                    ALTO for CDNi Request Routing
                    draft-seedorf-alto-for-cdni-00

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 focusses on the Request
   Routing Interface of CDNi, and more specifically on how the solutions
   currently being defined in the Application Layer Traffic Optimization
   (ALTO) WG can improve CDNi request routing. The overall intention
   behind this document is to foster discussions (in the CDNi as well as
   in the ALTO WG) regarding a) if, b) how, and c) under what conditions
   ALTO can be useful to optimize CDNi request routing. As basis for
   this discussion, this document provides concrete examples of how ALTO
   can be integrated within CDNi request routing. The examples in this
   document are based on the use cases and examples currently being
   discussed in the CDNi WG.

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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 [refs.cdniproblemstatement].

The CDNi problem statement envisions four interfaces to be standardized within the IETF for CDN interconnection [refs.cdniproblemstatement]:

o CDNI Request Routing Interface

o CDNI Metadata Interface

o CDNI Logging Interface

o CDNI Control Interface

This document focusses solely on the CDNI Request Routing Interface. In particular, this document shows concrete examples of how ALTO [RFC5693] can be integrated in CDNi request routing. The goal of this document is to show in what cases ALTO can benefit CDNi request routing, giving concrete examples and explaining how ALTO improves CDNi request routing in each of these examples. The examples used in this document are based on the use cases and request routing proposals currently being discussed in the CDNi WG [refs.cdniusecases] [refs.cdnistrawman] and in the ALTO WG [refs.altocdn]. The overall rationale of this document is to foster discussions (in the CDNi as well as in the ALTO WG) regarding a) if, b) how, and c) under what conditions ALTO can be useful to optimize CDNi request routing.

Throughout this document, we use the terminology for CDNi defined in [refs.cdniproblemstatement].

2. **CDNi Request Routing**

   The main purpose of the CDNI Request Routing Interface is described
   in [refs.cdniproblemstatement] 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 and to allow the downstream CDN to control what the
   upstream Request Routing function should return to the User Agent in
   the redirection message". 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

3. Using ALTO within CDNi Request Routing

   Application Layer Traffic Optimization (ALTO) 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 [refs.altocdn]. 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
   [refs.altocdn]). Also, the CDNi problem statement explicitly
   mentions ALTO as a candidate protocol for "algorithms for selection
   of CDN or Surrogate by Request-Routing systems"
   [refs.cdniproblemstatement]. Yet, there have not been concrete
   proposals so far on how to use ALTO in the context of CDN
   interconnection. This document tries to close this gap by giving
   some examples on how ALTO could be used within CDNi request routing.

   As explicitly being out-of-scope for CDNi
   [refs.cdniproblemstatement], the examples used in this document
   assume 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).

3.1. ALTO to simplify DNS-based Request Routing Redirection

   If CDNi request routing is based on DNS, ALTO can potentially help to
   avoid one or more DNS resolution steps. For instance, Figure 1 shows
   a modified version of the high-level message sequence chart from
   Figure 5 of [refs.cdniframework] (note that this figure is similar to
   the high-level message sequence chart shown in Figure 3 of
   [refs.cdnistrawman]). In the original figure (i.e. Figure 5 in
   [refs.cdniframework]), the DNS server hosted by the upstream CDN
   (assumed to be the authoritative DNS server for the requested
   content), returns a DNS CNAME and NS record which essentially directs
   the end user to the request router of the downstream CDN. However,
   this redirection involves another DNS resolution for the request

router of the downstream CDN to be performed by the end user.

In the example using ALTO provided in Figure 1 of this document, the downstream CDN provides the upstream CDN an ALTO network (and corresponding cost) map by means of the ALTO protocol [refs.altoprotocol] (0). This ALTO map provides sufficient information for the upstream CDN to directly return a suitable IP-address for the CDN entry point in the downstream CDN (2).

In principle, using ALTO this way the downstream CDN provider would provide the decision on which delivery node is best by means of an ALTO network map to the upstream CDN provider. This enables the upstream CDN provider to directly return a suitable delivery node in the downstream CDN to the end user as a response to the initial DNS request received by the upstream CDN provider.

An imlicit assumption for the example in Figure 1 to work is that the CDN entry point for the downstream CDN only depends on the location of the end user. Using the cost map, the upstream CDN can determine the "best" entry point in the downstream CDN. If the "best" entry point depends also on the target domain ("cdn.csp.com" in the example), it becomes more tricky to make such information available to the upstream CDN by means of ALTO network map and cost map. One possible way to still use ALTO in this case would be for the downstream CDN to provide a different cost map for each Content Service Provider (CSP).

```
          End-User                 Operator B               Operator A
              |                         |ALTO network/cost map     |
              |                         |------------------------>|(0)
              |                         |                         |
          |DNS cdn.csp.com             |                         |
          |------------------------------------------------------>|(1)
              |                         |                         |
              |                         |                         |
          |IPaddr of B's CDN Entry Point                         |(2)
          |<------------------------------------------------------|
          |HTTP cdn.csp.com            |                         |
          |------------------------>|                            |
              |                         |(3)                      |
              |                         |DNS op-b-acq.op-a.net     |
              |                         |------------------------>|
              |                         |                         |(4)
              |                         |IPaddr of A's Delivery Node
              |                         |<------------------------|
              |                         |HTTP op-b-acq.op-a.net    |
              |                         |------------------------>|
              |                         |                         |(5)
              |                         |Data                     |
              |                         |<------------------------|
          |Data                        |                         |
          |<------------------------|                            |
```
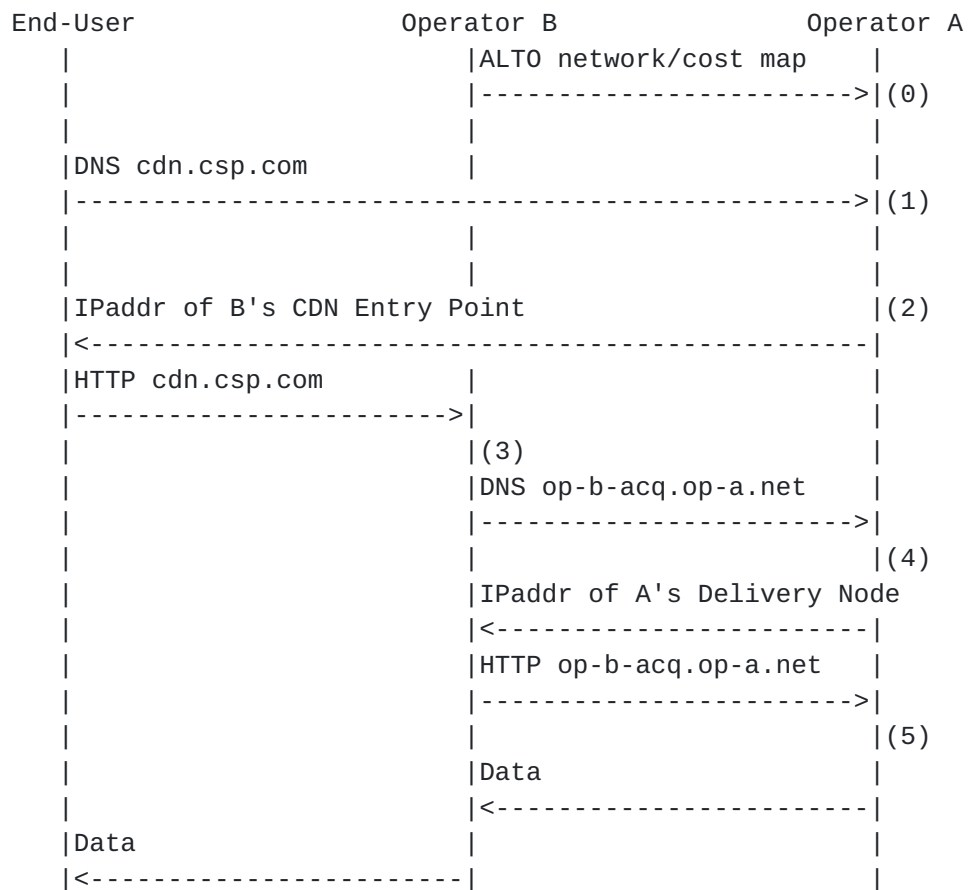
        Figure 1 - ALTO within DNS-based redirection of request routing

3.2. ALTO to simplify http-Redirection for Request Routing

   Similar to the example given in the previous subsection, ALTO can
   also help to reduce intermediate http redirection steps. Figure 2
   shows a modified version of the the high-level message sequence chart
   from Figure 3 of [refs.cdniframework] (note that this figure is
   similar to the high-level message sequence chart shown in Figure 1 of
   [refs.cdnistrawman]). In this case, the ALTO maps provided in step
   (0) by the downstream CDN potentially enable the upstream CDN to
   directly return - as a response to an http request - the hostname of
   the suitable cache (delivery node) in the downstream CDN by means of
   302-redirection (4). This use of ALTO would enable to avoid several
   http-302 redirections and DNS resolutions by the end user (compare
   with figure 3 of [refs.cdniproblemstatement], steps (2-4)).

   Depending on how dynamically the actual "best" delivery node changes
   (from the downstream CDN's request routing perspective), it might
   only be meaningful to return to the end user the "best" entry point

or cluster within the downstream CDN. This would require an
additional http-redirect by the downstream request router to the
"best" actual cache. However, even in such a case ALTO can save one
http-redirect and one DNS resolution at the end user, consequently
speeding up the overall process of CDNi request routing.

```
      End-User                    Operator B              Operator A
            |                              |ALTO network/cost map     |
            |                              |------------------------>|
            |DNS cdn.csp.com               |                         |
            |----------------------------------------------------->|
            |                              |                         |(1)
            |IPaddr of A's Request Router                            |
            |<-----------------------------------------------------|
            |HTTP cdn.csp.com              |                         |
            |----------------------------------------------------->|(2)
            |                              |                         |(3)
            |                              |                         |(4)
            |302 node1.peer-a.op-b.net/cdn.csp.com                   |
            |<-----------------------------------------------------|
            |DNS node1.peer-a.op-b.net|                              |
            |----------------------->|                               |
            |                              |(5)                      |
            |IPaddr of B's Delivery Node                             |
            |<-----------------------|                               |
            |                              |                         |
            |HTTP node1.peer-a.op-b.net/cdn.csp.com                  |
            |----------------------->|                               |
            |                              |(6)                      |
            |                              |DNS op-b-acq.op-a.net     |
            |                              |------------------------>|
            |                              |                         |(7)
            |                              |IPaddr of A's Request Router
            |                              |<-----------------------|
            |                              |HTTP op-b-acq.op-a.net    |
            |                              |------------------------>|
            |                              |                         |(8)
            |                              |302 node2.op-b.acq.op-A.net
            |                              |<-----------------------|
            |                              |DNS node2.op-b-acq.op-a.net
            |                              |------------------------>|
            |                              |                         |(9)
            |                              |IPaddr of A's Delivery Node
            |                              |<-----------------------|
            |                              |                         |(10)
            |                              |Data                     |
            |                              |<-----------------------|
            |Data                          |                         |
```

```
          |<------------------------|                          |
```

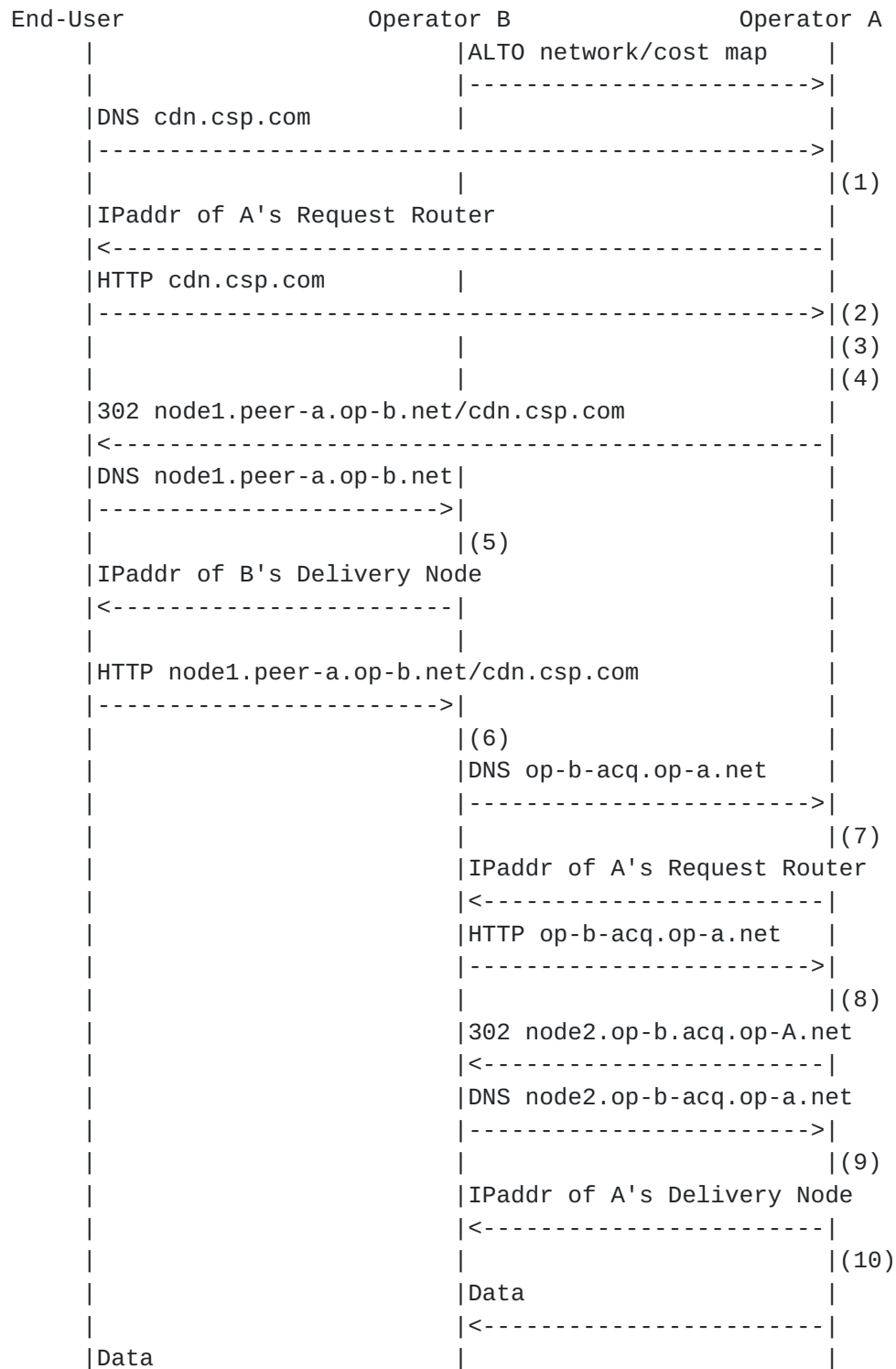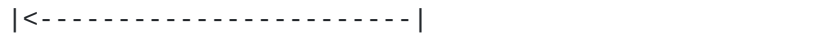   Figure 2 - ALTO within http-based redirection of request routing

3.3. ALTO to support Selection of Downstream CDN

   ALTO could also help for the upstream CDN provider to select a proper
   downstream CDN provider for a given end user request. For instance,
   a network map provided by each of several candidate downstream CDNs
   could provide information to the upstream CDN provider regarding the
   geopgraphical coverage, the location of "surrogates", or similar.
   Future versions of this document will discuss this use case in more
   detail, and provide concrete examples how ALTO can be used for
   downstream CDN selection by the upstream CDN provider.

[4](#). Security Considerations

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

5. **Summary and Outlook**

   This document presented some examples on how ALTO can be used within
   CDNi Request Routing and argued why such use of ALTO is meaningful in
   certain cases. The intention of this document is to arouse
   discussions in the CDNi WG as well as the ALTO WG in order to find
   consensus on scenarios where ALTO is beneficial to CDNi request
   routing and to form agreement on how ALTO should be used in such
   cases within the CDNi request routing protocol. It is the intention
   to capture the outcome of such continuing discussions in future
   versions of this document.

6. Acknowledgements

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