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A Uniform Resource Identifier for Geographic Locations ('geo' URI)
draft-ietf-geopriv-geo-uri-01

Abstract

This document specifies an Uniform Resource Identifier (URI) for geographic locations using the 'geo' scheme name. A 'geo' URI identifies a physical location in a two- or three-dimensional coordinate reference system in a compact, simple, human-readable, and protocol independent way. The default coordinate reference system used is WGS-84.

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1. Change Log

[Note to editors: This section is to be removed before publication - XML source available on request]

draft-ietf-geopriv-geo-uri-01
- added parameters to ABNF
- added optional 'crs' parameter to allow future use of other CRSes
- Many other changes to not preclude the future specification of other CRSes.
- some typos fixes - credits Bill McQuillan

draft-ietf-geopriv-geo-uri-00
- submitted as WG item
- changed IPR text because of text used from RFC 4395
- added considerations for comparing +180/-180 longitude URIs
- some editorial changes

draft-mayrhofer-geopriv-geo-uri-01
- added terminology text about WGS-84 (credits Carl Reed)
- removed "resolution" / "uncertainty" text
- added considerations regarding poles
- added text about invalid URIs

draft-mayrhofer-geopriv-geo-uri-00
- Initial version under new name, reverting to "plain" lat/lon scheme, with the "tiling" scheme moved to seperate draft (potentially published as "draft-mayrhofer-geopriv-geotile-uri"). refer to draft-mayrhofer-geo-uri-01 for the history of this document.
- Added GML mapping section

draft-mayrhofer-geo-uri-01
- removed parameters

draft-mayrhofer-geo-uri-00
- initial draft

2. Introduction

An increasing number of Internet protocols and data formats are extended by specifications for adding spatial (geographic) location. In most cases, latitude as well as longitude of simple points are added as new attributes to existing data structures. However, all those methods are very specific to a certain data format or protocol, and don't provide a protocol independent, compact and generic way to refer to a physical geographic location.

Over the past few years, fast emerging location aware applications and location based services were observable on the Internet. Most web search engines use geographic information, and a vivid open source mapping community brought an enormous momentum into location aware technology. A wide range and former to professionals exclusive tools and data were provided free of charge for an everyday use on the mass market.

The 'geo' URI scheme is another step into that direction and aims to facilitate, support and standardize the problem of location identification in geospatial services and applications. Accessing information about or trigger further services based on a particular place on earth shouldn't be any harder for users than clicking on a 'mailto:' link and write an email straight away.

According to [RFC3986], a Uniform Resource Identifier (URI) is "a compact sequence of characters that identifies an abstract or physical resource". The 'geo' URI scheme defined in this document identifies geographic locations (a physical resource) in a coordinate references system (CRS), per default in World Geodetic System 1984 (WGS-84) [WGS84]. The optional "crs" URI parameter described below may be used by future specifications to define the use of other CRSes. However, such definitions are out of scope of this document.

'Geo' URIs identify a geographic location using a textual representation of the location's spatial coordinates in either two or three dimensions (latitude, longitude, and optionally altitude for the default CRS of WGS-84). Such URIs are independent from a specific protocol, application, or data format, and can be used in any other protocol or data format that supports inclusion of arbitrary URIs.

For the sake of usability, the definition of the URI scheme is strictly focused on the simplest, but also most common representation of a spatial location - a single point. The provision of more complex geometries or locations described by civic addresses is out of scope of this document.

Note: The choice of WGS-84 as the default CRS is based on the widespread availability of Global Positioning System (GPS) devices, which use the WGS-84 reference system. It is anticipated that such devices serve as one of the primary data sources for authoring 'geo' URIs, hence the adoption of the native GPS reference system for the URI scheme. Also, many other data formats for representing geographic locations use the WGS-84 reference system, which makes transposing from and to such data formats less error prone (no re-projection involved).

3. Terminology

Geographic locations in this document are defined using WGS 84 (World Geodetic System 1984), equivalent to the International Association of Oil & Gas Producers (OGP) Surveying and Positioning Committee EPSG (European Petroleum Survey Group) code 4326 (2 dimensions) and 4979 (3 dimensions). This document does not assign responsibilities for coordinate transformations from and to other Spatial Reference Systems.

A 2-dimensional WGS-84 coordinate value is here represented as a comma-delimited latitude/longitude pair, measured in decimal degrees (un-projected). A 3-dimensional WGS-84 coordinate value is here represented by appending a comma-delimited altitude value in meters to such pairs.

Latitudes range from -90 to 90 and longitudes range from -180 to 180. Coordinates in the Southern and Western hemispheres as well as altitudes below the WGS-84 reference geoid are signed negative with a leading dash.

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].

4. IANA Registration of 'geo' URI Scheme

This section contains the fields required for the URI scheme registration, following the guidelines in section 5.4 of [RFC4395].

4.1. URI Scheme Name

geo

4.2. Status

permanent

4.3. URI Scheme Syntax

The syntax of the 'geo' URI scheme is specified below in Augmented Backus-Naur Form (ABNF) [RFC4234]:

```
geo-URI       = geo-scheme ":" geo-path
geo-scheme    = "geo"
geo-path      = coordinates *p
coordinates   = coord-a "," coord-b [ "," coord-c ]

coord-a       = num
coord-b       = num
coord-c       = num

p             = crsp / parameter
crsp          = ";crs=" crslabel
crslabel      = "wgs84"
parameter     = ";" pname [ "=" pvalue ]
pname         = 1*( alphanum / '-' )
pvalue        = 1*paramchar
paramchar     = p-unreserved / unreserved / pct-encoded

num           = [ "-" ] 1*DIGIT [ "." 1*DIGIT ]
unreserved    = alphanum / mark
mark          = "-" / "_" / "." / "!" / "~" / "*" /
                "'" / "(" / ")"
pct-encoded   = "%" HEXDIG HEXDIG
p-unreserved  = "[" / "]" / "/" / ":" / "&" / "+" / "$"
alphanum      = ALPHA / DIGIT
```

The optional "crs" parameter MUST NOT appear more than once. If other parameters are also given, the "crs" parameter MUST be given first. The definition of other parameters besides "crs" is out of scope for this document.

Future documents proposing the use of other CRSes may update the definition of the 'crslabel' component.

In case the URI identifies a location in the default CRS of WGS-84, its sub-components are further restricted as follows:

```
coord-a       = latitude
coord-b       = longitude
coord-c       = altitude

latitude      = [ "-" ] 1*2DIGIT [ "." 1*DIGIT ]
longitude     = [ "-" ] 1*3DIGIT [ "." 1*DIGIT ]
altitude      = [ "-" ] 1*DIGIT [ "." 1*DIGIT ]
```

4.4. URI Scheme Semantics

Data contained in a 'geo' URI identifies a physical resource: A spatial location on earth in the in a coordinate reference system, identified by the geographic coordinates encoded in the URI.

4.4.1. Coordinate Reference System Identification

The semantics of the 'coordinates' component depends on the CRS of the URI. The CRS itself is identified by the optional 'crs' parameter the default. A URI instance uses the default WGS-84 CRS if the 'crs' parameter is either missing, or contains the value of 'wgs84'. Other 'crs' values are not currently defined, but may be specified by future documents.

Interpretation of coordinates in a wrong CRS produces invalid location information. Consumers of 'geo' URIs therefore MUST NOT ignore the 'crs' parameter if given, and MUST NOT attempt to interpret the 'coordinates' component of given in an unknown CRS.

The following component description refers to the use of the default CRS (WGS-84) only. Future documents specifying other 'crs' parameter values MUST provide similar descriptions for the 'coordinates' sub-components in the described CRS.

4.4.2. Component Description for WGS-84

The "latitude", "longitude" and "altitude" components as specified in the URI scheme syntax (Section 4.3) are to be used as follows:

- The "latitude" component MUST contain the latitude of the identified location in decimal degrees in the reference system WGS-84.
- The "longitude" component MUST contain the longitude of the identified location in decimal degrees in the reference system WGS-84.
- If present, the OPTIONAL "altitude" component MUST contain the WGS-84 altitude of the identified location in meters.

If the altitude of the location is unknown, the "altitude" component MUST NOT be present in the URI. Specifically, unknown altitude MUST NOT be represented by setting the 'altitude' component to "0" (or any other arbitrary value).

The "longitude" components of coordinate values reflecting the poles (latitude set to -90 or 90 degrees) SHOULD be set to "0", although consumers of "geo" URIs MUST accept such URIs with any longitude value between -180 and 180.

'geo' URIs with longitude values outside the range of -180 to 180 decimal degrees or with latitude values outside the range of -90 to 90 degrees MUST be considered invalid.

4.4.3. URI Comparison

Two 'geo' URIs are equal when they use the same CRS, and their 'coord-a', 'coord-b' and 'coord-c' values are mathematically identical.

Two 'geo' URIs use the same CRS if:

- their 'crslabel' components are identical
- or if neither URIs contain a 'crs' parameter (in which case both URIs use WGS-84)
- or if one URI contains a 'crslabel' value of 'wgs84', while the other URI does not contain a 'crs' parameter (which means that both URIs use the WGS-84 reference system as well, with one of the URIs specifying the CRS explicitely)

For the default CRS of WGS-84, the following definitions apply additionally:

- Where the 'latitude' component of a 'geo' URI is set to either 90 or -90 degrees, the 'longitude' component MUST be ignored in comparison operations.
- A 'longitude' component of 180 degrees MUST be considered equal a 'longitude' component of -180 degrees for the purpose of URI comparison.

An URI with undefined (missing) 'coord-c' (altitude) value MUST NOT be considered equal to an URI containing an 'coord-c' value, even if the remaining values 'coord-a' and 'coord-b' are equivalent.

4.4.4. Interpretation of Undefined Altitude

A consumer of a 'geo' URI in the WGS-84 CRS with undefined 'altitude' MAY assume that the URI refers to the respective location on earth's physical surface at the given 'latitude' and 'longitude' coordinate.

However, as defined above, altitudes are relative to the WGS-84 reference geoid rather than earth's surface. Hence, an altitude value of 0 MUST NOT be interpreted as "on earth's surface".

4.5. Encoding Considerations

The 'coordinates' path component of the 'geo' URI (see Section 4.3) uses a comma (",") as a delimiter for subcomponents. This delimiter MUST NOT be percent encoded.

It is RECOMMENDED that for readability the contents of 'coord-a', 'coord-b' and 'coord-c' subcomponents are never percent encoded.

4.6. Applications/protocols That Use This URI Scheme

As many other URI scheme definitions, the 'geo' URI provides resource identification independent of a specific application or protocol. Examples of potential protocol mappings and use cases can be found in Section 6.

4.7. Interopability Considerations

As with any other new URI scheme, the 'geo' URI requires support in client applications. Users of applications which are not aware of the 'geo' scheme are likely unable to make direct use of the information in the URI. However, the simple structure of the 'geo' URI would even allow manual dereference by users.

Poorly authored 'geo' URI instances could contain whitespace and values with leading plus signs ("+"), which is not allowed according to the ABNF. Clients SHOULD, however, try to dereference such URIs after removing such whitespace and plus signs.

This specification does not define a query component. Future revisions might define such components, using the "?" character to delimit query components from the path component specified above. Clients MUST be prepared to encounter such 'geo' URI instances, and MUST reduce the URI to the components specified in Section 4.3 before they dereference the URI.

Clients MUST NOT attempt to dereference URIs given in an CRS that is unknown to the client, because doing so would produce entirely bogus results.

Authors of 'geo' URIs should carefully check that coordinate components are set in the specified order, since wrong order of those components is a commonly observed mistake and produces completely bogus locations.

4.8. Security Considerations

See Section 9 of [insert reference to this document]

4.9. Contact

Christian Spanring (mailto:cspanring@gmail.at, http://spanring.eu/), Alexander Mayrhofer (mailto:alexander.mayrhofer@nic.at, http://timatio.com/)

4.10. Author/Change controller

The 'geo' URI scheme is registered under the IETF part of the URI tree. As such, change control is up to the IETF.

4.11. References

RFC XXXX [change to RFC number once assigned]

5. URI Operations

Currently, just one operation on a 'geo' URI is defined - location dereference: In that operation, a client dereferences the URI by extracting the geographical coordinates from the URI path component ('geo-path' in the ABNF). Further use of those coordinates is then up to the application processing the URI, and might depend on the context of the URI.

An application may then use this location information for various purposes, for example:

- A web browser could use that information to open a web mapping service of the user's choice, and display a map of the location
- A navigational device such as a Global Positioning System (GPS) receiver could offer the user to start navigation to the location.

6. Use Cases and Examples

6.1. Plain 'geo' URI Example

The following 3-dimensional 'geo' URI example references to the office location of one of the authors in Vienna, Austria:

geo:48.2010,16.3695,183

A user could type the data extracted from this URI into a electronic navigation device, or even use it to locate the identified location on a paper map.

6.2. Hyperlink

'geo' URIs (like any other URI scheme) could also be embedded as hyperlinks in web pages. A Hyper Text Markup Language (HTML) snippet with such a hyperlink could look like:

```
<p>one of Vienna's popular sights is the <a href='geo:
48.198634,16.371648;crs=wgs84'>Karlskirche</a>.
```

A web brower could extract the coordinates from the HTML snippet, and offer the user various options (based on configuration, context), for example:

- display a small map thumbnail when the mouse pointer hovers over the link
- switch to a mapping service of the user's choice once the link is selected
- Locate nearby resources, for example by comparing the 'geo' URI with locations extracted from GeoRSS feeds the user has subscribed to.
- Convert the coordinates to a format suitable for uploading to a navigation device

Note that the URI in this example also makes use of the explicit specification of the CRS by using the 'crs' URI parameter.

6.3. 'geo' URI in 2-dimensional barcode

Due to it's short length, a 'geo' URI could easily be encoded in 2-dimensional barcodes. Such barcodes could be printed on business cards, flyers, paper maps and subsequently used by mobile devices, for example as follows:

1. User identifies such a barcode on a flyer, uses the camera on his mobile phone to photograph and decode the barcode
2. The mobile phone dereferences the 'geo' URI, and offers the user to calculate a navigation route to the identified location.
3. Using the builtin GPS, the user follows the navgiation instructions from his phone to reach the destination

7. GML Mappings

The Geographic Markup Language (GML) by the Open Geospatial Consortium (OGC) is a set of XML schemas to represent geographical features. Since GML is widely accepted, this document includes instructions on how to transpose 'geo' URIs from and to GML documents.

A 'geo' URI can be mapped from a GML "point", and any 'geo' URI can be mapped to a GML "point" (given that both support the CRS used). For the following sections, "%lat%", "%lon%" and "%alt%" are placeholders for latitude, longitude, and altitude values. Mappings are defined as follows:

7.1. 'geo' URI without altitude to GML 'Point'

An instance of a WGS 84 'geo' URI without the altitude element is mapped to a two-dimensional GML "Point" as follows:

'geo' URI:

```
geo:%lat%,%lon%
```

GML document:

```
<?xml version="1.0" encoding="UTF-8">
<Point srsDimension="2"
       srsName="urn:ogc:def:crs:EPSG:6.6:4326"
       xmlns="http://www.opengis.net/gml">
  <pos>%lat% %lon%</pos>
</Point>
```

7.2. 'geo' URI with Altitude to GML 'Point'

A WGS 84 'geo' URI instance with the altitude element is mapped to a three-dimensional GML "Point" as follows:

'geo' URI:

```
geo:%lat%,%lon%,%alt%
```

GML document:

```
<?xml version="1.0" encoding="UTF-8">
<Point srsDimension="3"
       srsName="urn:ogc:def:crs:EPSG:6.6:4979"
       xmlns="http://www.opengis.net/gml">
  <pos>%lat% %lon% %alt%</pos>
</Point>
```

7.3. GML 'Point' without Altitude to 'geo' URI

A GML 'Point' in the reference system identified as "urn:ogc:def:crs:EPSG:6.6:4326" is mapped to a 'geo' URI as follows:

GML document:

```
    <?xml version="1.0" encoding="UTF-8">
    <Point srsDimension="2"
           srsName="urn:ogc:def:crs:EPSG:6.6:4326"
           xmlns="http://www.opengis.net/gml">
      <pos>%lat% %lon%</pos>
    </Point>
```

'geo' URI:

```
    geo:%lat%,%lon%
```

Note: GML documents in other reference systems MAY be used as well if a transformation into "urn:ogc:def:crs:EPSG:6.6:4326" is defined and applied before the mapping step.

7.4. GML 'Point' with Altitude to 'geo' URI

A GML 'Point' in the reference system identified as "urn:ogc:def:crs:EPSG:6.6:4979" is mapped to a 'geo' URI as follows:

GML document:

```
    <?xml version="1.0" encoding="UTF-8">
    <Point srsDimension="3"
           srsName="urn:ogc:def:crs:EPSG:6.6:4979"
           xmlns="http://www.opengis.net/gml">
      <pos>%lat% %lon% %alt%</pos>
    </Point>
```

'geo' URI:

```
    geo:%lat%,%lon%,%alt%
```

Note: GML 'Point' instances in other reference systems could be used as well if a transformation into "urn:ogc:def:crs:EPSG:6.6:4979" is defined and applied before the mapping step. It should be noted that such reprojections are typically not lossless because of the limited accuracy of the mathematical calculations involved.

8. IANA Considerations

This document requests assignment of the 'geo' URI scheme in the IETF part of the URI scheme tree, according to the guidelines in BCP 115 (RFC 4395) [RFC4395]. The definitions required for the assignment are contained in Section 4.

9. Security Considerations

Because the 'geo' URI is not tied to any specific protocol, and identifies a physical location rather than a network resource, most of the general security considerations on URIs (Section 7 of RFC 3986) do not apply. However, the following (additional) issues apply:

9.1. Invalid Locations

The URI syntax (Section 4.3) makes it possible to construct valid 'geo' URIs which don't identify a valid location on earth. Applications MUST NOT use URIs which such invalid values, and SHOULD warn the user when such URIs are encountered.

An example of such an invalid URI would be <geo:94,0> (latitude "beyond" north pole).

9.2. Location Privacy

Location information about individuals is an extremely sensitive topic, especially when location is combined with Personally Identifyable Information (PII). Authors of 'geo' URIs MUST consider data protection and privacy before publishing such URIs.

However, it should be noted that a 'geo' URI by itself is just opaque location information, and privacy considerations typically arise only when such opaque location information is put in context by combining it with other information (for example, embedding it within a message to reflect the current location of a person).

10. Acknowledgements

The authors wish to acknowledge the helpful contributions from Carl Reed, Bill McQuillan, Martin Kofal, Andrew Turner, Kim Sanders and Ted Hardie.

11. References

11.1. Normative References

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11.2. Informative References

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