        CDNI Footprint and Capabilities Advertisement using ALTO
               draft-seedorf-cdni-request-routing-alto-07

Abstract

   Network Service Providers (NSPs) are currently considering to deploy
   Content Delivery Networks (CDNs) within their networks. As a
   consequence of this development, there is a need for interconnecting
   these local CDNs. The necessary interfaces for inter-connecting CDNs
   are currently being defined in the Content Delivery Networks
   Interconnection (CDNI) WG. This document focuses on the CDNI
   Footprint & Capabilities Advertisement interface (FCI).
   Specifically, this document specifies a new Application Layer Traffic
   Optimization (ALTO) service to facilitate Footprint & Capabilities
   Advertisement in a CDNI context.

Status of This Memo

   This Internet-Draft is submitted in full conformance with the
   provisions of BCP 78 and BCP 79.

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   material or to cite them other than as "work in progress."

   This Internet-Draft will expire on December 29, 2014.

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1. Introduction

   Many Network Service Providers (NSPs) are currently considering or
   have already started to deploy Content Delivery Networks (CDNs)
   within their networks. As a consequence of this development, there
   is a need for interconnecting these local CDNs. Content Delivery
   Networks Interconnection (CDNI) has the goal of standardizing
   protocols to enable such interconnection of CDNs [RFC6707].

   The CDNI problem statement [RFC6707] envisions four interfaces to be
   standardized within the IETF for CDN interconnection:

   o CDNI Request Routing Interface

        o CDNI Metadata Interface

        o CDNI Logging Interface

        o CDNI Control Interface

     This document focuses solely on the CDNI Request Routing Interface,
     which can be further divided into two interfaces (see [RFC6707] for a
     detailed description): the CDNI Request Routing Redirection interface
     (RI), and the CDNI Footprint & Capabilities Advertisement interface
     (FCI). This document specifies a new Application Layer Traffic
     Optimization (ALTO) [I-D.ietf-alto-protocol] service called 'CDNI
     Footprint & Capabilities Advertisement Service'. This service is
     used to transport a CDNI FCI JSON objects, which are defined in a
     separate document [I-D.ma-cdni-capabilities].

     Throughout this document, we use the terminology for CDNI defined in
     [I-D.ietf-cdni-problem-statement].

2. ALTO within CDNI Request Routing

     The main purpose of the CDNI Request Routing Interface is described
     in [RFC6707] as follows: "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." On a high level, the scope of the CDNI Request
     Routing Interface therefore contains two main tasks:

     o A) Determining if the downstream CDN is willing to accept a
        delegated content request

     o B) Redirecting the content request coming from an upstream CDN to
        the proper entry point or entity in the downstream CDN

     More precisely, in [I-D.ietf-cdni-framework] the request routing
     interface is broadly divided into two functionalities:

     o 1) the asynchronous advertisement of footprint and capabilities by
        a dCDN that allows a uCDN to decide whether to redirect particular
        user requests to that dCDN (the CDNI FCI)

     o 2) the synchronous operation of actually redirecting a user
        request (the CDNI RI)

Application Layer Traffic Optimization (ALTO)
[I-D.ietf-alto-protocol] is an approach for guiding the resource
provider selection process in distributed applications that can
choose among several candidate resources providers to retrieve a
given resource. By conveying network layer (topology) information,
an ALTO server can provide important information to "guide" the
resource provider selection process in distributed applications.
Usually, it is assumed that an ALTO server conveys information these
applications cannot measure themselves [RFC5693].

Originally, ALTO was motivated by the huge amount of cross-ISP
traffic generated by P2P applications [RFC5693]. Recently, however,
ALTO is also being considered for improving the request routing in
CDNs [I-D.jenkins-alto-cdn-use-cases]. In this context, it has also
been proposed to use ALTO for selecting an entry-point in a
downstream NSP's network (see section 3.4 "CDN delivering Over-The-
Top of a NSP's network" in [I-D.jenkins-alto-cdn-use-cases]). Also,
the CDNI problem statement explicitly mentions ALTO as a candidate
protocol for "algorithms for selection of CDN or Surrogate by
Request-Routing systems" [I-D.ietf-cdni-problem-statement].

3. Assumptions and High-Level Design Considerations

   In this section we list some assumptions and design issues to be
   considered when using ALTO for the CDNI Footprint and Capabilities
   Advertisement interface.

3.1. General Assumptions and Considerations

   Below we list some general assumptions and considerations:

   o As explicitly being out-of-scope for CDNI
      [I-D.ietf-cdni-problem-statement], it is assumed that ingestion of
      content or acquiring content across CDNs is not part of request
      routing as considered within CDNI standardization work. The focus
      of using ALTO (as considered in this document) is hence on request
      routing only, assuming that the content (desired by the end user)
      is available in the downstream CDN (or can be aquired by the
      downstream CDN by some means).

   o Federation Model: "Footprint and Capabilities Advertisement" and
      in general CDN request routing depends on the federation model
      among the CDN providers. Designing a suitable solution thus
      depends on whether a solution is needed for different settings,
      where CDNs consist of both NSP CDNs (serving individual ASes) and
      general, traditional CDNs (such as Akamai). We assume that CDNI
      is not designed for a setting where only NSP CDNs each serve a
      single AS only.

o In this document, it is assumed that the upstream CDN (uCDN) makes
   the decision on selecting a downstream CDN, based on information
   that each downstream CDN has made available to the upstream CDN.
   Further, we assume that in principle more than one dCDN may be
   suitable for a given end-user request (i.e. different dCDNs may
   claim "overlapping" footprints). The uCDN hence potentially has
   to select among several candidate downstream CDNs for a given end
   user request.

o It is not clear what kind(s) of business, contract, and
   operational relationships two peering CDNs may form. For the
   Internet, we see provider-customer and peering as two main
   relations; providers may use different charging models (e.g.,
   95-percentile, total volume) and may provide different SLAs.
   Given such unknown characteristics of CDN peering business
   agreements, we should design the protocol to support as much
   diverse potential business and operational models as possible.

3.2. Semantics for Footprint/Capabilities Advertisment

   The CDNI document on "Footprint and Capabilities Semantics"
   [I-D.ietf-cdni-footprint-capabilities-semantics] defines the
   semantics for the CDNI FCI. It thus provides guidance on what
   Footprint and Capabilities mean in a CDNI context and how a protocol
   solution should in principle look like. Here we briefly summarize
   the key points of the semantics of Footprint and Capabilities (for a
   detailed discussion, the reader is referred to
   [I-D.ietf-cdni-footprint-capabilities-semantics]):

o Often, footprint and capabilities are tied together and cannot be
   interpreted independently from each other. In such cases, i.e.
   where capabilities must be expressed on a per footprint basis, it
   may be beneficial to combine footprint and capabilities
   advertisement.

o Given that a large part of Footprint and Capabilities
   Advertisement will actually happen in contractual agreements, the
   semantics of CDNI Footprint and Capabilities advertisement refer
   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 request routing interface. 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 capabilities it has prior agreed to
   serve in a contract with a uCDN.

o It seems clear that "coverage/reachability" types of footprint
   must be supported within CDNI. The following such types of
   footprint are mandatory and must be supported by the CDNI FCI:

   * List of ISO Country Codes

   * List of AS numbers

   * Set of IP-prefixes

   A 'set of IP-prefixes' must be able to contain full IP addresses,
   i.e., a /32 for IPv4 and a /128 for IPv6, and also 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.

o For all of these 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 ASN(s), 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. Multiple
   footprint constraints are additive, i.e. the advertisement of
   different types of footprint narrows the dCDN candidacy
   cumulatively.

o The following capabilities seem useful as 'base' capabilities,
   i.e. ones that are needed in any case and therefore constitute
   mandatory capabilities to be supported by the CDNI FCI:

   * Delivery Protocol (e.g., HTTP vs. RTMP)

   * Acquisition Protocol (for aquiring content from a uCDN)

   * Redirection Mode (e.g., DNS Redirection vs. HTTP Redirection as
      discussed in [I-D.ietf-cdni-framework])

   * Capabilities related to CDNI Logging (e.g., supported logging
      mechanisms)

       * Capabilities related to CDNI Metadata (e.g., authorization
          algorithms or support for proprietary vendor metadata)

3.3. Advantages of using ALTO as the CDNI FCI protocol

   The following reasons make ALTO a suitable candidate protocol for
   downstream CDN selection as part of CDNI request routing and in
   particular for an FCI protocol:

   o CDN request routing is done at the application layer. ALTO is a
      protocol specifically designed to improve application layer
      traffic (and application layer connections among hosts on the
      Internet) by providing additonal information to applications that
      these applications could not easily retrieve themselves. For
      CDNI, this is exactly the case: a uCDN wants to improve
      application layer CDN request routing by using dedicated
      information (provided by a dCDN) that the uCDN could not easily
      obtain otherwise.

   o The semantics of an ALTO network map are an exact match for the
      needed information to convey a footprint by a downstream CDN, in
      particular if such a footprint is being expressed by IP-prefix
      ranges.

   o Security: ALTO maps can be signed and hence provide inherent
      integrity protection (see Section 6)

   o 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. A CDNI FCI
      interface based on ALTO would inherit this RESTful design.

   o Error-handling: The ALTO protocol has undergone extensive
      revisions in order to provide sophisticated error-handling,
      inparticular regarding unexpected cases. A CDNI FCI interface
      based on ALTO would inherit this thought-through and mature error-
      handling.

   o Filtered network map: The ALTO Map Filtering Service (see
      [I-D.ietf-alto-protocol] for details) would allow a uCDN to query
      only for parts of an ALTO map.

3.4. Selection of a Downstream CDN with ALTO

   Under the considerations stated in Section 3, ALTO can help the
   upstream CDN provider to select a proper downstream CDN provider for
   a given end user request as follows: Each downstream CDN provider

hosts an ALTO server which provides ALTO services which convey CDNI
FCI information to an ALTO client at the upstream CDN provider.

4. CDNI FCI ALTO Service

The ALTO protocol is based on an ALTO Information Service Framework
which consists of several services, where all ALTO services are
'provided through a common transport protocol, messaging structure
and encoding, and transaction model" [I-D.ietf-alto-protocol]. The
ALTO protocol specification [I-D.ietf-alto-protocol] defines several
such services, e.g. the ALTO map service.

This document defines a new ALTO Service called 'CDNI Footprint &
Capabilities Advertisement Service' which conveys JSON objects of
media type 'application/alto-fcimap+json'. This media type and JSON
object format is defined in [I-D.ma-cdni-capabilities]; this document
specifies how to transport such JSON objects via the ALTO protocol
with the ALTO 'CDNI Footprint & Capabilities Advertisement Service'.

4.1. Server Response Encoding

4.1.1. CDNI FCI Map

The media type of the CDNI FCI Map is 'application/alto-cdni-
fcimap+json'. The HTTP Method, Accept Input Parameters,
Capabilities, Uses, and Response of the CDNI FCI Map are specified in
[I-D.ma-cdni-capabilities].

4.1.2. Meta Information

The 'meta' field of a FCIMapData response MUST include 'vtag', which
is an ALTO Version Tag of the retrieved FCIMapData according to
[I-D.ietf-alto-protocol] (Section 10.3.). It thus contains a
'resource-id' attribute, and a 'tag' is an identifier string.

4.1.3. Data Information

The data component of a CDNI FCI Map resource is named 'fcimap' which
is a JSON object of type FCIMapData. This JSON object of type
FCIMapData is derived from ResponseEntityBase as specified in the
ALTO protocol [I-D.ietf-alto-protocol] (Section 8.4.) and specified
in [I-D.ma-cdni-capabilities].

4.2. Protocol Errors

Protocol errors are handled as specified in the ALTO protocol
[I-D.ietf-alto-protocol] (Section 8.5.).

4.3. Example

   The following example shows an CDNI FCI Map as in
   [I-D.ma-cdni-capabilities], however with meta-information as defined
   in Section 4.1.2 of this document.

```
GET /fcimap HTTP/1.1
Host: alto.example.com
Accept: application/alto-fcimap+json,application/alto-error+json

HTTP/1.1 200 OK
Content-Length: 439
Content-Type: application/alto-fcimap+json
{
  "meta" : {
    "vtag": {
      "resource-id": "my-default-fcimap",
       "tag": "da65eca2eb7a10ce8b059740b0b2e3f8eb1d4785"
    }
  },
  "fcimap": [
    { "name": "delivery_protocol",
      "values": [
        "HTTP",
        "RTSP",
        "MMS"
      ]
    },
    { "name": "delivery_protocol",
      "values": [
        "RTMP",
        "HTTPS"
      ],
      "footprint": [
        { "type": "IPv4CIDR",
          "values": [
            "10.1.0.0/16",
            "10.10.10.0/24"
          ]
        }
      ]
    }
  ]
}
```

5. Useful ALTO extensions for CDNI Request Routing

   It is envisioned that yet-to-be-defined ALTO extensions will be
   standardized that make the ALTO protocol more suitable and useful for
   applications other than the originally considered P2P use case
   [I-D.marocco-alto-next]. Some of these extensions to the ALTO
   protocol would be useful for ALTO to be used as a protocol within
   CDNI request routing, and in particular within the "Footprint and
   Capabilities Advertisment" part of the CDNI request routing
   interface.

   The following proposed extensions to ALTO would be beneficial to
   facilitate CDNI request routing with ALTO as outlined in Section 3.4:

   o Server-initiated Notifications and Incremental Updates: In case
      the footprint or the capabilities of a downstream CDN change
      abruptly (i.e. unexpectedly from the perspective of an upstream
      CDN), server initiated notifications would enable a dCDN to
      directly inform an upstream CDN about such changes. 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 very recent network and cost map from dCDN,
      and therefore redirect request to 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. A proposal for server-initiated
      ALTO updates can be found in [I-D.marocco-alto-ws]. A discussion
      of incremental ALTO updates can be found in
      [I-D.schwan-alto-incr-updates].

   o Content Availability on Hosts: A dCDN might want to express CDN
      capabilties in terms of certain content types (e.g. codecs/
      formats, or content from certain content providers). A new
      endpoint property for ALTO that would be able to express such
      "content availability" would enable a dCDN to make available such
      information to an upstream CDN. This would enable a uCDN to
      determine if a given dCDN actually has the capabilities for a
      given request with respect to the type of content requested.

   o 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 an upstream CDN for optimized downstream
      CDN selection. For 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 new endpoint properties, it
would enable more sophisticated means for downstream CDN selection
with ALTO.

6. 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 8.2.2. of [I-D.ietf-alto-protocol]. ALTO thus provides a proper
means for protecting the integrity of FCI information.

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

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the European Commission, or NICT.

8. References

8.1. Normative References

[RFC5693]   Seedorf, J. and E. Burger, "Application-Layer Traffic
            Optimization (ALTO) Problem Statement", RFC 5693, October
            2009.

[RFC6707]   Niven-Jenkins, B., Le Faucheur, F., and N. Bitar, "Content
            Distribution Network Interconnection (CDNI) Problem
            Statement", RFC 6707, September 2012.

[RFC6770]   Bertrand, G., Stephan, E., Burbridge, T., Eardley, P., Ma,
            K., and G. Watson, "Use Cases for Content Delivery Network
            Interconnection", RFC 6770, November 2012.

8.2. Informative References

   [I-D.peterson-CDNI-strawman]
            Peterson, L. and J. Hartman, "Content Distribution Network
            Interconnection (CDNI) Problem Statement", draft-peterson-
            CDNI-strawman-01 (work in progress), May 2011.

   [I-D.ietf-cdni-problem-statement]
            Niven-Jenkins, B., Faucheur, F., and N. Bitar, "Content
            Distribution Network Interconnection (CDNI) Problem
            Statement", draft-ietf-cdni-problem-statement-08 (work in
            progress), June 2012.

   [I-D.marocco-alto-next]
            Marocco, E. and V. Gurbani, "Extending the Application-
            Layer Traffic Optimization (ALTO) Protocol", draft-
            marocco-alto-next-00 (work in progress), January 2012.

   [I-D.ietf-alto-protocol]
            Alimi, R., Penno, R., and Y. Yang, "ALTO Protocol", draft-
            ietf-alto-protocol-27 (work in progress), March 2014.

   [I-D.ietf-cdni-requirements]
            Leung, K. and Y. Lee, "Content Distribution Network
            Interconnection (CDNI) Requirements", draft-ietf-cdni-
            requirements-17 (work in progress), January 2014.

   [I-D.ietf-cdni-use-cases]
            Bertrand, G., Emile, S., Burbridge, T., Eardley, P., Ma,
            K., and G. Watson, "Use Cases for Content Delivery Network
            Interconnection", draft-ietf-cdni-use-cases-10 (work in
            progress), August 2012.

   [I-D.marocco-alto-ws]
            Marocco, E. and J. Seedorf, "WebSocket-based server-to-
            client notifications for the Application-Layer Traffic
            Optimization (ALTO) Protocol", draft-marocco-alto-ws-02
            (work in progress), February 2014.

   [I-D.schwan-alto-incr-updates]
            Schwan, N. and B. Roome, "ALTO Incremental Updates",
            draft-schwan-alto-incr-updates-02 (work in progress), July
            2012.

   [I-D.jenkins-alto-cdn-use-cases]
             Niven-Jenkins, B., Watson, G., Bitar, N., Medved, J., and
             S. Previdi, "Use Cases for ALTO within CDNs", draft-
             jenkins-alto-cdn-use-cases-03 (work in progress), June
             2012.

   [I-D.ma-cdni-capabilities]
             Ma, K. and J. Seedorf, "CDNI Footprint & Capabilities
             Advertisement Interface", draft-ma-cdni-capabilities-05
             (work in progress), June 2014.

   [I-D.ietf-cdni-framework]
             Peterson, L., Davie, B., and R. Brandenburg, "Framework
             for CDN Interconnection", draft-ietf-cdni-framework-14
             (work in progress), June 2014.

   [I-D.liu-cdni-cost]
             Liu, H., "A Cost Perspective on Using Multiple CDNs",
             draft-liu-cdni-cost-00 (work in progress), October 2011.

   [I-D.spp-cdni-rr-foot-cap-semantics]
             Seedorf, J., Peterson, J., Previdi, S., Brandenburg, R.,
             and K. Ma, "CDNI Request Routing: Footprint and
             Capabilities Semantics", draft-spp-cdni-rr-foot-cap-
             semantics-04 (work in progress), February 2013.

   [I-D.ietf-cdni-metadata]
             Niven-Jenkins, B., Murray, R., Watson, G., Caulfield, M.,
             Leung, K., and K. Ma, "CDN Interconnect Metadata", draft-
             ietf-cdni-metadata-06 (work in progress), February 2014.

   [I-D.ietf-cdni-logging]
             Faucheur, F., Bertrand, G., Oprescu, I., and R.
             Peterkofsky, "CDNI Logging Interface", draft-ietf-cdni-
             logging-11 (work in progress), March 2014.

   [I-D.ietf-cdni-footprint-capabilities-semantics]
             Seedorf, J., Peterson, J., Previdi, S., Brandenburg, R.,
             and K. Ma, "CDNI Request Routing: Footprint and
             Capabilities Semantics", draft-ietf-cdni-footprint-
             capabilities-semantics-02 (work in progress), February
             2014.

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