Location Information Interoperability of CAP and PIDF-LO for Early Warning Systems

Karl Wolf
Vienna University of Technology
karl.wolf@student.tuwien.ac.at

ABSTRACT

The Common Alerting Protocol (CAP) is an open standard, which is universally used for early warning systems and other emergency information systems. Future early warning systems will also disseminate CAP warning messages to location aware Internet devices, such as notebooks, Internet phones or Internet-enabled television sets. These Internet devices have the option to acquire their current location as a Presence Information Data Format – Location Object (PIDF-LO) document by the protocols and means developed by the Internet Engineering Task Force (IETF). When an Internet device receives a CAP message, determination of whether this alert is relevant to the user at the current location is crucial. However, the civic address format of PIDF-LO is not interoperable with CAP. This paper describes these interoperability issues, which were collected during a prototype implementation and proposes a mapping of PIDF-LO location elements to CAP to achieve interoperability.

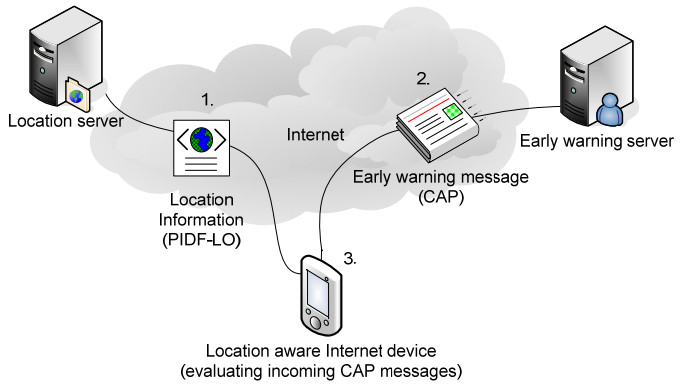
Keywords

PIDF-LO, CAP, location information, location interoperability, early warning.

INTRODUCTION

Location information is absolutely important for emergency management. Thus, interoperability of the used protocols and formats has to be considered to allow automated processing and evaluation of location information without doubt. This paper focuses on the interoperability issues that will arise in future early warning systems: many early warning systems already support or will implement the Common Alerting Protocol (CAP) (Westfall, 2010). CAP messages contain information about the geographic area the alert applies to. This area can be represented as geodetic shape, civic location and textual description. In future early warning architectures, CAP messages may be exchanged not only between agencies and across early warning systems, but also delivered to end devices, e.g. via the Internet. End devices such as mobile phones or Internet-enabled television sets can then determine, based on the area indicated in the alert message, whether this warning affects the current location and thus is relevant to its user. This CAP usage is mentioned in the CAP specification. Architectures have been discussed within the IETF, for example in (Rosen, Schulzrinne and Tschofenig, 2010). Furthermore, the IETF also developed open standards for Internet geolocation and location based services (Barnes, Winterbottom and Dawson, 2011). PIDF-LO (Peterson, 2005) is the IETF's format to represent geodetic and civic location. When the IETF's unified geolocation framework with its suite of protocols will be widely deployed on the Internet, the interoperability of location information with CAP has to be considered. When end devices connected to the Internet acquire their own location (e.g. with the help of a so called *location server*) in PIDF-LO format and receive alerts as CAP messages, it has to be ensured that it is possible to determine whether the location described in PIDF-LO lies inside the area indicated in CAP. This scenario is shown in Figure 1 and was also implemented in a prototype environment.

Location information can be typically encoded in forms of civic or geodetic location information. Civic location means that the location information is available as civic address, comprised of elements such as country, city, postal code, street name, house number, etc. In general this type of location information is provided to fixed endpoints, e.g. to a fixed line Internet connection. In mobile networks devices would be typically provided with geodetic location, comprised of latitude and longitude values.



1. Internet device configures or refreshes its location information.
2. CAP early warning message is disseminated.
3. Internet device evaluates whether its current location is affected by the warning.

Figure 1. A location aware Internet device provisioned with PIDF-LO location evaluates a received CAP message.

THE PRESENCE INFORMATION DATA FORMAT – LOCATION OBJECT

The IETF published the initial PIDF-LO specification as RFC 4119 (Peterson, 2005), followed by updates and usage clarifications in RFC 5139 (Thomson and Winterbottom, 2008) and RFC 5491 (Winterbottom, Thomson and Tschofenig, 2009). PIDF-LO documents allow the following two ways of location representation:

- Geodetic shapes: point, polygon, circle, ellipse, arc band, sphere, ellipsoid, prism
- Civic address: predefined types, e.g. country, A1 – A6, RD, HNO

PIDF-LO uses the World Geodetic System 1984 (WGS84) for geographic locations and supports a variety of shapes. For civic addresses, predefined civic address types such as country, city and street, to mention just a few, are specified. However, since civic addresses follow a different structure depending on jurisdiction, rules on how to use the PIDF-LO civic address types and their local meaning are required for interoperability. These rules should be published as so called civic address considerations for a particular country. So far such rules have only been registered for Austria at the Internet Assigned Numbers Authority (IANA) (Wolf and Mayrhofer, 2010).

PIDF-LO documents play a central role in the IETF's framework for Internet geolocation and are used for example in location configuration protocols on the Internet. Internet hosts requesting their location from a location server may receive a PIDF-LO document containing geodetic location, civic location, or both. More information about the Internet geolocation model is provided in (Barnes et al., 2011). PIDF-LO was also adopted for next generation emergency calling in North America (NENA, 2011).

THE COMMON ALERTING PROTOCOL

CAP is a simple and general purpose data format for a variety of applications, including early warning purposes. The current version 1.2 got adopted by the Organization for the Advancement of Structured Information Standards (OASIS) in 2010. CAP basically contains general information about the message itself, a description of the event and the affected area. For describing the area, the following representations are defined:

- Textual description of the area
- Geodetic shapes: circle and polygon
- Geocode: name value pair (no predefined names)

CAP uses WGS84 for geographic locations as well. In contrary to the IETF's approach, civic addresses are not explicitly covered by CAP. However, the CAP geocode element with its name value pair can contain codes to describe areas. By having no predefined names for the name value pair, compatibility with other systems can be achieved. However, interoperability is the CAP message generator's responsibility and knowledge of the coding scheme is required at the receiver. CAP also requires a textual description of the area, which is not suited for automated processing.

CAP allows having multiple circle, polygon and geocode elements in a single message. In this case, the resulting area is defined as the union of all included elements.

CAP can also be distributed by the OASIS Emergency Data Exchange Language (EDXL) Distribution Element

(Raymond, Webb and Aymond, 2006), which considers certain aspects of civic addresses by defining the elements *country*, *subdivision* and *locCodeUN*. However, neither all PIDF-LO civic address elements nor a geocode element for flexibility are available. Consequently, interoperability with PIDF-LO civic addresses is not ensured.

ACHIEVING LOCATION FORMAT INTEROPERABILITY

The reason for the need of location information interoperability is the use case of disseminating early warning CAP messages to location aware end devices. These end devices must be able to detect, if a warning is relevant to its user. Therefore, it has to be determined, whether the current location lies inside the area affected by the warning. The subsections below consider the case for civic and geodetic location information. When evaluating location information at end devices without further conversion (which may be error prone), only civic location information can be compared with civic location or areas and geodetic location information can only be compared with geodetic location information or areas. The generator of a CAP message does typically not know which type of location information all potential receivers have configured. Note that the CAP generator and the PIDF-LO generator are typically operated by different entities as shown in Figure 1. The framework and protocols developed by the IETF for Internet geolocation support both, civic and geodetic location information. Thus, certain end devices may have civic location information only, others geodetic location information only and some both. In order to ensure that all end devices are able to process the warning, a CAP generator should always issue CAP messages with both, civic and geodetic representation of the area the respective warning applies to.

Geodetic Location

CAP as well as PIDF-LO can contain geodetic location information. Various well known algorithms can be used to determine whether a given geodetic location described as PIDF-LO lies inside a geodetic area in CAP. For example, when the location of the end devices is described as a point in PIDF-LO and the CAP message contains a polygon, a point-in-polygon query can answer the question, whether this point lies within or outside the boundaries of the CAP polygon. This is one of the fundamental problems of geometry and thus long solved. One of the commonly used algorithms is the ray-crossings algorithm, which bases on a scheme already outlined in 1974 (Sutherland, Sproull and Schumacker, 1974).

Even though PIDF-LO supports more geodetic shapes than CAP, this does not impose issues besides the fact that calculation is getting more complex since for example overlapping polygons have to be evaluated.

Civic Location

The situation for civic address elements is more complicated, presumably because the structure of civic addresses is more complex and varies depending on jurisdiction. The IETF has defined a fixed set of civic address types, such as country, street or house number, but CAP allows a name value pair without any predefined element. Figure 2 shows an area representation used in a CAP message from the US National Weather Service and an excerpt of a PIDF-LO document describing a civic address in the US. Obviously, interoperability is not ensured, thus determination of whether the location described in PIDF-LO lies inside the area contained in the CAP message cannot be performed reliably.

```
<area>
  <areaDesc>Santa Clarita Valley</areaDesc>
  <geocode>
    <valueName>UGC</valueName>
    <value>CAZ088</value>
  </geocode>
</area>
```

```
<cl:civicAddress xml:lang="en">
  <cl:country>US</cl:country>
  <cl:A1>California</cl:A1>
  <cl:A2>Los Angeles County</cl:A2>
  <cl:A3>Santa Clarita</cl:A3>
  <cl:RD>Railroad</cl:RD>
  <cl:STS>Ave</cl:STS>
  <cl:HNO>24875</cl:HNO>
  <cl:PC>CA 91321</cl:PC>
</cl:civicAddress>
```

Figure 2. Exemplary CAP area representation (left) and PIDF-LO civic address (right) – not interoperable.

To ensure interoperability, the IETF's fixed set of civic address types would be required to be present in CAP messages as well. This can be accomplished by using the geocode element in CAP with its *valueName* and *value* pair. Since only one name value pair is allowed inside a geocode element, all PIDF-LO elements have to be present in one *value* element. Figure 3 shows such an area representation in CAP using *PIDF-LO* as *valueName*

and listing all civic address elements required to describe the area in the *value* element. This allows comparing values with the exemplary PIDF-LO civic address in Figure 2.

Note that CAP allows multiple occurrences of the area element and each area element may contain multiple geocode elements. However, the resulting target area is defined as the union of all indicated areas and thus is not suited to contain any hierarchical structure of civic address elements in multiple geocode elements. Furthermore it is also not intended to contain alternative codes describing the same area. This might be a drawback, since alternative representation of the same area with multiple geocode elements would be required, when trying to ensure interoperability with multiple systems.

However, identifying the same elements alone is not sufficient to figure out, if a specific civic address lies inside the area represented by civic address elements. First, civic address recommendations have to be followed. Second, in contrast to the point-in-polygon query for the geodetic situation, there is no easy to follow algorithm for civic location yet. Rules have not been published by the IETF up to now. An early draft discussing civic boundaries was not adopted and expired (Thomson and Wolf, 2011).

Since CAP alert messages typically apply to larger areas, a potential solution for early warning could be to use the set of hierarchical elements of PIDF-LO only, namely A1 to A6, as well as the country element to describe the area in CAP. Elements holding street names or house number may not be required, which eases the comparison process. In Figure 3, the elements A1-A3 in CAP have the same values as the PIDF-LO civic address elements in Figure 2, which means that the alert is of interest for that location.

Furthermore, multiple languages have to be considered and the requirements for individual countries with regards to early warning would have to be reflected in the civic address considerations.

```
<area>
  <areaDesc>Santa Clarita</areaDesc>
  <geocode>
    <valueName>PIDF-LO</valueName>
    <value>country="US";A1="California";A2="Los Angeles County";A3="Santa Clarita"</value>
  </geocode>
</area>
```

Figure 3. Area representation in CAP with geocode element containing PIDF-LO civic address elements for interoperability.

CONCLUSION

Since location information is a very crucial piece of information, interoperability has to be carefully considered. The framework and the set of protocols developed by the IETF for Internet geolocation allows location based services to benefit. As such, early warning systems based on dissemination of CAP messages to location aware Internet devices have great potential to extend currently deployed systems. However, it has to be ensured that the format the endpoint uses for its location configuration is interoperable with the format used to describe the area the warning applies to. For this purpose, an accepted coding scheme for the PIDF-LO civic address elements in CAP is required. This issue was noticed during the implementation of a prototype for early warning based on Digital Video Broadcast (DVB). A location aware DVB receiver configured its own civic location as PIDF-LO via location configuration and receiving CAP messages containing civic area descriptions as proposed in this paper was tested and the limitations mentioned above were noticed. Thus, further development is required.

Even though the Internet has become increasingly mobile and therefore usage of geodetic location information is likely to increase, it can still be expected that civic location will be provided by network operators to fixed subscriber lines. Consequently, civic and geodetic location information have to be considered, although handling of civic addresses is more complex and varies depending on jurisdiction. Therefore, civic address considerations on how to generate PIDF-LO documents would be required per country to ensure interoperability in the first place. When doing so, requirements for early warning purposes and the possibility to keep hierarchical elements that can be used for describing areas for early warning should be kept in mind.

Furthermore, it has to be noted that warnings would always have to be issued including both formats, civic and geodetic, in order to allow any endpoint to determine if that message is of interest to a user at the current location. Since the generator of a CAP message has no knowledge about whether the alert will be received by a mobile device having geodetic location or a fixed device knowing its civic address, both area descriptions should be included in CAP. This ensures that all receivers can process the information without the burden of converting location information. The IETF's geolocation architecture, which was adopted for next generation

emergency calling in North America (NENA, 2011), allows emergency calling to function with geodetic as well as with civic location information, which might also be relevant for early warning systems.

Further work is required to refine algorithms on how to determine whether a civic address lies inside a civic area or boundary, also reflecting individual civic address considerations and different languages. Otherwise different implementations will be deployed on the Internet, affecting applicability of location based services in general and imposing a risk on early warning systems.

REFERENCES

1. Barnes, R., Winterbottom, J. and Dawson, M. (2011) Internet geolocation and location-based services, *Communications Magazine, IEEE* , vol.49, no.4, pp.102-108.
2. NENA, National Emergency Number Association (2011) Detailed Functional and Interface Standards for the NENA i3 Solution, NENA 08-003 v1.
3. Peterson, J. (2005) A Presence-based GEOPRIV Location Object Format, RFC 4119.
4. Raymond, M., Webb S. and Aymond, P. (2006) Emergency Data Exchange Language (EDXL) Distribution Element, OASIS Standard.
5. Rosen, B., Schulzrinne, H. and Tschofenig, H. (2010) Session Initiation Protocol (SIP) Event Package for the Common Alerting Protocol (CAP), draft-ietf-atoca-cap-00 (work in progress).
6. Sutherland, I., Sproull, R. and Schumacker, R. (1974) A Characterization of Ten Hidden-Surface Algorithms. *ACM Comput. Surv*., 6, 1, 1-55.
7. Thomson, M. and Winterbottom, J. (2008) Revised Civic Location Format for Presence Information Data Format Location Object (PIDF-LO), RFC 5139.
8. Thomson, M. and Wolf, K. (2011) Describing Boundaries for Civic Addresses, draft-thomson-ecrit-civic-boundary-02 (work in progress).
9. Westfall, J. (2010) Common Alerting Protocol Version 1.2, OASIS Standard.
10. Winterbottom, J., Thomson, M. and Tschofenig H. (2009) GEOPRIV Presence Information Data Format Location Object (PIDF-LO) Usage Clarification, Considerations, and Recommendations, RFC 5491.
11. Wolf, K. and Mayrhofer, A. (2010) Considerations for Civic Addresses in the Presence Information Data Format Location Object (PIDF-LO): Guidelines and IANA Registry Definition, RFC 5774.