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Specifying Holes in LoST Service Boundaries
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Status of this Memo

Abstract

This document describes how holes can be specified in geodetic service boundaries. One means of implementing a search solution in a service database, such as one might provide with a LoST server, is described.

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1. Introduction

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The LoST protocol [RFC5222] (Hardie, T., Newton, A., Schulzrinne, H., and H. Tschofenig, "LoST: A Location-to-Service Translation Protocol," August 2008.) describes a protocol that's primary purpose is to map service and locations to destination addresses. LoST does this by provisioning boundary maps or areas against service URNs. The boundary is a polygon made up of sets of geodetic coordinates specifying an enclosed area. In some circumstances an area enclosed by a polygon, also known as an exterior polygon, may contain exception areas, or holes, that for the same service must yield a different destination to that described by the larger area. This document describes how holes SHOULD be specified in service boundaries defined using a GML encoding for the polygons and their internal elements (holes). GML polygons are based on elements defined in [ISO-19107] (ISO, "Geographic information - Spatial Schema," 5 2003.).

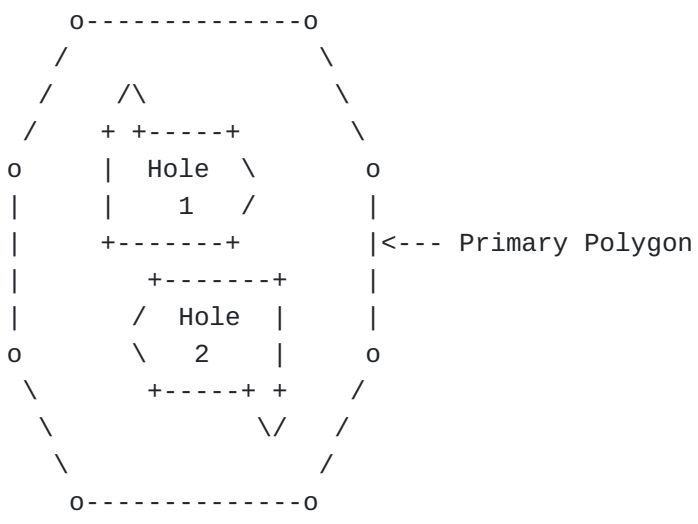

Figure 1: Holes in a Polygon

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2. Terminology

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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] (Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels," March 1997.).

3. Specifying Holes

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Holes related to an exterior boundary polygon MUST adhere to the following rules:

> **Rule 1:** Two holes MUST NOT have more than one point of intersection. If two or more holes share a common set of boundaries then to the primary polygon these represent a single hole in the service. The internal elements (holes) should have common boundaries removed and a single hole created irrespective of whether the excluded area is itself made up of multiple service boundaries.

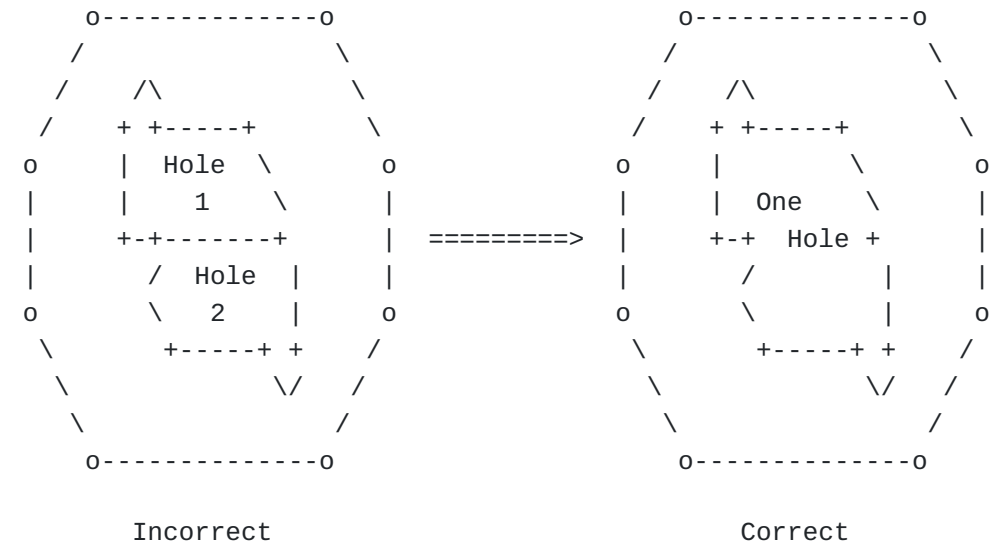

Figure 2: Incorrect Hole Specification with Boundary Sharing

Rule 2: A hole MUST NOT have more than one point of intersection with the outer-boundary of the primary (exterior) polygon. If more than one point of intersection occurs the primary polygon is either doesn't have a hole, it has an inlet as in Figure 3 (Correct Specification of an Inlet), or the primary polygon SHOULD be expressed as two polygons as in Figure 4 (Correct Specification of Hole with Multiple Outer-Boundary Intersections).

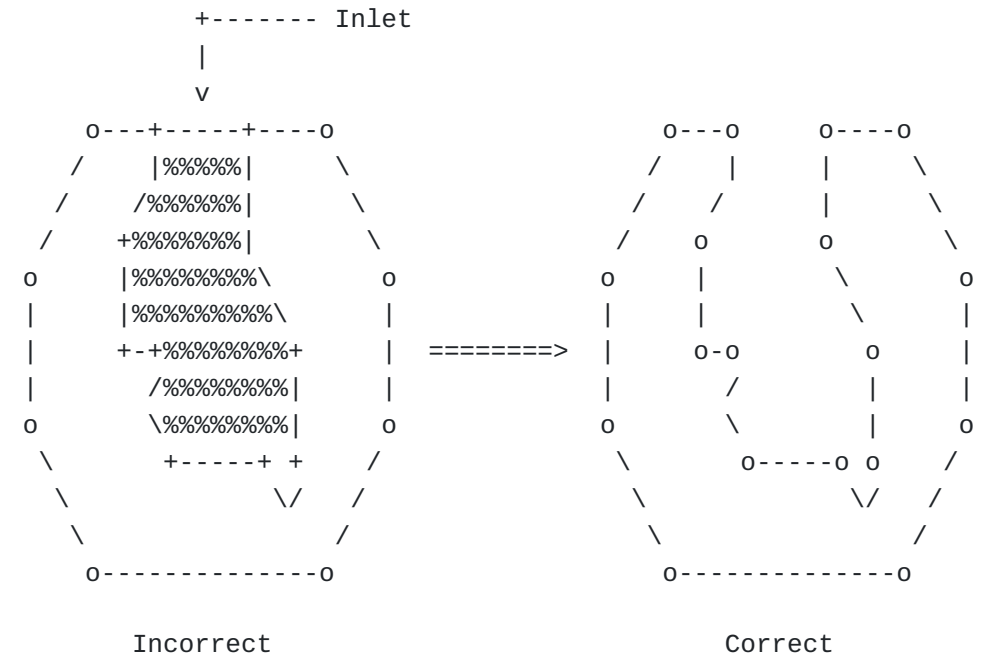

Figure 3: Correct Specification of an Inlet

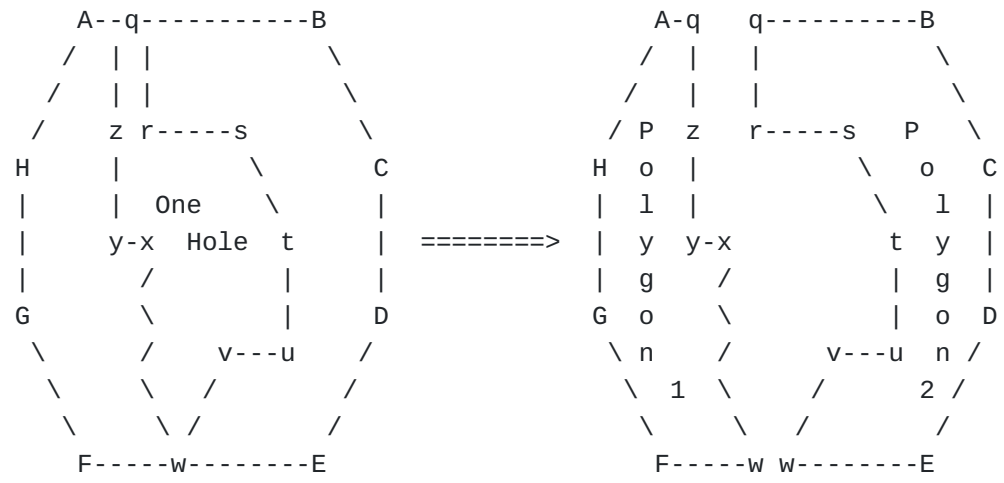

Figure 4: Correct Specification of Hole with Multiple Outer-Boundary Intersections

Similarly, a polygon containing a hole with an island must be represented as two polygons mapping to the same service.

> **Rule 3:** A hole MUST be a legal polygon in accordance with the geoshape specification [geoshape] (Thomson, M. and C. Reed, "GML 3.1.1 PIDF-LO Shape Application Schema for use by the Internet Engineering Task Force (IETF)," April 2007.). There is no restriction on the number of points that may be used to express the perimeter of the hole.

4. GML Polygons

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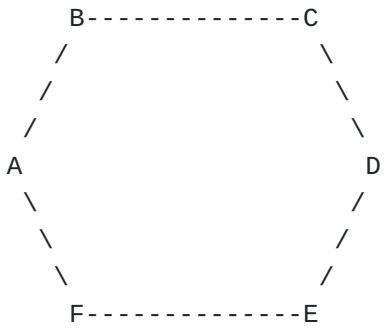
The GML encoding of a polygon defines a enclosed exterior boundary, with the first and last points of boundary being the same. Consider the example in Figure 5 (Hexagon and Associated GML).




```
<gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
  <gml:exterior>
    <gml:LinearRing>
      <gml:pos>43.311 -73.422</gml:pos> <!--A-->
      <gml:pos>43.111 -73.322</gml:pos> <!--F-->
      <gml:pos>43.111 -73.222</gml:pos> <!--E-->
      <gml:pos>43.311 -73.122</gml:pos> <!--D-->
      <gml:pos>43.411 -73.222</gml:pos> <!--C-->
      <gml:pos>43.411 -73.322</gml:pos> <!--B-->
      <gml:pos>43.311 -73.422</gml:pos> <!--A-->
    </gml:LinearRing>
  </gml:exterior>
</gml:Polygon>
```

Figure 5: Hexagon and Associated GML

NOTE that polygon vertices in Figure 5 (Hexagon and Associated GML) are expressed using <pos> elements for clarity. The vertices can also be expressed using a <posList> element.

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5. Holes in GML Polygons

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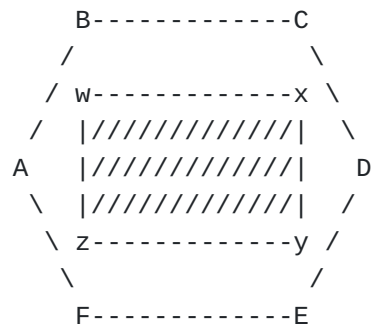
A hole is specified in the polygon by defining an interior boundary. The points defining the internal boundary define the area represented by the hole in the primary (exterior) polygon. The shaded area in Figure 6 (Hexagon with Hole) is represented by the 4 points of the interior boundary specified by (w,z,y,x).




```
<gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
  <gml:exterior>
    <gml:LinearRing>
      <gml:pos>43.311 -73.422</gml:pos> <!--A-->
      <gml:pos>43.111 -73.322</gml:pos> <!--F-->
      <gml:pos>43.111 -73.222</gml:pos> <!--E-->
      <gml:pos>43.311 -73.122</gml:pos> <!--D-->
      <gml:pos>43.511 -73.222</gml:pos> <!--C-->
      <gml:pos>43.511 -73.322</gml:pos> <!--B-->
      <gml:pos>43.311 -73.422</gml:pos> <!--A-->
    </gml:LinearRing>
  </gml:exterior>
  <gml:interior>
    <gml:LinearRing>
      <gml:pos>43.411 -73.322</gml:pos> <!--w-->
      <gml:pos>43.211 -73.322</gml:pos> <!--z-->
      <gml:pos>43.211 -73.222</gml:pos> <!--y-->
      <gml:pos>43.411 -73.222</gml:pos> <!--x-->
      <gml:pos>43.411 -73.322</gml:pos> <!--w-->
    </gml:LinearRing>
  </gml:interior>
</gml:Polygon>
```

Figure 6: Hexagon with Hole

6. Service Boundary Specification and Selection Algorithm

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A service boundary is represented by a polygon that may have many vertices. The enclosed area of the polygon represents the area in which a service, expressed as a service URN, maps to a single URI. Figure 6 (Hexagon with Hole) shall be used to illustrate two service boundaries. The first service boundary A->F shall be referred to as

area-A, and the second service boundary w->z shall be referred to as area-w. Further more area-A is directly represented by the GML encoding provided in Figure 6 (Hexagon with Hole). Area-w is represented as a hole in area-A by the interior boundary. Since area-w is also a service boundary, a separate polygon describing this area is also required and is shown in Figure 7 (GML for Area-w).

```
<gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
  <gml:exterior>
    <gml:LinearRing>
      <gml:pos>43.411 -73.322</gml:pos> <!--w-->
      <gml:pos>43.211 -73.322</gml:pos> <!--z-->
      <gml:pos>43.211 -73.222</gml:pos> <!--y-->
      <gml:pos>43.411 -73.222</gml:pos> <!--x-->
      <gml:pos>43.411 -73.322</gml:pos> <!--w-->
    </gml:LinearRing>
  </gml:exterior>
</gml:Polygon>
```

Figure 7: GML for Area-w

If this data were in a LoST server the data mappings may look similar to the example in Figure 8 (Service Boundary Specifications). This is an example only and does not represent actual LoST server provisioning or data transfer records. The example XML will not complie.

```
<?xml version="1.0" encoding="UTF-8"?>
  <entry>
    <name> Outer Area Police Department </name>
    <service>urn:service:sos.police</service>
    <serviceBoundary profile="geodetic-2d">
      <gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
        <gml:exterior>
          <gml:LinearRing>
            <gml:pos>43.311 -73.422</gml:pos>
            <gml:pos>43.111 -73.322</gml:pos>
            <gml:pos>43.111 -73.222</gml:pos>
            <gml:pos>43.311 -73.122</gml:pos>
            <gml:pos>43.511 -73.222</gml:pos>
            <gml:pos>43.511 -73.322</gml:pos>
            <gml:pos>43.311 -73.422</gml:pos>
          </gml:LinearRing>
        </gml:exterior>
        <!-- this is the service boundary hole -->
        <gml:interior>
          <gml:LinearRing>
            <gml:pos>43.411 -73.322</gml:pos>
            <gml:pos>43.211 -73.322</gml:pos>
            <gml:pos>43.211 -73.222</gml:pos>
            <gml:pos>43.411 -73.222</gml:pos>
            <gml:pos>43.411 -73.322</gml:pos>
          </gml:LinearRing>
        </gml:interior>
      </gml:Polygon>
    </serviceBoundary>
    <uri>sip:area-A-pd@example.com</uri>
    <uri>xmpp:area-A-pd@example.com</uri>
    <serviceNumber>000</serviceNumber>
  </entry>
  <entry>
    <name> Inner Area Police Department </name>
    <service>urn:service:sos.police</service>
    <serviceBoundary profile="geodetic-2d">
      <gml:Polygon srsName="urn:ogc:def:crs:EPSG::4326">
        <gml:exterior>
          <gml:LinearRing>
            <gml:pos>43.411 -73.322</gml:pos>
            <gml:pos>43.211 -73.322</gml:pos>
            <gml:pos>43.211 -73.222</gml:pos>
            <gml:pos>43.411 -73.222</gml:pos>
            <gml:pos>43.411 -73.322</gml:pos>
          </gml:LinearRing>
        </gml:exterior>
      </gml:Polygon>
```

```
      </serviceBoundary>
      <uri>sip:area-w-pd@example.com</uri>
      <uri>xmpp:area-w-pd@example.com</uri>
      <serviceNumber>000</serviceNumber>
    </entry>
```

Figure 8: Service Boundary Specifications

It is considered likely that LoST servers will need to provide responses sufficiently quickly to allow real-time queries to be performed as part of an emergency call routing flow. It is for this reason that databases supporting native geospatial query techniques are desirable and that service boundary specifications that are easily mapped to internal data structures are preferred. The format described in this memo makes support for this operation easy, while allowing an arbitrary number of holes in a service boundary to be specified.
Each primary polygon is stored in the geospatial database and mapped to a service URN and destination URI. Holes may be stored as polygons in a separate table and mapped to the primary polygon. When a location is found to map to a polygon, the exceptions table can be checked to see if the primary polygon contains any coverage holes. In general no holes will exist for a service boundary, so this check results in almost no overhead and the service mapping can be returned. Where one or more holes are found to exist, the provided location is checked against each hole. If the location is found to exist in one of the specified holes then the primary polygon can be discarded, and searching of the service boundary database can continue.

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7. Security Considerations

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This document does not introduce any security issues.

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8. IANA Considerations

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There are no specific IANA considerations for this document.

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9. Acknowledgements

Thanks to Carl Reed for input provided to the list some months back and for reviewing this document. Thanks also to Michael Haberler for suggesting that such a specification is required.

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10. References

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10.1. Normative References

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[RFC2119]	Bradner, S., “Key words for use in RFCs to Indicate Requirement Levels,” BCP 14, RFC 2119, March 1997 (TXT, HTML, XML).
[RFC5222]	Hardie, T., Newton, A., Schulzrinne, H., and H. Tschofenig, “LoST: A Location-to-Service Translation Protocol,” RFC 5222, August 2008 (TXT).
[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.

10.2. Informative References

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[I-D.ietf-ecrit-lost-sync]	Schulzrinne, H. and H. Tschofenig, “Synchronizing Location-to-Service Translation (LoST) Protocol based Service Boundaries and Mapping Elements,” draft-ietf-ecrit-lost-sync-09 (work in progress), March 2010 (TXT).
[ISO-19107]	ISO, “Geographic information - Spatial Schema,” ISO Standard 19107, First Edition, 5 2003.

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