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BRSKI over CoAP
draft-pritikin-coap-bootstrap-00

Abstract

This document provides an initial discussion of Bootstrapping of Remote Secure key infrastructures (BRSKI) when the device being bootstrapped speaks CoAP. The HTTPS REST methods leveraged by BRSKI are mapped to CoAP methods. Fragmentation management of large messages during EST certificate enrollment is addressed.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. Introduction

Many IoT and other devices are expected to use CoAP over UDP extensively. Bootstrapping these devices without requiring a full TCP stack is an often raised requirement for [I-D.ietf-anima-bootstrapping-keyinfra]. CoAP provides REST methods over DTLS and is substantially functional with the folling necessary additions:

DTLS: Because CoAP use of DTLS includes support for large handshake messages there is little to describe here. BRSKI and EST [RFC7030] are expanded to include DTLS.

REST: The mapping of BRSKI and EST messages to CoAP REST calls is described.

Fragmentation: Use of block chaining to support fragmentation of large BRSKI and EST messages is described.

2. Terminology

The key words "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].

3. Scope of solution

The definition of BRSKI over DTLS and CoAP is not intended to expand the scope of BRSKI to highly constrained devices. (ref: [RFC7228]). Instead it is intended to ensure that bootstrapping works for less constained devices that choose to limit their communications stack to UDP/CoAP.

The BRSKI document details extensions to EST as well as making section 5.7 requirements on EST flows. This document's references to BRSKI are intended to include all BRSKI extensions and all existing EST messages. This document could replace BRSKI -03 section 5.7.5. [[EDNOTE: making this section 5.8 might make the most sense.]]

Support for Observe CoAP options (https://tools.ietf.org/html/rfc7641) in Blocks with BRSKI is not supported in the current BRSKI/ EST message flows and is thus out-of-scope of this discussion. Observe options could be used by the server to notify clients about a change in the cacerts or csr attributes (resources) and might be an area of future work.

4. DTLS

During the DTLS handshake, if fragmentation is needed, "DTLS provides a mechanism for fragmenting a handshake message over a number of records, each of which can be transmitted separately, thus avoiding IP fragmentation" [RFC6347].

Within BRSKI and EST when "TLS" is referred to it is understood that CoAP security is provided using DTLS instead. No other changes are necessary (all provisional modes etc are the same as for TLS).

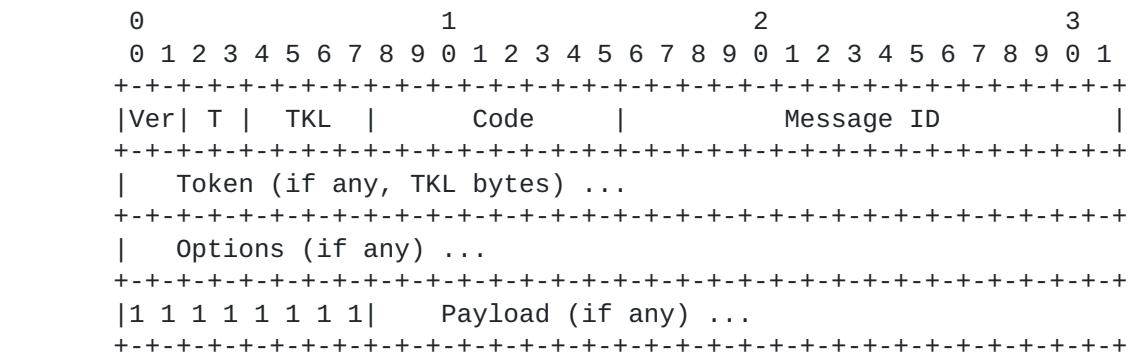
In a constrained CoAP environment, endpoints can't afford to establish a DTLS connection for every EST transaction. Authenticating and negotiating DTLS keys requires resources on low-end endpoints and consumes valuable bandwidth. The DTLS connection SHOULD remain open for persistent EST connections. For example a cacerts request that is followed by an enrollment request can leverage the same DTLS connection. Given that after a successfull enrollment, it is more likely that a new EST transaction will take place after a significant amount of time, the DTLS connections can only be kept alive for EST messages that are relatively close to each other.

5. Message Bindings

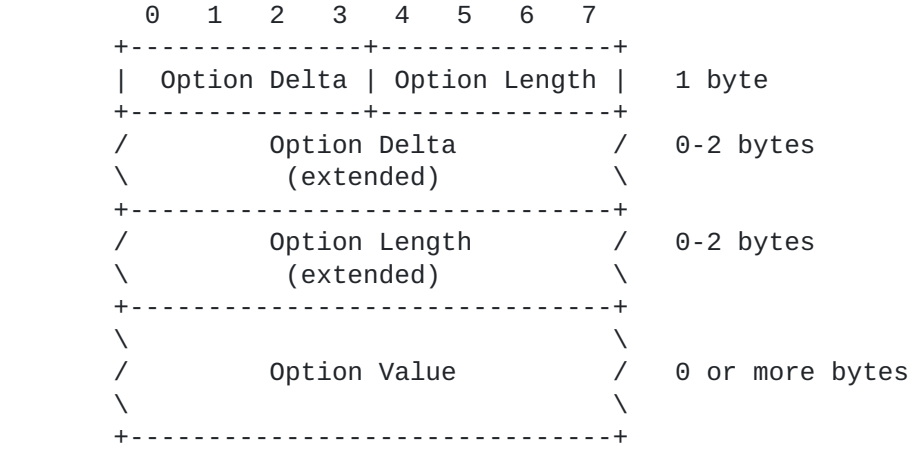
This section describes BRSKI to CoAP message mappings.

CoAP defines confirmed (CON), acknowledgements (ACK), reset (RST) and non-corfirmed (NON) message types. For confirmable messages, the responses are CoAP ACKs or RSTs. All /cacerts, /simpleenroll, /simplereenroll, /csrattrs, /fullcmc and /serverkeygen EST messages expect a response, so they are all CON messages.

A CoAP message has the following fields (from [I-D.ietf-core-block] Figure 7):



Then Ver, TKL, Token, Message ID are not affected in BRSKI. Their use is the same as in CoAP. The options that can be used in a CoAP header have the following format (from [I-D.ietf-core-block] Figure 8):



Options are used to convey Uri-Host, Uri-Path, Uri-Port, Content-Format and more in BRSKI which will be used to communicate the HTTP fields used in BRSKI messages. As for the HTTP response messages in BRSKI, they are translated to the Response Codes explained in [RFC7252] section 5.3.1

BRSKI URLs are https based (https://), in CoAPs these will be assumed to be transformed to coaps (coaps://)

Some examples of how an BRSKI message would be translated in CoAP follow. [[EDNOTE: This section to be expanded to ensure it covers all BRSKI edge conditions.]]

First let's see how a get cacerts message in EST would be in CoAP:

```
     GET /.well-known/est/cacerts HTTP/1.1
        User-Agent: curl/7.22.0 (i686-pc-linux-gnu) libcurl/7.22.0
                    OpenSSL/1.0.1 zlib/1.2.3.4 libidn/1.23 librtmp/2.3
        Host: 192.0.2.1:8085
        Accept: */*
```

The corresponding CoAP fields would be:

```
     Ver = 1
     T = 0 (means CON)
     Code = 0x01 (0.01 is GET)
     Options
      Option1 (Uri-Host)
        Option Delta = 0x3
        Option Length = 0x9
        Option Value = 192.0.2.1
      Option2 (Uri-Port)
        Option Delta = 0xA
        Option Length = 0x4
        Option Value = 8085
      Option3 (Uri-Path)
        Option Delta = 0xD
        Option Length = 0xD
        Extended Option Delta = 0x08
        Extended Option Length = 0x14
        Option Value = /.well-known/est/cacerts HTTP/1.1
     Payload = [Empty]
```

Now let's say we have a 200 OK response with a cert in EST:

```
      HTTP/1.1 200 OK
      Status: 200 OK
      Content-Type: application/pkcs7-mime
      Content-Transfer-Encoding: base64 (TODO: Verify if we need a new
                                         option registry for Encoding?)
      Content-Length: 4246 (TODO: this example overflows and would
                            need fragmentation. Choose a better
example.
                            Regardless we might need an CoAP option for
                            the content-length ie the CoAP payload?)

      MIIMOQYJKoZIhvcNAQcCoIIMKjCCDCYCAQExADALBgkqhkiG9w0BBwGgggwMMIIC
      +zCCAeOgAwIBAgIJAJpY3nUZO3qcMA0GCSqGSIb3DQEBBQUAMBsxGTAXBgNVBAMT
      ...
```

The corresponding CoAP fields would be:

```
     Ver = 1
     T = 2 (means ACK)
     Code = 0x21 (TODO: Maybe we need to create a 0x200 respond code.)
     Options
       Option1 (Content-Format)
         Option Delta = 0xC
         Option Length = 0xD
         Extended Option Length = 0x09
         Option Value = <number for application/pkcs7-mime>
                   (TODO: We need a new CoAP IANA registered value
                   application/pkcs7-mime; smime-type=certs-only,
                   application/csrattrs, application/pkcs10,
                   application/pkcs8,
                   application/pkcs12 )
     Payload = MIIMOQYJKoZIhvcNAQcCoIIMKjCCDCYCAQExA \
                 DALBgkqhkiG9w0BBwGgggwMMIIC...
```

[[EDNOTE: We might need a new Option for the Retry-After response message. We might need a new Option for the WWW-Authenticate response.]]

[[EDNOTE: username/password authentication can be described but is not a primary focus for BRSKI. It is important for generic EST exchanges but would an endpoint device with sufficient user interface to allow username/password input from an end user be required to use CoAP instead of a full HTTPS exchange?]]

6. Data Fragmentation

After the DTLS connection is established fragmentation will be needed for the CoAP messages which involve certificate enrollment and management.

Certificates can vary greatly in size based on signature algorithms, key sizes, and the fields used but even with ECC certs BRSKI CoAP messages can still exceed sizes in MTU of 1280 for IPv6 or 60-80 bytes for 6LoWPAN [RFC4919]) (see section 2 of [I-D.ietf-core-block]). For 256-bit curve, common ECDSA cert sizes are 500-1000bytes which could fluctuate based on the algorithms, SANs and cert fields. For 384-bit curves, ECDSA certs increase in size and can sometimes reach 1.5KB.

There are times when the EST cacert response from the server can include many certs that exceed maximum packet size. Or any one cert can be more than the MTU. CoAP RFC section 4.6 describes the possible payload sizes: "if nothing is known about the size of the headers, good upper bounds are 1152 bytes for the message size and 1024 bytes for the payload size". Also "If IPv4 support on unusual

networks is a consideration, implementations may want to limit themselves to more conservative IPv4 datagram sizes such as 576 bytes; per [RFC0791], the absolute minimum value of the IP MTU for IPv4 is as low as 68 bytes, which would leave only 40 bytes minus security overhead for a UDP payload". A fragmentation solution for BRSKI and EST CoAP message is required.

The [I-D.ietf-core-block] document describes how fragmentation can be done by using a pair of Block options added to the CoAP flow. Block1 options are used by the client PUT and POST requests. A Block1 in a client request needs a Block1 option in the responses. A Block2 comes from a server response that will also need Block2 from the client to acknowledge the block and get the rest of blocks from the server. So, Block1 is used when a request (POST for example) is done in BRSKI over CoAP with a payload that needs fragmentation. Then the server responds with Block1 option to acknowledge the fragment-blocks. Block2 is used when a BRSKI server response is big and needs fragmentation. The Block2 acknowledgements are requests with the same options as the initial request and a Block2 option. "To influence the block size used in a response, the requester MAY also use the Block2 Option on the initial request, giving the desired size, a block number of zero and an M bit of zero".

In a scenario with a big BRSKI POST we might have Block1 options from client to server and Block2 from server to client. In this case the Block1 blocks get completed and then the Block2 comes the other direction. The BLOCK draft also defines Size1 and Size2 options. These are used to convey the size of the resources in the requests or response. The Size1 response should be parseable by the client and server that should be able to follow and send BLOCK options afterwards if need be. Size1 sent in the request could also give the server an idea about the total size of the Block1 options. Similarly, Size2 option defined in BLOCK should be parseable by the server that is asked to provide the size estimate and by the client that is getting a response with Size2 size estimates of the total Block2 options.

6.1. Example fragmented response

An example of a server cacerts response that exceeds the MTU is:

An example of a server cacerts response that exceeds the MTU is

```
HTTP/1.1 200 OK
   Status: 200 OK
   Content-Type: application/pkcs7-mime; smime-type=certs-only
   Content-Transfer-Encoding: base64
   Content-Length: 1122

   MIIDOAYJKoZIhvcNAQcCoIIDKTCCAyUCAQExADALBgkqhkiG9w0BBwGgggMLMIID
   BzCCAe+gAwIBAgIBFTANBgkqhkiG9w0BAQUFADAbMRkwFwYDVQQDExBlc3RFeGFt
   cGxlQ0EgTndOMB4XDTEzMDUwOTIzMTU1M1oXDTE0MDUwOTIzMTU1M1owHzEdMBsG
   A1UEAxMUZGVtb3N0ZXA0IDEzNjgxNDEzNTIwggEiMA0GCSqGSIb3DQEBAQUAA4IB
   DwAwggEKAoIBAQClNp+kdz+Nj8XpEp9kaumWxDZ3eFYJpQKz9ddD5e5OzUeCm103
   ZIXQIxc0eVtMCatnRr3dnZRCAxGjwbqoB3eKt29/XSQffVv+odbyw0WdkQOIbntC
   Qry8YdcBZ+8LjI/N7M2krmjmoSLmLwU2V4aNKf0YMLR5Krmah3Ik31jmYCSvwTnv
   6mx6pr2pTJ82JavhTEIIt/fAYq1RYhkM1CXoBL+yhEoDanN7TzC94skfS3VV+f53
   J9SkUxTYcy1Rw0k3VXfxWwy+cSKEPREl7I6k0YeKtDEVAgBIEYM/L1S69RXTLuji
   rwnqSRjOquzkAkD31BE961KZCxeYGrhxaR4PAgMBAAGjUjBQMA4GA1UdDwEB/wQE
   AwIEsDAdBgNVHQ4EFgQU/qDdB6ii6icQ8wGMXvy1jfE4xtUwHwYDVR0jBBgwFoAU
   scRp5lujBKfYl6OLO7+5arIyQjwwDQYJKoZIhvcNAQEFBQADggEBACmxg1hvL6+7
   a+lFTARoxainBx5gxdZ9omSb0L+qL+4PDvg/+KHzKsDnMCrcU6M4YP5n0EDKmGa6
   4lY8fbET4tt7juJg6ixb95/760Th0vuctwkGr6+D6ETTfqyHnrbhX3lAhnB+0Ja7
   o1gv4CWxh1I8aRaTXdpOHORvN0SMXdcrlCys2vrtOl+LjR2a3kajJO6eQ5leOdzF
   QlZfOPhaLWen0e2BLNJI0vsC2Fa+2LMCnfC38XfGALa5A8e7fNHXWZBjXZLBCza3
   rEs9Mlh2CjA/ocSC/WxmMvd+Eqnt/FpggRy+F8IZSRvBaRUCtGE1lgDmu6AFUxce
   R4POrT2xz8ChADEA
```

Block options in CoAP messages can contain fields, SZX, M and NUM which are not affected by BRSKI.

Let's assume that the cacerts message will need to be broken up to 3 messages. The first block2 will be:

```
    Ver = 1
    T = 2 (means ACK)
    Code = 0x21 (means 2.01 success message.
           TODO: Do we need to create a 0x200 respond code.)
    Options
      Option1 (Content-Format)
        Option Delta = 0xC
        Option Length = 0xD
        Extended Option Length = 0x09
        Option Value = <number for application/pkcs7-mime;
                        smime-type=certs-only>
                  (TODO: We need a new CoAP IANA registered value
                  application/pkcs7-mime, application/csrattrs,
                  application/pkcs10, application/pkcs8,
                  application/pkcs12 )
      Option2 (Block2)
        Option Delta = 0xD
        Option Length = 0x1
        Extended Option Delta = 0x16
        Option Value = 0x0D
    Payload = MIIMOQYJKoZIhvcNAQcCoIIMKjCCDCYC \
              AQExADALBgkqhkiG9w0BBwGgggwMMIIC... (512 bytes)

  The second block2:

    Ver = 1
    T = 2 (means ACK)
    Code = 0x21
    Options
      Option1 (Content-Format)
        Option Delta = 0xC
        Option Length = 0xD
        Extended Option Length = 0x09
        Option Value = <number for application/pkcs7-mime;
                       smime-type=certs-only>
                  (TODO: We need a new CoAP IANA registered value
                  application/pkcs7-mime, application/csrattrs,
                  application/pkcs10, application/pkcs8,
                  application/pkcs12 )
      Option2 (Block2)
        Option Delta = 0xD
        Option Length = 0x1
        Extended Option Delta = 0x16
        Option Value = 0x1D
    Payload = ... (512 bytes)

  The third and final block2:
```

```
Ver = 1
T = 2 (means ACK)
Code = 0x21
Options
  Option1 (Content-Format)
    Option Delta = 0xC
    Option Length = 0xD
    Extended Option Length = 0x09
    Option Value = <number for application/pkcs7-mime;
                    smime-type=certs-only>
              (TODO: We need a new CoAP IANA registered value
              application/pkcs7-mime, application/csrattrs,
              application/pkcs10, application/pkcs8,
              application/pkcs12 )
  Option2 (Block2)
    Option Delta = 0xD
    Option Length = 0x1
    Extended Option Delta = 0x16
    Option Value = 0x25
Payload = ...
```

7. Proxying

[[EDNOTE: This section to be populated. It will address how proxying can take place by an entity that resides at the edge of the CoAP network, such as the Registrar, and can reach the BRSKI server residing in a traditional "TCP setting".]]

8. CoAP Parameters

[[EDNOTE: This section to be populated. It will address transmission parameters for BRSKI described in sections 4.7 and 4.8 of the CoAP draft. BRSKI does not impose any unique parameters that affect the CoAP parameters in Table 2 and 3 in the CoAP draft but the ones in CoAP could be affecting BRSKI. For example the processing delay of CAs could be less then 2s, but in this case they should send an CoAP ACK every 2s while processing.]]

9. Security Considerations

[[EDNOTE: This section to be populated. This document describes an existing protocol moved to CoAP and there should not be additional security concerns added beyond the protocol's or CoAP's specifics security considerations.]]

10. Normative References

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