Portlets-Based Portal for an E-Learning Grid

Felicia Ionescu       Elena Cristina Stoica       Mircea Deaconu       Alexandru David
University Politehnica of Bucharest
fionescu@tech.pub.ro   {ce_stoica, mirceade, alexandru.david}@yahoo.com

Abstract

This paper describes a portlet-based portal that provides user interfaces for access a Grid-based e-learning platform. E-learning platforms that exploit resources and computing power of Grid infrastructure define the concept of “e-learning Grid”. For the development of our e-learning Grid, we have used open source Globus Toolkit as core middleware and a Web e-learning application containing Learning Management System and Authoring Tools that supports Sharable Content Object Reference Model (SCORM). The users access Learning Management System and Grid resources through the Grid portal, developed in JSR-168 portlet technology, with GridSphere portlet container and Vine portlets for Grid-specific operations. The Grid portal supports users’ authentication and authorization, credential delegation and single-sign on based on session credentials. The solution adopted provides very flexible opportunities for development and maintenance.

1. Introduction

Currently, network-based (Web-based) e-learning systems [1], [2], [3] and Grid technologies [4], [5] still are two distinct areas. But Grid technology can provide support for enhance learning environments by enabling learning resources sharing and reuse, collaboration, personalization and accessibility. E-learning platforms that exploit resources and computing power of Grid infrastructure define the concept of “e-learning Grid” [6]. Many researchers and communities investigate theoretical and technical aspects of e-learning Grids: ELeGI (European Learning Grid Infrastructure) [7], Guro (Grid Utilization in e-Learning Objects) [8], GRIDCOLE (Grid Collaborative Learning Environment) [9] and many others.

However, there are still problems to solve in order to obtain a more complete solution, which could be integrated in standards and models of e-learning and, at the same time, to enjoy the benefits of Grid computing.

For the development of our e-learning Grid (called InfoLearning) we have used open source Globus Toolkit version 4 (GT4) [10], and a Web-based e-learning application containing Learning Management System. The users access the Learning Management System and Grid resources through a Grid portal, developed in JSR-168 portlet technology [11], with GridSphere portlet container [12] and Vine portlets [13]. The Grid portal supports users’ authentication with X509 credentials, delegation, single-sign on with session credentials and general purpose Grid functionality like launching jobs for remote execution or retrieving remotely-stored data.

In this paper, after a description of the architecture of our e-learning platform, with details regarding the solution and toolsets used for portal development (Section 2), we analyze security aspects in the e-learning platform, specifically in terms of authorization and authentication (Section 3). In the rest of the paper we describe mechanisms for automatic creation of users’ accounts, credentials and authorization maps (Section 4) and other services offered by Grid portal for e-learning platform users (Section 5). We conclude with observations about the advantages and limitations of this solution (Section 6).

2. Architecture of InfoLearning platform

InfoLearning platform has been developed as an integrated system for creation and presentation of e-learning materials, which supports using Grid infrastructure. The architecture of InfoLearning platform is structured in four systems (Figure 1):

(1) Grid infrastructure;
(2) Learning Management System (LMS);
(3) Grid portal;
(4) Learning Materials Repository.
Learning materials are stored in Learning Materials Repository that can be accessed by the LMS and Grid services. Users access the learning platform using a Web browser with HPPT/HTTPS protocols. The components of the InfoLearning platform will be briefly described below.

2.1. Grid infrastructure

As Grid core middleware was used Globus Toolkit version 4 (GT4), composed of various software components deployed in different nodes of the Grid. Each Grid node consists of one or more containers (Java, C or Python containers), services, libraries and other components necessary for authentication, data transfer, execution of computing tasks, publication-discovery services and resources, reservation and resource planning. Grid services and resources are accessed using Java CoG Kit (Java Commodity Grid Kit) library, which provides high-level interfaces to Grid infrastructure [14].

In the Grid infrastructure was also included MyProxy server, which is a X.509 credential management system that can handle both end entity X.509 certificates and X.509 proxy certificates [15]. MyProxy server enables a user to delegate a X.509 credential to a credential repository and associate a username and password with that credential. When the username and password is passed to the Grid portal, it contacts the MyProxy server, presents the username and password, and obtains a delegated X.509 credential to access Grid resources on behalf of the user.

2.2. Learning Management System

In our project, Learning Management System (LMS) is a Web application deployed in an Apache Tomcat Web server that manages delivering learning content to students, tracks progress and performances of the learners and allows the development of learning materials. It is a flexible framework that supports the most important principles established by actual e-learning standards (i.e. SCORM -Sharable Content Object Reference Model [16]) regarding the format of learning materials and real-time interactions.

2.3. Grid portal

The Grid portal is a specialized Web portal that provides an entry point both to the LMS system and Grid resources, services and data. The Grid portal manages the identity of all users (learners, authors and administrators) and offers Web interfaces for displaying resource information, job scheduling and file/data transfer.

To develop the portal for InfoLearning platform, JSR 168 portlets technology was chosen, which ensures flexibility, modularity and extensibility. Portlets are managed by a portlet container which provides a runtime environment to the portlets, and manages their lifecycles. A portlet is a Java Web component that generates dynamic content in response to some requests and is typically displayed as a small window inside of a Web page.
There are many variations of portlet containers to choose from, but the team which worked to integrate the portal has decided to meet some important criteria: the solution to be non-proprietary (open source), to be active in development and to use widely accepted standards. Thus, it was decided to use the GridSphere portlet container with Vine portlets.

The first versions of GridSphere have provided support for two sets of portlets: OGCE (Open Grid Computing Environment) [17] and GridPortlets [18], the second becoming a part of OGCE. Version 3 of GridSphere is not 100% compatible with OGCE portlets and recommends instead Vine portlets that are in development, unlike OGCE project, that has been frozen, so that the reason for this choice is clear.

To install Vine portlets, a Web container such as Apache Tomcat 5.5.23 (or newer) and a GridSphere 3 portlet container installed and configured are needed. Vine portlets come with configuration file Domain.xml located in $CATALINA_HOME/webapps/vine/WEB-INF/vine/resources/. In this file there are some important elements which should be configured and which will be presented in the following sections.

In addition to the portlet container, the GridSphere version 3 distribution includes a collection of basic user/administrative portlets: portlets for users to login/logout, for manage profile information, for starting, stopping or redeploying portlets as needed etc.

Grid-specific functionality is accomplished with Vine portlets that make use of the Java CoG Kit to actually carry out Grid-related operations. Vine portlets include: Account Manager, Credential Manager, File Manager, JobManager, Resource Manager.

Also, GridSphere 3 uses a database to manage its own users, roles, rights, etc. and can be configured to use different servers (mySQL, PostgreSQL etc.). In our project, GridSphere is configured with the same database server as those used by Globus, PostgreSQL 8.1 database server.

3. Authentication and authorization in InfoLearning platform

Grid portals manage Grid credentials on behalf of clients. Nowadays, most portals are setup in one of two ways: (1) each portal user has his or her own unique Grid account/credentials (2) multiple portal users are mapped to a single Grid account/credential.

For InfoLearning platform we have chosen the first solution, in which portal users have their own credentials, and the portal provides easy interface to manage credentials and access the Grid resources.

3.1. Authentication in InfoLearning platform

Taking into account that GridSphere supports authentication via one or more configurable modules, we could include two modules for user authentication. For this functionality, the desired authentication modules were registered in configuration file Domain.xml, like this:

```xml
<domain name="gt4" label="E-Learning Grid">
  <!-- Portlet authentication module -->
  <authenticationModule key="PortletAuthModule"/>
  <!--myProxy server authentication module-->
  <authenticationModule key="CredentialRepositoryAuthModule"/>
  ………………….
</domain>
```

PortletAuthModule is the default authentication module, which uses GridSphere database; Credential RepositoryAuthModule works with MyProxy server, which must be properly configured in the Domain.xml file. When more than one authentication module is configured, GridSphere will try them all, in configured priority order until one succeeds. User will only successfully be authenticated if one or more registered authentication modules return correctly from the authentication method.

3.2. Authorization in InfoLearning platform

For user authorization to access Grid resources, in InfoLearning Platform there are also available two modules. The first authorization module is those offered by GridSphere container with user roles. Currently users can be assigned to one of several roles: GUEST, USER, ADMIN, each with its own privileges. The default configuration for GridSphere is to allow anyone (GUEST) who visits the portal login screen to create an account for him. New roles can be defined, like STUDENT, PROFESSOR (which can access LMS e-learning application) and GRID_MEMBER (which can access Grid resources).
The second authorization module is defined for controlling access to Grid resources, using grid-mapfile files. A grid-mapfile file aims at authorizing users at the local level for accessing resources on that host. Such a file contains a table of M: N associations between a Distinguished Name (DN) used to specify the user identity (subject) in a Grid environment and local users of the system. If our case, an entry in grid-mapfile on the host portal looks something like this:

"/O=Grid/OU=GlobusTest/OU=simpleCA-portal/CN=mircea" vinemircea

This authorization mechanism by which a subject can be only grant or deny access to a host may seem ineffective, but things change if we take into account that the system administrator can restrict with a greater granularity the individual rights of the users using the authorization support of the operating system. Thus the mechanism for authorization by grid-mapfile can be considered not only simple but also quite strong, elegant and scalable.

4. Creating accounts, credentials and authorization maps

Since InfoLearning is a collaborative training platform for students (e-learning) and can have a very large number of users, it is ineffective as the portal administrator to handle manual creation and maintenance accounts. Therefore we have developed a way of integrating these operations, in which the administrator performs only strictly necessary operations for approval/rejection of requests accounts, and most tasks are handled by Vine and GridSphere portlets, some of them changed so that matching specifically requirements.

The UML sequence diagram from Figure 2 presents the sequence of events at the end of which a new user will be added in the system correctly, respecting the different rights (as assigned roles) and thus being able to access Grid resources and e-learning application.

4.1. Creating portal accounts

To create an account in GridSphere portal, a user must register (with the command Register in ), completing a form with various information: user name, portal login password (with its confirmation), e-mail and other data (step 1 of the diagram). This request is taken over by a GridSphere portlet (User Account Manager portlet), which sends an e-mail to portal administrator (step 2) with user identification data and two links, one for request approval and another for rejection. The administrator does not have anything to do than to follow the desired link (step 3 of diagram).
In case the request was approved, the portal performs several operations for user registration (step 4): stores the user name and encrypted password in the GridSphere database and sends an e-mail to user in which he is announced that his portal account was created (step 5). By default, a new created user has USER role; other roles (such as STUDENT, PROFESSOR, ADMIN, GRID_MEMBER) can be added by administrator. After receiving account confirmation mail, the user can login in portal and use those portal services entitled to him roles (step 6).

4.2. Creating Grid accounts

If a user has GRID_MEMBER role, it may make a request for a Grid account, which will allow further access to Grid resources, from portal or from e-learning application (step 7 of the diagram).

The request for a Grid account needs to complete a Submit Request Account form, in which the user must complete a Grid user name, under which will be seen in Grid and a Grid password (with confirmation). It is recommended that the Grid user name to be the same as portal user name, in order to be able to connect automatically in the portal with Grid password.

To create user Grid account and their credentials, Account Manager and Credential Manager Vine portlets process the account request and performs the following operations:

- Creates a system user on each host of the Grid (registered as hostResource in Domain.xml portlets configuration file).
- Creates an X509 credential for that user, with the certificate signed by the Grid Certification Authority (CA).
- Delegates a proxy credential in MyProxy server, using as passphrase for the private key encryption the password specified by the user in the Grid account request.
- Adds an entry that associates the distinguished name (DN) of the user with local system user name in all files /etc/grid-security/grid-mapfile on all Grid hosts, to authorize user access to them.

Account Request and Account Manager portlets use template scripts to add and delete users. These templates are available in $CATALINA_HOME/webapps/vine/WEB-INF/vine/scripts directory, change owners of files in /home directory, add and remove entries in grid-mapfile. For these operations the system user running the portal and system users created on the rest of nodes must have additional rights specified in the files /etc/sudoers on these systems. Added code is like this:

```bash
Cmd_Alias CMD=/usr/sbin/useradd, /usr/sbin/userdel, /bin/chown, /bin/chmod, /bin/mkdir, /usr/local/globus-4.0.6/sbin/grid-mapfile-add-entry, /usr/local/globus-4.0.6/sbin/grid-mapfile-delete-entry
user ALL=(ALL) NOPASSWD: SETENV: CMD
```

Another requirement arising from the template script analysis is that the user which runs the portal should have the right to connect without a password via SSH to all Grid hosts in order to create user accounts and to change grid-mapfile files. For this requirement, a passwordless SSH key for portal account is generated (with ssh-keygen command) and its public key is added to target host super user accounts list (in $USER_HOME/.ssh/authorized_keys file).

4.3. User authentication in portal and Grid

At this point, a user who has GRID_MEMBER role holds an user name and two passwords, one as portal user (stored encrypted in the GridSphere database) and another as Grid user, used for encryption the private key of the credential delegated in MyProxy server.

In InfoLearning platform is not necessary to use both passwords because Credential Manager portlet is configured to use either its own authentication module (PortletAuthModule), either MyProxy authentication module (CredentialRepositoryAuthModule).

For a user to login in the portal as well as in the Grid, he must login with the Grid password (in step 10, after he logged out as portal user, in step 9). When login with the Grid password, Credential Manager portlet retrieves a proxy credential from MyProxy server and stores the credential in an established location in the local file system, to be used when the user accesses Grid resources.

5. Other services offered by Vine portlets

In addition to these services that relate to the management of users, their authentication and authorization, Vine portlets provide access to Globus GT4 Grid resources through Web interfaces:

- Transfer files between Grid nodes;
- FileManager portlet can interact with both
GridFTP servers and RFT (Reliable File Transfer) services.
- Launching tasks in the Grid nodes; JobManager portlet interacts with WS-GRAM (Web Services Grid Resource Allocation and Management).
- Viewing Grid resources information; Resource Browser portlet allows displaying the state of the Grid nodes (hardware, software, job status, resources etc.) using WS-MDS service (Web Services Monitoring and Discovery System).

6. Conclusions

At this stage of the project, most components of the InfoLearning platform have been installed, configured and tested. GridSphere container with Vine portlets is a good choice for a portal for Globus Toolkit 4.0.6 Grid, since there are few other portal toolsets compatible with this version. Although Vine project is at the beginning and there are still some unsolved problems (such as the compatibility of ResourceBrowser portlet with Globus GT4.0.6 resources), Vine portlets have big chances to develop as a powerful solution.

The architecture adopted for our e-learning Grid offers possibilities of development, evolution and maintenance very flexible, since each architectural level can be configured and upgraded independently, and the interactions among them are based on standards and specifications mature and stable (WSRF for Grid services, JSR -168 for portlets, SCORM for learning activities).

7. References


