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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:

Autodesk, Canada
ESRI, USA
Image Matters, USA
Intergraph IntelliWhere, Australia
MapInfo, USA
Navigation Technologies, USA
Oracle, USA
Sun Microsystems, USA
Webraska, France
iii. Document Contributor Contact Points

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<th>COMPANY</th>
<th>ADDRESS</th>
<th>PHONE/FAX</th>
<th>EMAIL</th>
</tr>
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<td><a href="mailto:harryn@imagem.cc">harryn@imagem.cc</a></td>
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iv. Revision history

<table>
<thead>
<tr>
<th>Date</th>
<th>Release</th>
<th>Author</th>
<th>Paragraph modified</th>
<th>Description</th>
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<tr>
<td>28/11/2001</td>
<td>1.0</td>
<td>Tom Bychowski</td>
<td>First Draft</td>
<td>First Draft</td>
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</table>
| 01/12/2001    | 2.0     | Tom Bychowski| Changed the following:      | Changed the following:  
<p>|               |         |              | • Added routeHandle to the service response.                                | • Added provideRouteSummary to the service request.                        |
|               |         |              |                             | • Moved transportTypeList to from RoutePlanType to WayPointType. This allows different modes of transportation to be specified when departing each waypoint along a route. |</p>
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<tr>
<td>20/12/2001</td>
<td>4.0</td>
<td>Tom Bychowski</td>
<td>• Added routeHandleLifeSpan to route determination response parameters.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Added RouteInstructionsRequestType</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Added RouteGeometryRequestType</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Changed corridorSize to corridorWidth and wayPointRadius.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moved distanceUnits from DetermineRoute Request to RouteInstructions Request</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Much other miscellaneous based on review input.</td>
</tr>
<tr>
<td>03/01/2002</td>
<td>5.0</td>
<td>Tom Bychowski</td>
<td>• Removed get capabilities requirement.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Capitalized the first letter of all parameters of complex type.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Capitalized the first letter of all enumerated strings.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Added distanceUnitOfMeasure parameter to DetermineRoute Request</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Renamed distanceUnit in RouteInstructionsRequestType to distanceUnitOfMeasure.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Changed CorridorWidth and WayPointRadius properties in RouteMapRequestType to type DistanceQuantityType (composed of the distance value and the unit of measure).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Renamed “exception” to parameters to “Error” to avoid name conflicts with Java’s “enumeration” reserved word when using XML binding tools such as JAXB.</td>
</tr>
<tr>
<td>02/22/2002</td>
<td>6.0</td>
<td>Tom Bychowski</td>
<td>• Renamed distanceUnitOfMeasure parameters to distanceUnit of type DistanceUnitNameType.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Other miscellaneous name changes to synchronize with consolidated XLS schema.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Added WayPointListType.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• In RoutePlanType, replaced StartLocation, ViaLocationList, and EndLocation parameters with a WayPointList parameter.</td>
</tr>
</tbody>
</table>
• 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.

• Change RouteMapResponseType to RouteMapType, which is extended from MapADT.

<table>
<thead>
<tr>
<th>Date</th>
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<th>Author</th>
<th>Notes</th>
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<td>08/09/2002</td>
<td>7.0</td>
<td>Tom Bychowski</td>
<td>Updated request parameters for XLS v1.03 basic and full profiles.</td>
</tr>
<tr>
<td>11 Nov 2002</td>
<td>0.8.0</td>
<td>Harry Niedziadek</td>
<td>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.</td>
</tr>
<tr>
<td>Dec. 11 &amp; 16, 2002</td>
<td>0.2</td>
<td>Marwa Mabrouk &amp; HAN</td>
<td>Significant contributions throughout</td>
</tr>
<tr>
<td>April 17, 2003</td>
<td>0.3,0.4, 0.5</td>
<td>HAN</td>
<td>Schemas updated to GML 3.0 geometry. Schemas updated to LIF MLP 3.0.</td>
</tr>
</tbody>
</table>

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

**Issue Name:** [Issue Name, e.g., GML 3.0 Harmonization. (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.


Guidelines for Successful OGC Interface Specifications, OpenGIS document 00-014r1.


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.
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

<table>
<thead>
<tr>
<th>Request Parameters</th>
<th>Mandatory?</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NavigationPlan</td>
<td>Y</td>
<td>NavigationPlanType</td>
<td>Specifies the criteria upon which a new route is determined.</td>
</tr>
<tr>
<td>RouteHandle</td>
<td></td>
<td>RouteHandleType (ADT)</td>
<td>Reference to a previously determined route. Used to request additional information about the route, or to request an alternate route.</td>
</tr>
<tr>
<td>RouteInstructionsRequest</td>
<td>N</td>
<td>RouteInstructionsRequestType</td>
<td>Requests the return of turn-by-turn route instructions and travel advisories in a text, voice, or other presentation format.</td>
</tr>
<tr>
<td>RouteGeometryRequest</td>
<td>N</td>
<td>RouteGeometryRequestType</td>
<td>Requests the return of the route geometry.</td>
</tr>
<tr>
<td>RouteMapRequest</td>
<td>N</td>
<td>RouteMapRequestType</td>
<td>Requests the return of one or more maps of the route.</td>
</tr>
</tbody>
</table>
| 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.
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<thead>
<tr>
<th>Name</th>
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<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>NavigationPreference</td>
<td>Y</td>
<td>Enumeration</td>
<td>Routing preference to be taken into consideration when determining the route: [\text{&quot;Fastest&quot;} - \text{Minimize the travel time.}] [\text{&quot;Shortest&quot;} - \text{Minimize the travel distance.}] [\text{&quot;Easiest&quot;} - \text{Minimize the number of turns, or other difficult travel conditions.}] [\text{&quot;Pedestrian&quot;} - \text{Best route by foot.}] [\text{&quot;PublicTransportation&quot;} - \text{Best route by public transportation.}]</td>
</tr>
<tr>
<td>WayPointList</td>
<td>Y</td>
<td>WayPointListType(ADT)</td>
<td>List of waypoints along the route.</td>
</tr>
<tr>
<td>AvoidList</td>
<td>N</td>
<td>AvoidListType</td>
<td>List of areas, locations, and features in which the route should avoid passing through.</td>
</tr>
<tr>
<td>AdvisoryTypeList</td>
<td>N</td>
<td>AdvisoryTypeListType</td>
<td>A list of advisories to include or exclude in the route.</td>
</tr>
<tr>
<td>useRealTimeTraffic</td>
<td>N</td>
<td>Boolean</td>
<td>Specifies whether to use real time traffic information when determining the best route. Default is “false”</td>
</tr>
<tr>
<td>expectedStartTime</td>
<td>N</td>
<td>DateTime</td>
<td>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.</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
</table>
| timeRestrictionCheck | N         | Enumeration                        | Specifies whether route determination should take into account any time restrictions associated with segments of the transportation network:  
“HonorTimeRestrictions” – Take time restrictions into account.  
“IgnoreTimeRestrictions” – Don’t take time restrictions into account.  
“AvoidTimeRestrictions” – Avoid routing over segments which have time restrictions.  
Default = HonorTimeRestrictions |
| AvoidListType: Defines the list of areas, locations, and features in which the route should avoid passing through. |           |                                    |                                                                             |
| 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                | Specifies the types of features to avoid when determining the route:  
“Highway” – Minimize the use of highways.  
“Tollway” – Minimize the use of tollways. |
of tollways.

“UTurn” – Minimize the number of u-turns.

“Ferry” – Minimize the use of ferries.

**AdvisoryTypeListType**: Defines a list of advisory types to include or exclude in the route.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>filter</td>
<td>Y</td>
<td>Enumeration</td>
<td>Determines if the specified types of advisories are included or excluded.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If filter = “Include”, only the specified types of advisories are included.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If filter = “Exclude”, all the types of advisories except the specified types are included.</td>
</tr>
<tr>
<td>AdvisoryList</td>
<td>N</td>
<td>List of AdvisoryType(A DT)</td>
<td>Specifies the types of advisories to include or exclude in the route.</td>
</tr>
</tbody>
</table>

**RouteInstructionsRequestType**: Defines the request parameters for turn-by-turn route instructions and travel advisories formatted for presentation.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>format</td>
<td>N</td>
<td>String</td>
<td>The preferred format of the route instructions, specified as a mime type.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Defaults to text/plain.</td>
</tr>
<tr>
<td>Name</td>
<td>Mandatory</td>
<td>Data Type</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------</td>
<td>---------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>distanceUnit</td>
<td>N</td>
<td>DistanceUnitType (ADT)</td>
<td>The units of measure to be used for distances in the text directions:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Default = “M”</td>
</tr>
<tr>
<td>BoundingBox</td>
<td>N</td>
<td>BoxType (ADT)</td>
<td>Rectangular geographic area of route for which the geometry is requested.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If not specified, defaults to full route.</td>
</tr>
<tr>
<td>scale</td>
<td>N</td>
<td>Positive Integer</td>
<td>Maximum scale at which the route will be displayed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Expressed as a ratio of world units to a device unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>For example 1:50000 would be specified as 50000.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Default = 1</td>
</tr>
<tr>
<td>provideStartingPortion</td>
<td>N</td>
<td>Boolean</td>
<td>If true, return the geometry of the starting portion of the route contained</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>within the specified bounding area, up to the specified maximum number of</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>points.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>If false, return the geometry of the complete route contained within the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>specified area, reducing the accuracy of the geometry as necessary to not</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>exceed the specified maximum number of points.</td>
</tr>
</tbody>
</table>
### RouteMapRequestType: Defines the request parameters for route maps.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory?</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OutputList</td>
<td>Y</td>
<td>List of OutputType</td>
<td>Specifies the output of the map(s) to be generated. This is the full set of map output parameters defined by the Presentation Service.</td>
</tr>
</tbody>
</table>

**Name**

- Default = false

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory?</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>maxPoints</td>
<td>N</td>
<td>Positive Integer</td>
<td>Specifies the maximum number of geometric points to be returned. Default = 100</td>
</tr>
</tbody>
</table>

### RouteMapOutputType: Defines the rendered route map output parameters.

**A collection of one or more of the parameters below.**

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory?</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BBoxContent</td>
<td>N</td>
<td>BoxType (ADT)</td>
<td>Rectangular area to be displayed in the rendered map. If not specified, defaults to a</td>
</tr>
</tbody>
</table>
rectangular area bounding the full route.

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>width</td>
<td>N</td>
<td>Non-negative Integer</td>
<td>Pixel width of the resulting map.</td>
</tr>
<tr>
<td>height</td>
<td>N</td>
<td>Non-negative Integer</td>
<td>Pixel height of the resulting map.</td>
</tr>
<tr>
<td>format</td>
<td>N</td>
<td>String</td>
<td>Mime type describing the encoding.</td>
</tr>
<tr>
<td>BGcolor</td>
<td>N</td>
<td>String</td>
<td>Background color of the map.</td>
</tr>
<tr>
<td>transparent</td>
<td>N</td>
<td>Boolean</td>
<td>The opacity of the map. If set true, the map background is transparent. If set false, the map background is opaque.</td>
</tr>
</tbody>
</table>

### 9.1.2.2 Navigation Response Parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Mandatory</th>
<th>Data Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>RouteHandle</td>
<td>N</td>
<td>RouteHandleType (ADT)</td>
<td>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.</td>
</tr>
<tr>
<td>RouteSummary</td>
<td>N</td>
<td>RouteSummaryType (ADT)</td>
<td>Describes the overall characteristics of the route.</td>
</tr>
</tbody>
</table>
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).
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
<?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"/>
</schema>
```

Abstract type representing a travel maneuver. 

```xml
<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>
        </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>
```
<complexType>
  <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>
  <element name="_Manuever" type="xls:AbstractManeuverType" abstract="true">
    <annotation>
      <documentation>Base element representing a travel maneuver.</documentation>
    </annotation>
  </element>
</complexType>
<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 value="ProceedTo">
      <annotation>
      </annotation>
    </enumeration>
    <enumeration value="ProceedTo">
      <annotation>
      </annotation>
    </enumeration>
  </restriction>
</simpleType>
<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>

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

<enumeration value="Disembark">
  <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>
</enumeration>

<enumeration value="Stop">
  <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>
</enumeration>

<enumeration value="Advisory">
  <documentation>This notification describes a travel advisory. Continue along the current route segment.</documentation>
</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>
  </restriction>
</simpleType>
<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>
<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="xls:TravelTimeType"/>

<complexType name="ManeuverType">
    <annotation>
        <documentation>Defines a travel maneuver.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractManeuverType">
            <sequence>
                <element ref="xls:Place" minOccurs="0" maxOccurs="unbounded"/>
                <element ref="xls: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 name="towardsSignText" use="optional">
  <annotation>
    <documentation>Sign text specifying the place (generally a city) branched towards.</documentation>
  </annotation>
  <simpleType>
    <restriction base="string"/>
  </simpleType>
</element>

<attribute name="nextManeuverFollowsImmediately" type="boolean" use="optional" default="false"/>

<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></documentation>
  </annotation>
</complexType>
<documentation>Defines the extended characteristics of a segment along a route.</documentation>
<complexType base="xls:RouteSegmentType"/>
<complexType>
<element name="NextSegmentExtended"
type="xls:RouteSegmentExtendedType" substitutionGroup="xls:_NextSegment">
<documentation>Information about the segment of the route between this maneuver and the next.</documentation>
</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>
<complexType 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>
    </annotation>
  </enumeration>
</restriction>
</complexType>
<documentation>Current highway (controlled access road) is merging with another highway (controlled access road).</documentation>
<enumeration>
  <enumeration value="RampMerge">
    <documentation>Ramp is merging with current road.</documentation>
  </enumeration>
  <enumeration value="RoadsMerge">
    <documentation>Current road is merging with another road.</documentation>
  </enumeration>
</restriction>
</simpleType>
<complexType 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>
</complexType>
<complexType name="AbstractManeuverGeometryType" abstract="true">
  <annotation>
    <documentation>Defines the geometry of a travel maneuver.</documentation>
  </annotation>
</complexType>
<element name="_ManeuverGeometry" type="xls: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>
</complexType>
<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"/>
<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">
  <attribute name="previousLinkID" type="IDREF" use="optional"/>
  <extension>
    <complexContent/>
  </extension>
</complexType>
<element name="Link" type="xls:LinkType" substitutionGroup="xls:_Link">
  <annotation>
    <documentation>A road link in the maneuver geometry.</documentation>
  </annotation>
</element>
<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>
</complexType>
<complexType name="EntranceRampType">
  <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>
  <complexContent>
    <restriction base="xls:LinkType"/>
  </complexContent>
</complexType>

<element name="EntranceRamp" type="xls:EntranceRampType" substitutionGroup="xls: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="xls:LinkType"/>
  </complexContent>
</complexType>

<element name="ExitRamp" type="xls:ExitRampType" substitutionGroup="xls: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="xls:LinkType"/>
  </complexContent>
</complexType>

<element name="BoardingRamp" type="xls:BoardingRampType" substitutionGroup="xls:Link">
  <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>
</element>

<complexType name="ChangeoverType">
  <annotation>
    <documentation>Maneuver geometry representing a boarding ramp as a single link (the boarding ramp) connected to the maneuver's entry segment.</documentation>
  </annotation>
</complexType>
<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>

<complexType>
  <extension base="xls:LinkType"/>
</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>
</complexType>
<annotation>
  <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>
</annotation>

<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>
</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>
</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="xls:TransportType">
  <annotation>
    <documentation>Type of transportation.</documentation>
  </annotation>
</element>

</schema>
<?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">

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<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>
            <documentation>Response for requested list of travel maneuvers.</documentation>
          </annotation>
        </element>
      </sequence>
    </extension>
  </complexContent>
</complexType>
<documentation>Request parameters for turn-by-turn route directions and advisories formatted for presentation.</documentation>
</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>
</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>
    <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>
      </annotation>
    </attribute>
  </sequence>
</complexType>
<attribute name="timeRestrictionCheck" type="xls:TimeRestrictionCheckType" use="optional" default="HonorTimeRestrictions">
<documentation>Specifies whether route determination should take into account any time restrictions associated with segments of the transportation network.</documentation>
</attribute>
</complexType>

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Response
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<element name="NavigateResponse" type="xls:NavigateResponseType" substitutionGroup="xls:_ResponseParameters">
<documentation>Specifies the Determine Route response parameters.</documentation>
</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">
<documentation>Reference to the route stored at the Route Determination Service server.</documentation>
</element>
<element ref="xls:RouteSummary" minOccurs="0">
<documentation>Response for requested route summary.</documentation>
</element>
<element ref="xls:RouteGeometry" minOccurs="0">
<documentation>
</annotation>
</complexType>
<element name="NaviagtionAvoidFeature" type="xls:NavigationAvoidFeatureType">
  <annotation>
    <documentation>Type of feature to avoid when determining the route.</documentation>
  </annotation>
  <complexType>
    <annotation>
      <documentation>Enumeration of types of features to avoid when determining the route.</documentation>
    </annotation>
    <complexContent>
      <restriction base="string">
        <enumeration value="Highway">
          <annotation>
            <documentation>Minimize the use of highways.</documentation>
          </annotation>
        </enumeration>
      </restriction>
    </complexContent>
  </complexType>
</element>
<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>
    </restriction>
</simpleType>
<enumeration>
  <enumeration value="PublicTransportation">
    <annotation>
      <documentation>Best route by public transportation.</documentation>
    </annotation>
  </enumeration>
</restriction>
<element name="NavigationPreference" type="xls:NavigationPreferenceType">
  <annotation>
    <documentation>Preference to be taken into consideration when determining the route.</documentation>
  </annotation>
</element>
<element name="AdvisoryTypeList" type="xls: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="xls:AdvisoryCategoryType" minOccurs="0" maxOccurs="unbounded"/>
  </sequence>
  <attribute name="filter" type="xls: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">
<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>