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RFC 9224
Finding the Authoritative Registration Data Access Protocol (RDAP) Service

Abstract

This document specifies a method to find which Registration Data Access Protocol (RDAP) server is authoritative to answer queries for a requested scope, such as domain names, IP addresses, or Autonomous System numbers. This document obsoletes RFC 7484.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 7841.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at https://www.rfc-editor.org/info/rfc9224.

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1. Introduction

Querying and retrieving registration data from registries are defined in the Registration Data Access Protocol (RDAP) [RFC7480] [RFC7481] [RFC9082] [RFC9083]. These documents do not specify where to send the queries. This document specifies a method to find which server is authoritative to answer queries for the requested scope.

Top-Level Domains (TLDs), Autonomous System (AS) numbers, and network blocks are delegated by IANA to Internet registries such as TLD registries and Regional Internet Registries (RIRs) that then issue further delegations and maintain information about them. Thus, the bootstrap information needed by RDAP clients is best generated from data and processes already maintained by IANA; the relevant registries already exist at [ipv4reg], [ipv6reg], [asreg], and [domainreg]. This document obsoletes [RFC7484].

Per this document, IANA has created new registries based on a JSON format specified in this document, herein named RDAP Bootstrap Service Registries. These new registries are based on the existing entries of the above-mentioned registries. An RDAP client fetches the RDAP Bootstrap Service Registries, extracts the data, and then performs a match with the query data to find the authoritative registration data server and appropriate query base URL.

2. Conventions Used in This Document

The key words "**MUST**", "**MUST NOT**", "**REQUIRED**", "**SHALL**", "**SHALL NOT**", "**SHOULD**", "**SHOULD NOT**", "**RECOMMENDED**", "**NOT RECOMMENDED**", "**MAY**", and "**OPTIONAL**" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

3. Structure of the RDAP Bootstrap Service Registries

The RDAP Bootstrap Service Registries, as specified in Section 12 below, have been made available as JSON [RFC8259] objects, which can be retrieved via HTTP from locations specified by IANA. The JSON object for each registry contains a series of members containing metadata about the registry such as a version identifier, a timestamp of the publication date of the registry, and a description. Additionally, a "services" member contains the registry items themselves, as an array. Each item of the array contains a second-level array, with two elements, each of them being a third-level array.

Each element of the Services Array is a second-level array with two elements: in order, an Entry Array and a Service URL Array.

The Entry Array contains all entries that have the same set of base RDAP URLs. The Service URL Array contains the list of base RDAP URLs usable for the entries found in the Entry Array. Elements within these two arrays are not ordered in any way.

An example structure of the JSON output of an RDAP Bootstrap Service Registry is illustrated:

```
{
    "version": "1.0",
    "publication": "YYYY-MM-DDTHH:MM:SSZ",
    "description": "Some text",
    "services": [
      [
        ["entry1", "entry2", "entry3"],
        [
          "https://registry.example.com/myrdap/",
          "http://registry.example.com/myrdap/"
        ]
      ],
      [
        ["entry4"],
        [
          "https://example.org/"
        ]
      ]
    ]
}
```

The formal syntax is described in Section 10.

The "version" corresponds to the format version of the registry. This specification defines version "1.0".

The syntax of the "publication" value conforms to the Internet date/time format [RFC3339]. The value is the latest update date of the registry by IANA.

The optional "description" string can contain a comment regarding the content of the bootstrap object.

Per [RFC7258], in each array of base RDAP URLs, the secure versions of the transport protocol **SHOULD** be preferred and tried first. For example, if the base RDAP URLs array contains both HTTPS and HTTP URLs, the bootstrap client **SHOULD** try the HTTPS version first.

Base RDAP URLs **MUST** have a trailing "/" character because they are concatenated to the various segments defined in [RFC9082].

JSON names **MUST** follow the format recommendations of Section 6 of [RFC7480]. Any unrecognized JSON object properties or values **MUST** be ignored by implementations.

Internationalized Domain Name labels used as entries or base RDAP URLs in the registries defined in this document **MUST** be only represented using their A-label form as defined in [RFC5890].

All Domain Name labels used as entries or base RDAP URLs in the registries defined in this document **MUST** be only represented in lowercase.

4. Bootstrap Service Registry for Domain Name Space

The JSON output of this registry contains domain label entries attached to the root, grouped by base RDAP URLs, as shown in this example.

```
{
    "version": "1.0",
    "publication": "2024-01-07T10:11:12Z",
    "description": "Some text",
    "services": [
      [
        ["net", "com"],
        [
          "https://registry.example.com/myrdap/"
        ]
      ],
      [
        ["org", "mytld"],
        [
          "https://example.org/"
        ]
      ],
      [
        ["xn--zckzah"],
        [
          "https://example.net/rdap/xn--zckzah/",
          "http://example.net/rdap/xn--zckzah/"
        ]
      ]
    ]
}
```

The domain name's authoritative registration data service is found by doing the label-wise longest match of the target domain name with the domain values in the Entry Arrays in the IANA "Bootstrap Service Registry for Domain Name Space". The match is done per label, from right to left. If the longest match results in multiple entries, then those entries are considered equivalent. The values contained in the Service URL Array of the matching second-level array are the valid base RDAP URLs as described in [RFC9082].

For example, a domain RDAP query for a.b.example.com matches the com entry in one of the arrays of the registry. The base RDAP URL for this query is then taken from the second element of the array, which is an array of base RDAP URLs valid for this entry. The client chooses one of the base URLs from this array; in this example, it chooses the only one available, "https://registry.example.com/myrdap/". The segment specified in [RFC9082] is then appended to the base URL to complete the query. The complete query is then "https://registry.example.com/myrdap/domain/a.b.example.com".

If a domain RDAP query for a.b.example.com matches both com and example.com entries in the registry, then the longest match applies and the example.com entry is used by the client.

If the registry contains entries such as com and goodexample.com, then a domain RDAP query for example.com only matches the com entry because matching is done on a per-label basis.

The entry for the root of the domain name space is specified as "".

5. Bootstrap Service Registries for Internet Numbers

This section discusses IPv4 and IPv6 address space and Autonomous System numbers.

For IP address space, the authoritative registration data service is found by doing a longest match of the target address with the values of the arrays in the corresponding RDAP Bootstrap Service Registry for Address Space. The longest match is done the same way as in packet forwarding: the addresses are converted in binary form and then the binary strings are compared to find the longest match up to the specified prefix length. The values contained in the second element of the array are the base RDAP URLs as described in [RFC9082]. The longest match method enables covering prefixes of a larger address space pointing to one base RDAP URL while more specific prefixes within the covering prefix are being served by another base RDAP URL.

5.1. Bootstrap Service Registry for IPv4 Address Space

The JSON output of this registry contains IPv4 prefix entries, specified in Classless Inter-domain Routing (CIDR) format [RFC4632] and grouped by RDAP URLs, as shown in this example.

```
{
    "version": "1.0",
    "publication": "2024-01-07T10:11:12Z",
    "description": "RDAP Bootstrap file for example registries.",
    "services": [
      [
        ["198.51.100.0/24", "192.0.0.0/8"],
        [
          "https://rir1.example.com/myrdap/"
        ]
      ],
      [
        ["203.0.113.0/24", "192.0.2.0/24"],
        [
          "https://example.org/"
        ]
      ],
      [
        ["203.0.113.0/28"],
        [
          "https://example.net/rdaprir2/",
          "http://example.net/rdaprir2/"
        ]
      ]
    ]
}
```

For example, a query for "192.0.2.1/25" matches the "192.0.0.0/8" entry and the "192.0.2.0/24" entry in the example registry above. The latter is chosen by the client because it is the longest match. The base RDAP URL for this query is then taken from the second element of the array, which is an array of base RDAP URLs valid for this entry. The client chooses one of the base URLs from this array; in this example, it chooses the only one available, "https://example.org/". The {resource} specified in [RFC9082] is then appended to the base URL to complete the query. The complete query is then "https://example.org/ip/192.0.2.1/25".

5.2. Bootstrap Service Registry for IPv6 Address Space

The JSON output of this registry contains IPv6 prefix entries, using [RFC5952] text representation of the address prefixes format, grouped by base RDAP URLs, as shown in this example.

```
{
    "version": "1.0",
    "publication": "2024-01-07T10:11:12Z",
    "description": "RDAP Bootstrap file for example registries.",
    "services": [
      [
        ["2001:db8::/34"],
        [
          "https://rir2.example.com/myrdap/"
        ]
      ],
      [
        ["2001:db8:4000::/36", "2001:db8:ffff::/48"],
        [
          "https://example.org/"
        ]
      ],
      [
        ["2001:db8:1000::/36"],
        [
          "https://example.net/rdaprir2/",
          "http://example.net/rdaprir2/"
        ]
      ]
    ]
}
```

For example, a query for "2001:db8:1000::/48" matches the "2001:db8::/34" entry and the "2001:db8:1000::/36" entry in the example registry above. The latter is chosen by the client because it is the longest match. The base RDAP URL for this query is then taken from the second element of the array, which is an array of base RDAP URLs valid for this entry. The client chooses one of the base URLs from this array; in this example, it chooses "https://example.net/rdaprir2/" because it's the secure version of the protocol. The segment specified in [RFC9082] is then appended to the base URL to complete the query. The complete query is therefore "https://example.net/rdaprir2/ip/2001:db8:1000::/48". If the target RDAP server does not answer, the client can then use another URL prefix from the array.

5.3. Bootstrap Service Registry for AS Number Space

The JSON output of this registry contains entries for AS number ranges, grouped by base RDAP URLs, as shown in this example. The Entry Array is an array containing the list of AS number ranges served by the base RDAP URLs found in the second element. Each element of the array contains two AS numbers represented in decimal format, separated by a hyphen, that represents the range of AS numbers between the two AS numbers (inclusive), where values are in increasing order (e.g., 100-200, not 200-100). A single AS number is represented as a range of two identical AS numbers. AS numbers are represented as 'asplain' as defined in [RFC5396]. Ranges **MUST NOT** overlap.

```
{
    "version": "1.0",
    "publication": "2024-01-07T10:11:12Z",
    "description": "RDAP Bootstrap file for example registries.",
    "services": [
      [
        ["64496-64496"],
        [
          "https://rir3.example.com/myrdap/"
        ]
      ],
      [
        ["64497-64510", "65536-65551"],
        [
          "https://example.org/"
        ]
      ],
      [
        ["64512-65534"],
        [
          "http://example.net/rdaprir2/",
          "https://example.net/rdaprir2/"
        ]
      ]
    ]
}
```

For example, a query for AS 65411 matches the 64512-65534 entry in the example registry above. The base RDAP URL for this query is then taken from the second element of the array, which is an array of base RDAP URLs valid for this entry. The client chooses one of the base URLs from this array; in this example, it chooses "https://example.net/rdaprir2/". The segment specified in [RFC9082] is then appended to the base URL to complete the query. The complete query is, therefore, "https://example.net/rdaprir2/autnum/65411". If the server does not answer, the client can then use another URL prefix from the array.

6. Entity

Entities (such as contacts, registrants, or registrars) can be queried by handle as described in [RFC9082]. Since there is no global name space for entities, this document does not describe how to find the authoritative RDAP server for entities. However, it is possible that, if the entity identifier was received from a previous query, the same RDAP server could be queried for that entity, or the entity identifier itself is a fully qualified URL that can be queried. The mechanism described in [RFC8521] **MAY** also be used.

7. Non-existent Entries or RDAP URL Values

The registries may not contain the requested value. In these cases, there is no known RDAP server for that requested value, and the client **SHOULD** provide an appropriate error message to the user.

8. Deployment and Implementation Considerations

This method relies on the fact that RDAP clients are fetching the IANA registries to then find the servers locally. Clients **SHOULD NOT** fetch the registry on every RDAP request. Clients **SHOULD** cache the registry, but use underlying protocol signaling, such as the HTTP Expires header field [RFC7234], to identify when it is time to refresh the cached registry.

Some authorities of registration data may work together on sharing their information for a common service, including mutual redirection [REDIRECT-RDAP].

When a new object is allocated, such as a new AS range, a new TLD, or a new IP address range, there is no guarantee that this new object will have an entry in the corresponding bootstrap RDAP registry, since the setup of the RDAP server for this new entry may become live and registered later. Therefore, the clients should expect that even if an object, such as TLD, IP address range, or AS range is allocated, the existence of the entry in the corresponding bootstrap registry is not guaranteed.

9. Limitations

This method does not provide a direct way to find authoritative RDAP servers for any other objects than the ones described in this document. In particular, the following objects are not bootstrapped with the method described in this document:

- entities
- queries using search patterns that do not contain a terminating string that matches some entries in the registries
- nameservers
- help

10. Formal Definition

This section is the formal definition of the registries. The structure of JSON objects and arrays using a set of primitive elements is defined in [RFC8259]. Those elements are used to describe the JSON structure of the registries.

10.1. Imported JSON Terms

OBJECT: a JSON object, defined in Section 4 of [RFC8259]

MEMBER: a member of a JSON object, defined in Section 4 of [RFC8259]

MEMBER-NAME: the name of a MEMBER, defined as a "string" in Section 4 of [RFC8259]

MEMBER-VALUE: the value of a MEMBER, defined as a "value" in Section 4 of [RFC8259]

ARRAY: an array, defined in Section 5 of [RFC8259]

ARRAY-VALUE: an element of an ARRAY, defined in Section 5 of [RFC8259]

STRING: a "string", as defined in Section 7 of [RFC8259]

10.2. Registry Syntax

Using the above terms for the JSON structures, the syntax of a registry is defined as follows:

rdap-bootstrap-registry: an OBJECT containing a MEMBER version and a MEMBER publication, an optional MEMBER description, and a MEMBER services-list

version: a MEMBER with MEMBER-NAME "version" and MEMBER-VALUE a STRING

publication: a MEMBER with MEMBER-NAME "publication" and MEMBER-VALUE a STRING

description: a MEMBER with MEMBER-NAME "description" and MEMBER-VALUE a STRING

services-list: a MEMBER with MEMBER-NAME "services" and MEMBER-VALUE a services-array

services-array: an ARRAY, where each ARRAY-VALUE is a service

service: an ARRAY of 2 elements, where the first ARRAY-VALUE is an entry-list and the second ARRAY-VALUE is a service-uri-list

entry-list: an ARRAY, where each ARRAY-VALUE is an entry

entry: a STRING

service-uri-list: an ARRAY, where each ARRAY-VALUE is a service-uri

service-uri: a STRING

11. Security Considerations

By providing a bootstrap method to find RDAP servers, this document helps to ensure that the end users will get the RDAP data from an authoritative source instead of from rogue sources. The method has the same security properties as the RDAP protocols themselves. The transport used to access the registries uses TLS [RFC8446].

Additional considerations on using RDAP are described in [RFC7481].

12. IANA Considerations

IANA has created the RDAP Bootstrap Services Registries listed below and made them available as JSON objects. The contents of these registries are described in Sections 3, 4, and 5, with the formal syntax specified in Section 10. The registries **MUST** be accessible only through HTTPS (TLS [RFC8446]) transport.

The process for adding or updating entries in these registries differs from the normal IANA registry processes: these registries are generated from the data, processes, and policies maintained by IANA in their allocation registries ([ipv4reg], [ipv6reg], [asreg], and [domainreg]), with the addition of new RDAP server information.

IANA updates RDAP Bootstrap Services Registries entries from the allocation registries as those registries are updated.

This document does not change any policies related to the allocation registries; IANA has provided a mechanism for collecting the RDAP server information.

IANA has created a new top-level category on the Protocol Registries page: <https://www.iana.org/protocols>. The group is called "Registration Data Access Protocol (RDAP)". Each of the RDAP Bootstrap Services Registries has been made available for on-demand download in the JSON format by the general public, and that registry's URI is listed directly on the Protocol Registries page.

Other normal registries will be added to this group by other documents, but the reason the URIs for these registries are clearly listed on the main page is to make those URIs obvious to implementers -- these are registries that will be accessed by software, as well as by humans using them for reference information.

Because these registries will be accessed by software, the download demand for the RDAP Bootstrap Services Registries may be unusually high compared to normal IANA registries. The technical infrastructure by which registries are published has been put in place by IANA to support the load. Since the publication of [RFC7484], no issues have been reported regarding the load or the service.

As discussed in Section 8, software that accesses these registries will depend on the HTTP Expires header field to limit their query rate. It is, therefore, important for that header field to be properly set to provide timely information as the registries change, while maintaining a reasonable load on the IANA servers.

The HTTP Content-Type returned to clients accessing these JSON-formatted registries **MUST** be "application/json", as defined in [RFC8259].

Because of how information in the RDAP Bootstrap Services Registries is grouped and formatted, the registry entries may not be sortable. It is, therefore, not required or expected that the entries be ordered in any way.

12.1. Bootstrap Service Registry for IPv4 Address Space

Entries in this registry contain at least the following:

- a CIDR [RFC4632] specification of the network block being registered
- one or more URLs that provide the RDAP service regarding this registration

12.2. Bootstrap Service Registry for IPv6 Address Space

Entries in this registry contain at least the following:

- an IPv6 prefix [RFC5952] specification of the network block being registered
- one or more URLs that provide the RDAP service regarding this registration

12.3. Bootstrap Service Registry for AS Number Space

Entries in this registry contain at least the following:

- a range of Autonomous System numbers being registered
- one or more URLs that provide the RDAP service regarding this registration

12.4. Bootstrap Service Registry for Domain Name Space

Entries in this registry contain at least the following:

- a domain name attached to the root being registered
- one or more URLs that provide the RDAP service regarding this registration

13. References

13.1. Normative References

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13.2. Informative References

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[domainreg] IANA, "Root Zone Database", <https://www.iana.org/domains/root/db>.

[ipv4reg] IANA, "IANA IPv4 Address Space Registry", <https://www.iana.org/assignments/ipv4-address-space>.

[ipv6reg] IANA, "IPv6 Global Unicast Address Assignments", <https://www.iana.org/assignments/ipv6-unicast-address-assignments>.

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Appendix A. Changes since RFC 7484

There are no substantive changes except for minor clarifications. This update is primarily to meet the requirements for moving to an Internet Standard.

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