Information Elements for device location in IPFIX

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Abstract

This document defines a set of Information Elements for IP Flow Information Export (IPFIX) protocol to represent location information of any device (mobile or not) acting as an IPFIX flow exporter. The specified Information Elements support geodetic and civic location data.

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1 Introduction

The importance of geographic location information in the Internet is growing exponentially. Today's devices, including smartphones, tablets, sensors have capabilities to collect and expose their geographic location and these devices are involved in an increasing part of the overall network traffic. While fixed devices often rely on a single mean to collect their localization, mobile ones can exploit many location systems to know their physical location. This information is already used by numerous applications to deliver a wide range of services like mapping/navigation services, people/places finders and so on. Associating the location information of the device and its network traffic can be beneficial to many network management and measurement applications, including traffic patterns/trends analysis, anomaly and failure detection or simply provider-independent measurement. Fixed devices usually get their location information set by static configuration while mobile devices, due to their frequent moving, rely on dynamic location update. Flows are natural entities to which location information can be attached to for management purpose. Hence, providing a means of exporting and collection location associated to flows is highly desirable.

The IPFIX protocol [RFC5101] is designed to export information IP traffic flows and related measurements data. Thanks to its Template mechanism, it can export any type of information.

This document defines a set of IPFIX Information Elements to allow exporter processes running on a device, to encapsulate location information within exported flows using the IPFIX protocol. This document does not create any new format for location information itself. Numerous existing formats based on civic location, geographic coordinates, and the like, have been developed in other standards area. Instead, this document defines the IPFIX Information Elements that are suitable for identifying and encapsulating preexisting location information data.

1.1. Motivation

An IPFIX exporter is used to export information about IP traffic Flows and related measurement data at an Observation Point and send them to a collector. The collected information is represented and stored in two dimensions with their values over time to be used for a series of applications like performance assurance, capacity planning, security, billing, or basic monitoring. For exporters running on devices with frequent changing location, a network management application running on behalf of a collector needs to be aware of these changes since they may affect the behavior of the network and

help the operator to measure the performance metrics of each flow per location. Since the geographic location of an exporter may change over time, a new dimension needs to be added in the Flow definition. In fact, we are not dealing anymore with Flows associated to a fixed location, but with a multitude of sub-Flows for which the device locations are reported. To achieve this, location information needs to be obtained and transferred by the exporter running on the device. Typically, it would be beneficial if a network management application is able to identify service quality parameters according to mobile location changes, instead of assuming a single location for all observed parameters.

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 RFC 2119 [RFC2119].

2. Relationships with GEOPRIV

Carrying geographical location information on the Internet has been addressed by the GEOPRIV working group. There, a Dynamic Host Configuration Protocol (DHCPv4 and DHCPv6) option containing a civic address has been specified in [RFC4676] and another option containing geospatial information has been defined in [RFC6225]. The group also defined a set of requirements [RFC3693] to be respected when collecting and using location objects related to a user. These requirements including usage policies and privacy preferences associated to the location object as expressed by a user. All the security and privacy requirements defined in [RFC3693] concerning location data collection and usage MAY be applied to the IPFIX protocol when conveying location information. The GEOPRIV working group has extended in [RFC4119] the XML-based Presence Information Data Format to allow the encapsulation of location information within a presence document.

3 Location Information

There are two common ways to identify the location of a device, either through geospatial coordinates or by so-called civic location. Geospatial coordinates indicate longitude, latitude, and altitude, while civic location encompasses abstract ideas of where something is: in the kitchen, in a street address, on a train approaching Nancy, France. The usage of these two types of location representations are addressed by the GEOPRIV group both in [RFC5491] and [RFC5139]. This document does not define how the devices obtain

the location information, however we suppose that they use one or several existing mechanisms to obtain the location information.

3.1 Geospatial Location Information

Geospatial location relies on a numeric coordinates system to indicate longitude, latitude and altitude of the device. These coordinates represent a point in two (longitude and latitude) or in three dimensions (longitude, altitude and latitude). Using only a point to represent a location is not enough since an area of or volume of uncertainty SHALL be specified. In theory, the area or volume represents a coverage in which the device has a high probability of being found, and the point is the centroid for the area or volume. In [GeoShape] a set of geometric areas and volumes have been specified to define a location with uncertainty. A standard set of Coordinate Reference Systems (CRS) and unit of measure are also specified in [GeoShape].

In this document, we defined an Information Element to specify the CRS code and how coordinates are organized. However, implementations MUST specify distances and heights in meters as defined in EPSG 9001. Angular measures MUST be specified using degrees as identified by the EPSG 9102 code. The values of EPSG codes can be resolved by using the CRS Registry Service operated by the Oil and Gas Producers Association [OGP].

In this document, we make use of these shapes associated to a Coordinate Reference System (CRS) to specify geodetic Information Elements to convey a location using the IPFIX protocol. The IPFIX exporter processes running on the end mobile device SHOULD choose the suitable Information Elements to convey the available geodetic location information data of the device obtained by a localization method.

3.2 Civic Location Information

A civic location provides a human-usable information about the location of a device, particularly within buildings. It MAY be a civic address closely related to a postal address, commonly used by local postal service to deliver mail. It MAY be also a proximity information - for example, "living room", "office 123 in building 2". The format of civic location information has been addressed in [RFC4776] where a set of parameters are provided to describe a civic location. Compared to geodetic location information, civic location data can often be interpreted even if incomplete. For example, geodetic information are not available inside buildings.

4. Location Information Elements

The following Information Elements represent location-related information of a device. Associated with Information Elements already defined by IPFIX to export traffic flows, they SHALL be used to export geodetic or civic location of a device.

4.1. locationType

Description: Denotes the type of the location information. The type identifiers are related to geodetic or symbolic location representation. The geodetic types are defined in [GeoShape] as a set of geometry to encode a location information. The geometry set is defined in [GeoShape] for two dimensional and three dimensional shapes: Point (2d and 3d), Polygon (2d), Circle (2d), Ellipse (2d), Arc band (2d), Sphere (3d), Ellipsoid (3d), Prism (3d). The civic type represents a civic location information as specified in [RFC4776].

Data Type: unsigned8
Data Type Semantics: identifier
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 401

4.2. locationGeodeticCRSCode

Description: Denotes the Coordinate Reference System (CRS) codes to which the location coordinates are organized and related to the real world as specified in [GEOSHAPE]. In this document we mandate the use of the world geodetic system 1984 (WGS84) [WGS84] coordinate reference system and the usage of the European petroleum survey group (EPSG) code 4326 for two- dimensional (2d) shape representations and EPSG 4979 for three-dimensional (3d) volume representations.

Data Type: unsigned16
Data Type Semantics: identifier
PEN (provisional): 12559 (INRIA)
ElementId: 402

4.3. locationGeodeticPos

Description: Denotes a coordinate information value specified using either WGS 84 (latitude, longitude) or WGS 84 (latitude, longitude, altitude).

Data Type: string

PEN (provisional): 12559 (INRIA)
ElementId (provisional): 403

4.4. locationGeodeticPosList

Description: Denotes a list of coordinate information specified using locationInfoPos.

Data Type: basicList/allOf
Data Type Semantics: list
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 404

4.5. locationGeodeticRadius

Description: Denotes the radius value of a location described using a circular area in a two dimensional CRSs or a sphere shape in a three dimensional CRS.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 405

4.6. locationGeodeticHeight

Description: Denotes the height value of a location described using a prism shape.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 405

4.7. locationGeodeticSemiMajorAxis

Description: Denotes the length of a semi-major axe of a location described using an elliptical area in a two dimensional CRS or an ellipsoid in a three dimensional CRS.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 406

4.8. locationGeodeticSemiMinorAxis

Description: Denotes the length of a semi-minor axe of a location described using an elliptical area in a two dimensional CRS or an ellipsoid in a three dimensional CRS.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 407

4.9. locationGeodeticVerticalAxis

Description: Denotes the length of a vertical axis of a location described using an ellipsoid area in three dimensional CRS.
Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 408

4.10. locationGeodeticOrientation

Description: Denotes the angle to express the orientation of the semi-major axis from the center point of a location described using an elliptical area in a two dimensional CRS or an ellipsoid in a three dimensional CRS.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 409

4.11. locationGeodeticInnerRadius

Description: Denotes the inner radius value of location described using an arc band shape.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 410

4.12. locationGeodeticOuterRadius

Description: Denotes the outer radius value of location described using an arc band shape.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 411

4.13. locationGeodeticStartAngle

Description: Denotes the start angle value from north of location described using an arc band shape.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 412

4.14. locationGeodeticOpenningAngle

Description: Denotes the opening angle value of location described using an arc band shape.

Data Type: float32
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 413

4.15. locationCivicType

Description: Denotes the civic location information type as specified in [RFC4776].

Data Type: unsigned8
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 414

4.16. locationCivicLength

Description: Denotes the length in octet of the locationCivicValue Information Element.

Data Type: unsigned8
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 415

4.17. locationCivicValue

Description: Denotes a civic location information element that MUST be encoded as an UTF-8 string. The location information MAY be a

civic address as specified in [RFC4776] or a proximity information to known objects.

Data Type: string
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 416

4.18. locationMethod

Description: Denotes the way that the location information was derived or discovered.

Data Type: unsigned8
Data Type Semantics: identifier
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 417

4.19. locationTime

Description: Denotes the time when the location information is derived on the device where the IPFIX exporter is running. The time is expressed in milliseconds since January 1, 1970, 00:00:00 GMT.

Data Type: dateTimeMilliseconds
Data Type Semantics: quantity
PEN (provisional): 12559 (INRIA)
ElementId (provisional): 418

5 Using Location Information Elements

The specified location Information ELements in this document SHALL be used by an exporting process to construct an IPFIX location template with respect to these rules.
Rule #1: Location Information Elements MUST describe a discrete location defined as a place, point, area, or volume in which a device can be found.

Rule #2: In situations where a discrete location can be described in more than one way, each location SHOULD be described in a separate template record. A compound template record containing a subTemplateMultiList field [RFC6313] SHOULD be used in which each top- level element corresponds to a different location Template record. A device located using a geodetic point and a civic location indicating the floor in a building is an example of such a multi-way location description.

Rule #3: Providing more than one location data in an exported flow

MUST only done if the different locations refer to the same place.

Rule #4: When the location of the device changes, the current IPFIX flows MUST be expired by the exporter process running on the device.

Rule #5: When another type of location data is available and need to be send, the exporter MUST send the new template of the location format.

6 Recommended Templates for Geodetic and Civic location Export

The following templates are defined as recommended Templates for geodetic and civic locations. The geodetic templates are related to the eight shapes to define a location as a point, an area or a volume. The shapes definition and usage is provided in [GeoSHAPE]. Civic locations are represented using a template containing a subTemplateList [RFC6313] where each element of the list correspond to a template record. We provide also several examples of encoded location information using these different location types.

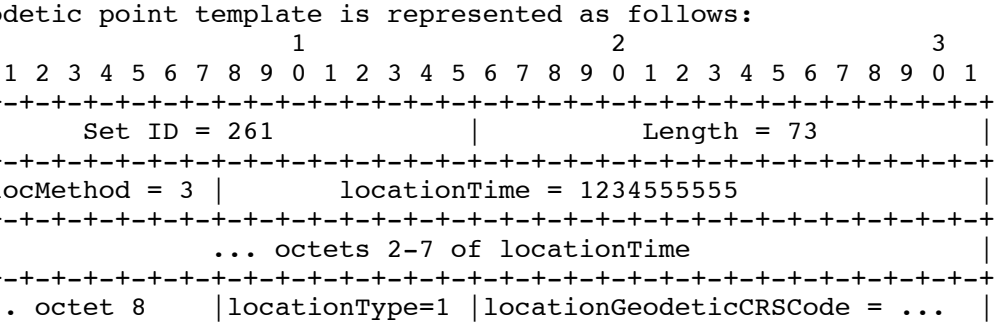
6.1. Geodetic point Template

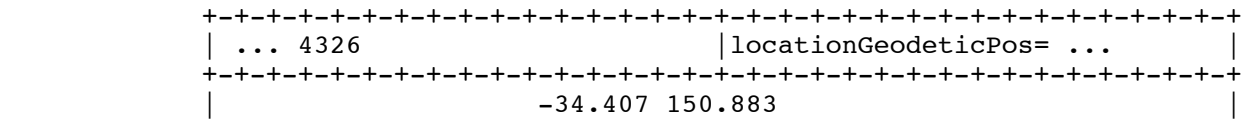
The point shape is the simplest form of geodetic location Information Element. It is used when there is no known uncertainty. Figure 1 shows an example of a Template to represent two or three dimensions location point.

```
Location record
 | locationMethod(xxx)[1]
 | locationTime(xxx)[8]
 | locationType(xxx)[1]
 | locationGeodeticCRSCode(xxx)[4]
 | locationGeodeticPos(xxx)[v]
```

Figure 1: A geodetic Template containing a point-based location

An example of a data record of a two-dimensions point using the geodetic point template is represented as follows:



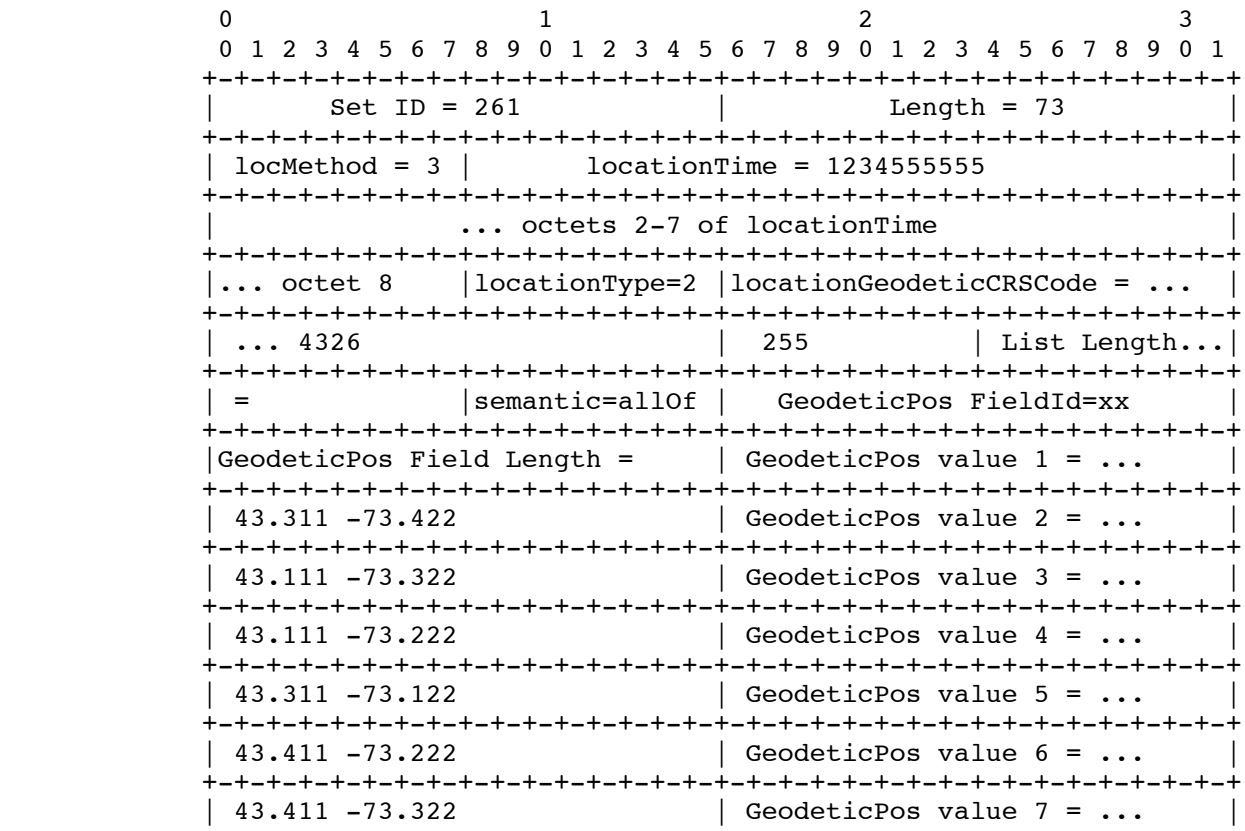


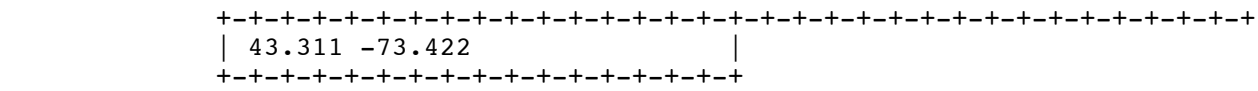
6.2. Geodetic polygon Template

Location record
- locationMethod(xxx)[1]
- locationTime(xxx)[8]
- locationType(xxx)[1]
- locationGeodeticCRSCode(xxx)[4]
- locationGeodeticPosList(xxx)[v]

Figure 2: A geodetic Template containing a polygon-based location

An example of a data record using the geodetic polygon template is represented as follows:



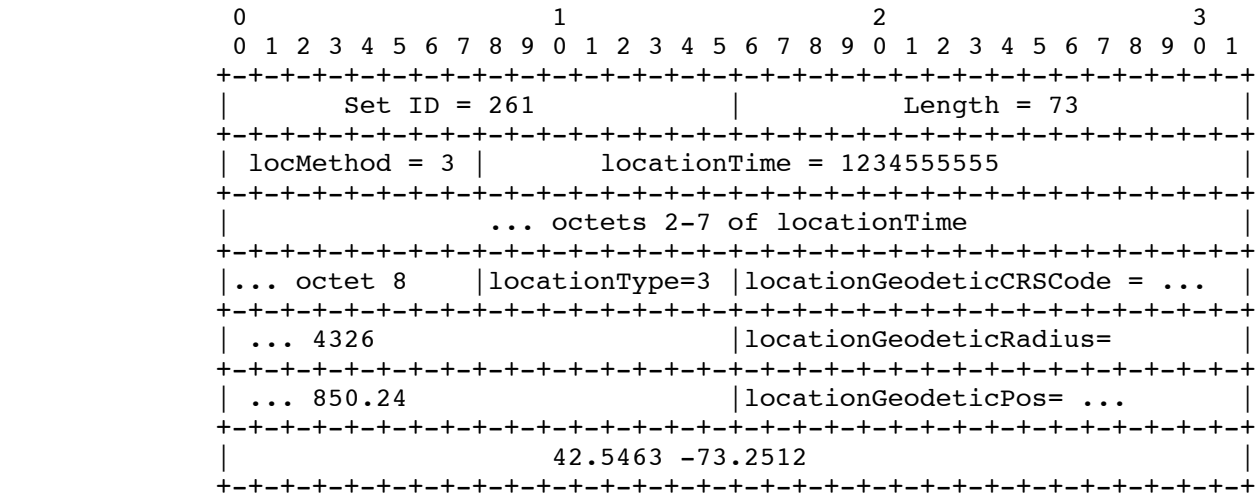


6.3. Geodetic circle and sphere Templates

Location Template record (ID = xxx)
- locationMethod(xxx)[1]
- locationTime(xxx)[8]
- locationType(xxx)[1]
- locationInfoCRSCode(xxx)[4]
- locationGeodeticRadius(xxx)[4]
- locationGeodeticPos(xxx)[v]

Figure 3: A geodetic Template containing a circle or a sphere based location

An example of a data record using the geodetic circle template is represented as follows:



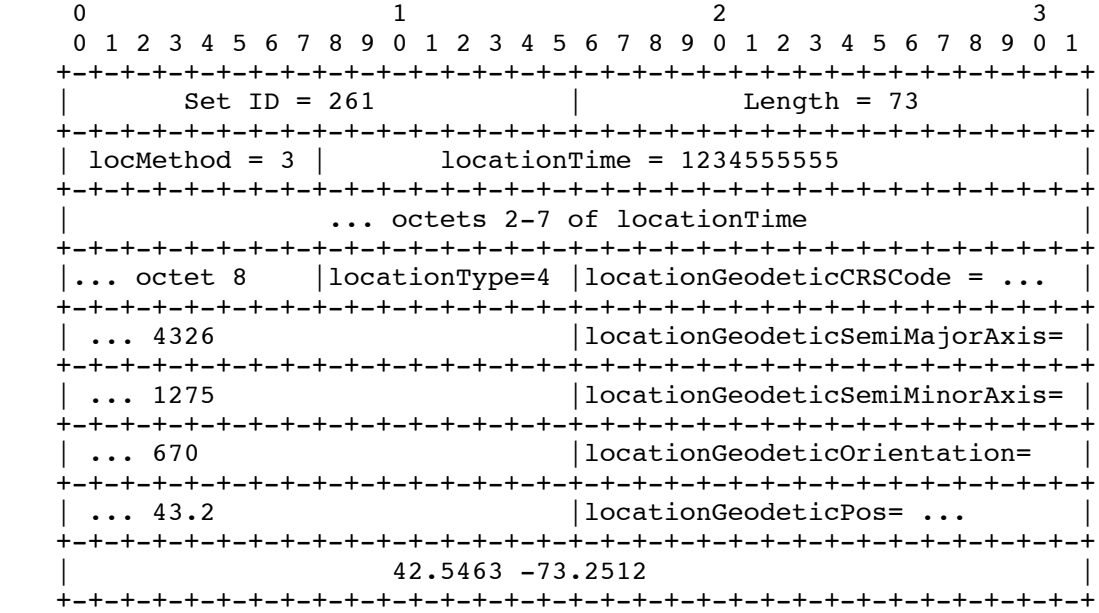
6.4. Geodetic ellipse Template

Location Template record (ID = xxx)
- locationMethod(xxx)[1]
- locationTime(xxx)[8]
- locationType(xxx)[1]
- locationInfoCRSCode(xxx)[4]
- locationGeodeticSemiMajorAxis(xxx)[4]
- locationGeodeticSemiMinorAxis(xxx)[4]

```
   | locationGeodeticOrientation(xxx)[4]
   | locationGeodeticPos(xxx)[v]
```

Figure 4: A geodetic Template containing an ellipse-based location

An example of a data record using the geodetic ellipse template is represented as follows:

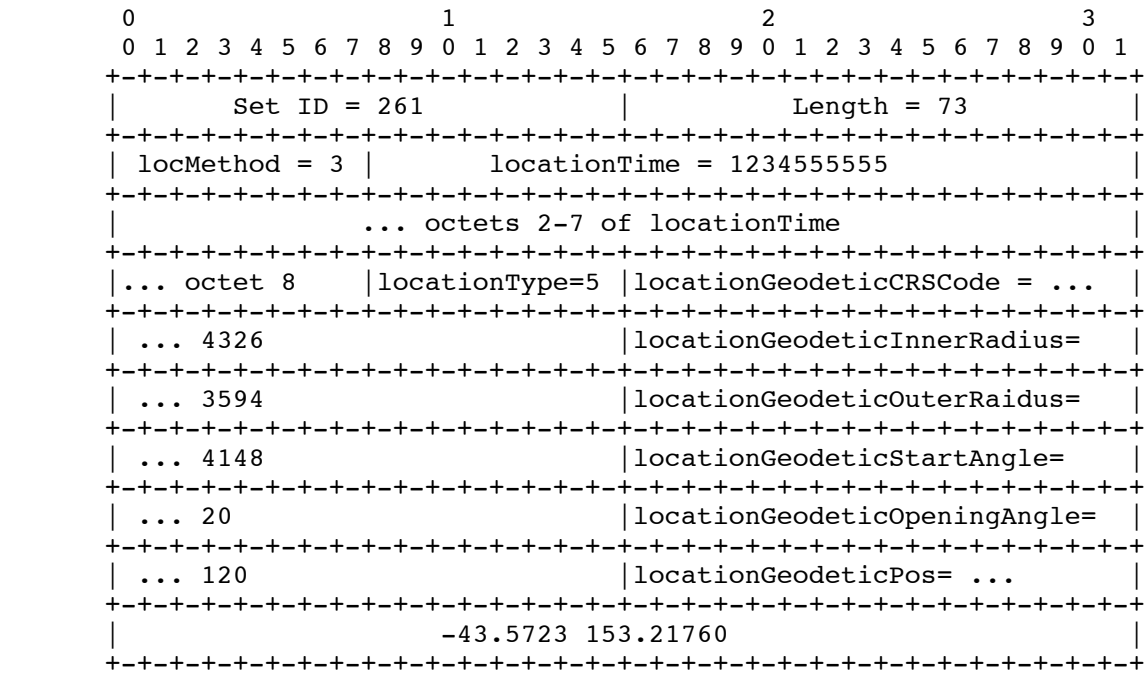


6.5. Geodetic arc band Template

```
Location record
  | locationMethod(xxx)[1]
  | locationTime(xxx)[8]
  | locationType(xxx)[1]
  | locationInfoCRSCode(xxx)[4]
  | locationGeodeticInnerRadius(xxx)[4]
  | locationGeodeticOuterRadius(xxx)[4]
  | locationGeodeticStartAngle(xxx)[4]
  | locationGeodeticStartAngle(xxx)[4]
  | locationGeodeticPos(xxx)[v]
```

Figure 5: A geodetic Template containing an arc band-based location

An example of a data record using the geodetic arc band template is represented as follows:

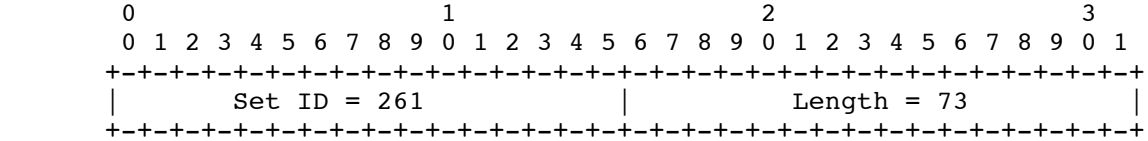


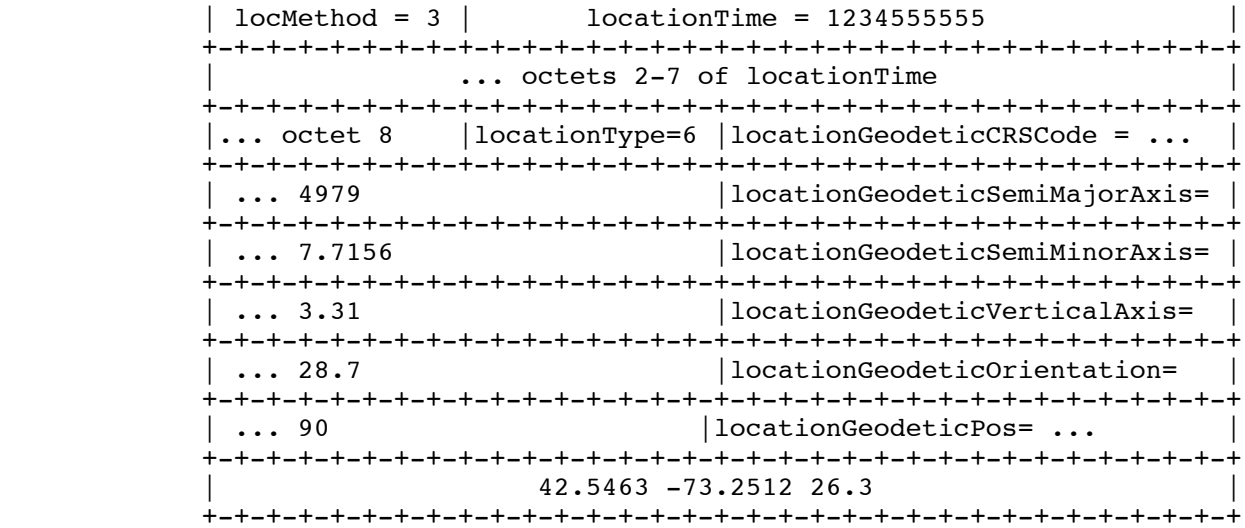
6.6. Geodetic ellipsoid Template

```
Location record
  | locationMethod(xxx)[1]
  | locationTime(xxx)[8]
  | locationType(xxx)[1]
  | locationInfoCRSCode(xxx)[4]
  | locationGeodeticSemiMajorAxis(xxx)[4]
  | locationGeodeticSemiMinorAxis(xxx)[4]
  | locationGeodeticVerticalAxis(xxx)[4]
  | locationGeodeticOrientation(xxx)[4]
  | locationGeodeticPos(xxx)[v]
```

Figure 6: A geodetic Template containing an ellipsoid-based location

An example of a data record using the geodetic ellipsoid template is represented as follows:



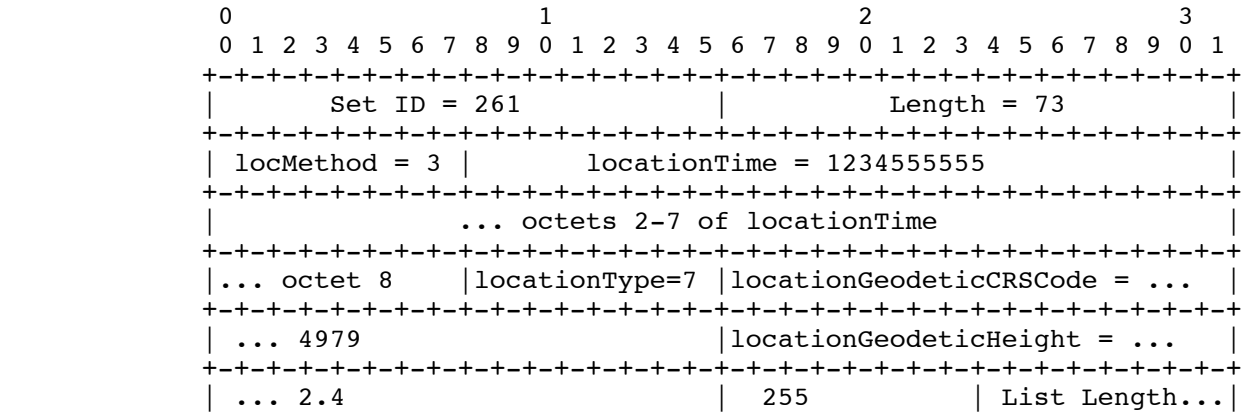


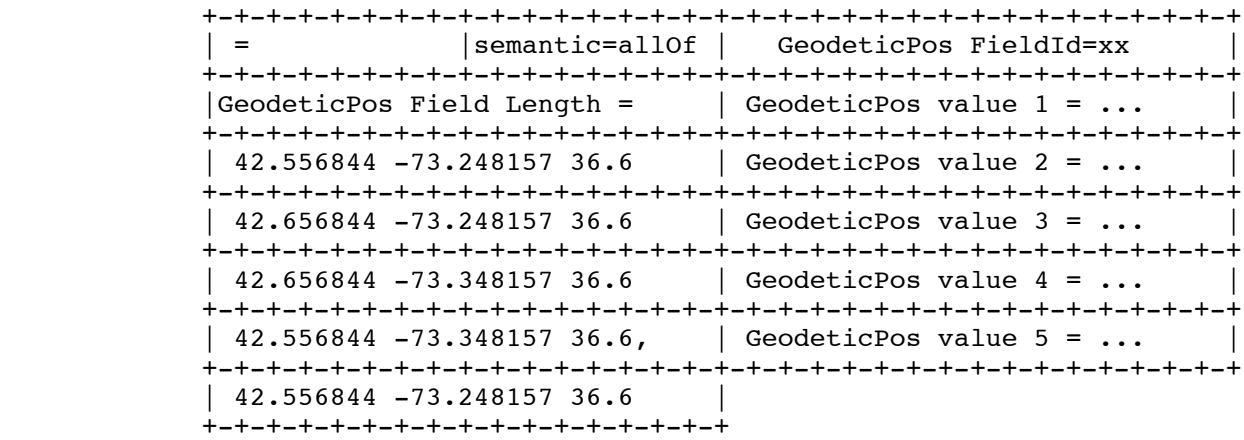
6.7. Geodetic prism Template

```
Location Template Record (ID = xxx)
  | locationMethod(xxx)[1]
  | locationTime(xxx)[8]
  | locationType(xxx)[1]
  | locationGeodeticCRSCode(xxx)[4]
  | locationGeodeticHeight(xxx)[4]
  | locationGeodeticPosList(xxx)[v]
```

Figure 7: A geodetic Template containing a prism-based location

An example of a data record using the Geodetic prism template is represented as follows:





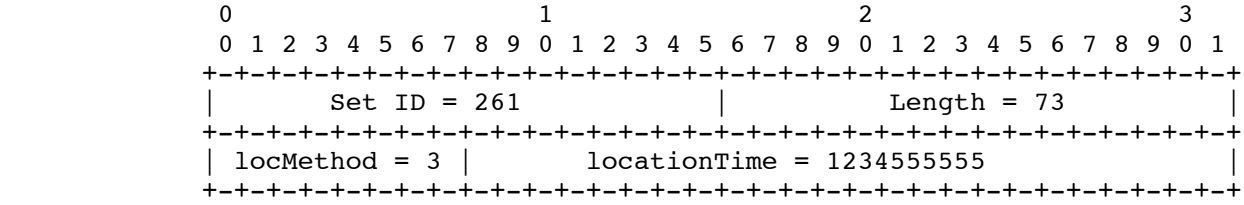
6.8. Civic location Template

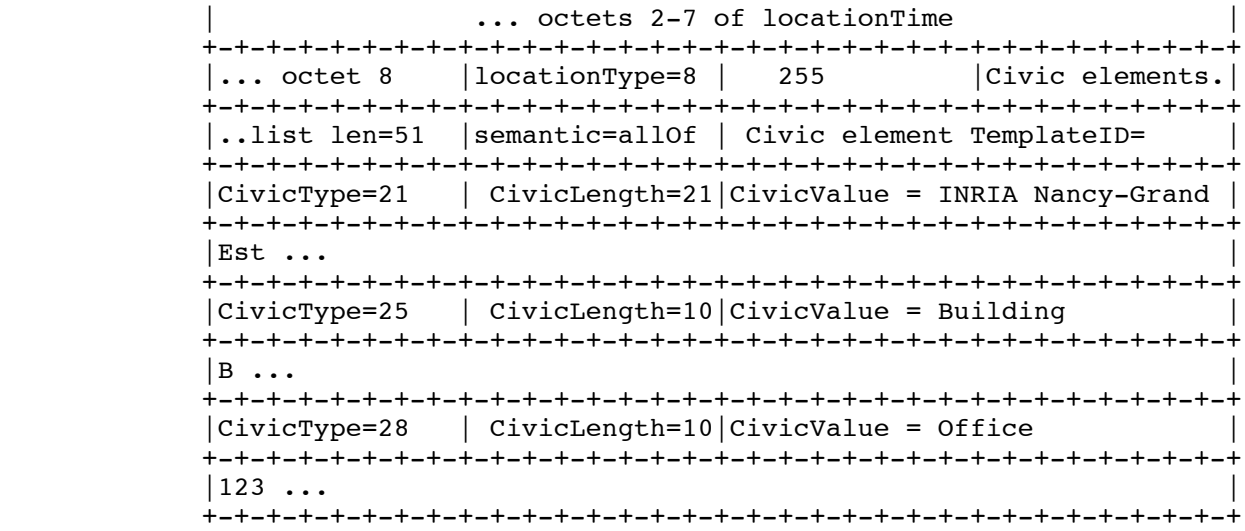
A civic-based location data record is a tuple-set of (locationCivicType, locationCivicLength, locationCivicValue) Information Elements. Each tuple is defined as an element of a subTemplateList Information Element with semantic allOf. In Figure 8, the template "Civic element" is defined for exporting each tuple.

```
Location Template Record (ID = xxx)
  | locationMethod(xxx)[1]
  | locationTime(xxx)[8]
  | locationType(xxx)[1]
  | subTemplateList (292)[0xFFFF]
  +-Civic element Template Record (ID = xxx)
     | locationCivicType(xxx)[1]
     | locationCivicLength(xxx)[1]
     | locationCivicValue(xxx)[v]
```

Figure 8: The two Templates to represent a civic-based location

As an illustration, we consider the exportation of the civic location "INRIA Nancy-Grand Est, Building B, office 123" obtained through a DHCP method. Using the templates described in Figure 7, the data record is the following:





Note that the values of the locationCivicType are defined in [RFC4776].

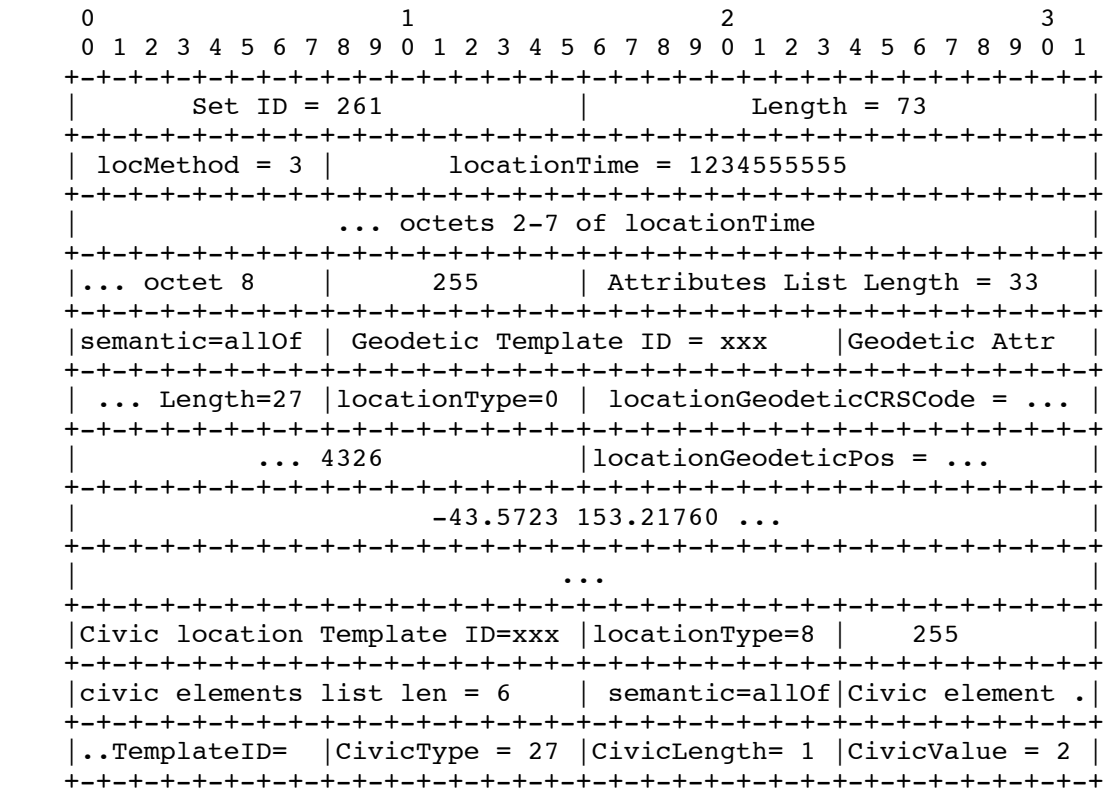
6.9. Compound location Template

A compound location is used to describe a location information represented by a composite of both civic and geodetic information. An example might be a two dimensions geodetic point (latitude, longitude) describing a location of a building and a civic element representing the floor in the building. A subTemplateMultiList [RFC6313] SHOULD be used to export a mixed template records of geodetic and civic information. To represent the example above, the following Template records are defined:

```
Compound location Template record (ID = xxx)
|locationMethod (xxx)[1]
|locationTime (xxx)[4]
|subTemplateMultiList(293)[0XFFFF]
+-- Geodetic location Template record (ID = xxx)
| locationType (xxx)[1]
| locationGeodeticCRSCode(xxx)[4]
| locationGeodeticPos(xxx)[v]
+-- Civic location Template record (ID = xxx)
| locationType (xxx)[1]
| subTemplateList (292) (0xFFFF)
+--- Civic element Template Record (ID = xxx)
  | locationCivicType(xxx)[1]
  | locationCivicLength(xxx)[1]
  | locationCivicValue(xxx)[v]
```

Figure 9: Template records to represent a compound location.

A data record encoded using the Template records of Figure 9 is the following:



A data record encoded using the Template records of Figure 9 is the following:

8 Security Considerations

The use of location information over Internet is discussed in "GeoPriv Requirements" [RFC3693]. The threats facing an Internet protocol that carries location information are detailed in [RFC3694]. The support of anonymization as expressed in [RFC6235] for flows carrying location data is recommended when possible since their dissemination raises greater privacy breaches risks for users. The applicability and the analysis of these security requirements on the IPFIX protocol when conveying location information is outside of the scope of this document. This document only specifies the new IPFIX Information Elements to convey location information. Otherwise, the same security considerations as those defined for the IPFIX protocol and the IPFIX information model apply.

9 IANA Considerations

This document specifies several new IPFIX Information Elements and types that need to be registered with the IANA.

9.1. locationType subregistry

Number	label	Reference
0	Point	EPSG:4326-WGS 84
1	Polygon	EPSG:4326-WGS 84
2	Circle	EPSG:4326-WGS 84
3	Ellipse	EPSG:4326-WGS 84
4	Arc Band	EPSG:4326-WGS 84
5	Sphere	EPSG:4979-WGS 84
6	Ellipsoid	EPSG:4979-WGS 84
7	Prism	EPSG:4979-WGS 84
8	Civic	[RFC4776][RFC5139]

9.2. locationMethod subregistry

The possible values of the location methods tokens are enumerated within an IANA registry [RFC4119]. However, integer identifiers for these methods need to be registered with the IANA as described in following:

Number	Method	Description
0	GPS	Global Positioning System
1	A-GPS	GPS with assistance
2	Manual	entered manually by a user
3	DHCP	provided by DHCP[RFC5985]
4	Triangulation	triangulated from time-of-arrival, signal strength or similar measurement
5	Cell	location of the cellular radio antenna
6	802.11	provided by 802.11 access point

10 References

10.1 Normative References

[GeoShape] Thomson, M. and C. Reed, "GML 3.1.1 PIDF-LO Shape Application Schema for use by the Internet Engineering Task Force (IETF)", Candidate OpenGIS Implementation Specification 06-142r1, Version: 1.0, April 2007.

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