Secure User Plane Location

Technical Overview

650-0035-01, Rev. 1

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PRELIMINARY

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Section 1: Introduction

This document was written for mobile network operators (MNOs), network equipment vendors (NEVs), and application developers who are creating programs and products for the Mobile Location Services (MLS) market. It focuses on Secure User Plane Location (SUPL) as the most effective means for bringing MLS to subscribers quickly and economically, and describes Global Locate's broad capabilities in support of mobile location business opportunities.

Mobile Location Services are expected to account for billions of dollars in annual revenue within the next two years. While mobile device manufacturers stand ready to embrace MLS, MNOs have been cautious about entering the market due to the cost and complexity of modifying Control Plane (C-Plane) network elements and protocols to support location services. SUPL was conceived to give MNOs a way of supporting location services with the least possible impact on the C-Plane. SUPL is a separate network layer that performs many MLS functions that would otherwise be governed within the C-Plane, and is designed to work with existing mobile Internet systems. With SUPL, MNOs can validate the potential of the MLS market with a relatively small budget and few risks.

1.1 SUPL Overview

SUPL was developed by the Open Mobile Alliance[1] (OMA), a mobile communications industry forum that was created to bring open standards, platform independence, and global interoperability to the MLS market. More than 360 companies are represented in OMA, including MNOs and NEVs, wireless vendors, mobile device manufacturers, content and service providers, and other suppliers. SUPL standards acknowledge Assisted GPS (A-GPS) as the most accurate location technology available today. As one of the only end-to-end suppliers of A-GPS products and data services, Global Locate has established relationships with companies across all MLS industry segments.

SUPL architecture is composed of two basic elements: a SUPL Enabled Terminal (SET) and a SUPL Location Platform (SLP). The SET is a mobile device, such as phone or PDA, that has been configured to support SUPL transactions. The SLP is a server or network equipment stack that handles tasks associated with user authentication, location requests, location-based application downloads, charging, and roaming.

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1. Go to www.openmobilealliance.org for more information on the OMA.

The core strength of SUPL is the utilization wherever possible of existing protocols, IP connections, and data-bearing channels[2]. SUPL standards are complementary to and compatible with C-Plane standards. SUPL supports C-Plane protocols developed for the exchange of location data between a mobile device and a wireless network, including RRLP[3] and TIA-801[4]. SUPL also supports MLP (Mobile Location Protocol), which defines the exchange of location data between a Location Services Provider and a wireless network.

1.2 Implementation: SUPL vs. C-Plane

Two functional entities must be added to the C-Plane network in order to support location services: a Serving Mobile Location Center (SMLC), which controls the coordination and scheduling of the resources required to locate the mobile device; and a Gateway Mobile Location Center (GMLC), which controls the delivery of position data, user authorization, charging, and more.

Although simple enough in concept, the actual integration of SMLCs and GMLCs into the Control Plane requires multi-vendor, multi-platform upgrades, as well as modifications to the interfaces between the various network elements. As with any complex endeavor, the larger the scope of the program, and the more parties that are involved, the greater the number of points at which failures can occur.

MLS through SUPL is far less cumbersome. The SLP takes on most of the tasks that would normally be assigned to the SMLC and GMLC, drastically reducing interaction with Control Plane elements. SUPL supports the same protocols for location data that were developed for the C-Plane, which means little or no modification of C-Plane interfaces is required. Because SUPL is implemented as a separate network layer, MNOs have the choice of installing and maintaining their own SLPs or outsourcing MLS to a Location Services Provider such as Global Locate.

The transition from C-Plane location technologies (such as E-OTD) to SUPL A-GPS location, where SLPs will assume many of the tasks that are performed by the GMLC or SMLC, is expected to be a process that operators will go through in incremental steps. Global Locate has addressed this by segmenting responsibilities between the Global Locate SLP product and existing GMLCs to avoid duplication of functionality.

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2. Includes GSM, UMTS, GPRS, EDGE, CDMA, and WCDMA.
3. Radio Resource LCS Protocol, 3GPP TS 04.31, v 8.13.0.
4. Telecommunications Industry Association 801-A, *Position Determination Service for cdma2000 ® Spread Spectrum Systems*.

1.3 A-GPS for Mobile Location Services

The "A" in A-GPS, and the foundation of Global Locate's mobile location products, is the assistance data provided to mobile A-GPS devices through a wireless network. With this data, mobile devices equipped with A-GPS can compute positions more quickly, and in much more difficult environments.

Traditional GPS receivers work best in open areas that offer an unobstructed line of sight to most of the GPS satellites orbiting overhead. In places where GPS signals are weak, obstructed, or scattered, as is the case inside an office building or in an urban canyon, traditional GPS receivers compute positions intermittently at best, and frequently cannot compute positions at all. Through competitive trials and in unforgiving real-world applications, Global Locate's A-GPS technology has consistently delivered positions in places where traditional GPS receivers fail.

Global Locate's A-GPS Server products have been in continuous commercial operation since 2002, serving over ten million subscribers with 99.999% annual uptime. Having evolved from this proven foundation, Global Locate's SUPL Server began participating in operator trials in Q2, 2005, with commercial sale of the Global Locate SLP targeted for Q4, 2005. The first phase of SUPL deployment will support complete functionality for A-GPS positioning services.

1.3.1 Worldwide Reference Network

The performance of a mobile A-GPS device depends on the number of satellites included in the assistance data it receives. Global Locate's Worldwide Reference Network (WWRN) is the leading source of such data in the mobile communications industry, and has been a key factor in the commercial success of Global Locate's A-GPS Server products. The WWRN is a global network of reference stations that continuously tracks all GPS satellites and forwards their data to redundant Data Hubs. Real-time data for the entire GPS constellation is streamed from the Hub sites to all Global Locate SLP targets, enabling a single SLP to provide assistance data or compute positions for mobile GPS devices anywhere in the world. Connectivity to the WWRN is handled through VPN or SSH over the public Internet for developer evaluation, operator trials and limited commercial introductions, and through private frame relay for larger commercial systems.

The WWRN is a pivotal resource for mobile location services that rely on A-GPS, not only because it frees MNOs from the enormous task of having to develop, monitor, and

maintain a GPS reference network, but because it offers A-GPS performance benefits that cannot be matched by a regional reference network. With data for all GPS satellites readily available through the Global Locate SLP, MNOs can focus on delivering MLS applications that take advantage of fast, accurate positions anytime, anywhere.

Figure 1: GPS Reference Stations and WWRN Data Hubs
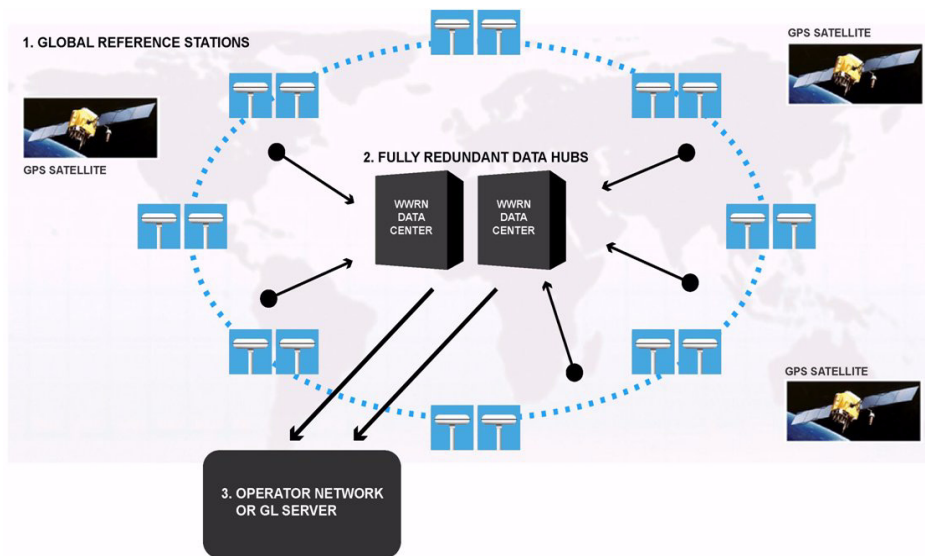
1.3.2 LTO Data

Building from GPS satellite data accumulated by the WWRN, Global Locate also offers Long Term Orbit (LTO) data products. LTO is a complete set of orbit data for all GPS satellites that is modeled in advance[5] and is valid for up to several days. This extended validity period is a powerful resource for global roaming because it makes out-of-network A-GPS operation possible for days at time. For example, upon arrival at an airport after an international flight, users may have difficulty connecting to the regional wireless network to get access to positioning services. LTO provides users with GPS assistance data that is largely unaffected by gaps in wireless service. A thorough discussion of LTO will be presented in an upcoming white paper.

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5. Long Term Orbit (LTO) data products use the WWRN streaming assistance data as raw data, and then compute predicted ephemeris for up to 10 days in the future. The raw ephemeris data is processed to account for the effects that impact the equations for satellite motion. The accuracy of position fixes using LTO is indistinguishable from that obtained using broadcast ephemeris for up to 48 hours. LTO is used in the WWRN as a reserve-level backup capability should prolonged interruptions in connectivity occur.

Section 2: Worldwide Advantage

Global Locate was founded on the idea of bringing superior location technology to the mobile communications market. Based on experience gleaned from commercial operation and in-depth collaboration with key middleware and NEV partners, the development of the Global Locate SUPL Location Platform represents a significant milestone in the pursuit of this goal.

With the introduction of its SUPL products, Global Locate is expanding its hosting infrastructure, and for the first time offering hosted end-user applications, where mobile sets directly access the Data Hubs over IP connections. With total coverage of the GPS constellation through the WWRN, Global Locate's A-GPS data services, including a hosted SLP solution, allow MNOs to offer their subscribers a mobile location utility capable of seamless roaming between markets, operators, and continents. By centralizing management of location services through Global Locate, MNOs can deliver MLS in several countries as easily as one. The benefit of worldwide A-GPS coverage is obvious in the mobile communications business environment, where mergers between operators and consolidation of assets are commonplace.

Figure 2: Hosted SLP Network
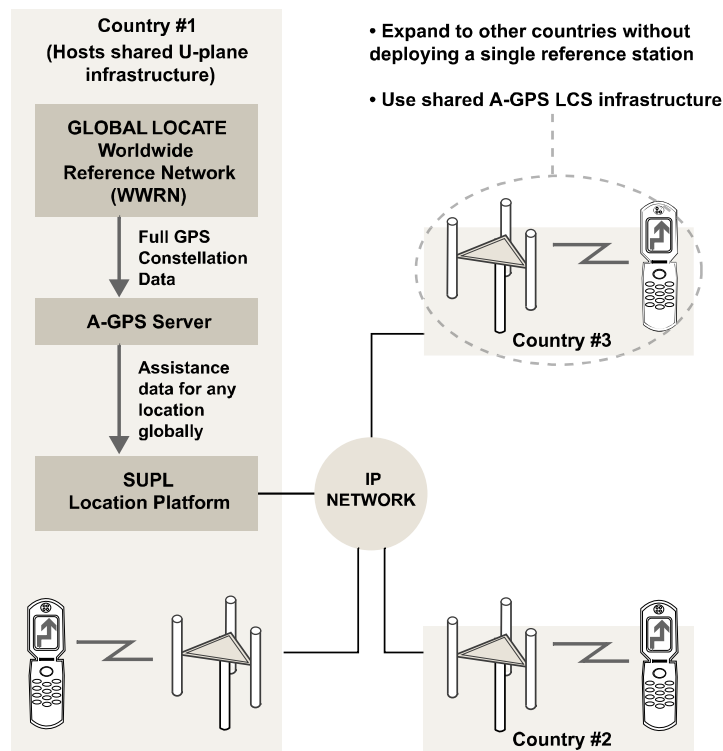
2.1 Home Roaming

Roaming standards defined in SUPL specifications can be divided into two basic approaches. In the first approach, the Visited SLP (V-SLP) may provide nothing more than the Cell ID of the tower being used by the roaming mobile set, and the positioning calculation is conducted between the roaming mobile set and the Home SLP (H-SLP) through a secure IP connection. In the second approach, the positioning calculation is conducted between the V-SLP and the roaming mobile set, again through a secure IP connection.

Either of these approaches requires that sufficient infrastructure be in place to support the positioning calculation. For A-GPS positioning, this means that the SUPL Provider in the visited region must have GPS reference stations in the area in order to serve the roaming subscriber, or the SUPL Provider in the home region must have a GPS reference network large enough to cover the visited region.

The centralized "home roaming" approach offered by Global Locate helps MNOs to reduce infrastructure expense, interface management, and O&M (Operation and Maintenance), and also delivers meaningful performance advantages to subscribers. With the Global Locate SLP getting data for the full GPS constellation from the WWRN data feed, home roaming through Global Locate's SLP can serve subscribers in any visited network, enabling MNOs to not only avoid the expense of establishing and supporting a GPS reference network, but also to do away with the need to install a single V-SLP or engage SUPL Providers in other regions. Because the Global Locate SLP can provide subscribers with GPS assistance data that is applicable wherever they may be roaming, there is no concern about what the visited network does or does not offer in terms of SLP infrastructure or reference station coverage.

Moreover, the WWRN's unique ability to provide assistance data for all satellites on a continuous basis allows assisted GPS operation without precise Cell ID location. In many networks, especially while roaming, Cell ID location may not be available for all base stations. In the event that Cell ID location from the visited network is unavailable, the WWRN delivers the SET assistance data based on an approximate position, which could be obtained using a country and city code. In the case of LTO data described in Section 1.3.2, the assistance data can be valid for days into the future, or can be supplied days in advance. Through the combination of home roaming, the WWRN, and LTO, Global Locate's SUPL products and services can help bring the same practicality and

reliability to MLS that subscribers expect from established mobile communication services.

2.2 Extra Points

In addition to the advantages explained above, the A-GPS Server engine within the Global Locate SLP has two unique and patented technologies. First, the A-GPS Server features a worldwide terrain model that allows positions to be computed with fewer satellite measurements. This feature also improves accuracy, particularly in hilly terrain. The model contains over one billion grid points, referenced to WGS84 (World Geodetic System 1984) with 18 meter altitude accuracy. Years of experience optimizing the A-GPS Server platform and database access algorithms ensure the terrain model's contribution to accuracy is delivered within milliseconds, transparent to the subscriber.

Second, with proprietary algorithms for processing pseudorange measurements, the A-GPS Server can compute positions without accurate GPS time tags. This allows it to be deployed on networks that are not synchronized to GPS time, such as GSM and UMTS (3G). It also reduces the infrastructure burden for operators because it eliminates the need for LMUs (Location Management Units) that are used to bring GPS synchronization to base stations deployed in non-CDMA networks.

Section 3: SLP Architecture

From the general overview in the previous section, this section expands detail on Global Locate's SLP product to a block diagram level as shown below in Figure 3, including interfaces to existing network elements.

Figure 3: SLP Architecture Block Diagram
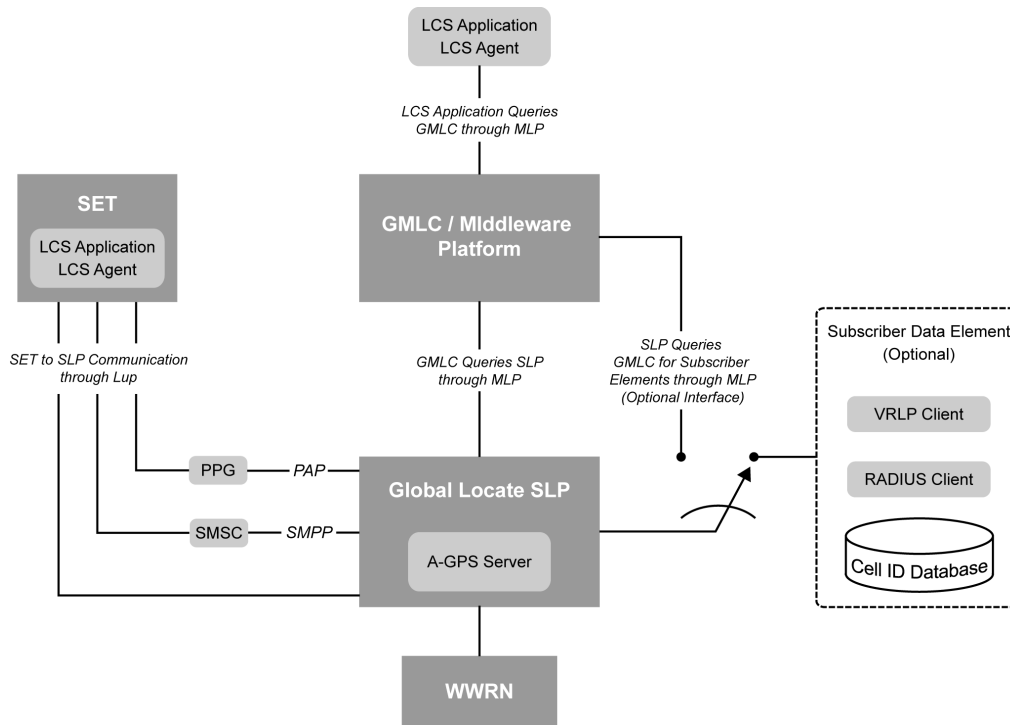
SLP

Global Locate's SUPL Location Platform, at the center lower section of Figure 3, is responsible for all aspects of SUPL communication between the SET and the rest of the SUPL enabled network. The SLP also provides all A-GPS data services from the embedded A-GPS Server engine, including providing assistance data and performing position computations.

GMLC/Middleware Platform

The GMLC, or Middleware platform, is often a pre-existing piece of equipment. It is responsible for providing interfaces to external applications such as an external LCS Agent that delivers location services to the SET. The GMLC also selects the appropriate location method; for legacy systems, the only method available is often Cell ID-based.

Location methods are extended to A-GPS by means of an MLP interface to the SLP. The underlying transport mechanism for all these interfaces, including MLP, is TCP/IP.

SET

The SET block on the left of Figure 3 corresponds to the handset, but more specifically to the LCS agent that handles interactions between the SET the SLP. To facilitate SUPL trials from end-to-end, Global Locate offers a development kit for LCS agent software to customers of its semiconductor products. Interaction between the SET and the SLP is done using TCP/IP over GPRS, EDGE, or any other air interface approved for use in SUPL systems.

WWRN

The WWRN in the lower right of Figure 4 provides GPS assistance data (satellite ephemeris, integrity, and other RRLP data types) to the A-GPS Server within the SLP. The data comes from Global Locate Data Hubs, typically through frame relay or, for smaller installations, through VPN over the public Internet. The interface uses a Global Locate proprietary streaming format known as GLTP (Global Locate Transport Protocol). The transport mechanism is User Datagram Protocol (UDP). The SLP receives data streams from all sources of WWRN data simultaneously, providing deep redundancy and robust fault protection.

Subscriber Data Module

This component is optional because its function can also be performed by the Middleware. A subscriber data module has several functions, including maintaining the cell ID database, querying roaming subscribers for cell ID through RLP (Roaming Location Protocol) and interface to a RADIUS server that cross-checks subscriber IP and MSISDN data for authentication. When the Middleware is handling tasks that might otherwise be handled by a Subscriber Data Module, the SLP retrieves the relevant data over a second interface to the Middleware. In this case, the SLP acts as a client, requesting data (such as IP and MSISDN cross-check authentication) from the Middleware.

SMSC and PPG interfaces

These interfaces support SET notification. For network initiated call flows, the SLP first notifies the SET, and the SET must then establish IP connectivity to the SLP.

SET notification can be done through SMS (Short Message Service) from the SLP through an SMSC (Short Message Service Center) using SMPP (Short Message Peer-to-Peer) protocol, or WAP push (Wireless Application Protocol) to a PPG (Push Proxy Gateway). For this communication through either an SMSC or PPG, the underlying data bearer is again TCP/IP—a common trait throughout the SUPL standard.

3.1 Call Flows

The call flows detailed below assume integration with a GMLC; however, in systems where there is no GMLC, the call flows are considerably simplified because GMLC functions are performed by the SLP.

Figure 4: Network Initiated Request

Specifications Subject to Change Without Notice 650-0035-01, Rev. 1
PRELIMINARY
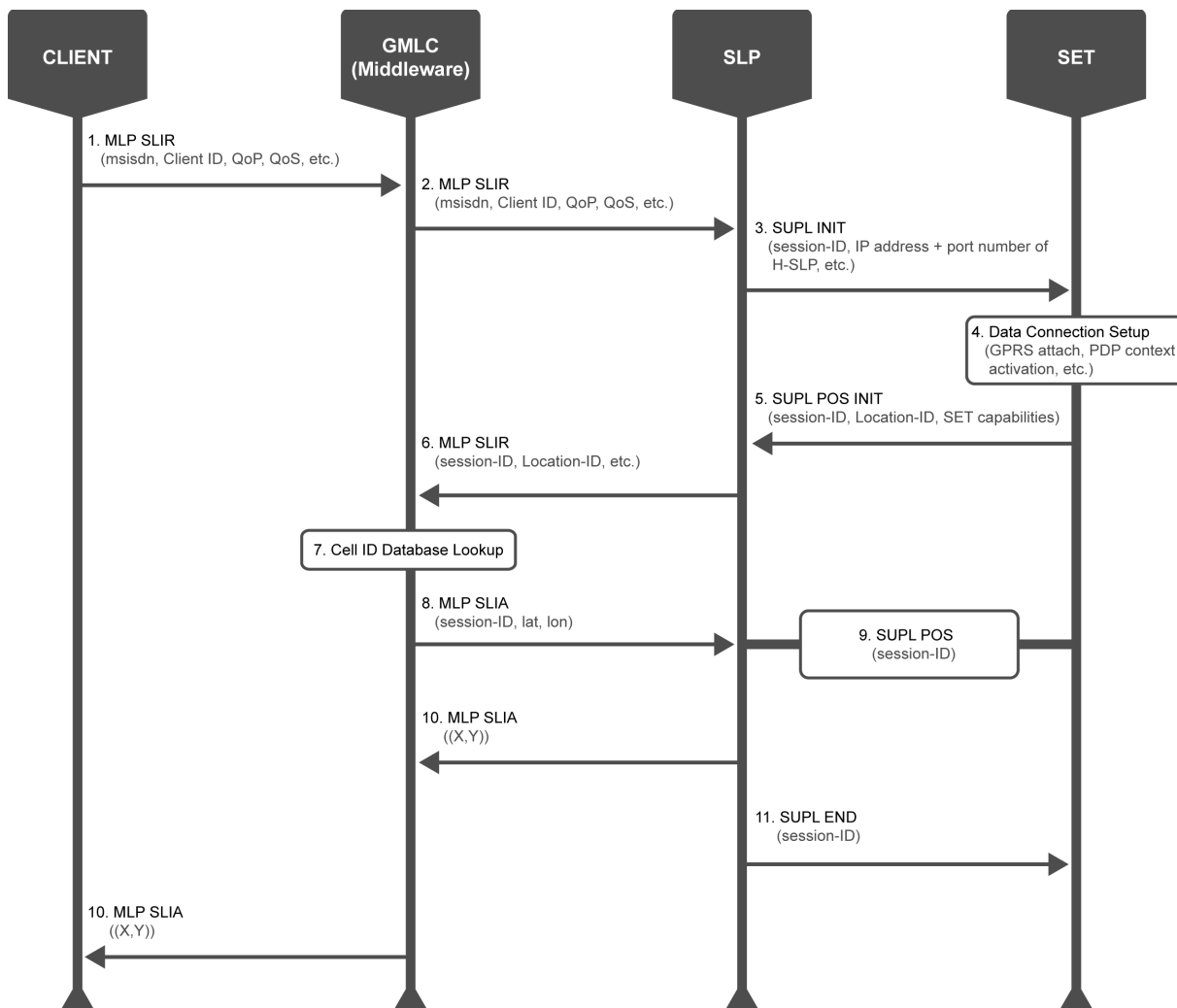
1. The Client application (LCS Agent) contacts the Middleware through SLIR (Standard Location Immediate Request). The Middleware conducts privacy checks to verify the application and transaction, then determines whether the transaction will be based on A-GPS or another positioning resource.

2. The GMLC begins the SUPL transaction with a second SLIR to the SLP that contains data needed by the SLP to perform SET notification.

3. The SUPL INIT command is sent from the SLP to the SET through SMS or WAP push.

4. Data connection setup is established within the SET through GPRS, EDGE, or other means.

5. The SET responds with a POS INIT, returning session ID, location ID, and SET capability data to the SLP.

6. The SLP queries the GMLC through SLIR for an estimated SET location and submits the Cell ID. GMLC and SLP switch roles at this point; the SLP, acting as a client, waits for the SLIA response from the GMLC.

7. The Cell ID database within the GMLC is queried to establish the initial position of the SET.

8. The GMLC verifies that the transaction is authorized, and returns the initial position through SLIA. In the case of a roaming subscriber, the GMLC may obtain initial position from a platform in the visited region. That transaction, if needed, is conducted through RLP (Roaming Location Protocol).

9. The SLP and SET work together to compute a position for the SET, using a series of RRLP transactions[6] embedded in SLP messages. The collaboration results in a position for the SET. This is computed by the SET itself in SET-Based systems, and by the A-GPS Server embedded within the SLP in SET-Assisted systems.

10. The computed SET position is returned to the GMLC by the SLP through SLIA (Standard Location Immediate Answer).

11. Having sent position to the GMLC, the SLP sends SUPL END to the SET. This the end of the transaction as far as the SLP and SET are concerned, although the GMLC has more steps to complete.

12. The GMLC detects the completion of the call flow between the SLP and the SET and returns the location to the Client application by SLIA. Other actions (not shown) are also taken by the GMLC, including billing for the service.

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6. A review of these transactions is presented in Appendix B.

Note that only two MLP message types, SLIR and SLIA, are used for the entire transaction sequence. This is important, because although MLP is very complex, utilization of MLP in SUPL architecture is not.

Figure 5: SET Initiated Request
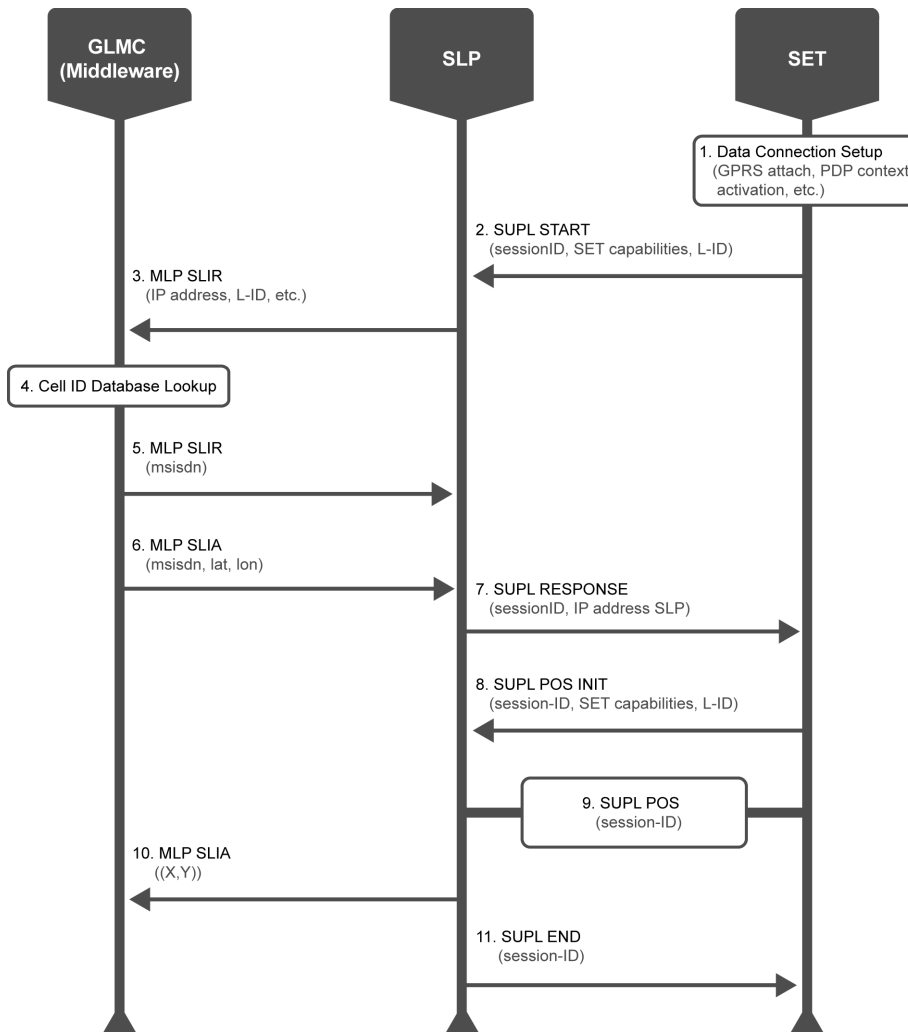
1. Prior to the SUPL call flow, the data connection between the SET and the wireless network is established through TCP/IP.

2. The call flow starts when the SET sends a SUPL START message to the SLP. The SLP IP request is provisioned into the SIM card of the SET. The request contains data describing SET capabilities for positioning technology and supported protocols. Positioning capabilities include SET-Based or SET-Assisted, E-CID (Enhanced Cell ID) and Autonomous, while supported protocols would include RRLP, and TIA-801.

3. The SLP requests initial position from the GMLC through SLIR in a manner similar to Step 6 in the Network Initiated call flow.

4. The GMLC verifies that the transaction is authorized and checks its Cell ID database to establish the initial position of the SET. As before, RLP might be required if the SET is roaming.

5. The GMLC returns the initial position of the SET to the SLP in an SLIA.

6. Concurrent with Step 5, the GMLC issues an SLIR to the SLP, requesting that the SLP provide the subscriber location at the end of the call flow. The SLIA that is returned by the SLP in Step 10 allows the GMLC to bill for the transaction. Many GMLCs have additional features, such as location caching, that take advantage of the subscriber location.

7, 8, and 9: In Steps 7 through 9, the SLP carries out the rest of the SUPL call flow with the SET. This consists of RRLP messages, and is described briefly in Appendix B.

10. Finally responding to the SLIR in Step 5, the SLP returns the final position to the GMLC through SLIA, allowing the GMLC to bill for the service.

11. The SLP sends a SUPL END message to SET declaring that the transaction has ended.

Section 4: Additional Interfaces

As part of the SUPL call flows described above, the Global Locate SLP also communicates through the interfaces described in this section.

PAP (Push Access Protocol)

The PAP interface to the PPG is one of two interfaces that can be used to establish communication between the SET and the TCP/IP data bearer (Step 1) in a SET-initiated SUPL call flow. The initiating WAP Push (PAP) message from the SET to the SLP includes the SUPL INIT message. Refer to OMA specifications[7] for more details.

SMPP (Short Message Peer-to-Peer)

Functionally similar to PAP, SMPP is the interface to the SMSC. Through SMS, the SET can also establish communication to the SMSC with a TCP/IP connection; this is the initial step in a SET-initiated SUPL call flow.

MLP interface in SLP

As discussed in previous sections, the Global Locate SLP uses the MLP interface both as a Server and a Client. In a Network-initiated case, the SLP acts as an MLP Server to receive requests from the GMLC, when the GMLC decides that the request it has received from an LCS client requires QoS that is best met with A-GPS positioning technology. In a SET initiated case, the SLP again uses the MLP interface as a Server, returning computed position to the GMLC for authentication, billing and record keeping purposes.

The GL SLP can also uses the MLP interface as a Client, requesting location (lat/lon) of a received Cell ID, from the GMLC, which is then acting as a Server. This interface also authenticates and logs SET based transactions in the GMLC.

In all the cases just reviewed, with the SLP acting as both Server and Client in a variety of transaction types, only two MLP interface types are used: SLIR and SLIA. Below are shown XML examples for both cases (Network Initiated, SET Initiated) and both types of MLP interface (MLP Server, MLP Client)

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7. Go to http://www.openmobilealliance.org/tech/affiliates/wap/wap-247-pap-20010429-a.pdf to get more information on PAP.

4.1 Network Initiated MLP

SLP as MLP Server: location request for an MSID, sent from the requesting entity to the SLP.

```
<slir ver="3.2.0" res_type="SYNC">
   <client>
      <id>theLES</id><pwd>thepwd</pwd>
      <serviceid>408</serviceid>
   </client>
      <msid type="MSISDN">
      <msid>461018765710</msid>
   <eqop>
      <resp_req type="LOW_DELAY" />
      <hor_acc>1000</hor_acc>
   </eqop>
   <loc_type type="CURRENT" />
   <prio type="HIGH" />
</slir>
```

Location answer from the SLP:

```
<slia ver="3.2.0">"
   <pos>
      <msid>461011334411</msid>
      <pd>
         <time utc_off="+0200">20020623134453</time>
         <shape>
            <EllipticalArea>
               <coord>
                  <X>30 16 28.308N</X>
                  <Y>45 15 33.444E</Y>
               </coord>
               <semiMajor>150</semiMajor>
               <semiMinor>275</semiMinor>
            </EllipticalArea>
            <alt>46</alt>
            <alt_acc>2</alt_acc>
         </shape>
      </pd>
   </pos>
</slia>
```

SLP as MLP Client: initial location request from the SLP to the position serving entity.

```
<slir ver="3.2.0" res_type="SYNC">
    <client>
        <id>GLSLP2</id><pwd>thepwd</pwd>
        <serviceid>408</serviceid>
    </client>
        <msid type="MSISDN">
        <msid>461018765710</msid>
        <msid type="IPV4">
        <msid>90.123.0.144</msid>
        <mcc>310</mcc><mnc>1</mnc><lac>1</lac><cellid>100</cellid>
        <loc_type type="INITIAL" />
        <prio type="HIGH"/>
</slir>
```

Location answer from the position serving entity:

```
<slia ver="3.2.0">"
    <pos>
        <msid>461011334411</msid>
        <pd>
            <time utc_off="+0200">20020623134453</time>
            <shape>
                <EllipticalArea>
                    <coord>
                        <X>30 16 28.308N</X>
                        <Y>45 15 33.444E</Y>
                    </coord>
                    <semiMajor>150</semiMajor>
                    <semiMinor>275</semiMinor>
                </EllipticalArea>
            </shape>
        </pd>
    </pos>
</slia>
```

4.2 SET Initiated MLP

SLP as MLP client: initial location request from the SLP to the position serving entity.

```
<slir ver="3.2.0" res_type="SYNC">
   <client>
      <id>GLSLP2</id><pwd>thepwd</pwd>
      <serviceid>408</serviceid>
   </client>
   <msid type="IPV4">
   <msid>190.123.0.144</msid>
   <requestor>
      <id><theSETapp></id>
      <serviceid><505></serviceid>
   </requestor>
   <mcc>310</mcc><mnc>1</mnc><lac>1</lac><cellid>100</cellid>
   <loc_type type="INITIAL" />
   <prio type="HIGH"/>
</slir>
```

Location answer from the position serving entity:

```
<slia ver="3.2.0">
   <pos>
      <msid>461011334411</msid>
      <pd>
         <time utc_off="+0200">20020623134453</time>
         <shape>
            <EllipticalArea>
               <coord>
                  <X>30 16 28.308N</X>
                  <Y>45 15 33.444E</Y>
               </coord>
               <semiMajor>150</semiMajor>
               <semiMinor>275</semiMinor>
            </EllipticalArea>
         </shape>
      </pd>
   </pos>
</slia>
```

SLP as MLP server: location request from the requesting entity to the SLP.

```
<slir ver="3.2.0" res_type="SYNC">
    <client>
        <id>theLES</id><pwd>thepwd</pwd>
        <serviceid>408</serviceid>
    </client>
    <msid type="MSISDN">
    <msid>461018765710</msid>
    <eqop>
        <resp_req type="LOW_DELAY" />
        <hor_acc>1000</hor_acc>
    </eqop>
        <loc_type type="CURRENT" />
    <prio type="HIGH" />
</slir>
```

Location answer from the SLP:

```
<slia ver="3.2.0">"
    <pos>
        <msid>461011334411</msid>
        <pd>
            <time utc_off="+0200">20020623134453</time>
            <shape>
                <EllipticalArea>
                    <coord>
                        <X>30 16 28.308N</X>
                        <Y>45 15 33.444E</Y>
                    </coord>
                    <semiMajor>150</semiMajor>
                    <semiMinor>275</semiMinor>
                </EllipticalArea>
                <alt>46</alt>
                <alt_acc>2</alt_acc>
            </shape>
        </pd>
    </pos>
</slia>
```

Section 5: Operation and Maintenance

Web Interface

Global Locate's SLP product provides a Web-based interface for operation and maintenance. The underlying O&M communication with the SLP is SNMP v2 based, and supports integration to commercial network monitoring systems (HP OpenView, NetCool, NetAct). The web-based interface allows fast and simple O&M integration, enabling development and trials, yet also providing extensibility into commercial operations. For integrations where Global Locate hosts the SLP, operators will often find the web-based interface more than adequate to their needs. It features a variety of Status pages, an SLP Utilization page, and a Configuration page.

SLP Status Page (Ready/Not Ready)

If the Status page indicates a "Ready" state, the SLP is ready to perform all functions. The Ready state inidicates normal readiness for all embedded A-GPS Server and interface modules within the SLP. The specific readiness of these states is indicated as described below

A-GPS Server Status

The Assistance data availability table lists satellites whose full assistance data is available, named by their PRN (Pseudo Random Noise) codes. Availability is given for Healthy satellites, and omits satellites undergoing scheduled maintenance or maneuver, or unscheduled outages, as defined by NANU (Notice Advisory to NavStar Users) messages available to the civilian sector from Schriever AFB and the US Coast Guard.

WWRN feed status (Active/Inactive)

This confirms streaming connectivity, over GLTP, to both of Global Locate's Data Hubs. Status Inactive, with indicates an ongoing loss

LTO status (t remaining, hrs; Active/Inactive)

LTO data is valid for 48 hours once computed, and is recomputed hourly at the Data Hubs and sent to all A-GPS Server and SLP targets on the WWRN data feed. While the WWRN data feed remains active, *t remaining* time will be within one hour of 48 hours. If WWRN feed status becomes inactive for longer than one hour, LTO will not be refreshed, and the value under *t remaining* will begin to decline.

In the event of sustained loss of the WWRN data feed, the A-GPS Server will switch to LTO data. *LTO Status Active* means the A-GPS Server is running on LTO data.

External interface status

- TCP/IP connection status to GMLC (Active/Inactive)

- TCP/IP connection status to PPG (Active/Inactive)

- TCP/IP connection status to SMSC (Active/Inactive

Utilization page

- Peak utilization information (peak transactions per hour)

- Current license information (allowed transactions per hour)

Configuration page

Very little configuration is required for the SLP. On this page, a table containing the necessary IP addresses is displayed, and is accessible for configuration through username/password security. Also accessible is the serial number and expiration status of the Global Locate license file.

Appendix A: Revision History

Revision	Date	Name	Description
1	14 July 2005	D. Lundgren M. Crawley	Initial release

Appendix B: RRLP Call Flows

The information in this appendix is based on the 3GPP technical specification for RRLP (3GPP TS 04.31, version 8.5.0). The 3GPP specification defines one basic message to show how location data is transferred between a mobile station and a Serving Mobile Location Center (SMLC). In this appendix, the mobile station is understood to be a SUPL Enabled Terminal (SET), and the SUPL Location Platform (SLP) will take the place of the SMLC. Please note that RRLP messages used in SUPL systems will be encased within a SUPL "envelope" protocol (ULP, or UserPlane Location Protocol) that controls the exchange of data between the SET and the SLP.

The process illustrated below is encapsulated in Step 9 of the Network Initiated call flow (Figure 4) and the SET Initiated call flow (Figure 5).

Figure 6: ULP/RRLP Call Flow
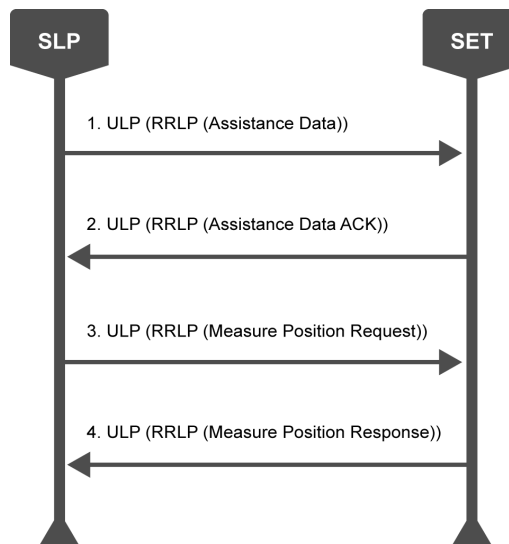
1. The SLP sends an Assistance Data packet to the SET. The assistance data may be sent in more than one packet. Each packet contains a reference number for delivery, assistance data for position measurement or position calculation (or both), and an element that indicates whether another packet of assistance data is forthcoming for the current session.

2. When the SET has received the complete set of assistance data, it sends an Assistance Data Acknowledgment packet to the SLP. The acknowledgment packet contains the reference number(s) of assistance data packet(s) received by the SET.

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3. The SLP sends a Measure Position Request packet to the SET. The packet contains a reference number for the request, response time, accuracy, positioning method, and other instructions.

4. The SET sends a Measure Position Response packet to the SLP. If the position calculation is performed on the SLP, the packet contains a host of GPS measurement information, including satellite IDs, carrier-to-noise ratio, doppler measurements, multipath indicator, pseudorange error, and more. If the position calculation is performed on the SET, the packet contains the all of the preceding data plus location data: GPS time of week at which the position calculation occurred, the position fix type (2D or 3D), and the position estimate calculated by the SET.

RRLP Error Handling

Both the SET and the SLP send an error packet in the event an incomplete or corrupted packet is received. The error packet contains a reference number for the corrupted packet, if available, and includes a specific notation for the type of error detected in the corrupted packet, such as Undefined, Incorrect Data, Unknown Reference Number, Missing Data, and others. If the SET receives an incomplete assistance data packet, it sends an error packet to the SLP, and the SLP responds by either re-sending the same assistance data, or by sending an updated set of assistance data.

Appendix C: Glossary

A-GPS	Assisted GPS. A method of GPS positioning whereby the GPS receiver is assisted in calculating positions by getting GPS ephemeris data through a means other than directly from the GPS satellites
CDMA	Code Division Multiple Access. A multiplexing spread spectrum radio signalling method that allows multiple transmitters to simultaneously send to a receiver on the same frequency without causing interference
C-Plane	Control Plane. The private signalling network and related infrastructure that provides wireless communication services to authorized subscribers
EDGE	Enhanced Data Rates for GSM Evolution. An enhancement to GPRS networks that can support data rates up to 384 kbps. EDGE was developed to support high bandwidth applications such as Internet connection and multimedia exchange
E-OTD	Enhanced Observed Time Difference. A time-based method of position calculation in which arrival times of signals from three or more cellular base stations and the known locations of the base stations are used by a mobile handset to triangulate its position
GPRS	General Packet Radio Service. A packet switched mobile data service that takes advantage of unused network bandwidth and provides data rates of 30 to 70 kbps
GSM	Global System for Mobile Communications. A digital wireless service for voice and data communications. GSM is an open standard being developed by the 3GPP
H-SLP	Home SLP. The SLP that serves a subscriber's home wireless network
LCS	Location Services. A generic term for services and related applications that are based on the geographic location of a mobile device, and are channelled primarily through wireless communication networks
LSP	Location Services Provider. A mobile network operator or SUPL provider that manages location services for MLS subscribers
MLP	Mobile Location Protocol. An application-level protocol for sending and receiving the location information of a mobile device such as a mobile phone or wireless PDA. MLP is the data interface used between SUPL providers, or between a SUPL provider and a mobile network operator. MLP is an XML language, and as such is not dependent on a particular network technology or data bearing channel
MLS	Mobile Location Services. An extension of LCS that includes a wide variety of real-time services and takes advantage of burgeoning wideband wireless communication services
MNO	Mobile Network Operator. A company that sells wireless communication services and owns the wireless communications infrastructure that makes the services possible
PAP	Push Access Protocol. A protocol that uses MIME elements to send XML data to a PPG server, and from the PPG to a mobile device such as a mobile phone or wireless PDA. By definition, the information sent through the PPG has not been requested by the mobile device. PAP is an Internet protocol and is not intended for use over the air
PPG	Push Proxy Gateway. A WAP server that has been configured to deliver information to a mobile device independent of an explicit request from the mobile device. In the context of SUPL, the SLP can initiate a session with the SET by sending it a SUPL INIT message. In this case, the SUPL INIT message would be sent from the SLP to the PPG over the Internet using PAP, and would be sent from the PPG to the SET using POTAP, a wireless interface.

POTAP	Push Over The Air Protocol. A protocol layer designed for wireless communication that is used to send information from a PPG to a mobile device. POTAP is based on WSP (Wireless Session Protocol), a binary protocol derived from HTTP
RLP	Roaming Location Protocol. A protocol that serves as the interface between two location servers. In the context of SUPL, RLP would be used in communications between a V-SLP and an H-SLP. RLP adheres to Mobile Location Protocol (MLP) structure.
RRC	Radio Resource Control. A C-Plane protocol that is used to control signalling and transfer of information between the mobile handset and radio network control elements
RRLP	Radio Resource LCS Protocol. A protocol developed for EDGE that enables a mobile handset to exchange position information with position serving entity such as an SLP. RRLP supports both A-GPS and E-OTD positioning
SET	SUPL Enabled Terminal. A device that can communicate with a SUPL network. Communication with the SUPL network is handled by SUPL Agent software running on the device. An SET could be a mobile phone, wireless PDA, PC, or any other device that can connect to an IP network
SLIA	Standard Location Immediate Answer. The MLP message sent in response to an SLIR message. The SLIA message contains a unique ID number for the request, the ID of the targeted mobile device, the position of the mobile device, the time at which the position was calculated, and more
SLIR	Standard Location Immediate Request. The MLP message used to request the location of a mobile device. The SLIR message contains ID of the targeted mobile device, an access code for obtaining the position of the mobile device, quality of position (QoP) and positioning priority, the ID of the service or application that is requesting the position of the mobile device, and more
SLP	SUPL Location Platform. A server or network stack that provides positions or position assistance data to an SET, and also supports functions related to roaming, security, authentication, charging, and more
SMPP	Short Message Peer-to-Peer. A protocol that enables "peer" network entities to send and receive SMS messages, such as an SMSC forwarding an SMS to another SMSC. In the context of SUPL, SMPP is the protocol used between the SLP and the SMSC
SMS	Short Message Service. A mobile communications service that enables subscribers to send short text messages between mobile phones and other wireless handheld devices. Messages are sent through an SMSC to the intended recipient. Short messages can also be used to send binary data. In the context of SUPL, an SLP would send a SUPL INIT message to the SMSC using SMPP, and the SMSC would encapsulate the SUPL INIT message in an SMS message and forward it to the intended SET
SMSC	Short Message Service Center. A network entity that receives and forwards SMS messages.
SUPL	Secure User Plane Location. A network layer that uses established data-bearing channels and positioning protocols for the exchange of location data between a SUPL Enabled Terminal (SET) and a SUPL Location Platform (SLP). SUPL is a key enabling technology for Mobile Location Services (MLS)
TIA-801	Telecommunications Industry Association Specification 801, Position Determination Service for cdma2000® Spread Spectrum System. The TIA specification that defines communications between a mobile station and a base station for mobile positioning services in a cdma2000 network
UDP	User Datagram Protocol. A transport layer protocol that was created to enable simple messaging between the application layer and the network layer. Unlike TCP, UDP has no mechanism for ensuring that UDP packets are delivered in the correct order and gives no indication that a packet has or has not been delivered. UDP is one of the core IP protocols.
ULP	UserPlane Location Protocol. A TCP/IP protocol developed to support the exchange of data between an SET and an SLP. In addition to location data, ULP also handles the exchange of authentication data. ULP uses ASN.1 encoding

UMTS	Universal Mobile Telecommunications System. An all-digital wireless communication service that combines the WCDMA air interface with GSM routing and digitizing standards to support broadband multimedia telecommunication services
V-SLP	Visited SLP. An SLP used by a subscriber who is roaming outside of his or her home network
WAP	Wireless Application Protocol. An open standard protocol developed to allow mobile wireless devices to connect to the Internet. WAP provides some of the functions as a standard Web browser, but has additional features to compensate for the processing and display limitations of mobile devices
WCDMA	Wideband Code Division Multiple Access. A wideband radio signalling method that uses the same multiplexing scheme as CDMA, but also includes a complete set of specifications that define signal modulation, datagram structures, interface protocols, and more. WCDMA is the air interface used in UMTS systems

Appendix D: References

1. 3GPP TS 44.031, *Location Services (LCS); Mobile Station (MS) — Serving Mobile Location Center (SMLC) Radio Resource LCS Protocol (RRLP),* V8.9.0, June 2004

2. OMA-AD-SUPL-V1_0-20050622-D, *Secure User Plane Location Architecture*, June 2005

3. OMA-RD-SUPL-V1_0-20050616-D, *Secure User Plane Location Requirements*, June 2005

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Specifications Subject to Change Without Notice

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