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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 to 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 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](#)], [[RFC8007](#)], [[RFC8008](#)], and [[RFC8804](#)]. 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](#)]. For consistency, this document follows the CDNI notation of uCDN for (the commercial CDN) and dCDN (the ISP caching layer).

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. Here we 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 adjustment for the example in [Section 2.1.1](#), now embedding a footprint object of type "SubdivisionCode". The Footprint Object in this example creates a constraints matching clients both in 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. Meaning, 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 an 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 in order 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 with 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 matches both IPv4 and IPv6 client addresses, we introduce below 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 limitaion, 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 [\[RFC8006\]](#). It includes a footprint-type property and a footprint-value array values.

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 adjustment for the example in [Section 2.2.1](#), now embedding 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"]
            }
          ]
        }
      ]
    }
  ]
}

```

An additional example is the collection of countrycode and subdivisioncode based footprint objects. In the example below we create a constraint covering autonomous system 64496 within the US (ISO [[IS03166-1](#)] alpha-2 code "US"), as well as Nova-Scotia province of Canada (ISO [[IS03166-2](#)] 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

As described in section 7.2 of [[RFC8006](#)] , the "CDNI Metadata Footprint Types" subregistry was created within the "Content Delivery Network Interconnection (CDNI) Parameters" registry. The created namespace defines the valid values for Footprint Object Types, and is already populated with the types described in Section 4.2.2.2 of [[RFC8006](#)] .

This document requests the registration of the two additional footprint type as defined in [Section 2.2](#) and [Section 2.1](#) :

Footprint Type	Description	Specification
FCI.subdivisioncode	ISO 3166-2 Country or Subdivision Code	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 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.

5. Acknowledgements

The authors would like to express their gratitude to Ori Finkelman and Kevin J. Ma for their guidance and reviews throughout the development of this document.

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[OCWG]

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