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Specifying Civic Address Extensions in PIDF-LO
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Abstract

New fields are occasionally added to civic addresses. A backwardly-compatible mechanism for adding civic address elements to the Geopriv civic address format is described. A formal mechanism for handling unsupported extensions when translating between XML and DHCP civic address forms is defined for entities that need to perform this translation. Initial extensions for some new elements are also defined. The LoST (RFC5222) protocol mechanism that returns civic address element names used for validation of location information is clarified and is normatively updated to require a qualifying namespace identifier on each civic address element returned as part of the validation process.

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1. Introduction

The Geopriv civic location specifications ([RFC4776], [RFC5139]) define an XML and binary representations for civic addresses that allow for the expression of civic addresses. Guidance for the use of these formats for the civic addresses in different countries is included in [RFC5774].

Subsequent to these specifications being produced, use cases for extending the civic address format with new elements have emerged. [RFC5774] describes a mechanism for mapping long-standing address formats into the civic address elements defined in [RFC4776] and [RFC5139]. However, some of these existing address elements do not readily fit into the civic address elements defined in [RFC4776] and [RFC5139]. In these cases creating new civic address elements provides a better solution than overloading existing civic address fields which may cause confusion.

The XML format for civic addresses [RFC5139] provides a mechanism that allows for the addition of standardized or privately understood elements. A similar facility for private extension is not provided for the DHCP format [RFC4776], though new specifications are able to define new CATypes (civic address types).

A recipient of a civic address in either format currently has no option other than to ignore elements that it does not understand. This results in any elements that are unknown to that recipient being discarded if a recipient performs a translation between the two formats. In order for a new extension to be preserved through translation by any recipient, the recipient has to understand the extension and know how to correlate an XML element with a CAtype.

This document describes how new civic address elements are added. Extensions always starts with the definition of XML elements. A mechanism for carrying the extension in the DHCP format is described. A new XML namespace containing a small number of additional civic elements is also defined and can be used as a template to illustrate how other extensions can be defined as required.

These mechanisms ensure that any translation between formats can be performed consistently and without loss of information. Translation between formats can occur without knowledge of every extension that is present.

The registry of numeric CATypes is modified so that creators of extensions can advertise new namespaces and the civic elements to encourage maximum reuse.

The additions described in this document are backwardly compatible. Existing implementations may cause extension information to be lost, but the presence of extensions does not affect an implementation that conforms to either [RFC4776] or [RFC5139].

This document also normatively updates [RFC5222] to clarify that the namespace must be included with the element name in the lists of valid, invalid and not checked elements in the <locationValidation> part of a LoST response. While the LoST schema does not need to be changed, the example in the document is updated to show the namespaces in the lists.

1.1. Motivating Example

One instance where translation might be necessary is where a device receives location configuration using DHCP [RFC4776]. Conversion of DHCP information to an XML form is necessary if the device wishes to use the DHCP-provided information in a range of applications, including location-based presence services [RFC4079], and emergency calling [RFC5012].

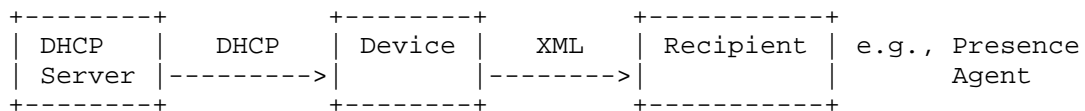


Figure 1: Conversion Scenario

The Device that performs the translation between the DHCP and XML formats might not be aware of some of the extensions that are in use. Without knowledge of these extensions and how they are represented in XML, the Device is forced to discard them.

These extensions could be useful, or may be critical, to the ultimate consumers of this information. For instance, an extension element might provide a presence watcher with important information in locating the Device, or an extension might be significant in choosing a particular call route.

1.2. 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 [RFC2119].

2. Specifying Civic Address Extensions

The civic schema in [RFC5139] defines an ordered structure of elements that can be combined to describe a civic address. The XML extension point at the end of this sequence is used to extend the address.

New elements are defined in a new XML namespace [XMLNS]. This is true of address elements with significance within private or localized domains, as well as those that are intended for global applicability.

New elements SHOULD use the basic "caType" schema type defined in [RFC5139]. This type provides an optional "xml:lang" attribute.

For example, suppose the (fictitious) Central Devon Canals Authority wishes to introduce a new civic element called "bridge". The authority defines an XML namespace that includes a "bridge" element. The namespace needs to be a unique URI, for example "http://devon.canals.example.com/civic".

A civic address that includes the new "bridge" element is shown in Figure 2.

```
<civicAddress xml:lang="en-GB"
  xmlns="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:cdc="http://devon.canals.example.com/civic">
  <country>UK</country>
  <A1>Devon</A1>
  <A3>Monkokehampton</A3>
  <RD>Deckport</RD>
  <STS>Cross</STS>

  <cdc:bridge>21451338</cdc:bridge>

</civicAddress>
```

Figure 2: Extended Civic Address Example

An entity that receives this location information might not understand the extension address element. As long as the added element is able to be safely ignored, the remainder of the civic address can be used. The result is that the information is not as useful as it could be, but the added element does not prevent the use of the remainder of the address.

The address can be passed to other applications, such as a LoST server [RFC5222], without modification. If the application

understands the added element(s), it is able to make use of that information. For example, if this civic address is acquired using HELD [RFC5985], it can be included in a LoST request directly.

3. Translating Unsupported Elements

Unsupported civic address elements can be carried without consequence as long as the format of the address does not change. However, conversion between formats has been shown to be necessary.

Format conversion required knowledge of the format of the address elements. An entity performing a conversion between XML and DHCP address formats was forced to discard unrecognized elements. The entity performing the conversion had no way to know the correct element to use in the target format.

This document defines a single extension element for the DHCP format that makes knowledge of extensions unnecessary during conversion. This extension element relies on the extension mechanisms defined for the XML format. New extensions to the civic address format **MUST** be defined only for the XML format; these extensions are then conveyed in DHCP using the extension element.

Further extensions to the DHCP format are prohibited: these extensions cannot be safely conveyed in environments where conversion is possible.

3.1. XML to DHCP Format Translation

Extensions to the XML format [RFC5139] are defined in a new XML namespace [XMLNS]. The XML namespace received in DHCP is expressed as a URL, however, it should not be dereferenced or treated as a source location for the actual schema and doing so will serve no useful purpose.

Extensions in the XML format can be added to a DHCP format civic address using an extension CAtype.

3.2. Extension Civic Address Type (CAtype)

The extension CAtype (CAtype code XX) [Note to IANA/RFC-Editor: please replace XX here and in Figure 3 and in Figure 5 with the assigned code] includes three values that uniquely identify the XML extension and its value: a namespace URI, the local name of the XML element, and the text content of that element. These three values are all included in the value of the CAtype, each separated by a single whitespace character.

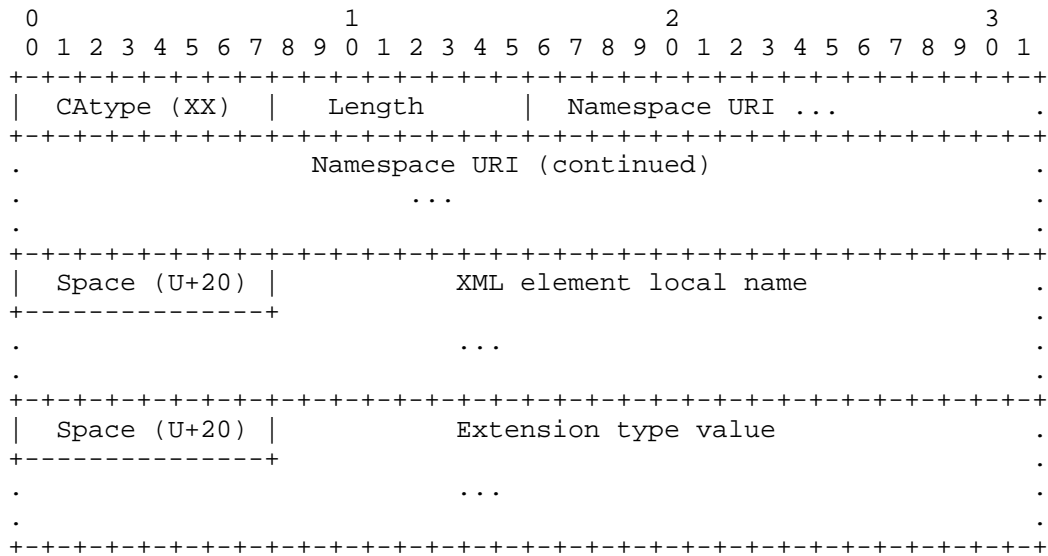


Figure 3: XML Civic Address Extension CAType

CAType (XX) identifies the extension CAType.

Length is the number of octets used to represent the namespace URI, local name and value.

The content of a CAType (after the CAType code and length) is UTF-8 encoded Unicode text [RFC3629]. A maximum of 255 octets is allowed. Octets consumed by the namespace URI and local name reduce the space available for values.

This conversion only works for elements that have textual content and an optional "xml:lang" attribute. Elements with complex content or other attributes - aside from namespace bindings - MUST be ignored if they are not understood.

3.3. DHCP to XML Format Translation

The registration of a new CAType following the process in [RFC4776] means that a recipient that does not know the equivalent XML is unable to produce a complete XML representation of the DHCP civic address. For this reason, this document ends the registration of new numeric CATypes. No new registrations of numeric CATypes can be made.

In lieu of making new numerical CAType assignments, this document creates a new extensionCA type which is defined in a manner that lets

new civic elements be described in DHCP form by carrying the name space and type name of the extension in parameters of the extensionCA type.

When converting to XML, the namespace prefix used for the extension element is selected by the entity that performs the conversion.

3.4. Conversion Example

The following example civic address contains two extensions:

```
<civicAddress xml:lang="en-US"
  xmlns="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:post="http://postsoftheworld.example.com/ns"
  xmlns:ap="http://example.com/airport/5.0">
  <country>US</country>
  <A1>CA</A1>

  <post:lamp>2471</post:lamp>
  <post:pylon>AQ-374-4(c)</post:pylon>

  <ap:airport>LAX</ap:airport>
  <ap:terminal>Tom Bradley</ap:terminal>
  <ap:concourse>G</ap:concourse>
  <ap:gate>36B</ap:gate>
</civicAddress>
```

Figure 4: XML Example with Multiple Extensions

This is converted to a DHCP form as follows:

```
country      = US
CAtype[0]    = en-US
CAtype[1]    = CA
CAtype[XX]   = http://postsoftheworld.example.com/ns lamp 2471
CAtype[XX]   = http://postsoftheworld.example.com/ns pylon AQ-374-4(c)
CAtype[XX]   = http://example.com/airport/5.0 airport LAX
CAtype[XX]   = http://example.com/airport/5.0 terminal Tom Bradley
CAtype[XX]   = http://example.com/airport/5.0 concourse G
CAtype[XX]   = http://example.com/airport/5.0 gate 36B
```

Figure 5: Converted DHCP Example with Multiple Extensions

4. CAtypes Registry

[RFC4776] created the CAtype registry. Among other things, this registry advertised available civic elements. While it has always

been possible to use an extension namespace to define civic elements that are not in the CAtype registry, and this document does not change that, the registry is valuable to alert implementors of commonly used civic elements and provides guidance to clients of what elements they should support.

This document alters the CAtype registry in several ways. It closes the registry to new numeric CAtypes. It deletes the "NENA" column, which is not needed. It adds columns for a namespace and contact, and changes the name of the column currently called "PIDF" to "Local Name". It also adds a column to the registry called "Type". "Type" can have one of two values "A" and "B". Type A elements are intended for wide use with many applications and SHOULD be implemented by all clients unless the client is certain the element will not be encountered. Type "B" civic elements MAY be implemented by any client.

Type A civic elements require IETF review, while Type B elements only require an expert review.

5. Civic Extensions

We use this new extension method to define some additional civic address elements which are needed to correctly encode civic locations in several countries. The definition of these new civic address elements also serves as an example of how to define additional elements using the mechanisms described in this document.

5.1. Pole Number

In some areas, utility and lamp posts carry a unique identifier, which we call a pole number in this document. In some countries, the label on the lamp post also carries the local emergency service number, such as "110", encouraging callers to use the pole number to identify their location.

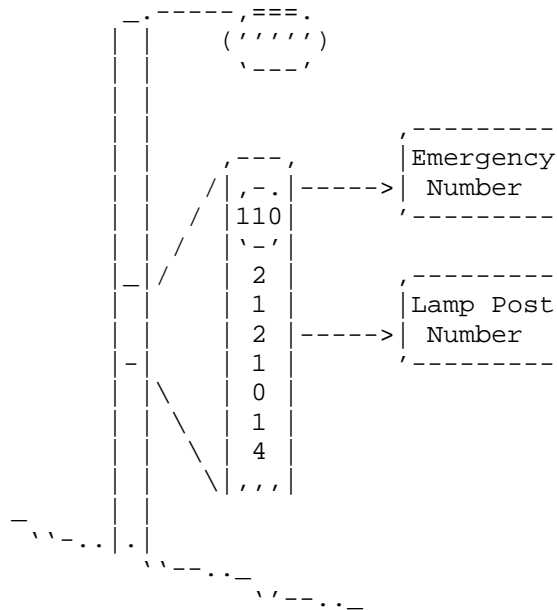


Figure 6: Lamp post with emergency number

5.2. Mile Post

On some roads, trails, railroad rights of way and other linear features, a post with a mile or kilometer distance from one end of the feature may be found (a "milepost"). There are other cases of poles or markers with numeric indications that are not the same as a "house number" or street address number.

5.3. Street Type Prefix

The civic schema defined in [RFC5139] allows the definition of address "123 Colorado Boulevard", but it does not allow for the easy expression of "123 Boulevard Colorado". Adding a street-type prefix, allows street named in this manner to be more easily represented.

5.4. House Number Prefix

The civic schema defined in [RFC5139] provides house number suffix element, allowing one to express an address like "123A Main Street", but it does not contain a corresponding house number prefix. The house number prefix element allows the expression of address such as "Z123 Main Street".

5.5. XML Extension Schema

```
<?xml version="1.0"?>
<xs:schema
  targetNamespace="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext"
  xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:xs="http://www.w3.org/2001/XMLSchema"
  xmlns:cae="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext"
  xmlns:xml="http://www.w3.org/XML/1998/namespace"
  elementFormDefault="qualified" attributeFormDefault="unqualified">

  <xs:import namespace="urn:ietf:params:xml:pidf:geopriv10:civicAddr"/>

  <!-- Post Number -->
  <xs:element name="PN" type="ca:caType"/>

  <!-- Milepost -->
  <xs:element name="MP" type="ca:caType"/>

  <!-- Street-Type prefix -->
  <xs:element name="STP" type="ca:caType"/>

  <!-- House Number Prefix -->
  <xs:element name="HNP" type="ca:caType"/>

</xs:schema>
```

5.6. Extension examples

```
<civicAddress xml:lang="en-US"
  xmlns="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:cae="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext">
  <country>US</country>
  <A1>CA</A1>
  <A2>Sacramento</A2>
  <RD>I5</RD>
  <cae:MP>248</cae:MP>
  <cae:PN>22-109-689</cae:PN>
</civicAddress>
```

XML Example with Post Number and Mile Post

```

<civicAddress xml:lang="en-US"
  xmlns="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:cae="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext">
  <country>US</country>
  <A1>CA</A1>
  <A2>Sacramento</A2>
  <RD>Colorado</RD>
  <HNO>223</HNO>
  <cae:STP>Boulevard</cae:STP>
  <cae:HNP>A</cae:HNP>
</civicAddress>

```

XML Example with Street prefix and House Number Prefix

6. Using Local Civic Extension with the LoST Protocol

One critical use of civic location information is in next generation emergency services applications, in particular call routing applications. In such cases location information is provided to a location-based routing service using the location to service transtion (LoST) protocol [RFC5222]. LoST is used to provide call routing information, but it is also used to validate location information to ensure that it can route to an emergency center when required.

LoST is an XML-based protocol and so the namespace extension mechanisms described in this document do not impact LoST. When LoST is used for validation a <locationValidation> element is returned containing a list of valid, a list of invalid, and a list of unchecked civic elements. Figure 7 is an extract of the validation response in Figure 6 from [RFC5222].

```

<locationValidation>
  <valid>country A1 A3 A6</valid>
  <invalid>PC</invalid>
  <unchecked>HNO</unchecked>
</locationValidation>

```

Figure 7: Location Validation Example from LoST (RFC5222)

The RelaxNG schema in [RFC5222] requires the elements in each of these lists to be namespace qualified, which makes the example in Figure 6 from [RFC5222] in error. This issue is especially significant when local-civic extensions are used as the domain to which the extensions are attributed may impact their interpretation by the server or client. To ensure that local-civic extensions do

not cause issues with LoST server and client implementations, all elements listed in a <valid>, <invalid>, or <unchecked> element MUST be qualified with a namespace. To illustrate this the extract above from figure 6 in [RFC5222] becomes Figure 8.

```
<locationValidation
  xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr">
  <valid>ca:country ca:A1 ca:A3 ca:A6</valid>
  <invalid>ca:PC</invalid>
  <unchecked>ca:HNO</unchecked>
</locationValidation>
```

Figure 8: Corrected Location Validation Example

If a validation request has also included the extensions defined in section Section 5 then the validation response would look like Figure 9.

```
<locationValidation
  xmlns:ca="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:cae="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext">
  <valid>ca:country ca:A1 ca:A3 ca:A6 cae:PN cae:STP</valid>
  <invalid>ca:PC</invalid>
  <unchecked>ca:HNO cae:MP cae:HNP</unchecked>
</locationValidation>
```

Figure 9: Corrected Location Validation Example

7. Security Considerations

This document defines a formal way to extend the existing Geopriv civic address schema. While no security threats are directly introduced by this document, creators of new civic address extensions should refer to sections 4.3.1 and 5.1 of [RFC3694] to understand the environments in which these new elements will be used. New elements should only be registered if the person or organization performing the registration understands any associated risks.

Security threats applicable to the civic address formats are described in [RFC4776] (DHCP) and [RFC5139] (XML).

8. IANA Considerations

This document alters the "CAtypes" registry on the "Civic Address

Types Registry" page established by [RFC4776].

8.1. CAtype Registration for Extensions

IANA has allocated a CAtype code of XX for the extension CAtype. Registrations using this code will be made below, in Section 8.4.

8.2. Changes to the CAtype Registry

IANA is asked to make the following changes to the CAtype registry:

- o No registrations of new CAtype numbers in the Civic Address Types Registry are permitted, except by IESG Approval [RFC5226] under unusual circumstances.
- o The following note will be placed in the header of the CAtypes registry, above the table:

Note: As specified in [[this RFC]], new registrations are only accepted for CAtype XX, using the template specified in Section 8.3.

- o The registration procedures are changed: IETF Review (if Type=A), Expert Review (if Type=B). The designated expert is unchanged.
- o The reference for the table is changed: [RFC4776], [[this RFC]]
- o The column called "NENA" is removed.
- o The column called "PIDF" is renamed to "Local Name".
- o New columns are added named "Namespace URI", "Contact", "Schema" and "Type". All existing entries will have the following values for those new columns:

Namespace URI: urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr

Contact: The IESG (iesg@ietf.org); the GEOPRIV working group (geopriv@ietf.org)

Schema: urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr

Type: A

8.3. Registration Template

New registrations in the Civic Address Types Registry require the following information:

CAtype: The assigned numeric CAtype. All new registrations will use the value XX.

Namespace URI: A unique identifier for the XML namespace used for the extension element.

Local Name: The local name of an XML element that carries the civic address element.

Description: A brief description of the semantics of the civic address element.

Example (optional): One or more simple examples of the element.

Contact: Contact details for the person providing the extension.

Specification (optional): A reference to a specification for the civic address element.

Schema (optional): A reference to a formal schema (XML schema, RelaxNG, or other form) that defines the extension.

Type: "A" or "B".

If Type is "A", all clients SHOULD implement this element. If Type is "B", clients MAY implement this element.

8.4. Registration of the CAtypes defined in this document

This section registers the following four new CAtypes in the Civic Address Types Registry.

Post Number (see Section 5.1):

CAtype: XX

Namespace URI: urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext

Local Name: PN

Description: Post number that is attributed to a lamp post or utility pole.

Contact: The IESG (iesg@ietf.org); the GEOPRIV working group (geopriv@ietf.org)

Specification: [[this RFC]], Section 5
Schema: urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr:ext
Type: A

Mile Post (see Section 5.2):
CAtype: XX
Namespace URI: urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext
Local Name: MP
Description: Mile Post a marker indicating distance to or from a place (often a town).
Contact: The IESG (iesg@ietf.org); the GEOPRIV working group (geopriv@ietf.org)
Specification: [[this RFC]], Section 5
Schema: urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr:ext
Type: A

Street Type Prefix (see Section 5.3):
CAtype: XX
Namespace URI: urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext
Local Name: STP
Description: Street Type Prefix.
Contact: The IESG (iesg@ietf.org); the GEOPRIV working group (geopriv@ietf.org)
Specification: [[this RFC]], Section 5
Schema: urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr:ext
Type: A

House Number Prefix (see Section 5.4):
CAtype: XX
Namespace URI: urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext
Local Name: HNP
Description: House Number Prefix.
Contact: The IESG (iesg@ietf.org); the GEOPRIV working group (geopriv@ietf.org)
Specification: [[this RFC]], Section 5
Schema: urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr:ext
Type: A

8.5. Registration Policy and Expert Guidance

The "CAtypes" registry is altered to operate on a registration policy of "Expert Review", and optionally "Specification Required" [RFC5226] if the element being registered has a Type value of "B".

The registration rules for "Specification Required" are followed only if a registration includes a reference to a specification. Registrations can be made without a specification reference.

If the element being registered has a Type value of "A" then the registration policy is "IETF Review" [RFC5226].

All registrations are reviewed to identify potential duplication between registered elements. Duplicated semantics are not prohibited in the registry, though it is preferred if existing elements are used. The expert review is advised to recommend the use of existing elements following the guidance in [RFC5774]. Any registration that is a duplicate or could be considered a close match for the semantics of an existing element SHOULD include a discussion of the reasons that the existing element was not reused.

[RFC6280] provides a comprehensive framework concerning the privacy of location information as pertaining to its use in Internet applications. The expert reviewer is asked to keep the spirit of this document in mind when reviewing new CAtype registrations.

8.6. URN sub-namespace registration

This document calls for IANA to register a new XML namespace, as per the guidelines in [RFC3688].

URI: urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext

Registrant Contact: IETF GEOPRIV working group, (geopriv@ietf.org),
James Winterbottom (james.Winterbottom@commscope.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>GEOPRIV Civic Address Extensions</title>
  </head>
  <body>
    <h1>Additional Fields for GEOPRIV Civic Address</h1>
    <h2>urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr:ext</h2>
    <p>See <a href="[RFC URL]">RFCXXXX</a>.</p>
  </body>
</html>
END
```

8.7. XML Schema Registration

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

URI: urn:ietf:params:xml:schema:pidf:geopriv10:civicAddr:ext

Registrant Contact: IETF GEOPRIV working group, (geopriv@ietf.org),
James Winterbottom (james.Winterbottom@commscope.com)

XML: The XML for this schema can be found as the entirety of
Section 5.5 of this document.

9. Acknowledgements

Thanks to anyone who has tried to extend the civic schema and found it a little less than intuitive.

10. References

10.1. Normative References

- [RFC2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", BCP 14, RFC 2119, March 1997.
- [RFC3629] Yergeau, F., "UTF-8, a transformation format of ISO 10646", STD 63, RFC 3629, November 2003.
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Relative Location Representation
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Abstract

This document defines an extension to PIDF-LO (RFC4119) 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.

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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, floorplan 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.

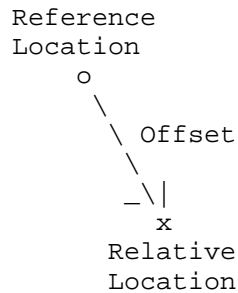
Two formats are included: an XML form that is intended for use in PIDF-LO [RFC4119] and a TLV format for use in other protocols such as those that already convey binary representation of location information defined in [RFC4776].

2. Conventions used in this document

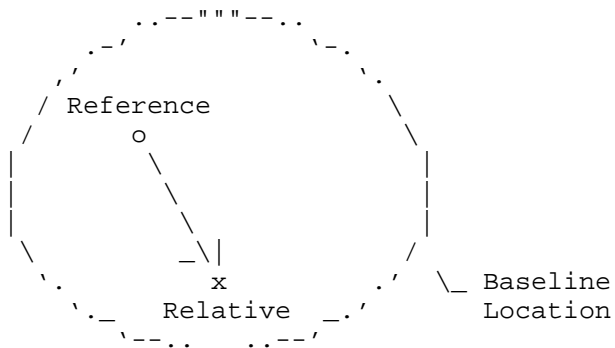
The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC2119].

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.



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.



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 either as 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 a 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, floorplan 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 Co-ordinate Reference System (CRS) with the WGS84 [WGS84] CRS. The document is assumed to be useable 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 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.

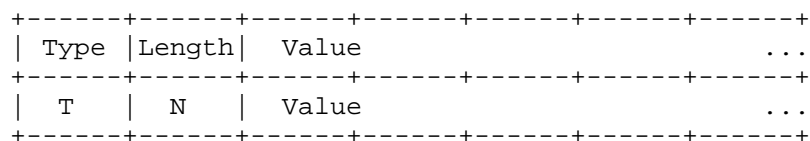


Figure 1: TLV-tuple format

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 "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 a reference location TLVs. The reference TLVs are followed by the relative offset, and optional map TLDs 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 [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 TLV

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
-----+-----+-----+-----+-----+-----+

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>
```

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 |
+-----+-----+-----+-----+
```

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>
```

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>

```

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                    |
+-----+-----+-----+-----+

```

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>

```

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>

```

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
+-----+		+-----+

Ellipse or Ellipsoid Encoding

4.9.4. Polygon or Prism Shape

A polygon or prism include 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>
```

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>
```

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 |
+-----+-----+-----+

```

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>
```

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

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   |
+-----+-----+-----+

```

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               |
+-----+-----+-----+

```

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   |
+-----+-----+-----+

```

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, 2-D or 3-D 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	...

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>
```

Map Reference Point Example XML

The map reference point uses a type code of 129.

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

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, plus 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, example <orientation>67.00</orientation>. In TLV form map orientation uses the code 130:

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

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)                ...
+-----+-----+-----+-----+-----+-----+
```

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>
```

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">

  <!-- [[NOTE TO RFC-EDITOR: Please replace all instances of the URL
        'http://ietf.org/rfc/rfcXXXX.txt' with the URL of published
        document and remove this note.]] -->

  <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/rfcXXXX.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="(!#$$%&'\*\+\-\.\dA-Z_\`a-z\|~]+
      /(!#$$%&'\*\+\-\.\dA-Z_\`a-z\|~]+([ \t ]*([ \t ])*(!#$$%&
      '\*\+\-\.\dA-Z_\`a-z\|~]+=([!#$$%&'\*\+\-\.\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>

```

xml schema relative-location

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, entitled "Civic and Relative Location Parameters" with the existing "Civic Address Types Registry (CATypes)" registry. As defined in [RFC5226], this new registry operates under "IETF Review" rules.

The content of this registry includes:

Relative Location Code: 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 which 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 Registry (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 Registry (CATypes)": 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 Registry (CATypes)" registry.

The values defined are:

RLtype	description	Reference
0-40 128	RESERVED by CATypes registry	this RFC & RFC4776
111	relative location reference	this RFC
113	relative location shape 2D point	this RFC

114	relative location shape 3D point	this RFC
115	relative location shape circular	this RFC
116	relative location shape spherical	this RFC
117	relative location shape elliptical	this RFC
118	relative location shape ellipsoid	this RFC
119	relative location shape 2D polygon	this RFC
120	relative location shape 3D polygon	this RFC
121	relative location shape prism	this RFC
122	relative location shape arc-band	this RFC
123	relative location dynamic orientation	this RFC
124	relative location dynamic speed	this RFC
125	relative location dynamic heading	this RFC
126	relative location map type	this RFC
127	relative location map URI	this RFC
129	relative location map coordinates	this RFC
130	relative location map angle	this RFC
131	relative location map scale	this RFC

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/rfcXXXX.txt">
        RFCXXXX</a>.</p>
    </body>
  </html>
<!--

```

[[NOTE TO RFC-EDITOR: Please replace all instances of RFCXXXX
with the number of the published document and remove this note.]]
-->
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

Registratant 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: RFCXXXX (this document)

Repository: [Editor/IANA note: please include a link to the registry location.]

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: RFCXXXX (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: RFCXXXX (this document)

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Location Information Server (LIS) Discovery using IP address and Reverse
DNS
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Abstract

The residential gateway is a device that has become an integral part of home networking equipment. Discovering a Location Information Server (LIS) is a necessary part of acquiring location information for location-based services. However, discovering a LIS when a residential gateway is present poses a configuration challenge, requiring a method that is able to work around the obstacle presented by the gateway.

This document describes a solution to this problem. The solution provides alternative domain names as input to the LIS discovery process based on the network addresses assigned to a Device.

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1. Introduction

A Location Information Server (LIS) is a service provided by an access network. The LIS uses knowledge of the access network topology and other information to generate location information for Devices. Devices within an access network are able to acquire location information from a LIS.

The relationship between a Device and an access network might be transient. Configuration of the correct LIS at the Device ensures that accurate location information is available. Without location information, some network services are not available.

The configuration of a LIS IP address on a Device requires some automated process. This is particularly relevant when one considers that Devices might move between different access networks served by different LISs. LIS Discovery [RFC5986] describes a method that employs the Dynamic Host Configuration Protocol (DHCPv4 [RFC2131], DHCPv6 [RFC3315]) as input to U-NAPTR [RFC4848] discovery.

A residential gateway, or home router, provides a range of networking functions for Devices within the network it serves. Unfortunately in most cases these functions effectively prevent the successful use of DHCP for LIS discovery.

One drawback with DHCP is that universal deployment of a new option takes a considerable amount of time. Often, networking equipment needs to be updated in order to support the new option. Of particular concern are the millions of residential gateway devices used to provide Internet access to homes and businesses. While [RFC5986] describes functions that can be provided by residential gateways to support LIS discovery, gateways built before the publication of this specification are not expected (and are likely not able) to provide these functions.

This document explores the problem of configuring Devices with a LIS address when a residential gateway is interposed between the Device and access network. Section 3 defines the problem and Section 4 describes a method for determining a domain name that can be used for discovery of the LIS.

In some cases, the solution described in this document is based on a Unilateral Self-Address Fixing (UNSAF) [RFC3424] method. For those cases, this solution is considered transitional until such time as the recommendations for residential gateways in [RFC5986] are more widely deployed. Considerations relating to UNSAF applications are described in Section 8.

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].

This document uses terminology established in [RFC6280] and [RFC5012]. The terms Device and LIS are capitalized throughout when they are used to identify the roles defined in [RFC6280].

3. Problem Statement

Figure 1 shows a simplified network topology for fixed wire-line Internet access. This arrangement is typical when wired Internet access is provided. The diagram shows two network segments: the access network provided by an internet service provider (ISP), and the residential network served by the residential gateway.

There are a number of variations on this arrangement, as documented in Section 3.1 of [RFC5687]. In each of these variations the goal of LIS discovery is to identify the LIS in the access network.

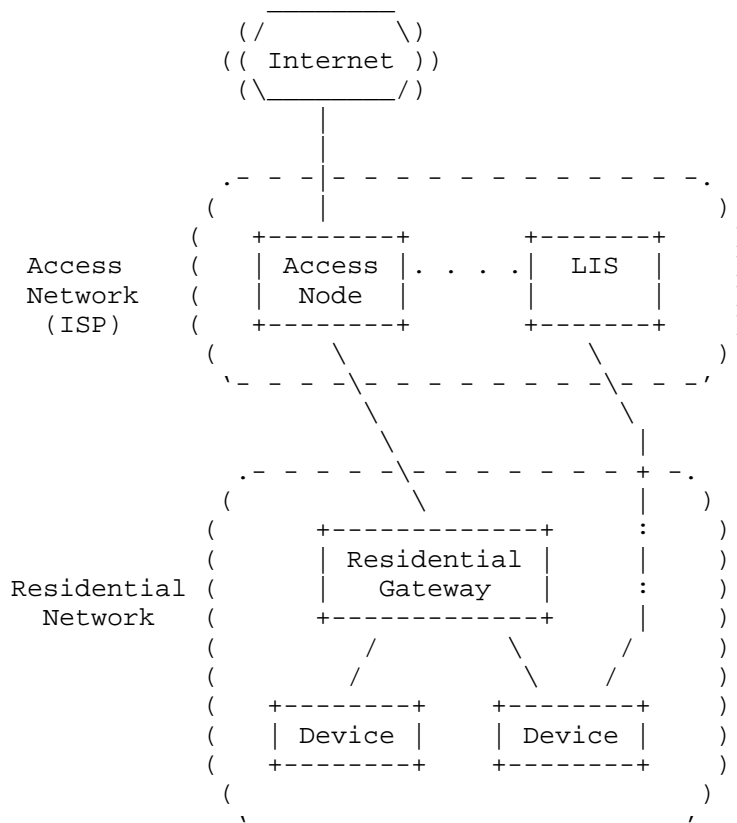


Figure 1: Simplified Network Topology

A particularly important characteristic of this arrangement is the relatively small geographical area served by the residential gateway. Given a small enough area, it is reasonable to delegate the responsibility for providing Devices within the residential network with location information to the ISP. The ISP is able to provide location information that identifies the residence, which should be adequate for a wide range of purposes.

A residential network that covers a larger geographical area might require a dedicated LIS, a case that is outside the scope of this document.

The goal of LIS discovery is to identify a LIS that is able to provide the Device with accurate location information. In the network topology described, this means identifying the LIS in the access network. The residential gateway is a major obstacle in achieving this goal.

3.1. Residential Gateway

A residential gateway can encompass several different functions including: modem, Ethernet switch, wireless access point, router, network address translation (NAT), DHCP server, DNS relay and firewall. Of the common functions provided, the NAT function of a residential gateway has the greatest impact on LIS discovery.

An ISP is typically parsimonious about their IP address allocations; each customer is allocated a limited number of IP addresses. Therefore, NAT is an extremely common function of gateways. NAT enables the use of multiple Devices within the residential network. However NAT also means that Devices within the residence are not configured by the ISP directly.

When it comes to discovering a LIS, the fact that Devices are not configured by the ISP causes a significant problem. Configuration is the ideal method of conveying the information necessary for discovery. Devices attached to residential gateways are usually given a generic configuration that includes no information about the ISP network. For instance, DNS configuration typically points to a DNS relay on the gateway device. This approach ensures that the local network served by the gateway is able to operate without a connection to the ISP, but it also means that Devices are effectively ignorant of the ISP network.

[RFC5986] describes several methods that can be applied by a residential gateway to assist Devices in acquiring location information. For instance, the residential gateway could forward LIS address information to hosts within the network it serves.

Unfortunately, such an active involvement in the discovery process only works for new residential gateway devices that implement those recommendations.

Where residential gateways already exist, direct involvement of the gateway in LIS discovery requires that the residential gateway be updated or replaced. The cost of replacement is difficult to justify to the owner of the gateway, especially when it is considered that the gateway still fills its primary function: Internet access. Furthermore, updating the software in such devices is not feasible in many cases. Even if software updates were made available, many residential gateways cannot be updated remotely, inevitably leading to some proportion that is not updated.

This document therefore describes a method that can be used by Devices to discover their LIS without any assistance from the network.

3.2. Residential Gateway Security Features

A network firewall function is often provided by residential gateways as a security measure. Security features like intrusion detection systems help protect users from attacks. Amongst these protections is a port filter that prevents both inbound and outbound traffic on certain TCP and UDP ports. Therefore, any solution needs to consider the likelihood of traffic being blocked.

4. IP-based DNS Solution

LIS discovery [RFC5986] uses a DNS-based Dynamic Delegation Discovery Service (DDDS) system as the basis of discovery. Input to this process is a domain name. Use of DHCP for acquiring the domain name is specified, but alternative methods of acquisition are permitted.

This document specifies a means for a Device to discover several alternative domain names that can be used as input to the DDDS process. These domain names are based on the IP address of the Device. Specifically, the domain names are a portion of the reverse DNS trees - either the ".in-addr.arpa." or ".ip6.arpa." tree.

The goal of this process is to make a small number of DDDS queries in order to find a LIS. After LIS discovery using the DHCP-based process in [RFC5986] has failed, a Device can:

1. Collect a set of IP addresses that refer to the Device (Section 4.1).

2. Convert each IP address into DNS names in the "in-addr.arpa." or "ip6.arpa." tree (Section 4.2).
3. Perform the DDDS process for LIS discovery on those DNS names ([RFC5986]).
4. Shorten the DNS names by some number of labels and repeat the DDDS process (Section 4.3).

A Device might be reachable at one of a number of IP addresses. In the process described, a Device first identifies each IP address that it is potentially reachable from. From each of these addresses, the Device then selects up to three domain names for use in discovery. These domain names are then used as input to the DDDS process.

4.1. Identification of IP Addresses

A Device identifies a set of potential IP addresses that currently result in packets being routed to it. These are ordered by proximity, with those addresses that are used in adjacent network segments being favoured over those used in public or remote networks. The first addresses in the set are those that are assigned to local network interfaces.

A Device can use the Session Traversal Utilities for NAT (STUN) [RFC5389] mechanism to determine its public reflexive transport address. The host uses the "Binding Request" message and the resulting "XOR-MAPPED-ADDRESS" parameter that is returned in the response.

Alternative methods for determining other IP addresses MAY be used by the Device. Port Control Protocol (PCP) [RFC6887], Universal Plug and Play (UPnP) [UPnP-IGD-WANIPConnection1] and NAT Port Mapping Protocol (NAT-PMP) [I-D.cheshire-nat-pmp] are both able to provide the external address of a residential gateway device when enabled. These as well as proprietary methods for determining other addresses might also be available. Because there is no assurance that these methods will be supported by any access network, these methods are not mandated. Note also that in some cases, methods that rely on the view of the network from the residential gateway device could reveal an address in a private address range (see Section 4.6).

In many instances, the IP address produced might be from a private address range. For instance, the address on a local network interface could be from a private range allocated by the residential gateway. In other cases, methods that rely on the view of the network (UPnP, NAT-PMP) from the residential gateway device could reveal an address in a private address range if the access network

also uses NAT. For a private IP address, the derived domain name is only usable where the DNS server used contains data for the corresponding private IP address range.

4.2. Domain Name Selection

The domain name selected for each resulting IP address is the name that would be used for a reverse DNS lookup. The domain name derived from an IP version 4 address is in the ".in-addr.arpa." tree and follows the construction rules in Section 3.5 of [RFC1035]. The domain name derived from an IP version 6 address is in the ".ip6.arpa." tree and follows the construction rules in Section 2.5 of [RFC3596].

4.3. Shortened DNS Names

Additional domain names are added to allow for a single DNS record to cover a larger set of addresses. If the search on the domain derived from the full IP address does not produce a NAPTR record with the desired service tag (e.g., "LIS:HELD"), a similar search is repeated based on a shorter domain name, using a part of the IP address:

- o For IP version 4, the resulting domain name SHOULD be shortened successively by one and two labels and the query repeated. This corresponds to a search on a /24 or /16 network prefix. This allows for fewer DNS records in the case where a single access network covering an entire /24 or /16 network is served by the same LIS.
- o For IP version 6, the resulting domain name SHOULD be shortened successively by 16, 18, 20 and 24 labels and the query repeated. This corresponds to a search on a /64, /56, /48 or /32 network prefix.

This set of labels is intended to provide network operators with a degree of flexibility in where LIS discovery records can be placed without significantly increasing the number of DNS names that are searched. This does not attach any other significance to these specific zone cuts, or create a classful addressing hierarchy based on the reverse DNS tree.

For example, the IPv4 address "192.0.2.75" could result in queries to:

- o 75.2.0.192.in-addr.arpa.
- o 2.0.192.in-addr.arpa.

- o 0.192.in-addr.arpa.

Similarly, the IPv6 address "2001:DB8::28e4:3a93:4429:dfb5" could result in queries to:

- o 5.b.f.d.9.2.4.4.3.9.a.3.4.e.8.2.0.0.0.0.0.0.0.0.8.b.d.0.1.0.0.2.ip6.arpa.
- o 0.0.0.0.0.0.0.0.0.8.b.d.0.1.0.0.2.ip6.arpa.
- o 0.0.0.0.0.0.8.b.d.0.1.0.0.2.ip6.arpa.
- o 0.0.0.0.8.b.d.0.1.0.0.2.ip6.arpa.
- o 8.b.d.0.1.0.0.2.ip6.arpa.

The limited number of labels by which each name is shortened is intended to limit the number of DNS queries performed by Devices. If no LIS is discovered by this method, the result will be that no more than five U-NAPTR resolutions are invoked for each IP address.

4.4. When To Use The Reverse DNS Method

The DHCP method described in [RFC5986] MUST be attempted on all local network interfaces before attempting this method. This method is employed either because DHCP is unavailable, when the DHCP server does not provide a value for the access network domain name option, or if a request to the resulting LIS results in a HELD "notLocatable" error or equivalent.

4.5. Private Address Spaces

Addresses from a private use address space can be used as input to this method. In many cases, this applies to addresses defined in [RFC1918], though other address ranges could have limited reachability where this advice also applies. This is only possible if a DNS server with a view of the same address space is used. Public DNS servers cannot provide useful records for private addresses.

Using an address from a private space in discovery can provide a more specific answer if the DNS server has records for that space. Figure 2 shows a network configuration where addresses from an ISP network could better indicate the correct LIS. Records in DNS B can be provided for the 10.0.0.0/8 range, potentially dividing that range so that a more local LIS can be selected.

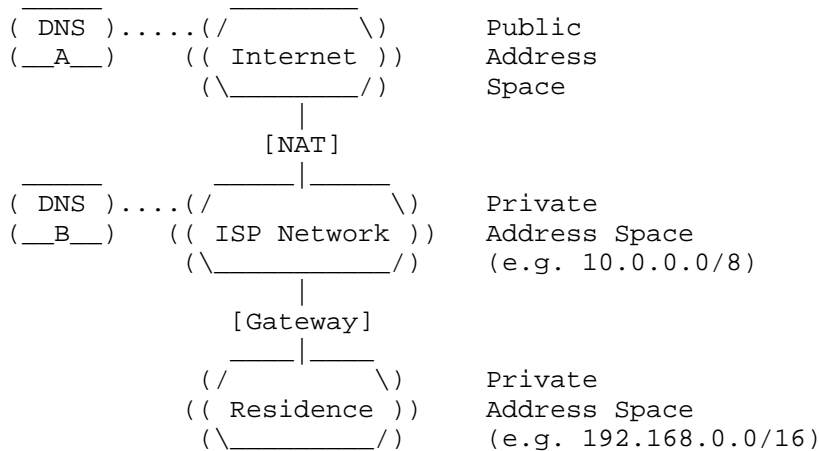


Figure 2: Address Space Example

The goal of automatic DNS configuration is usually to select a local DNS, which suits configurations like the one shown. However, use of public DNS or STUN servers means that a public IP address is likely to be found. For STUN in particular, selecting a public server minimizes the need for reconfiguration when a Device moves. Adding records for the public address space used by an access network ensures that the discovery process succeeds when a public address is used.

4.6. Necessary Assumptions and Restrictions

When used by a Device for LIS discovery this is an UNSAF application and is subject to the limitations described in Section 8.

It is not necessary that the IP address used is unique to the Device, only that the address can be somehow related to the Device or the access network that serves the Device. This allows a degree of flexibility in determining this value, although security considerations (Section 7) might require that the address be verified to limit the chance of falsification.

This solution assumes that the public reflexive transport address used by a Device is in some way controlled by the access network provider, or some other related party. This implies that the corresponding ".in-addr.arpa." or ".ip6.arpa." record can be updated by that entity to include a useful value for the LIS address.

4.7. Failure Modes

Successful use of private addresses relies on a DNS server that has records for the address space that is used. Using a public IP address increases the likelihood of this. This document relies on STUN to provide the Device with a public reflexive transport address. Configuration of a STUN server is necessary to ensure that this is successful.

In cases where a virtual private network (VPN) or other tunnel is used, the entity providing a public IP address might not be able to provide the Device with location information. It is assumed that this entity is able to identify this problem and indicate this to the Device (using the "notLocatable" HELD error, or similar). This problem is described in more detail in [RFC5985].

4.8. Deployment Considerations

An access network provider SHOULD provide NAPTR records for each public IP address that is used for Devices within the access network.

Any DNS server internal to a NAT SHOULD also include records for the private address range. These records might only be provided to clients making requests from the private address range. Doing so allows clients within the private address range to discover a LIS based on their IP address prior to any address translation. In geographically distributed networks that use a private address range, this enables the use of a different LIS for different locations, based on the IP address range used at each location. Use of a public, translated IP address for the network can still work, but it might result in a suboptimal LIS selection.

A network that operates network address translation SHOULD provide NAPTR records that reference a LIS endpoint with a public address. This requires the reservation of an IP and port for the LIS. To ensure requests toward the LIS from within the private address space do not traverse the NAT and have source addresses mapped by the NAT, networks can provide direct route to the LIS. Clients that perform discovery based on public DNS or STUN servers are thereby easier to trace based on source address information.

NAPTR records can be provided for individual IP addresses. To limit the proliferation of identical records, a single record can be placed at higher nodes of the tree (corresponding to /24 and /16 for IPv4; /64, /56, /48 and /32 for IPv6). A record at a higher point in the tree (those with a shorter prefix) applies to all addresses lower in the tree (those with a longer prefix); records at the lower point override those at higher points, thus allowing for exceptions to be specified.

5. IANA Considerations

This document has no IANA actions.

6. Privacy Considerations

As with all uses of geolocation information, it is very important that measures be taken to ensure that location information is not provided to unauthorized parties. The mechanism defined in this document is focused on the case where a device is learning its own location, so that it can provide that location information to applications. We assume that the device learning its own location is not a privacy risk. There are then two remaining privacy risks: The use of geolocation by applications, and abuse of the location configuration protocol.

The privacy considerations around the use of geolocation by applications vary considerably by application context. A framework for location privacy in applications is provided in [RFC6280].

The mechanism specified in this document allows a device to discover its local LIS, from which it then acquires its location using a Location Configuration Protocol [RFC5687]. If an unauthorized third party can spoof the LCP to obtain a target's location information, then the mechanism in this document could allow them to discover the proper server to attack for a given IP address. Thus, it is important that a LIS meet the security requirements of the LCP it implements. For HELD, these requirements are laid out in Section 9 of [RFC5985].

A Device that discovers a LIS using the methods in this document MUST NOT provide that LIS with additional information that might reveal its position, such as the location measurements described in [I-D.ietf-geopriv-held-measurements], unless it has a secondary method for determining the authenticity of the LIS, such as a white list.

7. Security Considerations

The security considerations described in [RFC5986] apply to the discovery process as a whole. The primary security concern is with the potential for an attacker to impersonate a LIS.

The added ability for a third party to discover the identity of a LIS does not add any concerns, since the identity of a LIS is considered public information.

In addition to existing considerations, this document introduces further security considerations relating to the identification of the IP address. It is possible that an attacker could attempt to provide a falsified IP address in an attempt to subvert the rest of the process.

[RFC5389] describes attacks where an attacker is able to ensure that a Device receives a falsified reflexive address. An on-path attacker might be able to ensure that a falsified address is provided to the Device. Even though STUN messages are protected by a STUN MESSAGE-INTEGRITY attribute, which is an HMAC that uses a shared secret, an on-path attacker can capture and modify packets, altering source and destination addresses to provide falsified addresses.

This attack could result in an effective means of denial of service, or a means to provide a deliberately misleading service. Notably, any LIS that is identified based on a falsified IP address could still be a valid LIS for the given IP address, just not one that is useful for providing the Device with location information. In this case, the LIS provides a HELD "notLocatable" error, or an equivalent. If the falsified IP address is under the control of the attacker, it is possible that misleading (but verifiable) DNS records could indicate a malicious LIS that provides false location information.

In all cases of falsification, the best remedy is to perform some form of independent verification of the result. No specific mechanism is currently available to prevent attacks based on falsification of reflexive addresses; it is suggested that Devices attempt to independently verify that the reflexive transport address provided is accurate. An independent, trusted source of location information could aid in verification, even if the trusted source is unable to provide information with the same degree of accuracy as the discovered LIS.

Use of private address space effectively prevents use of the usual set of trust anchors for DNSSEC. Only a DNS server that is able to see the same private address space can provide useful records. A Device that relies on DNS records in the private address space portion of the ".in-addr.arpa." or ".ip6.arpa." trees MUST either use an alternative trust anchor for these records or rely on other means of ensuring the veracity of the DNS records.

8. IAB Considerations

The IAB has studied the problem of Unilateral Self-Address Fixing (UNSAF) [RFC3424], which is the general process by which a client attempts to determine its address in another realm on the other side of a NAT through a collaborative protocol reflection mechanism, such as STUN.

This section only applies to the use of this method of LIS discovery by Devices and does not apply to its use for third-party LIS discovery.

The IAB requires that protocol specifications that define UNSAF mechanisms document a set of considerations.

1. Precise definition of a specific, limited-scope problem that is to be solved with the UNSAF proposal.

Section 3 describes the limited scope of the problem addressed in this document.

2. Description of an exit strategy/transition plan.

[RFC5986] describes behaviour that residential gateways require in order for this short term solution to be rendered unnecessary. When implementations of the recommendations in LIS discovery are widely available, this UNSAF mechanism can be made obsolete.

3. Discussion of specific issues that may render systems more "brittle".

A description of the necessary assumptions and limitations of this solution are included in Section 4.6.

Use of STUN for discovery of a reflexive transport address is inherently brittle in the presence of multiple NATs or address realms. In particular, brittleness is added by the requirement of using a DNS server that is able to view the address realm that contains the IP address in question. If address realms use overlapping addressing space, then there is a risk that the DNS server provides information that is not useful to the Device.

4. Identify requirements for longer term, sound technical solutions; contribute to the process of finding the right longer term solution.

A longer term solution is already provided in [RFC5986]. However, that solution relies on widespread deployment. The UNSAF solution provided here is provided as an interim solution that enables LIS access for Devices that are not able to benefit from deployment of the recommendations in [RFC5986].

5. Discussion of the impact of the noted practical issues with existing deployed NATs and experience reports.

The UNSAF mechanism depends on the experience in deployment of STUN [RFC5389]. On the whole, existing residential gateway devices are able to provide access to STUN and DNS service reliably, although regard should be given to the size of the DNS response (see [RFC5625]).

9. Acknowledgements

Richard Barnes provided the text in Section 6.

10. References

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Indoor Signal Position Conveyance
draft-jones-geopriv-sigpos-survey-02

Abstract

Location Information Servers rely on signal surveys to create a signal map allowing for subsequent device location determination. This document describes a method by which a Survey Device is able to provide indoor location related measurement data to a LIS for positioning purposes. Location related measurement information comprises observations concerning properties related to the position of a Survey Device and the radio, electromagnetic, and other observable environmental measures as perceived by the Survey Device. These measurements could be data about Wi-Fi signals, Bluetooth signals, barometric pressure, or any other environmental measurement which could sent to a LIS for subsequent processing to help determine the location of devices that later enter the venue. A basic set of location-related measurements, data rights disclosure and location types are defined.

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1. Introduction

This document describes a format for the expression of the measurements and locations of signals (SigPos) within a venue for purposes of providing location services.

The format includes a venue description, signal information, and data usage specifications.

A venue is defined as an area of interest for providing location services. Examples of a venue include a campus, a building, or a room. A venue should have a single administrative contact for purposes of this document.

A positioning beacon (hereafter referred to as a beacon) is a fixed wireless device whose location and signal information may be used for the purpose of positioning other wireless devices.

Signal information is inclusive of the specific description and measures of the signal (e.g. 802.11 Wi-Fi signals), a description of the device used to measure the signals, as well as the location and orientation of the device.

Multiple methods for providing location are defined including civic locations, geodetic locations, absolute locations, relative locations, and locations with error estimates.

In addition to the signal information, an optional section provides the ability to specify the data usage rights to be conferred to another entity. One right would be to grant a Location Information Service (LIS) rights to make use of the signal information to provide location services.

This document describes the use of HTTP/TLS as transport for the survey data.

1.1. Requirements Language

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

2. Overview

This document describes a common method to record, distribute and grant or constrain rights on signal location information related to the geospatial measurement of wireless RF signals. The document sets forth the motivation behind the effort, the basic design of the data format, the reasoning and technical approach for managing the rights of usage for the information, and provides various usage scenarios to further describe the architecture.

The primary motivation for this work is in providing a common framework for capturing and sharing information related to the geospatial measurement of RF and environmental signals for purposes of providing locative services based on the transmitters associated with these signals. There may be other uses such as network optimization and interference analysis that could be provided via this specification but these are not the primary goal.

Historically, each vendor or entity interested in using sensors (WiFi, cellular, sound ranging) to determine the location of a device has been required to know the geospatial location and attributes associated with a set of transmitters in order to provide location services based on these transmitters. If the locations of the transmitters were not known, the entity would need to 'map' these transmitters and their associated signals through various means and assign them a set of geospatial coordinates and some estimate of the signal map and signal properties of each transmitter.

The problem has grown in scale as the number of mobile devices has rapidly expanded along with the proliferation of location-based or location-enhanced applications. This problem can largely be solved for outdoor and coarse indoor positioning using a number of techniques such as drive scanning and end-user device reported

information combined with GPS. These techniques have enabled a large portion of the global WiFi signal set to be modeled and used for end-user positioning.

However, these methods, even when based on GPS information, have limits on the accuracy to which they can determine the location of a device solely on these signals. The problem is further exacerbated and compounded by the desire to provide indoor positioning with accuracy below 10 meters.

Outdoor scanning via vehicles and end-user devices is possible due to the reliable and global reach of GPS. Signals captured in open-air environments can be assigned geospatial coordinates based on the availability of a reliable GPS reading. However, the ability to leverage an existing positioning technology is severely limited when the scanning equipment moves indoors. The availability of GPS is reduced and in many places eliminated. This requires that the scanning equipment use some other means to determine the relative or absolute geospatial position within a building in order to associate the signal measurement with the location in the building.

This problem has been addressed by various means in what is generally referred to as a 'site survey'. Specialized hardware with professional grade GPS systems, highly calibrated sensors for dead reckoning, laser range finders or other techniques have often been deployed to accomplish these site surveys. These techniques provide a professional surveyor with the tools and capability to produce a highly accurate signal map of a given building. Unfortunately this process has several drawbacks:

- o the use of specialized hardware by highly trained engineers is expensive. Scalability is reduced by requiring the design and manufacture of specialized hardware as well as trained individuals to operate the hardware
- o the process is, in general, a proprietary venture. The resulting information is in a proprietary format and is intended to work with a specific vendor provided location system
- o it doesn't account for changes. Venues change, the radio, visual, and acoustical environment changes and the transmitters themselves are moved and replaced over time. Coping with this level of entropy and maintaining an up-to-date signal map is both time consuming and costly
- o the value is locked to a vendor. The value that is obtained from the effort to create a signal map may be realized by the vendor and not the venue owner. Even if the vendor made a portion of the

investment, the venue owner may be excluded from additional value in the future

- o high quality venue maps have not been readily accessible. Having location is an important part of the puzzle, but having the ability to lock the location to a map enables a wide range of applications
- o mobile devices and applications have traditionally been locked to the vendor who performed the site survey. This made it nearly impossible to scale across different applications and mobile platforms
- o context is generally more important for indoor positioning than latitude, longitude, and altitude. In other words, it is more important from a user perspective to identify the floor, the room, the aisle, etc. than it is to provide only x, y, z coordinates
- o there is no common way to convey the information to a LIS

The goal of this specification is to reduce these friction points and provide a common method for specifying, encoding, conveying, and granting usage rights to signal survey information.

3. Open Issues

This document contains a number of open issues that need to be addressed or items that need further refinement, including:

1. Survey Device Configuration Specification - this needs continued refinement
2. Bluetooth Measurements - these need to be added to the HELD Measurements specification
3. Specification of Licensing Options - are there more objections to including these
4. Complete xsd definition - a partial XSD is included in this draft, a complete specification is still needed
5. Explore use of draft-jennings-senml-10 (Media Types for Sensor Markup Language (SENML)) for sensor data encoding
6. Update 802.11 to use 802.11-2012 spec for country code

4. Description

The basic premise for the SigPos data container is to record a 'survey session'. A survey session generally represents a set of contiguous location and sensor scan records that were gathered by a given device. For example, this could represent a survey of the floor of a building, a single point survey, or a survey of a room.

This document defines a container for the conveyance of location-related measurement parameters or specifications related to beacon locations and their related signal patterns within an indoor venue. This is an XML container that identifies parameters by type and allows the Device to provide the results of any measurement it is able to perform. A set of measurement schemas are also defined that can be carried in the generic container. Lastly, it allows for the manual specification of both the beacons and their locations.

A number of additional concepts are included in this standard such as the identification of the equipment conducting the survey and the inclusion of both explicit and implicit location information. These will be detailed further in following sections.

The interpretation of the survey data is left to the implementer of the location service and is not explicitly part of this specification. For example, how to correlate a particular WiFi signal sample with an interpolated location, or how much time lapse between a WiFi signal reading and a GPS sample is permissible. These are choices that are decoupled from the data gathering and transmission, but every attempt has been made to provide the facility to include sufficient information in this standard to enable downstream algorithms to make appropriate choices.

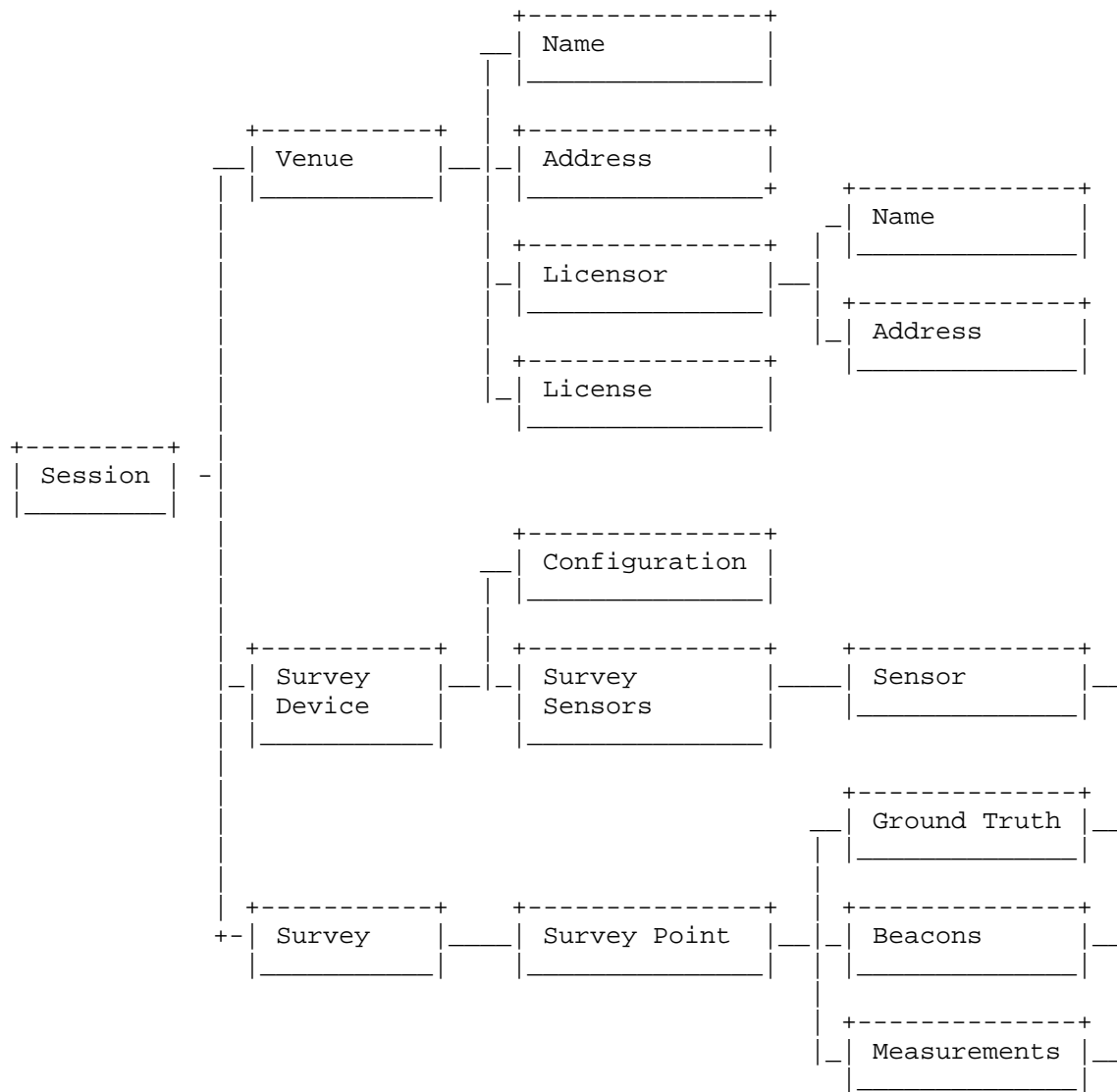
This document also describes the use of HTTP/TLS as transport for the survey container.

Each capture document corresponds to a 'session'. Each session can have a 'venue' section, a 'survey device' section, and a 'survey' section. The venue describes the venue, the location of the venue, the licensor organization as well as the data rights applicable to the survey. The Venue Section (Section 6.1) describes the venue or location of the survey, and the Survey Device section (Section 6.2) describes the device being used to capture the survey data.

The Survey Data section (Section 6.3) describes a method for the actual survey data to be formatted in a standardized format. Each capture session is meant to take place within a single building or structure corresponding to the venue described in the venue section. A session may be composed of many 'survey points'. Each survey point can have a location description, location elements, WiFi keys, WiFi readings and 'other' sensor readings.

Note, where possible, location-info objects as described within PIDF-LO and extensions are used to express location information.

An overview of the document structure is provided in the following figure.



Document structure overview.

Figure 1

5. Using PIDF-LO Location

All location information in this container is specified using the GEOPRIV Presence Information Data Format Location Object. This

includes the basic definition of the PIDF-LO [RFC4119] object, PIDF-LO Clarification [RFC5491], Revised Civic Location Format [RFC5139], Dynamic Extensions to PIDF-LO [RFC5962], PIDF-LO Relative Location [I-D.ietf-geopriv-relative-location], and Civic Address Extensions [RFC6848].

The PIDF-LO object provides a variety of mechanisms to indicate position. This may refer to the location of the venue, the location of a beacon or the location of the survey device itself. Several of the capabilities of the PIDF-LO object are discussed in this section. For a full specifications refer to the relevant RFCs and Internet Drafts.

The PIDF-LO object allows for specification of elements that encompass:

- o Position
- o Timestamp
- o Provider
- o Uncertainty
- o Bearing
- o Speed
- o Orientation

For purposes of signal positioning survey, we define several classes of PIDF-LO objects:

- o Manual geolocation - human manipulation or specification of a geolocation
- o Integrated geolocation - system generated geolocation (e.g. via GPS)
- o Relative location - geolocation based on a defined reference point

Each of these methods of providing location can be encoded within the constructs provided by the PIDF-LO structure when combined with the necessary extensions mentioned above and described in more detail in subsequent sections.

5.1. Device Orientation

The optional orientation elements allows the surveyor to provide precise information with respect to the orientation of the scanning device at the time the readings were made. This orientation information can be used to differentiate signal information when the device is held at different angles at each survey point.

From the "Dynamic Extensions to the Presence Information Data Format Location Object (PIDF-LO)" [RFC5962], we find:

"The <orientation> element describes the spatial orientation of the presentity -- the direction that the object is pointing. For a device, this orientation might depend on the type of device."

This proposed extension to the PIDF-LO object allows for the inclusion of device orientation within each PIDF-LO object.

An example specifying device orientation:

```
<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:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:gml="http://www.opengis.net/gml"
  entity="pres:alice@example.com">
  <dm:device id="abc123">
    <gp:geopriv>
      <gp:location-info>
        <dyn:Dynamic>
          <dyn:orientation>-3 12</dyn:orientation>
          <dyn:speed>24</dyn:speed>
          <dyn:heading>278</dyn:heading>
        </dyn:Dynamic>
      </gp:location-info>
      <gp:usage-rules/>
      <method>gps</method>
    </gp:geopriv>
    <timestamp>2009-06-22T20:57:29Z</timestamp>
    <dm:deviceID>mac:1234567890ab</dm:deviceID>
  </dm:device>
</presence>
```

6. Session

The session element creates a container for the other elements of the survey. There should be a single survey per document.

The session tag includes two required attributes: the sessionID and the sessionDate.

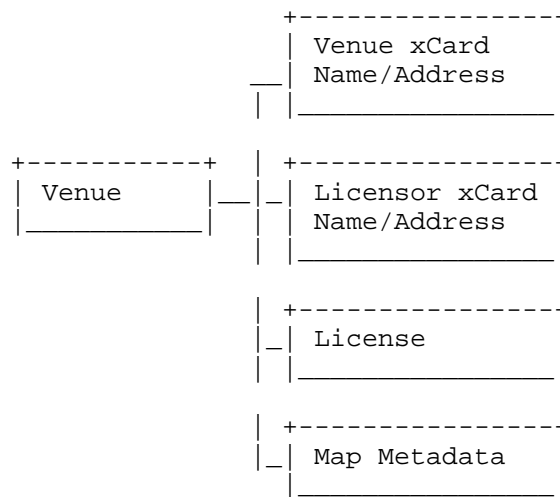
SessionID: contains an opaque string which provides a Universally Unique Identifier (UUID) identifier for this survey as defined by RFC4122 [RFC4122]A Universally Unique Identifier (UUID) URN Namespace.

SessionDate: contains the date the survey was completed.

```
<session sessionID="99FD84B9-8C0F-4E5E-B050-4E6B3D5C5D9F" sessionDate="2009-06-22T20:57:29Z">
  ...
</session>
```

6.1. Venue

The venue section describes the venue itself and also provides for two additional elements: the definition of the licensor and the definition of the policy for the included data.



Venue structure overview.

Figure 2

The venue section of the document provides for the ability to identify the venue in which the survey took place as well as the location of the venue.

6.1.1. Venue Name/Address

This optional element provides the ability to specify the name and address of the venue for identification purposes. This element uses the xCard [RFC6351] XML format to provide the necessary structure for these elements.

```
<?xml version="1.0" encoding="UTF-8"?>
<vcards xmlns:vc="urn:ietf:params:xml:ns:vcard-4.0">
  <vc:vcard>
    <vc:fn><vc:text>Example Building</vc:text></vc:fn>
    <vc:adr>
      <vc:parameters>
        <vc:type><vc:text>work</vc:text></vc:type>
        <vc:label><vc:text>Example Building
1 South Boston Street
Boston, MA USA 02210</vc:text></vc:label>
      </pvc:arameters>
      <vc:pobox/>
      <vc:ext/>
      <vc:street>1 South Boston Street</vc:street>
      <vc:locality>Boston</vc:locality>
      <vc:region>MA</vc:region>s
      <vc:code>02210</vc:code>
      <vc:country>USA</vc:country>
    </vc:adr>
  </vc:vcard>
</vcards>
```

6.1.2. Licensor

The optional licensor section allows for the definition of the organization or individual that has the right to grant another individual or entity a license to the data. The licensor section also makes use of the xCard [RFC6351] format for encoding information about the name and address of the licensor entity.

```
<?xml version="1.0" encoding="UTF-8"?>
<vcards xmlns:vc="urn:ietf:params:xml:ns:vcard-4.0">
  <vc:vcard>
    <vc:fn><text>Robert Builder</vc:text></vc:fn>
    <vc:n>
      <vc:surname>Builder</vc:surname>
```

```

        <vc:given>Robert</vc:given>
        <vc:additional/>
        <vc:prefix/>
        <vc:suffix/>
    </vc:n>
    <vc:adr>
        <vc:parameters>
            <vc:type><text>work</vc:text></vc:type>
            <vc:label><text>Robert Builder
1 South Boston Street
Boston, MA USA 02210</vc:text></vc:label>
        </vc:parameters>
        <vc:pobox/>
        <vc:ext/>
        <vc:street>1 South Boston Street</vc:street>
        <vc:locality>Boston</vc:locality>
        <vc:region>MA</vc:region>
        <vc:code>02210</vc:code>
        <vc:country>USA</vc:country>
    </vc:adr>
    <vc:tel>
        <vc:parameters>
            <vc:type>
                <vc:text>work</vc:text>
                <vc:text>voice</vc:text>
            </vc:type>
        </vc:parameters>
        <vc:uri>tel:+1-555-555-1212;ext=102</vc:uri>
    </vc:tel>
    <vc:email>
        <vc:parameters>
            <type><text>work</vc:text></vc:type>
        </vc:parameters>
        <vc:text>robert.builder@example.com</vc:text>
    </vc:email>
</vc:vcard>
</vcards>

```

6.1.3. Data Rights Management

The license object allows the licensor the ability to manage and grant usage rights to the survey data. This document includes a mechanism for including licensing terms. The licensing models are described in more detail below.

The <license> object is optional. If missing, the license type is assumed to be 'unrestricted' with a default expiration.

6.1.3.1. License Expiry

The optional License Expiry tag allows the surveyor to set time limits on the usage granted by the License Type. By default the data license expires 30 days after the date identified in the sessionDate.

```
<licenseExpiry>2008-04-29T14:33:58</licenseExpiry>
```

6.1.3.2. License URI

The License URI provides an optional element to identify the terms of a 'Private' license type. This allows the incorporation of additional information relating to the definition of the license terms.

6.1.3.3. License Type

The optional policy element is intended to allow the licensor of the data gathered for a given venue to provide granular control over the use and subsequent derivative works based on the data. In the event that no policy is specified, it is assumed that the data is released using the unrestricted policy.

There are eight pre-defined Data License Types grouped into three categories.

6.1.3.3.1. Unrestricted License

The unrestricted policy allows for the use and unrestricted derivative products based on the data set. If the data expires, the original data can no longer be used, but any derivative products that were generated during the granted use of the data remain valid.

Example of an unrestricted license declaration:

```
<license>
  <licenseExpiry>2008-04-29T14:33:58</licenseExpiry>
  <licenseType>unrestricted</licenseType>
</license>
```

6.1.3.3.2. Creative Commons License

The Creative Commons [CC] provide a number of licensing options which, in some cases, permit the licensor of the data to restrict commercial use and/or derivative works. Derivative use of survey data refers to the ability to build or improve a location system based on survey data. Survey data at a high quality could be used to

'seed' a location system, allowing an organization to bootstrap a location database over time. At some point, the original data could be removed but the derived database would allow the system to continue to be functional. For data licensors who wish to protect from this, the notion of derivative rights is included in the license structure.

Valid Creative Common license types for this specification include the following.

For non-commercial use:

- o Attribution-NonCommercial-ShareAlike CC BY-NC-SA - This license lets others remix, tweak, and build upon the licensor's work non-commercially, as long as they credit the licensor and license their new creations under the identical terms.
- o Attribution-NonCommercial CC BY-NC - This license lets others remix, tweak, and build upon the licensor's work non-commercially, and although their new works must also acknowledge the licensor and be non-commercial, they don't have to license their derivative works on the same terms.
- o Attribution-NonCommercial-NoDerivs CC BY-NC-ND - This license only allows others to use the licensor's works and share them with others as long as they credit the licensor, but they can't change them in any way or use them commercially.

For commercial use:

- o Attribution CC BY - This license lets others distribute, remix, tweak, and build upon the licensor's work, even commercially, as long as they credit the licensor for the original creation.
- o Attribution-NoDerivs CC BY-ND - This license allows for redistribution, commercial and non-commercial, as long as it is passed along unchanged and in whole, with credit to the licensor.
- o Attribution-ShareAlike CC BY-SA - This license lets others remix, tweak, and build upon the licensor's work even for commercial purposes, as long as they credit the licensor and license their new creations under the identical terms.

```
<license>
  <licenseExpiry>2008-04-29T14:33:58</licenseExpiry>
  <licenseType>CC BY-ND</licenseType>
</license>
```

6.1.3.3.3. Private License

The private license is intended to provide full control over the usage and derivative usage of the data. Any use of the data would be governed under a separate agreement between the licensor and the party wishing to make use of the data. By default, no rights are granted for private data.

For example, suppose a venue owner wishes to provide location services within their venue, but only for their own application. The arrangement for providing this service could be managed separately from the protocol. However, the data itself is fully transportable and allows for the venue owner to reprovision the service with a different provider if they so desire. Service providers without an arrangement could automatically determine that this data cannot be used.

```
<license>
  <licenseType>private</licenseType>
  <licenseURI>http://www.example.com/mylicense.html</licenseURI>
  <licenseExpiry>2008-04-29T14:33:58</licenseExpiry>
</license>
```

6.1.4. Map Metadata

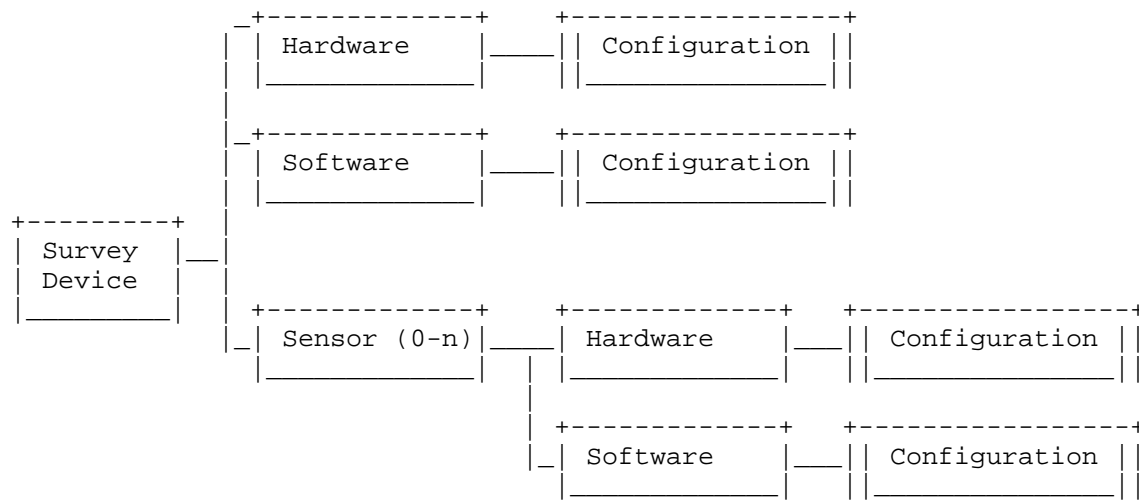
The optional "map" URL can be used to provide a user or system with a visual reference for the location information. This URL specification is based on that provided in Section 4.11 of PIDF-LO Relative Location [I-D.ietf-geopriv-relative-location] specification. For purposes of the overall Venue map, the offset SHOULD provide the offset to the starting location on the map for the survey.

```
<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>
```

6.2. Survey Device

The specification includes elements to describe the capabilities of the hardware and software of the scanning device as well as the hardware and software for the sensors that were used to capture the scan data. This can allow further downstream processing by discriminating source data based on capabilities and known device/sensor profiles and behaviors.

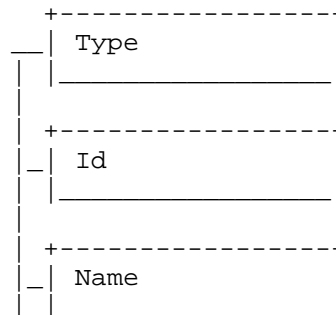
The Survey Device section SHOULD contain one device configuration record. It MAY contain 0-n sensor configuration elements.

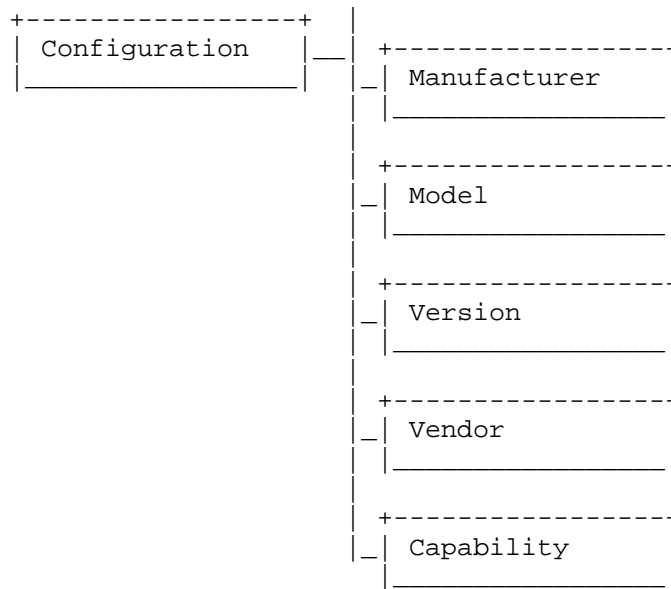


Survey Device structure overview.

Figure 3

6.2.1. Configuration Object





Survey Device Configuration structure overview.

Figure 4

The configuration object allows for the description of a various hardware components used to perform the survey. This allows for the description of the survey device itself as well as any sensors or radio components that are used in performing the survey.

The configuration object can contain various elements as described below. Required items are noted.

- o id - (required) - provides a locally unique identifier for the component being described. For example, this could be the MAC address if describing a WiFi Network Interface Card.
- o name - (required) - the name of the device/sensor
- o vendor - (0-1) - a human readable description of the component vendor
- o model - (0-1) - the model and model number of the component
- o capability - (0-n) - a name/value pair to allow arbitrary configuration and capability declarations for each configuration object.

6.2.2. Example Device Configuration

An example <device> object is shown below.

```
<device>
  <hardware>
    <configuration>
      <type>device</type>
      <name>mapit</name>
      <version>1.2</version>

      <id>abc</id>
      <model>900</model>
      <capability name="chipset">Intel Q965</capability>
      <capability name="power">12 volt</capability>
    </configuration>
  </hardware>
  <software>
    <configuration>
      <type>software</type>
      <name>Centos6</name>
      <version>2.6.18-308.1.1.el5 #1 SMP x86_64 GNU</version>
    </configuration>
  </software>
  <sensor>
    <hardware>
      <configuration>
        <id>000FFA9870BC</id>
        <name>External WiFi</name>
        <version>1.23</version>
        <vendor>atheros</vendor>
        <capability name="antenna">omni-directional</capability>
        <capability name="gain" units="dbm">10</capability>
        <capability name="chipset">atheros</capability>
        <capability name="standard">a,b,g,n</capability>
        <capability name="channel">1-13</capability>
      </capabilities>
    </configuration>
  </hardware>
  <software>
    <configuration>
      <name>atheros driver</name>
      <version>ath9k</version>
    </configuration>
  </software>
</sensor>
<sensor>
```

```

    <hardware>
      <configuration>
        <type>gps</type>
        <id>gm39211</id>
        <version>4.23a</version>
        <vendor>unknown</vendor>
        <capability name="antenna">combined</capability>
        <capability name="chipset">qualcomm</capability>
      </configuration>
    </hardware>
  </sensor>
</device>

```

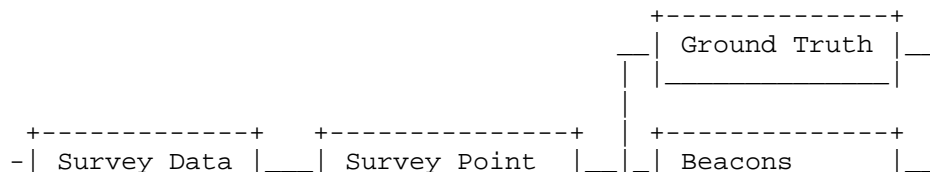
6.3. Survey Data

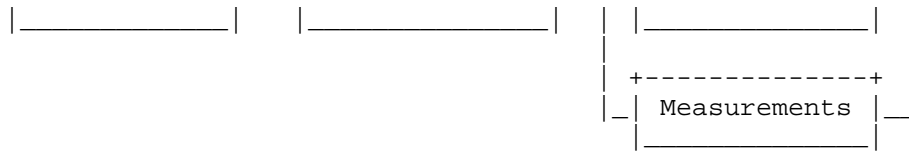
The survey section represents all of the scanned or input data gathered about the venue in this session. Within a 'survey', there may be 0-n 'readings' which will contain a complete set of information about a subset of the survey. For example, a single room could be captured within a 'readings' segment.

This document defines location-related measurement data types for a range of common sensor types.

All included measurement data definitions allow for arbitrary extension in the corresponding schema. As new parameters that are applicable to location determination are added, these can be added as new XML elements in a unique namespace. Though many of the underlying protocols support extension, creation of specific XML-based extensions to the measurement format is favored over accommodating protocol-specific extensions in generic containers.

Note, the "time" attribute records the time that the measurement or observation was made. This time can be different from the time that the measurement information was reported. Time information can be used to populate a timestamp on each ground truth element and to the root "measurement" element. If it is necessary to provide multiple sets of measurement data with different times, multiple "measurement" elements SHOULD be provided.





Document structure overview.

Figure 5

Survey Points describe a subset of the survey information and potentially include Ground Truth, Beacon IDs, and Signal Measurements. These categories of information are detailed further in the following sections.

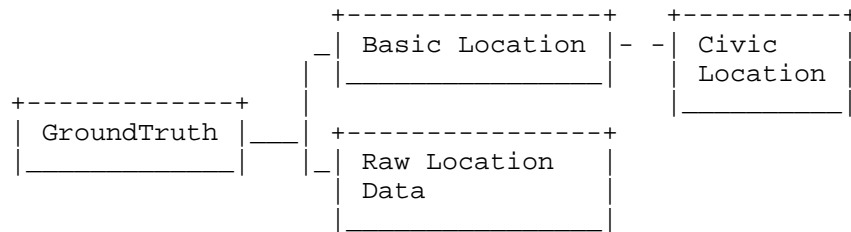
6.3.1. Ground Truth

Ground truth is a term that describes the location of the Survey Device.

The 'ground truth' element is designed to allow the specification and recording of the location at which the survey point was captured. To encompass various survey and usage scenarios, there are currently three GroundTruth types available for each survey point. These include PIDF-LO location object, a Contextual Location object, and/or a Raw Location object. These are described further below.

Multiple Ground Truth objects are allowed for interpolation between a starting point and an endpoint without explicitly declaring each scan position. The interpolation of the survey data is left to the downstream processor such as an LIS server.

groundTruth MUST have at least 1 SurveyPoint object as defined below.



Groundtruth structure overview.

Figure 6

6.3.1.1. PIDF-LO Location

This section describes the primary PIDF-LO method types that are supported by this specification. While all PIDF-LO location 'methods' are possible, the following are the only methods that MUST be supported.

- o GPS
- o A-GPS
- o Trilateration
- o Cell
- o Manual

In addition, support MUST be provided for relative locations as described below for each of the above PIDF-LO location methods.

6.3.1.1.1. Basic Location

Basic location represents a location as provided by the Survey Device. This could be from a location API, WiFi positioning, an integrated GPS, or any other mechanism that computes or determines the location of the survey device. To encompass this variety of locative technologies, the structure of the object provides numerous constructs.

An example of an integrated GPS location including dynamic orientation extensions is shown below. More examples of encodings can be found in PIDF-LO Usage [RFC5491].

```
<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:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:gml="http://www.opengis.net/gml">
  <tuple id="abcd123456">
    <status>
      <gp:geopriv>
        <gp:location-info>
          <gs:Ellipsoid srsName="urn:ogc:def:crs:EPSG::4326">
            <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>
    <dyn:Dynamic>
      <dyn:orientation>-3 12</dyn:orientation>
      <dyn:speed>24</dyn:speed>
      <dyn:heading>278</dyn:heading>
    </dyn:Dynamic>
  </gs:Ellipsoid>
</gp:location-info>
<gp:usage-rules/>
  <method>gps</method>
  <gp:usage-rules/>
</gp:geopriv>
<timestamp>2009-06-22T20:57:29Z</timestamp>
</status>
</tuple>
</presence>

```

6.3.1.1.2. Relative Location

A relative location is based on the topology of the venue and is specified by first declaring one or more anchors that contain a geospatial reference.

Relative Location MUST be defined using "Internet Draft Relative Location Representation" [I-D.ietf-geopriv-relative-location].

An example of a PIDF-LO geopriv object with relative location extensions included is shown below.

```

<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:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:gml="http://www.opengis.net/gml">
  <tuple id="abcd123456">
    <status>

```

```

    <gp:geopriv>
      <gp:location-info>
        <gml: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>
        </gml: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>
            <gml:Circle xmlns:gml="http://www.opengis.net/gml"
              srsName="urn:ietf:params:geopriv:relative:2d">
              <gml:pos>500.0 750.0</gml:pos>
              <gml:radius uom="urn:ogc:def:uom:EPSG::9001">
                5.0
              </gml:radius>
            </gml:Circle>
          </rel:offset>
        </rel:relative-location>
        <map:map>
          <map:urltype="image/png">
            https://www.example.com/flrpln/123South/flr-2</gp:url>
          <map:offset> 2670.0 1124.0 1022.0</gp:offset>
          <map:orientation>67.00</gp:orientation>
          <map:scale>10</gp:scale>
        </map:map>
      </gp:location-info>
      <gp:usage-rules/>
      <gp:method>Triangulation</gp:method>
    </gp:geopriv>
    <timestamp>2007-06-22T20:57:29Z</timestamp>
  </status>
</tuple>
</presence>

```

6.3.1.1.3. Manual Location

The manual location object allows the surveyor to specify the geospatial coordinate and/or a civic address to be associated with the 'readings' data.

This element contains any valid location, using the rules for a "location-info" element, as described in RFC 5491 [RFC5491].

Location information in a survey may be described in a geospatial manner based on a subset of Geography Markup Language (GML) 3.1.1 [OGC-GML3.1.1] or as civic location information RFC 5139 [RFC5139] and refined in RFC 5774 [RFC5774]. An OGC GML [OGC-GML3.1.1] profile for expressing geodetic shapes in a PIDF-LO is described in GML GeoShape Application Schema [GeoShape].

Below are several examples of manual location objects.

```
<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:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:gml="http://www.opengis.net/gml">
  <tuple id="abcd123456">
    <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>
        </gp:location-info>
      </gp:geopriv>
      <timestamp>2007-06-22T20:57:29Z</timestamp>
    </status>
  </tuple>
</presence>
```

Sample manual location using a point.

```
<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:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:gml="http://www.opengis.net/gml">
  <tuple id="abcd123456">
    <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">
              5.24
            </gs:radius>
          </gs:Circle>
        </gp:location-info>
      </gp:geopriv>
    </status>
  </tuple>
</presence>
```

```

        </gp:location-info>
      </gp:geopriv>
      <timestamp>2007-06-22T20:57:29Z</timestamp>
    </status>
  </tuple>
</presence>

```

Sample manual location using a circle with a radius to represent error estimate.

6.3.1.1.4. Civic Location

To support adding contextual information to survey points during the survey process, this specification includes the ability to add extended civic addresses as defined by the optional Contextual Location object. This object enables the capture of contextual information with respect to a survey point.

For example, an office building may have floors, wings, rooms, and cubes while an amusement park will have rides, booths, food stands and arcades. The civic address extensions provide a mechanism for extending these attributes and maintaining interoperability.

Example of civic location:

```

<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:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:gml="http://www.opengis.net/gml">
  <tuple id="abcd123456">
    <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>
          <civicAddress xml:lang="en-US"
            xmlns="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
            xmlns:post="http://postsoftheworld.net/ns"
            xmlns:ap="http://example.com/airport/5.0">
            <country>US</country>
            <Al>CA</Al>
            <post:lamp>2471</post:lamp>
            <post:pylon>AQ-374-4(c)</post:pylon>
            <ap:airport>LAX</ap:airport>
          </civicAddress>
        </gp:location-info>
      </gp:geopriv>
    </status>
  </tuple>
</presence>

```

```
        <ap:terminal>Tom Bradley</ap:terminal>
        <ap:concourse>G</ap:concourse>
        <ap:gate>36B</ap:gate>
      </civicAddress>
    </gp:location-info>
  </gp:geopriv>
  <timestamp>2007-06-22T20:57:29Z</timestamp>
</status>
</tuple>
</presence>
```

The optional civicAddress object can be included in any of the PIDF-LO objects defined above.

6.3.1.2. Raw Location Data

To support the capture and conveyance of underlying raw location data, a common optional container is defined for the expression of this location measurement data.

Currently only the 'GNSS' raw location type has been defined. Global Navigation Satellite System (GNSS) readings provide location measurements based on satellite navigation systems such as that provided by GPS.

Rather than decomposing GNSS output during the survey, the sentences from the GNSS systems are transported as is allowing full downstream processing of the data.

The type attribute specifies the GNSS system type which is responsible for the reading, e.g. GPS.

The GPS system generally uses the NMEA 0183 [NMEA0183] protocol for output and many systems have been built to handle this type of output. To provide the most transparent transport mechanism, the NMEA sentences are packaged as-is.

The possible sentence names are described below.

The REQUIRED set of sentences include:

```
$GPGGA - Global Positioning System Fix Data (required)
$GPGSA - GPS DOP and Active Satellites (recommended)
$GPRMC - Recommended Minimum Specific GPS/TRANSIT Data (recommended)
```

The remaining OPTIONAL sentences are detailed below:

\$GPAAM - Waypoint Arrival Alarm
\$GPALM - GPS Almanac Data<
\$GPAPA - Autopilot Sentence "A"
\$GPAPB - Autopilot Sentence "B"
\$GPASD - Autopilot System Data
\$GPBEC - Bearing & Distance to Waypoint, Dead Reckoning
\$GPBOD - Bearing, Origin to Destination
\$GPBWC - Bearing & Distance to Waypoint, Great Circle
\$GPBWR - Bearing & Distance to Waypoint, Rhumb Line
\$GPBWW - Bearing, Waypoint to Waypoint
\$GPDBT - Depth Below Transducer
\$GPDCN - Decca Position
\$GPDPT - Depth
\$GPFSI - Frequency Set Information
\$GPGLC - Geographic Position, Loran-C
\$GPGLL - Geographic Position, Latitude/Longitude
\$GPGSV - GPS Satellites in View
\$GPGXA - TRANSIT Position
\$GPHDG - Heading, Deviation & Variation
\$GPHDT - Heading, True
\$GPHSC - Heading Steering Command
\$GPLCD - Loran-C Signal Data
\$GPMTA - Air Temperature (to be phased out)
\$GPMTW - Water Temperature
\$GPMWD - Wind Direction
\$GPMWV - Wind Speed and Angle
\$GPOLN - Omega Lane Numbers
\$GPOSD - Own Ship Data
\$GPR00 - Waypoint active route (not standard)
\$GPRMA - Recommended Minimum Specific Loran-C Data
\$GPRMB - Recommended Minimum Navigation Information
\$GPROT - Rate of Turn
\$GPRPM - Revolutions
\$GPRSA - Rudder Sensor Angle
\$GPRSD - RADAR System Data
\$GPRTE - Routes
\$GPSFI - Scanning Frequency Information
\$GPSTN - Multiple Data ID
\$GPTRF - Transit Fix Data
\$GPTTM - Tracked Target Message
\$GPVBW - Dual Ground/Water Speed
\$GPVDR - Set and Drift
\$GPVHW - Water Speed and Heading
\$GPVLW - Distance Traveled through the Water
\$GPVPW - Speed, Measured Parallel to Wind
\$GPVTG - Track Made Good and Ground Speed
\$GPWCV - Waypoint Closure Velocity
\$GPWNC - Distance, Waypoint to Waypoint

\$GPWPL - Waypoint Location
\$GPXDR - Transducer Measurements
\$GPXTE - Cross-Track Error, Measured
\$GPXTR - Cross-Track Error, Dead Reckoning
\$GPZDA - Time & Date
\$GPZFO - UTC & Time from Origin Waypoint
\$GPZTG - UTC & Time to Destination Waypoint

The sentences contain the name of the sentence in the content so there is no reason to add additional identifying information beyond the sentence itself.

The GPS configuration may optionally be detailed in the device sensor descriptions section.

Example:

```
<rawlocation>
  <gnss type="gps">
    <sentences>
      <type>GPGGA</type>
      <value>
$GPGGA,092750.000,5321.6802,N,00630.3372,W,1,8,1.03,61.7,M,55.2,M,,*76
      </value>
      <type>GPGSA</type>
      <value>
$GPGSA,A,3,10,07,05,02,29,04,08,13,,,,,1.72,1.03,1.38*0A
      </value>
      <type>GPSV</type>
      <value>
$GPSV,3,1,11,10,63,137,17,07,61,098,15,05,59,290,20,08,54,157,30*70
      </value>
      <type>GPSV</type>
      <value>
$GPSV,3,2,11,02,39,223,19,13,28,070,17,26,23,252,,04,14,186,14*79
      </value>
      <type>GPRMC</type>
      <value>
$GPRMC,092750.000,A,5321.6802,N,00630.3372,W,0.02,31.66,280511,,,A*43
      </value>
    </sentences>
  </gnss>
</rawlocation>
```


6.3.2. Beacons

The intent of the <beacon> object is to allow the surveyor to identify individual beacons and specify the location of that beacon. In other words, in a site survey where beacon A is located at x1, y1 and beacon B is located at x2, y2, this construct would allow for that. This is for those instances where exact beacon position is useful for the LIS to compute device locations.

Beacon Identification

```
<beacon type="wifi","bluetooth",...>
```

The beacon object allows the identification of a specific set of beacons. A beacon is specified as an object to be used for positioning which can be identified by a unique identifier. For example in an Infrastructure WiFi network, the basic service set identifier (bssid) is the 48 bit MAC address of the access point. This specification allows for the possibility of manually identifying beacons and including that information in the survey.

The type attribute is required.

```
<beacon type="wifi">
  <id>
    <mac>003200A475C5</mac>
  </id>
</beacon>
```

The elements include:

- o id (required) - indicates the key(s) necessary to uniquely identify the beacon of the given type

6.3.3. Signal Measurements

Signal-Related Measurement Data Types

A common container is defined for the expression of location measurement data, as well as a simple means of identifying specific types of measurement data for the purposes of requesting them.

The following example shows a measurement container with measurement time included. A WiFi measurement is enclosed.

```
<lm:measurements xmlns:lm="urn:ietf:params:xml:ns:geopriv:lm"
  time="2008-04-29T14:33:58">
```

```
<wifi xmlns="urn:ietf:params:xml:ns:geopriv:lm:wifi">
  <ap serving="true">
    <bssid>00-12-F0-A0-80-EF</bssid>
    <ssid>wlan-home</ssid>
  </ap>
</wifi>
</lm:measurements>
```

The "measurement" element is used to encapsulate measurement data that is collected at a certain point in time. It contains time-based attributes that are common to all forms of measurement data, and permits the inclusion of arbitrary measurement data.

6.3.3.1. WiFi Measurements

WiFi Measurements are based on the proposed measurements defined in the IETF I-D Held Measurements [I-D.ietf-geopriv-held-measurements] document.

In WiFi, or 802.11 [IEEE.80211.2007], networks a Device might be able to provide information about the access point (AP) that it is attached to, or other WiFi points it is able to see. This is provided using the "wifi" element, as shown in Figure 6, which shows a single complete measurement for a single access point.

WiFi scan elements contain a single record for each Access Point which was scanned for each time stamp that that AP was scanned.

APs should be scanned as rapidly as feasible to obtain as many samples as possible.

```
<measurements xmlns="urn:ietf:params:xml:ns:geopriv:lm"
  time="2011-04-29T14:33:58">
  <wifi xmlns="urn:ietf:params:xml:ns:geopriv:lm:wifi">
    <nicType>Intel(r)PRO/Wireless 2200BG</nicType>
    <ap serving="true">
      <bssid>AB-CD-EF-AB-CD-EF</bssid>
      <ssid>example</ssid>
      <channel>5</channel>
      <location>
        <gml:Point xmlns:gml="http://opengis.net/gml">
          <gml:pos>-34.4 150.8</gml:pos>
        </gml:Point>
      </location>
      <type>a/g</type>
      <band>5</band>
      <regclass country="AU">2</regclass>
```

```

    <antenna>2</antenna>
    <flightTime rmsError="4e-9" samples="1">2.56e-9</flightTime>
    <apSignal>
      <transmit>23</transmit>
      <gain>5</gain>
      <rcpi dBm="true" rmsError="12" samples="1">-59</rcpi>
      <rsni rmsError="15" samples="1">23</rsni>
    </apSignal>
    <deviceSignal>
      <transmit>10</transmit>
      <gain>9</gain>
      <rcpi dBm="true" rmsError="9.5" samples="1">-98.5</rcpi>
      <rsni rmsError="6" samples="1">7.5</rsni>
    </deviceSignal>
  </ap>
</wifi>
</measurements>

```

802.11 WiFi Measurement Example

A wifi element is made up of one or more access points, and an optional "nicType" element. Each access point is described using the "ap" element, which is comprised of the following fields:

Required:

- o bssid: The basic service set identifier. In an Infrastructure BSS network, the bssid is the 48 bit MAC address of the access point. The "verified" attribute of this element describes whether the device has verified the MAC address or it authenticated the access point or the network operating the access point (for example, a captive portal accessed through the access point has been authenticated). This attributes defaults to a value of "false" when omitted.
- o rcpi: The received channel power indicator for the access point signal, as measured by the Device. This value SHOULD be in units of dBm (with RMS error in dB). If power is measured in a different fashion, the "dBm" attribute MUST be set to "false". Signal strength reporting on current hardware uses a range of different mechanisms; therefore, the value of the "nicType" element SHOULD be included if the units are not known to be in dBm and the value reported by the hardware should be included without modification. This element includes optional "rmsError" and "samples" attributes.

Optional (as defined in the IETF I-D Held Measurements [I-D.ietf-geopriv-held-measurements] document).

- o ssid
- o channel
- o location
- o type
- o band
- o regclass
- o antenna
- o flightTime
- o apSignal

6.3.3.2. Bluetooth Measurements

Note: these need to be clarified and added to held-measurements.

Bluetooth devices provide an alternative method for determining location. The bluetooth object provides a method to capture measurements related to bluetooth devices discovered during the survey.

- o Address/UUID - 48-bit unique identifier
- o Name
- o Version
- o Manufacturer
- o Features
- o Class
- o Signal Strength
- o Link Quality

6.3.3.3. Other Signal Measurements

The container allows for the definition of other measurements to be captured. These could include measurements of such things as sound ranging or echolocation signals, cellular signals, or other electromagnetic signal measurement.

7. XML Schema

This section gives the XML Schema Definition [W3C.REC-xmlschema-1-20041028] [W3C.REC-xmlschema-2-20041028] of the "application/held+xml" format. This is presented as a formal definition of the "application/sigpos+xml" format. Note that the XML Schema Definition is not intended to be used with on-the-fly validation of the presence XML document. Whitespaces are included in the schema to conform to the line length restrictions of the RFC format without having a negative impact on the readability of the document. Any conforming processor should remove leading and trailing white spaces.

The XML schema depicted below supports the Beacon Location mode of SigPos Survey data only.

```
<?xml version="1.0" encoding="utf-8"?>
<xs:schema xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
  xmlns:gml="http://opengis.net/gml"
  xmlns:vc="urn:ietf:params:xml:ns:vcard-4.0"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:lm="urn:ietf:params:xml:ns:geopriv:lm"
  xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:ap="http://example.com/airport/5.0"
  xmlns:pidf="urn:ietf:params:xml:ns:pidf"
  attributeFormDefault="unqualified"
  elementFormDefault="qualified"
  targetNamespace="jones:sigpos"
  xmlns:xs="http://www.w3.org/2001/XMLSchema">
  <xs:annotation>
    <xs:documentation>
      This document defines SigPos messages.
      (draft-jones-geopriv-sigpos-survey)
    </xs:documentation>
  </xs:annotation>

  <xs:import schemaLocation="/xsd/vcard.xsd"
    namespace="urn:ietf:params:xml:ns:vcard-4.0" />

  <xs:import schemaLocation="/xsd/pidf.xsd"
    namespace="urn:ietf:params:xml:ns:pidf" />
```

```
<xs:import schemaLocation="/xsd/geopriv-lm.xsd"
           namespace="urn:ietf:params:xml:ns:geopriv:lm" />

<xs:complexType name="responseType">
  <xs:complexContent>
    <xs:restriction base="xs:anyType">
      <xs:sequence>
        <xs:element name="message" type="sigpos:responseMsgType"
                     minOccurs="0" maxOccurs="unbounded"/>
        <xs:any namespace="##other" processContents="lax"
                 minOccurs="0" maxOccurs="unbounded"/>
      </xs:sequence>
      <xs:attribute name="code" type="xs:token" use="required"/>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:restriction>
  </xs:complexContent>
</xs:complexType>

<xs:complexType name="responseMsgType">
  <xs:simpleContent>
    <xs:extension base="xs:token">
      <xs:attribute ref="xml:lang"/>
      <xs:anyAttribute namespace="##any" processContents="lax"/>
    </xs:extension>
  </xs:simpleContent>
</xs:complexType>

<xs:element name="sigPosResponse" type="sigpos:responseType"/>

<xs:element name="sigposSubmission">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="session">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="venue">
              <xs:complexType>
                <xs:sequence>
                  <xs:element ref="vc:vcard" />
                  <xs:element name="owner">
                    <xs:complexType>
                      <xs:sequence>
                        <xs:element ref="vc:vcard" />
                      </xs:sequence>
                    </xs:complexType>
                  </xs:element>
                </xs:sequence>
              </xs:complexType>
            </xs:element>
            <xs:element name="license">
              <xs:complexType>
```

```
<xs:sequence>
  <xs:element name="license-type"
              type="xs:string" />
  <xs:element name="licenseExpiry"
              type="xs:dateTime" minOccurs="0"/>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="device" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="configuration">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="id" type="xs:string" />
            <xs:element name="name" type="xs:string" />
            <xs:element name="type" type="xs:string" />
            <xs:element name="model"
                      type="xs:unsignedShort" />
            <xs:element name="version"
                      type="xs:decimal" />
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
<xs:element maxOccurs="unbounded" name="sensor">
  <xs:complexType>
    <xs:sequence>
      <xs:element name="configuration">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="type"
                      type="xs:string" />
            <xs:element name="id"
                      type="xs:string" />
            <xs:element name="antenna"
                      type="xs:string" />
            <xs:element name="chipset"
                      type="xs:string" />
            <xs:element name="manufacturer"
                      type="xs:string" />
            <xs:element name="capabilities">
              <xs:complexType>
                <xs:sequence>
                  <xs:element minOccurs="0"
                            name="type" />
                </xs:sequence>
              </xs:complexType>
            </xs:element>
          </xs:sequence>
        </xs:complexType>
      </xs:element>
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
```

```

        type="xs:string" />
      <xs:element minOccurs="0"
        name="standard"
        type="xs:string" />
      <xs:element minOccurs="0"
        name="frequencyband"
        type="xs:string" />
    </xs:sequence>
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
<xs:element name="survey">
  <xs:complexType>
    <xs:sequence>
      <xs:element maxOccurs="unbounded"
        name="survey-point">
        <xs:complexType>
          <xs:sequence>
            <xs:element name="groundtruth">
              <xs:complexType>
                <xs:sequence>
                  <xs:element ref="pidf:presence" />
                  <xs:element name="rawlocation"
                    minOccurs="0">
                    <xs:complexType>
                      <xs:sequence>
                        <xs:element name="gnss">
                          <xs:complexType>
                            <xs:sequence>
                              <xs:element name="sentences">
                                <xs:complexType>
                                  <xs:sequence>
                                    <xs:choice
                                      maxOccurs="unbounded">
                                      <xs:element name="type"
                                        type="xs:string" />
                                      <xs:element name="value"
                                        type="xs:string" />
                                    </xs:choice>
                                  </xs:sequence>
                                </xs:complexType>
                              </xs:sequence>
                            </xs:complexType>
                          </xs:sequence>
                        </xs:sequence>
                      </xs:complexType>
                    </xs:sequence>
                  </xs:sequence>
                </xs:complexType>
              </xs:sequence>
            </xs:sequence>
          </xs:complexType>
        </xs:sequence>
      </xs:sequence>
    </xs:complexType>
  </xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>

```



```

        </xs:complexType>
      </xs:element>
    </xs:sequence>
    <xs:attribute name="type"
      type="xs:string"
      use="required" />
  </xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
<xs:element name="beacon" minOccurs="0">
  <xs:complexType>
    <xs:sequence>
      <xs:element maxOccurs="unbounded"
        name="mac" type="xs:string" />
    </xs:sequence>
    <xs:attribute name="type"
      type="xs:string" use="required" />
  </xs:complexType>
</xs:element>
<xs:element ref="lm:measurements"
  minOccurs="0"/>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:sequence>
<xs:attribute name="sessionID" type="xs:string"
  use="required" />
</xs:complexType>
</xs:element>
</xs:sequence>
</xs:complexType>
</xs:element>
</xs:schema>
```

SigPos Partial XML Schema

8. Security Considerations

Location-related measurement data can be as privacy sensitive as location information.

Survey data is effectively equivalent to location information if the contextual knowledge necessary to generate one from the other is readily accessible. Even where contextual knowledge is difficult to acquire, there can be no assurance that an authorized recipient of the contextual knowledge is also authorized to receive location information.

In order to protect the privacy of the subject of location-related survey data, this implies that survey data is protected with a similar degree of protection as location information.

Survey Data Privacy Model

In general, survey data represents a smaller privacy risk than personal location information. It does however represent potential privacy risks especially with respect to venues which have security risks or wish to maintain control over the exposure of detailed location information.

No entity is permitted to redistribute survey data except as specified in the data license. The Device directs other entities in how survey data is used and retained.

8.1. Assuring That the Proper LIS Has Been Contacted

This document assumes that the LIS to be contacted is identified either by an IP address or a domain name, as is the case for a LIS discovered as described in LIS Discovery [RFC5986]. As the SigPos transaction is conducted using TLS [RFC5246], the LIS can authenticate its identity, either as a domain name or as an IP address, to the client by presenting a certificate containing that identifier as a subjectAltName (i.e., as an iPAddress or dNSName, respectively). In the case of the HTTP binding described above, this is exactly the authentication described by TLS [RFC2818]. If the client has external information as to the expected identity or credentials of the proper LIS (e.g., a certificate fingerprint), these checks MAY be omitted. Any binding of SigPos MUST be capable of being transacted over TLS so that the client can request the above authentication, and a LIS implementation for a binding MUST include this feature. Note that in order for the presented certificate to be valid at the client, the client must be able to validate the certificate. In particular, the validation path of the certificate must end in one of the client's trust anchors, even if that trust anchor is the LIS certificate itself.

8.2. Protecting Responses from Modification

In order to prevent a response from being modified en route, messages must be transmitted over an integrity-protected channel. When the transaction is being conducted over TLS (a required feature per Section 11.1), the channel will be integrity protected by appropriate ciphersuites. When TLS is not used, this protection will vary depending on the binding; in most cases, without protection from TLS, the response will not be protected from modification en route.

9. Examples

The following sections provide examples of basic HTTP/HTTPS, a simple location request, and a location request for multiple location types, along with the relevant location responses. To focus on important portions of messages, the examples in Sections 10.2 and 10.3 do not show HTTP/HTTPS headers or the XML prologue. In addition, sections of XML not relevant to the example are replaced with comments.

9.1. Example of a WiFi Access Point Location Survey

The examples in this section show example HTTPS messages that include the SigPos submission or response document.

```
POST /location HTTP/1.1
Host: sigpos.example.com:49152
Content-Type: application/sigpos+xml;charset=utf-8
Content-Length: nnn
```

```
<?xml version="1.0"?> <sigpos xmlns="jones:sigpos".../>
```

A simple example of a small survey composed of two survey points is illustrated by the example message below. This uses the static beacon key survey model.

```
<?xml version="1.0"?>
<sigpos xmlns="jones:sigpos"
  xmlns:pidf="urn:ietf:params:xml:ns:pidf"
  xmlns:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:vc="urn:ietf:params:xml:ns:vccard-4.0"
  xmlns:ap="http://example.com/airport/5.0"
  xmlns:gml="http://www.opengis.net/gml">
<session sessionID=?axxwe82737?>
  <venue>
    <vc:vcCard>
      <vc:fn><vc:text>Example Building</vc:text></vc:fn>
      <vc:adr>
        <vc:parameters>
          <vc:type><vc:text>work</vc:text></vc:type>
          <vc:label><vc:text>Example Building
1 South Boston Street
Boston, MA USA 02210</vc:text></vc:label>
        </vc:parameters>
        <vc:pobox/>
        <vc:ext/>
        <vc:street>1 South Boston Street</vc:street>
        <vc:locality>Boston</vc:locality>
        <vc:region>MA</vc:region>
        <vc:code>02210</vc:code>
        <vc:country>USA</vc:country>
      </vc:adr>
    </vc:vcCard>
  </venue>
  <licensor>
    <vc:vcCard>
      <vc:fn><vc:text>Rober Builder</vc:text></vc:fn>
      <vc:n>
        <vc:surname>Builder</vc:surname>
        <vc:given>Robert</vc:given>
        <vc:additional/>
        <vc:prefix/>
        <vc:suffix/>
      </vc:n>
      <vc:adr>
```

```

        <vc:parameters>
          <vc:type><text>work</vc:text></vc:type>
          <vc:label><text>Rober Builder
1 South Boston Street
Boston, MA USA 02210</vc:text></vc:label>
        </vc:parameters>
        <vc:pobox/>
        <vc:ext/>
        <vc:street>1 South Boston Street</vc:street>
        <vc:locality>Boston</vc:locality>
        <vc:region>MA</vc:region>
        <vc:code>02210</vc:code>
        <vc:country>USA</vc:country>
      </vc:adr>
      <vc:tel>
        <vc:parameters>
          <vc:type>
            <vc:text>work</vc:text>
            <vc:text>voice</vc:text>
          </vc:type>
        </vc:parameters>
        <vc:uri>tel:+1-555-555-1212;ext=102</vc:uri>
      </vc:tel>
      <vc:email>
        <vc:parameters>
          <type><text>work</vc:text></vc:type>
        </vc:parameters>
        <vc:text>reober.builder@example.com</vc:text>
      </vc:email>
    </vc:vcard>
  </licensor>
  <license>
    <license-type>CC BY</license-type>
  </license>
</venue>
<survey>
  <survey-point>
    <groundtruth>
      <pidf:presence>
        <pidf:tuple id="abcd123456">
          <pidf:status>
            <gp:geopriv>
              <gp:location-info>
                <gml:Point xmlns:gml="http://opengis.net/gml">
                  <gml:pos>-34.4 150.8</gml:pos>
                </gml:Point>
                <cl:civicAddress>
                  <cl:country>US</cl:country>

```

```
<cl:A1>CA</cl:A1>
<ap:airport>LAX</ap:airport>
<ap:terminal>Tom Bradley</ap:terminal>
<ap:concourse>G</ap:concourse>
<ap:gate>36B</ap:gate>
</civicAddress>
</gp:location-info>
</gp:geopriv>
<pidf:timestamp>2012-02-21T14:33:58:05</pidf:timestamp>
</pidf:status>
</pidf:tuple>
</pidf:presence>
</groundtruth>
<beacon type="wifi">
  <mac>FF00FF723CBA</mac>
  <mac>FF00FF723CBB</mac>
</beacon>
</survey-point>
<survey-point>
  <groundtruth>
    <pidf:presence>
      <pidf:tuple id="abcd123456">
        <pidf:status>
          <gp:geopriv>
            <gp:location-info>
              <gml:Point xmlns:gml="http://opengis.net/gml">
                <gml:pos>-34.35 150.83</gml:pos>
              </gml:Point>
            </gp:location-info>
          </gp:geopriv>
          <pidf:timestamp>2012-02-21T14:33:58:06</pidf:timestamp>
        </pidf:status>
      </pidf:tuple>
    </pidf:presence>
  </groundtruth>
  <beacon type="wifi">
    <mac>FF00FF723A00</mac>
  </beacon>
</survey-point>
</survey>
</session>
</sigpos>
</xml>
```

802.11 WiFi Beacon Survey

9.2. Example of a WiFi Signal Survey

A simple example of wifi scan data conveyance using gps for ground truth is illustrated by the example message below.

```
<?xml version="1.0"?>
<sigpos xmlns="jones:sigpos"
  xmlns:pidf="urn:ietf:params:xml:ns:pidf"
  xmlns:cl="urn:ietf:params:xml:ns:pidf:geopriv10:civicAddr"
  xmlns:gp="urn:ietf:params:xml:ns:pidf:geopriv10"
  xmlns:dyn="urn:ietf:params:xml:ns:pidf:geopriv10:dynamic"
  xmlns:rel="urn:ietf:params:xml:ns:pidf:geopriv10:relative"
  xmlns:vc="urn:ietf:params:xml:ns:vcard-4.0"
  xmlns:ap="http://example.com/airport/5.0"
  xmlns:gml="http://www.opengis.net/gml">
  <session sessionID="axxwe82737">
  <venue>
    <vc:vcard>
      <vc:fn><vc:text>Example Building</vc:text></vc:fn>
      <vc:adr>
        <vc:parameters>
          <vc:type><vc:text>work</vc:text></vc:type>
          <vc:label><vc:text>Example Building
1 South Boston Street
Boston, MA USA 02210</vc:text></vc:label>
        </vc:parameters>
        <vc:pobox/>
        <vc:ext/>
        <vc:street>1 South Boston Street</vc:street>
        <vc:locality>Boston</vc:locality>
        <vc:region>MA</vc:region>
        <vc:code>02210</vc:code>
        <vc:country>USA</vc:country>
      </vc:adr>
    </vc:vcard>
  <licensor>
    <vc:vcard>
      <vc:fn><text>Rober Builder</vc:text></vc:fn>
      <vc:n>
        <vc:surname>Builder</vc:surname>
        <vc:given>Robert</vc:given>
        <vc:additional/>
        <vc:prefix/>
        <vc:suffix/>
      </vc:n>
      <vc:adr>
        <vc:parameters>
          <vc:type><text>work</vc:text></vc:type>
```

```

        <vc:label><text>Rober Builder
1 South Boston Street
Boston, MA USA 02210</vc:text></vc:label>
    </vc:parameters>
    <vc:pobox/>
    <vc:ext/>
    <vc:street>1 South Boston Street</vc:street>
    <vc:locality>Boston</vc:locality>
    <vc:region>MA</vc:region>
    <vc:code>02210</vc:code>
    <vc:country>USA</vc:country>
</vc:adr>
<vc:tel>
    <vc:parameters>
        <vc:type>
            <vc:text>work</vc:text>
            <vc:text>voice</vc:text>
        </vc:type>
    </vc:parameters>
    <vc:uri>tel:+1-555-555-1212;ext=102</vc:uri>
</vc:tel>
<vc:email>
    <vc:parameters>
        <type><text>work</vc:text></vc:type>
    </vc:parameters>
    <vc:text>reober.builder@example.com</vc:text>
</vc:email>
</vc:vcard>
</licensor>
<license>
    <license-type>unrestricted</license-type>
    <licenseExpiry>2012-10-29T14:33:58</licenseExpiry>
</license>
</venue>
<device>
    <configuration>
        <id>00EFDA7200B004</id>
        <name>lumina</name>
        <type>smartphone</type>
        <model>900</model>
        <version>1.2</version>
    </configuration>
    <sensor>
        <configuration>
            <type>wifi</type>
            <id>ath0</id>
            <antenna>omni-directional</antenna>
            <chipset>aetheros</chipset>

```



```

        <manufacturer>newco</manufacturer>
        <capabilities>
          <standard>a,b,g,n</standard>
          <frequencyband>1-13</frequencyband>
        </capabilities>
      </configuration>
    </sensor>
    <sensor>
      <configuration>
        <type>gps</type>
        <id>gps3210</id>
        <antenna>combined</antenna>
        <chipset>qualcomm</chipset>
        <manufacturer>newco</manufacturer>
        <capabilities>
          <type>standard</type>
        </capabilities>
      </configuration>
    </sensor>
  </device>
  <survey>
    <survey-point>
      <groundtruth>
        <pidf:presence>
          <pidf:tuple id="abcd123456">
            <pidf:status>
              <gp:geopriv>
                <gp:location-info>
                  <gml:Point xmlns:gml="http://opengis.net/gml">
                    <gml:pos>-34.35 150.83</gml:pos>
                  </gml:Point>
                </gp:location-info>
              </gp:geopriv>
              <pidf:timestamp>2012-02-21T14:33:58:06</pidf:timestamp>
            </pidf:status>
          </pidf:tuple>
        </pidf:presence>
        <rawlocation>
          <gnss type="gps">
            <sentences>
              <type>GPGGA</type>
              <value>
$GPGGA,092750.000,5321.6802,N,00630.3372,W,1,8,1.03,61.7,M,55.2,M,,*76
              </value>
              <type>GPGSA</type>
              <value>
$GPGSA,A,3,10,07,05,02,29,04,08,13,,,,,1.72,1.03,1.38*0A
              </value>
            </sentences>
          </gnss>
        </rawlocation>
      </groundtruth>
    </survey-point>
  </survey>

```

```

        <type>GPSV</type>
        <value>
$GPGSV,3,1,11,10,63,137,17,07,61,098,15,05,59,290,20,08,54,157,30*70
        </value>
        <type>GPSV</type>
        <value>
$GPGSV,3,2,11,02,39,223,19,13,28,070,17,26,23,252,,04,14,186,14*79
        </value>
        <type>GPRMC</type>
        <value>
$GPRMC,092750.000,A,5321.6802,N,00630.3372,W,0.02,31.66,280511,,,A*43
        </value>
    </sentences>
</gnss>
</rawlocation>
</groundtruth>
<lm:measurements xmlns:lm="urn:ietf:params:xml:ns:geopriv:lm"
    time="2008-04-29T14:33:58">
    <wifi xmlns="urn:ietf:params:xml:ns:geopriv:lm:wifi">
        <ap serving="true">
            <bssid>00-12-F0-A0-80-EF</bssid>
            <ssid>wlan-home</ssid>
            <rcpi>-85</rcpi>
        </ap>
        <ap>
            <bssid>00-11-F0-A0-80-EF</bssid>
            <ssid>wlan-other</ssid>
            <rcpi>-92</rcpi>
        </ap>
    </wifi>
</lm:measurements>
</survey-point>
</survey>
</session>
</sigpos>
</xml>

```

802.11 WiFi Signal Scan Survey

10. Acknowledgements

This template was derived from an initial version written by Pekka Savola and contributed by him to the xml2rfc project. Thanks to Richard Barnes and Stephane Terrenoir, Adam Roach, Robin Wilton, and Martin Thompson for initial reviews and valuable feedback.

11. IANA Considerations

This section creates a registry for Data License types (Section 6.1.3.3) and registers the namespaces and schema defined in the Schemas (Section 7) section.

11.1. URN Sub-Namespace Registration for urn:ietf:params:xml:ns:geopriv:sigpos

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

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

Registrant Contact: IETF, <TBD>.

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>SigPos Messages</title>
  </head>
  <body>
    <h1>Namespace for SigPos Messages</h1>
    <h2>urn:ietf:params:xml:ns:geopriv:sigpos</h2>
    <p>See draft-jones-geopriv-sigpos-survey</p>
  </body>
</html>
END
```

11.2. XML Schema Registration

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

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

Registrant Contact: IETF, <tbd>.

Schema: The XML for this schema can be found as the entirety of Section 9 of this document.

11.3. MIME Media Type Registration for 'application/sigpos+xml'

This section registers the "application/sigpos+xml" MIME type.

To: ietf-types@iana.org

Subject: Registration of MIME media type application/sigpos+xml

MIME media type name: application

MIME subtype name: sigpos+xml

Required parameters: (none)

Optional parameters: charset

Same as the charset parameter of "application/xml" as specified in RFC 3023 [RFC3023], Section 3.2.

Encoding considerations: Same as the encoding considerations of "application/xml" as specified in RFC 3023 [RFC3023], Section 3.2.

Security considerations: This content type is designed to carry protocol data related to the location of signal beacons, which could include information that is considered private. Appropriate precautions should be taken to limit disclosure of this information.

Interoperability considerations: This content type provides a basis for a protocol. There are multiple interoperable implementations of this protocol.

Published specification: <TBD>

Applications which use this media type: Location information surveyors and service providers.

Additional Information:

Magic Number(s): (none)

File extension(s): .heldxml

Macintosh File Type Code(s): "TEXT"

Person & email address to contact for further information:

Mary Barnes <tbd> Intended usage: LIMITED USE

Author/Change controller: The IETF

Other information: This media type is a specialization of application/xml [RFC3023], and many of the considerations described there also apply to application/held+xml.

11.4. IANA Registry for Data License Types

This document establishes a new IANA registry for the for Data License types (Section 6.1.3.3). This reegistry includes tokens for the Data License type. Referring to the [RFC5226], this registry operates under "Specification Required" rules. The IESG will appoint an Expert Review who will advice IANA promptly on each request for a new or updated Data License type.

Each entry in the registry requires the following information:

- o Data License name: the name of the data license
- o Brief Description: a brief description of the data license
- o URI: optional URI to the license definition

This section pre-registers 8 new 'licenseType' tokens associated with the 'licenseType'

1. unrestricted: this license allows for the use and unrestricted derivative products based on the data set
2. CC BY: this license lets others distribute, remix, tweak, and build upon your work, even commercially, as long as they credit you for the original creation.
3. CC BY-ND: this license allows for redistribution, commercial and non-commercial, as long as it is passed along unchanged and in whole, with credit to you.
4. CC BY-NC-SA: this license lets others remix, tweak, and build upon your work non-commercially, as long as they credit you and license their new creations under the identical terms.
5. CC BY-SA: this license lets others remix, tweak, and build upon your work even for commercial purposes, as long as they credit you and license their new creations under the identical terms.
6. CC BY-NC: this license lets others remix, tweak, and build upon your work even for commercial purposes, as long as they credit you and license their new creations under the identical terms.

7. CC BY-NC-ND: this license is the most restrictive of our six main licenses, only allowing others to download your works and share them with others as long as they credit you, but they can't change them in any way or use them commercially.
8. private: this license is intended to provide full control over the usage and derivative usage of the data. Any use of the data would be governed under a separate agreement between the licensor and the party wishing to make use of the data. By default, no rights are granted for private data.

12. References

12.1. Normative References

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