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              Guidelines for HTTP-CoAP Mapping Implementations
                      draft-ietf-core-http-mapping-07

Abstract

   This document provides reference information for implementing a proxy
   that performs translation between the HTTP protocol and the CoAP
   protocol, focusing on the reverse proxy case. It describes how a
   HTTP request is mapped to a CoAP request and how a CoAP response is
   mapped back to a HTTP response. Furthermore, it defines a template
   for URI mapping and provides a set of guidelines for HTTP to CoAP
   protocol translation and related proxy implementations.

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1. Introduction

   CoAP [RFC7252] has been designed with the twofold aim to be an
   application protocol specialized for constrained environments and to
   be easily used in REST architectures such as the Web. The latter
   goal has led to define CoAP to easily interoperate with HTTP
   [RFC7230] through an intermediary proxy which performs cross-protocol
   conversion.

   Section 10 of [RFC7252] describes the fundamentals of the CoAP-to-
   HTTP and the HTTP-to-CoAP cross-protocol mapping process. However,
   implementing such a cross-protocol proxy can be complex, and many
   details regarding its internal procedures and design choices require
   further elaboration. Therefore, a first goal of this document is to
   provide more detailed information to proxy designers and
   implementers, to help build proxies that correctly inter-work with
   existing CoAP and HTTP implementations.

   The second goal of this informational document is to define a
   consistent set of guidelines that a HTTP-to-CoAP proxy implementation
   MAY adhere to. The main reason for adhering to such guidelines is to
   reduce variation between proxy implementations, thereby increasing
   interoperability. (For example, a proxy conforming to these
   guidelines made by vendor A can be easily replaced by a proxy from
   vendor B that also conforms to the guidelines.)

   This document is organized as follows:

   o Section 2 describes terminology to identify proxy types, mapping
      approaches and proxy deployments;

   o Section 3 introduces the reverse HTTP-CoAP proxy;

   o Section 4 lists use cases in which HTTP clients need to contact
      CoAP servers;

    o Section 5 introduces a default HTTP-to-CoAP URI mapping syntax;

    o Section 6 describes how to map HTTP media types to CoAP content
       formats and vice versa;

    o Section 7 describes how to map CoAP responses to HTTP responses;

    o Section 8 describes additional mapping guidelines related to
       caching, congestion, timeouts and CoAP blockwise
       [I-D.ietf-core-block] transfers;

    o Section 10 discusses possible security impact of HTTP-CoAP
       protocol mapping.

2. Terminology

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

   HC Proxy: a proxy performing a cross-protocol mapping, in the context
   of this document a HTTP-CoAP mapping. A Cross-Protocol Proxy can
   behave as a Forward Proxy, Reverse Proxy or Interception Proxy. In
   this document we focus on the Reverse Proxy case.

   Forward Proxy: a message forwarding agent that is selected by the
   client, usually via local configuration rules, to receive requests
   for some type(s) of absolute URI and to attempt to satisfy those
   requests via translation to the protocol indicated by the absolute
   URI. The user decides (is willing to) use the proxy as the
   forwarding/de-referencing agent for a predefined subset of the URI
   space. In [RFC7230] this is called a Proxy. [RFC7252] defines
   Forward-Proxy similarly.

   Reverse Proxy: as in [RFC7230], a receiving agent that acts as a
   layer above some other server(s) and translates the received requests
   to the underlying server's protocol. A Reverse HC Proxy behaves as
   an origin (HTTP) server on its connection towards the (HTTP) client
   and as a (CoAP) client on its connection towards the (CoAP) origin
   server. The (HTTP) client uses the "origin-form" (Section 5.3.1 of
   [RFC7230]) as a request-target URI.

   Interception Proxy [RFC3040]: a proxy that receives inbound traffic
   flows through the process of traffic redirection; transparent to the
   client.

Placement terms: a Server-Side proxy is placed in the same network
domain as the server; conversely a Client-Side proxy is placed in the
same network domain as the client. In any other case, the proxy is
said to be External.

Note that a Reverse Proxy appears to a client as an origin server
while a Forward Proxy does not, so, when communicating with a Reverse
Proxy a client may be unaware it is communicating with a proxy at
all.

3. HTTP-CoAP Reverse Proxy

A Reverse HTTP-CoAP Proxy (HC proxy) is accessed by clients only
supporting HTTP, and handles their HTTP requests by mapping these to
CoAP requests, which are forwarded to CoAP servers; mapping back
received CoAP responses to HTTP responses. This mechanism is
transparent to the client, which may assume that it is communicating
with the intended target HTTP server. In other words, the client
accesses the proxy as an origin server using the "origin-form"
(Section 5.3.1 of [RFC7230]) as a request target.

See Figure 1 for an example deployment scenario. Here an HC Proxy is
placed server-side, at the boundary of the Constrained Network
domain, to avoid any HTTP traffic on the Constrained Network and to
avoid any (unsecured) CoAP multicast traffic outside the Constrained
Network. The DNS server is used by the HTTP Client to resolve the IP
address of the HC Proxy and optionally also by the HC Proxy to
resolve IP addresses of CoAP servers.

```
                                               Constrained Network
                                             .------------------.
                                            /      .------.       \
                                           /       | CoAP |        \
                                          /        |server|         \
                                         ||        '------'          ||
                                         ||                          ||
       .--------.  HTTP Request  .-----------.  CoAP Req  .------.    ||
       | HTTP   |---------------->| HTTP-CoAP |----------->| CoAP |    ||
       | Client |<----------------|   Proxy   |<-----------|Server|    ||
       '--------'  HTTP Response  '-----------'  CoAP Resp '------'    ||
                                         ||                          ||
                                         ||     .------.             ||
                                         ||     | CoAP |             ||
                                          \     |server|   .------.  /
                                           \    '------'   | CoAP | /
                                            \              |server|/
                                             \             '------'/
                                              '----------------'
```
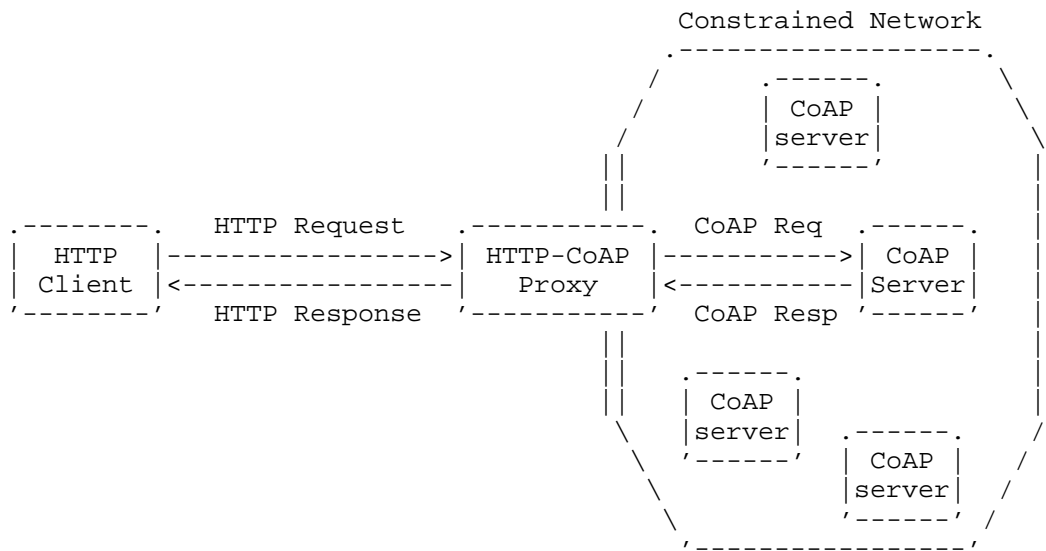
          Figure 1: Reverse Cross-Protocol Proxy Deployment Scenario

   Other placement options for the HC Proxy (not shown) are client-side,
   which is in the same domain as the HTTP Client; or external, which is
   both outside the HTTP Client's domain and the CoAP servers' domain.

   Normative requirements on the translation of HTTP requests to CoAP
   requests and of the CoAP responses back to HTTP responses are defined
   in Section 10.2 of [RFC7252]. However, that section only considers
   the case of a Forward HC Proxy in which a client explicitly indicates
   it targets a request to a CoAP server, and does not cover all aspects
   of proxy implementation in detail. This document provides guidelines
   and more details for the implementation of a Reverse HC Proxy, which
   MAY be followed in addition to the normative requirements. Note that
   most of the guidelines also apply to an Intercepting HC Proxy.

4. Use Cases

   To illustrate in which situations HTTP to CoAP protocol translation
   may be used, three use cases are described below.

   1. Smartphone and home sensor: A smartphone can access directly a
   CoAP home sensor using an authenticated 'https' request, if its home
   router contains an HC proxy. An HTML5 application on the smartphone
   can provide a friendly UI to the user using standard (HTTP)
   networking functions of HTML5.

2. Legacy building control application without CoAP: A building
    control application that uses HTTP but not CoAP, can check the status
    of CoAP sensors and/or actuators via an HC proxy.

3. Making sensor data available to 3rd parties: For demonstration or
    public interest purposes, a HC proxy may be configured to expose the
    contents of a CoAP sensor to the world via the web (HTTP and/or
    HTTPS). Some sensors might only handle secure 'coaps' requests,
    therefore the proxy is configured to translate any request to a
    'coaps' secured request. The HC proxy is furthermore configured to
    only pass through GET requests in order to protect the constrained
    network. In this way even unattended HTTP clients, such as web
    crawlers, may index sensor data as regular web pages.

5. URI Mapping

   Though, in principle, a CoAP URI could be directly used by a HTTP
   user agent to de-reference a CoAP resource through an HC proxy, the
   reality is that all major web browsers, networking libraries and
   command line tools do not allow making HTTP requests using URIs with
   a scheme "coap" or "coaps".

   Thus, there is a need for web applications to "pack" a CoAP URI into
   a HTTP URI so that it can be (non-destructively) transported from the
   user agent to the HC proxy. The HC proxy can then "unpack" the CoAP
   URI and finally de-reference it via a CoAP request to the target
   Server.

   URI Mapping is the process through which the URI of a CoAP resource
   is transformed into an HTTP URI so that:

   o the requesting HTTP user agent can handle it;

   o the receiving HC proxy can extract the intended CoAP URI
      unambiguously.

   To this end, the remainder of this section will identify:

   o the default mechanism to map a CoAP URI into a HTTP URI;

   o the URI template format to express a class of CoAP-HTTP URI
      mapping functions;

   o the discovery mechanism based on CoRE Link Format [RFC6690]
      through which clients of an HC proxy can dynamically discover
      information about the supported URI Mapping Template(s), as well
      as the base URI where the HC proxy function is anchored.

5.1. URI Terminology

   In the remainder of this section, the following terms will be used
   with a distinctive meaning:

   Target CoAP URI:
          URI which refers to the (final) CoAP resource that has to be
          de-referenced. It conforms to syntax defined in Section 6 of
          [RFC7252]. Specifically, its scheme is either "coap" or
          "coaps".

   Hosting HTTP URI:
          URI that conforms to syntax in Section 2.7 of [RFC7230]. Its
          authority component refers to an HC proxy, whereas path (and
          query) component(s) embed the information used by an HC proxy
          to extract the Target CoAP URI.

5.2. Default Mapping

   The default mapping is for the Target CoAP URI to be appended as-is
   to a base URI provided by the HC proxy, to form the Hosting HTTP URI.

   For example: given a base URI http://p.example.com/hc and a Target
   CoAP URI coap://s.example.com/light, the resulting Hosting HTTP URI
   would be http://p.example.com/hc/coap://s.example.com/light.

   Provided a correct Target CoAP URI, the Hosting HTTP URI resulting
   from the default mapping is always syntactically correct.
   Furthermore, the Target CoAP URI can always be extracted
   unambiguously from the Hosting HTTP URI. Also, it is worth noting
   that, using the default mapping, a query component in the target CoAP
   resource URI is naturally encoded into the query component of the
   Hosting URI, e.g.: coap://s.example.com/light?dim=5 becomes
   http://p.example.com/hc/coap://s.example.com/light?dim=5.

   There is no default for the base URI. Therefore, it is either known
   in advance, e.g. as a configuration preset, or dynamically discovered
   using the mechanism described in Section 5.4.

   The default URI mapping function is RECOMMENDED to be implemented and
   activated by default in an HC proxy, unless there are valid reasons,
   e.g. application specific, to use a different mapping function.

5.2.1. Optional Scheme Omission

   When found in a Hosting HTTP URI, the scheme (i.e., "coap" or
   "coaps"), the scheme component delimiter (":"), and the double slash

("//") preceding the authority MAY be omitted. In such case, a local default - not defined by this document - applies.

So, http://p.example.com/hc/s.coap.example.com/foo could either represent the target coap://s.coap.example.com/foo or coaps://s.coap.example.com/foo depending on application specific presets.

5.2.2. Encoding Caveats

When the authority of the Target CoAP URI is given as an IPv6address, then the surrounding square brackets MUST be percent-encoded in the Hosting HTTP URI, in order to comply with the syntax defined in Section 3.3. of [RFC3986] for a URI path segment. E.g.: coap://[2001:db8::1]/light?on becomes http://p.example.com/hc/coap://%5B2001:db8::1%5D/light?on.

Everything else can be safely copied verbatim from the Target CoAP URI to the Hosting HTTP URI.

5.3. URI Mapping Template

This section defines a format for the URI template [RFC6570] used by an HC proxy to inform its clients about the expected syntax for the Hosting HTTP URI.

When instantiated, an URI Mapping Template is always concatenated to a base URI provided by the HC proxy via discovery (see Section 5.4), or by other means.

A simple form (Section 5.3.1) and an enhanced form (Section 5.3.2) are provided to fit different users' requirements.

Both forms are expressed as level 2 URI templates [RFC6570] to take care of the expansion of values that are allowed to include reserved URI characters. The syntax of all URI formats is specified in this section in Augmented Backus-Naur Form (ABNF) [RFC5234].

5.3.1. Simple Form

The simple form MUST be used for mappings where the Target CoAP URI is going to be copied (using rules of Section 5.2.2) at some fixed position into the Hosting HTTP URI.

The following template variables MUST be used in mutual exclusion in a template definition:

```
   cu = coap-URI   ; from [RFC7252], Section 6.1
   su = coaps-URI  ; from [RFC7252], Section 6.2
   tu = cu / su
```

The same considerations as in Section 5.2.1 apply, in that the CoAP
scheme may be omitted from the Hosting HTTP URI.

5.3.1.1. Examples

All the following examples (given as a specific URI mapping template,
a Target CoAP URI, and the produced Hosting HTTP URI) use
http://p.example.com/hc as the base URI. Note that these examples
all define mapping templates that deviate from the default template
of Section 5.2 to be able to illustrate the use of the above template
variables.

1. "coap" URI is a query argument of the Hosting HTTP URI:

?coap_target_uri={+cu}

coap://s.example.com/light

http://p.example.com/hc?coap_target_uri=coap://s.example.com/light

2. "coaps" URI is a query argument of the Hosting HTTP URI:

?coaps_target_uri={+su}

coaps://s.example.com/light

http://p.example.com/hc?coaps_target_uri=coaps://s.example.com/light

3. Target CoAP URI as a query argument of the Hosting HTTP URI:

```
?target_uri={+tu}
```

```
coap://s.example.com/light
```

```
http://p.example.com/hc?target_uri=coap://s.example.com/light
```

or

```
coaps://s.example.com/light
```

```
http://p.example.com/hc?target_uri=coaps://s.example.com/light
```

4. Target CoAP URI in the path component of the Hosting HTTP URI
    (i.e., the default URI Mapping template):

```
/{+tu}
```

```
coap://s.example.com/light
```

```
http://p.example.com/hc/coap://s.example.com/light
```

or

```
coaps://s.example.com/light
```

```
http://p.example.com/hc/coaps://s.example.com/light
```

5. "coap" URI is a query argument of the Hosting HTTP URI; client
    decides to omit scheme because a default scheme is agreed
    beforehand between client and proxy:

```
?coap_uri={+cu}
```

```
coap://s.example.com/light
```

```
http://p.example.com/hc?coap_uri=s.example.com/light
```

5.3.2. Enhanced Form

   The enhanced form can be used to express more sophisticated mappings,
   i.e., those that do not fit into the simple form.

There MUST be at most one instance of each of the following template
variables in a template definition:


```
s  = "coap" / "coaps" ; from [RFC7252], Sections 6.1 and 6.2
hp = host [":" port]  ; from [RFC3986] Sections 3.2.2 and 3.2.3
p  = path-abempty     ; from [RFC3986] Section 3.3
q  = query            ; from [RFC3986] Section 3.4
qq = [ "?" query ]    ; qq is empty iff 'query' is empty
```


5.3.2.1. Examples

All the following examples (given as a specific URI mapping template,
a Target CoAP URI, and the produced Hosting HTTP URI) use
http://p.example.com/hc as the base URI.

1. Target CoAP URI components in path segments, and optional query
    in query component:

    {+s}{+hp}{+p}{+qq}

    coap://s.example.com/light

    http://p.example.com/hc/coap/s.example.com/light

    or

    coap://s.example.com/light?on

    http://p.example.com/hc/coap/s.example.com/light?on

2. Target CoAP URI components split in individual query arguments:

```
?s={+s}&hp={+hp}&p={+p}&q={+q}

coap://s.example.com/light

http://p.example.com/hc?s=coap&hp=s.example.com&p=/light&q=

or

coaps://s.example.com/light?on

http://p.example.com/hc?s=coaps&hp=s.example.com&p=/light&q=on
```

5.4. Discovery

In order to accommodate site specific needs while allowing third
parties to discover the proxy function, the HC proxy SHOULD publish
information related to the location and syntax of the HC proxy
function using the CoRE Link Format [RFC6690] interface.

To this aim a new Resource Type, "core.hc", is defined in this
document. It is associated with a base URI, and can be used as the
value for the "rt" attribute in a query to the /.well-known/core in
order to locate the base URI where the HC proxy function is anchored.

Along with it, the new target attribute "hct" is defined in this
document. This attribute MAY be returned in a "core.hc" link to
provide the URI Mapping Template associated to the mapping resource.
The default template given in Section 5.2, i.e., {+tu}, MUST be
assumed if no "hct" attribute is found in the returned link. If a
"hct" attribute is present in the returned link, then a compliant
client MUST use it to create the Hosting HTTP URI.

Discovery as specified in [RFC6690] SHOULD be available on both the
HTTP and the CoAP side of the HC proxy, with one important
difference: on the CoAP side the link associated to the "core.hc"
resource needs an explicit anchor referring to the HTTP origin, while
on the HTTP interface the link context is already the HTTP origin
carried in the request's Host header, and doesn't have to be made
explicit.

5.4.1. Discovering CoAP Resources

For a HTTP client, it may be unknown which CoAP resources are
available through a HC Proxy. By default an HC Proxy does not
support a method to discover all CoAP resources. However, if an HC
Proxy is integrated with a Resource Directory
([I-D.ietf-core-resource-directory]) function, an HTTP client can

discover all CoAP resources of its interest by doing an RD Lookup to the HC Proxy, via HTTP. This is possible because a single RD can support both CoAP and HTTP interfaces simultaneously. Of course the HTTP client will this way only discover resources that have been previously registered onto this RD by CoAP devices.

5.4.2. Examples

   o The first example exercises the CoAP interface, and assumes that
      the default template, {+tu}, is used:

       Req: GET coap://[ff02::1]/.well-known/core?rt=core.hc

       Res: 2.05 Content
             </hc>;anchor="http://p.example.com";rt="core.hc"

   o The second example - also on the CoAP side of the HC proxy - uses
      a custom template, i.e., one where the CoAP URI is carried inside
      the query component, thus the returned link carries the URI
      template to be used in an explicit "hct" attribute:

       Req: GET coap://[ff02::1]/.well-known/core?rt=core.hc

       Res: 2.05 Content
             </hc>;anchor="http://p.example.com";
             rt="core.hc";hct="?uri={+tu}"

   On the HTTP side, link information can be serialized in more than one
   way:

   o using the 'application/link-format' content type:

       Req: GET /.well-known/core?rt=core.hc HTTP/1.1
             Host: p.example.com

       Res: HTTP/1.1 200 OK
             Content-Type: application/link-format
             Content-Length: 18

             </hc>;rt="core.hc"

o using the 'application/link-format+json' content type as defined
   in [I-D.bormann-core-links-json]:

   Req: GET /.well-known/core?rt=core.hc HTTP/1.1
         Host: p.example.com

   Res: HTTP/1.1 200 OK
         Content-Type: application/link-format+json
         Content-Length: 31

         [{"href":"/hc","rt":"core.hc"}]

o using the Link header:

   Req: GET /.well-known/core?rt=core.hc HTTP/1.1
         Host: p.example.com

   Res: HTTP/1.1 200 OK
         Link: </hc>;rt="core.hc"

o An HC proxy may expose two different base URIs to differentiate
   between Target CoAP resources in the "coap" and "coaps" scheme:

   Req: GET /.well-known/core?rt=core.hc
         Host: p.example.com

   Res: HTTP/1.1 200 OK
         Content-Type: application/link-format+json
         Content-Length: 111

         [
           {"href":"/hc/plaintext","rt":"core.hc","hct":"{+cu}"},
           {"href":"/hc/secure","rt":"core.hc","hct":"{+su}"}
         ]

6. Media Type Mapping

6.1. Overview

   An HC proxy needs to translate HTTP media types (Section 3.1.1.1 of
   [RFC7231]) and content encodings (Section 3.1.2.2 of [RFC7231]) into
   CoAP content formats (Section 12.3 of [RFC7252]) and vice versa.

Media type translation can happen in GET, PUT or POST requests going
from HTTP to CoAP, and in 2.xx (i.e., successful) responses going
from CoAP to HTTP. Specifically, PUT and POST need to map both the
Content-Type and Content-Encoding HTTP headers into a single CoAP
Content-Format option, whereas GET needs to map Accept and Accept-
Encoding HTTP headers into a single CoAP Accept option. To generate
the HTTP response, the CoAP Content-Format option is mapped back to a
suitable HTTP Content-Type and Content-Encoding combination.

An HTTP request carrying a Content-Type and Content-Encoding
combination which the HC proxy is unable to map to an equivalent CoAP
Content-Format, SHALL elicit a 415 (Unsupported Media Type) response
by the HC proxy.

On the content negotiation side, failure to map Accept and Accept-*
headers SHOULD be silently ignored: the HC proxy SHOULD therefore
forward as a CoAP request with no Accept option. The HC proxy thus
disregards the Accept/Accept-* header fields by treating the response
as if it is not subject to content negotiation, as mentioned in
Sections 5.3.* of [RFC7231]. However, an HC proxy implementation is
free to attempt mapping a single Accept header in a GET request to
multiple CoAP GET requests, each with a single Accept option, which
are then tried in sequence until one succeeds. Note that an HTTP
Accept */* MUST be mapped to a CoAP request without Accept option.

While the CoAP to HTTP direction has always a well defined mapping
(with the exception examined in Section 6.2), the HTTP to CoAP
direction is more problematic because the source set, i.e.,
potentially 1000+ IANA registered media types, is much bigger than
the destination set, i.e., the mere 6 values initially defined in
Section 12.3 of [RFC7252].

Depending on the tight/loose coupling with the application(s) for
which it proxies, the HC proxy could implement different media type
mappings.

When tightly coupled, the HC proxy knows exactly which content
formats are supported by the applications, and can be strict when
enforcing its forwarding policies in general, and the media type
mapping in particular.

On the other side, when the HC proxy is a general purpose application
layer gateway, being too strict could significantly reduce the amount
of traffic that it'd be able to successfully forward. In this case,
the "loose" media type mapping detailed in Section 6.3 MAY be
implemented.

The latter grants more evolution of the surrounding ecosystem, at the
cost of allowing more attack surface. In fact, as a result of such
strategy, payloads would be forwarded more liberally across the
unconstrained/constrained network boundary of the communication path.
Therefore, when applied, other forms of access control must be set in
place to avoid unauthorized users to deplete or abuse systems and
network resources.

6.2. 'application/coap-payload' Media Type

If the HC proxy receives a CoAP response with a Content-Format that
it does not recognize (e.g. because the value has been registered
after the proxy has been deployed, or the CoAP server uses an
experimental value which is not registered), then the HC proxy SHALL
return a generic "application/coap-payload" media type with numeric
parameter "cf" as defined in Section 9.2.

For example, the CoAP content format '60' ("application/cbor") would
be represented by "application/coap-payload;cf=60", would '60' be an
unknown content format to the HC Proxy.

A HTTP client MAY use the media type "application/coap-payload" as a
means to send a specific content format to a CoAP server via an HC
Proxy if the client has determined that the HC Proxy does not
directly support the type mapping it needs. This case may happen
when dealing for example with newly registered, yet to be registered,
or experimental CoAP content formats.

6.3. Loose Media Type Mapping

By structuring the type information in a super-class (e.g. "text")
followed by a finer grained sub-class (e.g. "html"), and optional
parameters (e.g. "charset=utf-8"), Internet media types provide a
rich and scalable framework for encoding the type of any given
entity.

This approach is not applicable to CoAP, where Content Formats
conflate an Internet media type (potentially with specific
parameters) and a content encoding into one small integer value.

To remedy this loss of flexibility, we introduce the concept of a
"loose" media type mapping, where media types that are
specializations of a more generic media type can be aliased to their
super-class and then mapped (if possible) to one of the CoAP content
formats. For example, "application/soap+xml" can be aliased to
"application/xml", which has a known conversion to CoAP. In the
context of this "loose" media type mapping, "application/octet-

stream" can be used as a fallback when no better alias is found for a
specific media type.

Table 1 defines the default lookup table for the "loose" media type
mapping. Given an input media type, the table returns its best
generalized media type using the most specific match i.e. the table
entries are compared to the input in top to bottom order until an
entry matches.

```
+--------------------+------------------------+
| Internet media type | Generalized media type |
+--------------------+------------------------+
| application/*+xml   | application/xml        |
| application/*+json  | application/json       |
| text/xml            | application/xml        |
| text/*              | text/plain             |
| */*                 | application/octet-stream |
+--------------------+------------------------+
```

        Table 1: Media type generalization lookup table

The "loose" media type mapping is an OPTIONAL feature.
Implementations supporting this kind of mapping SHOULD provide a
flexible way to define the set of media type generalizations allowed.

6.4. Media Type to Content Format Mapping Algorithm

This section defines the algorithm used to map an HTTP Internet media
type to its correspondent CoAP content format.

The algorithm uses the mapping table defined in Section 12.3 of
[RFC7252] plus, possibly, any locally defined extension of it.
Optionally, the table and lookup mechanism described in Section 6.3
can be used if the implementation chooses so.

Note that the algorithm may have side effects on the associated
representation (see also Section 6.5).

In the following:

o C-T, C-E, and C-F stand for the values of the Content-Type (or
   Accept) HTTP header, Content-Encoding (or Accept-Encoding) HTTP
   header, and Content-Format CoAP option respectively.

o If C-E is not given it is assumed to be "identity".

o MAP is the mandatory lookup table, GMAP is the optional
   generalized table.

```
      INPUT:  C-T and C-E
      OUTPUT: C-F or Fail

      1.  if no C-T: return Fail
      2.  C-F = MAP[C-T, C-E]
      3.  if C-F is not None: return C-F
      4.  if C-E is not "identity":
      5.    if C-E is supported (e.g. gzip):
      6.       decode the representation accordingly
      7.       set C-E to "identity"
      8.    else:
      9.       return Fail
      10. repeat steps 2. and 3.
      11. if C-T allows a non-lossy transformation into \
      12.    one of the supported C-F:
      13.       transcode the representation accordingly
      14.       return C-F
      15. if GMAP is defined:
      16.    C-F = GMAP[C-T]
      17.    if C-F is not None: return C-F
      18. return Fail
```

                                Figure 2

6.5. Content Transcoding

6.5.1. General

   Payload content transcoding (e.g. see steps 11-14 of Figure 2) is an
   OPTIONAL feature. Implementations supporting this feature should
   provide a flexible way to define the set of transcodings allowed.

   As noted in Section 6.4, the process of mapping the media type can
   have side effects on the forwarded entity body. This may be caused
   by the removal or addition of a specific content encoding, or because
   the HC proxy decides to transcode the representation to a different
   (compatible) format. The latter proves useful when an optimized
   version of a specific format exists. For example an XML-encoded
   resource could be transcoded to Efficient XML Interchange (EXI)
   format, or a JSON-encoded resource into CBOR [RFC7049], effectively
   achieving compression without losing any information.

   However, it should be noted that in certain cases, transcoding can
   lose information in a non-obvious manner. For example, encoding an
   XML document using schema-informed EXI encoding leads to a loss of
   information when the destination does not know the exact schema
   version used by the encoder, which means that whenever the HC proxy
   transcodes an application/XML to application/EXI in-band metadata

could be lost. Therefore, the implementer should always carefully
verify such lossy payload transformations before triggering the
transcoding.

6.5.2. CoRE Link Format

The CoRE Link Format [RFC6690] is a set of links (i.e., URIs and
their formal relationships) which is carried as content payload in a
CoAP response. These links usually include CoAP URIs that might be
translated by the HC proxy to the correspondent HTTP URIs using the
implemented URI mapping function (see Section 5). Such a process
would inspect the forwarded traffic and attempt to re-write the body
of resources with an application/link-format media type, mapping the
embedded CoAP URIs to their HTTP counterparts. Some potential issues
with this approach are:

1. The client may be interested to retrieve original (unaltered)
    CoAP payloads through the HC proxy, not modified versions.

2. Tampering with payloads is incompatible with resources that are
    integrity protected (although this is a problem with transcoding
    in general).

3. The HC proxy needs to fully understand [RFC6690] syntax and
    semantics, otherwise there is an inherent risk to corrupt the
    payloads.

Therefore, CoRE Link Format payload should only be transcoded at the
risk and discretion of the proxy implementer.

6.5.3. Diagnostic Messages

CoAP responses may, in certain error cases, contain a diagnostic
message in the payload explaining the error situation, as described
in Section 5.5.2 of [RFC7252]. In this scenario, the CoAP response
diagnostic payload MUST NOT be returned as the regular HTTP payload
(message body). Instead, the CoAP diagnostic payload must be used as
the HTTP reason-phrase of the HTTP status line, as defined in
Section 3.1.2 of [RFC7230], without any alterations, except those
needed to comply to the reason-phrase ABNF definition.

7. Response Code Mapping

Table 2 defines the HTTP response status codes to which each CoAP
response code SHOULD be mapped. This table complies with the
requirements in Section 10.2 of [RFC7252] and is intended to cover
all possible cases. Multiple appearances of a HTTP status code in
the second column indicates multiple equivalent HTTP responses are

possible based on the same CoAP response code, depending on the
conditions cited in the Notes (third column and text below table).

```
+----------------------------+----------------------------+-------+
| CoAP Response Code         | HTTP Status Code           | Notes |
+----------------------------+----------------------------+-------+
| 2.01 Created               | 201 Created                | 1     |
| 2.02 Deleted               | 200 OK                     | 2     |
|                            | 204 No Content             | 2     |
| 2.03 Valid                 | 304 Not Modified           | 3     |
|                            | 200 OK                     | 4     |
| 2.04 Changed               | 200 OK                     | 2     |
|                            | 204 No Content             | 2     |
| 2.05 Content               | 200 OK                     |       |
| 4.00 Bad Request           | 400 Bad Request            |       |
| 4.01 Unauthorized          | 401 Unauthorized           | 5     |
| 4.02 Bad Option            | 400 Bad Request            | 6     |
| 4.03 Forbidden             | 403 Forbidden              |       |
| 4.04 Not Found             | 404 Not Found              |       |
| 4.05 Method Not Allowed    | 400 Bad Request            | 7     |
| 4.06 Not Acceptable        | 406 Not Acceptable         |       |
| 4.12 Precondition Failed   | 412 Precondition Failed    |       |
| 4.13 Request Ent. Too Large| 413 Request Repr. Too Large|       |
| 4.15 Unsupported Media Type| 415 Unsupported Media Type |       |
| 5.00 Internal Server Error | 500 Internal Server Error  |       |
| 5.01 Not Implemented       | 501 Not Implemented        |       |
| 5.02 Bad Gateway           | 502 Bad Gateway            |       |
| 5.03 Service Unavailable   | 503 Service Unavailable    | 8     |
| 5.04 Gateway Timeout       | 504 Gateway Timeout        |       |
| 5.05 Proxying Not Supported| 502 Bad Gateway            | 9     |
+----------------------------+----------------------------+-------+
```

Table 2: CoAP-HTTP Response Code Mappings

Notes:

1. A CoAP server may return an arbitrary format payload along with
   this response. This payload SHOULD be returned as entity in the
   HTTP 201 response. Section 7.3.2 of [RFC7231] does not put any
   requirement on the format of the entity. (In the past, [RFC2616]
   did.)

2. The HTTP code is 200 or 204 respectively for the case that a CoAP
   server returns a payload or not. [RFC7231] Section 5.3 requires
   code 200 in case a representation of the action result is
   returned for DELETE/POST/PUT, and code 204 if not. Hence, a
   proxy SHOULD transfer any CoAP payload contained in a CoAP 2.02
   response to the HTTP client using a 200 OK response.

3. HTTP code 304 (Not Modified) is sent if the HTTP client performed
    a conditional HTTP request and the CoAP server responded with
    2.03 (Valid) to the corresponding CoAP validation request. Note
    that Section 4.1 of [RFC7232] puts some requirements on header
    fields that must be present in the HTTP 304 response.

4. A 200 response to a CoAP 2.03 occurs only when the HC proxy, for
    efficiency reasons, is caching resources and translated a HTTP
    request (without conditional request) to a CoAP request that
    includes ETag validation. The proxy receiving 2.03 updates the
    freshness of its cached representation and returns the entire
    representation to the HTTP client.

5. A HTTP 401 Unauthorized (Section 3.1 of [RFC7235]) response MUST
    include a WWW-Authenticate header. Since there is no CoAP
    equivalent of WWW-Authenticate, the HC proxy must generate this
    header itself including at least one challenge (Section 4.1 of
    [RFC7235]). If the HC proxy does not implement a proper
    authentication method that can be used to gain access to the
    target CoAP resource, it can include a 'dummy' challenge for
    example "WWW-Authenticate: None".

6. A proxy receiving 4.02 may first retry the request with less CoAP
    Options in the hope that the CoAP server will understand the
    newly formulated request. For example, if the proxy tried using
    a Block Option [I-D.ietf-core-block] which was not recognized by
    the CoAP server it may retry without that Block Option. Note
    that HTTP 402 MUST NOT be returned because it is reserved for
    future use [RFC7231].

7. A CoAP 4.05 (Method Not Allowed) response SHOULD normally be
    mapped to a HTTP 400 (Method Not Allowed) code, because the HTTP
    405 response would require specifying the supported methods -
    which are generally unknown. In this case the HC Proxy SHOULD
    also return a HTTP reason-phrase in the HTTP status line that
    starts with the string "405" in order to facilitate
    troubleshooting. However, if the HC proxy has more granular
    information about the supported methods for the requested
    resource (e.g. via a Resource Directory
    ([I-D.ietf-core-resource-directory])) then it MAY send back a
    HTTP 405 (Method Not Allowed) with a properly filled in "Allow"
    response-header field (Section 7.4.1 of [RFC7231]).

8. The value of the HTTP "Retry-After" response-header field is
    taken from the value of the CoAP Max-Age Option, if present.

   9. This CoAP response can only happen if the proxy itself is
       configured to use a CoAP forward-proxy (Section 5.7 of [RFC7252])
       to execute some, or all, of its CoAP requests.

8. Additional Mapping Guidelines

8.1. Caching and Congestion Control

   An HC proxy SHOULD limit the number of requests to CoAP servers by
   responding, where applicable, with a cached representation of the
   resource.

   Duplicate idempotent pending requests by an HC proxy to the same CoAP
   resource SHOULD in general be avoided, by using the same response for
   multiple requesting HTTP clients without duplicating the CoAP
   request.

   If the HTTP client times out and drops the HTTP session to the HC
   proxy (closing the TCP connection) after the HTTP request was made,
   an HC proxy SHOULD wait for the associated CoAP response and cache it
   if possible. Subsequent requests to the HC proxy for the same
   resource can use the result present in cache, or, if a response has
   still to come, the HTTP requests will wait on the open CoAP request.

   According to [RFC7252], a proxy MUST limit the number of outstanding
   interactions to a given CoAP server to NSTART. To limit the amount
   of aggregate traffic to a constrained network, the HC proxy SHOULD
   also pose a limit to the number of concurrent CoAP requests pending
   on the same constrained network; further incoming requests MAY either
   be queued or dropped (returning 503 Service Unavailable). This limit
   and the proxy queueing/dropping behavior SHOULD be configurable. In
   order to effectively apply above congestion control, the HC proxy
   should be server-side placed.

   Resources experiencing a high access rate coupled with high
   volatility MAY be observed [I-D.ietf-core-observe] by the HC proxy to
   keep their cached representation fresh while minimizing the number of
   CoAP traffic in the constrained network. See Section 8.2.

8.2. Cache Refresh via Observe

   There are cases where using the CoAP observe protocol
   [I-D.ietf-core-observe] to handle proxy cache refresh is preferable
   to the validation mechanism based on ETag as defined in [RFC7252].
   Such scenarios include, but are not limited to, sleepy CoAP nodes --
   with possibly high variance in requests' distribution -- which would
   greatly benefit from a server driven cache update mechanism. Ideal
   candidates for CoAP observe are also crowded or very low throughput

networks, where reduction of the total number of exchanged messages
is an important requirement.

This subsection aims at providing a practical evaluation method to
decide whether refreshing a cached resource R is more efficiently
handled via ETag validation or by establishing an observation on R.

Let T_R be the mean time between two client requests to resource R,
let T_C be the mean time between two representation changes of R, and
let M_R be the mean number of CoAP messages per second exchanged to
and from resource R. If we assume that the initial cost for
establishing the observation is negligible, an observation on R
reduces M_R iff $T_R < 2*T_C$ with respect to using ETag validation,
that is iff the mean arrival rate of requests for resource R is
greater than half the change rate of R.

When observing the resource R, M_R is always upper bounded by $2/T_C$.

8.3. Use of CoAP Blockwise Transfer

An HC proxy SHOULD support CoAP blockwise transfers
[I-D.ietf-core-block] to allow transport of large CoAP payloads while
avoiding excessive link-layer fragmentation in constrained networks,
and to cope with small datagram buffers in CoAP end-points as
described in [RFC7252] Section 4.6.

An HC proxy SHOULD attempt to retry a payload-carrying CoAP PUT or
POST request with blockwise transfer if the destination CoAP server
responded with 4.13 (Request Entity Too Large) to the original
request. An HC proxy SHOULD attempt to use blockwise transfer when
sending a CoAP PUT or POST request message that is larger than
BLOCKWISE_THRESHOLD bytes. The value of BLOCKWISE_THRESHOLD is
implementation-specific, for example it can be:

o calculated based on a known or typical UDP datagram buffer size
   for CoAP end-points, or

o set to N times the known size of a link-layer frame in a
   constrained network where e.g. N=5, or

o preset to a known IP MTU value, or

o set to a known Path MTU value.

The value BLOCKWISE_THRESHOLD, or the parameters from which it is
calculated, should be configurable in a proxy implementation. The
maximum block size the proxy will attempt to use in CoAP requests
should also be configurable.

The HC proxy SHOULD detect CoAP end-points not supporting blockwise
transfers by checking for a 4.02 (Bad Option) response returned by an
end-point in response to a CoAP request with a Block* Option, and
subsequent absence of the 4.02 in response to the same request
without Block* Options. This allows the HC proxy to be more
efficient, not attempting repeated blockwise transfers to CoAP
servers that do not support it. However, if a request payload is too
large to be sent as a single CoAP request and blockwise transfer
would be unavoidable, the proxy still SHOULD attempt blockwise
transfer on such an end-point before returning the response 413
(Request Entity Too Large) to the HTTP client.

For improved latency an HC proxy MAY initiate a blockwise CoAP
request triggered by an incoming HTTP request even when the HTTP
request message has not yet been fully received, but enough data has
been received to send one or more data blocks to a CoAP server
already. This is particularly useful on slow client-to-proxy
connections.

8.4. Security Translation

For the guidelines on security context translations for an HC proxy,
see Section 10.2. A translation may involve e.g. applying a rule
that any "https" request is translated to a "coaps" request, or e.g.
applying a rule that a "https" request is translated to an unsecured
"coap" request.

8.5. CoAP Multicast

An HC proxy MAY support CoAP multicast. If it does, the HC proxy
sends out a multicast CoAP request if the Target CoAP URI's authority
is a multicast IP literal or resolves to a multicast IP address;
assuming the proper security measures are in place to mitigate
security risks of CoAP multicast (Section 10). If the security
policies do not allow the specific CoAP multicast request to be made,
the HC proxy SHOULD respond 403 (Forbidden).

If an HC proxy does not support CoAP multicast, it SHOULD respond 403
(Forbidden) to any valid HTTP request that maps to a CoAP multicast
request.

Details related to supporting CoAP multicast are currently out of
scope of this document since in a reverse proxy scenario a HTTP
client typically expects to receive a single response, not multiple.
However, an HC proxy that implements CoAP multicast MAY include
application-specific functions to aggregate multiple CoAP responses
into a single HTTP response. We suggest using the "application/http"
internet media type (Section 8.3.2 of [RFC7230]) to enclose a set of

one or more HTTP response messages, each representing the mapping of
one CoAP response.

8.6. Timeouts

When facing long delays of a CoAP server in responding, the HTTP
client or any other proxy in between MAY timeout. Further discussion
of timeouts in HTTP is available in Section 6.2.4 of [RFC7230].

An HC proxy MUST define an internal timeout for each pending CoAP
request, because the CoAP server may silently die before completing
the request. Assuming the Proxy may use confirmable CoAP requests,
such timeout value T SHOULD be at least

   T = MAX_RTT + MAX_SERVER_RESPONSE_DELAY

where MAX_RTT is defined in [RFC7252] and MAX_SERVER_RESPONSE_DELAY
is defined in [RFC7390]. An exception to this rule occurs when the
HC proxy is configured with a HTTP response timeout value that is
lower than above value T; then the lower value should be also used as
the CoAP request timeout.

8.7. Miscellaneous

In certain use cases, constrained CoAP nodes do not make use of the
DNS protocol. However even when the DNS protocol is not used in a
constrained network, defining valid FQDN (i.e., DNS entries) for
constrained CoAP servers, where possible, may help HTTP clients to
access the resources offered by these servers via an HC proxy.

HTTP connection pipelining (section 6.3.2 of [RFC7230]) may be
supported by an HC proxy. This is transparent to the CoAP servers:
the HC proxy will serve the pipelined requests by issuing different
CoAP requests. The HC proxy in this case needs to respect the NSTART
limit of Section 4.7 of [RFC7252].

9. IANA Considerations

9.1. New 'core.hc' Resource Type

This document registers a new Resource Type (rt=) Link Target
Attribute, 'core.hc', in the "Resource Type (rt=) Link Target
Attribute Values" subregistry under the "Constrained RESTful
Environments (CoRE) Parameters" registry.

Attribute Value: core.hc

Description: HTTP to CoAP mapping base resource.

Reference: See Section 5.4.

9.2. New 'coap-payload' Internet Media Type

This document defines the "application/coap-payload" media type with
a single parameter "cf". This media type represents any payload that
a CoAP message can carry, having a content format that can be
identified by a CoAP Content-Format parameter (an integer in range
0-65535). The parameter "f" is the integer defining the CoAP content
format.

Type name: application

Subtype name: coap-payload

Required parameters:

cf - CoAP Content-Format integer in range 0-65535 denoting the
content format of the CoAP payload carried.

Optional parameters: None

Encoding considerations:

The specific CoAP content format encoding considerations for the
selected Content-Format (cf parameter) apply.

Security considerations:

The specific CoAP content format security considerations for the
selected Content-Format (cf parameter) apply.

Interoperability considerations:

Published specification: (this I-D - TBD)

Applications that use this media type:

HTTP-to-CoAP Proxies.

Fragment identifier considerations: N/A

Additional information:

    Deprecated alias names for this type: N/A

    Magic number(s): N/A

File extension(s): N/A

Macintosh file type code(s): N/A

Person and email address to contact for further information:

Esko Dijk ("esko@ieee.org")

Intended usage: COMMON

Restrictions on usage:

An application (or user) can only use this media type if it has to
represent a CoAP payload of which the specified CoAP Content-Format
is an unrecognized number; such that a proper translation directly to
the equivalent HTTP media type is not possible.

Author: CoRE WG

Change controller: IETF

Provisional registration? (standards tree only): N/A

10. Security Considerations

The security concerns raised in Section 9.2 of [RFC7230] also apply
to the HC proxy scenario. In fact, the HC proxy is a trusted (not
rarely a transparently trusted) component in the network path.

The trustworthiness assumption on the HC proxy cannot be dropped,
because the protocol translation function is the core duty of the HC
proxy: it is a necessarily trusted, impossible to bypass, component
in the communication path.

A reverse proxy deployed at the boundary of a constrained network is
an easy single point of failure for reducing availability. As such,
special care should be taken in designing, developing and operating
it, keeping in mind that, in most cases, it has fewer limitations
than the constrained devices it is serving.

The following sub paragraphs categorize and discuss a set of specific
security issues related to the translation, caching and forwarding
functionality exposed by an HC proxy.

10.1. Traffic Overflow

   Due to the typically constrained nature of CoAP nodes, particular
   attention SHOULD be given to the implementation of traffic reduction
   mechanisms (see Section 8.1), because inefficient proxy
   implementations can be targeted by unconstrained Internet attackers.
   Bandwidth or complexity involved in such attacks is very low.

   An amplification attack to the constrained network may be triggered
   by a multicast request generated by a single HTTP request which is
   mapped to a CoAP multicast resource, as considered in Section 11.3 of
   [RFC7252].

   The risk likelihood of this amplification technique is higher than an
   amplification attack carried out by a malicious constrained device
   (e.g. ICMPv6 flooding, like Packet Too Big, or Parameter Problem on
   a multicast destination [RFC4732]), since it does not require direct
   access to the constrained network.

   The feasibility of this attack, disruptive in terms of CoAP server
   availability, can be limited by access controlling the exposed HTTP
   multicast resources, so that only known/authorized users access such
   URIs.

10.2. Handling Secured Exchanges

   An HTTP request can be sent to the HC proxy over a secured
   connection. However, there may not always exist a secure connection
   mapping to CoAP. For example, a secure distribution method for
   multicast traffic is complex and MAY not be implemented (see
   [RFC7390]).

   An HC proxy SHOULD implement explicit rules for security context
   translations. A translation may involve e.g. applying a rule that
   any "https" unicast request is translated to a "coaps" request, or
   e.g. applying a rule that a "https" request is translated to an
   unsecured "coap" request. Another rule could specify the security
   policy and parameters used for DTLS connections. Such rules will
   largely depend on the application and network context in which a
   proxy operates. These rules SHOULD be configurable in an HC proxy.

   If a policy for access to 'coaps' URIs is configurable in an HC
   proxy, it is RECOMMENDED that the policy is by default configured to
   disallow access to any 'coaps' URI by a HTTP client using an
   unsecured (non-TLS) connection. Naturally, a user MAY reconfigure
   the policy to allow such access in specific cases.

By default, an HC proxy SHOULD reject any secured client request if
there is no configured security policy mapping. This recommendation
MAY be relaxed in case the destination network is believed to be
secured by other, complementary, means. E.g.: assumed that CoAP
nodes are isolated behind a firewall (e.g. as in the SS HC proxy
deployment shown in Figure 1), the HC proxy may be configured to
translate the incoming HTTPS request using plain CoAP (NoSec mode).

The HTTP-CoAP URI mapping (defined in Section 5) MUST NOT map to HTTP
a CoAP resource intended to be only accessed securely.

A secured connection that is terminated at the HC proxy, i.e., the
proxy decrypts secured data locally, raises an ambiguity about the
cacheability of the requested resource. The HC proxy SHOULD NOT
cache any secured content to avoid any leak of secured information.
However, in some specific scenario, a security/efficiency trade-off
could motivate caching secured information; in that case the caching
behavior MAY be tuned to some extent on a per-resource basis.

10.3. Proxy and CoAP Server Resource Exhaustion

If the HC proxy implements the low-latency optimization of
Section 8.3 intended for slow client-to-proxy connections, the Proxy
may become vulnerable to a resource exhaustion attack. In this case
an attacking client could initiate multiple requests using a
relatively large message body which is (after an initial fast
transfer) transferred very slowly to the Proxy. This would trigger
the HC proxy to create state for a blockwise CoAP request per HTTP
request, waiting for the arrival of more data over the HTTP/TCP
connection. Such attacks can be mitigated in the usual ways for HTTP
servers using for example a connection time limit along with a limit
on the number of open TCP connections per IP address.

10.4. URI Mapping

The following risks related to the URI mapping described in Section 5
and its use by HC proxies have been identified:

DoS attack on the constrained/CoAP network.
   To mitigate, by default deny any Target CoAP URI whose authority
   is (or maps to) a multicast address. Then explicitly white-list
   multicast resources/authorities that are allowed to be de-
   referenced. See also Section 8.5.

Leaking information on the constrained/CoAP network resources and
topology.
   To mitigate, by default deny any Target CoAP URI (especially
   /.well-known/core is a resource to be protected), and then

explicit white-list resources that are allowed to be seen from
outside.

Reduced privacy due to the mechanics of the URI mapping.
    The internal CoAP Target resource is totally transparent from
    outside. An HC proxy can mitigate by implementing a HTTPS-only
    interface, making the Target CoAP URI totally opaque to a passive
    attacker.

11. Acknowledgements

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Appendix A. Change Log

   [Note to RFC Editor: Please remove this section before publication.]

   Changes from ietf-06 to ietf-07:

   o Addressed Ticket #384 - Section 5.4.1 describes briefly
      (informative) how to discover CoAP resources from an HTTP client.

   o Addressed Ticket #378 - For HTTP media type to CoAP content format
      mapping and vice versa: a new draft (TBD) may be proposed in CoRE
      which describes an approach for automatic updating of the media
      type mapping. This was noted in Section 6.1 but is otherwise
      outside the scope of this draft.

   o Addressed Ticket #377 - Added IANA section that defines a new HTTP
      media type "application/coap-payload" and created new Section 6.2
      on how to use it.

   o Addressed Ticket #376 - Updated Table 2 (and corresponding note 7)
      to indicate that a CoAP 4.05 (Method Not Allowed) Response Code
      should be mapped to a HTTP 400 (Bad Request).

   o Added note to comply to ABNF when translating CoAP diagnostic
      payload to reason-phrase in Section 6.5.3.

   Changes from ietf-05 to ietf-06:

   o Fully restructured the draft, bringing introductory text more to
      the front and allocating main sections to each of the key topics;
      addressing Ticket #379;

   o Addressed Ticket #382, fix of enhanced form URI template
      definition of q in Section 5.3.2;

   o Addressed Ticket #381, found a mapping 4.01 to 401 Unauthorized in
      Section 7;

   o Addressed Ticket #380 (Add IANA registration for "core.hc"
      Resource Type) in Section 9;

   o Addressed Ticket #376 (CoAP 4.05 response can't be translated to
      HTTP 405 by HC proxy) in Section 7 by use of empty 'Allow' header;

o Removed details on the pros and cons of HC proxy placement
   options;

o Addressed review comments of Carsten Bormann;

o Clarified failure in mapping of HTTP Accept headers (Section 6.3);

o Clarified detection of CoAP servers not supporting blockwise
   (Section 8.3);

o Changed CoAP request timeout min value to MAX_RTT +
   MAX_SERVER_RESPONSE_DELAY (Section 8.6);

o Added security section item (Section 10.3) related to use of CoAP
   blockwise transfers;

o Many editorial improvements.

Changes from ietf-04 to ietf-05:

o Addressed Ticket #366 (Mapping of CoRE Link Format payloads to be
   valid in HTTP Domain?) in Section 6.3.3.2 (Content Transcoding -
   CORE Link Format);

o Addressed Ticket #375 (Add requirement on mapping of CoAP
   diagnostic payload) in Section 6.3.3.3 (Content Transcoding -
   Diagnostic Messages);

o Addressed comment from Yusuke (http://www.ietf.org/mail-
   archive/web/core/current/msg05491.html) in Section 6.3.3.1
   (Content Transcoding - General);

o Various editorial improvements.

Changes from ietf-03 to ietf-04:

o Expanded use case descriptions in Section 4;

o Fixed/enhanced discovery examples in Section 5.4.1;

o Addressed Ticket #365 (Add text on media type conversion by HTTP-
   CoAP proxy) in new Section 6.3.1 (Generalized media type mapping)
   and new Section 6.3.2 (Content translation);

o Updated HTTPBis WG draft references to recently published RFC
   numbers.

o Various editorial improvements.

   Changes from ietf-02 to ietf-03:

   o Closed Ticket #351 "Add security implications of proposed default
      HTTP-CoAP URI mapping";

   o Closed Ticket #363 "Remove CoAP scheme in default HTTP-CoAP URI
      mapping";

   o Closed Ticket #364 "Add discovery of HTTP-CoAP mapping
      resource(s)".

   Changes from ietf-01 to ietf-02:

   o Selection of single default URI mapping proposal as proposed to WG
      mailing list 2013-10-09.

   Changes from ietf-00 to ietf-01:

   o Added URI mapping proposals to Section 4 as per the Email
      proposals to WG mailing list from Esko.

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