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GEOPRIV PIDF-LO Usage Clarification, Considerations and Recommendations
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Abstract

The Presence Information Data Format Location Object (PIDF-LO) specification provides a flexible and versatile means to represent location information. There are, however, circumstances that arise when information needs to be constrained in how it is represented so that the number of options that need to be implemented in order to make use of it are reduced. There is growing interest in being able to use location information contained in a PIDF-LO for routing applications. To allow successfully interoperability between applications, location information needs to be normative and more tightly constrained than is currently specified in the RFC 4119 (PIDF-LO). This document makes recommendations on how to constrain, represent and interpret locations in a PIDF-LO. It further recommends a subset of GML that is mandatory to implemented by applications involved in location based routing.

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1. Introduction

The Presence Information Data Format Location Object (PIDF-LO) [2] is the recommended way of encoding location information and associated privacy policies. Location information in a PIDF-LO may be described in a geospatial manner based on a subset of GMLv3, or as civic location information [5]. A GML profile for expressing geodetic shapes in a PIDF-LO is described in [3]. Uses for PIDF-LO are envisioned in the context of numerous location based applications. This document makes recommendations for formats and conventions to make interoperability less problematic.

2. Terminology

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 [1].

The definition for "Target" is taken from [6].

In this document a "discrete location" is defined as a place, point, area or volume in which a Target can be found. It must be described with sufficient precision to address the requirements of an intended application.

The term "compound location" is used to describe location information represented by a composite of both civic and geodetic information. An example of compound location might be a geodetic polygon describing the perimeter of a building and a civic element representing the floor in the building.

3. Using Location Information

The PIDF format provides for an unbounded number of <tuple> elements. Each <tuple> element contains a single <status> element that may contain more than one <geopriv> element as a child element. Each <geopriv> element must contain at least the following two child elements: <location-info> element and <usage-rules> element. One or more chunks of location information are contained inside a <location-info> element.

Hence, a single PIDF document may contain an arbitrary number of location objects some or all of which may be contradictory or complementary. Graphically, the structure of a PIDF-LO document can be depicted as shown in Figure 1.

```
<?xml version="1.0" encoding="UTF-8"?>
<presence>
   <tuple> -- #1
       <status>
            <geopriv> -- #1
                <location-info>
                    location chunk #1
                    location chunk #2
                    ...
                    location chunk #n
                <usage-rules>
            </geopriv>
            <geopriv> -- #2
            <geopriv> -- #3
            ...
            <geopriv> -- #m
       </status>
   </tuple>
   <tuple> -- #2
   <tuple> -- #3
   ...
   <tuple> -- #o
</presence>
```

Figure 1: Structure of a PIDF-LO Document

All of these potential sources and storage places for location lead to confusion for the generators, conveyors and consumers of location information. Practical experience within the United States National Emergency Number Association (NENA) in trying to solve these ambiguities led to a set of conventions being adopted. These rules

do not have any particular order, but should be followed by creators and consumers of location information contained in a PIDF-LO to ensure that a consistent interpretation of the data can be achieved.

Rule #1: A <geopriv> element MUST describe a discrete location.

Rule #2: Where a discrete location can be uniquely described in more than one way, each location description SHOULD reside in a separate <tuple> element.

Rule #3: Providing more than one location chunk in a single presence document (PIDF) MUST only be done if all objects refer to the same place.

This may occur if a Target's location is determined using a series of different techniques.

Rule #4: Providing more than one location chunk in a single <location-info> element SHOULD be avoided where possible. Rule #5 and Rule #6 provide further refinement.

Rule #5: When providing more than one location chunk in a single <location-info> element the locations MUST be provided by a common source at the same time and by the same location determination method.

Rule #6: Providing more than one location chunk in a single <location-info> element SHOULD only be used for representing compound location referring to the same place.

For example, a geodetic location describing a point, and a civic location indicating the floor in a building.

Rule #7: Where compound location is provided in a single <location-info> element, the coarse location information MUST be provided first.

For example, a geodetic location describing an area, and a civic location indicating the floor should be represented with the area first followed by the civic location.

Rule #8: Where a PIDF document contains more than one <tuple> element containing a <status> element with a <geopriv> element, the priority of tuples SHOULD be based on position of the <tuple> element within the PIDF document. That is to say, the tuple with the highest priority location occurs earliest in the PIDF document.

Rule #9: Where multiple PIDF documents can be sent or received together, say in a multi-part MIME body, and current location information is required by the recipient, then document selection SHOULD be based on document order, with the first document be considered first.

The following examples illustrate the application of these rules.

3.1. Single Civic Location Information

Jane is at a coffee shop on the ground floor of a large shopping mall. Jane turns on her laptop and connects to the coffee-shop's WiFi hotspot, Jane obtains a complete civic address for her current location, for example using the DHCP civic mechanism defined in [4]. A Location Object is constructed consisting of a single PIDF document, with a single <tuple> element, a single <status> element, a single <geopriv> element, and a single location chunk residing in the <location-info> element. This document is unambiguous, and should be interpreted consistently by receiving nodes if sent over the network.

3.2. Civic and Geospatial Location Information

Mike is visiting his Seattle office and connects his laptop into the Ethernet port in a spare cube. In this case location information is geodetic location, with the altitude represented as a building floor number. Mike's main location is the point specified by the geodetic coordinates. Further, Mike is on the second floor of the building located at these coordinates. Applying rules #6 and #7 are applied, the resulting compound location information is shown below.

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
   xmlns:gml="http://www.opengis.net/gml"
   entity="pres:mike@seattle.example.com">
  <tuple id="sg89ab">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gml:Point srsName="urn:ogc:def:crs:EPSG::4326"
             <gml:pos>-43.5723 153.21760</gml:pos>
          </gml:Point>
          <cl:civicAddress>
            <cl:FLR>2</cl:FLR>
          </cl:civicAddress>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2003-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```

3.3. Manual/Automatic Configuration of Location Information

Loraine has a predefined civic location stored in her laptop, since she normally lives in Sydney, the address is for her Sydney-based apartment. Loraine decides to visit sunny San Francisco, and when she gets there she plugs in her laptop and makes a call. Loraine's laptop receives a new location from the visited network in San Francisco. As this system cannot be sure that the pre-existing, and new location, describe the same place, Loraine's computer generates a new PIDF-LO and will use this to represent Loraine's location. If Loraine's computer were to add the new location to her existing PIDF location document (breaking rule #3), then the correct information may still be interpreted by the Location Recipient providing Loraine's system applies rule #9. In this case the resulting order of location information in the PIDF document should be San Francisco first, followed by Sydney. Since the information is provided by different sources, rule #8 should also be applied and the information placed in different tuples with the tuple containing the San Francisco location first.

4. Geodetic Coordinate Representation

The geodetic examples provided in RFC 4119 [2] are illustrated using the <gml:location> element, which uses the <gml:coordinates> element inside the <gml:Point> element and this representation has several drawbacks. Firstly, it has been deprecated in later versions of GML (3.1 and beyond) making it inadvisable to use for new applications. Secondly, the format of the coordinates type is opaque and so can be difficult to parse and interpret to ensure consistent results, as the same geodetic location can be expressed in a variety of ways. The PIDF-LO Geodetic Shapes specification [3] provides a specific GML profile for expressing commonly used shapes using simple GML representations. The shapes defined in [3] are the recommended shapes to ensure interoperability.

5. Geodetic Shape Representation

The cellular mobile world today makes extensive use of geodetic based location information for emergency and other location-based applications. Generally these locations are expressed as a point (either in two or three dimensions) and an area or volume of uncertainty around the point. In theory, the area or volume represents a coverage in which the user has a relatively high probability of being found, and the point is a convenient means of defining the centroid for the area or volume. In practice, most systems use the point as an absolute value and ignore the uncertainty. It is difficult to determine if systems have been implemented in this manner for simplicity, and even more difficult to predict if uncertainty will play a more important role in the future. An important decision is whether an uncertainty area should be specified.

The PIDF-LO Geodetic Shapes specification [3] defines eight shape types most of which are easily translated into shapes definitions used in other applications and protocols, such as Open Mobile Alliance (OMA) Mobile Location Protocol (MLP). For completeness the shapes defined in [3] are listed below:

- Point (2d and 3d)
- Polygon (2d)
- Circle (2d)
- Ellipse (2d)
- Arc band (2d)
- Sphere (3d)
- Ellipsoid (3d)
- Prism (3d)

All above-listed shapes are mandatory to implement.

The GeoShape specification [3] also describes a standard set of coordinate reference systems (CRS), unit of measure (UoM) and conventions relating to lines and distances. The use of the WGS-84 coordinate reference system and the usage of EPSG-4326 (as identified by the URN urn:ogc:def:crs:EPSG::4326) for two dimensional (2d) shape representations and EPSG-4979 (as identified by the URN urn:ogc:def:crs:EPSG::4979) for three dimensional (3d) volume representations is mandated. Distance and heights are expressed in meters using EPSG-9001 (as identified by the URN urn:ogc:def:uom:EPSG::9001). Angular measures MUST use either degrees or radians. Measures in degrees MUST be identified by the URN urn:ogc:def:uom:EPSG::9102, measures in radians MUST be identified by the URN urn:ogc:def:uom:EPSG::9101

Implementations MUST specify the CRS using the srsName attribute on the outermost geometry element. The CRS MUST NOT be respecified or changed for any sub-elements. The srsDimension attribute SHOULD be omitted, since the number of dimensions in these CRSs is known. A CRS MUST be specified using the above URN notation only, implementations do not need to support user-defined CRSs.

It is RECOMMENDED that where uncertainty is included, a confidence of 68% (or one standard deviation) is used. Specifying a convention for confidence enables better use of uncertainty values.

5.1. Polygon Restrictions

The Polygon shape type defined in [3] intentionally does not place any constraints on the number of vertices that may be included to define the bounds of a polygon. This allows arbitrarily complex shapes to be defined and conveyed in a PIDF-LO. However, where location information is to be used in real-time processing applications, such as location dependent routing, having arbitrarily complex shapes consisting of tens or even hundreds of points could result in significant performance impacts. To mitigate this risk it is recommended that Polygon shapes be restricted to a maximum of 15 points (16 including the repeated point) when the location information is intended for use in real-time applications. This limit of 15 points is chosen to allow moderately complex shape definitions while at the same time enabling interoperation with other location transporting protocols such as those defined in 3GPP (see [8]) and OMA where the 15 point limit is already imposed.

Polygons are defined with the minimum distance between two adjacent vertices (geodesic). A connecting line SHALL NOT cross another connecting line of the same Polygon. Polygons SHOULD be defined with the upward normal pointing up, this is accomplished by defining the vertices in counter-clockwise direction.

Points specified in a polygon MUST be coplanar, and it is RECOMMENDED that where points are specified in 3 dimensions that all points maintain the same altitude.

5.2. Shape Examples

This section provides some examples of where some of the more complex shapes are used, how they are determined, and how they are represented in a PIDF-LO. Complete details on all of the Geoshape types are provided in [3].

5.2.1. Point

The point shape type is the simplest form of geodetic LI, which is natively supported by GML. The gml:Point element is used when there is no known uncertainty. A point also forms part of a number of other geometries. A point may be specified using either WGS 84 (latitude, longitude) or WGS 84 (latitude, longitude, altitude). The next example shows a 2d point:

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:point2d@example.com">
  <tuple id="sg89abcd">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gml:Point srsName="urn:ogc:def:crs:EPSG::4326"
               xmlns:gml="http://www.opengis.net/gml">
            <gml:pos>-34.407 150.883</gml:pos>
          </gml:Point>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2007-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```

The next example shows a 3d point:

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:point3d@example.com">
  <tuple id="sg89ab5">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gml:Point srsName="urn:ogc:def:crs:EPSG::4979"
               xmlns:gml="http://www.opengis.net/gml">
            <gml:pos>-34.407 150.883 24.8</gml:pos>
          </gml:Point>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2007-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```

5.2.2. Polygon

The polygon shape may be used to represent a building outline or coverage area. The first and last points of the polygon have to be the same. For example, looking at the octagon below with vertices, A, H, G, F, E, D, C, B, A. The resulting polygon will be defined with 9 points, with the first and last points both having the coordinates of point A.

```
     B-------------C
    /               \
   /                 \
  /                   \
 A                     D
 |                     |
 |                     |
 |                     |
 |                     |
 H                     E
  \                   /
   \                 /
    \               /
     G--------------F
```

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:octagon@example.com">
  <tuple id="sg89ab">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
            <gml:exterior>
              <gml:LinearRing>
                <gml:pos>43.311 -73.422</gml:pos> <!--A-->
                <gml:pos>43.211 -73.422</gml:pos> <!--H-->
                <gml:pos>43.111 -73.322</gml:pos> <!--G-->
                <gml:pos>43.111 -73.222</gml:pos> <!--F-->
                <gml:pos>43.211 -73.122</gml:pos> <!--E-->
                <gml:pos>43.311 -73.122</gml:pos> <!--D-->
                <gml:pos>43.411 -73.222</gml:pos> <!--C-->
                <gml:pos>43.411 -73.322</gml:pos> <!--B-->
                <gml:pos>43.311 -73.422</gml:pos> <!--A-->
              </gml:LinearRing>
           </gml:exterior>
          </gml:Polygon>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2007-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```


5.2.3. Circle

The circular area is used for coordinates in two-dimensional CRSs to describe uncertainty about a point. The definition is based on the one-dimensional geometry in GML, gml:CircleByCenterPoint. The centre point of a circular area is specified by using a two dimensional CRS; in three dimensions, the orientation of the circle cannot be specified correctly using this representation. A point with uncertainty that is specified in three dimensions should use the Sphere shape type.

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:circle@example.com">
  <tuple id="sg89ab1">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
               <gml:pos>
                  42.5463 -73.2512
               </gml:pos>
               <gml:radius uom="urn:ogc:def:uom:EPSG::9001">
                  850.24
               </gml:radius>
          </gs:Circle>
        </gp:location-info>
      </gp:geopriv>
    </status>
  </tuple>
</presence>
```

5.2.4. Ellipse

An elliptical area describes an ellipse in two dimensional space. The ellipse is described by a center point, the length of its semi-major and semi-minor axes, and the orientation of the semi-major axis. Like the circular area (Circle), the ellipse MUST be specified using a two dimensional CRS.

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:Ellipse@somecell.example.com">
  <tuple id="sg89ab7">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:Ellipse srsName="urn:ogc:def:crs:EPSG::4326">
            <gml:pos>
            42.5463 -73.2512
            </gml:pos>
            <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">
            1275
            </gs:semiMajorAxis>
            <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">
            670
            </gs:semiMinorAxis>
            <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">
            43.2
            </gs:orientation>
          </gs:Ellipse>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2003-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```


The gml:pos element indicates the position of the center, or origin, of the ellipse. The gs:semiMajorAxis and gs:semiMinorAxis elements are the length of the semi-major and semi-minor axes respectively. The gs:orientation element is the angle by which the semi-major axis is rotated from the first axis of the CRS towards the second axis. For WGS 84, the orientation indicates rotation from Northing to Easting, which, if specified in degrees, is roughly equivalent to a compass bearing (if magnetic north were the same as the WGS north pole). Note: An ellipse with equal major and minor axis lengths is a circle.

5.2.5. Arc Band

The arc band shape type is commonly generated in wireless systems where timing advance or code offsets sequences are used to compensate for distances between handsets and the access point. The arc band is represented as two radii emanating from a central point, and two angles which represent the starting angle and the opening angle of the arc. In a cellular environment the central point is nominally the location of the cell tower, the two radii are determined by the extent of the timing advance, and the two angles are generally provisioned information.

For example, Paul is using a cellular wireless device and is 7 timing advance symbols away from the cell tower. For a GSM-based network this would place Paul roughly between 3,594 meters and 4,148 meters from the cell tower, providing the inner and outer radius values. If the start angle is 20 degrees from north, and the opening angle is 120 degrees, an arc band representing Paul's location would look similar to the figure below.

```
         N ^        ,.__
           | a(s)  /     `-.
           | 20   /         `-.
           |--.  /             `.
           |   `/                \
           |   /__                \
           |  .   `-.              \
           | .       `.             \
           |. \        \             .
        ---c-- a(o) -- |             | -->
           |.  / 120   '             |   E
           |  .       /              '
           |    .    /              ;
                  .,'              /
               r(i)`.             /
            (3594m)  `.          /
                       `.      ,'
                         `.  ,'
                       r(o)`'
                     (4148m)
```

The resulting PIDF-LO is reflected below.

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:paul@somecell.example.com">
  <tuple id="sg89ab">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:ArcBand srsName="urn:ogc:def:crs:EPSG::4326">
             <gml:pos>
               -43.5723 153.21760
             </gml:pos>
             <gs:innerRadius uom="urn:ogc:def:uom:EPSG::9001">
               3594
             </gs:innerRadius>
             <gs:outerRadius uom="urn:ogc:def:uom:EPSG::9001">
               4148
             </gs:outerRadius>
             <gs:startAngle uom="urn:ogc:def:uom:EPSG::9102">
               20
             </gs:startAngle>
             <gs:openingAngle uom="urn:ogc:def:uom:EPSG::9102">
               20
             </gs:openingAngle>
          </gs:ArcBand>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2003-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```

An important note to make on the arc band is that the center point used in the definition of the shape is not included in resulting enclosed area, and that Target may be anywhere in the defined area of the arc band.

5.2.6. Sphere

The sphere is a volume that provides the same information as a circle in three dimensions. The sphere has to be specified using a three dimensional CRS. The following example shows a sphere shape, which is identical to the circle example, except for the addition of an altitude in the provided coordinates.


```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:circle@example.com">
  <tuple id="sg89ab1">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:Sphere srsName="urn:ogc:def:crs:EPSG::4979">
            <gml:pos>
              42.5463 -73.2512 26.3
            </gml:pos>
            <gs:radius uom="urn:ogc:def:uom:EPSG::9001">
              850.24
            </gs:radius>
          </gs:Sphere>
        </gp:location-info>
      </gp:geopriv>
    </status>
  </tuple>
</presence>
```


5.2.7. Ellipsoid

The ellipsoid is the volume most commonly produced by GPS systems. It is used extensively in navigation systems and wireless location networks. The ellipsoid is constructed around a central point specified in three dimensions, and three axies perpendicular to one another are extended outwards from this point. These axies are defined as the semi-major (M) axis, the semi-minor (m) axis, and the vertical (v) axis respectively. An angle is used to express the orientation of the ellipsoid. The orientation angle is measured in degrees from north, and represents the direction of the semi-major axis from the center point.

```
               \
             _.-\"""""^"""""-._
           .'    \    |        `.
          /       v   m          \
         |         \  |           |
         |          -c ----M---->|
         |                        |
          \                      /
           `._                _.'
              `-...........-'
```

A PIDF-LO containing an ellipsoid would like something like the sample below.

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:somone@gpsreceiver.example.com">
  <tuple id="sg89ab">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:Ellipsoid srsName="urn:ogc:def:crs:EPSG::4979">
            <gml:pos>
              42.5463 -73.2512 26.3
            </gml:pos>
            <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">
              7.7156
            </gs:semiMajorAxis>
            <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">
              3.31
            </gs:semiMinorAxis>
           <gs:verticalAxis uom="urn:ogc:def:uom:EPSG::9001">
             28.7
           </gs:verticalAxis>
           <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">
             90
           </gs:orientation>
          </gs:Ellipsoid>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2003-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```

5.2.8. Prism

A prism may be used to represent a section of a building or range of floors of building. The prism extrudes a polygon by providing a height element. It consists of a base made up of coplanar 3 points defined in 3 dimensions all at the same altitude. The prism is then an extrusion from this base to the value specified in the height element. If the height is negative, then the prism is extruded from the top down, while a positive height extrudes from the bottom up. The first and last points of the polygon have to be the same.

For example, looking at the cube below. If the prism is extruded from the bottom up, then the polygon forming the base of the prism is defined with the points A, B, C, D, A. The height of the prism is the distance between point A and point E in meters. The resulting PIDF-LO is provided below.

```
     G-----F
    /|    /|
   / |   / |
  H--+--E  |
  |  C--|--B
  | /   | /
  |/    |/
  D-----A
```

```
<?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:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
 xmlns:gs="http://www.opengis.net/pidflo/1.0"
 xmlns:gml="http://www.opengis.net/gml"
   entity="pres:mike@someprism.example.com">
  <tuple id="sg89ab">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:Prism srsName="urn:ogc:def:crs:EPSG::4979">
            <gs:base>
               <gml:Polygon>
                  <gml:exterior>
                    <gml:LinearRing>
                       <gml:posList>
                           42.556844 -73.248157 36.6 <!--A-->
                           42.656844 -73.248157 36.6 <!--B-->
                           42.656844 -73.348157 36.6 <!--C-->
                           42.556844 -73.348157 36.6 <!--D-->
                           42.556844 -73.248157 36.6 <!--A-->
                        </gml:posList>
                     </gml:LinearRing>
                  </gml:exterior>
               </gml:Polygon>
            </gs:base>
            <gs:height uom="urn:ogc:def:uom:EPSG::9001">
               2.4
            </gs:height>
         </gs:Prism>
        </gp:location-info>
        <gp:usage-rules/>
      </gp:geopriv>
    </status>
    <timestamp>2007-06-22T20:57:29Z</timestamp>
  </tuple>
</presence>
```

6. Recommendations

As a summary, this document gives a few recommendations on the usage of location information in PIDF-LO. Nine rules specified in Section 3 give guidelines on avoiding ambiguity in PIDF-LO interpretations when multiple locations may be provided to a Target or location recipient.

It is recommended that only the shape types and shape representations described in [3] be used to express geodetic locations for exchange between general applications. By standardizing geodetic data representation interoperability issues are mitigated.

It is recommended that GML Polygons be restricted to a maximum of 16 points when used in location-dependent routing and other real-time applications to mitigate possible performance issues. This allows for interoperability with other location protocols where this restriction applies.

Geodetic location may require restricted shape definitions in regions where migratory emergency IP telephony implementations are deployed. Where the acceptable shape types are not understood restrictions to Point, Circle and Sphere representations should be used to accommodate most existing deployments.

Conversions from one geodetic shape type to another should be avoided where data is considered critical and the introduction of errors considered unacceptable.

In the absence of any application specific knowledge shapes and volumes should assumed to have a corresponding confidence value of 68% when associated representing a Target's location.

7. Security Considerations

The primary security considerations relate to how location information is conveyed and used, which are outside the scope of this document. This document is intended to serve only as a set of guidelines as to which elements MUST or SHOULD be implemented by systems wishing to perform location dependent routing. The ramification of such recommendations is that they extend to devices and clients that wish to make use of such services.

8. IANA Considerations

This document does not introduce any IANA considerations.

9. Acknowledgments

The authors would like to thank the GEOPRIV working group for their discussions in the context of PIDF-LO, in particular Carl Reed, Ron Lake, James Polk and Henning Schulzrinne. Furthermore, we would like to thank Jon Peterson as the author of PIDF-LO and Nadine Abbott for her constructive comments in clarifying some aspects of the document.

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10.2. Informative References

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