Internet Engineering Task Force (IETF)
Request for Comments: 7035
Category: Standards Track
ISSN: 2070-1721

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October 2013

Relative Location Representation

Abstract

This document defines an extension to the Presence Information Data Format Location Object (PIDF-LO) (RFC 4119) for the expression of location information that is defined relative to a reference point. The reference point may be expressed as a geodetic or civic location, and the relative offset may be one of several shapes. An alternative binary representation is described.

Optionally, a reference to a secondary document (such as a map image) can be included, along with the relationship of the map coordinate system to the reference/offset coordinate system, to allow display of the map with the reference point and the relative offset.

Status of This Memo

This is an Internet Standards Track document.

This document is a product of the Internet Engineering Task Force (IETF). It represents the consensus of the IETF community. It has received public review and has been approved for publication by the Internet Engineering Steering Group (IESG). Further information on Internet Standards is available in Section 2 of RFC 5741.

Information about the current status of this document, any errata, and how to provide feedback on it may be obtained at http://www.rfc-editor.org/info/rfc7035.

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1. Introduction

This document describes a format for the expression of relative location information.

A relative location is formed of a reference location plus a relative offset from that reference location. The reference location can be represented in either civic or geodetic form. The reference location can also have dynamic components such as velocity. The relative offset is specified in meters using a Cartesian coordinate system.

In addition to the relative location, an optional URI can be provided to a document that contains a map, floor plan, or other spatially oriented information. Applications could use this information to display the relative location. Additional fields allow the map to be oriented and scaled correctly.

Two formats are included: an XML form that is intended for use in PIDF-LO [RFC4119] and a TLV format for use in other protocols such as those that already convey binary representation of location information defined in [RFC4776].

2. Conventions Used in This Document

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 [RFC2119].

3. Overview

This document describes an extension to PIDF-LO [RFC4119] as updated by [RFC5139] and [RFC5491], to allow the expression of a location as an offset relative to a reference.

```
Reference
Location
    o
     \
      \ Offset
       \
      _\|
        x
      Relative
      Location
```

This extension allows the creator of a location object to include two location values plus an offset. The two location values, named "baseline" and "reference", combine to form the origin of the offset.

The final, relative location is described relative to this reference point.

```
                  ..--"""--..
               .-'           '-.
             ,'                 '.
            / Reference           \
           /      o                \
          |        \                |
          |         \               |
          |          \              |
           \         _\|           /
            '.          x         .'  \_ Baseline
              '._   Relative  _.'        Location
                 '--..___..--'
```

The baseline location is included outside of the <relative-location> element. The baseline location is visible to a client that does not understand relative location (i.e., it ignores the <relative-location> element).

A client that does understand relative location will interpret the location within the relative element as a refinement of the baseline location. This document defines both a reference location, which serves as a refinement of the baseline location and the starting point, and an offset, which describes the location of the Target based on this starting point.

Creators of location objects with relative location thus have a choice of how much information to put into the baseline location and how much to put into the reference location. For example, the baseline location value could be precise enough to specify a building that contains the relative location, and the reference location could specify a point within the building from which the offset is measured.

Location objects SHOULD NOT have all location information in the baseline location. Doing this would cause clients that do not understand relative location to incorrectly interpret the baseline location (i.e., the reference point) as the actual, precise location of the client. The baseline location is intended to carry a location that encompasses both the reference location and the relative location (i.e., the reference location plus offset).

It is possible to provide a valid relative location with no information in the baseline. However, this provides recipients who do not understand relative location with no information. A baseline location SHOULD include sufficient information to encompass both the reference and relative locations while providing a baseline that is as accurate as possible.

Both the baseline and the reference location are defined as either a geodetic location [OGC.GeoShape] or a civic address [RFC4776]. If the baseline location was expressed as a geodetic location, the reference MUST be geodetic. If the baseline location was expressed as a civic address, the reference MUST be civic.

Baseline and reference locations MAY also include dynamic location information [RFC5962].

The relative location can be expressed using a point (2- or 3-dimensional) or a shape that includes uncertainty: circle, sphere, ellipse, ellipsoid, polygon, prism, or arc-band. Descriptions of these shapes can be found in [RFC5491].

Optionally, a reference to a 'map' document can be provided. The reference is a URI [RFC3986]. The document could be an image or dataset that represents a map, floor plan, or other form. The type of document the URI points to is described as a MIME media type [RFC2046]. Metadata in the relative location can include the location of the reference point in the map as well as an orientation (angle from North) and scale to align the document Coordinate Reference System (CRS) with the World Geodetic System 1984 (WGS84) [WGS84] CRS. The document is assumed to be usable by the application receiving the PIDF with the relative location to locate the reference point in the map. This document does not describe any mechanisms for displaying or manipulating the document other than providing the reference location, orientation, and scale.

As an example, consider a relative location expressed as a point, relative to a civic location:


```
<presence xmlns="urn:ietf:params:xml:ns:pidf"
          xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model"
          xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
          xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
          xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
          xmlns:gml="http://www.opengis.net/gml"
          xmlns:gs="http://www.opengis.net/pidflo/1.0"
          entity="pres:relative@example.com">
  <dm:device id="relative1">
    <gp:geopriv>
      <gp:location-info>
        <ca:civicAddress xml:lang="en-AU">
          <ca:country>AU</ca:country>
          <ca:A1>NSW</ca:A1>
```

```
            <ca:A3>Wollongong</ca:A3>
            <ca:A4>North Wollongong</ca:A4>
            <ca:RD>Flinders</ca:RD>
            <ca:STS>Street</ca:STS>
            <ca:HNO>123</ca:HNO>
          </ca:civicAddress>
          <rel:relative-location>
            <rel:reference>
              <ca:civicAddress xml:lang="en-AU">
                <ca:LMK>Front Door</ca:LMK>
              </ca:civicAddress>
            </rel:reference>
            <rel:offset>
              <gml:Point xmlns:gml="http://www.opengis.net/gml"
                         srsName="urn:ietf:params:geopriv:relative:2d">
                <gml:pos>100 50</gml:pos>
              </gml:Point>
            </rel:offset>
          </rel:relative-location>
        </gp:location-info>
        <gp:usage-rules/>
        <gp:method>GPS</gp:method>
        <rel:map>
          <rel:url type="image/png">
             http://example.com/location/map.png
          </rel:url>
          <rel:offset>20. 120.</rel:offset>
          <rel:orientation>29.</rel:orientation>
          <rel:scale>20. -20.</rel:scale>
        </rel:map>
      </gp:geopriv>
      <dm:deviceID>mac:1234567890ab</dm:deviceID>
      <dm:timestamp>2007-06-22T20:57:29Z</dm:timestamp>
    </dm:device>
  </presence>
```


4. Relative Location

Relative location is a shape (e.g., point, circle, ellipse). The shape is defined with a CRS that has a datum defined as the reference (which appears as a civic address or geodetic location in the tuple) and the shape coordinates as meter offsets North/East of the datum measured in meters (with an optional Z offset relative to datum altitude). An optional angle allows the reference CRS be to rotated with respect to North.

4.1. Relative Coordinate System

The relative coordinate reference system uses a coordinate system with two or three axes.

The baseline and reference locations are used to define a relative datum. The reference location defines the origin of the coordinate system. The centroid of the reference location is used when the reference location contains any uncertainty.

The axes in this coordinate system are originally oriented based on the directions of East, North, and Up from the reference location: the first (x) axis increases to the East, the second (y) axis points North, and the optional third (z) axis points Up. All axes of the coordinate system use meters as a basic unit.

Any coordinates in the relative shapes use the described Cartesian coordinate system. In the XML form, this uses a URN of "urn:ietf:params:geopriv:relative:2d" for two-dimensional shapes and "urn:ietf:params:geopriv:relative:3d" for three-dimensional shapes. The binary form uses different shape type identifiers for 2D and 3D shapes.

Dynamic location information [RFC5962] in the baseline or reference location alters the relative coordinate system. The resulting Cartesian coordinate system axes are rotated so that the y axis is oriented along the direction described by the <orientation> element. The coordinate system also moves as described by the <speed> and <heading> elements.

The single timestamp included in the tuple (or equivalent) element applies to all location elements, including all three components of a relative location: baseline, reference, and relative. This is particularly important when there are dynamic components to these items. A location generator is responsible for ensuring the consistency of these fields.

4.2. Placement of XML Elements

The baseline of the reference location is represented as <location-info> like a normal PIDF-LO. Relative location adds a new <relative-location> element to <location-info>. Within <relative-location>, <reference> and <offset> elements are described. Within <offset> are the shape elements described below. This document extends PIDF-LO as described in [RFC6848].

4.3. Binary Format

This document describes a way to encode the relative location in a binary TLV form for use in other protocols that use TLVs to represent location.

A type-length-value encoding is used.

```
+------+------+------+------+------+------+------+
| Type |Length|  Value                         ...
+------+------+------+------+------+------+------+
|  T   |  N   |  Value                         ...
+------+------+------+------+------+------+------+
```

Figure 1: TLV Tuple Format

The Type field (T) is an 8-bit unsigned integer. The type codes used are registered in an IANA-managed "Relative Location Parameters" registry defined by this document and restricted to not include the values defined by the "Civic Address Types (CAtypes)" registry. This restriction permits a location reference and offset to be coded within the same object without type collisions.

The Length field (N) is defined as an 8-bit unsigned integer. This field can encode values from 0 to 255. The length field describes the number of bytes in the Value. Length does not count the bytes used for the Type or Length.

The Value field is defined separately for each type.

Each element of the relative location has a unique TLV assignment. A relative location encoded in TLV form includes both baseline and reference location TLVs and relative location TLVs. The reference TLVs are followed by the relative offset and optional map TLVs described in this document.

4.4. Distances and Angles

All distance measures used in shapes are expressed in meters.

All orientation angles used in shapes are expressed in degrees. Orientation angles are measured from WGS84 Northing to Easting with zero at Northing. Orientation angles in the relative coordinate system start from the second coordinate axis (y or Northing) and increase toward the first axis (x or Easting).

4.5. Value Encoding

The binary form uses single-precision floating-point values [IEEE.754] to represent coordinates, distance, and angle measures. Single-precision values are 32-bit values with a sign bit, 8 exponent bits, and 23 fractional bits. This uses the interchange format defined in [IEEE.754] and Section 3.6 of [RFC1014], that is: sign, biased exponent and significand, with the most significant bit first.

Binary-encoded coordinate values are considered to be a single value without uncertainty. When encoding a value that cannot be exactly represented, the best approximation MUST be selected according to [Clinger1990].

4.6. Relative Location Restrictions

More than one relative shape MUST NOT be included in either a PIDF-LO or TLV encoding of location for a given reference point.

Any error in the reference point transfers to the location described by the relative location. Any errors arising from an implementation not supporting or understanding elements of the reference point directly increases the error (or uncertainty) in the resulting location.

4.7. Baseline TLVs

Baseline locations are described using the formats defined in [RFC4776] or [RFC6225].

4.8. Reference TLVs

When a reference is encoded in binary form, the baseline and reference locations are combined in a reference TLV. This TLV is identified with the code 111 and contains civic address TLVs (if the baseline was a civic) or geo TLVs (if the baseline was a geo).

```
+------+------+------+------+------+------+
|  111 |Length|  Reference TLVs           |
+------+------+------+------+------+------+
```

Figure 2: Reference TLV

4.9. Shapes

Shape data is used to represent regions of uncertainty for the reference and relative locations. Shape data in the reference location uses a WGS84 [WGS84] CRS. Shape data in the relative location uses a relative CRS.

The XML form for shapes uses Geography Markup Language (GML) [OGC.GML-3.1.1], consistent with the rules in [RFC5491]. Reference locations use the CRS URNs specified in [RFC5491]; relative locations use either a 2D CRS ("urn:ietf:params:geopriv:relative:2d") or a 3D ("urn:ietf:params:geopriv:relative:3d"), depending on the shape type.

The binary form of each shape uses a different shape type for 2D and 3D shapes.

Nine shape type codes are defined.

4.9.1. Point

A point "shape" describes a single point with unknown uncertainty. It consists of a single set of coordinates.

In a two-dimensional CRS, the coordinate includes two values; in a three-dimensional CRS, the coordinate includes three values.

4.9.1.1. XML Encoding

A point is represented in GML using the following template:

```
<gml:Point xmlns:gml="http://www.opengis.net/gml"
           srsName="$CRS-URN$">
  <gml:pos>$Coordinate-1 $Coordinate-2$ $Coordinate-3$</gml:pos>
</gml:Point>
```

Figure 3: GML Point Template

Where "$CRS-URN$" is replaced by a "urn:ietf:params:geopriv:relative:2d" or "urn:ietf:params:geopriv:relative:3d" and "$Coordinate-3$" is omitted if the CRS is two-dimensional.

4.9.1.2. TLV Encoding

The point shape is introduced by a TLV of 113 for a 2D point and 114 for a 3D point.

```
+------+------+
| 113/4|Length|
+------+------+------+------+
|  Coordinate-1             |
+------+------+------+------+
|  Coordinate-2             |
+------+------+------+------+
|  (3D-only) Coordinate-3   |
+------+------+------+------+
```

Figure 4: Point Encoding

4.9.2. Circle or Sphere Shape

A circle or sphere describes a single point with a single uncertainty value in meters.

In a two-dimensional CRS, the coordinate includes two values, and the resulting shape forms a circle. In a three-dimensional CRS, the coordinate includes three values, and the resulting shape forms a sphere.

4.9.2.1. XML Encoding

A circle is represented in and converted from GML using the following template:

```
<gs:Circle xmlns:gml="http://www.opengis.net/gml"
           xmlns:gs="http://www.opengis.net/pidflo/1.0"
           srsName="urn:ietf:params:geopriv:relative:2d">
  <gml:pos>$Coordinate-1 $Coordinate-2$</gml:pos>
  <gs:radius uom="urn:ogc:def:uom:EPSG::9001">
    $Radius$
  </gs:radius>
</gs:Circle>
```

Figure 5: GML Circle Template

A sphere is represented in and converted from GML using the following template:

```
<gs:Sphere xmlns:gml="http://www.opengis.net/gml"
           xmlns:gs="http://www.opengis.net/pidflo/1.0"
           srsName="urn:ietf:params:geopriv:relative:3d">
  <gml:pos>$Coordinate-1 $Coordinate-2$ $Coordinate-3$</gml:pos>
  <gs:radius uom="urn:ogc:def:uom:EPSG::9001">
    $Radius$
  </gs:radius>
</gs:Sphere>
```

Figure 6: GML Sphere Template

4.9.2.2. TLV Encoding

A circular shape is introduced by a type code of 115. A spherical shape is introduced by a type code of 116.

```
+------+------+
| 115/6|Length|
+------+------+------+------+
|  Coordinate-1             |
+------+------+------+------+
|  Coordinate-2             |
+------+------+------+------+
|  (3D-only) Coordinate-3   |
+------+------+------+------+
|  Radius                   |
+------+------+------+------+
```

Figure 7: Circle or Sphere Encoding

4.9.3. Ellipse or Ellipsoid Shape

An ellipse or ellipsoid describes a point with an elliptical or ellipsoidal uncertainty region.

In a two-dimensional CRS, the coordinate includes two values plus a semi-major axis, a semi-minor axis, a semi-major axis orientation (clockwise from North). In a three-dimensional CRS, the coordinate includes three values, and in addition to the two-dimensional values, an altitude uncertainty (semi-vertical) is added.

4.9.3.1. XML Encoding

An ellipse is represented in and converted from GML using the following template:

```
<gs:Ellipse xmlns:gml="http://www.opengis.net/gml"
            xmlns:gs="http://www.opengis.net/pidflo/1.0"
            srsName="urn:ietf:params:geopriv:relative:2d">
  <gml:pos>$Coordinate-1 $Coordinate-2$</gml:pos>
  <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">
    $Semi-Major$
  </gs:semiMajorAxis>
  <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">
    $Semi-Minor$
  </gs:semiMinorAxis>
  <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">
    $Orientation$
  </gs:orientation>
</gs:Ellipse>
```

Figure 8: GML Ellipse Template

An ellipsoid is represented in and converted from GML using the following template:

```
<gs:Ellipsoid xmlns:gml="http://www.opengis.net/gml"
              xmlns:gs="http://www.opengis.net/pidflo/1.0"
              srsName="urn:ietf:params:geopriv:relative:3d">
  <gml:pos>$Coordinate-1 $Coordinate-2$ $Coordinate-3$</gml:pos>
  <gs:semiMajorAxis uom="urn:ogc:def:uom:EPSG::9001">
    $Semi-Major$
  </gs:semiMajorAxis>
  <gs:semiMinorAxis uom="urn:ogc:def:uom:EPSG::9001">
    $Semi-Minor$
  </gs:semiMinorAxis>
  <gs:verticalAxis uom="urn:ogc:def:uom:EPSG::9001">
    $Semi-Vertical$
  </gs:verticalAxis>
  <gs:orientation uom="urn:ogc:def:uom:EPSG::9102">
    $Orientation$
  </gs:orientation>
</gs:Ellipsoid>
```

Figure 9: GML Ellipsoid Template

4.9.3.2. TLV Encoding

An ellipse is introduced by a type code of 117, and an ellipsoid is introduced by a type code of 118.

```
+------+------+
| 117/8|Length|
+------+------+------+------+
|  Coordinate-1             |
+------+------+------+------+
|  Coordinate-2             |
+------+------+------+------+
|  (3D-only) Coordinate-3   |
+------+------+------+------+------+------+------+------+
|  Semi-Major Axis          |  Semi-Minor Axis          |
+------+------+------+------+------+------+------+------+
|  Orientation              |  (3D) Semi-Vertical Axis  |
+------+------+------+------+------+------+------+------+
```

Figure 10: Ellipse or Ellipsoid Encoding

4.9.4. Polygon or Prism Shape

A polygon or prism includes a number of points that describe the outer boundary of an uncertainty region. A prism also includes an altitude for each point and prism height.

At least 3 points MUST be included in a polygon. In order to interoperate with existing systems, an encoding SHOULD include 15 or fewer points, unless the recipient is known to support larger numbers.

4.9.4.1. XML Encoding

A polygon is represented in and converted from GML using the following template:

```
<gml:Polygon xmlns:gml="http://www.opengis.net/gml"
             srsName="urn:ietf:params:geopriv:relative:2d">
  <gml:exterior>
    <gml:LinearRing>
      <gml:posList>
        $Coordinate1-1$ $Coordinate1-2$
        $Coordinate2-1$ $Coordinate2-2$
        $Coordinate3-1$ ...
        ...
        $CoordinateN-1$ $CoordinateN-2$
        $Coordinate1-1$ $Coordinate1-2$
      </gml:posList>
    </gml:LinearRing>
  </gml:exterior>
</gml:Polygon>
```

Figure 11: GML Polygon Template

Alternatively, a series of <pos> elements can be used in place of the single "posList". Each <pos> element contains two or three coordinate values.

Note that the first point is repeated at the end of the sequence of coordinates and no explicit count of the number of points is provided.

A GML polygon that includes altitude cannot be represented perfectly in TLV form. When converting to the binary representation, a two-dimensional CRS is used, and altitude is removed from each coordinate.

A prism is represented in and converted from GML using the following template:

```
<gs:Prism xmlns:gml="http://www.opengis.net/gml"
          xmlns:gs="http://www.opengis.net/pidflo/1.0"
          srsName="urn:ietf:params:geopriv:relative:3d">
  <gs:base>
    <gml:Polygon>
      <gml:exterior>
        <gml:LinearRing>
          <gml:posList>
            $Coordinate1-1$ $Coordinate1-2$ $Coordinate1-3$
            $Coordinate2-1$ $Coordinate2-2$ $Coordinate2-3$
            $Coordinate2-1$ ... ...
            ...
            $CoordinateN-1$ $CoordinateN-2$ $CoordinateN-3$
            $Coordinate1-1$ $Coordinate1-2$ $Coordinate1-3$
          </gml:posList>
        </gml:LinearRing>
      </gml:exterior>
    </gml:Polygon>
  </gs:base>
  <gs:height uom="urn:ogc:def:uom:EPSG::9001">
    $Height$
  </gs:height>
</gs:Prism>
```

Figure 12: GML Prism Template

Alternatively, a series of <pos> elements can be used in place of the single "posList". Each <pos> element contains three coordinate values.

4.9.4.2. TLV Encoding

A polygon containing 2D points uses a type code of 119. A polygon with 3D points uses a type code of 120. A prism uses a type code of 121. The number of points can be inferred from the length of the TLV.

```
+------+------+
|119-21|Length|
+------+------+------+------+
|  (3D-only) Height         |
+------+------+------+------+
|  Coordinate1-1            |
+------+------+------+------+
|  Coordinate1-2            |
+------+------+------+------+
|  (3D-only) Coordinate1-3  |
+------+------+------+------+
|  Coordinate2-1            |
+------+------+------+------+
 ...
+------+------+------+------+
|  CoordinateN-1            |
+------+------+------+------+
|  CoordinateN-2            |
+------+------+------+------+
|  (3D-only) CoordinateN-3  |
+------+------+------+------+
```

Figure 13: Polygon or Prism Encoding

Note that unlike the polygon representation in GML, the first and last points are not the same point in the TLV representation. The duplicated point is removed from the binary form.

4.9.5. Arc-Band Shape

An arc-band describes a region constrained by a range of angles and distances from a predetermined point. This shape can only be provided for a two-dimensional CRS.

Distance and angular measures are defined in meters and degrees, respectively. Both are encoded as single-precision floating-point values.

4.9.5.1. XML Encoding

An arc-band is represented in and converted from GML using the following template:

```
<gs:ArcBand xmlns:gml="http://www.opengis.net/gml"
            xmlns:gs="http://www.opengis.net/pidflo/1.0"
            srsName="urn:ietf:params:geopriv:relative:2d">
  <gml:pos>$Coordinate-1$ $Coordinate-2$</gml:pos>
  <gs:innerRadius uom="urn:ogc:def:uom:EPSG::9001">
    $Inner-Radius$
  </gs:innerRadius>
  <gs:outerRadius uom="urn:ogc:def:uom:EPSG::9001">
    $Outer-Radius$
  </gs:outerRadius>
  <gs:startAngle uom="urn:ogc:def:uom:EPSG::9102">
   $Start-Angle$
  </gs:startAngle>
  <gs:openingAngle uom="urn:ogc:def:uom:EPSG::9102">
    $Opening-Angle$
  </gs:openingAngle>
</gs:ArcBand>
```

Figure 14: GML Arc-Band Template

4.9.5.2. TLV Encoding

An arc-band is introduced by a type code of 122.

```
+------+------+
| 122  |Length|
+------+------+------+------+
|  Coordinate               |
+------+------+------+------+
|  Coordinate               |
+------+------+------+------+------+------+------+------+
|  Inner Radius             |  Outer Radius             |
+------+------+------+------+------+------+------+------+
|  Start Angle              |  Opening Angle            |
+------+------+------+------+------+------+------+------+
```

Figure 15: Arc-Band Encoding

4.10. Dynamic Location TLVs

Dynamic location elements use the definitions in [RFC5962].

4.10.1. Orientation

The orientation of the Target is described using one or two angles. Orientation uses a type code of 123.

```
+------+------+
| 123  |Length|
+------+------+------+------+
|         Angle             |
+------+------+------+------+
|   (Optional) Angle        |
+------+------+------+------+
```

Figure 16: Dynamic Orientation TLVs

4.10.2. Speed

The speed of the Target is a scalar value in meters per second. Speed uses a type code of 124.

```
+------+------+
| 124  |Length|
+------+------+------+------+
|         Speed             |
+------+------+------+------+
```

Figure 17: Dynamic Speed TLVs

4.10.3. Heading

The heading, or direction of travel, is described using one or two angles. Heading uses a type code of 125.

```
+------+------+
| 125  |Length|
+------+------+------+------+
|         Angle             |
+------+------+------+------+
|   (Optional) Angle        |
+------+------+------+------+
```

Figure 18: Dynamic Heading TLVs

4.11. Secondary Map Metadata

The optional "map" URL can be used to provide a user of relative location with a visual reference for the location information. This document does not describe how the recipient uses the map nor how it locates the reference or offset within the map. Maps can be simple images, vector files, 2D or 3D geospatial databases, or any other form of representation understood by both the sender and recipient.

4.11.1. Map URL

In XML, the map is a <map> element defined within <relative-location> and contains the URL. The URL is encoded as a UTF-8-encoded string. An "http:" [RFC2616] or "https:" [RFC2818] URL MUST be used unless the entity creating the PIDF-LO is able to ensure that authorized recipients of this data are able to use other URI schemes. A "type" attribute MUST be present and specifies the kind of map the URL points to. Map types are specified as MIME media types as recorded in the IANA Media Types registry, for example, <map type="image/png"> https://www.example.com/floorplans/123South/floor-2</map>.

In binary, the map type is a separate TLV from the map URL. The media type uses a type code of 126; the URL uses a type code of 127.

```
+------+------+------+------+------+------+------+
|  126 |Length|   Map Media Type               ...
+------+------+------+------+------+------+------+
|  127 |Length|   Map Image URL                ...
+------+------+------+------+------+------+------+
```

Figure 19: Map URL TLVs

Note that the binary form restricts data to 255 octets. This restriction could be problematic for URLs in particular. Applications that use the XML form, but cannot guarantee that a binary form won’t be used, are encouraged to limit the size of the URL to fit within this restriction.

4.11.2. Map Coordinate Reference System

The CRS used by the map depends on the type of map. For example, a map described by a 3-D geometric model of the building may contain a complete CRS description in it. For some kinds of maps, typically described as images, the CRS used within the map must define the following:

- o The CRS origin
- o The CRS axes used and their orientation
- o The unit of measure used

This document provides elements that allow for a mapping between the local coordinate reference system used for the relative location and the coordinate reference system used for the map where they are not the same.

4.11.2.1. Map Reference Point Offset

This optional element identifies the coordinates of the reference point as it appears in the map. This value is measured in a map-type-dependent manner, using the coordinate system of the map.

For image maps, coordinates start from the upper left corner, and coordinates are first counted by column with positive values to the right; then, rows are counted with positive values toward the bottom of the image. For such an image, the first item is columns, the second rows, and any third value applies to any third dimension used in the image coordinate space.

The <offset> element contains 2 (or 3) coordinates similar to a GML <pos>. For example:

```
<offset> 2670.0 1124.0 1022.0</offset>
```

The map reference point uses a type code of 129.

```
+------+------+
| 129  |Length|
+------+------+------+------+
|  Coordinate-1             |
+------+------+------+------+
|  Coordinate-2             |
+------+------+------+------+
|  (3D-only) Coordinate-3   |
+------+------+------+------+
```

Figure 20: Map Reference Point Coordinates TLV

If omitted, a value containing all zeros is assumed. If the coordinates provided contain fewer values than are needed, the first value from the set is applied in place of any absent values. Thus, if a single value is provided, that value is used for Coordinate-2 and Coordinate-3 (if required). If two values are provided and three are required, the value of Coordinate-1 is used in place of Coordinate-3.

4.11.2.2. Map Orientation

The map orientation includes the orientation of the map direction in relation to the Earth. Map orientation is expressed relative to the orientation of the relative coordinate system. This means that map orientation with respect to WGS84 North is the sum of the orientation field and any orientation included in a dynamic portion of the reference location. Both values default to zero if no value is specified.

This type uses a single-precision floating-point value of degrees relative to North.

In XML, the <orientation> element contains a single floating-point value, for example, <orientation>67.00</orientation>. In TLV form, map orientation uses the code 130:

```
+------+------+------+------+------+------+
|  130 |Length|  Angle                    |
+------+------+------+------+------+------+
```

Figure 21: Map Orientation TLV

4.11.2.3. Map Scale

The optional map scale describes the relationship between the units of measure used in the map, relative to the meters unit used in the relative coordinate system.

This type uses a sequence of IEEE 754 [IEEE.754] single-precision floating-point values to represent scale as a sequence of numeric values. The units of these values are dependent on the type of map and could, for example, be pixels per meter for an image.

A scaling factor is provided for each axis in the coordinate system. For a two-dimensional coordinate system, two values are included to allow for different scaling along the x and y axes independently. For a three-dimensional coordinate system, three values are specified for the x, y, and z axes. Decoders can determine the number of scaling factors by examining the length field.

Alternatively, a single scaling value MAY be used to apply the same scaling factor to all coordinate components.

Images that use a rows/columns coordinate system often use a left-handed coordinate system. A negative value for the y/rows axis scaling value can be used to account for any change in direction between the y axis used in the relative coordinate system and the rows axis of the image coordinate system.

In XML, the <scale> element MAY contain a single scale value or MAY contain 2 (or 3) values in XML list form. In TLV form, scale uses a type code of 131. The length of the TLV determines how many scale values are present:

```
+------+------+------+------+------+------+
|  131 |Length|  Scale(s)                ...
+------+------+------+------+------+------+
```

Figure 22: Map Scale TLV

4.11.3. Map Example

An example of expressing a map is:

```
<rel:map>
  <rel:url type="image/jpeg">
    http://example.com/map.jpg
  </rel:url>
  <rel:offset>200 210</rel:offset>
  <rel:orientation>68</rel:orientation>
  <rel:scale>2.90 -2.90</rel:scale>
</rel:map>
```

Figure 23: Map Example

5. Examples

The examples in this section combine elements from [RFC3863], [RFC4119], [RFC4479], [RFC5139], and [OGC.GeoShape].

5.1. Civic PIDF with Polygon Offset

```
<presence xmlns="urn:ietf:params:xml:ns:pidf"
          xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model"
          xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
          xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
          xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
          xmlns:gml="http://www.opengis.net/gml"
          xmlns:gs="http://www.opengis.net/pidflo/1.0"
          entity="pres:ness@example.com">
  <dm:device id="nesspc-1">
```

```
      <gp:geopriv>
        <gp:location-info>
          <ca:civicAddress xml:lang="en-AU">
            <ca:country>AU</ca:country>
            <ca:A1>NSW</ca:A1>
            <ca:A3>Wollongong</ca:A3>
            <ca:A4>North Wollongong</ca:A4>
            <ca:RD>Flinders</ca:RD>
            <ca:STS>Street</ca:STS>
            <ca:HNO>123</ca:HNO>
          </ca:civicAddress>
          <rel:relative-location>
            <rel:reference>
              <ca:civicAddress xml:lang="en-AU">
                <ca:LMK>Front Door</ca:LMK>
                <ca:BLD>A</ca:BLD>
                <ca:FLR>I</ca:FLR>
                <ca:ROOM>113</ca:ROOM>
              </ca:civicAddress>
            </rel:reference>
            <rel:offset>
               <gml:Polygon xmlns:gml="http://www.opengis.net/gml"
                    srsName="urn:ietf:params:geopriv:relative:2d">
                 <gml:exterior>
                   <gml:LinearRing>
                     <gml:pos>433.0 -734.0</gml:pos> <!--A-->
                     <gml:pos>431.0 -733.0</gml:pos> <!--F-->
                     <gml:pos>431.0 -732.0</gml:pos> <!--E-->
                     <gml:pos>433.0 -731.0</gml:pos> <!--D-->
                     <gml:pos>434.0 -732.0</gml:pos> <!--C-->
                     <gml:pos>434.0 -733.0</gml:pos> <!--B-->
                     <gml:pos>433.0 -734.0</gml:pos> <!--A-->
                   </gml:LinearRing>
                 </gml:exterior>
              </gml:Polygon>
            </rel:offset>
          </rel:relative-location>
        </gp:location-info>
       <gp:usage-rules/>
        <gp:method>GPS</gp:method>
      </gp:geopriv>
      <dm:deviceID>mac:1234567890ab</dm:deviceID>
      <dm:timestamp>2007-06-22T20:57:29Z</dm:timestamp>
    </dm:device>
  </presence>
```

5.2. Geo PIDF with Circle Offset


```
<?xml version="1.0" encoding="UTF-8"?>
    <presence xmlns="urn:ietf:params:xml:ns:pidf"
         xmlns:dm="urn:ietf:params:xml:ns:pidf:data-model"
         xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
         xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
         xmlns:gml="http://www.opengis.net/gml"
         xmlns:gs="http://www.opengis.net/pidflo/1.0"
         entity="pres:point2d@example.com">
      <dm:device id="point2d">
        <gp:geopriv>
          <gp:location-info>
            <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
              <gml:pos>-34.407 150.883</gml:pos>
              <gs:radius uom="urn:ogc:def:uom:EPSG::9001">
                     50.0
              </gs:radius>
            </gs:Circle>
            <rel:relative-location>
              <rel:reference>
                <gml:Point srsName="urn:ogc:def:crs:EPSG::4326">
                  <gml:pos>-34.407 150.883</gml:pos>
                </gml:Point>
              </rel:reference>
              <rel:offset>
                <gs:Circle xmlns:gml="http://www.opengis.net/gml"
                      srsName="urn:ietf:params:geopriv:relative:2d">
                    <gml:pos>500.0 750.0</gml:pos>
                    <gs:radius uom="urn:ogc:def:uom:EPSG::9001">
                       5.0
                     </gs:radius>
               </gs:Circle>
             </rel:offset>
             <rel:map>
                <rel:url type="image/png">
                  https://www.example.com/flrpln/123South/flr-2
                </rel:url>
                <rel:offset>2670.0 1124.0 1022.0</rel:offset>
                <rel:orientation>67.00</rel:orientation>
                <rel:scale>10 -10</rel:scale>
             </rel:map>
            </rel:relative-location>
          </gp:location-info>
          <gp:usage-rules/>
          <gp:method>Wiremap</gp:method>
        </gp:geopriv>
        <dm:deviceID>mac:1234567890ab</dm:deviceID>
```

```
      <dm:timestamp>2007-06-22T20:57:29Z</dm:timestamp>
    </dm:device>
  </presence>
```

5.3. Civic TLV with Point Offset

Type	Value
0	en
1	IL
3	Chicago
34	Wacker
18	Drive
19	3400
112	Reference
25	Building A
27	Floor 6
26	Suite 213
28	Reception Area
115	100 70
126	image/png
127	http://maps.example.com/3400Wacker/A6
129	0.0 4120.0
130	113.0
131	10.6

6. Schema Definition

Note: The pattern value for "mimeType" has been folded onto multiple lines. Whitespace has been added to conform to comply with document formatting restrictions. Extra whitespace around the line endings MUST be removed before using this schema.

```
<?xml version="1.0"?>
<xs:schema
    xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    xmlns:gml="http://www.opengis.net/gml"
    targetNamespace="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
    elementFormDefault="qualified"
    attributeFormDefault="unqualified">

  <xs:annotation>
    <xs:appinfo
        source="urn:ietf:params:xml:schema:pidf:geopriv10:relative">
      Relative Location for PIDF-LO
    </xs:appinfo>
    <xs:documentation source="http://ietf.org/rfc/rfc7035.txt">
      This schema defines a location representation that allows for
      the description of locations that are relative to another.
      An optional map reference is also defined.
    </xs:documentation>
  </xs:annotation>

  <xs:import namespace="http://www.opengis.net/gml"/>

  <xs:element name="relative-location" type="rel:relativeType"/>

  <xs:complexType name="relativeType">
    <xs:complexContent>
      <xs:restriction base="xs:anyType">
        <xs:sequence>
          <xs:element name="reference" type="rel:referenceType"/>
          <xs:element name="offset" type="rel:offsetType"/>
          <xs:any namespace="##any" processContents="lax"
                  minOccurs="0" maxOccurs="unbounded"/>
        </xs:sequence>
        <xs:anyAttribute namespace="##other" processContents="lax"/>
      </xs:restriction>
    </xs:complexContent>
  </xs:complexType>

  <xs:complexType name="referenceType">
    <xs:complexContent>
```

```
          <xs:restriction base="xs:anyType">
            <xs:sequence>
              <xs:any namespace="##other" processContents="lax"
                      minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:restriction>
        </xs:complexContent>
      </xs:complexType>

      <xs:complexType name="offsetType">
        <xs:complexContent>
          <xs:restriction base="xs:anyType">
            <xs:sequence>
              <xs:element ref="gml:_Geometry"/>
              <xs:any namespace="##other" processContents="lax"
                      minOccurs="0" maxOccurs="unbounded"/>
            </xs:sequence>
          </xs:restriction>
        </xs:complexContent>
      </xs:complexType>

      <xs:element name="map" type="rel:mapType"/>
      <xs:complexType name="mapType">
        <xs:complexContent>
          <xs:restriction base="xs:anyType">
            <xs:sequence>
              <xs:element name="url" type="rel:mapUrlType"/>
              <xs:element name="offset" type="rel:doubleList"
                          minOccurs="0"/>
              <xs:element name="orientation" type="rel:doubleList"
                          minOccurs="0"/>
              <xs:element name="scale" type="rel:doubleList"
                          minOccurs="0"/>
            </xs:sequence>
          </xs:restriction>
        </xs:complexContent>
      </xs:complexType>

      <xs:complexType name="mapUrlType">
        <xs:simpleContent>
          <xs:extension base="xs:anyURI">
            <xs:attribute name="type" type="rel:mimeType"
                          default="application/octet-stream"/>
          </xs:extension>
        </xs:simpleContent>
      </xs:complexType>

      <xs:simpleType name="mimeType">
```

```
      <xs:restriction base="xs:token">
       <xs:pattern value="[!#$%&amp;'\*\+\-\.\dA-Z^_`a-z\|~]+
       /[!#$%&amp;'\*\+\-\.\dA-Z^_`a-z\|~]+([\t ]*;([\t ])*[!#$%&amp;
       '\*\+\-\.\dA-Z^_`a-z\|~]+=([!#$%&amp;'\*\+\-\.\dA-Z^_`a-z\|~]+|
        &quot;([!#-\[\]-~]|[\t ]*|\\[\t !-~])*&quot;))*"/>
      </xs:restriction>
    </xs:simpleType>

    <xs:simpleType name="doubleList">
      <xs:list itemType="xs:double"/>
    </xs:simpleType>

  </xs:schema>
```

7. Security Considerations

This document describes a data format. To a large extent, security properties of this depend on how this data is used.

Privacy for location data is typically important. Adding relative location may increase the precision of the location but does not otherwise alter its privacy considerations, which are discussed in [RFC4119].

The map URL provided in a relative location could accidentally reveal information if a Location Recipient uses the URL to acquire the map. The coverage area of a map, or parameters of the URL itself, could provide information about the location of a Target. In combination with other information that could reveal the set of potential Targets that the Location Recipient has location information for, acquiring a map could leak significant information. In particular, it is important to note that the Target and Location Recipient are often the same entity.

Access to map URLs MUST be secured with TLS [RFC5246] (that is, restricting the map URL to be an https URI), unless the map URL cannot leak information about the Target's location. This restricts information about the map URL to the entity serving the map request. If the map URL conveys more information about a Target than a map server is authorized to receive, that URL MUST NOT be included in the PIDF-LO.

8. IANA Considerations

8.1. Relative Location Registry

This document creates a new registry called "Relative Location Parameters". This shares a page, titled "Civic Address Types Registry" with the existing "Civic Address Types (CAtypes)" registry. As defined in [RFC5226], this new registry operates under "IETF Review" rules.

The content of this registry includes:

Relative Location Code (RLtype): Numeric identifier, assigned by IANA.

Brief description: Short description identifying the meaning of the element.

Reference to published specification: A stable reference to an RFC that describes the value in sufficient detail so that interoperability between independent implementations is possible.

Values requested to be assigned into this registry MUST NOT conflict with values assigned in the "Civic Address Types (CAtypes)" registry or vice versa, unless the IANA Considerations section for the new value explicitly overrides this prohibition and the document defining the value describes how conflicting TLV codes will be interpreted by implementations. To ensure this, the CAtypes entries are explicitly reserved in the initial values table below. Those reserved entries can be changed, but only with caution, as explained here.

To make this clear for future users of the registry, the following note is added to the "Civic Address Types (CAtypes)" registry:

> The registration of new values should be accompanied by a corresponding reservation in the Relative Location Parameters registry.

Similarly, the "Relative Location Parameters" registry bears the note:

> The registration of new values should be accompanied by a corresponding reservation in the Civic Address Types (CAtypes) registry.

The values defined are:

RLtype	description	Reference
0-40 128	RESERVED by CAtypes registry	RFC 7035 & RFC 4776
111	relative location reference	RFC 7035
113	relative location shape 2D point	RFC 7035
114	relative location shape 3D point	RFC 7035
115	relative location shape circular	RFC 7035
116	relative location shape spherical	RFC 7035
117	relative location shape elliptical	RFC 7035
118	relative location shape ellipsoid	RFC 7035
119	relative location shape 2D polygon	RFC 7035
120	relative location shape 3D polygon	RFC 7035
121	relative location shape prism	RFC 7035
122	relative location shape arc-band	RFC 7035
123	relative location dynamic orientation	RFC 7035
124	relative location dynamic speed	RFC 7035
125	relative location dynamic heading	RFC 7035
126	relative location map type	RFC 7035
127	relative location map URI	RFC 7035
129	relative location map coordinates	RFC 7035
130	relative location map angle	RFC 7035
131	relative location map scale	RFC 7035

8.2. URN Sub-Namespace Registration

This document registers a new XML namespace, as per the guidelines in [RFC3688].

URI: urn:ietf:params:xml:ns:pidf:geopriv10:relative

Registrant Contact: IETF, GEOPRIV working group (geopriv@ietf.org), Martin Thomson (martin.thomson@skype.net).

XML:

```
BEGIN
  <?xml version="1.0"?>
  <!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Strict//EN"
       "http://www.w3.org/TR/xhtml1/DTD/xhtml1-strict.dtd">
  <html xmlns="http://www.w3.org/1999/xhtml" xml:lang="en">
    <head>
      <title>GEOPRIV Relative Location</title>
    </head>
    <body>
      <h1>Format for representing relative location</h1>
      <h2>urn:ietf:params:xml:ns:pidf:geopriv10:relative</h2>
      <p>See <a href="http://www.rfc-editor.org/rfc/rfc7035.txt">
             RFC 7035</a>.</p>
    </body>
  </html>

   END
```

8.3. XML Schema Registration

This section registers an XML schema as per the procedures in [RFC3688].

URI: urn:ietf:params:xml:schema:pidf:geopriv10:relative

Registrant Contact: IETF, GEOPRIV working group (geopriv@ietf.org), Martin Thomson (martin.thomson@skype.net)

Schema: The XML for this schema is found in Section 6 of this document.

8.4. Geopriv Identifiers Registry

This section registers two URNs for use in identifying relative coordinate reference systems. These are added to a new "Geopriv Identifiers" registry according to the procedures in Section 4 of [RFC3553]. The "Geopriv Identifiers" registry is entered under the "Uniform Resource Name (URN) Namespace for IETF Use" category.

Registrations in this registry follow the "IETF Review" [RFC5226] policy.

Registry name: Geopriv Identifiers

URN Prefix: urn:ietf:params:geopriv:

Specification: RFC 7035 (this document)

Repository: http://www.iana.org/assignments/geopriv-identifiers

Index value: Values in this registry are URNs or URN prefixes that start with the prefix "urn:ietf:params:geopriv:". Each is registered independently.

Each registration in the "Geopriv Identifiers" registry requires the following information:

URN: The complete URN that is used or the prefix for that URN.

Description: A summary description for the URN or URN prefix.

Specification: A reference to a specification describing the URN or URN prefix.

Contact: Email for the person or groups making the registration.

Index value: As described in [RFC3553], URN prefixes that are registered include a description of how the URN is constructed. This is not applicable for specific URNs.

The "Geopriv Identifiers" registry has two initial registrations, included in the following sections.

8.4.1. Registration of Two-Dimensional Relative Coordinate Reference System URN

This section registers the "urn:ietf:params:geopriv:relative:2d" URN in the "Geopriv Identifiers" registry.

URN: urn:ietf:params:geopriv:relative:2d

Description: A two-dimensional relative coordinate reference system

Specification: RFC 7035 (this document)

Contact: IETF, GEOPRIV working group (geopriv@ietf.org), Martin Thomson (martin.thomson@skype.net)

Index value: N/A

8.4.2. Registration of Three-Dimensional Relative Coordinate Reference System URN

This section registers the "urn:ietf:params:geopriv:relative:3d" URN in the "Geopriv Identifiers" registry.

URN: urn:ietf:params:geopriv:relative:3d

Description: A three-dimensional relative coordinate reference system

Specification: RFC 7035 (this document)

Contact: IETF, GEOPRIV working group (geopriv@ietf.org), Martin Thomson (martin.thomson@skype.net)

Index value: N/A

9. Acknowledgements

This document is the product of a design team on relative location. Besides the authors, this team included Marc Linsner, James Polk, and James Winterbottom.

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