REST Profile of XACML v3.0 Version 1.0

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Related work:
This specification is related to:

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This specification defines a profile for the use of XACML in a RESTful architecture.

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1 Introduction

{Non-normative}
This specification defines a profile for the use of the OASIS eXtensible Access Control Markup Language (XACML), versions 3.0 [XACMLv3] and earlier. Use of this profile requires no changes or extensions to the XACML standard.

This specification begins with a non-normative discussion of the topics and terms of interest in this profile. The normative section of the specification describes the details of web services that conforming implementations must support.

This specification assumes the reader is somewhat familiar with XACML. A brief overview of XACML is available in [XACMLIntro].

1.1 Terminology
The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [RFC2119].

1.2 Glossary
Client
The agent that initiates requests to a server.

Representation
A sequence of bytes, in a given format, that represents a resource in some way.

Request
The HTTP request message sent from the client to the server [HTTP]. Note that this is not the same concept as a XACML request [XACMLv3].

Resource
A service that is offered by the server [REST]. This can be static, like a document, or dynamic, like a search. Note that this is not the same concept as a XACML resource [XACMLv3].

Response
The HTTP response message returned from the server to the client [HTTP]. Note that this is not the same concept as a XACML response [XACMLv3].

Server
The agent that handles requests from a client.

1.3 Normative References


1.4 Non-Normative References


1.5 Rationale

1.5.1 Externalization of Access Control

XACML [XACMLIntro] can be used for controlling access within a single application. This removes hard-coded security constraints from the application code, making it easier to change them. It also makes it possible to use a standard Policy Decision Point (PDP), so that organizations can make a proper make-or-buy decision. For virtually all organizations, authorization is not their core business, so being able to use an off-the-shelf product is appealing.

Although these are substantial benefits, XACML really shines when authorization is completely externalized from the application. Policies can then be reused across many applications, each using the same PDP. This leads to greater consistency of access control rules and improved efficiency in maintaining them.

1.5.2 Cloud Computing

Once access control policies are externalized from the application, the PDP can become a service to be shared in a cloud computing scenario.

The National Institute of Standards and Technology (NIST) defines cloud computing as “a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction.” [Cloud]

Applying the ideas of cloud computing to access control leads to Authorization as a Service (AZaaS). The Cloud Security Alliance sees this as part of the Identity and Access Management category of service that they distinguish in the Security as a Service field [SecaaS]. Note that AZaaS requires a much heavier load on servers than Authentication as a Service, since authentication happens only once for a user session, while authorization must occur on every user action.

1.5.3 REST

In cloud computing, services are shared and must therefore be accessed over a computer network. Cloud infrastructure will thus by definition have a network-addressable API. Such an API can be built on RESTful principles.

REpresentational State Transfer (REST) is a system of architectural constraints that govern the interaction between a client and a server [REST]. In cloud computing, the client is the cloud service consumer, and the server is the cloud service itself. The constraints that REST adds to a client-server system are:

1. **Statelessness**: Each request from client to server must contain all of the information necessary to understand the request, and cannot take advantage of any stored context on the server. It improves visibility, reliability and scalability.

2. **Cache**: Data within a response to a request must be implicitly or explicitly labeled as cacheable or non-cacheable. It improves efficiency and scalability.

3. **Uniform interface**: Client and server interact through a generalized interface. It improves visibility, simplicity and evolvability, at the expense of efficiency. This is the distinguishing feature of REST. The constraints on the generalized interface are:
i. **Identification of resources**: The key abstraction of information in REST is a resource. Any information that can be named can be a resource: a document or image, a temporal service, a collection of other resources, a non-virtual object, and so on. Each resource is identified by a resource identifier. In practice, this will be a Uniform Resource Identifier [URI].

ii. **Manipulation of resources through representations**: Actions on resources are performed on representations of those resources. A representation is a sequence of bytes, plus representation metadata to describe those bytes. In practice, representations will be MIME media types [Media].

iii. **Self-descriptive messages**: All the information required to process a request is available in the request. This includes the host, message control metadata (like Content-Length), representation metadata and the resource representation.

iv. **Hypermedia as the engine of application state (HATEOAS)**: The client knows only the starting URL of the server. All future interactions are discovered from representations. This allows the server to evolve separately from the clients.

4. **Layered system**: Clients and servers can be composed of hierarchical layers such that each component cannot see beyond the immediate layer with which it is interacting. It improves simplicity and scalability at the expense of efficiency.

5. **Code-on-demand**: Client functionality can be extended by downloading and executing code in the form of applets or scripts. It improves simplicity and extensibility at the expense of visibility and security. This is an optional constraint.

The constraints of a RESTful architecture lead to simple, scalable, and evolvable systems. Simplicity means that few demands are placed on the cloud service consumer, whereas scalability and evolvability let the cloud service meet its rapid provisioning and releasing requirements, while incrementally expanding its services.

1.5.4 **RESTful Authorization as a Service**

Due to the pervasive nature of access control, Authorization-as-a-Service will result in many calls to the authorization servers. These servers must therefore perform and scale extremely well. Thus it makes sense to use a RESTful architecture for them.

This specification defines a profile for the use of XACML in a RESTful architecture, enabling the interoperability of RESTful Authorization-as-a-Service (AZaaS) solutions. The MIME media types [Media] available for representations of the various XACML constructs are defined separately [XACMLMedia].

1.6 **Use Cases**

This version of this profile will only consider the PEP and PDP. Later versions may involve other components of the XACML architecture, like the PAP and PIP.

1.6.1 **PEP ↔ PDP**

Line Of Business applications contain Policy Enforcement Points (PEPs) that interact with Policy Decision Points (PDPs) from various vendors. These PDPs may either be dedicated to the application, or be simultaneously offered to multiple applications (Authorization as a Service).
2 RESTful Services

{Normative}

2.1 Network Transport

The following URI SHALL be used as the identifier for the functionality specified in this section of this profile:

- urn:oasis:names:tc:xacml:3.0:profile:rest:http

Although not strictly required by REST, this specification mandates that HTTP MUST be used as the protocol to transport network messages [HTTP] between client and server.

For additional security, it is RECOMMENDED that SSL/TLS be used [HTTPS]. See section 3, Security Considerations, for more on securing the RESTful interactions.

Note that additional transport protocols are allowed but outside the scope of this profile.

2.2 Resources

The following sections describe the mandatory and optional resources that this profile defines. Each section defines which operations are supported on the resource, and what their requirements are. In particular, HTTP status codes [HTTP] define success or failure of the operation. See section 3, Security Considerations, for information on securing the RESTful interactions and representations.

2.2.1 Entry Point

The following URI SHALL be used as the identifier for the functionality specified in this section of this profile:

- urn:oasis:names:tc:xacml:3.0:profile:rest:home

<table>
<thead>
<tr>
<th>Operation</th>
<th>Request Body</th>
<th>Response Body</th>
<th>Description</th>
<th>Status Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>GET</td>
<td></td>
<td>XACML entry point</td>
<td></td>
<td>200, 400, 401, 403, 406, 5xx</td>
</tr>
</tbody>
</table>

To enable the discoverability requirement, a RESTful XACML system MUST have a single entry point at a known location [HomeDocument]. It is RECOMMENDED that the location of the entry point remain fixed, even as the service evolves, to allow older clients to remain functional. Each implementation of this profile MUST document the location of the entry point.

Note that the XACML entry point MAY be part of a larger RESTful system. In that case, the entry point location is not known in advance, but discovered from the enclosing system. The link relation http://docs.oasis-open.org/ns/xacml/relation/home SHALL be used for links to this resource. The documentation SHOULD contain information on how to discover the XACML entry point using this link relation.

The XACML entry point representation that is returned SHOULD NOT contain anything other than links to other resources specified in this profile.

2.2.2 Policy Decision Point

The following URI SHALL be used as the identifier for the functionality specified in this section of this profile:

- urn:oasis:names:tc:xacml:3.0:profile:rest:pdp
The link relation type for links to this resource is http://docs.oasis-open.org/ns/xacml/relation/pdp.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Request Body</th>
<th>Response Body</th>
<th>Description</th>
<th>Status Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>POST</td>
<td>XACML request</td>
<td>XACML response</td>
<td>Makes an access control decision</td>
<td>200, 400, 401, 403, 406, 415, 5xx</td>
</tr>
</tbody>
</table>

A server MUST support <Request> from XACML core [XACMLv3] as the XACML request in the request body.

A server MAY additionally support <XACMLAuthzDecisionQuery> from the SAML Profile [SAML4XACML] as the XACML request. When <XACMLAuthzDecisionQuery> is used, requests and responses can be correlated using the request's ID and the response's InResponseTo attributes. When <Request> is used, this additional functionality is not available and the PEP must either use a new TCP/IP session, or wait with sending a request over the current session until the response for the previous request is received.

The processing and response MUST be as specified in the respective specification, either [XACMLv3] or [SAML4XACML].

Note that success of the HTTP operation (i.e. status code 200) doesn’t mean that authorization is granted. It means that the response body is valid, and that the response body contains the XACML decision, which could be Deny. Likewise, a status code of 403 doesn’t imply a XACML decision of Deny, but instead means that the user is not allowed to ask the PDP for an access decision.

Also note that, although this operation uses POST, it is both idempotent and safe [HTTP].

2.3 Representations

MIME media types defined for XACML in [XACMLMedia] or elsewhere MUST be used to represent resources. Whenever a representation is not available in that specification, a conforming implementation MAY chose its own representation. However, this specification will define constraints that such a representation MUST adhere to.

2.3.1 Linking

A fundamental concept in a RESTful architecture is that of linking between resources [REST].

For XML based representations, links MUST follow the Atom Syndication Format [Atom]. The link relation types [WebLink] for the services in this specification are given in their respective sections below. For instance, a link to the PDP could be

```xml
<atom:link rel="http://docs.oasis-open.org/ns/xacml/relation/pdp"
href="/authorization/pdp"/>
```

For JSON based representations, links MUST map from Atom XML to JSON. For instance, a link to the PDP could be

```json
"link":
  {rel: "http://docs.oasis-open.org/ns/xacml/relation/pdp",
   href: "/authorization/pdp"
  }
```

Likewise, other representations SHOULD follow Atom as closely as possible.

Whenever it is not possible to add links to a representation, for instance because the representation must conform to a schema that doesn’t support links, or because the representation is binary, links MUST be added using the Link HTTP header [WebLink]. In case of multiple links, the title attribute of the Link header field MAY be used to correlate the link to an item in the representation.
2.3.2 Entry Point

The **representation** of the entry point **resource** SHOULD NOT contain anything other than links to other **resources** specified by this profile.

2.4 Examples

2.4.1 Obtain an Access Decision

The following is a sequence of REST calls to obtain an authorization decision from a PDP. The **client** starts by accessing the entry point:

```plaintext
GET /authorization HTTP/1.0
Host: www.example.com
Accept: application/xml
Content-Length: 0
```

To which the **server** responds:

```plaintext
HTTP/1.0 200 OK
Content-Type: application/xml
Content-Length: <nnnn>

<resources xmlns="http://ietf.org/ns/home-documents"
xmlns:atom="http://www.w3.org/2005/Atom">
  <resource rel="http://docs.oasis-open.org/ns/xacml/relation/pdp">
    <atom:link href="/authorization/pdp"/>
  </resource>
</resources>
```

The **client** looks for a resource with relation type `http://docs.oasis-open.org/ns/xacml/relation/pdp` and posts the XACML request to it:

```plaintext
POST /authorization/pdp HTTP/1.0
Host: www.example.com
Accept: application/xacml+xml; version=3.0
Content-Type: application/xacml+xml; version=3.0
Content-Length: <nnnn>

<Request xmlns="urn:oasis:names:tc:xacml:3.0:core:schema:wd-17">
  <!-- XACML request -->
</Request>
```

And finally the **server** responds with the access decision:

```plaintext
HTTP/1.0 200 OK
Content-Type: application/xacml+xml; version=3.0
Content-Length: <nnnn>

<Response xmlns="urn:oasis:names:tc:xacml:3.0:core:schema:wd-17">
  <!-- XACML response -->
</Response>
```
3 Security Considerations

{Non-normative}

Security and privacy considerations for the use of XACML in general are defined in [XACMLv3]. This section describes some additional considerations that have to do with the networked nature of a RESTful architecture, together with the administrative capabilities set out by this profile.

3.1 Network Transport

The use of SSL/TLS [HTTPS] is RECOMMENDED to protect data as it is transferred across the network.

3.2 Authentication

This specification leaves the issue open of how to authenticate. Implementations MUST document how they handle authentication.

HTTP status code 401 (Unauthorized) [HTTP] MAY be used to indicate that an operation on a resource is denied because the requestor is not authenticated. However, the problem of authentication over HTTP is not completely solved. [HTTPAuthN] defines Basic and Digest authentication. Basic authentication MUST NOT be used, since it sends the password in plain text over the network. Digest authentication MAY be used.

Additional standards like [OpenID], [SAMLv2] or [SASL] MAY be used instead of or in addition to HTTP Digest authentication.

3.3 Authorization

This specification RECOMMENDS that authorization be implemented using XACML. Implementations can perform authorization based upon the identity of the requestor, as well as on any appropriate additional, trusted, attribute. The use of the XACML Administration and Delegation Profile [Admin] is RECOMMENDED.

HTTP status code 403 (Forbidden) [HTTP] MUST be used to indicate that an operation on a resource is denied because the requestor is not authorized.

Authorization SHOULD be used to exclude from the response any links to resources that the requestor is not allowed to retrieve.

3.4 Non-Repudiation

In some situations it is important to have an audit trail of access decisions that were made. This audit trail must be at least tamper-evident. For this purpose, the SAML Profile for XACML [SAML4XACML] can be used to sign the access request and response.
4 Conformance

{Non-normative}

4.1 Conformance Clauses

This section lists those portions of the specification that MUST be included in an implementation of a server that claims to conform to this profile.

<table>
<thead>
<tr>
<th>Identifier</th>
<th>M/O</th>
</tr>
</thead>
<tbody>
<tr>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:http</td>
<td>M</td>
</tr>
<tr>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:home</td>
<td>M</td>
</tr>
<tr>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:pdp</td>
<td>M</td>
</tr>
</tbody>
</table>

4.2 Test Assertions

This section lists test assertions [TAG] that help verify conformance to this specification.

4.2.1 Network Transport


Normative Source

The client must use HTTP when communicating with the server (From the more general source: HTTP MUST be used as the protocol to transport network messages between client and server)

Target

Network message from the client

Predicate

The [message] starts with an HTTP request line [HTTP]

Prescription Level

mandatory


Normative Source

The server must use HTTP when communicating with the client (From the more general source: HTTP MUST be used as the protocol to transport network messages between client and server)

Target

Network message from the server

Predicate

The [message] starts with an HTTP response line [HTTP]

Prescription Level

Mandatory

4.2.2 Entry Point


Normative Source

A RESTful XACML system MUST have a single entry point at a known location. Each implementation of this profile MUST document the location of the entry point

Target

server documentation

Predicate

The [documentation] lists a (procedure for discovering a) single entry point URL at which the server can be accessed
### Prescription Level

<table>
<thead>
<tr>
<th>Id</th>
<th>Normative Source</th>
<th>Target</th>
<th>Predicate</th>
<th>Prescription Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:home:status</td>
<td>GET on the home location MUST return status code 200</td>
<td><strong>Response</strong> to <strong>GET</strong> <strong>request</strong> on the home location</td>
<td>mandatory</td>
</tr>
<tr>
<td></td>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:home:body</td>
<td>GET on the home location MUST return a home document</td>
<td><strong>Response</strong> to <strong>GET</strong> <strong>request</strong> on the home location</td>
<td>mandatory</td>
</tr>
<tr>
<td></td>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:home:pdp</td>
<td>The XACML entry point representation SHOULD contain a link to the PDP</td>
<td><strong>Response</strong> to <strong>GET</strong> <strong>request</strong> on the home location</td>
<td>mandatory</td>
</tr>
</tbody>
</table>

### 4.2.3 Policy Decision Point

<table>
<thead>
<tr>
<th>Id</th>
<th>Normative Source</th>
<th>Target</th>
<th>Predicate</th>
<th>Prescription Level</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:xacml:status</td>
<td>POST on the PDP with a valid XACML request MUST return status code 200</td>
<td><strong>Response</strong> to <strong>POST</strong> <strong>request</strong> on the PDP location with valid XACML request in the body</td>
<td>mandatory</td>
</tr>
<tr>
<td></td>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:xacml:body</td>
<td>POST on the PDP with a valid XACML request MUST return a valid XACML response in the body</td>
<td><strong>Response</strong> to <strong>POST</strong> <strong>request</strong> on the PDP location with valid XACML request in the body</td>
<td>mandatory</td>
</tr>
<tr>
<td></td>
<td>urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:xacml:invalid</td>
<td>POST on the PDP with an invalid XACML request MUST return status code 400 (Bad Request)</td>
<td><strong>Response</strong> to <strong>POST</strong> <strong>request</strong> on the PDP location with invalid XACML request in the body</td>
<td>mandatory</td>
</tr>
<tr>
<td>Target</td>
<td>Response to POST request on the PDP location with invalid XACML request in the body</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicate</td>
<td>The HTTP status code in the [response] is 400</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prescription Level</td>
<td>mandatory</td>
<td></td>
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<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>Normative Source</td>
<td>POST on the PDP with a valid XACML request MUST return status code 200</td>
</tr>
<tr>
<td>Target</td>
<td>Response to POST request on the PDP location with valid XACML request wrapped in a xacml-samlp:XACMLAuthzDecisionQuery in the body</td>
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<tr>
<td>Predicate</td>
<td>The HTTP status code in the [response] is 200</td>
</tr>
<tr>
<td>Prescription Level</td>
<td>optional</td>
</tr>
</tbody>
</table>

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<tbody>
<tr>
<td>Normative Source</td>
<td>POST on the PDP with a valid XACML request MUST return a valid XACML response in the body</td>
</tr>
<tr>
<td>Target</td>
<td>Response to POST request on the PDP location with valid XACML request wrapped in a xacml-samlp:XACMLAuthzDecisionQuery in the body</td>
</tr>
<tr>
<td>Predicate</td>
<td>The HTTP body in the [response] is a valid XACML response wrapped in a samlp:Response</td>
</tr>
<tr>
<td>Prescription Level</td>
<td>optional</td>
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<tbody>
<tr>
<td>Normative Source</td>
<td>POST on the PDP with an invalid XACML request MUST return status code 400 (Bad Request)</td>
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<tr>
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<tr>
<td>Predicate</td>
<td>The HTTP status code in the [response] is 400</td>
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<tr>
<td>Prescription Level</td>
<td>optional</td>
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</table>
Appendix A. Acknowledgments

The following individuals have participated in the creation of this specification and are gratefully acknowledged:

**Participants:**
- David Brossard, Axiomatics
- Jean-Paul Buu-Sao, TSCP
- Jacques Durand, Fujitsu
- Craig Forster, IBM
- Hal Lockhart, Oracle
- Danny Thorpe, Dell
- Erik Wilde, EMC
## Appendix B. Revision History

<table>
<thead>
<tr>
<th>Revision</th>
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<tbody>
<tr>
<td>WD01</td>
<td>2012-02-14</td>
<td>Rémon Sinnema</td>
<td>Defined use cases</td>
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<tr>
<td>WD02</td>
<td>2012-04-24</td>
<td>Rémon Sinnema</td>
<td>Initial full draft</td>
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</table>
| WD03     | 2012-05-03 | Rémon Sinnema | Fixed typos
Renamed Use Cases section to Rationale
Introduced Use Cases section
Moved everything representation related out of the section on resources
Added examples
Improved authorization section |
| WD04     | 2012-05-22 | Rémon Sinnema | Conformance section should succinctly indicate what needs to be implemented
Added platform use case
Added policy version resource |
| WD05     | 2012-05-31 | Rémon Sinnema | PDP is now optional, allowing PAP-only servers
Added explanatory text for delete example
Added note on policies contained within policy sets
Added note that supplied policies must be valid according to the policy schema
Improved wording in Security section
Added "lost" paragraph from WD02 about the contents of the entry point resource
Added text on different types of PAPs
Added text on policy (version) equality
Added use of HTTP to conformance section |
| WD06     | 2012-10-9  | Rémon Sinnema | Added domain terms
Added section on test assertions
Removed policy administration related text
Updated text to better fit the home document standard
Added section on non-repudiation
Replaced reference to XACML Media Types Profile with URL of Internet Draft
Added text on embedding XACML REST in a larger RESTful system |