LPP Extensions Requirements

Candidate Version 2.0 – 02 Dec 2014

Open Mobile Alliance

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1. Scope (Informative)

This document specifies the requirements of the OMA LPP Extensions (LPPe).

2. References

2.1 Normative References

[3GPP-LPP]	LTE Positioning Protocol, 3GPP TS 36.355, URL: http://www.3gpp.org/
[OMA-LPPe-v1-1-RD]	"LPP Extensions Requirements", Open Mobile Alliance™, Version 1.1, OMA-RD-LPPe-V1_1-20120612-C, URL: http://www.openmobilealliance.org/
[OMA-SUPLv3-RD]	"Secure User Plane Location Requirements" , Open Mobile Alliance™, Version 3.0, OMA-RD-SUPL-V3_0, URL: http://www.openmobilealliance.org/
[RFC2119]	"Key words for use in RFCs to Indicate Requirement Levels", S. Bradner, March 1997, URL: http://www.ietf.org/rfc/rfc2119.txt

2.2 Informative References

3. Terminology and Conventions

3.1 Conventions

The key words “MUST”, “MUST NOT”, “REQUIRED”, “SHALL”, “SHALL NOT”, “SHOULD”, “SHOULD NOT”, “RECOMMENDED”, “MAY”, and “OPTIONAL” in this document are to be interpreted as described in [RFC2119].

All sections and appendixes, except “Scope” and “Introduction”, are normative, unless they are explicitly indicated to be informative.

3.2 Definitions

Baseline	Vector between antenna reference points
Relative Position	See baseline
Relative Velocity	First time derivative of the baseline
Server	Termination point of LPP/LPPe
Target	Termination point of LPP/LPPe

3.3 Abbreviations

A-GNSS	Assist GNSS
AP	Access Point
BT	Bluetooth
DSL	Digital Subscriber Line
ECID	Enhanced Cell ID
EDGE	Enhanced Data rates for Global Evolution
E-OTD	Enhanced Observed Time Difference
EPDU	External Protocol Data Unit
E-UTRAN	Evolved UTRAN
FDD	Frequency-Division Duplex
GERAN	GSM/EDGE RAN
GNSS	Global Navigation Satellite System
GSM	Global System for Mobile communications
IPDL	Idle Period Downlink
IRBP	Image Recognition Based Positioning
LAN	Local Area Network
LBS	Location-Based Services
LCS	Location Services
LPP	LTE Positioning Protocol, defined in [3GPP-LPP]
LPPe	OMA LPP Extensions
LTE	Long Term Evolution
OMA	Open Mobile Alliance
OTDOA	Observed Time Difference of Arrival
PDR	Pedestrian Dead Reckoning
RAN	Radio Access Network

SET	SUPL Enabled Terminal
SLP	SUPL Location Platform
SUPL	Secure User Plane Location
SV	Space Vehicle
TDD	Time-Division Duplex
UE	User Equipment
UMTS	Universal Mobile Telecommunication System
UTC	Universal Time Coordinated
UTRA	Universal Terrestrial Radio Access
UTRAN	Universal Terrestrial RAN
WLAN	Wireless Local Area Network

4. Introduction (Informative)

4.1 Version 1.0

LTE Positioning Protocol LPP [3GPP-LPP] is a positioning protocol for E-UTRAN control plane. However, LPP has been designed in such a way that it can also be utilized outside the control plane domain such as in the user plane in the context of SUPL.

LPP elementary messages (Request and Provision of Capabilities and Location Information and Assistance Data) each include a container, an EPDU, which can be used by standardization fora outside 3GPP to define their own extensions to LPP messages. OMA LPP Extensions take advantage of this option.

A variety of known and emerging positioning technologies are not in the scope of 3GPP work. This is natural, because control plane deployments are bandwidth-constrained and limited to access types that are part of the control plane system. However, the user plane does not have any such limitations and, hence, new positioning technologies improving accuracy, availability and integrity can be realized in the user plane.

The advantages resulting from OMA building LPPe on top of the 3GPP-defined LPP include the convergence of control and user plane positioning protocols, reduced work load and being able to use the same LPPe protocol stack both in the control and user planes.

LPPe Version 1.0 is restricted to point to point operation between a location server and a target device.

4.2 Version 1.1

LPPe Version 1.1 supports the following capabilities additional to those in Version 1.0

- Broadcast of unsolicited LPP/LPPe Provide Assistance Data messages.
- Request and provision of assistance data point to point related to LPP/LPPe broadcast support.
- Support of Ground Morphology assistance data (altitude and/or building height).

4.3 Version 2.0

LPPe Version 2.0 supports the following capabilities additional to those in Version 1.1

- Support of new positioning methods such as Image Recognition Based Positioning (IRBP) and Pedestrian Dead Reckoning (PDR).
- Positioning methods in WLAN environments for enhancing accuracy and availability.
- Support for Crowdsourcing.
- Provision of maps (indoor and outdoor).

5. LPP Extensions release description (Informative)

3GPP LPP is a positioning protocol that provides procedures for

- Request and Provision of location information including raw measurements
- Request and Provision of assistance data
- Request and Provision of target capabilities

OMA LPP Extensions (LPPe) build on the 3GPP-defined LPP and extends the location, measurement and assistance data capabilities beyond 3GPP LPP without unnecessarily duplicating the work done in 3GPP.

The purpose of OMA LPPe Release 1.1 is to enable support for

- High accuracy GNSS methods in the form of new positioning methods and assistance data types
- Emerging radio network –based positioning technologies including the radio network measurement reports for selected radio access types
- Terminal-to-terminal positioning and assistance data transfer
- Broadcast of assistance data

Moreover, OMA LPPe attempts to be bearer-independent as far as possible with respect to non-bearer associated position methods like A-GNSS and any terrestrial method applicable to a non-serving network.

As for OMA LPPe Release 2.0, besides the previous requirements, the purpose is to enable support for

- Image Recognition Based Positioning (IRBP) as new positioning method
- Pedestrian Dead Reckoning (PDR) as new positioning method
- Enhancement of positioning accuracy and availability in WLAN environments
- Crowdsourcing
- Maps provision

These new positioning methods and enhancements introduced in OMA LPPe Release 2.0 will improve location service quality such as service availability, accuracy and time to fix and extend the service to areas traditionally difficult to serve (e.g., indoor locations).

5.1 End-to-end Service Description

3GPP LPP and OMA LPPe together provide a protocol for estimating user position and velocity at a desired accuracy and time to fix. Estimation may include positioning method negotiation as well as assistance data and/or measurement transfer.

It should be noted that LPP/LPPe is not an LBS protocol and does not expose an API to LCS application. LPP/LPPe provides means for obtaining the position of the target as well as other location-related information from the target, which information may then be used by the LCS application.

6. Requirements (Normative)

6.1 High-Level Functional Requirements

Label	Description	Release
LPP-HLF-001	LPPe SHALL support fixed access types such as Cable, DSL, LAN, etc.	1.0
LPP-HLF-002	LPPe SHALL support dynamic swapping of LPP target and server roles in a client to client scenario and for certain instances of terminal to network scenario. **Informational Note 1**: In a client (terminal, laptop or any other end-user device) to client scenario, role swapping may be used to enable either end to provide location information and capabilities to the other; in a terminal to network scenario, it may be used to support transfer of capabilities and location information from a server to a target. **Informational Note 2**: Additional capabilities may be needed to indicate an ability to swap roles	1.0
LPP-HLF-003	LPPe SHALL follow the protocol architecture, messaging, conventions and rules defined in [3GPP-LPP]. **Informational Note:** Protocol architecture refers to the LPP termination points defined as target and server in [3GPP-LPP]. Messaging refers to the messages, message directions as well as to procedure and transaction handling. Rules refer to e.g. use of error and abort messages.	1.0
LPP-HLF-004	LPPe SHALL be backwards compatible in point to point mode. **Informational Note**: backwards compatibility is not required for broadcast mode because broadcast is not supported by LPPe 1.0.	1.1

Table 1: High-Level Functional Requirements

6.1.1 Security

Label	Description	Release
LPP-SEC-001	LPPe SHALL rely on the security procedures provided by its transport. **Informational Note:** LPPe contains no security procedures of its own	1.0

Table 2: High-Level Functional Requirements – Security Items

6.1.1.1 Authentication

Not applicable

6.1.1.2 Authorization

Not applicable

6.1.1.3 Data Integrity

Not applicable

6.1.1.4 Confidentiality

Not applicable

6.1.2 Charging Events

Label	Description	Release
LPP-CHG-001	LPPe SHALL enable charging for LPP/LPPe assistance data that is broadcast	1.1

Table 3: High-Level Functional Requirements - Charging Events

6.1.3 Administration and Configuration

Not applicable

6.1.4 Usability

Not applicable

6.1.5 Interoperability

Not applicable

6.1.6 Privacy

Not applicable

6.2 Overall System Requirements

None

6.3 Location Technology Requirements

6.3.1 Assistance Data Requirements

Label	Description	Release
LPP-AD-001	LPPe SHALL support request and provision of assistance data change notifications for the conditions, where the data the UE has is invalid, incorrect, inaccurate or worse than determined performance threshold. **Informational Note 1**: Assistance data change notifications can be used with, e.g., extended navigation models, local troposphere models and local ionosphere models. **Informational Note 2:** Notification may also be given proactively, in which case the notification indicates the time from which onwards the data is invalid. **Informational Note 3:** This requirement relates to the use case B.1 in [OMA-LPPe-v1-1-RD]	FUTURE
LPP-AD-002	LPPe SHALL support more precise ionosphere models. **Informational Note 1**: More precise is with respect to the currently supported GNSS native ionosphere models in [3GPP-LPP]. **Informational Note 2**: More precision may be obtained for instance by new model types or limiting the validity area and period. **Informational Note 3:** This requirement relates to the use case B.2 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-003	LPPe SHALL support troposphere models. **Informational Note:** This requirement relates to the use case B.2 in [OMA-LPPe-v1-1-RD]	1.0

LPP-AD-004	LPPe SHALL support altitude assistance for improved availability and altitude performance. **Informational Note:** This requirement relates to the use case B.2 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-005	LPPe information elements SHOULD be specified so that they enable broadcasting the data for a wide area. **Informational Note:** This requirement relates to the use case B.3 in [OMA-LPPe-v1-1-RD]	1.1
LPP-AD-006	LPPe SHALL support measurements and assistance for high-accuracy relative positioning. **Informational Note:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-007	LPPe SHALL support periodic assistance data and periodic assistance data with data continuity between the assistance data messages. **Information Note 1:** Data continuity refers to the assistance data being generated and/or tracked also between the assistance data deliveries as opposed to the snapshot at the delivery time. **Informational Note 2:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-008	LPPe SHALL support modifying the (continuous) periodic assistance data session. **Informational Note 1**: Modification in this context may include terminating the session, extending the session or changing the delivery interval. **Informational Note 2:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-009	LPPe SHALL support the change of reference station providing position estimation continuity. **Informational Note:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-010	LPPe SHALL support more precise and/or more extended SV orbit and clock parameterizations. **Informational Note 1**: More precise and more extended are with respect to the currently supported GNSS native orbit/clock parameterizations in [3GPP-LPP]. **Informational Note 2:** This requirement relates to the use case B.7 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-011	LPPe SHALL support SV orbit and clock model degradation models. **Informational Note:** This requirement relates to the use case B.7 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-012	LPPe shall support SV differential code biases for transmitted RF signals and antenna offset vectors. **Informational Note:** This requirement relates to the use case B.7 in [OMA-LPPe-v1-1-RD]	1.0

LPP-AD-013	LPPe SHALL support request and provision of updated assistance data, e.g. to replace invalid, incorrect or out-of-date data in a UE. **Informational Note 1:** LPP-AD-001 introduces the notification to the target that some event, related to the assistance data the UE has, has taken place. This requirement defines the request for the potentially changed data. **Informational Note 2:** This requirement relates to the use case B.10 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-014	LPPe SHALL support requesting information, if the data the UE has is invalid, incorrect or out-of-date, and support providing the UE with information from which time onwards the data the UE has is invalid. **Informational Note 1:** LPP-AD-001 introduces the notification to the target that some event, related to the assistance data the UE has, has taken place. This requirement defines the request/response procedure for checking the applicability of the data the UE has. **Informational Note 2:** This requirement relates to the use case B.10 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-015	LPPe SHALL support mechanism for providing the UE an estimation of the assistance data size that might be provided **Informational Note:** This requirement relates to the use case B.10 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-016	LPPe SHALL support mechanism for proprietary assistance data and measurement extensions with standardized labeling and a data container. LPPe capabilities SHALL enable an endpoint to indicate its support of such proprietary data. **Informational Note:** This requirement relates to the use case B.10 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-017	LPPe SHALL support versioning of assistance data, where applicable. **Informational Note 1:** Versioning does not refer to the versioning of the data formats, but to the different revisions of the content, i.e. to changing the version number, when the data is updated at the server side. Timestamping is one example of providing versioning. **Informational Note 2:** This requirement relates to the use case B.10 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-018	LPPe SHALL support for applicable data types request and provision for assistance data that extends assistance data that the UE already has. **Informational Note:** This requirement relates to the use case B.10 in [OMA-LPPe-v1-1-RD]	1.0
LPP-AD-019	LPPe SHALL support request and provision of assistance data comprising base station, WiFi AP, BT AP and other short range communication node identities and/or addresses, locations, transmit power, antenna gain, maximum antenna range, frequency use and other information helpful to performing measurements of these network nodes.	1.0
LPP-AD-020	LPPe SHALL support request and provision of assistance data for non-serving access networks that may be visible to a UE for position methods supported by LPP and LPPe for a serving network.	1.0

LPP-AD-021	LPPe SHALL support assistance data applicable to positioning-enabled nodes in a building. **Informational Note 1:** Assistance data may include node positions (absolute, relative, civic address, in-building address), node IDs, node types, antenna, calibration or other useful information on such nodes. **Informational Note 2:** Positioning nodes are any tags, beacons or devices that are used for positioning. This requirement focuses on tag positioning technology whereas LPP-AD-019 focuses on wireless communication systems (WIFi, BT, etc.).	1.0
LPP-AD-022	LPPe SHALL support mechanism for delivery of ground morphology information in a selected area. **Informational Note 1:** Ground morphology information shall include ground altitude and buildings height **Informational Note 2:** The requirement relates to use case B.12 in [OMA-LPPe-v1-1-RD]	1.1
LPP-AD-023	LPPe SHALL support transfer of map data for a selected area in a standard format. **Informational Note 1:** Map data may be for indoor or outdoor purposes. **Informational Note 2:** The requirement relates to use case B.5. **Informational Note 3:** LPPe will not define the content and encoding of map data. Instead, existing standards will be referenced.	2.0
LPP-AD-024	LPPe SHALL support request and provision of assistance data to improve the positioning accuracy in the selected area in the WLAN environment. **Informational Note 1:** The selected area may be an area including the current UE location or some area remote from the UE location.	2.0
LPP-AD-025	LPPe SHALL support request and provision of area information for locations where a transition from indoor to outdoor and vice versa may occur. **Informational Note 1:** In general, indoor/outdoor transitions take place in designated areas (e.g., entrance/exit of buildings, airports, sports arenas, etc.). The area information provided contains geographical information describing these areas of transit and can be used to support seamless indoor/outdoor positioning in these areas. **Informational Note 2:** The requirement relates to use case B.7.	2.0
LPP-AD-026	LPPe SHALL support request and provision of Radio Map data for a selected area. **Informational Note 1**: The requirement relates to use case B.8.	FUTURE

Table 4: Location Technology Requirements – Assistance Data Items

6.3.2 Assistance Data Broadcast Requirements

Label	Description	Release
LPP-BC-001	LPPe SHALL support broadcast of unsolicited LPP/LPPe Provide Assistance Data messages	1.1
LPP-BC-002	LPPe SHALL enable inclusion within a single LPP/LPPe Provide Assistance Data message of assistance data including location coordinates and GNSS timing for base stations, access points and other nodes within a small local area **Informational Note:** a UE that is moving will be able to receive broadcast assistance data from one node and apply it to other nearby nodes without waiting to receive assistance data from these other nodes. Additionally, a server will be able to assemble LPP/LPPe broadcast messages for a group of nodes and not necessarily have to assemble a unique message for each individual node.	1.1

LPP-BC-003	LPPe SHALL define a means of labelling different types of assistance data in a flexible manner to support identification of the type or types of assistance being broadcast by a particular system without the need to receive and decode broadcast assistance data messages. **Informational Note :** a broadcast system may use the labels to advertise support for different types of assistance data and/or provide broadcast scheduling information	1.1
LPP-BC-004	LPPe SHALL support request and provision point to point of assistance data related to broadcast assistance data. The associated assistance data SHALL be permitted to include deciphering keys for charging purposes, information on the geographic area and broadcast system applicable to broadcast support and a list of the types of assistance data being broadcast.	1.1

Table 5: Location Technology Requirements – Assistance Data Broadcast Requirements

6.3.3 Measurement and Location Information Requirements

Label	Description	Release
LPP-MLI-001	LPPe SHALL support local troposphere measurements. **Informational Note:** This requirement relates to the use case B.4 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-002	LPPe SHALL support ionosphere delay measurements. **Informational Note:** This requirement relates to the use case B.4 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-003	LPPe SHALL support UE provision of satellite assistance data. **Informational Note 1**: UE may provide satellite assistance data to another UE or to a server (SLP). **Informational Note 2**: Satellite assistance data may include ephemerides, almanac, UTC model, GNSS-GNSS time offsets and broadcast ionosphere model. **Informational Note 3:** This requirement relates to the use case B.4 in [OMA-LPPe-v1-1-RD]	1.0
LLP-MLI-004	LPPe MAY support periodic measurements with measurement continuity between the measurement messages. **Informational note 1:** Data continuity refers to the measurements being made also over the interval between the measurement messages as opposed to the snapshot measurements at the message delivery time. **Informational Note 2:** This requirement may be better supported in LPP or SUPL 3.0 which may be evaluated during the TS phase. **Informational Note 3:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-005	LPPe MAY support modifying the (continuous) periodic measurement session. **Informational Note 1**: Modification in this context may include terminating the session, extending the on-going session or changing the delivery interval. **Informational Note 2:** This requirement may be better supported in LPP or SUPL 3.0 which may be evaluated during the TS phase. **Informational Note 3:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0

LPP-MLI-006	LPPe SHALL support carrying antenna information for improved performance. **Informational Note 1**: Antenna information may include antenna identification and antenna orientation information. **Informational Note 2:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-007	LPPe SHALL support carrying pressure information between the entities being positioned with respect to each other for improved relative altitude performance. **Informational Note:** This requirement relates to the use case B.6 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-008	LPPe SHALL support UE-based/UE-assisted GERAN ECID **Informational Note:** This requirement relates to the use case B.8 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-009	LPPe SHALL support UE-based/UE-assisted UTRA-TDD/FDD ECID **Informational Note:** This requirement relates to the use case B.8 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-010	LPPe SHALL support UE-assisted/UE-based WLAN ECID **Informational Note:** This requirement relates to the use case B.8 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-011	LPPe SHALL support UE-assisted/UE-based E-OTD **Informational Note:** This requirement relates to the use case B.8 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-012	LPPe SHALL support UE-assisted/UE-based OTDOA-IPDL **Informational Note:** This requirement relates to the use case B.8 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-013	LPPe SHALL support representing absolute position in centimeter-level resolution in WGS-84 or other geographic coordinate system. The associated uncertainty MUST have similar resolution. **Informational Note:** This requirement relates to the use case B.9 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-014	LPPe SHALL support representing absolute velocity in millimeter/second-level resolution. The associated uncertainty MUST have similar resolution. **Informational Note:** This requirement relates to the use case B.9 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-015	LPPe SHALL support presenting relative position in centimeter-level resolution. The associated uncertainty MUST have similar resolution. **Informational Note 1**: The meaning of the relative position, i.e. the end points of the vector representing relative position, must be defined during the LPPe TS work. **Informational Note 2:** This requirement relates to the use case B.9 in [OMA-LPPe-v1-1-RD]	1.0
LPP-MLI-016	LPPe SHALL support presenting relative velocity in millimeter/second-level resolution. **Informational Note 1**: Relative velocity is to be understood as the time derivative of the vector representing relative position, i.e. it is the relative motion of the baseline end points. **Informational Note 2:** This requirement relates to the use case B.9 in [OMA-LPPe-v1-1-RD]	FUTURE

LPP-MLI-017	LPPe SHALL support requesting and providing information related to the UE motion state. **Informational Note 1**: Motion state may include attributes such as walking, running, cycling and driving. **Informational Note 2**: Transferred requirement from [OMA-SUPLv3-RD]	1.0
LPP-MLI-018	LPPe SHALL support UE-based OTDOA positioning for E-UTRAN. Support of OTDOA (UE assisted and UE based versions) SHALL extend to femtocells. **Informational Note 1:** Assistance data provided will not duplicate support already in LPP. **Informational Note 2:** Additional information may be provided to identify and assist use of femtocells.	1.0
LPP-MLI-019	LPPe SHALL support reporting of multiple serving and non-serving, current and past E-CID measurements from the UE to an appropriate entity in the network for all the supported wireless access types. LPPe SHALL support reporting of multiple serving and non-serving positioning supporting measurements to the network for all the supported fixed access types. **Informational Note:** this requirement is synonymous to the Multiple Location ID feature in SUPL 2.0	1.0
LPP-MLI-020	LPPe SHALL support request and provision of high confidence error bounds **Informational Note:** This requirement relates to the use case B.11 in [OMA-LPPe-v1-1-RD]	FUTURE
LPP-MLI-021	LPPe SHALL support request and provision of relative changes in location over a single time period or over a sequence of time periods including historic time periods.	1.0
LPP-MLI-022	LPPe SHALL support request for and provision of the IP address of all the available bearers.	1.0
LPP-MLI-023	LPPe SHALL support request and provision of location measurements (or a location estimate based on measurements) for non-serving access networks that may be visible to a UE for position methods supported by LPP and LPPe for a serving network	1.0
LPP-MLI-024	LPPe SHALL support request and provision of the target orientation information. **Informational Note**: Transferred requirement from [OMA-SUPLv3-RD]	1.0
LPP-MLI-025	LPPe SHALL support UE-assisted/UE-based Image Recognition-Based (IRB) positioning. **Informational Note:** This requirement relates to the use case B.2 and B.9.	2.0
LPP-MLI-026	LPPe SHALL support UE-based/UE-assisted Pedestrian Dead Reckoning (PDR). **Informational Note 1**: The requirement relates to use case B.3.	2.0
LPP-MLI-027	LPPe SHALL support UE-assisted motion sub-state. **Informational Note 1:** UE-assisted motion sub-state may include pedestrian sub-states such as for example particular poses or scenarios (e.g., hold, swing, on phone call, in pocket, walking up/down stairs, riding an elevator, escalators, etc.). **Informational Note 2**: The requirement relates to use case B.4.	2.0

LPP-MLI-028	LPPe SHALL support crowdsourcing of access network or short range node measurements. **Informational Note 1:** Crowdsourcing is a mechanism whereby large numbers of UEs perform access network and/or short range node measurements. Crowd Sourced Data may include positions estimates (absolute, relative, civic address, in-building address, etc.), together with node measurements, node IDs, node types, antenna, calibration or other useful information on such nodes. All collected measurements must clearly distinguish between the access network technology that is being measured and the positioning technology that is being used to make the position estimate that is associated with it. **Informational Note 2:** The requirement relates to use case B.6	2.0
LPP-MLI-029	LPPe SHALL support configuration of crowdsourcing parameters for individual UEs. **Informational Note 1:** The conditions under which UEs are to perform crowdsourcing measurements (including what kind of measurements) and when to report these measurements to a server are configured by the server for all its affiliated UEs. **Informational Note 2:** The requirement relates to use case B.6	2.0
LPP-MLI-030	LPPe SHALL support improved location of a target UE in a WLAN environment including providing better support for association of WLAN assistance data with the current UE location and supporting UE feedback on the correctness of received assistance data. **Informational Note 1:** The requirement relates to use case B.10.	2.0

Table 6: Location Technology Requirements – Measurement and Location Information Items

6.3.4 Capability Requirements

Label	Description	Release
LPP-C-001	LPPe capability transfer SHALL be capable of operating in a bidirectional manner (i.e. UE capability transfer to an SLP and SLP capability transfer to a UE) **Informational Note:** This requirement relates to the use case B.5 in [OMA-LPPe-v1-1-RD]	1.0
LPP-C-002	LPPe capabilities of a SET and SLP SHALL indicate any support for broadcast of LPP/LPPe assistance data and ability to request and transfer assistance data point to point related to support of broadcast assistance data	1.1

Table 7: Location Technology Requirements – Capability Items

6.4 Improved Performance for Indoor Location

Label	Description	Release
LPP-IL-001	LPPe SHALL support delivery of indoor context information to the UE. **Informational Note:** Indoor context information may include information such as the indoor location (e.g. JFK Airport, terminal 3), anchor points from which to determine relative location (e.g. Terminal 1, gate 20C is at lat x, long y, etc.) or other relevant information.	1.0

LPP-IL-002	LPPe SHALL support delivery of indoor context information from the UE to an appropriate entity in the network. **Informational Note 1**: UE may provide indoor reference point data to a location server. **Informational Note 2**: Indoor reference point assistance data may include map-aided absolute/relative coordinate, civic address and place label.	1.0
LPP-IL-003	LPPe SHALL support delivery of radio characteristic information to the UE for enhanced indoor location. **Informational Note**: This requirement relates to the use case B.1.	2.0

Table 8: Improved Performance for Indoor Location

Appendix A. Change History (Informative)

A.1 Approved Version History

Reference	Date	Description
n/a	n/a	No prior version

A.2 Draft/Candidate Version 2.0 History

Document Identifier	Date	Sections	Description
Draft Versions OMA-RD-LPPe-V2_0	25 Oct 2012	All	First baseline based on LPPe 1.1 with proposed changes for LPPe 2.0
	21 Nov 2012	6.4, B.1	OMA-LOC-2012-0271R02-CR_LPPe_2_0_RD_Support_Environment_related_Information
		6.3.3, B.2	OMA-LOC-2012-0273R01-CR_LPPe2.0_IRB_Location_Method_RD
		6.3.3, B.3	OMA-LOC-2012-0278-CR_LPPe_2.0_RD_Pedestrian_Dead_Reckoning
		6.3.3, B.4	OMA-LOC-2012-0279R03-CR_LPPe_2.0_RD_Pedestrian_motion_state
		6.3.1, B.5	OMA-LOC-2012-0280R02-CR_LPPe_2.0_RD_Maps_Provision
	05 Feb 2013	2.1, 6.1, 6.3.1, 6.3.3, 6.3.4	OMA-LOC-2013-0009-CR_LPPe_2.0_RD_use_case_reference
	28 Feb 2013	3.3, 4.3, 6.3.1, 6.3.3, B.6	OMA-LOC-2013-0011-CR_LPPe_2_0_RD_Update_Version_Desc OMA-LOC-2013-0015R01-CR_LPPe_2 0_RD_requirements OMA-LOC-2013-0022-CR_LPPe_2_0_RD_Update_Abbreviations OMA-LOC-2013-0024R01-CR_LPPe_2_0_RD_Supporting_Assistance_Data_in_WLAN_Environments
	29 Mar 2013	6.3.1, 6.3.3, B.7, B.8, B.9	OMA-LOC-2013-0023R02-CR_LPPe_2_0_RD_Area_Information_for_Seamless_Positioning OMA-LOC-2013-0026R02-CR_LPPe_2_0_RD_UE_based_Fingerprint_IRBP_Support OMA-LOC-2013-0032-CR_LPPe_2_0_RD_UE_based_IRBP_Support_
	30 Apr 2013	Throughout the document	As per comments received in OMA-RDRR-LPPe-V2_0-20130430-D OMA-LOC-2013-0042-CR_LPPe_2.0_RD_requirements OMA-LOC-2013-0043R03-CR_LPPe_2.0_RD_editorial_corrections
Candidate Version OMA-RD-LPPe-V2_0	21 May 2013	n/a	Status changed to Candidate by TP TP Ref # OMA-TP-2013-0134-INP_LPPe_2.0_for_Candidate_Approval
Draft Versions OMA-RD-LPPe-V2_0	06 Nov 2014	Throughout the document	As per comments received during consistency review and agreed proposed solutions documented in OMA-CONRR-LPPe-V2_0-20141105-D
	11 Nov 2014	N/A	Editorial changes
Candidate Version OMA-RD-LPPe-V2_0	02 Dec 2014	n/a	Status changed to Candidate by TP TP Ref # OMA-TP-2014-0269-INP_LPPe_V2_0_ERP_and_ETR_for_Candidate_Approval

Appendix B. Use Cases (Informative)

Editor's note: Use cases specified in this appendix only cover Release 2.0.

B.1 Delivery of Radio Characteristic Information

B.1.1 Short Description

Due to factors such as non-line-of-sight propagation, multipath fading, absorption and signal obstruction, indoor positioning is in general more complicated than outdoor positioning. This may lead to reduced positioning accuracy or the inability to obtain a position fix at all.

However, if an UE obtains radio characteristic information in the form of assistance data, (e.g., appropriate radio propagation models, error correction information for accurate measurement, the number of walls and direction between the UE and APs, etc.), it may be possible to improve or even enable indoor positioning.

B.1.2 Market benefits

Consumers will see improved positioning performance in indoor locations.

B.2 Image Recognition

B.2.1 Short Description

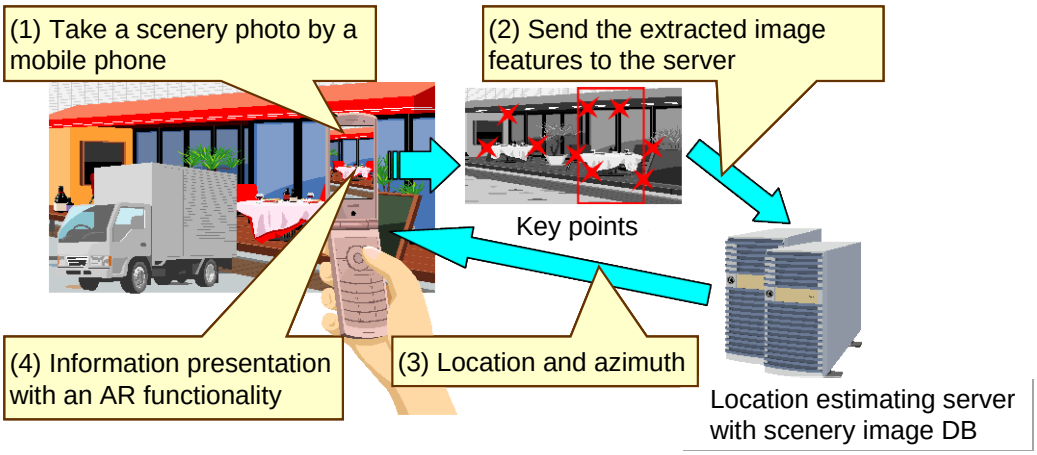

Figure 1: Overview of the proposed image recognition-based positioning method

Figure 1 shows an overview of the proposed image recognition-based positioning method. A photo is first taken by a camera equipped with a mobile terminal, and then image features are extracted from a photo. The image features are then sent to a server in which image feature matching is performed between the features sent and the features in a scenery image data base. The best match is selected if the matching score is high enough, and the location information corresponding to the best match is recognized as the location of the mobile terminal. Azimuth information as well as position information (i.e., latitude, longitude, and altitude) are estimated and sent back to the terminal.

B.2.2 Market benefits

The image recognition-based positioning method may result in low cost deployments by simply using the built in cameras of mobile phones (i.e., the UE). This positioning method may also improve the positioning accuracy particularly in indoor environments.

B.3 Pedestrian Dead Reckoning (PDR)

B.3.1 Short Description

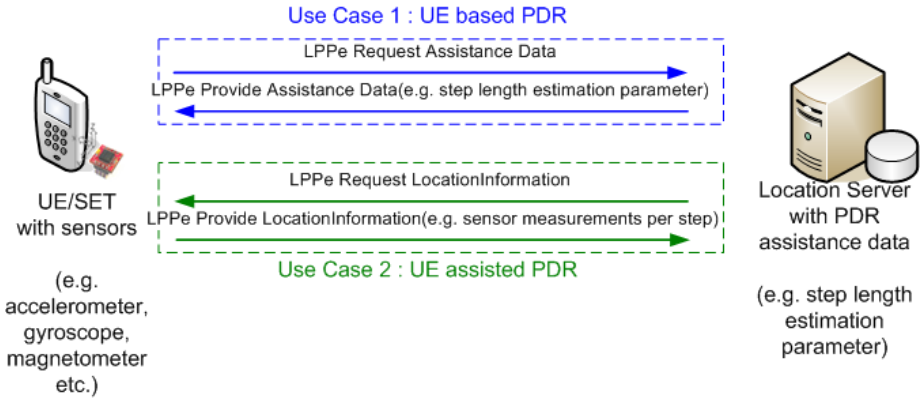

Figure 2: Overview of the pedestrian dead reckoning (PDR)

Pedestrian Dead Reckoning (PDR) refers to determining a UE's position from sensor measurements. Such measurements may include accelerometer, gyroscope and magnetometer information that allow for relative positioning by estimating step count, step length and heading. Pedestrian DR can provide not only relative positioning but also absolute positioning by combining network or GNSS based positioning methods. In addition, it enables support for enhanced location accuracy by route or POI matching from indoor or outdoor maps.

Pedestrian Dead Reckoning (PDR) can further be improved by introducing PDR estimation models (e.g. step detection, step length estimation, heading estimation models) that allow for more accurate positioning accuracy.

B.3.2 Market benefits

Pedestrian DR based methods result in low cost deployments by utilizing MEMS sensors already found in many UEs. This positioning method also does not require any additional infrastructure. Moreover, providing sensor based standalone positioning allows for positioning continuity and accuracy in areas where other positioning technologies (e.g., A-GNSS, etc.) do not work reliably (e.g., in indoor and urban canyon environments).

B.4 UE-assisted motion sub-state

B.4.1 Short Description

This short description illustrates the concept of pedestrian sub-states. It applies also to other motion sub-states.

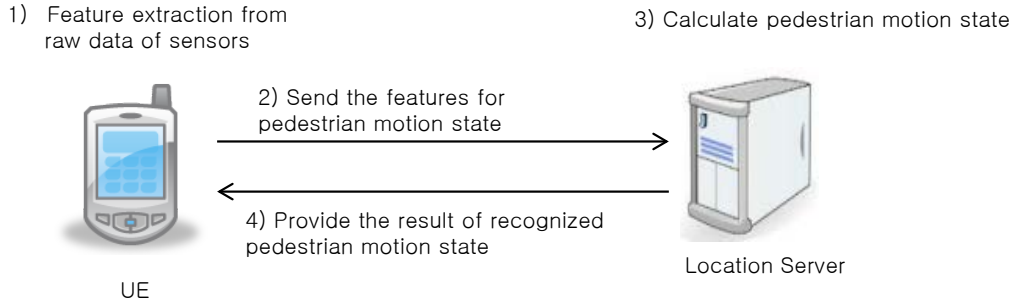

Figure 3: Overview of UE-assisted pedestrian motion sub-state

UE-assisted pedestrian motion state refers to determining any pedestrian poses or situations when the UE's motion state is pedestrian (e.g. hold, swing, on phone call, in the pocket, walking up/down stairs, riding an elevator, escalators, etc.). This information may be useful in itself because it will provide location-based applications with a new kind of users' state in addition to position, velocity, direction, etc. during walking. For example, if a UE's pedestrian motion state is determined as "walking while in the pocket" and the current ring tone is set to silent mode, it will be helpful to change the silent mode to ring mode automatically in order to notify the user. Furthermore, it will help a UE to support PDR according to its current pedestrian motion state, which will improve the location performance by receiving appropriate PDR estimation models (e.g. step detection, step length estimation, heading estimation, etc.).

B.4.2 Market benefits

UE-assisted pedestrian motion state helps consumers to improve their location performance by receiving appropriate PDR estimation models according to current pedestrian motion states from a location server.

B.5 Maps Provision

B.5.1 Short Description

Maps may be provided for both Indoor and outdoor use cases:

Outdoor maps are of benefit to outdoor positioning methods, where a user is in a constrained environment, such as if a user can only move along a road, river or similar constraining entity.

Outdoor maps can cover wide geographical areas if these can be supported in the Target.

The maps themselves are used to indicate the extent of the constraints, e.g. the local network of roads, together with sets of attributes (metadata) for each road.

Indoor maps are of benefit to indoor positioning methods, such as PDR (Pedestrian Dead Reckoning), WLAN based positioning procedures, and others that are applicable within buildings.

Consequently maps that are defined for indoor use have limited geographical extent, i.e. they only need to cover areas of the size of buildings.

The Indoor maps themselves must be sufficient to define the boundaries within the buildings spaces – i.e. the locations of walls, and also the ways through, such as doorways or escalators/lifts ("Accessors"). The maps will also need to include a limited amount of metadata for the entities defined in the map. Furthermore, for indoor navigation service, indoor maps will permit the provision of routing information, e.g. a set of node and link information on the user's selected route.

B.5.2 Market benefits

Provision of maps enables a positioning system to take geographical or physical constraints into account, and also to identify the civic location of a user. Thus the provision of maps permits a faster or more accurate position identification procedure, and it also permits an indoor location to be identified in additional, indoor-centric ways.

B.6 Crowdsourcing

B.6.1 Short Description

Crowdsourcing is a method for determining the physical location of positioning nodes (e.g., GSM/WCDMA/LTE cell/sectors, WiFi APs, BT Beacons, etc.) based on radio measurements of these nodes performed by a large number of UEs, that are also cross referenced by simultaneous measurements that are made by using other technologies

E.g. a UE might collect information using one positioning technology, together with contemporary measurements from a second. The measurements on the second technology may provide independent constraints on the measurements of the first, and hence the information can be used to deduce changes in the networks that are used. The measurements can be accumulated (possibly over several locations and user reports) and processed to provide continuous estimates for the state of the measured networks and the locations of the transmitters.

UEs may be instructed by the server under which conditions and when to report measurements to the server. For instance UEs may be instructed to only perform (and store) measurements if the UE knows its own location with sufficient accuracy. The server may also instruct the UE when to report obtained (and stored) measurements and locations to the server (e.g., at certain times of day, periodically, when a certain number of measurements has been performed and stored, when a new radio source is detected, or other triggers such as when a geofence is crossed).

B.6.2 Market benefits

In a typical Location System, the locations of positioning nodes, such as those of transmitters or beacons, are manually surveyed and entered into a database that is used to populate location assistance provisioning messages.

For example, the locations of cellular transmitters may be obtained from site information provided by a cellular operator. As another, the locations of Wi-Fi transmitters might be determined through site surveys.

However, surveying and maintaining such a database can be a cumbersome and expensive exercise, as the whole reference system needs to be resurveyed when changes are made. Further, the data should be updated when any change to the reference system takes place, but in many cases it is difficult even to know when a reference has been moved.

By utilizing the positioning measurements that are normally obtained by users for location calculations, made in their normal course of activity, or explicitly requested, crowdsourcing provides an automated and cost effective means to verify and update, or even create, the reference database.

Accurate and well maintained reference data is essential for proper positioning and it constitutes a major cost factor for operators of location servers.

B.7 Indoor/Outdoor Transit Area Information

B.7.1 Short Description

During a positioning session, a UE may transit from an indoor to an outdoor area (or vice versa). In this situation, the UE may have to change the positioning method according to the new environment (i.e. indoor vs. outdoor and vice versa). For example, a UE may change the positioning method from A-GNSS to WLAN positioning or PDR when entering a building. Without additional help, however, the UE may not be able to change the positioning method in time since the UE may not have recognized the transition from outdoor to indoor. Consequently the positioning accuracy and availability may suffer during the period of transition. For example, when a UE transitions from indoor to outdoor, the UE may temporarily be unable to acquire its position since A-GNSS positioning may not be available right away (e.g., missing assistance data) while WLAN based positioning may no longer work (e.g., APs only provide indoor coverage).

For example, a UE may already prepare to use A-GNSS while still inside a building (e.g., requesting assistance data) in anticipation that it will transition from indoor to outdoor. By the same token, a UE about to enter a building may request WLAN assistance data in anticipation that it will soon transition from outdoor to indoor.

In general, indoor/outdoor transitions take place in designated areas such as entrance/exits of buildings, airports, sports arenas, etc. Any information that a UE can obtain (in form of assistance data) about these designated areas will greatly assist the positioning process (e.g., switching to a new positioning method, etc.) in these difficult but crucial areas.

B.7.2 Market benefits

Consumers will experience improved and seamless positioning not only while indoors or outdoors, but also while in transition.

B.8 Radio Map Data Support

B.8.1 Short Description

In general, Radio Map data is a set of recorded RSS (Received Signal Strength) patterns for well-defined reference points. As shown in the figure below, a service provider administrator defines the reference points and installs the access points where

the service provider provides Location-based Services (e.g., shopping mall, indoor parking lots), and estimates and records the RSS patterns at the defined reference points, which is Radio Map data before the service is operated.

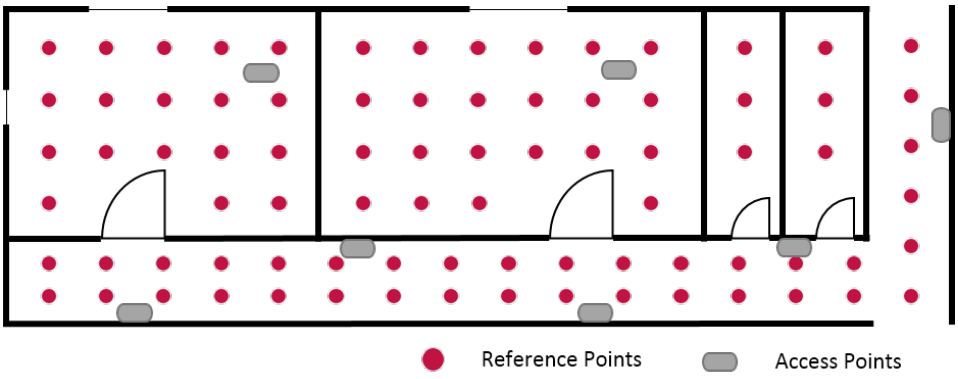

Figure 4: Reference points and access points in an area for making a radio map

During the service operating phase, the UE records the RSS patterns from the accessible APs, and compares the RSS fields of the entries stored in the Radio Map. The position of the UE is then extracted from the reference points of the entry with the closest match.

For this operation, the UE requests and acquires the Radio Map from the service operators, and the Radio Map needs to be optimized for a selected area and updated based on the UE's current position.

B.8.2 Market Benefits

With the Radio Map data stored in the UE, consumers can take some advantages that low accuracy, security, and privacy problems can be solved and some applications that require low latency of acquiring position fixes (e.g., indoor navigation) can meet the requirement.

B.9 UE-based IRB Positioning

B.9.1 Short Description

Some LBS innovative applications, like Pedestrian Navigation and Augmented Reality, require real-time, continuous, and low-latency positioning for maintaining the required quality of service. While this requirement may generally be met by UE-assisted IRB positioning, there are scenarios (e.g., large image objects, etc.) where UE-assisted IRB positioning may not be able to meet these low-latency requirements.

In UE-based mode, however, a UE will be able to download IRB reference data, consisting of partial objective data restricted to an area around a reference position. This approach avoids the potential high latencies of UE assisted mode.

Any UE that has adequate IRB assistance data and sufficient computing power will be able to use UE-based IRB positioning.

B.9.2 Market Benefits

UE-based IRB positioning will reduce the latency of IRB accurate position estimation. This feature can provide value in augmented reality application and pedestrian navigation in indoor and urban canyoning environments, where the position information should be continuously updated with low delay.

B.10 Improved Location in a WLAN Environment

B.10.1 Short Description

In WLAN environments with large number of APs, a UE needs to be able to concentrate on a select few APs for positioning. This is because in typical WLAN deployments most APs are not visible to the UE i.e., they are outside the UE's radio range (the APs may be on different floors, behind walls, around the corner or otherwise outside radio range of the UE).

In order to allow a UE to concentrate on APs within its radio range, the server may provide the UE with a list of APs which are within the UEs radio range. As an example, a UE entering a specific floor within a building may be provided with a list of APs deployed on this floor. By the same token, a UE leaving a specific floor and entering another floor may be provided with a list of APs deployed on this floor while at the same time APs on the previously visited floor would be removed from the list of APs within radio range.

In a variation of the above, a UE may report to the server if an AP presumed to be within the UE's radio range (i.e., an AP on the APs within radio range list) is in fact not present. This feedback mechanism allows the server to perform real time maintenance of its lists of AP available at specific locations and times.

B.10.2 Market benefits

Benefits for the end user are improved time to fix and improved battery life. The time to fix improvement stems from the fact that a UE can selectively search for APs it knows are within its radio range as opposed to searching for all possible APs. The improved battery life is due to the fact that the UE won't need to spend energy on searching for all possible APs but can instead focus on the select few that are within its radio range.