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Information Elements for IPFIX Metering Process Location
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Abstract

This document defines a set of Information Elements for the IP Flow Information Export (IPFIX) protocol for exporting location information of any device (both fixed and mobile) that acts as an IPFIX Flow Exporter. The specified Information Elements support both geospatial and civic location data.

Table of Contents

1. Introduction

The importance of geographic location information in the Internet is growing rapidly. It can be used for business advertisements, admission control and security analysis, for example. Most mobile devices, such as smart phones, tablets and sensors, have capabilities for determining and exposing their geographic location. Besides that, they are accountable for an increasing share of the overall network traffic. In contrast to fixed devices, which usually have their physical location configured in a static manner, mobile devices can exploit several location systems for obtaining their location. This type of information is already used by a wide range of applications and services, such as navigation systems and friend finder services. Relating the location information of a device to this network traffic can be beneficial to many network management and measurement applications, including traffic profiling, anomaly detection and provider-independent network measurements. Hence, exporting location information associated to traffic Flows is desirable in various situations.

The IPFIX protocol [RFC7011] has been designed for the purpose of exporting IP traffic Flows based on Information Elements. This document defines a set of IPFIX Information Elements that provide a means for Metering Processes to encapsulate location information within exported Flows. This will be done by relying on existing location information formats, as they have been developed in other standardization areas for encoding civic locations, geographic coordinates, etc. In summary, this document defines the IPFIX Information Elements that are suitable for encapsulating pre-existing location information data.

1.1. Motivation

A typical IPFIX Metering Process is used for aggregating IP traffic and related measurement data into Flow Records at a fixed Observation Point. After expiration, Flow Records are sent to a Flow Collector for storage and analysis. The collected information is typically represented in a purely time-based manner, which means that Flow Records provide an aggregated view on network traffic over time. However, when Metering Processes are running on devices with a (frequently) changing physical location, data analysis applications may need to be aware of these movements since they are likely to affect the behavior of the network in terms of routing, throughput, etc. An example scenario is a virtualized environment, where virtual machines change location during migration from one server to another, or even between data centers. Thus, a location-aware metering process will be able to associate their Flows to their current locations.

In fact, we are not dealing anymore with Flows associated to a fixed Observation Point, but with a multitude of sub-Flows for which the Observation Point locations have to be reported. To facilitate this, location information needs to be obtained and processed by the Metering Process in an IPFIX Flow Exporter. In the end, it will be beneficial when network management applications are able to relate service quality parameters to 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 [RFC2119].

2. Relationships with GEOPRIV

Associating geographic location information with network traffic on the Internet has been addressed by the GEOPRIV working group. There, a Dynamic Host Configuration Protocol (DHCPv4 and DHCPv6) option containing civic address information has been specified in [RFC4776]. A similar option for geospatial information has been defined in [RFC6225]. The group has also defined a set of requirements to be respected when collecting and using Location Objects related to a specific user [RFC3693]. These requirements include usage policies and privacy preferences associated to the Location Object as expressed by a user. All the security and privacy requirements defined in [RFC3693] concern location data collection, and usage MAY be applied to the IPFIX protocol when conveying location information. The GEOPRIV working group has extended the XML-based Presence Information Data Format in [RFC5491], to allow the encapsulation of location information within a presence document.

3. Location Information

The location of a device can generally be defined in two ways, namely by geospatial location coordinates and civic location information. Geospatial location coordinates are made up of latitude, longitude and altitude coordinates, while civic location information encompasses abstract notions of a location, such as "in the kitchen", "in Bakerstreet" or "in a train approaching Nancy, France". The usage of these two types of location representations are addressed by the GEOPRIV group in [RFC5491] and [RFC5139], respectively. This document assumes that devices use one or more existing mechanisms for the purpose of retrieving location information and therefore does not define any new mechanisms for location retrieval.

3.1. Geospatial Location Information

To obtain geospatial location information, one needs to rely on a numeric coordinate system. Such systems provide location information either in two dimensions (latitude and longitude) or three dimensions (latitude, longitude and altitude). Relying on a single point of location is normally not considered sufficient, since an area or volume of uncertainty SHALL be specified. In theory, this 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 has been specified to define a location with uncertainty. A standard set of Coordinate Reference Systems (CRS) and units of measure are also specified in [GeoShape]. 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].

3.2. Civic Location Information

In contrast to geospatial location information, which relies on numeric data formats, the civic location format conveys pure textual information. It is applicable to device locations in buildings, for example. It MAY be a civic address closely related to a postal address, commonly used by local postal services for delivering mail. It MAY also be some approximated information, such as "living room", "Office 123 in Building 2". The civic location information format has been addressed in [RFC4776], where a set of parameters are provided to describe civic locations. In contrast to geospatial location information, which is the geospatial location of the device as a set of latitude, longitude and altitude coordinates represented by a CRS, civic location information can often be interpreted even if incomplete. For example, while geospatial information is not available inside buildings, civic location information can still provide an estimation of a device's location.

4. Location Information Elements

The following Information Elements can be used for exporting location-related information of a Metering Process. They SHALL be used for exporting geospatial and civic location, together with IPFIX Information Elements already defined for exporting IP traffic Flows.

4.1. geospatialLocationCRSCode

Description: Denotes the Coordinate Reference System (CRS) codes according 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: 401

4.2. geospatialLocationLat

Description: Denotes the coordinate information value of the latitude.

Data Type: float64
PEN (provisional): 12559 (Inria)
ElementId (provisional): 402

4.3. geospatialLocationLng

Description: Denotes the coordinate information value of the longitude.

Data Type: float64
PEN (provisional): 12559 (Inria)
ElementId (provisional): 403

4.4. geospatialLocationAlt

Description: Denotes the coordinate information value of the altitude.

Data Type: float64
PEN (provisional): 12559 (Inria)
ElementId (provisional): 404

4.5. geospatialLocationRadius

Description: Denotes a radius value (in meters) of a location described using a circular area in a two-dimensional CRS 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. civicLocationType

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

Data Type: unsigned8
PEN (provisional): 12559 (Inria)
ElementId (provisional): 406

4.7. civicLocationValue

Description: Denotes a civic location information element that MUST be encoded as a UTF-8 string. The location information MAY be a civic address as specified in [RFC4776] or information on proximity to known objects.

Data Type: string
PEN (provisional): 12559 (Inria)
ElementId (provisional): 407

4.8. locationMethod

Description: Denotes the way in which the location information has been obtained. The locationMethod sub-registry is defined in Section 8.1.

Data Type: unsigned8
Data Type Semantics: identifier
PEN (provisional): 12559 (Inria)
ElementId (provisional): 408

4.9. locationTime

Description: Denotes the time when the location information is obtained on a device acting as an IPFIX Flow Exporter. The time is expressed in seconds since January 1, 1970, 00:00:00 UTC.

Data Type: dateTimeSeconds
Data Type Semantics: quantity
PEN (provisional): 12559 (Inria)
ElementId (provisional): 409

5. Guidelines for Using Location Information Elements

The specified location Information Elements in this document SHALL be used by a Metering Process for constructing an IPFIX location Template with respect to the following conventions.

Guideline #1: Location Information Elements MUST describe a discrete location defined as a place, point or area in which a Metering Process (i.e., IPFIX Flow Exporter) can be found.

Guideline #2: In situations where a discrete location can be described in multiple ways, each location SHOULD be described by means of a separate Template. A compound Template containing a subTemplateMultiList field [RFC6313] SHOULD be used in which each top-level element corresponds to a different location Template. For example, the location of a device being at the fifth floor of a particular building can be described using both a geospatial point (the location of the building) and civic information (fifth floor of a building).

Guideline #3: Exporting more than one location in a Flow Record MUST only be done if the different location descriptions refer to different places.

Guideline #4: A Metering Process MAY apply time-based Flow expiration policies as described in Section 5.1.1 of [RFC5470], or location-/distance-based expiration policies. For example, a Metering Process MAY expire current Flows when the device moves from one room to another.

Guideline #5: When another type of location data is available and needed to be sent, the Flow Exporter MUST send the template of the new location format.

6. Recommended Templates for Geospatial and Civic Location Export

The following Templates are defined as recommended Templates for exporting geospatial and civic location information. The geospatial templates are related to a point, circle or area shapes. The definition and usage of the shapes is covered in [GeoSHAPE]. Civic locations can be exported using a Template containing a subTemplateList [RFC6313], where each element of the list corresponds to a Template.

6.1. Geospatial Point Location Template

The point shape is the simplest form of a geospatial location, which SHOULD be used when there is no known uncertainty. The following Template is defined for exporting a 2D geospatial point location:

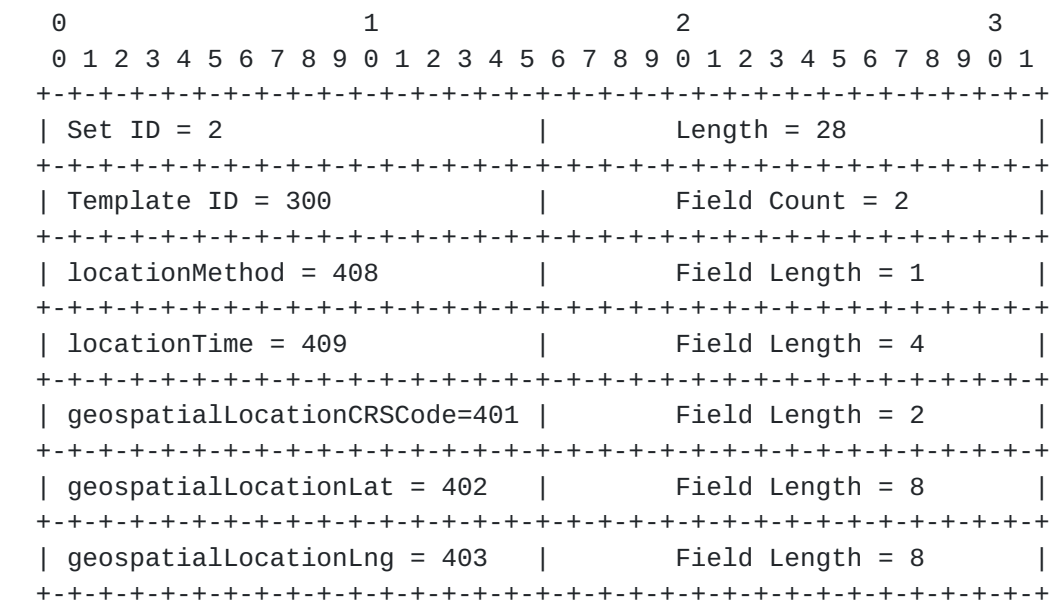

Figure 1: Template for exporting a 2D point-based geospatial location

For illustration, the following presents an example Data Record to export a 2D geospatial point location:

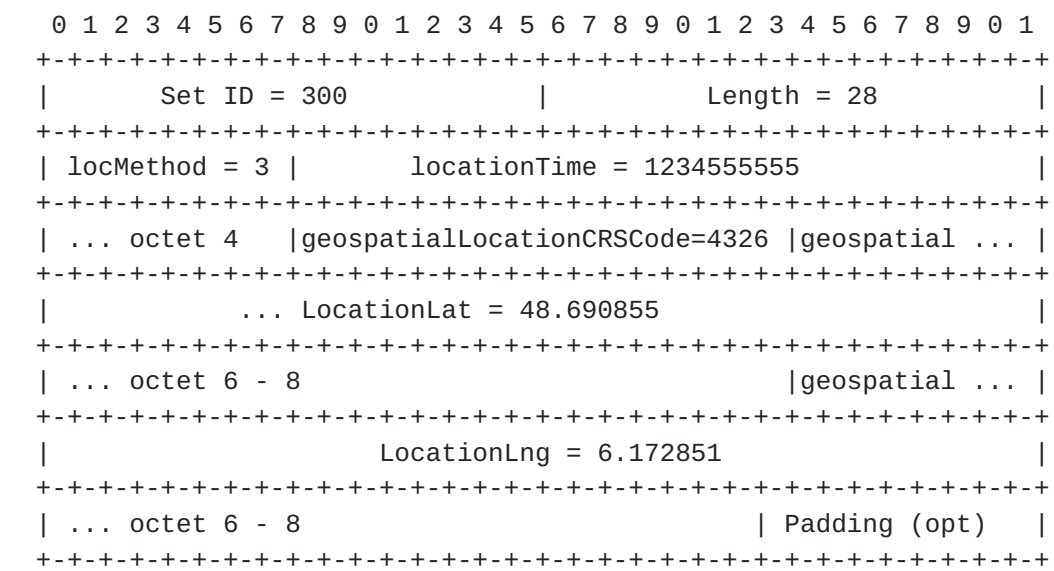

Figure 2: Data Record of a geospatial 2D point location

6.2. Geospatial Circle Location Template

The circle Template is suitable for exporting the location of a flow observed within a circle shape where its center is represented using a geospatial point position and its radius represents the

uncertainty.

Template Record for Geospatial Circle (ID = 301)
| locationMethod(408)[1]
| locationTime(409)[4]
| geospatialLocationCRSCode(401)[2]
| geospatialLocationRadius(405)[4]
| geospatialLocationLat(402)[8]
| geospatialLocationLng(403)[8]

Figure 3: Template for exporting a circle-based geospatial location

The following presents an example of a Data Record carrying a circle-based geospatial location:

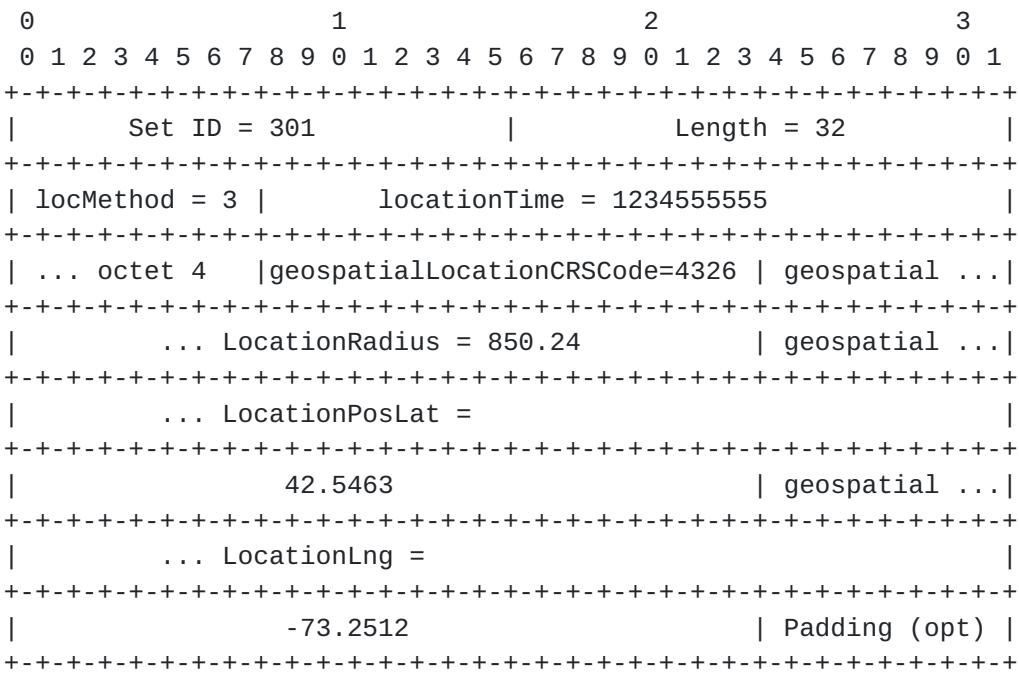

Figure 4: Data Record of a circle-based geospatial location

6.3. Geospatial List Template

The list locations Template is suitable for exporting a variable-length list of different geospatial point positions of a single flow. For example, it could be used to export the start and the end locations of a flow. The template relies on a subTemplateList data type to export the list of geospatial point-based positions. This template requires [RFC6313] compliant Exporting and Collecting Processes. Figure 5 depicts an example of such a subTemplate for exporting each element of the list.

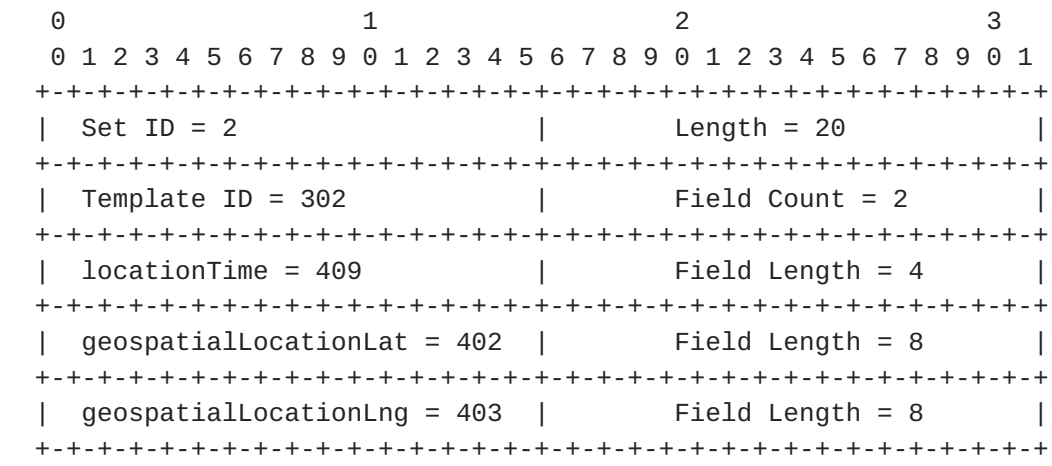

Figure 5: Template for exporting a geospatial 2D point-based position

```
Template Record for Geospatial List (ID = 303)
 | locationMethod(408)[1]
 | geospatialLocationCRSCode(401)[2]
 +-subTemplateList(292)[0XFFFF]
   +-Geospatial 2D Point position Template Record(302)[16]
```

Figure 6: Template for exporting a geospatial list of locations

The following presents an example Data Record carrying a list of two geospatial point positions. Each point-based position is defined as an element of a subTemplateList Information Element with semantic "allOf".

Figure 7: Data Record of a geospatial list of point-based locations

6.4. Civic Location Template

A civic-based location Data Record consists of a tuple of (civicLocationType, civicLocationValue) Information Elements. Each tuple is defined as an element of a subTemplateList Information Element with semantic "allOf". This template requires [RFC6313] compliant Exporting and Collecting Processes.

```
Template Record for Civic location (ID = 304)
 | locationMethod(408)[1]
 | locationTime(409)[4]
 +-subTemplateList (292)[0xFFFF]
   +-Civic element Template Record (ID = 305)
     | civiLocationType(406)[1]
     | civicLocationValue(407)[v]
```

Figure 8: Template for exporting a civic location

The "Civic element" Template Record, as shown in Figure 8, MUST be defined for each tuple. For the purpose of illustration, we consider exporting the civic location "Inria Nancy-Grand Est, Building B, Office 123" obtained through DHCP. Using the Template described in Figure 8, the resulting Data Record is as follows:

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|       Set ID = 304            |          Length = 62          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| locMethod = 3 |       locationTime = 1234555555               |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| ... octet 4   |   255         |Civic elements list length = 50|
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
| semantic=allOf| Civic element TemplateID = 305| CivicType=21  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     21        |       CivicValue = Inria Nancy-Grand          |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            Est ...            | CivicType=25  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     10        |       CivicValue = Building                   |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                              B ...            | CivicType=28  |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|     10        |       CivicValue = Office                     |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                            123 ...                            |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

Figure 9: Data Record of a civic location

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

6.5. Compound Location Template

A compound location is used to describe a location, represented by a composite of both civic and geospatial information. An example situation is a two-dimensional geospatial 2D point position (latitude, longitude) describing a location of a building, and a civic element representing the floor in that building. A subTemplateMultiList [RFC6313] SHOULD be used to export a Template for both geospatial and civic information. To represent the above example, the following Template is defined:

```
Template Record for Compound Location (ID = 306)
 | locationTime(409)[4]
 +-subTemplateMultiList(293)[0XFFFF]
   +-Geospatial Template Record (ID = 307)
     | locationMethod(408)[1]
     | geospatialLocationCRSCode(401)[2]
     | geospatialLocationLat(402)[8]
     | geospatialLocationLng(403)[8]
   +-Civic location Template Record (ID = 308)
     | locationMethod(408)[1]
     | civicLocationType(406)[1]
     | civicLocationValue(407)[v]
```

Figure 10: Template for exporting a compound location

A data Record encoded using the Template shown in Figure 11 is represented as follows:

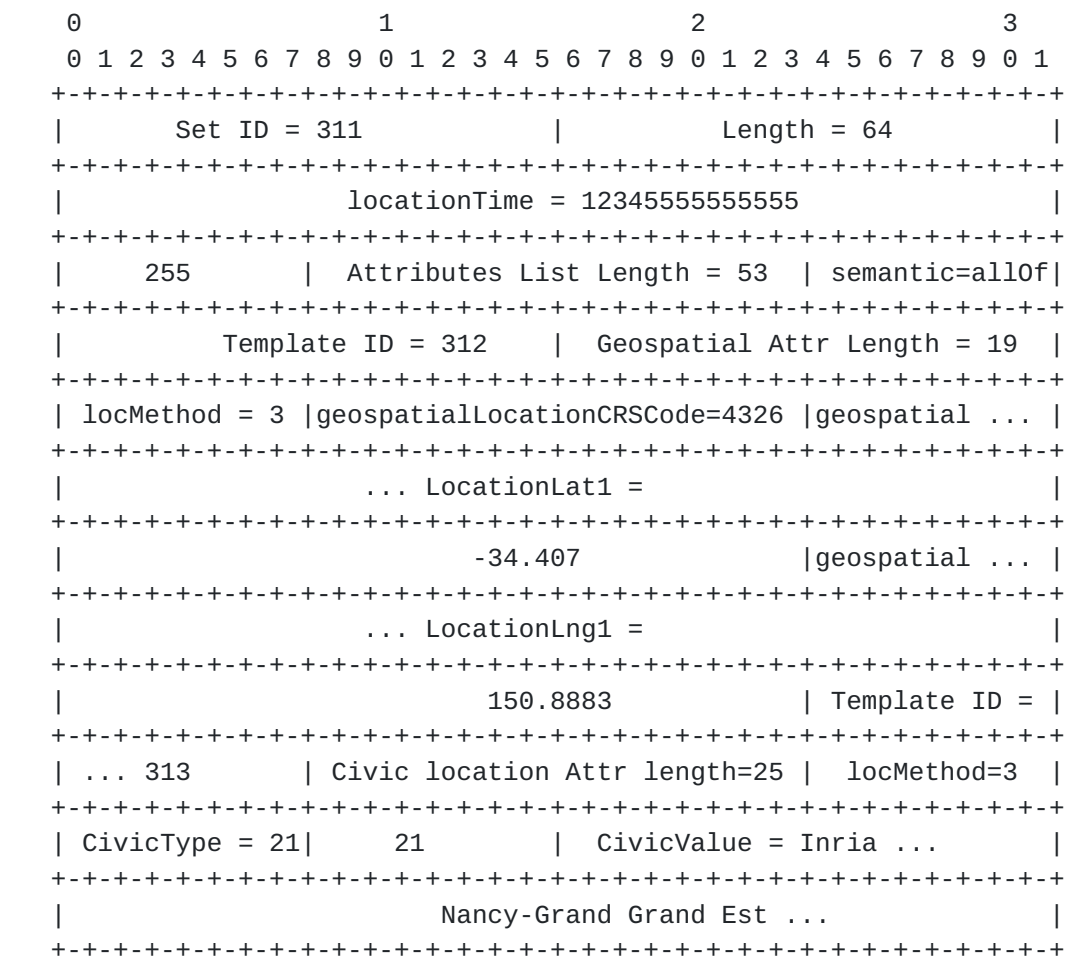

Figure 11: Data Record of a compound location

7. Security Considerations

The use of location information on the Internet has been discussed in "GeoPriv Requirements" [RFC3693], while the threats facing Internet protocols that carry location information are detailed in [RFC3694]. Support for Flow Record anonymization, as expressed in [RFC6235], is strongly recommended, since the dissemination of Flow Records including location information raises greater privacy issues than the dissemination of regular Flow Records. The applicability and analysis of these security requirements for the IPFIX protocol - especially in the case where location information is conveyed - is however outside of the scope of this document. This document only specifies the new IPFIX Information Elements for exporting location information. Otherwise, the same security considerations as those defined for the IPFIX protocol and the IPFIX information model apply.

8. IANA Considerations

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

8.1. locationMethod Sub-Registry

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

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	IEEE 802.11 access point location

9. Acknowledgements

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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.

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

[RFC6313] Claise, B., Dhandapani, G., Aitken, P., and S. Yates, "Export of Structured Data in IP Flow Information Export (IPFIX)", RFC 6313, July 2011.

[RFC7011] Claise, B., Ed., Trammell, B., Ed., and P. Aitken, "Specification of the IP Flow Information Export (IPFIX) Protocol for the Exchange of Flow Information", STD 77, RFC 7011, September 2013.

[RFC5470] Sadasivan, G., Brownlee, N., Claise, B., and J. Quittek, "Architecture for IP Flow Information Export", RFC 5470, March 2009.

[RFC4776] Schulzrinne, H., "Dynamic Host Configuration Protocol (DHCPv4 and DHCPv6) Option for Civic Addresses Configuration Information", RFC 4776, November 2006.

[RFC6225] Polk, J., Linsner, M., Thomson, M., and B. Aboba, Ed., "Dynamic Host Configuration Protocol Options for Coordinate-Based Location Configuration Information", RFC 6225, July 2011.

[RFC5139] Thomson, M. and J. Winterbottom, "Revised Civic Location Format for Presence Information Data Format Location Object (PIDF-LO)", RFC 5139, February 2008.

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

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

[RFC6235] Boschi, E. and B. Trammell, "IP Flow Anonymization Support", RFC 6235, May 2011.

10.2. Informative References

[NFDUMP] Haag, P., "NFDUMP", http://nfdump.sourceforge.net, May 2013.

[NFSEN] Haag, P., "NfSen", http://nfsen.sourceforge.net, January 2012.

[SURFMAP] Hofstede, R., Fioreze, T., "SURFmap: A Network Monitoring Tool Based on the Google Maps API", Proceedings of the IFIP/IEEE International Symposium on Integrated Network Management, 2009, June 2009.

[OGP] Oil and Gas Producers Association, "EPSG Geodetic

Parameter Registry", http://www.epsg-registry.org, August 2011.

[RFC5513] Farrel, A., "IANA Considerations for Three Letter Acronyms", RFC 5513, April 1 2009.

Appendix A. Example Implementation

This appendix is intended to show an example application that relies on the set of IPFIX Information Elements described in this document. This application, named SURFmap, is a network monitoring tool based on the Google Maps API and uses Flow data to visualize network Flows on a map [SURFMAP]. By default, geolocation databases are used for retrieving the (estimated) physical location associated to an IP address. The Information Elements described in this document, however, will allow SURFmap to use the absolute location information exported for Flows.

SURFmap has been developed in the past as a plugin to NfSen [NFSEN]. NfSen provides a Web-frontend to nfdump [NFDUMP], which is a set of tools for flow data collection and processing, among others. To support collection and processing of Flow Records containing any of the new Information Elements (e.g. by SURFmap), an extension to nfdump has been developed.

The following presents a set of Flow Records that have been exported by a mobile Flow Exporter. Several fields, such as destination IP address and port number, location timestamp and location method have been left out for the sake of space. It is clear that the mobile device has moved while exporting Flow Records, as the latitude and longitude coordinates have changed over time.

Start time	Src IP Addr:Port	Pkts	Bytes	Latitude	Longtitude
20:19:21.852	173.194.40.113:443	9	2730	48.690855	6.172851
20:21:42.307	91.202.200.229:80	13	9137	48.690855	6.172851
20:21:42.307	10.21.20.232:59521	15	1547	48.690855	6.172851
20:22:38.084	73.194.40.113:80	8	1799	48.690855	6.172851
20:22:38.084	10.21.20.232:34056	9	877	48.690855	6.172851
21:17:13.498	173.194.45.80:443	12	2830	48.713145	6.17526
21:17:13.498	10.21.20.232:49233	15	2301	48.713145	6.17526
21:17:16.919	10.21.20.232:15572	1	72	48.744506	6.154815
21:17:16.919	172.20.2.39:53	1	257	48.744506	6.15481

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