" />
    </activity>
    <system methodcall="com.groiss.wf.SystemAction.nop()" />
    <system methodcall="com.groiss.wf.SystemAction.nop()" />
    <activity id="aftersys_task">
      <agent string="form.recipient" />
      <form name="form" />
    </activity>
  </case>
  <case name="fifth choice: andpar">
    <andpar>
      <parallel>
        <activity id="andpar1_task">
          <agent string="form.recipient" />
          <form name="form" />
        </activity>
      </parallel>
      <parallel>
        <activity id="andpar2_task">
          <agent string="all" />
          <form name="form" />
        </activity>
      </parallel>
      <parallel>
        <activity id="andpar3_task">
          <agent string="form.recipient" />
          <form name="form" />
        </activity>
      </parallel>
    </andpar>
  </case>
  <case name="sixth choice: orpar">
    <orpar>
      <parallel>
        <activity id="orpar1_task">
          <agent string="form.recipient" />
          <form name="form" />
        </activity>
      </parallel>
      <parallel>
        <activity id="orpar2_task">
          <agent string="form.recipient" />
          <form name="form" />
        </activity>
      </parallel>
    </orpar>
  </case>
```

```
<parallel>
  <activity id="orpar3_task">
    <agent string="form.recipient" />
    <form name="form" />
  </activity>
</parallel>
</orpar>
</case>
<case name="eight choice: subprocesses">
  <call id="subflow1">
    <form name="form" />
  </call>
</case>
<case name="nineth choice: goto (into the while)">
  <goto label="in_while" />
</case>
</choice>
<exit condition="xpath:$form_form/finished = 'true'" />
</loop>
</process>
```

15.7 Extension API

Parsing a standard XWDL-file without extensions is done by *@enterprise* itself. For the proper treatment of extension attributes and extension elements, we define a callback-interface. We will use the JDOM-API [6] for processing.

```
public interface IExtensionHandler {
    public void init();
    public void handle(Element e, Step s, ProcessDefinition pd);
    public void afterSave(ProcessDefinition pd, boolean saved)
        throws Exception;
}
```

Call details:

- for extended elements: when the element is recognized, processing of the JDOM-tree of the element is done by the handler. The tree walker in *@enterprise* will never step "into" such a subtree.
- for extended attributes: when the containing element is recognized. The handler is expected to process the extended attributes and nothing else.
- oids for the process and the steps are already set when the handler is called, but the objects themselves have not yet been written to the database.

The extensionHandler is specified via a processing-instruction in the XWDL-file:

```
<?xwml extensionHandler="at.adonis.xwml.ExtensionHandler"?>
```

15. XWDL

The processing instruction must be included at the outermost document level (before the root XML element).

For debugging purposes, a `NullExtensionHandler` can be specified. This handler logs its calls to the system log at log level `ERROR`.

```
<?xwdl extensionHandler="com.groiss.wf.xwdl.NullExtensionHandler"?>
```

16. BPMN

16.1 Introduction

This chapter presents the details of the BPMN 2.0 export functionality of *@enterprise*. BPMN 2.0 [10] and *@enterprise* constructs cannot be simply exchanged for each other. While a principal mapping between the model elements can be achieved in a quite straightforward manner, there are subtle differences in the details.

The goal of the BPMN exporter is to provide a BPMN view of *@enterprise* process definitions with a suitable amount of detail to allow for extension and documentation with third-party BPMN (drawing) tools.

The internal *@enterprise* layout information like position and size of the nodes and the endpoints and way points of the edges is provided. But since the various tools have quite different geometrical layouts of nodes and routing approaches to edges, the layout will usually need to be manually adjusted to some degree.

The BPMN process export can be initiated from the tab *Source* of a process definition. There are two buttons providing the ability to view or to download the BPMN representation of a process definition.

16.2 Common elements

16.2.1 Basic layout

Within the root `definitions` element, there will be nested the `itemDefinition` elements, `signal` elements, `message` elements, `interface` elements and their nested `operation` elements. Then the central `process` element follows. After it, there will be `globalUserTask` elements and `resource` elements. The last structure is the single `BPMNDiagram` element which contains the geometrical information.

16.2.2 Principal definitions

The `definitions` root element contains the information prescribed by [10] and the *@enterprise* specific extension namespace.

For the namespace prefix, `groissep` is used, the corresponding namespace name is `https://www.groiss.com/bpmn20`. The `exporter` attribute of the `definitions` element is `Groiss @enterprise`, the `id` attribute is the oid of the process definition, with a `"_"` prefix, the `name` attribute is the name of the process definition.

16.2.3 Form types

For each form type mentioned in the process definition and each subform table mentioned in parallel for constructs, an `itemDefinition` element is created. The concrete type definitions (Java classes) are not exported with the process.

For process form variables, the `id` attribute of the `itemDefinition` starts with "formtype_", then the id of the *@enterprise* form type, an underscore and the version of the form type are appended (e.g. `formtype_mainform_1`). The attribute `structureRef` captures the type information of the form, its value is the class name of the Java-class that *@enterprise* generates for the form type (e.g. `com.dec.avw.appl.mainform_1`). The `itemKind` attribute is always *Information* and the `isCollection` attribute is always *false*.

For subform tables mentioned in *parfor* constructs, the `id` attribute of the `itemDefinition` starts with "formtype_", then the id of the *@enterprise* form type of the main form, an underscore, the version of the form type and the id of the subform table are appended (e.g. `formtype_mainform_1.1`). The attribute `structureRef` captures the type information of the form, its value is the class name of the Java-class that *@enterprise* generates for the formtype of the subform, prefixed by "setof_" (e.g. `setof_com.dec.avw.appl.subform_1`). The `itemKind` attribute is always *Information* and the `isCollection` attribute is always *true*.

16.2.4 Signals

Signals are generated for event-nodes and for choice constructs.

In the header, a `signal` element is generated for each event name mentioned in the *sync*, *raiseEvent*, *register* and *unregister @enterprise* nodes of the process definition.

The name of the signal is the *@enterprise* event name. If an event context object (a form variable) was given in the event-node, then the signals `structureRef` attribute will reference the corresponding `itemDefinition` for the form type.

Likewise, for each choice-construct, a synthetic `signal` element is generated in the header. The `id` of this signal is prefixed with "signal_choice", followed by the `id` of the choice step, the signals `name` is prefixed by "choice_", followed by the `id` of the choice step. There is no type information associated with this signal.

16.2.5 Messages

Messages are used rather sparingly and just when the XML schema demands such a construct.

The exporter generates one dummy `message` element with `id` of `create_batch_job_message`, when batch job nodes are used in the process definition at all.

Another `message` element is generated, if web service nodes are used in the process definition. The message `id` is `ws_placeholder_message`.

16.2.6 Interfaces and Operations

An `interface` element is constructed for each Web client or Web server entry mentioned in the `invoke`, `receive` and `reply` nodes of the process. Each interface contains all the `operation` elements of the web service or web client used by the process. Each of the operations will reference the dummy `ws_placeholder_message` message.

For each batch adapter class used in batch job nodes, there is a single `interface` element with a single `operation` element. The `id` of the interface element is the batch adapter class name, prefixed with "if_". The `id` of the operation element is the `id` of the interface element with an suffix of ".createJob".

16.2.7 Resource Definitions

For each of the four principal types of resource definitions (user, role optionally with an organizational unit, agent of a previous task and agent referenced by a form field), one `resource` element is defined as follows:

<i>Resource Id</i>	<i>Resource Parameter Name</i>	<i>Description</i>
userById	userId	id of the user
roleById	roleId [orgUnitId]	id of the role id of the organizational unit (optional)
previousAgentByLabel	label	label of the task
agentByFormField	formId fieldName	id of the form variable name of the form field

The resource definitions are parametrized to allow for flexible and concise reference via `potentialOwner` or `humanPerformer` elements in the `userTask` elements.

All four resource definitions are included in every exported BPMN model, even if they are not used.

16.2.8 Expressions

There are three variants of expressions in process definitions: the *@enterprise* proprietary WDL-condition can be used, as well as Groovy and XPath.

An expression is mapped to a `formalExpression` element, or to an element with the `xsi:type` of `tFormalExpression`. The following table shows the value of the `language` attribute of the containing element for the three types of expressions. The expression itself is captured as the elements content in the form of CDATA.

<i>Expression Type</i>	<i>URI language attribute</i>
Groovy	https://groovy-lang.org
WDL	https://www.groiss.com/wdl
XPath	https://www.w3.org/TR/xpath

A notable special case is the specification of a single Java method call which is a subset of the WDL.

16.2.9 Omissions and Aspects for further enhancement

The following aspects of *@enterprise* process definitions are currently not within the scope of the BPMN export mechanism:

- escalations
- timing information
- real data type structures for forms and form fields
- form field modes
- inherent properties of tasks and processes (like due date, organizational units, ...)
- details of web services like types, messages and mappings of message elements to properties

Currently there is also no normative schema description for the proprietary extension elements.

16.3 Mapping of *@enterprise* constructs

16.3.1 Process definition and form declarations

The process definition itself is mapped to a `process` element. The `id` attribute is the id of the process definition concatenated with "_" and the version of the process definition. The `name` attribute is the name of the process definition. Attribute `isClosed` is set to false, since there may always be additional events (like abort) occurring in *@enterprise*. Attribute `isExecutable` is set to true, if the process definition was active.

The nested `documentation` element is populated with the description of the process definition.

There is a nested `groissep:process` extension element, where all the properties directly attached to an *@enterprise* process definition are preserved in the export in the form of attributes. The mapping should be self-explanatory.

An additional extension element `groissep:exporter` is written with the attributes `built`, `servername`, `hostname` and `exportedBy` populated with the export date, the `avw.servername` configured in *@enterprise* the hostname of the exporting machine and the principal who initiated the export.

The begin node of the process is mapped to an `startEvent` element, the end node is written as an `endEvent` element.

For each of the process form variables, irrespective whether they are local forms variables or in-out form variables, a nested `property` element is written. The `id` attribute is the id of the form variable. The type of the form is referenced via the `itemSubjectRef` attribute

which states the id of the corresponding `itemDefinition` element. The `name` attribute is just the id of the form variable.

There may be a nested extension element named `groissep:property`, if there is additional information available. The attribute `formname` will carry the display name of the form variable (if they are different). In the case of an *@enterprise* view form, the attribute `baseForm` references the id of the base form variable.

16.3.2 Annotations

Annotations are mapped to `textAnnotation` elements. Those elements are nested within the current context (which might be the top level `process` element or which might be a nested `subProcess` element from a "parallel for" node. The `id` attribute of the `textAnnotation` element is the oid of the annotation, prefixed by "_". The text of the annotation is captured in the content of a nested `text` element. An `association` element connects the `textAnnotation` element via its `sourceRef` attribute to the element of the target node via its `targetRef` attribute.

16.3.3 Flows

The edges in the process graph are represented in *@enterprise* as Flow objects. Each Flow object is mapped to a `sequenceFlow` element. The `id` attribute is the oid of the Flow object.

Those elements are nested within the current context (which might be the top level `process` element or which might be a nested `subProcess` element from a "parallel for" node.

Conditional expressions in *@enterprise* are usually attached to nodes (like `if` or `choice branch`). Contrastingly, in BPMN, the expressions are specified within the flows. The exporter will attach the expressions from the *@enterprise* nodes to the appropriate `sequenceFlow` elements.

For each `sequenceFlow` element which is not a 'normal' *@enterprise* flow, there is a nested `groissep:flow` extension element with the attributes `type` and `typeName` to capture the kind of flow in terms of *@enterprise*.

16.3.4 Common step structure

For each of the steps of an *@enterprise* process definition (the nodes in the process graph), an appropriate BPMN element will be generated as detailed below. In addition to the specific node information there are some common aspects. The `id` attribute of the BPMN element of the step will be the *@enterprise* step id (a numbering scheme within a process definition) prefixed by "_". The `name` attribute of the element will usually correspond to the text displayed within or below the node in the process editor.

There will be a nested extension element `groissep:step` with the attributes `type`, `typeName`, `name`, `label`, `icon` and `color`. For steps which are tasks, there may be an additional `skipable` attribute.

16.3.5 Activities

Tasks

For each task node, a `userTask` element will be generated.

The agents of the task will be captured as a sequence of nested `humanPerformer` elements (in the case of users and agents of previous steps), and `potentialOwner` elements (for roles and agents via formfields). Those elements will have the appropriate nested `resourceRef` and `resourceParameterBinding` elements like outlined in section [Resource Definitions](#) above.

In the case of a Java method expression to define the agent, there will be a `potentialOwner` element with a nested `resourceAssignmentExpression` with a nested `formalExpression` element containing the expression as CDATA.

A notable semantic difference between *@enterprise* and BPMN is that a multi valued list of agent descriptions in *@enterprise* means that the task will be routed in sequential order to the agents of the list, while the semantics of multiple performers in BPMN is questionable.

The nested `documentation` element is populated with the description of the task definition.

There will be a nested extension element `groissep:userTask` with the attributes `taskId`, `name`, `version`, `active`, `duration`, `cost`, `effort`, `firstAgentAtRuntime` and `furtherAgentsAtRuntime`. Within these elements there will also be nested element capturing the condition and method hooks potentially attached to a task. Those elements will be

- `groissep:preProcessingAction`,
- `groissep:postCondition`,
- `groissep:compensationAction`,
- `groissep:takeAction` and
- `groissep:untakeAction`

which are `formalExpressions`. The `groissep:postCondition` element could have a nested `message` element for the post condition message.

The specification of the step forms, that is which form variable is visible in which user task, is somewhat involved within the context of BPMN.

For a task without any step forms, there will be a nested `ioSpecification` element with a nested empty `inputSet` element and a nested empty `outputSet`.

Since *@enterprise* stepform semantics imply potential read write access to the forms, a form variable has always the data input as well as the data output aspect.

For each step form variable, there will be a `dataInput` element (with attribute `id` consisting of the prefix "in," followed by the id of the containing `userTask` element and a sequence number within the step), as well as a `dataOutput` element (with `id` attribute

prefix of "out"). Both elements will have the id of the form variable as `name` and the id of the corresponding `itemDefinition` (formtype) as `itemSubjectRef`.

The `inputSet` element will contain `dataInputRefs` for all the forms, the `outputSet` element will contain `dataOutputRefs` for them.

Additionally, for each of the step forms, there will be one `dataInputAssociation` element as well as one `dataOutputAssociation` element.

The data input associations connect the "formvar" property to the corresponding "in_stepid_number" data inputs. Likewise, the data output associations connect the "out_stepid_number" data outputs to the corresponding "pform_formvar" property.

Adhoc tasks

For each *@enterprise* adhoc task, there will be a `globalUserTask` element. Those elements are not within the main `process` element, but will be appended to it. Extension elements of adhoc tasks are identical to 'ordinary' user tasks.

The representation of adhoc tasks differs from the one for 'ordinary' user tasks in three areas:

- adhoc tasks do not have a direct representation in the process graph, there will be no geometry information associated with them.
- there will be no resource assignment (via `potentialOwner` or `humanPerformer` elements)
- there will be no `dataInputAssociation` and no `dataOutputAssociation` elements for step forms

Subprocess calls

A subprocess node is mapped to a `callActivity` element. The attribute `calledElement` has the *@enterprise* id of the called process. The inner structure of the subprocess itself is not included in the BPMN export of the calling process definition. To specify the actual parameters (form variables) for the call, there will be a nested `ioSpecification` element and a `dataInputAssociation` and `dataOutputAssociation` element per form variable just like for the stepforms of user tasks.

System task nodes

A system-node is mapped to a `scriptTask` element with a nested `script` element. The attribute `scriptFormat` of the `scriptTask` element will contain the MIME type of the script language. The `script` element contains the CDATA of the script text. The used MIME types are `application/x-xpath` for XPATH, `application/x-groovy` for Groovy and `application/x-wdl` for WDL.

Batch nodes

A batch-node is mapped to a `serviceTask` element with *batch* as `implementation` attribute. For each *@enterprise* batch adapter class name, an `interface` element with

a single nested `operation` element is generated in the header. The `id` of the interface element is batch adapter class name, prefixed with "if_". The `id` of the operation element is the `id` of the interface element with an suffix of ".createJob". The XML schema also needs an `inMessageRef`, which always references the dummy `create_batch_job_message`. This message will only be generated in the header, if batch-nodes are used in the process at all.

16.3.6 Control structures

If construct

Each if-node and elsif-node is mapped to a an `exclusiveGateway` with *Diverging* direction. The `then` flow (`groissep:flow`) will carry the expression (`conditionExpression`), the `else` flow is marked as the default flow. The end-node is an `exclusiveGateway` element with *Converging* direction.

While construct

A while-node is mapped to a an `exclusiveGateway` with *Diverging* direction. The `then` flow (`groissep:flow`) will carry the expression (`conditionExpression`), the `else` flow is marked as the default flow. Note that there is no corresponding end-node for the while-node.

Loop construct

A loop-node is mapped to an `exclusiveGateway` element with *Converging* direction. The corresponding exit-when-node is an `exclusiveGateway` with direction *Diverging*. The `then` flow (`groissep:flow`) from the exit-when-node will carry the expression (`conditionExpression`), the `else` flow is marked as the default flow.

Choice construct

A choice-node is mapped to an `inclusiveGateway` with direction *Diverging*. For each choice node, there is a corresponding `signal` element generated in the root `definitions` element. The `id` of the signal is prefixed with "signal_choice", followed by the `id` of the choice step. The `name` of the signal is prefixed by "choice_", followed by the `id` of the choice step. The signal itself symbolizes the manual choice selection of the user. It will carry the information about which one of the branches is to be followed. For each of the following choice-branch-nodes, an `intermediateCatchEvent` is created. The nested `signalEventDefinition` references the choices signal via attribute `signalRef`. The optional expressions for branch selectability by the user are annotated at the flows between the choice-node and the choice-branch-nodes. A missing expression is transformed to a `true` expression. The end-node of the choice is an `exclusiveGateway` element with direction *Converging*.

Andpar and Orpar constructs

The starting nodes of andpar and orpar constructs are mapped to `parallelGateway` elements with *Diverging* direction. The join-nodes of andpar and orpar constructs are mapped to a `complexGateway` element with direction *Converging*.

For or-join-nodes, the `activationCondition` of the converging gateway will be annotated with `1 of n`.

For and-join-nodes without an explicit expression, the `activationCondition` will be *n of n*, while for and-join-nodes with an explicit expression, the `activationCondition` will be *m of n*. For the last case, the expression itself will be captured in a nested `groissep:endpar / groissep:method` extension element.

Branch construct

A branch-node is mapped to an `parallelGateway` element with *Diverging* direction. The branch-flow from the branch-node is named *branch*, while the normal is not annotated in any special way. An end-branch-node is mapped to an `endEvent` element.

Goto and Goto-end constructs

Goto-nodes and Goto-end-nodes are mapped to `exclusiveGateway` elements with direction *Diverging*. The normal flow from the goto-node (to the target of the goto) is marked via the `default` attribute. The corresponding `sequenceFlow` element is named `goto`, the the `sequenceFlow` element of the other flow object is annotated with a *false* expression via a nested `conditionExpression` element.

Parallel-For construct

A parfor-node construct is mapped to a `subProcess` element. The parfor-node itself and the corresponding endfor-node are mapped to `startEvent` and `endEvent` elements. Those elements and the other nodes and flows within the construct are nested within a `subProcess` element with an `id` attribute of the id of the `startEvent` element with an suffix of `"_SP"`.

The nested `multiInstanceLoopCharacteristics` element of the `subProcess` element is marked as parallel by setting attribute `isSequential` to *false*. If there is a method call specified in the end node of the parallel for, there will be a nested `completionCondition` element with the formal expression corresponding to the method.

All the *@enterprise* nodes and flows within the parallel for will be nested within the `subProcess` element; the flows to the begin of and from the end of the parallel for are adapted to reference this element.

There are two principle forms of parallel for constructs. The first one states an iterator class which determines the parallel instances, the second one iterates over a subform

table.

For the kind of parallel for with an iterator class, this class is written as a nested `loopCardinality` element within the `multiInstanceLoopCharacteristics`.

For the second kind of parallel for which iterates over a subform table, there will be a nested `dataObject` element representing the subform table. The `id` attribute of this element consists of

- the id of the main form,
- a ".",
- the id (number) of the subform table
- suffixed by the id of the parent `subProcess` element.

The attribute `isCollection` will be set to `true`. The appropriate `itemDefinition` will be references via attribute `itemSubjectRef`.

The `multiInstanceLoopCharacteristics` element will contain a `loopDataInputRef` as well as a `loopDataOutputRef` element which refer to this data object. The local loop variable is represented by a `property` element nested within the `subProcess` element. The `id` attribute of the property is set to the id of the form variable. The type of the form is referenced via the `itemSubjectRef` attribute which states the id of the corresponding `itemDefinition` element. The `name` attribute is just the id of the form variable. This property is also referenced by the `inputDataItem` and `outputDataItem` elements nested within the `multiInstanceLoopCharacteristics`.

There may be a condition at the parallel for node which decides if a subform instance should result in a parallel instance. This condition is captured as element `groissep:whenExpression` within a nested `groissep:parfor` extension element. The actual nodes within the parallel for respectively the `subProcess` element will start with a nested `startEvent` element and conclude with an `endEvent` element.

16.3.7 Events

Sync nodes

A sync-node is mapped to an `intermediateCatchEvent` element with a nested `signalEventDefinition` element which references the `signal` element that has also been generated in the root `definitions` element.

The id of this signal is the *@enterprise* event name, prefixed with "signal_". The name of the signal is the *@enterprise* event name.

If the event context object was given in the sync-node, and this was a form or a formfield, then the signals `structureRef` attribute will reference the corresponding

`itemDefinition` for the form type. The `signalEventDefinition` element of the `intermediateCatch` element references the id of the signal by its `signalRef` attribute. Additionally, there will be a `dataOutput` element, a `dataOutputAssociationElement`, and an `outputSet` element by which the output signal of the catch event is mapped to the form variable (if applicable).

The `groissep:sync` extension element will carry the information about the *@enterprise* event handler class and the context string.

Raise nodes

A raise-node is mapped to an `intermediateThrowEvent` element with a nested `signalEventDefinition` element which references the `signal` element that has also been generated in the root `definitions` element.

The id of the signal is the *@enterprise* event name, prefixed with "signal_". The name of the signal is the *@enterprise* event name.

If an event context object was given in the raise-node, and this was a form or a formfield, then the signals `structureRef` attribute will reference the corresponding `itemDefinition` for the form type. The `signalEventDefinition` element of the `intermediateThrow` element references the id of the signal by its `signalRef` attribute. Additionally, there will be a `dataInput` element, a `dataInputAssociationElement`, and an `inputSet` element by which the form variable is marked as input for the signal of the throw event (if applicable).

The `groissep:raiseEvent` extension element will capture the *@enterprise* event transaction mode and the context string.

Register nodes

An event-register-node is mapped to a `scriptTask` element which contains the *@enterprise* expression to register an event.

Additionally, a `signal` element has also been generated in the root `definitions` element. This signal is not directly linked to the `scriptTask` element. The id of the signal is the *@enterprise* event name, prefixed with "signal_". The name of the signal is the *@enterprise* event name. If an event context object was given in the register-node, and this was a form or a formfield, then the signals `structureRef` attribute will reference the corresponding `itemDefinition` for the form type.

Unregister nodes

An event-unregister-node is mapped to a `scriptTask` element which contains the *@enterprise* expression to register an event.

Additionally, a `signal` element has also been generated in the root `definitions` element. This signal is not directly linked to the `scriptTask` element. The id of the signal is

the *@enterprise* event name, prefixed with "signal_". The name of the signal is the *@enterprise* event name. There is no event context object in this case.

Wait nodes

A wait node is mapped to a `intermediateCatchEvent` element with a nested `timerEventDefinition` element.

If a time interval was given, it is included in a nested `timeDuration` element in ISO-8601 syntax. For workdays, which are not included in ISO-8601 semantics, the suffix "D_W" will be used.

Other arbitrary date expressions are captured by a nested `timeDate/formalExpression` element.

16.3.8 Web services

Invoke nodes

A web service invoke-node is mapped to a `serviceTask` element with `implementation` attribute *##WebService*. The `operationRef` attribute references the corresponding nested `operation` element in the appropriate interface.

An optional exception handling is mapped to a `boundaryEvent` element attached to the `serviceTask` via attribute `attachedToRef`. A nested `errorEventDefinition` element captures the exception semantics. The end-node of the exception handling is mapped to an `exclusiveGateway` element with *Converging* direction. At this gateway, the normal flow and the exception flow will meet again.

Receive nodes

A web service receive-node is mapped to a `receiveTask` element with `implementation` attribute *##WebService*. The `operationRef` attribute references the corresponding nested `operation` element in the appropriate interface.

If the reception starts the process, the `instantiate` attribute will be set to *true*. No further transformations (like omission of preceding start events) are applied.

Reply nodes

A web service reply-node is mapped to a `sendTask` element with `implementation` attribute *##WebService*. The `operationRef` attribute references the corresponding nested `operation` element in the appropriate interface.

17. Usage of DOJO and JavaScripts

This chapter describes the handling of the *@enterprise* JavaScript library, the DOJO components (AJAX), how to use customized DOJO controls and the new smartclient handling.

17.1 The *@enterprise* JavaScript library

This section describes how to embed the *@enterprise* JavaScript library and how the files are organized in packages. Furthermore some useful methods are explained.

Each page which should use JavaScript must contain following import within the `head`-tag. The files are taken from the JavaScript source directory, packaged into the page and cached on the server:

```
<script type="text/javascript" src="../../scripts/dojo/dojo.js"
        data-dojo-config="parseOnLoad: true">
</script>
```

All *@enterprise* JavaScript methods are structured in packages and are stored in `alllangs/scripts/ep/_base` within the `ep-impl-<version>.jar`. Some useful methods are described below:

- `ep.util.isFF`: Check, if the current browser is Firefox.
- `ep.util.isIE`: Check, if the current browser is Internet Explorer.
- `ep.util.isSafari`: Check, if the current browser is Safari. Example:

```
if(ep.util.isFF) {
    //handling for Firefox
    ...
}
else if(ep.util.isIE) {
    //handling for Internet Explorer
    ...
}
else if(ep.util.isSafari) {
    //handling for Safari
    ...
}
else {
```



```
//handling for all other browsers
...
}
```

- `ep.util.getParam(name, query_string)` : This method gets the parameter value from the `query_string` of the URL (= everything behind the question mark). The parameter `query_string` is optionally and if not used, `document.location.search` is the default search string.
- `ep.util.moveEntries(sourceid, targetid, sorted, indexarray)` : Moves the selected entries from selectlist *sourceid* (= id of the source selectlist) to selectlist *targetid* (= id of the target selectlist). The parameter *sorted* is a boolean parameter and indicates, if the moved entries should be sorted in target selectlist. The parameter *indexarray* contains the indices of the entries in source selectlist, which should be moved. If the parameter *indexarray* is null, all entries are moved.
- `ep.util.moveAllEntries(sourceid, targetid, sorted, indexarray)` : Moves all entries from selectlist *sourceid* (= id of the source selectlist) to selectlist *targetid* (= id of the target selectlist) analogous to `ep.util.moveEntries()`.
- `ep.util.showToolbar(actions, target, toolbar, orientation)` : By calling this method the servlet method `com.groiss.avw.html.HTMLToolbar.show` will be invoked. The parameter *actions* contains all actions, which should be displayed in toolbar. The *actions* parameter is a whitespace separated string containing the id's of the actions (from a XML-configuration). The *target* parameter indicates the location, where the toolbar should be displayed. If the parameter is empty, *parent.right* is used. With the optional parameter *toolbar* you can define the toolbar frame. If not defined, the *parent.toolbarframe* is default. The parameter *orientation* can be used to set the alignment of the toolbar. The character **v** symbolizes, that a vertical toolbar should be used; **h** or empty *orientation* parameter means that horizontal toolbar should be used.

Example:

```
<body onload="ep.util.showToolbar(
    'admin.refreshControl myxml.save', 'parent.right')">
...
</body>
```

- `ep.util.clearToolbar(toolbar)` : This method removes all functions from the toolbar. With the optional parameter *toolbar* you can define the toolbar frame. If not defined, *parent.toolbarframe* is default.
- `ep.util.urlEncode(val, doc)` : This method encodes a string (= parameter *val*) and returns the encoded value for URL's. The optional parameter *doc* contains a reference to a document object; if the parameter is not used, the current document is used.
- `ep.util.urlDecode(val)` : This method is the direct opposite to `ep.util.urlEncode()`.
- `ep.util.refreshOpener()` : Method to refresh the opener window, e.g. if data are changed in a popup and the opener should be refreshed with this data.

17.2 Using DOJO in *@enterprise*

The DOJO toolkit is an open source modular JavaScript library designed to ease the rapid development of cross platform, JavaScript/Ajax based applications and web sites. One important feature of Ajax applications is asynchronous communication of the browser with the server: information is exchanged and the page's presentation is updated without a need for reloading the whole page.

@enterprise uses the latest [DOJO version](#).

17.2.1 Add DOJO to a page/form

This section describes which components are necessary to use DOJO in your forms (xhtml, xforms) with the standard *@enterprise* style:

1. Most important import is:

```
<script type="text/javascript" src="../../scripts/dojo/dojo.js"
      data-dojo-config="parseOnLoad: true">
</script>
```

Depending on the used DOJO control (see section [Usage of customized DOJO controls](#)) it is recommended to use DOJO layers for reducing server requests and increasing performance. In XForms layers are imported automatically, in all other cases use the layer `ep/common-form-widgets.js` like in following example:

```
<script type="text/javascript" src="../../scripts/ep/common-form-widgets.js">
</script>
```

2. Import style definition:

```
<link rel="stylesheet" type="text/css"
      href="../../servlet.method/com.groiss.gui.css.StyleConf.loadCSS">
</link>
```

3. Import widgets, for example:

```
require(["dojo/parser",
        "ep/widget/DateField", //necessary for date fields
        "ep/widget/ObjectSelect"]); //necessary for obj. select
```

DOJO widgets are prepackaged components of JavaScript code, HTML markup and CSS style declarations that can be used to enrich websites with various interactive features that work across browsers.

4. Add the following css-class to the body tag:

```
<body class="claro">
```

Hint: It is recommended to use `dojo/ready` instead of `<body onLoad="foo()">`. More details according this issue can be found [here](#).

17.2.2 Usage of customized DOJO controls

This section describes how the components `DateField` and `ObjectSelect` can be added to the form.

Date control - ep/widget/DateField

For adding a datefield an input-field must be created of `dojoType` `ep/widget/DateField` like in following example:

```
<input type="text" name="changeTime" id="changeTime" showTime="false"
value="" data-dojotype="ep/widget/DateField" selectToday="true"/>
```

The attribute `showTime` means, that the time is displayed, if set to `true`. If attribute `selectToday` is set to `true`, an additional icon (function) for getting the current day is displayed beside the date picker. With attribute `defaultTime` then defined default time (hh:mm pattern) is selected, otherwise if no default time is specified, the current time of the client will be used (for `dateTime` fields only). If the value of a datefield should be changed, the method `set` should be used like in following example. The method `get` reads the value of the datefield.

```
require(["dijit/registry"], function(registry) {
    registry.byId('changeTime').set('value', '01-01-2009');
    registry.byId('changeTime').get('value'); //read value of datefield
});
```

Object selection - ep/widget/ObjectSelect

For adding a object selection an select-field must be created of `dojoType` `ep/widget/ObjectSelect` like in following example:

```
<select id="substitute" data-dojotype="ep/widget/ObjectSelect"
name="substitute" style="width:400px" class="ep_select"
classname="com.groiss.org.User" searchAttributes="surname,id"
value="['','']">
</select>
```

The attribute `classname` is required and must contain a java class of type `com.groiss.store.Persistent`. The following optional attributes can be entered:

- **searchAttrs:** A comma separated list of attributes can be entered for searching the input string.
- **searchid:** This parameter must be used, if a WHERE-clause with parameter should be used. The searchid consists of the xml-id (created by the *@enterprise GUI-Configuration*) and the node-id, i.e. `<xmlid>.<nodeid>` and executes the appropriate action node of the xml.
- **parameters:** The parameters for the attribute *condition* in xml-file, if the WHERE-clause contains parameter.

- `attrs`: A comma separated list of attributes to display; if empty: `toString`
- `noClass`: If set to true, the selected value will be in form `<oid>` instead of `<classname>:<oid>` (default: false)
- `value`: Initial value in form `['label','classname:oid']`
- `fetchAttrs`: Allow to (pre-)fetch dependent objects from the database by efficient operations. The content is a comma separated list of names of java fields of the corresponding class. The field names must denote persistent objects! Usually one `BulkQuery` per field is executed instead of a (single record) select-statement per record and field.

If the selection needs a condition with parameter, it must be defined in following way:

Write an `query` node in application's XML which has been created by the *@enterprise GUI-Configuration*. This query must be inside the `<nodes>` block (see section [Non tree nodes \(<nodes>\)](#)). In our example we need all departments with sub-departments:

```
<nodes>
...
<query id="DeptsWithSubdeptsSelect">
  <classname>com.groiss.org.Dept</classname>
  <attrs>name</attrs>
  <searchAttrs>name,id</searchAttrs>
  <title>@@@ep:dept@@</title>
  <condition>
    oid in (select superdept from avw_flatdepttree where application=?)
  </condition>
  <types>Long</types>
  <rightsMayExecute>NONE</rightsMayExecute>
  <allowModifications>true</allowModifications>
</query>
...
</nodes>
```

The attribute `condition` defines the SQL WHERE-clause. The parameters can be defined with question marks (?) which are the placeholders. In this case the attribute `types` is necessary to define the datatypes of the given parameters of the condition. For each parameter in condition a type is needed (comma-separated list). Possible values are:

- Persistent
- Date
- Long
- Double
- Integer
- String

- `OIDList`

A parameter with type `OIDList` has to be a nested JSON array (double square brackets are needed!), e.g. `[[oid1,oid2,oid3]]`. The condition has only one question mark (e.g: "oid not in (?)").

A special placeholder is `${user}` which is filled with the oid of the current thread user - example:

```
<nodes>
  <query id="UserSelectWithoutCurrentUser">
    ...
    <condition>oid > 1000 AND oid != ${user}</condition>
    ...
  </query>
</nodes>
```

The attribute `rightsMayExecute` defines the right-id which right should be checked. If the value *NONE* is entered, no right check will be performed.

If the property `allowModifications` is set to *true* insert, update and delete using `JSONLoader` is allowed.

After creating an action node we have to set the attributes `searchid` and `parameters` in the appropriate HTML-file. In our example the parameter is the oid of the default-application:

```
<select name="dept" id="dept" class="ep_select" style="width:400"
  tabindex="2" data-dojo-type="ep/widget/ObjectSelect"
  autoComplete="true" searchid="<xmlid>.DeptsWithSubdeptsSelect"
  parameters="1">
</select>
```

The attributes `searchid` and `parameters` can be set via JavaScript by using the `set` method like `set("searchid", value)` and `set("parameters", value)`. Following an example how to use these functions:

```
require(["dijit/registry"], function(registry) {
  var appl = registry.byId("application");
  var proc = registry.byId("proctype");
  if(appl.value && appl.value!='') {
    proc.set("searchid", "ProcDefOfApplicationSelect");
    proc.set("parameters", ''+appl.value);
  }
});
```

The methods `get` and `set` should be used in the same way described in section *Date control - ep/widget/DateField*. In object selection the method `get('value')` returns the **key** only! If the displayed value of the current selection is needed, the method `get('displayedValue')` has to be used.

17.2.3 Implementing own widgets

Functionality beyond forms should be handled with widgets. This section describes some cases using widgets in *@enterprise*. First of all widgets should be placed in applications under `appli/classes/alllangs/scripts/ep/widget`. A widget consists of a JavaScript file and perhaps a template (html file). A tutorial how to create and implement widgets is described [here](#).

Public *@enterprise* widgets

@enterprise offers some public widgets which are needed for creating own applications. Two widgets (ObjectSelect and DateField) are described already in sections above, but there are some other mentionable widgets:

- `ep/widget/smartclient/grid/Column`: Necessary widget for overwriting column behaviour, e.g. in worklist (attribut `jsClass` in xml file - see section [Configuring the Worklist Client](#)).
- `ep/widget/smartclient/_Action`: Widget for creating (task) functions and described in section below.
- `ep/widget/smartclient/ProcessDetails`: This widget allows to display the process details with methods `showDetails(objectId,props)` and `getInlineDetails(objectId,props)`.
- `ep/widget/smartclient/ProcessDetailsHandler`: Standard process detail handler for displaying detail tabs of a process. It is possible to implement a own detail handler and enter it at the process definition in administration in appropriate field.
- `ep/widget/smartclient/StandardDialog`: Widget opens a popup with a Cancel button by default, OK button and resize handling is optionally. The Cancel button closes the dialog and discard all changes. The OK button calls the function `onCommit` of the panel and closes finally the dialog. Example:

```
var thePane = new PanelType({
  onCommit: function(onComplete) {
    // do something..
    onComplete();
  }
});

var dlg = new Dialog({
  title: "Test dialog",
  content: thePane,
  showOK: true
});
```

It is important that the function `onCommit` is defined before the dialog is created. If components in dialog should resize, the style class *balloon* must be defined.

- `ep/widget/smartclient/SelectDialog`: Widget opens a popup where multiple selection of objects is possible. Following examples shows the functionality:

```
SelectDialog.show({style: {height: "300px", width: "600px"},
  tabs: [{title: "###forms##",
    url: "mypackage.MyClass.listFormTypes?exclusive="+
      self._getMultiSelectValuesAsString(self.formtypesSelect)}}]).then(
  function(result) {
    array.forEach(result.values, function(formtype){
      self.formtypesSelect.addEntry({value: formtype.value}, formtype.value);
    });
  });
```

This example opens a dialog for formtypes selection. The formtypes are retrieved via the given url from server. The `show` methods returns a deferred object which allows to add a `then` method which contains the selected objects as result. The result is a object containing a values array. The values are objects of the store which were selected.

```
SelectDialog.show({style: {height: "300px", width: "600px"},
  tabs: [{searchid: "mygui.UserSelect"},
    {searchid: "mygui.DeptSelect"},
    {searchid: "mygui.RoleSelect"}]).then(
  function(result) {
    if (result.searchid == "mygui.UserSelect") {
      // special treatment for first tab
    }
    ...
  })
```

In this example a dialog with 3 tabs is created. The tabs are defined as query-node in GUI xml (see section [Usage of customized DOJO controls](#) - subsection *Object selection - ep/widget/ObjectSelect*). The result contains the searchid which indicates the selected tab.

- `ep/widget/smartclient/Toolbar`: Widget for defining a toolbar with actions.
- `ep/config`: AMD plugin to load server-config parameters. These parameters are defined in `properties.xml` of appropriate application (see section [Organization of Files](#)). Example:

```
define(["dojo/_base/declare",
  "ep/widget/smartclient/_Action",
  "dojo/request",
  "ep/Utils",
  "ep/config!"],
function(declare,
  _Action,
  request,
  Utils,
  serverProps) {
  return declare([_Action], {
    actionPerformed:function(evt) {
      console.debug(serverProps["client.property"]);
      console.debug(serverProps["myappl:my.client.property"]);
    }
  })
})
```

```
});  
});
```

With help of the AMD-loader plugin `ep/config!` it is also possible to access/save any user properties on the client. Usage:

```
define(["ep/config!",function(epConfig){  
    return declare([...],function() {  
        anyfunc: function() {  
            //access user property  
            console.debug(epConfig.userproperties.get("user.property"));  
            //set user property  
            epConfig.userproperties.set("user.property","new value");  
        }  
    });  
});
```

Defined user properties may only be accessible on the client, if they are tagged as `allowOnClient="true"`. The attribute `needsClientRefresh` indicates, if a manual client refresh is needed (value "true") or not. If value is "true" the user will be prompted, if the refresh could be performed immediately after saving changed user property.

Utility widget

In many cases some common functions are always needed. In *@enterprise* these functions are implemented in JavaScript class *Utils.js* (import as *ep/Utils*). Following functions are available:

- `showErrorMessage(e)` : Function to show errors especially at AJAX calls. The argument could be a String or a JSON result of a AJAX call, e.g.

```
request.post("url", {handleAs:"json"}).then(function(result) {  
    }, Utils.showErrorMessage);
```

If the HTTP response code is an error code, `showErrorMessage` will be called. The Dispatcher recognize AJAX calls and returns the appropriate JSON object.

- `getErrorInfo(error)` : Returns a JSON object representing the error received from a servlet method or null, if the error is sent by some other source. If the result is not null, it may contain the following properties:
 - `errornumber`: the number of a *com.groiss.util.ApplicationException*
 - `message`: the message of a *com.groiss.util.ApplicationException*
 - `error`: the message text of the error
 - `showHTML`: if true, the message should not be encoded when shown to the user
- `alert(message,title)` : This function opens a dialog which shows the given *message*. If no *title* is passed, the default 'Warning' will be taken as the dialogs title.

- `refreshWorklists(data, showFirst, showDetailsOfFirstAdded, selectAdded)` : This method is called with the results on an worklist action. It publishes the added and deleted entries to the respective worklists. If *showFirst* is true, it publishes a show topic for the first added entry. If *showDetailsOfFirstAdded* is true, the details of first added entry are shown. If *selectAdded* is true, the added entry will be selected.
- `showWorklist(id)` : Show the worklist with the given xml-id. Note, that the worklist is not refreshed by this call!
- `formatDateTime(d, pattern)`, `formatDate(d)` : These methods take the server settings and formats the given date. If *d* is null, an empty string will be returned. The parameter *pattern* allows to define a own date-pattern; if null, the default pattern of *@enterprise* is taken.
- `formatPersistent(p)` : A persistent on client exists as JSON object with following structure:

```
{ objectId: "classname:oid", _toString: "a_string" }
```

The method *formatPersistent(p)* returns the field *_toString*. On server side such objects are build with *StoreUtil.toJSONAsReference(persistent)*.

- `formatMessage(string, /* array */ replacements)` : Formats a message (argument *string*) like *MessageFormat* in Java.
- `htmlEncode(str)` : This function translates some special characters to their representation in HTML.
- `showProcessDetails(pi, selTab, popupContext)` : With this function the process details can be shown in a popup window. The argument *pi* must consist of *<classname>:<oid>*. The argument *tab* indicates which tab should be opened. The following shortcuts can be used:
 - *notes* for notes tab.
 - *history* for history tab.
 - *process* for process tab.
 - *documents* for documents tab.
 - *form:<formid>* for form tab.
- `openUserInfo(object, node, orient)` : This function opens a tooltip dialog with information about the given user (argument *object* as *<classname>:<oid>*).
- `taskString(ai)` and `docsString(doc)` : These functions returns the string representation of given activity instance or document. Both methods can contain the object as argument or a list of objects. The methods generate HTML: a break (*
*) between the entries and an icon at documents. These methods are used e.g. in worklist dialogs and in document list.

- `showDMSFolder(folder, showToolbar, disableUpNav)` : This function opens the DMS folder of given DMS object in a popup window. The boolean parameter *showToolbar* indicates, if a toolbar should be displayed. The boolean parameter *disableUpNav* allows to avoid breadcrumb navigation to any parent of the folder passed to that function.
- `executeReport(reportId, params, showToolbar, showClose, newWindow)` : Shows given report (= *reportId*) in a popup. It is possible to add additional parameters (= *params*) as array which are added to the request. The boolean parameter *showToolbar* indicates, if a toolbar should be displayed. With boolean parameter *showClose* you can display a close button in popup or not and *newWindow* indicates, if a popup or the current window should be used for representation of reporting result.
- `confirm(message)` : A confirmation dialog is displayed with an OK and Cancel button and the given *message*. Usage:

```
Utils.confirm('text').then(function-on-ok, function-on-cancel);
```

- `yesNoCancel(message)` : A dialog that shows the buttons *Yes*, *No* and *Cancel* with given *message*. Usage:

```
Utils.yesNoCancel('text').then(
    function-on-yes_or_no("yes"|"no"), function-on-cancel);
```

- `prompt(message, defaultValue)` : A dialog that prompts for input of one value. Usage:

```
Utils.prompt('text', defaultValue).then(
    function-on-ok(newValue), function-on-cancel);
```

- `hasRight(right, object)` : Returns a deferred JSONObject with the property 'hasRight' holding the information if the current user has the passed right on the passed object. The parameter *right* contains the id of the right and *object* the target of this check (as "classname:oid" string, but can be null, if no target specific check). Usage:

```
Utils.hasRight("right-id", object).then(function(result));
```

- `getCurrentUser()` : Returns the current user as "<classname>:<oid>" string.

Worklist data

The worklist is submitted as JSON array to the client with a set of attributes. The attributes are categorized in must fields and optional fields. Must fields are always available even the value of a field is null. Optional fields are available only, if the appropriate worklist is configured.

Following must fields are available (on client e.g. wrapped in parameter *ai* for a worklist entry):

- `objectId`: Contains the string <classname>:<oid> of current activity instance, e.g. com.dec.avw.core.StepInstance:4295009902

- **id**: The process/activity instance id, e.g. 2
- **priority**: The priority of the current activity instance, e.g. 0
- **subject**: The subject of the activity instance, e.g. "My subject"
- **application**: Contains an array with following attributes about the application of activity instance:
 - **id**: The id of the application, e.g. default
 - **_toString**: The toString-representation of the application, e.g. Default
 - **objectId**: Contains the string <classname>:<oid>, e.g. com.dec.avw.core.Application:1
 - **_filterVal**: The value used for (column) filtering in worklist table, e.g. "default"
 - **_sortValue**: The value used for (column) sorting in worklist table, e.g. "Default"
- **task**: An array with following attributes about the task of current activity instance:
 - **id**: The id of the task, e.g. order
 - **_toString**: The toString-representation of the task, e.g. Order
 - **objectId**: Contains the string <classname>:<oid>, e.g. com.dec.avw.core.Task:4294967315
 - **version**: The version of the task, e.g. 1
 - **_filterVal**: The value used for (column) filtering in worklist table, e.g. "order"
 - **_sortValue**: The value used for (column) sorting in worklist table, e.g. "order"
- **activityForms**: An array of objects containing all process forms used by process instance. Each array element (= object) contains following attributes:
 - **id**: The id of the process form, e.g. proc_f
 - **title**: The displayed title of process form, e.g. "Process form"
 - **formtype**: The formtype information about the process form with following attributes:
 - * **id**: The id of the formtype, e.g. jobform
 - * **version**: The version of the formtype, e.g. 5
- **agent**: The agent of the current task (= activity instance) with following attributes:
 - **id**: The id of the agent, e.g. eisenberg
 - **_toString**: The toString-representation of the agent, e.g. "Roland Eisenberg"
 - **objectId**: Contains the string <classname>:<oid>, e.g. com.dec.avw.core.User:4294967203
- **pd**: This attribute contains the process definition information about current activity instance:
 - **id**: The id of the process definition, e.g. jobproc
 - **_toString**: The toString-representation of the process definition, e.g. Jobproc

- *objectId*: Contains the string <classname>:<oid>, e.g. com.dec.avw.core.ProcessDefinition:4294967273
 - *version*: The version of the process definition, e.g. 7
 - *_filterVal*: The value used for (column) filtering in worklist table, e.g. "Jobproc"
 - *_sortValue*: The value used for (column) sorting in worklist table, e.g. "Jobproc"
- *pi*: Detailed information about process instance of current activity instance (= *ai*.getProcessInstance()):
 - *oid*: The oid of the process instance, e.g. 4295611007
 - *_toString*: The toString-representation of the process instance, e.g. "Process 768"
 - *objectId*: Contains the string <classname>:<oid>, e.g. com.dec.avw.core.StepInstance:4295611007
 - *priority*: The priority of the process instance, e.g. 0
 - *dueDate*: The process due date in milliseconds, e.g. 1389703560000
 - *startedAt*: The date when process instance has been started (in ms), e.g. 1389692755000
 - *startedBy*: The agent who started the process instance analog to attribute *agent* described above
- *orgUnit*: The organizational unit of the current activity instance:
 - *id*: The id of the organizational unit, e.g. GI
 - *_toString*: The toString-representation of the organizational unit, e.g. "FRE-QUENTIS AG"
 - *objectId*: Contains the string <classname>:<oid>, e.g. com.dec.avw.core.Dept:4294967205
- *hasNotes*: Indicates, if notes are attached to process (activity instance) as boolean value true/false
- *hasDocuments*: Indicates, if documents are attached to process (activity instance) as boolean value true/false
- *hasSeen*: Indicates, if activity instance is seen or unseen (boolean value true/false)
- *taken*: Contains the date in milliseconds about the time when activity instance was taken (e.g. from role-worklist)
- *started*: Contains the date in milliseconds when current activity instance was started
- *dueDate*: The due date of current activity instance in milliseconds
- *taskfunctions*: The task functions of activity instance as an array of strings containing <classname>:<oid>

- `canUntake`: Indicates, if activity instance can be untaken (boolean value true/false)
- `origin`: Symbolizes, if user sees the (activity) instance via substitution or not (possible values are in Java class *ActivityInstance*)

Optional fields could be for example:

- `finished`: The finished date of an activity instance, e.g. in suspension list
- `lastAction`: The last action as numeric value (see Java class *ActivityInstance* for details)
- `currentEditor`: The current editor of the activity instance (only available, if AUTO-TAKE is activated) which contains the information analog to attribute *agent* mentioned above
- `onBehalfOf`: The original agent before representant has taken it containing the same information as attribute *agent*
- `description`: The description of the current activity instance

In the new GUI the worklist is cached on the client and the changes are sent selectively. There are 3 situations how worklists can be refreshed and shown again:

1. Worklist refresh is needed, because activity instances were changed (e.g. after process start). An example (variant 2) is shown in the demo function `com.groiss.demo.StartJob.start`:

```
JSONObject result = ClientUtil.getChangesAsJSON("demo.wl", true);
return new ActionPage("parent.require(['ep/Utils'],function(Utils) {" +
    "Utils.refreshWorklists(" + result + ",true);});");
```

2. Worklist refresh is needed, but activity instances were not changed (e.g. form field has been changed which is displayed in worklist as column value). In this case the first step is to add the changed activity instances as changes by using the `com.groiss.wfe.WfEngine` method `propagateChange`. The second step is the same as described in point 1. An example is shown in the demo function `com.groiss.demo.DemoFunctions.approve`.

3. Show the worklist only, because nothing has been changed. An example (variant 3) is shown in the demo function `com.groiss.demo.StartJob.start`:

```
return new ActionPage("parent.require(['ep/Utils'],function(Utils) {" +
    "Utils.showWorklist('demo.wl');});");
```

Information about the server-side function `ClientUtil.getChangesAsJson` is available in *@enterprise* APIDoc. The client-side functions `refreshWorklists` and `showWorklist` are described in section *Utility widget* of chapter [Implementing own widgets](#).

Functions

Functions in smartclient should be developed as DOJO widget on client side. For this purpose the *@enterprise* widget `ep/widget/smartclient/_Action` must be extended by writing an own widget. This widget must be entered in *@enterprise* administration at *Applications/<appl>/Functions/<function-object>/Tab "General"/Client action*, if used as (task) function or it is possible to define the widget in GUI-Configuration (XML) like in following example:

```
<action id="approve">
  <name>@@@approve@@</name>
  <onClick>ep/widget/smartclient/demo/Approve</onClick>
  <apply>MULTI</apply>
</action>
```

Following an example for a client side function:

```
define(["dojo/_base/declare",
        "ep/widget/smartclient/_Action",
        "dojo/request",
        "ep/widget/smartclient/wl-util",
        "ep/config!"],
function(declare,
        _Action,
        request,
        wlUtil,
        serverProps) {
return declare(_Action, {
  actionPerformed:function(evt) {

    console.debug(serverProps["demo:client.property"]);

    request.post("com.groiss.demo.DemoFunctions.approve2",{
      handleAs: "json",
      data:{
        object: this.getSelectedIds(),
        nodeid: this.nodeid
      }
    }).then(function(result) {
      wlUtil.refreshWorklists(result);
    });
  },
  isEnabled:function() {
    var selection = this.getSelection();
    if(selection.length==0) {
      return false;
    }
    for (var i = 0; i< selection.length; i++) {
      if (selection[i].pd.id != "demo_order") {
        return false;
      }
    }
  }
});
return true;
```

```
    }  
  });  
});
```

In the example above the id's of selected worklist entries are submitted to the server-side function `com.groiss.demo.DemoFunctions.approve2` for processing. This example is also available in *@enterprise Demo package*.

17.2.4 Smartclient notification API

The new notification API allows to send and receive arbitrary events to/at HTML-based smartclients. The *@enterprise* notification API is based on *CometD* which is a scalable HTTP-based event routing bus that uses a AJAX push technology pattern. More information about CometD can be found [here](#).

The server / resp. server nodes in a cluster configuration can receive `NotificationItems` which are distributed within the cluster nodes and to the clients.

The components of a `NotificationItem` are the destination (this is a combination of application, org-unit and agent) and the payload (the serializable java object). *@enterprise* offers the notification class `com.groiss.notification.BasicNotificationItem` which is able to be extended. For `NotificationItems` for smartclients two method implementations are needed

- a topic which allows to further differentiate the items at reception,
- a method `getJsonPayload` which transforms the payload into a `JSONObject`.

In order to send such `NotificationItems`, the facade `com.groiss.notification.NotificationSuite` is provided. The most important method there is:

```
public static void publish(NotificationItem ni, short type);
```

This method publishes a `NotificationItem`. The parameter *type* can be used to denote, if an item is inserted, updated or deleted. Use the statics provided in the class `com.groiss.Notification.Names` for the values of this parameter.

Hint: The event is not published until after the transaction has been successfully committed. In case of rollback, the items are silently discarded.

At a smartclient which wants to receive such notifications, the following steps are needed:

- Require / include the `dojo/cometd`
- Initialization of the CometD framework
- Subscription to the items topic (usually starting with `"/service/ep/appl/"` or `"/ep/appl/"`)
- Implementation of a method to call when an item is received

Since a smartclient makes use of "internal" notifications, it executes all the relevant steps, so it is recommended to integrate the functionality. Nevertheless, a mostly self contained demo client is provided to allow to experiment with the functionality. The demo client can be started via:

```
../servlet.method/com.groiss.demo.DemoNotificationClient.show
```

The JAVA sources for the client can be found in the demo package at `demos/java/com/groiss/demo/DemoNotification*.java` and the corresponding HTML masks at `demos/classes/demo/masks/notification/*.*`

Authorization for notification

When your specific notification functionality is integrated in the smartclient, no special steps for authorization are needed. The HTTP session is automatically used to initiate the handshake with CometD and to establish proper credentials for the CometD session. Also when a proprietary client is being used, and this client does make use of the usual HTTP session mechanism via the session cookie, no special action is needed, the CometD session will still be authorized for the user of the HTTP session. But when a client is being used with its own session handling mechanism, which does not rely on the HTTP session cookie, special handling is needed. An authenticated HTTP session must be established and the id of this session must be provided during the initial CometD handshake. In your client, use:

```
var credentials = {
  "com.groiss.auth": {
    // value provided to your client via your authentication mechanism
    http_session_id: "<http_session_id>"
  }
};

cometd.handshake(credentials);
```

17.3 Styling

Sometimes it is desirable to use own styles for an application instead of standard *@enterprise* styles. For this purpose it is possible to place a file `styles.less` in the application class path as described in section [Organization of Files](#).

Hint: For compatibility reasons we also support the name `styles.css`. If a `styles.less` and a `styles.css` file exists, the first one will be loaded.

To provide a consistent naming convention and to avoid confusion with existing selectors, *@enterprise* uses prefixed CSS class names. For example, the classes assigned to form-based-icons have the following structure `scForm-<formid> scForm-version-<version>`. The CSS class structure is created as following:

General

- Main page
 - <XMLID> - always assigned to the <html> tag
- Toolbar
 - <XMLID>.<action> - assigned to a button in the toolbar and its icon node . All *@enterprise* standard actions that are defined in `admin.xml` are therefore expanded with this prefix.
`class="... admin.insert scHasIcon scHasContent dijitButton"`
 - `taskfunction:<taskfunction-ID>` - assigned to the button and icon node of task-functions.
`class="... taskfunction:create_selfsigned_usercert scHasNoIcon"`
 - `scHasIcon`, `scHasContent` - assigned to the button node if an icon is defined for the button
- Functions (Dropdown menu items)
 - `taskfunction:<taskfunction-ID>` - analog to taskfunction in toolbar
- Start process (Dropdown menu items)
 - `scProcess-<processid>`, `scProcess-version-<version>`, `scApplication-<applicationid>` - assigned to the icon node.
- Navigation
 - <XMLID>.<nodeID> + <nodeID> - assigned to the top level nodes in the navigation menu.
`class="... dijitIcon standard.tasks tasks"`
 - `scNavigationNode` - assigned to all nodes in the navigation menu.
`class="... scNavigationNode standard.wl dojoDndContainer"`
 - <XMLID>.<nodeID> - assigned to the respective elements.
 - `report:<reportID>` - assigned to reports in the navigation.
`class="... report:stepinterval scNavigationNode"`

DMS

- Table rows
 - `scForm-<formID>`, `scForm-version-<version>` - assigned to a row in the DMS table.
`class="... scDmsForm scForm-Standarddokument scForm-version-1"`
- Form Icons in DMS table row
 - `scDmsDocument`, `scDms<extension>`, `scDmsMime<mimetypepart1>`, `scDmsMime<mimetypepart2>`, `scDmsForm`, `scForm-<formid>`, `scForm-version-<version>` - assigned to a icon node or to the children of the icon node.

```
<div class="dijitInline scIcon scDmsDocument scDmsxml scDmsMimetext
      cDmsMimexml scDmsForm scForm-Standarddokument scForm-version-1">
</div>
<span class="scName">XMLitsm</span><span class="scExtension">
.xml
</span>
```

- Form Icons in DMS new function

- * scForm-<formid>, scForm-version-<version> - assigned to a icon node or the children of the icon node.

Worklist

- Worklist rows

- scPriority-<priority>
 - scProcess-<processid>
 - scProcess-version-<version>
 - scApplication-<applicationid>
 - scTask-<taskid>
 - scTask-version-<version>
 - scHasNotes - assigned to a process with a note.
 - scHasDocuments - assigned to a process with documents.
 - scOverdue - assigned if due date is exceeded.
 - scUnseen - assigned to new processes.

```
class="scPriority-0 scProcess-AdHoc scProcess-version-1
      scApplication-default scTask-adhoc scTask-version-1
      scHasNotes scHasDocuments"
```

- Form icons in worklist rows

- scForm-<formid>
 - scForm-version-<version>
 - scFormShortcut scActivityForm-<formid>
- ```
... class="scFormShortcut scActivityForm-form" title="Form">
<div class="dijitInline scIcon scDmsForm scForm-test_form
scForm-version-1"></div>
```

- Process details

- scProcessDetails
  - scProcess-<processid>
  - scProcess-version-<version>
  - scApplication-<applicationid>
  - scTask-<taskid>
  - scTask-version-<version>

- `scPriority-<priority>`

- **Miscellaneous**

- `scInfoPane` - top level class assigned to a info pane.
- `scDocumentsPane` - assigned to a *Documents* tab.
- `scNotesPane` - assigned to a *Notes* tab.
- `scProcessImagePane` - assigned to a *Process graph* tab.
- `scProcHistoryGridPane` - assigned to a *History* tab.
- `scMailPane` - assigned to a *Mail* tab.

### **Reporting**

- **Top level**

- `scReport` - **always** assigned to a top level element of an report
- `scReport-<reportid>`

- **Rows**

- `scReportingCell-<entity>-<attribute>`
- `scReportingType-<type>` - **assigned** according to a report type.

```
class="...scReportingCell-processInstance-pi_started scReportingType-date"
```

### **Subform tables**

- `scColumn-<columnId>` - assigned to the `td` of the respective column

#### **17.3.1 Referencing icons**

*@enterprise* uses icons from [icomoon library](#).

These icons are available in file `ep-icomoon-repackaged-*.jar` in the `lib`-directory of *@enterprise* and are usable in several variants:

- **Webfont:**

Used for all our standard icons. It requires a font-file, that is imported by default (as long as `com.groiss.gui.css.StyleConf.loadCSS` is imported in the html-file). To use such font-icons it is convenient to specify them in LESS:

```
.scIcon.scInfo:after {
 content: @icon-bubble-notification;
 color: orange;
}
```

For all available icons, we have created less-variables that allows you to use the icons as shown above. The variable names are `@icon-ICONID`. The `iconid` can be found in the icon-preview on [icomoon.io](#) if you drive with the mouse over the icons.

- Images:

All icons are also available as images, are included in `ep-icomoon-repackaged-*.jar` and can be loaded via `../images/icomoon/iconid.svg`. There are two formats of the icons, they are included as SVG (advantage: scaling image without losing quality) and as PNG. Pictures can be set in LESS as background-image in the `styles.less` file.

If you want to use your own icons, you have to put your icon in the class path, see section [Mapping of URLs to files or methods](#).

### 17.3.2 Styling examples

Examples 1, 2, and 4 can be found in `styles.less` of the demo application.

**Example 1:** Add an icon to a menu item in the navigation tree.

```
.scMainAccordion .dijitAccordionTitle .dijitIcon.demoLinks:after {
 content: @icon-link3;
}
```

The `xml-node-id` is set as icon class which allows to define custom icons.

**Example 2:** Icon for a toolbar function and an action configured in the XML.

```
.taskfunction\:demo_approve.dijitIcon:after,
.demo\.approve.dijitIcon:after {
 content: @icon-checkmark;
}
```

**Example 3:** Add an icon to (process) entry in "Start process" drop-down.

```
.scProcess.scProcess-<myprocid>.dijitIcon:after {
 content: @icon-<processStartIcon>;
}
```

**Example 4:** Set the font-size for the id-column in `demo.wl` worklist.

```
.demo\.wl .dgrid-content .dgrid-column-id {
 font-size: 120%;
}
```

**Example 5:** Set the icon for the favorite report or any report in the navigation tree.

```
.dijitIcon.report\:stepinterval:after{
 content:@icon-star-full;
}
```

## 18. Mobile GUI Client

This chapter describes the possibilities to adapt the Mobile GUI client. The description how to use the mobile client can be found in the [User manual](#).

After activating the button *Logon* the appropriate configuration file (XML) in the default urls are searched with the suffix *\_mobile* only. The default XML for the mobile client is *standard\_mobile.xml*.

It is also possible to define an own `com.groiss.wf.html.Worklist` implementation (see *@enterprise API*), but the method `listFilters` is not relevant.

The detail page of a worklist entry can be modified by setting a `ep/widget/smartclient/wl/ProcessDetailsHandler` for your process definition in administration. You'll have to implement `getMobileDetails:function(object,props)` and return either a

- `dojox/mobile/View` or
- a `dojo/Deferred` which resolves to a `dojox/mobile/View`

### 18.1 Worklist Example

This example shows how to use an own `com.groiss.wf.html.Worklist` implementation. First we need a `Worklist` class like in following example:

```
public class MobileWLAdapter implements Worklist {

 @Override
 /* If subject of a task is empty, show <No subject> */
 public void modifyTableLine(ActivityInstance ai,
 Map<String,Object> line) {
 Object o = line.get("subject");
 if(o instanceof String) {
 if(StringUtil.isEmpty((String)o))
 line.put("subject", "<No subject>");
 }
 }

 @Override
```

```
/* Get title of worklist */
public String getTitle() {
 return "My Mobile Worklist";
}

@Override
/* Get list of all ais which are in itsm-application. If no itsm
 * application is installed, show default worklist*/
public List<ActivityInstance> getList(List<ActivityInstance> l) {
 WfEngine wfe = WfEngine.getInstance();
 OrgData org = OrgData.getInstance();
 Application appl = org.getById(Application.class, "itsm");
 if(appl != null)
 return wfe.getWorklist(appl, true);
 else
 return null;
}

@Override
/* Set new line style for RM processes - placeholder %linestyle% */
public String lineStyle(ActivityInstance ai, String style) {
 WfEngine wfe = WfEngine.getInstance();
 ProcessInstance pi = wfe.getMainProcess(ai);
 if(pi.getProcessDefinition().getName().equalsIgnoreCase("RM")) {
 return "rm_linestyle";
 }
 return null;
}
}
```

This class displays *<No subject>* if there's no subject available. The `getList` method operates like a worklist-filter, which displays tasks of a particular application only. Furthermore the line-style of a worklist-entry is changed, if a task of a particular process is displayed in the worklist.

After creating a worklist implementation, the configuration file (XML) must be prepared as in the following example. For this purpose open the GUI configuration in Administration of *@enterprise* and make a copy of the entry with id *standard\_mobile*. Rename it and edit the entry by adding the worklist class *MobileWLAdapter* to the worklist-node. For more information about GUI Configuration please take a look into [System Administration Guide](#) - chapter [GUI Configuration](#).

### Snippet of configuration file:

```
...
<worklist id="wl">
 <name>@@@ep:worklist@@</name>
 <type>USER</type>
 <default>true</default>
 <onClick>ep/widget/smartclient/mobile/Worklist</onClick>
```

```
<widget>ep/widget/smartclient/mobile/WorklistListItem</widget>
<showInlineDetailsAt>column:id</showInlineDetailsAt>
<tableHandler>com.groiss.demo.MobileWLAdapter</tableHandler>
<actions>
 <action id="untake" />
 <action id="finish_mobile" />
 <action id="goBack_mobile" />
 <action id="seeLater_mobile" />
 <action id="setAgent_mobile" />
</actions>
<columns>
 <row>
 <column id="id" name="@@@ep:id@" visible="true" rowSpan="2" />
 <column id="orgUnit" name="@@@ep:deptshort@" visible="true" />
 </row>
 <row>
 <column id="subject" name="@@@ep:subject@" visible="true" />
 </row>
</columns>
<defaultSortColumn>-taken</defaultSortColumn>
</worklist>
...
```

Make sure you use the appropriate \*\_mobile-Actions in your mobile-ready GUI-config.

## 18.2 DOJO Client

The mobile *@enterprise* smartclient is built upon the mobile DOJO components (dojox/mobile). The following global variable can be used:

- **currentView**: Gets updated everytime a transition is performed and contains the view currently on top.

Following are the modules that can be used to implement a mobile interface for an application:

### 18.2.1 Mobile Grid Renderer Action

The `ep/widget/smartclient/mobile/MobileGridRendererAction` should be used to create and show a view with a grid similar to the worklist.

To configure some behavior, the following flags can be used:

- **isSearchable**: The visibility of the search button in the toolbar can be configured (magnifier icon).
- **viewPropertiesVisible**: `true` per default, when set to `false`, the button used to configure the view properties is never shown.

The following functions can be implemented:

- `_addBeforeGrid()` : Function gets executed before the grid is added to the view.
- `_configGrid(grid)` : When additional configuration of the grid is necessary, this function has to be implemented. It gets executed after the grid object has been created.
- `_createStore()` : Gets called from `postscript` function. The default implementation creates a `ep/widget/smartclient/dstore/RequestMemory` store which target is the `JsonLoader` with the node id as the path.
- `_getActions()` : For the returned actions toolbar buttons get created which perform the appropriate action when tapped.
- `_getColumns()` : Returns the column which the grid has to show. The default implementation returns the `columns` field of the node object (those are given in the `columns` element of the table element in the GUI configuration). The returned columns have to be an array or a promise which resolves into an array.  
  
The returned array can also have arrays as its elements (like a two dimensional array). In this case, the cells themselves get arranged in a grid-like fashion where each entry can have multiple rows. It should be considered that there must not be any unoccupied positions when using `colSpan` and `rowSpan`.
- `_getGridConfig()` : The returned object gets mixed into the configuration of the grid. The default implementation returns an object containing among others the selection mode and the node object.
- `_getViewConfig()` : The returned object gets mixed into the configuration of the view.
- `_onSelect(row, col, evt)` : Gets executed when some grid entry gets tapped. This is done before the potential default action gets executed.
- `_setupColumn(col)` : The column objects get created using this function. The default implementation creates an object of the type described by `col.jsClass` if this field is defined. `_ColumnBase` gets used otherwise.

An implementation of such a mobile grid renderer action could roughly look like the following example:

```
...
declare([MobileGridRendererAction], {
 _createStore: function(){
 this.store = ...;
 },

 _getColumns: function(){
 return [
 {
 id: "demo",
 name: "Demo",
 ...
 }
]
 }
});
```



```
 },
 ...
]
},

_getGridConfig: function(){
 var config = this.inherited(arguments);

 var myConf = {
 sort: [{
 property: "demo",
 descending: true
 }],
 ...
 };

 dojo.mixin(config, myConf);
 return config;
},

_getViewConfig: function(){
 return {
 label: "demo"
 ...
 };
},

_onSelect: function(row, col, evt){
 msgUtil.alert(row.data.demo);
 ...
},
...
});
...
```

### 18.2.2 View

The mobile client follows the principle of so called views.

In *@enterprise* the default base module is `ep/widget/smartclient/mobile/View` which is an extension of `dojox/mobile/View`.

The following functions of the *@enterprise* View module can be overridden:

- `onStartupCompleted()` : Gets called when the `startup` function has been executed. When the function gets executed multiple times, only the first time the actual startup procedure and this function get executed.

The following fields can be set:

- `isDisposable`: `false` on default. When `true`, view destroys itself when moved to view positioned before the one to destroy.

- `emitSelectTopic`: undefined on default. When `true`, the corresponding item in the navigation view gets highlighted. Recommended for views which get shown directly on click on navigation entry.

The following functions can be executed (as methods):

- `addAction(toolbarButton, overflow, before, notClearable)`: Adds the given toolbar button to the heading of the view. `overflow` is `true` per default and shows that the toolbar button can be hidden in the overflow section of the heading (shown as tree dots when there are too many buttons). `before` describes a dom element of another button after which the given toolbar button should be inserted. `notClearable` is `false` on default and prevents the heading from removing the toolbar button when the `clear` function gets executed when set to `true`.
- `goToStartView()`: Show start view of current view when available.

### 18.2.3 ScrollableView

`ep/widget/smartclient/mobile/ScrollableView` with heading where the content is scrollable. Extends the `View` module described in chapter [View](#) and `dojox/mobile/ScrollableView`. Gets used in *@enterprise* for the process details view.

### 18.2.4 \_ShowViewAction

This (`ep/widget/smartclient/mobile/_ShowViewAction`) is an extension of `ep/widget/smartclient/_Action` specialized in showing a view to the user on `actionPerformed`. As this module does not do much on its own, the extension has to offer an implementation of the `getView` function which returns a `View` object or a promise to one. The following example shows how this could be implemented:

```
var action = new _ShowViewAction({
 getView: function(startview){
 return new View({
 isDisposable: true,
 label: "Demo View",
 moveTo: startview,
 ...
 });
 }
});
```

The `actionPerformed` method could be called multiple times. When the view gets destroyed or the field is set to `null` inbetween executions of `actionPerformed`, `getView` gets executed again and the returned view is used afterwards.

### 18.2.5 waitingOverlay-util

The functions `showOverlay` and `hideOverlay` of `ep/widget/smartclient/mobile/waitingOverlay-util` can be called without instantiation and show and hide the loading overlay respectively.

### 18.2.6 ToolBarButton

The `ep/widget/smartclient/mobile/ToolBarButton` inherits from `dojox/mobile/ToolBarButton` and adds support for actions. Label, icon and behaviour on click are taken from the action when provided. Even nested actions are supported and can be shown by pressing and holding the toolbar button. The existence of nested actions is shown by a small arrow pointing downward below the icon of the toolbar button.

### 18.2.7 ListItem

`ep/widget/smartclient/mobile/ListItem` extends `dojox/mobile/ListItem` and adds support for *@enterprise* actions. Label, icon and behaviour on click are taken from the action when provided. It can be used instead of `dojox/mobile/ListItem` (e.g. for entries in `dojox/mobile/RoundRectList` objects).

### 18.2.8 Dialog

`ep/widget/smartclient/mobile/Dialog` extends `dojox/mobile/SimpleDialog`. The dialog gets hidden when the overlay in the back gets clicked and support for defining a content element is added. The additional properties can be used as follows:

- `content`: Initial content of the dialog. Can be a widget or a DOM element. The default value is `null`.
- `disposable`: Describes if the dialog should destroy itself when hidden. Is set to `true` on default.
- `hideOnCoverClick`: Sets whether the dialog should hide itself when the cover behind it gets pressed. `true` is considered as the default value.

An example of such a dialog could be:

```
var myContentNode = ...;
var dlg = new Dialog({
 content: myContentNode
});
dlg.show();
```

### 18.2.9 msg-util

The functions `alert` and `confirm` of `ep/widget/smartclient/mobile/msg-util` provide functionalities for showing and handling the related dialogs.

- `alert(message)` : Show the message to the user. Returned `Deferred` object gets resolved when the button of dialog is pressed.
- `confirm(message, config)` : Should be used when the user has to accept or deny something. The returned `Deferred` object gets resolved when the user pressed the first button and rejected when the second button gets pressed. The labels of the buttons can be configured by setting the fields `labelOk` and `labelCancel` of `config`.

### 18.2.10 mobile-util

ep/widget/smartclient/mobile/mobile-util provides following methods:

- `showView(destinationView, direction, fromView, transition, callback, def, doNotTriggerRouter)` : Show given view or view with given id to the user.
  - **destinationView** (dojo/mobile/View or String Id of View Widget) is the view (or the id thereof) to show.
  - **direction** (int) describes the direction from which the new view should appear (1 per default; view appears from the right side).
  - **fromView** (dojo/mobile/View) is the view from which the transition gets performed. `window.currentView` is taken when `fromView` is not given.
  - **transition** (String) is the effect used and "slide" is taken as the default for non menu drawer views.
  - The given **callback** function is executed after the new view has been shown.
  - **def** is the `Deferred` object returned by this function. When `def` is not given, a new one gets created. It gets resolved after the new view has been shown.
  - **doNotTriggerRouter** (boolean): when `true`, no additional fragment (hash) gets created.  
These fragments are used for navigating *@enterprise* using the browser navigation.
- `addAndShowView(...)` : Does the same as the function described above but also places the given destination view and starts it up.

### 18.2.11 dms-show-util

ep/widget/smartclient/mobile/dms/dms-show-util provides following methods:

- `showExplorer(folderObjectId, dmsNodeId)` : Show an explorer view for given folder.
  - **folderObjectId** classname:oid of folder to show. When not given, root folder is used.
  - **dmsNodeId** id of DMS node (as defined in GUI configuration). When not given, DMS node is taken automatically.
- `showForm(formObject, dmsNodeId)` : Show a given form in a new view.
  - **formObject** classname:oid of form to show or form object gotten from the explorer.
  - **dmsNodeId** id of DMS node (as defined in GUI configuration). When not given, DMS node is taken automatically.

### 18.2.12 ObjectSelect

This `ep/widget/smartclient/mobile/ObjectSelect` widget works similar to the one of the non-mobile client. A text field on the left side of the widget shows its value and a button on the right side symbolizes that this is an object select widget. Pressing on the widget opens a grid view presenting the possible values to the user.

- **gridConfig:** An optional object containing fields to mix into the `MobileGridRendererAction` object which gets created to show the grid for choosing an option. See chapter [Mobile Grid Renderer Action](#) for further information.

### 18.2.13 Column

The module `ep/widget/smartclient/mobile/grid/Column` extends `ep/widget/smartclient/grid/Column` with the convenience of tap handling. The column has to be shown in a mobile grid or an extension of it (which is the case when using `MobileGridRendererAction`) to make use of this feature.

- `onTap` gets called every time a cell of the column is tapped. By default `onTap` is `null` and has to be implemented to add functionality.
  - **object** the object describing the current row data (which is also the first parameter of `renderCell`).

## 18.3 Mobile Forms

The mobile client could serve a different purpose as the non-mobile one. As the mobile and non-mobile devices get used in a completely different way, the use of mobile forms seems justified.

*@enterprise* does not support creating mobile forms, but it does support presenting one to the user when available. To use such a mobile form, a mask has to be created with the same name as the original one but having the suffix `_mobile` before the dot separating the name from the extension. When the form on a mobile device is to be shown and such a mobile version of the mask file exists, *@enterprise* will choose it over the non-mobile version.

## 18.4 LESS for mobile GUI Configurations

The LESS file used for the mobile client works the same way as the one for the non-mobile one. It uses the style sheet `styles.less` given with the *@enterprise* application. See chapter [Styling](#) for further information. The `<html>` node of the mobile client does always have the LESS class `mobile` set on it. As the Less CSS preprocessor gets used in *@enterprise*, nested LESS selectors are possible. To avoid any side effects from the mobile LESS styles in other GUI Configurations, mobile-only styles should be defined within a selector like the following one:

```
html.mobile.myGuiConfig{
 ...
}
```

### 18.5 Showing Mobile Views

The class `com.groiss.smartclient.mobile.MobileView` contains methods for showing mobile views without the context of the mobile *@enterprise* client. The implemented `show` method has been overloaded several times: It can be used as a servlet method where the request contains a parameter `modules` with the module path as its content. On the other hand it can be called with the following arguments:

- `title` the title shown in the browser tab (optional, server name and user shown as default)
- `module` the action module to show (required)
- `args` some arguments given to the action instance as `JSONObject` (optional)
- `debug` can be forced by providing `true` as the last argument. Otherwise the value of the configuration will be used.

## 19. Automated GUI Testing

To perform Automated GUI Testing it is crucial that the relevant GUI elements, e.g. input field or buttons, can be identified in a unique and stable way to interact with those elements, e.g. by entering some text into input fields or clicking on a button. For this purpose the quasi standard of setting a DOM attribute named `data-testid` on those elements has become established.

Since *@enterprise* 11.0 we have started to integrate this DOM attribute into our GUI components and elements. As it is impossible and also not practical to define system wide unique values for the `data-testid` of each GUI element we have decided to use quite short values which are unique within a given context.

Take the dialog for changing the agent of an activity instance as an example: to uniquely identify the row representing a user with id *u0815* the following XPath can be used:

```
//*[@data-testid='changeAgent-dialog']///*[@data-testid='users-table']
//*[@data-testid='u0815-row']
```

This XPath resolves as following:

1. `changeAgent-dialog`: is the `data-testid` for dialog *Change Agent*
2. `users-table`: is the `data-testid` for the table holding the user representations within that dialog
3. `u0815-row`: is the `data-testid` for row representing user id *u0815* within the users table in that dialog

Another characteristic is worth mentioning: in modern browsers, GUI elements like buttons are composed of various nested DOM nodes. The most relevant nodes are:

1. the root node used to style/compose the element
2. the node to interact with the element

To stay with the example of a button we take a look at the login button.

```
<span class="dijit dijitReset dijitInline ep_button scPrimaryAction scHasNoIcon
 dijitButton" role="presentation" data-testid="login-button-wrapper"
 widgetid="uniqName_3_0">
 <span class="dijitReset dijitInline dijitButtonNode"
 data-dojo-attach-event="ondijitclick:__onClick" role="presentation">
```

```
<span class="dijitReset dijitStretch dijitButtonContents"
 data-dojo-attach-point="titleNode,focusNode" role="button"
 aria-labelledby="uniqName_3_0_label" id="uniqName_3_0"
 data-testid="login-button" tabindex="3" style="user-select: none;">
...

```

In this example you can see that:

1. the root node of the button has the `data-testid login-button-wrapper`
2. the node to interact with the button has the `data-testid login-button`

Note that depending on your Test Automation Tool it may also be possible to interact with the root node to trigger the button.

**Attention:** the feature of adding a `data-testid` attribute is experimental which means:

1. its values might change due to upcoming needs or problems
2. not every element being of interest for an automated test may have a `data-testid`

Feedback on this new feature is highly appreciated - as are requests for missing `data-testid` attributes on elements you need for your tests.

### 19.1 Identifying elements in *@enterprise* forms

Forms are a main part in automated testing of *@enterprise* applications. *@enterprise* does not add `data-testid` attributes to the fields of such forms as they already have an attribute that is suited to uniquely identify those fields. This attribute is `data-xforms-ref`. Here is an example for field *purpose* in the *order* form of our demo application:

```
<textarea rows="4" cols="40" name="_xf5" style="width:450px;height:80px" id="_xf5"
 data-xforms-ref="/data/form/purpose" data-xforms-required="false">
</textarea>

```

To access that field in automated tests the following XPath can be used:

```
//*[@data-xforms-ref='/data/form/purpose']
```

As you can see the element in this example also has an attribute `id` with a value that is unique within that form. But the value for this attribute is created in an automated way which does not guarantee that this value remains stable over time. So this attribute is not suited as a stable unique identifier, but `data-xforms-ref` is.

Note: attribute `data-xforms-ref` is only available for *@enterprise* forms of template type *XFORMS*. For forms of other template types you need to add suited attributes (e.g. `data-testid`) on your own into the mask files of your forms if no suitable attributes already exist.



## 20. Decision Support

### 20.1 Decision Trees

A decision tree algorithm has been implemented in *@enterprise*. Although there are quite some libraries out there supporting this task, they are either not delivering the desired functionality (e.g. pruning, access to certain fields, splitting behavior) or are published under an incompatible license.

#### 20.1.1 Splitting

Splitting is done based on the difference of impurity resulting from the split.

- **Impurity Measures** There exist different methods on how to determine which attribute to choose for splitting the current data set.
- **Entropy** This approach is based on the entropy in information. It describes how much information is stored on average to represent the current situation.

$$Entropy(t) = - \sum_{i=0}^{c-1} p(i|t) * \log_2 p(i|t) \quad (20.1)$$

- **Gini Index**

The gini index describes the probability that a random instance of the current dataset is labeled incorrectly.

$$Gini(t) = 1 - \sum_{i=0}^{c-1} p(i|t)^2 \quad (20.2)$$

- **Classification Error** This approach represents the probability that a sample of the data set is not labeled with the most probable label.

$$ClassificationError(t) = 1 - \max_i [p(i|t)] \quad (20.3)$$

#### 20.1.2 Attributes

Two types of supported attributes can be distinguished. On one hand there are nominal attributes where the value of this field in an instance is part of a given set. On the other hand there are numeric attributes where the values are of a given number set.

### Nominal Attributes

Nominal attributes get split using multiway splits. This means that for every possible value a child node is generated.

### Numeric Attributes

Numeric attributes get split using binary splits only. There are exactly two child nodes. One represents values which are equal or smaller than a given split point and the other one represents values which are strictly greater than the given split point.

It is known that the split point is greater than or equal as the minimum value for the particular attribute and less than or equal as the maximum value for the particular attribute.

Numeric attributes may be used more than one time in a path to some leaf node.

#### 20.1.3 Pruning

When leaving the decision tree as it is generated by the above mentioned algorithm, it is most likely subject to overfitting. This means that it also takes outliers into account quite heavily. Also, the tree can get bigger than it needs to be.

#### Post Pruning

Pruning, which is done after the decision tree has been built is called post pruning.

- **Pessimistic Post Pruning** In pessimistic post pruning, the number of leaf nodes gets penalized. Is the unpruned version of the tree better even when taking the penalty into account, it will not be pruned. The heavier the penalty multiplier is chosen, the more pruning will be done.

$$\frac{n + \text{penalty} * |\text{leafNodes}|}{N} \quad (20.4)$$

[13] describes this pruning method with a fixed penalty of  $\frac{1}{2}$ .

- **Reduced Error Pruning** For reduced error pruning (REP), the training set gets split into a growing and a pruning set. The growing set is used like the training set would be used otherwise for training the decision tree model. The pruning set is used afterwards where the instances of this set get classified by the decision tree built using the growing set. Is the error smaller or equal when classifying the pruning set, the subtree gets pruned. When one subtree does not get pruned, no parent node will get pruned (concept of *safe nodes*). [11]
- **Minimal Error Pruning** There are two kinds of estimates implemented in the minimal error pruning implementation: m-estimate and Laplace-estimate.

The m-estimate takes some knowledge of an expert into account.

$$\frac{n_y + p_y * m}{N + m} \quad (20.5)$$

For the m-estimate, the formula described in 20.5 is used where  $N$  describes the amount of instances in the used data set,  $p_y$  the a priori probability that the label  $y$  is assigned to an instance,  $n_y$  the amount of instances which have class label  $y$  in the data set and  $m$  the parameter chosen by an expert.

The Laplace-estimate does not take any expert knowledge into account. It is assumed that the distribution of the a-priori probabilities for each class label is uniform.

$$\frac{n_y + 1}{N + k} \quad (20.6)$$

Special functionality can not be achieved by only using the functions provided by the graphical interface. Additional classes can be implemented for classifying, giving information or pruning in the special case of a decision tree.

## 20.2 Integration in @enterprise

In @enterprise decision trees are used to perform classifications based on some input, typically process related data. In this chapter we will describe the base API classes used to perform such classifications and how you as an API programmer can use those classes and also can provide customizations/extensions.

### 20.2.1 ClassificationService

`com.groiss.ml.classifier.ClassificationService` provides the main entry point for API programmers who want to interact with the decisions support via API. It provides 3 groups of related utility methods (for more details see the API documentation):

- **management:** These methods provide the possibilities to build a classifier (i.e. to calculate the decision tree based on input and output configuration) and to evaluate the performance of such classifiers (i.e. measures like the percentage of correctly classified instances, precision, recall, f-measure etc. [12]).

- `evaluate(String, ProcessDefinition)`
  - `build(String, ProcessDefinition)`

Note: Evaluation is also used when building a classifier to rate the quality of the building process. For this case also cross validation is supported to find the best result of that process. (Usage of cross validation can be activated in the decision support related server configuration section.)

- **classification:** Once a classifier is build it can be used to perform classification predictions. The following methods either return such predictions so that the API programmer can handle the result by himself, or they execute the classifiers and store the most probable classification into the configured output filed as long as it fullfils the specified minimum probability.

- `classify(String, ActivityInstance)`

- `classifications(String, ActivityInstance)`
- `executeClassification(String, ActivityInstance, double)`
- `executeClassifications(ActivityInstance, double)`
- **extension:** It is also possible to implement and integrate custom classifiers and field configurations. More details on how to do this is described in the following sections.
  - `registerClassifier(Class<? extends Classifier>)`
  - `registerField(Class<? extends ProcessField>)`

So if you are just interested in using standard classifiers and their assignments to processes done via the administration UI the only additionally notable class is

`com.groiss.ml.classifier.ClassificationAction`

which is described in section *Tab: Decision Support* of the [Administration Manual](#).

Otherwise, i.e. you want to write and provide custom classifiers, the following sections will provide information about the relevant classes and interfaces and how to use them.

### 20.2.2 Classifier

A classifier is represented by the interface `com.groiss.ml.classifier.Classifier` which provides methods to perform its operations on `com.groiss.ml.ds.Instance` objects. Those methods are:

- `ClassificationResult<Integer> classify(Instance instance)`  
This method will return the most probable classification for the passed instance.
- `List<ClassificationResult<Integer>> classifications(Instance instance)`  
A list of all found classifications ordered by their probability in descending order.

The `com.groiss.ml.classifier.ClassificationResult` holds a classification and its probability. The classification is an integer value which represents either the concrete value for the classification (in case of a `Numeric Attribute`) or the index of the concrete value (in case of a `Nominal Attribute`).

### 20.2.3 Attributes, Instances and Data Sets

An attribute represents a column in a data set. It is implemented as the generic abstract class `com.groiss.ml.ds.Attribute` for which the following concrete implementations are provided:

- `com.groiss.ml.ds.NominalAttribute`: Nominal attributes represent a set of values a field in the particular column of the data set can be set to.  
`BooleanAttribute` is a subclass of `NominalAttribute` of type `Boolean` and has the values `true` and `false` already added to it.
- `com.groiss.ml.ds.NumericAttribute`: A field in the particular column of the data set can be set to a numeric value.  
`DateAttribute` is a subclass of `NumericAttribute` of type `Long` specialized for describing dates.

A data set (`com.groiss.ml.ds.DataSet`) set describes a set of instances (`Instance`) and has a set of attributes describing it's columns.

sepalength	sepalwidth	petallength	petalwidth	class
5.1	3.5	1.4	0.2	Iris-setosa
4.9	3.0	1.4	0.2	Iris-setosa
4.7	3.2	1.3	0.2	Iris-setosa
7.0	3.2	4.7	1.4	Iris-versicolor
6.4	3.2	4.5	1.5	Iris-versicolor
6.9	3.1	4.9	1.5	Iris-versicolor
5.5	2.3	4.0	1.3	Iris-versicolor
6.5	2.8	4.6	1.5	Iris-versicolor
6.3	3.3	6.0	2.5	Iris-virginica
5.8	2.7	5.1	1.9	Iris-virginica
7.1	3.0	5.9	2.1	Iris-virginica
6.3	2.9	5.6	1.8	Iris-virginica
6.5	3.0	5.8	2.2	Iris-virginica
...	...	...	...	...

Table 20.1: Excerpt from the iris data set [14]

Table 20.1 shows some parts of the iris data set [14]. The structure can be interpreted as follows: each instance is represented by a row in the table while each attribute is shown as a column. In this case the sepal and petal lengths and widths are measured and a label describing which type of iris is given.

The sepal and petal lengths and widths are given as numeric attributes. Each cell can become any real numeric value. The class attribute is a nominal attribute and cells can therefore only hold a value contained in a given set. In this case it would be  $\{Iris-setosa, Iris-versicolor, Iris-virginica\}$ .

#### 20.2.4 Connect Classifiers and Processes

In *@enterprise* we use classifiers in context of processes. We build them with process related data as input and we also want to use the output in context of the process data. To do so the following interfaces are provided:

- `com.groiss.ml.classifier.ClassifierAssignment`: represents a record added via tab 'Decision Support' in the detail view of a process in the administration UI. It defines the inputs needed for building and predictions as well as the output (for more details see section *Tab: Decision Support* in the [Administration Manual](#)).
- `com.groiss.ml.classifier.ClassifierOption`: To allow parameterisation of classifiers it is possible to pass options to specified classifier. Each option has a name which is prefixed with a hyphen and zero or more arguments which must not be prefixed with a hyphen.
- `com.groiss.ml.classifier.FormClassifier`: an extension of the `Classifier` which gets the `ClassifierAssignment` injected so that it knows on which data it has to operate.

- `com.groiss.ml.classifier.Buildable`: extends the `Classifier` to provide a method with which a classifier can be build (i.e. can calculate its decision tree based on the passed `com.groiss.ml.ds.DataSet`).
- `com.groiss.ml.field.Field`: Specifies the data source for an attribute, which is a process form field in this context. Such a source is used to retrieve the value for an attribute or to store that value (but only if `isAllowedAsOutputField()` returns true for the field instance).

### 20.2.5 Custom enhancements

#### Adding a new classifier

To add a custom classifier you have to implement the `com.groiss.ml.classifier.Classifier` interface and you have to register that class via method `registerClassifier(Class<? extends Classifier>)` of class `com.groiss.ml.classifier.ClassificationService`. As registering must only run one time, it is recommended to put this call in the `startup` method of the application class. This classifier becomes available to **all** classifier assignments.

**Note:** if your custom classifier needs access to its `ClassifierAssignment` it must extend `com.groiss.ml.classifier.FormClassifier`.

`com.groiss.demo.ml.classifier.ZeroR` in the `demo` package is an implementation of the *zero rule classifier* which often is used as a baseline classifier. This classifier does not look at any values of the instances, but only does classify every given instance to the label to which the majority of training instances conform. As this classifier also implements the `Buildable` interface, the method `buildClassifier(DataSet)` has to be implemented. During classification, the `distributionForInstance(Instance)` method gets called. In this implementation, it always returns the stored label at the first position.

#### Adding generated Fields

It is also possible to add custom fields by extending `com.groiss.ml.field.ProcessField`. Such an implementation can be registered via method `registerField(Class<? extends ProcessField>)` of class `com.groiss.ml.classifier.ClassificationService`. Also here registering must only run one time, so again it is recommended to put this call in the `startup` method of the application class. This field then becomes available to **all** classifier assignments.

Such a subclass needs to implement the abstract method `insertValue(Instance, DataSet, ProcessInstance)`. When building the related `Instance` objects, this method gets called for each of them.

`com.groiss.demo.ml.classifier.DemoInputField` in the `demo` package describes an implementation of a generated input field. The attribute describing the field is a `BooleanAttribute`, which is a nominal attribute (in this case, values can either be true or false). It can be seen from the implementation of `insertValue(Instance, DataSet, ProcessInstance)` that the value for the related attribute in each dataset entry is set to whether there are notes belonging to the given process instance or not. When building a classifier which leverages this field, for each instance an additional value gets calculated and set.

## 21. Using the Reporting API

The following chapter shall give an overview about the possibilities to customize the reporting component.

### 21.1 Hidden Configuration

Reporting uses 2 hidden parameters in configuration file.

- `itext.pdf.font`: Path to font file to use in pdf files. If report includes Unicode characters, this font has to be a TrueType font.
- `avw.reporting.schemaxml`: Path to the system schema XML file. Needed to ensure compatibility to version 7.0 when `reporting.XML` was edited to fit application requirements. If possible don't overwrite schema XML but use the new merging of system schema XML and application schemas.

### 21.2 XML Configuration

The reporting uses XML-documents to declare the choosable data on the one hand and the chosen query on the other hand. To understand, how to customize the reporting, a closer look at the XML specification is needed.

#### 21.2.1 Schema

The schema file contains all needed information about the pool of data, which can be used in reports. Reporting merges the configured schema file with any file named "reporting.xml" in the configured application paths.

```
<!ELEMENT Schema (mapping*,entity+,relation*)>
<!--ATTLIST Schema xmlid ID #REQUIRED
 name CDATA #IMPLIED
 furtherHops CDATA #IMPLIED
 defaultTimemodel CDATA #IMPLIED
 defaultTimeUnit CDATA #IMPLIED
 addForms (TRUE | FALSE) "FALSE"-->
```

### Example:

```
<Schema xmlid="avw" name="@@@reporting@@@"
 furtherHops="2"
 defaultTimeUnit="hours"
 defaultTimemodel="com.groiss.reporting.data.impl.TimeInterval"
 addForms="TRUE">

</Schema>
```

### Mappings

Mappings are used to translate data into their natural meaning, e.g. ActivityInstance Status is a number and each number means a status. The reporting user does not want to know the number but the status name. So this translation is made with a mapping. Mappings are defined once and can be referenced often by their id. Mappings are used to define which exporter, charts and timemodels shall be available for users. Even the possible implementation of an HasSubClass Persistent are defined by a mapping.

```
<!ELEMENT mapping (mapentry+)>
 <!ATTLIST mapping xmlid ID #REQUIRED>
<!ELEMENT mapentry EMPTY>
 <!ATTLIST mapentry
 key CDATA #REQUIRED
 value CDATA #REQUIRED>
```

#### Example 1: Mapping for Translating status keys

```
<mapping
 xmlid="aiStatus">
 <mapentry key="0" value="@@@started@@@"/>
 <mapentry key="1" value="@@@suspended@@@"/>
 <mapentry key="2" value="@@@finished@@@"/>
 <mapentry key="4" value="@@@aborted@@@"/>
 <mapentry key="5" value="@@@active@@@"/>
 <mapentry key="6" value="@@@waiting@@@"/>
 <mapentry key="7" value="@@@compensated@@@"/>
</mapping>
```

#### Example 2: Mapping for Subclasses of Agent

```
<mapping xmlid="agentSubclasses">
 <mapentry key="c1" value="com.groiss.org.User"/>
 <mapentry key="c2" value="com.groiss.org.Role"/>
</mapping>
```

### Entity

Entities are representing selections of tables in the database. One table can be defined as several entities if needed. In the system scheme the avw\_stepinstance table is defined



## 21. Using the Reporting API

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once as `ProcessInstance` (with selection type=22) and once as `ActivityInstance` (with selection type=20). Entities contains at least one attribute and several selections.

```
<!ELEMENT entity (attribute*,selection*)>
 <!ATTLIST entity xmlid ID #REQUIRED
 table CDATA #REQUIRED
 class CDATA #REQUIRED
 name CDATA #IMPLIED
 tablealias CDATA #REQUIRED>D
<!ELEMENT selection EMPTY>
 <!ATTLIST selection
 attribute CDATA #REQUIRED
 operator CDATA #REQUIRED
 value CDATA #REQUIRED>
```

### Example: Entity of Processdefinition

```
<entity
 xmlid="process"
 name="@@@objectname_processdefinition@"
 class="com.groiss.wf.ProcessDefinition"
 table="avw_procdefinition"
 tablealias="pd">

</entity>
```

### Attribute

Attributes can be attached to the query as select attribute or as condition. The way a attribute is stored in report result, is defined in an implementation of the `ReportingData` Interface. Attributes may contain several selects to gain data from the database (e.g. a `TimeInterval` needs at least two timestamps).

```
<!ELEMENT attribute (select*)>
 <!ATTLIST attribute
 xmlid CDATA #REQUIRED
 name CDATA #IMPLIED
 mapping IDREF #IMPLIED
 aggrs CDATA #IMPLIED
 class CDATA #IMPLIED>
<!ELEMENT select (#PCDATA)>
 <!ATTLIST select entity CDATA #IMPLIED
 tablealias CDATA #IMPLIED>
```

### Relations

Relations define how entities can be joined. A relation has a name (which is displayed in join select mask) and two joinparts. Additionally a outer join can be specified.

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```
<!ELEMENT relation (joinpart,joinpart)>
 <!ATTLIST relation name CDATA #IMPLIED
 outer (LEFT | RIGHT | NONE) "NONE">
<!ELEMENT joinpart EMPTY>
 <!ATTLIST joinpart entity CDATA #REQUIRED
 attribute CDATA #REQUIRED>
```

### 21.2.2 Query

Queries are defined in XML documents, too. This XML tree is generated while configuring the query options at the Report designer mask. But you can even write it manually. A query consists of 3 parts: The select attributes, a condition tree and the joins. Joins have to be declared because the reporting engine provides the possibility to join entities over several ways.

```
<!ELEMENT query (attribute*,conditions?,join*,export?)>
<!ATTLIST query xmlid ID #REQUIRED
unit CDATA #IMPLIED
minunit CDATA #IMPLIED
timemodel CDATA #IMPLIED
timezone CDATA #IMPLIED
locale CDATA #IMPLIED
parammask CDATA #IMPLIED
lockoperator (TRUE|FALSE) "FALSE"
distinct (TRUE|FALSE) "FALSE"
addarchive (TRUE|FALSE) "FALSE"
addrownumber (TRUE|FALSE) "FALSE">
```

### Parameter

Parameters are used as child nodes of attributes and exporters. Its a key value pair which may be used to store additional data.

```
<!ELEMENT parameter EMPTY>
<!ATTLIST parameter xmlid ID #IMPLIED
 key CDATA #REQUIRED
 value CDATA #REQUIRED>
```

### Attributes

Attributes in Query-XML refer to attributes in the schema.

```
<!ELEMENT attribute (parameter*)>
<!ATTLIST attribute
 xmlid ID #IMPLIED
 displayname CDATA #IMPLIED
 entity CDATA #IMPLIED
 tablealias CDATA #IMPLIED
 attribute CDATA #REQUIRED
 aggregation CDATA #IMPLIED>
```

```
type CDATA #IMPLIED
dateformat CDATA #IMPLIED
select CDATA #IMPLIED
others CDATA #IMPLIED
sorting (ASC |DESC |NONE) "NONE">
```

### Conditions

The conditions of the query are defined as a tree of condition-elements, connectors and parentheses. The defined root element is the Conditions-element, which contains one or no condition or parentheses element and several pairs of connectors and conditions/parentheses.

```
<!ELEMENT conditions ((condition|parentheses)?,
 (connector,(condition|parentheses))*)>
<!--ATTLIST conditions
 xmlid ID #IMPLIED-->
<!ELEMENT parentheses ((condition|parentheses)?,
 (connector,(condition|parentheses))*)>
<!--ATTLIST parentheses
 xmlid ID #IMPLIED-->
<!--ELEMENT connector EMPTY-->
<!--ATTLIST connector
 xmlid ID #IMPLIED
 type (AND | OR) "AND"-->
<!--ELEMENT condition EMPTY-->
<!--ATTLIST condition xmlid ID #IMPLIED
 entity CDATA #REQUIRED
 tablealias CDATA #REQUIRED
 attribute CDATA #REQUIRED
 displayname CDATA #IMPLIED
 operator CDATA #IMPLIED
 value CDATA #IMPLIED
 type CDATA #IMPLIED
 paramatexec (TRUE|FALSE) "FALSE"
 others CDATA #IMPLIED-->
```

### Join

The selected join paths for the usage in report are stored in the XML. The joins have to build a graph so that every entity is connected to an other entity. A join can include several relations, which can include entities which are not referenced at the attributes or conditions of the report, too. Every relation is used to do the correct join. If the entity of a joinpart is not used in the report, the standard alias defined in schema is used.

```
<!--ATTLIST join
 xmlid ID #IMPLIED
 ent1 CDATA #REQUIRED
 ent2 CDATA #REQUIRED
 alias1 CDATA #REQUIRED
```

```
alias2 CDATA #REQUIRED>
<!ELEMENT relation (joinpart,joinpart)>
<!ATTLIST relation
 xmlid ID #IMPLIED
 outer (LEFT | RIGHT | NONE) "NONE">
<!ELEMENT joinpart EMPTY>
<!ATTLIST joinpart entity CDATA #REQUIRED
 xmlid ID #IMPLIED
 attribute CDATA #REQUIRED>
```

### Export

The export options are stored in xml, too. The export element can have several parameters (key-value pairs) to configure export options and drill-down functions. The type attribute includes the classname, if no package is defined the default package will be used.

```
<!ELEMENT export (parameter*)>
<!ATTLIST export type CDATA #REQUIRED
 xmlid ID #IMPLIED>
```

## 21.3 API

Sometimes the engine has to be extended to fit application requirements. Therefore an API was designed to enable project specific reports.

### 21.3.1 com.groiss.reporting.data.TimeModel

TimeModels are calculating TimeIntervals between 2 Date objects. Implement the `getInterval` Method, which returns the interval in milliseconds as a long value.

```
public interface TimeModel {

 public long getInterval(Date start,Date end);
 public String getModelName();
}
```

Register your TimeModel in reporting schema in the mapping *timemodels* to mark it as selectable in reporting designer.

**Example: DemoTimeModel** Calculates the milliseconds between two date objects.

```
public long getInterval (Date start, Date end) {

 long time1 = start.getTime();
 long time2 = end.getTime();
 return (time2-time1);
}

public String getModelName() {
 return "DefaultTimeModel" ;
}
```

### 21.3.2 com.groiss.reporting.data.ReportingExportable

Exporters of reporting must handle objects implementing this interface. The `getValue` Method returns the valueholder object, `toJson()` the JSON representation used when getting rendered in the browser and `toText` a text representation to use for CSV or Excelexport.

```
public interface ReportingExportable extends Comparable {
 public String toText();
 public JSONObject toJson();
 public Object getValue();
 public String getColumnRenderer();
}
```

Example will be given in Chapter [com.groiss.reporting.data.ReportingData](#).

### 21.3.3 com.groiss.reporting.data.ReportingData

This interface extends the `ReportingExportable` and provides methods to overwrite the attribute's behavior when added to a report. We recommend to extend default implementation `com.groiss.reporting.data.impl.DefaultReportingData`.

```
public interface ReportingData extends ReportingExportable {

 public Attribute getAttribute();
 public void setAttribute(Attribute a);
 public Entity getEntity();
 public void setEntity(Entity e);
 public void addSelectAttributeToQuery(Query q, Element select);
 public void addConditionToQuery(Query q, Element c);
 public void setValue (ResultSet rs, Element selectAttribute, Query q);
 public default void addClientConditionWidgetOptions(
 JSONObject json, boolean isParamAtExec, Element condition)
 public List<Pair<String,String>> getOperatorList(boolean comesFromParamMask);
 public Collection<ReportingExportable> completeSeries(
 Set<ReportingExportable> series, Query q);
}
```

**getAttribute,setAttribute,getEntity,setEntity** set and return the entity and attribute object of relating scheme which are referenced this `ReportingData` Object.

**addSelectAttributeToQuery** has to implement, how an attribute is added to the select statement of a SQL Query. Has to call `com.groiss.reporting.Query.addSelect` and `com.groiss.reporting.Query.addSelectIndexOfAttrib(Element, int)` to register the attribute!

**addConditionToQuery** has to implement the logic how attribute is added to the conditions of a SQL Query. Has to call `com.groiss.reporting.Query.addCondition`.

**setValue** gains the data from `ResultSet` and stores it.

**addClientConditionWidgetOptions** adds condition widget information to the attribute store. The implementing widget is stored as `condwidget` attribute to the JSON-object. Any additional Data will be passed to the widget at instantiation.

**getOperatorList** returns a pairlist of selectable operators. The key is the XML representation of the operator, the value of the I18N string of the operator.

**completeSeries** invokes matrix-style reports to be able to add missing entries in the given series. returns the full series (e.g. for dates all dates from t1-t2, for persistent all elements of a certain type etc.)

**Example: com.groiss.demo.ProgressReportingData** The Goal is to add a selectable attribute to reporting schema, which indicates the average progress of all order items Therefore you have to add the following attribute to reporting schema in the entity "demo\_order\_1" The output shall be the average progress with a '%' sign afterward. If it is HTML it shall be a link which does a JavaScript alert.

We want the engine to allow a field which calculates the product of amount and price at execution time of the report. Therefore you have to add following attribute to reporting schema in the entity "demo\_order\_1":

```
<attribute xmlid="averageprocess" name="@@@averageprocess@"
 class="com.groiss.demo.ProgressReportingData">
 <select entity="demo_orderitem_1" tablealias="avg_oderitem_1">
 avg(avg_oderitem_1.amount)
 </select>
</attribute>
```

The output shall be the product with a Dollar sign afterwards. His HTML representation shall be a Link with a Javascript alert showing the product, which is handled by the implementing DOJO widget . Because we are extending `DefaultReportingData` we do not need to implement every method.

You will find an implementation in the demo package of *@enterprise*.

(see: `com.groiss.demo.reporting.ProgressReportingData`)

### 21.3.4 com.groiss.reporting.data.NumericValue

ReportingData Objects have to implement this interface, if the value is aggregateable but does not fit to the standard dataobjects.

```
public interface NumericValue extends ReportingData {
 public NumericValue add(NumericValue v2);
 public NumericValue avg(long count);
}
```

### 21.3.5 ReportingExporter

Reporting Engine returns a `Tablemodel` containing `ReportingExportable` objects as result of a report. The output format of this `Tablemodel` can be modified by implementing

an own Exporter. To mark exporter as selectable in reporting designer, add it to the mapping "exporter" in reporting.xml.

```
public interface ReportingExporter {
 public String getExportName() ;
 public JSONArray getExportOptionsJSON() throws JSONException;
 public void export(HttpServletResponse res, Query q,
 TableModel tm) throws Exception;
}
```

**getExportName** returns the Name of this Exporter. Is displayed in export option page to select exporter.

**getExportOptionsJSON** enables exporter to add option fields to the export option page. Return a jsonarray which contains jsonobjects which have at least an id, a label and an implementing widget.

**export** Iterate over the tablemodel and manipulate data like needed for export. You will find an implementation in the demo package of *@enterprise*. (see `com.groiss.demo.reporting.FileSystemExporter`)

### 21.3.6 ClientSideExporter

Due to the new GUI of *@enterprise* 11.0 a subinterface of `ReportingExporter` has been introduced. Implement this interface if you need to overwrite the exporting functions of a report.

```
public interface ClientSideExporter extends ReportingExporter{
 public String getClientSideRenderer();
 public List<Map<String, Object>> toJson(
 Query q, ReportingTableModel tm) throws JSONException;
 public JSONArray getResultDetailsJson(
 Query q, int count) throws JSONException;
}
```

**getClientSideRenderer** Returns the path to a renderer widget, which has to display the result.

**toJson** Transfers the Tablemodel data to a JSON Object which will be passed to the `ClientSideRenderer`

**getResultDetailsJson** Returns a JSON Array which holds all information displayed as report details. Every label and value pair is handled as a JSON Array.

## 21.4 Implementing your own Search Mask

To implement your own search mask, just design a form with the needed input fields. When submitting the search, instantiate an `ep/widget/smartclient/reporting/ReportingResult` object and put it in the designated target. The `ReportingResult` object executes the report the passed report (passed in parameter `query.xml` or `query.id` and adds the form data given in parameter `postParams` to the sql condition. The naming and handling of parameters is described in the following section.

The recommended way is to build a stored report in Report designer, which includes *parameter-at-execution* conditions for each field of the search mask. In the search mask for each condition a *value*-field, an *operator*-field and in some cases an *others*-field are needed to complete conditions. The engine expects post parameters called *value0*, *operator0* and *others0* for explicit parameter substitution. 0 stands for the index of the condition in the conditions tree starting with 0. So if the first and the third condition of the report need explicit parameter input, the fields *value0*, *operator0*, *others0*, *value2*, *operator2* and *other2* are expected. If needed you may name the condition with a parameter tag (key="paramname"), so that you may reference the parameter with *paramname\_value*, *paramname\_operator* and *paramname\_others*. Since *@enterprise 11.0* you can specify the parameter name in the reporting mask of conditions too. Add a field *comesFromParamMask* with value "1" to the search mask, so that engine expects the parameter in the post parameters.



Attribute	Description
xmlid	The Id of the schema
name	The name of the schema, can be localized
furtherhops	To determine the pool of possible Joins for 2 entities, the shortest join path is searched! This parameter delimits the amount of selectable joins to all joins, which need not more join hops than the shortest path plus this parameter value
defaultTimemodel	The default timemodel, which should be used for reports to calculate Timeintervals. Must implement the <i>com.groiss.reporting.data.TimeModel</i> interface.
defaultTimeunit	The default timeunit of timeintervals
addForms	Forms are not declared in the schema file by default. They are added automatically during the parsing, if this flag is set to true!

Table 21.1: Description of element Schema

Attribute	Description
xmlid	The Id of the map is used to reference it in the attributes.
key	The key of this entry. If Mapping is used for translation, the key is the value in the database.
value	The string representing the database value or the full classname of the exporter, charttype or timemodel.

Table 21.2: Description of element mapping

Attribute	Description
xmlid	The Id of the entity is used to reference it in the query XML tree.
table	The name of the database table.
class	The persistent implementation representing this table in <i>@enterprise</i> . This is needed to get information about the field types.
name	The name of this entity. May include I18N keys, so each string starting with <i>@@@</i> and ending with <i>@@</i> is replaced.
tablealias	The default tablealias for this entity. It can be overwritten by the query XML document.
selection	The selection defines a condition to restrict the data tuples of this entity. The selection consists of an (database-)attribute name, an operator and a value. (e.g: ActivityInstance: selection: attribute="type";operator="=";value="20")

Table 21.3: Description of element entity

Attribute	Description
xmlid	The Id of the attribute is used to reference it in the query XML tree.
name	The name of this attribute. May include I18N keys, so every string starting with @@@ and ending with @@ is replaced.
class	The implementation of <i>com.groiss.reporting.data.ReportingData</i> interface. If not specified the Default-Implementation is used.
mapping	The id of the referenced mapping to translate data or to know the possible implantations of HasSubclasses Persistents.
aggrs	The selectable aggregations for this attribute. If not specified, the aggregations are calculated depending on the field type. But sometimes it does not make sense to calculate an average of a numeric data (e.g. Process:Version).
select	The select Attribute contains the name of the database field. If a select is needed from an other entity, the attributes entity and tablealias are specified to gain this additional information. (e.g.: StepDuration needs start and end time of ActivityInstance)

Table 21.4: Description of element attribute in schema

Attribute	Description
entity	The entity id of this joinpart.
attribute	A DB-field which is used to join.

Table 21.5: Description of element relation

Attribute	Description
xmlid	The Id of the query
unit	The maximum timeunit of timeintervals. Possible values: "seconds","minutes","hours","days","weeks"
minunit	The minimum timeunit of timeintervals.
timemodel	The timemodel, which should be used for this report to calculate Timeintervals. Has to implement the <code>com.groiss.reporting.data.TimeModel!</code>
locale	If a Report should be executed in a specific language, the shortname locale is defined here! (e.g. en_US)
timezone	If the report should be executed in a specific timezone, the id of the timezone is defined here
parammask	The path to an alternativ paramask. Customized Parameter mask has to fit all naming conventions.
lockoperator	If this flag is set to <i>TRUE</i> , the operator selectlist in parameter at execution mask are displayed readonly. This affects standard parameter mask but not a customized one.
distinct	If this flag is set to true, only equal tuples in the result-set are not displayed.
addarchive	This flag has to be true, if the report shall include <code>avw_stepinstance</code> records from the archive schema!
addrownumber	This flag has to be true, if the report shall include rownumbers in the first column. (Note that this needs a special treatment when implementing an Exporter!)

Table 21.6: Description of element query

Attribute	Description
xmlid	An optional field, which has to declare an unique id for this attribute. If not specified, the engine set a unique id automatically. The id is used for referencing the attribute at the edit mode.
displayname	The name of this column. If not specified, the default attribute name from schema is the column name. Can include I18N keys
entity	The id of the referenced entity, which contains the referenced attribute in schema. If its a user-defined attribute, the tablename in the database is stored in the entity field.
tablealias	The tablealias for this entity. Entity-Id and tablealias are the unique id of an entity in the query. For each entity a join has to be declared.
attribute	The id of the referenced attribute of the schema. If its an user-defined attribute, its set to "userdefined"!
select	A sql-syntax fitting expression, which is copied in the select statement.
type	If select expression returns not the default type of the attribute, which is declared in schema, define full-qualified class name here. If its <code>com.groiss.reporting.data.impl.TimeInterval</code> 2 date type are suggested.
aggregation	The aggregation for this attribute. Aggregations are grouped by all non aggregated attributes in the result. If the select includes an sql aggregation, specify here "sqlaggr".
sorting	Can be "ASC" for ascending, "DESC" for descending or none for no sorting. Sorting is done as the attribute are ordered, so the sorting of the first attribute has an higher priority than the second one.
others	This is optional wildcard attribute. It can be used for different things. The default data types interpret the others attribute as an user-defined selection due to the entity

Table 21.7: Description of element attribute in query

Attribute	Description
xmlid	An optional field, which has to declare a unique id for this attribute. If not specified, the engine will set a unique id automatically. The id is used for referencing the element at the edit mode.
connector: type	Type of boolean operation. Can be AND or OR, AND is default!
entity	The id of the referenced entity, which contains the referenced attribute in schema. If it's a user-defined attribute, the tablename in the database is stored in the entity field.
tablealias	The tablealias for this entity. Entity-Id and tablealias are the unique id of an entity in the query. For each entity a join has to be declared.
attribute	The id of the referenced attribute of the schema. If it is a user-defined attribute, it will be set to "userdefined"!
displayname	A description of this condition. May include I18N keys.
operator	The operator of this condition, for example in, like, = or >! If it is a user-defined SQL Condition, operator contains the expression, which may be written in PreparedStatement syntax.
value	Value for prepared Statements. Several values can be separated by a comma.
type	The type of the value string for parsing it to the fitting object.
others	This is an optional wildcard attribute. It can be used for different things. DateReportingData Objects for example suggest unit here if a relative date condition is specified. Text condition store the ignorecase option here.
paramatexec	True if parameter at execution is needed. In this case the operator and the value is used as default parameters.

Table 21.8: Description of elements of conditions tree

Attribute	Description
ent1	The entity id of the source entity of the join
alias1	The tablealias of the source entity of the join
ent2	The entity id of the target entity of the join
alias2	The tablealias of the target entity of the join
other fields	see <a href="#">21.2.1</a>

Table 21.9: Description of element join

## 22. RESTful API

*@enterprise* provides a RESTful API which is specified using the OpenAPI<sup>1</sup> Specification. A specification file defines the whole set of supported operations as well as a description of the API and can be gotten from a running *@enterprise* server via one of the following URLs:

- `<ep-host>:<ep-port>/<contextpath>/ep-rest/v1/openapi.yaml`
- `<ep-host>:<ep-port>/<contextpath>/ep-rest/v1/openapi.json`

Alternatively you can explore the RESTful API in a browser using the integrated Swagger UI which is available under this URL:

`<ep-host>:<ep-port>/<contextpath>/swagger-ui/index.html`

This UI provides a more convenient entry point to the descriptions of the RESTful API as well as executing the first API request.

**Hint:** The RESTful API must be activated to make the mentioned URLs work. Please refer to the configuration section in the [installation manual](#) for activating the API. How to activate Basic-Auth for this API can also be found in that section. Please note that Basic Auth should only be used when using HTTPS or in development or test environments.

### 22.1 Authorization with Keycloak

As an alternative to authorization via Basic Auth *@enterprise* can be extended to support a bearer token based authorization using Keycloak. To be able to use this authorization mechanism you need to install the optional (and not free of charge) *@enterprise* application 'Keycloak Integration' and follow the installation instructions described in the manuals of that application.

After this you need to perform the following additional configuration changes in 'Configuration/Web components':

- add the following line to 'Init Parameter for Additional Filter': `urlpattern=/ep-rest/v1`
- add the following line to 'URI Patterns to exclude from Additional Filter': `/ep-rest/v1/openapi.yaml`

---

<sup>1</sup>Formerly known as Swagger

# A. Database Schema Overview

## A.1 Introduction to the Database Schema

This appendix briefly describes the database tables of *@enterprise*. The file `sql/schema.sql` in the `epimpl.jar` file contains the table definitions. Note, that you cannot use the file directly to create the schema, because we use placeholders for database dependent data types<sup>1</sup>.

Most tables are mapped directly to a Java class -

see the description of `com.groiss.store.Persistent` for details of this mapping.

In the following diagrams, the essential and most complex parts of the schema are depicted. The used notation is a variant of the UML class diagram. Figure [A.1](#) explains the used notation.

When referencing relationships are depicted, the line ends are annotated with the name of the table column which holds the referenced value. This is usually the primary key of a table, which is almost always the column `oid`. For the sake of brevity, we will neither explicitly include the `oid` column nor depict the referencing column (e.g. `application` in figure [A.1](#)). A corresponding join between `Role` and `Application` would be expressed either as:

```
select * from avw_role r, avw_application a where r.application=a.oid
```

or, using a more modern SQL syntax, as:

```
select * from avw_role r join avw_application a on r.application=a.oid
```

In the following, the schema is presented in a modular way organized by module or functional area. Within each section, the tables are ordered alphabetically. For the sake of brevity, not all tables are also included in a schema drawing. Each table is described via its name, a Java class name, an optional Java interface name and a brief description.

---

<sup>1</sup>Using the following URL, an administrator can obtain a schema definition suitable for the DBMS being used:

```
../wf/servlet.method/com.dec.avw.config.HTMLConfig.scriptToNative?
```

```
filename=sql/schema.sql&database=com.dec.gi.sql.<Translator>
```

Possible values for `<Translator>` are: `DBDerby`, `DBDB2`, `DBH2`, `DBMSSql2005`, `DBOracle`, `DBOracleLOB`, `DBPostgreSQL`

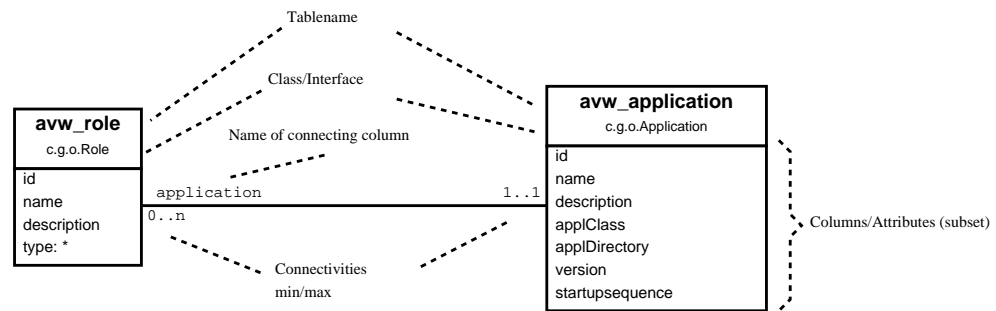


Figure A.1: Notation for schema diagrams

## A.2 Organizational Schema

The following tables describe the principal organizational data, like the users, their roles, and the organizational (departmental) structure. The diagram in Fig. A.2 depicts the essential tables and their relationship.

### Table: **avw\_application**

Description: Applications group together roles, rights, process definitions, etc.

Interface: `com.groiss.org.Application`

Class: `com.dec.avw.core.Application`

### Table: **avw\_dirserver**

Description: Source or destination LDAP servers for organizational data.

Class: `com.groiss.ldap.DirectoryServer`

### Table: **avw\_deferredchange**

Description: The set of pending changes (to be carried out in the future).

Class: `com.dec.gi.sql.DeferredChange`

### Table: **avw\_dept**

Description: The organizational units.

Interface: `com.groiss.org.OrgUnit`

Class: `com.dec.avw.core.Dept`

### Table: **avw\_depthierarchy**

Description: The hierarchy of organizational units.

Class: `com.dec.avw.core.DeptHierarchy`

### Table: **avw\_depthistory**

Description: Historical departmental relationships (splits and mergers).

Class: `com.dec.avw.core.DeptHistory`

### Table: **avw\_depttree**

Description: Defines an organization tree.





Table: **avw\_objectextension**

Description: Relates extension objects to their base objects.

Class: `com.dec.avw.core.ObjectExtension`

Table: **avw\_orgclass**

Description: Categorization of organizational units.

Interface: `com.groiss.org.OrgClass`

Class: `com.dec.avw.core.OrgClass`

Table: **avw\_role**

Description: The definition of roles.

Interface: `com.groiss.org.Role`

Class: `com.dec.avw.core.Role`

Table: **avw\_rolesubstitute**

Description: The relation of role assignments to the substitutes.

Class: `com.dec.avw.core.RoleSubstitute`

Table: **avw\_user**

Description: User accounts.

Interface: `com.groiss.org.User`

Class: `com.dec.avw.core.User`

Table: **avw\_userrole**

Description: Assignments of users to roles.

Interface: `com.groiss.org.UserRole`

Class: `com.dec.avw.core.UserRole`

Table: **avw\_usersubstitute**

Description: Relates users to their substitutes.

Class: `com.dec.avw.core.UserSubstitute`

### A.3 Schema for Process Definitions

The following tables contain the data for process definitions and dependent objects necessary for defining workflows (forms, tasks, etc.).

The diagram in fig. [A.3](#) depicts the schema and also shows the most essential run time data schema elements.

Table: **avw\_activityform**

Description: Form variable declarations. The relation between a process definition (or task) and the form types.

Class: `com.dec.avw.core.ActivityForm`

## A. Database Schema Overview

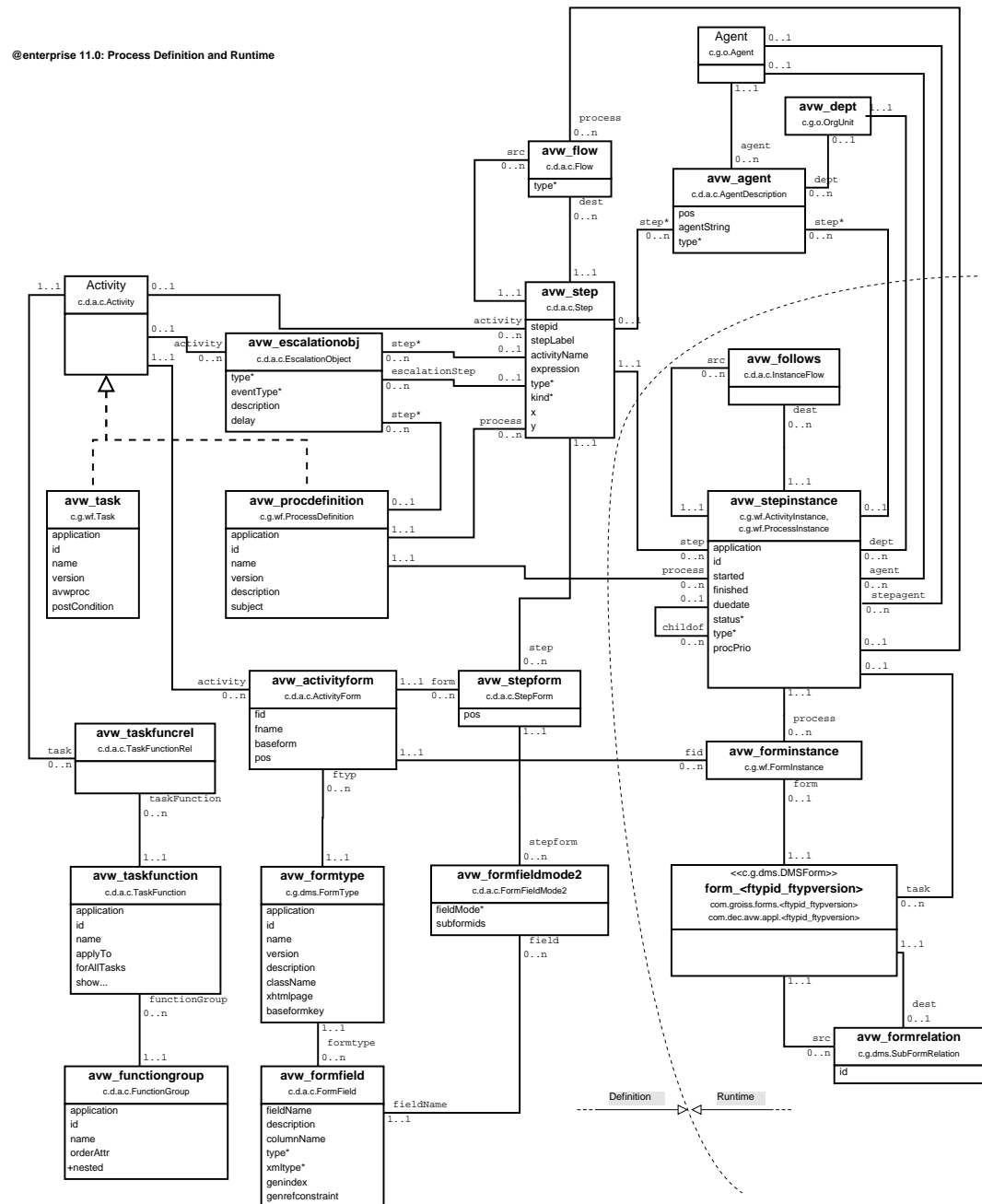


Figure A.3: Process Definition and essential Run-Time Data

### Table: **avw\_agent**

Description: Description of agents of steps and step instances.

Class: `com.dec.avw.core.AgentDescription`

### Table: **avw\_annotation**

Description: Annotations in the process diagrams.

Class: `com.dec.avw.core.Annotation`

Table: **avw\_escalationobj**

Description: Definition of escalations in task and process timeouts.

Class: `com.dec.avw.core.EscalationObject`

Table: **avw\_flow**

Description: The paths between steps. May be restricted to one process instance (ad-hoc steps).

Class: `com.dec.avw.core.Flow`

Table: **avw\_formfield**

Description: The fields of the forms.

Class: `com.dec.avw.core.FormField`

Table: **avw\_formfieldmode2**

Description: The modes/visibilities of form fields in steps.

Class: `com.dec.avw.core.FormFieldMode2`

Table: **avw\_formtype**

Description: The types of forms.

Interface: `com.groiss.dms.FormType`

Class: `com.dec.avw.core.FormType`

Table: **avw\_functiongroup**

Description: Groups of functions.

Class: `com.dec.avw.core.FunctionGroup`

Table: **avw\_procdefinition**

Description: The process definitions.

Interface: `com.groiss.wf.ProcessDefinition`

Class: `com.dec.avw.core.ProcessDefinition`

Table: **avw\_step**

Description: Steps in the process definitions.

Class: `com.dec.avw.core.Step`

Table: **avw\_stepform**

Description: Relates the steps to the form variables (which forms are used in which step).

Class: `com.dec.avw.core.StepForm`

Table: **avw\_task**

Description: Manual activities within a process definition.

Interface: `com.groiss.wf.Task`

Class: `com.dec.avw.core.Task`

**Table: `avw_taskfunction`**

Description: Function definitions (esp. attached to tasks).

Interface: `com.groiss.wf.Function`

Class: `com.dec.avw.core.TaskFunction`

**Table: `avw_taskfuncrel`**

Description: The relation between functions and tasks.

Class: `com.dec.avw.core.TaskFunctionRelation`

## A.4 Schema for Run-Time Data

### A.4.1 Essential Process Run-Time Data

To get a more complete picture of the interrelations between run time data and process definition schema elements, the most essential run time schema elements are depicted in figure [A.3](#). Less significant run time data schema elements will be dealt with in the next section.

**Table: `avw_follows`**

Description: The paths between step instances.

Class: `com.dec.avw.core.InstanceFlow`

**Table: `avw_forminstance`**

Description: The relation between the forms and the process instance.

Interface: `com.groiss.wf.FormInstance`

Class: `com.dec.avw.core.FormInstance`

**Table: `avw_formrelation`**

Description: The relation between forms and subforms.

Interface: `com.groiss.dms.SubformRelation`

Class: `com.dec.avw.core.FormRelation`

**Table: `avw_stepinstance`**

Description: The instances of processes and steps.

Interface: `com.groiss.wf.ActivityInstance`, `com.groiss.wf.ProcessInstance`

Class: `com.dec.avw.core.StepInstance`

**Table: `form_<ftypid_ftypversion>`**

Description: The (generated) tables for the forms. One table per form type.

Interface: `com.groiss.forms.<ftypid_ftypversion>` or  
`com.dec.avw.appl.<ftypid_ftypversion>`

Class: `com.dec.avw.core.Form`

#### A.4.2 Further Process Run-Time Data Schema

Table: **avw\_archivedproc**

Description: May be used to record traces of archived processes.

Class: `com.groiss.archive.ArchivedProcess`

Table: **avw\_basicevent**

Description: Records persistent events.

Interface: `com.groiss.event.Event`

Class: `com.groiss.event.BasicEvent`

Table: **avw\_batchjob**

Description: Captures state information about batch job process step instances.

Class: `com.groiss.wf.batch.impl.BatchJob`

Table: **avw\_currenteditor**

Description: In installations with autotake activated, records which agent is currently editing which form.

Class: `com.dec.avw.core.CurrentEditor`

Table: **avw\_escalationfire**

Description: Contains state of fired escalations.

Class: `com.dec.avw.core.EscalationFired`

Table: **avw\_eventregistry**

Description: Records event registrations.

Interface: `com.groiss.event.EventRegistry`

Class: `com.groiss.event.impl.EventRegistryImpl`

Table: **avw\_procfieldvals**

Description: Values of important fields of process instances; needed for full-text searches.

Class: `com.dec.avw.core.ProcessFieldValues`

Table: **avw\_procrelation**

Description: Can record arbitrary relationships between process instances.

Class: `com.groiss.wf.ProcessRelation`

Table: **avw\_suspension**

Description: Records suspension intervals of step instances.

Interface: `com.groiss.wf.Suspension`

Class: `com.dec.avw.core.Suspension`

Table: **avw\_seenobject**

Description: This table records which user has seen which step instance.

Class: `com.dec.avw.core.SeenObject`

Table: **avw\_seenobject2**

Description: Offers possibility to record which user has seen which arbitrary persistent object.

**Class:** com.dec.avw.core.SeenObject2

Table: **avw\_sequence**

Description: Contains the counters e.g. for process ids (id=processid).

Class: –

## A.5 Schema of Permission system

The picture in fig. A.4 shows the schema elements dealing with permissions.

## @enterprise 11.0: Permissions

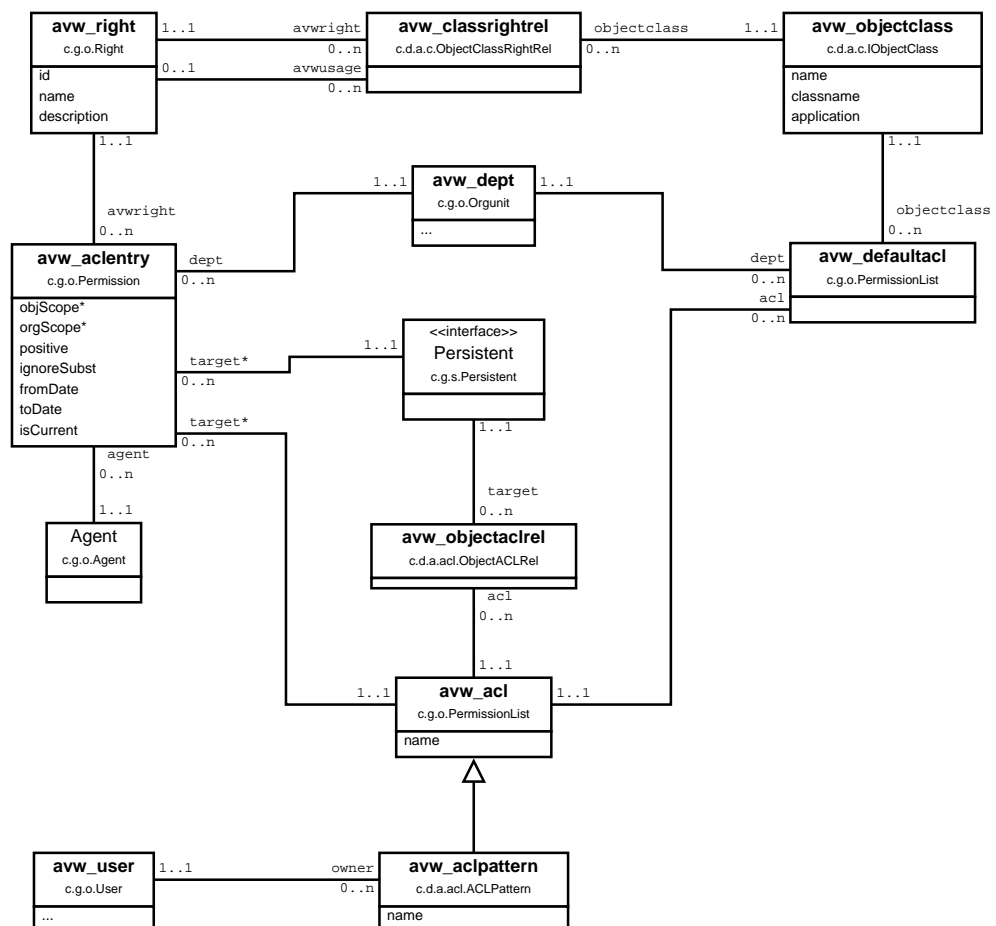


Figure A.4: **Permission Schema**

**Table: avw\_acl**

Description: Defines access control lists (ACLs).

Interface: `com.groiss.org.PermissionList`

Class: `com.dec.avw.core.ACL`

**Table: avw\_aclentry**

Description: The relation between agents (user or role), rights, and objects.

Interface: `com.groiss.org.Permission`

Class: `com.dec.avw.acl.ACLEntry`

**Table: avw\_aclpattern**

Description: Prototype ACLs of users.

Class: `com.dec.avw.acl.ACLPattern`

**Table: avw\_classrightrel**

Description: Defines the relation between object classes and the rights that can be applied.

Class: `com.dec.avw.core.ObjectClassRightRel`

**Table: avw\_defaultacl**

Description: The relation between object classes and their default access control list.

Class: `com.dec.avw.core.DefaultACL`

**Table: avw\_objectaclrel**

Description: The relation between objects and ACLs.

Class: `com.dec.avw.core.ObjectACLRel`

**Table: avw\_objectclass**

Description: Object classes.

Interface: `com.dec.avw.core.IObjectClass`

Class: `com.dec.avw.core.ObjectClass`, `com.dec.avw.core.FormType`

**Table: avw\_right**

Description: The definition of rights.

Interface: `com.groiss.org.Right`

Class: `com.dec.avw.core.Right`

**Table: avw\_stepperpermission**

Description: Defines rights on documents within the context of a process step.

Class: `com.groiss.accesscontrol.StepPermission`

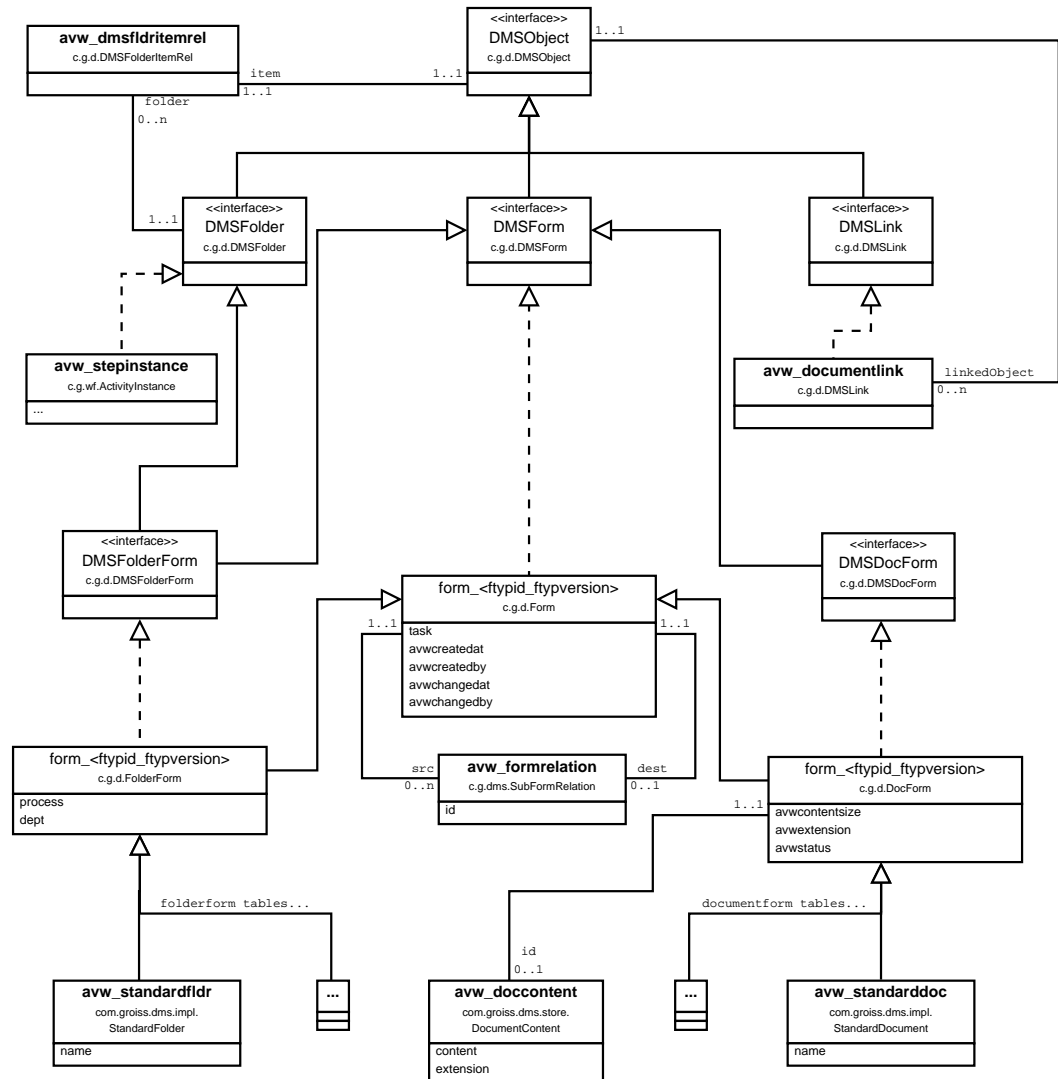


## A.6 Schema for Document Management

### A.6.1 Main tables in DMS

Fig. A.5 shows the central schema of the document management.

**@enterprise 11.0: Documents and Forms**



**Figure A.5: Schema of Documents**

Table: **avw\_dmsfldritemrel**

Description: Relates folders and their contents; is also used for the relation between process instances and their documents because process instances are folders, too.

**Class:** `com.groiss.dms.impl.DMSFolderItemRel`

**Table: avw\_doccontent**

Description: Content of documents.

Class: `com.groiss.dms.store.DocumentContent`

**Table: avw\_documentlink**

Description: Links to documents (internal in *@enterprise*).

Interface: `com.groiss.dms.DMSLink`

Class: `com.groiss.dms.impl.DMSObjectLink`

**Table: avw\_standarddoc**

Description: Standard documents.

Interface: `com.groiss.dms.DMSDocForm`

Class: `com.groiss.dms.impl.StandardDocument`

**Table: avw\_standardfldr**

Description: Standard folders for documents.

Interface: `com.groiss.dms.DMSFolderForm`

Class: `com.groiss.dms.impl.StandardFolder`

### A.6.2 Additional Tables for Document Management

**Table: avw\_dockeywordrel**

Description: Relation between DMSObjects and attached keywords.

Class: `com.groiss.dms.impl.DocKeywordRel`

**Table: avw\_email**

Description: Document form for emails.

Interface: `com.groiss.dms.DMSDocForm`

Class: `com.groiss.dms.impl.Email`

**Table: avw\_folderprops**

Description: Properties of folders (columns,actions,restrictions,paging).

Class: `com.groiss.dms.impl.FolderProperties`

**Table: avw\_formfieldvals**

Description: Field values of specific form objects; needed for full-text searches.

Class: `com.dec.avw.core.FormFieldValues`

**Table: avw\_keyword**

Description: Keywords for documents. May be organized hierarchically.

Interface: `com.groiss.dms.Keyword`

Class: `com.groiss.dms.impl.KeywordImpl`

**Table: avw\_news**

Description: News, messages of the day.

Interface: `com.groiss.dms.DMSForm`

Class: `com.groiss.dms.impl.News`

Table: **avw\_note3**

Description: Notes attached to process instances or documents.

Interface: `com.groiss.dms.DMSNote`

Class: `com.groiss.dms.impl.Note3`

Table: **avw\_recyclebin**

Description: User specific recycle bins for documents.

Interface: `com.groiss.dms.DMSFolderForm`

Class: `com.groiss.dms.impl.RecycleBin`

Table: **avw\_recbinrelext**

Description: Preserves original context of items in recycle bins.

Class: `com.groiss.dms.impl.RecycleBinRelExtension`

Table: **avw\_thumbnail**

Description: Thumbnail representations of document contents

Class: `com.groiss.smartclient.dms.Thumbnail`

Table: **avw\_value**

Description: Values for value lists.

Interface: `com.groiss.dms.DMSForm`

Class: `com.groiss.dms.impl.Value`

Table: **avw\_valuelist**

Description: Value lists (enumeration types).

Interface: `com.groiss.dms.DMSForm`

Class: `com.groiss.dms.impl.Valuelist`

Table: **avw\_weblink**

Description: External links.

Interface: `com.groiss.dms.DMSWebLink`

Class: `com.groiss.dms.impl.WebLink`

## A.7 Miscellaneous

### A.7.1 User related tables

Table: **avw\_connectedshare**

Description: Relates users connections to shared folders

Class: `com.dec.avw.core.ConnectedShare`

Table: **avw\_dashboard**

Description: Holds user defined dashboard information.

Class: `com.groiss.avw.html.DashboardDefinition`

Table: **avw\_dashboarditem**

Description: The individual items of the dashboards.

Class: `com.groiss.avw.html.DashboardItem`

Table: **avw\_documenttracker**

Description: Records interest of users to follow document changes.

Class: `com.groiss.messaging.impl.DocumentTracker`

Table: **avw\_folderitemrel**

Description: Relates Activityinstances to Userfolders and Processinstances to Referencefolders.

Class: `com.dec.avw.core.FolderItemRel`

Table: **avw\_processtracker**

Description: Records interest of users to follow a process.

Class: `com.dec.avw.core.ProcessTracker`

Table: **avw\_profilepicture**

Description: Pictures attached to users (profiles).

Class: `com.groiss.dms.impl.ProfilePicture`

Table: **avw\_recentlyused**

Description: Record which objects have been used by a user (to build list of favorites).

Class: `com.groiss.avw.RecentlyUsed`

Table: **avw\_referencefldr**

Description: Reference folders contain pointers to process instances (search results).

Class: `com.dec.avw.core.ReferenceFolder`

Table: **avw\_seenreference**

Description: Which user has seen which process instance in a reference folder.

Class: `com.dec.avw.core.SeenReference`

Table: **avw\_server**

Description: Represents an *@enterprise* installation.

Class: `com.dec.avw.core.Server`

Table: **avw\_trackedstep**

Description: Stores all tracked steps for a process tracker

Class: `com.dec.avw.core.TrackedStep`

Table: **avw\_unsuccesslogin**

Description: Stores unsuccessful login attempts.

Class: `com.dec.avw.core.UnsuccessfulLogins`

**Table: avw\_userfilter2**

Description: Stores user defined filters for table display in GUI.

Class: `com.dec.avw.core.UserFilter2`

**Table: avw\_userfolder**

Description: Definition of user folders (which contain ActivityInstances).

Interface: `com.groiss.wf.UserFolder`

Class: `com.dec.avw.core.UserFolder`

**Table: avw\_userkeystore**

Description: Keystores of agents.

Class: `com.dec.avw.core.AgentKeystore`

**Table: avw\_userprop**

Description: User properties.

Class: `com.dec.avw.core.UserProperty`

**Table: avw\_usersession**

Description: Login sessions of users.

Interface: `com.groiss.org.IUserSession`

Class: `com.groiss.org.impl.UserSession`

**Table: avw\_usersessionrole**

Description: Relates usersessions to (temporarily granted) roles.

Class: `com.dec.avw.core.UserSessionRole`

### A.7.2 Reporting

**Table: avw\_contextescalationfire**

Description: Records fired escalations for stored queries for process instances.

Class: `com.dec.avw.core.ContextEscalationFired`

**Table: avw\_storedquery2**

Description: Query definitions for reports (may be related to function groups).

Class: `com.groiss.reporting.StoredQuery`

### A.7.3 Schema for messaging (e-mail)

**Table: avw\_mailbox**

Description: Mail account and processing information.

Interface: `com.groiss.mail.MailBox`

Class: `com.groiss.mail.MailBoxImpl`

**Table: avw\_mailqueueitem**

Description: Queues unsent mail items.

Class: `com.groiss.mail.MailQueueItem`

Table: **avw\_messagejournal**

Description: Records sent messages.

Class: `com.groiss.mail.MessageJournal`

Table: **avw\_msgrecipient**

Description: Recipient definitions for message templates.

Class: `com.groiss.messaging.Recipient`

Table: **avw\_messagetemplate**

Description: Templates for messages.

Interface: `com.groiss.messaging.MessageTemplate`

Class: `com.groiss.messaging.MessageTemplateImpl`

### A.7.4 Schema for Timers

Table: **avw\_timerentry**

Description: The timer entries.

Interface: `com.groiss.timer.TimerEntry`

Class: `com.groiss.timer.impl.TimerEntry`

Table: **avw\_timerrun**

Description: Persistent planned essential timer runs.

Class: `com.groiss.timer.impl.TimerRun`

### A.7.5 Schema for GUI configurations

Table: **avw\_defaulturl**

Description: Relates default GUI entry points to agents.

Class: `com.groiss.avw.DefaultURL`

Table: **avw\_guiconfig**

Description: Stores information about available GUI configurations.

Class: `com.groiss.avw.GuiConfig`

### A.7.6 System State

Table: **avw\_clusterlock**

Description: Cluster wide lock info for determining the distinguished cluster timer node.

Class: –

Table: **avw\_config**

Description: Optional storage for configuration files.

Class: –

Table: **avw\_lock**

Description: Table for obtaining a (cluster-wide) lock.

Class: `com.groiss.store.Lock`

Table: **avw\_oid**

Description: Records next free oid value.

Class: –

Table: **avw\_runningnode**

Description: Stores state of nodes in a clustered installation.

Class: `com.groiss.server.RunningNode`

Table: **avw\_sysevent**

Description: Stores system events (startup, shutdown, ...).

Class: `com.groiss.avw.SysEvent`

Table: **avw\_version**

Description: Records the version of *@enterprise*.

Class: –

### A.7.7 Calendar Schema

The following tables comprise the schema part of the calendar functions.

Table: **avw\_calattendee**

Description: Relates attendees and calendar events.

Class: `com.groiss.calendar.pers.Attendee`

Table: **avw\_calevent**

Description: Calendar events.

Interface: `com.groiss.calendar.pers.CalEventImpl`

Class: `com.groiss.cal.CalEvent`

Table: **avw\_caleventfired**

Description: Records fired calendar events.

Class: `com.groiss.calendar.pers.CalEventReminded`

Table: **avw\_calview**

Description: Stores sets of users and resources.

Class: `com.groiss.calendar.pers.CalView`

Table: **avw\_calviewobject**

Description: Relates views and contained objects.

Class: `com.groiss.calendar.pers.ViewedObject`

Table: **avw\_calviewsrc**

Description: Maps calender views to source data.

Class: `com.groiss.calendar.pers.ViewedSource`

Table: **avw\_externalcal**

Description: Addresses of external calendars for users.

Class: `com.groiss.calendar.pers.ExternalCalendar`

Table: **avw\_resource**

Description: Schedulable resources.

Class: `com.groiss.calendar.pers.Resource`

### A.7.8 Schema for Webservices

The following tables are used for web service definition and details about invoking them in process steps.

Table: **avw\_ws\_activity**

Description: Referenced by web service steps (receive, reply, invoke). Points to a web service operation.

Interface: `com.dec.avw.core.Activity`

Class: `com.groiss.ws.wf.WebserviceActivity`

Table: **avw\_ws\_parameter**

Description: Parameters for web service operations.

Class: `com.groiss.ws.Parameter`

Table: **avw\_ws\_parameter\_mapping**

Description: Mapping between web service activities and parameters.

Class: `com.groiss.ws.wf.ParameterMapping`

Table: **avw\_webservice**

Description: Definitions of Web services.

Class: `com.groiss.ws.WebService`

Table: **avw\_webservice\_operation**

Description: Individual operations for Web services.

Class: `com.groiss.ws.WebserviceOperation`

### A.7.9 Schema for WfXML

These are the tables for communication via WfXML.



Table: **avw\_wfxml2accesslog**

Description: Log entries about WfXML operations.

Class: `com.groiss.wfxml2.dataobject.AccessLogEntry`

Table: **avw\_wfxml2asynclistener**

Description: Stores listeners for asynchronous callbacks.

Class: `com.groiss.wfxml2.dataobject.InternalRequestListener`

Table: **avw\_wfxml2intobservers**

Description: Stores internal process instance observers.

Class: `com.groiss.wfxml2.dataobject.InternalProcessStateObserver`

Table: **avw\_wfxml2observers**

Description: Stores external process instance observers.

Class: `com.groiss.wfxml2.dataobject.ExternalProcessStateObserver`

Table: **avw\_wfxml2pendingmsg**

Description: Intermediate store for pending outgoing messages.

Class: `com.groiss.wfxml2.dataobject.PendingMessage`

Table: **avw\_wfxml2pd**

Description: Conceptual WfXML remote process definitions.

Class: `com.groiss.wfxml2.engine.remote.registry.ProcessDefinition`

Table: **avw\_wfxml2remoteinstance**

Description: Stores data about remote process instances.

Class: `com.groiss.wfxml2.dataobject.RemoteProcessInstance`

Table: **avw\_wfxml2rpd**

Description: Connects conceptual remote ProcessDefinitions with concrete partners.

Class: `com.groiss.wfxml2.engine.remote.registry.RemoteProcessDefinition`

Table: **avw\_wfxmlpartner**

Description: Partner system descriptions for WfXML communication.

Class: `com.groiss.wfxml.Partner`

### A.7.10 Schema for Plan Management

Tables for process time planning data.

Table: **avw\_milestone**

Description: Marks special plan progress for some plan entries.

Class: `com.groiss.planning.Milestone`

Table: **avw\_planentry**

Description: Relates process plans and steps of process definitions.

Class: `com.groiss.planning.PlanEntry`

Table: **avw\_planentryinstance**

Description: Relates plan entries to process instances.

Class: `com.groiss.planning.PlanEntryInstance`

Table: **avw\_processplan**

Description: Relates process definitions and process plan types.

Class: `com.groiss.planning.ProcessPlan`

Table: **avw\_plantype**

Description: Plan types.

Class: `com.groiss.planning.PlanType`

### A.7.11 Tables for Process Debugging

Table: **avw\_testcase**

Description: Testcases for Process Debugger.

Class: `com.groiss.proctest.TestCase`

Table: **avw\_teststep**

Description: Steps for testcases for Process Debugger.

Class: `com.groiss.proctest.TestStep`

### A.7.12 Tables used for decision support

Table: **avw\_classifier\_assignment**

Description: Which classifier belongs to which field.

Class: `com.groiss.ml.classifier.impl.ClassifierAssignmentImpl`

Table: **avw\_classifier\_assignment\_task**

Description: Describes which tasks can be used at which classifier assignment.

Class: `com.groiss.ml.classifier.impl.ClassifierAssignmentTask`

## A.8 Obsolete schema elements

The following tables are not used any more by *@enterprise* itself. Nevertheless, they remain in the schema, because applications may still be using them.

Table: **avw\_document**

Description: Used for documents (pre 4.0).

Class: `com.dec.avw.core.Document`

**Table: avw\_document2**

Description: Meta-data attached to documents (until 6.0).

Class: `com.dec.avw.core.Document2`

**Table: avw\_doctype**

Description: Classification of documents (until 4.0).

Class: `com.dec.avw.core.DocumentType`

**Table: avw\_docversion**

Description: Version of the documents (until 6.4).

Class: `com.groiss.dms.impl.DocumentVersion`

**Table: avw\_docversionrel**

Description: Relation between documents versions and documents (until 6.4).

Class: `com.groiss.dms.impl.DocumentVersionRel`

**Table: avw\_folderrestrict**

Description: Content restriction for DMS folders.

Class: `com.dec.avw.core.FolderRestriction`

**Table: avw\_formfieldmode**

Description: The modes of form fields in activities (until 6.1).

Class: `com.dec.avw.core.FormFieldMode`

**Table: avw\_formversion**

Description: Relates forms to their versions (until 6.4).

Class: `com.dec.avw.core.FormVersion`

**Table: avw\_lastupdate**

Description: Holds maximum oid of last synchronization of (replicated) master data.

Class: -

**Table: avw\_note**

Description: Notes attached to process (until 4.0).

Class: `com.dec.avw.core.Note`

**Table: avw\_procdocument**

Description: Relation between process instance and documents (until 6.0).

Class: `com.dec.avw.core.ProcessDocument`

**Table: avw\_processobject**

Description: Relation between process instance and note (until 4.0).

Class: `com.dec.avw.core.ProcessObject`

**Table: avw\_queryattr**

Description: Attribute details of reports (until 7.0).

Class: `com.dec.avw.core.ProcessObject`

Table: **avw\_querycond**

Description: Condition details of reports (until 7.0).

Class: `com.dec.avw.core.ProcessObject`

Table: **avw\_storedquery**

Description: Table containing the stored queries (until 6.4).

Class: `com.dec.avw.monitoring.StoredQuery`

Table: **form\_standarddoc\_1**

Description: Standard document types (until 6.0).

Class: `com.dec.avw.appl.Standarddokument_1`

## Bibliography

- [1] Java 2 Platform, Enterprise Edition (J2EE), <https://www.oracle.com/java/technologies/appmodel.html>
- [2] World Wide Web Consortium: XHTML 1.0, <https://www.w3.org>
- [3] Internet Engineering Task Force: RFC 1867, <https://www.ietf.org/rfc/rfc1867.txt>
- [4] Workflow Management Coalition: Workflow Standard - Interoperability, Wf-XML Binding Version 1.1, <https://wfmc.org>
- [5] Modularization of XHTML; <https://www.w3.org/TR/xhtml-modularization>
- [6] <http://www.jdom.org>
- [7] Axis2 Web Service framework; <https://axis.apache.org/axis2/java/core>
- [8] Apache Axis2 Tools, <https://axis.apache.org/axis2/java/core/tools/index.html>
- [9] Apache Axis2 Codegen Tool  
<https://axis.apache.org/axis2/java/core/tools/CodegenToolReference.html>
- [10] Business Process Modeling and Notation (BPMN) V 2.0.2. OMG Document Number formal/2013-12-09  
<https://www.omg.org/spec/BPMN/2.0.2/About-BPMN>
- [11] An analysis of reduced error pruning - Elomaa, Tapio and Kaariainen, Matti in Journal of Artificial Intelligence Research, 2001
- [12] Sensitivity and specificity, Wikipedia contributors  
[https://en.wikipedia.org/wiki/Sensitivity\\_and\\_specificity](https://en.wikipedia.org/wiki/Sensitivity_and_specificity) (accessed March 2019)
- [13] Simplifying decision trees, Quinlan, J. Ross in International journal of man-machine studies, Elsevier 1987
- [14] The use of multiple measurements in taxonomic problems, Fisher, Ronald A in Annals of eugenics, 1936 Wiley Online Library