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A YANG Grouping for Geographic Locations

Abstract

This document defines a generic geographical location YANG grouping. The geographical location grouping is intended to be used in YANG data models for specifying a location on or in reference to Earth or any other astronomical object.

Status of This Memo

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1. Introduction

In many applications, we would like to specify the location of something geographically. Some examples of locations in networking might be the location of data centers, a rack in an Internet exchange point, a router, a firewall, a port on some device, or it could be the endpoints of a fiber, or perhaps the failure point along a fiber.

Additionally, while this location is typically relative to Earth, it does not need to be. Indeed, it is easy to imagine a network or device located on the Moon, on Mars, on Enceladus (the moon of Saturn), or even on a comet (e.g., 67p/churyumov-gerasimenko).

Finally, one can imagine defining locations using different frames of reference or even alternate systems (e.g., simulations or virtual realities).

This document defines a 'geo-location' YANG grouping that allows for all the above data to be captured.

This specification conforms to [ISO.6709.2008].

The YANG data model described in this document conforms to the Network Management Datastore Architecture (NMDA) defined in [RFC8342].

1.1. Terminology

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

2. The Geolocation Object

2.1. Frame of Reference

The frame of reference ('reference-frame') defines what the location values refer to and their meaning. The referred-to object can be any astronomical body. It could be a planet such as Earth or Mars, a moon such as Enceladus, an asteroid such as Ceres, or even a comet such as 1P/Halley. This value is specified in 'astronomical-body' and is defined by the International Astronomical Union <http://www.iau.org>. The default 'astronomical-body' value is 'earth'.

In addition to identifying the astronomical body, we also need to define the meaning of the coordinates (e.g., latitude and longitude) and the definition of 0-height. This is done with a 'geodetic-datum' value. The default value for 'geodetic-datum' is 'wgs-84' (i.e., the World Geodetic System [WGS84]), which is used by the Global Positioning System (GPS) among many others. We define an IANA registry for specifying standard values for the 'geodetic-datum'.

In addition to the 'geodetic-datum' value, we allow overriding the coordinate and height accuracy using 'coord-accuracy' and 'height-accuracy', respectively. When specified, these values override the defaults implied by the 'geodetic-datum' value.

Finally, we define an optional feature that allows for changing the system for which the above values are defined. This optional feature adds an 'alternate-system' value to the reference frame. This value is normally not present, which implies the natural universe is the system. The use of this value is intended to allow for creating virtual realities or perhaps alternate coordinate systems. The definition of alternate systems is outside the scope of this document.

2.2. Location

This is the location on, or relative to, the astronomical object. It is specified using two or three coordinate values. These values are given either as 'latitude', 'longitude', and an optional 'height', or as Cartesian coordinates of 'x', 'y', and 'z'. For the standard location choice, 'latitude' and 'longitude' are specified as decimal degrees, and the 'height' value is in fractions of meters. For the Cartesian choice, 'x', 'y', and 'z' are in fractions of meters. In both choices, the exact meanings of all the values are defined by the 'geodetic-datum' value in Section 2.1.

2.3. Motion

Support is added for objects in relatively stable motion. For objects in relatively stable motion, the grouping provides a three-dimensional vector value. The components of the vector are 'v-north', 'v-east', and 'v-up', which are all given in fractional meters per second. The values 'v-north' and 'v-east' are relative to true north as defined by the reference frame for the astronomical body; 'v-up' is perpendicular to the plane defined by 'v-north' and 'v-east', and is pointed away from the center of mass.

To derive the two-dimensional heading and speed, one would use the following formulas:

$$speed = \sqrt{v_{north}^{2} + v_{east}^{2}}$$

$$heading = \arctan(v_{east} / v_{north})$$

For some applications that demand high accuracy and where the data is infrequently updated, this velocity vector can track very slow movement such as continental drift.

Tracking more complex forms of motion is outside the scope of this work. The intent of the grouping being defined here is to identify where something is located, and generally this is expected to be somewhere on, or relative to, Earth (or another astronomical body). At least two options are available to YANG data models that wish to use this grouping with objects that are changing location frequently in non-simple ways. A data model can either add additional motion data to its model directly, or if the application allows, it can require more frequent queries to keep the location data current.

2.4. Nested Locations

When locations are nested (e.g., a building may have a location that houses routers that also have locations), the module using this grouping is free to indicate in its definition that the 'reference-frame' is inherited from the containing object so that the 'reference-frame' need not be repeated in every instance of location data.

2.5. Non-location Attributes

During the development of this module, the question of whether it would support data such as orientation arose. These types of attributes are outside the scope of this grouping because they do not deal with a location but rather describe something more about the object that is at the location. Module authors are free to add these non-location attributes along with their use of this location grouping.

2.6. Tree

The following is the YANG tree diagram [RFC8340] for the geo-location grouping.

```
  module: ietf-geo-location
    grouping geo-location:
      +-- geo-location
         +-- reference-frame
         |  +-- alternate-system?    string {alternate-systems}?
         |  +-- astronomical-body?   string
         |  +-- geodetic-system
         |     +-- geodetic-datum?    string
         |     +-- coord-accuracy?    decimal64
         |     +-- height-accuracy?   decimal64
         +-- (location)?
         |  +--:(ellipsoid)
         |  |  +-- latitude?    decimal64
         |  |  +-- longitude?   decimal64
         |  |  +-- height?      decimal64
         |  +--:(cartesian)
         |     +-- x?           decimal64
         |     +-- y?           decimal64
         |     +-- z?           decimal64
         +-- velocity
         |  +-- v-north?   decimal64
         |  +-- v-east?    decimal64
         |  +-- v-up?      decimal64
         +-- timestamp?         yang:date-and-time
         +-- valid-until?       yang:date-and-time
```

3. YANG Module

This model imports Common YANG Data Types [RFC6991]. It uses YANG version 1.1 [RFC7950].

```
<CODE BEGINS> file "ietf-geo-location@2022-02-11.yang"
module ietf-geo-location {
  yang-version 1.1;
  namespace "urn:ietf:params:xml:ns:yang:ietf-geo-location";
  prefix geo;
  import ietf-yang-types {
    prefix yang;
    reference "RFC 6991: Common YANG Data Types";
  }

  organization
    "IETF NETMOD Working Group (NETMOD)";
  contact
   "WG Web:   <https://datatracker.ietf.org/wg/netmod/>
    WG List:  <mailto:netmod@ietf.org>

    Editor:   Christian Hopps
              <mailto:chopps@chopps.org>";

  description
    "This module defines a grouping of a container object for
     specifying a location on or around an astronomical object (e.g.,
     'earth').

     The key words 'MUST', 'MUST NOT', 'REQUIRED', 'SHALL', 'SHALL
     NOT', 'SHOULD', 'SHOULD NOT', 'RECOMMENDED', 'NOT RECOMMENDED',
     'MAY', and 'OPTIONAL' in this document are to be interpreted as
     described in BCP 14 (RFC 2119) (RFC 8174) when, and only when,
     they appear in all capitals, as shown here.

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     Redistribution and use in source and binary forms,
     with or without modification, is permitted pursuant to,
     and subject to the license terms contained in, the
     Revised BSD License set forth in Section 4.c of the
```

```
       IETF Trust's Legal Provisions Relating to IETF Documents
       (https://trustee.ietf.org/license-info).

       This version of this YANG module is part of RFC 9179
       (https://www.rfc-editor.org/info/rfc9179); see the RFC itself
       for full legal notices.";

    revision 2022-02-11 {
      description
        "Initial Revision";
      reference
        "RFC 9179: A YANG Grouping for Geographic Locations";
    }

    feature alternate-systems {
      description
        "This feature means the device supports specifying locations
         using alternate systems for reference frames.";
    }

    grouping geo-location {
      description
        "Grouping to identify a location on an astronomical object.";

      container geo-location {
        description
          "A location on an astronomical body (e.g., 'earth')
           somewhere in a universe.";

        container reference-frame {
          description
            "The Frame of Reference for the location values.";

          leaf alternate-system {
            if-feature "alternate-systems";
            type string;
            description
              "The system in which the astronomical body and
               geodetic-datum is defined.  Normally, this value is not
               present and the system is the natural universe; however,
               when present, this value allows for specifying alternate
               systems (e.g., virtual realities).  An alternate-system
               modifies the definition (but not the type) of the other
               values in the reference frame.";
          }
          leaf astronomical-body {
            type string {
              pattern '[ -@\[-\^_-~]*';
            }
            default "earth";
            description
              "An astronomical body as named by the International
               Astronomical Union (IAU) or according to the alternate
               system if specified.  Examples include 'sun' (our star),
               'earth' (our planet), 'moon' (our moon), 'enceladus' (a
               moon of Saturn), 'ceres' (an asteroid), and
               '67p/churyumov-gerasimenko (a comet).  The ASCII value
               SHOULD have uppercase converted to lowercase and not
               include control characters (i.e., values 32..64, and
               91..126).  Any preceding 'the' in the name SHOULD NOT be
               included.";
            reference
              "https://www.iau.org/";
          }
          container geodetic-system {
            description
              "The geodetic system of the location data.";
            leaf geodetic-datum {
              type string {
                pattern '[ -@\[-\^_-~]*';
              }
```

```
        description
          "A geodetic-datum defining the meaning of latitude,
           longitude, and height.  The default when the
           astronomical body is 'earth' is 'wgs-84', which is
           used by the Global Positioning System (GPS).  The
           ASCII value SHOULD have uppercase converted to
           lowercase and not include control characters
           (i.e., values 32..64, and 91..126).  The IANA registry
           further restricts the value by converting all spaces
           (' ') to dashes ('-').
           The specification for the geodetic-datum indicates
           how accurately it models the astronomical body in
           question, both for the 'horizontal'
           latitude/longitude coordinates and for height
           coordinates.";
        reference
          "RFC 9179: A YANG Grouping for Geographic Locations,
           Section 6.1";
      }
      leaf coord-accuracy {
        type decimal64 {
          fraction-digits 6;
        }
        description
          "The accuracy of the latitude/longitude pair for
           ellipsoidal coordinates, or the X, Y, and Z components
           for Cartesian coordinates.  When coord-accuracy is
           specified, it indicates how precisely the coordinates
           in the associated list of locations have been
           determined with respect to the coordinate system
           defined by the geodetic-datum.  For example, there
           might be uncertainty due to measurement error if an
           experimental measurement was made to determine each
           location.";
      }
      leaf height-accuracy {
        type decimal64 {
          fraction-digits 6;
        }
        units "meters";
        description
          "The accuracy of the height value for ellipsoidal
           coordinates; this value is not used with Cartesian
           coordinates.  When height-accuracy is specified, it
           indicates how precisely the heights in the
           associated list of locations have been determined
           with respect to the coordinate system defined by the
           geodetic-datum.  For example, there might be
           uncertainty due to measurement error if an
           experimental measurement was made to determine each
           location.";
      }
    }
  }
  choice location {
    description
      "The location data either in latitude/longitude or
       Cartesian values";
    case ellipsoid {
      leaf latitude {
        type decimal64 {
          fraction-digits 16;
        }
        units "decimal degrees";
        description
          "The latitude value on the astronomical body.  The
           definition and precision of this measurement is
           indicated by the reference-frame.";
      }
      leaf longitude {
        type decimal64 {
```

```
          fraction-digits 16;
        }
        units "decimal degrees";
        description
          "The longitude value on the astronomical body.  The
           definition and precision of this measurement is
           indicated by the reference-frame.";
      }
      leaf height {
        type decimal64 {
          fraction-digits 6;
        }
        units "meters";
        description
          "Height from a reference 0 value.  The precision and
           '0' value is defined by the reference-frame.";
      }
    }
    case cartesian {
      leaf x {
        type decimal64 {
          fraction-digits 6;
        }
        units "meters";
        description
          "The X value as defined by the reference-frame.";
      }
      leaf y {
        type decimal64 {
          fraction-digits 6;
        }
        units "meters";
        description
          "The Y value as defined by the reference-frame.";
      }
      leaf z {
        type decimal64 {
          fraction-digits 6;
        }
        units "meters";
        description
          "The Z value as defined by the reference-frame.";
      }
    }
  }
  container velocity {
    description
      "If the object is in motion, the velocity vector describes
       this motion at the time given by the timestamp.  For a
       formula to convert these values to speed and heading, see
       RFC 9179.";
    reference
      "RFC 9179: A YANG Grouping for Geographic Locations";

    leaf v-north {
      type decimal64 {
        fraction-digits 12;
      }
      units "meters per second";
      description
        "v-north is the rate of change (i.e., speed) towards
         true north as defined by the geodetic-system.";
    }

    leaf v-east {
      type decimal64 {
        fraction-digits 12;
      }
      units "meters per second";
      description
        "v-east is the rate of change (i.e., speed) perpendicular
```

```
              to the right of true north as defined by
              the geodetic-system.";
         }

         leaf v-up {
           type decimal64 {
             fraction-digits 12;
           }
           units "meters per second";
           description
             "v-up is the rate of change (i.e., speed) away from the
              center of mass.";
         }
       }
       leaf timestamp {
         type yang:date-and-time;
         description
           "Reference time when location was recorded.";
       }
       leaf valid-until {
         type yang:date-and-time;
         description
           "The timestamp for which this geo-location is valid until.
            If unspecified, the geo-location has no specific
            expiration time.";
       }
     }
   }
 }
 <CODE ENDS>
```

4. ISO 6709:2008 Conformance

[ISO.6709.2008] provides an appendix with a set of tests for conformance to the standard. The tests and results are given in the following table along with an explanation of inapplicable tests.

Test	Description	Pass Explanation
A.1.2.1	elements required for a geographic point location	CRS is always indicated
A.1.2.2	description of a CRS from a register	CRS register is defined
A.1.2.3	definition of CRS	N/A - Don't define CRS
A.1.2.4	representation of horizontal position	latitude/longitude values conform
A.1.2.5	representation of vertical position	height value conforms
A.1.2.6	text string representation	N/A - No string format

Table 1: Conformance Test Results

For test 'A.1.2.1', the YANG geo-location object either includes a Coordinate Reference System (CRS) ('reference-frame') or has a default defined [WGS84].

For 'A.1.2.3', we do not define our own CRS, and doing so is not required for conformance.

For 'A.1.2.6', we do not define a text string representation, which is also not required for conformance.

5. Usability

The geo-location object defined in this document and YANG module has been designed to be usable in a very broad set of applications. This includes the ability to locate things on astronomical bodies other than Earth, and to utilize entirely different coordinate systems and realities.

5.1. Portability

In order to verify portability while developing this module, the following standards and standard APIs were considered.

5.1.1. IETF URI Value

[RFC5870] defines a standard URI value for geographic location data. It includes the ability to specify the 'geodetic-value' (it calls this 'crs') with the default being 'wgs-84' [WGS84]. For the location data, it allows two to three coordinates defined by the 'crs' value. For accuracy, it has a single 'u' parameter for specifying uncertainty. The 'u' value is in fractions of meters and applies to all the location values. As the URI is a string, all values are specified as strings and so are capable of as much precision as required.

URI values can be mapped to and from the YANG grouping with the caveat that some loss of precision (in the extremes) may occur due to the YANG grouping using decimal64 values rather than strings.

5.1.2. W3C

W3C defines a geolocation API in [W3CGEO]. We show a snippet of code below that defines the geolocation data for this API. This is used by many applications (e.g., Google Maps API).

```
interface GeolocationPosition {
  readonly attribute GeolocationCoordinates coords;
  readonly attribute DOMTimeStamp timestamp;
};

interface GeolocationCoordinates {
  readonly attribute double latitude;
  readonly attribute double longitude;
  readonly attribute double? altitude;
  readonly attribute double accuracy;
  readonly attribute double? altitudeAccuracy;
  readonly attribute double? heading;
  readonly attribute double? speed;
};
```

Figure 1: Snippet Showing Geolocation Definition

5.1.2.1. Comparison with YANG Data Model

Field	Type	YANG	Type
accuracy	double	coord-accuracy	dec64 fr 6
altitude	double	height	dec64 fr 6
altitudeAccuracy	double	height-accuracy	dec64 fr 6
heading	double	v-north, v-east	dec64 fr 12
latitude	double	latitude	dec64 fr 16
longitude	double	longitude	dec64 fr 16
speed	double	v-north, v-east	dec64 fr 12

timestamp	DOMTimeStamp	timestamp	string

Table 2

accuracy (double): Accuracy of 'latitude' and 'longitude' values in meters.

altitude (double): Optional height in meters above the [WGS84] ellipsoid.

altitudeAccuracy (double): Optional accuracy of 'altitude' value in meters.

heading (double): Optional direction in decimal degrees from true north increasing clockwise.

latitude, longitude (double): Standard latitude/longitude values in decimal degrees.

speed (double): Speed along the heading in meters per second.

timestamp (DOMTimeStamp): Specifies milliseconds since the UNIX Epoch in a 64-bit unsigned integer. The YANG data model defines the timestamp with arbitrarily large precision by using a string that encompasses all representable values of this timestamp value.

W3C API values can be mapped to the YANG grouping with the caveat that some loss of precision (in the extremes) may occur due to the YANG grouping using decimal64 values rather than doubles.

Conversely, only YANG values for Earth using the default 'wgs-84' [WGS84] as the 'geodetic-datum' can be directly mapped to the W3C values as W3C does not provide the extra features necessary to map the broader set of values supported by the YANG grouping.

5.1.3. Geography Markup Language (GML)

ISO adopted the Geography Markup Language (GML) defined by OGC 07-036 [OGC] as [ISO.19136.2007]. GML defines, among many other things, a position type 'gml:pos', which is a sequence of 'double' values. This sequence of values represents coordinates in a given CRS. The CRS is either inherited from containing elements or directly specified as attributes 'srsName' and optionally 'srsDimension' on the 'gml:pos'.

GML defines an Abstract CRS type from which Concrete CRS types are derived. This allows for many types of CRS definitions. We are concerned with the Geodetic CRS type, which can have either ellipsoidal or Cartesian coordinates. We believe that other non-Earth-based CRSs as well as virtual CRSs should also be representable by the GML CRS types.

Thus, GML 'gml:pos' values can be mapped directly to the YANG grouping with the caveat that some loss of precision (in the extremes) may occur due to the YANG grouping using decimal64 values rather than doubles.

Conversely, mapping YANG grouping values to GML is fully supported for Earth-based geodetic systems.

GML also defines an observation value in 'gml:Observation', which includes a timestamp value 'gml:validTime' in addition to other components such as 'gml:using', 'gml:target', and 'gml:resultOf'. Only the timestamp is mappable to and from the YANG grouping. Furthermore, 'gml:validTime' can either be an instantaneous measure ('gml:TimeInstant') or a time period ('gml:TimePeriod'). The instantaneous 'gml:TimeInstant' is mappable to and from the YANG grouping 'timestamp' value, and values down to the resolution of seconds for 'gml:TimePeriod' can be mapped using the 'valid-until' node of the YANG grouping.

5.1.4. KML

KML 2.2 [KML22] (formerly Keyhole Markup Language) was submitted by Google to the Open Geospatial Consortium (https://www.opengeospatial.org/) and was adopted. The latest version as of this writing is KML 2.3 [KML23]. This schema includes geographic location data in some of its objects (e.g., 'kml:Point' or 'kml:Camera' objects). This data is provided in string format and corresponds to the values specified in [W3CGEO]. The timestamp value is also specified as a string as in our YANG grouping.

KML has some special handling for the height value that is useful for visualization software, 'kml:altitudeMode'. The values for 'kml:altitudeMode' include 'clampToGround', which indicates the height is ignored; 'relativeToGround', which indicates the height value is relative to the location's ground level; or 'absolute', which indicates the height value is an absolute value within the geodetic datum. The YANG grouping can directly map the ignored and absolute cases but not the relative-to-ground case.

In addition to the 'kml:altitudeMode', KML also defines two seafloor height values using 'kml:seaFloorAltitudeMode'. One value is to ignore the height value ('clampToSeaFloor') and the other is relative ('relativeToSeaFloor'). As with the 'kml:altitudeMode' value, the YANG grouping supports the ignore case but not the relative case.

The KML location values use a geodetic datum defined in Annex A of [ISO.19136.2007] with identifier 'LonLat84_5773'. The altitude value for KML absolute height mode is measured from the vertical datum specified by [WGS84].

Thus, the YANG grouping and KML values can be directly mapped in both directions (when using a supported altitude mode) with the caveat that some loss of precision (in the extremes) may occur due to the YANG grouping using decimal64 values rather than strings. For the relative height cases, the application doing the transformation is expected to have the data available to transform the relative height into an absolute height, which can then be expressed using the YANG grouping.

6. IANA Considerations

6.1. Geodetic System Values Registry

IANA has created the "Geodetic System Values" registry under the "YANG Geographic Location Parameters" registry.

This registry allocates names for standard geodetic systems. Often, these values are referred to using multiple names (e.g., full names or multiple acronyms). The intent of this registry is to provide a single standard value for any given geodetic system.

The values SHOULD use an acronym when available, they MUST be converted to lowercase, and spaces MUST be changed to dashes "-".

Each entry should be sufficient to define the two coordinate values and to define height if height is required. So, for example, the 'wgs-84' is defined as WGS-84 with the geoid updated by at least [EGM96] for height values. Specific entries for [EGM96] and [EGM08] are present if a more precise definition of the data is required.

It should be noted that [RFC5870] also created a registry for geodetic systems (the "'geo' URI 'crs' Parameter Values" registry); however, this registry has a very strict modification policy. The authors of [RFC5870] have the stated goal of making CRS registration hard to avoid proliferation of CRS values. As our module defines alternate systems and has a broader scope (i.e., beyond Earth), the registry defined below is meant to be more easily modified.

The allocation policy for this registry is First Come First Served

[RFC8126], as the intent is simply to avoid duplicate values.

The Reference value can either be a document or a contact person as defined in [RFC8126]. The Change Controller (i.e., Owner) is also defined by [RFC8126].

The initial values for this registry are as follows. They include the non-Earth-based geodetic-datum value for the Moon based on [MEAN-EARTH].

Name	Description	Reference	Change Controller
me	Mean Earth/Polar Axis (Moon)	RFC 9179	IETF
wgs-84-96	World Geodetic System 1984	RFC 9179	IETF
wgs-84-08	World Geodetic System 1984	RFC 9179	IETF
wgs-84	World Geodetic System 1984	RFC 9179	IETF

Table 3

6.2. Updates to the IETF XML Registry

This document registers a URI in the "IETF XML Registry" [RFC3688]. Following the format in [RFC3688], the following registration has been made:

URI: urn:ietf:params:xml:ns:yang:ietf-geo-location
Registrant Contact: The IESG.
XML: N/A; the requested URI is an XML namespace.

6.3. Updates to the YANG Module Names Registry

This document registers one YANG module in the "YANG Module Names" registry [RFC6020]. Following the format in [RFC6020], the following registration has been made:

Name: ietf-geo-location
Maintained by IANA: N
Namespace: urn:ietf:params:xml:ns:yang:ietf-geo-location
Prefix: geo
Reference: RFC 9179

7. Security Considerations

The YANG module specified in this document defines a schema for data that is designed to be accessed via network management protocols such as the Network Configuration Protocol (NETCONF) [RFC6241] or RESTCONF [RFC8040]. The lowest NETCONF layer is the secure transport layer, and the mandatory-to-implement secure transport is Secure Shell (SSH) [RFC6242]. The lowest RESTCONF layer is HTTPS, and the mandatory-to-implement secure transport is TLS [RFC8446].

The NETCONF access control model [RFC8341] provides the means to restrict access for particular NETCONF or RESTCONF users to a preconfigured subset of all available NETCONF or RESTCONF protocol operations and content.

Since the modules defined in this document only define groupings, these considerations are primarily for the designers of other modules that use these groupings.

All the data nodes defined in this YANG module are writable/creatable/deletable (i.e., "config true", which is the default).

None of the writable/creatable/deletable data nodes in the YANG module defined in this document are by themselves considered more sensitive or vulnerable than standard configuration.

Some of the readable data nodes in this YANG module may be considered sensitive or vulnerable in some network environments. It is thus important to control read access (e.g., via get, get-config, or notification) to these data nodes.

Since the grouping defined in this module identifies locations, authors using this grouping SHOULD consider any privacy issues that may arise when the data is readable (e.g., customer device locations, etc).

8. Normative References

[EGM08] Pavlis, N., Holmes, S., Kenyon, S., and J. Factor, "An Earth Gravitational Model to Degree 2160: EGM08.", Presented at the 2008 General Assembly of the European Geosciences Union, Vienna, April 2008.

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Appendix A. Examples

Below is a fictitious module that uses the geo-location grouping.

```
module example-uses-geo-location {
  namespace
    "urn:example:example-uses-geo-location";
  prefix ugeo;
```

```
  import ietf-geo-location { prefix geo; }
  organization "Empty Org";
  contact "Example Author <eauthor@example.com>";
  description
    "Example use of geo-location";
  revision 2022-02-11 { reference "None"; }
  container locatable-items {
    description
      "The container of locatable items";
    list locatable-item {
      key name;
      description
        "A locatable item";
      leaf name {
        type string;
        description
          "The name of locatable item";
      }
      uses geo:geo-location;
    }
  }
}
```

Figure 2: Example YANG Module Using Geolocation

Below is the YANG tree for the fictitious module that uses the geo-location grouping.

```
  module: example-uses-geo-location
    +--rw locatable-items
       +--rw locatable-item* [name]
          +--rw name            string
          +--rw geo-location
             +--rw reference-frame
             |  +--rw alternate-system?    string
             |  |       {alternate-systems}?
             |  +--rw astronomical-body?   string
             |  +--rw geodetic-system
             |     +--rw geodetic-datum?    string
             |     +--rw coord-accuracy?    decimal64
             |     +--rw height-accuracy?   decimal64
             +--rw (location)?
             |  +--:(ellipsoid)
             |  |  +--rw latitude?    decimal64
             |  |  +--rw longitude?   decimal64
             |  |  +--rw height?      decimal64
             |  +--:(cartesian)
             |     +--rw x?           decimal64
             |     +--rw y?           decimal64
             |     +--rw z?           decimal64
             +--rw velocity
             |  +--rw v-north?   decimal64
             |  +--rw v-east?    decimal64
             |  +--rw v-up?      decimal64
             +--rw timestamp?         yang:date-and-time
             +--rw valid-until?       yang:date-and-time
```

Figure 3: Example YANG Tree Using Geolocation

Below is some example YANG XML data for the fictitious module that uses the geo-location grouping.


```
<locatable-items xmlns="urn:example:example-uses-geo-location">
  <locatable-item>
    <name>Gaetana's</name>
    <geo-location>
      <latitude>40.73297</latitude>
      <longitude>-74.007696</longitude>
    </geo-location>
  </locatable-item>
  <locatable-item>
```

```
      <name>Pont des Arts</name>
      <geo-location>
        <timestamp>2012-03-31T16:00:00Z</timestamp>
        <latitude>48.8583424</latitude>
        <longitude>2.3375084</longitude>
        <height>35</height>
      </geo-location>
    </locatable-item>
    <locatable-item>
      <name>Saint Louis Cathedral</name>
      <geo-location>
        <timestamp>2013-10-12T15:00:00-06:00</timestamp>
        <latitude>29.9579735</latitude>
        <longitude>-90.0637281</longitude>
      </geo-location>
    </locatable-item>
    <locatable-item>
      <name>Apollo 11 Landing Site</name>
      <geo-location>
        <timestamp>1969-07-21T02:56:15Z</timestamp>
        <reference-frame>
          <astronomical-body>moon</astronomical-body>
          <geodetic-system>
            <geodetic-datum>me</geodetic-datum>
          </geodetic-system>
        </reference-frame>
        <latitude>0.67409</latitude>
        <longitude>23.47298</longitude>
      </geo-location>
    </locatable-item>
    <locatable-item>
      <name>Reference Frame Only</name>
      <geo-location>
        <reference-frame>
          <astronomical-body>moon</astronomical-body>
          <geodetic-system>
            <geodetic-datum>me</geodetic-datum>
          </geodetic-system>
        </reference-frame>
      </geo-location>
    </locatable-item>
  </locatable-items>
```

Figure 4: Example XML Data of Geolocation Use

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