CDN Footprint Discovery
draft-bertrand-cdni-footprint-discovery-01

Abstract

   Interconnected CDNs need to exchange information on the set of end-
   users to which they can deliver content. This information is
   commonly referred to as "CDN Footprint". This memo presents use
   cases for CDN Footprint Discovery in CDNI. It provides a survey of
   existing work on the subject and a set of additional requirements for
   controlling the exchange of Footprint information.

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Table of Contents

1. Terminology

We adopt the terminology described in
[I-D.ietf-cdni-problem-statement] and [I-D.davie-cdni-framework], and
extend it with the additional terms defined below.

Aggregate CDN Footprint: a set of User-Agent reachability information
for which a CDN claims that it can deliver content in good
conditions, by itself or through one of its dCDNs. The CDN Footprint
aggregates information on the footprint of the dCDNs with whom a uCDN
is interconnected.

High-Level CDN Footprint: the part of the footprint information that
reflects rather static and business-level information. As an
example, the failure of a Surrogate does not change the High-level
CDN Footprint information but may change detailed information of an
element of the CDN Footprint.

On-Net Footprint: a set of User-Agent reachability information for
which a CDN claims that it can deliver content directly. For
instance, a given Access CDN may assert that its On-Net CDN Footprint
encompasses all end-users in AS 64496 and AS 64497.

CDN Delivery Proximity: Information on the network distance between a
set of end-users in the CDN Footprint and the closest Surrogates of
the considered CDN or of one of its dCDNs. Various metrics can be
considered for defining this distance; examples of such metrics
include the AS hop count or an accumulated Interior Gateway Protocol
(IGP) metric.

CDN Footprint Discovery: discovery of information on CDN Footprint
and CDN Delivery Proximity. CDN Footprint Discovery provides the
information that enables a uCDN's Request Routing Interface to select
the most appropriate dCDN for a given content request. CDN Footprint
Discovery encompasses two different parts:

1. High-Level Footprint Discovery permits discovering groups of end-
    users/Surrogates and interconnection costs between them.

2. Detailed Footprint Discovery permits exchanging information that
    is subject to more scalability and confidentiality constraints.
    The level of information sharing must be tightly controlled.

CDN Footprint Discovery Interface: An interface that enables CDN
Footprint Discovery. Section 3 details the use cases for a CDN
Footprint Discovery Interface.

[2](#). Introduction

This memo presents use cases for CDN Footprint and CDN Delivery
Proximity discovery in CDNI. It provides a survey of existing work
on the subject and a set of additional requirements for controlling
the exchange of Footprint information.

The reader should be familiar with the work of the CDNI WG:

o CDNI problem statement [[I-D.ietf-cdni-problem-statement](#)] defines
   the problem area that the CDNI working group is chartered to
   address.

o [[I-D.ietf-cdni-use-cases](#)] outlines real world use-cases for
   interconnecting CDNs. These use cases (e.g., "QoE and QoS
   Improvement") require the discovery of CDN Footprint information.

o [[I-D.ietf-cdni-requirements](#)] specifies a set of requirements for
   CDN Footprint Discovery.

The present document describes:

o The use cases for CDN Footprint Discovery ([Section 3](#)),

o The requirements for CDN Footprint Discovery ([Section 4](#)),

o A survey of Footprint Discovery protocols ([Section 5](#)).

[2.1](#). Abbreviations

o CDN: Content Delivery Network

o CDNP: Content Delivery Network Provider

o CSP: Content Service Provider

o dCDN: downstream CDN

o IGP: Interior Gateway Protocol

o NSP: Network Service Provider

o uCDN: upstream CDN

3. Use-Cases for Footprint Discovery

The present memo considers the use cases for a Footprint Discovery
Protocol in a multi-CDN case [I-D.ietf-cdni-use-cases]. It does not
consider mono-CDN issues.

[I-D.davie-cdni-framework] (Section 3.5.) describes "Dynamic
Footprint Discovery" as a situation where "being able to dynamically
discover the set of requests that a given dCDN is willing and able to
serve is beneficial. For example, a CDN might at one time be able to
serve a certain set of client IP prefixes, but that set might change
over time due to changes in the topology and routing policies of the
IP network." [I-D.davie-cdni-framework] provides an example where
footprint information exchanges occur through the request routing
interface and are triggered by an end-user's request (DNS resolution
or content request).

In the present memo, we seek to clarify in which cases such Footprint
Discovery through a protocol is required.

3.1. Protocol Not Required

In most cases, High-Level CDN Footprint Discovery does not require a
protocol, as in the following examples cases:

o High-Level CDN Footprint is Germany

o High-Level CDN Footprint is AS 64496

However, the two following special cases deserve particular
attention:

1. When the dCDNs' Footprints overlap,

2. When end-users outside the dCDNs' Footprints can request content.

In these two cases, the uCDN needs additional criteria than the
dCDN's Footprint to select the "best" CDN. For instance, a static
rule can be configured to select one of the available dCDNs.
Alternatively, the uCDN may use dCDN's Delivery Proximity information
to elect a delivering CDN.

The remainder of this memo focuses on cases, where either CDN
Footprint is defined dynamically or uCDN requires dynamic Delivery
Proximity information on dCDNs.

3.2. Protocol Potentially Required

In some cases, the uCDN needs dCDNs' Delivery Proximity information
to determine which dCDN is the "best" to serve a given set of end-
users. For instance, the "best" CDN can be defined as the one that
has deployed Surrogates topologically the closest to the end-user
(e.g., an Access CDN). This topological information is tightly
related to the underlying networks: one may consider that a Surrogate
is topologically far from the end-user if the path between these two
entities crosses high cost links or many links. While information
about the Surrogates location is rather confidential, abstract
information about the path's cost between a set of end-users and the
closest Surrogates in a CDN may be generic enough to avoid disclosing
confidential information about the network.

CDN federations might involve several levels of CDN interconnection.
In such scenarios, the CDN Footprint of a given CDN represents the
aggregation of the CDN Footprint of all its own dCDNs. Therefore,
some variations of the dCDNs' Footprint can result in variations of
the CDN's Footprint. This example shows that the more levels of
delegation we consider, the more dynamic the CDN Footprint
information becomes. Nevertheless, in the medium term, complex
deployments scenarios involving more than a few levels of delegations
are unlikely, because of performance issues. Consequently, we
consider that the High-Level CDN Footprint is rather static and
remains valid for at least 24 hours.

Depending on the considered metric, the CDN Delivery Proximity may
change rarely (e.g., AS hop count) or more frequently (e.g.,
accumulated IGP metric).

4. Additional Requirements

[I-D.ietf-cdni-requirements], already specifies two requirements
related to Footprint Discovery: REQ-2 and REQ-3. We remind these two
requirements below.

"REQ-2 [MED] The CDNI Request-Routing interface should allow the
Downstream CDN to communicate to the Upstream CDN aggregate
information to facilitate CDN selection during request routing, such
as Downstream CDN capabilities, resources and affinities (i.e.
Preferences or cost). This information could, for example, include:

o supported content types and delivery protocols

o footprint (e.g., layer-3 coverage)

   o a set of metrics/attributes (e.g., Streaming bandwidth, storage
      resources, distribution and delivery priority)

   o a set of affinities (e.g., Preferences, indication of
      distribution/delivery fees)

   o information to facilitate request redirection (e.g., Reachability
      information of Downstream CDN Request Routing system)."

   "REQ-3 [MED] In the case of cascaded redirection, the CDNI Request-
   Routing interface shall allow the Downstream CDN to also include in
   the information communicated to the Upstream CDN, information on the
   capabilities, resources and affinities of CDNs to which the
   Downstream CDN may (in turn) redirect requests received by the
   Upstream CDN. In that case, the CDNI Request-Routing interface shall
   prevent looping of such information exchange."

   We define additional requirements, specific to Footprint Discovery.

   FPT-1 [MED] A uCDN must be able to discover CDN Footprint and CDN
   Delivery Proximity information about dCDNs.

   FPT-2 [HIGH] A dCDN MUST be able to control what other CDNs can
   discover about its CDN Footprint and CDN Delivery Proximity.

   We also clarify REQ-3:

   FPT-3 [MED] A uCDN should not forward to any other CDN the Footprint
   and Delivery Proximity information that it has discovered about a
   dCDN without the explicit agreement of this dCDN.

   Finally, the deployment of a Footprint Discovery Interface imposes
   some operational requirements. For instance, a Footprint Discovery
   protocol must not affect network stability and scalability. It must
   also be simple enough to avoid increasing the networks' operation
   complexity.

   FPT-4 [HIGH] A Footprint Discovery protocol should not affect network
   stability and scalability.

5. **Survey of CDN Footprint Discovery**

5.1. **Legacy Protocols**

5.1.1. Legacy BGP

Consider a dCDN that claims its CDN Footprint covers AS 64496. BGP
advertises AS-Path information that easily enables a uCDN to map end-
users to the dCDN, basing on the end-users' IP address and on a
mapping of IP addresses to AS numbers.

BGP also provides CDN Delivery Proximity information: for instance, a
CDN listening to BGP advertisements is able to determine the AS-path
length to the advertised prefixes. Note that BGP information might
be collected in the network and provided to the CDN through another
protocol rather than directly through BGP.

5.1.2. Legacy BGP Community Tag

The NSP may use part of the community tags carried by its legacy
internal BGP to filter and gather the prefixes in stable groups (see
section 5.1.7 of [I-D.ietf-alto-deployments]) that are then used by
its internal CDN [I-D.jenkins-alto-cdn-use-cases] for fine-grained
request routing based on these groups. A protocol (e.g., HTTP-based)
can be used to advertise aggregated information on such groups rather
than detailed information per prefix. This provides a simple way to
aggregate information for scalability and confidentiality purposes.

An operator may consider that the grouping of prefixes into zones
(the list of prefixes with a given community value) is confidential,
as this grouping discloses information on the network's organization.

5.2. New Proposals

5.2.1. BGP Extension for CDNI

[I-D.previdi-cdni-footprint-advertisement] proposes a BGP-based
mechanism to advertise connectivity information in the context of
CDNI. It is based on the introduction of a CDN sub address Family
(SAFI) and leverages BGP (extended) community tags. It uses
Multiprotocol-BGP (MP-BGP [RFC4760]) in order for CDNs and/or ISPs to
advertise their connectivity to footprints. A new NLRI is defined to
carry CDN connectivity advertisements. In summary, the draft defines
a "CDN-level BGP" to complement the legacy network-level BGP
described in Section 5.1.1 and Section 5.1.2.

5.2.2. ALTO Footprint

[I-D.jenkins-alto-cdn-use-cases] describes the use cases for a CDN to
be able to obtain network topology and cost information from an ALTO
server. These use cases include: "Exposing NSP End User Reachability
to a CDN, Exposing CDN End User Reachability to CSPs, CDN deployed

within a Broadband network, CDN delivering Over-The-Top of a NSP's
network, and CDN acquiring content from multiple upstream sources".
An additional use case may be to advertise CDN End User Reachability
to upstream CDNs.

The NSP CDN acting as a dCDN ALTO server may filter and send prefix
groups (see Section 5.1.2) to uCDN ALTO clients according to its
policies and with respect to a separate agreement it has with each
uCDN. A group may appear as a PID in ALTO network and cost maps.

6. Survey of CDN Delivery Proximity Discovery

6.1. BGP-TE

[I-D.gredler-idr-ls-distribution] proposes a BGP-based mechanism by
which link state and traffic engineering information can be collected
from networks and shared with external components.

6.2. BGP AIGP

The Accumulated IGP Metric Attribute for BGP [I-D.ietf-idr-aigp]
defines a new TLV attribute in BGP that allows redistribution of IGP
costs between ASes belonging to the same managing entity. With AIGP,
path selection can take into account IGP costs from other ASes for
reaching a certain prefix. For the interconnection of multiple CDNs
managed by the same entity ("Inter-Affiliates Interconnection"
[I-D.ietf-cdni-use-cases]), the AIGP information may enable a uCDN to
determine which dCDN is topologically the closest to a set of end-
users. However, the deployment limitations of AIGP listed in
[I-D.ietf-idr-aigp] (Section 2. and 3.1.) restrict the applicability
of AIGP for this use case.

6.3. BGP Extension for CDNI

See Section 5.2.1.

6.4. ALTO

[I-D.penno-alto-cdn] (Section 7.1.) describes how ALTO can be used by
CDNs in a different administrative domain than the ISP to provide the
cost from each CDN node to all known Subscriber PIDs. This mechanism
enables the CDN to determine its CDN Delivery Proximity to groups of
end users.

[I-D.ietf-alto-deployments] discusses deployment related issues of
ALTO for peer-to-peer and CDNs. In Section 5.1, it presents the use
of ALTO for a mono-CDN case. The ALTO server may leverage the BGP

information (e.g., BGP community attribute) to group prefixes into
PIDs. ALTO cost map permits providing cost information between PIDs
and could be used by a dCDN to communicate its CDN Delivery Proximity
to an uCDN.

[I-D.seedorf-alto-for-cdni] briefly mentions that ALTO could support
selection of downstream CDN but does not indicate the way the ALTO
server is fed.

[6.5](#). **Generic Capability Advertisement**

[I-D.he-cdni-cap-info-advertising] proposes an HTTP/1.1-based
protocol which is used to communicate capability information (e.g.,
resources, footprint, load) "to facilitate selection of the
Downstream CDN by the Upstream CDN request routing system".

[7](#). **Synthesis**

The use cases section shows that in the short term, the need for a
Footprint Advertisement Protocol is limited to specific use cases.
The survey shows that multiple new proposals addressing CDN Footprint
Discovery are being defined, but none is mature and fulfills all the
requirements yet.

As a result, we consider that if there is enough interest for
developing a CDN Footprint Advertisement Protocol, more work is
needed to fulfill the specific requirements that arise in the context
of CDNI.

Key building blocks for a Footprint Discovery protocol are clearly
identified:

1.   Information on the network-level connectivity to groups of
     prefixes, i.e., to groups of end-users, is required. For
     instance, BGP-level inter-domain routing data can typically be
     the source of this type of information, which may be advertised
     through a protocol based on HTTP, for example, or directly
     through BGP.

2.   A mechanism to group end-users that must be served from the same
     set of Surrogates (e.g., representing a given CDN) is required.
     For example, BGP extended community attribute and ALTO PIDs
     typically provide such mechanisms. The grouping of end-users can
     disclose confidential information on the CDN or network
     organization, therefore, a CDN/NSP will provide the groups'
     definitions only to its trusted partners.

3. A mechanism to discover generic cost information (uCDN Delivery
   Proximity) for the delivery from a given set of Surrogates (e.g.,
   a CDN) to a given set of end-users is required. For example,
   ALTO cost maps, legacy BGP, BGP AIGP, and Previdi's MP-BGP
   extension typically provide such information, which may be
   advertised through the aforementioned protocols directly or
   through another protocol (e.g., HTTP based). To fulfill the
   topology hiding requirements (identified in [RFC5693] (Section
   5.5.) and [I-D.penno-alto-cdn] (Section 6.1.)), the advertised
   information must not disclose confidential information on the
   CDN's and underlying networks' topology (i.e., it must not permit
   to derive a detailed network map).

IETF may design a Footprint Discovery mechanism basing on these
building blocks. To increase the chances for this mechanism to be
deployed by operators, such a mechanism should give enough control on
information advertisement and respect operational requirements such
as not being too tightly bound to the network.

8. IANA Considerations

This memo includes no request to IANA.

9. Security Considerations

Footprint Discovery exposes information about the internals of CDNs.
Therefore, it is subject to confidentiality issues.

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