ETSI TR 122 935 V10.0.0 (2011-05)

Technical Report

Digital cellular telecommunications system (Phase 2+);
Universal Mobile Telecommunications System (UMTS);
LTE;
Feasibility study on Location Services (LCS)
for Wireless Local Area Network (WLAN) interworking
(3GPP TR 22.935 version 10.0.0 Release 10)

Reference
RTR/TSGS-0122935va00

Keywords
GSM, LTE, UMTS

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Sous-Préfecture de Grasse (06) N° 7803/88

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Foreword

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The present document may refer to technical specifications or reports using their 3GPP identities, UMTS identities or GSM identities. These should be interpreted as being references to the corresponding ETSI deliverables.

The cross reference between GSM, UMTS, 3GPP and ETSI identities can be found under http://webapp.etsi.org/key/queryform.asp.

Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.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.
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Introduction

The objective of this feasibility study is to outline the technical requirements, scope of work required, and perform a gap analysis to determine whether existing 3GPP specifications can support LCS requirements for 3GPP WLAN interworking. If it is determined that providing for this service is feasible, then this feasibility study will continue forward to encompass future work.

1 Scope

The 3GPP has developed and continues to develop Location Services (LCS) requirements and standards for GSM and UMTS. To further the advancement of LCS within the 3GPP, LCS requirements and standards may be extended for 3GPP WLAN interworking to support the same location-based services that have been deployed today for GSM and UMTS. LCS with 3GPP WLAN Interworking system is considered to enlarge the area of location services.

The purpose of the feasibility study is to study a generic interworking functionality for LCS between 3GPP system and WLAN systems (e.g. IEEE 802.11 family, HIPERLAN/2, …). Specifically, the feasibility study aims to:

- Study the LCS requirements for 3GPP WLAN Interworking scenarios.
- Study the different possible LCS architectures for interworking.

Also, the feasibility study will:

- Assess the service requirements for support of LCS over I-WLAN
- Define the MMI aspects, i.e., the minimum set of functions to support LCS when the choice of access system by the user and/or terminal for when both access systems is available.
- Assess the charging requirements and architecture impacts. In particular, consider whether or not WLAN charging for LCS should be integrated with the architecture for UMTS charging for LCS.
- Assess the security requirements, given the prerequisite that a) the security level of the UMTS platform itself is not impacted, b) the security level provided to users in the WLAN mode is comparable to the one of UMTS.

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. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document.*

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TS 23.032: "Universal Geographical Area Description".

[3] 3GPP TS 22.101: "Service principles".

[4] 3GPP TS 22.105: "Services and Service Capabilities".

[5] 3GPP TS 22.115: "Charging and Billing".

[6] Open Mobile Alliance (OMA): OMA-RD-Parlay_Service_Access-V1_0-20100427-A

[7] 3GPP TS 23.110: " UMTS Access Stratum; Services and Functions".

[8] 3GPP TS 22.071: " Location Services (LCS); Service Description; Stage 1".

[9] 3GPP TS 23.271: "Functional Stage 2 description of Location Services (LCS)".

[10] 3GPP TS 22.234: "Requirements on 3GPP system to Wireless Local Area Network (WLAN) interworking".

[11] 3GPP TS 22.934: "Feasibility study on 3GPP system to Wireless Local Area Network (WLAN) interworking".

[12] 3GPP TS 23.234: "3GPP system to Wireless Local Area Network (WLAN) interworking; System description".

[13] 3GPP TR 23.934: "3GPP system to Wireless Local Area Network (WLAN) interworking; Functional and architectural definition".

[14] 3GPP TS 25.305: "Stage 2 functional specification of User Equipment (UE) positioning in UTRAN".

[15] Open Mobile Alliance, OMA-RD-SUPL "Secure User Plane Requirements".

[16] Open Mobile Alliance, OMA-AD-SUPL "Secure User Plane Architecture".

[17] Open Mobile Alliance, OMA-TS-SUPL "User Plane Location Protocol".

3 Definitions and abbreviations

3.1 Abbreviations

For the purposes of the present document, in addition to 3GPP TR.21.905, the following abbreviations apply:

3GPP	Third Generation Partnership Project
AAA	Authentication, Authorization, Accounting
AP	Access Point
GMLC	Gateway Mobile Location Centre
I-WLAN	Interworking WLAN
LCS	Location Service
UE	User Equipment

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:

Change of Area: is one event supported for deferred Location Requests. Change of Area means that the network is required to report the location or the occurrence of the event of the requested subscriber in triggered fashion immediately after the network (MSC/SGSN) processes the mobility event for the new location of the subscriber. Usually new location is noticed after the Location Update, Handover, RAU, Registration or RANAP Location Report, e.g. when the SAI changes.

Codeword: access code, which is used by a Requestor or LCS Client in order to gain acceptance of a location request for a Target UE. The codeword is part of the privacy information that may be registered by a Target UE user.

Current Location: after a location attempt has successfully delivered a location estimate and its associated time stamp, the location estimate and time stamp are referred to as the 'current location' at that point in time.

Deferred location request: a location request where the location response (responses) is (are) required after specific event has occurred. Event may or may not occur immediately. In addition event may occur many times.

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 UE 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). The LCS Client is identified by a unique international identification, e.g. E.164.

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 UEs.

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.

Service Identifier: A service provided by an LCS Client is identified by a Service Identifier. One LCS client may have one or more services. The combination of the LCS client Identifier and the Service Identifier constitute a unique identification of a service.

Location Estimate: the geographic location of a UE 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.

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 UE. The permission shall be granted either on activation by the target UE or permanently for a contractual period of time agreed between the target UE 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 UE being positioned.

Requestor: an originating entity, which has requested the location of the target UE from the LCS client.

Target UE: The UE being positioned.

Target UE Subscription Profile: the profile detailing the subscription to various types of privacy classes.

UE available: deferred Location Request event in which the MSC/SGSN has established a contact with the UE. Note, this event is considered to be applicable when the UE is temporarily unavailable due to inaction by the UE user, temporarily loss of radio connectivity or IMSI detach and so on. Note that IMSI detach is only applicable in the case UE has previously been registered and information is still kept in the node.

4 Main concepts

This clause covers the main concepts of providing location services for I-WLAN within 3GPP systems.

4.1 Benefits of LCS for I-WLAN

WLAN-based public hotspots are experiencing phenomenal growth. The areas covered by these hotspots include airports, hotels, shopping malls, coffee houses, and other public areas. The intent of 3GPP-WLAN interworking is to extend 3GPP services and functionality to the WLAN access environment. LCS is one of the functionalities developed by 3GPP for GSM and UMTS.

Subscribers will soon get used to LCS as a part of their cellular service capabilities. Though the primary objective of I-WLAN access is for higher speed data access, subscribers will expect to get LCS functionality from I-WLAN. As voice services using IP transport become more prevalent, subscribers may not know if the voice call is over the I-WLAN or over cellular networks. Many of the location services that are available in the cellular subscription will have a similar appeal in the confines of I-WLAN coverage areas. Examples include finding the nearest coffee shop in a large shopping mall or the nearest souvenir shop in an airport. Another example is the need to support location information for emergency calls made over I-WLAN.

From an operator's perspective, LCS in I-WLAN offers opportunities for additional revenue from value added services from LCS clients. These clients include subscribers as well as non-subscribers to other services. LCS may also serve to enhance or support certain O&M related tasks, supplementary services, and IN-related services. An operator may be mandated to have LCS to support emergency calls from I-WLAN service areas. LCS may also be used to support lawful interception. LCS capability may become a service differentiator when multiple I-WLAN operators compete in a given area.

Third party providers and merchants will require LCS capability for proximity marketing. LCS may also benefit third parties from offering value added services to end subscribers.

4.2 LCS Applications for I-WLAN

Wireless service providers are deploying wireless broadband data services based on UMTS and I-WLAN. As a commercial, value-added service, wireless service providers are deploying location services within their 3GPP networks. By combining location services with I-WLAN, wireless service providers may generate additional revenues from their investments in 3GPP location services and I-WLAN.

In mentioning this opportunity, the question that often arises is "What commercial location services are possible with I-WLAN?" This clause outlines use cases for three types of commercial location services for I-WLAN. One, the commercial location services for I-WLAN can be taken directly from the services planned for 3GPP networks. Two, coupling location with presence technology being used by an I-WLAN user is another natural extension of commercial location services for the instant messaging (IM) industry. Three, bringing a product or service advertisement to a consumer at the right time and the right place has always been the goal of the advertising industry. To help meet its goal, the advertising industry can leverage location-based advertising for consumers using I-WLAN.

4.2.1 Leverage of today's Location Services

Many of the location services planned for today's 3GPP networks would be of value to the I-WLAN customer. One example is the location service called "find-the-nearest-shop." This service would find the find the nearest, most convenient restaurant, bar, or place to shop. The "find-the nearest-shop" service could even provide detailed directions to help the I-WLAN user to quickly get to their lunch meeting.

Besides the "find-the-nearest" service, other possible location services planned [8] for 3GPP networks that could be extended to I-WLAN:

Tracking Fleet Management: enables an enterprise or a public organization to track the location of vehicles (cars, trucks, etc.) and use location information to optimize services. Asset Management: 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). People Monitoring: track the location of a person/child and geofencing. **Information Services -** allow subscribers to access information for which the information is filtered and tailored based on the location of the requesting user. Navigation: guide the handset user to his/her destination. Sightseeing: enable the delivery of location specific information to a sightseer. Mobile Yellow Pages: provide the user with the location of the nearest service point, e.g. Italian restaurant. Dating and games: provide location of user for gaming and dating. **Public Safety -** Service providers offer these location-based services for the good of the public. Emergency Services: E911, E112. Community Notification: notify wireless subscribers within a specific geographic location of emergency alerts. This may include such alerts as tornado warnings, pending volcano eruptions, etc.	**Network Enhancing** Network Planning: locate calls/connections in certain areas to estimate the distribution of calls/connections and user mobility for network planning purposes. These applications may be used for hot spot detection and user behavior modelling. Radio Resource Management: more intelligent handovers and more efficient WLAN channel allocation techniques. Network QoS: track dropped calls/connections to identify problematic areas. The system may also be used to identify poor quality areas. **Examples:** Hot spot location: learn the locations of where users access an I-WLAN. Tracking of dropped calls/connections: identify where users experience dropped calls/connection. **Location Based Charging** Communications Services Rate Setting: allows a subscriber to be charged different rates depending on the subscriber's location or geographic zone, or changes in location or zone. Usage Rate Setting: users are billed for access to public parks or theme parks based on their location. Users may be charged for tolls based on their location.

4.2.2 Additional Location Services with WLAN

I-WLAN may enable additional location services for commercialization. An example is the merging of presence information with the location of an I-WLAN terminal. In this example users of IM want to know when their friends are reachable with IM. Presence services tell users that their friends are ready to chat via IM. Often times the IM conversations include the exchanges of "Where are you?" to find whether their friend is at home or in a coffee house.

By adding location services to presence information, I-WLAN users can tell their friends where they are, instantly and automatically. For example, an I-WLAN user is within a very busy coffee shop and chatting via IM with a friend. The presence and location information delivered to the friend allows her to find that the I-WLAN user is in the coffee shop. Now knowing that the I-WLAN is in the coffee shop, the friend asks about the daily specials. Finding that her favorite flavored coffee is on special, the friend decides to go have a special coffee and meet with the I-WLAN user in the coffee shop. Location services for I-WLAN make it happen by instantly and automatically delivering the I-WLAN user's location to her friend.

In another example of I-WLAN enabling additional location services for commercialization is coupling location with advertising for I-WLAN users. When a user pauses to access an I-WLAN, they may have time to explore their surroundings. One good way to help introduce the I-WLAN user to their surroundings is to tell them about the shoe sale up on the third floor or the latest CD from their favorite rock band that went on sale in the record store next door. The wireless service provider could optionally show the advertising in the I-WLAN service log-in screen or via a pop-

up window. The location service matches the advertising to the location so the I-WLAN user is put into a convenient position to make a purchase.

4.3 Potential for implementation of LCS for I-WLAN

This clause addresses where LCS applies to I-WLAN and the applicability of OMA User Plane Approach to LCS for I-WLAN.

4.3.1 I-WLAN interworking scenario analysis

TR 22.934 [11] defines six different scenarios of interworking for I-WLANs. This clause describes how each scenario may or may not support LCS.

Scenario 1 (Common Billing and Customer Care) does not pose any new requirements on 3GPP specifications. There is no LCS for I-WLAN support for this scenario. However, this does not preclude location services offered by the WLAN operator that is not a part of I-WLAN services.

Scenario 2 (3GPP-based Access Control and Charging) offers only IP connectivity and does not offer access to any 3GPP system PS-based services. Therefore, there is no LCS for I-WLAN support. As in scenario 1, any WLAN operator-provided location service support is not precluded.

In scenario 3 (Access to 3GPP System PS-based Services) allows access to PS services. This scenario may support LCS for I-WLAN as a part of PS-based services.

Scenarios 4, 5, 6 are to allow services supported in scenario 3 to survive different levels of service continuity. These scenarios may support LCS for I-WLAN.

4.3.2 Applicability of OMA user plane approach to LCS for I-WLAN

Existing 3GPP specifications do not support the protocol needed to successfully transfer the location information from a terminal to a 3GPP network via I-WLAN, however OMA (Open Mobile Alliance) Location group has been working on the technical specifications in order to transmit location data over the user plane, specifications [15], [16] and [17] are referenced here.

5 Technical service requirements

Future standardization of LCS for I-WLAN will need to take into account the LCS technical service requirements [8]. LCS for I-WLAN may require additional technical service requirements. This clause describes the additional technical service requirements that LCS for I-WLAN may require.

5.1 LCS for I-WLAN additional requirements framework

The following high level requirements are applicable to LCS for I-WLAN:

- Multiple positioning methods should be supported in the I-WLAN, including (but not limited to) Network Assisted GPS and methods using WLAN access point locations (e.g. Civic Address Locations).

  [Editors note: Civic address location document reference to be provided]

- LCS for I-WLAN should provide position information to an LCS client existing within PLMN (including I-WLAN), external to the PLMN, or in User Equipment.

- LCS for I-WLAN may include the serving AP identity to the LCS client.

5.2 Functional requirements

The following clauses describe functional service requirements for supporting LCS in I-WLAN.

5.2.1 Quality of Service

The Quality of Service consists of horizontal accuracy, vertical accuracy, response time and QoS class.

LCS for I-WLAN can typically expect horizontal accuracies of between 10 m and 100m.

If the location of an I-WLAN (e.g. I-WLAN Access Point) is used to determine the position of a UE, then it should be ensured that the reported location of that I-WLAN is accurate. If the I-WLAN has been moved to a distant place, then the location information associated with it must be updated before it is used again. The consequences of providing false I-WLAN location information can be serious, e.g. for an emergency call. Methods of ensuring the reliability fall outside the scope of SA1, but may involve calibrating the access point's location using another 3GPP positioning technology, or including a warning flag if accuracy can not be guaranteed.

5.2.2 Coverage

Any properly authorized location-based service may position a target UE located in an I-WLAN AN.

5.2.3 Roaming target UE

Provided that a roaming agreement exists and coverage is available, any properly authorized LCS client may request and receive the location of a target I-WLAN UE located in a home network or in a visited network.

5.2.4 Privacy

[Editorial Note: FFS]

6 Summary and conclusion

The intent of 3GPP-WLAN interworking is to extend 3GPP services and functionality to the WLAN access environment. LCS functionalities developed by 3GPP for GSM and UMTS will have a similar appeal in I-WLAN coverage areas. This feasibility study has found no reason why existing 3GPP LCS specifications cannot support LCS requirements for I-WLAN. Additional considerations are required, e.g. in SA2, CT1.

According to this study, it is feasible to offer LCS in I-WLAN. LCS for I-WLAN can leverage on today's location services and may offer additional services. In order to support LCS in I-WLAN, multiple positioning methods need to include WLAN access point locations. The LCS capability in I-WLAN allows any properly authorized location based service to position an I-WLAN UE in any I-WLAN including roaming. LCS functionality in I-WLAN enhances the overall value of I-WLAN services.

Annex A (normative): Attributes of Specific Services

[Editor's Note: This proposed clause contains a table depicting the range of values that may be expected for various attributes of location-based services. FFS]

Annex B (informative): Potential for Implementation

B.1 Wireless LAN positioning techniques

This clause describes several wireless LAN positioning techniques that exist for determining the location of I-WLAN UE. The positioning techniques can be grouped into WLAN location database techniques, WLAN radio-based positioning techniques, and 3GPP RAN techniques. One or a combination of these techniques can be applied to determine the position of an I-WLAN UE.

B.1.1 WLAN location database positioning techniques

Operators of commercial WLAN deployments typically maintain databases containing the location of hotspots and the WLAN access points within a hotspot. When an I-WLAN UE is associated with an access point within these hotspots, the access point has a unique MAC address that it broadcasts to the I-WLAN UE. The position of the I-WLAN UE can be determined by performing a position look-up in a hotspot and/or access point database based upon the access point MAC address received by the I-WLAN UE.

B.1.2 WLAN radio-based positioning techniques

Several radio-based positioning techniques with variations are available for WLAN. The RF triangulation technique calculates the position of an I-WLAN UE based on the received signal strength from three or more WLAN access points and a database of WLAN access point locations. The RF fingerprinting technique requires the I-WLAN operators to make an RF fingerprint of a known area. To make the RF fingerprint, the I-WLAN operator measures received signal strengths from multiple access points and records the exact position where each received signal strength measurements is made. When the position of the I-WLAN UE is requested, the I-WLAN UE measures the received signal strength from multiple access points and an algorithm compares the measurements against the RF fingerprint to determine the position of the I-WLAN UE. Time difference of arrival is another possibility for a radio-based positioning technique.

B.1.3 3GPP RAN positioning techniques

When a UE is capable of simultaneously accessing an I-WLAN and a GERAN/UTRAN, either GERAN or UTRAN positioning techniques could be applied to an I-WLAN UE. When a position of the I-WLAN UE is requested, the UE could initiate a session with the GERAN or UTRAN, wait until the GERAN or UTRAN determines its position, and then resume the session with the I-WLAN. In the case for Scenario 4 [11] , a separate session could be initiated between the I-WLAN UE and the GERAN or UTRAN to perform positioning.

B.2 General navigation systems

Some I-WLAN UE will be equipped with auxiliary equipment and software to enable them to make estimates of their location based on radio signals and other techniques outside the I-WLAN and 3GPP RAN environment. For example, some I-WLAN UE may be equipped with GPS. LCS for I-WLAN will not address these general navigation systems because they are outside the control of a 3GPP network.

B.3 Positioning information sources

The positioning of an I-WLAN UE should not be limited to a single positioning technique or system. As operating conditions vary both within and between the I-WLAN and 3GPP networks, the LCS design should be able to make use of as many measurements and techniques as are available and are appropriate for the needs of (and the cost of) the service being provided.

The positioning process should have the option to include all of the available I-WLAN and 3GPP RAN signals, including those from other networks with coverage available to the UE. While it should not be necessary for the I-WLAN UE to access these other networks, the I-WLAN UE and the location process should be able to make use of the signals from these sources in addition to those of the serving network. It is critical to positioning accuracy that as many

measurements are made as possible. This is particularly important in regions where the serving operator may provide coverage with only a single WLAN access point. Typically there will be additional coverage of these regions by other WLAN operators, but perhaps only from one WLAN access point from each operator. By making measurements of the signals from several operators the I-WLAN UE will typically be able to obtain information to make a better location estimate than would be possible with just the signals from a single operator. The use of signals and other information from several operators would, of course, be subject to suitable operator agreement.

In some cases the I-WLAN UE may be able to operate in other modes (e.g. GSM, UMTS) for which a location service feature is also provided. The signals of the other mode and location information may be helpful to the I-WLAN LCS. For example, measurements of the GSM signals may be used by the I-WLAN calculation function to supplement the I-WLAN positioning techniques. The use of this information would, of course, be subject to suitable operator agreements. The techniques for this inter-mode operation and any signalling between networks are FFS.

The positioning process shall include the option to accommodate several techniques of measurement and processing to ensure that the evolution follows changing service requirements and to take advantage of advancing technology. The information sources and the signalling required for this interaction are FFS.

Annex C (informative): Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
14/09/05	SP-29	SP-050529	-	-	Approved at SA #29	2.0.0	7.0.0
	SP-42				Upgraded to Rel-8	7.0.0	8.0.0
	SP-46				Updated to Rel-9 by MCC	8.0.0	9.0.0

SP#	Doc-1st-Level	Doc-2nd-Level	Spec	CR	Rev	Phase	Cat	Subject	Version-Current	Version-New	Workitem
SP-49	SP-100575	S1-102058	22.935	0001	-	Rel-9	D	Removal of references to 3GPP OSA	9.0.0	9.1.0	TEI9
2011-03	-	-	-	-	-	-	-	Update to Rel-10 version (MCC)	9.1.0	10.0.0	

History

Document history		
V10.0.0	May 2011	Publication