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A protocol for location transformations  
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## Abstract

This document defines a general protocol useful for transforming location information between various formats for use by location relevant messaging elements and applications.

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## [1.](#) Introduction

All location-based services rely on location information in one form or another. In the case where location information is available, but is not in a readily usable form, it must be transformed. Location transformation is more complicated than straightforward unit conversion, since location can be represented according to many different frames of reference.

This document introduces a general method, or protocol, which can be implemented by client and server applications to transform location information between a variety of location forms and formats. It is conceivable that many kinds of applications could benefit from this mechanism, but are likely to be too numerous to describe here, and therefore, except for example purposes, are beyond the scope of this document.

A section that provides a mechanism for the discovery of transformation services using the LoST protocol [[RFC5222](#)] is included.

The structure of this document includes terminology, [Section 2](#),

followed by a discussion of the basic elements involved in location transformation. These elements, or actors, are discussed in an overview section, [Section 3](#), accompanied by a graph, associated processing steps, and a brief discussion around the use, options, and message examples for a location transformation protocol.

## [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](#)], with the important qualification that, unless otherwise stated, these terms apply to the design of the Location Configuration Protocol and the Location Dereferencing Protocol, not its implementation or application.

The following terms are defined in this document:

Transformation: Rendering one form of location information into another form.

Location: Referring to Location information that is useful in the context of location-based applications.

Geocoding: A process of transforming a civic style location into a geographic style of location.

Reverse Geocoding: A process of transforming a geographic style of location into a civic style of location.

Geographic location: A format of location information that is represented by geographic coordinates within a geographic coordinate system.

Geodetic location: A replacement term for geographic location.

Datum: A defined system of reference associated with the associated set of geographic location information.

### [3.](#) Overview of Location Transformation

For location information to be usable, it must be represented in a form that makes sense to the person or application that receives it. In most cases, location information is in one of two common forms, civic location, and geographic, or "geodetic" location.

Civic location, which has a datum that varies by country, or region,

is most often thought of as a "street address". A civic location is often represented as the common address at which a person lives or works, or even just visits. An example of this might be the (example) address of "316 Hightower Street, Independence, Missouri, USA", which represents a house, apartment, or building number, along some named street or thoroughfare, within some village, town, or city, and belonging to particular state, province, and country. The notion of having a standard set of civic address elements may exist among some jurisdictions on Earth, though is not universally the case.

Geodetic location, (in this document, we equate the term geodetic location with geographic location), represents a specific place on some kind of grid. As an example, one commonly used reference system standard, or "datum", is referred to as WGS84, and defines a global grid that can be used to locate a position anywhere on earth using a set of geodetic coordinates for latitude, longitude, and (optionally) altitude.

Whereas most geodetic datums are more broadly defined to be a continental or globally applicable coordinate reference system, civic locations are defined locally, based on a specific preference, dictated by a municipality, region, county, state, or country.

The transformation mechanism described here is not only for use in transforming location information from civic-to-geodetic, or geodetic-to-civic, but also between various civic, geo, and other representations.



Geographic Information System (GIS) is software that is designed to enable applications that rely on location. GIS applications provide a mechanism to store, compare, manipulate, and report geographic information, incorporating many types of geodetic and civic location features and elements. GIS systems, once they are provisioned with location data, are useful in associating geodetic data with civic data. For example, given a lat/lon, a GIS application can be used to display the coordinate position on a geographic map display, and can be used to associate other geographic features, including a civic location in close proximity to the input set of coordinates.

## [5.](#)   Location Transformation Services

Location transformation services are intentioned to be able to support public, private, or commercial needs, and are envisioned to be made available via the Internet or through commercial network interconnections.

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## [6.](#) Simple Location Transformation Protocol

The transform element

The crsType element

The location element

The runTime element

The matched element

The similar element

The shape element

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## [7.](#)   Discovering the Location Transformation Service

In order to process a location transformation, there must be a mechanism to discover such a service. The LoST [\[RFC5222\]](#) protocol does service discovery by using already supplied location, as well as Service URN that is specific to the service being requested.

For this purpose, a new service URN, urn:service:transform is introduced. Since a LoST server is expected to contain both geodetic and civic data layer information, either form is supported in the input, along with the specific service urn.

If the LoST server cannot successfully perform this transformation because the input location is outside it's internal data footprint, it is expected that a URI would be returned that would point the LoST client to a more location appropriate LoST server.

## [8.](#) Applications in Location Transformation

### [8.1.](#) Civic-to-Geodetic Location Transforms

#### Description

Geocoding is the transformation of a civic address into a set of geodetic coordinates. Since the specific technique of conversion to these geodetic coordinates is implementation specific, this document only describes the interface over which a request/response for a civic address is sought. Many forms of a civic address can be used as input, and the response can be provided according to a specified datum, or may be in accordance with a default datum if no input datum is requested, or the requested datum is unavailable. The common case for geocoding is to provide a civic street address and get back a lat/lon (2D example). This interface supports the return of polygon data sets as well as individual coordinates. It also supports specific shape types as well as point data.

#### Examples

USPS-Civic-to-Geo-Point USPS Street Address to WGS84 geographic

coordinate pair

MSAG-Civic-to-Geo-Polygon MSAG Street Address to Parcel polygon  
(multi-coordinate set)

## [8.2.](#) Geodetic-to-Civic Location Transforms

### Description

Reverse geocoding is the transformation from a set of geodetic coordinates to a representative civic location. Every commercial GIS software has its own unique algorithm that it uses to make this conversion. Because of this, it may be that no two vendors' geocoding operations result in the same output. The type of data used within the GIS also has an important impact on the expected results. Finite polygon data, for example, (often referred to as parcel polygons), that is loaded into a GIS will provide a much more sensible rendering of a civic address than would be produced by the datasets containing only point data (e.g., site structure) or street centerline data. As with geocoding, because this operation is implementation specific, this document only describes the interface protocol over which a request/response for a civic location is asked for. Since civic

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location can be represented in Various formats, both the request and response message sets will contain profile identifiers that describe which form of civic location was sought, as well as which type was returned (in case the requested type was unavailable).

### A Couple of Use Case Examples

2D-Geo-to-Postal Two dimensional geographic coordinates to USPS  
Street Address

A transformation from a two-dimensional geodetic coordinate set to a USPS styled civic location in a form consistent with USPS Publication 28 guidelines. This case is when a lat/lon target destination is supplied by, lets say a personal navigation device, but no corresponding civic location is provided.

3D-Geo-to-Postal Three dimensional geographic coordinates to USPS  
Street Address

This transformation is a variation of the above case, but bring  
in the ability to do transformations where elevation or  
altitude differentiates one civic location from another (e.g.,  
hi-rise apartment building).

### [8.3.](#) Sample Coordinate Reference System Transformations

#### Potential Applications of Transformed Location

Of the many Coordinate Reference Systems and published addressing  
standards currently in use, some of the more popular CRS' used in  
commercial and public safety contexts are as follows.

NAD83-to-WGS84 NAD83 (North American Datum 1983) to WGS84 (World  
Geodetic Standard 1984) Geodetic transforms

WGS84-to-NAD83 WGS84 to NAD83 Geodetic transforms

MSAG-to-USPS MSAG to USPS Civic transforms

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## [9.](#) Location Messaging Profiles

A location message profile described here is an example of an xml  
representation of the each kind of request and response message and  
location profile specified within the messages.

### [9.1.](#) Geographic Location Profiles

#### [9.1.1.](#) Two Dimensional Geographic Coordinate profile

Example xml to be supplied]

### [9.1.2.](#) 3-D Geographic Coordinate profile

Example xml to be supplied]

## [9.2.](#) Civic Location Profiles

### [9.2.1.](#) Street Address profile

Example xml to be supplied]

### [9.2.2.](#) USPS Address profile

Example xml to be supplied]

## [9.3.](#) Hybrid Location Profiles

### [9.3.1.](#) 2-D Geographic Coordinates with Civic Address "floor" element

Example xml to be supplied]

## [9.4.](#) Polygon (shape) Profiles

### [9.4.1.](#) Municipal (i.e., Parcel) boundary

Example xml to be supplied]

### [9.4.2.](#) standard geometric shapes

Examples of xml for each of the following to be supplied]

point:

circle:

ellipse:

ellipsoid:



sphere:

arc band:

## [10.](#)   Output Resolution

Along with the actual location information, additional qualifying information is also necessary, depending on the type of location used

### [10.1.](#)   Geocoding Resolution

#### [10.1.1.](#)   Uncertainty and Confidence

For any geodetic point shape that is measured directly, or in this case, derived as a result of a transformation operation, there must be included with the result, additional qualifying information, such as the point's resolution, essentially a tolerance, or the amount of probable error, and the estimated probability of that resolution/error.

### [10.2.](#)   Reverse Geocoding Resolution

For any civic address that is returned from a reverse geocoding operation, it may be advantageous to know which elements of the civic location that was returned were found in the GIS data layer. Some of these data may be matched in the internal data structure

#### [10.2.1.](#)   Matched-Point, Matched-Polygon, unmatched-interpolated, and unchecked address elements

to be supplied]

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## [11.](#) Errors and Warnings

### [11.1.](#) Error messages

#### [11.1.1.](#) 4XX Bad Responses

to be supplied]

#### [11.1.2.](#) 5XX Internal System Errors

to be supplied]

### [11.2.](#) Warning messages

to be supplied]

### [11.3.](#) Informational messages

Matched element response

Element not matched response

Unused element response

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[12.](#) Relax NG schema

[This section to be supplied]

[13.](#) Considerations for International CRS support

Civic Address Profile definitions

[This section to be supplied]

Geographic CRS definitions

[This section to be supplied]

#### [14.](#) Security Considerations

[This section to be supplied]

## [15.](#) IANA Considerations

[This section to be supplied]

## [16.](#) Acknowledgements

[This section to be supplied]





## 17. References

### 17.1. Normative References

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

### 17.2. Informative References

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