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Content Delivery Network Interconnection (CDNI) Request Routing: CDNI

Footprint and Capabilities Advertisement using ALTO

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Abstract

The Content Delivery Networks Interconnection (CDNI) framework in RFC

6707 defines a set of protocols to interconnect CDNs to achieve

multiple goals, including extending the reach of a given CDN. A CDNI

Request Routing Footprint & Capabilities Advertisement interface

(FCI) is needed to achieve the goals of a CDNI. RFC 8008 defines

the FCI semantics and provides guidelines on the FCI

protocol, but the exact protocol is not specified. This document

defines a new Application-Layer Traffic Optimization (ALTO) service,

called "CDNI Advertisement Service", that provides an implementation

of the FCI, following the guidelines defined in RFC 8008.

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1. Introduction

The ability to interconnect multiple content delivery networks (CDNs)

has many benefits, including increased coverage, capability, and

reliability. The Content Delivery Networks Interconnection (CDNI)

framework [RFC6707] defines four interfaces to

interconnect CDNs: (1) the CDNI Request Routing Interface, (2)

the CDNI Metadata Interface, (3) the CDNI Logging Interface, and (4)

the CDNI Control Interface.

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Among these four interfaces, the CDNI Request Routing Interface

provides key functions, as specified in [RFC6707]: "The CDNI Request

Routing interface enables a Request Routing function in an Upstream

CDN to query a Request Routing function in a Downstream CDN to

determine if the Downstream CDN is able (and willing) to accept the

delegated Content Request. It also allows the Downstream CDN to

control what should be returned to the User Agent in the redirection

message by the upstream Request Routing function." At a high level,

the scope of the CDNI Request Routing Interface, therefore, contains

two main tasks: (1) determining if the dCDN (downstream CDN) is

willing to accept a delegated content request, and (2) redirecting

the content request coming from a uCDN (upstream CDN) to the proper

entry point or entity in the dCDN.

Correspondingly, the Request Routing Interface is broadly divided

into two functionalities: (1) the CDNI Footprint & Capabilities

Advertisement interface (FCI) defined in [RFC8008], and (2) the CDNI

Request Routing Redirection interface (RI) defined in [RFC7975].

This document focuses on the first functionality (CDNI FCI).

Specifically, CDNI FCI allows both an advertisement from a dCDN to a

uCDN (push) and a query from a uCDN to a dCDN (pull) so that the uCDN

knows whether it can redirect a particular user request to that dCDN.

A key component in defining CDNI FCI is defining objects describing

the footprints and capabilities of a dCDN. Such objects are already

defined in [RFC8008]. However, no protocol is defined to transport and update such

objects between a uCDN and a dCDN.

To define such a protocol, this document specifies an extension of

the Application-Layer Traffic Optimization (ALTO) [RFC7285] protocol

by introducing a new ALTO service called "CDNI Advertisement

Service".

Section 2.3 discusses the benefits in using ALTO as a transport protocol.

.

2. Terminology and Background

The design of CDNI FCI transport using ALTO assumes an

understanding of both FCI semantics and ALTO. Hence, this document

starts with a non-normative review for both.

2.1. Terminology

The document uses the terms for CDNI as defined in [RFC6707],

[RFC8006], and [RFC8008]. Also, the document uses the ALTO terms defined in [RFC7285]

and [I-D.ietf-alto-unified-props-new].

This document

uses the following abbreviations:

\* ALTO: Application-Layer Traffic Optimization Advertisement interface

\* ASN: Autonomous System Number

\* CDN: Content Delivery Network

\* CDNI: CDN Interconnection

\* dCDN: Downstream CDN

\* FCI: CDNI FCI, CDNI Request Routing Footprint & Capabilities

\* IRD: Information Resource Directory in ALTO

\* PID: Provider-defined Identifier in ALTO

\* uCDN: Upstream CDN

2.2. Semantics of FCI Advertisement

[RFC8008] defines the

semantics of CDNI FCI, provides guidance on what Footprint and

Capabilities mean in a CDNI context, and specifies the requirements

on the CDNI FCI transport protocol. The definitions in [RFC8008]

depend on [RFC8006]. Below is a non-normative review of key related

points of [RFC8008] and [RFC8006]. For detailed information and

normative specification, the reader should refer to these two RFCs.

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\* Multiple types of mandatory-to-implement footprints (i.e., ipv4cidr,

ipv6cidr, asn, and countrycode) are defined in [RFC8006]. A "Set

of IP-prefixes" can contain both full IP addresses (i.e., a /32

for IPv4 or a /128 for IPv6) and IP prefixes with an arbitrary

prefix length. There must also be support for multiple IP address

versions, i.e., IPv4 and IPv6, in such a footprint.

\* Multiple initial types of capabilities are defined in [RFC8008]

including (1) Delivery Protocol, (2) Acquisition Protocol, (3)

Redirection Mode, (4) Capabilities related to CDNI Logging, and

(5) Capabilities related to CDNI Metadata. They are required in

all cases and, therefore, considered as mandatory-to-implement

capabilities for all CDNI FCI implementations.

\* Footprint and capabilities are defined together and cannot be

interpreted independently from each other. Specifically,

[RFC8008] integrates footprint and capabilities with an approach

of "capabilities with footprint restrictions", by expressing

capabilities on a per footprint basis.

\* Specifically, for all mandatory-to-implement footprint types,

footprints can be viewed as constraints for delegating requests to

a dCDN: A dCDN footprint advertisement tells the uCDN the

limitations for delegating a request to the dCDN. For IP prefixes

or Autonomous System Numbers (ASNs), the footprint signals to the uCDN that it should

consider the dCDN a candidate only if the IP address of the

request routing source falls within the prefix set or ASN,

respectively. The CDNI specifications do not define how a given

uCDN determines what address ranges are in a particular ASN.

Similarly, for country codes, a uCDN should only consider the dCDN

a candidate if it covers the country of the request routing

source. The CDNI specifications do not define how a given uCDN

determines the country of the request routing source. Different

types of footprint constraints can be combined together to narrow

the dCDN candidacy, i.e., the uCDN should consider the dCDN a

candidate only if the request routing source satisfies all the

types of footprint constraints in the advertisement.

\* Given that a large part of Footprint and Capabilities

Advertisement may happen in contractual agreements, the

semantics of CDNI Footprint and Capabilities advertisement refers

to answering the following question: what exactly still needs to

be advertised by the CDNI FCI? For instance, updates about

temporal failures of part of a footprint can be useful information

to convey via the CDNI FCI. Such information would provide

updates on information previously agreed in contracts between the

participating CDNs. In other words, the CDNI FCI is a means for a

dCDN to provide changes/updates regarding a footprint and/or

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capabilities that it has previously agreed to serve in a contract

with a uCDN. Hence, server push and incremental encoding will be

necessary techniques.

2.3. ALTO Background and Benefits

Application-Layer Traffic Optimization (ALTO) [RFC7285] defines an

approach for conveying network layer (topology) information to

"guide" the resource provider selection process in distributed

applications that can choose among several candidate resources

providers to retrieve a given resource. Usually, it is assumed that

an ALTO server conveys information that these applications cannot

measure or have difficulty measuring themselves [RFC5693].

Originally, ALTO was motivated by optimizing cross-ISP traffic

generated by P2P applications [RFC5693]. However, ALTO can also be

used for improving the request routing in CDNs. In particular, the

CDNI problem statement [RFC6707] explicitly mentions ALTO as a

candidate protocol for "actual algorithms for selection of CDN or

Surrogate by Request-Routing systems".

The following reasons make ALTO a suitable candidate protocol for

dCDN selection as part of CDNI request routing and, in particular,

for an FCI protocol:

\* Application Layer-oriented: ALTO is a protocol specifically

designed to improve application layer traffic (and application

layer connections among hosts on the Internet) by providing

additional information to applications that these applications

could not easily retrieve themselves. This matches the need of

CDNI, where a uCDN wants to improve application layer CDN request

routing by using information (provided by a dCDN) that the uCDN

could not easily obtain otherwise. Hence, ALTO can help a uCDN to

select a proper dCDN by first providing dCDNs' capabilities as

well as footprints (see Section 3) and then providing costs of

surrogates in a dCDN by ALTO cost maps.

\* Security: The identification between uCDNs and dCDNs is an

important requirement (see Section 8). ALTO maps can be signed

and hence provide inherent origin protection. Please see

Section 15.1.2 of [RFC7285] for detailed protection strategies.

\* RESTful design: The ALTO protocol has undergone extensive

revisions in order to provide a RESTful design regarding the

client-server interaction specified by the protocol. It is

flexible and extensible enough to handle existing and potential

future data formats defined by CDNI. It can provide the

consistent client-server interaction model for other existing CDNI

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interfaces or potential future extensions and therefore reduce the

learning cost for both users and developers, although they are not

in the scope of this document. A CDNI FCI interface based on ALTO

would inherit this RESTful design. Please see Section 3.

\* Error-handling: The ALTO protocol provides extensive error-

handling in the whole request and response process (see

Section 8.5 of [RFC7285]). A CDNI FCI interface based on ALTO

would inherit this extensive error-handling framework. Please see

Section 5.

\* Map Service: The semantics of an ALTO network map is an exact

match for the needed information to convey a footprint by a dCDN,

in particular, if such a footprint is being expressed by IP-prefix

ranges. Please see Section 4.

\* Filtered Map Service: The ALTO map filtering service would allow a

uCDN to query only for parts of an ALTO map. For example, the

ALTO filtered property map service can enable a uCDN to query

properties of a part of footprints efficiently. Please see

Section 6.

\* Server-initiated notifications and incremental updates: When the

footprint or the capabilities of a dCDN change (i.e., unexpectedly

from the perspective of a uCDN), server-initiated notifications

would enable a dCDN to inform a uCDN about such changes directly.

Consider the case where - due to failure - part of the footprint

of the dCDN is not functioning, i.e., the CDN cannot serve content

to such clients with reasonable QoS. Without server-initiated

notifications, the uCDN might still use a recent network and cost

map from the dCDN, and therefore redirect requests to the dCDN

which it cannot serve. Similarly, the possibility for incremental

updates would enable efficient conveyance of the aforementioned

(or similar) status changes by the dCDN to the uCDN. The newest

design of ALTO supports server pushed incremental updates

[RFC8895].

\* Content availability on hosts: A dCDN might want to express CDN

capabilities in terms of certain content types (e.g., codecs/

formats, or content from certain content providers). ALTO Entity

Property Map [I-D.ietf-alto-unified-props-new] would enable a dCDN

to make such information available to a uCDN. This would enable a

uCDN to assess whether a dCDN has the capabilities for

a given type of content requested.

\* Resource availability on hosts or links: The capabilities on links

(e.g., maximum bandwidth) or caches (e.g., average load) might be

useful information for a uCDN for optimized dCDN selection. For

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instance, if a uCDN receives a streaming request for content with

a certain bitrate, it needs to know if it is likely that a dCDN

can fulfill such stringent application-level requirements (i.e.,

can be expected to have enough consistent bandwidth) before it

redirects the request. In general, if ALTO could convey such

information via ALTO Entity Property Map

[I-D.ietf-alto-unified-props-new], it would enable more

sophisticated means for dCDN selection with ALTO. ALTO Path

Vector Extension [I-D.ietf-alto-path-vector] is designed to allow

ALTO clients to query information such as capacity regions for a

given set of flows.

3. CDNI Advertisement Service

The ALTO protocol relies upon the ALTO Information Service framework

which consists of multiple services. All ALTO services are

"provided through a common transport protocol, messaging structure

and encoding, and transaction model" [RFC7285]. The ALTO protocol

specification defines multiple initial services, e.g., the

ALTO network map service and cost map service.

This document defines a new ALTO service, called "CDNI Advertisement

Service", which conveys JSON [RFC8259] objects of media type

"application/alto-cdni+json". These JSON objects are used to

transport BaseAdvertisementObject objects defined in [RFC8008]. This

document specifies how to transport such BaseAdvertisementObject

objects via the ALTO protocol with the ALTO "CDNI Advertisement

Service". Similar to other ALTO services, this document defines the

ALTO information resource for the "CDNI Advertisement Service" as

follows.

Note that the encoding of BaseAdvertisementObject reuses the one

defined in [RFC8008] and therefore also follows the recommendations

of I-JSON (Internet JSON) [RFC7493], which is required by [RFC8008].

3.1. Media Type

The media type of the CDNI Advertisement resource is "application/

alto-cdni+json".

3.2. HTTP Method

A CDNI Advertisement resource is requested using the HTTP GET method.

3.3. Accept Input Parameters

There are no applicable Accept Input parameters.

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3.4. Capabilities

There are no applicable capabilities.

3.5. Uses

The "uses" field MUST NOT appear unless the CDNI Advertisement

resource depends on other ALTO information resources. If the CDNI

Advertisement resource has dependent resources, the resource IDs of

its dependent resources MUST be included into the "uses" field. This

document only defines one potential dependent resource for the CDNI

Advertisement resource. See Section 4 for details of when and how to

use it. Future documents may extend the CDNI Advertisement resource

and allow other dependent resources.

3.6. Response

The "meta" field of a CDNI Advertisement response MUST include the

"vtag" field defined in Section 10.3 of [RFC7285]. This field

provides the version of the retrieved CDNI FCI resource.

If a CDNI Advertisement response depends on other ALTO information

resources, it MUST include the "dependent-vtags" field, whose value

is an array to indicate the version tags of the resources used, where

each resource is specified in "uses" of its Information Resource

Directory (IRD) entry.

The data component of an ALTO CDNI Advertisement response is named

"cdni-advertisement", which is a JSON object of type

CDNIAdvertisementData:

object {

CDNIAdvertisementData cdni-advertisement;

} InfoResourceCDNIAdvertisement : ResponseEntityBase;

object {

BaseAdvertisementObject capabilities-with-footprints<0..\*>;

} CDNIAdvertisementData;

Specifically, a CDNIAdvertisementData object is a JSON object that

includes only one property named "capabilities-with-footprints",

whose value is an array of BaseAdvertisementObject objects. It

provides capabilities with footprint restrictions for uCDN to decide

the dCDN selection. If the value of this property is an empty array,

it means the corresponding dCDN cannot provide any mandatory-to-

implement CDNI capabilities for any footprints.

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The syntax and semantics of BaseAdvertisementObject are well defined

in Section 5.1 of [RFC8008]. A BaseAdvertisementObject object

includes multiple properties, including capability-type, capability-

value, and footprints, where footprints are defined in

Section 4.2.2.2 of [RFC8006].

To be self-contained, below is an equivalent specification of

BaseAdvertisementObject described in the ALTO-style notation (see

Section 8.2 of [RFC7285]). As mentioned above, the normative

specification of BaseAdvertisementObject is in [RFC8008].

object {

JSONString capability-type;

JSONValue capability-value;

Footprint footprints<0..\*>;

} BaseAdvertisementObject;

object {

JSONString footprint-type;

JSONString footprint-value<1..\*>;

} Footprint;

For each BaseAdvertisementObject, the ALTO client MUST interpret

footprints appearing multiple times as if they appeared only once.

If footprints in a BaseAdvertisementObject is null or empty or not

appearing, the ALTO client MUST understand that the capabilities in

this BaseAdvertisementObject have the "global" coverage, i.e., the

corresponding dCDN can provide them for any request routing source.

Note: Further optimization of BaseAdvertisement objects to

effectively provide the advertisement of capabilities with footprint

restrictions is certainly possible. For example, these two examples

below both describe that the dCDN can provide capabilities

["http/1.1", "https/1.1"] for the same footprints. However, the

latter one is smaller in its size.

EXAMPLE 1

{

"meta": {...},

"cdni-advertisement": {

"capabilities-with-footprints": [

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [

"http/1.1"

]

},

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"footprints": [

<Footprint objects>

]

},

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [

"https/1.1"

]

},

"footprints": [

<Footprint objects>

]

}

]

}

}

EXAMPLE 2

{

"meta": {...},

"cdni-advertisement": {

"capabilities-with-footprints": [

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [

"https/1.1",

"http/1.1"

]

},

"footprints": [

<Footprint objects>

]

}

]

}

}

Since such optimizations are not required for the basic

interconnection of CDNs, the specifics of such mechanisms are outside

the scope of this document.

This document only requires the ALTO server to provide the initial

FCI-specific CDNI Payload Types defined in [RFC8008] as the

mandatory-to-implement CDNI capabilities.

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3.7. Examples

3.7.1. IRD

Below is the IRD of a simple, example ALTO server. The server

provides both base ALTO information resources (e.g., network maps)

and CDNI FCI related information resources (e.g., CDNI Advertisement

resources), demonstrating a single, integrated environment.

Specifically, the IRD announces nine information resources as

follows:

\* two network maps,

\* one CDNI Advertisement resource without dependency,

\* one CDNI Advertisement resource depending on a network map,

\* one filtered CDNI Advertisement resource to be defined in

Section 5,

\* one property map including "cdni-capabilities" as its entity

Property,

\* one filtered property map including "cdni-capabilities" and "pid"

as its entity properties, and

\* two update stream services:

- one for updating CDNI Advertisement resources

- one for updating property maps

GET /directory HTTP/1.1

Host: alto.example.com

Accept: application/alto-directory+json,application/alto-error+json

HTTP/1.1 200 OK

Content-Length: 3431

Content-Type: application/alto-directory+json

{

"meta": {

"default-alto-network-map": "my-default-network-map"

},

"resources": {

"my-default-network-map": {

"uri": "https://alto.example.com/networkmap",

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"media-type": "application/alto-networkmap+json"

},

"my-eu-netmap": {

"uri": "https://alto.example.com/myeunetmap",

"media-type": "application/alto-networkmap+json"

},

"my-default-cdnifci": {

"uri": "https://alto.example.com/cdnifci",

"media-type": "application/alto-cdni+json"

},

"my-cdnifci-with-pid-footprints": {

"uri": "https://alto.example.com/networkcdnifci",

"media-type": "application/alto-cdni+json",

"uses": [ "my-eu-netmap" ]

},

"my-filtered-cdnifci": {

"uri": "https://alto.example.com/cdnifci/filtered",

"media-type": "application/alto-cdni+json",

"accepts": "application/alto-cdnifilter+json"

},

"cdnifci-property-map": {

"uri": "https://alto.example.com/propmap/full/cdnifci",

"media-type": "application/alto-propmap+json",

"uses": [ "my-default-cdni" ],

"capabilities": {

"mappings": {

"ipv4": [ "my-default-cdni.cdni-capabilities" ],

"ipv6": [ "my-default-cdni.cdni-capabilities" ],

"countrycode": [

"my-default-cdni.cdni-capabilities" ],

"asn": [ "my-default-cdni.cdni-capabilities" ]

}

}

},

"filtered-cdnifci-property-map": {

"uri": "https://alto.example.com/propmap/lookup/cdnifci-pid",

"media-type": "application/alto-propmap+json",

"accepts": "application/alto-propmapparams+json",

"uses": [ "my-default-cdni", "my-default-network-map" ],

"capabilities": {

"mappings": {

"ipv4": [ "my-default-cdni.cdni-capabilities",

"my-default-network-map.pid" ],

"ipv6": [ "my-default-cdni.cdni-capabilities",

"my-default-network-map.pid" ],

"countrycode": [

"my-default-cdni.cdni-capabilities" ],

"asn": [ "my-default-cdni.cdni-capabilities" ]

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}

}

},

"update-my-cdni-fci": {

"uri": "https://alto.example.com/updates/cdnifci",

"media-type": "text/event-stream",

"accepts": "application/alto-updatestreamparams+json",

"uses": [

"my-default-network-map",

"my-eu-netmap",

"my-default-cdnifci",

"my-filtered-cdnifci",

"my-cdnifci-with-pid-footprints"

],

"capabilities": {

"incremental-change-media-types": {

"my-default-network-map": "application/json-patch+json",

"my-eu-netmap": "application/json-patch+json",

"my-default-cdnifci":

"application/merge-patch+json,application/json-patch+json",

"my-filtered-cdnifci":

"application/merge-patch+json,application/json-patch+json",

"my-cdnifci-with-pid-footprints":

"application/merge-patch+json,application/json-patch+json"

}

}

},

"update-my-props": {

"uri": "https://alto.example.com/updates/properties",

"media-type": "text/event-stream",

"uses": [

"cdnifci-property-map",

"filtered-cdnifci-property-map"

],

"capabilities": {

"incremental-change-media-types": {

"cdnifci-property-map":

"application/merge-patch+json,application/json-patch+json",

"filtered-cdnifci-property-map":

"application/merge-patch+json,application/json-patch+json"

}

}

}

}

}

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3.7.2. A Basic Example

This basic example demonstrates a simple CDNI Advertisement resource,

which does not depend on other resources. There are three

BaseAdvertisementObjects in this resource and these objects'

capabilities are http/1.1 delivery protocol, [http/1.1, https/1.1]

delivery protocol, and https/1.1 acquisition protocol, respectively.

GET /cdnifci HTTP/1.1

Host: alto.example.com

Accept: application/alto-cdni+json, application/alto-error+json

HTTP/1.1 200 OK

Content-Length: 1352

Content-Type: application/alto-cdni+json

{

"meta": {

"vtag": {

"resource-id": "my-default-cdnifci",

"tag": "da65eca2eb7a10ce8b059740b0b2e3f8eb1d4785"

}

},

"cdni-advertisement": {

"capabilities-with-footprints": [

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [

"http/1.1"

]

},

"footprints": [

{

"footprint-type": "ipv4cidr",

"footprint-value": [ "192.0.2.0/24" ]

},

{

"footprint-type": "ipv6cidr",

"footprint-value": [ "2001:db8::/32" ]

}

]

},

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [

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"https/1.1",

"http/1.1"

]

},

"footprints": [

{

"footprint-type": "ipv4cidr",

"footprint-value": [ "198.51.100.0/24" ]

}

]

},

{

"capability-type": "FCI.AcquisitionProtocol",

"capability-value": {

"acquisition-protocols": [

"https/1.1"

]

},

"footprints": [

{

"footprint-type": "ipv4cidr",

"footprint-value": [ "203.0.113.0/24" ]

}

]

}

]

}

}

3.7.3. Incremental Updates

A benefit of using ALTO to provide CDNI Advertisement resources is

that such resources can be updated using ALTO incremental updates

[RFC8895]. Below is an example that also shows the benefit of having

both JSON merge patch and JSON patch to encode updates.

At first, an ALTO client requests updates for "my-default-cdnifci",

and the ALTO server returns the "control-uri" followed by the full

CDNI Advertisement response. Then when there is a change in the

delivery-protocols in that http/1.1 is removed (from [http/1.1,

https/1.1] to only https/1.1) due to maintenance of the http/1.1

clusters, the ALTO server regenerates the new CDNI Advertisement

resource and pushes the full replacement to the ALTO client. Later

on, the ALTO server notifies the ALTO client that "192.0.2.0/24" is

added into the "ipv4" footprint object for delivery-protocol

https/1.1 by sending the change encoded by JSON patch to the ALTO

client.

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POST /updates/cdnifci HTTP/1.1

Host: alto.example.com

Accept: text/event-stream,application/alto-error+json

Content-Type: application/alto-updatestreamparams+json

Content-Length: 86

{

"add": { "my-cdnifci-stream": {

"resource-id": "my-default-cdnifci"

}

}

}

HTTP/1.1 200 OK

Connection: keep-alive

Content-Type: text/event-stream

event: application/alto-updatestreamcontrol+json

data: {"control-uri":

data: "https://alto.example.com/updates/streams/3141592653589"}

event: application/alto-cdni+json,my-cdnifci-stream

data: { ... full CDNI Advertisement resource ... }

event: application/alto-cdni+json,my-cdnifci-stream

data: {

data: "meta": {

data: "vtag": {

data: "tag": "dasdfa10ce8b059740bddsfasd8eb1d47853716"

data: }

data: },

data: "cdni-advertisement": {

data: "capabilities-with-footprints": [

data: {

data: "capability-type": "FCI.DeliveryProtocol",

data: "capability-value": {

data: "delivery-protocols": [

data: "https/1.1"

data: ]

data: },

data: "footprints": [

data: { "footprint-type": "ipv4cidr",

data: "footprint-value": [ "203.0.113.0/24" ]

data: }

data: ]

data: },

data: { ... other CDNI advertisement object ... }

data: ]

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data: }

data: }

event: application/json-patch+json,my-cdnifci-stream

data: [

data: { "op": "replace",

data: "path": "/meta/vtag/tag",

data: "value": "a10ce8b059740b0b2e3f8eb1d4785acd42231bfe"

data: },

data: { "op": "add",

data: "path": "/cdni-advertisement/capabilities-with-footprints

/0/footprints/0/footprint-value/-",

data: "value": "192.0.2.0/24"

data: }

data: ]

4. CDNI Advertisement Service using ALTO Network Map

4.1. Network Map Footprint Type: altopid

The ALTO protocol defines a concept called Provider-defined

Identifier (PID) to represent a group of IPv4 or IPv6 addresses which

can be applied the same management policy. The PID is an alternative

to the pre-defined CDNI footprint types (i.e., ipv4cidr, ipv6cidr,

asn, and countrycode).

To leverage this concept, this document defines a new CDNI Footprint

Type called "altopid". A CDNI Advertisement resource can depend on

an ALTO network map resource and use "altopid" footprints to compress

its CDNI Footprint Payload.

Specifically, the "altopid" footprint type indicates that the

corresponding footprint value is a list of PIDNames as defined in

[RFC7285]. These PIDNames are references of PIDs in a network map

resource. Hence a CDNI Advertisement resource using "altopid"

footprints depends on a network map. For such a CDNI Advertisement

resource, the resource id of its dependent network map MUST be

included in the "uses" field of its IRD entry, and the "dependent-

vtags" field with a reference to this network map MUST be included in

its response (see the example in Section 4.2.3).

4.2. Examples

The following examples use the same IRD given in Section 3.7.1.

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4.2.2. ALTO Network Map for CDNI Advertisements

Below is provided a sample network map whose resource id is "my-eu-netmap". This map is referenced by the CDNI Advertisement example in

Section 4.2.3.

GET /myeunetmap HTTP/1.1

Host: alto.example.com

Accept: application/alto-networkmap+json,application/alto-error+json

HTTP/1.1 200 OK

Content-Length: 326

Content-Type: application/alto-networkmap+json

{

"meta": {

"vtag": [

{ "resource-id": "my-eu-netmap",

"tag": "3ee2cb7e8d63d9fab71b9b34cbf764436315542e"

}

]

},

"network-map": {

"south-france" : {

"ipv4": [ "192.0.2.0/24", "198.51.100.0/25" ],

"ipv6": [ "2001:db8::/32" ]

},

"germany": {

"ipv4": [ "203.0.113.0/24" ]

}

}

}

4.2.3. ALTO PID Footprints in CDNI Advertisements

This example shows a CDNI Advertisement resource that depends on a

network map described in Section 4.2.2.

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GET /networkcdnifci HTTP/1.1

Host: alto.example.com

Accept: application/alto-cdni+json,application/alto-error+json

HTTP/1.1 200 OK

Content-Length: 706

Content-Type: application/alto-cdni+json

{

"meta": {

"dependent-vtags": [

{

"resource-id": "my-eu-netmap",

"tag": "3ee2cb7e8d63d9fab71b9b34cbf764436315542e"

}

]

},

"cdni-advertisement": {

"capabilities-with-footprints": [

{ "capability-type": "FCI.DeliveryProtocol",

"capability-value": [ "https/1.1" ],

"footprints": [

{ "footprint-type": "altopid",

"footprint-value": [ "south-france" ]

}

]

},

{ "capability-type": "FCI.AcquisitionProtocol",

"capability-value": [ "https/1.1" ],

"footprints": [

{ "footprint-type": "altopid",

"footprint-value": [ "germany", "south-france" ]

}

]

}

]

}

}

4.2.4. Incremental Updates

In this example, the ALTO client is interested in changes of "my-

cdnifci-with-pid-footprints" and its dependent network map "my-eu-

netmap". Considering two changes, the first one is to change

footprints of the https/1.1 delivery protocol capability, and the

second one is to remove the "south-france" PID from the footprints of

the https/1.1 acquisition protocol capability.

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POST /updates/cdnifci HTTP/1.1

Host: alto.example.com

Accept: text/event-stream,application/alto-error+json

Content-Type: application/alto-updatestreamparams+json

Content-Length: 174

{

"add": { "my-eu-netmap-stream": {

"resource-id": "my-eu-netmap"

},

"my-netmap-cdnifci-stream": {

"resource-id": "my-cdnifci-with-pid-footprints"

}

}

}

HTTP/1.1 200 OK

Connection: keep-alive

Content-Type: text/event-stream

event: application/alto-updatestreamcontrol+json

data: {"control-uri":

data: "https://alto.example.com/updates/streams/3141592653590"}

event: application/alto-networkmap+json,my-eu-netmap-stream

data: { ... full Network Map of my-eu-netmap ... }

event: application/alto-cdnifci+json,my-netmap-cdnifci-stream

data: { ... full CDNI Advertisement resource ... }

event: application/json-patch+json,my-netmap-cdnifci-stream

data: [

data: { "op": "replace",

data: "path": "/meta/vtag/tag",

data: "value": "dasdfa10ce8b059740bddsfasd8eb1d47853716"

data: },

data: { "op": "add",

data: "path":

data: "/cdni-advertisement/capabilities-with-footprints

/0/footprints/0/footprint-value/-",

data: "value": "germany"

data: }

data: ]

event: application/json-patch+json,my-netmap-cdnifci-stream

data: [

data: { "op": "replace",

data: "path": "/meta/vtag/tag",

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data: "value": "a10ce8b059740b0b2e3f8eb1d4785acd42231bfe"

data: },

data: { "op": "remove",

data: "path":

data: "/cdni-advertisement/capabilities-with-footprints

/1/footprints/0/footprint-value/1"

data: }

data: ]

5. Filtered CDNI Advertisement using CDNI Capabilities

Sections 3 and 4 describe CDNI Advertisement Service which can

be used to enable a uCDN to get capabilities with footprint

restrictions from dCDNs. However, since always getting full CDNI

Advertisement resources from dCDNs is inefficient, this document

introduces a new service, named "Filtered CDNI Advertisement Service",

to allow a client to filter a CDNI Advertisement resource using a

client-given set of CDNI capabilities. For each entry of the CDNI

Advertisement response, an entry will only be returned to the client

if it contains at least one of the client given CDNI capabilities.

The relationship between a filtered CDNI Advertisement resource and a

CDNI Advertisement resource is similar to the relationship between a

filtered network/cost map and a network/cost map.

5.1. Media Type

A filtered CDNI Advertisement resource uses the same media type

defined for the CDNI Advertisement resource in Section 3.1: "application/alto-cdni+json".

5.2. HTTP Method

A filtered CDNI Advertisement resource is requested using the HTTP

POST method.

5.3. Accept Input Parameters

The input parameters for a filtered CDNI Advertisement resource are

supplied in the entity body of the POST request. This document

specifies the input parameters with a data format indicated by the

media type "application/alto-cdnifilter+json" which is a JSON object

of type ReqFilteredCDNIAdvertisement, where:

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object {

JSONString capability-type;

JSONValue capability-value;

} CDNICapability;

object {

CDNICapability cdni-capabilities<0..\*>;

} ReqFilteredCDNIAdvertisement;

with fields:

capability-type: The same as Base Advertisement Object's capability-

type defined in Section 5.1 of [RFC8008].

capability-value: The same as Base Advertisement Object's

capability-value defined in Section 5.1 of [RFC8008].

cdni-capabilities: A list of CDNI capabilities defined in

Section 5.1 of [RFC8008] for which footprints are to be returned.

If this list is empty, the ALTO server MUST interpret it as a

request for the full CDNI Advertisement resource. The ALTO server

MUST interpret entries appearing in this list multiple times as if

they appeared only once. If the ALTO server does not define any

footprints for a CDNI capability, it MUST omit this capability

from the response.

5.4. Capabilities

There are no applicable capabilities.

5.5. Uses

Same to the "uses" field of the CDNI Advertisement resource (see

Section 3.5).

5.6. Response

If the request is invalid, the response MUST indicate an error, using

ALTO protocol error handling specified in Section 8.5 of [RFC7285].

Specifically, a filtered CDNI Advertisement request is invalid if:

\* the value of "capability-type" is null;

\* the value of "capability-value" is null;

\* the value of "capability-value" is inconsistent with "capability-

type".

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When a request is invalid, the ALTO server MUST return an

"E\_INVALID\_FIELD\_VALUE" error defined in Section 8.5.2 of [RFC7285],

and the "value" field of the error message SHOULD indicate this CDNI

capability.

The ALTO server returns a filtered CDNI Advertisement resource for a

valid request. The format of a filtered CDNI Advertisement resource

is the same as a full CDNI Advertisement resource (See Section 3.6.)

The returned filtered CDNI Advertisement resource MUST contain all

the BaseAdvertisementObject objects satisfying the following

condition: The CDNI capability object of each included

BaseAdvertisementObject object MUST follow two constraints:

\* The "cdni-capabilities" field of the input includes a CDNI

capability object X having the same capability type as it.

\* All the mandatory properties in its capability value is a superset

of mandatory properties in capability value of X semantically.

See Section 5.7.2 for a concrete example.

The version tag included in the "vtag" field of the response MUST

correspond to the full CDNI Advertisement resource from which the

filtered CDNI Advertisement resource is provided. This ensures that

a single, canonical version tag is used independently of any

filtering that is requested by an ALTO client.

5.7. Examples

The following examples use the same IRD example as in Section 3.7.1.

5.7.2. A Basic Example

This example filters the full CDNI Advertisement resource in

Section 3.7.2 by selecting only the http/1.1 delivery protocol

capability. Only the second BaseAdvertisementObjects in the full

resource will be returned because the second object's capability is

http/1.1 and https/1.1 delivery protocols which is the superset of

https/1.1 delivery protocol.

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POST /cdnifci/filtered HTTP/1.1

Host: alto.example.com

Accept: application/alto-cdni+json

Content-Type: application/cdnifilter+json

Content-Length: 166

{

"cdni-capabilities": [

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [ "https/1.1" ]

}

}

]

}

HTTP/1.1 200 OK

Content-Length: 543

Content-Type: application/alto-cdni+json

{

"meta": {

"vtag": {

"resource-id": "my-filtered-cdnifci",

"tag": "da65eca2eb7a10ce8b059740b0b2e3f8eb1d4785"

}

},

"cdni-advertisement": {

"capabilities-with-footprints": [

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [

"https/1.1",

"http/1.1"

]

},

"footprints": [

{

"footprint-type": "ipv4cidr",

"footprint-value": [ "198.51.100.0/24" ]

}

]

}

]

}

}

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5.7.3. Incremental Updates

In this example, the ALTO client only cares about the updates of one

advertisement object for delivery protocol capability whose value

includes "https/1.1". So, it adds its limitation of capabilities in

"input" field of the POST request.

POST /updates/cdnifci HTTP/1.1

Host: fcialtoupdate.example.com

Accept: text/event-stream,application/alto-error+json

Content-Type: application/alto-updatestreamparams+json

Content-Length: 329

{

"add": {

"my-filtered-fci-stream": {

"resource-id": "my-filtered-cdnifci",

"input": {

"cdni-capabilities": [

{

"capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": [ "https/1.1" ]

}

}

]

}

}

}

}

HTTP/1.1 200 OK

Connection: keep-alive

Content-Type: text/event-stream

event: application/alto-updatestreamcontrol+json

data: {"control-uri":

data: "https://alto.example.com/updates/streams/3141592653590"}

event: application/alto-cdni+json,my-filtered-fci-stream

data: { ... filtered CDNI Advertisement resource ... }

event: application/json-patch+json,my-filtered-fci-stream

data: [

data: {

data: "op": "replace",

data: "path": "/meta/vtag/tag",

data: "value": "a10ce8b059740b0b2e3f8eb1d4785acd42231bfe"

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data: },

data: { "op": "add",

data: "path":

data: "/cdni-advertisement/capabilities-with-footprints

/0/footprints/0/footprint-value/-",

data: "value": "192.0.2.0/24"

data: }

data: ]

6. Query Footprint Properties using ALTO Property Map Service

Besides the requirement of retrieving footprints of given

capabilities, another common requirement for uCDN is to query CDNI

capabilities of given footprints.

Considering each footprint as an entity with properties including

CDNI capabilities, a natural way to satisfy this requirement is to

use the ALTO property map as defined in

[I-D.ietf-alto-unified-props-new]. This section describes how ALTO

clients look up properties for individual footprints. First, it

describes how to represent footprint objects as entities in the ALTO

property map. Then it describes how to represent footprint

capabilities as entity properties in the ALTO property map. Finally,

it provides examples of the full property map and the filtered

property map supporting CDNI capabilities, and their incremental

updates.

6.1. Representing Footprint Objects as Property Map Entities

A footprint object has two properties: footprint-type and footprint-

value. A footprint-value is an array of footprint values conforming

to the specification associated with the registered footprint type

("ipv4cidr", "ipv6cidr", "asn", "countrycode", and "altopid").

Considering each ALTO entity defined in

[I-D.ietf-alto-unified-props-new] also has two properties: entity

domain type and domain-specific identifier, a straightforward

approach to represent a footprint as an ALTO entity is to represent

its footprint-type as an entity domain type, and its footprint value

as a domain-specific identifier.

Each existing footprint type can be represented as an entity domain

type as follows:

\* According to [I-D.ietf-alto-unified-props-new], "ipv4" and "ipv6"

are two predefined entity domain types, which can be used to

represent "ipv4cidr" and "ipv6cidr" footprints respectively. Note

that both "ipv4" and "ipv6" domains can include not only

hierarchical addresses but also individual addresses. Therefore,

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a "ipv4cidr" or "ipv6cidr" footprint with the longest prefix can

also be represented by an individual address entity. When the

uCDN receives a property map with individual addresses in an

"ipv4" or "ipv6" domain, it can translate them as corresponding

"ipv4cidr" or "ipv6cidr" footprints with the longest prefix.

\* "pid" is also a predefined entity domain type, which can be used

to represent "altopid" footprints. Note that "pid" is a resource-

specific entity domain. To represent an "altopid" footprint, the

specifying information resource of the corresponding "pid" entity

domain MUST be the dependent network map used by the CDNI

Advertisement resource providing this "altopid" footprint.

\* However, no existing entity domain type can represent "asn" and

"countrycode" footprints. To represent footprint-type "asn" and

"countrycode", this document registers two new entity domains in

Section 7 in addition to the ones in

[I-D.ietf-alto-unified-props-new].

Here is an example of representing a footprint object of "ipv4cidr"

type as a set of "ipv4" entities in the ALTO property map. The

representation of the footprint object of "ipv6cidr" type is similar.

{ "footprint-type": "ipv4cidr",

"footprint-value": ["192.0.2.0/24", "198.51.100.0/24"]

} --> "ipv4:192.0.2.0/24", "ipv4:198.51.100.0/24"

And here is an example of corresponding footprint object of

"ipv4cidr" type represented by an individual address in an "ipv4"

domain in the ALTO property map. The translation of the entities in

an "ipv6" domain is similar.

"ipv4:203.0.113.100" --> {

"footprint-type": "ipv4cidr",

"footprint-value": ["203.0.113.100/32"]

}

6.1.1. ASN Domain

The ASN entity domain associates property values with Autonomous Systems in

the Internet.

6.1.1.1. Entity Domain Type

The entity domain type of the ASN domain is "asn" (in lowercase).

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6.1.1.2. Domain-Specific Entity Identifiers

The entity identifier of an entity in an ASN domain MUST be encoded as a

string consisting of the characters "as" (in lowercase) followed by

the ASN [RFC6793] as a decimal number without

leading zeros.

6.1.1.3. Hierarchy and Inheritance

There is no hierarchy or inheritance for properties associated with

ASN.

6.1.2. COUNTRYCODE Domain

The COUNTRYCODE entity domain associates property values with countries.

6.1.2.1. Entity Domain Type

The entity domain type of the COUNTRYCODE domain is "countrycode" (in

lowercase).

6.1.2.2. Domain-Specific Entity Identifiers

The entity identifier of an entity in a COUNTRYCODE domain is encoded

as an ISO 3166-1 alpha-2 code [ISO3166-1] in lowercase.

6.1.2.3. Hierarchy and Inheritance

There is no hierarchy or inheritance for properties associated with

country codes.

6.2. Representing CDNI Capabilities as Property Map Entity Properties

This document defines a new entity property type called "cdni-

capabilities". An ALTO server can provide a property map resource

mapping the "cdni-capablities" entity property type for a CDNI

Advertisement resource that it provides to an "ipv4", "ipv6", "asn"

or "countrycode" entity domain.

6.2.1. Defining Information Resource Media Type for Property Type cdni-

capabilities

The entity property type "cdni-capabilities" allows defining

resource-specific entity properties. When resource-specific entity

properties are defined with entity property type "cdni-capabilities",

the defining information resource for a "cdni-capabilities" property

MUST be a CDNI Advertisement resource provided by the ALTO server.

The media type of the defining information resource for a "cdni-

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capabilities" property is therefore:

application/alto-cdni+json

6.2.2. Intended Semantics of Property Type cdni-capabilities

A "cdni-capabilities" property for an entity is to indicate all the

CDNI capabilities that a corresponding CDNI Advertisement resource

provides for the footprint represented by this entity. Thus, the

value of a "cdni-capabilities" property MUST be a JSON array. Each

element in a "cdni-capabilities" property MUST be an JSON object as

format of CDNICapability (see Section 5.3). The value of a "cdni-

capabilities" property for an "ipv4", "ipv6", "asn", "countrycode" or

"altopid" entity MUST include all the CDNICapability objects

satisfying the following conditions: (1) they are provided by the

defining CDNI Advertisement resource; and (2) the represented

footprint object of this entity is in their footprint restrictions.

6.3. Examples

The following examples use the same IRD example given by Section 3.7.1.

6.3.2. Property Map

This example shows a full property map in which entities are

footprints and entities' property is "cdni-capabilities".

GET /propmap/full/cdnifci HTTP/1.1

Host: alto.example.com

Accept: application/alto-propmap+json,application/alto-error+json

HTTP/1.1 200 OK

Content-Length: 1476

Content-Type: application/alto-propmap+json

{

"property-map": {

"meta": {

"dependent-vtags": [

{ "resource-id": "my-default-cdnifci",

"tag": "7915dc0290c2705481c491a2b4ffbec482b3cf62"}

]

},

"countrycode:us": {

"my-default-cdnifci.cdni-capabilities": [

{ "capability-type": "FCI.DeliveryProtocol",

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"capability-value": {

"delivery-protocols": ["http/1.1"]}}]

},

"ipv4:192.0.2.0/24": {

"my-default-cdnifci.cdni-capabilities": [

{ "capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": ["http/1.1"]}}]

},

"ipv4:198.51.100.0/24": {

"my-default-cdnifci.cdni-capabilities": [

{ "capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": ["https/1.1", "http/1.1"]}}]

},

"ipv4:203.0.113.0/24": {

"my-default-cdnifci.cdni-capabilities": [

{ "capability-type": "FCI.AcquisitionProtocol",

"capability-value": {

"acquisition-protocols": ["http/1.1"]}}]

},

"ipv6:2001:db8::/32": {

"my-default-cdnifci.cdni-capabilities": [

{ "capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": ["http/1.1"]}}]

},

"asn:as64496": {

"my-default-cdnifci.cdni-capabilities": [

{ "capability-type": "FCI.DeliveryProtocol",

"capability-value": {

"delivery-protocols": ["https/1.1", "http/1.1"]}}]

}

}

}

6.3.3. Filtered Property Map

This example uses the filtered property map service to get "pid" and

"cdni-capabilities" properties for two footprints "ipv4:192.0.2.0/24"

and "ipv6:2001:db8::/32".

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POST /propmap/lookup/cdnifci-pid HTTP/1.1

Host: alto.example.com

Content-Type: application/alto-propmapparams+json

Accept: application/alto-propmap+json,application/alto-error+json

Content-Length: 173

{

"entities": [

"ipv4:192.0.2.0/24",

"ipv6:2001:db8::/32"

],

"properties": [ "my-default-cdnifci.cdni-capabilities",

"my-default-networkmap.pid" ]

}

HTTP/1.1 200 OK

Content-Length: 772

Content-Type: application/alto-propmap+json

{

"property-map": {

"meta": {

"dependent-vtags": [

{"resource-id": "my-default-cdnifci",

"tag": "7915dc0290c2705481c491a2b4ffbec482b3cf62"},

{"resource-id": "my-default-networkmap",

"tag": "7915dc0290c2705481c491a2b4ffbec482b3cf63"}

]

},

"ipv4:192.0.2.0/24": {

"my-default-cdnifci.cdni-capabilities": [

{"capability-type": "FCI.DeliveryProtocol",

"capability-value": {"delivery-protocols": ["http/1.1"]}}],

"my-default-networkmap.pid": "pid1"

},

"ipv6:2001:db8::/32": {

"my-default-cdnifci.cdni-capabilities": [

{"capability-type": "FCI.DeliveryProtocol",

"capability-value": {"delivery-protocols": ["http/1.1"]}}],

"my-default-networkmap.pid": "pid3"

}

}

}

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6.3.4. Incremental Updates

In this example, the ALTO client is interested in updates for the

properties "cdni-capabilities" and "pid" of two footprints

"ipv4:192.0.2.0/24" and "countrycode:fr".

POST /updates/properties HTTP/1.1

Host: alto.example.com

Accept: text/event-stream,application/alto-error+json

Content-Type: application/alto-updatestreamparams+json

Content-Length: 325

{

"add": {

"fci-propmap-stream": {

"resource-id": "filtered-cdnifci-property-map",

"input": {

"properties": [ "my-default-cdnifci.cdni-capabilities",

"my-default-networkmap.pid" ],

"entities": [ "ipv4:192.0.2.0/24",

"ipv6:2001:db8::/32" ]

}

}

}

}

HTTP/1.1 200 OK

Connection: keep-alive

Content-Type: text/event-stream

event: application/alto-updatestreamcontrol+json

data: {"control-uri":

data: "https://alto.example.com/updates/streams/1414213562373"}

event: application/alto-cdni+json,fci-propmap-stream

data: { ... filtered property map ... }

event: application/merge-patch+json,fci-propmap-stream

data: {

data: "property-map": {

data: "meta": {

data: "dependent-vtags": [

data: { "resource-id": "my-default-cdnifci",

data: "tag": "2beeac8ee23c3dd1e98a73fd30df80ece9fa5627"},

data: { "resource-id": "my-default-networkmap",

data: "tag": "7915dc0290c2705481c491a2b4ffbec482b3cf63"}

data: ]

data: },

data: "ipv4:192.0.2.0/24": {

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data: "my-default-cdnifci.cdni-capabilities": [

data: { "capability-type": "FCI.DeliveryProtocol",

data: "capability-value": {

data: "delivery-protocols": ["http/1.1", "https/1.1"]}}]

data: }

data: }

data: }

event: application/json-patch+json,fci-propmap-stream

data: [

data: { "op": "replace",

data: "path": "/meta/dependent-vtags/0/tag",

data: "value": "61b23185a50dc7b334577507e8f00ff8c3b409e4"

data: },

data: { "op": "replace",

data: "path":

data: "/property-map/countrycode:fr/my-default-networkmap.pid",

data: "value": "pid5"

data: }

data: ]

7. IANA Considerations

7.1. application/alto-\* Media Types

This document updates the IANA Media Types Registry by registering

two additional ALTO media types, listed in Table 1.

+=============+======================+======================+

| Type | Subtype | Specification |

+=============+======================+======================+

| application | alto-cdni+json | Section 3 of RFCthis |

+-------------+----------------------+----------------------+

| application | alto-cdnifilter+json | Section 5 of RFCthis |

+-------------+----------------------+----------------------+

Table 1: Additional ALTO Media Types.

Type name:

application

Subtype name:

This document registers multiple subtypes, as listed in Table 1.

Required parameters:

n/a

Optional parameters:

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n/a

Encoding considerations:

Encoding considerations are identical to those specified for the

"application/json" media type. See [RFC8259].

Security considerations:

Security considerations related to the generation and consumption

of ALTO Protocol messages are discussed in Section 15 of

[RFC7285].

Interoperability considerations:

n/a

Published specification:

This document is the specification for these media types; see

Table 1 for the section documenting each media type.

Applications that use this media type:

ALTO servers and ALTO clients either stand alone or are embedded

within other applications.

Additional information:

Magic number(s): n/a

File extension(s): This document uses the mime type to refer to

protocol messages and thus does not require a file extension.

Macintosh file type code(s): n/a

Person & email address to contact for further information:

See Authors' Addresses section.

Intended usage:

COMMON

Restrictions on usage:

n/a

Author:

See Authors' Addresses section.

Change controller:

Internet Engineering Task Force (mailto:iesg@ietf.org).

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7.2. CDNI Metadata Footprint Type Registry

This document updates the CDNI Metadata Footprint Types Registry

created by Section 7.2 of [RFC8006]. A new footprint type is to be

registered, listed in Table 2.

+================+=====================+======================+

| Footprint Type | Description | Specification |

+================+=====================+======================+

| altopid | A list of PID names | Section 4 of RFCthis |

+----------------+---------------------+----------------------+

Table 2: CDNI Metadata Footprint Type

[RFC Editor: Please replace RFCthis with the published RFC number for

this document.]

7.3. ALTO Entity Domain Type Registry

This document updates the ALTO Entity Domain Type Registry created by

Section 11.2 of [I-D.ietf-alto-unified-props-new]. Two new entity

domain types are to be registered, listed in Table 3.

+=============+================+=============+===================+

| Identifier | Entity Address | Hierarchy & | Media Type of |

| | Encoding | Inheritance | Defining Resource |

+=============+================+=============+===================+

| asn | See Section | None | None |

| | 6.1.1.2 of | | |

| | RFCthis | | |

+-------------+----------------+-------------+-------------------+

| countrycode | See Section | None | None |

| | 6.1.2.2 of | | |

| | RFCthis | | |

+-------------+----------------+-------------+-------------------+

Table 3: Additional ALTO Entity Domain Types

[RFC Editor: Please replace RFCthis with the published RFC number for

this document.]

7.4. ALTO Entity Property Type Registry

This document updates the ALTO Entity Property Type Registry created

by Section 11.3 of [I-D.ietf-alto-unified-props-new]. A new entity

property type is to be registered, listed in Table 4.

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+===================+====================+===================+

| Identifier | Intended Semantics | Media Type of |

| | | Defining Resource |

+===================+====================+===================+

| cdni-capabilities | Section 6.2 of | application/alto- |

| | RFCthis | cdni+json |

+-------------------+--------------------+-------------------+

Table 4: Additional ALTO Entity Property Type

[RFC Editor: Please replace RFCthis with the published RFC number for

this document.]

8. Security Considerations

As an extension of the base ALTO protocol [RFC7285], this document

fits into the architecture of the base protocol. And hence Security

Considerations of the base protocol (Section 15 of [RFC7285]) fully

apply when this extension is provided by an ALTO server.

In the context of CDNI Advertisement, the following security

considerations should be considered:

\* For authenticity and integrity of ALTO information, an attacker

may disguise itself as an ALTO server for a dCDN, and provide

false capabilities and footprints to a uCDN using the CDNI

Advertisement service. Such false information may lead a uCDN to

(1) select an incorrect dCDN to serve user requests, or (2) skip

uCDNs in good conditions.

\* For potential undesirable guidance from authenticated ALTO

information, a dCDN can provide a uCDN with limited capabilities

and smaller footprint coverage so that the dCDN can avoid

transferring traffic for a uCDN which they should have to

transfer.

\* For confidentiality and privacy of ALTO information, footprint

properties integrated with ALTO property maps may expose network

location identifiers (e.g., IP addresses or fine-grained PIDs).

\* For availability of ALTO services, an attacker may conduct service

degradation attacks using services defined in this document to

disable ALTO services of a network. It may request potentially

large, full CDNI Advertisement resources from an ALTO server in a

dCDN continuously, to consume the bandwidth resources of that ALTO

server. It may also query filtered property map services with

many smaller individual footprints, to consume the computation

resources of the ALTO server.

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Although protection strategies as described in Section 15 of

[RFC7285] should be applied to address aforementioned security and

privacy considerations, two special cases need to be included as

follows:

\* As required by section 7 of [RFC8008],

"All protocols that implement these capabilities and footprint

advertisement objects are REQUIRED to provide integrity and

authentication services."

Therefore, the uCDN (ALTO Client) MUST be authenticated to the

dCDN (ALTO Server). And the dCDN (ALTO Server) MUST support HTTP

Digest Authentication and MAY also support TLS mutual

authentication. The authentication method will need to be

negotiated out of band and is out of scope for this document, as

is the approach for provisioning and managing these credentials.

\* One specific information leakage risk introduced by this document

could not be addressed by these strategies. In particular, if a

dCDN signs agreements with multiple uCDNs without any isolation,

this dCDN may disclose extra information of one uCDN to another

one. In that case, one uCDN may redirect requests which should

not have to be served by this dCDN to it.

To reduce the risk, a dCDN SHOULD isolate full/filtered CDNI

Advertisement resources for different uCDNs. It could consider

generating URIs of different full/filtered CDNI Advertisement

resources by hashing its company ID, a uCDN's company ID as well

as their agreements. A dCDN SHOULD avoid exposing all full/

filtered CDNI Advertisement resources in one of its IRDs.

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