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CDNI Request Routing: Footprint and Capabilities Semantics
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Abstract

This document captures the semantics of the "Footprint and Capabilities Advertisement" part of the CDNI Request Routing interface, i.e., the desired meaning of "Footprint" and "Capabilities" in the CDNI context, and what the "Footprint and Capabilities Advertisement Interface (FCI)" offers within CDNI. The document also provides guidelines for the CDNI FCI protocol. It further defines a Base Advertisement Object, the necessary registries for capabilities and footprints, and guidelines on how these registries can be extended in the future.

Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

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1. Introduction and Scope

The CDNI working group is working on a set of protocols to enable the interconnection of multiple CDNs. This CDN interconnection (CDNI) can serve multiple purposes, as discussed in [RFC6770], for instance, to extend the reach of a given CDN to areas in the network which are not covered by this particular CDN.

The goal of this document is to achieve a clear understanding about the semantics associated with the CDNI Request Routing Footprint & Capabilities Advertisement Interface (from now on referred to as FCI), in particular the type of information a downstream CDN 'advertises' regarding its footprint and capabilities. To narrow down undecided aspects of these semantics, this document tries to establish a common understanding of what the FCI needs to offer and accomplish in the context of CDN Interconnection.

It is explicitly outside the scope of this document to decide on specific protocols to use for the FCI. However, guidelines for such FCI protocols are provided.

General assumptions in this document:

- o The CDNs participating in the interconnected CDN have already performed a boot strap process, i.e., they have connected to each other, either directly or indirectly, and can exchange information amongst each other.

- o The upstream CDN (uCDN) receives footprint and/or capability advertisements from a set of downstream CDNs (dCDNs). Footprint advertisement and capability advertisement need not use the same underlying protocol.

- o The uCDN receives the initial request-routing request from the endpoint requesting the resource.

The CDNI Problem Statement [RFC6707] describes the Request Routing Interface as: "[enabling] 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". In addition, RFC6707 says "the CDNI Request Routing interface is also expected to enable a downstream CDN to provide to the upstream CDN (static or dynamic) information (e.g., resources, footprint, load) to facilitate selection of the downstream CDN by the upstream CDN request routing system when processing subsequent content requests from User Agents". It thus considers

"resources" and "load" as capabilities to be advertised by the downstream CDN.

The range of different footprint definitions and possible capabilities is very broad. Attempting to define a comprehensive advertisement solution quickly becomes intractable. The CDNI requirements draft [RFC7337] lists the specific requirements for the CDNI Footprint & Capabilities Advertisement Interface in order to disambiguate footprints and capabilities with respect to CDNI. This document defines a common understanding of what the terms 'footprint' and 'capabilities' mean in the context of CDNI, and details the semantics of the footprint advertisement mechanism and the capability advertisement mechanism.

2. Design Decisions for Footprint and Capabilities

A large part of the difficulty in discussing the FCI lies in understanding what exactly is meant when trying to define footprint in terms of "coverage" or "reachability." While the operators of CDNs pick strategic locations to situate caches, a cache with a public IPv4 address is reachable by any endpoint on the Internet unless some policy enforcement precludes the use of the cache.

Some CDNs aspire to cover the entire world; we refer to these as global CDNs. The footprint advertised by such a CDN in the CDNI environment would, from a coverage or reachability perspective, presumably cover all prefixes. Potentially more interesting for CDNI use cases, however, are CDNs that claim a more limited coverage, but seek to interconnect with other CDNs in order to create a single CDN fabric which shares resources.

Furthermore, not all capabilities need to be footprint restricted. Depending upon the use case, the optimal semantics of "footprints with capability attributes" vs. "capabilities with footprint restrictions" are not clear.

The key to understanding the semantics of footprint and capability advertisement lies in understand why a dCDN would advertise a limited coverage area, and how a uCDN would use such advertisements to decide among one of several dCDNs. The following section will discuss some of the trade-offs and design decisions that need to be decided upon for the CDNI FCI.

2.1. Advertising Limited Coverage

The basic use case that would motivate a dCDN to advertise a limited coverage is that the CDN was built to cover only a particular portion of the Internet. For example, an ISP could purpose-build a CDN to

serve only their own customers by situating caches in close topological proximity to high concentrations of their subscribers. The ISP knows the prefixes it has allocated to end users and thus can easily construct a list of prefixes that its caches were positioned to serve.

When such a purpose-built CDN interconnects with other CDNs and advertises its footprint to a uCDN, however, the original intended coverage of the CDN might not represent its actual value to the interconnection of CDNs. Consider an ISP-A and ISP-B that both field their own CDNs, which they interconnect via CDNI. A given user E, who is a customer of ISP-B, might happen to be topologically closer to a cache fielded by ISP-A, if E happens to live in a region where ISP-B has few customers and ISP-A has many. In this case, is it ISP-A's CDN that "covers" E? If ISP-B's CDN has a failure condition, is it up to the uCDN to understand that ISP-A's caches are potentially available as back-ups - and if so, how does ISP-A advertise itself as a "standby" for E? What about the case where CDNs advertising to the same uCDN express overlapping coverage (for example, mixing global and limited CDNs)?

The answers to these questions greatly depend on how much information the uCDN wants to use to make a selection of a dCDN. If a uCDN has three dCDNs to choose from that "cover" the IP address of user E, obviously the uCDN might be interested to know how optimal the coverage is from each of the dCDNs - coverage need not be binary, either provided or not provided. dCDNs could advertise a coverage "score," for example, and provided that they all reported scores fairly on the same scale, uCDNs could use that to make their topological optimality decision. Alternately, dCDNs could advertise the IP addresses of their caches rather than prefix "coverage," and let the uCDN decide for itself (based on its own topological intelligence) which dCDN has better resources to serve a given user.

In summary, the semantics of advertising footprint depend on whether such qualitative metrics for expressing footprint (such as the coverage 'score' mentioned above) are included as part of the CDNI FCI, or if the focus is just on 'binary' footprint.

2.2. Capabilities and Dynamic Data

In cases where the apparent footprints of dCDNs overlap, uCDNs might also want to rely on other factors to evaluate the respective merits of dCDNs. These include facts related to the caches themselves, to the network where the cache is deployed, to the nature of the resource sought, and to the administrative policies of the respective networks.

In the absence of network-layer impediments to reaching caches, the choice to limit coverage is necessarily an administrative policy. Much policy needs to be agreed upon before CDNs can interconnect, including questions of membership, compensation, volumes, and so on. A uCDN certainly will factor these sorts of considerations into its decision to select a dCDN, but there is probably little need for dCDNs to actually advertise them through an interface - they will be settled out-of-band as a precondition for interconnection.

Other facts about the dCDN would be expressed through the interface to the uCDN. Some capabilities of a dCDN are static, and some are highly dynamic. Expressing the total storage built into its caches, for example, changes relatively rarely, whereas the amount of storage in use at any given moment is highly volatile. Network bandwidth similarly could be expressed as either total bandwidth available to a cache, or based on the current state of the network. A cache can at one moment lack a particular resource in storage, but have it the next.

The semantics of the capabilities interface will depend on how much of the dCDN state needs to be pushed to the uCDN and qualitatively how often that information needs to be updated.

2.3. Advertisement versus Queries

In a CDNI environment, each dCDN shares some of its state with the uCDN. The uCDN uses this information to build a unified picture of all of the dCDNs available to it. In architectures that share detailed capability information, the uCDN could perform the entire request-routing operation down to selecting a particular cache in the dCDN. However, when the uCDN needs to deal with many potential dCDNs, this approach does not scale, especially for dCDNs with thousands or tens of thousands of caches; the volume of updates to footprint and capability becomes onerous.

Were the volume of FCI updates from dCDNs to exceed the volume of requests to the uCDN, it might make more sense for the uCDN to query dCDNs upon receiving requests (as is the case in the recursive redirection mode described in [RFC7336]), instead of receiving advertisements and tracking the state of dCDNs. The advantage of querying dCDNs would be that much of the dynamic data that dCDNs cannot share with the uCDN would now be factored into the uCDN's decision. dCDNs need not replicate any state to the uCDN - uCDNs could effectively operate in a stateless mode.

The semantics of both footprint and capability advertisement depend on the service model here: are there cases where a synchronous query/

response model would work better for the uCDN decision than a state replication model?

2.4. Avoiding or Handling 'cheating' dCDNs

In a situation where more than one dCDN is willing to serve a given end user request, it might be attractive for a dCDN to 'cheat' in the sense that the dCDN provides inaccurate information to the uCDN in order to convince the uCDN to select it over 'competing' dCDNs. It could therefore be desirable to take away the incentive for dCDNs to cheat (in information advertised) as much as possible. One option is to make the information the dCDN advertises somehow verifiable for the uCDN. On the other hand, a cheating dCDN might be avoided or handled by the fact that there will be strong contractual agreements between a uCDN and a dCDN, so that a dCDN would risk severe penalties or legal consequences when caught cheating.

Overall, the information a dCDN advertises (in the long run) needs to be somehow qualitatively verifiable by the uCDN, though possibly through non-real-time out-of-band audits. It is probably an overly strict requirement to mandate that such verification be possible "immediately", i.e., during the request routing process itself. If the uCDN can detect a cheating dCDN at a later stage, it might suffice for the uCDN to "de-incentivize" cheating because it would negatively affect the long-term business relationship with a particular dCDN.

2.5. Focusing on Main Use Cases

To narrow down semantics for "footprint" and "capabilities" in the CDNI context, it can be useful to initially focus on key use cases to be addressed by the CDNI WG that are to be envisioned in the main deployments in the foreseeable future. In this regard, a main realistic use case is the existence of ISP-owned CDNs, which essentially cover a certain operator's network. At the same time, however, the possibility of overlapping footprints cannot be excluded, i.e., the scenario where more than one dCDN claims it can serve a given end user request. The ISPs can also choose to interconnect with a fallback global CDN.

It seems reasonable to assume that in most use cases it is the uCDN that makes the decision on selecting a certain dCDN for request routing based on information the uCDN has received from this particular dCDN. It can be assumed that 'cheating' CDNs will be dealt with via means outside the scope of CDNI and that the information advertised between CDNs is accurate. In addition, excluding the use of qualitative information (e.g., cache proximity, delivery latency, cache load) to predict the quality of delivery

would further simplify the use case allowing it to better focus on the basic functionality of the FCI.

3. Main Use Case to Consider

Focusing on a main use case that contains a simple (yet somewhat challenging), realistic, and generally imaginable scenario can help in narrowing down the requirements for the CDNI FCI. To this end, the following (simplified) use case can help in clarifying the semantics of footprint and capabilities for CDNI. In particular, the intention of the use case is to clarify what information needs to be exchanged on the CDNI FCI, what types of information need to be supported in a mandatory fashion (and which can be considered optional), and what types of information need to be updated with respect to a priori established CDNI contracts.

Use case: A given uCDN has several dCDNs. It selects one dCDN for delivery protocol A and footprint 1 and another dCDN for delivery protocol B and footprint 1. The dCDN that serves delivery protocol B has a further, transitive (level-2) dCDN, that serves delivery protocol B in a subset of footprint 1 where the first-level dCDN cannot serve delivery protocol B itself. What happens if capabilities change in the transitive level-2 dCDN that might affect how the uCDN selects a level-1 dCDN (e.g., in case the level-2 dCDN cannot serve delivery protocol B anymore)? How will these changes be conveyed to the uCDN? In particular, what information does the uCDN need to be able to select a new first-level dCDN, either for all of footprint 1 or only for the subset of footprint 1 that the transitive level-2 dCDN served on behalf of the first-level dCDN?

4. Semantics for Footprint Advertisement

Roughly speaking, "footprint" can be defined as "ability and willingness to serve" by a downstream CDN. However, in addition to simple "ability and willingness to serve", the uCDN could want additional information to make a dCDN selection decision, e.g., "how well" a given dCDN can actually serve a given end user request. The "ability and willingness" to serve SHOULD be distinguished from the subjective qualitative measurement of "how well" it was served. One can imagine that such additional information is implicitly associated with a given footprint, due to contractual agreements, SLAs, business relationships, or past perceptions of dCDN quality. As an alternative, such additional information could also be explicitly tagged along with the footprint.

It is reasonable to assume that a significant part of the actual footprint advertisement will happen in contractual agreements between participating CDNs, prior to the advertisement phase using the CDNI

FCI. The reason for this assumption is that any contractual agreement is likely to contain specifics about the dCDN coverage (footprint) to which the contractual agreement applies. In particular, additional information to judge the delivery quality associated with a given dCDN footprint might be defined in contractual agreements, outside of the CDNI FCI. Further, one can assume that dCDN contractual agreements about the delivery quality associated with a given footprint will probably be based on high-level aggregated statistics and not too detailed.

Given that a large part of footprint advertisement will actually happen in contractual agreements, the semantics of CDNI footprint 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 it has prior agreed to serve in a contract with a uCDN.

Generally speaking, one can imagine two categories of footprint to be advertised by a dCDN:

o Footprint could be defined based on "coverage/reachability", where coverage/reachability refers to a set of prefixes, a geographic region, or similar boundary. The dCDN claims that it can cover/reach 'end user requests coming from this footprint'.

o Footprint could be defined based on "resources", where resources refers to surrogates/caches a dCDN claims to have (e.g., the location of surrogates/resources). The dCDN claims that 'from this footprint' it can serve incoming end user requests.

For each of these footprint types, there are capabilities associated with a given footprint:

o capabilities such as delivery protocol, redirection mode, and metadata, which are supported in the coverage area for a "coverage/reachability" defined footprint, or

o capabilities of resources, such as delivery protocol, redirection mode, and metadata, which apply to a "resource" defined footprint.

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:

- o List of ISO Country Codes

- o List of AS numbers

- o 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, as well as IP prefixes with an arbitrary prefix length. There also MUST be support for multiple IP address versions, i.e., IPv4 and IPv6, in such a footprint.

"Resource" types of footprints are more specific than "coverage/ reachability" types of footprints, where the actual coverage/ reachability are extrapolated from the resource location (e.g., netmask applied to resource IP address to derive IP-prefix). The specific methods for extrapolating coverage/reachability from resource location are beyond the scope of this document. In the degenerate case, the resource address could be specified as a coverage/reachability type of footprint, in which case no extrapolation is necessary. Resource types of footprints could expose the internal structure of a CDN network which could be undesirable. As such, the resource types of footprints are not considered mandatory to support for CDNI.

For all of these mandatory-to-implement footprint types, the 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: the advertisement of different types of footprint narrows the dCDN candidacy cumulatively.

In addition to these mandatory "coverage/reachability" types of footprint, other optional "coverage/reachability" types of footprint or "resource" types of footprint MAY be defined by future specifications. To facilitate this, a clear process for specifying optional footprint types in an IANA registry is specified in the CDNI Metadata Footprint Types registry (defined in the CDNI Metadata Interface document [I-D.ietf-cdni-metadata]).

Independent of the exact type of a footprint, a footprint might also include the connectivity of a given dCDN to other CDNs that are able to serve content to users on behalf of that dCDN, to cover cases with cascaded CDNs. Further, the downstream CDN needs to be able to express its footprint to an interested upstream CDN (uCDN) in a comprehensive form, e.g., as a data set containing the complete footprint. Making incremental updates, however, to express dynamic changes in state is also desirable.

5. Semantics for Capabilities Advertisement

In general, the dCDN MUST be able to express its general capabilities to the uCDN. These general capabilities could express if the dCDN supports a given service, for instance, HTTP vs HTTPS delivery. Furthermore, the dCDN MUST be able to express particular capabilities for the delivery in a particular footprint area. For example, the dCDN might in general offer HTTPS but not in some specific areas, either for maintenance reasons or because the caches covering this particular area cannot deliver this type of service. Hence, in certain cases footprint and capabilities are tied together and cannot be interpreted independently from each other. In such cases, i.e., where capabilities need to be expressed on a per footprint basis, it could be beneficial to combine footprint and capabilities advertisement.

A high-level and very rough semantic for capabilities is thus the following: Capabilities are types of information that allow a uCDN to determine if a downstream CDN is able (and willing) to accept (and properly handle) a delegated content request. In addition, Capabilities are characterized by the fact that this information can change over time based on the state of the network or caches.

At a first glance, several broad categories of capabilities seem useful to convey via an advertisement interface, however, advertising capabilities that change highly dynamically (e.g., real-time delivery performance metrics, CDN resource load, or other highly dynamically changing QoS information) is beyond the scope for CDNI FCI. First, out of the multitude of possible metrics and capabilities, it is hard to agree on a subset and the precise metrics to be used. Second, it seems infeasible to specify such highly dynamically changing capabilities and the corresponding metrics within a reasonable time-frame.

Useful capabilities refer to information that does not change highly dynamically and which in many cases is absolutely necessary to decide on a particular dCDN for a given end user request. For instance, if an end user request concerns the delivery of a video file with a

certain protocol, the uCDN needs to know if a given dCDN has the capability of supporting this delivery protocol.

Similar to footprint advertisement, it is reasonable to assume that a significant part of the actual (resource) capabilities advertisement will happen in contractual agreements between participating CDNs, i.e., prior to the advertisement phase using the CDNI FCI. The role of capability advertisement is hence rather to enable the dCDN to update a uCDN on changes since a contract has been set up (e.g., in case a new delivery protocol is suddenly being added to the list of supported delivery protocols of a given dCDN, or in case a certain delivery protocol is suddenly not being supported anymore due to failures). Capabilities advertisement thus refers to conveying information to a uCDN about changes/updates of certain capabilities with respect to a given contract.

Given these semantics, it needs to be decided what exact capabilities are useful and how these can be expressed. Since the details of CDNI contracts are not known at the time of this writing (and the CDNI interface are better off being agnostic to these contracts anyway), it remains to be seen what capabilities will be used to define agreements between CDNs in practice. One implication for standardization could be to initially only specify a very limited set of mandatory capabilities for advertisement and have on top of that a flexible data model that allows exchanging additional capabilities when needed. Still, agreement needs to be found on which capabilities (if any) will be mandatory among CDNs. As discussed in Section 2.5, finding the concrete answers to these questions can benefit from focusing on a small number of key use cases that are highly relevant and contain enough complexity to help in understanding what concrete capabilities are needed to facilitate CDN Interconnection.

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

o Delivery Protocol (for delivering content to the end user)

o Acquisition Protocol (for acquiring content from the uCDN or origin server)

o Redirection Mode (e.g., DNS Redirection vs. HTTP Redirection as discussed in [RFC7336])

o CDNI Logging (i.e., supported logging fields)

o CDNI Metadata (i.e., supported Generic Metadata types)

It is not feasible to enumerate all the possible options for the mandatory capabilities listed above (e.g., all the potential delivery protocols or metadata options) or anticipate all the future needs for additional capabilities. It would be unreasonable to burden the CDNI FCI specification with defining each supported capability. Instead, the CDNI FCI specification SHOULD define a generic protocol for conveying any capability information (e.g. with common encoding, error handling, and security mechanism; further requirements for the CDNI FCI Advertisement Interface are listed in [RFC7337]). In this respect, it seems reasonable to define a registry which initially contains the mandatory capabilities listed above, but can be extended as needs dictate. This document defines the registry (and the rules for adding new entries to the registry) for the different capability types (see Section 8). Each capability type MAY have a list of valid values. Future specifications which define a given capability MUST define any necessary registries (and the rules for adding new entries to the registry) for the values advertised for a given capability type.

The "CDNI Logging Fields Names" registry defines all supported logging fields, including mandatory-to-implement logging fields. Advertising support for mandatory-to-implement logging fields SHOULD be supported but would be redundant. CDNs SHOULD NOT advertise support for mandatory-to-implement logging fields. The following logging fields are defined as optional in the CDNI Logging Interface document [I-D.ietf-cdni-logging]:

- s-ccid

- s-sid

The CDNI Metadata Interface document [I-D.ietf-cdni-metadata] does not define any optional GenericMetadata types. Advertising support for mandatory-to-implement GenericMetadata types SHOULD be supported. Advertisement of mandatory-to-implement GenericMetadata MAY be necessary, e.g., to signal temporary outages and subsequent recovery, however, it is expected that mandatory-to-implement GenericMetadata will be supported and available in the typical case. In the typical case, advertising support for mandatory-to-implement GenericMetadata would be redundant, therefore, CDNs SHOULD NOT advertise support for mandatory-to-implement GenericMetadata types by default.

6. Negotiation of Support for Optional Types of Footprint/Capabilities

The notion of optional types of footprint and capabilities implies that certain implementations might not support all kinds of footprint and capabilities. Therefore, any FCI solution protocol MUST define how the support for optional types of footprint/capabilities will be negotiated between a uCDN and a dCDN that use the particular FCI protocol. In particular, any FCI solution protocol MUST specify how to handle failure cases or non-supported types of footprint/capabilities.

In general, a uCDN MAY ignore capabilities or types of footprints it does not understand; in this case it only selects a suitable downstream CDN based on the types of capabilities and footprint it understands. Similarly, if a dCDN does not use an optional capability or footprint which is, however, supported by a uCDN, this causes no problem for the FCI functionality because the uCDN decides on the remaining capabilities/footprint information that is being conveyed by the dCDN.

7. Capability Advertisement Object

To support extensibility, the FCI defines a generic base object (similar to the CDNI Metadata interface GenericMetadata object) [I-D.ietf-cdni-metadata] to facilitate a uniform set of mandatory parsing requirements for all future FCI objects.

Future object definitions (e.g. regarding CDNI Metadata or Logging) will build off the base object defined here, but will be specified in separate documents.

7.1. 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 capability-type property above.

Mandatory-to-Specify: Yes.

7.2. Delivery Protocol Capability Object

The Delivery Protocol capability object is used to indicate support for one or more of the protocols listed in the CDNI Metadata Protocol Types registry (defined in the CDNI Metadata Interface document [I-D.ietf-cdni-metadata]).

Property: delivery-protocols

Description: List of supported CDNI Delivery Protocols.

Type: List of Protocol Types (from the CDNI Metadata Protocol Types registry [I-D.ietf-cdni-metadata])

Mandatory-to-Specify: Yes.

7.3. Acquisition Protocol Capability Object

The Acquisition Protocol capability object is used to indicate support for one or more of the protocols listed in the CDNI Metadata Protocol Types registry (defined in the CDNI Metadata Interface document [I-D.ietf-cdni-metadata]).

Property: acquisition-protocols

Description: List of supported CDNI Acquisition Protocols.

Type: List of Protocol Types (from the CDNI Metadata Protocol Types registry [I-D.ietf-cdni-metadata])

Mandatory-to-Specify: Yes.

7.4. Redirection Mode Capability Object

The Redirection Mode capability object is used to indicate support for one or more of the modes listed in the CDNI Capabilities Redirection Modes registry (see Section 8.2).

Property: redirection-modes

Description: List of supported CDNI Redirection Modes.

Type: List of Redirection Modes (from Section 8.2)

Mandatory-to-Specify: Yes.

7.5. Capability Advertisement Object Serialization

The following shows an example of CDNI FCI Capability Advertisement Object Serialization.


```
{
  "capabilities": [
    {
      "capability-type": "FCI.DeliveryProtocol"
      "capability-value": {
        "delivery-protocols": [
          "http1.1"
        ]
      }
    },
    {
      "capability-type": "FCI.AcquisitionProtocol"
      "capability-value": {
        "acquisition-protocols": [
          "http1.1",
          "https1.1"
        ]
      }
    },
    {
      "capability-type": "FCI.RedirectionMode"
      "capability-value": {
        "redirection-modes": [
          "DNS-I",
          "HTTP-I"
        ]
      }
    }
  ]
}
```


8. IANA Considerations

8.1. CDNI Payload Types

This document requests the registration of the following CDNI Payload Types under the IANA CDNI Payload Type registry:

Payload Type	Specification
FCI.DeliveryProtocol	RFCthis
FCI.AcquisitionProtocol	RFCthis
FCI.RedirectionMode	RFCthis

[RFC Editor: Please replace RFCthis with the published RFC number for this document.]

8.1.1. CDNI FCI DeliveryProtocol Payload Type

Purpose: The purpose of this payload type is to distinguish FCI advertisement objects for supported delivery protocols

Interface: FCI

Encoding: see Section 7.2 and Section 7.5

8.1.2. CDNI FCI AcquisitionProtocol Payload Type

Purpose: The purpose of this payload type is to distinguish FCI advertisement objects for supported acquisition protocols

Interface: FCI

Encoding: see Section 7.3 and Section 7.5

8.1.3. CDNI FCI RedirectionMode Payload Type

Purpose: The purpose of this payload type is to distinguish FCI advertisement objects for supported redirection modes

Interface: FCI

Encoding: see Section 7.4 and Section 7.5

8.2. Redirection Mode Registry

The IANA is requested to create a new "CDNI Capabilities Redirection Modes" registry in the "Content Delivery Networks Interconnection (CDNI) Parameters" category. The "CDNI Capabilities Redirection Modes" namespace defines the valid redirection modes that can be advertised as supported by a CDN. Additions to the Redirection Mode

namespace conform to the "IETF Review" policy as defined in [RFC5226].

The following table defines the initial Redirection Modes:

Redirection Mode	Description	RFC
DNS-I	Iterative DNS-based Redirection	RFCthis
DNS-R	Recursive DNS-based Redirection	RFCthis
HTTP-I	Iterative HTTP-based Redirection	RFCthis
HTTP-R	Recursive HTTP-based Redirection	RFCthis

[RFC Editor: Please replace RFCthis with the published RFC number for this document.]

9. Security Considerations

This specification describes the semantics for capabilities and footprint advertisement objects across interconnected CDNs. It does not, however, specify a concrete protocol for transporting those objects. Specific security mechanisms can only be selected for concrete protocols that instantiate these semantics. This document does, however, place some high-level security constraints on such protocols.

All protocols that implement these semantics are REQUIRED to provide integrity and authentication services. Without authentication and integrity, an attacker could trivially deny service by forging a footprint advertisement from a dCDN which claims the network has no footprint or capability. This would prevent the uCDN from delegating any requests to the dCDN. Since a pre-existing relationship between all dCDNs and uCDNs is assumed by CDNI, the exchange of any necessary credentials could be conducted before the FCI interface is brought online. The authorization decision to accept advertisements would also follow this pre-existing relationship and any contractual obligations that it stipulates.

All protocols that implement these semantics are REQUIRED to provide confidentiality services. Some dCDNs are willing to share information about their footprint or capabilities with a uCDN but not with other, competing dCDNs. For example, if a dCDN incurs an outage that reduces footprint coverage temporarily, that could be

information the dCDN would want to share confidentially with the uCDN.

As specified in this document, the security requirements of the FCI could be met by hop-by-hop transport-layer security mechanisms coupled with domain certificates as credentials (e.g., TLS transport for HTTP as per [RFC2818] and [RFC7230], with usage guidance from [RFC7525]). There is no apparent need for further object-level security in this framework, as the trust relationships it defines are bilateral relationships between uCDNs and dCDNs rather than transitive relationships.

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