



REST Profile of XACML v3.0 Version 1.0

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Abstract:

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

Status:

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

This specification begins with a discussion of the topics and terms of interest in this profile. It then describes the details of RESTful services that conforming implementations must support. All sections of this profile are normative unless explicitly stated otherwise.

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* [HTTPMessage]. 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* [HTTPMessage]. 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

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1.4 Non-Normative References

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- [Media]** *MIME Media Types*. <http://www.iana.org/assignments/media-types/index.html>
- [OAuth]** *The OAuth 2.0 Authorization Framework*. October 2012. IETF RFC 6749. <http://tools.ietf.org/html/rfc6749>

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[REST]	<i>Roy Fielding, Architectural Styles and the Design of Network-based Software Architectures</i> . 2000. http://www.ics.uci.edu/~fielding/pubs/dissertation/fielding_dissertation.pdf
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[Siren]	<i>Siren</i> . November 2012. Draft. http://www.iana.org/assignments/media-types/application/vnd.siren+json
[UBER]	<i>Uniform Basis for Exchanging Representations (UBER)</i> . June 2014. Draft. https://github.com/mamund/media-types/blob/master/uber-hypermedia.asciidoc
[XACMLIntro]	<i>A Brief Introduction to XACML</i> . 14 March 2003, http://www.oasis-open.org/committees/download.php/2713/Brief_Introduction_to_XACML.html

1.5 Rationale

{Non-normative}

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 described by 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

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 [**HTTPMessage**] 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 [**HTTPSemantics**] 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`

Operation	Request Body	Response Body	Description	Status Codes
GET		XACML entry point		200, 400, 401, 403, 406, 5xx

To enable the discoverability requirement, a RESTful XACML system MUST have a single entry point at a known location (the “billboard URI”). 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 for links to this *resource* is

`http://docs.oasis-open.org/ns/xacml/relation/pdp`.

Operation	Request Body	Response Body	Description	Status Codes
POST	XACML request	XACML response	Makes an access control decision	200, 400, 401, 403, 406, 415, 5xx

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].

The POST method is used rather than GET because the XACML request may contain sensitive data and because of practical considerations like limits on URI length [HTTPMethod]. Although the POST method is used, this operation is both idempotent and safe [HTTPSemantics]. It is RECOMMENDED that **servers** include cache control headers [HTTPCache] in their **responses** to make this explicit.

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.

2.3 Representations

XACML requests and responses SHOULD be represented using registered media types defined specifically for XACML, in [XACMLMedia] or elsewhere (e.g. in the upcoming JSON profile).

Other representations MAY use any media type that matches the constraints outlined in the remainder of this section.

2.3.1 Linking

A fundamental concept in a RESTful architecture is that of linking between **resources** [REST]. It is therefore of the utmost importance to use media types, like the Atom Syndication Format [Atom], that define linking structures. Such media types are also referred to as hypermedia types.

There has been a spur of activity in this space recently. Interesting examples are [Mason], [Siren], and [UBER].

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 in Atom [Atom] would be represented as

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

The same link to the PDP in Siren [Siren] would be represented as

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

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.

2.3.3 XACML versions, Representation Formats, and Content Negotiation

This profile is agnostic to the version and format of XACML used. **Clients** and **servers** SHOULD use content negotiation [HTTPSemantics] to agree on the version and format of XACML used in their exchanges. XACML media types [Media] MUST support a `version` parameter for this purpose. See the Examples section for the use of the `Accept` and `Content-Type` headers [HTTPSemantics] used in content negotiation.

It's an error for **clients** or **servers** to send a body where the **representation** doesn't match the `Content-Type`. **Servers** MUST return `400 Bad Request` when a **client** does so.

HTTP allows `Content-Type` and `Accept` to be different, so a **client** could supply a JSON-formatted **request** and ask for an XML-formatted **response** or vice versa. Although this profile doesn't define a use case for that, it also doesn't forbid it. **Servers** that are not willing to honor such **requests** SHOULD either return `406 Not Acceptable` or simply return the **response** in the format of their choosing.

2.4 Examples

{Non-normative}

2.4.1 Obtain an Access Decision

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

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

To which the **server** responds:

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

<?xml version="1.0"?>
<resources xmlns="http://ietf.org/ns/home-documents" >
  <resource rel="http://docs.oasis-open.org/ns/xacml/relation/pdp">
    <link href="/authorization/pdp"/>
  </resource>
</resources>
```

In this example, the response follows the XML syntax for home documents [HomeDocXml].

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:

```
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>

<?xml version="1.0"?>
<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:

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

<?xml version="1.0"?>
<Response xmlns="urn:oasis:names:tc:xacml:3.0:core:schema:wd-17">
  <!-- XACML response -->
</Response>
```

3 Security Considerations

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 the requestor. Implementations MUST document how they handle authentication.

HTTP status code 401 (Unauthorized) [HTTPAuthN] 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], [OAuth], [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) [HTTPSemantics] 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 access.

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

{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.

Identifier	M/O
urn:oasis:names:tc:xacml:3.0:profile:rest:http	M
urn:oasis:names:tc:xacml:3.0:profile:rest:home	M
urn:oasis:names:tc:xacml:3.0:profile:rest:pdp	M

4.2 Test Assertions

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

4.2.1 Network Transport

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:http:client
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 [HTTPMessage]
Prescription Level	mandatory

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:http:server
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 [HTTPMessage]
Prescription Level	Mandatory

4.2.2 Entry Point

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:home:documentation
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	mandatory
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Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:home:status
Normative Source	GET on the entry point location MUST return status code 200
Target	Response to GET request on the entry point location
Predicate	The HTTP status code in the [response] is 200
Prescription Level	Mandatory

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:home:pdp
Normative Source	The XACML entry point representation SHOULD contain a link to the PDP
Target	Response to GET request on the entry point location
Predicate	The [response] body contains a resource with link relation <code>http://docs.oasis-open.org/ns/xacml/relation/pdp</code> and a valid URL
Prescription Level	mandatory

4.2.3 Policy Decision Point

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:xacml:status
Normative Source	POST on the PDP with a valid XACML request MUST return status code 200
Target	Response to POST request on the PDP location with valid XACML request in the body
Predicate	The HTTP status code in the [response] is 200
Prescription Level	mandatory

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:xacml:body
Normative Source	POST on the PDP with a valid XACML request MUST return a valid XACML response in the body
Target	Response to POST request on the PDP location with valid XACML request in the body
Predicate	The HTTP body in the [response] is a valid XACML response
Prescription Level	mandatory

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:xacml:invalid
Normative Source	POST on the PDP with an invalid XACML request MUST return status code 400 (Bad Request)
Target	Response to POST request on the PDP location with invalid XACML request in the body
Predicate	The HTTP status code in the [response] is 400
Prescription Level	mandatory

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:saml:status
Normative Source	POST on the PDP with a valid XACML request MUST return status code 200

Target	Response to <code>POST request</code> on the PDP location with valid XACML request wrapped in a <code>xacml-samlp:XACMLAuthzDecisionQuery</code> in the body
Predicate	The HTTP status code in the [response] is 200
Prescription Level	optional

Id	urn:oasis:names:tc:xacml:3.0:profile:rest:assertion:pdp:saml:body
Normative Source	<code>POST</code> on the PDP with a valid XACML request MUST return a valid XACML response in the body
Target	Response to <code>POST request</code> on the PDP location with valid XACML request wrapped in a <code>xacml-samlp:XACMLAuthzDecisionQuery</code> in the body
Predicate	The HTTP body in the [response] is a valid XACML response wrapped in a <code>samlp:Response</code>
Prescription Level	optional

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

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
- David Chadwick, Individual
- Jacques Durand, Fujitsu
- Craig Forster, IBM
- Hal Lockhart, Oracle
- Danny Thorpe, Dell
- Erik Wilde, EMC

Appendix B. Revision History

Revision	Date	Editor	Changes Made
WD01	2012-02-14	Rémon Sinnema	Defined use cases
WD02	2012-04-24	Rémon Sinnema	Initial full draft
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
WD07	2013-01-25	Rémon Sinnema	Added section on content negotiation
WD08	2014-06-10	Rémon Sinnema	Renamed to follow profile naming convention. Fixed normative/non-normative indicators on sections. Updated HTTP RFCs. Added text on HTTP level caching. Added explanation on the use of <code>POST</code> rather than <code>GET</code> . Replaced XACML media type draft with RFC. Added text on hypermedia types. Added text on sending JSON requests and asking for XML responses or vice versa.

			Relaxed constraints on entry point representation.
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