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OGC Location Services: Tracking Service Interface Standard

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i. Preface

OGC official documents use a triple decimal-dot notation (i.e. MM.xx.ss). This document may be identified as MM.xx (Major.minor) and may include increments to the third dot series (schema changes) without any modification to this document, or the version displayed on the document. This means, for example, that a document labeled with versions 1.1.0 and 1.1.1 or even 1.1.9 are exactly the same except for modifications to the official schemas that are maintained and perpetually located at: <http://schemas.opengis.net/>

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

ii. Submitting organizations

The following organizations submitted this document to the Open Geospatial Consortium Inc.

MAGIC Services Forum, MobileGIS Ltd, Navteq, Oak Ridge National Laboratories, Skyline Software, deCarta, Tele Atlas, US Army Corps of Engineers TEC.

Part of this paper was written in the frame of the research activities of the European project LIAISON. LIAISON has received research funding from the Community's Sixth Framework Program.

iii. Document contributor contact points

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iv. Revision history

Date	Release	Editor	Primary clauses modified	Description
2006-02-13		Smyth	all	First draft
2007-03-15		Smyth	all	Post OWS-4 revision
2007-11-30		Smyth	all	Editorial corrections
2007-12-6	1.0	C. Reed	Various	Get document ready for posting as a standard

v. Changes to the OpenGIS[→] Abstract Specification

The OpenGIS® Abstract Specification does not require changes to accommodate the technical contents of the OGC Tracking Service.

vi. Future work

Improvements in this document are desirable to increase conformance with related OGC standards and meet commercial functionality and performance requirements. It is anticipated that further trials with this draft specification will result in minor changes and additions as determined by early applications.

Foreword

This Tracking Service Interface Standard is based on and extends the OLS 1.2 Core Standard. It is intended to define an independent new Tracking Service interface that complements the other OGC Location Service interface standards.

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

Recipients of this document are requested to submit, with their comments, notification of any relevant patent claims or other intellectual property rights of which they may be aware that might be infringed by any implementation of the standard set forth in this document, and to provide supporting documentation.

Introduction

The OpenGIS Tracking Service Interface Standard supports a very simple functionality allowing a collection of movable objects to be tracked as they move and change orientation. The standard addresses the absolute minimum in functionality in order to address the need for a simple, robust, and easy-to-implement open standard for geospatial tracking.

This OGC standard was developed in activities completed in the OpenLS Thread in the OGC Web Services 3 (OWS-3) and OWS-4 Testbeds. The OWS-3 Testbed was an OGC interoperability activity scheduled for April-September 2005 and the follow-on OWS-4 Testbed was completed in December 2007. The purpose of the OWS-3 and OWS-4 Testbeds was to provide experience and results useful in refinement and extension of OGC's XML Web services specifications for a variety of spatial applications. The OpenLS Thread is focussed on lightweight applications targeting mobile phones and PDAs.

The OpenGIS Location Services (OLS) comprise an open platform for position access and location-based applications targeting Mobile Terminals. The OLS feature set is defined by "Core Services and Abstract Data Types (ADT)" that comprise this platform. The OLS version 1.2 services are defined in the Open Geospatial Consortium (OGC) document OGC 07-074.

OLS 1.2 is structured as a set of services. Each service is independently accessible via an XML API. The services use an OLS-specific XML messaging format intended for network data transfer HTTP. The seven services defined for OLS 1.2 are:

1. **Directory Service.** Provides access to an online directory (e.g. Yellow Pages) enabling an application to find the location of a *specific* or *nearest* place, product, or service.
2. **Gateway Service.** Retrieves the position of a known Mobile Terminal from the network. This interface is modelled after the LIF/OMA Mobile Location Protocol (MLP), Standard Location Immediate Service, specified in OMA (Open Mobile Alliance) MLP 3.0.
3. **Geocoding Service.** Converts a text description of a location, such as a place name, street address, or postal code to a position structured as Point geometry (see the OGC Geography Markup Language (GML) Standard for descriptions of ISO geometry).
4. **Reverse Geocoding Service.** Converts given position into a normalized description of a feature location (Address with Point), where the address may be a street address, intersection address, place name, or postal code.
5. **Route Service.** Determines travel routes and navigation information between two or more points.

6. **Navigation Service.** As an enhanced version of the **Route Service**, determines routes between two or more points and the associated navigation information.
7. **Presentation Service.** Creates maps and other graphic depictions of selected geospatial data, with a set of ADTs as logical layers.

The current OGC Location Service Standards (OLS 1.2) are commercially useful in their present form. They enable the intended functionality, they can be implemented, they are internally complete and consistent, and they interface with the external environment using primitives shared with other geospatial domains.

There are several areas where improvements and extensions would be helpful. In particular, the capabilities of the mobile terminals (PDAs and wireless telephone handsets) have increased many times since OLS 1.1 was defined. At the same time the available bandwidth, robustness of connections and network latency has improved to a lesser extent. This has made it attractive to make the information content of messages between terminals and servers more complex but not necessarily more voluminous. In addition, use cases relating to deployment of responders in safety and security operations have become more important.

OGC Location Service (OLS) Tracking Service

1 Definitions and Scope

The term “Tracking” implies that there is a central repository of dynamic location information, a mechanism for updating the content of the repository, and a means for querying the location of some or all of the objects. In the development of the service, we also found it useful to be able to relay or “proxy” dynamic tracking information.

1.1 Functionality Addressed by the Proposal

The proposed Tracking Service supports three functional capabilities:

- 1) Position Update to a central Tracking Server.
- 2) Position Query of the central Tracking Server by subscriber or Mobile Terminal ID.
- 3) Relay of Position Update messages from Tracking Server to other downstream consumers in a proxy server arrangement.

The OLS Tracking Service (OLS-TS) is intended for bandwidth efficient transfer, aggregation, query, and relay of position and other sensed or intrinsic properties of a connected mobile terminal. While various transports, encodings, and protocols may be used on an originating device, all other messaging is in the form of XML documents sent over HTTP using the GET or POST verbs and the request/response message format defined in OLS 1.2. This document describes messaging architecture and the structure and semantics of the OLS-TS messages to support. These parallel the functional capabilities:

1. Updating the position of mobile devices using XML messaging.
2. Querying the position of wireless devices from an OLS Tracking server, over the Web, using the OLS XML protocol.
3. Forwarding position updates to additional clients from an OLS Tracking server.

1.2 A Note on Proprietary and/or Native Mobile Device Formats

One objective of the Tracking Service is to support “native” position message formats so that mobile terminals may send position updates with minimal onboard processing. We believe that it is possible to automate the parsing of native position messages with the combination of a universal parser and an XML document that describes the message

format. This at present is little more than a dream with some partially developed examples that illustrate the possibility of successful implementation. Other architectures are possible, such as a plug-in architecture that allows decoders to be developed and dynamically connected to the input side of a Tracking Server.

Ultimately we realized that this did not fit within the “keep it simple” principle so we eliminated all description of native formats. This does not mean that this standard prohibits native formats in updating the repository (“Tracking Server”) but rather that it is simply not within the scope of this standard.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

Abstract Specification Topic 0: Overview, OGC document 99-100r1

OGC 05-008c1, OWS Common Implementation Specification, May 2005

OGC 07-074 Open Location Services Core Standard, December 2007.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in OLS 1.2 and the following apply:

3.1

mobile device

mobile terminal

an entity being tracked

listener

a system receiving updates from a tracking server

3.2

tracking server

location repository

the system supporting the update, query, and listener operations

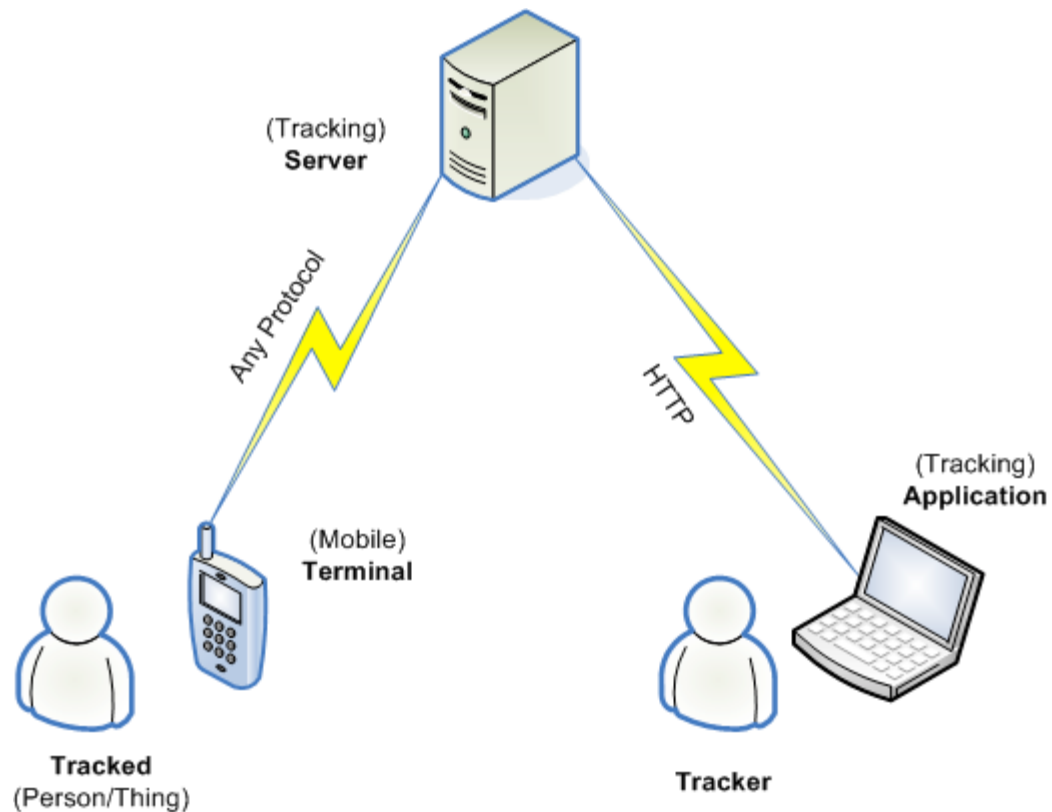


Figure 1 — Illustration of Tracking Service Terminology

4 Conventions

4.1 Symbols (and abbreviated terms)

The following are the acronyms, abbreviations, and symbols referenced in this document:

API	Application Program Interface
COTS	Commercial Off The Shelf
DCE	Distributed Computing Environment
DCP	Distributed Computing Platform
DCOM	Distributed Component Object Model
GML	Geographic Markup Language
LIAISON	An IST-6 Project of the European Union.

ISO	International Organization for Standardization
OGC	Open Geospatial Consortium
OLS	Open Location Services, OLS
OLS	Open Location Services, OLS
OWS	OGC Web Services
UML	Unified Modeling Language
XML	Extended Markup Language
1D	One Dimensional
2D	Two Dimensional
3D	Three Dimensional

4.2 UML

Certain diagrams that appear in this standard are presented using the Unified Modelling Language (UML) static structure diagram, as described in Subclause 5.2 of the OGC Web Services Common Implementation Specification [OGC 04-016r2].

4.3 Document terms and definitions

This document uses the standard terms defined in Subclause 5.3 of [OGC 04-016r2].

5 Introduction

This is an extension to OLS 1.2.

5.1 Use Cases

There are four use cases addressed by this proposal:

1. A person (or other valuable entity) associates with a mobile device so that the entity may be tracked.
2. A mobile device sends an update of its location at a specific time to a tracking server.
3. An application retrieves the location(s) of a mobile device, filtered by space and time.
4. An application registers its Web address and authentication credentials with a tracking server for the purpose of receiving position updates from the tracking

server as though the tracking server were one or more of the mobile devices tracked by the tracking server.

These use cases are illustrated in the following diagram:

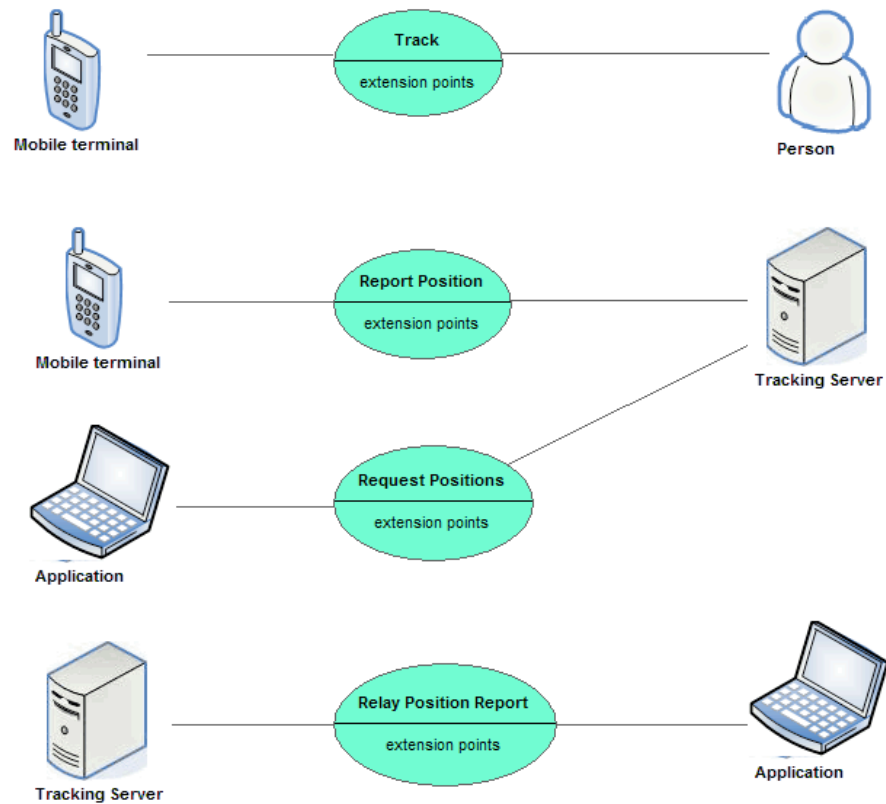


Figure 2 — The Four Tracking Service Use Cases

The Tracking Service uses the existing OLS structure to implement functionality covering the use cases. The dependency is one-way. The rest of the OLS standard does not depend at all on the Tracking Service.

5.2 Core Functionality

5.3 Core Functionality of the Proposed new OLS Tracking Service

The Tracking Service implementation is based on three OLS request/response pairs. As in the other OLS services, the requests are made via HTTP POST and the responses are returned by the server. All messaging is synchronous and bidirectional. The following paragraphs summarise the three families of request/response messages. The schema should be consulted for precise standard of the details.

5.3.1 TrackingUpdateRequest/Response Messages

The Tracking Update Request is used by a Mobile Terminal to report its position and by a Tracking Server to forward position updates to a Listener. As noted, the Tracking Server may receive position information by other means, outside the scope of the Tracking Service standard including but not limited to “native” format updates from devices in formats such as NMEA 0183 sentences.

6 Tracking Service Standard (Normative)

6.1 Implementation

Implementations of the Tracking Service shall implement all of the request and response messages specific in XML Schema Description language in Annex A. There are no optional parts.

The Tracking service implementation shall support three types of request messages. Each type shall produce a corresponding response message as follows:

6.1.1 Tracking Update

A TrackingUpdate Request SHALL append an ID string to the sequence. The two requirements on this string are:

- That the server SHALL be able to recognize the ID string in an incoming request containing an ID string created by that server, in which case it SHALL ignore the incoming request and
- That the server SHALL insure that any ID string it appends will not be mistakenly recognized by another server as having been appended by that other server.

These requirements may be met, for example, by appending a string containing a registered domain name controlled by the organization operating the server or by a globally universally unique identifier (GUID) generated on the server. The value of the element SHALL be ignored. The server ID SHALL be carried by a mandatory attribute ServerID of type anyURI.

The TrackingUpdate Response SHALL acknowledge a valid request.

6.1.2 Tracking Query

A TrackingQuery Request SHALL specify a class of mobile devices and optional spatial filter for the locations to be returned in a response. A Request SHALL return location information for tracked entities whose positions are associated with a specific XLS Name and Password or optional Foreign access key.

A TrackingQuery Response SHALL contain the tracking location and identification of all tracked entities stored in the server under the XLS Name and Password used in the Request or optional foreign access key.

6.1.3 Tracking Listener

A listener SHALL be capable of receiving the TrackingUpdateRequest on the provided URL. If no IDSubset element is present then all IDs will be reported. If an IDSubset element specifies a list of IDs then reports SHALL be forwarded only for those IDs. A host SHALL make a request to a tracking server to add or remove one or more specific mobile terminals or all mobile terminals associated with the ols userName with which the node identifies itself with one of the following values:

- . "add_all" SHALL cause the server to create "notify_all" if necessary and set it to true. The server SHALL clear the notification subset and non-notification subsets if they exist. When "notify_all" is true, the server SHALL forward all position updates from any mobile terminal associated with the ols userName.

- . "add_subset" (or the deprecated synonym "add") SHALL not change the "notify_all" state if it exists. If notify_all does not exist, it is created and set to "false". If "notify_all" is true then "add_subset" SHALL have no effect. If notify_all is false then the mobile terminal IDs in the list accompanying the request SHALL be added to the notification set. Duplicate IDs SHALL be ignored.

- . "remove_all" SHALL cause the server to clear and release all internal state or other resources relating to relay of position reports to this node for this userName. Consequently the server SHALL cease forwarding any position updates from any mobile terminal associated with the ols username. "remove_all" SHALL completely cancel the effect of "add_all" or "add_subset".

- . "remove_subset" (or the deprecated synonym "remove") SHALL not change the "notify_all" state. If "notify_all" is true, then the mobile terminal IDs in the list SHALL be added to the non-notification subset. Duplicate IDs are ignored. If notify_all is false, any of the IDs in the list accompanying the request and also appearing in the notification subset SHALL be removed from the notification subset. The list SHALL *not* be added to the non-notification subset.

- . The notification subset SHALL be empty if "notify_all" is true and the non-notification subset SHALL be empty if "notify_all" is false.

- . Any IDs in the notification subset or the non-notification subset that do not exist are not detected by the server. These IDs simply take up space but SHALL not enable or block relay of mobile terminal position updates.

- . Mobile terminals may be added or removed from the tracking server's current collection after a request to add_all has been made. When the internal state "notify_all" is true, the server SHALL always forward position reports from the *current* set of mobile

terminals associated with the userName *not* the set as of the time of the listener request.

. If a node has never made an "add_all" or "add_subset" request (either ever or since a "remove_all" request then the server SHALL have no "notify_all" state for the node and userName.

A request remove_all or remove_subset SHALL have no effect if the "notify_all" state does not exist for the node and userName.

7 Example Request/Response Message Pairs (Informative)

The following are examples of XML request and response pairs that conform to the Tracking service standard.

7.1.1.1.1 Request: Single Update with a Foreign Access Key

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"
  sessionID="bungabunga"/>
  <Request methodName="TrackingUpdateRequest" requestID="OU1"
  version="1.0">
    <TrackingUpdateRequest foreignAccessKey="metoo">
      <ID>650-270-7020</ID>
      <Position levelOfConf="LOC unknown">
        <gml:Point id="some-id-string" gid="some-gid-string"
        srsName="some-uri-to-srs">
          <gml:pos dimension="3" srsName="some-other-uri-to-
          srs">35.35 -85.85 1919</gml:pos>
        </gml:Point>
        <Time begin="2006-10-31T20:36:55.515-05:00"/>
        <Speed uom="MPH" value="222.222"/>
        <Direction uom="uom:degrees" value="555.555"/>
      </Position>
```



```

    <Timestamp time="2007-01-29T10:28:06"/>
    <Property key="numsats" val="6"/>
  </TrackingUpdateRequest>
</Request>
</XLS>

```

7.1.1.1.2 Response: Single Update with a Foreign Access Key

```

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader sessionID="bungabunga"/>
  <Response version="ORNL-1.1" requestID="OU1">
    <TrackingUpdateResponse>
      <ID>650-270-7020</ID>
    </TrackingUpdateResponse>
  </Response>
</XLS>

```

7.1.1.1.3 Request: Single Update with a Non-standard CRS

```

<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls"
xmlns:gml="http://www.opengis.net/gml">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"
sessionID="bungabunga"/>
  <Request methodName="TrackingUpdateRequest" requestID="OU1"
version="1.0">
    <TrackingUpdateRequest>
      <ID>wackyID</ID>
      <Position levelOfConf="LOC unknown">

```

```
<gml:Point id="some-wacky-id-string" gid="some-wacky-gid-
string" srsName="myWacky">
    <gml:pos dimension="2">123.4 567.8</gml:pos>
</gml:Point>
<Time begin="2007-01-29T10:28:09"/>
<Speed uom="MPH" value="222.222"/>
<Direction uom="uom:degrees" value="55.555"/>
</Position>
<Timestamp time="2007-01-29T10:28:09"/>
<Property key="patientID" val="123456"/>
</TrackingUpdateRequest>
</Request>
</XLS>
```

7.1.1.1.4 Response: Single Update with a Non-standard CRS

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
    <ResponseHeader sessionID="bungabunga"/>
    <Response version="ORNL-1.1" requestID="OU1">
        <TrackingUpdateResponse>
            <ID>wackyID</ID>
        </TrackingUpdateResponse>
    </Response>
</XLS>
```

7.1.1.1.5 Request: Multiple Update

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

```

<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">

  <RequestHeader clientName="ORNL" clientPassword="mypassword"
  sessionID="bungabunga"/>

  <Request methodName="TrackingUpdateRequest" requestID="OU2-1"
  version="1.0">

    <TrackingUpdateRequest>

      <ID>650-270-7020</ID>

      <Position levelOfConf="LOC unknown">

        <gml:Point id="some-id-string" gid="some-gid-string"
        srsName="some-uri-to-srs">

          <gml:pos dimension="3" srsName="some-other-uri-to-
          srs">35.35 -85.85 1919</gml:pos>

        </gml:Point>

      </Position>

      <Timestamp time="2007-01-29T10:28:11"/>

      <Property key="pet-type" val="cat"/>

      <Property key="pet-name" val="fluffy"/>

    </TrackingUpdateRequest>

  </Request>

  <Request methodName="TrackingUpdateRequest" requestID="OU2-2"
  version="1.0">

    <TrackingUpdateRequest>

      <ID>650-270-7777</ID>

      <WGS84 lat="35.999" lon="-84.333"/>

      <Timestamp time="2007-01-29T10:28:11"/>

      <Property key="pet-type" val="cat"/>

      <Property key="pet-name" val="duffy"/>

    </TrackingUpdateRequest>

  </Request>

```

</XLS>

7.1.1.1.6 Response: Multiple Update

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader sessionID="bungabunga"/>
  <Response version="ORNL-1.1" requestID="OU2-1">
    <TrackingUpdateResponse>
      <ID>650-270-7020</ID>
    </TrackingUpdateResponse>
  </Response>
</XLS>
```

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader sessionID="bungabunga"/>
  <Response version="ORNL-1.1" requestID="OU2-2">
    <TrackingUpdateResponse>
      <ID>650-270-7777</ID>
    </TrackingUpdateResponse>
  </Response>
</XLS>
```

7.1.2 TrackingQuery Request/Response Messages

The Tracking Query Request is used by an application to request the location of one or more mobile terminals during a specified time span. The information is delivered in the response.

7.1.2.1 Example Request/Response Message Pairs

7.1.2.1.1 Request: Query ID using Non-standard CRS

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0">
    <TrackingQueryRequest>
      <ID>wackyID</ID>
    </TrackingQueryRequest>
  </Request>
</XLS>
```

7.1.2.1.2 Response: Query ID using Non-standard CRS

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OQ3">
    <TrackingQueryResponse>
      <Entity>
        <ID>wackyID</ID>
        <Timespan start="2007-01-29T15:28:09.000Z"/>
        <Property val="222.2220001220703" key="speed"/>
        <Property val="55.55500030517578" key="heading"/>
        <Position levelOfConf="LOC unknown">
          <gml:Point srsName="myWacky" gid="some-wacky-
gid-string">
```

```
567.8</gml:pos>
    <gml:pos dimension="2">123.4
    </gml:Point>
    <Time begin="2007-01-29T10:28:09"/>
    <Speed uom="MPH" value="222.222"/>
    <Direction uom="uom:degrees" value="55.555"/>
  </Position>
</Entity>
</TrackingQueryResponse>
</Response>
</XLS>
```

7.1.2.1.3 Request: Query on ID

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls"
xmlns:gml="http://www.opengis.net/gml">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingQueryRequest" requestID="OQ1"
version="1.0">
    <TrackingQueryRequest>
      <ID>408-294-8400</ID>
      <CenterContext SRS="WGS-84">
        <CenterPoint>
          <gml:pos>41.002 -72.002</gml:pos>
        </CenterPoint>
        <Radius unit="KM">0.3</Radius>
      </CenterContext>
      <SpatialResolution meters="100"/>
    </TrackingQueryRequest>
  </Request>
</XLS>
```

```

    <Timespan start="2002-10-10T12:00:00-05:00" end="2006-10-
10T14:00:00-05:00"/>

    <Property key="pet-name" val="*fluffy*"/>

</TrackingQueryRequest>

</Request>

</XLS>

```

7.1.2.1.4 Response: Query on ID

```

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

<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">

    <ResponseHeader/>

    <Response version="ORNL-1.1" requestID="OQ1">

        <ErrorList>

            <Error severity="Warning" message="GML center context
not supported" errorCode="NotSupported"/>

        </ErrorList>

    </Response>

</XLS>

```

7.1.2.1.5 Request: Query on GML Centre

```

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

<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls"
xmlns:gml="http://www.opengis.net/gml">

    <RequestHeader clientName="ORNL" clientPassword="mypassword"/>

    <Request methodName="TrackingQueryRequest" requestID="OQ2"
version="1.0">

        <TrackingQueryRequest>

            <ID>650-270-7020</ID>

            <WGS84CenterContext>

```

```
<Center lat="90" lon="180"/>
<Radius unit="KM">0.3</Radius>
</WGS84CenterContext>
<SpatialResolution meters="100"/>
<Timespan start="2002-10-10T12:00:00-05:00" end="2006-10-
10T14:00:00-05:00"/>
<Property key="pet-name" val="*fluffy*"/>
</TrackingQueryRequest>
</Request>
</XLS>
```

7.1.2.1.6 Response: Query on GML Centre

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OQ2">
    <ErrorList>
      <Error severity="Warning" message="WGS84 center
context not supported" errorCode="NotSupported"/>
    </ErrorList>
  </Response>
</XLS>
```

7.1.2.1.7 Request: Query on ID with Properties

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0">
```



```

<TrackingQueryRequest>
  <ID>865-740-0628</ID>
</TrackingQueryRequest>
</Request>
</XLS>

```

7.1.2.1.8 Response: Query on ID with Properties

```

<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OQ3">
    <TrackingQueryResponse>
      <Entity>
        <ID>865-740-0628</ID>
        <Timespan start="2006-11-16T17:02:34.671Z"/>
        <Property val="1.2427424" key="speed_mph"/>
        <Property val="jxt" key="handle"/>
        <Property val="611.0" key="alt_feet"/>
        <Property val="unknown" key="triage_status"/>
        <Property val="unknown" key="patient_id"/>
        <Property val="281" key="heading"/>
        <Position levelOfConf="LOC unknown">
          <gml:Point id="some-id-string" gid="some-gid-
string" srsName="some-uri-to-srs">
            <gml:pos dimension="3" srsName="some-other-
uri-to-srs">35.35 -85.85 1919</gml:pos>
          </gml:Point>
        </Position>
      </Entity>
    </TrackingQueryResponse>
  </Response>
</XLS>

```

```
        </Position>
    </Entity>
</TrackingQueryResponse>
</Response>
</XLS>
```

7.1.2.1.9 Request: Query on Non-existent ID

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
    <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
    <Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0">
        <TrackingQueryRequest>
            <ID>910-263-9888</ID>
        </TrackingQueryRequest>
    </Request>
</XLS>
```

7.1.2.1.10 Response: Query on Non-existent ID

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
    <ResponseHeader/>
</XLS>
```

7.1.2.1.11 Request: Query using Response Number Limit and Timespan Limit

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
    <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
```

```

<Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0" maximumResponses="3">

  <TrackingQueryRequest>

    <ID>865-740-0628</ID>

    <Timespan start="2002-10-10T12:00:00-05:00" end="2006-10-
13T14:00:00-05:00"/>

  </TrackingQueryRequest>

</Request>

</XLS>

```

7.1.2.1.12 Response: Query using Response Number Limit and Timespan Limit

```

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

<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">

  <ResponseHeader/>

</XLS>

```

7.1.2.1.13 Request: Query using Timespan with Start and no End.

```

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

<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">

  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>

  <Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0" maximumResponses="3">

    <TrackingQueryRequest>

      <ID>865-740-0628</ID>

      <Timespan start="2005-10-12T15:30:00"/>

    </TrackingQueryRequest>

  </Request>

</XLS>

```

7.1.2.1.14 Response: Query using Timespan with Start and no End.

```

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

<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">

  <ResponseHeader/>

  <Response version="ORNL-1.1" requestID="OQ3">

    <TrackingQueryResponse>

      <Entity>

        <ID>865-740-0628</ID>

        <Timespan start="2006-11-16T17:02:25.250Z"/>

        <Property val="jxt" key="handle"/>

        <Property val="1.2427424" key="speed_mph"/>

        <Property val="602.0" key="alt_feet"/>

        <Property val="unknown" key="triage_status"/>

        <Property val="unknown" key="patient_id"/>

        <Property val="272" key="heading"/>

        <Position levelOfConf="LOC unknown">

          <gml:Point id="some-id-string" gid="some-gid-
string" srsName="some-uri-to-srs">

            <gml:pos dimension="3" srsName="some-other-
uri-to-srs">35.35 -85.85 1919</gml:pos>

          </gml:Point>

        </Position>

      </Entity>

    </TrackingQueryResponse>

  </Response>

</Response version="ORNL-1.1" requestID="OQ3">

```

```

<TrackingQueryResponse>
  <Entity>
    <ID>865-740-0628</ID>
    <Timespan start="2006-11-16T17:02:25.328Z"/>
    <Property val="1.2427424" key="speed_mph"/>
    <Property val="jxt" key="handle"/>
    <Property val="602.0" key="alt_feet"/>
    <Property val="unknown" key="triage_status"/>
    <Property val="unknown" key="patient_id"/>
    <Property val="272" key="heading"/>
    <WGS84 lon="51.70609" lat="31.0439"/>
  </Entity>
</TrackingQueryResponse>
</Response>
<Response version="ORNL-1.1" requestID="OQ3">
  <TrackingQueryResponse>
    <Entity>
      <ID>865-740-0628</ID>
      <Timespan start="2006-11-16T17:02:25.328Z"/>
      <Property val="1.2427424" key="speed_mph"/>
      <Property val="jxt" key="handle"/>
      <Property val="602.0" key="alt_feet"/>
      <Property val="unknown" key="triage_status"/>
      <Property val="unknown" key="patient_id"/>
      <Property val="272" key="heading"/>
      <Position levelOfConf="LOC unknown">

```

```
        <gml:Point id="some-id-string" gid="some-gid-
string" srsName="some-uri-to-srs">
            <gml:pos dimension="3" srsName="some-other-
uri-to-srs">35.35 -85.85 1919</gml:pos>
        </gml:Point>
    </Position>
</Entity>
</TrackingQueryResponse>
</Response>
</XLS>
```

7.1.2.1.15 Request: Query without Timespan – Most Recent Location.

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
    <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
    <Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0">
        <TrackingQueryRequest>
            <ID>865-740-0628</ID>
        </TrackingQueryRequest>
    </Request>
</XLS>
```

7.1.2.1.16 Response: Query without Timespan – Most Recent Location.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
    <ResponseHeader/>
    <Response version="ORNL-1.1" requestID="OQ3">
```

```

<TrackingQueryResponse>
  <Entity>
    <ID>865-740-0628</ID>
    <Timespan start="2006-11-16T17:02:34.671Z"/>
    <Property val="1.2427424" key="speed_mph"/>
    <Property val="jxt" key="handle"/>
    <Property val="611.0" key="alt_feet"/>
    <Property val="unknown" key="triage_status"/>
    <Property val="unknown" key="patient_id"/>
    <Property val="281" key="heading"/>
    <Position levelOfConf="LOC unknown">
      <gml:Point id="some-id-string" gid="some-gid-
string" srsName="some-uri-to-srs">
        <gml:pos dimension="3" srsName="some-other-
uri-to-srs">35.35 -85.85 1919</gml:pos>
      </gml:Point>
    </Position>
  </Entity>
</TrackingQueryResponse>
</Response>
</XLS>

```

7.1.2.1.17 Request: Query on Multiple IDs.

```

<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingQueryRequest" requestID="OQ3-1"
version="1.0">

```

```
<TrackingQueryRequest>
  <ID>865-740-0628</ID>
</TrackingQueryRequest>
</Request>

<Request methodName="TrackingQueryRequest" requestID="OQ3-2"
version="1.0">
  <TrackingQueryRequest>
    <ID>910-263-9888</ID>
  </TrackingQueryRequest>
</Request>
</XLS>
```

7.1.2.1.18 Response: Query on Multiple IDs.

Note that the second ID was not in the server's database.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OQ3-1">
    <TrackingQueryResponse>
      <Entity>
        <ID>865-740-0628</ID>
        <Timespan start="2006-11-16T17:02:34.671Z"/>
        <Property val="1.2427424" key="speed_mph"/>
        <Property val="jxt" key="handle"/>
        <Property val="611.0" key="alt_feet"/>
        <Property val="unknown" key="triage_status"/>
        <Property val="unknown" key="patient_id"/>
      </Entity>
    </TrackingQueryResponse>
  </Response>
</XLS>
```



```

        <Property val="281" key="heading"/>
        <Position levelOfConf="LOC unknown">
            <gml:Point id="some-id-string" gid="some-gid-
string" srsName="some-uri-to-srs">
                <gml:pos dimension="3" srsName="some-other-
uri-to-srs">35.35 -85.85 1919</gml:pos>
            </gml:Point>
        </Position>
    </Entity>
</TrackingQueryResponse>
</Response>
</XLS>
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
    <ResponseHeader/>
</XLS>

```

7.1.2.1.19 Request: Query with no ID and no Bounding Box.

```

<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
    <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
    <Request methodName="TrackingQueryRequest" requestID="OQ3"
version="1.0" maximumResponses="3">
        <TrackingQueryRequest>
            <ID/>
        </TrackingQueryRequest>
    </Request>

```

</XLS>

7.1.2.1.20 Response: Query with no ID and no Bounding Box.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OQ3">
    <ErrorList>
      <Error severity="Error" message="An empty ID request
MUST include a bounding box or center context"
errorCode="NotSupported"/>
    </ErrorList>
  </Response>
</XLS>
```

7.1.3 Listener Request/Response

The Listener Request is used by a server or an application to request that the position updates for a specified Mobile Terminal or Terminals be forwarded to the Listener. The Response contains forwarded updates in the same structure used in Tracking Update Requests.

7.1.3.1 Example Request/Response Message Pairs

7.1.3.1.1 Request: Listener Add Subset.

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingListenerRequest" requestID="OL1"
version="1.0">
    <TrackingListenerRequest action="add_subset"
URL="http://FRODO.ornl.gov:8084/OLSTracker/track"
clientName="ORNL" clientPassword="mypassword">
      <IDSubset>xxx-yyy-zzzz</IDSubset>
```

```

    <IDSubset>650-270-7020</IDSubset>

    <IDSubset>555-555-1212</IDSubset>

  </TrackingListenerRequest>

</Request>

</XLS>

```

7.1.3.1.2 Response: Listener Add Subset.

```

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

<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">

  <ResponseHeader/>

  <Response version="ORNL-1.1" requestID="OL1">

    <TrackingListenerResponse>

      <ID>xxx-yyy-zzzz</ID>

      <ID>650-270-7020</ID>

      <ID>555-555-1212</ID>

    </TrackingListenerResponse>

  </Response>

</XLS>

```

7.1.3.1.3 Request: Listener Add All.

```

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

<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">

  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>

  <Request methodName="TrackingListenerRequest" requestID="OL1"
version="1.0">

    <TrackingListenerRequest action="add_all"
URL="http://FRODO.ornl.gov:8084/OLSTracker/track"
clientName="ORNL" clientPassword="mypassword"
foreignAccessKey="metoo">

```

```
    </TrackingListenerRequest>
  </Request>
</XLS>
```

7.1.3.1.4 Response: Listener Add All.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OL1">
    <TrackingListenerResponse/>
  </Response>
</XLS>
```

7.1.3.1.5 Request: Listener Remove Subset.

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingListenerRequest" requestID="OL1"
version="1.0">
    <TrackingListenerRequest action="remove_subset"
URL="http://FRODO.ornl.gov:8084/OLSTracker/track"
clientName="ORNL" clientPassword="mypassword">
      <IDSubset>Pet ID 12345</IDSubset>
      <IDSubset>650-270-7020</IDSubset>
      <IDSubset>555-yyy-1212</IDSubset>
    </TrackingListenerRequest>
  </Request>
</XLS>
```

7.1.3.1.6 Response: Listener Remove Subset.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
  <Response version="ORNL-1.1" requestID="OL1">
    <TrackingListenerResponse>
      <ID>650-270-7020</ID>
    </TrackingListenerResponse>
  </Response>
</XLS>
```

7.1.3.1.7 Request: Listener Remove All.

```
<?xml version="1.0" encoding="UTF-8"?>
<XLS version="1.0" lang="en" xmlns="http://www.opengis.net/xls">
  <RequestHeader clientName="ORNL" clientPassword="mypassword"/>
  <Request methodName="TrackingListenerRequest" requestID="OL1"
version="1.0">
    <TrackingListenerRequest action="remove_all"
URL="http://FRODO.ornl.gov:8084/OLSTracker/track"
clientName="ORNL" clientPassword="mypassword">
    </TrackingListenerRequest>
  </Request>
</XLS>
```

7.1.3.1.8 Response: Listener Remove All.

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<XLS version="1.0" xmlns:gml="http://www.opengis.net/gml"
xmlns="http://www.opengis.net/xls">
  <ResponseHeader/>
```

```
<Response version="ORNL-1.1" requestID="OL1">  
  <TrackingListenerResponse/>  
</Response>  
</XLS>
```

8 Other Issues

8.1 Authentication and Position Ownership (Privacy)

The Tracking Service follows the conventions of the OLS 1.1 authentication framework. A position can be updated or queried only by a mobile terminal or client able to supply the corresponding “clientName”. The mechanism for associating a mobile terminal and a client name in a Tracking Server is outside the scope of this document.

8.2 Coordinate Reference Systems

Some positions may refer to coordinate reference systems using structures defined in the OGC Geographic Markup Language (GML). GML allows the specification of named coordinate reference systems for 2- and 3-dimensional coordinates. A large number of standard coordinate reference systems (CRS) are available as well as an unlimited number of private CRS. Use of a private CRS requires special arrangements between Mobile Terminals and Applications in order to correctly interpret the position information. In such cases the Tracking Server does not interpret or transform the coordinates but rather passes the information to it on to the requesting application or Listener.

8.3 Natural Keys

Mobile terminals MUST be uniquely identifiable in order to correctly store and interpret position messages. There are three broad ranges of possibilities in devising unique IDs for the wide range of devices. One is the existence of a central authority or mechanism for assigning unique IDs to devices. For example, telephones and network interface cards have universally unique IDs. A second possibility is dynamic ID assignment of “temporarily permanent” IDs by a server or set of servers within a (reliably connected) network. Both of these possibilities require infrastructure and coordination to be established before any IDs may be granted.

The third possibility (and the one specified for use with the Tracking Service) is to use “natural keys”. A natural key is an identifier that coincidentally has the properties of universal assignment and uniqueness (or at least uniqueness within a geographic region) but which is assigned to a mobile terminal for some other purpose. An electronic ID, a serial number, a name/password pair, an IETF X.509 PKI certificate, or a telephone number might serve as a natural key. The great advantage of a natural key is that it already exists and requires no effort or administration to be used in a tracking application.

8.4 Update Forwarding

Update Forwarding is a service that a Tracking Server may support. Update Forwarding allows a client to requester as a listener for position updates from one or several mobile terminals. The Update Forwarding service sends the updated positions asynchronously to all listeners registered for a corresponding mobile terminal. This minimizes network traffic and reduces the number of clients polling a Tracking Server only to determine if position update(s) exist.

One potential danger in allowing Update Forwarding is that a message cycle might be created where position updates are forwarded in a loop involving two or more Tracking Servers supporting Update Forwarding. The semantics of the message passing [using the XML message anyway] implies that

- a. each time a position update is forwarded, an identity token of the server (e.g. A URL, URI, or IP address) is added to the message and
- b. a server will not forward a message that contains its identity token.

Annex A (normative)

Tracking Service Schema

A.1 General

The Tracking Service message structures incorporate portions of the OLS 1.1 and GML4XLS specification

A.2 Schema in XSD

```

<?xml version="1.0" encoding="UTF-8"?>
<!-- OLS Tracking Service -->
<!-- -->
<schema xmlns="http://www.w3.org/2001/XMLSchema"
  xmlns:gml="http://www.opengis.net/gml" xmlns:xls="http://www.opengis.net/xls"
  targetNamespace="http://www.opengis.net/xls" elementFormDefault="qualified">
  <!--Copyright © 2003-2007 Open Geospatial Consortium, Inc. All Rights Reserved.
  http://www.opengeospatial.org/about/?page=ipr-->
  <import namespace="http://www.opengis.net/gml"
  schemaLocation="gml4xls.xsd"/>
  <include schemaLocation="xls.xsd"/>
  <element name="TrackingUpdateRequest"
  substitutionGroup="xls:_RequestParameters">
    <annotation>
      <documentation>Content of a LocationUpdateRequest. Note that location
  information may be delivered to a server by other means outside the scope of this
  standard.</documentation>
    </annotation>
    <complexType>
      <complexContent>
        <extension base="xls:AbstractRequestParametersType">
          <sequence>
            <element name="ListenerHistory" minOccurs="0"
  maxOccurs="unbounded">
              <annotation>
                <documentation>Each server forwarding a
  TrackingUpdateRequest MUST append an ID string to the sequence. The two
  requirements on this string are
  . that the server SHALL be able to recognize the ID string in an incoming request
  containing an ID string created by that server, in which case it SHALL ignore the
  incoming request and

```


. that the server SHALL insure that any ID string it appends will not be mistakenly reconized by another server as having been appended by that other server.requirements may be met, for example, by appending a string containing a registered domain name controlled by the organization operating the server or by a globally universally unique identifier (GUUID) generated on the server. value of the element is ignored. The server ID is carried by a mandatory attribute ServerID of type anyURI.</documentation>

```

</annotation>
<complexType>
  <simpleContent>
    <extension base="anySimpleType">
      <attribute name="UniqueServerID"
type="anyURI" use="required"/>
    </extension>
  </simpleContent>
</complexType>
</element>
<element name="ID">
  <annotation>
    <documentation>Specifies the tracked entity whose
location is being updated</documentation>
  </annotation>
  <simpleType>
    <restriction base="string"/>
  </simpleType>
</element>
<choice>
  <annotation>
    <documentation>The position SHALL be specified as
an XLS Position type.</documentation>
  </annotation>
  <element name="Position" type="xls:PositionType"/>
  <!-- Position includes speed and direction, uncertainty, etc.--
>
  </choice>
  <element name="Timestamp" type="xls:TimeStampType"
minOccurs="0"/>
  <element name="Property" type="xls:PropertyType"
minOccurs="0" maxOccurs="unbounded"/>
</sequence>
</extension>
</complexContent>
</complexType>
</element>
<complexType name="PropertyType">
  <annotation>
    <documentation>This type is a general "key and value" attribution
mechanism. Both key and value are of type string. While the key is a required attribute,

```

the value may be absent. The interpretation of a missing value is application dependent.</documentation>

```

</annotation>
  <attribute name="key" type="string" use="required"/>
  <attribute name="val" type="string" use="optional"/>
</complexType>
<element name="TrackingUpdateResponse"
substitutionGroup="xsl:_ResponseParameters">
  <annotation>
    <documentation>The content of a server's response to a
TrackingUpdateRequest</documentation>
  </annotation>
  <complexType>
    <complexContent>
      <extension base="xsl:AbstractResponseParametersType">
        <sequence>
          <element name="ID" minOccurs="0">
            <annotation>
              <documentation>Specifies the identity whose location
was successfully updated</documentation>
            </annotation>
            <simpleType>
              <restriction base="string"/>
            </simpleType>
          </element>
        </sequence>
      </extension>
    </complexContent>
  </complexType>
</element>
<element name="TrackingQueryRequest"
substitutionGroup="xsl:_RequestParameters">
  <annotation>
    <documentation>The content of a TrackingQueryRequest.
</documentation>
  </annotation>
  <complexType>
    <complexContent>
      <extension base="xsl:AbstractRequestParametersType">
        <sequence>
          <element name="ID">
            <annotation>
              <documentation>Specifies the identity whose location
is being queried</documentation>
            </annotation>
            <simpleType>
              <restriction base="string"/>
            </simpleType>
          </element>
        </sequence>
      </extension>
    </complexContent>
  </complexType>
</element>

```

```

    </simpleType>
  </element>
  <choice minOccurs="0">
    <annotation>
      <documentation>There are two possible ways to specify
a geographic query region:
. using the XLS Position representation.types of regions are supported:
. a "box" in geographic coordinates or
. a "disk" based on a geographic center and a radius.</documentation>
    </annotation>
    <element name="BBoxContext"
type="gml:EnvelopeType">
      <annotation>
        <documentation>Context described as a GML-
based bounding box</documentation>
      </annotation>
    </element>
    <element name="CenterContext"
type="xls:CenterContextType">
      <annotation>
        <documentation>A "disk" defined by a GML-based
center point and scale</documentation>
      </annotation>
    </element>
  </choice>
  <element name="SpatialResolution"
type="xls:SpatialResolutionType" minOccurs="0">
    <annotation>
      <documentation>The resolution of the position
reports.</documentation>
    </annotation>
  </element>
  <element name="Timespan" type="xls:TimespanType"
minOccurs="0">
    <annotation>
      <documentation>The time span over which position
information is requested.</documentation>
    </annotation>
  </element>
  <element name="Property" type="xls:PropertyType"
minOccurs="0" maxOccurs="unbounded">
    <annotation>
      <documentation>Additional attributes of the position
reports specific as key and value pairs. The interpretation of these properties is
application dependent.</documentation>
    </annotation>
  </element>

```

```

        </sequence>
      </extension>
    </complexContent>
  </complexType>
</element>
<complexType name="TimespanType">
  <annotation>
    <documentation>A range of times. If start not specified, range collapses to
discrete time</documentation>
  </annotation>
  <attribute name="start" type="dateTime"/>
  <attribute name="end" type="dateTime" use="required"/>
</complexType>
<complexType name="SpatialResolutionType">
  <annotation>
    <documentation>optional spatial granularity filter</documentation>
  </annotation>
  <attribute name="meters" type="double"/>
</complexType>
<element name="TrackingQueryResponse"
substitutionGroup="xls:_ResponseParameters">
  <annotation>
    <documentation>The content of a server's response to a
TrackingQueryRequest.</documentation>
  </annotation>
  <complexType>
    <complexContent>
      <extension base="xls:AbstractResponseParametersType">
        <sequence>
          <element name="Entity" minOccurs="0"
maxOccurs="unbounded">
            <complexType>
              <sequence>
                <element name="ID" minOccurs="0">
                  <annotation>
                    <documentation>Specifies the identity of
the entities whose location(s) is (are) returned</documentation>
                  </annotation>
                  <simpleType>
                    <restriction base="string"/>
                  </simpleType>
                </element>
                <element name="Timespan"
type="xls:TimespanType" minOccurs="0">
                  <annotation>

```

<documentation>The time span for which the results are supplied. The only requirement is that the supplied results all lie within the specified range.</documentation>

```

</annotation>
</element>
<element name="Property"
type="xls:PropertyType" minOccurs="0" maxOccurs="unbounded">

```

<documentation>Additional attributes of the entity whose position is reported. Interpretation of specific key and value pairs is application dependent.</documentation>

```

</annotation>
</element>
<choice minOccurs="0">
  <documentation>The position information
  SHALL be supplied as the XLS Position based on the GML Point type.</documentation>

```

```

  </annotation>
  <element name="Position"
type="xls:PositionType"/>

```

```

</choice>
</sequence>
</complexType>
</element>
</sequence>
</extension>
</complexContent>
</complexType>
</element>
<element name="TrackingListenerRequest"
substitutionGroup="xls:_RequestParameters">
  <documentation>

```

The content of a request to add or remove a listener. A listener MUST implement be capable of receiving the TrackingUpdateRequest on the provided URL. If no IDSubset element is present then all IDs will be reported. If an IDSubset element specifies a list of IDs then reports will be forwarded only for those IDs. node may make a request to a tracking server to add or remove one or more specific mobile terminals or all mobile terminals associated with the ols userName with which the node identifies itself. The four operations are:

. "add_all" will cause the server to create "notify_all" if necessary and set it to true. The server will clear the notification subset and non-notification subsets if they exist. When "notify_all" is true, the server will forward all position updates from any mobile terminal associated with the ols userName.

. "add_subset" (or the deprecated synonym "add") will not change the "notify_all" state if it exists. If notify_all does not exist, it is created and set to "false". If "notify_all" is true

then "add_subset" has no effect. If notify_all is false then the mobile terminal IDs in the list accompanying the request will be added to the notification set. Duplicate IDs are ignored.

. "remove_all" will cause the server to clear and release all internal state or other resources relating to relay of position reports to this node for this userName. Consequently the server will cease forwarding any position updates from any mobile terminal associated with the ols username. "remove_all" completely cancels the effect of "add_all" or "add_subset".

. "remove_subset" (or the deprecated synonym "remove") will not change the "notify_all" state. If "notify_all" is true, then the mobile terminal IDs in the list will be added to the non-notification subset. Duplicate IDs are ignored. If notify_all is false, any of the IDs in the list accompanying the request and also appearing in the notification subset will be removed from the notification subset. The list will *not* be added to the non-notification subset.

:

. The notification subset should be empty if "notify_all" is true and the non-notification subset should be empty if "notify_all" is false.

. Any IDs in the notification subset or the non-notification subset that do not exist are not detected by the server. These IDs simply take up space but do not enable or block relay of mobile terminal position updates.

. Mobile terminals may be added or removed from the tracking server's current collection after a request to add_all has been made. When the internal state "notify_all" is true, the server will always forward position reports from the *current* set of mobile terminals associated with the userName *not* the set as of the time of the listener request.

. If a node has never made an "add_all" or "add_subset" request (either ever or since a "remove_all" request then the server has no "notify_all" state for the node and userName.

. It is a no-op to request remove_all or remove_subset if the "notify_all" state does not exist for the node and userName.

```

</documentation>
  </annotation>
  <complexType>
    <complexContent>
      <extension base="xls:AbstractRequestParametersType">
        <sequence>
          <element name="IDSubset" minOccurs="0"
maxOccurs="unbounded">
            <annotation>
              <documentation>Specifies a subset of identities to listen
to, action is add_all this is ignored if present.action is add_subset and this is absent then

```

the request is ignored.action is remove_all this is ignored if present.action is remove_subset and this is absent then the request is ignored.</documentation>

```

    </annotation>
    <simpleType>
      <restriction base="string"/>
    </simpleType>
  </element>
</sequence>
<attribute name="URL"/>
<attribute name="clientName"/>
<attribute name="clientPassword"/>
<attribute name="action" default="add_all">
  <simpleType>
    <restriction base="string">
      <enumeration value="add"/>
      <enumeration value="remove"/>
      <enumeration value="add_all"/>
      <enumeration value="add_subset"/>
      <enumeration value="remove_all"/>
      <enumeration value="remove_subset"/>
    </restriction>
  </simpleType>
</attribute>
</extension>
<!-- forwarded TrackingUpdateRequests will use this is Header-->
<!-- forwarded TrackingUpdateRequests will use this is Header-->
</complexContent>
</complexType>
</element>
<element name="TrackingListenerResponse"
substitutionGroup="xls:_ResponseParameters">
  <annotation>
    <documentation>The content of a response to a
TrackingListenerRequest</documentation>
  </annotation>
  <complexType>
    <complexContent>
      <extension base="xls:AbstractResponseParametersType">
        <sequence>
          <element name="ID" minOccurs="0"
maxOccurs="unbounded">
            <annotation>
              <documentation>Specifies the identities for whom a
listener was successfully added</documentation>
            </annotation>
            <simpleType>
              <restriction base="string"/>

```

```
</simpleType>  
</element>  
</sequence>  
</extension>  
</complexContent>  
</complexType>  
</element>  
</schema>
```