Authentication and Authorization

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Overview

The Fedora 4 Authentication (AuthN) and Authorization (AuthZ) framework is designed to be flexible and extensible, to allow any organization to configure access to suit its needs.

The following sections explain the Fedora 4 AuthN/Z framework, and provide instructions for configuring some out-of-the-box access controls.

For clarity's sake, a distinction is made between Authentication and Authorization:

- **Authentication** answers the question "who is the person, and how do I verify that they are who they say they are?" Fedora 4 relies on the web servlet container to answer this question.
- **Authorization** answers the question, "does this person have permission to do what they want to do?". Fedora 4 provides three different ways to answer this question:
  - Simple servlet container authentication. Anyone who has authenticated through the web application container (Tomcat, Jetty, WebSphere, etc.) has permission to do everything – in effect all, authenticated users are superusers.
  - Basic Access Roles authorizations. Authenticated users are mapped onto one or more preconfigured roles; a user's role determines what they have permission to do.
  - XACML authorizations. Policies created using the XACML framework are used to determine what operations are permissible to whom, using user and resource properties exposed to the XACML engine.

Servlet Container Configuration

Fedora 4 uses servlet container authentication (Realms) to provide minimal protection for your repository, including the set up of "superuser" accounts. User credentials are configured in your web application container, usually in a properties file or XML file. By configuring superuser accounts you can require authentication for all management (write) operations. This document describes how to set up Fedora and either Tomcat or Jetty to enable HTTP Basic Authentication, using simple user files. Consult your web application server documentation for other ways to configure and manage users; Fedora can handle any user principal passed to it by the servlet container, as provisioned by any of the container's supported authentication mechanisms.

The superuser role is **fedoraAdmin**. This is comparable to the **fedoraAdmin** superuser role in Fedora 3, used for Fedora 3 API-M operations.

- Configure your repo.xml file
- Configure your repository.json file
- Configure your web.xml
- Configure your web application container
    - Jetty
    - Tomcat

If you are starting from the pre-packaged authorization war file (fcrepo-webapp-plus-[rbacl | xacml]-<version>.war), you should skip to step #4 below.

1. Configure your repo.xml file

Add the beans *authenticationProvider* and *fad* to your repo.xml file, and make the *modeshapeRepofactory* bean dependent on *authenticationProvider*. Use the class **org.fcrepo.auth.ServletContainerAuthenticationProvider** as your authentication provider. Here is an example repo.xml that configures authentication and authorization using the Basic Roles authorization delegate:

repo.xml with authentication configured

```
<?xml version="1.0" encoding="UTF-8"?>
<beans xmlns="http://www.springframework.org/schema/beans"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:context="http://www.springframework.org/schema/context"
    xmlns:p="http://www.springframework.org/schema/p"
    xmlns:util="http://www.springframework.org/schema/util"
    xsi:schemaLocation="
    http://www.springframework.org/schema/beans http://www.springframework.org/schema/beans/spring-beans-
3.0.xsd
    http://www.springframework.org/schema/context http://www.springframework.org/schema/context/spring-
context-3.0.xsd
    http://www.springframework.org/schema/util http://www.springframework.org/schema/util/spring-util.
xsd">

    <!-- Context that supports the actual ModeShape JCR itself -->

    <context:annotation-config/>

    <bean name="modeshapeRepofactory"
        class="org.fcrepo.kernel.impl.spring.ModeShapeRepositoryFactoryBean"
        p:repositoryConfiguration="${fcrepo.modeshape.configuration:classpath:/config/servlet-auth
/repository.json}"
        depends-on="authenticationProvider"/>

    <bean class="org.modeshape.jcr.JcrRepositoryFactory"ModeShapeEngine" init-method="start"/>

    <bean id="connectionManager" class="org.apache.http.impl.conn.PoolingHttpClientConnectionManager" />

    <!-- Optional PrincipalProvider that will inspect the request header, "some-header", for user role
values -->
    <bean name="headerProvider" class="org.fcrepo.auth.common.HttpHeaderPrincipalProvider">
        <property name="headerName" value="some-header"/>
        <property name="separator" value=","/>
    </bean>

    <util:set id="principalProviderSet">
        <ref bean="headerProvider"/>
    </util:set>

    <bean name="fad" class="org.fcrepo.auth.roles.basic.BasicRolesAuthorizationDelegate"/>

    <bean name="authenticationProvider" class="org.fcrepo.auth.common.
ServletContainerAuthenticationProvider">
        <property name="fad" ref="fad"/>
        <property name="principalProviders" ref="principalProviderSet"/>
    </bean>

    <!-- For the time being, load annotation config here too -->
    <bean class="org.fcrepo.metrics.MetricsConfig"/>
</beans>
```

2. ## Configure your repository.json file

Modify the security section to enable both authenticated (via authentication provider) and internal sessions between Fedora and ModeShape. It should match this block:

repository.json security

```
"security" : {
        "anonymous" : {
            "roles" : ["readonly","readwrite","admin"],
            "useOnFailedLogin" : false
        },
        "providers" : [
            { "classname" : "org.fcrepo.auth.common.ServletContainerAuthenticationProvider" }
        ]
    },
```

3. ## Configure your web.xml

Configure your **web.xml**.

Modify fcrepo-webapp/src/main/webapp/WEB-INF/web.xml by uncommenting the security configuration

```
  <!--Uncomment section below to enable Basic-Authentication-->
  <security-constraint>
    <web-resource-collection>
      <web-resource-name>Fedora4</web-resource-name>
      <url-pattern>/*</url-pattern>
      <http-method>DELETE</http-method>
      <http-method>PUT</http-method>
      <http-method>HEAD</http-method>
      <http-method>OPTIONS</http-method>
      <http-method>PATCH</http-method>
      <http-method>GET</http-method>
      <http-method>POST</http-method>
    </web-resource-collection>
    <auth-constraint>
      <role-name>fedoraUser</role-name>
      <role-name>fedoraAdmin</role-name>
    </auth-constraint>
    <user-data-constraint>
      <transport-guarantee>NONE</transport-guarantee>
    </user-data-constraint>
  </security-constraint>
  <login-config>
    <auth-method>BASIC</auth-method>
    <realm-name>fcrepo</realm-name>
  </login-config>
```

The "auth-constraint" element must contain the roles defined as your users (see below for jetty and tomcat).

4. ## Configure your web application container

- **Jetty**
  - Create your **jetty-users.properties** file. This file contains entries in the format *username: password [, role, ...]*, where
    - *username* is the user's login id (the principal)
    - *password* is the user's password
    - *role* is the servlet role they are assigned upon login; jetty allows you to specify any number of roles (or no role at all). Fedora currently supports two roles: **fedoraAdmin**, which is the superuser role, and has rights to do everything; and **fedoraUser**, which is a user role, and must be granted permissions by the Policy Enforcement Point to perform actions.

    Sample **jetty-users.properties** file that contains three users, two of whom are regular users, and the third of whom (fedoraAdmin) is a Fedora superuser:

    jetty-users.properties

    ```
    testuser: password1,fedoraUser
    adminuser: password2,fedoraUser
    fedoraAdmin: secret3,fedoraAdmin
    ```

- Configure your Jetty login realm.
  - Standalone
    Modify your **jetty.xml** file to configure the login realm and include the jetty-users.properties file:

    jetty.xml login service

```
<Configure class="org.eclipse.jetty.webapp.WebAppContext">

  <!-- Set this to the webapp root of your Fedora 4 repository -->
  <Set name="contextPath">/</Set>
  <!-- Set this to the path of of fcrepo4 WAR file -->
  <Set name="war"><SystemProperty name="jetty.home" default="."/>/webapps/fcrepo4</Set>

  <Get name="securityHandler">
    <Set name="loginService">
      <New class="org.eclipse.jetty.security.HashLoginService">
        <Set name="name">fcrepo4</Set>
        <!-- Set this to the path to your jetty-users.properties file -->
        <Set name="config"><SystemProperty name="jetty.home" default="."/>/path/to
/jetty-users.properties</Set>
      </New>
    </Set>
  </Get>

</Configure>
```

  - Embedded in Maven
    - The fcrepo-webapp Maven project includes jetty-maven-plugin. The property *jetty.users.file* sets the location of the **jetty-users.properties** file. Run the fcrepo-webapp server with the following system property:

      ```
      -Djetty.users.file=/path/to/jetty-users.properties
      ```

See the Jetty Authentication documentation for more details.

Tomcat

- Create or edit your `$CATALINA_HOME/conf/tomcat-users.xml` file. It has entries of the form

  ```
  <user name="principal" password="password" roles="role1, role2, ..." />
  ```

  where:

  - *name* is the user's login id (the principal)
  - *password* is the user's password
  - *roles* are the servlet roles they are assigned upon login; tomcat allows you to specify any number of roles (or no role at all). Fedora currently supports two roles: **fedoraAdmin**, which is the superuser role, and has rights to do everything; and **fedoraUser**, which is a user role, and must be granted permissions by the Policy Enforcement Point to perform actions.

  Sample **tomcat-users.xml** file that contains three users, two of whom are regular users, and the third of whom (fedoraAdmin) is a Fedora superuser:

  tomcat-users.xml

```
<tomcat-users>
  <role rolename="fedoraUser" />
  <role rolename="fedoraAdmin" />
  <user name="testuser" password="password1" roles="fedoraUser" />
  <user name="adminuser" password="password2" roles="fedoraUser" />
  <user name="fedoraAdmin" password="secret3" roles="fedoraAdmin" />
</tomcat-users>
```

- Configure your Tomcat login realm.
  Modify your file `$CATALINA_HOME/conf/server.xml` file to configure the login realm with the Fedora 4 webapp context:

Tomcat server.xml Realm

```
<Context>
...
  <Realm className="org.apache.catalina.realm.UserDatabaseRealm"
         resourceName="UserDatabase" />
</Context>
```

See the Tomcat Realms documentation for more details.

Authorization Delegates

Overview

Fedora Authorization Delegates allow you to implement one interface to enforce access control over your Fedora repository. This interface, FedoraAuthorizationDelegate, has callbacks that allow you to restrict ModeShape operations and filter search results. After following these configuration steps, Fedora's REST endpoints will respond with 403 response codes when the requested action is unauthorized by the authorization delegate.

Use of an authorization delegate and Fedora-specific authorization is optional. You can also configure Fedora to run without API security. You may want to only enforce container authentication or leave the service running completely unsecured, behind a firewall for instance. For details, see How to configure Fedora without authorization.

Fedora Administrators (fedoraAdmin user role)

The authorization delegate is not consulted when servlet credentials identify a client with the **fedoraAdmin** role. When the container has authenticated the connected client as a **fedoraAdmin**, all actions are permitted and PEP is bypassed.

FedoraAuthorizationDelegate Implementations

There are two reference implementations available:

- Basic Role-based Authorization Delegate - An authorization delegate that operates on three fixed roles that may be assigned throughout the repository tree. (reader, writer, admin)
- XACML Authorization Delegate

You can also create an authorization delegate implementation and perform security checks differently, possibly including calls to remote services.

Two files contain the configuration options for authorization delegates:

- **repo.xml**: the global repository configuration file. Three beans enable the PEP extension:
  - *modeshapeRepoFactory*: should contain a dependency on the *authenticationProvider* bean
  - *authenticationProvider*: should specify the *ServletContainerAuthenticationProvider* class, so that the servlet container handles authentication
    - This bean should have a property "fad" that points to the *fad* bean, to enable the servlet container authentication provider to use the authorization delegate
  - *fad*: should point to your class with the authorization delegate implementation
- **repository.json**: the ModeShape configuration file. It contains a security section, where the **internal session** authentication between Fedora and the ModeShape storage layer is configured. Note that the roles configured here do not apply to end user authentication and authorization..

Step-by-step:

1. Open the repo.xml file in your Fedora web application.
2. Add your authorization delegate implementation as a bean in this file and give it the ID of "fad". Your authorization delegate bean may include more specific configuration details than the example.
3. Now add the Fedora ModeShape Authentication Provider bean. (see repo.xml example)
4. Make sure that your modeshapeRepofactory bean has the depends-on attribute pointing at the authenticationProvider (see repo.xml example).
5. Open your repository.json file.
6. Add org.fcrepo.auth.ServletContainerAuthenticationProvider as a provider in the security section. (see repository.json example)

Example repo.xml (repository and security beans)

```
<bean name="modeshapeRepofactory" class="org.fcrepo.kernel.spring.ModeShapeRepositoryFactoryBean"
  depends-on="authenticationProvider">
    <property name="repositoryConfiguration" value="${fcrepo.modeshape.configuration:repository.json}" />
</bean>

<bean name="fad" class="your.own.implementation"/>

<bean name="authenticationProvider" class="org.fcrepo.auth.ServletContainerAuthenticationProvider">
  <property name="fad" ref="fad"/>
</bean>
```

Example repository.json (security section)

```
"security" : {
  "anonymous" : {
    "roles" : ["readonly","readwrite","admin"],
    "useOnFailedLogin" : false
  },
  "providers" : [
    { "classname" : "org.fcrepo.auth.ServletContainerAuthenticationProvider" }
  ]
},
```

Access Roles Module

- Overview
- REST API
- Example Data
- Inheritance of Effective Roles
- Cascading Delete Permission
- Authorization Operations and Example

Overview

This module creates a REST API to assign new roles to identities and to query the roles already assigned on Fedora resources.

In roles-based access control, users or groups are not granted specific actions on resources; rather, users and groups have roles assigned to them on resources, and these roles are mapped onto permitted actions elsewhere. This makes it much easier to manage permissions globally: rarely will masses of resources need to be updated if their permissions change. Only the role-to-permission mapping will be updated. Role-based access control is a common pattern in security, providing extensible role-specific behavior while retaining straightforward management.

This module does not define any specific roles or enforce permissions granted to roles. For roles to be effective, this module must be configured alongside an authorization delegate that is aware of roles. One roles-aware authorization delegate is provided as a reference implementation, the Basic Roles-Based Authorization Delegate.

REST API

The module adds another REST endpoint to every Fedora resource path. The URL pattern is as follows:

`<path to Container>/fcr:accessroles`

REST methods:

method	description
GET	Retrieves the roles assigned on a resource.
GET w/effective parameter	Retrieves the effective roles assigned on a resource, which may cascade from an ancestor role assignment.
POST	Sets all the roles assigned on a resource.
DELETE	Removes any roles assigned on a resource, such that effective roles are inherited again.

The POST and GET methods currently support a JSON structure (as Content-type *application/json*) where principals are mapped to lists of roles:

```
{
  "johndoe" : [ "reader" ],
  "janedoe" : [ "writer" ],
  "freddoe" : [ "patron", "editor" ]
}
```

This module assigns one or more roles to a string, which is the name of a security principal. (java.security.Principal) The principals used in your repository environment must have unique names. You may use whatever principals you wish, but we recommend applying the appropriate standard for your environment. This module does not validate principal names.

Fedora uses a principal named "EVERYONE" to represent the general public. This principal is added to every incoming web request. You may assign any role to the EVERYONE principal.

By default, role names are not validated, since the module does not define the set of role names that may be assigned in Fedora. However, you may configure a set of specific roles and then the API will validate roles.

Example Data

```
root/  (default content roles, i.e. no roles for anyone)
 Container A  (EVERYONE => reader; johndoe => admin)
    Binary 1  (johndoe => admin)
    Container Q  (EVERYONE => reader; johndoe => admin)
        Container R (janedee => admin)
 Container B  (EVERYONE => reader; johndoe => admin)
    Container T
        Container V
 Container C
```

Inheritance of Effective Roles

Descendant resources inherit the roles assigned on ancestor resources *only if they have no roles assigned themselves*. If a resource has any roles assigned, *these assignments override ALL ancestor assignments*.

The following cases, based on the example data above, demonstrate how inheritance plays out.

1. Binary 1 of Container A only allows one principal to access the resource: *johndoe*. He will have *admin* privileges. None of the ACLs on Container A will be applied; the binary will not inherit the *EVERYONE => reader* ACL on Container A.
2. Container R, a child of Container Q, has its own content ACL: *janedee* has *admin* privileges on Container R. No one else has any access to the resource, not even the parent resource (Container Q) principals (*EVERYONE* and *johndoe*).
3. Container T, a child of Container B, has no content ACLs. So it inherits the ACLs of its most immediate ancestor with content ACLs: Container B. *EVERYONE* has reader privileges on Container T, and *johndoe* has *admin* privileges on the Container.
4. Container V also inherits the ACLs of Container B (its most immediate ancestor with content ACLs).
5. Container C has no content ACL; it inherits the ACLs of the root resource, which is to say, nothing. No one other than *fedoraAdmin* has any access to this Container.

Cascading Delete Permission

When deleting a resource, the user must have an effective role that will allow them to delete *ALL* the descendant Containers under the resource. (binaries, child Containers, etc..) If any descendant resource cannot be deleted, then the entire delete transaction will be denied.

For example, in the graph shown above, the principal *johndoe* cannot delete container A, although he has an admin role on it and its binary; that is because he does not have an effective role on Container R, the resource's grandchild, that will permit him to delete it. If he wants to delete Container A, he will first have to ask *janedee* to delete Container R.

Authorization Operations and Example

(Editor's note: this section would make more sense within the Basic Roles auth delegate documentation/page)

Order of operation:

- **Container Authentication**: A user comes into the system. They are assigned a **user principal**:
  - If they authenticate through some authentication gateway, then their principal may be generated from some of the person's attributes;
  - Whether they authenticate or not, the request will always acquire an "EVERYONE" principal.
- **Fedora Principal Provider extensions:** Principal provider extensions may bring in more principals after authentication, such as groups, from sources like LDAP.
- **Fedora Roles Authorization Delegate Queries for Assigned Roles on Content: What roles have been assigned?**
  - The authorization layer queries the requested repository resource(s) for any content-assigned roles.

    - If none are found locally, then it will query each ancestor in turn until role assignments are found.
    - If no role assignments are found in the tree of resources, then a default set of role assignments is used. (see Container C above)
- **Fedora Roles Authorization Delegate - Role Resolution: What roles does this request have?**
    - The set of principals in the request are compared to the principals in the ACLs on the resource. The roles for each matching principal in the Container ACL are the **effective roles** for the user.
    - At this point we have the effective access roles for this operation
- **Fedora Roles Authorization Delegate - Policy Enforcement: Does this role have permission to perform the requested action?**
    - Note: The Fedora Authorization Delegate is an extension point, so enforcement will vary by the chosen implementation. We assume that installations will combine the access roles module with a roles-based authorization delegate.
    - The effective roles, assigned to the user on the content, are used to determine if the user has permission to perform the action on a given resource.
    - Basic Roles authorization delegate implementation does permission checks in java code:
        - Permission is determined by evaluating at a minimum the effective roles for the user on the resource in question, and the action requested.
    - In other roles-based authorization delegate implementations, more factors may also enter into the equation to determine permission.
- The authorization delegate will return a response to ModeShape, which will throw an exception to Fedora if access has been denied.
- Fedora will respond with a 403 if the given REST operation is denied.

- The one exception to this process is the **fedoraAdmin container role**. If the request has a fedoraAdmin user role (in the container), then no resource checks are made. The authorization delegate is not consulted as admins have permission to do everything. Resources will never have the fedoraAdmin role explicitly assigned to them, since it is a container role and not a content role. (e.g. a tomcat user role)

Examples:

1. Unauthenticated user requests to see Container A.
    a. The user is assigned the user principal "EVERYONE".
    b. The authorization delegate intercepts the request, gets the ACLs for Container A: "EVERYONE" => "reader" and "johndoe" => "admin".
    c. The authorization delegate compares the user principal "EVERYONE" to the principals in Container A's ACLs, and sees that "EVERYONE" matches. The effective role for this request is "reader", the role paired with the principal "EVERYONE" on the Container.
    d. The authorization delegate sees if the role "reader" can view the Container; it can.
    e. The authorization delegate returns "yes", and the request proceeds.
2. Unauthenticated user requests to see binary 1 on Container A.
    a. The user is assigned the user principal "EVERYONE".
    b. The authorization delegate intercepts the request, gets the ACLs for binary 1: "johndoe" => "admin".
    c. The authorization delegate compares the user principal "EVERYONE" to the principals in binary 1's ACLs, but does not find a match.
    d. The authorization delegate returns "no", and the request is denied.
3. Unauthenticated user requests to delete Container B.
    a. The user is assigned the user principal "EVERYONE".
    b. The authorization delegate intercepts the request, gets the ACLs for Container B: "EVERYONE" => "reader" and "johndoe" => "admin".
    c. The authorization delegate compares the principal "EVERYONE" to the principals in Container B's ACLs, and sees that "EVERYONE" matches. The effective role for this request is "reader", the role paired with the principal "EVERYONE" on the Container.
    d. The authorization delegate sees if the role "reader" can delete the Container; it cannot.
    e. The authorization delegate returns "no", and the request is denied.
4. John Doe requests to update binary 1 on Container A.
    a. The user is assigned the user principals "johndoe" and "EVERYONE".
    b. The authorization delegate intercepts the request, gets the ACLs for binary 1: "johndoe" => "admin".
    c. The authorization delegate compares the user principals "johndoe" and "EVERYONE" to the principals in binary's ACLs, and sees that "johndoe" matches. The effective role for this request is "admin", the role paired with the principal "johndoe" on the Container.
    d. The authorization delegate sees if the role "admin" can update the Container; it can.
    e. The authorization delegate returns "yes", and the request proceeds.

Basic Role-based Authorization Delegate

This authorization delegate makes decisions based on the four basic roles of "metadata reader", "reader", "writer", and "admin". These roles are assigned to principals on Fedora resources. Assigned roles are inherited through the repository tree until blocked by another assignment.

The role **metadata reader** has not yet been implemented.

This authorization delegate makes use of the Access Roles Module to assign and query roles in the repository.

Roles

- **metadata reader** - can retrieve information about Fedora Containers, but cannot retrieve content
- **reader** - can retrieve information about Fedora Containers, including content
- **writer** - all permissions of reader; can create, modify and delete Fedora Containers
- **admin** - all permissions of writer; can modify the roles assigned to Fedora Containers

Policy

The permissions granted to these roles are fixed. Rather than consulting any declarative policy, this authorization delegate has hard-coded role-permission assignments in the source code.

Role/Permission Matrix

	metadata reader	reader	writer	admin
read properties	X	X	X	X
read content		X	X	X
write			X	X
write roles				X

Configuring the Basic Role-Based Authorization Delegate

See Authorization Delegates for more information on how an authorization delegate is configured.

Edit your **repo.xml** file to configure the authentication provider. The file should contain these three beans, as shown:

```
<bean name="modeshapeRepofactory" class="org.fcrepo.kernel.spring.ModeShapeRepositoryFactoryBean"
  depends-on="authenticationProvider">
    <property name="repositoryConfiguration" value="${fcrepo.modeshape.configuration:repository.json}" />
</bean>

<bean name="fad" class="org.fcrepo.auth.roles.basic.BasicRolesAuthorizationDelegate"/>

<bean name="authenticationProvider" class="org.fcrepo.auth.common.ServletContainerAuthenticationProvider">
    <property name="fad" ref="fad"/>
</bean>
```

Edit your **repository.json** file to enable an authenticated internal session between Fedora and ModeShape, so that the security section matches the example shown:

```
"security" : {
  "anonymous" : {
    "roles" : ["readonly","readwrite","admin"],
    "useOnFailedLogin" : false
  },
  "providers" : [
    { "classname" : "org.fcrepo.auth.common.ServletContainerAuthenticationProvider" }
  ]
},
```

XACML Authorization Delegate

This is an implementation of the authorization delegate API. This PEP compiles request and environment information into an authorization request that is passed to a XACML policy decision point (PDP).

- Requirements
- How to Map to XACML Policies
    - Policy Persistence
    - Finding the Effective Policy Set
    - No Applicable Policies
    - Implementation
- Local PDP
    - Cascading Deletes

        - XACML AuthZ Delegate
        - PolicyFinderModule (w/PolicyLocator for JBossPDP configuration)
        - ModeShapeResourceFinderModule
        - AttributeFinderModule(s)
            - ResourceAttributeFinderModule(s)
            - SubjectAttributeFinderModule
            - EnvironmentAttributeFinderModule
- XACML Role-Based Access Control

Requirements

- Authoring XACML policies is an involved technical process, with behavior hinging upon the total policy set. For this reason policies/sets will be centralized, named and reused as much as possible. (Less is more)
- Administrators may choose to enforce a different set of XACML policies at any point within the repository tree.
- Metadata, such as ACLs or rights statements, can be used to avoid authoring more XACML.
    - Resource properties can determine the relevant policy within a set and the outcome from within that policy.
    - Policies may depend upon an access role attribute.
    - Policies may reference any value obtained via a SPARQL query, relative to the content resource, but the query must be mapped to a XACML attribute in configuration.
- Policies (and/or sets of them) must be stored in the repository.
- Policies must be enforced on externally managed content, i.e. projected resources within a federated resource. (inc. filesystem connector)
- Must be able to authorize based on requesting I.P. address
- Must be able to authorize based on resource mixin types
- Must be able to authorize based on Hydra rightsMetadata datastream
- Must be able to authorize based on resource mimetype
- Must be possible to use same rules as defined in policies in the following contexts (except for #1, we only need to demonstrate/document the possibilities):
    1. calls to Fedora REST-API
    2. calls to Fedora Java classes
    3. calls to external Solr index
    4. calls to external triplestore

How to Map to XACML Policies

This includes how policies are stored in the repository and how they are linked with content resources.

Policy Persistence

Policy and Policy Set resources may be stored in any part of the repository tree at the discretion of the administrator.

Policies and Policy Sets are referenceable fcr:datastream resources that contain XACML XML.

Policy sets contain Fedora URI references to other policy sets and policies. Policy sets can define a tree structure of policies.

Policy URIs have the form `info:fedora/path/to/PolicyResource`. These URIs are the IDs of the Policies and PolicySets in the XACML datastream.

Finding the Effective Policy Set

One policy set in the workspace will be configured (in the XACML Policy Finder Module) as the default policy for the workspace. This is the same as saying that this default policy set is effective at the root of the Fedora resource tree and everywhere else unless overridden.

Any fcr:resource may set a property **policy** which makes a strong reference to a single policy or set resource. This overrides the effective XACML policy for itself and child resources. This action requires administrator levels of access, as determined by the effective policy, or by use of a login with the fedoraAdmin role.

The Fedora Policy Finder implements the JBoss XACML PolicyFinderModule interface. It retrieves the policy or set that is effective for a given context resource, and searches the tree for the closest parent with a policy property and returns that XACML. It also resolves internal URI references from policy sets at the request of the PDP, looking in the workspace by policy URI.

Note: When combining XACML policies in sets, you specify a combining algorithm of either permit-override or deny-override. For this reason the policy property is single-valued.

Here is an example repository tree:

- ROOT
    - collection A
        - policy property --> policy A
    - collection B (inherits default policy set from ROOT)
    - policies
        - default policy set (XACML contains links to B and C)
        - policy set A (XACML contains links to default and D)
        - policy B
        - policy C
        - policy D

- collection X
  - policy set Z(XACML contains links to Y and W)
  - policy Y
  - policy W
  - My Documents
    - policy property --> policy set Z

No Applicable Policies

This situation can arise when the only policy set (or policy) for some content contains a *target* element or any other XACML construct that restricts it's applicability to authz requests. If the PDP can find no policy that targets the request, it returns a NOT_APPLICABLE result to the XACML AuthZ Delegate. The delegate will then return false to ModeShape, indicating that the action is not permitted.

Implementation

The delegate uses a JBoss XACML engine. PicketLink and PicketBox projects use the same XACML PDP, which is the Sun XACML implementation repackaged by JBoss. (PicketLink is a larger umbrella project of security services.)

The JBoss XACML engine has no significant runtime dependencies, outside of a PicketLink utilities jar. The other dependencies are the Java Servlet API and XML APIs.

Relevant APIs:

- org.jboss.security.xacml.sunxacml.finder.PolicyFinderModule is used to find a policy (or policy set) that matches the request evaluation context. Also used to lookup a policy that is referenced within a policy set by ID.
- org.jboss.security.xacml.sunxacml.finder.AttributeFinderModule is used to find attribute values when evaluating a policy.
- Constructing a policy set for the JBOSS engine:
  - see JCR 2.0 16.3 and JBossLDAPPolicyLocator as an example.

Sun XACML Javadoc: http://sunxacml.sourceforge.net/javadoc/

Local PDP

Is this better implemented as a remote or a local PDP service. The PDP can be used as a bean without the webapp runtime, or it can be configured as a separate service (SOAP). The trade-offs are identified in the table below.

Internal PDP (within ModeShape JVM)	External PDP (remote XACML service)
Minimal administrative overhead through dependency injection, etc..	Flexible, can be any XACML implementation
ModeShape cache will keep frequently used ACL metadata in memory. Removes the need for any additional cache.	Decent performance may require custom metadata caches.
No network overhead making connections or marshaling data.	Network latency, etc..
Decision and policy cache invalidation may be based on events.	Cache invalidation requires wiring JCR or Fedora JMS specifics into the chosen XACML service. Cache invalidation would be asynchronous.
Adds complexity to the runtime webapp – moving closer to a monolithic, coupled application.	

Cascading Deletes

When Modeshape checks for permission to remove a resource and the authz delegate returns true, there are no followup checks for removal of the child resources. The children (and their children, etc) are deleted along with the parent, but the AuthZ Delegate gets no permission callback for them.

The JBoss/Sun PDP has a notion of scope for an evaluation that can be EvaluationCtx.SCOPE_IMMEDIATE, EvaluationCtx.SCOPE_CHILDREN or EvaluationCtx.SCOPE_DESCENDANTS. If we are to use the scope feature, we need to implement another interface to retrieve children/descendants. This interface is a org.jboss.security.xacml.sunxacml.finder.ResourceFinder. When descendants are in the evaluation scope, then each is evaluated in turn by the PDP. The PDP traverses the descendants first, resolving applicable policies for each resource in turn. So this strategy should honor policy overrides with the scope of a tree delete action.

XACML AuthZ Delegate

This is the implementation of the AuthZ Delegate interface. The delegate functions as a Policy Enforcement Point (PEP) in the XACML orchestration. The delegate formulates requests for decisions and dispatch them to the JBossPDP. It interprets the results and return an appropriate response to the hasPermission() method. Most of the work for this component is in building a request context for the PDP.

PolicyFinderModule (w/PolicyLocator for JBossPDP configuration)

Fedora will need an implementation of this interface, originally part of Sun XACML. This finder module will deliver the correct policy set for the resource ID in a XACML request context according the rules for "Finding the Effective Policy Set" above. A similar kind of lookup, based on resource path, happens in the access roles provider.

This is admittedly a little abstruse, but the policy finder module becomes part of the PDP via an implementation of the PolicyLocator interface. An implementation must have a no argument constructor and received configuration via a setOptions() callback method. The PolicyLocator has a map where it will store its PolicyFinderModule for use by the JBossPDP. A simple example is the JBossPolicyLocator, which puts a list of pre-configured policies into a wrapper policy finder module. This wrapper policy finder module is added to the locator's internal map under the policy finder module key. To see how the PDP builds the list of policy finder modules at initialization time, see JBossPDP.boostrapPDP(), especially the createPolicyFinderModules() method. There you can see it build a list of finder modules from each configured policy locator.

The policy lookup operation involves the following steps:

1. finding the nearest real resource for a given the path, since access checks are sometimes performed on new resources before they are added.
2. Then you find the nearest parent with a policy property.
3. Then you read in and return the policy XACML. (There is a PolicyReader class you can use here)
4. It will also need to support requests for policies by resource URI, i.e. resolving policies that are linked from the first policy.

ModeShapeResourceFinderModule

Implements callback methods for finding child and descendant resources. This is used for delete and possibly move operations, which have cascading effect on the resource tree.

AttributeFinderModule(s)

Attribute finder modules do not work the same as policy finder modules. The AttributeLocator is an implementation of the AttributeFinderModule interface.

ResourceAttributeFinderModule(s)

These finder modules retrieve information about the resource which is being accessed. They should be implemented as several finder modules for clarity.

A triple finder module resolves attribute IDs (URIs) to RDF properties on fedora resources. Attributes are not configured in advance. XACML authors may reference any URI and if there is one or more triple with the correct subject resource and predicate, then the resource will be returned. It should match the data type expected in XACML, which is also part of the arguments passed to the finder module.

A SPARQL finder module retrieves data indirectly linked to the subject resource. This finder module will resolve attributes via a configured map of attribute IDs to SPARQL queries.

A common fedora finder module retrieves the standard attributes noted in the Fedora XACML Attributes page.

JBoss has an abstract class called StorageAttributeLocator which may be useful for formulating SPARQL queries that function much like prepared statements against a DB, where there is a replacement value. That pattern may be useful for a ResourceAttributeFinderModule.

SubjectAttributeFinderModule

EnvironmentAttributeFinderModule

XACML Role-Based Access Control

Fedora implements the XACML 2.0 Role-Based Access Control profile out-of-the-box. Under the profile, policies are divided into two types: **Roles** and **Per missions**. **Role** policies only define *Subjects*, then link to **Permission** policies. Permission policies only define permission sets: *Rules* that apply to *Reso urces* and *Actions*. Policies are grouped into *PolicySets*. Permission policy sets are never referenced directly, but only through Role policy sets.

This model makes it simple to assign multiple roles to intersecting sets of permissions, and to allow for hierarchical roles: more powerful roles can inherit the permissions of lesser roles, then extend them in their own permission policy. Thus, an admin role inherits the permissions of both reader and writer roles.

The Fedora default policies implement the roles **admin**, **writer**, and **reader**. See Fedora Basic Roles - ModeShape Permission for a mapping of roles to ModeShape actions and permissions..

Fedora XACML RBAC policies on github

Some notes on identifier conventions:

- *PolicySetId* identifiers will be URIs of the form `info:fedora/policies/PolicyResource`. This identifier will be resolvable to the path to the policy resource in the repository.
- Internal policy element identifiers for the XACML elements *PolicyId* and *RuleId* will have the urn prefix `fcrepo-xacml.`

Bypassing Authorization

Running Fedora without authorization means that the REST API is available to any request coming from the container and lacks any finer-grained security. This is useful when Fedora is running behind another application that connects to Fedora and implements its own security checks. In addition, this configuration is useful for temporary demonstrations and for running software tests that do not require security.

This configuration does not preclude the use of container authentication to secure Fedora. However, container roles are not used for any further authorization within Fedora. All requests are treated as superusers.

The security bypass for REST endpoint is accomplished by supplying an alternate ModeShape authentication provider for servlet credentials. This servlet authentication provider permits all actions at the modeshape level and does not use a PEP (Policy Enforcement Point).

Step-by-Step:

1. If you previously configured a PEP, open your repo.xml file and remove any beans that are instances of "org.fcrepo.auth.common.ServletContainerAuthenticationProvider".
2. Also remove the PEP bean, if one was configured.
3. Remove the depends-on attribute on the modeshapeRepofactory bean, if there is one.
4. Open your repository.json file
5. Under security, configure the "BypassSecurityServletAuthenticationProvider", as shown in the example below.

Example repository.json (security section)

```
"security" : {
  "anonymous" : {
    "roles" : ["readonly","readwrite","admin"],
    "useOnFailedLogin" : false
  },
  "providers" : [
    { "classname" : "org.fcrepo.auth.commons.BypassSecurityServletAuthenticationProvider" }
  ]
},
```