Open GIS Consortium Inc.

Date: 19 April 2003

Reference number of this OpenGIS® Project Document: **OGC 03-006r1**

Version: 0.5.0

Category: OpenGIS® Implementation Specification

Authors: Marwa Mabrouk, ESRI
Tom Bychowski, NavTech
Jonathan Williams, Hutchison 3G
Harry Niedzwiadek, Image Matters
Yaser Bishr, Image Matters
Jean-Francois Gaillet, Webraska
Neil Crisp, Intergraph
Will Wilbrink, MapInfo
Mike Horhammer, Oracle
Greg Roy, Autodesk

Editor: Marwa Mabrouk, ESRI

OpenGIS® Location Services (OpenLS™): Core Services

[Part 1-Directory Service, Part 2-Gateway Service, Part 3-Location Utility Service (Geocoder/Reverse Geocoder), Part 4-Presentation Service, Part 5-Route Service]

Document type: OpenGIS Implementation Specification
Document subtype:
Document stage: Request For Comment (RFC)
Document language: English

Table of Contents

i. Preface

This OpenGIS Implementation Specification defines OpenGIS Location Services (OpenLS): Core Services, Parts 1-5, which consists of the composite set of basic services comprising the OpenLS Platform. This platform is also referred to as 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.

This document consolidates most of the specifications contained in the Interoperability Program Reports 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

All questions regarding this submission should be directed to the editors.

CONTACT	COMPANY	ADDRESS	PHONE/FAX	EMAIL
Yaser Bishr (Co-Author)	OGC IP Team	105 S. King Street Leesburg, VA 20175	+1 (703) 669-5510 +1 (703) 669-5515	yaserb@imagem.cc
Tom Bychowski (Co-Author)	Navigation Technologies	222 Merchandise Mart Plaza Suite 200 Chicago, IL. 60654 USA	Ph: +1 312-894-7316 Fax: 312-894-7225	tbychows@chi.navtech.com
Neil Crisp (Co-Author)	IntelliWhere Division, Intergraph Corporation.	Floor 3, 299 Coronation Drive, Milton Queensland 4064. Australia.	+61 7 35108917	neil.crisp@Intergraph.com

Jean-François Gaillet (Co-Author)	Webraska	22 Avenue Guynemer BP 107 Maisons-Laffitte Cedex France	+33 1 39 12 88 00 +33 1 39 12 88 08	jfgaillet@webraska.com
Marwa Mabrouk (Editor, Co-Author)	ESRI Inc.	380 New York st. Redlands CA 92373, USA	+1 (909) 793-2853	mmabrouk@esri.com
Harry Niedzwiadek (Co-Author)	Image Matters	105 S. King Street Leesburg, VA 20175	+1 (703) 669-5510 +1 (703) 669-5515	harryn@imagem.cc
Jonathan Williams (Co-Author)	Hutchison3G, UK Limited	Star House, 20 Grenfell Road, Maidenhead, SL6 1EH, United Kingdom	+44 1628 766 183	jonathan.williams2@hutchison3g.com
Will Wilbrink (Co-Author)	MapInfo	MapInfo Corp 26 Wellington St East Suite 500 Toronto, Ontario M5E1S2	+1 (416) 609-7794	will_wilbrink@mapinfo.com

iv. Revision history

Date	Release	Author	Paragraph modified	Description
Oct. 2001 – Oct. 2002	various	various	N/A	Most of the content for this specification came from the final specifications developed under the OpenLS 1/1.1 initiatives, namely: – *OpenLS Reference Architecture: Draft Implementation Specification, Version 0.2.0*, November 2002, OpenGIS Discussion Paper 02-089. – *OpenLS Route Determination Service: Draft Implementation Specification, Version 0.8.0*, November 2002, OpenGIS Discussion Paper 02-090. – *OpenLS Presentation Service: Draft Implementation Specification, Version 0.1.8*, November 2002, OpenGIS Discussion Paper 02-091. – *OpenLS Location Utility Services (Geocoder and Reverse Geocoder): Draft Implementation Specification, Version 0.6.0*, November 2002,

				OpenGIS Discussion Paper 02-092. – *OpenLS Gateway Service: Draft Implementation Specification, Version 0.2.0*, November 2002, OpenGIS Discussion Paper 02-093. – *OpenLS Directory Service: Draft Implementation Specification, Version 0.8.0*, November 2002, OpenGIS Discussion Paper 02-094. This document supersedes these specifications.
Dec. 11 & 16, 2002	0.2	Marwa Mabrouk & HAN	Significant contributions throughout	All specs were combined into one document. The schemas were simplified. The full profile of the Route Determination Service becomes the new Navigation Service. The basic profile of the former Route Determination Service becomes the new Route Service. Abstract types are removed from the new Route Service and Navigation Service to be consistent with other OpenLS Core Services. Issues were added.
Dec 19, 2002	0.2 (retained version number)	HAN	Various.	At the request of the TC: 1) Added outstanding issues inline, and 2) Added notation to title page to reflect draft state of the document.
April 18, 2003	0.3, 0.4, 0.5	MM, HAN, WW, PD, GR, OR	Various	Schemas updated to GML 3.0 geometry. Schemas updated to LIF MLP 3.0. Numerous inconsistencies were fixed, clarifications were added and schema bugs fixed on the basis of comments from MapInfo and Autodesk.

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): Core Services [Part 1-Directory Service, Part 2-Gateway Service, Part 3-Location Utility Service (Geocoder/Reverse Geocoder), Part 4-Presentation Service, Part 5-Route Service]

1 Scope

This OpenGIS® Implementation Specification describes OpenGIS® Location Services (OpernLS): Core Services, Parts 1-5, also known as the GeoMobility Server (GMS), an open platform for location-based application services. It also outlines the scope and relationship of OpenLS with respect to other specifications and standardization activities.

The primary objective of OpenLS is to define access to the Core Services and Abstract Data Types (ADT) that comprise the GeoMobility Server, 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 13 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.

Abstract Specification Topic 0: Overview, OpenGIS® document 99-100r1.
Guidelines for Successful OGC Interface Specifications, OpenGIS document 00-014r1.
OpenGIS® Geography Markup Language (GML), Version 3.0, 18 December 2002, OpenGIS Implementation Specification 02-023r4. Available [Online]: http://www.opengis.org/techno/documents/02-023r4.pdf.

OpenGIS® Location Services (OpenLS): Part 6: Navigation Service, Version 0.5, April 18, 2003, OpenGIS RFC 03-007r1. Available [Online]: <http://www.opengis.org/techno/discussions/03-007r1.pdf>.
*Recommended Definition Data for Coordinate Reference Systems and Coordinate Transformation*s. OGC Project Document 01-014r5. Available [Online]: <http://www.opengis.org/techno/discussions/01-014r5.pdf>.
OGC Units of Measure Use and Definition Recommendations. OGC Recommendation Paper. OGC Project Document 02-007r4. Available [Online]: <http://www.opengis.org/techno/discussions/02-007r4.pdf>.
OpenGIS® Simple Features Specification for SQL. OGC Implementation Specification. Available [Online]: <http://www.opengis.org/techno/specs/99-049.pdf>.
*XML Linking Language (XLink) Version 1.*0. W3C Recommendation (27 June 2001). Available [Online]: <http://www.w3.org/TR/xlink/>
*Namespaces in XM*L. W3C Recommendation (14 January 1999). Available [Online]: <http://www.w3.org/TR/1999/REC-xml-names-19990114/>
*XML Schema Part 1: Structure*s. W3C Recommendation (2 May 2001). Available [Online]: <http://www.w3.org/TR/xmlschema-1/>
*XML Schema Part 2: Datatype*s. W3C Recommendation (2 May 2001). Available [Online]: <http://www.w3.org/TR/xmlschema-2/>

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.

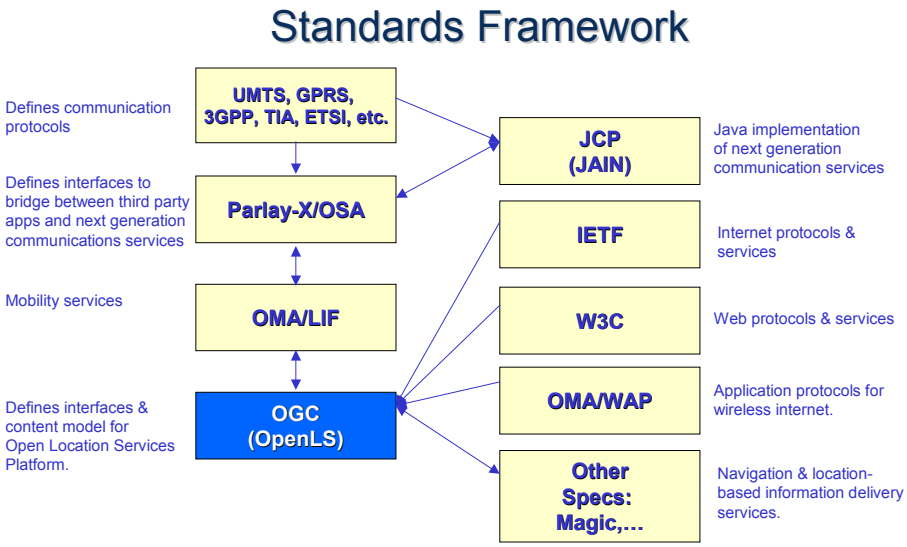


Figure 1. Standards Framework

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. (This service is documented under separate cover, see section 3.)

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 General Requirements

Note: These requirements were taken from the document entitled: "XML for Location Services (XLS) Requirements", dated 15 Apr 2002, v1.1, and supersede that document.

These requirements pertain to the exchange of location information for the GeoMobility Server, an open location services platform. As such, these requirements reflect the character and nature of location information exchange for the OpenLS Core Services. The following sponsor observations led to these requirements:

- The location services market demands technology that subscribes to the principal of simplicity so that these services will be widely adopted throughout the wireless-IP realm. The objective is to shield the wireless provider from "GIS complexity". We are driven by the desire to hit the mainstream with simple, essential, widely adopted capabilities. Also, one size does not necessarily fit all. Consider these technologies that have emerged for wireless IP:
    - Java: J2ME
    - SVG: Mobile SVG
    - kDom and kXML (kxml.enhydra.org)
- Small form factor mobile terminals with limited memory, power, and processing resources and limited bandwidth demands lightweight solutions for location information exchange. Devices widely available in the market could be classified into three general classes.
    - Class A - Devices with very limited capabilities like pagers and cell phones
    - Class B - Devices with moderate capabilities like Palm OS PDA
    - Class C - Devices with relatively good capabilities like Windows CE devices
- Current network capabilities are very limited in bandwidth. Bandwidth available for devices ranges between 9.6 Kbps and 28.8 Kbps in general
- Next generation devices will be smarter and therefore will accept location information for limited onboard processing.
- Back-end server traffic is also a concern. Messages should be as compact as possible.

7.2.1 Usage Scenarios

The usage scenarios for XLS are captured in the use cases for the OpenLS Core Services (see references in section 3). These use cases define the general scope of XLS.

7.2.2 Design Guidelines

The following design guidelines were considered for XLS. They are based on participants' experience in both the wireless community and with the OGC process. They constitute general design guidance toward achieving OpenLS objectives.

7.2.2.1 General Guidelines

1) XLS *must* be based on current market conditions in terms of available technology, content and industry standards.

2) XLS *should* be simple and sufficient. This means that it should be able to adequately represent geographic objects for location services with minimum overhead and complexity (i.e., easy to encode and decode). As such, XLS *must* implement the Abstract Data Types for OpenLS. These types must be extensible.

3) XLS *should* have small footprint (compact for transmission to low powered mobile terminals with limited memory).

4) XLS *should* be developed such that it can be implemented in J2ME based platforms, and accessible by kDom and kXML APIs, with their current capabilities and maybe other wireless platforms that may emerge.

5) A single profile of XLS *may* be insufficient to deal with the variety of mobile devices. (For example, Mobile SVG will have two profiles: SVG-Basic and SVG-Tiny). Similarly, XLS *may* exist in two profiles that correspond to different classes of devices. In this case an appropriate capabilities discovery scheme should be devised to allow clients to discover which profiles are supported by the server

7.2.2.2 Compatible, Consistent and Extensible

1) XLS *should* be scalable so that it can support a wide variety of devices, users, and applications.

2) A simple data model should support XLS for all Abstract Data Types. This will minimize the overhead for feature (object) construction and deconstruction for OpenLS applications and services.

3) XLS *should* be defined in XML schema (xsd).

4) XLS types *should* be defined in a way that would give them enough flexibility to be used according to SOAP encoding rules.

5) XLS specification activities *should* be harmonized with ISO 19133 (Navigation), ISO 19118 (XML Encoding rules) and GML.

6) XLS *should* be designed so that XLS instances can be transformed (e.g., through an XSLT stylesheet) into GML.

7) An appropriate versioning scheme should be devised to guarantee clear versioning numbers.

7.2.3 Detailed Requirements

7.2.3.1 General

1) XLS *must* be based upon well-defined Abstract Data Types for OpenLS.

2) Similar to GML, XLS *should* maintain the separation between location information content and presentation. XLS can be directly rendered on the mobile device or through a standard technology like Mobile SVG. (Current parsers for the devices do not have XSLT support.)

7.2.3.2 Encoding

1) XLS *must* encode the Abstract Data Types for OpenLS in a compact form. The effort to keep the model simple goes hand-in-hand with the need to avoid the overhead of unnecessary encoding, decoding and feature construction/deconstruction complexity for users of OpenLS services.

2) XLS *should* use short tags.

3) XLS *may* use a minimum tag set that is sufficient to meet the encoding requirements for the OpenLS Abstract Data Types.

4) XLS *may* include binary encodings.

5) XLS *should* avoid multiple levels of nesting. (Keep the depth of the trees shallow for simplicity and to minimize the size of code written to handle it. This helps to keep the applications installed on wireless devices as small in size as possible.)

7.2.3.3 Properties

1) XLS *must* support the properties required for Abstract Data Types for OpenLS.

2) Properties *must* be simple properties. Multiple nesting levels should be avoided in properties to avoid complexity.

7.2.3.4 Metadata

1) XLS *should* support metadata.

7.2.3.5 Geometry Elements

1) XLS *must* include point, line, line-string and polygon geometries, per OGC Simple Feature Model.

2) XLS *may* include other geometries.

7.2.3.6 XLS Feature Relationship Schema

1) XLS *may* use Xlink to reference local resources or remote resources in the same document only, in an appropriate way that would work with the limited capabilities of available parsers.

2) XLS *must* support simple relationships in which relationships do not carry properties.

7.2.3.7 XLS Feature Schema

1) XLS *should* support a simplified feature model that doesn't require multiple nesting levels.

2) XLS *must* support the Abstract Data Types for OpenLS and related operations.

7.3 Interface Envelop and Encoding Requirements

This section outlines the requirements pertaining to the encoding of the interfaces (i.e., the Request and Response Parameters) for OpenLS Core Services.

7.3.1 Key Concepts

a) A Client Application is any application that interacts with Core Services, whether it resides on an end-user device or on a server.

b) A Request is the XML string that is passed from a Client Application to a Core Service.

c) A Response is the XML string that is passed from a Core Service to the Client Application.

d) A Session is a series of interactions between a Client Application and one or more Core Services. Those interactions are typically in the form of series of Requests and Responses.

e) Well-Known Request Type and Well-known Response Type are Types that are known to both Client Applications and Core Services.

f) In this document we refer to the 'Request and Response pair' for a Core Service as: R/R.

7.3.2 General Usage Pattern

Figure 2 illustrates the general usage pattern for XML based R/R in OpenLS. The use case starts with the execution of a Client Application that processes a user's request for service. This in turn leads to a request for the use of a Core Service, e.g., a Directory Service. The Client Application encodes the request for the Core Service as an XML Request. Using the HTTP/Post method, the XML Request is sent to a Servlet. The Servlet parses the XML Request, and according to the Request tags, generates the proper function call to the Core Service. The Core Service processes the Request and sends back the Response to the Servlet. The Servlet in turn encodes the Response as an XML Response and forwards it to the Client Application. The Client Application in turn decodes the XML Response and applies the proper presentation functions for display on the Client Device. In the case of thin Client Devices, it is possible that parsing of the XML Response is done on the server and the portrayal content is streamed directly to the Client Device.

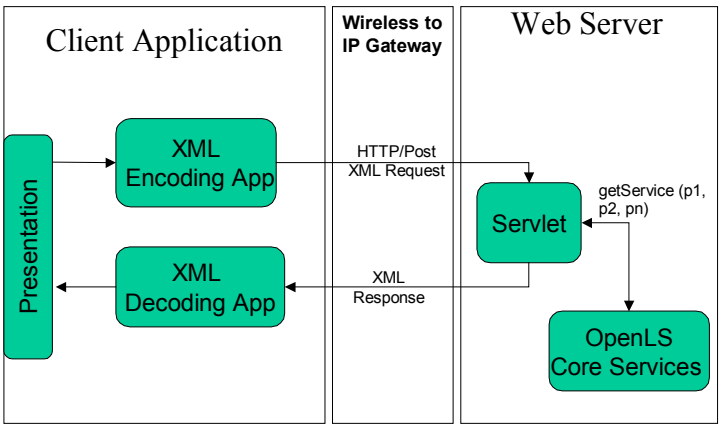


Figure 2. Usage Pattern for OpenLS Request/Response Pairs

7.3.3 Assumptions

1) The architecture is based on connectionless protocol. A Client Application may establish a connection for making a Request, and disconnect right after a Response has arrived.

2) The Client Application knows the Request URI for the OpenLS Core Service. This includes the Port Number.

3) Client Applications are aware of all Interfaces that the Core Service exposes.

4) The Core Service can parse and understand the semantics of the XML Request Parameters generated by the Client Application.

5) Core Services know all the mandatory and optional Request Parameters generated by Client Applications.

6) Client Applications can parse and understand the semantics of the XML Response Parameters generated by Core Services.

7) Client Applications know all mandatory Response Parameters, and possibly some, all, or none of the optional Response Parameters generated by Core Services. If an optional parameter is sent to a Client Application, it is then assumed that the Client Application can understand it; otherwise the Client Application generates an error message or ignores this optional Response Parameter.

7.3.4 General Requirements

The following requirements pertain to both Request and Response Schemas:

1) The R/R schemas ***must*** be based on XML Schema, re: W3C Recommendation (2 May 2001).

2) Encoded ADT-based R/R Parameters in XML ***must*** be consistent with the encoding guidelines and requirements as stipulated in the latest version of the XML for Location Services (XLS) Requirements (section 7.2).

3) R/R pairs ***must*** be consistent with the XLS ADTs.

4) R/R Pairs ***must*** be Well-Known Types.

5) Upon receiving a Request from a Client Application, a Core Service ***must*** send at least one Well-Known Response to the Client Application. A Response might be an answer to the Request, an error message, or an acknowledgement of receiving the Request.

6) XML R/R instances ***must*** be well formed and valid with respect to their schemas.

7.3.5 Encoding Requirements

7.3.5.1 Naming

1) If applicable, you ***should*** satisfy encoding name conventions as stipulated in the latest version of the XML for Location Services (XLS) Requirements (section 7.2).

2) You ***should*** use English descriptors that accurately describe the attribute/element/type, etc. For example, use names like *firstName*, *grandTotal*, or *CorporateCustomer*. Although names like *x1*, *y1*, or *fn* are easy to type because they're short, they do not provide any indication of what they represent and result in schemas that are difficult to understand, maintain, and enhance.

3) Be consistent in using terminology. You ***should*** use terminology that applies for the application domain. For example, if you create an element *MobileDevice* and the mobile operators call it *MobileTerminal*, use the latter.

4) You ***should*** use avoid long names. Some standards recommend a maximum of 13 characters and some 15 characters. For OpenLS, try to limit names to 15 characters in length.

5) Do your best to avoid the use of abbreviations. If you must use an abbreviation, then be consistent with its use. For example, if you want to use a short form for the word "number", then you ***should*** use something like '*nbr'* or '*num'* (it doesn't really matter what form you use), but be consistent in its use.

6) You ***should*** avoid names that are similar or differ only in case. For example *Name* and *name*. This aids interpretability of the schema.

7) You ***should*** avoid names that only differ in their plurality. For example, the attribute names *mobileTerminal* and *mobileTerminals* should not be used together.

8) In general, you ***should*** use lower case letters, but capitalize the first letter of element names, enumerations and type names. You ***should*** use all lower case for attribute names, unless you are using a compound name (see the next requirement).

9) You ***should*** use mixed case to make compound names more readable. Specifically, you ***should*** use upper case for the first letter in all but the first word of a compound Attribute name (e.g., *attributeName*), or upper case for the first letter of all words comprising a compound element name, type name or enumeration (e.g. *ElementName*).

10) Abstract Types ***should*** use the keyword 'Abstract' in their name. For example, an Abstract Type for *Device* might be represented as: *AbstractDeviceType*.

11) You ***should*** use an underscore (i.e. '_') to prefix abstract element names (e.g., *_Device*).

12) You ***should*** avoid the use of acronyms. If you find it necessary to use an acronym, you ***should*** capitalize all letters. For example, using the acronym 'GIS', use *GISAttribute* for an attribute and *GISObject* for an element.

7.3.5.2 Structures

1) If possible, you ***should*** use Attributes instead of Elements. You ***should*** use Attributes if they are simple types and have cardinality = 1, at most.

2) You ***should*** avoid using Anonymous Types. Named types allow reuse.

3) You ***should*** avoid using the same local Element name for different types.

4) You ***must*** use "sequence" blocks instead of "all" blocks within "ComplexType". Complex types that contain "all" blocks cannot be legally subtyped.

5) You ***should*** avoid Anonymous "choice" Blocks.

6) You ***should*** only declare List types when necessary.

7) You ***should*** avoid unsignedInt, unsignedByte, unsignedLong, and unsignedShort and use facets instead when you need to restrict the domain.

7.3.5.3 Coordinate Systems and Units of Measure

1) You ***should*** use degrees as the default units of measure for angles.

2) You ***should*** use meters as the default units of measure for distances and coordinates.

3) You ***should*** express azimuth in degrees measured clockwise from true north.

4) You ***should*** use WGS 84 as the default datum and Coordinate Reference System.

5) You ***should*** follow the OGC recommendation for Coordinate Reference Systems (SRS).

6) You ***should*** follow the OGC recommendation for Units of Measure.

7.3.5.4 Name Spaces

1) All schemas generated under the OpenLS initiative ***must*** set the targetNameSpace attribute value to: http://www.opengis.net/xls.

7.3.6 Request Requirements

Each OpenLS Core Service shall have an XML Request Packet that contains the Request. The XML Request Packet ***mus*t** include at least two main Blocks[1], a Header Block and one or more Method Blocks (which will contain the actual requests):

1) Request Header Block

   a) A Request Header Block ***should*** contain the username and password for the Client Application.

   b) A Request Header Block ***should*** contain the type of the client device, if applicable (based upon a well-known list of known types).

   c) A Request Header Block ***may*** contain a client-defined Session Identifier, to be echoed back by the server.

2) Request Method Block(s)

   a) An XML Request ***should*** contain zero or more Method Blocks.

   b) A Request Method Block ***must*** contain a "global" unique method name (Type NMT) that identifies the method that will be invoked by the Core Service. The term "global" refers to a unique ID that identifies a method in the context of the applicable OpenLS Core Service.

   c) A Request Method Block ***must*** contain Request Version, which indicates the version of the Request that it supports.

   d) A Request Method Block ***mus*t** contain Response Version, which indicates the version of the Response that the Client Application supports.

   e) A Request Method Block ***must*** contain a maximum of one Sub-Block that contains the XML payload (the request parameters) for the specified method.

   f) Each Request Method Block ***must*** have a Request Identifier. The Request Identifier is a string that ***must*** appear in the Method Request Tag as an 'ID' attribute. A Request Identifier ***must*** be unique within the scope of a session.

7.3.7 Response Requirements

The XML Response Packet ***mus*t** include at least two main Blocks, a Header Block and one or more Response Method Blocks:

1) Response Header Block

[1] This structure is designed for compatibility with a SOAP-based API.

a) A Header Block ***may*** include the status of the Response (use a standard list of enumerations for status -- TBD).

b) A Header Block ***should*** contain a Session Identifier, which corresponds with the applicable Request Session Identifier.

Note: The error list associated with the Header Block is for authentication errors and other errors generated for the envelop, whereas error lists associated with a Response Method Block are for individual responses.

2) Response Method Block(s)

a) An XML Response ***must*** contain at least one Response Method Block.

b) The Response Method Block ***must*** contain zero or one Sub-Blocks that contain the XML payload for the specified method.

c) A Response Method Block ***must*** contain Response Version, which indicates the version used to encode the Response.

d) A Response Method Block ***may*** include the status of the Method Response (use a standard list of enumerations for status -- TBD).

e) A Response Method Block ***may*** include zero or more Fault (Error) Elements, which indicate the error status (use a standard enumerated list of errors -- TBD), code and description generated during the scope of the session. [Note: Error handling is based upon the SOAP Fault Element.]

f) Response Packets ***may*** have the same identifier as the Method Request Tag. The 'ID' is a ***must*** if this method employs a Request Identifier, and it ***must*** match the Request Identifier. Having more than one Response Method Block is usually a result of sending more than one Request Method Block.

7.3.8 HTTP Transaction Protocol Requirements

7.3.8.1 HTTP Request Requirements

1) OpenLS Core Services ***must*** conform to HTTP/1.1 Post Request according to IETF RFC 2616.

2) HTTP/1.1 Post Requests ***must*** contain Two Blocks. The first Block ***must*** be the header that conforms to HTTP/1.1. The second Block, the body, ***must*** contain the content payload of the Request.

3) HTTP/1.1 Post Request Header Block:

a) ***Must*** include the Content-Length.

b) ***Must*** include the Content-Type. For the purpose of this test bed, the Content-Type ***must*** be text/xml.

c) ***Must*** contain CRLF (Carriage Return and Line Feed).

4) HTTP/1.1 Post Request Body Block

a) The Request Block ***must*** include the XML payload of the Request.

The following is an example of an HTTP/1.1 Post Request:

```
<SLIR requestVersion=”1.1” responseVersion=”1.4” id=”1>
      <GatewayParameters>
                  <MSIDS>
                        <MsInformation msIdType="msisdn" msIDValue=”
+12066741000”/>
                  </MSIDS>
      </GatewayParameters>
</SLIR>
```

7.3.8.2 HTTP Response Requirements

1) OpenLS Core Services ***must*** conform to HTTP/1.1 Post Response according to IETF RFC 2616.

2) HTTP/1.1 Post Responses ***must*** contain Two Blocks. The first Block ***must*** be the header that conforms to HTTP/1.1. The second Block, the body, ***must*** contain the response to the Post Request.

3) HTTP/1.1 Post Response Header Block

a) ***Must*** include the Content-Length.

b) ***Must*** include a Response code and its corresponding Response String as described in RFC 2616 for HTTP/1.1.

c) ***Must*** include the Content-Type. For the purpose of this test bed, the Content-Type ***must*** be text/xml.

d) The Header ***must*** contain CRLF (Carriage Return and Line Feed).

4) HTTP/1.1 Post Response Body Block

a) This block ***must*** include the XML String of the Response.

The following is an example of an HTTP/1.1 Post Response:

```
<SLIA Version=”1.4” language=”english” id=”1”>
    <GatewayParameters>
        <MSIDS>
            <MsInformation msIdType="msisdn" msIDValue=”
+12066741000”>
                <Position>
                    <gml:Point>
                        <gml:pos>47.611197 -122.347565</gml:pos>
                    </gml:Point>
                </Position>
            </MSInformation>
        </MSIDS>
    </GatewayParameters>
</SLIA>
```

7.4 Abstract Data Type Requirements

The ADTs are well-known information types that are used by the Core Services, and form the Information Framework for the GeoMobility Server.

7.4.1 Address ADT

Address ADT contains address information for a geographic place. Addresses reference and uniquely identify particular points of interest and can serve as the basis for aggregating data for that location. The Address ADT consists of a street address (or intersection), place name (e.g. country, municipality, etc.), postal code, street locator, building locator, and supplemental address information. As used here, addresses are the means of referencing primarily residences and buildings (of all types, where a subscriber may conduct business).

7.4.2 Area of Interest (AOI) ADT

Contains an Area of Interest as defined by a named circle, bounding box, or polygon. Used to as a search parameter or can be displayed for a subscriber (e.g. Hot Zone).

7.4.3 Location ADT

The extensible, abstract type for all expressions of Location that can be used by OpenLS application and services to specify the location of a target or a subscriber. Location is the

root of a semantic tree that includes a Point, Position ADT, Address ADT, and POI ADT as its subtypes.

7.4.4 Map ADT

Map ADT contains a rendered map that results from the Map Portrayal Operation of the Presentation Service. It can then be used as input to other Presentation Services. Map ADT consists of content information (format, width and height) and context information (bounding box, center point and scale).

7.4.5 Point of Interest (POI) ADT

A place or entity with a fixed position that may be used as a reference point or a target in an OpenLS service. The POI is the primary output from a Directory Service, and thus, is also the "place" where one might obtain a product or service. It contains name, type, category, address, phone number, and other directory information about the place, product, and/or service.

7.4.6 Position ADT

Position ADT contains any observed or calculated position, in the broad semantic context of the use of the term. It primarily contains a geographic position and quality of position. Position is the primary output from a Gateway Service. Position maps to the semantics of the *Location, Shape* and *Quality of Position* elements, as defined in the Mobile Location Protocol (MLP) Specification (Version 3.0, Location Interoperability Forum---LIF). Thus, it contains the full definition of a position of a Mobile Terminal (Standard Location Immediate Service). Position may also be used by an OpenLS application to represent any position of interest. Position is distinguished from POI, which is a well-known place with a position, name, address, etc.

7.4.7 Route Instructions List ADT

Route Instructions List ADT contains a list of travel instructions consisting of turn-by-turn directions and advisories along the route, ordered in sequence of their occurrence, and formatted for presentation to the user. Route Instructions List ADT is generated by the Route Service and "presented" to a subscriber via the Presentation Service.

7.4.8 Route ADT

The Route ADT is actually two ADTs: Route Summary and Route Geometry. Route Summary contains the route's overall characteristics, such as its start point, waypoints, end point, transportation type, total distance, travel time, and bounding box. Route Geometry contains a list of geographic positions along the route, ordered in the sequence of planned travel, starting with the position of the route's origin and ending with the position of the route's destination. The geometry includes the positions of all nodes along the route, including waypoints. The geometry also includes intermediate points needed to describe the geometric shape of the route segments between each node in the route. These

two ADTs are generated by the Route Service and "presented" to a subscriber as routing information, e.g. as a route displayed over a map, via the Presentation Service, or they are used directly by an application to guide a mobile subscriber to their destination.

8 Top-Level Architecture

Figure 3 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.

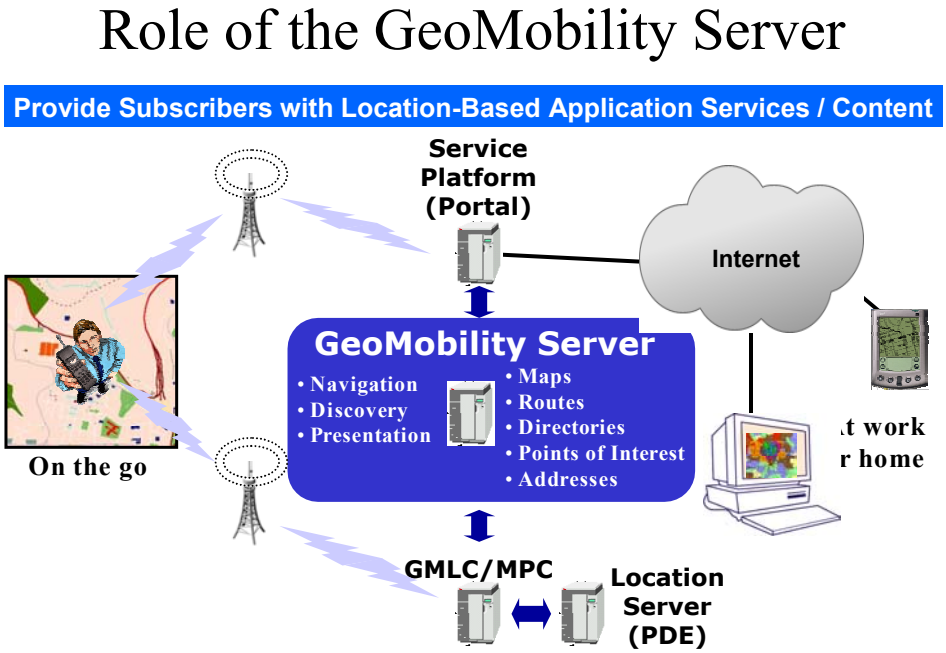


Figure 3. Role of the GeoMobility Server

9 OpenLS Core Services

The Core Services are location-based application services that form the Services Framework for the GeoMobility Server. See the associated specifications for these services for details about each of these services (these references are listed in section 3).

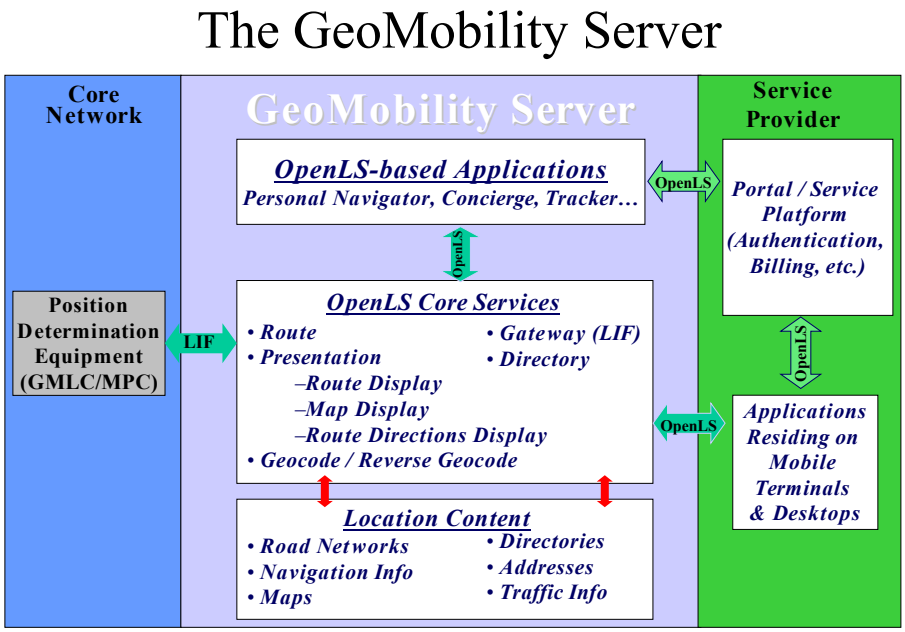


Figure 4. The GeoMobility Server

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=EPSG4326);

- 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 Part 1: Directory Service

This service provides subscribers with access to an online directory to find the nearest or a specific place, product or service. Through a suitably equipped OpenLS application, the subscriber starts to formulate the search parameters in the service request, identifying the place, product or service that they seek by entering the name, type, category, keyword, phone number, or some other 'user-friendly' identifier. A position must also be employed

in the request when the subscriber is seeking the nearest place, product or service, or if they desire a place, product or service at a specific location or within a specific area. The position may be the current Mobile Terminal position, as determined through the Gateway Service, or a remote position determined in some other manner. The directory type may also be specified (e.g. yellow pages, restaurant guide, etc). Given the formulated request, the Directory Service searches the appropriate online directory to fulfill the request, finding the nearest or specific place, product or service, depending on the search criteria. The service returns one or more responses to the query (with locations and complete descriptions of the place, product, or service, depending upon directory content), where the responses are in ranked order based upon the search criteria.

9.1.1 Pinpoint Directory Service

Provides subscribers with access to an online directory to find the location of a **specific** place, product or service. This service is independent of subscriber location (e.g., the subscriber may wish to 'pinpoint' a place in a distant country).

9.1.2 Proximity Directory Service

Provides subscribers with access to an online directory to find the **nearest** place, product or service.

From the Usage Scenarios below, it seems unnecessary to separate these usages into two services, when they are simply special cases of the same underlying Directory Service request.

The examples below will illustrate that there are two simple cases for finding a particular point of interest that roughly correspond to the Pinpoint and Proximity requests:

1. By some property of the Point of Interest (e.g., unique identifier, name, description, phone number, absolute location)

2. By its location relative to some other point of interest (e.g., Nearest to me, within some distance of a specified entity, within some defined boundary).

Any of these or combinations of these may be made using the combined Directory Services request which is specified below.

9.1.3 Requirements

9.1.3.1 General

The definition of request/response pairs defined below will encompass the requirements for both Pinpoint and Proximity Directory Services. The two usages of the Directory Service will be affected by selecting the appropriate optional parameters in the XML schema.

9.1.3.2 Request Requirements

The parameters of the combined Pinpoint/Proximity request *must* include:

- Directory Type: e.g., White Pages, Yellow Pages, Green Pages, etc.

The Pinpoint query will use parameters that will uniquely identify the Point of Interest. At least one of the following options *may* be used to identify the target location:

- Point of Interest Name, identifying a specific location – e.g., Red Dragon Chinese Restaurant;
- Point of Interest Point, identifying an exact location coordinate of the Point of Interest;
- Point of Interest Address, identifying the street address of the Point of Interest.

The Proximity query will use parameters that will identify a shortlist of candidate locations by distance from a location that may itself be specified by a Pinpoint query, e.g., "Give me the taxi rank nearest to the Red Dragon Chinese Restaurant".

This may involve a combination of Proximity parameters to spatially constrain the search:

- Proximity Type: type of proximity algorithm – e.g., Linear Distance, Bounding Polygon;
- Source Location – point for determining proximity (possibly a POI);
- Proximity Minimum Distance;
- Proximity Maximum Distance;
- Proximity WithinBoundary, a polygon for Bounding Polygon search;

It will also involve a combination of parameters to constrain the result of the search:

- Maximum Number of elements to be returned: e.g., nearest 5 restaurants.
- Sort criteria (attribute to sort on; ascending/descending).

Other parameters may be used to constrain the search, resulting in a shortlist of Points of Interest:

- List of Point of Interest Place/Product/Service types identifying a group of locations with some common attribute - e.g., Restaurants, Restaurants.Asian, Restaurants.Asian.Chinese, Restaurants.Asian.Chinese.Seafood;

- Formal Categorisation in the form of a Name Reference System, e.g., NAICS, NACE, UPC, specifying the properties appropriate to that Name Reference System;

- List of one or more keywords;

- Partial street address, such as State, City or Suburb.

The XML Request will comprise a Header Block and a Method Block, according to the Request and Response Encoding Requirements.

9.1.3.3 Response Requirements

The parameters of the combined Proximity/Pinpoint response include the required elements of the Point of Interest ADT.

The XML Response will comprise a Header Block and a Method Block, according to the Request and Response Encoding Requirements.

9.1.4 Use Cases

The user of the Directory Service wishes to locate a particular Place, Product or Service. The user may constrain the request by specifying parameters that filter out candidate places/products/services according to some identifier, attribute, or location.

Example usage scenarios for Directory Service are captured below.

9.1.4.1 Use Case 1

Constraining the request by identifier amounts to a Pinpoint White Pages query: “Where is the Red Dragon Chinese Restaurant?”

9.1.4.2 Use Case 2

Constraining the request just by attribute amounts to a normal Yellow Pages query: “Where are the Chinese Restaurants?”

9.1.4.3 Use Case 3

Constraining the request by location relative to a given location amounts to a Proximity query: “Where is the nearest Chinese Restaurant to my hotel?”

9.1.4.4 Use Case 4

Constraining the request by location within a boundary amounts to a different Proximity query: “Which Chinese Restaurants are within 500m of my hotel?”

Any of these requests could result in a response consisting of a text address list, a location map, or, if a source location is provided with the request, a route map and a list of directions.

9.1.5 Request and Response Parameters for Directory Service

This section specifies the request and response parameters for the Directory Service. Note that it not required to specify a Spatial Reference System as all co-ordinates will be referenced to WGS 84 (latitude, longitude).

9.1.5.1 Directory Request Parameters

A collection of one or more of the parameters below			
Name	**Mandatory?**	**Data Type**	**Description**
POI Location	N*	Location ADT	Start point for proximity searches (may be a POI). *Mandatory if proximity type set to Linear distance. Subtypes are: Address, Nearest and WithinDistance. Nearest and WithinDistance also have an Address subtype.
Address	N	Address ADT	Address for this POI
Nearest		Integer	Searching for closest services
Within Distance		WithinDistanceType	Searching for services no further than this distance.
MaximumDistance		Decimal	The maximum distance for the search
MinimumDistance		Decimal	The minimum distance for the search

WithinBoundary		AOI ADT	Polygon to search within.
POIProperties	Y	POIPropertiesType	Container for the list of properties that will be used to do the search
directoryType	N	String	One of the following: White Pages, Yellow Pages, Green Pages, and Blue Pages. This is not an exhaustive list of directories, and there is no requirement that one vendor should implement all of them.
POIProperty	N	POIPropertyType	The property used to search for a POI, a property would contain a name and value. Because the directory service doesn't implement a capabilities request that describes the structure of the data, a generic enumeration has been devised to allow for generic searches, without having to know the data structure

Name	Y	POIPropertyNameType	Values allowed for this attribute are: • ID • POIName • PhoneNumber • Keyword (a generic parameter) • NAICS_type • NAICS_subtype • NAICS_category • SIC_type • SIC_subtype • SIC_category • SIC_code • Other (custom values)
value	Y	String	The value of this property
SortCriteria	N	String	Attribute to be used for sorting result. Sort may be based upon: POIName, distance or other POIPropertyNameType (e.g., NAICS_type)
SortDirection	N	Boolean	Ascending/Descending

9.1.5.1.1 Example Directory Requests

a. Use Case 1 – "Where is the Red Dragon Chinese Restaurant?"

```
<DirectoryRequest>
    <POIProperties directoryType="White Pages">
        <POIProperty name="POIName" value="Red Dragon Chinese Restaurant"/>
    </POIProperties>
</DirectoryRequest>
```

b. Use Case 2 – "Where are the Chinese Restaurants?"

```
<DirectoryRequest>
    <POIProperties directoryType="Yellow Pages">
        <POIProperty name="NAICS_type" value="Restaurant"/>
```

```
        <POIProperty name="NAICS_subType" value="Chinese"/>
    </POIProperties>
</DirectoryRequest>
```

c. Use Case 3 – "Where is the nearest Chinese Restaurant to my hotel?"

```
<DirectoryRequest>
    <POILocation>
        <Nearest>
            <POI ID="1">
                <POIAttributeList>
                    <POIInfoList>
                        <POIInfo name="POI Name" value="My Hotel"/>
                    </POIInfoList>
                </POIAttributeList>
            </POI>
        </Nearest>
    </POILocation>
    <POIProperties directoryType="Yellow Pages">
        <POIProperty name="NAICS_type" value="Restaurant"/>
        <POIProperty name="NAICS_subType" value="Chinese"/>
    </POIProperties>
</DirectoryRequest>
```

d. Use Case 4 – "Which Chinese Restaurants are within 500m of my hotel?"

```
<DirectoryRequest>
    <POILocation>
        <WithinDistance>
            <POI ID="1">
                <POIAttributeList>
                    <POIInfoList>
                        <POIInfo name="POI Name" value="My Hotel"/>
                    </POIInfoList>
                </POIAttributeList>
            </POI>
            <MaximumDistance value="500"/>
        </WithinDistance>
    </POILocation>
    <POIProperties directoryType="Yellow Pages">
        <POIProperty name="NAICS_type" value="Restaurant"/>
        <POIProperty name="NAICS_subType" value="Chinese"/>
    </POIProperties>
</DirectoryRequest>
```

9.1.5.2 Directory Response Parameters

Response Parameters
A collection of one or more of the parameters below.

Name	Mandatory?	Data Type	Description
POIContext	N	POIWithDistanceType	A list of one or more POIs and there distance from the request location.
Points of Interest / Distance pairs	N	List of POI and Distance (Integer) pairs	List of all Point of Interest records satisfying the request and the distance from the source location. Distance will be zero for WithinBoundary request.

9.1.5.3 Notes:

a. Depending on the nature of the query, some terms within the query may be mandatory or not.

b. The proximity query performs a spatial filter on a list of Points of Interest. These POIs may be listed explicitly by a unique identifier (ID, Name, Coordinate, Coordinate List, Address) or derived from categories, formal categories or keywords within a Directory Type.

9.2 Part 2: Gateway Service

This is the interface between the GeoMobility Server and Location Server that resides in the GMLC or MPC through which OpenLS services obtain position data for Mobile Terminals. This interface is modeled after the MLP specified in LIF 3.0 for Standard Location Immediate Service.

9.2.1 Requirements

The following six use cases will be used to formulate the requirements. These use cases have been grouped into 3 priority categories, with priority 1 having the highest priority and the only mandatory support. The Gateway Service *should* support the following requirements:

Use Case	Priority
Client requests a single mobile terminal's immediate location.	1
Client requests single mobile terminal's periodic location	2

Client requests multiple mobiles' immediate location	2
Client requests single mobile terminal's triggered location	3
Client request multiple mobiles' periodic location	3
Client requests multiple mobiles' triggered location	3

9.2.2 A Location Request Use Case

A subscriber wants to use a Location-Based Service. The Gateway Service is employed to obtain the position of the subscriber's mobile terminal from the network. A Location Service Client sends the request to determine a position to the Gateway. The Gateway calculates the position of the subscriber's mobile terminal and forwards to the Location Service Client, which may store it for as long as needed. The request will be sent to the gateway as follows:

```
<InputGatewayParameters priority="HIGH" locationType="CURRENT_OR_LAST"
requestedsrsName="WGS84">
        <InputMSIDS>
            <InputMSInformation  msIDType="IPV4"
msIDValue="461018765728"></MSInformation>
        </ InputMSIDS >
        <RequestedQoP responseReq="No_Delay" responseTimer="20">
            <HorizontalAcc>
                <Distance value="1000"></Distance>
            </HorizontalAcc>
        </RequestedQoP>
    </InputGatewayParameters >
```

The gateway response will be provided as follows:

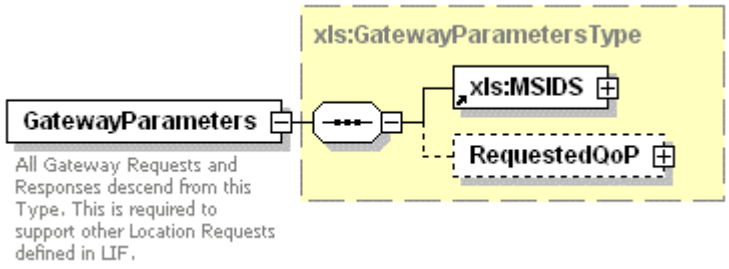
```
        <SLIA Version="1.4" language="english" id="1">
            <OutputGatewayParameters>
                <OutputMSIDS>
                    <OutputMSInformation msIdType="msisdn" msIDValue="
  +12066741000">
                        <Position>
                            <gml:Point>
                                <gml:pos>47.611197 -122.347565</gml:pos>
                            </gml:Point>
                        </Position>
                    </OutputMSInformation>
                </OutputMSIDS>
            </OutputGatewayParameters>
```

```
</SLIA>
```

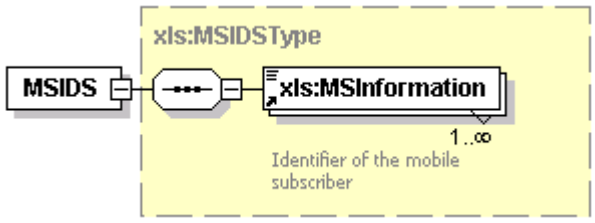
9.2.3 Request and Response Parameters

This section specifies the request and response parameters for the Gateway Service.

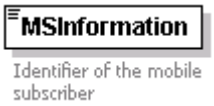
Element **GatewayParameters**

diagram	
type	xls:GatewayParametersType
attributes	Name / Type / Use / Default / Fixed locationType / string / optional / CURRENT requestedsrsName / string / optional ver / string / 1.0 priority / string / optional / HIGH
annotation	documentation: All Gateway Requests and Responses descend from this Type. This is required to support other Location Requests defined in LIF.

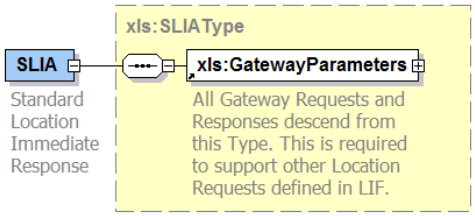
Element **MSIDS**

Diagram	
type	xls:MSIDSType
children	xls:MSInformation
attributes	Name / Type / Use / Default / Fixed session / string / optional

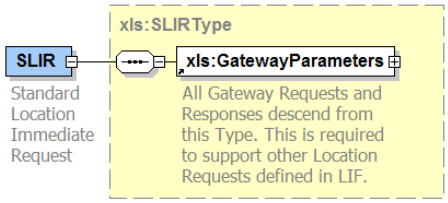
Element **MSInformation**

Diagram					
type	**xls:MSInformationType**				
children	**xls:Position**				
attributes	Name	Type	Use	Default	Fixed
	msIDType	string		MSISDN	
	msIDValue	string			
	encription	string	optional	ASC	
Annotation	Identifier of the mobile subscriber				

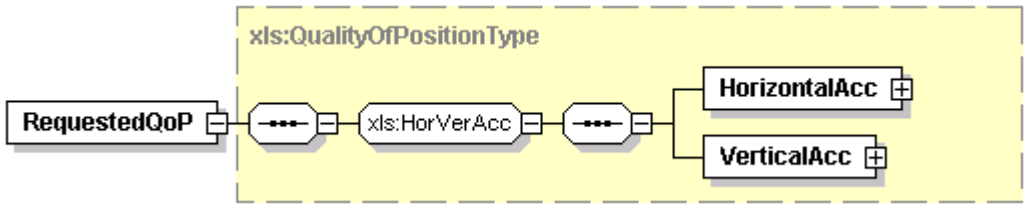
element **SLIA**

Diagram					
type	**xls:SLIAType**				
children	**xls:InputGatewayParameters**				
attributes	Name	Type	Use	Default	Fixed
	requestID	string	optional		
	additionalInfo	string			
Annotation	Standard Location Immediate Response				

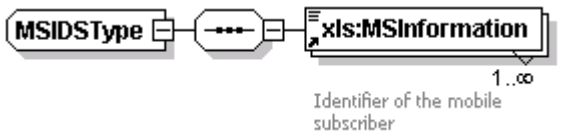
element **SLIR**

Diagram	
type	xls:SLIRType
attributes	Name: responseType; Type: string; Use: optional; Default: PERSISTENCE; Fixed:
Annotation	Standard Location Immediate Request

element **RequestedQoP**

Diagram	
type	xls:QualityOfPositionType
children	HorizontalAcc VerticalAcc
attributes	Name: responseReq; Type: string; Use: optional; Default: Delay_Tol; Fixed: Name: responseTimer; Type: string; Use: optional; Default: ; Fixed:

complexType **MSIDSType**

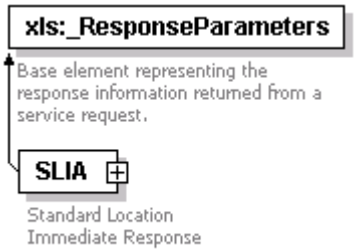
Diagram	
children	xls:MSInformation
attributes	Name: ; Type: ; Use: ; Default: ; Fixed:

	session	string	optional

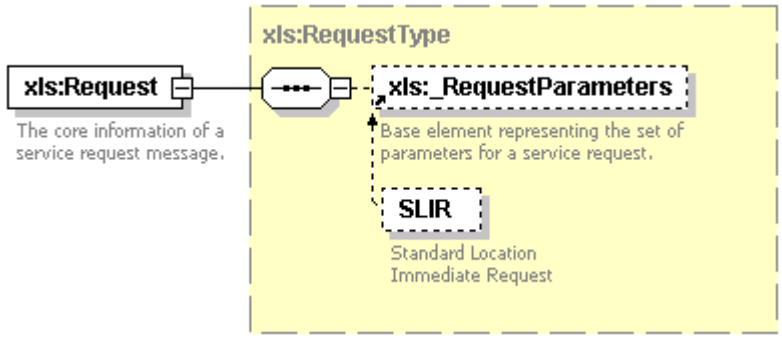
element **xls:_RequestParameters**

Diagram	
type	xls:AbstractRequestParametersType
Annotation	Base element representing the set of parameters for a service request.

element **xls:_ResponseParameters**

Diagram	
type	xls:AbstractResponseParametersType
Annotation	Base element representing the response information returned from a service request.

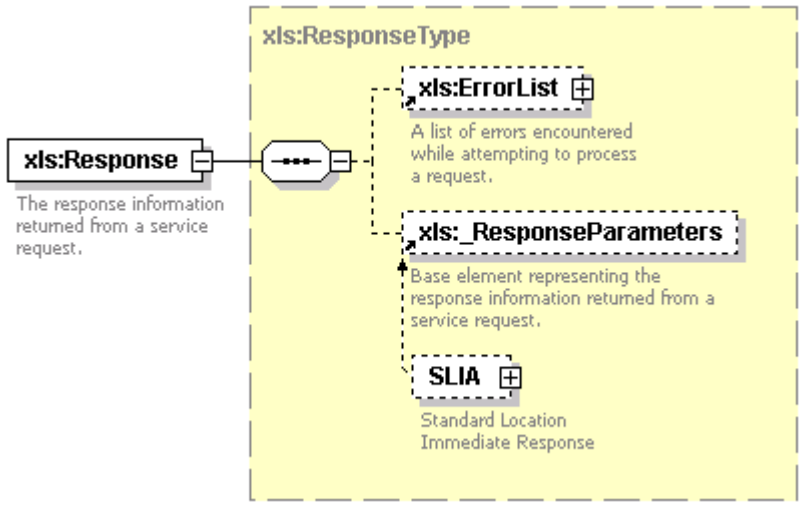
element **xls:Request**

Diagram	
type	**xls:RequestType**
children	**xls:_RequestParameters**
attributes	Name / Type / Use / Default / Fixed methodName / NMTOKEN / required version / string / required requestID / string / required
Annotation	The core information of a service request message.

element **xls:RequestHeader**

Diagram	
type	**xls:RequestHeaderType**
attributes	Name / Type / Use / Default / Fixed clientName / string / optional clientPassword / string / optional deviceType / string / optional sessionID / string / optional language / language / optional
Annotation	The header information for request messages.

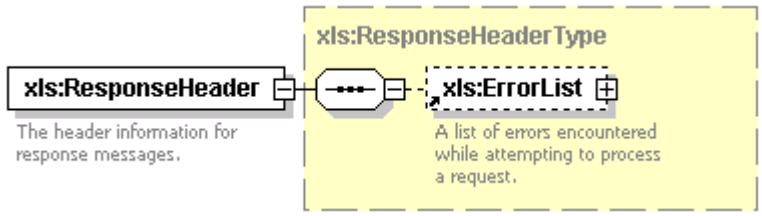
element **xls:Response**

Diagram	
type	**xls:ResponseType**
children	**xls:ErrorList** **xls:_ResponseParameters**

attributes	Name	Type	Use	Default	Fixed
	version	string	required		
	requestID	string	required		

Annotation	The response information returned from a service request.

element **xls:ResponseHeader**

Diagram	
type	**xls:ResponseHeaderType**
children	**xls:ErrorList**

attributes	Name	Type	Use	Default	Fixed
	sessionID	string	optional		

Annotation	The header information for response messages.

9.3 Part 3: Location Utility Service (Geocoder/ Reverse Geocoder)

This service performs as a geocoder by determining a geographic position, given a place name, street address or postal code. It also returns a complete, normalized description of the place (which is useful, say, when only partial information is known). The service also performs as a reverse geocoder by determining a complete, normalized place name/street address/postal code, given a geographic position. Both the geocoder and reverse geocoder may return zero, one, or more responses to a service request, depending on subscriber request information, the algorithm being employed, and the match criteria.

9.3.1 Requirements

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.

9.3.1.1 Geocoder Service

The following requirements *must* be supported by the Geocoder Service:

- Given an Address ADT, *must* be capable of using an address matching Geocoding algorithm to determine a position for the specified address.
- *Must* be capable of performing geocoding using an incomplete address and return the complete set of address information (i.e., a normalized address).
- *Must* be able to indicate the number of matches in the response (possibly zero) for a particular address supplied in the geocoding request.
- *Must* be capable of processing one or more addresses in a single geocoding request.
- *May* provide information on the quality of the result using a 'match code'.

9.3.1.2 Reverse Geocoder Service

The following requirements must be supported by the Reverse Geocoder Service:

- Given a Position ADT, *must* be able to return one or more locations (i.e., Address ADTs with associated Point geometries), and optionally, the ranges of these locations from the given position, as it is defined in the Position ADT.

- The form of the returned address(es) *must* be based upon the user's preference, as stated in the request. The user should be able to specify a preference of StreetAddress, StreetIntersection, or PositionOfInterest (Place and/or PostalCode). If not specified, the service should default to StreetAddress.

- *Must* be capable of returning all location information of a preferred type within an area of interest (AOI ADT – a Circle, Polygon or Box).

Must be able to indicate the number of matches in the response (possibly zero) for a given request.

9.3.2 Use Cases

9.3.2.1 Geocoder Service

Once a Geocoder Service determines a position from a partial or complete address, then the pertaining information element becomes a location-based resource that can be readily exploited by another service, like Directory or Route.

9.3.2.1.1 Use Case 1 – Given an Address, Find a Position

A company has a database with a list of its customers and addresses. They want to geocode their database and have a geometry (Point) attached to the addresses. This will then be used to display the locations of customers on a mobile device.

9.3.2.1.2 Use Case 2 – Drive to an Address (Position)

A motorist wishes to drive from home to an address in Regent Street, London. The address is geocoded and its location used as a destination within in a route planning application.

9.3.2.1.3 Use Case 3 – Given a Place/ Street Name, Find its Position and Display it on a Map

Elvis Presley wants a map to his new dwelling place. He only knows part of the address: "Heartbreak Hotel", "Lonely Street".

The partial address is fed into a Geocoder Service that determines the complete normalized address and position of Elvis' dwelling. This in turn is fed into a Route Service that calculates the route from Elvis' current position (as determined for his cell phone) to the dwelling. The result is a map.

9.3.2.2 Reverse Geocoder Service

9.3.2.2.1 Use Case 1 – Given a Position, Find an Address

The Reverse Geocoding Service is normally requested by an application that merely needs to determine the address for a given position. The application sends a Position ADT to the Reverse Geocoder, which returns the Address of the position.

9.3.2.2.2 Use Case 2 – Where am I?

A mobile phone user is walking down a road and wants to know the address of the building that she is standing outside.

The returned address information returned may be displayed for the subscriber, used to generate a voice command or otherwise used by the OpenLS applications.

9.3.2.2.3 Use Case 3 – Provide Location Context

How "Get Location Service" is provided by the Reverse Geocoder Service:

A user needs an answer to the question "Where Am I?" based on their current location. They desire expanded "location context", e.g., street, place, jurisdiction. The application sends the Position ADT to the Reverse Geocoder Service, which returns the expanded location information for that position. The application can then extract the location information corresponding to the required context "street address", "place" etc.

9.3.3 Request and Response Parameters

This section specifies the primary request and response parameters for the Geocoder and Reverse Geocoder Services.

9.3.3.1 Geocoder Service

Primary GeocodeRequest Parameters			
A collection of one or more of the parameters below.			
Name	**Mandatory?**	**Data Type**	**Description**

Address	Y	Address ADTs	List of 1→∞ Addresses. May be unstructured free form address, partial or complete addresses.
Primary GeocodeResponse Parameters			
For each Address request, the response (GeocodeResponseList) will contain a collection of the following parameters:			
Name	**Mandatory?**	**Data Type**	**Description**
numberOfAddresses (attribute of GeocodeResponseList)	Y	Integer (non-negative)	Number of valid responses (GeocodedAddress) found by the Geocoder Service for a given Address request; may be zero.
List of 1→∞ GeocodedAddress(es) sorted by the Accuracy of the match, with highest accuracy first, each with the following parameters:			
Point	Y	Point (Geometry)	The position of the GeocodedAddress response resulting from the geocoding operation.
Address	Y	Address ADT	The actual Address for the GeocodedAddress response. These are normalised addresses.
GeocodeMatchCode	N	GeocodingQOSType	The QoS information for the GeocodedAddress response. Provides information on the quality of the match. These results consist of an Accuracy (GeocodeAccuracyType) and a MatchCode (GeocodeMatchType)

9.3.3.2 Reverse Geocoder Service

Primary ReverseGeocodeRequest Parameters			
Name	**Mandatory?**	**Data Type**	**Description**
Position	Y	Position ADT	The starting position (lat,long) for Reverse Geocoder.
SearchArea	N	AOI ADT	Area to restrict the search for addresses. Can be a Circle, Polygon or Box. This function can be used as an approach to narrow down candidates or widen the area of search. It is independent of the position shape.
ReverseGeocodePreference	N	ReverseGeocodePreferenceType	Describes the preference for the response from the Reverse Geocoder Service: StreetAddress, IntersectionAddress, or PositionOfInterest (Place and/or PostalCode). If not specified, then the service will return the nearest StreetAddress.
Primary ReverseGeocodeResponse Parameters			
Name	**Mandatory?**	**Data Type**	**Description**
List of 0→∞ ReverseGeocodedLocation(s) sorted by the SearchCentreDistance (the distance between the starting Position in the request and each Point-Address response), in order (with shortest distance first), where each ReverseGeocodedLocation has the following parameters:			

Address	Y	Address ADT	The actual Address for the ReverseGeocodedLocation response. These are normalised addresses.
Point	Y	Point (geometry)	The position (lat, long) of the ReverseGeocodedLocation response.
SearchCentreDistance	N	Float (decimal metres)	Distance of Point from starting Position.

Notes:

1. SearchArea must contain starting Position; therefore the service must be capable of validating this.

2. All response lists are sorted in order of shortest to longest SearchCentreDistance (default in metres).

3. If SearchArea is not specified, only the nearest valid response is returned.

9.4 Part 4: Presentation Service

This service renders geographic information for display on a Mobile Terminal. Any OpenLS Application may call upon this service to obtain a map of a desired area, with or without map overlays that depict one or more OpenLS ADTs, such as Route Geometry, Point of Interest, Area of Interest, Location, Position and/or Address. The service may also be employed to render route directions from Route Maneuver List ADT and/or Route Instructions List ADT.

9.4.1 Requirements

The main purpose of the Presentation Service is the portrayal of maps, and the portrayal of ADTs as map overlays. The act of portrayal is taking the information from the other OpenLS Core Services (ADTs), adding style and producing output that is easily understood by a user.

DESCRIPTION	***Must***	***Should***	***May***

Accept output Parameters	✔		
Support context parameters	✔		
Accept a list of ADT's	✔		
Provide a base map		✔	
Support named styles			✔
Support user defined styles			✔
GetCapabilities *			✔

*GetCapabilities provides a list of the following: layers, styles, formats and SRS's.

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.

9.4.1.1 Output Parameters

Defines what the size and encoding of the portrayed map should be using the following criteria:

- **Width –** The width of the map in pixels.

- **Height –** The height of the map in pixels.
- **Format –** Parameter that specifies what the encoding of the map should be. This is specified as a mime-type. The mime-types supported are left up to the implementation.
- **Transparency -** Boolean that defines the opacity of the background of the map.
- **Background Color –** Defines the background color of a map if it is opaque.
- **Content –** Specifies what type of content would be returned, whether the URL or the data as base64

9.4.1.2 Context

Defines what area of the world the map is portraying**.** This can be defined in the following ways:

- **Bounding Box**- Two-point box in a specific SRS that defines the extents of the map (WGS 84 is the default). This is the same bounding box used in WMS and is present for compatibility with it.
- **Center Point and Scale -** The center point defines the center of your map at a particular scale and projection.
    - **Center Point –** The center point of the map. This point is specified in WGS 84 as a latitude/longitude in decimal format.
    - **Scale –** The ratio between device units and world units. Specified as the number of world units per device units. Thus 1:50000 would be expressed as a scale of 50000.
    - **Azimuth –** The orientation of the map. This is expressed in clockwise degrees from north.
    - **DPI –** Dots per inch of the device.
    - **SRS –** Spatial Reference System. Provides what projection should be used when creating the map.
    - **DisplayScale -** A ratio of distance. For example 1:5000 would be expressed as 5000, it's always expressed per 1 pixel of the display.

If context is not specified the implementation must derive it from the ADTs.

9.4.1.3 Overlays

Defines a list of ADTs for portrayal on the map.

- **ADT** (Abstract Data Type) – ADTs are usually obtained as outputs from other core services. To date we have Position ADT, Route ADT, POI ADT and Map ADT.
    - **Z Order** – The order in which the ADTs are laid on top of each other over the base map.
- **Custom Style** – This is either a named-style or a user-defined style. This specification doesn't define a specific format for style description. This is a placeholder for custom extensions to use. Also, a placeholder for future versions to define.

If a style is not specified it is up to the implementation to use a default.

9.4.1.4 Base Map

Provides a backdrop for the ADTs and is made up of a set of layers. The user determines the layers that are to be included or excluded from the base map in their request. The implementation *must* create and support its own list of layers for the user to choose from.

- **Layers** – The list of layers of interest
    - Filter – Determines if the layers are included or excluded. "Give me only the following layers" or "Give me all layers but the following".
- **Custom Style** – This is either a named-style or a user-defined style. This specification doesn't define a specific format for style description. This is a placeholder for custom extensions to use. Also, a placeholder for future versions to define.

If a style is not specified it is up to the Implementation to use a default.

9.4.1.5 Style

Defines how the ADTs should look. The implementation should create and support their own list of styles for the consumer to choose from.

- **Named Style** – A string that is provided by the implementation.
- **User Defined Style** – The consumer defines the content of the style. This specification doesn't define a specific format for style description. This is a placeholder for custom extensions to use. Also, a placeholder for future versions to define.

9.4.1.6 Get Capabilities

Provides the user with the list of capabilities that the implementation provides. Consists of the following:

- **Layers** - Layers provided by the implementation.
- **Style** – Styles provided by the implementation.
- **Format –** Mime-types supported by the implementation.
- **SRS –** Spatial Reference Systems supported, in EPSG:XXXX format.

9.4.2 Use Cases

9.4.2.1 Use Case 1

Joe User wants to see where his house is located on a map. To satisfy this use case the presentation service needs to show a base map with the position of Joe's house overlaid onto it.

For an example see section 9.4.4.1.

9.4.2.2 Use Case 2

Planning a family road trip, Joe User wants to see how get from his house in Calgary, Alberta, to the hotel he has booked in San Diego, California. To satisfy this use case the presentation service needs to show map(s) with the route and the two points of interest overlaid onto it.

For an example see section 9.4.4.2.

9.4.3 Request and Response Parameters

This section specifies the request and response parameters for the Presentation Service.

9.4.3.1 Request Parameters

REQUEST PARAMETER	REQUIRED	DATA TYPE	DATA DESCRIPTION
Output Parameters	✔		List of Outputs (1 to unbounded)
• Width	✔	Integer	Number of pixels
• Height	✔	Integer	Number of pixels
• Format	✔	String	Mime-type
• Transparent	-	Boolean	Defaults to true if not specified
• BGcolor	-	String	RGB Hex Format Defaults to "#FFFFFF" (white)
• Content	-	URL Data	Specifies the type of output the map is returned in whether URL or data for base 64, default value is URL
Bounding Box Context	-	XLS Box	2 point box in a specified SRS
Center Context	-		
• Azimuth	-	Integer	Orientation. Specified in clockwise degrees from north
• SRS	✔	String	EPSG:XXXX format
• Center Point	-	XLS Point	latitude/longitude WGS84
• DisplayScale	-	Integer	Ratio of world units to a device unit.

			to a device unit. For example 1:50000 would be specified as 50000
• DPI	-	Integer	Dots per inch of the device
• Radius	-	Integer	Defines area required to be displayed
Overlay	-		List of overlays (0 – unbounded)
• ADT	✔	XLS ADT	Currently PositionADT, RouteADT, POI ADT & MapADT
• Style	-		Either a Named Style or a User Defined Style Implementation uses a default if neither is specified
• Zorder	-		The order in which the overlay's are laid on top of each other over the base map
BaseMap	-		
Layer	-	String	The list of layers that will be filtered to make up the base map
Style	-	String	Custom styles are used. This is a placeholder for custom styles or future additions to

			the spec
Filter	✔	String	Either “include” or “exclude”
Get Capabilities	-		Has no data. Simply allows one to request capabilities.

Notes:

2. Either a Bounding Box Context or a Center Context can be specified (not both). If neither is specified, the implementation must derive it from the ADTs.

3. If an implementation provides Get Capabilities, the request can be either a “Portray” request or a “Get Capabilities” request (not both).

9.4.3.2 Response Parameters

RESPONSE PARAMETER	REQUIRED	DATA TYPE	DATA DESCRIPTION
Map ADT	✔	XLS MapADT	Contains the encoded map, Can have multiple maps if the request have specified multiple ones
Get Capabilities Response			
• Available Layers	✔	String	A list of strings
• Available Formats	✔	String	A list MIME-type strings
• Available SRS’s	✔	String	A list of EPSG:XXXX strings

• Available Styles	✔	String	A list of strings

Notes:

1. Either a “PortrayResponse” or a “Get Capabilities Response” can be returned (not both).

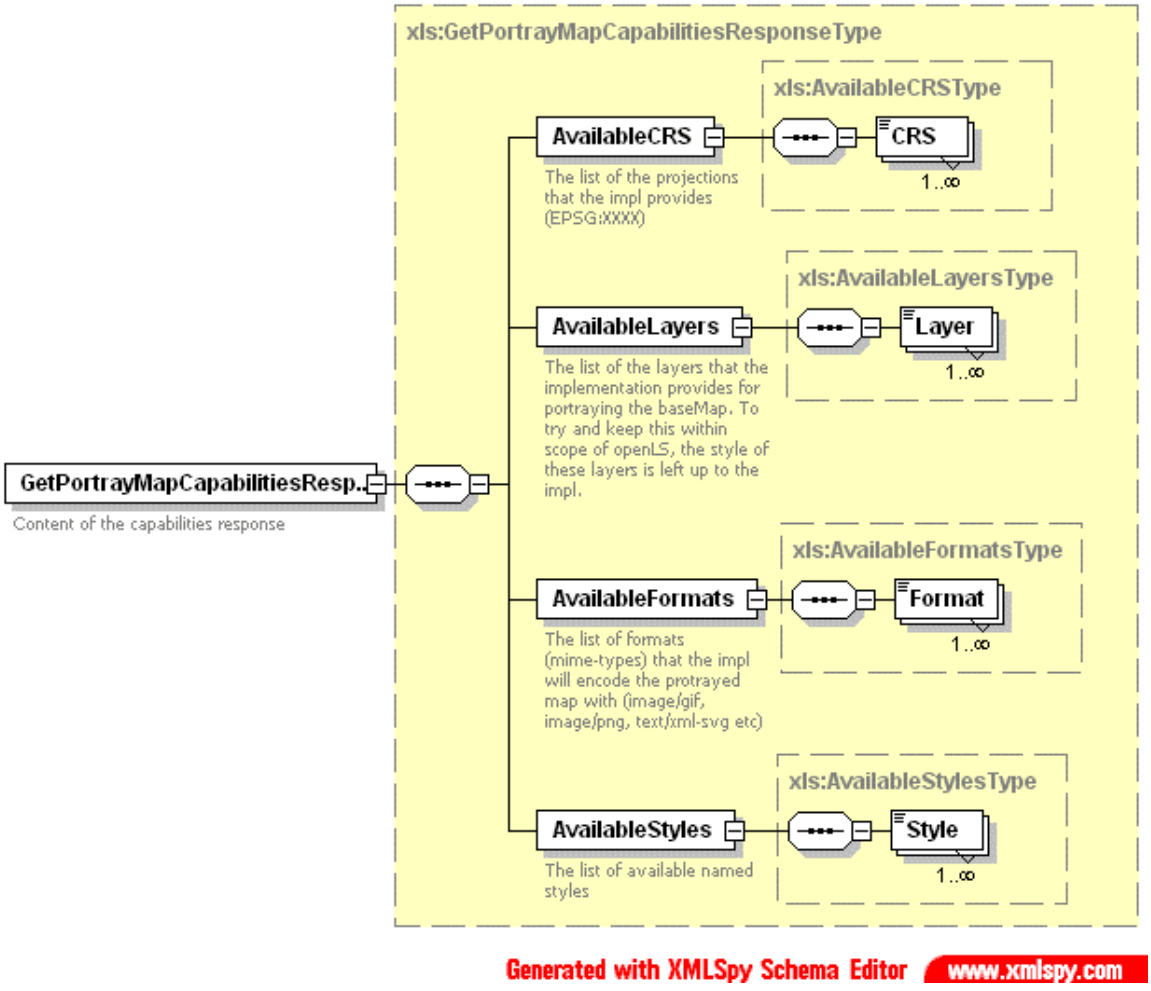


Figure 5 GetPortrayMapCapilities Response

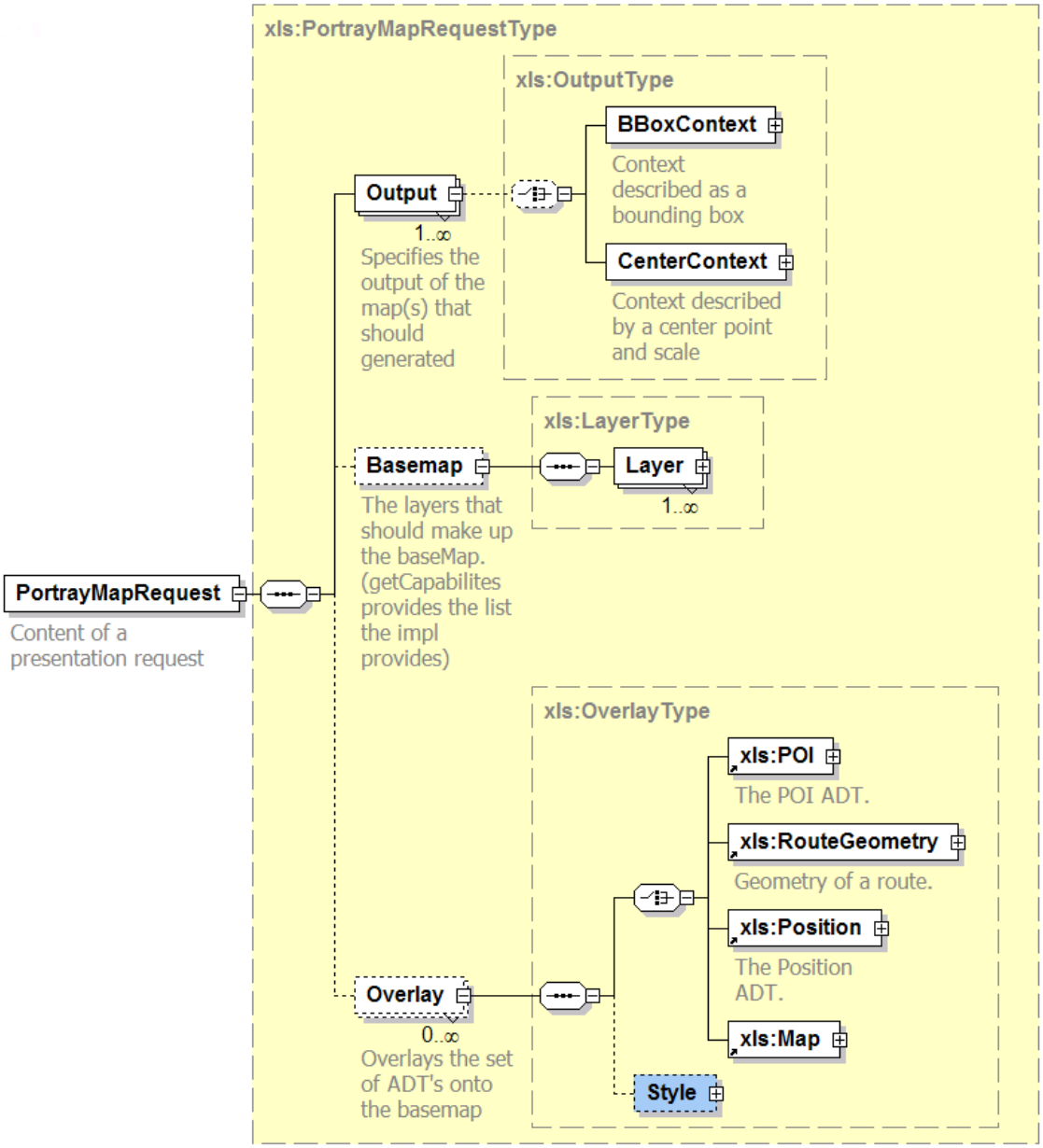


Figure 6 PortrayMap Request

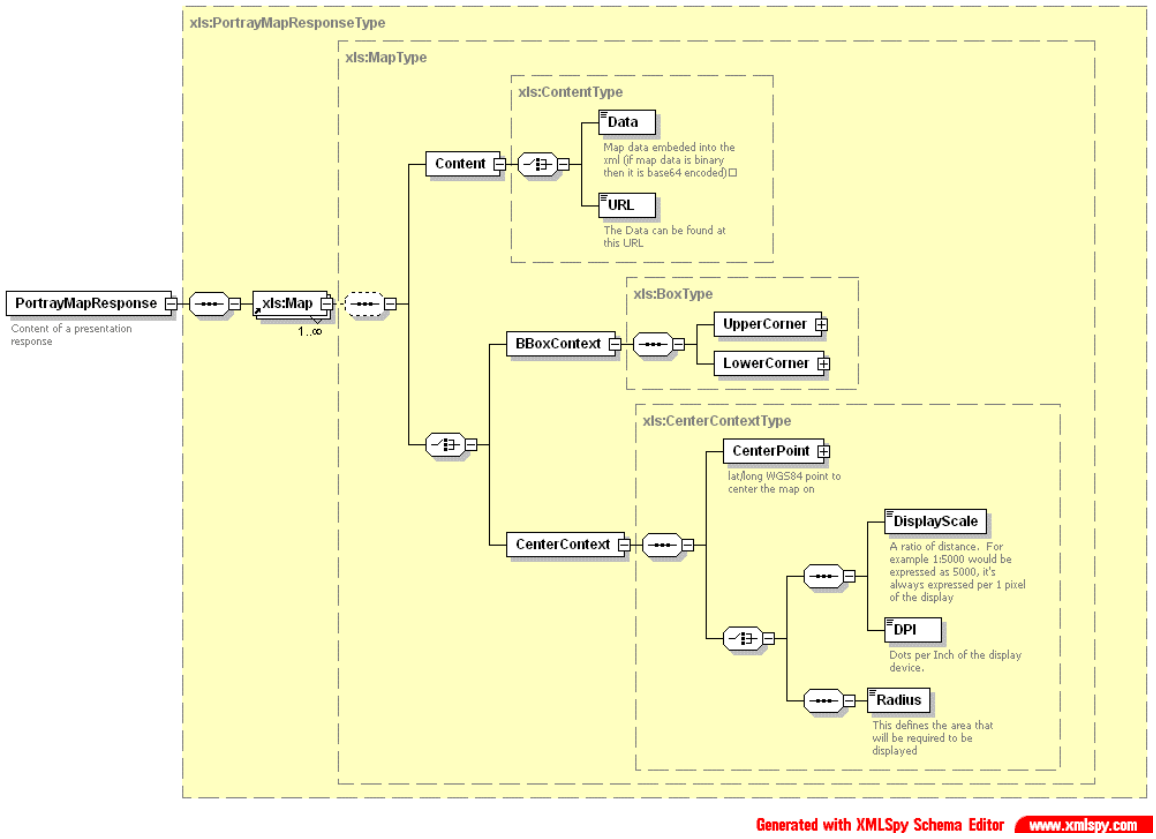


Figure 7 PortrayMap Response

9.4.4 Request and Response Pairs for Use Cases

The following are examples of one way to solve the use cases defined in Section 8; they are not the only solutions.

9.4.4.1 Use Case 1 Example

In order to satisfy Use Case 1, the application must acquire a Position ADT for where Joe's home is located. One way to do this is to have the Geocoder Service geocode his address, thus determining a Position ADT.

In this example we are asking for:

- 640x480 image in PNG format
- At a scale of 1:20000
- In WGS 84 / UTM zone 11N (EPSG:32611) projection
- With a north orientation

- Centered on Joe's house
- Base map will consist of all layers (using default style) made available by the implementation
- The location of Joe's home will be shown using the default style provided by the implementation

Request:

```
<?xml version="1.0" encoding="UTF-8"?>

<PortrayMapRequest>

        <Output width=”640” height=”480” format=”image/png”>
            <gml:Envelope>
                    <gml:pos>-114.342 50.234  -114.123 50.031  </gml:pos>
            </ gml:Envelope >
        </Output>

        <!—Ask the impl to exclude no layers (thus, create the base map with all your layers) -->
        <Basemap filter="Exclude" />

        <Overlay>
            <Position>
                <!-- This ADT contains the lat/lon of Joe's House -->
            </Position>
        </Overlay>

</ PortrayMapRequest >
```

Response:

```
<?xml version="1.0" encoding="UTF-8"?>
<PortrayMapResponse>

        <!-- There is an OutputResponse for each Output request (in the same order as requested) -->

            <Map>
                <Content width="640" height="480" format="image/png">
                    <URL> http://www.mapseter.com/lbs/maps/hgtr837468.png </URL>
                </Content>
                <gml:Envelope>
                    <gml:pos>-114.342 50.234  -114.123 50.031  </gml:pos>
                </ gml:Envelope >
            </Map>

    </PortrayMapResponse>
```

9.4.4.2 Use Case 2 Example

A prerequisite for this use case are Position ADTs for Joe's home and the Hotel. We also need the Route ADT, which shows the route from the home to the hotel. The Route ADT may be obtained from the Route Service.

Because the route is very large and we want to see it at a detailed scale we will be asking for multiple maps.

We are asking for:

- (N) maps centered on different points of the route
- 640x480 image in PNG format
- At a scale of 1:80000
- In UTM projection
- With a north orientation
- Base map will consist of only the road network and landmarks
- The base map and the ADTs will be displayed using the "post-modernistic" style
- The position of Joe's House and the Hotel will be drawn on top of the route

Request:

```
<PortrayMapRequest>

        <Output width="640" height="480" format="image/png">
            <gml:Envelope>
                    <gml:pos>-114.342 50.234  -114.123 50.031  </gml:pos>
            </ gml:Envelope >
        </Output>

        <Output width="640" height="480" format="image/png">
            <gml:Envelope>
                    <gml:pos> -120.312 48.823 -114.123 50.031  </gml:pos>
            </ gml:Envelope >
        </Output>

        <Output width="640" height="480" format="image/png">
            <gml:Envelope>
                    <gml:pos> -120.312 48.823 -125.235 46.284</  </gml:pos>
            </ gml:Envelope >
        </Output>


        <!-- Multiple more outputs can be request, but I think you get the point :) -->


        <Basemap filter="Include">
            <Layer name="Road Network">
                <Style>
                    <Name>post-modernistic</Name>
                </Style>
            </Layer>

            <Layer name=" Landmarks">
                <Style>
```

```
                <Name>post-modernistic</Name>
            </Style>
        </Layer>
    </Basemap>

    <Overlay zorder="0">
        <RouteGeometry>
            <!-- This ADT contains the route from Joe's Home to the Hotel -->
        </RouteGeometry>
        <Style>
            <Name>post-modernistic</Name>
        </Style>
    </Overlay>

    <Overlay zorder="1">
        <Position>
            <!-- This ADT contains the lat/lon of Joe's House -->
        </Position>
        <Style>
            <Name>post-modernistic</Name>
        </Style>
    </Overlay>

    <Overlay zorder="1">
        <Position>
            <!-- This ADT contains the lat/lon of the Hotel -->
        </Position>
        <Style>
            <Name>post-modernistic</Name>
        </Style>
    </Overlay>


</ PortrayMapRequest >
```

Response:

```
<PortrayMapResponse>

    <!-- There is an OutputResponse for each Output request (in the same order as requested) -->

        <Map>
            <Content width="640" height="480" format="image/png">
                <URL> http://www.mapseter.com/lbs/maps/hgtr837468.png </URL>
            </Content>
            <Output width=”640” height=”480” format=”image/png”>
        <gml:Envelope>
                <gml:pos>-114.342 50.234  -114.123 50.031  </gml:pos>
        </ gml:Envelope >
    </Output>
        </Map>

        <Map>
            <Content width="640" height="480" format="image/png">
                <URL> http://www.mapseter.com/lbs/maps/hgtr83567.png </URL>
            </Content>
            <Output width=”640” height=”480” format=”image/png”>
        <gml:Envelope>
                <gml:pos> -120.312 48.823 -114.123 50.031  </gml:pos>
        </ gml:Envelope >
    </Output>
```

```
        </Map>

        <Map>
            <Content width="640" height="480" format="image/png">
                <URL> http://www.mapseter.com/lbs/maps/hgtr83324.png </URL>
            </Content>
                <Output width=”640” height=”480” format=”image/png”>
        <gml:Envelope>
                <gml:pos> -120.312 48.823 -125.235 46.284</  </gml:pos>
        </ gml:Envelope >
    </Output>
        </Map>

</PortrayMapResponse>
```

9.5 Part 5: Route Service

This service determines a route for a subscriber. The subscriber must use a navigation application to set up the use of the service. They must indicate the start point (usually the position acquired through the Gateway Service, but this could be a planned trip from a specified location, say, from their home), and the endpoint (any location, like a place for which they only have the phone number or an address, or a place acquired through a search to a Directory Service). The subscriber may optionally specify waypoints, in some manner, the route preference (fastest, shortest, least traffic, most scenic, etc.), and the preferred mode of transport. The subscriber may optionally store a route for as long as needed, thus requiring the means to also fetch a stored route.

An enhanced version of this service, the Navigation Service, is described under separate cover (see Normative References, section 3). The Navigation Service supports the same parameters as the Route Service, plus additional parameters for navigation purposes.

9.5.1 Requirements

The Route Service *shall* support the following functionality:

- Given a set of route criteria, determine a new route.
- Re-determine 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.
- After determining the route, return any combination of the following information:
  - ❖ summary information
  - ❖ route geometry

- maps of the route
- turn-by-turn instructions and advisories for presentation

9.5.2 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.

9.5.3 Request and Response Parameters

9.5.3.1 Route Service Request Parameters

Request Parameters			
A collection of one or more of the parameters below			
Name	**Mandatory**	**Data Type**	**Description**
RoutePlan	Y	RoutePlanType	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	RouteInstructions RequestType	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"
distanceUnit	N	DistanceUnitType (ADT)	Specifies the unit for measuring distance. Default = "M"

RoutePlanType: Defines the criteria upon which a route is determined.			
Name	**Mandatory**	**Data Type**	**Description**
RoutePreference	Y	Enumeration	Routing preference to be taken into consideration when determining the route: "Fastest" – Minimize the travel time. "Shortest" – Minimize the travel distance. "Pedestrian" – Best route by foot.
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.
useRealTimeTraffic	N	Boolean	Specifies whether to use real time traffic information when determining the best route.

			Default is “false”
expectedStartTime	N	DateTime	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.

AvoidListType: Defines the list of areas, locations, and features in which the route should avoid passing through.			
Name	**Mandatory**	**Data Type**	**Description**
AOI	N	AreaOfInterest (ADT)	Specifies the geographic areas to avoid.
Address	N	Address (ADT)	Specifies the address for the point to avoid
POI	N	POI (ADT)	Specifies a POI to avoid
Position	N	Position (ADT)	Specifies the locations to avoid.
AvoidFeature	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.

RouteInstructionsRequestType: Defines the request parameters for turn-by-turn route instructions and travel advisories formatted for presentation.			
Name	**Mandatory**	**Data Type**	**Description**
format	N	String	The preferred format of the route instructions, specified as a mime type. Defaults to text/plain.
distanceUnit	N	DistanceUnitType (ADT)	The units of measure to be used for distances in the text directions: Default = "M"

RouteGeometryRequestType: Defines the request parameters for route geometry.			
Name	**Mandatory**	**Data Type**	**Description**
BoundingBox	N	Gml: EnvelopeType	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	Specifies the maximum number of geometric points to be returned. Default = 100

RouteMapRequestType: Defines the request parameters for route maps.			
Name	**Mandatory?**	**Data Type**	**Description**
Output	Y	RouteMapOutputType	Specifies the output of the map(s) to be generated. This is a subset of the map output parameters defined by the Presentation Service.

RouteMapOutputType: Defines the rendered route map output parameters. This is a subset of the map output parameters defined by the Presentation Service.			
A collection of one or more of the parameters below.			
Name	**Mandatory**	**Data Type**	**Description**
BBoxContent	N	Gml:EnvelopeType	Rectangular area to be displayed in the rendered map.

			map. If not specified, defaults to a rectangular area bounding the full route.
width	Y	Non-negative Integer	Pixel width of the resulting map.
height	Y	Non-negative Integer	Pixel height of the resulting map.
format	Y	String	Mime type describing the encoding.
BGcolor	N	String	The 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.

9.5.3.2 Route Service Response Parameters

Response Parameters			
A collection of one or more of the parameters below.			
Name	**Mandatory**	**Data Type**	**Description**
RouteHandle	N	RouteHandleType (ADT)	Contains a reference to the route stored at the Route Determination Service server. Can be used in subsequent requests to the Route Service to request additional information about the route, or to request an alternate route.

RouteSummary	Y	RouteSummaryType (ADT)	Describes the overall characteristics of the route.
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	RouteMapType	Contains a list of route maps.

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 8).

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

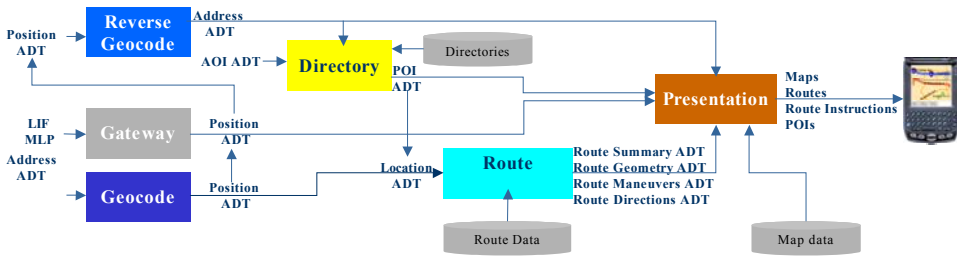


Figure 8. OpenLS Information Model

11 General Use Cases

Use Case I. A subscriber wants to access a list of restaurants nearby its location. He/she does not have any positioning capabilities on his/her device. The position of the subscriber is provided by network elements (GMLC/MPC).

The following sequence of events take place:

- A subscriber accesses the telecom operator portal via the wireless network;
- The portal identifies the service requested by the subscriber and directs the request to a 'Restaurant Guide' application running on the GeoMobility Server; this application can also be hosted on a 3rd party server;
- The requested service sends a request to a GMLC to get the position of the subscriber's Mobile Terminal;
- The GMLC provides an estimation of the Mobile Terminal position;
- Knowing the subscriber position, the 'Restaurant Guide' application sends a request, including the returned Mobile Terminal position in the form of a Position ADT, to a Directory Service that returns a list of restaurants within a certain radius around the estimated subscriber position;
- The list of restaurants is sent back to the subscriber;
- An application running on the Mobile Terminal allows the subscriber to view and interact with the list. [The next actions the subscriber is likely to take are to select a restaurant from the list and then ask for the directions and route map to assist them in driving from where they are to the chosen restaurant.]

An example of sequence for a service request is illustrated in the following figure.

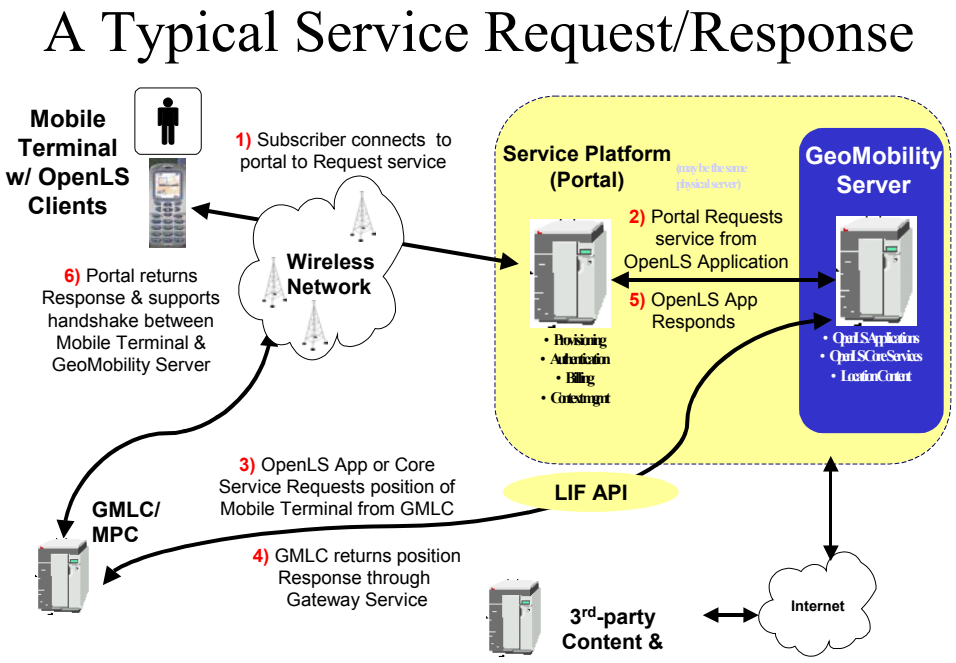


Figure 9. A Typical Service Request/Response

The MLP defined by LIF is used to access GMLC/MPC positioning information. GMS resources are accessed through OpenLS APIs.

12 Architecture Details

The Operator's Portal likely hosts the following functions:

1. Front-end functions to support session management, authentication of the subscribers, requests handling, etc. This box can also be a simple relay, transferring requests for services from subscribers to 3rd party applications.
2. LBS support functions for billing, privacy management and roaming.
3. A Service Platform hosting different applications (including proxies to OpenLS Applications that run on the GMS) and various supporting functions to support personalization, context management, etc. The service platform may also access a Location Server through the Gateway Service (based upon LIF 3.0).
4. Optionally, the Service Platform may host OpenLS Applications like 'Personal Navigator' and 'Concierge'.

The GMS hosts the following functions:

1. Possibly, OpenLS Applications, like 'Personal Navigator' and 'Concierge'. These applications access OpenLS Core Services through their APIs. They are the consumers of OpenLS ADTs.
2. OpenLS Core Services (Route, Location Utility, Directory, Presentation, and Gateway). These services are accessible through OpenLS APIs, as defined in the specifications. They in turn access the location content needed to perform their functions.
3. Location Content Databases. Contain any map data, route networks, address data navigation support data, and directories with any place, product or service information. Accessed through OGC Interfaces (Web Feature Server, Web Map Server, Web Coverage Server) or other interfaces, depending on implementation requirements. [More specification work is planned here in future test beds.]
4. OpenLS Applications and Core Services can also access other GMSs and location content databases hosted by 3rd parties.

The following figure highlights the functional roles of the Portal, Service Platform, GMS, GMLC/MPC, and 3rd party platforms.

13 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.

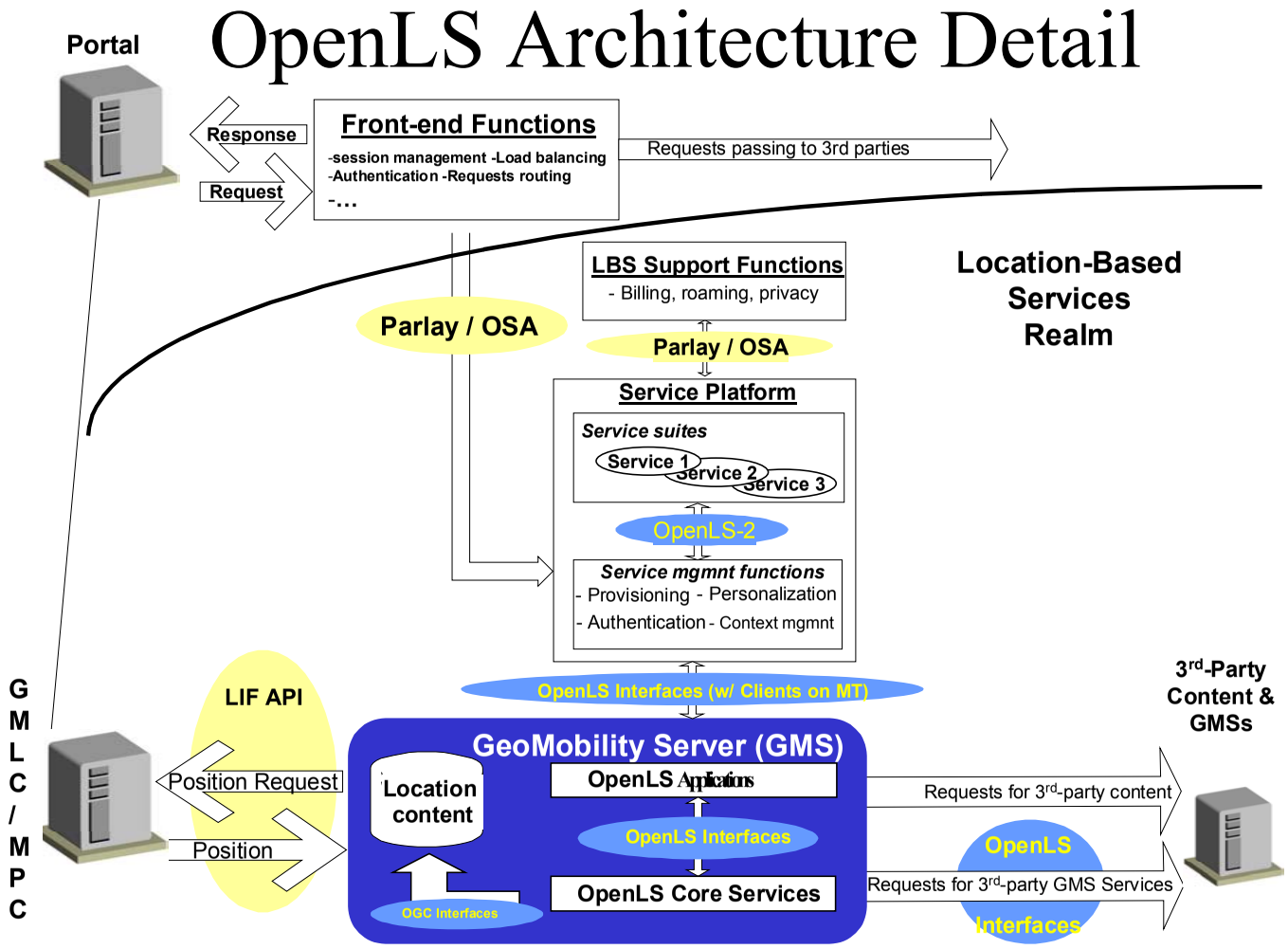
TBD.

14 Future Work

This specification is the result of nearly two years of effort and implementation testing. Considerable effort has been invested in harmonizing this specification suite with other OGC specifications, particularly GML 3.0, and OMA specifications, particularly LIF 3.0. It is the view of the submitters that the results of these harmonization efforts are adequate and sufficient, based upon the requirements defined in this document and the results of implementation and test activities. The submitters recognize that this harmonization process must continue so that every attempt is made to

satisfy the needs of the market, to address the feedback received from implementers and other OGC members, and to remain consistent with evolving OGC and OMA specifications.

The submitters will be responsible for evaluating and responding to comments received during the 30-day public comment period.



Annex A.1: OpenGIS® Location Services (OpenLS) Core Services Schema, XML/S Profile (Normative)

The OpenLS schema, XML/S Profile, is presented below.

ADT.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns:xls="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
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="geometry.xsd"/>
   <!--  The ADTs defined in this document represent the minimum set of
essential elements as determined from the analysis of the APIs provided by
OpenLS sponsors and participants. There are many additional elements that may
be added but these are considered to be optional. The APIs considered include:
Oracle, Webraska, ESRI, Vodafone, opt[e]way, NavTech, IntelliWhere, and
LocatioNet. -->
   <!--
================================================================
================
                  Root ADT XML schema types - XLS, ADT and Location
   ================================================================
==================== -->
   <attribute name="lang" type="language"/>
   <element name="_ADT" type="xls:AbstractDataType" abstract="true">
      <annotation>
         <documentation>This is the abstract type that all other abstract types will
extend</documentation>
      </annotation>
   </element>
   <complexType name="AbstractDataType"/>
   <element name="_Location" type="xls:AbstractLocationType" abstract="true"
substitutionGroup="xls:_ADT"/>
   <complexType name="AbstractLocationType" abstract="true">
```

```
        <annotation>
          <documentation>Location can be one of four things: Position, POI,
Address or Point. Each of those types has been defined in the XLS namespace
with this in condiseration.  </documentation>
        </annotation>
        <complexContent>
          <extension base="xls:AbstractDataType"/>
        </complexContent>
    </complexType>
    <!--
================================================================
=====
              Position ADT
    ================================================================
========== -->
    <complexType name="AbstractPositionType" abstract="true">
        <complexContent>
          <extension base="xls:AbstractLocationType"/>
        </complexContent>
    </complexType>
    <element name="_Position" type="xls:AbstractPositionType" abstract="true"
substitutionGroup="xls:_Location"/>
    <complexType name="PositionType">
        <complexContent>
          <extension base="xls:AbstractPositionType">
            <sequence>
              <element ref="gml:Point"/>
              <choice minOccurs="0">
                <element ref="xls:Ellipse"/>
                <element ref="gml:CircleByCenterPoint"/>
                <element ref="xls:CircularArc"/>
                <element ref="gml:Polygon"/>
                <element ref="gml:MultiPolygon"/>
              </choice>
              <element name="QoP" type="xls:QualityOfPositionType"
minOccurs="0">
                <annotation>
                  <documentation>QoP as defined by LIF.</documentation>
                </annotation>
              </element>
              <element ref="xls:Time" minOccurs="0"/>
              <element name="Speed" type="xls:SpeedType" minOccurs="0"/>
              <element name="Direction" type="xls:AngleType" minOccurs="0"/>
            </sequence>
            <attribute name="levelOfConf" type="string" use="optional"/>
          </extension>
```

```
        </complexContent>
    </complexType>
    <element name="Position" type="xls:PositionType"
substitutionGroup="xls:_Position">
        <annotation>
            <documentation>The Position ADT. Normally used to represent an
observation/calculated position for a mobile terminal, but can be any position
used by the platform. Equates with the position in LIF MLP. Contains Point with
optional Shape, QoP, Speed, Direction and Time. Also has levelOfConfidence
attribute.</documentation>
        </annotation>
    </element>
    <complexType name="QualityOfPositionType">
        <sequence>
            <group ref="xls:HorVerAcc"/>
        </sequence>
        <attribute name="responseReq" use="optional" default="Delay_Tol">
            <simpleType>
                <restriction base="string">
                    <enumeration value="No_Delay"/>
                    <enumeration value="Low_Delay"/>
                    <enumeration value="Delay_Tol"/>
                </restriction>
            </simpleType>
        </attribute>
        <attribute name="responseTimer" type="string" use="optional"/>
    </complexType>
    <complexType name="HorAccType">
        <choice>
            <element ref="xls:Distance"/>
            <element ref="xls:Angle"/>
            <!-- modified this type to Angle instead of multiangle based on
Maidenhead decision not to use
            multiangle in the OpenLS uom - marwa 26/1/02        -->
        </choice>
    </complexType>
    <complexType name="VerAccType">
        <sequence>
            <element ref="xls:Distance"/>
        </sequence>
    </complexType>
    <group name="HorVerAcc">
        <annotation>
            <documentation>HAN, 30 Sept 02. Don't see the need for this element.
Only used here in Position ADT.</documentation>
        </annotation>
```

```
        <sequence>
            <element name="HorizontalAcc" type="xls:HorAccType"/>
            <element name="VerticalAcc" type="xls:VerAccType"/>
        </sequence>
    </group>
    <!-- ========================================================
                        Point of Interest ADT
    ========================================================================
-->
    <complexType name="AbstractPOIType" abstract="true">
        <complexContent>
            <extension base="xls:AbstractLocationType"/>
        </complexContent>
    </complexType>
    <element name="_POI" type="xls:AbstractPOIType"
substitutionGroup="xls:_Location">
        <annotation>
            <documentation>Point of Interest is a place, product or service  with a
fixed position, typically identified by name rather than by address and
characterized by type, that may be used as a reference point or a target in a
location based service request.</documentation>
        </annotation>
    </element>
    <complexType name="PointOfInterestType">
        <complexContent>
            <extension base="xls:AbstractPOIType">
                <sequence>
                    <annotation>
                        <documentation>HAN, 29 Sept 02. We need to look more
closely at this choice block (it's too restrictive). Since we don't have a
getCapabilities, there is really no way that a client can discover the information a
Directory Service could possibly return. Also, clients have no way to specify
which of these information types they want returned (ReferenceSystem,
POIInfoList, Point, and/or Address), like we do for GeoCode. Plus, when a
Directory Service has two or more of these types, with the choice block there is
no way for the a client to receive the full information set. Do we want to change
this to a sequence block and/or change POIAttributeList and/or Point to optional?
Also, we need to examine the role of POI in this form since it may not return a
Point or Address and therefore may not have sufficient info to be used in location
services that require a position of some sort.
[MM] 17/3/03. Made the change from a choice block to a sequence block. Made
the elements optional inside the sequence block
 </documentation>
                    </annotation>
                    <element ref="xls:POIAttributeList" minOccurs="0"/>
                    <element ref="gml:Point" minOccurs="0"/>
```

```
                <element ref="xls:Address" minOccurs="0"/>
                <!--  ref="xls:Point"/> -->
            </sequence>
            <attribute name="ID" type="string" use="required"/>
            <attribute name="POIName" type="string" use="optional"/>
            <attribute name="phoneNumber" type="string" use="optional"/>
            <attribute name="description" type="string" use="optional"/>
        </extension>
    </complexContent>
</complexType>
<element name="POI" type="xls:PointOfInterestType"
substitutionGroup="xls:_POI">
    <annotation>
        <documentation>The POI ADT. Primarily generated in the responses
from Directory Services. Can also be used as a filter in the request to a Directory
Service for nearest/within distance conditions. </documentation>
    </annotation>
</element>
<element name="POIAttributeList" type="xls:POIAttributeListType">
    <annotation>
        <documentation>One or more formal name classifications and/or one or
more name/value pairs.</documentation>
    </annotation>
</element>
<complexType name="POIAttributeListType">
    <sequence>
        <element ref="xls:ReferenceSystem" minOccurs="0"/>
        <element ref="xls:POIInfoList" minOccurs="0"/>
    </sequence>
</complexType>
<complexType name="POIInfoListType">
    <sequence>
        <element ref="xls:POIInfo" maxOccurs="unbounded"/>
    </sequence>
</complexType>
<element name="POIInfoList" type="xls:POIInfoListType">
    <annotation>
        <documentation>List of other information available about the POI in
name/value pairs.</documentation>
    </annotation>
</element>
<complexType name="POIInfoType">
    <attribute name="name" type="string" use="required"/>
    <attribute name="value" type="string" use="required"/>
</complexType>
<element name="POIInfo" type="xls:POIInfoType">
```

```
        <annotation>
          <documentation>POI Information defined as a Name/Value
pair</documentation>
        </annotation>
    </element>
    <complexType name="ReferenceSystemType">
        <sequence>
          <element ref="xls:_NamedReferenceSystem"
maxOccurs="unbounded"/>
        </sequence>
    </complexType>
    <element name="ReferenceSystem" type="xls:ReferenceSystemType">
        <annotation>
          <documentation>HAN, 29 Sept 02. Formal name reference system.
Three are defined here (NACE, NAICS and SIC), but any others may be defined
and added to this schema.</documentation>
        </annotation>
    </element>
    <complexType name="AbstractNamedReferenceSystem" abstract="true"/>
    <element name="_NamedReferenceSystem"
type="xls:AbstractNamedReferenceSystem" abstract="true"/>
    <complexType name="NAICSType">
        <complexContent>
          <extension base="xls:AbstractNamedReferenceSystem">
            <attribute name="type" type="string" use="optional"/>
            <attribute name="subType" type="string" use="optional"/>
            <attribute name="category" type="string" use="optional"/>
          </extension>
        </complexContent>
    </complexType>
    <element name="NAICS" type="xls:NAICSType"
substitutionGroup="xls:_NamedReferenceSystem"/>
    <complexType name="SICType">
        <complexContent>
          <extension base="xls:AbstractNamedReferenceSystem">
            <attribute name="type" type="string" use="optional"/>
            <attribute name="subType" type="string" use="optional"/>
            <attribute name="category" type="string" use="optional"/>
            <attribute name="code" type="string" use="optional"/>
          </extension>
        </complexContent>
    </complexType>
    <element name="SIC" type="xls:SICType"
substitutionGroup="xls:_NamedReferenceSystem"/>
    <complexType name="NACEType">
        <complexContent>
```

```
            <extension base="xls:AbstractNamedReferenceSystem">
               <attribute name="division" type="string" use="optional"/>
               <attribute name="group" type="string" use="optional"/>
               <attribute name="class" type="string" use="optional"/>
               <attribute name="description" type="string" use="optional"/>
            </extension>
         </complexContent>
      </complexType>
      <element name="NACE" type="xls:NACEType"
substitutionGroup="xls:_NamedReferenceSystem"/>
      <!--
================================================================
=============== -->
      <element name="AOI" type="xls:AreaOfInterestType"
substitutionGroup="xls:_ADT">
         <annotation>
            <documentation>The Area of Interest (AOI) ADT. Can be a Circle,
Polygon or Point.</documentation>
         </annotation>
      </element>
      <complexType name="AreaOfInterestType">
         <complexContent>
            <extension base="xls:AbstractDataType">
               <choice>
                  <element ref="gml:CircleByCenterPoint"/>
                  <element ref="gml:Polygon"/>
                  <element ref="gml:Envelope"/>
                  <!-- ref="xls:Circle"/> -->
                  <!-- <element ref="xls:Box"/> -->
               </choice>
            </extension>
         </complexContent>
      </complexType>
      <!--
================================================================
================
                     Address ADT definitions
      ================================================================
==================== -->
      <complexType name="AbstractAddressType" abstract="true">
         <annotation>
            <documentation>
      The AddressType is the Address_ADT for OpenLS and it supports the
concepts of the OGC Geocoder document 01-026r1
      with some modifications which resulted in both simplifications and improved
handling capability.  The definition is also
```

```
    broad enough to handle some of the more obscure occurrences of street
addressing as well as handling the
    case of when all you have is an un-parsed string representing the complete
address.  We could generalize this even
    further to handle non-street addressing schemes found in other industries,
such as the Municipal Survey Addressing
    schemes that are used by Municipalities to address the lots on which a
building may be placed but that is probably a
    future requirement outside the scope of OLS1.
        </documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractLocationType">
                <attribute name="addressee" type="string" use="optional"/>
                <attribute name="countryCode" type="xls:CountryCodeType"
use="required"/>
            </extension>
        </complexContent>
    </complexType>
    <simpleType name="CountryCodeType">
        <annotation>
            <documentation xml:lang="en">
        ISO 3166 Alpha-2 Country Codes
        </documentation>
        </annotation>
        <restriction base="string"/>
    </simpleType>
    <complexType name="StreetAddressType">
        <annotation>
            <documentation>A set of precise and complete data elements that
cannot be subdivided and that describe the physical location of a
place.</documentation>
        </annotation>
        <sequence>
            <element ref="xls:_StreetLocation" minOccurs="0"/>
            <element ref="xls:Street"/>
        </sequence>
    </complexType>
    <element name="StreetAddress" type="xls:StreetAddressType">
        <annotation>
            <documentation>Structured street address.</documentation>
        </annotation>
    </element>
    <element name="_StreetLocation" type="xls:AbstractStreetLocatorType">
        <annotation>
            <documentation>The location on a street.</documentation>
```

```
        </annotation>
    </element>
    <complexType name="AbstractStreetLocatorType" abstract="true">
        <annotation>
            <documentation>
    The AbstractStreetLocatorType is an abstract type  for describing the location on a street within an AddressType.
    We do this because the components of a location on a street vary greatly throughout the world.
    So that the schema can accommodate this variation we create derived types such as the
    BuildingLocatorType which has the components for an apartment or suite or floor within a building.
        </documentation>
        </annotation>
    </complexType>
    <element name="Building" type="xls:BuildingLocatorType" substitutionGroup="xls:_StreetLocation">
        <annotation>
            <documentation>An addressable place; normally a location on a street: number, subdivision name and/or building name.</documentation>
        </annotation>
    </element>
    <complexType name="BuildingLocatorType">
        <annotation>
            <documentation>A type of AbstractStreetLocatorType</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractStreetLocatorType">
                <attribute name="number" type="string" use="optional"/>
                <attribute name="subdivision" type="string" use="optional"/>
                <attribute name="buildingName" type="string" use="optional"/>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="StreetIntersectionType">
        <annotation>
            <documentation>Describes the intersection of two streets</documentation>
        </annotation>
        <sequence>
            <element ref="xls:Street"/>
            <element name="IntersectingStreet" type="xls:StreetNameType">
                <annotation>
                    <documentation>Structured street name for intersecting street.</documentation>
```

```
            </annotation>
          </element>
        </sequence>
    </complexType>
    <element name="StreetIntersection" type="xls:StreetIntersectionType">
        <annotation>
            <documentation>Street and intersecting street.</documentation>
        </annotation>
    </element>
    <complexType name="StreetNameType">
        <annotation>
            <documentation>The data elements that make up the name of a
street</documentation>
        </annotation>
        <simpleContent>
            <extension base="string">
                <attribute name="directionalPrefix" type="string" use="optional"/>
                <attribute name="typePrefix" type="string" use="optional"/>
                <attribute name="officialName" type="string" use="optional"/>
                <attribute name="typeSuffix" type="string" use="optional"/>
                <attribute name="directionalSuffix" type="string" use="optional"/>
                <attribute name="muniOctant" type="gml:CompassPointEnumeration"
use="optional"/>
            </extension>
        </simpleContent>
    </complexType>
    <element name="Street" type="xls:StreetNameType">
        <annotation>
            <documentation>Structured Street Name.</documentation>
        </annotation>
    </element>
    <element name="Address" type="xls:AddressType"
substitutionGroup="xls:_Location">
        <annotation>
            <documentation>The Address ADT. An address that is either a “Free
Form Address” or a “Street Address” or an “Intersection Address”, with 0 or more
“place” elements and an optional “postalCode” element. It also has two optional
attributes, the “addressee” and the “phone number”, and one required attribute,
the “country”.</documentation>
        </annotation>
    </element>
    <complexType name="AddressType">
        <annotation>
            <documentation>Defines an address</documentation>
        </annotation>
        <complexContent>
```

```
            <extension base="xls:AbstractAddressType">
               <choice>
                  <element name="freeFormAddress" type="string">
                     <annotation>
                        <documentation>An unstructured free form
address.</documentation>
                     </annotation>
                  </element>
                  <sequence>
                     <choice minOccurs="0">
                        <element ref="xls:StreetAddress"/>
                        <element ref="xls:StreetIntersection"/>
                     </choice>
                     <element ref="xls:Place" minOccurs="0"
maxOccurs="unbounded"/>
                     <element ref="xls:PostalCode" minOccurs="0"/>
                  </sequence>
               </choice>
            </extension>
         </complexContent>
      </complexType>
      <simpleType name="NamedPlaceClassification">
         <annotation>
            <documentation>The classification for the hierarchy a level of which is
defined to be one of five different types: CountrySubDivision,
CountrySecondarySubdivision, Municipality, or
MunicipalitySubdivision.</documentation>
         </annotation>
         <restriction base="string">
            <enumeration value="CountrySubdivision"/>
            <enumeration value="CountrySecondarySubdivision"/>
            <enumeration value="Municipality"/>
            <enumeration value="MunicipalitySubdivision"/>
         </restriction>
      </simpleType>
      <element name="Place" type="xls:NamedPlaceType">
         <annotation>
            <documentation>HAN, 29 Sept 02. Place represents a hierarchical set of
geographic regions/placenames: country subdivision, country secondary
subdivision, municipality, and municipality subdivision.</documentation>
         </annotation>
      </element>
      <complexType name="NamedPlaceType">
         <annotation>
            <documentation>
      The NamedPlaceType defines a named place within an AddressType.
```

```
    A named place has a classification (such as country, country subdivision, or
municipality).
        </documentation>
        </annotation>
        <simpleContent>
            <extension base="string">
                <attribute name="type" type="xls:NamedPlaceClassification"
use="required"/>
            </extension>
        </simpleContent>
    </complexType>
    <element name="PostalCode" type="xls:PostalCodeType">
        <annotation>
            <documentation>A zipcode or international postal code as defined by
the governing postal authority.</documentation>
        </annotation>
    </element>
    <simpleType name="PostalCodeType">
        <annotation>
            <documentation>
    The AbstractPostalCodeType is an abstract type  for postal code within an
AddressType.
    We do this because the components of a postal code vary greatly throughout
the world.
    So that the schema can accommodate this variation we create derived types
such as the
    USZipCodeType which has the components for a US zipcode
        </documentation>
        </annotation>
        <restriction base="string"/>
    </simpleType>
    <!--
========================================================== -->
    <annotation>
        <documentation>HAN, 29 Sept 02. These types don't fit well with ADTs,
rather with Location Utility. Should move them. Also, GeocodingQOSType should
be renamed GeocodeMatchCodeType, for consistency, or the element
GeocodeMatchCode should be renamed GeocodingQOS.</documentation>
    </annotation>
    <element name="GeocodeMatchCode" type="xls:GeocodingQOSType">
        <annotation>
            <documentation>Provides information on the quality of the match
operation (accuracy and match code).</documentation>
        </annotation>
    </element>
    <complexType name="GeocodingQOSType">
```

```
        <annotation>
          <documentation>Quality of service type</documentation>
        </annotation>
        <attribute name="accuracy" type="float" use="optional">
          <annotation>
            <documentation>This is the score (probability) assocaited with the
match function</documentation>
          </annotation>
        </attribute>
        <attribute name="matchType" type="string" use="optional">
          <annotation>
            <documentation>Describes the type of match made by the function,
example zip+4</documentation>
          </annotation>
        </attribute>
    </complexType>
    <!-- ========================================================
                        Map ADT
    ========================================================== --
>
    <element name="Map" type="xls:MapType" substitutionGroup="xls:_ADT"/>
    <complexType name="MapType">
        <complexContent>
          <extension base="xls:AbstractDataType">
            <sequence minOccurs="0">
              <element name="Content" type="xls:ContentType"/>
              <choice>
                <element name="BBoxContext" type="gml:EnvelopeType"/>
                <element name="CenterContext"
type="xls:CenterContextType"/>
                <!--  type="xls:BoxType"/> -->
              </choice>
            </sequence>
          </extension>
        </complexContent>
    </complexType>
    <complexType name="ContentType">
        <choice>
          <element name="Data" type="string">
            <annotation>
              <documentation>Map data embeded into the xml (if map data is
binary then it is base64 encoded) </documentation>
            </annotation>
          </element>
          <element name="URL" type="string">
            <annotation>
```

```
                <documentation>The Data can be found at this
URL</documentation>
            </annotation>
         </element>
      </choice>
      <attribute name="format" type="string" use="required"/>
      <attribute name="width" type="integer" use="required"/>
      <attribute name="height" type="integer" use="required"/>
   </complexType>
   <complexType name="CenterContextType">
      <sequence>
         <element name="CenterPoint" type="gml:PointType">
            <annotation>
               <documentation>lat/long WGS84 point to center the map
on</documentation>
            </annotation>
            <!-- type="xls:PointType"> -->
         </element>
         <choice>
            <sequence>
               <element name="DisplayScale" type="integer">
                  <annotation>
                     <documentation>A ratio of distance.  For example 1:5000
would be expressed as 5000, it's always expressed per 1 pixel of the
display</documentation>
                  </annotation>
               </element>
               <element name="DPI" type="integer">
                  <annotation>
                     <documentation>Dots per Inch of the display
device.</documentation>
                  </annotation>
               </element>
            </sequence>
            <sequence>
               <element name="Radius" type="xls:RadiusType">
                  <annotation>
                     <documentation>This defines the area that will be required to
be displayed</documentation>
                  </annotation>
               </element>
            </sequence>
         </choice>
      </sequence>
      <attribute name="azimuth" type="integer" use="optional">
         <annotation>
```

```
            <documentation>The orientation of the map, clockwise degrees from
north.</documentation>
         </annotation>
      </attribute>
      <attribute name="SRS" type="string" use="required">
         <annotation>
            <documentation>The Spatial Reference System that the data with be
projected to in EPSG:XXXX format (getCapabilites provides the list of SRS's
supported).</documentation>
         </annotation>
      </attribute>
   </complexType>
   <complexType name="RadiusType">
      <simpleContent>
         <extension base="decimal">
            <attribute name="unit" type="xls:DistanceUnitType" use="required"/>
         </extension>
      </simpleContent>
   </complexType>
   <!--
   ============================================================
====================
               Route Abstract Types
   ============================================================
======================== -->
   <complexType name="AbstractRouteSummaryType" abstract="true">
      <annotation>
         <documentation>Abstract type which specifies a route's overall
characteristics.</documentation>
      </annotation>
      <complexContent>
         <extension base="xls:AbstractDataType">
            <sequence>
               <element name="TotalTime" type="duration">
                  <annotation>
                     <documentation>Estimated time to travel the complete route.
Expressed in seconds.</documentation>
                  </annotation>
               </element>
               <element name="TotalDistance" type="xls:DistanceType">
                  <annotation>
                     <documentation>Total distance covered by the
route.</documentation>
                  </annotation>
               </element>
               <element ref="xls:BoundingBox">
```

```
                    <annotation>
                        <documentation>Rectangular area bounding the complete
route.</documentation>
                    </annotation>
                </element>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<element name="_RouteSummary" type="xls:AbstractRouteSummaryType"
abstract="true" substitutionGroup="xls:_ADT">
    <annotation>
        <documentation>Base element which represents a route's overall
characteristics.</documentation>
    </annotation>
</element>
<complexType name="AbstractRouteSegmentType" abstract="true">
    <annotation>
        <documentation>Defines the characteristics of a segment along a
route.</documentation>
    </annotation>
    <sequence>
        <element ref="xls:Distance">
            <annotation>
                <documentation>Distance along the segment.</documentation>
            </annotation>
        </element>
        <element name="TravelTime" type="duration">
            <annotation>
                <documentation>Estimated time to travel the complete route,
Expressed in seconds.</documentation>
            </annotation>
        </element>
        <element ref="xls:BoundingBox">
            <annotation>
                <documentation>Rectangular area bounding the
segment.</documentation>
            </annotation>
        </element>
    </sequence>
    <attribute name="name" type="string" use="optional">
        <annotation>
            <documentation>Name of segment, e.g.: street name, or the name of
the public transit line.  When the name is unknown, this should be an empty
string.  When not specified, the name is assumed to be the same as the previous
segment.</documentation>
```

```
            </annotation>
        </attribute>
    </complexType>
    <element name="_NextSegment" type="xls:AbstractRouteSegmentType"
abstract="true">
        <annotation>
            <documentation>Base element which represents the information about
the segment of the route between the current maneuver and the
next.</documentation>
        </annotation>
    </element>
    <complexType name="AbstractWayPointType" abstract="true">
        <annotation>
            <documentation>Abstract type representing a location to be visited
along a route.</documentation>
        </annotation>
    </complexType>
    <element name="_WayPoint" type="xls:AbstractWayPointType"
abstract="true">
        <annotation>
            <documentation>A location to be visited along a route.</documentation>
        </annotation>
    </element>
    <!--
    ============================================================
====================
            Route ADT
    ============================================================
========================= -->
    <complexType name="RouteSummaryType" abstract="true">
        <annotation>
            <documentation>Specifies a route's overall
characteristics.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractRouteSummaryType"/>
        </complexContent>
    </complexType>
    <element name="RouteSummary" type="xls:RouteSummaryType"
substitutionGroup="xls:_RouteSummary">
        <annotation>
            <documentation>A route's overall characteristics.</documentation>
        </annotation>
    </element>
    <element name="BoundingBox" type="gml:EnvelopeType">
        <annotation>
```

```
            <documentation>Rectangular bounding area.</documentation>
        </annotation>
        <!-- type="xls:BoxType" changed to gml:EnvelopeType -->
    </element>
    <complexType name="RouteSegmentType">
        <annotation>
            <documentation>Defines the characteristics of a segment along a
route.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractRouteSegmentType"/>
        </complexContent>
    </complexType>
    <element name="NextSegment" type="xls:RouteSegmentType"
substitutionGroup="xls:_NextSegment">
        <annotation>
            <documentation>Information about the segment of the route between
this maneuver and the next.</documentation>
        </annotation>
    </element>
    <complexType name="WayPointType">
        <annotation>
            <documentation>Defines a location to be visited along a
route.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractWayPointType">
                <sequence>
                    <element ref="xls:_Location"/>
                    <element ref="xls:GeocodeMatchCode" minOccurs="0"/>
                </sequence>
                <attribute name="stop" type="boolean" use="optional" default="true">
                    <annotation>
                        <documentation>Specifies whether the traveler plans to stop at
the waypoint, or simply pass through it.                    </documentation>
                    </annotation>
                </attribute>
            </extension>
        </complexContent>
    </complexType>
    <element name="StartPoint" type="xls:WayPointType"
substitutionGroup="xls:_WayPoint">
        <annotation>
            <documentation>Starting point of the route.</documentation>
        </annotation>
    </element>
```

```
    <element name="ViaPoint" type="xls:WayPointType"
substitutionGroup="xls:_WayPoint">
        <annotation>
            <documentation>Intermediate waypoint along the
route.</documentation>
        </annotation>
    </element>
    <element name="EndPoint" type="xls:WayPointType"
substitutionGroup="xls:_WayPoint">
        <annotation>
            <documentation>Ending point of the route (i.e. the
destination)</documentation>
        </annotation>
    </element>
    <complexType name="WayPointListType">
        <annotation>
            <documentation>Defines a list of waypoints along a
route.</documentation>
        </annotation>
        <sequence>
            <element ref="xls:StartPoint"/>
            <element ref="xls:ViaPoint" minOccurs="0" maxOccurs="unbounded"/>
            <element ref="xls:EndPoint"/>
        </sequence>
    </complexType>
    <element name="WayPointList" type="xls:WayPointListType">
        <annotation>
            <documentation>List of waypoints along a route.</documentation>
        </annotation>
    </element>
    <element name="RouteInstructionsList" type="xls:RouteInstructionsListType"
substitutionGroup="xls:_ADT">
        <annotation>
            <documentation>A list of route instructions.</documentation>
        </annotation>
    </element>
    <complexType name="RouteInstructionsListType">
        <annotation>
            <documentation>Defines a list of route instructions.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractDataType">
                <sequence>
                    <element ref="xls:RouteInstruction" maxOccurs="unbounded"/>
                </sequence>
```

```
            <attribute name="format" type="string" use="optional"
default="text/plain">
                <annotation>
                    <documentation>Mime type describing the
encoding.</documentation>
                </annotation>
            </attribute>
            <attribute ref="xls:lang" use="required">
                <annotation>
                    <documentation>Specifies the language in which the
instructions are given.</documentation>
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<complexType name="RouteInstructionType">
    <annotation>
        <documentation>Defines a single turn-by-turn route instruction or
advisory formatted for presentation.</documentation>
    </annotation>
    <simpleContent>
        <extension base="string"/>
    </simpleContent>
</complexType>
<element name="RouteInstruction" type="xls:RouteInstructionType">
    <annotation>
        <documentation>A turn-by-turn route instruction or advisory formatted
for presentation.</documentation>
    </annotation>
</element>
<element name="RouteHandle" type="xls:RouteHandleType">
    <annotation>
        <documentation>A reference to a route stored at the Route
Determination Service server.</documentation>
    </annotation>
</element>
<complexType name="RouteHandleType">
    <annotation>
        <documentation>Defines a reference to a route stored at the Route
Determination Service server.</documentation>
    </annotation>
    <attribute name="serviceID" type="string" use="required">
        <annotation>
            <documentation>Uniquely identifies the service which holds the
route.</documentation>
```

```
            </annotation>
        </attribute>
        <attribute name="routeID" type="string" use="required">
            <annotation>
                <documentation>Uniquely identifies the route store at the
service.</documentation>
            </annotation>
        </attribute>
    </complexType>
    <complexType name="RouteGeometryType">
        <annotation>
            <documentation>Defines the geometry of a route.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractDataType">
                <sequence>
                    <element ref="gml:LineString"/>
                    <!-- ref="xls:LineString"/> -->
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <element name="RouteGeometry" type="xls:RouteGeometryType"
substitutionGroup="xls:_ADT">
        <annotation>
            <documentation>Geometry of a route.</documentation>
        </annotation>
    </element>
</schema>
```

gml4xls.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:gml="http://www.opengis.net/gml"
xmlns:sch="http://www.ascc.net/xml/schematron"
xmlns="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified"
attributeFormDefault="unqualified">
    <annotation>
        <documentation>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.</documentation>
</annotation>
<annotation>
<documentation>GML Subset schema for gml:_Object,gml:metaDataProperty,gml:_association,gml:AssociationType,gml:members,gml:Array,gml:curveProperty,gml:LineString,gml:LinearRing,gml:exterior,gml:interior,gml:Polygon,gml:surfaceMember,gml:surfaceProperty,gml:MultiSurface,gml:multiSurfaceProperty,gml:SurfaceInterpolationType,gml_Feature,gml:featureProperty,gml:featureMembers,gml:_FeatureCollection,gml:featureMember,gml:featureMembers,gml:_FeatureCollection,gml:Dictionary,gml:doubleList,gml:pos,gml:pointRep,gml:CircleByCenterPoint, written by gmlSubset.xslt.

Created using Saxon XSLT processor with the following command 2002-020-13 Paul Daisey U.S. Census
$ java com.icl.saxon.StyleSheet -o gml4xls.xsd gmldep.xml gmlSubset.xslt
// output file input file stylesheet

2003-03-05 - SJDC - commented out various pieces to create a more restricted profile of GML for XLS use.
All changes indicated [SJDC]

2003-03-14 - Marwa Mabrouk - Removed a lot of types only leaving the exact types used by XLS. And made editorial changes to clean up the schema and only leave the types used. The fully commented schema will be retained separately for those interested in researching it

</documentation>
</annotation>
<import namespace="http://www.w3.org/1999/xlink" schemaLocation="xlinks.xsd"/>
<!-- == -->
<element name="_Object" abstract="true">
<annotation>
<documentation>This abstract element is the head of a substitutionGroup hierararchy which may contain either simpleContent or complexContent elements. It is used to assert the model position of "class" elements declared in other GML schemas. </documentation>
</annotation>
</element>
<!-- == -->
<attribute name="id" type="ID">
<annotation>
<documentation>Database handle for the object. It is of XML type “ID”, so is constrained to be unique in the XML document within which it occurs. An external identifier for the object in the form of a URI may be constructed using

```
standard XML and XPointer methods.  This is done by concatenating the URI for
the document, a fragment separator “#”, and the value of the id attribute.
</documentation>
        </annotation>
    </attribute>
    <!-- ================================================== -->
    <complexType name="AbstractGMLType" abstract="true">
        <annotation>
            <documentation>All complexContent GML elements are directly or
indirectly derived from this abstract supertype
    to establish a hierarchy of GML types that may be distinguished from other
XML types by their ancestry.
    Elements in this hierarchy may have an ID and are thus referenceable.
</documentation>
        </annotation>
        <attribute ref="gml:id" use="optional"/>
    </complexType>
    <!-- ================================================== -->
    <element name="_GML" type="gml:AbstractGMLType" abstract="true"
substitutionGroup="gml:_Object">
        <annotation>
            <documentation>Global element which acts as the head of a substitution
group that may include any element which is a GML feature, object, geometry or
complex value</documentation>
        </annotation>
    </element>
    <!-- ================================================== -->
    <element name="_Curve" type="gml:AbstractCurveType" abstract="true"
substitutionGroup="gml:_GeometricPrimitive">
        <annotation>
            <documentation>The "_Curve" element is the abstract head of the
substituition group for all (continuous) curve elements.</documentation>
        </annotation>
    </element>
    <!-- ================================================== -->
    <complexType name="AbstractCurveType" abstract="true">
        <annotation>
            <documentation>An abstraction of a curve to support the different levels
of complexity. The curve can always be viewed as a geometric primitive, i.e. is
continuous.</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractGeometricPrimitiveType"/>
        </complexContent>
    </complexType>
    <!-- ================================================== -->
```

```
    <complexType name="AbstractGeometricPrimitiveType" abstract="true">
      <annotation>
        <documentation>This is the abstract root type of the geometric
primitives. A geometric primitive is a geometric object that is not decomposed
further into other primitives in the system. All primitives are oriented in the
direction implied by the sequence of their coordinate tuples.</documentation>
      </annotation>
      <complexContent>
        <extension base="gml:AbstractGeometryType"/>
      </complexContent>
    </complexType>
    <!-- ========================================== -->
    <complexType name="AbstractGeometryType" abstract="true">
      <annotation>
        <documentation>All geometry elements are derived directly or indirectly
from this abstract supertype. A geometry element may have an identifying
attribute ("gml:id"), a name (attribute "name") and a description (attribute
"description"). It may be associated with a spatial reference system (attribute
"srsName"). The following rules shall be adhered: - Every geometry type shall
derive from this abstract type. - Every geometry element (i.e. an element of a
geometry type) shall be directly or indirectly in the substitution group of
_Geometry.</documentation>
      </annotation>
      <complexContent>
        <extension base="gml:AbstractGMLType">
          <attribute name="gid" type="string" use="optional">
            <annotation>
              <documentation>This attribute is included for backward
compatibility with GML 2 and is deprecated with GML 3. This identifer is
superceded by "gml:id" inherited from AbstractGMLType. The attribute "gid"
should not be used anymore and may be deleted in future versions of GML
without further notice.</documentation>
            </annotation>
          </attribute>
          <attribute name="srsName" type="anyURI" use="optional">
            <annotation>
              <documentation>In general this reference points to a CRS
instance of gml:CoordinateReferenceSystemType (see
coordinateReferenceSystems.xsd). For well known references it is not required
that the CRS description exists at the location the URI points to (Note: These
"WKCRS"-ids still have to be specified).  If no srsName attribute is given, the
CRS must be specified as part of the larger context this geometry element is part
of, e.g. a geometric aggregate.</documentation>
            </annotation>
          </attribute>
        </extension>
```

```
        </complexContent>
    </complexType>
    <!-- ========================================================== -->
    <element name="_GeometricPrimitive"
type="gml:AbstractGeometricPrimitiveType" abstract="true"
substitutionGroup="gml:_Geometry">
        <annotation>
            <documentation>The "_GeometricPrimitive" element is the abstract
head of the substituition group for all (pre- and user-defined) geometric
primitives.</documentation>
        </annotation>
    </element>
    <!-- ========================================================== -->
    <element name="_Geometry" type="gml:AbstractGeometryType"
abstract="true" substitutionGroup="gml:_GML">
        <annotation>
            <documentation>The "_Geometry" element is the abstract head of the
substituition group for all geometry elements of GML 3. This includes pre-defined
and user-defined geometry elements. Any geometry element must be a direct or
indirect extension/restriction of AbstractGeometryType and must be directly or
indirectly in the substitution group of "_Geometry".</documentation>
        </annotation>
    </element>
    <!-- ========================================================== -->
    <element name="LineString" type="gml:LineStringType"
substitutionGroup="gml:_Curve"/>
    <!-- ========================================================== -->
    <complexType name="LineStringType">
        <annotation>
            <documentation>              A LineString is a special curve that consists
of a single segment with linear interpolation. It is defined by two or more
coordinate tuples, with linear interpolation between them. It is backwards
compatible with the LineString of GML 2, GM_LineString of ISO 19107 is
implemented by LineStringSegment.            </documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractCurveType">
                <sequence>
                    <annotation>
                        <documentation>GML supports two different ways to specify the
control points of a line string. 1. A sequence of "pos" (DirectPositionType) or
"pointRep" (PointPropertyType) elements. "pos" elements are control points that
are only part of this curve, "pointRep" elements contain a point that may be
referenced from other geometry elements or reference another point defined
outside of this curve (reuse of existing points). 2. The "coordinates" element
allows for a compact way to specifiy the coordinates of the control points, if all
```

```
control points are in the same coordinate reference systems and belong to this
curve only. The number of direct positions in the coordinates list must be at least
two.</documentation>
                </annotation>
                <element ref="gml:pos"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<!-- ========================================================== -->
<element name="pos" type="gml:DirectPositionType"/>
<!-- ========================================================== -->
<complexType name="DirectPositionType">
    <annotation>
        <documentation>DirectPosition instances hold the coordinates for a
position within some coordinate reference system (CRS). Since DirectPositions,
as data types, will often be included in larger objects (such as geometry
elements) that have references to CRS, the "srsName" attribute will in general be
missing, if this particular DirectPosition is included in a larger element with such a
reference to a CRS. In this case, the CRS is implicitly assumed to take on the
value of the containing object's CRS.</documentation>
    </annotation>
    <simpleContent>
        <extension base="gml:doubleList">
            <attribute name="srsName" type="anyURI" use="optional">
                <annotation>
                    <documentation>In general this reference points to a CRS
instance of gml:CoordinateReferenceSystemType (see
coordinateReferenceSystems.xsd). For well known references it is not required
that the CRS description exists at the location the URI points to (Note: These
"WKCRS"-ids still have to be specified).  If no srsName attribute is given, the
CRS must be specified as part of the larger context this geometry element is part
of, e.g. a geometric element like point, curve, etc. It is expected that the attribute
will be specified at the direct position level only in rare cases.</documentation>
                </annotation>
            </attribute>
            <attribute name="dimension" type="positiveInteger" use="optional">
                <annotation>
                    <documentation>The attribute "dimension" is the length of
coordinate sequence (the number of entries in the list). This is determined by the
coordinate reference system.</documentation>
                </annotation>
            </attribute>
        </extension>
    </simpleContent>
</complexType>
```

```
    <!-- ================================================== -->
    <simpleType name="doubleList">
        <annotation>
            <documentation>XML List based on XML Schema double type.  An
element of this type contains a space-separated list of double
values</documentation>
        </annotation>
        <list itemType="double"/>
    </simpleType>
    <!-- ================================================== -->
    <element name="Point" type="gml:PointType"
substitutionGroup="gml:_GeometricPrimitive"/>
    <!-- ================================================== -->
    <complexType name="PointType">
        <annotation>
            <documentation>A Point is defined by a single coordinate
tuple.</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractGeometricPrimitiveType">
                <sequence>
                    <choice>
                        <annotation>
                            <documentation>GML supports two different ways to specify
the direct poisiton of a point. 1. The "pos" element is of type DirectPositionType.
</documentation>
                        </annotation>
                        <element ref="gml:pos"/>
                    </choice>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ================================================== -->
    <element name="LinearRing" type="gml:LinearRingType"
substitutionGroup="gml:_Ring"/>
    <!-- ================================================== -->
    <complexType name="LinearRingType">
        <annotation>
            <documentation>A LinearRing is defined by four or more coordinate
tuples, with linear interpolation between them; the first and last coordinates must
be coincident.</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractRingType">
                <sequence>
```

```
                <annotation>
                    <documentation>GML supports two different ways to specify the
control points of a linear ring.
1. A sequence of "pos" (DirectPositionType) or "pointRep" (PointPropertyType)
elements. "pos" elements are control points that are only part of this ring,
"pointRep" elements contain a point that may be referenced from other geometry
elements or reference another point defined outside of this ring (reuse of existing
points).
2. The "coordinates" element allows for a compact way to specifiy the
coordinates of the control points, if all control points are in the same coordinate
reference systems and belong to this ring only. The number of direct positions in
the coordinate list must be at least four.</documentation>
                </annotation>
                <element ref="gml:pos"/>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<!-- ========================================================== -->
<complexType name="AbstractRingType" abstract="true">
    <annotation>
        <documentation>
            An abstraction of a ring to support surface boundaries of different
complexity.
        </documentation>
    </annotation>
    <complexContent>
        <extension base="gml:AbstractGeometryType"/>
    </complexContent>
</complexType>
<!-- ========================================================== -->
<element name="_Ring" type="gml:AbstractRingType" abstract="true"
substitutionGroup="gml:_Geometry">
    <annotation>
        <documentation>The "_Ring" element is the abstract head of the
substituition group for all closed boundaries of a surface patch.</documentation>
    </annotation>
</element>
<!-- ========================================================== -->
<element name="exterior" type="gml:AbstractRingPropertyType">
    <annotation>
        <documentation>A boundary of a surface consists of a number of rings.
In the normal 2D case, one of these rings is distinguished as being the exterior
boundary. In a general manifold this is not always possible, in which case all
boundaries shall be listed as interior boundaries, and the exterior will be
empty.</documentation>
```

```
      </annotation>
   </element>
   <!-- ========================================================== -->
   <complexType name="AbstractRingPropertyType">
      <annotation>
         <documentation>
               Encapsulates a ring to represent the surface boundary property of a
surface.
         </documentation>
      </annotation>
      <sequence>
         <element ref="gml:_Ring"/>
      </sequence>
   </complexType>
   <!-- ========================================================== -->
   <element name="interior" type="gml:AbstractRingPropertyType">
      <annotation>
         <documentation>A boundary of a surface consists of a number of rings.
The "interior" rings seperate the surface / surface patch from the area enclosed
by the rings.</documentation>
      </annotation>
   </element>
   <!-- ========================================================== -->
   <element name="Polygon" type="gml:PolygonType"
substitutionGroup="gml:_Surface"/>
   <!-- ========================================================== -->
   <complexType name="PolygonType">
      <annotation>
         <documentation>A Polygon is a special surface that is defined by a
single surface patch. The boundary of this patch is coplanar and the polygon
uses planar interpolation in its interior. It is backwards compatible with the
Polygon of GML 2, GM_Polygon of ISO 19107 is implemented by
PolygonPatch.</documentation>
      </annotation>
      <complexContent>
         <extension base="gml:AbstractSurfaceType">
            <sequence>
               <element ref="gml:exterior" minOccurs="0"/>
               <element ref="gml:interior" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ========================================================== -->
   <complexType name="AbstractSurfaceType">
```

```
        <annotation>
          <documentation>
            An abstraction of a surface to support the different levels of
complexity. A surface is always a continuous region of a plane.
          </documentation>
        </annotation>
        <complexContent>
          <extension base="gml:AbstractGeometricPrimitiveType"/>
        </complexContent>
    </complexType>
    <!-- ================================================== -->
    <element name="_Surface" type="gml:AbstractSurfaceType" abstract="true"
substitutionGroup="gml:_GeometricPrimitive">
        <annotation>
          <documentation>The "_Surface" element is the abstract head of the
substituition group for all (continuous) surface elements.</documentation>
        </annotation>
    </element>
    <!-- ================================================== -->
    <complexType name="AbstractGeometricAggregateType" abstract="true">
        <annotation>
          <documentation>This is the abstract root type of the geometric
aggregates.</documentation>
        </annotation>
        <complexContent>
          <extension base="gml:AbstractGeometryType"/>
        </complexContent>
    </complexType>
    <!-- ================================================== -->
    <element name="_GeometricAggregate"
type="gml:AbstractGeometricAggregateType" abstract="true"
substitutionGroup="gml:_Geometry">
        <annotation>
          <documentation>The "_GeometricAggregate" element is the abstract
head of the substituition group for all geometric aggremates.</documentation>
        </annotation>
    </element>
    <!-- ================================================== -->
    <element name="MultiPolygon" type="gml:MultiPolygonType"
substitutionGroup="gml:_GeometricAggregate">
        <annotation>
          <documentation>Use the "MultiSurface" element
instead.</documentation>
        </annotation>
    </element>
    <complexType name="MultiPolygonType">
```

```
        <annotation>
          <documentation>
            A MultiPolygon is defined by one or more Polygons, referenced
through polygonMember elements.          </documentation>
        </annotation>
        <complexContent>
          <extension base="gml:AbstractGeometricAggregateType">
            <sequence>
              <element ref="gml:polygonMember" minOccurs="0"
maxOccurs="unbounded"/>
            </sequence>
          </extension>
        </complexContent>
    </complexType>
    <element name="polygonMember" type="gml:PolygonPropertyType">
        <annotation>
          <documentation>This property element either references a polygon via
the XLink-attributes or contains the polygon element.</documentation>
        </annotation>
    </element>
    <complexType name="PolygonPropertyType">
        <annotation>
          <documentation>A property that has a polygon as its value domain can
either be an appropriate geometry element encapsulated in an element of this
type or an XLink reference to a remote geometry element (where remote
includes geometry elements located elsewhere in the same document). Either
the reference or the contained element must be given, but neither both nor
none.</documentation>
        </annotation>
        <sequence>
          <element ref="gml:Polygon" minOccurs="0"/>
        </sequence>
    </complexType>
    <!-- ================================================== -->
    <simpleType name="SurfaceInterpolationType">
        <annotation>
          <documentation>SurfaceInterpolationType is a list of codes that may be
used to identify the interpolation mechanisms specified by an
application schema.</documentation>
        </annotation>
        <restriction base="string">
          <enumeration value="none"/>
          <enumeration value="planar"/>
          <enumeration value="spherical"/>
        </restriction>
    </simpleType>
```

```
    <!-- ================================================== -->
    <element name="boundedBy" type="gml:BoundingShapeType"/>
    <!-- ================================================== -->
    <complexType name="BoundingShapeType">
        <annotation>
            <documentation>Bounding shape.</documentation>
        </annotation>
        <sequence>
            <group ref="gml:boundingShape"/>
        </sequence>
    </complexType>
    <!-- ================================================== -->
    <group name="boundingShape">
        <choice>
            <element ref="gml:Envelope"/>
            <element ref="gml:Null"/>
        </choice>
    </group>
    <!-- ================================================== -->
    <element name="Envelope" type="gml:EnvelopeType"
substitutionGroup="gml:_Geometry"/>
    <!-- ================================================== -->
    <complexType name="EnvelopeType">
        <annotation>
            <documentation>Envelope defines an extent using a pair of positions
defining opposite corners in arbitrary dimensions.</documentation>
        </annotation>
        <complexContent>
            <extension base="gml:AbstractGeometryType">
                <sequence>
                    <choice>
                        <element ref="gml:pos" minOccurs="2" maxOccurs="2"/>
                    </choice>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ================================================== -->
    <element name="Null" type="gml:NullType"/>
    <!-- ================================================== -->
    <simpleType name="NullType">
        <annotation>
            <documentation>Utility type for null elements.  The value may be
selected from one of the enumerated tokens, or may be a URI in which case this
should identify a resource which describes the reason for the null.
</documentation>
```

```
      </annotation>
      <union memberTypes="gml:NullEnumeration anyURI"/>
   </simpleType>
   <!-- ========================================== -->
   <simpleType name="NullEnumeration">
      <annotation>
         <documentation> Some common reasons for a null value:

      innapplicable - the object does not have a value
      missing - The correct value is not readily available to the sender of this data.
                  Furthermore, a correct value may not exist.
      template - the value will be available later
      unknown - The correct value is not known to, and not computable by, the
sender of this data.
                  However, a correct value probably exists.
      withheld - the value is not divulged

      Specific communities may agree to assign more strict semantics when
these terms are used in a particular context.
     </documentation>
      </annotation>
      <restriction base="string">
         <enumeration value="inapplicable"/>
         <enumeration value="missing"/>
         <enumeration value="template"/>
         <enumeration value="unknown"/>
         <enumeration value="withheld"/>
      </restriction>
   </simpleType>
   <!-- ========================================== -->
   <element name="CircleByCenterPoint" type="gml:CircleByCenterPointType"
substitutionGroup="gml:ArcByCenterPoint"/>
   <!-- ========================================== -->
   <complexType name="CircleByCenterPointType">
      <annotation>
         <documentation>A CircleByCenterPoint is an ArcByCenterPoint with
identical start and end angle to form a full circle. Again, this represenation can be
used only in 2D.</documentation>
      </annotation>
      <complexContent>
         <extension base="gml:ArcByCenterPointType"/>
      </complexContent>
   </complexType>
   <!-- ========================================== -->
   <complexType name="ArcByCenterPointType">
      <annotation>
```

```
            <documentation>
               This variant of the arc requires that the points on the arc have to be
computed instead of storing the coordinates directly. The control point is the
center point of the arc plus the radius and the bearing at start and end. This
represenation can be used only in 2D.
            </documentation>
         </annotation>
         <complexContent>
            <extension base="gml:AbstractCurveSegmentType">
               <sequence>
                  <annotation>
                     <documentation>GML supports two different ways to specify the
control points of a curve segment.
1. A "pos" (DirectPositionType) or "pointRep" (PointPropertyType) element. The
"pos" element contains a center point that is only part of this curve segment, a
"pointRep" element contains a point that may be referenced from other geometry
elements or reference another point defined outside of this curve segment (reuse
of existing points).
2. The "coordinates" element can be used to specifiy the coordinates of the
center point, too. The number of direct positions in the coordinate list must be
one.</documentation>
                  </annotation>
                  <element ref="gml:pos"/>
                  <element name="radius" type="gml:LengthType">
                     <annotation>
                        <documentation>The radius of the arc.</documentation>
                     </annotation>
                  </element>
                  <element name="startAngle" type="gml:AngleType"
minOccurs="0">
                     <annotation>
                        <documentation>The bearing of the arc at the
start.</documentation>
                     </annotation>
                  </element>
                  <element name="endAngle" type="gml:AngleType"
minOccurs="0">
                     <annotation>
                        <documentation>The bearing of the arc at the
end.</documentation>
                     </annotation>
                  </element>
               </sequence>
               <attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArcCenterPointWithRadius">
                  <annotation>
```

```
                    <documentation>The attribute "interpolation" specifies the curve
interpolation mechanism used for this segment. This mechanism
uses the control points and control parameters to determine the position of this
curve segment. For an ArcByCenterPoint the interpolation is fixed as
"circularArcCenterPointWithRadius".</documentation>
                </annotation>
            </attribute>
            <attribute name="numArc" type="integer" use="required" fixed="1">
                <annotation>
                    <documentation>Since this type describes always a single arc,
the attribute is fixed to "1".</documentation>
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<!-- ========================================== -->
<complexType name="AbstractCurveSegmentType" abstract="true">
    <annotation>
        <documentation>
            Curve segment defines a homogeneous segment of a curve.
        </documentation>
    </annotation>
</complexType>
<!-- ========================================== -->
<simpleType name="CurveInterpolationType">
    <annotation>
        <documentation>CurveInterpolationType is a list of codes that may be
used to identify the interpolation mechanisms specified by an
application schema.</documentation>
    </annotation>
    <restriction base="string">
        <enumeration value="linear"/>
        <enumeration value="geodesic"/>
        <enumeration value="circularArcCenterPointWithRadius"/>
    </restriction>
</simpleType>
<!-- ========================================== -->
<element name="ArcByCenterPoint" type="gml:ArcByCenterPointType"
substitutionGroup="gml:_CurveSegment"/>
<!-- ========================================== -->
<element name="_CurveSegment" type="gml:AbstractCurveSegmentType"
abstract="true">
    <annotation>
```

```
            <documentation>The "_CurveSegment" element is the abstract head of
the substituition group for all curve segment elements, i.e. continuous segments
of the same interpolation mechanism.</documentation>
         </annotation>
      </element>
      <!-- ========================================== -->
      <complexType name="LengthType">
         <annotation>
            <documentation>Value of a length (or distance) quantity, with its units.
Uses the MeasureType with the restriction that the unit of measure referenced by
uom must be suitable for a length, such as metres or feet. </documentation>
         </annotation>
         <simpleContent>
            <extension base="gml:MeasureType"/>
         </simpleContent>
      </complexType>
      <!-- ========================================== -->
      <complexType name="MeasureType">
         <annotation>
            <documentation>Number with a scale.
       The value of uom (Units Of Measure) attribute is a reference to a Reference
System for the amount, either a ratio or position scale. </documentation>
         </annotation>
         <simpleContent>
            <extension base="double">
               <attribute name="uom" type="anyURI" use="required"/>
            </extension>
         </simpleContent>
      </complexType>
      <!-- ========================================== -->
      <complexType name="AngleType">
         <annotation>
            <documentation>Value of an angle quantity recorded as a single
number, with its units. Uses the MeasureType with the restriction that the unit of
measure referenced by uom must be suitable for an angle, such as degrees or
radians. </documentation>
         </annotation>
         <simpleContent>
            <extension base="gml:MeasureType"/>
         </simpleContent>
      </complexType>
      <!--
=============================================================
======  -->
      <element name="CompassPoint" type="gml:CompassPointEnumeration"/>
```

```
   <!--
=============================================================
======  -->
   <simpleType name="CompassPointEnumeration">
      <restriction base="string">
         <enumeration value="N"/>
         <enumeration value="NNE"/>
         <enumeration value="NE"/>
         <enumeration value="ENE"/>
         <enumeration value="E"/>
         <enumeration value="ESE"/>
         <enumeration value="SE"/>
         <enumeration value="SSE"/>
         <enumeration value="S"/>
         <enumeration value="SSW"/>
         <enumeration value="SW"/>
         <enumeration value="WSW"/>
         <enumeration value="W"/>
         <enumeration value="WNW"/>
         <enumeration value="NW"/>
         <enumeration value="NNW"/>
      </restriction>
   </simpleType>
   <!--
=============================================================
======  -->
</schema>
```

XLS.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns="http://www.w3.org/2001/XMLSchema"
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="ADT.xsd"/>
   <element name="XLS" type="xls:XLSType">
      <annotation>
```

```
            <documentation>The top element of an OpenLS request-response
message; an XML document.</documentation>
        </annotation>
    </element>
    <complexType name="XLSType">
        <annotation>
            <documentation>Defines the top element of an XML document
representing a message.</documentation>
        </annotation>
        <sequence>
            <element ref="xls:_Header"/>
            <element ref="xls:_Body"/>
        </sequence>
        <attribute name="version" type="decimal" use="required"/>
        <attribute ref="xls:lang" use="optional"/>
    </complexType>
    <element name="_Header" type="xls:AbstractHeaderType" abstract="true">
        <annotation>
            <documentation>Defines the portion of a message that contains header
information; see _Body for  the specific information needed to execute a
request.</documentation>
            <documentation>Base element representing all types of header
information.</documentation>
        </annotation>
    </element>
    <complexType name="AbstractHeaderType" abstract="true">
        <annotation>
            <documentation>Defines the portion of a message that contains
information orthogonal to the specific information needed to execute a request.
Typical header information includes infomation associated with authentication
and authorization, transaction management, payment processing, tracing and
auditing.</documentation>
            <documentation>Abstract type common to all types of header
information.</documentation>
        </annotation>
    </complexType>
    <element name="_Body" type="xls:AbstractBodyType" abstract="true">
        <annotation>
            <documentation>The portion of a message containing information that is
core to the message; the request-response pair.</documentation>
            <documentation>Base element representing all types of body
information.</documentation>
        </annotation>
    </element>
    <complexType name="AbstractBodyType" abstract="true">
        <annotation>
```

```
            <documentation>Defines the portion of a message containing
information that is core to the message.</documentation>
            <documentation>Abstract type common to all types of body
information.</documentation>
        </annotation>
    </complexType>
    <element name="RequestHeader" type="xls:RequestHeaderType"
substitutionGroup="xls:_Header">
        <annotation>
            <documentation>The header information for request
messages.</documentation>
        </annotation>
    </element>
    <complexType name="RequestHeaderType">
        <annotation>
            <documentation>Defines the header information for request
messages.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractHeaderType">
                <attribute name="clientName" type="string" use="optional">
                    <annotation>
                        <documentation>The client name, used for
authentication.</documentation>
                    </annotation>
                </attribute>
                <attribute name="clientPassword" type="string" use="optional">
                    <annotation>
                        <documentation/>
                        <documentation>The client password, used for
authentication.</documentation>
                    </annotation>
                </attribute>
                <attribute name="deviceType" type="string" use="optional">
                    <annotation>
                        <documentation>The type of client device, if applicable (based
upon a well-known list of device types). </documentation>
                    </annotation>
                </attribute>
                <attribute name="sessionID" type="string" use="optional">
                    <annotation>
                        <documentation>A client-defined unique session lidentifier,
which should be returned in the response header.</documentation>
                    </annotation>
                </attribute>
                <attribute name="MSID" type="string" use="optional">
```

```
                <annotation>
                    <documentation>A client-defined unique lidentifier, which
should be returned in the response header.</documentation>
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<element name="Request" type="xls:RequestType"
substitutionGroup="xls:_Body">
    <annotation>
        <documentation>The core information of a service request
message.</documentation>
    </annotation>
</element>
<complexType name="RequestType">
    <annotation>
        <documentation>Defines the core information of a service request
message.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractBodyType">
            <sequence>
                <element ref="xls:_RequestParameters" minOccurs="0"/>
            </sequence>
            <attribute name="methodName" type="NMTOKEN" use="required">
                <annotation>
                    <documentation>The name of the method to be invoked by the
service.</documentation>
                </annotation>
            </attribute>
            <attribute name="version" type="string" use="required">
                <annotation>
                    <documentation>The version level of the request parameters
supported by the client.</documentation>
                </annotation>
            </attribute>
            <attribute name="requestID" type="string" use="required">
                <annotation>
                    <documentation>A client-defined request identifier, unique
within the scope of the session.  The request identifier must be returned in the
service response.</documentation>
                </annotation>
            </attribute>
            <attribute name="maximumResponses" type="nonNegativeInteger"
use="optional">
```

```
                <annotation>
                    <documentation>This parameter will allow the request to control
the number of responses generated. For example the POI request will use this as
a contraint to generate a certain number of POIs. In the special cases where one
of the responses can contain multiple values this will be controlled within the
request itself, in those cases this parameter will not be
applicable</documentation>
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<element name="_RequestParameters"
type="xls:AbstractRequestParametersType" abstract="true">
    <annotation>
        <documentation>Base element representing the set of parameters for a
service request.</documentation>
    </annotation>
</element>
<complexType name="AbstractRequestParametersType" abstract="true">
    <annotation>
        <documentation>Abstract type representing the set of parameters for a
service request.</documentation>
    </annotation>
</complexType>
<element name="ResponseHeader" type="xls:ResponseHeaderType"
substitutionGroup="xls:_Header">
    <annotation>
        <documentation>The header information for response
messages.</documentation>
    </annotation>
</element>
<complexType name="ResponseHeaderType">
    <annotation>
        <documentation>Defines the header information for response
messages.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractHeaderType">
            <sequence>
                <element ref="xls:ErrorList" minOccurs="0"/>
            </sequence>
            <attribute name="sessionID" type="string" use="optional">
                <annotation>
                    <documentation>The session identifier, specified by the client in
the request header.</documentation>
```

```
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<element name="Response" type="xls:ResponseType"
substitutionGroup="xls:_Body">
    <annotation>
        <documentation>The response information returned from a service
request.</documentation>
    </annotation>
</element>
<complexType name="ResponseType">
    <annotation>
        <documentation>Defines the response information returned from a
service response.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:AbstractBodyType">
            <sequence>
                <element ref="xls:ErrorList" minOccurs="0"/>
                <element ref="xls:_ResponseParameters" minOccurs="0"/>
            </sequence>
            <attribute name="version" type="string" use="required">
                <annotation>
                    <documentation>The version level of the response parameters
supported by the service.</documentation>
                </annotation>
            </attribute>
            <attribute name="requestID" type="string" use="required">
                <annotation>
                    <documentation>The request identifier, unique within the scope
of the session, specified by the client in the service request.</documentation>
                </annotation>
            </attribute>
            <attribute name="numberOfResponses" type="nonNegativeInteger"
use="optional">
                <annotation>
                    <documentation>This is the number of responses that are
generated by the request. For example a POI search will generate multiple POIs
as a result of that. Some requests of OpenLS allow for the generation of multiple
values inside one of the responses, these cases will be handled inside the
response itself, this attribute in this case is not applicable to that
</documentation>
                </annotation>
            </attribute>
```

```
            </extension>
        </complexContent>
    </complexType>
    <element name="_ResponseParameters"
type="xls:AbstractResponseParametersType" abstract="true">
        <annotation>
            <documentation>Base element representing the response information
returned from a service request.</documentation>
        </annotation>
    </element>
    <complexType name="AbstractResponseParametersType" abstract="true">
        <annotation>
            <documentation>Abstract type representing the response information
returned from a service request.</documentation>
        </annotation>
    </complexType>
    <element name="ErrorList" type="xls:ErrorListType">
        <annotation>
            <documentation>A list of errors encountered while attempting to process
a request.</documentation>
        </annotation>
    </element>
    <complexType name="ErrorListType">
        <annotation>
            <documentation>Defines a list of errors.</documentation>
        </annotation>
        <sequence>
            <element ref="xls:Error" maxOccurs="unbounded"/>
        </sequence>
        <attribute name="highestSeverity" type="xls:SeverityType" use="optional"
default="Warning">
            <annotation>
                <documentation>Set to the highest severity of any of the Error
elements. Specifically, if any of the Error elements have a severity of Error then
highestSeverity must be set to Error, otherwise set highestSeverity to
Warning.</documentation>
            </annotation>
        </attribute>
    </complexType>
    <element name="Error" type="xls:ErrorType">
        <annotation>
            <documentation>Contains error and/or status
information.</documentation>
        </annotation>
    </element>
    <complexType name="ErrorType">
```

```
        <annotation>
          <documentation>Defines the characteristics of a processing
error.</documentation>
        </annotation>
        <attribute name="errorCode" type="xls:ErrorCodeType" use="required">
          <annotation>
            <documentation>XML qualified name identifying the error. The well-
known error codes within the "http://www.opengis.org/xls" namespace are
enumerated in the type ErrorCodeEnum.</documentation>
          </annotation>
        </attribute>
        <attribute name="severity" type="xls:SeverityType" use="optional"
default="Warning">
          <annotation>
            <documentation>Indicates the severity of the error.</documentation>
          </annotation>
        </attribute>
        <attribute name="locationID" type="IDREF" use="optional">
          <annotation>
            <documentation>The ID of the element associated with the
error.</documentation>
          </annotation>
        </attribute>
        <attribute name="locationPath" type="string" use="optional">
          <annotation>
            <documentation>If the XML is well formed, then this attribute contains
the path to the XML element or attribute associated with the
error.</documentation>
          </annotation>
        </attribute>
        <attribute name="message" type="string" use="optional">
          <annotation>
            <documentation>Provides a human readable explanation of the error,
which is not intended for algorithmic processing.</documentation>
          </annotation>
        </attribute>
    </complexType>
    <simpleType name="ErrorCodeType">
        <annotation>
          <documentation>Enumeration of error codes defined within the
"http://www.opengis.net/xls" namespace.</documentation>
        </annotation>
        <restriction base="string">
          <enumeration value="RequestVersionMismatch">
            <annotation>
```

```
                <documentation>Version of Request Schema not
supported.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="ResponseVersionMismatch">
            <annotation>
                <documentation>Version of Response Schema not
supported.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="ValueNotRecognized">
            <annotation>
                <documentation>Element content or attribute value not
recognized.  Although the document is well formed and valid, the
element/attribute contains a value that could not be recognized and therefore
could not be used by the service processing the message.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="NotSupported">
            <annotation>
                <documentation>Element or attribute not supported. Although the
document is well formed and valid, an element or attribute is present that is
consistent with the rules and constraints contained in the OpenLS specification,
but is not supported by the service processing the message.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="Inconsistent">
            <annotation>
                <documentation>Element content or attribute value inconsistent
with other elements or attributes. Although the document is well formed and
valid, according to the rules and constraints contained in the OpenLS
specification the content of an element or attribute is inconsistent with the content
of other elements or their attributes.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="OtherXml">
            <annotation>
                <documentation>Other error in an element content or attribute
value. Although the document is well formed and valid, the element content or
attribute value contains values that do not conform to the rules and constraints
contained in the OpenLS specification and is not covered by other error codes.
The Error message attribute should be used to indicate the nature of the
problem.</documentation>
            </annotation>
        </enumeration>
        <enumeration value="DeliveryFailure">
```

```
            <annotation>
               <documentation>Message Delivery Failure. A message has been
received that either probably or definitely could not be sent to its next destination.
Note: if severity is set to Warning then there is a small probability that the
message was delivered.</documentation>
            </annotation>
         </enumeration>
         <enumeration value="SecurityFailure">
            <annotation>
               <documentation>Message Security Checks Failed. Validation of
signatures or checks on the authenticity or authority of the sender of the
message have failed.</documentation>
            </annotation>
         </enumeration>
         <enumeration value="Unknown">
            <annotation>
               <documentation>Unknown Error. Indicates that an error has
occurred that is not covered explicitly by any of the other errors. The Error
message attribute should be used to indicate the nature of the
problem.</documentation>
            </annotation>
         </enumeration>
      </restriction>
   </simpleType>
   <simpleType name="SeverityType">
      <annotation>
         <documentation>Enumeration of the error severity
levels.</documentation>
      </annotation>
      <restriction base="string">
         <enumeration value="Warning">
            <annotation>
               <documentation>This indicates that although there is an error,
other parts of the request will still be processed in the normal
way.</documentation>
            </annotation>
         </enumeration>
         <enumeration value="Error">
            <annotation>
               <documentation>This indicates that there is an unrecoverable error
in the request and no part of the request will processed.</documentation>
            </annotation>
         </enumeration>
      </restriction>
   </simpleType>
</schema>
```

DirectoryService.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
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="XLS.xsd"/>
   <!-- ================================================== --
>
   <element name="DirectoryRequest" type="xls:DirectoryRequestType"
substitutionGroup="xls:_RequestParameters"/>
   <complexType name="DirectoryRequestType">
      <annotation>
         <documentation>ADT for a DirectoryRequest</documentation>
      </annotation>
      <complexContent>
         <extension base="xls:AbstractRequestParametersType">
            <sequence>
               <element ref="xls:POILocation" minOccurs="0"/>
               <element ref="xls:_POISelectionCriteria"/>
            </sequence>
            <attribute name="sortCriteria" type="xls:SortCriteriaType"
use="optional">
               <annotation>
                  <documentation>POI property used to sort the result. Could be
by distance from the source POI.</documentation>
               </annotation>
            </attribute>
            <attribute name="sortDirection" type="xls:SortDirectionType"
use="optional" default="Ascending">
               <annotation>
                  <documentation>Ascending/Descending</documentation>
               </annotation>
            </attribute>
         </extension>
      </complexContent>
   </complexType>
```

```
   <!-- ========================================================= -->
   <element name="DirectoryResponse" type="xls:DirectoryResponseType"
substitutionGroup="xls:_ResponseParameters">
      <annotation>
         <documentation>Directory Service Response</documentation>
      </annotation>
   </element>
   <!-- ========================================================= -->
   <complexType name="DirectoryResponseType">
      <annotation>
         <documentation>ADT for a ProximityResponse. One or more POIs may
be returned</documentation>
      </annotation>
      <complexContent>
         <extension base="xls:AbstractResponseParametersType">
            <sequence>
               <element name="POIContext" type="xls:POIWithDistanceType"
minOccurs="0" maxOccurs="unbounded"/>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <!-- ========================================================= -->
   <complexType name="WithinBoundaryType">
      <annotation>
         <documentation>Defines a spatial filter which selects POIs located
within a specified bounding area.</documentation>
      </annotation>
      <sequence>
         <element ref="xls:AOI"/>
      </sequence>
   </complexType>
   <!-- ========================================================= -->
   <complexType name="WithinDistanceType">
      <annotation>
         <documentation>Defines a spatial filter which selects POIs located
within a specified distance from a location.</documentation>
      </annotation>
      <sequence>
         <element ref="xls:_Location"/>
         <element name="MinimumDistance" type="xls:DistanceType"
minOccurs="0"/>
```

```
            <element name="MaximumDistance" type="xls:DistanceType"
minOccurs="0"/>
        </sequence>
    </complexType>
    <!-- ================================================== --
>
    <complexType name="NearestType">
        <annotation>
            <documentation>Defines a spatial filter which selects the POI nearest to
the specified location.</documentation>
        </annotation>
        <sequence>
            <element ref="xls:_Location" maxOccurs="unbounded"/>
        </sequence>
        <attribute name="nearestCriterion" type="xls:NearestCriterionType"
use="optional" default="Proximity">
            <annotation>
                <documentation>Proximity - nearest by straightline
distance</documentation>
            </annotation>
        </attribute>
    </complexType>
    <simpleType name="NearestCriterionType">
        <restriction base="string">
            <enumeration value="Proximity"/>
            <enumeration value="Fastest"/>
            <enumeration value="Shortest"/>
            <enumeration value="Easiest"/>
        </restriction>
    </simpleType>
    <!-- ================================================== --
>
    <element name="_POISelectionCriteria"
type="xls:AbstractPOISelectionCriteriaType">
        <annotation>
            <documentation>Base element that specifies POI selection
criteria</documentation>
        </annotation>
    </element>
    <!-- ================================================== --
>
    <complexType name="AbstractPOISelectionCriteriaType" abstract="true">
        <annotation>
            <documentation>Abstract POI selection criteria</documentation>
        </annotation>
    </complexType>
```

```
    <!-- ================================================== -->
    <simpleType name="SortCriteriaType">
        <annotation>
            <documentation>Defines the POI Property used for sorting the responses</documentation>
        </annotation>
        <restriction base="string">
            <enumeration value="Name"/>
            <enumeration value="Type"/>
            <enumeration value="Distance"/>
        </restriction>
    </simpleType>
    <!-- ================================================== -->
    <simpleType name="SortDirectionType">
        <annotation>
            <documentation>Defines the sort direction (Ascending/Descending)</documentation>
        </annotation>
        <restriction base="string">
            <enumeration value="Ascending"/>
            <enumeration value="Descending"/>
        </restriction>
    </simpleType>
    <!-- ================================================== -->
    <element name="POILocation" type="xls:POILocationType"/>
    <complexType name="POILocationType">
        <annotation>
            <documentation>Defines the type of location constraints to perform search.</documentation>
        </annotation>
        <choice>
            <element ref="xls:Address"/>
            <element name="Nearest" type="xls:NearestType"/>
            <element name="WithinDistance" type="xls:WithinDistanceType"/>
            <element name="WithinBoundary" type="xls:WithinBoundaryType"/>
        </choice>
    </complexType>
    <!-- ================================================== -->
    <complexType name="POIWithDistanceType">
        <annotation>
            <documentation>Defines a POI and its distance from a predetermined point.</documentation>
```

```
        </annotation>
        <sequence>
            <element ref="xls:POI"/>
            <element ref="xls:Distance" minOccurs="0"/>
        </sequence>
    </complexType>
    <!-- ========================================================= --
>
    <element name="POIProperties"
substitutionGroup="xls:_POISelectionCriteria">
        <annotation>
            <documentation>Specifies POI selection criteria as a list of
properties</documentation>
        </annotation>
        <complexType>
            <complexContent>
                <extension base="xls:POIPropertiesType"/>
            </complexContent>
        </complexType>
    </element>
    <!-- ========================================================= --
>
    <complexType name="POIPropertiesType">
        <annotation>
            <documentation>Defines POI selection criteria as a list of
properties</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractPOISelectionCriteriaType">
                <sequence>
                    <element ref="xls:_POIProperty" minOccurs="0"
maxOccurs="unbounded"/>
                </sequence>
                <attribute name="directoryType" type="string" use="optional"/>
            </extension>
        </complexContent>
    </complexType>
    <!-- ========================================================= --
>
    <complexType name="AbstractPOIPropertyType" abstract="true">
        <annotation>
            <documentation>Abstract POI property</documentation>
        </annotation>
    </complexType>
    <!-- ========================================================= --
>
```

```
    <element name="_POIProperty">
        <annotation>
            <documentation>Base element representing a POI
property</documentation>
        </annotation>
    </element>
    <complexType name="POIPropertyType">
        <annotation>
            <documentation>Defines a POI property, represented as a name/value
pair</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractPOIPropertyType">
                <attribute name="name" type="xls:POIPropertyNameType"
use="required"/>
                <attribute name="value" type="string" use="required"/>
            </extension>
        </complexContent>
    </complexType>
    <!-- ================================================== --
>
    <element name="POIProperty" type="xls:POIPropertyType"
substitutionGroup="xls:_POIProperty">
        <annotation>
            <documentation>A POI property, represented as a name/value
pair</documentation>
        </annotation>
    </element>
    <simpleType name="POIPropertyNameType">
        <annotation>
            <documentation>Enumeration of  references to properties within the POI
element</documentation>
        </annotation>
        <restriction base="string">
            <enumeration value="ID"/>
            <enumeration value="POIName"/>
            <enumeration value="PhoneNumber"/>
            <enumeration value="Keyword"/>
            <enumeration value="NAICS_type"/>
            <enumeration value="NAICS_subType"/>
            <enumeration value="NAICS_category"/>
            <enumeration value="SIC_type"/>
            <enumeration value="SIC_subType"/>
            <enumeration value="SIC_category"/>
            <enumeration value="SIC_code"/>
            <enumeration value="other"/>
```

```
        </restriction>
    </simpleType>
</schema>
```

GatewayService.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns="http://www.w3.org/2001/XMLSchema"
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="XLS.xsd"/>
    <!--================= Gateway Request and Response
Context==========================-->
    <element name="_GatewayParameters"
type="xls:AbstractGatewayParametersType" abstract="false">
        <annotation>
            <documentation>All Gateway Requests and Responses descend from
this Type. This is required to support other Location Requests defined in
LIF.</documentation>
        </annotation>
    </element>
    <complexType name="AbstractGatewayParametersType" abstract="true">
        <sequence>
            <element name="RequestedQoP" type="xls:QualityOfPositionType"
minOccurs="0"/>
            <!--element ref="xls:MSIDS"/-->
        </sequence>
        <attribute name="locationType" use="optional" default="CURRENT">
            <annotation>
                <documentation>Defines the type of location
requested</documentation>
            </annotation>
            <simpleType>
                <restriction base="string">
                    <enumeration value="CURRENT"/>
                    <enumeration value="LAST"/>
                    <enumeration value="CURRENT_OR_LAST"/>
                </restriction>
            </simpleType>
```

```
        </attribute>
        <attribute name="requestedsrsName" type="string" use="optional">
            <annotation>
                <documentation>The requested Spatial Reference
system</documentation>
            </annotation>
        </attribute>
        <attribute name="ver" type="string" default="1.0">
            <annotation>
                <documentation>The version of LIF that this Request
supports</documentation>
            </annotation>
        </attribute>
        <attribute name="priority" use="optional" default="HIGH">
            <annotation>
                <documentation>The priority of the request</documentation>
            </annotation>
            <simpleType>
                <restriction base="string">
                    <enumeration value="NORMAL"/>
                    <enumeration value="HIGH"/>
                </restriction>
            </simpleType>
        </attribute>
    </complexType>
    <element name="InputGatewayParameters"
type="xls:InputGatewayParametersType"
substitutionGroup="xls:_GatewayParameters"/>
    <complexType name="InputGatewayParametersType">
        <complexContent>
            <extension base="xls:AbstractGatewayParametersType">
                <sequence>
                    <element ref="xls:InputMSIDS"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <element name="OutputGatewayParameters"
type="xls:OutputGatewayParametersType"
substitutionGroup="xls:_GatewayParameters"/>
    <complexType name="OutputGatewayParametersType">
        <complexContent>
            <extension base="xls:OutputGatewayParametersType">
                <sequence>
                    <element ref="xls:OutputMSIDS"/>
                </sequence>
```

```
            </extension>
        </complexContent>
    </complexType>
    <!-- ====================Gateway Request
======================-->
    <element name="SLIR" type="xls:SLIRType"
substitutionGroup="xls:_RequestParameters">
        <annotation>
            <documentation>Standard Location Immediate
Request</documentation>
        </annotation>
    </element>
    <complexType name="SLIRType">
        <complexContent>
            <extension base="xls:AbstractRequestParametersType">
                <sequence>
                    <element ref="xls:InputGatewayParameters"/>
                </sequence>
                <attribute name="responseType" use="optional"
default="PERSISTENT">
                    <annotation>
                        <documentation>Response type at the Standard Location
Immediate Service</documentation>
                    </annotation>
                    <simpleType>
                        <restriction base="string">
                            <enumeration value="PERSISTENT"/>
                            <enumeration value="PUSH"/>
                        </restriction>
                    </simpleType>
                </attribute>
            </extension>
        </complexContent>
    </complexType>
    <!--==================== MSID============================-->
    <element name="_MSInformation" type="xls:AbstractMSInformationType"
abstract="true">
        <annotation>
            <documentation>Identifier of the mobile subscriber</documentation>
        </annotation>
    </element>
    <complexType name="AbstractMSInformationType">
        <attribute name="msIDType" default="MSISDN">
            <annotation>
                <documentation>Type of identifier for the mobile subscriber.
MSISDN: Mobile Station International ISDN Number. IMSI: International Mobile
```

```
Subscriber Identity. IMEI: International Mobile station Equipment Identity. MIN:
Mobile Identification Number. MDN: Mobile Directory Number. EME_MSID:
Emergency MSID. IPV4: Mobile station IP address (Version 4). IPV6: Mobile
station IP address (Version 6)
</documentation>
            </annotation>
            <simpleType>
               <restriction base="string">
                  <enumeration value="MSISDN"/>
                  <enumeration value="MIN"/>
                  <enumeration value="IMSI"/>
                  <enumeration value="IMEI"/>
                  <enumeration value="MDN"/>
                  <enumeration value="EME_MSID"/>
                  <enumeration value="IPV4"/>
                  <enumeration value="IPV6"/>
               </restriction>
            </simpleType>
         </attribute>
         <attribute name="msIDValue" type="string"/>
         <attribute name="encription" use="optional" default="ASC">
            <annotation>
               <documentation>Type of encoding for MSID identifier for the mobile
subscriber. ASC: Normal textual  format. B64:    Base 64 encoding. CRP:
Encrypted format: In some countries the Network Operator (where is placed the
Location Server) isn't allowed to send to a LCS the private information of an MS
like MSISDN.The Network Operator can send out to LCS the Encrypted MSID,
since only the Network Operator is the only entity able to decode this information,
the LCS will be never able to break the privacy of the MS.</documentation>
            </annotation>
            <simpleType>
               <restriction base="string">
                  <enumeration value="ASC"/>
                  <enumeration value="B64"/>
                  <enumeration value="CRP"/>
               </restriction>
            </simpleType>
         </attribute>
         <attribute name="MSInfo" type="string" use="optional">
            <annotation>
               <documentation>
                        A change has been made to make the MSInformationType
not extend String. This attriubute has been added to acomodate that. In it general
information that would have gone in the tag would be represented.
                     </documentation>
            </annotation>
```

```
        </attribute>
    </complexType>
    <element name="InputMSInformation" type="xls:InputMSInformationType"
substitutionGroup="xls:_MSInformation"/>
    <complexType name="InputMSInformationType">
        <complexContent>
            <extension base="xls:AbstractMSInformationType"/>
        </complexContent>
    </complexType>
    <element name="OutputMSInformation" type="xls:OutputMSInformationType"
substitutionGroup="xls:_MSInformation"/>
    <complexType name="OutputMSInformationType">
        <complexContent>
            <extension base="xls:AbstractMSInformationType">
                <sequence>
                    <element ref="xls:Position"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!--====================MSIDS=============================-->
    <element name="_MSIDS" type="xls:AbstractMSIDSType" abstract="true"/>
    <annotation>
        <documentation>List of identifiers of mobile subscribers</documentation>
    </annotation>
    <complexType name="AbstractMSIDSType">
        <attribute name="session" use="optional">
            <simpleType>
                <restriction base="string">
                    <enumeration value="APN"/>
                    <enumeration value="DIAL"/>
                </restriction>
            </simpleType>
        </attribute>
    </complexType>
    <element name="InputMSIDS" type="xls:InputMSIDSType"
substitutionGroup="xls:_MSIDS"/>
    <complexType name="InputMSIDSType">
        <complexContent>
            <extension base="xls:AbstractMSIDSType">
                <sequence>
                    <element ref="xls:InputMSInformation"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
```

```
    <element name="OutputMSIDS" type="xls:OutputMSIDSType"
substitutionGroup="xls:_MSIDS"/>
    <complexType name="OutputMSIDSType">
        <complexContent>
            <extension base="xls:AbstractMSIDSType">
                <sequence>
                    <element ref="xls:OutputMSInformation"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ==============Gateway
Answer======================================== -->
    <element name="SLIA" type="xls:SLIAType"
substitutionGroup="xls:_ResponseParameters">
        <annotation>
            <documentation>Standard Location Immediate
Response</documentation>
        </annotation>
    </element>
    <complexType name="SLIAType">
        <complexContent>
            <extension base="xls:AbstractResponseParametersType">
                <sequence>
                    <element ref="xls:OutputGatewayParameters"/>
                    <!--element ref="xls:Position"/-->
                </sequence>
                <attribute name="requestID" type="string" use="optional">
                    <annotation>
                        <documentation>Unique identification of a
request</documentation>
                    </annotation>
                </attribute>
            </extension>
        </complexContent>
    </complexType>
</schema>
```

LocationUtilityService.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns:xls="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
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="XLS.xsd"/>
    <!-- ======================================================== --
>
    <element name="GeocodeRequest" type="xls:GeocodeRequestType"
substitutionGroup="xls:_RequestParameters">
        <annotation>
            <documentation>Geocode Service Request</documentation>
        </annotation>
    </element>
    <!-- ======================================================== --
>
    <complexType name="GeocodeRequestType">
        <annotation>
            <documentation>Geocode Request. </documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractRequestParametersType">
                <sequence>
                    <element ref="xls:Address" maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ======================================================== --
>
    <element name="GeocodeResponse" type="xls:GeocodeResponseType"
substitutionGroup="xls:_ResponseParameters">
        <annotation>
            <documentation>Geocode Service Response</documentation>
        </annotation>
    </element>
    <!-- ======================================================== --
>
    <complexType name="GeocodedAddressType">
        <sequence>
            <element ref="gml:Point"/>
            <element ref="xls:Address"/>
            <element ref="xls:GeocodeMatchCode" minOccurs="0"/>
            <!--  ref="xls:Point"/> -->
        </sequence>
```

```
    </complexType>
    <!-- ================================================== -->
    <complexType name="GeocodeResponseListType">
        <sequence>
            <element name="GeocodedAddress" type="xls:GeocodedAddressType"
maxOccurs="unbounded">
                <annotation>
                    <documentation>The list of 1-n addresses that are  returned for
each Address request, sorted by Accuracy.</documentation>
                </annotation>
            </element>
        </sequence>
        <attribute name="numberOfAddresses" type="nonNegativeInteger"
use="required">
            <annotation>
                <documentation>This is the number of addresses generated per
response</documentation>
            </annotation>
        </attribute>
    </complexType>
    <element name="GeocodeResponseList"
type="xls:GeocodeResponseListType">
        <annotation>
            <documentation>The list of  responses for each of the requested
Address ADTs. Each requested address may have 1-n responses
(numberOfAddresses). </documentation>
        </annotation>
    </element>
    <complexType name="GeocodeResponseType">
        <annotation>
            <documentation>GeocodeResponse. The addresses returned will be
normalized Address ADTs as a result of any parsing by the geocoder,
etc.</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractResponseParametersType">
                <sequence>
                    <element ref="xls:GeocodeResponseList"
maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <!-- ================================================== -->
```

```
   <element name="ReverseGeocodeRequest"
type="xls:ReverseGeocodeRequestType"
substitutionGroup="xls:_RequestParameters">
      <annotation>
         <documentation>Reverse Geocode Service Request</documentation>
      </annotation>
   </element>
   <!-- ========================================================= --
>
   <complexType name="ReverseGeocodeRequestType">
      <annotation>
         <documentation>Reverse Geocode Request.</documentation>
      </annotation>
      <complexContent>
         <extension base="xls:AbstractRequestParametersType">
            <sequence>
               <element ref="xls:Position"/>
               <element ref="xls:ReverseGeocodePreference" minOccurs="0"
maxOccurs="unbounded"/>
               <element name="SearchArea" type="xls:SearchAreaType"
minOccurs="0">
                  <annotation>
                     <documentation>A search area to restrict the search for
Reverse Geocode.</documentation>
                  </annotation>
               </element>
            </sequence>
         </extension>
      </complexContent>
   </complexType>
   <complexType name="SearchAreaType">
      <sequence>
         <element ref="xls:AOI" minOccurs="0"/>
      </sequence>
   </complexType>
   <!-- ========================================================= --
>
   <element name="ReverseGeocodeResponse"
type="xls:ReverseGeocodeResponseType"
substitutionGroup="xls:_ResponseParameters">
      <annotation>
         <documentation>Reverse Geocode Service Response</documentation>
      </annotation>
   </element>
   <!-- ========================================================= --
>
```

```
    <complexType name="ReverseGeocodedLocationType">
        <sequence>
            <element ref="gml:Point"/>
            <element ref="xls:Address"/>
            <element ref="xls:SearchCentreDistance" minOccurs="0"/>
            <!-- ref="xls:Point"/> -->
        </sequence>
    </complexType>
    <complexType name="ReverseGeocodeResponseType">
        <annotation>
            <documentation>ADT for a ReverseGeocodeResponse. One or more
addresses may be returned</documentation>
        </annotation>
        <complexContent>
            <extension base="xls:AbstractResponseParametersType">
                <sequence>
                    <element name="ReverseGeocodedLocation"
type="xls:ReverseGeocodedLocationType" minOccurs="0"
maxOccurs="unbounded">
                        <annotation>
                            <documentation>Reverse Geocoder may find 0 to n Point-
Address combinations that match.</documentation>
                        </annotation>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <simpleType name="ReverseGeocodePreferenceType">
        <annotation>
            <documentation>Defines a Preference for Reverse Geocode response.
HAN 30 Sept 02. PositionOfInterest is Vague. I interpret this to be Place and/or
PostalCode, the other elements for Address. </documentation>
        </annotation>
        <restriction base="string">
            <enumeration value="StreetAddress"/>
            <enumeration value="IntersectionAddress"/>
            <enumeration value="PositionOfInterest"/>
        </restriction>
    </simpleType>
    <element name="ReverseGeocodePreference"
type="xls:ReverseGeocodePreferenceType">
        <annotation>
            <documentation>Describes the preference for what the Reverse
Geocoder service should return: StreetAddress, IntersectionAddress, or
PositionOfInterest (Place and/or PostalCode). If not specified, then the service
```

```
will return the nearest StreetAddress.  HAN 30 Sept 02, this shouldn't be
unbounded, right? Should only be 1 preference. </documentation>
        </annotation>
    </element>
    <element name="SearchCentreDistance" type="xls:DistanceType">
        <annotation>
            <documentation>Distance of reverse geocoded location from starting
position.</documentation>
        </annotation>
    </element>
</schema>
```

PresentationService.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns:xls="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
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="XLS.xsd"/>
    <!--
==========================================GetCapabilities
Request=====================-->
    <element name="GetPortrayMapCapabilitiesRequest"
type="xls:GetPortrayMapCapabilitiesRequestType"
substitutionGroup="xls:_RequestParameters">
        <annotation>
            <documentation>Request the capabilities that the implementation
provides (srs, formats, layers, styles)</documentation>
        </annotation>
    </element>
    <complexType name="GetPortrayMapCapabilitiesRequestType">
        <complexContent>
            <extension base="xls:AbstractRequestParametersType"/>
        </complexContent>
    </complexType>
    <!--
==========================================GetCapabilities
Response====================-->
```

```
    <element name="GetPortrayMapCapabilitiesResponse"
type="xls:GetPortrayMapCapabilitiesResponseType"
substitutionGroup="xls:_ResponseParameters">
        <annotation>
            <documentation>Content of the capabilities response</documentation>
        </annotation>
    </element>
    <complexType name="GetPortrayMapCapabilitiesResponseType">
        <complexContent>
            <extension base="xls:AbstractResponseParametersType">
                <sequence>
                    <element name="AvailableSRS" type="xls:AvailableSRSType">
                        <annotation>
                            <documentation>The list of the projections that the impl
provides (EPSG:XXXX)</documentation>
                        </annotation>
                    </element>
                    <element name="AvailableLayers"
type="xls:AvailableLayersType">
                        <annotation>
                            <documentation>The list of the layers that the
implementation provides for portraying the baseMap. To try and keep this within
scope of openLS, the style of these layers is left up to the impl.</documentation>
                        </annotation>
                    </element>
                    <element name="AvailableFormats"
type="xls:AvailableFormatsType">
                        <annotation>
                            <documentation>The list of formats (mime-types) that the
impl will encode the protrayed map with (image/gif, image/png, text/xml-svg
etc)</documentation>
                        </annotation>
                    </element>
                    <element name="AvailableStyles" type="xls:AvailableStylesType">
                        <annotation>
                            <documentation>The list of available named
styles</documentation>
                        </annotation>
                    </element>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
    <complexType name="AvailableSRSType">
        <sequence>
            <element name="SRS" type="string" maxOccurs="unbounded"/>
```

```
      </sequence>
   </complexType>
   <complexType name="AvailableLayersType">
      <sequence>
         <element name="Layer" type="string" maxOccurs="unbounded"/>
      </sequence>
   </complexType>
   <complexType name="AvailableFormatsType">
      <sequence>
         <element name="Format" type="string" maxOccurs="unbounded"/>
      </sequence>
   </complexType>
   <complexType name="AvailableStylesType">
      <sequence>
         <element name="Style" type="string" maxOccurs="unbounded"/>
      </sequence>
   </complexType>
   <!--
==========================================Request=========
============-->
   <element name="PortrayMapRequest" type="xls:PortrayMapRequestType"
substitutionGroup="xls:_RequestParameters">
      <annotation>
         <documentation>Content of a presentation request</documentation>
      </annotation>
   </element>
   <complexType name="PortrayMapRequestType">
      <complexContent>
         <extension base="xls:AbstractRequestParametersType">
            <sequence>
               <element name="Output" type="xls:OutputType"
maxOccurs="unbounded">
                  <annotation>
                     <documentation>Specifies the output of the map(s) that
should generated</documentation>
                  </annotation>
               </element>
               <element name="Basemap" type="xls:LayerType" minOccurs="0">
                  <annotation>
                     <documentation>The layers that should make up the
baseMap. (getCapabilites provides the list the impl provides)
   </documentation>
                  </annotation>
               </element>
               <element name="Overlay" type="xls:OverlayType" minOccurs="0"
maxOccurs="unbounded">
```

```
                    <annotation>
                        <documentation>Overlays the set of ADT's onto the
basemap</documentation>
                    </annotation>
                </element>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<!--
================================================================
=====-->
<complexType name="OutputType">
    <choice minOccurs="0">
        <element name="BBoxContext" type="gml:EnvelopeType">
            <annotation>
                <documentation>Context described as a bounding
box</documentation>
            </annotation>
            <!-- type="xls:BoxType"> -->
        </element>
        <element name="CenterContext" type="xls:CenterContextType">
            <annotation>
                <documentation>Context described by a center point and
scale</documentation>
            </annotation>
        </element>
    </choice>
    <attribute name="width" type="nonNegativeInteger">
        <annotation>
            <documentation>width of the resulting map in
pixels</documentation>
        </annotation>
    </attribute>
    <attribute name="height" type="nonNegativeInteger">
        <annotation>
            <documentation>height of the resulting map in
pixels</documentation>
        </annotation>
    </attribute>
    <attribute name="format" type="string">
        <annotation>
            <documentation>mime type describing the encoding (getCapabilites
provides the list that the impl provides)</documentation>
        </annotation>
    </attribute>
```

```
        <attribute name="BGcolor" type="string" use="optional">
            <annotation>
                <documentation>Background Color of the map in RGB Hex format,
defaults to "#FFFFFF" (White)</documentation>
            </annotation>
        </attribute>
        <attribute name="transparent" type="boolean" use="optional">
            <annotation>
                <documentation>The opacity of the map, defaults to true if not
specified</documentation>
            </annotation>
        </attribute>
        <attribute name="content" type="xls:contentType" use="optional"
default="URL"/>
        <!-- [MM] 17/3/03 added this new attribute to allow client to pick between
the two modes that the map can be returned in -->
        <!--[MM] 17/3/03 sequence>
            <element name="Clip" type="xls:ClipType" minOccurs="0">
                <annotation>
                    <documentation>Specifies the clipping shape to be used when
portraying the map</documentation>
                </annotation>
            </element-->
        <!--/sequence-->
    </complexType>
    <simpleType name="contentType">
        <annotation>
            <documentation>Map can be returned as one of those content
types</documentation>
        </annotation>
        <restriction base="string">
            <enumeration value="URL"/>
            <enumeration value="Data"/>
        </restriction>
    </simpleType>
    <complexType name="OverlayType">
        <sequence>
            <choice>
                <element ref="xls:POI"/>
                <element ref="xls:RouteGeometry"/>
                <element ref="xls:Position"/>
                <element ref="xls:Map"/>
            </choice>
            <element name="Style" type="xls:StyleType" minOccurs="0">
                <annotation>
```

```
                <documentation>The Style describing how the ADT's should be
portrayed. Either a named style or a user defined style. The implementation
should use a default if neither is specified</documentation>
            </annotation>
         </element>
      </sequence>
      <attribute name="zorder" type="integer" use="optional">
         <annotation>
            <documentation>The order in which the overlay's are laid on top of
each other over the base map</documentation>
         </annotation>
      </attribute>
   </complexType>
   <complexType name="LayerType">
      <sequence>
         <element name="Layer" maxOccurs="unbounded">
            <complexType>
               <sequence>
                  <element name="Style" type="xls:StyleType" minOccurs="0">
                     <annotation>
                        <documentation>The style describing how the layer
should be portrayed</documentation>
                     </annotation>
                  </element>
               </sequence>
               <attribute name="name" type="string" use="required">
                  <annotation>
                     <documentation>The layer name, getCapabilites provides a
list the impl provides</documentation>
                  </annotation>
               </attribute>
            </complexType>
         </element>
      </sequence>
      <attribute name="filter" use="required">
         <simpleType>
            <restriction base="string">
               <enumeration value="Include"/>
               <enumeration value="Exclude"/>
            </restriction>
         </simpleType>
      </attribute>
   </complexType>
   <complexType name="StyleType">
      <choice>
         <element name="Name" type="string">
```

```
            <annotation>
               <documentation>Portray using a named style</documentation>
            </annotation>
         </element>
         <element name="StyleContent" type="string">
            <annotation>
               <documentation>Portray using a user defined
style</documentation>
            </annotation>
         </element>
      </choice>
   </complexType>
   <complexType name="ClipType">
      <choice>
         <element ref="gml:Polygon">
            <annotation>
               <documentation>Clips the portrayed map with a
polygon</documentation>
            </annotation>
         </element>
         <element ref="gml:CircleByCenterPoint">
            <annotation>
               <documentation>Clips the portrayed map with a
circle</documentation>
            </annotation>
            <!--  ref="xls:Circle" -->
         </element>
         <element name="LineCorridor" type="xls:LineCorridorType">
            <annotation>
               <documentation>Clips the portrayed map along a line with a
corridor width</documentation>
            </annotation>
         </element>
      </choice>
   </complexType>
   <complexType name="LineCorridorType">
      <sequence>
         <element ref="gml:LineString"/>
         <element ref="xls:Distance"/>
         <!-- ref="xls:LineString  -->
      </sequence>
   </complexType>
   <!--
==========================================Response=======
==============-->
```

```
    <element name="PortrayMapResponse" type="xls:PortrayMapResponseType"
substitutionGroup="xls:_ResponseParameters">
        <annotation>
            <documentation>Content of a presentation response</documentation>
        </annotation>
    </element>
    <complexType name="PortrayMapResponseType">
        <complexContent>
            <extension base="xls:AbstractResponseParametersType">
                <sequence>
                    <element ref="xls:Map" maxOccurs="unbounded"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
</schema>
```

RouteService.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns:xls="http://www.opengis.net/xls"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:gml="http://www.opengis.net/gml" 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="XLS.xsd"/>
    <!--
================================================================
=========================
            Route Service Basic
    ================================================================
============================== -->
    <element name="DetermineRouteRequest"
type="xls:DetermineRouteRequestType"
substitutionGroup="xls:_RequestParameters">
        <annotation>
            <documentation>Specifies the Determine Route request
parameters.</documentation>
```

```
      </annotation>
   </element>
   <complexType name="DetermineRouteRequestType">
      <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 proviously determined
route stored at the Route Determination Service server.</documentation>
                     </annotation>
                  </element>
                  <element ref="xls:RoutePlan"/>
               </choice>
               <element ref="xls:RouteInstructionsRequest" minOccurs="0">
                  <annotation>
                     <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="distanceUnit" type="xls:DistanceUnitType"
use="optional" default="M">
               <annotation>
                  <documentation>Specifies the unit for measuring
distance.</documentation>
               </annotation>
```

```
            </attribute>
          </extension>
        </complexContent>
    </complexType>
    <element name="RoutePlan" type="xls:RoutePlanType">
        <annotation>
            <documentation>The criteria upon which a route is
determined.</documentation>
        </annotation>
    </element>
    <complexType name="RoutePlanType">
        <annotation>
            <documentation>Defines the criteria upon which a route is
determined.</documentation>
        </annotation>
        <sequence>
            <element ref="xls:RoutePreference"/>
            <element ref="xls:WayPointList"/>
            <element ref="xls:AvoidList" minOccurs="0"/>
        </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>
            </annotation>
        </attribute>
    </complexType>
    <element name="AvoidList" type="xls:AvoidListType">
        <annotation>
            <documentation>The list of areas, locations, and types of features in
which the route should avoid passing through.</documentation>
        </annotation>
    </element>
    <complexType name="AvoidListType">
        <annotation>
            <documentation>Defines the list of areas, locations, and types of
features in which the route should avoid passing through.</documentation>
        </annotation>
```

```
        <sequence>
            <element ref="xls:AOI" minOccurs="0" maxOccurs="unbounded">
                <annotation>
                    <documentation>List of geographic areas to
avoid.</documentation>
                </annotation>
            </element>
            <element ref="xls:_Location" minOccurs="0" maxOccurs="unbounded">
                <annotation>
                    <documentation>List of locations to avoid.</documentation>
                </annotation>
            </element>
            <element ref="xls:AvoidFeature" minOccurs="0"
maxOccurs="unbounded"/>
        </sequence>
    </complexType>
    <element name="RouteMapRequest" type="xls:RouteMapRequestType">
        <annotation>
            <documentation>The request parameters for route
maps.</documentation>
        </annotation>
    </element>
    <complexType name="RouteMapRequestType">
        <annotation>
            <documentation>Defines the request parameters for route
maps.</documentation>
        </annotation>
        <sequence>
            <element name="Output" type="xls:RouteMapOutputType"
maxOccurs="unbounded"/>
        </sequence>
    </complexType>
    <complexType name="RouteMapOutputType">
        <annotation>
            <documentation>Defines the rendered route map output
parameters.</documentation>
        </annotation>
        <sequence>
            <element name="BBoxContext" type="gml:EnvelopeType"
minOccurs="0">
                <annotation>
                    <documentation>Rectangular area to be displayed in the rendered
map.  If not specified, defaults to full route.</documentation>
                </annotation>
                <!-- type="xls:BoxType" -->
            </element>
```

```
        </sequence>
        <attribute name="width" type="nonNegativeInteger">
            <annotation>
                <documentation>pixel width of the resulting map</documentation>
            </annotation>
        </attribute>
        <attribute name="height" type="nonNegativeInteger">
            <annotation>
                <documentation>pixel height of the resulting map</documentation>
            </annotation>
        </attribute>
        <attribute name="format" type="string">
            <annotation>
                <documentation>mime type describing the
encoding</documentation>
            </annotation>
        </attribute>
        <attribute name="BGcolor" type="string" use="optional"/>
        <attribute name="transparent" type="boolean" use="optional"/>
    </complexType>
    <element name="RouteInstructionsRequest"
type="xls:RouteInstructionsRequestType">
        <annotation>
            <documentation>The request parameters for turn-by-turn route
instructions and travel advisories formatted for presentation.</documentation>
        </annotation>
    </element>
    <complexType name="RouteInstructionsRequestType">
        <annotation>
            <documentation>Defines the request parameters for turn-by-turn route
instructions and travel advisories formatted for presentation.</documentation>
        </annotation>
        <attribute name="format" type="string" use="optional" default="text/plain">
            <annotation>
                <documentation>The preferred format of the route instructions,
specified as a mime type.</documentation>
            </annotation>
        </attribute>
        <attribute name="distanceUnit" type="xls:DistanceUnitType" use="optional"
default="M">
            <annotation>
                <documentation>The unit of measure to be used for distances in the
text directions.</documentation>
            </annotation>
        </attribute>
    </complexType>
```

```
    <element name="RouteGeometryRequest"
type="xls:RouteGeometryRequestType">
        <annotation>
            <documentation>The request parameters for route
geometry.</documentation>
        </annotation>
    </element>
    <complexType name="RouteGeometryRequestType">
        <annotation>
            <documentation>Defines the request parameters for route
geometry.</documentation>
        </annotation>
        <sequence>
            <element name="BoundingBox" type="gml:EnvelopeType"
minOccurs="0">
                <annotation>
                    <documentation>Rectangular area of route for which the geometry
is requested.  If not specified, defaults to full route.</documentation>
                </annotation>
                <!-- type="xls:BoxType" -->
            </element>
        </sequence>
        <attribute name="scale" type="positiveInteger" use="optional" default="1">
            <annotation>
                <documentation>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.</documentation>
            </annotation>
        </attribute>
        <attribute name="provideStartingPortion" type="boolean" use="optional"
default="false">
            <annotation>
                <documentation>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.</documentation>
            </annotation>
        </attribute>
        <attribute name="maxPoints" type="positiveInteger" use="optional"
default="100">
            <annotation>
                <documentation>Maximum number of geometric points to
return.</documentation>
            </annotation>
```

```
        </attribute>
    </complexType>
    <!--
==========================================================
=====================
          Response
    ==========================================================
============================ -->
    <element name="DetermineRouteResponse"
type="xls:DetermineRouteResponseType"
substitutionGroup="xls:_ResponseParameters">
        <annotation>
            <documentation>Specifies the Determine Route response
parameters.</documentation>
        </annotation>
    </element>
    <complexType name="DetermineRouteResponseType">
        <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">
                        <annotation>
                            <documentation>Response for requested route
summary.</documentation>
                        </annotation>
                    </element>
                    <element ref="xls:RouteGeometry" minOccurs="0">
                        <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>
            </sequence>
        </extension>
    </complexContent>
</complexType>
<element name="RouteMap" type="xls:RouteMapType">
    <annotation>
        <documentation>A route map.</documentation>
    </annotation>
</element>
<complexType name="RouteMapType">
    <annotation>
        <documentation>Defines a route map.</documentation>
    </annotation>
    <complexContent>
        <extension base="xls:MapType"/>
    </complexContent>
</complexType>
<element name="AvoidFeature" type="xls:AvoidFeatureType">
    <annotation>
        <documentation>Type of feature to avoid when determining the
route.</documentation>
    </annotation>
</element>
<simpleType name="AvoidFeatureType">
    <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>
        <enumeration value="Tollway">
            <annotation>
                <documentation>Minimize tolls.</documentation>
```

```
            </annotation>
         </enumeration>
      </restriction>
   </simpleType>
   <simpleType name="RoutePreferenceType">
      <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="Pedestrian">
            <annotation>
               <documentation>Best route by foot.</documentation>
            </annotation>
         </enumeration>
      </restriction>
   </simpleType>
   <element name="RoutePreference" type="xls:RoutePreferenceType">
      <annotation>
         <documentation>Preference to be taken into consideration when
determining the route.</documentation>
      </annotation>
   </element>
</schema>
```

XLinks.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.w3.org/1999/xlink"
xmlns:xsd="http://www.w3.org/2001/XMLSchema"
```

```
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:xlink="http://www.w3.org/1999/xlink">
   <annotation>
      <documentation>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.</documentation>
   </annotation>
   <annotation>
      <appinfo source="urn:opengis:specification:gml:schema-
xlinks:v3.0c2">xlinks.xsd v3.0b2 2001-07</appinfo>
      <documentation>
         GML 3.0 xlinks schema. .
      </documentation>
   </annotation>
   <!--
=============================================================
=
      global declarations

   ============================================================
==== -->
   <!-- locator attribute -->
   <attribute name="href" type="anyURI"/>
   <!-- semantic attributes -->
   <attribute name="role" type="anyURI"/>
   <attribute name="arcrole" type="anyURI"/>
   <attribute name="title" type="string"/>
   <!-- behavior attributes -->
   <attribute name="show">
      <annotation>
         <documentation>
      The 'show' attribute is used to communicate the desired presentation
      of the ending resource on traversal from the starting resource; it's
      value should be treated as follows:
      new - load ending resource in a new window, frame, pane, or other
            presentation context
      replace - load the resource in the same window, frame, pane, or
                other presentation context
      embed - load ending resource in place of the presentation of the
              starting resource
      other - behavior is unconstrained; examine other markup in the
              link for hints
      none - behavior is unconstrained
```

```
    </documentation>
      </annotation>
      <simpleType>
         <restriction base="string">
            <enumeration value="new"/>
            <enumeration value="replace"/>
            <enumeration value="embed"/>
            <enumeration value="other"/>
            <enumeration value="none"/>
         </restriction>
      </simpleType>
   </attribute>
   <attribute name="actuate">
      <annotation>
         <documentation>
      The 'actuate' attribute is used to communicate the desired timing
      of traversal from the starting resource to the ending resource;
      it's value should be treated as follows:
      onLoad - traverse to the ending resource immediately on loading
               the starting resource
      onRequest - traverse from the starting resource to the ending
                  resource only on a post-loading event triggered for
                  this purpose
      other - behavior is unconstrained; examine other markup in link
              for hints
      none - behavior is unconstrained
    </documentation>
      </annotation>
      <simpleType>
         <restriction base="string">
            <enumeration value="onLoad"/>
            <enumeration value="onRequest"/>
            <enumeration value="other"/>
            <enumeration value="none"/>
         </restriction>
      </simpleType>
   </attribute>
   <!-- traversal attributes -->
   <attribute name="label" type="string"/>
   <attribute name="from" type="string"/>
   <attribute name="to" type="string"/>
   <!--
========================================================================
=
      Attributes grouped by XLink type, as specified in the W3C
      Proposed Recommendation (dated 2000-12-20)
```

```
   ============================================================
=== -->
   <attributeGroup name="simpleLink">
      <attribute name="type" type="string" fixed="simple" form="qualified"/>
      <attribute ref="xlink:href" use="optional"/>
      <attribute ref="xlink:role" use="optional"/>
      <attribute ref="xlink:arcrole" use="optional"/>
      <attribute ref="xlink:title" use="optional"/>
      <attribute ref="xlink:show" use="optional"/>
      <attribute ref="xlink:actuate" use="optional"/>
   </attributeGroup>
   <attributeGroup name="extendedLink">
      <attribute name="type" type="string" fixed="extended" form="qualified"/>
      <attribute ref="xlink:role" use="optional"/>
      <attribute ref="xlink:title" use="optional"/>
   </attributeGroup>
   <attributeGroup name="locatorLink">
      <attribute name="type" type="string" fixed="locator" form="qualified"/>
      <attribute ref="xlink:href" use="required"/>
      <attribute ref="xlink:role" use="optional"/>
      <attribute ref="xlink:title" use="optional"/>
      <attribute ref="xlink:label" use="optional"/>
   </attributeGroup>
   <attributeGroup name="arcLink">
      <attribute name="type" type="string" fixed="arc" form="qualified"/>
      <attribute ref="xlink:arcrole" use="optional"/>
      <attribute ref="xlink:title" use="optional"/>
      <attribute ref="xlink:show" use="optional"/>
      <attribute ref="xlink:actuate" use="optional"/>
      <attribute ref="xlink:from" use="optional"/>
      <attribute ref="xlink:to" use="optional"/>
   </attributeGroup>
   <attributeGroup name="resourceLink">
      <attribute name="type" type="string" fixed="resource" form="qualified"/>
      <attribute ref="xlink:role" use="optional"/>
      <attribute ref="xlink:title" use="optional"/>
      <attribute ref="xlink:label" use="optional"/>
   </attributeGroup>
   <attributeGroup name="titleLink">
      <attribute name="type" type="string" fixed="title" form="qualified"/>
   </attributeGroup>
   <attributeGroup name="emptyLink">
      <attribute name="type" type="string" fixed="none" form="qualified"/>
   </attributeGroup>
</schema>
```

UOM.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns="http://www.w3.org/2001/XMLSchema"
xmlns:xlink="http://www.w3.org/1999/xlink"
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.-->
    <import namespace="http://www.w3.org/1999/xlink"
schemaLocation="xlinks.xsd"/>
    <complexType name="AbstractMeasureType" abstract="true">
        <attribute name="value" type="decimal" use="required"/>
        <attribute name="accuracy" type="decimal" use="optional"/>
    </complexType>
    <element name="_Measure" type="xls:AbstractMeasureType"
abstract="true"/>
    <simpleType name="DistanceUnitType">
        <restriction base="string">
            <enumeration value="KM"/>
            <enumeration value="M"/>
            <enumeration value="DM"/>
            <enumeration value="MI"/>
            <enumeration value="YD"/>
            <enumeration value="FT"/>
        </restriction>
    </simpleType>
    <complexType name="DistanceType">
        <complexContent>
            <extension base="xls:AbstractMeasureType">
                <attribute name="uom" type="xls:DistanceUnitType" use="optional"
default="M"/>
            </extension>
        </complexContent>
    </complexType>
    <element name="Distance" type="xls:DistanceType"
substitutionGroup="xls:_Measure"/>
    <complexType name="AltitudeType">
        <complexContent>
```

```
            <extension base="xls:DistanceType"/>
        </complexContent>
    </complexType>
    <element name="Altitude" type="xls:AltitudeType"/>
    <!--
==========================================================
-->
    <complexType name="AngleType">
        <complexContent>
            <extension base="xls:AbstractMeasureType">
                <attribute name="uom" type="string" use="optional"
fixed="DecimalDegrees"/>
            </extension>
        </complexContent>
    </complexType>
    <element name="Angle" type="xls:AngleType"
substitutionGroup="xls:_Measure"/>
    <!--
==========================================================
-->
    <simpleType name="SpeedUnitType">
        <restriction base="string">
            <enumeration value="KPH"/>
            <enumeration value="MPH"/>
            <enumeration value="MPS"/>
            <enumeration value="FPS"/>
        </restriction>
    </simpleType>
    <complexType name="SpeedType">
        <complexContent>
            <extension base="xls:AbstractMeasureType">
                <attribute name="uom" type="xls:SpeedUnitType" use="optional"
default="KPH"/>
            </extension>
        </complexContent>
    </complexType>
    <element name="Speed" type="xls:SpeedType"
substitutionGroup="xls:_Measure"/>
    <!--
==========================================================
-->
    <complexType name="TimeStampType">
        <attribute name="begin" type="dateTime" use="required"/>
        <attribute name="duration" type="duration" use="optional"/>
    </complexType>
    <element name="TimeStamp" type="xls:TimeStampType"/>
```

```
    <complexType name="TimeType">
        <complexContent>
            <extension base="xls:TimeStampType">
                <attribute name="utcOffset" type="integer" use="optional"/>
            </extension>
        </complexContent>
    </complexType>
    <element name="Time" type="xls:TimeType"/>
</schema>
```

Geometry.xsd

```
<?xml version="1.0" encoding="UTF-8"?>
<schema targetNamespace="http://www.opengis.net/xls"
xmlns:xls="http://www.opengis.net/xls" xmlns:gml="http://www.opengis.net/gml"
xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns="http://www.w3.org/2001/XMLSchema" elementFormDefault="qualified">
    <!--© OGC 2003 - 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.-->
    <import namespace="http://www.opengis.net/gml"
schemaLocation="gml4xls.xsd"/>
    <import namespace="http://www.w3.org/1999/xlink"
schemaLocation="xlinks.xsd"/>
    <include schemaLocation="UOM.xsd"/>
    <!-- ================================ type
================================== -->
    <complexType name="EllipseType">
        <complexContent>
            <extension base="gml:AbstractGeometricPrimitiveType">
                <sequence>
                    <choice>
                        <element ref="gml:pos"/>
                    </choice>
                    <element name="majorAxis" type="gml:LengthType"/>
                    <element name="minorAxis" type="gml:LengthType"/>
                    <element name="rotation" type="gml:AngleType"/>
                </sequence>
            </extension>
        </complexContent>
    </complexType>
```

```
   <!-- ================================ element
================================== -->
   <element name="Ellipse" type="xls:EllipseType"/>
   <!-- ================================ LIF CicularArcArea Element
================================== -->
   <element name="CircularArc" type="xls:CircularArcType"/>
   <!-- ================================================ -->
   <annotation>
      <documentation>A CircularArc is a geometric object defined by LIF (MLP
3.0) which is defined by two arcs (r[1] > r[2]), and  two lines that radiate from the
center point, at a given start angle and end angle.  As with the definitions for
circle and ellipse, this object is defined by its parameters: a center point, two
radii, and two angles. This represenation can be used only in
2D.</documentation>
   </annotation>
   <complexType name="CircularArcType">
      <annotation>
         <documentation>This is Modeled after GML ArcByCenterPointType.
</documentation>
      </annotation>
      <complexContent>
         <extension base="gml:AbstractGeometricPrimitiveType">
            <sequence>
               <element ref="gml:pos"/>
               <element name="innerRadius" type="gml:LengthType">
                  <annotation>
                     <documentation>The radius of the inner
arc.</documentation>
                  </annotation>
               </element>
               <element name="outerRadius" type="gml:LengthType">
                  <annotation>
                     <documentation>The radius of the outer
arc.</documentation>
                  </annotation>
               </element>
               <element name="startAngle" type="gml:AngleType">
                  <annotation>
                     <documentation>The bearing of the arc and radial line at the
start.</documentation>
                  </annotation>
               </element>
               <element name="endAngle" type="gml:AngleType">
                  <annotation>
                     <documentation>The bearing of the arc and radial line at the
end.</documentation>
```

```
                    </annotation>
                </element>
            </sequence>
            <attribute name="interpolation" type="gml:CurveInterpolationType"
fixed="circularArcCenterPointWithRadius">
                <annotation>
                    <documentation>The attribute "interpolation" specifies the curve
interpolation mechanism used for this segment. This mechanism
uses the control points and control parameters to determine the position of this
curve segment. For an ArcByCenterPoint the interpolation is fixed as
"circularArcCenterPointWithRadius".</documentation>
                </annotation>
            </attribute>
            <attribute name="numArc" type="integer" use="required" fixed="1">
                <annotation>
                    <documentation>Since this type describes always a single arc,
the attribute is fixed to "1".</documentation>
                </annotation>
            </attribute>
        </extension>
    </complexContent>
</complexType>
<!-- ========================end of circular arc
========================== -->
</schema>
```

Annex A.2: OpenGIS® Location Services (OpenLS) Schema, SOAP Profile (Informative)

At some point in the future, the sponsors of this specification intend to support a SOAP profile of OpenLS. However, this will be produced during subsequent testbed project activities.

For information purposes, an initial version of a SOAP Profile is presented below. This was contributed by one of the sponsors. Please note that this is **informative** only (not mandatory). It's NOT required to implement any SOAP interfaces to be compliant with OpenLS.

```
<?xml version="1.0" encoding="UTF-8" ?>
<!--
 Schema for the SOAP/1.1 envelope

    This schema has been produced using W3C's SOAP Version 1.2 schema
    found at:

    http://www.w3.org/2001/06/soap-envelope

    Copyright 2001 Martin Gudgin, Developmentor.

    Changes made are the following:
    - reverted namespace to http://schemas.xmlsoap.org/soap/envelope/
    - reverted mustUnderstand to only allow 0 and 1 as lexical values
     - made encodingStyle a global attribute 20020825

    Original copyright:

    Copyright 2001 W3C (Massachusetts Institute of Technology,
    Institut National de Recherche en Informatique et en Automatique,
    Keio University). All Rights Reserved.
    http://www.w3.org/Consortium/Legal/

    This document is governed by the W3C Software License [1] as
    described in the FAQ [2].

    [1] http://www.w3.org/Consortium/Legal/copyright-software-19980720
    [2] http://www.w3.org/Consortium/Legal/IPR-FAQ-20000620.html#DTD
```

```
 -->
<xs:schema xmlns:xs="http://www.w3.org/2001/XMLSchema"
xmlns:tns="http://schemas.xmlsoap.org/soap/envelope/"
targetNamespace="http://schemas.xmlsoap.org/soap/envelope/">
 <!--  Envelope, header and body
 -->
 <xs:element name="Envelope" type="tns:Envelope" />
 <xs:complexType name="Envelope">
 <xs:sequence>
 <xs:element ref="tns:Header" minOccurs="0" />
 <xs:element ref="tns:Body" minOccurs="1" />
 <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax" />
 </xs:sequence>
 <xs:anyAttribute namespace="##other" processContents="lax" />
 </xs:complexType>
 <xs:element name="Header" type="tns:Header" />
 <xs:complexType name="Header">
 <xs:sequence>
 <xs:any namespace="##other" minOccurs="0" maxOccurs="unbounded"
processContents="lax" />
 </xs:sequence>
 <xs:anyAttribute namespace="##other" processContents="lax" />
 </xs:complexType>
 <xs:element name="Body" type="tns:Body" />
 <xs:complexType name="Body">
 <xs:sequence>
 <xs:any namespace="##any" minOccurs="0" maxOccurs="unbounded"
processContents="lax" />
 </xs:sequence>
 <xs:anyAttribute namespace="##any" processContents="lax">
 <xs:annotation>
 <xs:documentation>Prose in the spec does not specify that attributes are
allowed on the Body element</xs:documentation>
 </xs:annotation>
 </xs:anyAttribute>
 </xs:complexType>
<!--  Global Attributes.  The following attributes are intended to be usable via
qualified attribute names on any complex type referencing them.
 -->
 <xs:attribute name="mustUnderstand" default="0">
 <xs:simpleType>
 <xs:restriction base="xs:boolean">
 <xs:pattern value="0|1" />
 </xs:restriction>
 </xs:simpleType>
```

```
  </xs:attribute>
  <xs:attribute name="actor" type="xs:anyURI" />
 <xs:simpleType name="encodingStyle">
 <xs:annotation>
  <xs:documentation>'encodingStyle' indicates any canonicalization conventions
followed in the contents of the containing element. For example, the value
'http://schemas.xmlsoap.org/soap/encoding/' indicates the pattern described in
SOAP specification</xs:documentation>
  </xs:annotation>
  <xs:list itemType="xs:anyURI" />
  </xs:simpleType>
  <xs:attribute name="encodingStyle" type="tns:encodingStyle" />
 <xs:attributeGroup name="encodingStyle">
  <xs:attribute ref="tns:encodingStyle" />
  </xs:attributeGroup>
  <xs:element name="Fault" type="tns:Fault" />
<xs:complexType name="Fault" final="extension">
 <xs:annotation>
  <xs:documentation>Fault reporting structure</xs:documentation>
  </xs:annotation>
 <xs:sequence>
  <xs:element name="faultcode" type="xs:QName" />
  <xs:element name="faultstring" type="xs:string" />
  <xs:element name="faultactor" type="xs:anyURI" minOccurs="0" />
  <xs:element name="detail" type="tns:detail" minOccurs="0" />
  </xs:sequence>
  </xs:complexType>
 <xs:complexType name="detail">
 <xs:sequence>
  <xs:any namespace="##any" minOccurs="0" maxOccurs="unbounded"
processContents="lax" />
  </xs:sequence>
  <xs:anyAttribute namespace="##any" processContents="lax" />
  </xs:complexType>
  </xs:schema>
```