Constrained Application Protocol

(RFC 6690, RFC7252, draft-ietf-core-block-17, draft-ietf-core-observe-16)

The Constrained Application Protocol (CoAP) is a specialized web transfer protocol for use with constrained nodes and constrained (e.g., low-power, lossy) networks.

CoAP Message Format

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|Ver| T | TKL |     Code      |          Message ID           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Token (if any, TKL bytes) ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|   Options (if any) ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|1 1 1 1 1 1 1 1|    Payload (if any) ...
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Ver: Version, T: Type, TKL: Token Length

Message types

```
+------+----------------+
| Type | Name           |
+------+----------------+
|   0  | CONfirmable    |
|   1  | NON-confirmable|
|   2  | ACKnowledgement|
|   3  | ReSeT          |
+------+----------------+
```

Method codes

```
+------+--------+
| Code | Name   |
+------+--------+
| 0.01 | GET    |
| 0.02 | POST   |
| 0.03 | PUT    |
| 0.04 | DELETE |
+------+--------+
```

Response codes

```
 0
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|class|  detail |
+-+-+-+-+-+-+-+-+
```

```
+------+--------------+
|Class |              |
+------+--------------+
| 2.xx | Success      |
| 4.xx | Client Error |
| 5.xx | Server Error |
+------+--------------+
```

```
+------------+----------------------------+
| Code       | Description                |
+------------+----------------------------+
| 2.01 (65)  | Created                    |
| 2.02 (66)  | Deleted                    |
| 2.03 (67)  | Valid                      |
| 2.04 (68)  | Changed                    |
| 2.05 (69)  | Content                    |
| 4.00 (128) | Bad Request                |
| 4.01 (129) | Unauthorized               |
| 4.02 (130) | Bad Option                 |
| 4.03 (131) | Forbidden                  |
| 4.04 (132) | Not Found                  |
| 4.05 (133) | Method Not Allowed         |
| 4.06 (134) | Not Acceptable             |
| 4.12 (140) | Precondition Failed        |
| 4.13 (141) | Request Entity Too Large   |
| 4.15 (143) | Unsupported Content-Format |
| 5.00 (160) | Internal Server Error      |
| 5.01 (161) | Not Implemented            |
| 5.02 (162) | Bad Gateway                |
| 5.03 (163) | Service Unavailable        |
| 5.04 (164) | Gateway Timeout            |
| 5.05 (165) | Proxying Not Supported     |
+------------+----------------------------+
```

Options

```
+-----+---+---+---+---+----------------+--------+--------+------------+
| No. | C | U | N | R | Name           | Format | Length | Default    |
+-----+---+---+---+---+----------------+--------+--------+------------+
|   1 | x |   |   | x | If-Match       | opaque | 0-8    | (none)     |
|   3 | x | x | - |   | Uri-Host       | string | 1-255  | (see note 1)|
|   4 |   |   |   | x | ETag           | opaque | 1-8    | (none)     |
|   5 | x |   |   |   | If-None-Match  | empty  | 0      | (none)     |
|   7 | x | x | - |   | Uri-Port       | uint   | 0-2    | (see note 1)|
|   8 |   |   |   | x | Location-Path  | string | 0-255  | (none)     |
|  11 | x | x | - | x | Uri-Path       | string | 0-255  | (none)     |
|  12 |   |   |   |   | Content-Format | uint   | 0-2    | (none)     |
|  14 |   | x | - |   | Max-Age        | uint   | 0-4    | 60         |
|  15 | x | x | - | x | Uri-Query      | string | 0-255  | (none)     |
|  17 | x |   |   |   | Accept         | uint   | 0-2    | (none)     |
|  20 |   |   |   | x | Location-Query | string | 0-255  | (none)     |
|  35 | x | x | - |   | Proxy-Uri      | string | 1-1034 | (none)     |
|  39 | x | x | - |   | Proxy-Scheme   | string | 1-255  | (none)     |
|  60 |   |   | x |   | Size1          | uint   | 0-4    | (none)     |
+-----+---+---+---+---+----------------+--------+--------+------------+
```

C=Critical, U=Unsafe, N=No-Cache-Key, R=Repeatable

Note 1: taken from destination address/port of request message

Content-Formats

```
+--------------------------+-----+
| Media type               | Id. |
+--------------------------+-----+
| text/plain;charset=utf-8 |   0 |
| application/link-format  |  40 |
| application/xml          |  41 |
| application/octet-stream |  42 |
| application/exi          |  47 |
| application/json         |  50 |
| application/cbor         |  60 |
+--------------------------+-----+
```

URI schemes

```
coap-URI = "coap:" "//" host [ ":" port ] path-abempty [ "?" query ]
coaps-URI = "coaps:" "//" host [ ":" port ] path-abempty [ "?" query ]
```

Transmission parameters

```
+-------------------+---------------+
| name              | default value |
+-------------------+---------------+
| ACK_TIMEOUT       | 2 seconds     |
| ACK_RANDOM_FACTOR | 1.5           |
| MAX_RETRANSMIT    | 4             |
| NSTART            | 1             |
| DEFAULT_LEISURE   | 5 seconds     |
| PROBING_RATE      | 1 Byte/second |
+-------------------+---------------+
```

Link Format .well-known/core

Link format can be used to describe hosted resources, their attributes, and other relationships between links.
Example:

```
REQ: GET /.well-known/core

RES: 2.05 Content

</sensors>;ct=40;title="Sensor Index",
</sensors/temp>;rt="temperature-c";if="sensor",
</sensors/light>;rt="light-lux";if="sensor",
<http://www.example.com/sensors/t123>;anchor="/sensors/temp";rel="describedby",
</t>;anchor="/sensors/temp";rel="alternate"
```

ABNF:

```
Link           = link-value-list
link-value-list = [ link-value *[ "," link-value ]]
link-value     = "<" URI-Reference ">" *( ";" link-param )
link-param     = ( ( "rel" "=" relation-types )
                 / ( "anchor" "=" DQUOTE URI-Reference DQUOTE )
                 / ( "rev" "=" relation-types )
                 / ( "hreflang" "=" Language-Tag )
                 / ( "media" "=" ( MediaDesc
                                 / ( DQUOTE MediaDesc DQUOTE ) ) )
                 / ( "title" "=" quoted-string )
                 / ( "title*" "=" ext-value )
                 / ( "type" "=" ( media-type / quoted-mt ) )
```
```
                 / ( "rt" "=" relation-types )
                 / ( "if" "=" relation-types )
                 / ( "sz" "=" cardinal )
                 / ( link-extension ) )
link-extension = ( parmname [ "=" ( ptoken / quoted-string ) ] )
               / ( ext-name-star "=" ext-value )
ext-name-star  = parmname "*" ; reserved for RFC-2231-profiled
                              ; extensions.  Whitespace NOT
                              ; allowed in between.
ptoken         = 1*ptokenchar
ptokenchar     = "!" / "#" / "$" / "%" / "&" / "'" / "("
               / ")" / "*" / "+" / "-" / "." / "/" / DIGIT
               / ":" / "<" / "=" / ">" / "?" / "@" / ALPHA
               / "[" / "]" / "^" / "_" / "`" / "{" / "|"
               / "}" / "~"
media-type     = type-name "/" subtype-name
quoted-mt      = DQUOTE media-type DQUOTE
relation-types = relation-type
               / DQUOTE relation-type *( 1*SP relation-type ) DQUOTE
relation-type  = reg-rel-type / ext-rel-type
reg-rel-type   = LOALPHA *( LOALPHA / DIGIT / "." / "-" )
ext-rel-type   = URI
cardinal       = "0" / ( %x31-39 *DIGIT )
LOALPHA        = %x61-7A   ; a-z
quoted-string  = <defined in [RFC2616]>
URI            = <defined in [RFC3986]>
URI-Reference  = <defined in [RFC3986]>
type-name      = <defined in [RFC4288]>
subtype-name   = <defined in [RFC4288]>
MediaDesc      = <defined in [W3C.HTML.4.01]>
Language-Tag   = <defined in [RFC5646]>
ext-value      = <defined in [RFC5987]>
parmname       = <defined in [RFC5987]>
```

Block

In order to transfer larger payloads with CoAP — for instance, for firmware updates — the Block option can be used.

```
+-----+---+---+---+---+--------+--------+--------+---------+
| No. | C | U | N | R | Name   | Format | Length | Default |
+-----+---+---+---+---+--------+--------+--------+---------+
|  23 | x | x | - | - | Block2 | uint   | 0-3 B  | (none)  |
|  27 | x | x | - | - | Block1 | uint   | 0-3 B  | (none)  |
+-----+---+---+---+---+--------+--------+--------+---------+
```

```
 0
 0 1 2 3 4 5 6 7
+-+-+-+-+-+-+-+-+
|  NUM  |M| SZX |
+-+-+-+-+-+-+-+-+

 0                   1
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|          NUM          |M| SZX |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

 0                   1                   2
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                  NUM                  |M| SZX |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Observe

In order to follow state changes of CoAP resources the Observe option can be used.

```
+-----+---+---+---+---+---------+--------+--------+---------+
| No. | C | U | N | R | Name    | Format | Length | Default |
+-----+---+---+---+---+---------+--------+--------+---------+
|   6 |   | x | - |   | Observe | uint   | 0-3 B  | (none)  |
+-----+---+---+---+---+---------+--------+--------+---------+
```

References

This cheatsheet is based on and heavily stole from the following documents:
Link-format: http://tools.ietf.org/html/rfc6690
CoAP: http://tools.ietf.org/html/rfc7252
Block: http://tools.ietf.org/html/draft-ietf-core-block-17
Observe: http://tools.ietf.org/html/draft-ietf-core-observe-16