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Extending the Presence Information Data Format - Location Object (PIDF-LO) for Assisted Global Positioning System (A-GPS) Data

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Abstract

This document defines how a device encapsulates Assisted Global Positioning System (A-GPS) data to ask a Location Information Server (LIS) to calculate the device's position, and return that information to the device. This communication will be completed using the Session Initiation Protocol (SIP), using Presence Filters specific to A-GPS in a (SUBSCRIBE) request, and a Presence Information Data Format - Location Object (PIDF-LO) as the (NOTIFY) reply.

Table of Contents

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].

1. Introduction

US Global Positioning System (GPS) is widely accepted to enable clients to calculate their location based on data the device receives from satellites. In order to compute the location, an entity must triangulate data received from at least three satellites. For an initial cold start, the GPS device must wait a certain time called the Time-to-First-Fix (TTFF), before it can successfully begin reporting the location. Under certain circumstances, this time can be as long as 12 minutes. The device must also have a line of site view to at least three satellites to successfully get a position fix. This also causes additional battery drain on mobile devices.

In order to address these line of site and timing problems, primarily to reduce the TTFF, a solution called the Assisted GPS (A-GPS) has been deployed [IEEE-1]. A-GPS works by allowing devices to obtain ephemeris data from an Assisted GPS server.

Assisted GPS enables faster computation of the location information

at the clients. This document describes the messaging required to enable Assisted GPS computation on client devices - based on the SIP subscription model established in RFC 3265 [RFC3265], as well as

augmenting the PIDF-LO, as defined in RFC 4119 [RFC4119], to encapsulate additional location related data to a Assisted GPS server. Additionally, this document will define a set of Presence filters to identify within the SIP SUBSCRIBE what is wanted in the NOTIFY. This set of filters is an extension of the SIP 'Location Get' filters first described in here [ID-SIP-GET].

1.1 Terminology and Acronym Explosion

The following terms will be used within this document

A-GPS	Assisted Global Positioning System - A method of GPS positioning where the receiver is assisted through a means other than directly from the GPS satellites.
BS	Base Station [RFC5154] - A generalized equipment set that provides connectivity, management, and control between the subscriber station and IEEE 802.16 network. The term BS can also be applied to cellular systems
DGPS	Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that uses a network of fixed, ground-based reference stations to broadcast the difference between the positions indicated by the satellite systems and the known fixed positions
Ephemeris	An ephemeris is a table of values that gives the positions of astronomical objects in the sky at a given time or times
LIS	Location Information Server - a special instance of a Location Server that consolidates locations of endpoints and responds to queries for locations of devices.
LBS	Location Based Services
LS	Location Server. Defined in RFC 3693 as a device that receives location from a Location Target directly, or from another LS in a chain of LSs, and transmits location to another LS. An LS does not response to queries about a Target's location.
MAC	Media Access Protocol.

MS, SS, MSS: Mobile Station (MS),
Subscriber station (SS),

	Mobile Node (MN) [RFC5121] - The terms subscriber station, mobile station, and mobile node are used to convey the same semantics in this document and refer to an IP host.
TTFF	Time to First Fix. The time required by a GPS receiver to first calculate its position.
UTC	Coordinated Universal Time

2. Assisted-GPS Communications Overview

The GPS devices must have network connectivity for the 'A' in A-GPS in order to get this ephemeris data from the server. These devices usually have a cellular or wireless LAN connection in order to contact the Assisted GPS server. The Assisted GPS server, with good satellite reception and computational power, can assist the client devices to obtain satellite constellation information known as the almanac, satellite ephemeris data, thereby reducing the TTFF. In addition to improving the TTFF, A-GPS requires less computational power and consumes less power at client devices when compared to traditional GPS.

A device capable of using Assisted GPS obtains dynamic assistance information from the Location Information Server (LIS), and requires connectivity or attachment to the network. The A-GPS capable device can take advantage of assists during at least the following scenarios:

1. during boot time - when a device initially powers up
2. at network attachment time - when a device detects attachment to a network
3. Periodically, while attached to the network.
4. On demand, while attached to the network.

The type of server that does this calculation is some form of a LIS, one that is A-GPS capable. The device needs to contact a LIS, and request that it do the conversion. The answer from the LIS will be the conversion that is used.

A-GPS does not have to be a one-time only communication (see Figure 1.). The device can create a subscription with the LIS for periodic or triggered updates (see Figure 2). If triggered updates are a requirement, then SIP appears to be the only IETF protocol (to date) that can accomplish this function, based on the subscription model it has.

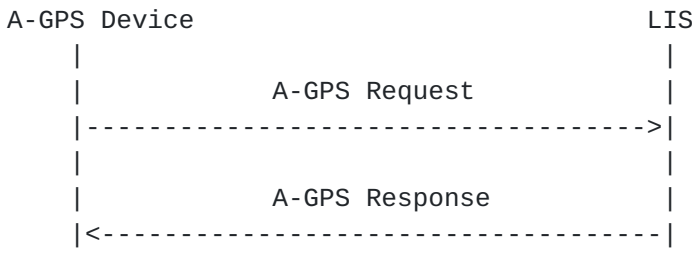

Figure 1. Single Request for A-GPS

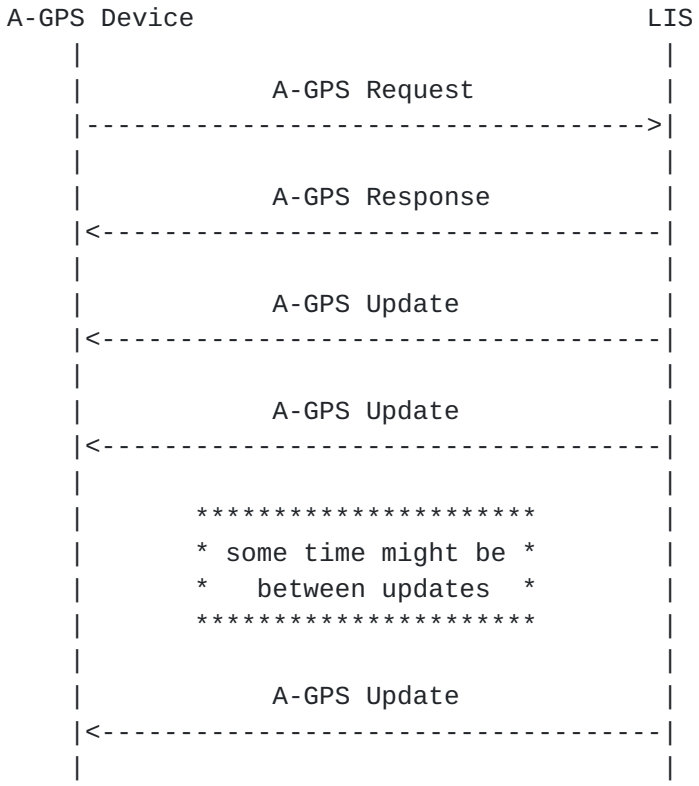

Figure 2. Single Request, Multiple Responses for A-GPS

In Figure 2, the request might create a subscription, asking that more than one notification be sent back to the device. These notifications can be periodic, meaning at a certain interval in time until the subscription is updated or terminated. These notifications can be triggered by the device moving, or thinks it has moved. How a device detects this is out of scope of this document.

3. A-GPS Elements Defined

RFC 4119 extended the PIDF [RFC3863] <status> element with a complex element called <geopriv>. PIDF-LO also created two major

subselements which are encapsulated within <geopriv>: one for location information and one for usage rules. This document does not affect the usage rules subelement. The <location-info> element

MUST contain one or more directives indicating the XML schema(s) that are used for geographic location formats, according to RFC 4119. This document creates a new schema under the <location-info> element, effectively lateral to geo-coordinate location and civic location already established within RFC 4119.

This extension to PIDF-LO creates the <gp:a-gps> element. Below are the mandatory and optional XML subelements contained within the <gp:a-gps> element, with definitions and value ranges. Out of respect for the WiMAX Forum, this payload will be minimal in size, because WiMAX deals with power constrained devices communicating over low speed links (or high speed links shared by many devices - sometimes allowing for each to only have a small part of the available bandwidth), therefore this needs to be thought of in terms of how the XML can be placed into a binary bit-map.

There are 4 message types for adding A-GPS to the PIDF-LO,

Location-Request,
Location-Response,
Assisted-Request and
Assisted-Response.

Some of the individual fields are mandatory (M), and some are optional (O). Each of the message types starts the same 3 elements, with the following elements:

A-GPS Header (Mandatory fields)

Message length (4 bytes) Length of the SIP Payload in bytes

Transaction ID (2 bytes)

Message Type (1 byte) MT = 0 for Assist-REQ
MT = 1 for Assist-RSP
MT = 2 for LOC-REQ
MT = 3 for LOC-RSP

The next set of elements within the XML depends on which of the 4 message types is being communicated. One, and only one of the following message types MUST appear as the next XML elements within the same PIDF-LO.

(M) means an element is mandatory in the message type.
(O) means the element is optional in the message type.

3.1 Message Type=0 Assist Request

Satellite System Type (M) This is set to the type of GPS

satellite system in place. Choices for this element are Navstar, or Galileo.

1 byte :

Local Reference Identifier (M) This is set to the local reference identifier, known to the client at the time of the query. A client accessing this over a wireless LAN network item 1

Local Reference ID (M) For WiMAX or cellular systems, this can be set to the Base-station ID, or for WiFi systems, this can be set to the Access Point MAC address.

Assist-REQ from LS (M) (2 Bytes) bit map of the requested info:

Bit 0: Location aid: coarse location aiding to assist the GPS measurements
Bit 1: coarse time aid
Bit 2: DGPS corrections
Bit 3: navigational model
Bit 4: Acquisition assistance
Bit 5: Satellite health
Bit 6: Ionospheric model
Bit 7: UTC Model
Bit 8: Almanac
Bits 9-15: Reserved

Aiding Mask (O) Aiding Mask for the satellites (32 bit quantity, 1 bit per satellite)

Bit set => ephemeris for the satellite requested

Periodicity (O) Periodicity of the response as expected by the Mobile System. Expressed in terms of time interval (minutes) between two consecutive Responses by LS. Needed only for periodic location

Duration (O) Total duration for which the assist-REQ is valid (in minutes). Needed only for periodic location

3.2 Message Type=1 Assist Response

> Satellite System Type (O) Local reference Identifier. Included
if location aiding is requested by the

	MS for MS initiated TTFF enhancements. For network initiated TTFF enhancement, this parameter is always included.
>sign of latitude (O)	North or south
>latitude (O)	Integer (0..2^23-1). The latitude encoded value (N) is derived from the actual latitude X in degrees (0..90) by this formula: N <= 2^23 X /90 < N+1
>longitude (O)	Integer (-2^23.. 2^23-1). The longitude encoded value (N) is derived from the actual longitude X in degrees (-180..+180) by this formula: N <= 2^24 X /360 < N+1
>uncertainty ellipse (O)	semi major, semi minor, major axis. Refer to Annex A in the LBS Spec
>confidence level (O)	Represents the confidence by which the position of a target entity is known to be within the shape description (i.e., uncertainty ellipse for 2D description, uncertainty ellipsoid for 3D description) and is expressed as a percentage. This is an integer (0..100).
>Z height (O)	Provides altitude information in meters Integer (0..2^15-1). Refer to annex A for details
>Z height uncertainty (O)	Contains the altitude uncertainty code. Refer to Annex A for details
Time aid (O)	Included if time aiding is requested by the MS for MS initiated TTFF enhancements. For network initiated TTFF enhancement, this parameter is always included.
Assistance Data (O)	Included, if requested by MS, based on

the bit map set by the MS in the
Assist-REQ message

Error code (O)	Included in the event of an error. Please see LBS document for the codes

3.3 Message Type=2 Location Request

(Optional unless otherwise indicated)

Periodicity (O)	Periodicity of the response as expected by the MS. Expressed in terms of time interval (seconds) between two consecutive Responses by LS. Needed only for periodic location.
Duration (O)	Total duration for which the LOC-REQ is valid (in seconds). Needed only for periodic location.
Location capabilities (M)	Indicates the capabilities of the MS. A bit vector: Bit 0: Uplink (TDOA) Time Difference of Arrival Bit 1: Down Link (DL) Round Trip Delay (RTD) measurements only Bit 2: DL RD measurements only Bit 3: DL Receive Signal Strength Indication (RSSI) measurements only Bits 4-7: reserved.
Accuracy (O)	Desired accuracy of the location response
Latency (O)	Desired Latency for the location response

3.4 Message Type=3 location Response

MS location (M)	Location of the MS as calculated by it.
>Timestamp (M)	Timestamp when location was calculated
>sign of latitude (M)	North or south
>latitude (M)	Integer (0..2^23-1). The latitude encoded value (N) is

derived from the actual latitude X in
degrees (0..90) by this formula:

	N <= 2^23 X /90 < N+1
>longitude (M)	Integer (-2^23.. 2^23-1). The longitude encoded value (N) is derived from the actual longitude X in degrees (-180..+180) by this formula: N <= 2^24 X /360 < N+1
>uncertainty ellipse (O)	semi major, semi minor, major axis. Refer to Annex A in the LBS Spec
>confidence level (O)	Represents the confidence by which the position of a target entity is known to be within the shape description (i.e., uncertainty ellipse for 2D description, uncertainty ellipsoid for 3D description) and is expressed as a percentage. This is an integer (0..100).
>Z height (O)	Provides altitude information in meters Integer (0..2^15-1). Refer to annex A for details
>Z height uncertainty (O)	Contains the altitude uncertainty code. Refer to Annex A for details
Error code (O)	Included in the event of an error. Please see LBS document for the codes

4. XML Examples

The following is an example taken from RFC4119 [RFC4119] (with an updated times) which provides GPS coordinates as its location format. All the security and privacy rules apply to this PIDF-LO extension as they do to RFC 4119, including any retransmission and retention-expiry elements.

```
<?xml version="1.0" encoding="UTF-8"?>
 <presence xmlns="urn:ietf:params:xml:ns:pidf"
    xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
    xmlns:gml="urn:opengis:specification:gml:schema-xsd:feature:v3.0"
    entity="pres:geotarget@example.com">
```

```
  <tuple id="sg89ae">
   <status>
```

```
    <gp:geopriv>
      <gp:location-info>
        <gml:location>
          <gml:Point gml:id="point1" srsName="epsg:4326">
            <gml:coordinates>37:46:30N 122:25:10W</gml:coordinates>
          </gml:Point>
        </gml:location>
      </gp:location-info>
      <gp:usage-rules>
        <gp:retransmission-allowed>no</gp:retransmission-allowed>
        <gp:retention-expiry>2008-08-03T04:57:29Z</gp:retention-expiry>
      </gp:usage-rules>
    </gp:geopriv>
   </status>
   <timestamp>2008-07-28T20:57:29Z</timestamp>
  </tuple>
 </presence>
```

Removing the non-location specific (i.e., header) elements, we have above this:

```
   <status>
    <gp:geopriv>
      <gp:location-info>
        <gml:location>
          <gml:Point gml:id="point1" srsName="epsg:4326">
            <gml:coordinates>37:46:30N 122:25:10W</gml:coordinates>
          </gml:Point>
        </gml:location>
      </gp:location-info>
      <gp:usage-rules>
        <gp:retransmission-allowed>no</gp:retransmission-allowed>
        <gp:retention-expiry>2008-08-03T04:57:29Z</gp:retention-expiry>
      </gp:usage-rules>
    </gp:geopriv>
   </status>
```

This A-GPS extension will fit **here** in the schema below

```
   <status>
    <gp:geopriv>
      <gp:location-info>
        <gml:location>
          <gml:Point gml:id="point1" srsName="epsg:4326">
            <gml:coordinates>37:46:30N 122:25:10W</gml:coordinates>
          </gml:Point>
        </gml:location>
      / <gp:a-gps>
**here**  ...
```

```
      \ </gp:a-gps>
      </gp:location-info>
      <gp:usage-rules>
```

```
       <gp:retransmission-allowed>no</gp:retransmission-allowed>
       <gp:retention-expiry>2008-08-03T04:57:29Z</gp:retention-expiry>
     </gp:usage-rules>
   </gp:geopriv>
  </status>
```

4.1 Example XML for Message Type=0 Assist Request

```
  <status>
   <gp:geopriv>
     <gp:location-info>
       <gml:location>
       </gml:location>
       <gp:a-gps>
         <messageLength>(4 bytes)</messageLength>
         <transactionID>(2 bytes)</transactionID>
         <messageType>(4 values)</messageType>
         <servingBsId></servingBsId>
         <requestedAssistFromLS>(2 bytes)</requestedAssistFromLS>
         <aidingMask>(4 bytes)</aidingMask>
         <periodicity>(range)</periodicity>
         <duration>(range)</duration>
       </gp:a-gps>
     </gp:location-info>
     <gp:usage-rules>
     </gp:usage-rules>
   </gp:geopriv>
  </status>
```

4.2 Example XML for Message Type=1 Assist Response

```
  <status>
   <gp:geopriv>
     <gp:location-info>
       <gml:location>
       </gml:location>
       <gp:a-gps>
         <messageLength>(4 bytes)</messageLength>
         <transactionID>(2 bytes)</transactionID>
         <messageType>(4 values)</messageType>
         <serving_scannedBsIDloc></serving_scannedBsIDloc>
         <signOfLatitude></signOfLatitude>
         <latitude></latitude>
         <longitude></longitude>
         <uncertaintyEllipse></uncertaintyEllipse>
         <confidenceLevel></confidenceLevel>
```

```
          <zHeight></zHeight>
          <zHeightUncertainty></zHeightUncertainty>
          <timeAid></timeAid>
```

```
          <assistanceData></assistanceData>
          <errorCode></errorCode>
        </gp:a-gps>
      </gp:location-info>
      <gp:usage-rules>
      </gp:usage-rules>
    </gp:geopriv>
   </status>
```

4.3 Example XML for Message Type=2 Location Request

```
   <status>
    <gp:geopriv>
      <gp:location-info>
        <gml:location>
        </gml:location>
        <gp:a-gps>
          <messageLength>(4 bytes)</messageLength>
          <transactionID>(2 bytes)</transactionID>
          <messageType>(4 values)</messageType>
          <periodicity></periodicity>
          <duration></>duration>
          <locationCapabilities></locationCapabilities>
          <accuracy></accuracy>
          <latency></latency>
        </gp:a-gps>
      </gp:location-info>
      <gp:usage-rules>
      </gp:usage-rules>
    </gp:geopriv>
   </status>
```

4.4 Example XML for Message Type=3 Location Response

```
   <status>
    <gp:geopriv>
      <gp:location-info>
        <gml:location>
        </gml:location>
        <gp:a-gps>
          <messageLength>(4 bytes)</messageLength>
          <transactionID>(2 bytes)</transactionID>
          <messageType>(4 values)</messageType>
          <msLocation></msLocation>
          <timestamp></timestamp>
          <signOfLatitude></signOfLatitude>
          <latitude></latitude>
```

```
          <longitude></longitude>
          <uncertaintyEllipse></uncertaintyEllipse>
          <confidenceLevel></confidenceLevel>
```

```
          <zHeight></zHeight>
          <zHeightUncertainty></zHeightUncertainty>
          <errorCode></errorCode>
        </gp:a-gps>
      </gp:location-info>
      <gp:usage-rules>
      </gp:usage-rules>
    </gp:geopriv>
  </status>
```

5. XML Schema for A-GPS within PIDF-LO

TBD

6. Filters to ask for A-GPS within SUBSCRIBE

TBD

7. Known Open Issues

This document is admittedly incomplete. There are many fields and definitions that are not expanded or explained. Part of this is due to synchronizing this document with the WiMAX Forum's WiMAX Location Protocol (WLP), which is still be worked on. Part of this is due to there not being enough time to complete this document.

- does this extension to RFC 4119 necessitate extending the <provided-by> element to include the URI of the LIS?

8. Security considerations

This document introduces no new security considerations from that in RFC 4119 [RFC4119].

9. IANA considerations

TBD

(the modified PIDF-LO schema, the A-GPS filters, and the <method> element will be listed here)

10. Acknowledgments

Your name here... or if you contribute a fair amount of text, you can be a co-author.

11. References

11.1. Normative References

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11.2. Informative References

none

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