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**Content Delivery Network Interconnection (CDNI) Footprint Types:
Subdivision Code and Union**

Abstract

Open Caching architecture is a use case of Content Delivery Networks
Interconnection (CDNI) in which the commercial Content Delivery
Network (CDN) is the upstream CDN (uCDN) and the ISP caching layer
serves as the downstream CDN (dCDN). This document supplements the
CDNI Metadata Footprint Types defined in RFC 8006. The Footprint
Types defined in this document can be used for Footprint objects as
part of the Metadata interface (MI) defined in RFC 8006 or the
Footprint & Capabilities Advertisement interface (FCI) defined in
RFC 8008. The defined Footprint Types are derived from requirements
raised by Open Caching but are also applicable to CDNI use cases in
general.

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1. Introduction

The Streaming Video Alliance [SVA] is a global association that
works to solve streaming video challenges in an effort to improve
end-user experience and adoption. The Open Caching Working Group
[OCWG] of the Streaming Video Alliance [SVA] is focused on the
delegation of video delivery requests from commercial CDNs to a
caching layer at the ISP's network. Open Caching architecture is a
specific use case of CDNI where the commercial CDN is the upstream
CDN (uCDN) and the ISP caching layer is the downstream CDN (dCDN).
The Open Caching Request Routing Specification [OC-RR] defines the
Request Routing process and the interfaces that are required for its
provisioning. This document defines and registers CDNI Footprint and
Capabilities objects [RFC8008] that are required for Open Caching
Request Routing.

For consistency with other CDNI documents this document follows the CDNI convention of uCDN (upstream CDN) and dCDN (downstream CDN) to represent the commercial CDN and ISP caching layer respectively.

This document registers two CDNI Metadata Footprint Types (section 7.2 of [RFC8006]) for the defined objects:

   *SubdivisionCode Footprint Type (e.g., for dCDN advertising a
    footprint that is specific to a State in the USA)

   *Collection Footprint Type (for dCDN advertising a footprint that
    consists of a group built from multiple Footprints Types. E.g.,
    both IPv4 and IPv6 client addresses)

1.1. Terminology

The following terms are used throughout this document:

   *CDN - Content Delivery Network

Additionally, this document reuses the terminology defined in [RFC6707], [RFC7336], [RFC8006], and [RFC8008]. Specifically, we use the following CDNI acronyms:

   *uCDN, dCDN - Upstream CDN and Downstream CDN respectively (see
    [RFC7336])

1.2. Requirements Language

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.

2. CDNI Metadata Additional Footprint Types

Section 5 of [RFC8008] describes the FCI Capability Advertisement Object, which includes an array of CDNI Footprint Objects. Each such object has a footprint-type and a footprint-value, as described in section 4.2.2.2 of [RFC8006]. This document defines additional footprint types, beyond those mentioned in CDNI metadata [RFC8006].

2.1. CDNI Metadata SubdivisionCode Footprint Type

Section 4.3.8 of [RFC8006] specifies the "Country Code" footprint type for listing [ISO3166-1] alpha-2 codes. Using Footprint Objects of this type, one can define an FCI Capability Advertisement Object footprint constraints that match a specific country. Herein is define the subdivisioncode simple data type, as well as a footprint

type allowing the dCDN to define constraints matching geographic areas with better granularity, specifically using the [ISO3166-2] Country Subdivision codes.

2.1.1. CDNI Metadata SubdivisionCode Data Type

The "SubdivisionCode" data type specified in Section 2.1.1.1, describes a country specific subdivision using an [ISO3166-2] code. The data type is added to the list of data types described in section 4.3 of [RFC8006] that are used as properties of CDNI Metadata objects.

2.1.1.1. CDNI Metadata SubdivisionCode Data Type Description

A [ISO3166-2] code in lower case. Each code consists of two parts, separated by a hyphen. The first part is the [ISO3166-1] code of the country. The second part is a string of up to three alphanumeric characters.

Type: String

Example SubdivisionCodes:

"ca-ns"

"us-ny"

2.1.2. CDNI Metadata SubdivisionCode Footprint Type Description

The "SubdivisionCode" simple data type specified in Section 2.1.1 , is added to the data types listed as footprint types in section 4.2.2.2 of [RFC8006] .

Below is an example using a footprint object of type "SubdivisionCode". The Footprint Object in this example creates a constraints matching clients both in the Nova-Scotia province of Canada (ISO [ISO3166-2] code "CA-NS"), as well as in the state of New-York In the US (ISO [ISO3166-2] code "US-NY").

```
{
  "capabilities": [
    {
      "capability-type": <CDNI capability object type>,
      "capability-value": <CDNI capability object>,
      "footprints": [
          {
              "footprint-type": "subdivisioncode",
              "footprint-value": ["ca-ns", "us-ny"]
          }
      ]
    }
  ]
}
```

2.2. CDNI Metadata FootprintUnion Footprint Type

As described in section 5 of [RFC8008], the FCI Capability
Advertisement Object includes an array of CDNI Footprint Objects.
Appendix B of [RFC8008] specifies the semantics of a Footprint
Objects array as a multiple, additive, footprint constraints. This
implies that the advertisement of different footprint types narrows
the dCDN's candidacy cumulatively.

Sections 4.3.5 and 4.3.6 of [RFC8006] specify the "IPv4CIDR" and
"IPv6CIDR" footprint types, respectively, for listing IP addresses
blocks. Using Footprint Objects of these types, one can define FCI
Capability Advertisement Object footprint constraints that match
IPv4 or IPv6 clients. However, the described "narrowing" semantic of
the Footprint Objects array prevents the usage of these objects
together to create a footprint constraint that matches IPv4 clients
together with IPv6 clients.

Below is an example for an attempt at creating an object matching
IPv4 clients of subnet "192.0.2.0/24", as well as IPv6 clients of
subnet "2001:db8::/32". Such a definition results in an empty list
of clients, as the constraints are additives and a client address
cannot be both IPv4 and IPv6.

```
{
  "capabilities": [
    {
      "capability-type": <CDNI capability object type>,
      "capability-value": <CDNI capability object>,
      "footprints": [
          {
              "footprint-type": "ipv4cidr",
              "footprint-value": ["192.0.2.0/24"]
          },
          {
              "footprint-type": "ipv6cidr",
              "footprint-value": ["2001:db8::/32"]
          }
      ]
    }
  ]
}
```

To overcome the described limitation and allow a list of footprint
constraints that match both IPv4 and IPv6 client addresses, below is
introduced the "FootprintUnion" footprint type. This footprint type
allows the collection of multiple footprint-objects into a unified
object. It is useful for resolving the above limitation, as well as
for unifying footprints of additional types such as countrycode and
subdivisioncode.

2.2.1. CDNI Metadata FootprintUnion Data Type

The "FootprintUnion" data type is based on the Footprint Object
already defined in section 4.2.2.2 of [RFC8006]. The footprint-value
for a FootprintUnion object is an array of Footprint objects, where
the Footprint objects may be of any Footprint Type other than
FootprintUnion.

2.2.2. CDNI Metadata FootprintUnion Footprint Type Description

The "footprintunion" data type specified in Section 2.2.1, is added
to the data types listed as footprint types in section 4.2.2.2 of
[RFC8006].

Below is an example using a footprint object of type
"footprintunion".

```
{
  "capabilities": [
    {
      "capability-type": <CDNI capability object type>,
      "capability-value": <CDNI capability object>,
      "footprints": [
        {
          "footprint-type": "footprintunion",
          "footprint-value": [
            {
              "footprint-type": "ipv4cidr",
              "footprint-value": ["192.0.2.0/24"]
            },
            {
              "footprint-type": "ipv6cidr",
              "footprint-value": ["2001:db8::/32"]
            }
          ]
        }
      ]
    }
  ]
}
```

The footprint union also allows to compose a countrycode and
subdivisioncode based footprint objects. In the example below we
create a constraint covering autonomous system 64496 within the US
(ISO [ISO3166-1] alpha-2 code "US") and the Nova-Scotia province of
Canada (ISO [ISO3166-2] code "CA-NS").

```
{
  "capabilities": [
    {
      "capability-type": <CDNI capability object type>,
      "capability-value": <CDNI capability object>,
      "footprints": [
        {
          "footprint-type": "asn",
          "footprint-value": ["as64496"]
        },
        {
          "footprint-type": "footprintunion",
          "footprint-value": [
            {
              "footprint-type": "countrycode",
              "footprint-value": ["us"]
            },
            {
              "footprint-type": "subdivisioncode",
              "footprint-value": ["ca-ns"]
            }
          ]
        }
      ]
    }
  ]
}
```

3. IANA Considerations

3.1. CDNI Metadata Footprint Types

Section 7.2 of [RFC8006] creates the "CDNI Metadata Footprint Types"
subregistry within the "Content Delivery Network Interconnection
(CDNI) Parameters" registry.

This document requests the registration of the two additional
Footprint Types as defined in Section 2.2 and Section 2.1 :

Footprint Type	Description	Specification
FCI.subdivisioncode	ISO 3166-2 Subdivision Code: An alpha-2 ISO 3166-1 Country Code, followed by a separator and up to three alphanumeric characters	RFCthis
FCI.footprintunion	Footprint Object as specified in [RFC8006]	RFCthis

Table 1

[RFC Editor: Please replace RFCthis with the published RFC number for this document.]

4. Security Considerations

This specification is in accordance with the CDNI Metadata and the CDNI Request Routing: Footprint and Capabilities Semantics. As such, it is subject to the security and privacy considerations as defined in Section 8 of [RFC8006] and in Section 7 of [RFC8008] respectively. More specifically, the use of "SubdivisionCode" footprint type, introduces a higher level of granularity into the published dCDN Footprint. Therefore, to meet confidentiality requirements, the use of transport-layer security mechanisms as specified in Section 7 of [RFC8008], is required.

5. Acknowledgements

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