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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 document also updates RFC 9241 with relevant ALTO entity domain types. 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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Table of Contents

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 a dCDN advertising a
   footprint that is specific to a State in the USA)

  *Collection Footprint Type (for a 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])

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 constraint that matches 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

An [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 constraint 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 enables composing 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. ALTO Property Map Service Entity

Section 6 of [RFC9241] describes how to represent footprint objects
as entities in the ALTO property map. The approach is to represent
the "footprint-type" as an entity domain type of the ALTO entity,
and the footprint value as its domain-specific identifier. [RFC9241]
further refers to the representation of footprint objects of types
"asn" and "countrycode". Here we extend this definition to the
"subdivisioncode" footprint-type.

3.1. SUBDIVISIONCODE Domain

The SUBDIVISIONCODE domain associates property values that defines
codes for the names of the principal subdivisions.

3.1.1. Entity Domain Type

The entity domain type of the SUBDIVISIONCODE domain is
"subdivisioncode" (in lowercase).

3.1.1.1. Domain-Specific Entity Identifiers

The entity identifier of an entity in a SUBDIVISIONCODE is encoded as an alpha-2 [ISO3166-1] Country Code, followed by a separator and up to three alphanumeric characters.

4. IANA Considerations

4.1. 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	[ISO3166-2] Subdivision Code: An alpha-2 [ISO3166-1] Country Code, followed by a separator and up to three alphanumeric characters.	RFCthis
FCI.footprintunion	A combination of other Footprint Objects	RFCthis

Table 1

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

4.2. ALTO Entity Domain Types

Section 12.3 of [RFC9240] creates the "ALTO Entity Domain Types" registry.

This document requests the registration of an additional ALTO Entity Domain Types:

Identifier	Entity Identifier Encoding	Hierarchy and Inheritance	Media Type of Defining Resource	Mapping to ALTO Address Type
subdivisioncode	See RFCthis, Section 3.1.1.1	None	None	false

Table 2

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

5. 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.

6. Acknowledgements

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and Kevin J. Ma for their guidance and reviews throughout the
development of this document.

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