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## OpenGIS® Location Services (OpenLS™):

### Part 6-Navigation Service

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## **i. Preface**

This OpenGIS Implementation Specification defines the interface for OpenGIS® Location Services (OpenLS): Part 6 - Navigation Service (formerly the Full Profile of the Route Determination Service), which is part of the GeoMobility Server (GMS), an open location services platform.

This specification was produced immediately following the OpenLS 1/1.1 testbed initiatives, October 2001 – October 2002, and reflects lessons learned and the results of these efforts. It also includes enhancements and fixes made subsequent to the testbed efforts by an ad hoc work group consisting of the sponsors of this specification.

The Navigation Service was formed by breaking out the Full Profile of the Route Determination Service from the basic set of Core Services, as developed during the testbed initiatives. Likewise, the Route Service was formed from the Basic Profile of the Route Determination Service, as developed during the testbed initiatives.

## **ii. Submitting organizations**

This Implementation Specification is being submitted to OGC by the following organizations:

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Image Matters, USA  
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MapInfo, USA  
Navigation Technologies, USA  
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### iv. Revision history

Date	Release	Author	Paragraph modified	Description
28/11/2001	1.0	Tom Bychowski		First Draft
01/12/2001	2.0	Tom Bychowski		Changed the following: <ul style="list-style-type: none"> <li>• Added routeHandle to the service response.</li> <li>• Added provideRouteSummary to the service request.</li> </ul>
16/12/2001	3.0	Tom Bychowski		<ul style="list-style-type: none"> <li>• Moved transportTypeList to from RoutePlanType to WayPointType. This allows different modes of transportation to be specified when departing each waypoint along a route.</li> </ul>

				<ul style="list-style-type: none"> <li>• Added routeHandleLifeSpan to route determination response parameters.</li> <li>• Added RouteInstructionsRequestType</li> <li>• Added RouteGeometryRequestType</li> </ul>
20/12/2001	4.0	Tom Bychowski		<ul style="list-style-type: none"> <li>• Changed corridorSize to corridorWidth and wayPointRadius.</li> <li>• Moved distanceUnits from DetermineRoute Request to RouteInstructions Request</li> <li>• Much other miscellaneous based on review input.</li> </ul>
03/01/2002	5.0	Tom Bychowski		<ul style="list-style-type: none"> <li>• Removed get capabilities requirement.</li> <li>• Capitalized the first letter of all parameters of complex type.</li> <li>• Capitalized the first letter of all enumerated strings.</li> <li>• Added distanceUnitOfMeasure parameter to DetermineRoute Request</li> <li>• Renamed distanceUnit in RouteInstructionsRequestType to distanceUnitOfMeasure.</li> <li>• Changed CorridorWidth and WayPointRadius properties in RouteMapRequestType to type DistanceQuantityType (composed of the distance value and the unit of measure).</li> <li>• Renamed “exception” to parameters to “Error” to avoid name conflicts with Java’s “enumeration” reserved word when using XML binding tools such as JAXB.</li> </ul>
02/22/2002	6.0	Tom Bychowski		<ul style="list-style-type: none"> <li>• Renamed distanceUnitOfMeasure parameters to distanceUnit of type DistanceUnitNameType.</li> <li>• Other miscellaneous name changes to synchronize with consolidated XLS schema.</li> <li>• Added WayPointListType.</li> <li>• In RoutePlanType, replaced StartLocation, ViaLocationList, and EndLocation parameters with a WayPointList parameter.</li> </ul>

				<ul style="list-style-type: none"> <li>• Removed all Error parameters. Errors are now reported in the XLS message envelope's ErrorList. This eliminated the need for RouteSummaryResponseType, ManeuverListResponseType, RouteGeometryResponseType, and RouteInstructionsResponseType, so they were removed.</li> <li>• Change RouteMapResponseType to RouteMapType, which is extended from MapADT.</li> </ul>
08/09/2002	7.0	Tom Bychowski		<ul style="list-style-type: none"> <li>• Updated request parameters for XLS v1.013 basic and full profiles.</li> </ul>
11 Nov 2002	0.8.0	Harry Niedzwiadek	Various	<ul style="list-style-type: none"> <li>• Updated document version number to comply with the new OGC convention. Revised the following sections: Preface, Forward, Scope, Conventions, Description of the OpenLS Core Services, Use Cases and Request and Response Parameters. Updated Requirements section to reflect XLS v1.0.3a. Added terms. Added normative references (Section 3). Replaced normative schema with v1.0.3a, and placed it in Annex A to be consistent with other specs.</li> </ul>
Dec. 11& 16 2002	0.2	Marwa Mabrouk & HAN	Significant contributions throughout	<ul style="list-style-type: none"> <li>• This spec formed from the Full Profile of the former Route Determination Service, becoming the Navigation Service. The Basic Profile was consolidated with the other basic Core Services. The schemas were simplified. Abstract types were removed from the new services to be consistent with other OpenLS Core Services. Issues were added.</li> </ul>
April 17, 2003	0.3,0.4, 0.5	HAN	Various	<ul style="list-style-type: none"> <li>• Schemas updated to GML 3.0 geometry. Schemas updated to LIF MLP 3.0.</li> </ul>

The issues in this specification are captured in the following format:

**Issue Name:** [Issue Name, e.g., GML 3.0 Harmonization. (Your Initials, Date)]

**Issue Description:** [Issue Description.]

**Resolution:** [Insert Resolution Details and History.] (Your Initials, Date)]

## **v. Changes to the OpenGIS® Abstract Specification**

The OpenGIS® Abstract Specification does not require changes to accommodate the technical contents of this document.

## **Foreword**

The information in this document was substantially derived from the OpenLS 1/1.1 testbed initiatives.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. Open GIS Consortium shall not be held responsible for identifying any or all such patent rights.

# **OpenGIS® Location Services (OpenLS): Part 6 - Navigation Service**

## **1 Scope**

This OpenGIS Implementation Specification defines the interfaces for OpenGIS® Location Services (OpenLS): Part 6 - Navigation Service (formerly the Full Profile of the Route Determination Service), which is part of the GeoMobility Server (GMS), an open location services platform.

## **2 Conformance**

The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance, are specified in ISO 19105: Geographic information — Conformance and Testing. See section 11 concerning the requirements and procedures for OpenLS Conformance.

## **3 Normative references**

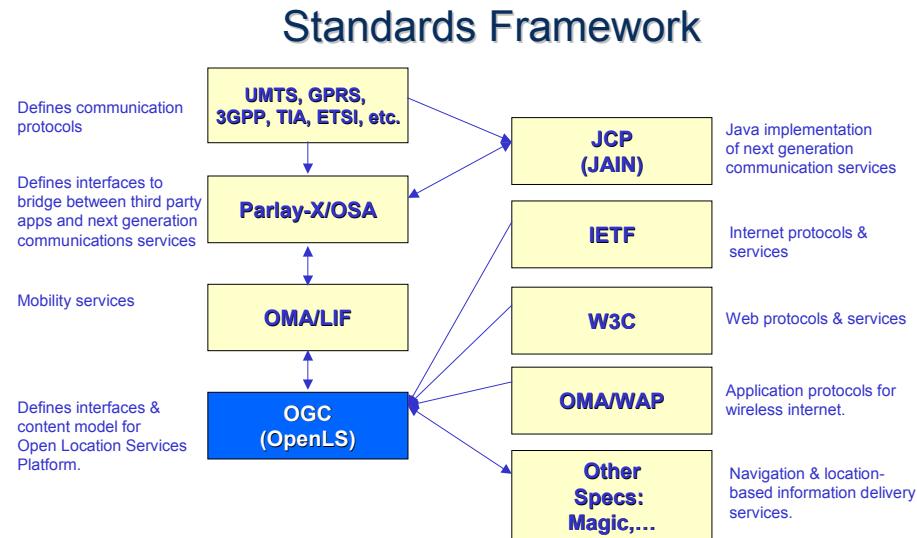
The following normative documents contain provisions, which through reference in this document constitute provisions of this architecture. For dated references, subsequent amendments to these publications or revisions of any of these publications do not apply. However, parties to agreements based on this document are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the documents applies.

<i>Abstract Specification Topic 0: Overview</i> , OpenGIS® document 99-100r1.
<i>Guidelines for Successful OGC Interface Specifications</i> , OpenGIS document 00-014r1.
<i>OpenGIS® Geography Markup Language (GML)</i> , Version 3.0, 18 December 2002, OpenGIS Implementation Specification 02-023r4. Available [Online]: <a href="http://www.opengis.org/techno/documents/02-023r4.pdf">http://www.opengis.org/techno/documents/02-023r4.pdf</a> .
<i>OpenGIS® Location Services (OpenLS): Part 1-5: Core Services</i> , Version 0.5, April 18, 2003, OpenGIS RFC 03-006r1. Available [Online]: < <a href="http://www.opengis.org/techno/discussions/03-007r1.pdf">http://www.opengis.org/techno/discussions/03-007r1.pdf</a> >.

<p><i>Recommended Definition Data for Coordinate Reference Systems and Coordinate Transformations.</i> OGC Project Document 01-014r5. Available [Online]: &lt;<a href="http://www.opengis.org/techno/discussions/01-014r5.pdf">http://www.opengis.org/techno/discussions/01-014r5.pdf</a>&gt;.</p>
<p><i>OGC Units of Measure Use and Definition Recommendations.</i> OGC Recommendation Paper. OGC Project Document 02-007r4. Available [Online]: &lt;<a href="http://www.opengis.org/techno/discussions/02-007r4.pdf">http://www.opengis.org/techno/discussions/02-007r4.pdf</a>&gt;.</p>
<p><i>OpenGIS® Simple Features Specification for SQL.</i> OGC Implementation Specification. Available [Online]: &lt;<a href="http://www.opengis.org/techno/specs/99-049.pdf">http://www.opengis.org/techno/specs/99-049.pdf</a>&gt;.</p>
<p><i>XML Linking Language (XLink) Version 1.0.</i> W3C Recommendation (27 June 2001). Available [Online]: &lt;<a href="http://www.w3.org/TR/xlink/">http://www.w3.org/TR/xlink/</a>&gt;</p>
<p><i>Namespaces in XML.</i> W3C Recommendation (14 January 1999). Available [Online]: &lt;<a href="http://www.w3.org/TR/1999/REC-xml-names-19990114/">http://www.w3.org/TR/1999/REC-xml-names-19990114/</a>&gt;</p>
<p><i>XML Schema Part 1: Structures.</i> W3C Recommendation (2 May 2001). Available [Online]: &lt;<a href="http://www.w3.org/TR/xmlschema-1/">http://www.w3.org/TR/xmlschema-1/</a>&gt;</p>
<p><i>XML Schema Part 2: Datatypes.</i> W3C Recommendation (2 May 2001). Available [Online]: &lt;<a href="http://www.w3.org/TR/xmlschema-2/">http://www.w3.org/TR/xmlschema-2/</a>&gt;</p>

#### **4 Relationship to Other Standards Activities**

Other standards activities that were reviewed and considered under the OpenLS initiative include related standards initiatives at ISO, W3C, IETF, OMA/LIF, 3GPP, AMIC, MAGIC, WAP, JAIN and Parlay, as well as other emerging and adopted OGC specifications.

**Figure 1. Standards Framework**

## 5 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

### 5.1 Abstract Data Type (ADT)

The basic information construct used by the GeoMobility Server and associated Core Services. Consists of well-known data types and structures for location information. Defined as application schemas that are encoded in XML for Location Services (XLS).

### 5.2 Area of Interest (AOI)

A user defined area (represented by a bounding box, circle or polygon). Often used as a filter in a query.

### 5.3 (OpenLS) Core Services

The basic services that comprise the open service platform (GeoMobility Server) defined under OpenLS.

### 5.4 Directory Service

A network-accessible service that provides access to an online directory (e.g. Yellow Pages) to find the location of a *specific* or *nearest* place, product or service.

**5.5 Gateway Service**

A network-accessible service that fetches the position of a known mobile terminal from the network. This interface is modeled after the Mobile Location Protocol (MLP), Standard Location Immediate Service, specified in LIF 3.0 (see Open Mobile Alliance).

**5.6 Geocoder Service**

A network-accessible service that transforms a description of a location, such as a place name, street address or postal code, into a normalized description of the location with a Point geometry (see GML Specification for OGC geometry).

**5.7 GeoMobility Server**

The open service platform comprising the Core Services developed under the OGC OpenLS initiatives.

**5.8 Location-Based Service (LBS)**

A wireless-IP service that uses geographic information to serve a mobile user. Any application service that exploits the position of a mobile terminal.

**5.9 Navigation Service**

An enhanced version of the Route Service, which is a network-accessible service that determines travel routes and navigation information between two or more points.

**5.10 Point of Interest (POI)**

A location (with a fixed position) where one can find a place, product or service, typically identified by name rather than by address and characterized by type, which may be used as a reference point or a target in a location based service request, e.g., as the destination of a route.

**5.11 Presentation (Map Portrayal) Service**

A network-accessible service that portrays a map made up of a base map derived from any geospatial data and a set of ADT's as overlays.

**5.12 Reverse Geocoder Service**

A network-accessible service that transforms a given position into a normalized description of a feature location (Address with Point), where the address may be defined as a street address, intersection address, place name or postal code.

**5.13 Route Service**

A network-accessible service that determines travel routes and navigation information between two or more points.

**5.14 XML for Location Services (XLS)**

The method for encoding request/response messages and associated Abstract Data Types for the GeoMobility Server.

## **6 Symbols (and abbreviated terms)**

The following symbols and abbreviated terms are used in this document.

ADT	Abstract Data Type
API	Application Program Interface
GMLC	Gateway Mobile Location Center
GMS	GeoMobility Server
LBS	Location Based Service
LIF	Location Interoperability Forum
MLP	Mobile Location Protocol
MPC	Mobile Positioning Center
OGC	Open GIS Consortium
OMA	Open Mobile Alliance
OSA	Open Service Architecture
XLS	XML for Location Services
XML	eXtended Markup Language

## **7 Requirements**

### **7.1 Terminology**

The key words “**must**”, “**should**” and “**may**” are to be interpreted in the detailed requirements as follows:

**Must**—The item is an absolute requirement of the specification.

**Should**—There may exist valid reasons in particular circumstances to ignore the item, but the full implications must be understood and carefully weighed before choosing a different approach.

**May**—The item will be considered, but further examination is needed to determine if the item should be treated as a requirements.

Note that only the *Italic* versions of these terms are to be interpreted as above.

## **7.2 Navigation Service Requirements**

The Navigation Service *shall* support the following functionality:

- Given a set of route criteria, determine a new route.
- Redetermine a route, using the routing criteria of an existing route.

The new route may be different than the existing route due to changes in real time traffic, and if the travel start time defaults to the current time, due to transportation network time restrictions, or any other reason.

- Determine an alternate route. This new route has minimal overlap with the existing route.
- After determining the route, return any combination of the following information:
  - summary information
  - route maneuver information
  - route geometry
  - maps of the route
  - turn-by-turn instructions and advisories for presentation

## **8 Top-Level Architecture**

Figure 2 shows how the concept GeoMobility Server relates to the other elements of an LBS architecture. The GeoMobility server is an element offering basic functions on which location-based applications are built (the OpenLS Core Services). This server uses open interfaces to access network location capacity (provided through a GMLC, for instance) and provides a set of interfaces allowing applications hosted on this server, or on another server, to access the OpenLS Core Services (see definition of Core Services in section 9).

The GeoMobility Server also provides content such as maps, routes, addresses, points of interest, traffic, etc. It can also access other local content databases via the Internet.

In summary, the GeoMobility Server contains:

- The Core Services and their OpenLS interfaces;
- The OpenLS Information Model, consisting of ADTs;

- Possibly, a set of local applications build upon the Core Services and accessing them through OpenLS interfaces;
- Content such as map data, points of interest, routes, and so on used by the Core Services. This content can also be hosted on other servers and accessed through the Internet; and
- Possibly other supporting functions for personalization, context management, billing, logging, etc.

## Role of the GeoMobility Server

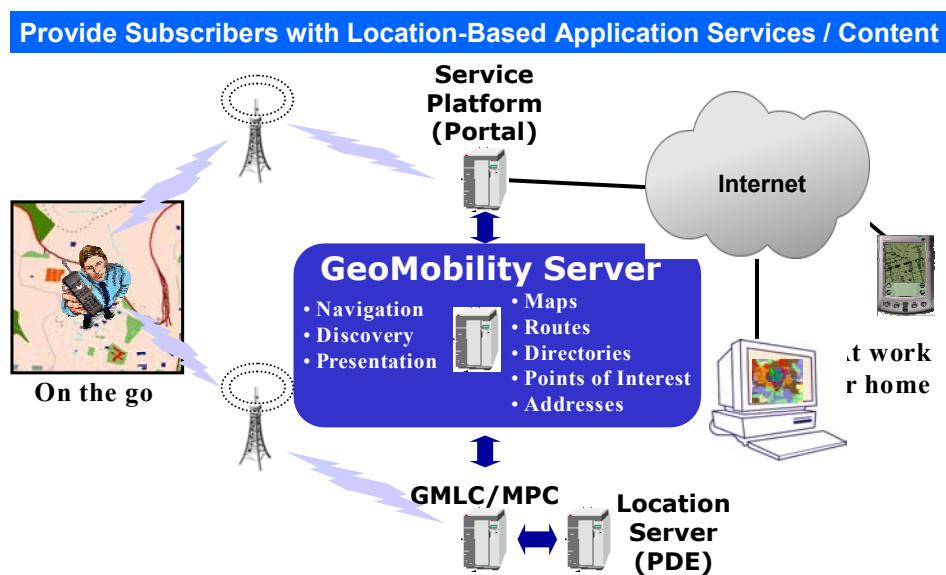


Figure 2. Role of the GeoMobility Server

## 9 OpenLS Core Services

The Core Services are location-based application services that form the Services Framework for the GeoMobility Server. See the associated specification for these services (this reference is listed in section 3).

## The GeoMobility Server

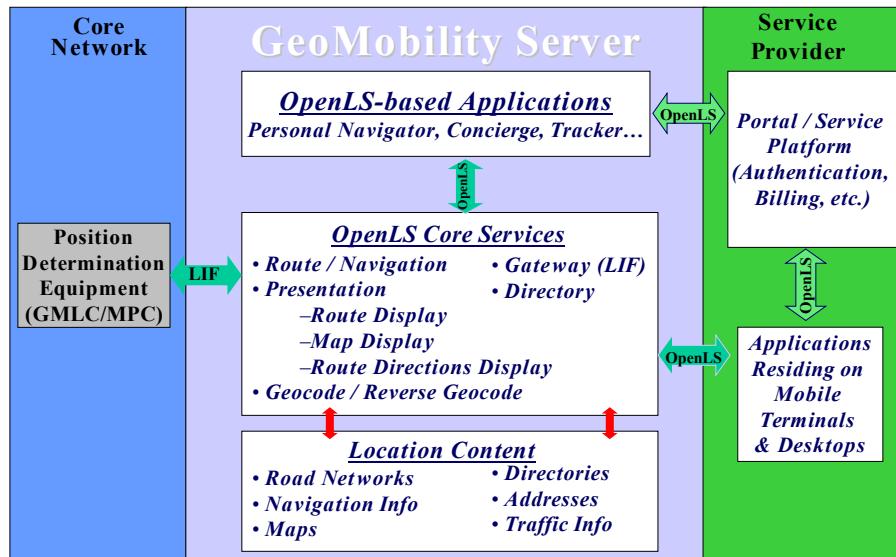


Figure 3. The GeoMobility Server

Note: It is not necessary to specify a Coordinate Reference System for Point geometries that are used by these services because the default for all coordinates used by the GeoMobility Server is WGS 84. The coordinate conventions are as follows:

- Default Coordinate Reference System - WGS 84 (srsName='4326');
- Coordinate Order - Latitude, Longitude;
- Value Type - Decimal Degrees;
- Latitude Sign is +90 at North Pole to -90 at South Pole;
- Longitude Sign is -180 west from Greenwich at the International Dateline to +180 east from Greenwich at the International Dateline.

### 9.1 Navigation Service

### 9.1.1 Use Cases

**Use Case 1:** The user wants to know: *Which route should I take?* The user has specified the endpoints, and optionally some waypoints, in some manner, or these points have been specified for the user. The starting point is either defined from a GPS or cellular network measurement or entered manually by the user. This information is then fed to a service that determines the route. Optionally, the user may specify route determination criteria. These criteria might be: fastest, shortest, least traffic, most scenic, etc. and can also specify the preferred mode of transport of the user. The routing algorithm might default to a single criterion, such as fastest. The route can also be optionally stored on the terminal or application server. The user may store it for as long as needed, thus requiring the means to also fetch a stored route.

### 9.1.2 Request and Response Parameters

#### 9.1.2.1 Navigation Request Parameters

<b>Request Parameters</b>			
<b>A collection of one or more of the parameters below</b>			
<b>Name</b>	<b>Mandatory?</b>	<b>Data Type</b>	<b>Description</b>
NavigationPlan	Y	NavigationPlanType	Specifies the criteria upon which a new route is determined.
RouteHandle		RouteHandleType (ADT)	Reference to a previously determined route. Used to request additional information about the route, or to request an alternate route.
RouteInstructionsRequest	N	RouteInstructionsRequestType	Requests the return of turn-by-turn route instructions and travel advisories in a text, voice, or other presentation format.
RouteGeometryRequest	N	RouteGeometryRequestType	Requests the return of the route geometry.
RouteMapRequest	N	RouteMapRequestType	Requests the return of one or more maps of the route.

provideRouteHandle	N	Boolean	Requests the return of a route handle.  Default = “false”
provideRouteSummary	N	Boolean	Requests the return of route summary information.  Default = “false”
provideManeuverList	N	Boolean	Requests the return of detailed route maneuver and segment information.  Default = “false”
distanceUnit	N	DistanceUnitType (ADT)	Specifies the unit for measuring distance.  Default = “M”
provideManeuverGeometry	N	Boolean	Requests the return of the route maneuver's geometry.  Default = “false”
provideAlternateRoute	N	Boolean	Requests the determination of an alternative to the specified route, where the new route and the specified route would have minimal overlap.  If set “true”, the existing route must be specified in the RouteHandle parameter. If RouteHandle is not specified, an “Inconsistent” request error is returned.  Default = “false”

**NavigationPlanType:** Defines the criteria upon which a route is determined.

Name	Mandatory	Data Type	Description
NavigationPreference	Y	Enumeration	<p>Routing preference to be taken into consideration when determining the route:</p> <p>“Fastest” – Minimize the travel time.</p> <p>“Shortest” – Minimize the travel distance.</p> <p>“Easiest” – Minimize the number of turns, or other difficult travel conditions.</p> <p>“Pedestrian” – Best route by foot.</p> <p>“PublicTransportation” – Best route by public transportation.</p>
WayPointList	Y	WayPointListType (ADT)	List of waypoints along the route.
AvoidList	N	AvoidListType	List of areas, locations, and features in which the route should avoid passing through.
AdvisoryTypeList	N	AdvisoryTypeListType	A list of advisories to include or exclude in the route.
useRealTimeTraffic	N	Boolean	<p>Specifies whether to use real time traffic information when determining the best route.</p> <p>Default is “false”</p>
expectedStartTime	N	DateTime	<p>Specifies the date and time at which travel is expected to begin.</p> <p>Specified in the format YYYY-MM-DD HH:MM.</p> <p>Defaults to current date and</p>

			time.
timeRestrictionCheck	N	Enumeration	<p>Specifies whether route determination should take into account any time restrictions associated with segments of the transportation network:</p> <p>“HonorTimeRestrictions” – Take time restrictions into account.</p> <p>“IgnoreTimeRestrictions” – Don’t take time restrictions into account.</p> <p>“AvoidTimeRestrictions” – Avoid routing over segments which have time restrictions.</p> <p>Default = HonorTimeRestrictions</p>

**AvoidListType: Defines the list of areas, locations, and features in which the route should avoid passing through.**

Name	Mandatory	Data Type	Description
AOIList	N	List of AreaOfInterest Type (ADT)	Specifies the geographic areas to avoid.
LocationList	N	List of AbstractLocationType (ADT)	Specifies the locations to avoid.
AvoidFeatureList	N	List of Enumeration	<p>Specifies the types of features to avoid when determining the route:</p> <p>“Highway” – Minimize the use of highways.</p> <p>“Tollway” – Minimize the use</p>

			<p>of tollways.</p> <p>“UTurn” – Minimize the number of u-turns.</p> <p>“Ferry” – Minimize the use of ferries.</p>
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<b>AdvisoryTypeListType: Defines a list of advisory types to include or exclude in the route.</b>			
<b>Name</b>	<b>Mandatory</b>	<b>Data Type</b>	<b>Description</b>
filter	Y	Enumeration	<p>Determines if the specified types of advisories are included or excluded.</p> <p>If filter = “Include”, only the specified types of advisories are included.</p> <p>If filter = “Exclude”, all the types of advisories except the specified types are included.</p>
AdvisoryList	N	List of AdvisoryType(A DT)	Specifies the types of advisories to include or exclude in the route.

<b>RouteInstructionsRequestType: Defines the request parameters for turn-by-turn route instructions and travel advisories formatted for presentation.</b>			
<b>Name</b>	<b>Mandatory</b>	<b>Data Type</b>	<b>Description</b>
format	N	String	<p>The preferred format of the route instructions, specified as a mime type.</p> <p>Defaults to text/plain.</p>

distanceUnit	N	DistanceUnitType (ADT)	The units of measure to be used for distances in the text directions:  Default = "M"
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<b>RouteGeometryRequestType:</b> Defines the request parameters for route geometry.			
Name	Mandatory	Data Type	Description
BoundingBox	N	BoxType (ADT)	Rectangular geographic area of route for which the geometry is requested.  If not specified, defaults to full route.
scale	N	Positive Integer	Maximum scale at which the route will be displayed.  Expressed as a ratio of world units to a device unit.  For example 1:50000 would be specified as 50000.  Default = 1
provideStartingPortion	N	Boolean	If true, return the geometry of the starting portion of the route contained within the specified bounding area, up to the specified maximum number of points.  If false, return the geometry of the complete route contained within the specified area, reducing the accuracy of the geometry as necessary to not exceed the specified maximum number of points.

			Default = false
maxPoints	N	Positive Integer	<p>Specifies the maximum number of geometric points to be returned.</p> <p>Default = 100</p>

<b>RouteMapRequestType:</b> Defines the request parameters for route maps.			
<b>Name</b>	<b>Mandatory?</b>	<b>Data Type</b>	<b>Description</b>
OutputList	Y	List of OutputType  (defined by Presentation Service)	<p>Specifies the output of the map(s) to be generated.</p> <p>This is the full set of map output parameters defined by the Presentation Service.</p>

<b>RouteMapOutputType:</b> Defines the rendered route map output parameters.			
<b>A collection of one or more of the parameters below.</b>			
<b>Name</b>	<b>Mandatory?</b>	<b>Data Type</b>	<b>Description</b>
BBoxContent	N	BoxType (ADT)	<p>Rectangular area to be displayed in the rendered map.</p> <p>If not specified, defaults to a</p>

			rectangular area bounding the full route.
width	N	Non-negative Integer	Pixel width of the resulting map.
height	N	Non-negative Integer	Pixel height of the resulting map.
format	N	String	Mime type describing the encoding.
BGcolor	N	String	Background color of the map.
transparent	N	Boolean	The opacity of the map.  If set true, the map background is transparent. If set false, the map background is opaque.

### 9.1.2.2 Navigation Response Parameters

<b>Response Parameters</b>			
<b>A collection of one or more of the parameters below.</b>			
<b>Name</b>	<b>Mandatory</b>	<b>Data Type</b>	<b>Description</b>
RouteHandle	N	RouteHandleType (ADT)	Contains a reference to the route stored at the Navigation Service server.  Can be used in subsequent requests to the Navigation Service to request additional information about the route, or to request an alternate route.
RouteSummary	N	RouteSummaryType (ADT)	Describes the overall characteristics of the route.

RouteManeuverList	N	RouteManeuverListType (ADT)	List of travel maneuvers.
RouteGeometry	N	RouteGeometryType (ADT)	Contains the route geometry.
RouteInstructionsList	N	RouteInstructionsListType (ADT)	Contains a list of turn-by-turn route instructions and advisories, formatted for presentation.
RouteMap	N	List of RouteMapType (ADT)	Contains a list of route maps.

**RouteMapType**

- Defines a map containing the determined route.

Exactly the same as a map returned by the Map Presentation Service. Defined as an extension to the MapType ADT, with no additions or changes.

## 10 OpenLS Information Model

The OpenLS Core Services exchange content in the form of well-known OpenLS Abstract Data Types (ADTs). Collectively these ADTs comprise the OpenLS Information Model (Figure 4).

The OpenLS Information Model	
Position ADT	Point location in well-known coordinate system
Address ADT	Street address or intersection
Point of Interest (POI) ADT	The location where someone can find place, product or service
Area of Interest (AOI) ADT	A polygon, bounding box or circle used as a search template
Location ADT	A location (Position, Address or POI)
Map ADT	The portrayal of maps and feature overlays (routes & POI)
Route Summary ADT	Metadata pertaining to a route
Route Geometry ADT	Geometry data for a route
Route Maneuvers ADT	Navigation maneuver data for a route
Route Directions ADT	Turn-by-turn navigation instructions for a route

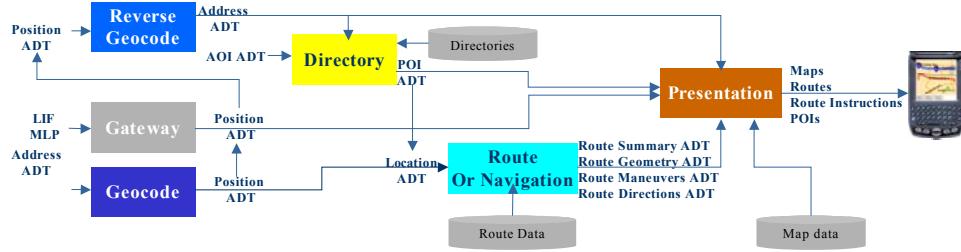


Figure 4. OpenLS Information Model

## 11 Conformance Requirements and Procedures

Conformance and Testing for this Implementation Specification must be based upon the normative schema in Annex A. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance, are specified in ISO 19105: Geographic information — Conformance and Testing.

The sponsors of this specification have devised the following conformance test requirements and procedures.

TBD.
------

## Annex A.1: OpenGIS Location Services (OpenLS) Navigation Service Schema (Normative)

The XML for Location Services (XLS) schema for Navigation Service, Version 0.2.0 is presented below.

### ADT\_Navigation.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns:gml="http://www.opengis.net/gml" xmlns:xls="http://www.opengis.net/xls"
xmlns="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
    <!--Copyright (c) 2003 OGC, All Rights Reserved - This OGC document is a
    draft and is copyright-protected by OGC. While the reproduction of drafts in any
    form for use by participants in the OGC Interoperability Program is permitted
    without prior permission from OGC, neither this document nor any extract from it
    may be reproduced, stored or transmitted in any form for any other purpose
    without prior written permission from OGC.-->
    <include schemaLocation="ADT.xsd"/>
    <!-- new Abstract types pasted from common here-->
    <complexType name="AbstractManeuverType" abstract="true">
        <annotation>
            <documentation>Abstract type representing a travel
maneuver.</documentation>
        </annotation>
        <sequence>
            <element name="ManeuverPoint" type="gml:PointType">
                <annotation>
                    <documentation>Geographic coordinate of the
maneuver.</documentation>
                </annotation>
                <!-- type="xls:PointType"> -->
            </element>
            <element ref="xls:_NextSegment" minOccurs="0"/>
        </sequence>
        <attribute name="id" type="ID" use="required"/>
        <attribute name="actionType" type="xls:RouteActionType" use="required">
            <annotation>
                <documentation>The action to be taken by the traveler to continue
along the route.</documentation>
            </annotation>
        </attribute>
    </complexType>
</schema>
```

```

        </annotation>
    </attribute>
    <attribute name="directionOfTurn" type="xls:TurnDirectionType"
use="optional">
        <annotation>
            <documentation>Direction of turn to be made (applicable only on a
turn instruction).</documentation>
        </annotation>
    </attribute>
    <attribute name="junctionType" type="xls:JunctionCategoryType"
use="optional">
        <annotation>
            <documentation>Type of junction at which the maneuver
occurs.</documentation>
        </annotation>
    </attribute>
    <attribute name="junctionName" type="string" use="optional">
        <annotation>
            <documentation>Name of the junction or associated place, e.g. name
of intersection, roundabout, or enclosed traffic area, highway entrance or exit
number, or name of public transportation stop.</documentation>
        </annotation>
    </attribute>
    <attribute name="numberExitsToPass" type="nonNegativeInteger"
use="optional">
        <annotation>
            <documentation>Number of exits or intersections to pass before
turning off of a roundabout or complex intersection.</documentation>
        </annotation>
    </attribute>
</complexType>
<element name="_Maneuver" type="xls:AbstractManeuverType"
abstract="true">
    <annotation>
        <documentation>Base element representing a travel
maneuver.</documentation>
    </annotation>
</element>
<complexType name="AbstractRouteManeuverListType" abstract="true">
    <annotation>
        <documentation>Abstract definition of a list of travel
maneuvers.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractDataType">
            <sequence>

```

```

        <element ref="xls:_Maneuver" maxOccurs="unbounded"/>
    </sequence>
</extension>
</complexContent>
</complexType>
<element name="_RouteManeuverList"
type="xls:AbstractRouteManeuverListType" abstract="true"
substitutionGroup="xls:_ADT">
    <annotation>
        <documentation>Base element which represents a list of travel
maneuvers.</documentation>
    </annotation>
</element>
<!-- new simple types here -->
<simpleType name="TurnDirectionType">
    <annotation>
        <documentation>Enumeration of direction of turns.</documentation>
    </annotation>
    <restriction base="string">
        <enumeration value="Straight"/>
        <enumeration value="KeepLeft"/>
        <enumeration value="KeepRight"/>
        <enumeration value="SlightLeft"/>
        <enumeration value="Left"/>
        <enumeration value="SharpLeft"/>
        <enumeration value="SlightRight"/>
        <enumeration value="Right"/>
        <enumeration value="SharpRight"/>
        <enumeration value="UTurn"/>
    </restriction>
</simpleType>
<simpleType name="RouteActionType">
    <annotation>
        <documentation>Enumeration of types of actions performed by the
traveler to continue along a route.</documentation>
    </annotation>
    <restriction base="string">
        <enumeration value="Turn">
            <annotation>
                <documentation>Used to direct the traveler to turn onto (or enter)
the next segment along the route.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="ProceedTo">
            <annotation>

```

<documentation>Used when directing the traveler to move onto (or enter) the next segment along the route without specifying how, e.g. in the case of the first instruction on a route, or instructions to walk to the public transportation center.</documentation>

```

</annotation>
</enumeration>
<enumeration value="Embark">
    <annotation>
        <documentation>Used when directing the traveler to board a public mode of transportation, e.g. a ferry, bus, train, or airplane.</documentation>
    </annotation>
</enumeration>

```

```

<enumeration value="Disembark">
    <annotation>
        <documentation>Used when directing the traveler to leave or get off a public mode of transportation, e.g. a ferry, bus, train, or airplane.</documentation>
    </annotation>
</enumeration>

```

```

<enumeration value="Stop">
    <annotation>
        <documentation>Used to inform the traveler that he has arrived at a stopping point, which could be either an intermediate waypoint or the destination.</documentation>
    </annotation>
</enumeration>

```

```

<enumeration value="Advisory">
    <annotation>
        <documentation>This notification describes a travel advisory.

```

Continue along the current route segment.</documentation>

```

</annotation>
</enumeration>
</restriction>
</simpleType>
<simpleType name="JunctionCategoryType">
    <annotation>
        <documentation>Enumeration of junction types.</documentation>
    </annotation>
    <restriction base="string">
        <enumeration value="Intersection"/>
        <enumeration value="Roundabout"/>
        <enumeration value="EnclosedTrafficArea">
            <annotation>
                <documentation>A confined traffic area in which unstructured traffic movements are allowed.</documentation>
            </annotation>

```

```

</enumeration>
<enumeration value="EntranceRamp"/>
<enumeration value="ExitRamp"/>
<enumeration value="Changeover">
    <annotation>
        <documentation>Crossing between one highway/motorway to
another.</documentation>
    </annotation>
</enumeration>
<enumeration value="BoardingRamp">
    <annotation>
        <documentation>Boarding ramp to a public mode of transportation,
such as a ferry or subway.</documentation>
    </annotation>
</enumeration>
<enumeration value="None">
    <annotation>
        <documentation>Occurs when there is a road name change, or
other advisory at this location.</documentation>
    </annotation>
</enumeration>
</restriction>
</simpleType>
<simpleType name="RoadClassType">
    <annotation>
        <documentation>Relative size or importance of the road, ranked
numerically where class 1 roads are the most important (or major) roads. The
number of road classes can vary from one country to another, and depends upon
the road data supplier.</documentation>
    </annotation>
    <restriction base="positiveInteger">
</simpleType>
<simpleType name="RouteSegmentCategoryType">
    <annotation>
        <documentation>Enumeration of segment types.</documentation>
    </annotation>
    <restriction base="string">
        <enumeration value="Road"/>
        <enumeration value="Ferry"/>
        <enumeration value="Rail"/>
        <enumeration value="Walkway"/>
        <enumeration value="Subway"/>
        <enumeration value="LightRail"/>
        <enumeration value="Bus"/>
    </restriction>
</simpleType>

```

```

<!-- a new element to remove the RouteSummary Type -->
<complexType name="TravelTimeType">
  <attribute name="fixedTravelTime" type="duration" use="optional">
    <annotation>
      <documentation>Estimated time to travel the complete route,
      assuming ideal conditions without any traffic. Expressed in
      seconds.</documentation>
    </annotation>
  </attribute>
  <attribute name="realTravelTime" type="duration" use="optional">
    <annotation>
      <documentation>Estimated time to travel the complete route, taking
      into account available traffic information. Expressed in
      seconds.</documentation>
    </annotation>
  </attribute>
  <attribute name="historicalTravelTime" type="duration" use="optional">
    <annotation>
      <documentation>Estimated time to travel the complete route, based
      on historical data. Expressed in seconds.</documentation>
    </annotation>
  </attribute>
</complexType>
<element name="TravelTime" type="xsd:TravelTimeType"/>
<!-- ===== -->
<complexType name="ManeuverType">
  <annotation>
    <documentation>Defines a travel maneuver.</documentation>
  </annotation>
  <complexContent>
    <extension base="xsd:AbstractManeuverType">
      <sequence>
        <element ref="xsd:Place" minOccurs="0"
maxOccurs="unbounded"/>
        <element ref="xsd:Advisory" minOccurs="0"
maxOccurs="unbounded"/>
        <element name="Geometry" minOccurs="0">
          <annotation>
            <documentation>The geometry of this
maneuver.</documentation>
          </annotation>
        </element>
      </sequence>
    </extension>
  </complexContent>
</complexType>

```

```

        </element>
    </sequence>
    <attribute name="towardsSignText" use="optional">
        <annotation>
            <documentation>Sign text specifying the place (generally a city)
branched towards.</documentation>
        </annotation>
        <simpleType>
            <restriction base="string"/>
        </simpleType>
    </attribute>
    <attribute name="nextManeuverFollowsImmediately" type="boolean"
use="optional" default="false"/>
        </extension>
    </complexContent>
</complexType>
<element name="Maneuver" type="xls:ManeuverType"
substitutionGroup="xls:_Maneuver">
    <annotation>
        <documentation>A travel maneuver.</documentation>
    </annotation>
</element>
<complexType name="RouteManeuverListType">
    <annotation>
        <documentation>Defines a list of travel maneuvers.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractRouteManeuverListType">
            <attribute name="maximumRoadClass" type="xls:RoadClassType"
use="optional">
                <annotation>
                    <documentation>The maximum number of levels used in
ranking the relative size or importance of the roads.</documentation>
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<element name="RouteManeuverList" type="xls:RouteManeuverListType"
substitutionGroup="xls:_RouteManeuverList">
    <annotation>
        <documentation>A list of travel maneuvers.</documentation>
    </annotation>
</element>
<complexType name="RouteSegmentExtendedType">
    <annotation>

```

```

<documentation>Defines the extended characteristics of a segment
along a route.</documentation>
</annotation>
<complexContent>
  <extension base="xls:RouteSegmentType"/>
</complexContent>
</complexType>
<element name="NextSegmentExtended"
type="xls:RouteSegmentExtendedType" substitutionGroup="xls:_NextSegment">
  <annotation>
    <documentation>Information about the segment of the route between
this maneuver and the next.</documentation>
  </annotation>
</element>
<complexType name="AdvisoryType">
  <annotation>
    <documentation>Defines a travel advisory.</documentation>
  </annotation>
  <attribute name="type" type="xls:AdvisoryCategoryType" use="required"/>
  <attribute name="associatedName" type="string" use="optional">
    <annotation>
      <documentation>Name of the place, landmark, or crossroad
associated with each advisory, e.g. name of country, state, city, or other named
place entered or left, name of city bypassed, name of landmark, or name of
crossroad.</documentation>
    </annotation>
  </attribute>
  <attribute name="placeType" type="xls:NamedPlaceClassification"
use="optional">
    <annotation>
      <documentation>Classification of name place that was entered or
exited.</documentation>
    </annotation>
  </attribute>
  <attribute name="sideOfRoad" type="xls:SideOfRoadType" use="optional">
    <annotation>
      <documentation>Side of the road (left, right, or both) on which the
destination, intermediate waypoint, landmark or crossroad is
located.</documentation>
    </annotation>
  </attribute>
</complexType>
<element name="Advisory" type="xls:AdvisoryType">
  <annotation>
    <documentation>A travel advisory.</documentation>
  </annotation>

```

```

</element>
<simpleType name="AdvisoryCategoryType">
  <annotation>
    <documentation>Enumeration of types of advisory.</documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="StartLocation"/>
    <enumeration value="EndLocation"/>
    <enumeration value="ViaLocation"/>
    <enumeration value="EnterPlace">
      <annotation>
        <documentation>Entering a named place, such as a country, state,
or city.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="ExitPlace">
      <annotation>
        <documentation>Exiting a named place, such as a
city.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="BypassCity">
      <annotation>
        <documentation>Road network branch at which a traveler turns to
bypass a city.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="StreetNameChange"/>
    <enumeration value="Tollbooth"/>
    <enumeration value="Landmark">
      <annotation>
        <documentation>May be used to mark a named location relative to
an upcoming turn onto and unnamed road, e.g. "Take the third right after
"landmark name".</documentation>
      </annotation>
    </enumeration>
    <enumeration value="Crossroad">
      <annotation>
        <documentation>May be used to mark a named location relative to
an upcoming turn onto and unnamed road, e.g. "Take the third right after
"crossroad name".</documentation>
      </annotation>
    </enumeration>
    <enumeration value="HighwaysMerge">
      <annotation>

```

```
        <documentation>Current highway (controlled access road) is
merging with another highway (controlled access road).</documentation>
        </annotation>
    </enumeration>
    <enumeration value="RampMerge">
        <annotation>
            <documentation>Ramp is merging with current
road.</documentation>
        </annotation>
    </enumeration>
    <enumeration value="RoadsMerge">
        <annotation>
            <documentation>Current road is merging with another
road.</documentation>
        </annotation>
    </enumeration>
</restriction>
</simpleType>
<simpleType name="SideOfRoadType">
    <annotation>
        <documentation>Enumeration of side of road on which something is
located.</documentation>
    </annotation>
    <restriction base="string">
        <enumeration value="Left"/>
        <enumeration value="Right"/>
        <enumeration value="Both"/>
    </restriction>
</simpleType>
<complexType name="AbstractManeuverGeometryType" abstract="true">
    <annotation>
        <documentation>Defines the geometry of a travel
maneuver.</documentation>
    </annotation>
</complexType>
<element name="_ManeuverGeometry"
type="xsl:AbstractManeuverGeometryType" abstract="true">
    <annotation>
        <documentation>The geometry of a travel maneuver.</documentation>
    </annotation>
</element>
<complexType name="AbstractLinkType" abstract="true">
    <annotation>
        <documentation>Abstract type representing a road link in the maneuver
geometry.</documentation>
    </annotation>
```

```

<complexContent>
  <extension base="xls:AbstractManeuverGeometryType"/>
</complexContent>
</complexType>
<element name="_Link" type="xls:AbstractLinkType" abstract="true"
substitutionGroup="xls:_ManeuverGeometry">
  <annotation>
    <documentation>Base element representing a road link in the maneuver
geometry.</documentation>
  </annotation>
</element>
<complexType name="LinkType">
  <annotation>
    <documentation>Defines a road link in the maneuver
geometry.</documentation>
  </annotation>
  <complexContent>
    <extension base="xls:AbstractLinkType">
      <sequence>
        <element name="InterLinkAngle" type="xls:AngleType"
minOccurs="0">
          <annotation>
            <documentation>Angle relative to the previous link. Can also
be thought of as the angle of turn required to move onto this link from the
previous link, measured clockwise, where 0° is straight ahead, 90° is a full right
turn, and 270° is a full left turn. For RoundaboutLinkType links, this angle is
relative to the roundabout's entry link. </documentation>
          </annotation>
        </element>
        <element name="PositionOnRoundabout" type="xls:AngleType"
minOccurs="0">
          <annotation>
            <documentation>Position of this link on a roundabout relative
to the entry link. Measured as the clockwise angle between the position of the
roundabout's entry link and this link.</documentation>
          </annotation>
        </element>
        <element name="Length" type="xls:DistanceType"
minOccurs="0">
          <annotation>
            <documentation>Distance along the link.</documentation>
          </annotation>
        </element>
      </sequence>
      <attribute name="id" type="ID" use="optional"/>
    </extension>
  </complexContent>
</complexType>

```

```

<attribute name="roadClass" type="xls:RoadClassType"
use="optional"/>
    <attribute name="accessible" type="boolean" use="optional"
default="true">
        <annotation>
            <documentation>Indicates whether the link can be legally
traversed by the traveller from the direction of the previous link.</documentation>
        </annotation>
    </attribute>
    <attribute name="oneWay" type="boolean" use="optional"
default="false"/>
        <annotation>
            <documentation>Specifies whether this is the route entry
link.</documentation>
        </annotation>
    </attribute>
    <attribute name="isManeuverEntryLink" type="boolean" use="optional"
default="false">
        <annotation>
            <documentation>Specifies whether this is the link onto which
the route continues.</documentation>
        </annotation>
    </attribute>
    <attribute name="isRouteLink" type="boolean" use="optional"
default="true"/>
        <annotation>
            <documentation>A road link in the maneuver
geometry.</documentation>
        </annotation>
    </attribute>
<complexType name="EntranceRampType">
    <annotation>
        <documentation>Defines a maneuver geometry representing a highway
entrance ramp as a single link (the entrance ramp) connected to the maneuver's
entry segment.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:LinkType"/>
    </complexContent>

```

```
</complexType>
<element name="EntranceRamp" type="xIs:EntranceRampType"
substitutionGroup="xIs:Link">
  <annotation>
    <documentation>Maneuver geometry representing a highway entrance
ramp as a single link (the entrance ramp) connected to the maneuver's entry
segment.</documentation>
  </annotation>
</element>
<complexType name="ExitRampType">
  <annotation>
    <documentation>Defines a maneuver geometry representing a highway
exit ramp as a single link (the exit ramp) connected to the maneuver's entry
segment (the highway).</documentation>
  </annotation>
  <complexContent>
    <extension base="xIs:LinkType"/>
  </complexContent>
</complexType>
<element name="ExitRamp" type="xIs:ExitRampType"
substitutionGroup="xIs:Link">
  <annotation>
    <documentation>Maneuver geometry representing a highway exit ramp
as a single link (the exit ramp) connected to the maneuver's entry segment (the
highway).</documentation>
  </annotation>
</element>
<complexType name="BoardingRampType">
  <annotation>
    <documentation>Defines a maneuver geometry representing a boarding
ramp as a single link (the boarding ramp) connected to the maneuver's entry
segment.</documentation>
  </annotation>
  <complexContent>
    <extension base="xIs:LinkType"/>
  </complexContent>
</complexType>
<element name="BoardingRamp" type="xIs:BoardingRampType"
substitutionGroup="xIs:Link">
  <annotation>
    <documentation>Maneuver geometry representing a boarding ramp as a
single link (the boarding ramp) connected to the maneuver's entry
segment.</documentation>
  </annotation>
</element>
<complexType name="ChangeoverType">
```

```

<annotation>
  <documentation>Defines a maneuver geometry representing a crossing
between one highway/motorway to another as a single link (the upcoming
highway) connected to the maneuver's entry segment (the previous highway).
</documentation>
</annotation>
<complexContent>
  <extension base="xls:LinkType"/>
</complexContent>
</complexType>
<element name="Changeover" type="xls:ChangeoverType"
substitutionGroup="xls:Link">
  <annotation>
    <documentation>Maneuver geometry representing a crossing between
one highway/motorway to another as a single link (the upcoming highway)
connected to the maneuver's entry segment (the previous highway).
</documentation>
  </annotation>
</element>
<complexType name="ConnectedLinksType">
  <annotation>
    <documentation>Defines a maneuver geometry representing a junction
as a network of connected links, starting with the maneuver's entry
segment.</documentation>
  </annotation>
  <complexContent>
    <extension base="xls:AbstractManeuverGeometryType">
      <sequence>
        <element ref="xls:_Link" maxOccurs="unbounded"/>
      </sequence>
    </extension>
  </complexContent>
</complexType>
<element name="ConnectedLinks" type="xls:ConnectedLinksType"
substitutionGroup="xls:_ManeuverGeometry">
  <annotation>
    <documentation>Maneuver geometry representing a junction as a
network of connected links, starting with the maneuver's entry
segment.</documentation>
  </annotation>
</element>
<complexType name="IntersectionType">
  <annotation>
    <documentation>Defines a maneuver geometry representing a simple
intersection as the set of road links connected to the maneuver's entry segment
at a single node.</documentation>
  </annotation>

```

```

</annotation>
<complexContent>
  <extension base="xls:ConnectedLinksType"/>
</complexContent>
</complexType>
<element name="Intersection" type="xls:IntersectionType"
substitutionGroup="xls:ConnectedLinks">
  <annotation>
    <documentation>Maneuver geometry representing a simple intersection
as the set of road links connected to the maneuver's entry segment at a single
node.</documentation>
  </annotation>
</element>
<complexType name="RoundaboutType">
  <annotation>
    <documentation>Defines a maneuver geometry representing a circular
roundabout with a set of connecting road links which extend from the
roundabout.</documentation>
  </annotation>
  <complexContent>
    <extension base="xls:ConnectedLinksType"/>
  </complexContent>
</complexType>
<element name="Roundabout" type="xls:RoundaboutType"
substitutionGroup="xls:ConnectedLinks">
  <annotation>
    <documentation>Maneuver geometry representing a circular roundabout
with a set of road links extending from the roundabout.</documentation>
  </annotation>
</element>
<complexType name="EnclosedTrafficAreaType">
  <annotation>
    <documentation>Defines a maneuver geometry representing an
enclosed traffic area as a set of connected road links.</documentation>
  </annotation>
  <complexContent>
    <extension base="xls:ConnectedLinksType"/>
  </complexContent>
</complexType>
<element name="EnclosedTrafficArea" type="xls:EnclosedTrafficAreaType"
substitutionGroup="xls:ConnectedLinks">
  <annotation>
    <documentation>Maneuver geometry representing an enclosed traffic
area as a set of connected road links.</documentation>
  </annotation>
</element>

```

```

<simpleType name="RouteSegmentAttributeType">
  <annotation>
    <documentation>Enumeration of types of segment
attributes.</documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="Toll"/>
    <enumeration value="Endway"/>
    <enumeration value="Tunnel"/>
    <enumeration value="Bridge"/>
  </restriction>
</simpleType>
<simpleType name="TransportType">
  <annotation>
    <documentation>Enumeration of types of transportation. Derived from
ISO GDF 4.0.</documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="AllVehicles"/>
    <enumeration value="PassengerCar"/>
    <enumeration value="DeliveryTruck"/>
    <enumeration value="TransportTruck"/>
    <enumeration value="Pedestrian"/>
    <enumeration value="Bicycle"/>
    <enumeration value="EmergencyVehicle"/>
    <enumeration value="Taxi"/>
    <enumeration value="PublicBus"/>
    <enumeration value="HighOccupancyVehicle"/>
    <enumeration value="LightRail"/>
    <enumeration value="Rail"/>
    <enumeration value="Subway"/>
    <enumeration value="Ferry"/>
  </restriction>
</simpleType>
<element name="Transport" type="xsd:TransportType">
  <annotation>
    <documentation>Type of transportation.</documentation>
  </annotation>
</element>
</schema>

```

NavigationService.xsd
-----------------------

```

<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml" xmlns:xls="http://www.opengis.net/xls"
elementFormDefault="qualified">
  <!--Copyright (c) 2003 OGC, All Rights Reserved - This OGC document is a
  draft and is copyright-protected by OGC. While the reproduction of drafts in any
  form for use by participants in the OGC Interoperability Program is permitted
  without prior permission from OGC, neither this document nor any extract from it
  may be reproduced, stored or transmitted in any form for any other purpose
  without prior written permission from OGC.-->
  <include schemaLocation="RouteService.xsd"/>
  <include schemaLocation="PresentationService.xsd"/>
  <include schemaLocation="ADT_Navigation.xsd"/>
  <element name="NavigateRequest" type="xls:.NavigateRequestType"
substitutionGroup="xls:_RequestParameters">
    <annotation>
      <documentation>Specifies the Determine Route request
parameters.</documentation>
    </annotation>
  </element>
  <complexType name="NavigateRequestType">
    <annotation>
      <documentation>Defines the Determine Route request
parameters.</documentation>
    </annotation>
    <complexContent>
      <extension base="xls:AbstractRequestParametersType">
        <sequence>
          <choice>
            <element ref="xls:RouteHandle">
              <annotation>
                <documentation>Reference to a previously determined
route stored at the Route Determination Service server.</documentation>
              </annotation>
            </element>
            <element ref="xls:NavigationPlan"/>
          </choice>
          <element ref="xls:RouteManeuverList" minOccurs="0">
            <annotation>
              <documentation>Response for requested list of travel
maneuvers.</documentation>
            </annotation>
          </element>
          <element ref="xls:RouteInstructionsRequest" minOccurs="0">
            <annotation>

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        <documentation>Request parameters for turn-by-turn route
directions and advisories formatted for presentation.</documentation>
        </annotation>
    </element>
    <element ref="xls:RouteGeometryRequest" minOccurs="0">
        <annotation>
            <documentation>Request parameters for route
geometry.</documentation>
            </annotation>
        </element>
        <element ref="xls:RouteMapRequest" minOccurs="0"/>
    </sequence>
    <attribute name="provideRouteHandle" type="boolean"
use="optional" default="false">
        <annotation>
            <documentation>Requests the return of a route
handle.</documentation>
            </annotation>
        </attribute>
        <attribute name="provideRouteSummary" type="boolean"
use="optional" default="true">
            <annotation>
                <documentation>Requests the return of route summary
information.</documentation>
            </annotation>
        </attribute>
        <attribute name="provideManeuverList" type="boolean"
use="optional" default="false">
            <annotation>
                <documentation>Requests the return of detailed route
maneuver and segment information.</documentation>
            </annotation>
        </attribute>
        <attribute name="distanceUnit" type="xls:DistanceUnitType"
use="optional" default="M">
            <annotation>
                <documentation>Specifies the unit for measuring
distance.</documentation>
            </annotation>
        </attribute>
        <attribute name="provideManeuverGeometry" type="boolean"
use="optional" default="false">
            <annotation>
                <documentation>Requests the return of the route maneuver's
geometry.</documentation>
            </annotation>

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</attribute>
<attribute name="provideAlternateRoute" type="boolean"
use="optional" default="false">
<annotation>
<documentation>Requests the determination of an alternative to
the existing route. If set "true", the existing route must be specified in the
routeHandle parameter.</documentation>
</annotation>
</attribute>
</extension>
</complexContent>
</complexType>
<element name="NavigationPlan" type="xls:NavigationPlanType">
<annotation>
<documentation>The criteria upon which a route is
determined.</documentation>
</annotation>
</element>
<complexType name="NavigationPlanType">
<annotation>
<documentation>Defines the criteria upon which a route is
determined.</documentation>
</annotation>
<sequence>
<element ref="xls:NavigationPreference"/>
<element ref="xls:WayPointList"/>
<element ref="xls:AvoidList" minOccurs="0"/>
<element ref="xls:AdvisoryTypeList" minOccurs="0">
<annotation>
<documentation>Types of advisories to include or
exclude.</documentation>
</annotation>
</element>
</sequence>
<attribute name="useRealTimeTraffic" type="boolean" use="optional"
default="false">
<annotation>
<documentation>Specifies whether to use real time traffic information
when determining the best route.</documentation>
</annotation>
</attribute>
<attribute name="expectedStartTime" type="dateTime" use="optional">
<annotation>
<documentation>Specifies the date and time at which travel is
expected to begin. Specified in the format YYYY-MM-DD HH:MM. Defaults to
current date and time.</documentation>

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        </annotation>
    </attribute>
    <attribute name="timeRestrictionCheck"
type="xls:TimeRestrictionCheckType" use="optional"
default="HonorTimeRestrictions">
        <annotation>
            <documentation>Specifies whether route determination should take
into account any time restrictions associated with segments of the transportation
network.</documentation>
        </annotation>
    </attribute>
</complexType>
<!--
=====
===== Response
=====
-->
<element name="NavigateResponse" type="xls:.NavigateResponseType"
substitutionGroup="xls:_ResponseParameters">
    <annotation>
        <documentation>Specifies the Determine Route response
parameters.</documentation>
    </annotation>
</element>
<complexType name="NavigateResponseType">
    <annotation>
        <documentation>Defines the Determine Route response
parameters.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractResponseParametersType">
            <sequence>
                <element ref="xls:RouteHandle" minOccurs="0">
                    <annotation>
                        <documentation>Reference to the route stored at the Route
Determination Service server.</documentation>
                    </annotation>
                </element>
                <element ref="xls:RouteSummary" minOccurs="0">
                    <annotation>
                        <documentation>Response for requested route
summary.</documentation>
                    </annotation>
                </element>
                <element ref="xls:RouteGeometry" minOccurs="0">

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<annotation>
  <documentation>Response for requested route
geometry.</documentation>
</annotation>
</element>
<element ref="xls:RouteInstructionsList" minOccurs="0">
  <annotation>
    <documentation>Response for requested route
instructions.</documentation>
  </annotation>
</element>
<element ref="xls:RouteMap" minOccurs="0"
maxOccurs="unbounded">
  <annotation>
    <documentation>Response list for requested route
maps.</documentation>
  </annotation>
</element>
<element ref="xls:RouteManeuverList" minOccurs="0">
  <annotation>
    <documentation>Response for requested list of travel
maneuvers.</documentation>
  </annotation>
</element>
</sequence>
</extension>
</complexContent>
</complexType>
<element name="NavigationAvoidFeature"
type="xls:NavigationAvoidFeatureType">
  <annotation>
    <documentation>Type of feature to avoid when determining the
route.</documentation>
  </annotation>
</element>
<simpleType name="NavigationAvoidFeatureType">
  <annotation>
    <documentation>Enumeration of types of features to avoid when
determining the route.</documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="Highway">
      <annotation>
        <documentation>Minimize the use of highways.</documentation>
      </annotation>
    </enumeration>
  </restriction>
</simpleType>

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<enumeration value="Tollway">
  <annotation>
    <documentation>Minimize tolls.</documentation>
  </annotation>
</enumeration>
<enumeration value="UTurn">
  <annotation>
    <documentation>Minimize the number of u-
turns.</documentation>
  </annotation>
</enumeration>
<enumeration value="Ferry">
  <annotation>
    <documentation>Minimize the use of ferries.</documentation>
  </annotation>
</enumeration>
</restriction>
</simpleType>
<simpleType name="NavigationPreferenceType">
  <annotation>
    <documentation>Enumeration of preferences to be taken into
consideration when determining the route.</documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="Fastest">
      <annotation>
        <documentation>Minimize the travel time by
vehicle.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="Shortest">
      <annotation>
        <documentation>Minimize the travel distance by
vehicle.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="Easiest">
      <annotation>
        <documentation>Minimize the number of turns, or other difficult
travel conditions by vehicle.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="Pedestrian">
      <annotation>
        <documentation>Best route by foot.</documentation>
      </annotation>
    </enumeration>
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</enumeration>
<enumeration value="PublicTransportation">
    <annotation>
        <documentation>Best route by public
transportation.</documentation>
    </annotation>
</enumeration>
</restriction>
</simpleType>
<element name="NavigationPreference"
type="xsl:NavigationPreferenceType">
    <annotation>
        <documentation>Preference to be taken into consideration when
determining the route.</documentation>
    </annotation>
</element>
<element name="AdvisoryTypeList" type="xsl:AdvisoryTypeListType">
    <annotation>
        <documentation>A list of advisory types to include or exclude in the
route.</documentation>
    </annotation>
</element>
<complexType name="AdvisoryTypeListType">
    <annotation>
        <documentation>Defines a list of advisory types to include or exclude in
the route.</documentation>
    </annotation>
    <sequence>
        <element name="AdvisoryType" type="xsl:AdvisoryCategoryType"
minOccurs="0" maxOccurs="unbounded"/>
    </sequence>
    <attribute name="filter" type="xsl:FilterType" use="required">
        <annotation>
            <documentation>Determines if the specified types of advisories are
included or excluded. If filter = "Include", only the specified types of advisories
are included. If filter = "Exclude", all the types of advisories except the specified
types are included.</documentation>
        </annotation>
        </attribute>
    </complexType>
<simpleType name="TimeRestrictionCheckType">
    <annotation>
        <documentation>Enumeration of ways to handle time restrictions
associated with segments of the transportation network.</documentation>
    </annotation>
    <restriction base="string">

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```
<enumeration value="HonorTimeRestrictions">
  <annotation>
    <documentation>Take time restrictions into account.</documentation>
  </annotation>
</enumeration>
<enumeration value="IgnoreTimeRestrictions">
  <annotation>
    <documentation>Don't take time restrictions into account.</documentation>
  </annotation>
</enumeration>
<enumeration value="AvoidTimeRestrictions">
  <annotation>
    <documentation>Avoid routing over segments which have time restrictions.</documentation>
  </annotation>
</enumeration>
</restriction>
</simpleType>
<simpleType name="FilterType">
  <annotation>
    <documentation>Enumeration of types of filtering to be performed.</documentation>
  </annotation>
  <restriction base="string">
    <enumeration value="Include">
      <annotation>
        <documentation>Indicates that only the specified items should be included.</documentation>
      </annotation>
    </enumeration>
    <enumeration value="Exclude">
      <annotation>
        <documentation>Indicates that all items except the specified ones should be included.</documentation>
      </annotation>
    </enumeration>
  </restriction>
</simpleType>
</schema>
```