Expressing Confidence in a Location Object
draft-thomson-geopriv-confidence-04

Abstract

   A confidence element is described that expresses the estimated
   probability that the associated location information is correct.
   This element conveys information that might otherwise be lost about
   the probability distribution represented by a region of uncertainty.

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   This Internet-Draft will expire on February 28, 2014.

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1. Introduction

   Location information is often less than perfect. Two measures are
   used to quantify how imperfect the location information is:
   uncertainty and confidence. These terms, and their relationship with
   location information are explored in detail in
   [I-D.thomson-geopriv-uncertainty]. Standard forms for the expression
   of uncertainty are included in [RFC5491], but confidence is fixed to
   a value of 95%.

   On the whole, a fixed definition for confidence ensures consistency
   between implementations. Location generators that are aware of this
   constraint can generate location information at the required
   confidence. Location recipients are able to make sensible
   assumptions about the quality of the information that they receive.

   In some circumstances - particularly with pre-existing systems -
   location generators might provide location information with some
   other confidence. Common values include 38%, 67% and 90%; all of
   which are prevalent in current systems. Existing forms of expressing
   location information, such as that defined in [TS-3GPP-23_032],
   contain elements that express the confidence in the result.

   The addition of a confidence element provides information that was
   previously unavailable to recipients of location information.
   Without this information, a location server or generator that has
   access to location information with a confidence lower than 95% has
   two options:

   o The location server can scale regions of uncertainty in an attempt
      to acheive 95% confidence. This scaling process significantly
      degrades the quality of the information, because the location
      server might not have the necessary information to scale
      appropriately; the location server is forced to make assumptions
      that are likely result in either an overly conservative estimate
      with high uncertainty or a overestimate of confidence.

   o The location server can ignore the confidence entirely, which
      results in giving the recipient a false impression of its quality.

   Both of these choices degrade the quality of the information
   provided.

   The addition of a confidence element avoids this problem entirely if
   a location recipient supports and understands the element. A
   recipient that does not understand, and hence ignores, the confidence
   element is in no worse a position than if the location server ignored
   confidence.

1.1. 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].

   This document relies on the definitions in
   [I-D.thomson-geopriv-uncertainty] and [RFC3693].

2. Representation of Confidence in PIDF-LO

   The confidence element MAY be added to the "location-info" element of
   the Presence Information Data Format - Location Object (PIDF-LO)
   [RFC4119] document. This element expresses the confidence in the
   associated location information as a percentage.

   The confidence element optionally includes an attribute that
   indicates the shape of the probability density function (PDF) of the
   associated region of uncertainty. Three values are possible:
   unknown, normal and rectangular.

   Indicating a particular PDF only indicates that the distribution
   approximately fits the given shape based on the methods used to
   generate the location information. The PDF is normal if there are a
   large number of small, independent sources of error; rectangular if
   all points within the area have roughly equal probability of being
   the actual location of the Target; otherwise, the PDF MUST either be
   set to unknown or omitted.

If a PIDF-LO does not include the confidence element, confidence is
95% [RFC5491]. A Point shape does not have uncertainty (or it has
infinite uncertainty), so confidence is meaningless for a point;
therefore, this element MUST be omitted if only a point is provided.

2.1. Generating Locations with Confidence

Location generators SHOULD attempt to ensure that confidence is equal
in each dimension when generating location information. This
restriction, while not always practical, allows for more accurate
scaling, if scaling is necessary.

Confidence MUST NOT be included unless location information cannot be
acquired with 95% confidence.

2.2. Consuming and Presenting Confidence

The inclusion of confidence that is anything other than 95% presents
a potentially difficult usability for applications that use location
information. Effectively communicating the probability that a
location is incorrect to a user can be difficult.

It is inadvisable to simply display locations of any confidence, or
to display confidence in a separate or non-obvious fashion. If
locations with different confidence levels are displayed such that
the distinction is subtle or easy to overlook - such as using fine
graduations of color or transparency for graphical uncertainty
regions, or displaying uncertainty graphically, but providing
confidence as supplementary text - a user could fail to notice a
difference in the quality of the location information that might be
significant.

Depending on the circumstances, different ways of handling confidence
might be appropriate. [I-D.thomson-geopriv-uncertainty] describes
techniques that could be appropriate for consumers that use automated
processing as well as background on the issue.

Providing that the full implications of any choice for the
application are understood, some amount of automated processing could
be appropriate. In a simple example, applications could choose to
discard or suppress the display of location information if confidence
does not meet a pre-determined threshold.

In settings where there is an opportunity for user training, some of
these problems might be mitigated by defining different operational
procedures for handling location information at different confidence
levels.

3. Example

The PIDF-LO document in Figure 1 includes a representation of
uncertainty as a circular area. The confidence element (on the line
marked with a comment) indicates that the confidence is 67% and that
it follows a normal distribution.

```
  <pidf:presence
      xmlns:pidf="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:gs="http://www.opengis.net/pidflo/1.0"
      xmlns:gml="http://www.opengis.net/gml"
      xmlns:con="urn:ietf:params:xml:ns:pidf:geopriv:conf"
      entity="pres:alice@example.com">
    <dm:device id="sg89ab">
      <pidf:status>
        <gp:geopriv>
          <gp:location-info>
            <gs:Circle srsName="urn:ogc:def:crs:EPSG::4326">
              <gml:pos>42.5463 -73.2512</gml:pos>
              <gs:radius uom="urn:ogc:def:uom:EPSG::9001">
                850.24
              </gs:radius>
            </gs:Circle>
<!-- c -->  <con:confidence pdf="normal">67</con:confidence>
          </gp:location-info>
          <gp:usage-rules/>
        </gp:geopriv>
      </pidf:status>
      <dm:deviceID>mac:010203040506</dm:deviceID>
    </dm:device>
  </pidf:presence>
```

                 Figure 1: Example PIDF-LO with Confidence

4. Confidence Schema

```
<?xml version="1.0"?>
<xs:schema
    xmlns:conf="urn:ietf:params:xml:ns:geopriv:conf"
    xmlns:xs="http://www.w3.org/2001/XMLSchema"
    targetNamespace="urn:ietf:params:xml:ns:geopriv:conf"
    elementFormDefault="qualified"
    attributeFormDefault="unqualified">

  <xs:annotation>
    <xs:appinfo
```

```
        source="urn:ietf:params:xml:schema:geopriv:conf">
      PIDF-LO Confidence
    </xs:appinfo>
    <xs:documentation source="http://www.ietf.org/rfc/rfcXXXX.txt">
      <!-- [[NOTE TO RFC-EDITOR: Please replace above URL with URL of
           published RFC and remove this note.]] -->
      This schema defines an element that is used for indicating
      confidence in PIDF-LO documents.
    </xs:documentation>
  </xs:annotation>

  <xs:element name="confidence" type="conf:confidenceType"/>
  <xs:complexType name="confidenceType">
    <xs:simpleContent>
      <xs:extension base="conf:confidenceBase">
        <xs:attribute name="pdf" type="conf:pdfType"
                      default="unknown"/>
      </xs:extension>
    </xs:simpleContent>
  </xs:complexType>
  <xs:simpleType name="confidenceBase">
    <xs:restriction base="xs:decimal">
      <xs:minExclusive value="0.0"/>
      <xs:maxExclusive value="100.0"/>
    </xs:restriction>
  </xs:simpleType>
  <xs:simpleType name="pdfType">
    <xs:restriction base="xs:token">
      <xs:enumeration value="unknown"/>
      <xs:enumeration value="normal"/>
      <xs:enumeration value="rectangular"/>
    </xs:restriction>
  </xs:simpleType>
</xs:schema>
```

5. IANA Considerations

5.1. URN Sub-Namespace Registration for urn:ietf:params:xml:ns:geopriv:conf

This section registers a new XML namespace,
"urn:ietf:params:xml:ns:geopriv:conf", as per the guidelines in
[RFC3688].

   URI: urn:ietf:params:xml:ns:geopriv:conf

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

      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>PIDF-LO Confidence Attribute</title>
            </head>
            <body>
              <h1>Namespace for PIDF-LO Confidence Attribute</h1>
              <h2>urn:ietf:params:xml:ns:geopriv:conf</h2>
    [[NOTE TO IANA/RFC-EDITOR: Please update RFC URL and replace XXXX
        with the RFC number for this specification.]]
              <p>See RFCXXXX.</p>
            </body>
          </html>
        END

5.2. XML Schema Registration

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

   URI: urn:ietf:params:xml:schema:geopriv:conf

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

   Schema: The XML for this schema can be found as the entirety of
      Section 4 of this document.

6. Security Considerations

   The security (and privacy) implications related to adding this
   information are not significant.

7. References

7.1. Normative References

   [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate
              Requirement Levels", BCP 14, RFC 2119, March 1997.

   [RFC3688] Mealling, M., "The IETF XML Registry", BCP 81, RFC 3688,
              January 2004.

   [RFC4119] Peterson, J., "A Presence-based GEOPRIV Location Object
              Format", RFC 4119, December 2005.

7.2. Informative References

   [RFC3693] Cuellar, J., Morris, J., Mulligan, D., Peterson, J., and
              J. Polk, "Geopriv Requirements", RFC 3693, February 2004.

   [I-D.thomson-geopriv-uncertainty]
              Thomson, M. and J. Winterbottom, "Representation of
              Uncertainty and Confidence in PIDF-LO", draft-thomson-
              geopriv-uncertainty-07 (work in progress), March 2012.

   [RFC5491] Winterbottom, J., Thomson, M., and H. Tschofenig, "GEOPRIV
              Presence Information Data Format Location Object (PIDF-LO)
              Usage Clarification, Considerations, and Recommendations",
              RFC 5491, March 2009.

   [TS-3GPP-23_032]
              3GPP, "Universal Geographic Area Description (GAD)", 3GPP
              TS 23.032 11.0.0, September 2012.

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