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S. Hollenbeck
Verisign Labs

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Federated Authentication for the Registration Data Access Protocol (RDAP) using OpenID Connect
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Abstract

The Registration Data Access Protocol (RDAP) provides "RESTful" web services to retrieve registration metadata from domain name and regional internet registries. RDAP allows a server to make access control decisions based on client identity, and as such it includes support for client identification features provided by the Hypertext Transfer Protocol (HTTP). Identification methods that require clients to obtain and manage credentials from every RDAP server operator present management challenges for both clients and servers, whereas a federated authentication system would make it easier to operate and use RDAP without the need to maintain server-specific client credentials. This document describes a federated authentication system for RDAP based on OpenID Connect.

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Table of Contents

1. Introduction

The Registration Data Access Protocol (RDAP) provides "RESTful" web services to retrieve registration metadata from domain name and regional internet registries. RDAP allows a server to make access control decisions based on client identity, and as such it includes support for client identification features provided by the Hypertext Transfer Protocol (HTTP) [RFC7230].

RDAP is specified in multiple documents, including "HTTP Usage in the Registration Data Access Protocol (RDAP)" [RFC7480], "Security Services for the Registration Data Access Protocol (RDAP)" [RFC7481], "Registration Data Access Protocol Query Format" [RFC7482], and "JSON Responses for the Registration Data Access Protocol (RDAP)" [RFC7483]. RFC 7481 describes client identification and authentication services that can be used with RDAP, but it does not specify how any of these services can (or should) be used with RDAP.

1.1. Problem Statement

The traditional "user name and password" authentication method does not scale well in the RDAP ecosystem. Assuming that all domain name and address registries will eventually provide RDAP service, it is impractical and inefficient for users to secure login credentials from the hundreds of different server operators. Authentication methods based on user names and passwords do not provide information that describes the user in sufficient detail (while protecting the personal privacy of the user) for server operators to make fine-grained access control decisions based on the user's identity. The authentication system used for RDAP needs to address all of these needs.

1.2. Proposal

A basic level of RDAP service can be provided to users who possess an identifier issued by a recognized provider who is able to authenticate and validate the user. The identifiers issued by social media services, for example, can be used. Users who require higher levels of service (and who are willing to share more information about them self to gain access to that service) can secure identifiers from specialized providers who are or will be able to provide more detailed information about the user. Server operators can then make access control decisions based on the identification information provided by the user.

A federated authentication system would make it easier to operate and use RDAP by re-using existing identifiers to provide a basic level of access. It can also provide the ability to collect additional user

identification information, and that information can be shared with the consent of the user. This document describes a federated authentication system for RDAP based on OpenID Connect [OIDC] that meets all of these needs.

2. Conventions Used in This Document

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 RFC 2119 [RFC2119].

3. Federated Authentication for RDAP

RDAP itself does not include native security services. Instead, RDAP relies on features that are available in other protocol layers to provide needed security services including access control, authentication, authorization, availability, data confidentiality, data integrity, and identification. A description of each of these security services can be found in "Internet Security Glossary, Version 2" [RFC4949]. This document focuses on a federated authentication system for RDAP that provides services for authentication, authorization, and identification, allowing a server operator to make access control decisions. Section 3 of RFC 7481 [RFC7481] describes general considerations for RDAP access control, authentication, and authorization.

The traditional client-server authentication model requires clients to maintain distinct credentials for every RDAP server. This situation can become unwieldy as the number of RDAP servers increases. Federated authentication mechanisms allow clients to use one credential to access multiple RDAP servers and reduce client credential management complexity.

3.1. RDAP and OpenID Connect

OpenID Connect 1.0 [OIDCC] is a decentralized, single sign-on (SSO) federated authentication system that allows users to access multiple web resources with one identifier instead of having to create multiple server-specific identifiers. Users acquire identifiers from OpenID Providers, or OPs. Relying Parties, or RPs, are applications (such as RDAP) that outsource their user authentication function to an OP. OpenID Connect is built on top of the authorization framework provided by the OAuth 2.0 [RFC6749] protocol.

The OAuth authorization framework describes a method for users to access protected web resources without having to hand out their credentials. Instead, clients are issued Access Tokens by authorization servers with the permission of the resource owners.

Using OpenID Connect and OAuth, multiple RDAP servers can form a federation and clients can access any server in the federation by providing one credential registered with any OP in that federation. The OAuth authorization framework is designed for use with HTTP and thus can be used with RDAP.

3.1.1. Terminology

This document uses the terms "client" and "server" defined by RDAP [RFC7480]. An RDAP client performs the role of an OpenID Connect Core [OIDCC] Entity or End-User. An RDAP server performs the role of an OpenID Connect Core Relying Party (RP). Additional terms from Section 1.2 of the OpenID Connect Core specification are incorporated by reference.

3.1.2. Overview

At a high level, RDAP authentication of a browser-based client using OpenID Connect requires completion of the following steps:

1. An RDAP client (acting as an OpenID End-User) sends an HTTP (or HTTPS) query containing OAuth 2.0 request parameters to an RDAP server.
2. The RDAP server (acting as an OpenID Relying Party (RP)) prepares an Authentication Request containing the desired request parameters.
3. The RDAP server sends the RDAP client and Authentication Request to an Authorization Server operated by an OpenID Provider (OP) using an HTTP redirect.
4. The Authorization Server authenticates the RDAP Client.
5. The Authorization Server obtains RDAP Client consent/ authorization.
6. The Authorization Server sends the RDAP Client back to the RDAP server with an Authorization Code using an HTTP redirect.
7. The RDAP server requests a response using the Authorization Code at the Token Endpoint.
8. The RDAP server receives a response that contains an ID Token and Access Token in the response body.
9. The RDAP server validates the ID Token and retrieves the RDAP client's Subject Identifier.

The RDAP server can then make identification, authorization, and access control decisions based on local policies, the ID Token received from the OP, and the received Claims. Note that OpenID Connect describes different process flows for other types of clients, such as script-based or command line clients.

3.1.3. RDAP Authentication and Authorization Steps

End-Users MUST possess an identifier (an OpenID) issued by an OP to use OpenID Connect with RDAP. The OpenID Foundation maintains a list of OPs on its web site [1]. Additional OPs are almost certainly needed to fully realize the potential for federated authentication with RDAP because RDAP has authorization and access control requirements that go beyond the end-user authentication requirements of a typical web site.

OpenID Connect requires RPs to register with OPs to use OpenID Connect services for an End-User. That process is REQUIRED and is described by the "OpenID Connect Dynamic Client Registration" protocol [OIDCR].

3.1.3.1. Provider Discovery

An RDAP server/RP needs to receive an identifier from an End-User that can be used to discover the End-User's OP. That process is REQUIRED and is documented in the "OpenID Connect Discovery" protocol [OIDCD].

3.1.3.2. Authentication Request

Once the OP is known, an RP MUST form an Authentication Request and send it to the OP as described in Section 3 of the OpenID Connect Core protocol [OIDCC]. The authentication path followed (authorization, implicit, or hybrid) will depend on the Authentication Request response_type set by the RP. The remainder of the processing steps described here assume that the Authorization Code Flow is being used by setting "response_type=code" in the Authentication Request.

The benefits of using the Authorization Code Flow for authenticating a human user are described in Section 3.1 of the OpenID Connect Core protocol. The Implicit Flow is more commonly used by clients implemented in a web browser using a scripting language; it is described in Section 3.2 of the OpenID Connect Core protocol. The Hybrid Flow (described in Section 3.3 of the OpenID Connect Core protocol) combines elements of the Authorization and Implicit Flows by returning some tokens from the Authorization Endpoint and others from the Token Endpoint.

An Authentication Request can contain several parameters. REQUIRED parameters are specified in Section 3.1.2.1 of the OpenID Connect Core protocol [OIDCC]. Other parameters MAY be included.

The OP receives the Authentication Request and attempts to validate it as described in Section 3.1.2.2 of the OpenID Connect Core protocol [OIDCC]. If the request is valid, the OP attempts to authenticate the End-User as described in Section 3.1.2.3 of the OpenID Connect Core protocol [OIDCC]. The OP returns an error response if the request is not valid or if any error is encountered.

3.1.3.3. End-User Authorization

After the End-User is authenticated, the OP MUST obtain authorization information from the End-User before releasing information to the RDAP Server/RP. This process is described in Section 3.1.2.4 of the OpenID Connect Core protocol [OIDCC].

3.1.3.4. Authorization Response and Validation

After the End-User is authenticated, the OP will send a response to the RP that describes the result of the authorization process in the form of an Authorization Grant. The RP MUST validate the response. This process is described in Sections 3.1.2.5 - 3.1.2.7 of the OpenID Connect Core protocol [OIDCC].

3.1.3.5. Token Processing

The RP sends a Token Request using the Authorization Grant to a Token Endpoint to obtain a Token Response containing an Access Token, ID Token, and an OPTIONAL Refresh Token. The RP MUST validate the Token Response. This process is described in Sections 3.1.3 - 3.1.3.8 of the OpenID Connect Core protocol [OIDCC].

3.1.3.6. Delivery of User Information

The set of Claims can be retrieved by sending a request to a UserInfo Endpoint using the Access Token. The Claims MAY be returned in the ID Token. The process of retrieving Claims from a UserInfo Endpoint is described in Sections 5.3 - 5.3.4 of the OpenID Connect Core protocol [OIDCC].

OpenID Connect specified a set of standard Claims in Section 5.1. Additional Claims for RDAP are described in Section 3.1.4.1.

3.1.4. Specialized Parameters for RDAP

3.1.4.1. Claims

OpenID Connect claims are pieces of information used to make assertions about an entity. Section 5 of the OpenID Connect Core protocol [OIDCC] describes a set of standard claims that can be used

to identify a person. Section 5.1.2 notes that additional claims MAY be used, and it describes a method to create them.

3.1.4.1.1. Stated Purpose

There are communities of RDAP users and operators who wish to make and validate claims about a user's "need to know" when it comes to requesting access to a resource. For example, a law enforcement agent or a trademark attorney may wish to be able to assert that they have a legal right to access a protected resource, and a server operator will need to be able to receive and validate that claim. These needs can be met by defining and using an additional "purpose" claim.

The "purpose" claim identifies the purpose for which access to a protected resource is being requested. The processing of this claim is subject the server acceptance of the purpose and successful authentication of the End-User. The "purpose" value is a case-sensitive string containing a StringOrURI value as specified in Section 2 of the JSON Web Token (JWT) specification ([RFC7519]). Use of this claim is OPTIONAL.

4. Protocol Parameters

This specification adds the following protocol parameters to RDAP:

1. A query parameter to request authentication for a specific end-user identity.
2. A path segment to request an ID Token and an Access Token for a specific end-user identity.
3. A query parameter to deliver an ID Token and an Access Token for use with an RDAP qeury.

4.1. Client Authentication Request and Response

Client authentication is requested by adding a query component to an RDAP request URI using the syntax described in Section 3.4 of RFC 3986 [RFC3986]. The query used to request client authentication is represented as a "key=value" pair using a key value of "id" and a value component that contains the client identifier issued by an OP. An example:

https://example.com/rdap/domain/example.com?id=user.idp.example

The response to an authenticated query MUST use the response structures specified in RFC 7483 [RFC7483]. Information that the end-user is not authorized to receive MUST be omitted from the response.

4.2. Token Request and Response

Clients MAY send a request to an RDAP server to authenticate an end-user and return an ID Token and an Access Token from an OP that can be then be passed to the RP/RDAP server to authenticate and process subsequent queries. Identity provider authentication is requested using a "tokens" path segment and a query parameter with key value of "id" and a value component that contains the client identifier issued by an OP. An example:

https://example.com/rdap/tokens?id=user.idp.example

The response to this query MUST contain a JSON object that contains two name-value pairs, in any order, representing the returned ID Token and Access Token. The ID Token is represented using a key value of "id_token". The Access Token is represented using a key value of "access_token". The token values returned in the RDAP server response MUST be Base64url encoded as described in RFCs 7515 [RFC7515] and 7519 [RFC7519].

An example (the encoded tokens have been abbreviated for clarity):

```
{
 "access_token" : "eyJ0...NiJ9",
 "id_token" : "eyJ0...EjXk"
}
```

Figure 1

An RDAP server that processes this type of query MUST determine if the identifier is associated with an OP that is recognized and supported by the server. Servers MUST reject queries that include an identifier associated with an unsupported OP with an HTTP 501 (Not Implemented) response. An RDAP server that receives a query containing an identifier associated with a recognized OP MUST perform the steps required to authenticate the user with the OP using a browser or browser-like client and return encoded tokens to the client. Note that tokens are typically valid for a limited period of time and new tokens will be required when an existing token's validity period has expired.

The tokens can then be passed to the server for use with an RDAP query using a query parameter with key values of "id_token" and "access_token" and values that represent the encoded tokens. An example (the encoded tokens have been abbreviated and the URI split across multiple lines for clarity):

https://example.com/rdap/domain/example.com

```
?id_token=eyJ0...EjXk
&access_token=eyJ0...NiJ9
```

The response to an authenticated query MUST use the response structures specified in RFC 7483 [RFC7483]. Information that the end-user is not authorized to receive MUST be omitted from the response.

4.3. Parameter Processing

An RDAP server that receives a query containing tokens associated with a recognized OP and authenticated end user MUST process the query and return an RDAP response that is appropriate for the end user's level of authorization and access. Errors based on processing the token MUST be signaled with an appropriate HTTP status code as described in Section 3.1 of RFC 6750 [RFC6750].

Unrecognized query parameters MUST be ignored. An RDAP request that does not include an "id" query component MUST be processed as an unauthenticated query. An RDAP server that processes an authenticated query MUST determine if the identifier is associated with an OP that is recognized and supported by the server. Servers MUST reject queries that include an identifier associated with an unsupported OP with an HTTP 501 (Not Implemented) response. An RDAP server that receives a query containing an identifier associated with a recognized OP MUST perform the steps required to authenticate the user with the OP, process the query, and return an RDAP response that is appropriate for the end user's level of authorization and access.

5. Non-Browser Clients

The flow described in Section 3.1.3 requires a client to interact with a server using a web browser. This will not work well in situations where the client is automated or an end-user is using a command-line client such as curl [2] or wget [3]. This is a known issue with OpenID Connect, and is typically addressed using a two-step process:

1. Authenticate with the OP using a browser or browser-like client and store the ID Token and Access Token locally.
2. Send a request to the content provider/RP along with the ID Token and Access Token received from the OP.

The Access Token MAY be passed to the RP in an HTTP "Authorization" header [RFC7235] or as a query parameter. The Access Token MUST be specified using the "Bearer" authentication scheme [RFC6750] if it is passed in an "Authorization" header. The ID Token MUST be passed to the RP as a query parameter.

Here are two examples using the curl and wget utilities. Start by authenticating with the OP:

https://example.com/rdap/tokens?id=user.idp.example

Save the token information and pass it to the RP along with the URI representing the RDAP query. Using curl (encoded tokens have been abbreviated for clarity:

```
curl -H "Authorization: Bearer eyJ0...NiJ9"\
-k https://example.com/rdap/domain/example.com\
?id_token=eyJ0...EjXk

curl -k https://example.com/rdap/domain/example.com\
?id_token=eyJ0...EjXk&access_token=eyJ0...NiJ9
```

Using wget:

```
wget --header="Authorization: Bearer eyJ0...NiJ9"\
https://example.com/rdap/domain/example.com\
?id_token=eyJ0...EjXk

wget https://example.com/rdap/domain/example.com\
?id_token=eyJ0...EjXk&access_token=eyJ0...NiJ9
```

6. Additional Questions and Discussion Topics

For the time being this section will serve as a place to capture unanswered questions, topics for future discussion, and anything else that might deserve additional text in the future.

Recursive or proxy RDAP servers: how might federated authentication work in a model where a subset of RDAP servers act as proxies to other RDAP servers? Is it possible to cache user credentials in such a way that authentication process latency can be reduced?

Additional claims: are there any other claims that need to be defined and registered?

Implementations: does it make sense to add text describing existing implementations that can be used for experimentation?

7. IANA Considerations

IANA is requested to register the following value in the JSON Web Token Claims Registry:

Claim Name: "purpose"

Claim Description: The stated purpose for submitting a request to access a protected RDAP resource.
Change Controller: Scott Hollenbeck, shollenbeck@verisign.com
Specification Document(s): Section 3.1.4.1.1 of this document.

8. Security Considerations

Security considerations for RDAP can be found in RFC 7481 [RFC7481]. Security considerations for OpenID Connect Core [OIDCC] and OAuth [RFC6749] can be found in their reference specifications. OpenID Connect defines optional mechanisms for robust signing and encryption that can be used to provide data integrity and data confidentiality services as needed. Security services for ID Tokens and Access Tokens (with references to the JWT specification) are described in the OpenID Connect Core protocol.

8.1. Authentication and Access Control

Having completed the client identification, authorization, and validation process, an RDAP server can make access control decisions based on a comparison of client-provided information and local policy. For example, a client who provides an email address (and nothing more) might be entitled to receive a subset of the information that would be available to a client who provides an email address, a full name, and a stated purpose. Development of these access control policies is beyond the scope of this document.

9. Acknowledgements

The author would like to acknowledge the following individuals for their contributions to the development of this document: Rhys Smith, Jaromir Talir, and Alessandro Vesely. In addition, the Verisign Registry Services Lab development team of Sai Mogali, Swapneel Sheth, and Nitin Singh provided critical "proof of concept" implementation experience that helped demonstrate the validity of the concepts described in this document.

10. References

10.1. Normative References

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10.3. URIs

[1] http://openid.net/get-an-openid/

[2] http://curl.haxx.se/

[3] https://www.gnu.org/software/wget/

Appendix A. Change Log

00: Initial version.
01: Updated flow description (Section 3.1.2) and description of the registration process (Section 3.1.3). Thanks to Jaromir Talir.
02: Updated flow description.
03: Added description of query parameters and non-browser clients. Updated security considerations to note issues associated with access control.
04: Updated references for JSON Web Token, OpenID Connect Core, and OpenID Connect Discovery. Added acknowledgement to the Verisign Labs developers. Changed intended status to Standards Track. Added text to describe protocol parameters and processing. Other minor edits.
05: Added examples for curl and wget. Added a reference to RFC 7235.

Author's Address

Scott Hollenbeck
Verisign Labs
12061 Bluemont Way
Reston, VA 20190
USA

Email: shollenbeck@verisign.com
URI: http://www.verisignlabs.com/