

# **CDNI Request Routing with ALTO**

## **draft-seedorf-cdni-request-routing-alto-05**

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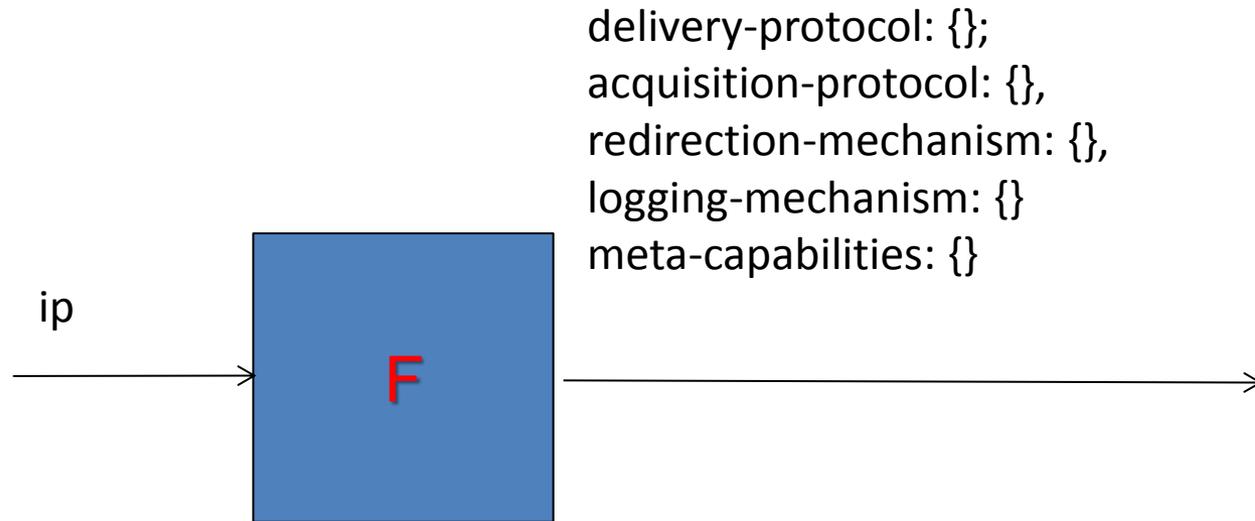
# ALTO within CDNI Request Routing

**ALTO is Candidate for the CDNI Footprint / Capabilities Advertisement Interface (FCI)**

## **draft-seedorf-cdni-request-routing-alto**

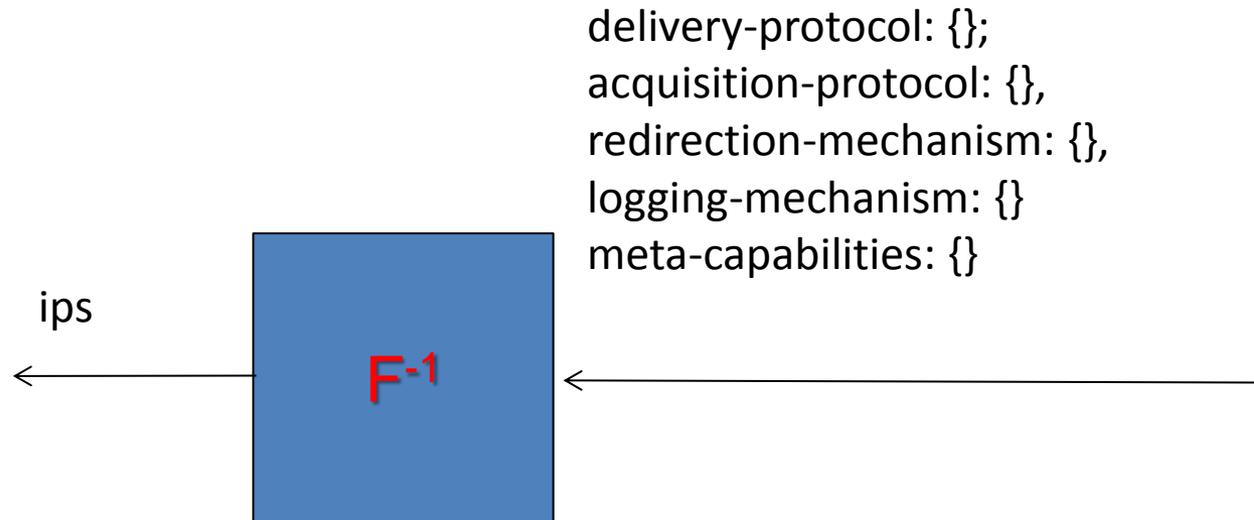
- outlines how ALTO can be used as CDNI FCI protocol and for dCDN selection
- discusses design choices, advantages of ALTO, and presents concrete examples

# Basic Conceptual F&CI



- Problem of this representation format
  - 4 billion entries if naïve representation using per IPv4
  - Per CIDR aggregation may still need a large number of CIDRs
- **ALTO PIDs provide flexible aggregation of endpoints to reduce entries**
  - E.g., South-France, Germany, ...

# A Different View: Can also look at Inverse Function



- Instead of representing  $F$ , representing the inverse function  $F^{-1}$
- Further, since  $F$  is composed of 5 functions for 5 mandatory capabilities,  $F_{dp}$ ,  $F_{ap}$ ,  $F_{rm}$ ,  $F_{lm}$ ,  $F_{mc}$ , we can represent their inverse functions as well.

## Example: $F_{dp}^{-1}$

- {HTTP} -> list of endhosts,
- {HTTPS} -> list of endhosts,
- {RMTP} -> list of endhosts,
- {HTTP, HTTPS} -> list of endhosts,
- {HTTP, RMTP} -> ...
- {HTTPS, RMTP} -> ...
- {HTTP, HTTPS, RMTP} -> ...
- // empty one does not need to be listed

# Scalability of Inverse Representation

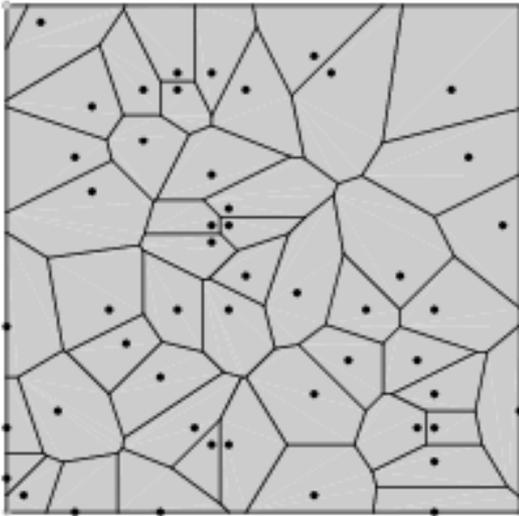
- Suppose each of the 5 capabilities has 4 values
- Then total entries:
  - $5 * (16 - 1) = 75$
  - If the capabilities of an endhost changes, the maximum number of updated entries is 10 (2 entries per capability and 5 capabilities)

# Further Optimization

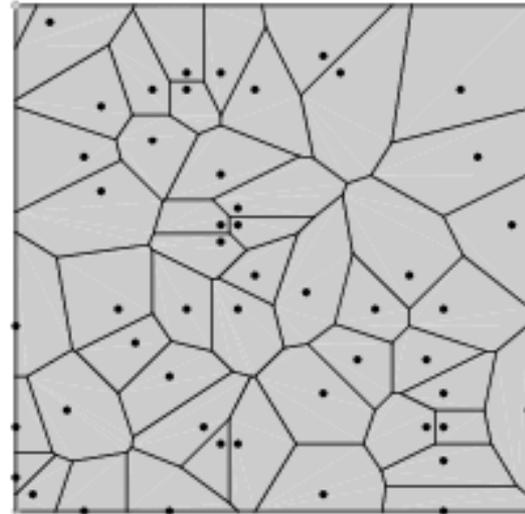
- Some capabilities can be coupled, e.g., a dCDN has only two combinations of DP and AP
  - DP = HTTP ^ AP = HTTP -> list of endhosts
  - DP = RTMP ^ AP = FTP -> list of endhost
- Specify  $F_{DP \times AP}^{-1}$  with only two entries
  - {DP = HTTP, AP = HTTP} -> list of endhosts
  - {DP = RTMP, AP = FTP} -> list of endhost
  - Savings can be substantial if list is long
- Can prove reach optimal with this flexibility

# ALTO Encoding Advantage

- Flexible using either a capabilities centric ( $F^{-1}$ ) or a footprint centric (F), or combination encoding of F&C

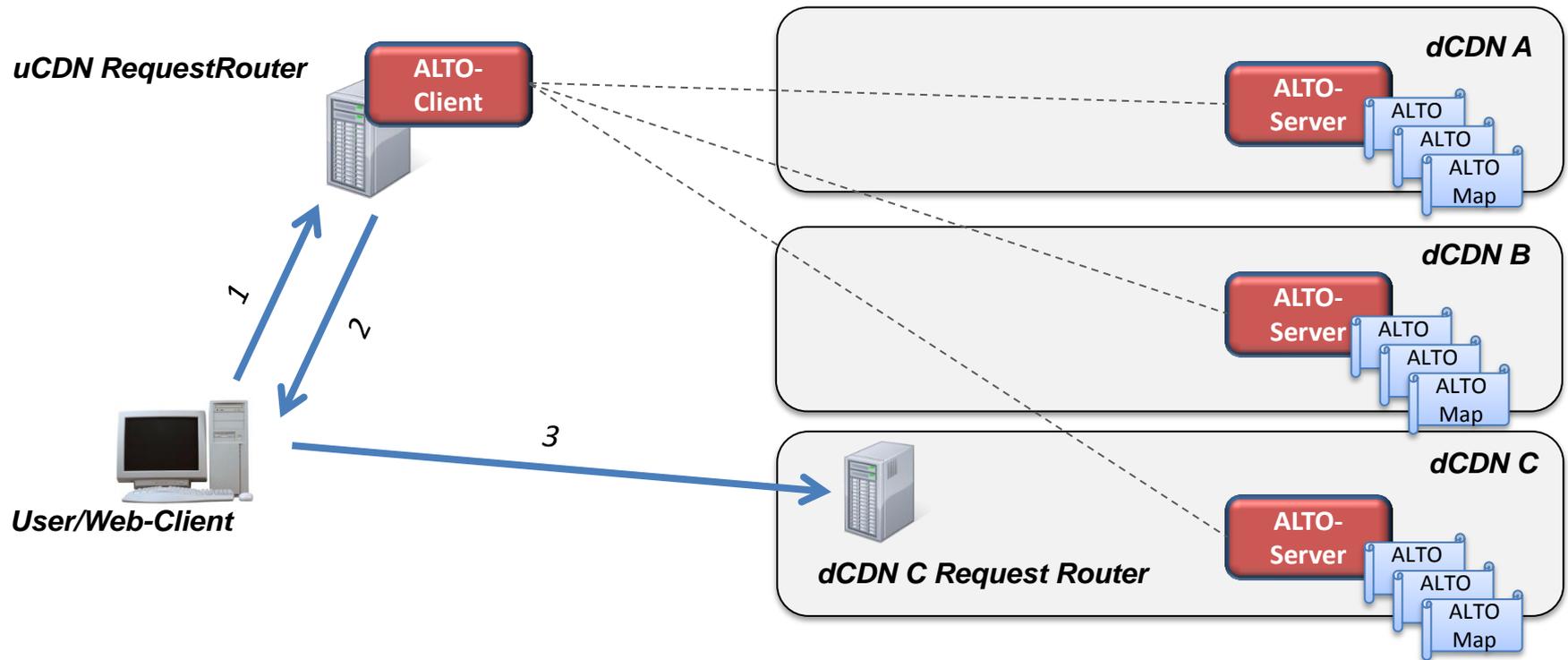


Capabilities centric: each PID represents a fixed set of capabilities, and changes are made only to addresses in each PID



Footprint centric: each PID represents a fixed set of addresses, and changes are made only to capabilities of each PID

# High-Level Example of Selecting a Downstream CDN



- uCDN fetches from each dCDN Network Maps that denote its footprints and capabilities
  - uCDN can selectively retrieve Filtered Network Maps
- A dCDN can update uCDN with changes

# Example ALTO Network Map

GET /networkmap/eu HTTP/1.1

Host: cdni.example.com

Accept: application/alto-networkmap+json,application/alto-error+json

HTTP/1.1 200 OK

Content-Length: TBA

Content-Type: application/alto-networkmap+json

```
{
  "meta" : {
    "vtag" : [
      { "resource-id": "my-eu-netmap",
        "tag": "1266506139"
      }
    ]
  },
  "network-map" : {
    "south-france" : {
      "ipv4" : [ "192.0.2.0/24", "198.51.100.0/25" ], "cdni-fruit" : ["orange"]
    },
    "germany" : {
      "ipv4" : [ "192.0.3.0/24" ]
    },
    "rest" : { "ipv4": [0.0.0.0/0], "ipv6": [::/0] }
  }
}
```

Longest prefix matching  
determines PID membership

# Example ALTO PID Property

HTTP/1.1 200 OK

Content-Length: TBA

Content-Type: application/alto-pidprop+json

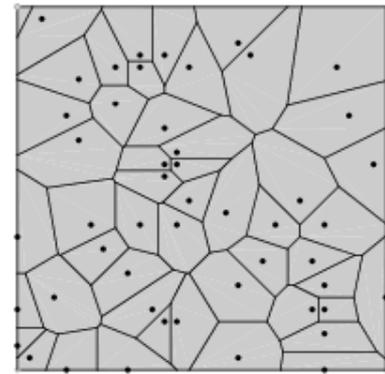
```
{
  "meta" : {
    "dependent-vtags" : [
      {"resource-id": "my-eu-netmap",
       "tag": "1266506139"}
    ]
  },
  "properties": {
    "pid:south-france" : { "delivery-protocol": ["HTTP"], ... },
    "pid:germany" : { "delivery-protocol": ["HTTP", "HTTPS"], ... },
    "pid:rest" : {}
  }
}
```

# Incremental Update

- Use JSON Patch (RFC6902) or ALTO incremental update, after defined
  - Can patch either endpoints defined in PIDs, or properties of PIDs, or both
- JSON Patch example

```
PATCH /networkmap/euprop HTTP/1.1
Host: ucdn.example.org
Content-Length: TBA
Content-Type: application/json-patch+json
If-Match: "abc123"
[
  { "op": "move", "from": "/a/b/c", "path": "/a/b/d" }
]
```

# Other Features of ALTO for CDNi



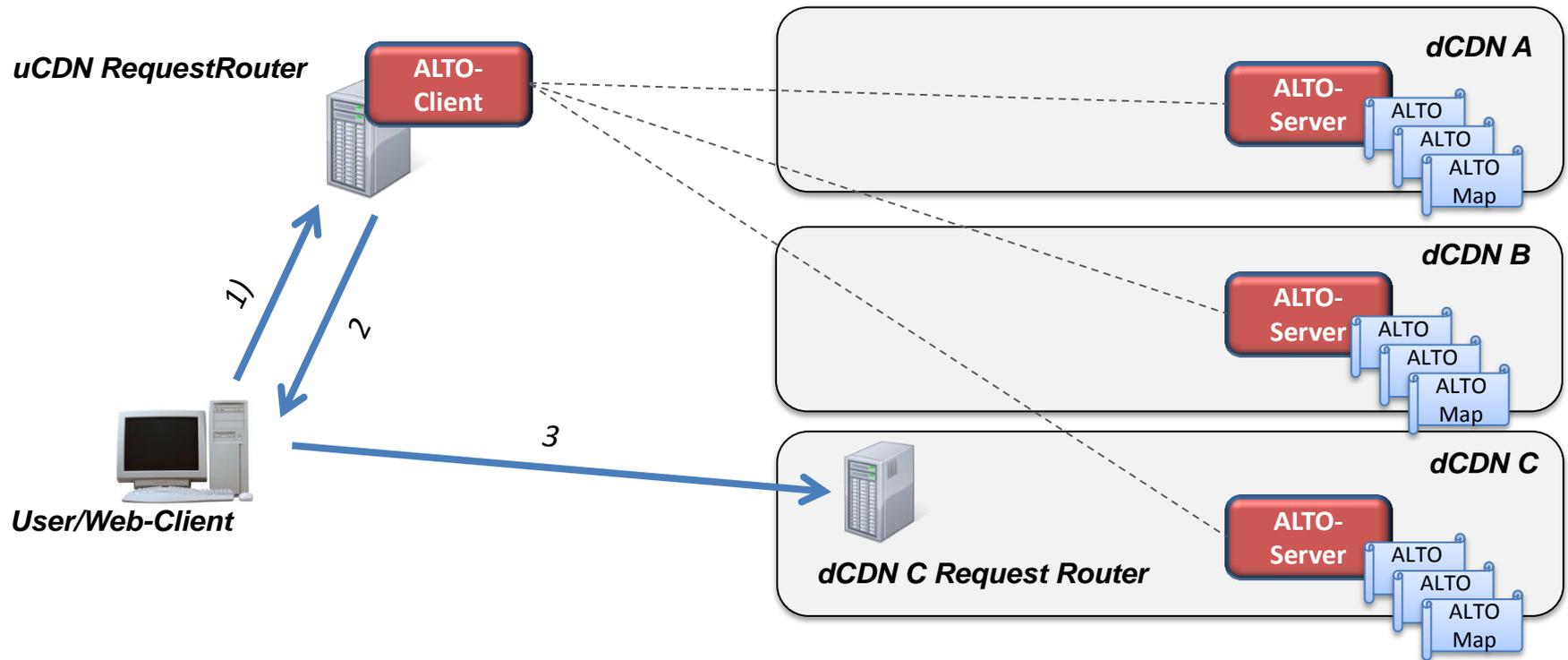
- Filtered network map
  - Retrieve partial network map (e.g., HTTP)
- Filtered properties
- Endpoint Property Service
  - Query F&C given an individual endpoint (without querying the whole map)
- Define the semantics of additional foot print types, e.g.,
  - Define one Network Map to denote the meaning of each type (e.g., an asn Network Map, a country-code Network Map, a fruit Network Map)
- **PID concept allows clean separation between footprint and capabilities**
  - **PID gives name to a footprint**
  - **can then easily change separately either**
    - **Properties for footprint**
    - **Composition of footprint**

# Acknowledgements

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Backup Slides

# High-Level Example of Selecting a Downstream CDN



- 1) Each dCDN provides a footprint network map "NM\_cov"
- 2) Each dCDN additionally provides capability network maps "CM\_1", ..., "CM\_n"
  - provide the upstream CDN information regarding the support for capabilities each individual downstream CDN would imply depending on the given location of an end user request
  - can be retrieved selectively by the uCDN by using the Filtered Network Map option, see Section 10.2.1. in draft-ietf-alto-protocol-17

# How can mandatory types of footprint/capabilities be conveyed with ALTO?

- **Footprint Advertisement with ALTO network map**

- dCDN provides ALTO network map
  - ALTO network map: groups network locations (e.g. IP-prefixes) into “PIDs”
  - Network map of dCDN contains footprint of dCDN grouped into PIDs

- **Capabilities Advertisement with ALTO network maps**

- dCDN provides ALTO network maps
  - network maps provided by a dCDN can group the dCDN's coverage footprint into several PIDs, where each PID name has a certain 'capability' semantic
  - E.g., for each supported delivery protocol, the dCDN would provide an ALTO PID in a network map that contains all IP-prefixes that support this delivery protocol

