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Transport of CoAP over SMS, USSD and GPRS
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Abstract

The Short Message Service (SMS) and Unstructured Supplementary Service Data (USSD) of mobile cellular networks is frequently used in Machine-To-Machine (M2M) communications, such as for telematic devices. The service offers small packet sizes and high delays just as other typical low-power and lossy networks (LLNs), i.e. 6LoWPANs. The design of the Constrained Application Protocol (CoAP), that took the limitations of LLNs into account, is thus also applicable to telematic M2M devices. The adaptation of CoAP to the SMS or USSD transport mechanisms and the combination with IP transported over cellular networks is described in this document.

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1. Introduction

This specification details the usage of the Constrained Application Protocol on the Short Message Service (SMS) or Unstructured Supplementary Service Data (USSD) of mobile cellular networks.

1.1. Motivation

In some M2M environments, internet connectivity is not supported by the constrained end-points, but a cellular network connection is supported instead. Internet connectivity might also be switched off for power saving reasons or the cellular coverage does not allow for Internet connectivity. In these situations, SMS and USSD will be supported, instead of UDP/IP over General Packet Radio Service (GPRS), Hish Speed Packet Access (HSPA) or Long Term Evolution (LTE) networks.

In Open Mobile Alliance (OMA) LightweightM2M technical specification [oma_lightweightm2m_ts], SMS is identified as an alternative transport for CoAP messages.

In 3GPP, SMS is identified as the transport protocol for small data transmissions (See [3gpp_ts23_888] for Key Issue on Machine Type Communication (MTC) Device Trigger and the proposed solutions in Sections 6.2, 6.42, 6.44, 6.48, 6.52, 6.60, and 6.61). In [3gpp_ts23_682] 'Architecture Enhancements to facilitate communications with Packet Data Networks and Applications' SMS is at the moment the only Trigger Delivery (Trigger Delivery using T4). USSD does seem to be in standardisation as a solution for MTC Device Trigger.

M2M protocols using SMS, e.g. for telematics, are using mostly various diverse proprietary and closed binary protocols with limited publicly available documentation at the moment.

USSD is a very basic service in mobile networks which uses fewer network components to provide a service similar to SMS. This makes USSD very cheap for mobile network operators and chipset manufactures as they do not have to provide additional infrastructure. This is why USSD is from a technical point of view supported by all handsets and other mobile devices in all networks.

Where short messages are normally stored in the SMS Center (SMS-C) before the actual delivery takes place, USSD messages are not stored but delivered immediately. If it is impossible to deliver a USSD message within the first attempt, delivery fails. This could be a problem, but could also be seen as an advantage as long as delivery problems are covered by higher level protocols, such as CoAP.

Without store-and-forward mechanisms the delivery is absolutely deterministic. There is only "success" or "failure" and no "wait a minute".

2. Terminology

The terms CoAP Server and CoAP Client are used synonymously to Server and Client as specified in the terminology section of [I-D.ietf-core-coap].

3. Requirements Language

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

4. Scenarios

Several scenarios are presented first for M2M communications with CoAP. First Mobile-Originating Mobile-Terminating (MO-MT) scenarios are presented, where both CoAP endpoints are in devices in a cellular network. Next, Mobile-Terminating (MT) scenarios are detailed, where only the CoAP server is in a cellular network. Finally, Mobile-Originating (MO) scenarios where the CoAP client is in the cellular network.

4.1. MO-MT Scenarios

Figure 1 to Figure 5 show various applicable usage scenarios of CoAP in M2M communications. Two mobile cellular terminals communicate by exchanging CoAP Request and Response embedded into short message protocol data units (PDUs) (depicted in Figure 1).

```
         CoAP-REQ           CoAP-REQ
+-------+  (SMS)  +--------+  (SMS)  +-------+
|   A   | --------> | SMS-C | -------> |   B   |
|(cell)| <-------- |        | <------- |(cell)|
+-------+ CoAP-RES +--------+ CoAP-RES +-------+
           (SMS)              (SMS)
```

Figure 1: Cellular and Cellular Communication (only SMS-based)

Two mobile cellular terminals communicate by exchanging the CoAP Request in a short message PDU and the CoAP Response using GPRS transport. (depicted in Figure 2).

```
                 CoAP-REQ            CoAP-REQ
      +-------+   (SMS)   +-------+   (SMS)  +-------+
      |   A   | --------> | SMS-C | -------> |   B   |
      |(cell)|            |       |          |(cell)|
      +-------+           +-------+          +-------+
         ^                                       |
         |                +-------+              |
         |                | GGSN  |              |
         +--------------- |       | <------------+
                CoAP-RES  +-------+    CoAP-RES
                 (GPRS)                 (GPRS)
```

Figure 2: Cellular and Cellular Communication (SMS/GPRS-based)

The support for GPRS for the CoAP responses might be useful, so as to use SMS only for the request and as a wake-up signal for the device hosting the CoAP server. That device could then initiate a packet data protocol (PDP) context with the cellular network in order to bring up Internet connectivity. After having setup Internet connectivity, further message exchange can fully rely on IP. Network initiated PDP contexts could partly obsolete this mechanism.

4.2. MT Scenarios

An IP host and a mobile cellular terminal communicate by exchanging CoAP Request and Response. The IP host uses protocols offered by the SMS-C (e.g. Short Message Peer-to-Peer (SMPP [smpp]), Computer Interface to Message Distribution (CIMD [cimd]), Universal Computer Protocol/External Machine Interface (UCP/EMI [ucp])) to submit a short message for delivery, which contains the CoAP Request (depicted in Figure 3).

```
                   CIMD                CoAP-REQ
     +------+      SMPP     +-------+    (SMS)   +------+
     |  A   | --------> | SMS-C | ---------> |  B   |
     | (IP) | <-------- |       | <--------- |(cell)|
     +------+           +-------+  CoAP-RES  +------+
                                     (SMS)
```

Figure 3: IP and Cellular Communication (only SMS-based)

Again, the return path for the CoAP Response might be GPRS (depicted in Figure 4).

```
                         CIMD                CoAP-REQ
              +------+   SMPP    +-------+    (SMS)   +------+
              |  A   | --------> | SMS-C | ---------> |  B   |
              | (IP) |           |       |            |(cell)|
              +------+           +-------+            +------+
                 ^                                       |
                 |               +-------+               |
                 |               | GGSN  |               |
                 +-------------- |       | <-------------+
                      CoAP-RES   +-------+    CoAP-RES
                        (IP)                   (GPRS)
```

Figure 4: IP and Cellular Communication (SMS and GPRS-based)

There are service providers offering SMS and/or USSD delivery and notification using an HTTP/REST interface (depicted in Figure 5).

```
             HTTP-REQ                 CIMD           CoAP-REQ
   +------+ (CoAP-DATA) +----------+  SMPP   +-----+ (SMS/USSD) +------+
   |      |             | SMS/USSD |  SS7    |SMS-C|            |      |
   |  A   | ----------> | Service  | ------> |  /  | ---------> |  B   |
   | (IP) | <---------- | Provider | <------ | HLR | <--------- |(cell)|
   +------+  HTTP-RES   +----------+         +-----+  CoAP-RES  +------+
            (CoAP-DATA)                              (SMS/USSD)
```

Figure 5: IP and Cellular Communication (only SMS/USSD-based, using an SMS/USSD service provider)

4.3. MO Scenarios

A mobile cellular terminal and an IP host communicate by exchanging CoAP Request and Response. The mobile cellular terminal sends a CoAP Request in a short message, which is in turn forwarded by the SMS-C (e.g. with Short Message Peer-to-Peer (SMPP [smpp]), Computer Interface to Message Distribution (CIMD [cimd]), Universal Computer Protocol/External Machine Interface (UCP/EMI [ucp])) as depicted in Figure 6). This scenario can be a fall-back for mobile-originating communication, when IP connectivity cannot be setup (e.g. due to missing coverage).

```
                        CoAP-REQ              CIMD
              +------+   (SMS)   +-------+    SMPP    +------+
              |  A   | --------> | SMS-C | ---------> |  B   |
              |(cell)| <-------- |       | <--------- | (IP) |
              +------+  CoAP-RES +-------+            +------+
                        (SMS)
```

Figure 6: Cellular and IP Communication (only SMS-based)

There are service providers offering SMS and/or USSD delivery and notification using an HTTP/REST interface (depicted in Figure 7).

```
          CoAP-REQ            CIMD              HTTP-REQ
+------+ (SMS/USSD) +-------+  SMPP  +----------+ (CoAP-DATA) +----+
|      |            | SMS-C |  SS7   | SMS/USSD |             |    |
|  A   | ---------> |   /   | -----> | Service  | ----------> | B  |
|(cell)| <--------- |  HLR  | <----- | Provider | <---------- |(IP)|
+------+  CoAP-RES  +-------+        +----------+  HTTP-RES   +----+
         (SMS/USSD)                               (CoAP-DATA)
```

Figure 7: IP and Cellular Communication (only SMS/USSD-based, using an SMS/USSD service provider)

If IP connectivity can be setup by the mobile cellular device, the complete communication can be handled using UDP/IP by employing regular CoAP [I-D.ietf-core-coap] (depicted in Figure 8.

```
+------+  CoAP-REQ +-------+            +------+
|  A   | --------> | GGSN  | ---------> |  B   |
|(cell)| <-------- |       | <--------- | (IP) |
+------+  CoAP-RES +-------+            +------+
```

Figure 8: Cellular and IP Communication (GPRS-based)

5. Examples

Two mobile cellular terminals communicate by exchanging the CoAP Request in an SMS PDU and the CoAP Response using GPRS transport. (depicted in Figure 9).

```
               CoAP-REQ
+-----------+    (SMS)     +----------+
|  Client   | -----------> |  Server  |
|  (cell)   | <----------- |  (cell)  |
+-----------+   CoAP-RES   +----------+
                 (GPRS)
```

Figure 9

In the examples below, Client (Client Address A) sends GET request to Server (Server Address A) through SMS, and uses Response-To-URI-Host and Response-To-URI-Port to indicate the IP address and port (Client Address B). Then the Server (Server Address B) sends back the response to the Client through GPRS to Client Address B. The tel:

addresses in the examples are to be interpreted as described in RFC 3966 [RFC3966].

```
              Client Address A (CA): tel:+1-201-555-0123
              Client Address B (CB): 10.1.1.1

              Server Address A (SA): tel:+1-201-555-0124
              Server Address B (SB): 10.1.1.2
```

Figure 10

```
Client   Server
CA  CB   SA  SB
|   |    |   |
+------->|   |            Header: GET (T=NON, Code=1, MID=0x7d38)
| GET    |   |             Token: 0x53
|   |    |   |          Uri-Path: "temperature"
|   |    |   | Response-To-Uri-Host: 10.1.1.1
|   |    |   | Response-To-Uri-Port: 5683
|   |    |   |
|   |<-------+  Header: 2.05 Content (T=NON, Code=69, MID=0xad7b)
|   |  2.05  |   Token: 0x53
|   |    |   | Payload: "22.3 C"
|   |    |   |
```

Figure 11: NON A, NON B

```
Client   Server
CA  CB   SA  SB
|   |    |   |
+------->|   |            Header: GET (T=CON, Code=1, MID=0x7d38)
| GET    |   |             Token: 0x53
|   |    |   |          Uri-Path: "temperature"
|   |    |   | Response-To-Uri-Host: 10.1.1.1
|   |    |   | Response-To-Uri-Port: 5683
|   |    |   |
|<-------+   |            Header: (T=ACK, Code=0, MID=0x7d38)
|   |    |   |
|   |<-------+  Header: 2.05 Content (T=NON, Code=69, MID=0xad7b)
|   |  2.05  |   Token: 0x53
|   |    |   | Payload: "22.3 C"
|   |    |   |
```

Figure 12: CON A, ACK A, NON B (separate)

```
Client   Server
CA  CB   SA  SB
|   |    |   |
+------->|   |            Header: GET (T=CON, Code=1, MID=0x7d38)
| GET    |   |             Token: 0x53
|   |    |   |          Uri-Path: "temperature"
|   |    |   | Response-To-Uri-Host: 10.1.1.1
|   |    |   | Response-To-Uri-Port: 5683
|   |    |   |
|   |<-------+            Header: (T=ACK, Code=0, MID=0x7d38)
|   |    |   |
|   |<-------+  Header: 2.05 Content (T=NON, Code=69, MID=0xad7b)
|   |  2.05  |   Token: 0x53
|   |    |   | Payload: "22.3 C"
|   |    |   |
```

Figure 13: CON A, ACK B, NON B (separate)

```
   Client   Server
   CA  CB   SA  SB
   |   |     |   |
   +------->|    |            Header: GET (T=CON, Code=1, MID=0x7d38)
   | GET     |   |             Token: 0x53
   |   |     |   |          Uri-Path: "temperature"
   |   |     |   | Response-To-Uri-Host: 10.1.1.1
   |   |     |   | Response-To-Uri-Port: 5683
   |   |     |   |
   |<-------+    |  Header: 2.05 Content (T=ACK, Code=69, MID=0x7d38)
   |    2.05 |   |   Token: 0x53
   |   |     |   | Payload: "22.3 C"
   |   |     |   |
```

Figure 14: CON A, ACK A

```
   Client   Server
   CA  CB   SA  SB
   |   |     |   |
   +------->|    |            Header: GET (T=CON, Code=1, MID=0x7d38)
   | GET     |   |             Token: 0x53
   |   |     |   |          Uri-Path: "temperature"
   |   |     |   | Response-To-Uri-Host: 10.1.1.1
   |   |     |   | Response-To-Uri-Port: 5683
   |   |     |   |
   |   |<-------+  Header: 2.05 Content (T=ACK, Code=69, MID=0x7d38)
   |   |  2.05   |   Token: 0x53
   |   |     |   | Payload: "22.3 C"
   |   |     |   |
```

Figure 15: CON A, ACK B

```
Client   Server
CA  CB   SA  SB
|   |    |   |
+------->|   |            Header: GET (T=NON, Code=1, MID=0x7d38)
| GET    |   |             Token: 0x53
|   |    |   |          Uri-Path: "temperature"
|   |    |   | Response-To-Uri-Host: 10.1.1.1
|   |    |   | Response-To-Uri-Port: 5683
|   |    |   |
|   |<-------+  Header: 2.05 Content (T=CON, Code=69, MID=0x7d38)
|   |  2.05  |   Token: 0x53
|   |    |   | Payload: "22.3 C"
|   |    |   |
|   +------->|            Header: (T=ACK, Code=0, MID=0x7d38)
|   |    |   |
```

Figure 16: NON A, CON B, ACK B

```
Client   Server
CA  CB   SA  SB
|   |    |   |
+------->|   |            Header: GET (T=CON, Code=1, MID=0x7d38)
| GET    |   |             Token: 0x53
|   |    |   |          Uri-Path: "temperature"
|   |    |   | Response-To-Uri-Host: 10.1.1.1
|   |    |   | Response-To-Uri-Port: 5683
|   |    |   |
|<-------+   |            Header: (T=ACK, Code=0, MID=0x7d38)
|   |    |   |
|   |<-------+  Header: 2.05 Content (T=CON, Code=69, MID=0xad7b)
|   |  2.05  |   Token: 0x53
|   |    |   | Payload: "22.3 C"
|   |    |   |
|   +------->|  Header: (T=ACK, Code=0, MID=0xad7b)
|   |    |   |
```

Figure 17: CON A, ACK A, CON B, ACK B (separate)

```
   Client   Server
   CA  CB   SA  SB
   |   |    |   |
   +------->|   |            Header: GET (T=CON, Code=1, MID=0x7d38)
   | GET    |   |             Token: 0x53
   |   |    |   |          Uri-Path: "temperature"
   |   |    |   | Response-To-Uri-Host: 10.1.1.1
   |   |    |   | Response-To-Uri-Port: 5683
   |   |    |   |
   |   |<-------+            Header: (T=ACK, Code=0, MID=0x7d38)
   |   |    |   |
   |   |<-------+  Header: 2.05 Content (T=CON, Code=69, MID=0xad7b)
   |   |  2.05  |   Token: 0x53
   |   |    |   | Payload: "22.3 C"
   |   |    |   |
   |   +------->|  Header: (T=ACK, Code=0, MID=0xad7b)
   |   |    |   |
```

Figure 18: CON A, ACK B, CON B, ACK B (separate)

6. Message Exchanges

6.1. Message Exchange for SMS in a Cellular-To-Cellular Mobile-Originated and Mobile-Terminated Scenario

The CoAP Client works as a Mobile Station to send the short message, and the CoAP Server works as another Mobile Station to receive the short message. All the short messages are stored and forwarded by the Service Center. The message exchange between the CoAP Client and the CoAP Server is depicted in the figure below:

```
         MS/CoAP CLIENT        Service Center          MS/CoAP SERVER
               |                        |                         |
               |   ---SMS-SUBMIT--->    |                         |
               | <-SMS-SUBMIT-REPORT--  |                         |
               |                        |                         |
               |                        |    --SMS-DELIVER--->    |
               |                        | <-SMS-DELIVER-REPORT--  |
               |                        |                         |
               | <-SMS-STATUS-REPORT--  |                         |
               |                        |                         |
```

Figure 19: CoAP Messages over SMS

Note that the message exchange is just for one request message from CoAP Client and CoAP Server. It includes the following steps:

Step 1: The CoAP Client sends a CoAP request in a SMS-SUBMIT message to the Service Center. The CoAP Server address is specified as TP-Destination-Address (see [3gpp_ts_23_040]).

Step 2: The Service Center returns a SMS-SUBMIT-REPORT message to the CoAP Client.

Step 3: The Service Center stores the received SMS message and forwards it to the CoAP Server, using an SMS-DELIVER message. The CoAP Client address is specified as a TP Originating Address (see [3gpp_ts_23_040]).

Step 4: The CoAP Server returns an SMS-DELIVER-REPORT message to the Service Center.

Step 5: The Service Center returns the SMS-STATUS-REPORT message to the CoAP Client to indicate the SMS delivery status, if required by the CoAP Client.

Note that the SMS-STATUS-REPORT message just indicates the transport layer SMS delivery status and has no relationship with the confirmable message or non-confirmable message. If the CoAP Client has sent a confirmable message, the CoAP Server MUST use a separate SMS message to transmit the ACK.

6.2. Message Exchange for USSD

The message exchange for USSD is shown simplified in Figure 20 and Figure 21. The communication between MS, MSC, VLR, HLR, and USSD-GW is based on SS7 signalling and the communication between USSD-GW is based on IP. Messages ending with _RPC are Remote Procedure Calls (e.g. REST); messages without _RPC are SS7 signalling.

Message Sequence Charts with more details can be found in [3gpp_ts23_090].

In Figure 20 the message sequence chart for the USSD transport (Mobile Originated) is shown.

```
          MS/CoAP CLIENT   MSC/VLR/HLR/USSD-GW         CoAP SERVER
               |                    |                         |
               | ---USSD_REQUEST--> |                         |
               |                    |                         |
               |                    | ---USSD_REQUEST_RPC-->  |
               |                    | <--USSD_RESPONSE_RPC--  |
               |                    |                         |
               | <--USSD_RESPONSE-- |                         |
               |                    |                         |
```

Figure 20: CoAP Messages over USSD (Mobile Originated)

In Figure 21 the message sequence chart for the USSD transport (Mobile Terminated) is shown.

```
          MS/CoAP SERVER   MSC/VLR/HLR/USSD-GW         CoAP CLIENT
               |                    |                         |
               |                    | <--USSD_REQUEST_RPC---  |
               |                    |                         |
               | <--USSD_REQUEST--- |                         |
               | ---USSD_RESPONSE-> |                         |
               |                    |                         |
               |                    | ---USSD_RESPONSE_RPC->  |
               |                    |                         |
```

Figure 21: CoAP Messages over USSD (Mobile Terminated)

7. Encoding of CoAP for non-IP transports

7.1. Encoding of CoAP for SMS transport

The content of a short message can be coded in 7, 8 or 16 bit characters [3gpp_ts23_038]. The advantages and disadvantages are:

a. 7 bit encoding: Sending 7 bit encoded short message possible with almost all devices. CoAP binary data needs to be re-encoded, possibly with Base64 RFC 4648 [RFC4648].

b. 8 bit encoding: CoAP binary data does not need to be re-encoded. Not all telematic devices support 8 bit short message encoding.

c. 16 bit encoding: CoAP binary data needs to be re-encoded. Not all telematic devices support 16 bit short message encoding.

More considerations about SMS encoding can be found in [I-D.bormann-coap-misc].

7.2. Encoding of CoAP for USSD transport

The encoding of USSD data is identical to the encoding of short messages.

8. Message Size Implementation Considerations

Using 7 bit encoding 160 characters are allowed in 1 short message, while using 8 bit encoding 140 characters are allowed. [3gpp_ts23_038]

Possible options for larger CoAP messages are:

a. Multiple short message concatenation

b. CoAP Block [I-D.ietf-core-block]

It is RECOMMENDED that SMS is not used to transfer very large resource data using Blocks.

There is no possibility to concatenate messages with USSD, thus the only option would be CoAP Block is necessary.

9. Addressing

For SMS in cellular networks, the CoAP endpoints have to work with a SIM (Subscriber Identity Module) card and have to be addressed by the MSISDN (Mobile Station ISDN (MSISDN) number).

To allow the CoAP client to detect that the short message contains a CoAP message, the TP-DATA-Coding-Scheme SHOULD be included.

For mobile-originated USSD the addressing is done by a so called application numbers.

10. Options

Uri-Host: Contrary to the default value of the Uri-Host Option being the IP literal as given in [I-D.ietf-core-coap], the default value when using CoAP with the coap+tel:// scheme is the telephone-subscriber as defined in RFC3966. If Uri-Host is not the default value, the value is an IP literal as in [I-D.ietf-core-coap]

Uri-Port: The default value of the Uri-Port is not useful in combination with the coap+tel:// scheme. Therefore Uri-Port MUST NOT be included, if the Uri-Host is the default value or is not included in the message.

End-points receiving CoAP messages over SMS with such options MUST behave as specified in [I-D.ietf-core-coap].

10.1. New Options for mixed IP/non-IP operation.

When CoAP should be used in mixed IP and non-IP mode (e.g. SMS/USSD and GPRS as in Figure 2 and Figure 4) the server needs to be informed about the client’s alternative address that should be used for the CoAP Response. For this reason the new options Response-To-Uri-Host and Response-To-Uri-Port are proposed.

No.	C	U	N	R	Name	Format	Length	Default
34					Response-To-Uri-Host	string	1-270 B	(none)
38					Response-To-Uri-Port	uint	0-2 B	5683

Table 1: New CoAP Option Numbers

If the Response-To-Uri-Host is present in the request, server MUST send the response to the indicated URI address, instead of the client’s original request URI.

The options SHOULD NOT be used in the response.

The options MUST NOT occur more than once.

11. URI Scheme

The coap:// scheme defines that a CoAP server is reachable over UDP/IP. Hence, a new URI scheme is needed for CoAP servers which are reachable over SMS/USSD. The URI scheme for CoAP over SMS/USSD is derived from the CoAP scheme in [I-D.ietf-core-coap]. As there is no host and port available for the SMS/USSD transport, those parts are replaced with the "telephone-subscriber" from [RFC3966].

11.1. URI Scheme

The syntax of the "coap+tel" URI scheme is specified below in Augmented Backus-Naur Form (ABNF) [RFC5234]. The definitions of "path-abempty", "query", are adopted from [RFC3986]. The definition of "telephone-subscriber" is adopted from [RFC3966].

11.1.1. Formal Definition

```
         coap-sms-URI = "coap+tel:" "//" telephone-subscriber
                        path-abempty [ "?" query ]

telephone-subscriber = <defined in RFC3966">"
path-abempty         = <defined in RFC3986">"
query                = <defined in RFC3986">"
```

11.1.2. Example

```
coap+tel://+15105550101/.well-known/core
```

12. Transmission Parameters

It is RECOMMENDED to configure the RESPONSE_TIMEOUT variable for a higher duration than specified in [I-D.ietf-core-coap] for the applications described here. The actual value SHOULD be chosen based on experience with SMS, USSD and GPRS.

13. Multicast

Multicast is not possible with SMS and USSD transports.

14. Proxying Considerations

In case of non-IP transport, several use cases might arise for proxies:

- o For a CoAP IP Client and a Mobile Terminated CoAP Server: An HTTP-CoAP Proxy at the mobile network / IP network border.
- o For a Mobile Originated CoAP Client and (CoAP/HTTP) IP Server: A CoAP-CoAP or CoAP-HTTP Proxy at the mobile network and IP network border or in the server network.
- o If an LLN is attached to the Mobile: A CoAP-CoAP Proxy into the LLN.

In Figure 22 a typical M2M scenario is shown where a User (U) is connected by an IP network to an M2M service provider (M). Over a cellular network the M2M telematic device (T) is attached. Possibly a constrained network is attached to the telematic device.

```
+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
```

Figure 22: M2M architecture

In sections Section 14.1 to Section 14.4 several combinations of CoAP and HTTP clients, servers and proxies are shown. The various cases are not distinct but can be mixed to meet the M2M requirements.

14.1. Mobile Telematic Server

```
      C-C: CoAP Client
      C-S: CoAP Server

+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                                      |
 C-C                                    C-S
```

Figure 23: M2M architecture (Mobile Telematic Server) A

```
      C-C: CoAP Client
      C-C-P: CoAP-CoAP Proxy (Forward Proxy)
      C-S: CoAP Server

+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                 |                    |
 C-C              C-C-P                 C-S
```

Figure 24: M2M architecture (Mobile Telematic Server) B

```
             H-C: HTTP Client
             H-C-P: HTTP-CoAP Proxy (Forward Proxy)
             C-S: CoAP Server

       +---+   *-----*   +---+   *--------*   +---+   *----------*
       |   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
       | U |-| network |-| M |-|  network   |-| T |-|    network    |
       |   |  \       /  |   |  \          /  |   |  \             /
       +---+   *-----*   +---+   *--------*   +---+   *----------*
         |                 |                    |
        H-C              H-C-P                 C-S
```

Figure 25: M2M architecture (Mobile Telematic Server) C

14.2. Mobile Telematic Client

```
             C-C: CoAP Client
             C-S: CoAP Server

       +---+   *-----*   +---+   *--------*   +---+   *----------*
       |   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
       | U |-| network |-| M |-|  network   |-| T |-|    network    |
       |   |  \       /  |   |  \          /  |   |  \             /
       +---+   *-----*   +---+   *--------*   +---+   *----------*
         |                                      |
        C-S                                    C-C
```

Figure 26: M2M architecture (Mobile Telematic Client) A

```
             C-C: CoAP Client
             C-C-P: CoAP-CoAP Proxy (Forward Proxy)
             C-S: CoAP Server

       +---+   *-----*   +---+   *--------*   +---+   *----------*
       |   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
       | U |-| network |-| M |-|  network   |-| T |-|    network    |
       |   |  \       /  |   |  \          /  |   |  \             /
       +---+   *-----*   +---+   *--------*   +---+   *----------*
         |                 |                    |
        C-S              C-C-P                 C-C
```

Figure 27: M2M architecture (Mobile Telematic Client) B

```
             C-C: CoAP Client
             H-C-P: HTTP-CoAP Proxy (Forward Proxy)
             H-S: HTTP Server

       +---+   *-----*   +---+   *--------*   +---+   *-----------*
       |   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
       | U |-| network |-| M |-|  network   |-| T |-|    network    |
       |   |  \       /  |   |  \          /  |   |  \             /
       +---+   *-----*   +---+   *--------*   +---+   *-----------*
         |                 |                    |
        H-S              H-C-P                 C-C
```

Figure 28: M2M architecture (Mobile Telematic Client) C

14.3. Mobile Server

```
             C-C: CoAP Client
             C-S: CoAP Server

       +---+   *-----*   +---+   *--------*   +---+   *-----------*
       |   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
       | U |-| network |-| M |-|  network   |-| T |-|    network    |
       |   |  \       /  |   |  \          /  |   |  \             /
       +---+   *-----*   +---+   *--------*   +---+   *-----------*
         |                                                  |
        C-C                                                C-S
```

Figure 29: M2M architecture (Mobile Server) A

```
             C-C: CoAP Client
             C-C-P: CoAP-CoAP Proxy (Forward Proxy)
             C-S: CoAP Server

       +---+   *-----*   +---+   *--------*   +---+   *-----------*
       |   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
       | U |-| network |-| M |-|  network   |-| T |-|    network    |
       |   |  \       /  |   |  \          /  |   |  \             /
       +---+   *-----*   +---+   *--------*   +---+   *-----------*
         |                 |                                |
        C-C              C-C-P                             C-S
```

Figure 30: M2M architecture (Mobile Server) B

H-C: HTTP Client
H-C-P: HTTP-CoAP Proxy (Cross-Protocol Forward Proxy)
C-S: CoAP Server

```
+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                 |                                |
 H-C              H-C-P                             C-S
```

Figure 31: M2M architecture (Mobile Server) C

C-C: CoAP Client
C-C-P1: CoAP-CoAP Proxy (Forward Proxy)
C-C-P2: CoAP-CoAP Proxy (Mirror Proxy)
C-S: CoAP Server (actually Clients which PUT to C-C-P2)

```
+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                 |                    |           |
 C-C              C-C-P1               C-C-P2       C-S
```

Figure 32: M2M architecture (Mobile Server) D

14.4. Mobile Client

C-C: CoAP Client
C-S: CoAP Server

```
+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                                                  |
 C-S                                                C-C
```

Figure 33: M2M architecture (Mobile Client) A

```
      C-C: CoAP Client
      C-C-P: CoAP-CoAP Proxy (Reverse Proxy)
      C-S: CoAP Server

+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                                      |             |
 C-S                                   C-C-P          C-C
```

Figure 34: M2M architecture (Mobile Client) B

```
      C-C: CoAP Client
      C-C-P1: CoAP-CoAP Proxy (Forward Proxy)
      C-C-P2: CoAP-CoAP Proxy (Mirror Proxy)
      C-S: CoAP Server (actually Clients which PUT to C-C-P2)

+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                 |                    |             |
 C-S              C-C-P2               C-C-P1         C-C
```

Figure 35: M2M architecture (Mobile Client) C

```
      C-C: CoAP Client
      C-C-P: CoAP-CoAP Proxy (Forward Proxy)
      H-C-P: HTTP-CoAP Proxy (Mirror Proxy)
      H-S: HTTP Server

+---+   *-----*   +---+   *--------*   +---+   *-----------*
|   |  /  IP   \  |   |  / cellular \  |   |  / constrained \
| U |-| network |-| M |-|  network   |-| T |-|    network    |
|   |  \       /  |   |  \          /  |   |  \             /
+---+   *-----*   +---+   *--------*   +---+   *-----------*
  |                 |                    |             |
 H-S              H-C-P                C-C-P          C-C
```

Figure 36: M2M architecture (Mobile Client) D

15. Security Considerations

It is possible that a malicious CoAP Client sends repeated requests, and it may cost money for the CoAP Server to use SMS to send back associated responses. To avoid this situation, the CoAP Server implementation can authenticate the CoAP Client before responding to the requests. For example, the CoAP Server can maintain an MSISDN white list. Only the MSISDN specified in the white list will be allowed to send requests. The requests from others will be ignored or rejected.

As this option is used to redirect the response to another address, it may be used by a malicious party to send it to an address other than its own. For example, A can use his mobile phone to send an SMS/CoAP GET, with B's IP address as Response-To-Uri-Host. In this way, B will GET data that he never requested.

To avoid this, server implementations need to verify if the requesting client is a trusted client, and also verify if the redirected address is a trusted address.

Security in the cellular network operator network at transport layer by using dedicated Access Points Names (APNs) for the GPRS M2M data. Security for the access to the cellular network operator network (for GPRS/IP as well as short message submission) can be provided at transport layer as well, e.g. by Transport Layer Security (TLS) or Virtual Private Networks (VPNs). Security mechanisms defined in [3gpp_ts23_888] are used to guarantee transport security. The CoAP Payload can be secured using Object Security. If the digital signature does not match pre-shared certificates or decryption fails with a pre-shared key, the server SHOULD ignore the message.

16. IANA Considerations

16.1. CoAP Option Number

The IANA is requested to add the following option number entries to the CoAP Option Number Registry:

Number	Name	Reference
34	Response-To-Uri-Host	Section 2 of this document
38	Response-To-Uri-Port	Section 2 of this document

16.2. URI Scheme Registration

This document requests the registration of the Uniform Resource Identifier (URI) scheme "coap+tel". The registration request complies with [RFC4395].

URI scheme name.

coap+tel

Status.

Permanent.

URI scheme syntax.

Defined in Section 11 of [RFCXXXX].

URI scheme semantics.

TBD

Encoding considerations.

The scheme encoding conforms to the encoding rules established for URIs in [RFC3986], i.e. internationalized and reserved characters are expressed using UTF-8-based percent-encoding.

Applications/protocols that use this URI scheme name.

The scheme is used by CoAP endpoints to access CoAP resources over non-IP transports, i.e. cellular networks.

Interoperability considerations.

None.

Security considerations.

See Section 15 of [RFCXXXX].

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References.

[RFCXXXX]

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18.1. Normative References

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Appendix A. Changelog

Changed from draft-02 to draft-03:

- Added reference to OMA LightweightM2M Technical Specification in "Motivation" section.

- Chose CoAP option numbers and updated the option number table to meet draft-ietf-core-coap-13. Table 1

Changed from draft-01 to draft-02:

- Added security considerations: Transport and Object Security. Section 15

- Reply-To-* changed to Response-To-*. Section 16 and Section 10.1

- Added URI scheme. Section 11

- Added possible CON/NON/ACK interactions. Section 5

- Added possible M2M proxy scenarios. Section 14

- Added reference to bormann-coap-misc for other SMS encoding. Section 7.1

- Updated requirements on Uri-Host and Uri-Port for coap+tel://. Section 10

- Chose CoAP option numbers and updated the option number table to meet draft-ietf-core-coap-10. Table 1

- Added an IANA registration for the URI scheme. Section 16.2

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