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Transport of CoAP over SMS
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Abstract

Short Message Service (SMS) 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 other transports. The adaptation of CoAP to SMS transport mechanisms is described in this document.

Status of this Memo

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1. Introduction

This specification details the usage of the Constrained Application Protocol on the Short Message Service (SMS) 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 will be supported, instead of UDP/IP over General Packet Radio Service (GPRS), High Speed Packet Access (HSPA) or Long Term Evolution (LTE) networks.

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).

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.

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

2. Terminology

This document uses the following terminology:

CoAP Server and Client
: 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].

Mobile Station (MS)
: A Mobile Station includes all required user equipment and software that is needed for communication with a mobile network. As defined in [etsi_ts101_748].

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 over SMS. 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

Two mobile cellular terminals communicate by exchanging a CoAP Request and Response embedded into short message protocol data units (PDUs) (depicted in Figure 1). Both terminals are connected via a Short Message Service Centre (SMS-C).

```
          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)

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 2).

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

Figure 2: IP and Cellular Communication

There are service providers that offer SMS delivery and notification using an HTTP/REST interface (depicted in Figure 3).

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

Figure 3: IP and Cellular Communication (using an SMS 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 4). 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 4: Cellular and IP Communication

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

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

Figure 5: IP and Cellular Communication (using an SMS Service Provider)

5. Message Exchanges

5.1. 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 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 6: 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. Encoding Schemes of CoAP for SMS transport

Short messages can be encoded by using various alphabets: GSM 7 bit default alphabet ([3gpp_ts23_038]), 8 bit data alphabet, and 16 bit USC2 data alphabet ([iso_ucs2]). These encodings lead to message sizes of 160, 140, and 70 characters, respectively. The support of 7 bit encoding is mandatory on a MS. The 7 bit and 16 bit encodings are dependent on the language that needs to be encoded, e.g. USC2 for Arabic, Chinese, Japanese, etc. 8 bit encoding can be used for user specific encoding. Furthermore, the supported encoding scheme highly depends on the implementations of the MS itself.

According to [3gpp_ts23_038], GSM 7 bit encoding shall be supported by all MSs offering SMS services. Since not all MSs support 8 bit short message encoding, the prefered encoding scheme for CoAP messages over SMS is therefore 7 bit, e.g. together with Base64 ([RFC4648]) or SMS encoding in [I-D.bormann-coap-misc].

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

7. Message Size Implementation Considerations

By using 7 bit encoding, a maximum length of 160 characters is allowed in one short message [3gpp_ts23_038]. Consequently, the maximum length for a CoAP message results in 140 bytes. 160 characters = (140 bytes * 8)/7.

Possible options for larger CoAP messages are:

Concatenated short messages
Most MSs are able to send concatenation short messages in order to tranmsit longer messages. The total length of a concatenated short message can consist of up to 255 single messages and result in total length of 39015 7 bit characters or 34170 bytes. Resulting from this, the maximum length of each individual message reduces to 153 (160 - 7) characters (133 bytes).

CoAP blockwise transfer
According to [I-D.ietf-core-block], the Block Size (SZX) of blockwise transfer in CoAP is represented as a three-bit unsigned integer. Thus, the possible block sizes are to the power of two. (Block size = 2**(SZX + 4)). Due to the limitations of 160 characters (140 bytes) for one short message, the maximum value of SZX is 3 (Block size = 128 byte).

However, it is RECOMMENDED that SMS is not used to transfer very large resource data using blockwise transfer.

8. 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.

9. Options for mixed IP operation

In case a CoAP Server has more than one network interface, e.g. SMS and IP, the CoAP Client might want the server to send the response via an alternative transport, i.e. to it's alternative address. However, that implies that the initiating CoAP Client is aware of the presence of the alternative interface. 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.

10. 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.

TODO: Update whenever it has been clarified in [I-D.silverajan-core-coap-alternative-transports]

11. 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 .

12. Multicast

Multicast is not possible with SMS transports.

13. 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.

14. IANA Considerations

14.1. 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 9 of this document
38	Response-To-Uri-Port	Section 9 of this document

14.2. URI Scheme Registration

According to [I-D.silverajan-core-coap-alternative-transports] this document requests the registration of the Uniform Resource Identifier (URI) scheme "coap+alt". The registration request complies with [RFC4395].

15. Acknowledgements

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16. References

16.1. Normative References

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16.2. Informative References

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Appendix A. Changelog

Changed from draft-03 to draft-04:

- o Various editorial changes.
- o Removed USSD and GPRS related parts.
- o Removed section 5: Examples
- o Removed section 14: Proxying Considerations
- o Added more block size considerations.
- o Added more concatenated SMS considerations.
- o Rewrote encoding scheme section; 7 bit encoding only.

Changed from draft-02 to draft-03:

- o Added reference to OMA LightweightM2M Technical Specification in "Motivation" section.
- o Chose CoAP option numbers and updated the option number table to meet draft-ietf-core-coap-13.

Changed from draft-01 to draft-02:

- o Added security considerations: Transport and Object Security. Section 13
- o Reply-To-* changed to Response-To-*. Section 14

- o Added URI scheme.

- o Added possible CON/NON/ACK interactions.

- o Added possible M2M proxy scenarios.

- o Added reference to bormann-coap-misc for other SMS encoding. Section 6

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

- o Chose CoAP option numbers and updated the option number table to meet draft-ietf-core-coap-10. />

- o Added an IANA registration for the URI scheme. Section 14.2

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