Content Delivery Network Interconnection (CDNI) Request Routing: CDNI Footprint and Capabilities Advertisement using ALTO

draft-alto-cdni-request-routing-alto-03

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Outline

- Summary of Changes
- Discussions

Summary of Changes-1

- Make Introduction section more compact and add the outline of this document (Section 1)
- Add some pointers/examples to strengthen benefits of using ALTO (Section 2.2)
- Update CDNI FCI Map response schema (Section 3.6)
  - Use the BaseAdvertisementObject defined in RFC 8008
  - Add an example to show that optimization of BaseAdvertisement objects is possible
- Add descriptions of "altonetworkmap" footprint type and dependency between CDNI FCI Map and Network Map (Section 4.1)
- Add the error handling for Filtered CDNI FCI Map (Section 5.6)

Summary of Changes-2

- Update data component's name of CDNI FCI Map to "cdni-fci-map"
- Update media type of CDNI FCI Map to "application/alto-cdnifcimap+json" (Section 3/4.2/5.7/6.2)
- Update media type of queries of CDNI FCI Map to "application/alto-cdnifcifilter+json" (Section 5.3)
- Extend Security Considerations (Section 8)
- Make descriptions of Exmaples more clean
- Small text edits

Revision of Introduction (Section 1)

- Change no that important lists into plain texts
- Remove unnecessary descriptions
- Add the outline of this document

The rest of this document is organized as follows. Section 2 provides non-normative background on both CDNI FCI and ALTO. Section 3 introduces the most basic service, called CDNI FCI Map, to realize CDNI FCI using ALTO. Section 4 demonstrates a key benefit of using ALTO: the ability to integrate CDNI FCI with ALTO network maps. Such integration provides a new granularity to describe footprints. Section 5 builds on filtered ALTO maps to introduce filtered CDNI FCI maps using capabilities so that a uCDN can get footprints with given capabilities instead of getting the full map which can be huge. Section 6 further shows a benefit of using ALTO: the ability to query footprint properties using ALTO unified properties. In this way, a uCDN can effectively fetch capabilities of some footprints in which it is interested. IANA and security considerations are discussed in Section 7 and Section 8 respectively.

Strengthen Benefits of using ALTO (Section 2.2)

1. ALTO can help a uCDN request routing
   - Add how ALTO can help a uCDN to select a proper dCDN
2. ALTO network map can be used to convey a footprint by a dCDN
   - Add a pointer to Section 4 CDNI FCI Map using ALTO Network Map
3. Security (ALTO maps can be signed)
   - Identification between uCDNs and dCDNs are extremely important
   - Add a pointer to Section 8 Security Considerations
4. RESTful-Design
   - Add a pointer to Section 3 CDNI FCI Map
5. Error-handling
   - Add a pointer to Section 5 Filtered CDNI FCI Map which includes how to use ALTO error-codes to present queries' errors

Strengthen Benefits of using ALTO (Section 2.2)

6. Filtered map service
   - Add an example that we can directly use filtered unified property map to filter on footprints
7. Server-initiated Notificatoins and Incremental Updates
   - Small text edits
8. Content Availability on Hosts
   - The new endpoint property for ALTO would enable to provide such information
   - Add a pointer to Section 6
9. Resource Availability on Hosts or Links
   - Add a reference to ALTO Path Vetor Extension

Update CDNI FCI Map Response Schema (Section 3.6)

- Use Base Advertisement Object defined in RFC 8008 to encode CDNI FCI Map
- The original encoding of base advertisement object and fooprint is remained for self-contained purpose

5.1. Base Advertisement Object

The FCIBase object is an abstraction for managing individual CDNI capabilities in an opaque manner.

Property: capability-type

Description: CDNI capability object type.

Type: FCI-specific CDNI Payload Type (from the "CDNI Payload Types" registry [RFC7736])

Mandatory-to-Specify: Yes.

Property: capability-value

Description: CDNI capability object.

Type: Format/Type is defined by the value of the capability-type property above

Mandatory-to-Specify: Yes.

Property: footprints

Description: CDNI capability footprint.

Type: List of CDNI Footprint objects (from the "CDNI Metadata Footprint Types" registry [RFC8006])

Mandatory-to-Specify: No.

```
object {
    CDNIFCIMapData cdnifci-map;
} InfoResourceCDNIFCIMap : ResponseEntityBase;

object {
    CDNIFCIObject capabilities<1..*>;
} CDNIFCIMapData

object {
    JSONString capability-type;
    JSONValue capability-value;
    CDNIFCIFootprint footprints<0..*>;
} CDNIFCIObject;

object {
    JSONString footprint-type;
    JSONString footprint-value<1..*>;
} CDNIFCIFootprint
```

```
object {
    CDNIFCIMapData cdni-fci-map;
} InfoResourceCDNIFCIMap : ResponseEntityBase;

object {
    BaseAdvertisementObject capabilities<1..*>;
} CDNIFCIMapData
```

Update CDNI FCI Map Response Schema (Section 3.6)

- Add an example to show that optimization of BaseAdvertisement objects is possible. However, the specifics of such mechanisms are outside the scope of this document.

```
EXAMPLE 1
   {
      "meta" : {...},
      "cdni-fci-map": {
        "capabilities": [
          {
            "capability-type": "FCI.DeliveryProtocol",
            "capability-value": {
              "delivery-protocols": [
                "http/1.1"
              ]
            },
            "footprints": [
              <Footprint objects>
```

```
            ]
          },
          {
            "capability-type": "FCI.DeliveryProtocol",
            "capability-value": {
              "delivery-protocols": [
                "https/1.1"
              ]
            },
            "footprints": [
              <Footprint objects>
            ]
          }
        ]
      }
    }
```

```
EXAMPLE 2
   {
      "meta" : {...},
      "cdni-fci-map": {
        "capabilities": [
          {
            "capability-type": "FCI.DeliveryProtocol",
            "capability-value": {
              "delivery-protocols": [
                "https/1.1",
                "http/1.1"
              ]
            },
            "footprints": [
              <Footprint objects>
            ]
          }
        ]
      }
    }
```

- Example 1 and Example 2 are two different encodings of the same footprints with the same capabilities ([https/1.1, http/1.1] delivery procols)

Updates of Footprint Type "altonetworkmap" (Section 4.1)

- "altonetworkmap" footprint type indicates that the corresponding footprint value is a list of PIDNames
- These PIDNames are references of PIDs in a network map
- CDNI FCI map with "altonetworkmap" footprints dpends on a network map
- "dependent-vtag" field with a reference to a related network map MUST be included in the CDNI FCI map

```
   Specifically, CDNI footprints using ALTO network maps should use a
   new CDNI Footprint Type called "altonetworkmap".

   "altonetworkmap" 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 FCI map with "altonetworkmap" footprints depends on a network
   map.  For such a CDNI FCI map, the "dependent-vtag" field with a
   reference to a network map it depends on MUST be included in it (see
   the example in Section 4.2.3).
```

Error Handling of Filtered CDNI FCI Map (Section 5.6)

5.6. Response

The response MUST indicate an error, using ALTO protocol error handling specified in Section 8.5 of the ALTO protocol [RFC7285], if the request is invalid.

Specifically, a filtered CDNI FCI map request can be invalid as follows:

- The value of "capability-type" is null;
- The value of "capability-value" is null;
- The value of "capability-value" is inconsistent with "capability-type".

When the 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 FCI capability.

The ALTO server return a filtered CDNI FCI map for a valid request. The format of a filtered CDNI FCI map is the same as an unfiltered CDNI FCI map. See Section 3.6 for the format.

The returned CDNI FCI map MUST contain only BaseAdvertisementObject objects whose CDNI capability object is the superset of one of CDNI capability object in "cdni-fci-capabilities". Specifically, that a CDNI capability object A is the superset of another CDNI capability object B means that these two CDNI capability objects have the same capability type and mandatory properties in capability value of A MUST include mandatory properties in capability value of B semantically. See Section 5.7.2 for a concrete example.

Update Data Component's Name of CDNI FCI Map to "cdni-fci-map"

- Description in Section 3
- Related examples in Section 3.7/4.2/5.7/6.2

```
3.6.  Response

   If a CDNI FCI map does not depend on other resources, the "meta"
   field of a CDNI FCI map response MUST include the "vtag" field
   defined in Section 10.3 of [RFC7285], which provides the version tag
   of the retrieved CDNI FCI map.  If a CDNI FCI map response depends on
   a resource such a network map, it MUST include the "dependen
   field, whose value is an array to indicate the version tag o
   resource used, where the resource is specified in "uses" of the IRD.
   The current defined dependent resource is only network map, and the
   usage of it is described in Section 4.  The data component of an ALTO
   CDNI FCI map response is named "cdnifci-map", which is a JSON object
   of type CDNIFCIMapData:
```

```
3.6.  Response

   If a CDNI FCI map does not depend on other resources, the "meta"
   field of a CDNI FCI map response MUST include the "vtag" field
   defined in Section 10.3 of [RFC7285], which provides the version tag
   of the retrieved CDNI FCI map.  If a CDNI FCI map response depends on
   a resource such a network map, it MUST include the "dependent-vtags"
   field, whose value is an array to indicate the version tag of the
   resource used, where the resource is specified in "uses" of the IRD.
   The current defined dependent resource is only network map, and the
   usage of it is described in Section 4.  The data component of an ALTO
   CDNI FCI map response is named "cdni-fci-map", which is a JSON object
   of type CDNIFCIMapData:
```

```
"cdni-fcimap": {
   "capabilities": [{
      "capability-type":  “FCI.DeliveryProtocol”,
      “capability-value”: {
         “delivery-protocols”: [“http/1.1”]
      }
      “footprints”: [<Footprint objects>]
   }]
}
```

```
"cdni-fci-map": {
   "capabilities": [{
      "capability-type":  “FCI.DeliveryProtocol”,
      “capability-value”: {
         “delivery-protocols”: [“http/1.1”]
      }
      “footprints”: [<Footprint objects>]
   }]
}
```

Update Media Type of CDNI FCI Map to "application/alto-cdnifcimap+json"

- Description in Section 3
- Related examples in Section 3.7/4.2/5.7/6.2

```
   This document defines a new ALTO Map Service called "CDNI FCI Map
   Service" which conveys JSON objects of media type "application/cdni".
   This media type and JSON object format is defined in [RFC8006] and
   [RFC8008]; this document specifies how to transport such JSON objects
   via the ALTO protocol with the ALTO "CDNI FCI Map Service".  Given
   that the "CDNI FCI Map Service" is very similar in structure to the
   two already defined map services (network maps and cost maps), the

   specification of CDNI FCI Map below uses the same specifica
   structure for Cost Map specification in Section 11.2.3 of [RFC7285]
   when specifying cost maps.

3.1.  Media Type

   The media type of the CDNI FCI Map is "application/cdni".
```

```
   This document defines a new ALTO Map Service called "CDNI FCI Map
   Service" which conveys JSON objects of media type "application/alto-
   cdnifcimap+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 FCI Map Service".  Given that
   the "CDNI FCI Map Service" is very similar in structure to the two
   already defined map services (network maps and cost maps), the
   specification of CDNI FCI Map below uses the same specification
   structure for Cost Map specification in Section 11.2.3 of [RFC7285]
   when specifying cost maps.

3.1.  Media Type

   The media type of the CDNI FCI Map is "application/alto-
   cdnifcimap+json".
```

Update Media Type of Queries of Filtered CDNI FCI Map to "application/alto-cdnifcifilter+json"

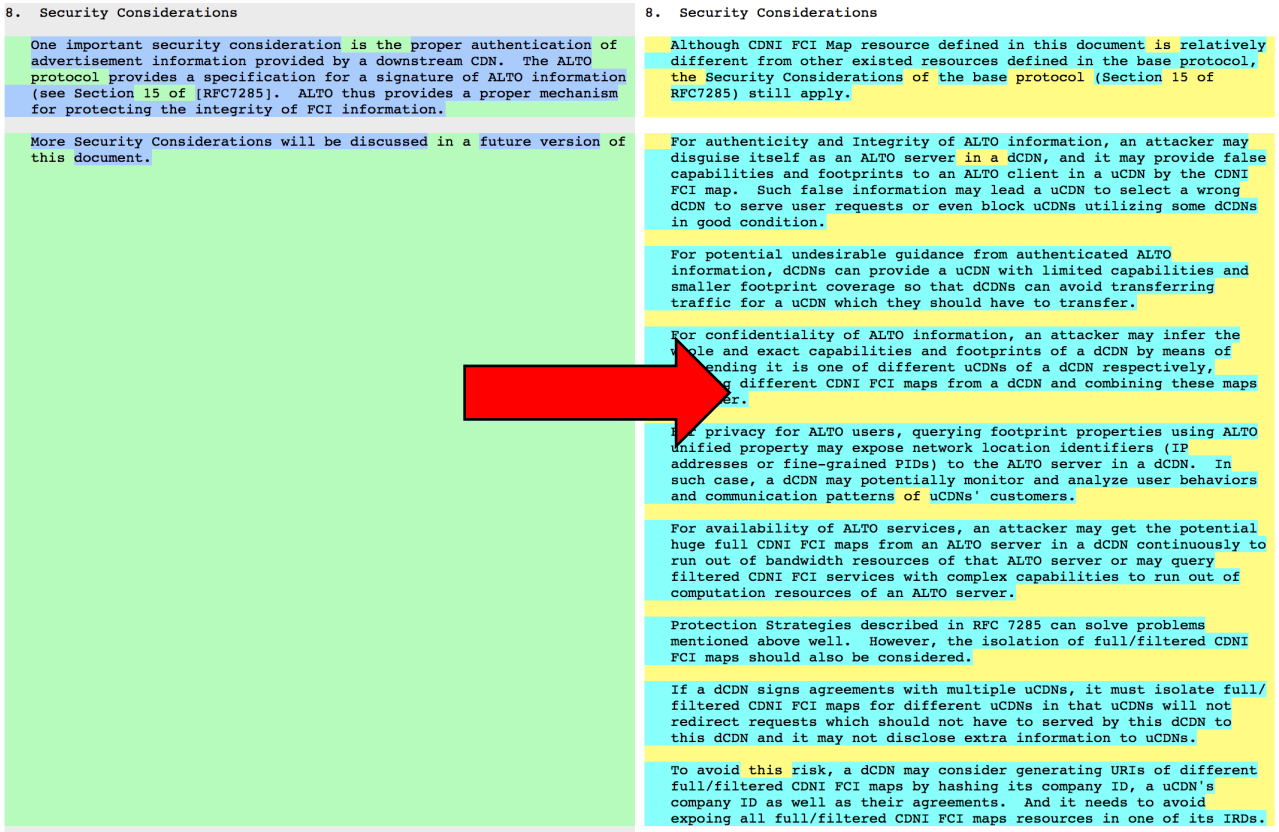
- Description in Section 5.3
- Related examples in Section 5.7

```
5.3.  Accept Input Parameters

   The input parameters for a filtered CDNI FCI map 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-cdni-filter", which is a JSON object of type
   ReqFilteredCDNIFCIMap, where:
```

```
5.3.  Accept Input Parameters

   The input parameters for a filtered CDNI FCI map 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-cdnifcifilter+json" which is a JSON object of type
   ReqFilteredCDNIFCIMap, where:
```

Extend Security Considerations (Section 8)

- Despite of 5 security considerations described in RFC 7285, we must strengthen the isolation of full/filtered CDNI FCI maps for different uCDNs. Otherwise it may lead that uCDNs may redirect requests to the wrong dCDN which can not serve these requests. A potential solution of it is that we can not include all CDNI FCI maps in one IRD.



8. Security Considerations

One important security consideration is the proper authentication of advertisement information provided by a downstream CDN. The ALTO protocol provides a specification for a signature of ALTO information (see Section 15 of [RFC7285]. ALTO thus provides a proper mechanism for protecting the integrity of FCI information.

More Security Considerations will be discussed in a future version of this document.

8. Security Considerations

Although CDNI FCI Map resource defined in this document is relatively different from other existed resources defined in the base protocol, the Security Considerations of the base protocol (Section 15 of RFC7285) still apply.

For authenticity and Integrity of ALTO information, an attacker may disguise itself as an ALTO server in a dCDN, and it may provide false capabilities and footprints to an ALTO client in a uCDN by the CDNI FCI map. Such false information may lead a uCDN to select a wrong dCDN to serve user requests or even block uCDNs utilizing some dCDNs in good condition.

For potential undesirable guidance from authenticated ALTO information, dCDNs can provide a uCDN with limited capabilities and smaller footprint coverage so that dCDNs can avoid transferring traffic for a uCDN which they should have to transfer.

For confidentiality of ALTO information, an attacker may infer the whole and exact capabilities and footprints of a dCDN by means of pretending it is one of different uCDNs of a dCDN respectively, collecting different CDNI FCI maps from a dCDN and combining these maps together.

For privacy for ALTO users, querying footprint properties using ALTO unified property may expose network location identifiers (IP addresses or fine-grained PIDs) to the ALTO server in a dCDN. In such case, a dCDN may potentially monitor and analyze user behaviors and communication patterns of uCDNs' customers.

For availability of ALTO services, an attacker may get the potential huge full CDNI FCI maps from an ALTO server in a dCDN continuously to run out of bandwidth resources of that ALTO server or may query filtered CDNI FCI services with complex capabilities to run out of computation resources of an ALTO server.

Protection Strategies described in RFC 7285 can solve problems mentioned above well. However, the isolation of full/filtered CDNI FCI maps should also be considered.

If a dCDN signs agreements with multiple uCDNs, it must isolate full/filtered CDNI FCI maps for different uCDNs in that uCDNs will not redirect requests which should not have to served by this dCDN to this dCDN and it may not disclose extra information to uCDNs.

To avoid this risk, a dCDN may consider generating URIs of different full/filtered CDNI FCI maps by hashing its company ID, a uCDN's company ID as well as their agreements. And it needs to avoid expoing all full/filtered CDNI FCI maps resources in one of its IRDs.

Revision of Examples' Descriptions

- Revise the descriptions in Section 3.7.1/3.7.2
- Add more desciptions in Section 3.7.3/5.7.2
  - 3.7.3 Add more explain for incremental updates response
  - 5.7.2 More descriptions on how to filter on capabilities

Disscussions

- What other ALTO features may be benefit to CDNI?
  - Calendar?
  - PV?
  - …?

Disscussions

- CDNI has 4 interfaces
  - CDNI Request Routing Interface
  - CDNI Metadata Interface
  - CDNI Logging Interface
  - CDNI Contrl Interface

- If FCI uses ALTO, can other use ALTO as well? Or at least how all 4 fit together?

Next Steps

- Get comments from WG members

Backup Slides

Make CDNI FCI Map Structure Consist with Network/Cost Map

- Rename "cdni-fcimap" → "cdni-fci-map"

Version 00

```
"cdni-fcimap": {
   "capabilities": [{
      "capability-type":  “FCI.DeliveryProtocol”,
      “capability-value”: {
         “delivery-protocols”: [“http/1.1”]
      }
      “footprints”: [<Footprint objects>]
   }]
}
```


Version 01

```
"cdni-fci-map": {
   "capabilities": [{
      "capability-type":  “FCI.DeliveryProtocol”,
      “capability-value”: {
         “delivery-protocols”: [“http/1.1”]
      }
      “footprints”: [<Footprint objects>]
   }]
}
```

Summary of Changes

- Add a new Section Protocol Error (Section 7)
- Update media type of CDNI FCI Map to "application/alto-cdnifcimap+json" (Section 3/4.2/5.7/6.2)
- Update data component's name of CDNI FCI Map to "cdni-fci-map" (Section 3/4.2/5.7/6.2)
- Update CDNI FCI Map response schema (Section 3.6)
  - Use the BaseAdvertisementObject defined in RFC 8008

Add a new Section Protocol Error

Only need to explain the error-handling mechanism of filtered CDNI FCI map. Others are the same as the original.

```
POST /cdnifcimap/filtered HTTP/1.1
HOST: alto.example.com
Content-Type: application/cdnifilter+json
Accept: application/cdni

{
  "cdni-fci-capabilities": [
    {
      "capability-type": "FCI.DeliveryProtocol",
      "capability-value": {
        "delivery-protocols": [
           "http/1.1"
        ]
      }
    }
  ]
}
```

Error handling

- E_SYNTAX
  - Covers all cases of syntax errors of filtered CDNI FCI map queries
- E_INVALID_FIELD_VALUE
  - The value of "capability-type" is null
  - The value of "capability-value" is null
  - The value of "capability-value" is inconsistent with "capability-type"