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3RD GENERATION  
PARTNERSHIP  
PROJECT 2  
"3GPP2"

# IP Based Location Services

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## *Stage 1 Requirements*

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***REVISION HISTORY***

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# 1 Introduction and Scope

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This version of the Stage 1 supports location through IP in current packet data connections offered in cdma2000<sup>®1</sup>. SIP-based services in the All-IP domain (MMD), such as VoIP, are not assumed to be supported. Thus deployment of IP Based Location Services will be possible prior to a full standardization and deployment of MMD. By the same token, there is no concept of an “emergency call” in the current packet data domain.

The scope of S.P0066 is an extension of the legacy network location services capability described in N.P0013, by adding an IP style interface capability. To offer services compliant to S.P0066, mobile devices, location service clients, and servers offering location service applications, do not need to support circuit switched services and/or SS7 signaling. They can be Internet and packet data capable devices only.

## 2 References

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[1] N.S0013 Location Services Authentication/Privacy/ Security and Enhancements

## 3 Definitions and Abbreviations

### 3.1 Definitions

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(see TIA/EIA-664 page 4)

#### 3.1.1.1 Accuracy

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The difference between the actual position of the target MS and the position estimate (e.g., as provided by position determining entity).

#### 3.1.1.2 Actual Position

---

The actual coordinates of the Target MS based on a geographic measure.

#### 3.1.1.3 Altitude

---

The geodetic position of the Target MS in terms of distance above or below the WGS-84 ellipsoid surface.

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<sup>1</sup> cdma2000<sup>®</sup> is the trademark for the technical nomenclature for certain specifications and standards of the Organizational Partners (OPs) of 3GPP2. Geographically (and as of the date of publication), cdma2000<sup>®</sup> is a registered trademark of the Telecommunications Industry Association (TIA-USA) in the United States.

#### **3.1.1.4 Confidence**

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The confidence by which the position of a Target MS is known to be within the shape description, (expressed as a percentage).

#### **3.1.1.5 Current Position**

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After a position determination has successfully provided a position estimate and its associated time stamp, the position estimate is referred to as the “current position” at that point in time.

#### **3.1.1.6 Last Known Position**

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The current position estimate (and its associated time stamp) that is stored for the Target MS in the MPC is referred to as the “last known position” until replaced by a later position estimate and its time stamp.

#### **3.1.1.7 LCS**

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Location Services

#### **3.1.1.8 LCS Client**

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An entity (e.g., service control function) that interacts with an MPC for the purpose of obtaining position information for one or more Target MSs within a set of specified parameters such as PQoS. LCS Clients subscribe to LCS in order to obtain position information for the purpose of providing location based applications. The LCS Client is responsible for formatting and presenting data and managing the user interface. The LCS Client may reside in the MS.

#### **3.1.1.9 LCS Client Personalization**

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A collection of attributes of LCS related parameters assigned to an LCS Client.

#### **3.1.1.10 LDC (Location Distribution Control)**

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Location Distribution Control. Process of controlling (restricting) location information distribution in the Internet, e.g. for the purpose of user privacy protection.

#### **3.1.1.11 Mobile Position Center (MPC)**

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The MPC serves as the point of interface to the wireless network for the position determination network. The MPC serves as the proxy entity, which may, on behalf of the Target MS, retrieve, forward, store, and control position information within the position network. Depending on the available location determination technology, the MPC can select the PDE(s) to use in position determination and forward the position estimate to the requesting entity (e.g., LCS Client), or store it for subsequent retrieval. The MPC may restrict access to position information for a Target MS (e.g. release position information to authorized entities).

**3.1.1.12 MPC**

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Mobile Position Center

**3.1.1.13 PDE**

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Position Determining Entity

**3.1.1.14 Position Determining Entity (PDE)**

---

The PDE facilitates determination of the geographical position of a Target MS. The input to the PDE for requesting the position is a set of parameters such as PQoS requirements. Multiple PDEs may serve the coverage area of an MPC and multiple PDEs may serve the same coverage area of an MPC utilizing different position determining technologies.

**3.1.1.15 Position Estimate**

---

The geographic position of a Target MS as determined by a PDE and the Target MS. The reference system for the coding of the Target MS position is the World Geodetic System 1984, (WGS-84).

**3.1.1.16 Position Quality of Service (PQoS)**

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A set of attributes associated with a request for the geographic position of a Target MS. The attributes include the required horizontal accuracy, vertical accuracy, response time, priority, and maximum age of the Target MS position.

**3.1.1.17 PQoS**

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Position Quality of Service

**3.1.1.18 Priority**

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The MPC may process requests for the position of a Target MS with different levels of priority. A request with a higher priority may be given faster access to position determining resources than a lower priority request.

**3.1.1.19 Target MS**

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The Target MS is the MS to be positioned.

**3.1.1.20 Target MS Privacy Profile**

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The profile detailing the location privacy information for the MS (e.g., LDC class, LCS Client exception list).

### 3.1.1.21 Transaction Rate

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The frequency of position information requests for a location based service.

## 4 General Feature Description

### 4.1 Location Services (LCS)

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Location Services (LCS) are network capabilities which enable the deployment of location based applications. The descriptions of possible location applications enabled by these capabilities are outside the scope of this document.

#### 4.1.1 Applicability to Telecommunications Services

---

IP Based LCS can be offered without subscription to basic telecommunication services.

LCS are available to a variety of LCS Clients including:

- Value Added Services (or external) LCS Clients
- Wireless Service Provider LCS Clients
- MS LCS Clients

LCS are applicable to any Target MS, and are subject to the location information distribution control specified by the MS subscriber. LCS are limited by the position determination method in use at the serving system and the positioning capability of the MS.

## 5 Detailed Functionality Requirements

### 5.1 LCS

#### 5.1.1 Position Information

---

Position Information is an estimate of the geographic position for a Target MS provided to an LCS Client. The position estimate is expressed as a shape. A shape is used to represent the uncertainty of the Target MS position. Velocity may be used to describe the speed and bearing of the Target MS.

##### 5.1.1.1 Reference System

---

The reference system for the coding of positions is the World Geodetic System 1984, (WGS 84). The origin of the WGS 84 co-ordinate system is the geometric center of the WGS 84 ellipsoid. The ellipsoid is constructed by the rotation of an ellipse around the minor axis which is oriented in the North-South direction. The rotation axis is the polar axis of the ellipsoid, and the plane orthogonal to it and including the center of symmetry is the equatorial plane.

The relevant dimensions are as follows:

- Major Axis = 6378137 meters
- Minor Axis = 6356752.314 meters

Co-ordinates are then expressed in terms of longitude and latitude relevant to this ellipsoid. The range of longitude is  $-180^{\circ}$  to  $+180^{\circ}$ , and the range of latitude is  $-90^{\circ}$  to  $+90^{\circ}$ .  $0^{\circ}$  longitude corresponds to the Greenwich Meridian, and positive angles are to the East, while negative angles are to the West.  $0^{\circ}$  latitude corresponds to the equator, and positive angles are to the North, while negative angles are to the South. Altitudes are defined as the distance between the ellipsoid and the point, along a line orthogonal to the ellipsoid.

### 5.1.1.2 Shapes

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The geodetic position of the Target MS is expressed as a shape. A number of different shapes can be selected according to need.

### 5.1.1.3 Ellipsoid Point

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Information that describes a point on the surface of the WGS-84 ellipsoid that consists of latitude and longitude. In practice, such a description can be used to refer to a point on Earth's surface, or close to Earth's surface, with the same longitude and latitude.

### 5.1.1.4 Ellipsoid Point with Uncertainty

---

Information that describes a point that is characterized by the co-ordinates of an ellipsoid point (the origin) and a distance  $r$ . It describes the set of points on the ellipsoid which are at a distance from the origin less than or equal to  $r$ , the distance being the geodesic distance over the ellipsoid, i.e., the minimum length of a path staying on the ellipsoid and joining the two points. Similar to the ellipsoid point, this can be used to indicate points on the Earth surface, or near the Earth surface, of same latitude and longitude. The typical use of this shape is to indicate a point when its position is known only with a limited accuracy, but the geometric contributions of uncertainty can be quantified.

### 5.1.1.5 Ellipsoid Point with Altitude and Uncertainty

---

Information that describes a point that is characterized by the co-ordinates of an ellipsoid point, an uncertainty distance  $r$ , an altitude  $a$  and an altitude uncertainty  $h$ . It describes the set of points which are at a vertical distance  $h$  or less from the origin. The origin is a point at altitude  $a$  above an ellipsoid point with uncertainty. The typical use of this shape is to indicate a point when its position is known only with a limited accuracy, but the geometric contributions of uncertainty can be quantified.

### 5.1.1.6 Velocity

---

A description of velocity may be applicable to a Target MS on or close to the Earth's surface.

### 5.1.1.7 Horizontal Velocity

---

Information that describes the horizontal speed and bearing. The horizontal speed gives the magnitude of the horizontal component of the velocity of a Target MS. The bearing provides the direction of the horizontal component of velocity taken clockwise from North.

### 5.1.1.8 Horizontal and Vertical Velocity

---

Information that describes the horizontal speed and bearing, vertical speed and direction. The horizontal speed and bearing characterize the horizontal component of velocity. The vertical speed and direction provides the component of velocity of a Target MS in a vertical direction.

### 5.1.1.9 Horizontal Velocity with Uncertainty

---

Information that describes the horizontal speed and bearing as a vector  $V$  and an uncertainty speed  $s$ . This describes a set of velocity vectors  $v$  that are related to the given velocity vector  $V$  as follows:

$$|V - v| \leq s$$

### 5.1.1.10 Horizontal and Vertical Velocity with Uncertainty

---

Information that describes the horizontal speed and bearing, giving a horizontal velocity vector  $V_{x,y}$ , a vertical speed and direction giving a vertical velocity component  $V_z$ , and uncertainty speeds  $s_1$  and  $s_2$ . It describes the set of velocity vectors  $v$  with horizontal and vertical components  $v_{x,y}$ , and  $v_z$  that are related to the given velocity components  $V_{x,y}$ , and  $V_z$  as follows:

$$|V_{x,y} - v_{x,y}| \leq s_1$$

$$|V_z - v_z| \leq s_2$$

### 5.1.1.11 Timestamp

---

All position estimates shall be time stamped to provide to a LCS Client an indication of the time at which the estimate was obtained.

## 5.1.2 LCS Client Subscription

---

The LCS Client may subscribe to LCS features. The LCS Client Subscription information may contain the range of QoS levels that are applicable for the LCS Client and other subscription parameters.

### LCS Client ID

The identity of the LCS Client.

### LCS Client MS Barring List

The LCS Client is not permitted to obtain the position of the MSs identified in this optional list.

#### **LCS Client Target MS List**

The LCS Client is only permitted to obtain the position for the MSs identified in this optional list.

#### **LCS Client Priority**

The Priority levels that are applicable for the LCS Client.

#### **LCS Client Maximum Transaction Rate**

The maximum rate of position information requests applicable for the LCS Client.

#### **Response Time**

The maximum time delay for obtaining the response to a position information request.

### **5.1.3 Position Quality of Service (PQoS)**

---

The Position Quality of Service (PQoS) is a set of attributes that reflect the accuracy, response time, priority and maximum age of the position information needed for a location based service. Different services may require different levels of accuracy, response time and age of the position information.

The LCS Client specifies the PQoS required for the Target MS's position estimate. If it can be determined at the time of the request that the PQoS cannot be met, position determination should not be initiated. Bi-lateral agreements may determine whether a position estimate that does not meet the requested PQoS shall be returned to the LCS Client.

#### **5.1.3.1 Horizontal Accuracy**

---

An LCS Client may specify the required horizontal accuracy. The horizontal accuracy of the position estimate shall be satisfied as closely as possible to the requested horizontal accuracy, when other quality of service factors are not in conflict.

The horizontal and vertical position estimates may be independently considered. Some applications may not require both, others may require both but with different levels of accuracy.

Given that the position estimate is the best possible estimate within the bounds of required response time, the position estimates of the Target MS (assuming several estimates are made) will reveal a "spread" of estimates around the actual MS position. The distribution of position estimates can be described by normal statistical parameters and suggests that a small proportion of position estimates may lie outside of the acceptable Position Quality of Service (PQoS) parameters for specific services.

It may be possible to provide information on the confidence associated with a position estimate. This may be used by location services to decide if a position update should be requested, for example, if the reported accuracy falls below a threshold determined by the LCS Client for a specific service.

It may also be possible to determine velocity (speed and heading) information from a single position request (i.e., the response to a single request may provide the results of multiple positioning determinations).

When delivered with a position estimate, the confidence region parameters, speed and heading may allow an application to improve the service delivered to the MS user. Some examples are given below:

- a. **Confidence Region:** Measure of uncertainty that specifies the size and orientation of the ellipse in which an MS is likely to lie with a predetermined confidence (e.g., 67%). The size of the confidence region may be used by the LCS Client to request an updated position estimate.
- b. **Speed:** Enables road traffic congestion monitoring and average travel time estimates between positions.
- c. **Heading:** The position estimate of a vehicle may be improved to identify the appropriate side of the highway. This may enable the provision of traffic information that relates only to the Target MS direction of travel.

### 5.1.3.2 Vertical Accuracy

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Accuracy may be independently considered with respect to horizontal and vertical positioning estimates, and if applicable, velocity estimates. Some location services may not require both, others may require both, but with different degrees of accuracy.

### 5.1.3.3 Response Time

---

Different location based services, or different LCS Clients, may have different requirements (depending on the urgency of the positioning request) for obtaining a response. Trade-offs may be necessary between requirements for positioning accuracy and response time.

Response Time is one of the PQoS parameters. The LCS client may specify the required response time either at provisioning or when the request for position information is made. When a response time is specified, the response time requirement shall be satisfied as closely as possible, when other quality of service parameters are not in conflict.

The following response time options are applicable:

1. **no delay:** any available Last Known Position estimate of the target MS shall be immediately returned. If no position estimate is available, a failure indication shall be returned and, optionally, the procedures to obtain a position estimate may be initiated (e.g., to be available for a future request).
2. **low delay:** fulfillment of the response time requirement takes precedence over fulfillment of the accuracy requirement. The *Current Position* estimate shall be returned with minimum delay. The *Position Estimate* shall be obtained to fulfill any accuracy requirement, but in doing so shall not add any additional delay

(i.e., a response with lower accuracy is more desirable than waiting for a more accurate response).

3. **delay tolerant:** fulfillment of the accuracy requirement takes precedence over fulfillment of the response time requirement. If necessary, the response for providing the position estimate shall be delayed until the accuracy requirements of the requesting LCS Client are met. The *Current Position* estimate shall be obtained to fulfill the accuracy requirement.

#### 5.1.4 Security

---

Position information shall be safeguarded against unapproved disclosure or usage. Position information shall also be provided in a secure and reliable manner that ensures the information is neither lost nor corrupted.

The identity and authorization privileges of the LCS Client shall be verified before responding to the LCS Client request.

#### 5.1.5 Target MS Privacy

---

Position information must always be available to a wireless service provider LCS Client that requires the position information for internal network operations.

The MS subscriber shall have means to control access to position information for value added services. Unless required by regulatory or legal actions, or as overridden by the Target MS user, the position of the Target MS may be distributed only within the Target MS Privacy constraints (See Section 5.2, Location Distribution Control).

#### 5.1.6 Normal Procedures with Successful Outcome

##### 5.1.6.1 Authorization

---

LCS may be generally available or may be provided after pre-arrangement with the service provider.

The subscription information for the LCS Client may contain the range of Position Quality of Service (PQoS) values and subscriptions list that the LCS Client is allowed to request.

For certain Wireless Service Provider controlled LCS Clients, subscription information may be unnecessary. For these LCS Clients, subscription to the LCS feature is given implicitly. These LCS Clients are empowered to request position information for a Target MS.

##### 5.1.6.2 De- Authorization

---

LCS may be withdrawn at the subscriber's request or for administrative reasons.

**5.1.6.3 Registration**

---

LCS has no registration.

**5.1.6.4 De-Registration**

---

LCS has no de-registration.

**5.1.6.5 Activation**

---

LCS is activated upon authorization.

**5.1.6.6 De-Activation**

---

LCS shall be de-activated upon de-authorization.

**5.1.6.7 Invocation**

---

LCS is invoked by an LCS Client requesting Target MS position information. The LCS Client shall specify the desired PQoS in the request for position information.

**5.1.6.8 Normal Operation with Successful Outcome**

---

Position information shall be disclosed to a properly authorized LCS Client if considerations of Target MS privacy are satisfied and the requested PQoS level can be met. In case position information is not available to the required PQoS level, position information may still be disclosed to the LCS Client. The position information disclosed may be the current position or the last known position of the Target MS.

**5.1.6.9 Data Recording**

---

The following data may be recorded when position determination is completed:

- type and identity of the LCS Client,
- identity of the Target MS,
- success or failure,
- PDE used,
- position estimate (including confidence),
- response time
- timestamp.

Reliability information indicating the measure of how often position information requests that satisfy the PQoS requirements are successful, may be recorded.

## **5.1.7 Exception Procedures or Unsuccessful Outcome**

### **5.1.7.1 Registration**

---

None identified.

### **5.1.7.2 De-Registration**

---

None identified.

### **5.1.7.3 Activation**

---

None identified.

### **5.1.7.4 De-Activation**

---

None identified.

### **5.1.7.5 Invocation**

---

A negative response shall be provided to the LCS Client if any of the following conditions occur:

- the LCS Client is not authorized to request position information for the Target MS,
- the LCS Client requests an unauthorized PQoS level,
- position information is not available to the requested PQoS level and a lower level of quality is not consistent with bi-lateral agreements.

## **5.1.8 Alternate Procedures**

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None identified.

## **5.1.9 Interactions With Other Network Services**

---

No interactions have been identified with the following exceptions:

### **5.1.9.1 Emergency Services (9-1-1)**

---

A request for Target MS position from an Emergency Services system shall take precedence over IP Based LCS.

### **5.1.9.2 Location Distribution Control (LDC)**

---

LDC takes precedence over LCS.

## **5.2 Location Distribution Control (LDC)**

---

Location Distribution Control (LDC) restricts distribution and presentation of a Target MS's position information in accordance with the user's privacy information.

The serving network may determine the position of the subscriber using appropriate position determining technology. The network may make this information available to LCS Clients in order to provide location-based services.

LDC restricts the presentation of a Target MS's to those LCS Clients that are authorized to receive the location information. The position information is restricted regardless of call/session status of the MS.

LDC does not impact an MS user's ability to engage in telecommunications services.

### **5.2.1 Applicability to Telecommunications Services**

---

LDC is applicable to IP Based telecommunications services.

### **5.2.2 Normal Procedure With Successful Outcome**

#### **5.2.2.1 Authorization**

---

LDC may be generally available or may be provided after pre-arrangement with the home service provider.

LDC may be offered with several subscription options:

Subscription Options	Values
LDC Class	Unconditionally Restricted. Position information for the Target MS shall only be disclosed to: <ul style="list-style-type: none"> <li>• An LCS Client that has been exempted from the MS's location privacy restrictions by regulatory or legal actions,</li> <li>• A service provider controlled LCS Client that requires the position information for internal network operations.</li> </ul>
	Pre-Authorized LCS Clients Only. Position information for the Target MS shall only be disclosed to: <ul style="list-style-type: none"> <li>• An LCS Client that has been exempted from the MS's location privacy restrictions by regulatory or legal actions,</li> <li>• A service provider controlled LCS Client that requires the position information for internal network operations.</li> <li>• An LCS Client that is on a semi-permanent list of LCS Clients that have been explicitly authorized by the subscriber to receive the position information.</li> </ul>
	Pre-Authorized LCS Clients and User Authorized LCS Clients. Position information for the MS shall only be disclosed to: <ul style="list-style-type: none"> <li>• An LCS Client that has been exempted from the MS's location privacy restrictions by regulatory or legal actions,</li> <li>• A service provider controlled LCS Client that requires the position information for internal network operations.</li> <li>• An LCS Client that is on a semi-permanent list of LCS Clients that have been explicitly authorized by the subscriber to receive the position information.</li> <li>• An LCS Client that has received temporary authorization for the position information upon explicit service invocation by the MS user. This authorization applies only to that specific service instance for a limited duration.</li> </ul>
	Unrestricted. Position information for the Target MS may be disclosed to any LCS Client.

**Table 1 LDC Subscription Options**

#### 5.2.2.2 De-Authorization

LDC may be withdrawn at the subscriber's request or for administrative reasons.

#### 5.2.2.3 Registration

The LCS exception list (i.e., the list of LCS Clients exempt from the Target MS's location privacy restrictions) shall be registered upon authorization for subscribers to LDC modes of *Pre-Authorized LCS Clients Only* and *Pre-Authorized LCS Clients and User Authorized LCS Clients*.

#### 5.2.2.4 De-Registration

The LCS exception list shall be de-registered upon de-authorization.

### 5.2.2.5 Activation and De-Activation

---

LDC is activated upon authorization. LDC shall be de-activated upon de-authorization.

### 5.2.2.6 Normal Operation With Successful Outcome

---

When position information is to be sent to the LCS Client, the Target MS Privacy information is checked to determine if the LCS Client is authorized to have access to the position information. If such authorization exists, the position information is provided to the LCS Client, unless the authorization is overridden by the Target MS user. If not authorized, the position information is not provided to the LCS Client.

Some LCS Clients shall be exempt from LDC:

- A wireless service provider controlled LCS Client that requires position information for internal network operations, such as:
  - » An LCS Client supporting network operator applications (e.g., customer service)
  - » An LCS Client supporting location-based services where the subscriber identity remains anonymous (e.g., network traffic measurement, network radio engineering)
  - » An LCS Client that is invoked in response to disruption of network operations by a specific mobile
  - » An LCS Client that is invoked in response to a specific mobile which fraudulently accesses network services
- LCS Clients that have been exempted from the Target MS's location privacy restrictions by regulatory or legal actions, including, in some countries, LCS Clients supporting certain emergency services (e.g., calls to Public Safety agencies)

The interaction between LDC and LCS Clients is determined by the home service provider. The Serving service provider may be involved in the interaction between LDC and at least certain LCS Clients.

Optionally, if subscribed to LCS mode of *Pre-Authorized LCS Clients* and *User Authorized LCS Clients*, the MS user may be prompted for permission to supply position information to the requesting application.

### 5.2.2.7 Charging Record

---

The system should record information for the LDC rejection of LCS Client request.

## 5.2.3 Exception Procedures or Unsuccessful Outcome

### 5.2.3.1 Registration

---

None identified.

**5.2.3.2 De-Registration**

---

None identified.

**5.2.3.3 Activation**

---

None identified.

**5.2.3.4 De-Activation**

---

None identified.

**5.2.3.5 Invocation**

---

None identified.

**5.2.3.6 Exceptions While Roaming**

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*Unconditionally Restricted* LDC Mode treatment may be applied to roaming subscribers.

**5.2.3.7 Exceptions During Intersystem Handoff**

---

None identified.

**5.2.4 Alternative Procedures**

---

None identified.

**5.2.5 Interactions With Other Wireless Services**

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None identified.

## Informative Annex A

### Deviations from Requirements in N.S0013

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This informative Annex outlines the differences between requirements in this document (S.R0066-0) and requirements (Stage 1) portions of N.S0013. In case of conflict between the main part of this document and this informative Annex, the main part of the document shall take precedence.

This Stage 1 document is largely based on relevant Location Services Stage 1 from [1] with the following deviations:

- Location Information Restriction (LIR) is renamed to Location Distribution Control (LDC)
- Definitions of LCS Client Personalization, LDC, and Target MS are added or modified
- Circuit-switched call related text is removed

In summary, S.R0066-0 requires that the same or analogous intrinsic Location Services capabilities as specified in [1] be supported over Internet Protocol.