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Contents

Foreword

This Technical Specification (TS) has been produced by the 3GPP.
The contents of ~~the present~~this document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of this TS, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version 3.y.z

where:

x the first digit:

1 presented to TSG for information;

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the specification;

1 Scope

~~The present~~This document provides the Stage One description of Location Services (LCS) ~~networks~~. A Stage One description provides an overall service description, primarily from the service subscriber's and user's points of view, but not dealing with the details of the Man Machine Interface (MMI). This TS includes information applicable to network operators, service providers and terminal, base station system, switch and data base manufacturers.

NOTE: Location Services may be considered as a network provided enabling technology consisting of standardized service capabilities which enable~~s~~ the provision of location based applications. ~~This~~ These application~~s~~ may be service provider specific. The description of the numerous and varied possible location applications which are enabled by this technology are outside the scope of this specification. However, clarifying examples of how the functionality being specified may be used to provide specific location services is included in various sections of the specification.

~~The present~~This document ~~contains~~ provides ~~the~~ core requirements ~~for the LCS~~ to an extent sufficient to derive a complete definition of ~~the LCS~~location services at the service level. However, the present document ~~also documents~~ provides ~~some~~ additional requirements which may suggest in a non-normative manner certain ways the system may be implemented to support ~~the LCS feature.~~location services.

LCS can be offered without subscription to basic telecommunication services. LCS is available to the following categories of LCS clients:

- Value Added Services LCS Clients – use LCS to support various value added services. These clients can include MS subscribers as well as non-subscribers to other services.
- PLMN Operator LCS Clients – use LCS to enhance or support certain O&M related tasks, supplementary services, IN related services and bearer services and teleservices.
- Emergency Services LCS Clients – use LCS to enhance support for emergency calls from subscribers.
- Lawful Intercept LCS Clients – use LCS to support various legally required or sanctioned services.

LCS is applicable to any target MS whether or not the MS supports LCS, but with restrictions on choice of positioning method or notification of a location request to the MS user when LCS or individual positioning methods, respectively, are not supported by the MS.

~~LCS will be developed in phases. Phase 1 includes provision of the following:~~

~~LCS Phase 1. This is the initial default phase of LCS. It provides a generic flexible architecture capable of supporting all positioning methods. Specific support is provided for Time Of Arrival (TOA), Enhanced Observed Time Difference (E-OTD) and Global Positioning System (GPS) based positioning methods. Support is provided for emergency services, value added services and PLMN operator services.~~

~~Chapter 9 specifies requirements for further LCS phases.~~

LCS is being developed in phases with enhancements added in yearly releases:

1. GSM Release 98: This is the initial default phase of LCS. It provides a generic flexible architecture capable of supporting all positioning methods. Specific support is provided for Time Of Arrival (TOA), Enhanced Observed Time Difference (E-OTD) and Global Positioning System (GPS) based positioning methods. Support is provided for emergency services, value added services and PLMN operator services.

2. GSM Release 99: This provides the same capabilities as GSM Release 98, since GSM Release 98 specifications were copied as "mirror" specifications in GSM Release 99.

3. UMTS Release 99: LCS is supported in the circuit switched domain of the 3G core network (GMLC connected to MSC). UTRAN R99 specifications support cell coverage (ie cell identity) based LCS. (The radio interface RRC specification also support IPDL-OTDOA and network assisted GPS (assistance data broadcasting), but the UTRAN internal interfaces do not yet support these two methods in R99.)

4. GSM/UMTS Release 2000: LCS shall be supported in the circuit switched domain and in the packet switched domain including GPRS. LCS shall be supported in GERAN and in UTRAN FDD and UTRAN TDD. The positioning methods in UTRAN will be at least the 3 methods identified earlier: cell coverage based, IPDL-OTDOA and assisted GPS. LCS support is to be included in the Open Service Architecture (OSA) including enhancements for the support of value added services, and support for the velocity parameter in the position request /response. New LCS service features, some of which are currently described in chapter 9, shall be evaluated and fully described as seen feasible. The objective is to have common service descriptions for all Access Networks in this stage 1 specification. Possible deviations shall be noted in the text.

5. Future releases: For further study

2. References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies.
- A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.
- For this Release ~~1999~~ 2000 document, references to GSM documents are for Release ~~1999~~ 2000 versions ~~(version 8.x.y)~~.

2.1 Normative references

[1] GSM 01.04: "Digital cellular telecommunication system (Phase 2+); Abbreviations and acronyms".

[2] TR 21.905: “Vocabulary for 3GPP Specifications”.

[3] TS 23.032: "Universal Geographical Area Description"

[4] TS 22.101: "Service principles"

[5] TS 22.105: "Services and Service Capabilities"

[6] TS 22.115: "Charging and Billing"

[7] TS 22.121: "Virtual Home Environment"

[8] TS 23.110: " UMTS Access Stratum; Services and Functions"

2.2 Informative references

[9] TR 25.923: "Report on Location Services (LCS)"

[10] PD 30.lcs: "Project Plan for location services in UMTS"

[11] Third generation (3G) mobile communication system; Technical study report on the location services and technologies, ARIB ST9 December 1998.

[12] The North American Interest Group of the GSM MoU ASSOCIATION: Location Based Services, Service Requirements Document of the Services Working Group

3 Definitions and abbreviations

3.1 Abbreviations

For the purposes of the present document, in addition to GSM 01.04 [1] and TR.21.905, ~~-~~the following abbreviations apply:

LCS	Location Service
NA-ESRD	North American Emergency Services Routing Digits
NA-ESRK	North American Emergency Services Routing Key
NANP	North American Numbering Plan

<< editorial note: add definitions for UE and MS; or perhaps move all definitions to the vocabulary document >>

NOTE: In the present document, acronyms are used in the text as if they are read either in their fully expanded form or in their alphabet names with no consistent principle.

3.2 Definitions

For the purposes of the present document the following definitions apply:
Current Location: after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp is referred to as the 'current location' at that point in time.
Deferred location request: a location request where the location response (responses) is (are) not required immediately.
Immediate location request: a location request where a single location response only is required immediately.
Initial Location: in the context of an originating emergency call the location estimate and the associated time stamp at the commencement of the call set-up is referred to as 'initial location'.
Last Known Location: The current location estimate and its associated time stamp for Target MS stored in the LCS Server is referred to as the 'last known location' and until replaced by a later location estimate and a new time stamp is referred to as the 'last known location'.
LCS Client: a software and/or hardware entity that interacts with a LCS Server for the purpose of obtaining location information for one or more Mobile Stations. LCS Clients subscribe to LCS in order to obtain location information. LCS Clients may or may not interact with human users. The LCS Client is responsible for formatting and presenting data and managing the user interface (dialogue).
NOTE: The LCS Client may reside inside or outside the PLMN.
LCS Client Access barring list: an optional list of MSISDNs per LCS Client where the LCS Client is not allowed to locate any MSISDN therein.
LCS Client Subscription Profile: a collection of subscription attributes of LCS related parameters that have been agreed for a contractual period of time between the LCS client and the service provider.
LCS Feature: the capability of a PLMN to support LCS Client/server interactions for locating Target MSs.
LCS Server: a software and/or hardware entity offering LCS capabilities. The LCS Server accepts requests, services requests, and sends back responses to the received requests. The LCS server consists of LCS components which are distributed to one or more PLMN and/or service provider.
Location Estimate: the geographic location of an MS and/or a valid Mobile Equipment (ME), expressed in latitude and longitude data. The Location Estimate shall be represented in a well-defined universal format. Translation from this universal format to another geographic location system may be supported, although the details are considered outside the scope of the primitive services.
North American Emergency Services Routing Digits (NA-ESRD): a telephone number in the North American Numbering Plan (NANP) that can be used to identify a North American emergency services provider and its associated LCS client. The ESRD also identifies the base station, cell site or sector from which a North American emergency call originates.
North American Emergency Services Routing Key (NA-ESRK): a telephone number in the North American Numbering Plan (NANP) assigned to an emergency services call by a North American VPLMN for the duration of the call. The NA-ESRK is used to identify (e.g. route to) both the emergency services provider and the switch in the VPLMN currently serving the emergency caller. During the lifetime of an emergency services call, the NA-ESRK also identifies the calling mobile subscriber.
PLMN Access barring list: an optional list of MSISDN per PLMN where any LCS Client is not allowed to locate any MSISDN therein except for certain exceptional cases.
Privacy Class: list of LCS Clients defined within a privacy exception class to which permission may be granted to locate the target MS. The permission shall be granted either on activation by the target MS or permanently for a contractual period of time agreed between the target MS and the service provider.
Privacy Exception List: a list consisting of various types of privacy classes (i.e. operator related, personal etc.). Certain types of classes may require agreement between the service provider and the target MS.**Target MS:** The MS being positioned.
Target MS Subscription Profile: the profile detailing the subscription to various types of privacy classes.

4 Functional Requirements

3GPP standards shall support location service features, to allow new and innovative location based services to be developed. It shall be possible to identify and report in a standard format (e.g. geographical co-ordinates) the current location of the user's terminal and to make the information available to the user, ME, network operator, service provider, value added service providers and for PLMN internal operations.
The location ~~identification~~ is provided to identify the likely location of specific MEs. This is meant to be used for charging, location-based services, lawful interception, emergency calls, etc., as well as the positioning services.
The standard shall support both GSM BSS and UTRAN to facilitate determination of the location of a mobile station.

~~NOTE: UTRAN will include support for LCS at Rel 1999, however full system support for LCS with UTRAN will be a part of release 2000.~~

The following subsections provide general descriptions of attributes that can be used to describe or characterize various location services. Location-based services may be described in terms of these attributes.

The relative importance of these attributes varies from service to service. However, accuracy, coverage, privacy and transaction rate may be considered the primary distinguishing attributes that define a value-added service. Briefly,

accuracy is the difference between actual location and estimated location,

coverage is an expression of the geographic area in which the MS user will receive an adequate perceived quality of service,

privacy describes the user's perception of confidentiality of the location information, and

transaction rate indicates how frequently network messaging is required to support the service.

A general comparison of the specific attributes of various location-based services is provided in Annex B of this document.

4.1 High Level Requirements

The following high level requirements are applicable:

1. The supporting mechanisms should incorporate flexible modular components with open interfaces that facilitate equipment interoperability and the evolution of service providing capabilities.

~~3.~~2. The network should be sufficiently flexible to accommodate evolving enabling mechanisms and service requirements to provide new and improved services.

~~4.~~3. It shall be possible to provide multiple layers of permissions to comply with local, national, and regional privacy requirements.

~~5.~~4. Multiple positioning methods should be supported in the different Access Networks, including (but not limited to) UL-TOA, E-OTD, IPDL-OTDOA, Network Assisted GPS and methods using cell site or sector information and Timing Advance or RoundTrip Time measurements.

~~6.~~5. The location determining process should be able to combine diverse positioning techniques and local knowledge when considering quality of service parameters to provide an optimal positioning request response.

~~7.~~6. It should be possible to provide position information to location services applications existing within the PLMN, external to the PLMN, or in Mobile Equipment;

~~8.~~7. Support should be provided for networks based on an Intelligent Network architecture (i.e. with specific support for CAMEL based Location Services).

4.~~1~~2 Location Information

4.~~1~~2.1 Geographic Location

Provision of the geographic location of a target MS is applicable to all LCS services.

4.~~2~~3 Quality of Service

4.~~2~~3.1 Horizontal Accuracy

The accuracy that can be provided with various positioning technologies depends on a number of factors, many of which are dynamic in nature. As such the accuracy that will be realistically achievable in an operational system will vary due to such factors as the dynamically varying radio environments (considering signal attenuation and multipath propagation), network topography in terms of base station density and geography, and positioning equipment available.

The accuracy for location services can be expressed in terms of a range of values that reflect the general accuracy level needed for the application. Different services require different levels of positioning accuracy. The range may vary from tens of meters (navigation services) to perhaps kilometers (fleet management).

The majority of attractive value added location services are enabled when location accuracies of between 25m and 200m can be provided.

Based on decreasing accuracy requirement some examples of location services are provided below:

·????Location-independent	Most existing cellular services, Stock prices, sports reports
·????PLMN or country	Services that are restricted to one country or one PLMN
·????Regional (up to 200km)	Weather reports, localized weather warnings, traffic information (pre-trip)
·????District (up to 20km)	Local news, traffic reports
·????Up to 1 km	Vehicle asset management, targeted congestion avoidance advice
·????500m to 1km	Rural and suburban emergency services, manpower planning, information services (where are?)
·????100m (67%)	U.S. FCC mandate (99-245) for wireless emergency calls using network based positioning methods
·????300m (95%)	
·????75m-125m	Urban SOS, localized advertising, home zone pricing, network maintenance, network demand monitoring, asset tracking, information services (where is the nearest?)
·????50m (67%)	U.S. FCC mandate (99-245) for wireless emergency calls using handset based positioning methods
·????150m (95%)	
·????10m-50m	Asset Location, route guidance, navigation

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

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

It may be possible to provide information on the confidence that can be associated with a location 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 or Network Operator for a specific service.

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

When delivered with a location 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: Simple 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 network operator or the LCS Client to request an updated location estimate.

~~(c)~~(b) Speed: enables e.g. congestion monitoring, and average travel time estimates between locations.

~~(d)~~(c) Heading: the location 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 user's direction of travel.

For Value Added Services and PLMN Operator Services, the following is applicable:
Accuracy is application driven and is one of the negotiable Quality of Service (QoS) parameters.
The precision of the location shall be network design dependent, i.e., should be an operator's choice. This precision requirement may vary from one part of a network to another.
The LCS shall allow an LCS Client to specify or negotiate the required horizontal accuracy. The LCS shall normally attempt to satisfy or approach as closely as possible the requested or negotiated accuracy when other quality of service parameters are not in conflict.
~~The required location accuracy varies from 10m up to 1km, depending on applications. The location determining process may be able to combine several techniques to accommodate local conditions and evolving technology. The accuracy provided as a result of a given positioning attempt may vary depending on dynamically changing radio conditions and other factors.~~
For Emergency Services (where required by local regulatory requirements) the following requirements shall be met:

- The LCS Server shall attempt to obtain the horizontal location of the calling MS, in terms of universal latitude and longitude coordinates, and shall provide this to an Emergency Service Provider. The accuracy shall be defined by local regulatory requirements. Annex A shows such requirements as exist in the United States.

NOTE: The LCS Server provides the location service capabilities but the mechanism by which location is reported to an emergency service provider is outside the scope of this service.

4.~~2~~3.2 Vertical Accuracy

For Value Added Services, and PLMN Operator Services, the following is applicable:
The LCS Server may provide the vertical location of an MS in terms of either absolute height/depth or relative height/depth to local ground level. The LCS Server shall allow a LCS Client to specify or negotiate the required vertical accuracy. The LCS Server shall normally attempt to satisfy or approach as closely as possible the requested or negotiated accuracy when other quality of service parameters are not in conflict.
The vertical accuracy may range from a about ten metres (e.g. to resolve within 1 floor of a building) to hundreds of metres.
For Emergency Services (where required by local regulatory requirements) there is no requirement for the support of vertical positioning.

4.~~2~~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. The location server may need to make trade-offs between requirements for positioning accuracy and response time.
For Value Added Services, and PLMN Operator Services, the following is applicable:
Response Time is one of the negotiable QoS parameters. Support of response time by a Public Land Mobile Network (PLMN) is optional. The LCS Server may allow a LCS Client to specify or negotiate the required response time (in the context of immediate location request, see table 1) either at provisioning or when the request is made. The LCS Server may optionally ignore any response time specified by the LCS Client that was not negotiated. If response time is not ignored, the LCS Server shall attempt to satisfy or approach it as closely as possible when other quality of service parameters are not in conflict.
For immediate location request response time options are as follows::

a) "no delay": the server should immediately return any location estimate that it currently has. ~~t~~The LCS Server shall return either Initial or Last Known Location of the Target MS. If no estimate is available, the LCS Server shall return the failure indication and may optionally initiate procedures to obtain a location estimate (e.g. to be available for a later request).

b) "low delay": fulfillment of the response time requirement takes precedence over fulfillment of the accuracy requirement. ~~t~~The LCS Server shall return the Current Location with minimum delay. The LCS shall attempt to fulfill any accuracy requirement, but in doing so shall not add any additional delay (i.e. a quick response with lower accuracy is more desirable than waiting for a more accurate response).~~.~~

c) "delay tolerant": fulfillment of the accuracy requirement takes precedence over fulfillment of the response time requirement. If necessary, the server should delay providing a response until the accuracy requirement of the requesting application is met. ~~t~~The LCS Server shall obtain a Current Location with regard to fulfilling the accuracy requirement.

For Emergency Services (where required by local regulatory requirements) there may be no requirement to support negotiation of response time. The network shall then provide a response as quickly as possible with minimum delay. Response time supervision may be implementation dependent.

4.4 Reliability

Reliability provides a measure of how often positioning requests that satisfy QoS requirements are successful. For some applications, such as cross-country vehicle tracking, this may not be especially critical. If a positioning attempt fails, due to lack of coverage or transient radio conditions, etc, another positioning attempt may be made. However for other services, perhaps such as child tracking, reliability may be more important.

The network shall provide statistical reporting of reliability (QoS parameters) data.

4.~~3~~5 Priority

Location requests for different services may be processed with different levels of priority.

For Value Added Services, and PLMN Operator Services, the following is applicable:
The LCS Server may allow different location requests to be assigned different levels of priority. A location request with a higher priority may be accorded faster access to resources than one with a lower priority and may receive a faster, more reliable and/or more accurate location estimate.
For Emergency Services (where required by local regulatory requirements) the location request shall be processed with the highest priority level.

4.~~4~~6 Timestamp

For Value Added Services, and PLMN Operator Services, and Emergency Services (where required by local regulatory requirements), the LCS Server shall timestamp all location estimates provided to a LCS Client indicating the time at which the estimate was obtained.

4.~~5~~7 Security

Specific local, national, and regional security regulations must be complied with.

Position information should be safeguarded against unapproved disclosure or usage. Position information should also be provided in a secure and reliable manner that ensures the information is neither lost nor corrupted. Audit records should be maintained of positioning requests and responses to facilitate resolution of security violations.
The LCS Client may be authorized by the LCS Server. Existing security mechanisms as well as security mechanisms of the LCS Server shall be used for authorizing the LCS Client and its request for location information.
For Value Added Services, the following is applicable:
Only authorized LCS Clients shall be able to access the LCS Server. Before providing the location of a Target MS to any authorized LCS Client, the LCS Server shall verify both the identity and authorization privileges of the LCS Client .
Once the LCS Server has verified that a particular LCS Client is authorized to locate a particular Target MS, any location estimate requested shall be provided to the LCS Client in a secure and reliable manner, such that the location information is neither lost, corrupted nor made available to any unauthorized third party.
For PLMN operator services, location information shall be provided in a secure and reliable manner. The ability to obtain location information shall depend on local regulatory laws and requirements in conjunction with requirements for MS privacy.
For Emergency Services (where required by local regulatory requirements) the following requirements shall be met:
Position information shall be provided to the Emergency Services Network as an authorized LCS client. Target MS authorization checks normally performed for value added services are not applicable (privacy is over-ridden). The position information shall be provided to the Emergency Services Network in a secure and reliable manner, such that the location information is neither lost, corrupted, nor made available to any unauthorized third party.

4.~~6~~8 Privacy

Specific local, national, and regional privacy regulations must be complied with, and multiple layers of permissions may be required.

Location information must always be available to the network service provider.

Means shall be provided for the MS subscriber to control privacy for value added services.

Unless required by local regulatory requirements, or overridden by the target MS User, the target MS may be positioned only if allowed in the MS subscription profile. In general, for valued added location services, the target MS being positioned should be afforded the maximum possible privacy, and should not be positioned unless the positioning attempt is explicitly authorized. In the absence of specific permission to position the target MS, the target MS should not be positioned.

It may also be possible for a target MS to authorize positioning attempts after the target MS is notified of a positioning request and the target MS grants permission for positioning (see the subsequent "target subscriber notification" section of this document).

The privacy of an inanimate asset for an embedded target MS may be completely defined by the MS subscriber.

Additionally, specific privacy exceptions may exist for compliance with mandated location based services (such as for emergency services or lawful intercept) which are required by national or local regulatory requirements.
~~Unless required by local regulatory requirements, or overridden by the target MS User, the target MS may be positioned only if allowed in the MS subscription profile.~~

For Value Added Services, the following is applicable:
The Target MS Subscriber shall be able to restrict access to the location information (permanently or on a per attempt basis). The LCS Client access shall be restricted unless otherwise stated in the Target MS Subscription Profile. The home network shall have the capability of defining the default circumstances in which the Target MS's location is allowed to be provided - as required by various administrations and/or network requirements.
~~If indicated in the subscription profile, where a target MS supports the LCS, the target MS user shall be notified of each location request for which there is no restriction in the MS subscription profile and be enabled to accept or reject it. The default treatment, in the absence of an indication from the MS user, is to accept.~~
~~The target MS subscriber may also subscribe to notification for each location request that is restricted in the MS subscription profile and be enabled to accept or reject it – the default treatment in the absence of an indication from the MS user being to reject. Where a target MS does not support LCS, a location request for which there is no restriction in the MS subscription profile shall be denied where required by local regulatory requirements and allowed otherwise. In the latter case, the LCS server may maintain a record of each location request including the result and the identity of the LCS client.~~
It shall be possible for location services to support conditional positioning. Under these conditions, an application that is granted conditional positioning authorization must notify and obtain positioning authorization from the user of the target MS prior to performing the positioning process. Thus the user of the target MS shall be able to accept or reject the positioning attempt.

The default treatment, which is applicable in the absence of a response from the Target MS, shall be specified in the LCS Subscription Profile. Thus for some location services the default treatment may be to accept the positioning request, whereas for other location services the default treatment may be to reject the positioning attempt.

However, considering that in general, users shall be afforded the maximum possible privacy, and shall not be positioned unless the target subscriber authorizes the requesting location application to perform positioning, the default condition shall normally be to deny the positioning attempt.
For PLMN operator services, the target MS subscriber may be able to restrict access to location information used to enhance or support particular types of service. The LCS client access shall be restricted unless stated otherwise in the Target MS subscription profile. The target MS user shall not be notified of any authorized location attempt.
For Emergency Services (where required by local regulatory requirements) Target MSs making an emergency call may be positioned regardless of the privacy attribute value of the subscriber associated with the Target MS (or ME) making the call.
For Lawful Interception Services (where required by local regulatory requirements), target MSs may be positioned under all circumstances required by local regulatory requirements. The target MS user shall not be notified of any location attempt.

4.9 Service Authorization

Requests for positioning information should be processed only if the requesting application is authorized. The identity and authorization privileges of the requesting application should be verified prior to processing positioning requests.

4.10 Service Activation and De-Activation

To maximize the adoption of location services, the service activation process must be simple. Three types of service package, may be distinguished, each of which may require a different service activation process:

1. On Demand: the user accesses services only when required.
2. Period Subscription: the subscriber requires periodic availability of the service
3. ~~4.~~ Mixed: some services provided on subscription and the remainder on-demand.

The process of activation + service delivery + deactivation may be provided in a single transaction. It may be possible for a subscriber to activate a location service on one occasion before deactivating an existing invocation.

Furthermore, a location service may be 'enabled' at the point of sale as part of the service package purchased by the MS subscriber. The use of Over-The-Air (OTA) provisioning may allow the location feature to be enabled for MS-based positioning methods.

4.11 Coverage

In general an MS user should be able to access a location service anywhere within the operator's coverage area, or within the roaming area. Three levels of coverage may be considered:

1. Home Network - Complete
~~3.~~2. Home Network - Partial
~~4.~~3. Roaming Networks

Considering network topography and dynamically varying environmental factors, a network operator may not be able to guarantee homogeneous service quality across the entire home network geographic area, or roaming partners' networks. Even within those areas where service is offered, the provided quality of service may vary due to dynamic environmental (i.e. radio) conditions. Additionally, the location method may have an accuracy that depends on the MS location, for example due to varying radio conditions, cell configuration and cell density in different areas, and geometric dilution of precision.

Furthermore the roaming partner's network may not accept a similar location method to that experienced by the user in the home network.

Finally, the service may not be available in a roaming partner's network despite technical interoperability between the location method supported by the MS and the network.

Therefore coverage may be considered not only to be a technical attribute, but may also be related to roaming contracts between network operators. In general, provided that a roaming agreement exists, any properly authorized location-based service may position a Target MS in either the Home PLMN (HPLMN) or a Visited PLMN (VPLMN). It may also be noteworthy that some location based services (such as location based information services) may be especially attractive to subscribers roaming outside their home networks.

4.~~7~~12 Roaming Target MS

With respect to roaming, specific local, national, and regional privacy regulations must be complied with, and multiple layers of permissions may be required.

Many location-based services may be especially attractive to subscribers roaming outside their home PLMN. As such, support should be provided for the transparent and consistent provision of location based services to the fullest extent possible. Consideration for roaming support should be provided with the following priorities:

1. Roaming between GSM family networks.
2. Roaming between 2nd Generation GSM systems and IMT 2000 family networks.
3. Roaming between GSM and ANSI-41 or other systems.

If the location capability in the VPLMN is compatible with that provided in the HPLMN, the same parameters must be provided to the location server in the VPLMN that would be provided to the server in the HPLMN to enable provision of the same services.

For Value Added Services, the following is applicable:
Provided that a roaming agreement exists, the LCS feature shall allow any properly authorized LCS client to request and receive the location of a particular Target MS when the Target MS is either located in its Home PLMN (HPLMN) or Visited PLMN (VPLMN). Any PLMN not supporting the LCS feature shall return a suitable error response to any other PLMN from which an LCS request is received: the requesting PLMN shall then infer that the LCS feature is not supported and provide a suitable error response in turn to the requesting LCS Client.
For PLMN Operator Services, location of any roaming target MS shall be supported in the VPLMN as allowed by both local regulatory requirements and considerations, where applicable, of MS privacy.
For Emergency Services (where required by local regulatory requirements) the Serving PLMN shall support the positioning of all Target MSs including roaming Target MSs currently serviced by that serving PLMN. There is no requirement for a HPLMN to position ~~the~~ Target MSs that have roamed outside the HPLMN.

4.~~8~~13 Support for all MSs

For value added services, and PLMN operator services, the LCS feature may be supported for all MSs.
For Emergency Services (where required by local regulatory requirements), positioning shall be supported for all MSs (i.e. including legacy MSs) where coverage is provided, and also MSs without a SIM/USIM.

4.~~9~~14 Support for Unauthorized MSs

For value added services, support of unauthorized MSs may be provided by the PLMN.
For PLMN operator services, positioning of unauthorized MSs may be provided by the PLMN as required by local regulatory requirements.

For Emergency Services (where required by local regulatory requirements), the PLMN shall support positioning for unauthorized MSs (i.e. including stolen MSs and MSs without a SIM/USIM).

NOTE: A ~~GSM~~ subscriber is in general identified as an MS containing in it the SIM/USIM associated with the subscriber. In some exceptional cases (e.g., an ~~E-911~~emergency call), an MS without a valid ~~GSM~~ subscription recognized in the PLMN can become a Target MS. In such a case, the subscriber may be identified by the identity associated with the Mobile Equipment (ME) involved in the call.

4.~~10~~15 Periodic Location Reporting

Periodic location reporting is the act of LCS Server initiating multiple position locations spread over a period of time. The periodic reporting function is generally applicable for asset management services and exists as several variants, each applicable to different value added services:

-?????Location reporting only within predetermined period	e.g. commercial asset tracking and, subject to provision of privacy, manpower planning.
-?????Periodic location reporting within specified period and reporting triggered by a specific event	e.g. high value asset security, stolen vehicle monitoring, home zone charging.
-?????Periodic location reporting triggered by a specific event	e.g. 24hr depot management, transit passenger information systems

Periodic location determination and reporting increases network traffic. However, scheduling the periods of location monitoring and reporting will reduce this. Finally, event-based logic provided by the network operator that monitors the asset (location and status) and only reports events that meet conditions agreed with the application may reduce network traffic further without reducing the QoS.

If this event-based or time-based decision process is the responsibility of the application and not the network operator then all of the above services can be regarded as periodic location reporting.

For value added services, and PLMN operator services, support of periodic location reporting may be provided by the PLMN.

For Emergency Services (where required by local regulatory requirements), there is no requirement for the PLMN to support periodic location reporting.

4.~~11~~16 MS-Based Location Calculation

MS-Based Location Calculation may be supported on either a per-request basis or autonomously whereby a single request from an MS subscriber enables MS based location calculation over an extended period without further interaction with the PLMN.

For Commercial Services, the following may be applicable for autonomous location:

The network may broadcast location assistance information to mobiles, which enables mobiles to calculate their own location. The network may encrypt the location assistance information. If the location assistance information is encrypted, a single common standardized encryption algorithm shall be used.

The location assistance information may be available to the MS at all times, continuously in idle mode and during a call, without additional point to point signaling. The network may request location information from the MS for operator or for service provider applications. For this purpose a point to point signalling connection must be established.

4.~~12~~17 Mobile Originating Location

Mobile Originating Location is the capability of the mobile station to obtain its own geographical location or have its own geographic location transferred to another LCS client.

For Value Added Services, the following may be applicable:

There are three classes of mobile originating location:

A) Basic Self Location - The mobile station needs to interact with the network for each separate location request

B) Autonomous Self Location - The mobile station does not need to interact with the network for each separate location request. One interaction with the network enables the mobile station to obtain multiple location positionings over a predetermined period of time.

C) Transfer to Third Party – The location of the mobile station is transferred by request of the mobile station to another specified LCS client.

4.18 Velocity

<< text to be provided >>

<< editor's note: support for a velocity parameter in the position request response needs to be provided to efficiently enable some commercial services (vehicle tracking). Velocity is the combination of Speed and Heading (direction) of a Target UE as described in chapter 4.3.1 Horizontal Accuracy. >>

5 Logical Description

5.1 Logical Reference Model

Figure 1 shows the logical reference model for LCS whereby an LCS Client is enabled to request location information for one or more certain target MSs from the LCS Server supported by a PLMN. The LCS Server employs a positioning function to obtain the location information and furnish the information to the LCS Client. The particular requirements and characteristics of an LCS Client are made known to the LCS Server by its LCS Client Subscription Profile. The particular LCS-related restrictions associated with each Target MS are detailed in the Target MS Subscription Profile. The LCS feature shall allow a Target MS to be positioned within a specified Quality of Service. The LCS feature shall allow the location of a Target MS to be determined at any time whilst the MS is attached.

The LCS feature shall support conveyance of both the location Quality of Service (QoS) requirements of the LCS Client and the location information returned to the LCS Client in a universal standard format.

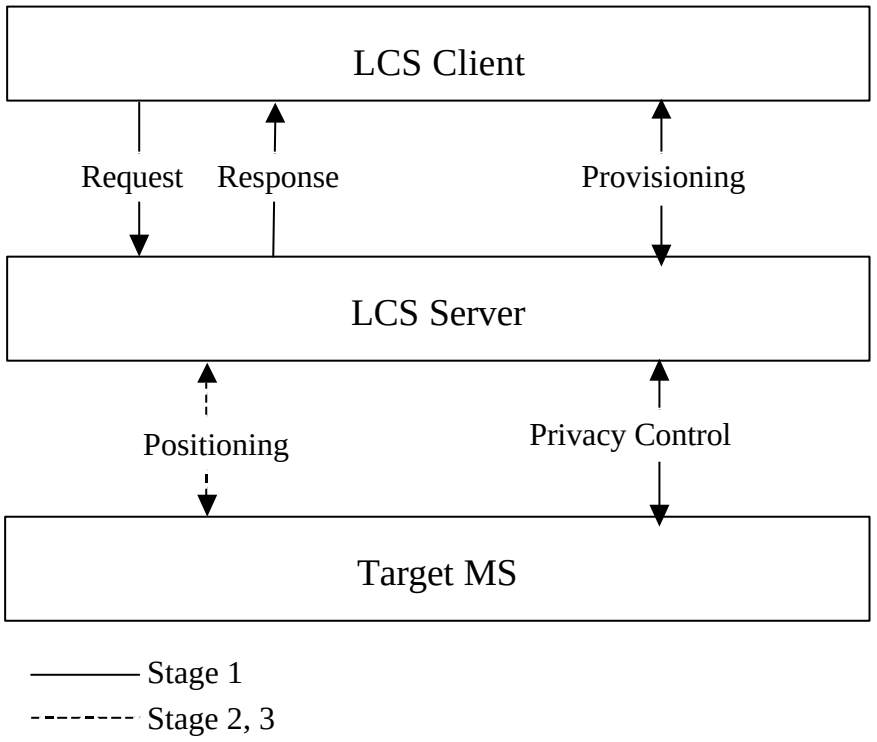

Figure 1. LCS Logical Reference Model

5.2 Functional Entities

5.2.1 LCS Client

An LCS Client is a logical functional entity that makes a request to the PLMN LCS server for the location information of one or more than one target MSs within a specified set of parameters such as QoS. The LCS Client may reside in an entity (including an MS) within the PLMN or in an entity external to the PLMN. The specification of the LCS Client's internal logic and its relationship to any external user is outside the scope of this document.

5.2.2 LCS Server

An LCS server consists of a number of location service components and bearers needed to serve the LCS clients. The LCS server shall provide a platform which will enable the support of location based services in parallel to other telecommunication services such as speech, data, messaging, other teleservices, user applications and supplementary services and therefore enable the market for services to be determined by users and service providers. The LCS server may respond to a location request from a properly authorized LCS client with location information for the target MSs specified by the LCS client if considerations of target MS privacy are satisfied. The LCS server may enable an LCS client to determine the services provided to it by the LCS server through a process of provisioning.

5.2.3 Positioning Function

Positioning is the basic function that performs the actual positioning of a specific target MS. The input to this function is a positioning request from a LCS Client with a set of parameters such as QoS requirements. The end results of this function are the location information for the positioned target MS.

5.2.4 Target MS

The Target MS is the object to be positioned by the LCS Server. For network based positioning methods, no support for LCS is required by the target MS. For mobile assisted and mobile based positioning methods, the target MS actively supports LCS. For all positioning methods, the ability to control privacy may be required to be given to the MS user for each location request and/or to the MS subscriber through subscription to satisfy local regulatory requirements (see the previous section on Privacy).

5.3 Functional Interfaces

5.3.1 LCS Client / LCS Server Interface

The LCS client/server use LCS messages to exchange information. Each LCS message contains a set of parameters.
In the case of MS Based positioning methods, if the LCS Client is located in the MS, then an internal LCS Client /LCS Server interface may be supported.

NOTE: Further regional/national specific interfaces between LCS clients and servers may need to be supported in addition to the interfaces described here.

5.3.2.1 Location Service Request

Using the Location Service Request, an LCS client communicates with the LCS server to request the location information for one or more target MSs within a specified set of quality of service parameters.
As shown in Table 1, a location service may be specified as immediate or deferred.

Table 1: Location Service Requests

Request Type	Response Time	Number of Responses
Immediate	Immediate	Single
Deferred	Delayed (event driven)	One or More

For Emergency Services, LCS shall support requests for the initial, the current (updated), or the last known position of an ME while a voice connection is established.

5.3.2.2 Location Service Response

The Location Service Response provides the result of an immediate Location Service Request from the LCS Server to the LCS Client.
A LCS response is either '*immediate*' or '*deferred*'. The LCS Request indicates the type of response the LCS Client wishes to receive. The two types of location response are described in table 2.

Table 2: Types of LCS Response

Response	Description
Immediate	A Location Response is referred to as 'immediate ', when a response to a request for location information is answered immediately (within a set time). The response shall be single and not dependent to any event.
Deferred	A Location Response is referred to as 'deferred', when a response to a request for location information is returned after the occurrence of an event specified by the LCS client. The response can be single or periodic.

5.3.2.3 Location Service Request Report

The Location Service Request Report provides the result of a deferred Location Service Request from the LCS Server to the LCS Client. The report is provided using a dialog between the LCS Client and the LCS Server that is initiated by the LCS Server.

5.4 Location information

5.4.1 Sources of location information

It shall be possible for the location determining process to make use of several sources of information in determining the location. Propagation and deployment conditions may limit the number or quality of measurements or additional measurements may be possible. Some ME may also have additional (independent) sources of position information. The LCS shall be capable of making use of the restricted or the extra information as appropriate for the service being requested.

6 Service Provision

6.1 Identification of a Target MS

For value added services, the following is applicable:
The LCS client shall identify a target MS using the MSISDN.
For PLMN operator services, the LCS client may identify a target MS using any of the following:

MISISDN

IMSI

An identifier internal to the PLMN
For emergency services (where required by local regulatory requirements), the LCS client may identify a target MS using any one of the following:

MSISDN

IMSI

NA-ESRK + (optionally) IMEI

6.2 Location Information Provided to the LCS Client

For value added services, the following is applicable:
The LCS Server shall provide, on request, the current or most recent geographic location (if available) of the Target MS or, if location fails, an error indication plus optional reason for the failure.
For PLMN operator services (where allowed by local regulatory requirements and restrictions on MS privacy), location related information for a particular target MS may be provided to a PLMN operator LCS client either on request or on the occurrence of an event in the LCS server that has been defined to equate to such a request.
For emergency services (where required by local regulatory requirements), location related information may be provided to an emergency services LCS Client either without any request from the client at certain points in an emergency services call (e.g. following receipt of the emergency call request, when the call is answered, when the call is released) or following an explicit request from the client. The former type of provision is referred to as a "push" while the latter is known as a "pull". In the case of a "pull", the emergency service LCS Client shall identify the Target MS as defined in section 6.1. Table 3 shows the information that may be provided to the client for either a "push" or a "pull".

Table 3: Location related information provided to an emergency services LCS Client

Type of Access	Information Items
Push	Current Geographic Location (if available) MSISDN IMSI IMEI NA-ESRK NA-ESRD State of emergency call – unanswered, answered, released (note 1)
Pull	Geographic location (note 2), either: Current location initial location at start of emergency call

NOTE 1: indication of call release means that any NA-ESRK will no longer identify the calling MS subscriber

NOTE 2: which type of location is required will be indicated by the LCS Client

6.3 LCS Client Subscription

It shall be possible for an LCS Client to subscribe to the LCS feature for third-party location with or without subscription to other services. A LCS Client may subscribe to one or more service providers' LCS feature in one or more PLMNs. The LCS Client Subscription Profile of a client may contain the range of QoS and subscriptions that the LCS Client is allowed to request.

For certain authorized LCS Clients internal to the PLMN, a subscription profile may be unnecessary. For these LCS Clients subscription to LCS feature is given implicitly as a result of subscription to an authorized PLMN service (e.g. supplementary services). These LCS Clients are empowered to access the LCS Server and request location information for a Target MS.

For emergency services, the subscription requirements to the LCS feature may not be needed.

6.4 Target MS Subscription

6.4.1 Privacy Subscription Options

It shall be possible for a Target MS Subscriber to subscribe to various types of privacy classes. The default treatment in the absence of the information to the contrary in the Target MS Subscription Profile shall be to assume that access is restricted to all LCS Clients (unless using privacy overriding, or otherwise overridden by local regulatory requirements). Privacy Attributes consist of:

Privacy Exception List: determines which LCS Clients and classes of LCS Clients may position a Target MS;

Privacy Override Indicator: determines applicability of the Privacy Exception List.

6.4.2 Privacy Exception List

To support privacy , the LCS Server shall enable each Target MS Subscriber to subscribe to a "privacy exception list" containing the LCS Client identifiers and classes of LCS Clients to which the MS's location may be provided. An empty privacy exception list shall signify an intent to withhold location from all LCS Clients. The classes that can be included are as follows.

? Universal Class: location services may be provided to all LCS Clients;

? Call-related Class: location services may be provided to any value added LCS client that currently has a temporary association with the Target MS in the form of an established voice or data call originated by the Target MS;

? Call-unrelated Class – location services may be provided to a particular value added LCS Client or particular group of value added LCS Clients – where each LCS Client or group of LCS Clients is identified by a unique international, e.g. E.164, number. For each identified LCS Client or group of LCS Clients, one of the following geographical restrictions shall apply:

a) Location request allowed from an LCS Client served by identified PLMN only;

~~a)~~b) Location request allowed from an LCS Client served in the home country only;

c) Location request allowed from any LCS Client;

PLMN Operator Class – location services may be provided by particular types of LCS clients supported within the HPLMN or VPLMN. The following types of clients are distinguished (see note):

? Clients broadcasting location related information to the MSs in a particular geographic area – e.g. on weather, traffic, hotels, restaurants;

a) O&M client (e.g. an Operations System) in the HPLMN

b) O&M client (e.g. an Operations System) in the VPLMN

c) Clients recording anonymous location information (i.e. without any MS identifiers) – e.g. for traffic engineering and statistical purposes

d) Clients enhancing or supporting any supplementary service, IN service, bearer service or teleservice subscribed to by the target MS subscriber.

NOTE: The definitions of the various PLMN operator categories may be supplemented by more precise language in contractual agreements both between MS subscribers and their home service providers and between individual network operators with inter-PLMN roaming agreements. Such classification of the PLMN operator categories is outside the scope of this specification.

6.4.3 Privacy Override Indicator

The privacy override indicator is applicable to lawful intercept and emergency services as allowed by local regulatory requirements. It is not applicable to value added and PLMN operator services. The Privacy Override Indicator shall be used to determine whether Subscriber Privacy of the Target MS subscriber should be overridden or not. This indicator will be set for certain special LCS Clients when it is justified. Each LCS Client shall be associated with a particular value of a position privacy override indicator during the LCS Client provisioning. The privacy override indicator is only valid when the LCS Server for the LCS client is located in the same country of the Target MS.

6.4.4 Subscription to Mobile Originating Location

The MS subscriber may subscribe to the following types of Mobile Originating Location (as defined in section 4):

A) Basic Self Location

B) Autonomous Self Location

C) Transfer to Third Party

6.5 Security

The LCS Server may authorize the LCS Client. There may be security mechanisms to authorize the LCS Client's request for locating a Target MS based on:

LCS Client access barring list(s),

PLMN/SP access barring list~~.~~,

Point of origin of a location request.

6.6 Charging

The LCS Server shall enable a PLMN to charge LCS Clients for the LCS features that the PLMN provides. . The information that the operator uses to generate a bill to an LCS Client is operator or service provider specific. The charging information may be collected both for the LCS Client and ~~to~~ for inter-network revenue sharing.
To support charging and billing for location services, additional information will need to be provided in call detail records.

Charging for value added location services may be provided on a transaction basis, periodically, or a mixture of both.

To support transaction based charging where applicable, service associated call detail records may need to include (as a minimum) the following additional information (depending on the specific service):

? Type and Identity of the LCS Client;

? Identity of the target MS;
? Results (e.g. success/failure, method used, position, response time, accuracy)
? Time Stamp;
? Type of coordinate system used.

7 Provisioning and Administration

7.1 Procedures for an LCS Client

These procedures are concerned with the LCS client's provisioning and administration to the LCS feature.

7.1.1 Provisioning

~~The provisioning~~ Provisioning is an action to make the LCS feature available to a subscriber.
Provisioning ~~The provision~~ may be:

- General: where the service may be made available to all subscribers without prior arrangements being made with the service provider (i.e. emergency calls).
- Pre-arranged: where the service is made available to an individual LCS Client only after the necessary arrangements have been made with the service provider.

7.1.2 Withdrawal

~~The w~~Withdrawal is an action taken by the service provider to remove ~~the~~ an available LCS feature from a LCS Client's subscription profile ~~access~~.
~~The w~~Withdrawal may be:

- General: where the LCS feature is removed from all LCS Clients.
- Specific: where the LCS feature is removed on an individual basis per LCS Client.

7.1.3 Invocation

~~The i~~Invocation is an action to invoke the LCS feature, taken by the LCS Client (e.g. issuing a location request) or automatically by the LCS server as a result of a particular condition (e.g. mobile originating emergency call, etc.).

7.2 Procedures for a Target MS

These procedures are concerned with a Target MS's privacy exception list.. For emergency services, provisioning and withdrawal for Target MSs may not apply.

7.2.1 Provisioning

Provisioning is an an action to make the privacy exception list with its privacy classes available to a Target MS. The provision may be:

- General: where the list is made available to all Target MS's without prior arrangements being made with the service provider. The list shall contain the default privacy class.
- Pre-arranged: where any extra privacy permission class (--granting permission to locate an MS Client) shall be capable of being independently provisioned for a target MS as agreed with the service provider for a certain contractual period.

7.2.2 Withdrawal

Withdrawal is an action taken by the service provider to remove an available privacy class from a target MS's PEL. ~~The w~~Withdrawal may be:

- General: where a privacy class is removed from all target MSs provided with this privacy class.
- Specific: where each of the privacy classes in the privacy exception list shall be independently withdrawn at the subscriber's request or for administrative reasons.

8 Interactions with Bearer and Teleservices and Other Services

LCS shall support location of any Target MS that is idle or has established a voice call.
Location of a Target MS that has a call using any other circuit switched teleservice or any other circuit switched bearer service is for further study.
Location of a GPRS terminal or an MS using SMS may be supported.
Provision of location services to assist supplementary services and CAMEL is outside the scope of this specification.
The operation of location services shall be independent of other services - including Number Portability, private numbering, CAMEL, supplementary services, teleservices, and bearer services.

9 Cross Phase Compatibility for R99

This section details the cross phase compatibility requirements relating to the service requirements in this document.
Note: when a change is introduced which affects the 3GPP specifications, it is said to be 'backward compatible' if existing equipment can continue to operate and perform correctly with equipment that conforms to the new implementation.

9.1 Compatibility With Existing Standards

Where the service and operational requirements in this document relate to a core network functionality, compatibility is required.
UTRAN LCS mechanisms shall be developed to maximise synergies with LCS earlier phases and shall hence support LCS Phase 2 enhancements.
<< editor's note: is clarification required, what are LCS Phase 2 enhancements? >>

9.2 Compatibility With Future Releases

It is envisaged that 3GPP standards will evolve beyond ~~R99~~R00, for example with the addition of new service requirements. The standards which define the technical implementation of ~~R99~~ R00 should be developed in such a way that it is practical to add the requirements in this section in a backward compatible manner.
Following chapters include requirements that are foreseen for future release.
<< editor's note: these need further consideration with respect to R00 (no longer future releases) >>

9.2.1 UTRAN support

UTRAN shall support, or at least be prepared for, important location services features in 3GPP Release 99. The measurement method(s) concluded to be feasible for UTRAN shall be selected and standardized in 3GPP Release 99. It shall be possible to enable the introduction of more positioning methods later, with minimum impact on systems in operation.
It shall be possible for the location service to be used by the majority of ME within the UTRAN area without compromising the radio transmission or the signalling capabilities of the radio system. The location service is not an occasional "emergency only" service.
It shall be possible for the location service to be used by both "active" ~~ME~~ UE and by "idle" ~~ME~~UE.

9.2.2 Location identification in UTRAN and/or UE ~~ME~~

When location identification is supported by UTRAN, the following apply,

1) UTRAN obtains ‘Area ID’ and/or geographic co-ordinates with uncertainty parameters for identification of the likely location of ME, to be sent to the NAS entity side of the CN (i.e., edge node) ‘Area ID’ represents either a radio access cell/sector or a geographic area. ‘Area ID’ is coded in the same format as Cell Global Identification (CGI).

2) It shall be possible to report the [estimated achieved] accuracy level of the location report as a resolution that will be limited by the accuracy capability of the local serving UTRAN and the capability of the ME. Note that certain effects, such as multipath propagation, may lead to one-sided errors and thus a non-circular location error zone is likely.

3) Location information is always at least obtained from UTRAN by the appropriate edge node(s) at the activation of a Call/PDP Context. A mechanism to make it possible to obtain the location information at the release of a Call/PDP Context should be specified. Location information sent to the edge node at other occasions is on the basis of asynchronous requests from the edge node to UTRAN. An edge node can request UTRAN to send the location information with the two types of requests, Type 1 (Direct request) where UTRAN sends location information only

once at the request and Type 2 (Event request) where UTRAN sends location information at each specified event (e.g. Cell Update) requested by the edge node.

9.2.3 Quality level negotiation

It shall be possible for the LCS Client to specify or negotiate a (minimum) level of quality, such as accuracy, in a ME location information request. Different applications demand different levels of positioning accuracy and other positioning performance parameters, so the levels of performance should be classified according to the type of applications. The quality of location information can involve parameters like accuracy, update frequency, time stamp, time-to-first-fix, reliability, continuity, etc in a feasible way. The quality of the generated location information can exceed the required level. In case location information is not available to the required quality level , the request can either be denied and the service execution terminated, or the user accepts the lower quality information. The quality level requirement of each service (application) could be set both by the subscriber and the service provider.
It shall be possible to select the repetition rate of the location information update. The reports may be distributed to different clients at different rates.

9.2.4 Defined geographical areas

It shall be possible to specify a geographical area as ellipse to a resolution that will be limited by the accuracy capability of the part of the serving network where the user is registered.
It may be possible to identify and report when the user's terminal enters or leaves a specified geographic area.
In order to enable ME to determine itself if it enters or leaves a defined geographical area information about the defined geographical area shall be made available to client. The method is FFS, one alternative is that cells covering parts of the geographical area broadcasts information about the geographical area.

9.2.5 Continuous check of location

The client may continuously check its current location with or without requesting signalling support from the network using the Self Location feature. In this way the client may become aware of entering or leaving a predefined geographical area, as defined above, and/ or it can supply the user or an application with real-time tracking information.

9.2.6 Identification of a Target MS

In future releases support usage of IP addresses for MS identification shall be supported by the standard.9.2.7 PS Services
LCS shall support location services for packet switched services in future releases.

9.2.~~8~~ 7 VHE

LCS shall support VHE 22.121 [7]. Specifically negotiation of parameters shall be done using VHE service capability features.

Annex A (Informative): USA FCC Wireless E911 Rules

Action was taken by the FCC on September 15, 1999, with respect to E911 location technology by the Third Report and Order (FCC 99-245).The FCC has adopted the following revisions to its wireless E911 rules:

? Wireless carriers who employ a Phase II location technology that requires new, modified or upgraded handsets (such as GPS-based technologies) may phase-in deployment of Phase II subject to the following requirements:
- Without respect to any PSAP request for Phase II deployment, the carrier shall:
    1. Begin selling and activating ALI-capable handsets no later than March 1, 2001;
    2. Ensure that at least 50 percent of all new handsets activated are ALI-capable no later than October 1, 2001; and
    3. Ensure that at least 95 percent of all new digital handsets activated are ALI- capable no later than October 1, 2002.
- Once a PSAP request is received, the carrier shall, in the area served by the PSAP:

Within six months or by October 1, 2001, whichever is later:
    1. Ensure that 100 percent of all new handsets activated are ALI-capable;
    2. Implement any network upgrades or other steps necessary to locate handsets; and
    3. Begin delivering to the PSAP location information that satisfies Phase II requirements.

Within two years or by December 31, 2004, whichever is later, undertake reasonable efforts to achieve 100 percent penetration of ALI-capable handsets in its total subscriber base.

? For roamers and other callers without ALI-capable handsets, carriers shall support Phase I ALI and other available best practice methods of providing the location of the handset to the PSAP.

? To be allowable under the FCC rules, an ALI technology that requires new, modified, or upgraded handsets shall conform to general standards and be interoperable, allowing roaming among different carriers employing handset-based location technologies.

? For carriers employing network-based location technologies, the FCC replaces its current plan, which requires that implementation be fully accomplished within 6 months of a PSAP request, with a revised rule requiring the carrier to deploy Phase II to 50 percent of callers within 6 months of a PSAP request and to 100 percent of callers within 18 months of such a request.

? The FCC adopts the following revised standards for Phase II location accuracy and reliability:

? For network-based solutions: 100 meters for 67 percent of calls, 300 meters for 95 percent of calls;

? For handset-based solutions: 50 meters for 67 percent of calls, 150 meters for 95 percent of calls.

? The FCC directs wireless carriers to report their plans for implementing E911 Phase II, including the technology they plan to use to provide caller location, by October 1, 2000. This report shall provide information to permit planning for Phase II implementation by public safety organizations, equipment manufacturers, local exchange carriers, and the FCC, in order to support Phase II deployment by October 1, 2001.

Annex B (Informative): Descriptions of Possible Location Based Services

1 Public Safety Services

Service providers offer these location-based services for the good of the public. They are made available without requiring pre-subscription.

1.1 Emergency Services

Specific consideration of mandated Emergency Services is outside the scope of this specification. Such requirements may be regionally or nationally specific.

1.1.1 Attributes

Specific consideration of the attributes for mandated Emergency Services is outside the scope of this specification. However, the current requirements specified by the U.S. FCC Phase II Mandate may be useful as an example.

> The FCC's Third Report and Order (FCC 99-245) in the matter of revision of the commission's rules to ensure compatibility with Enhanced 911 Emergency Calling Systems (CC Docket No. 94-102 RM-8143), adopted September 15, 1999, states:
> *We adopt the following revised standards for Phase II location accuracy and reliability:*
>
> - *For network-based solutions: 100 meters for 67% of calls, 300 meters for 95 percent of calls;*
> - *For handset-based solutions: 50 meters for 67% of calls, 150 meters for 95 percent of calls.*

The network should be sufficiently flexible to accommodate evolving enabling mechanisms and service requirements to provide new and improved services.

1.1.2 Emergency Alert Services

Emergency Alert Services may be enabled to notify wireless subscribers within a specific geographic location of emergency alerts. This may include such alerts as tornado warnings, pending volcano eruptions, etc.

No requirements currently exist for Emergency Alert Services, and they may be considered for further study.

2 Location Based Charging

Location Based Charging allows a subscriber to be charged different rates depending on the subscriber's location or geographic zone, or changes in location or zone. The rates charged may be applicable to the entire duration of the call, or to only a part of call's duration. This service may be provided on an individual subscriber basis, or on a group basis.

For example, when provided on an individual basis this service could apply reduced rates to those areas most often frequented by the subscriber by taking into consideration the subscriber's daily route and life style. Different rates may be applied at country clubs, golf courses, or shopping malls. For example, a "home" zone may be defined which is centered around a user's home, an agreed larger area, work or travel corridor or some unrelated zone. The zone may vary in size and shape from a cell (or sector) coverage area to a precisely defined polygon completely independent of cell coverage.

Additionally, different rates may be applied in different zones based on the time of day or week.

In addition to being applicable on an individual basis, this service may be applicable on a group basis, which may be desirable for example, for business groups. Locations may be defined for business groups to include corporate campuses, work zones or business zones with different tiers of charging rates.

Individual and group subscribers should be notified of the zone or billing rate currently applicable, and be notified when the rate changes. Location Based Charging may be invoked upon initial registration. A charging zone would then be associated with the subscriber's location. When the subscriber moves to a different zone, the subscriber would be notified.

This service should be transparently provided to the subscriber (i.e. independent of existing voice calls, data, or other services being provided).

2.1 Attributes

Normal service operation includes invocation upon initial registration, autonomous registration, call origination, and call termination. Location-Based Charging should analyze location information to compare against service zones established for the subscriber. The service would notify the subscriber of their relative location to the established service zone, indicating either "in" or "out" of zone. As the subscriber changes location or predefined location service area they should be notified of their location-based charging service opportunity, being "in" or "out" of a subscribed zone. Except for subscriber notification, the user should experience transparency in interaction with other services (Voice, Data, SMS, etc).

This service may, as an option, be activated/de-activated using special feature codes on a subscriber or business customer basis.

2.1.1 Target Subscriber Notification

The user needs to be informed on an ongoing basis which zone and billing rate is currently applicable.

Users should be enabled to make an informed decision on expected call charges and therefore need to be provided charging zone information accurately, and in a timely manner, being notified which zone they are in when a call is set up. Notification to the subscriber/user could be provided in several forms including tone, announcement, or short message.

The billing system will need to consider the following possible scenarios:

1. For the duration of the call, the subscriber remains in a single charging zone
2. During the call, the charging zones may change
   - 2.1. The user may initiate a call in one zone, then move to a different zone where the call is terminated.
   - 2.2. The user may cross back and forth between zones multiple times during the duration of a call, and the call may terminate in the zone it was originated from, or in a different zone.

Notification to the user may be via the MS MMI prior to initiation of the call and, during the call.

2.1.2 Charging

To support appropriate charging, call detail records may need to include the following additional information:

1. Location Service (Location Based Charging) Identification
2. Location Information
3. **Zone Information**
4. Type of Event
5. Duration of Event

2.1.3 Roaming

If a subscriber with active location based charging roams into a system that does not support the service, the subscriber may be notified of an "out of coverage zone" notification using the best possible method (MS display, SMS, etc.).

3 Tracking Services

Although Fleet and Asset Management services may be offered as separate services, within this document they are described as a single service category. In a similar manner, Person Tracking may be viewed as a form of personal asset tracking.

3.1 Fleet and Asset Management Services

Fleet and Asset Management services allow the tracking of location and status of specific service group users. Examples may include a supervisor of a delivery service who needs to know the location and status of employees, parents who need to know where their children are, animal tracking, and tracking of assets.

The service may be invoked by the managing entity, or the entity being managed, depending on the service being provided.

Fleet Management may enable an enterprise or a public organization to track the location of vehicles (cars, trucks, etc.) and use location information to optimize services.

Asset management services, for example, may range from asset visualization (general reporting of position) to stolen vehicle location and geofencing (reporting of location when an asset leaves or enters a defined zone). The range of attributes for these services is wide.

For Fleet and Asset Management services, a distinction may be made between the manager of the fleet/assets in charge of tracking, and the entities being tracked (service group users, etc). The tracking service may make use of mobile station handsets with possible specialized functions (Web browsers, etc) to allow for tracking and specific methods for communicating with the managing entity. A managing entity would be able to access one or several managed entities' location and status information through a specified communication interface (Internet, Interactive Voice Response, Data service, etc). The managing entity would be able to access both real-time and recent location and status results of managed entities.

The network shall provide the capability to provide the last known location and timestamp. In cases where the service group user's mobile station is not registered (i.e. Inactive, out of coverage) the last known location information and timestamp may optionally be provided. If this information is unavailable in real-time, a reason for why the information is unattainable may be provided. The managing entity may also be able to relay messages to service group users through the appropriate interface, as well as receive messages originated by the service group users.

Activation of Fleet and Asset Management services could be performed via subscriber provisioning by the service provider, as well as by offering subscriber-based service activation codes to the service group user/subscriber. The managing entity could also initiate service via requests to a provisioning system through Interactive Voice Response or Internet request. A feature code may optionally also be provided to allow for specific mobile user group subscriber activation by the managing entity (*FC + Mobile ID). A specific user group mobile could also be able to self-activate through the use of a feature code.

3.2 Traffic Monitoring

Mobiles in automobiles on freeways anonymously sampled to determine average velocity of vehicles. Congestion detected and reported.

Congestion, average flow rates, vehicle occupancy and related traffic information can be gathered from a variety of sources including roadside telematic sensors, roadside assistance organizations and ad-hoc reports from individual drivers. In addition average link speeds can be computed through anonymous random sampling of MS locations.

3.2.1 Attributes

3.2.1.1 Privacy

Anonymous sampling of target MS requires all unique information relating to the MS location to be retained by the network operator. Depending on the capabilities of the location method (ref. section 3.4) traffic behavior described above can only be determined if an MS is sampled at least twice within a finite predetermined period.

The MS identification must be sufficiently unique to allow time separated measurements to be paired before discarding the source MS identification.

The level of uniqueness can be a highly truncated form of the MS-IMSI (or equivalent). For example maintaining 1000 unattached location estimates for subsequent pairing with future estimates will only require 3 least significant digits of the IMSI. Ambiguity in matching will occur but at a low (detectable) rate. Finally, all unattached estimates can be set to expire after a preset time.

4 Enhanced Call Routing

Enhanced Call Routing (ECR) allows subscriber or user calls to be routed to the closest service client based on the location of the originating and terminating calls of the user. The user may optionally dial a feature or service code to invoke the service (*GAS for closest gas station, etc).

In addition to routing the call based on location, ECR should be capable of delivering the location information to the associated service client. For example, this capability may be needed for services such as Emergency Roadside Service. This could be used for the purpose of dispatching service agents for ECR service clients that can make use of this information.

ECR services may be offered, for example, through menu driven access allowing users to interactively select from a

variety of services.

5 Location Based Information Services

Location-Based Information services allow subscribers to access information for which the information is filtered and tailored based on the location of the requesting user. Service requests may be initiated on demand by subscribers, or automatically when triggering conditions are met, and may be a singular request or result in periodic responses.

The following subsections provide some examples of possible location based information services.

5.1 Navigation

The purpose of the navigation application is to guide the handset user to his/her destination. The destination can be input to the terminal, which gives guidance how to reach the destination. The guidance information can be e.g. plain text, symbols with text information (e.g. turn + distance) or symbols on the map display. The instructions may also be given verbally to the users by using a voice call.

Note: this may involve a service provider giving verbal directions to a lost motorist, or providing periodic short text messages (possibly using SMS), in addition to, or as an alternative to the provision of a graphic map.

This can be accomplished through carrying a GSM mobile phone that has location technology capabilities down to a few feet. Less granularity impedes the applicability of this functionality.

This service can either be menu driven from a handset using SIM Application Toolkit or a WAP based terminal with a map application running – similar to a GPS system. A central server may handle all mapping of locations, and may save specific locations (i.e., favorite fishing holes).

5.2 City Sightseeing

City Sightseeing would enable the delivery of location specific information to a sightseer. Such information might consist of combinations of the services described throughout this document to describe historical sites, providing navigation directions between sites, facilitate finding the nearest restaurant, bank, airport, bus terminal, restroom facility, etc.

5.3 Location Dependent Content Broadcast

The main characteristic of this service category is that the network automatically broadcasts information to terminals in a certain geographical area. The information may be broadcast to all terminals in a given area, or only to members of specific group (perhaps only to members of a specific organization). The user may disable the functionality totally from the terminal or select only the information categories that the user is interested in.

An example of such a service may be localized advertising. For example, merchants could broadcast advertisements to passersby based on location / demographic / psychographic information (for example "today only, 30% off on blue jeans").

5.4 Mobile Yellow Pages

The internet has also changed how people find phone numbers. Instead of thumbing through the yellow pages or calling Directory assistance you simply go online and search the number. The need for paper copy phonebooks is gone. Wireless takes this one step further by adding the location of the subscriber to the search. Now the phone number of the nearest location can be ascertained as opposed to all locations within a 50-mile area.

Mobile Yellow Pages services provide the user with the location of the nearest service point, e.g. Italian restaurant. The result of the query may be a list of service points fulfilling the criteria (e.g. Italian restaurants within three kilometers). The information can be provided to the users in text format (e.g. name of the restaurant, address and telephone number) or in graphical format (map showing the location of the user and the restaurants).

5.5 Location Sensitive Internet

Location Sensitive Internet is for further study.

6 Network Enhancing Services

The Network Enhancing Services described in this section are for further study and privacy issues will require further consideration.

6.1 Applications for Network Planning

The network operator may be able to use location information to aid network planning. The operator may be able to locate calls in certain areas to estimate the distribution of calls and user mobility for network planning purposes. These applications may be used for hot spot detection and user behavior modeling

6.2 Applications for Network QoS Improvements

The network operator may be able to use location services to improve the Quality of Service of the network. The location system may be used to track dropped calls to identify problematic areas. The system may also be used to identify poor quality areas.

6.3 Improved Radio Resource Management

The location of the handset may be used for more intelligent handovers and more efficient channel allocation techniques.

Appendix C (Informative): Attributes of Specific Services

The following table (provided by the GSM Alliance Services Working Group) depicts ranges of values that may be expected for various attributes of location based services.

Requirement -> Service Category	Service Authorization	Privacy	Target Subscriber Notification	Horizontal Accuracy	Vertical Accuracy	Response Time	Reliability	Security	Periodic Location Reporting	Service Registration	Service Activation	Service De-Activation	Service Invocation	Roaming	Service Specific Considerations
Public Safety Services															
Emergency Services	None req'd	Implied when dialing 911 info provided to safety organizations	Not required	Network based: 100m (67%) 300m (95%) Handset based: 50m (67%) 150m (95%)	n/a now (5-15m future?)	5 sec.	Same as GSM	Same as GSM	Required Period TBD suggest 1-10 minutes	None req'd	None required	Not Allowed	Keystroke or Dialed string (911)	Required if emergency call can be made	
Emergency Alert Services	Req'd	Info only passed to subscribed to service provider	Not required	125 m (10 m future?)	n/a now (5-15m future?)	5 sec.	Same as GSM	Same as GSM	Required Period TBD suggest 1-10 minutes	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Automatic	Preferred where roaming is allowed	
Location Sensitive Charging															
Home-Zone Billing	Req'd	Info only passed to subscribed to carrier	Not required	Depends on billing zone (5m-300m)	n/a	Depends on increments of billing.	Same as GSM	Same as GSM	Required depends on billing increment and coverage zone	Req'd	Interactive with Carrier	Interactive with Carrier	Automatic	n/a	
Tracking Services															

Requirement -> Service Category	Service Authorization	Privacy	Target Subscriber Notification	Horizontal Accuracy	Vertical Accuracy	Response Time	Reliability	Security	Periodic Location Reporting	Service Registration	Service Activation	Service De-Activation	Service Invocation	Roaming	Service Specific Considerations
Fleet Mgment.	Req'd	Info only passed to subscribed to service provider	Not required	125m-Cell ID	n/a	5 sec.	Same as GSM	Same as GSM	Required (1-10 minutes)	Req'd	Interactive or live operator	Interactive or live operator	Interactive or live operator	Preferred where roaming is allowed	
Asset Mgment	Req'd	Info only passed to subscribed to service provider	Not required	10m-125m	n/a (5-15m future?)	5 sec.	Same as GSM	Same as GSM	Required (1-10 minutes)	Req'd	Interactive or live operator	Interactive or live operator	Interactive or live operator	Preferred where roaming is allowed	Special Terminal

Requirement -> Service Category	Service Authorization	Privacy	Target Subscriber Notification	Horizontal Accuracy	Vertical Accuracy	Response Time	Reliability	Security	Periodic Location Reporting	Service Registration	Service Activation	Service De-Activation	Service Invocation	Roaming	Service Specific Considerations
Person Tracking	Req'd	Info only passed to subscribed to service provider	May be required (Child versus Employee?)	10m-125m	n/a (5-15m future?	5 sec.	Same as GSM	Same as GSM	Required (1-10 minutes)	Req'd	Interactive or live operator	Interactive or live operator	Interactive or live operator	Preferred where roaming is allowed	
Pet Tracking	Req'd	Info only passed to subscribed to service provider	Not required	10m-125m	n/a (5-15m future?	5 sec.	Same as GSM	Same as GSM	Required (1-10 minutes)	Req'd	Interactive or live operator	Interactive or live operator	Interactive or live operator	Preferred where roaming is allowed	Special Terminal
Traffic Monitoring															
Traffic Congestion Reporting	Req'd	No specific Target MS info allowed	Not required	10-40m Hi- res. req'd muti- near proximity lanes (opposing and adjacent)	May be req'd for over-passes	5 sec.	Same as GSM	Same as GSM	Required (1-2 minutes)	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	High bandwidth req on network.
Enhanced Call Routing															

Requirement -> Service Category	Service Authorization	Privacy	Target Subscriber Notification	Horizontal Accuracy	Vertical Accuracy	Response Time	Reliability	Security	Periodic Location Reporting	Service Registration	Service Activation	Service De-Activation	Service Invocation	Roaming	Service Specific Considerations
Routing to Nearest Commercial Enterprise	Req'd	Info only passed to subscribed to service provider	Not required	10m-125m	n/a	5 sec.	Same as GSM	Same as GSM	Not required	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	
Roadside Assistance	Req'd	Info only passed to subscribed to service provider	Not required	10m-125m	n/a	5 sec.	Same as GSM	Same as GSM	Not required	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	
Location Based Information Services															
Navigation	Req'd	Info only passed to subscribed to service provider	Required	10m-125m	n/a	5 sec.	Same as GSM	Same as GSM	Required (1-10 minutes)	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	

Requirement -> Service Category	Service Authorization	Privacy	Target Subscriber Notification	Horizontal Accuracy	Vertical Accuracy	Response Time	Reliability	Security	Periodic Location Reporting	Service Registration	Service Activation	Service De-Activation	Service Invocation	Roaming	Service Specific Considerations
City Sightseeing	Req'd	Info only passed to subscribed to service provider	Not required	10m-125m	n/a	5 sec.	Same as GSM	Same as GSM	Not required	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	
Localized Advertising	Req'd	Info only passed to subscribed to service provider	Not required	125m-Cell ID	n/a	Not sensitive (default to 5 sec.)	Same as GSM	Same as GSM	Not required	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	
Mobile Yellow Pages	Req'd	Info only passed to subscribed to service provider	Not required	125m-Cell ID	n/a	5 sec.	Same as GSM	Same as GSM	Not required	Req'd	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	By menu, keystroke, interactive or live operator	Preferred where roaming is allowed	
Service Provider Specific Services															
Network Planning	Not Req'd	Specific Target MS info allowed	Not Required	10m-Cell ID	n/a	5 sec.	Same as GSM	Same as GSM	Required (1 minute)	Not Req'd	N/a	n/a	n/a	n/a	
Dynamic Network Control	Not Req'd	Specific Target MS info allowed	Not Required	10m-Cell ID	n/a	5 sec.	Same as GSM	Same as GSM	Required (1 minute)	Not Req'd	N/a	n/a	n/a	n/a	

Annex ~~B~~D:
Change history

Change history						
TSG SA#	**Spec**	**Version**	**CR**	**<Phase>**	**New Version**	**Subject/Comment**
Jun 1999	GSM 02.71	7.0.0				Transferred to 3GPP SA1
SA#04	22.071				3.0.0	
SA#05	22.071	3.0.0	001rev1 002 003 004	R99	3.1.0	Changes to the LCS stage 1 to add support for mobile originated positioning requests as a service parameter. U.S. specific Emergency Services accuracy requirements removed. LCS UMTS requirements LCS accuracy clarifications Editorial update of references for GSM/3GPP use.
SA#06	22.071	3.1.0	005	R99	3.2.0	U.S. specific Emergency Services requirements included as an informative annex.

History

Document history		
V3.0.0	August 1999	Transferred to TSG SA at ETSI SMG#29. Under TSG TSG SA Change Control.
V3.1.0	October 1999	Inclusion of CRs at #05
V3.2.0	December 1999	Inclusion of CRs approved at #06