

Attachment 4-2-11

WiMAX Forum[®] Network Architecture

Protocols and Procedures for Location Based Services

WMF-T33-110-R015v01

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WiMAX Forum[®] Approved
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TABLE OF CONTENTS

1.	REVISION HISTORY	1
2.	DOCUMENT SCOPE	2
3.	ABBREVIATIONS AND DEFINITIONS	3
3.1	ABBREVIATIONS	3
3.2	TERMS & DEFINITIONS	4
4.	REFERENCES	6
5.	REQUIREMENTS AND PRINCIPLES.....	7
5.1	OVERALL LBS REQUIREMENTS FOR WiMAX	7
5.2	R2 INTERFACE SPECIFIC REQUIREMENTS.....	8
5.3	PRIVACY PROTECTION.....	9
6.	NETWORK REFERENCE MODEL	10
6.1	FUNCTIONAL ENTITIES	10
6.2	REFERENCE POINTS	11
7.	LBS PROCEDURES	12
7.1	MS MANAGED LOCATION	12
7.2	LBS AUTHENTICATION AND AUTHORIZATION	13
7.3	NETWORK MANAGED LOCATION.....	14
7.3.1	<i>Control Plane location procedures.....</i>	<i>15</i>
7.3.2	<i>User Plane Location Procedures.....</i>	<i>25</i>
7.3.3	<i>Mixed Plane Location.....</i>	<i>31</i>
7.3.4	<i>MS' LBS Capabilities negotiation</i>	<i>33</i>
7.4	INTRA-NAP MEASUREMENT PROCEDURES.	33
7.4.1	<i>R6/R4/R8 LBS messages.</i>	<i>33</i>
7.4.2	<i>Reference signals for measurement</i>	<i>34</i>
7.4.3	<i>MS managed location.</i>	<i>35</i>
7.4.4	<i>Network managed location.</i>	<i>36</i>
7.5	LBS ERROR HANDLING	42
7.5.1	<i>Location Procedure for Unavailable/Powered-off MSes.....</i>	<i>43</i>
7.5.2	<i>Authentication, Authorization, or Privacy Failure</i>	<i>43</i>
7.5.3	<i>Paging Failure Procedure</i>	<i>46</i>
7.5.4	<i>Error scenarios summary</i>	<i>47</i>
7.6	LBS ACCOUNTING	47
7.6.1	<i>Accounting Architecture</i>	<i>47</i>
7.6.2	<i>LBS Accounting Requirements and Principles</i>	<i>48</i>
7.6.3	<i>LBS Accounting Procedures</i>	<i>49</i>
7.7	LBS ROAMING	51
7.7.1	<i>Location determination at the visited network.....</i>	<i>51</i>
7.7.2	<i>Location determination at the home network</i>	<i>53</i>
7.8	LBS QUALITY OF SERVICE	53
8.	LBS SPECIFIC MESSAGES AND TLVS	55
8.1	LBS R4/R6/R8 DEFINITION	55
8.1.1	<i>R4_Measurement_Request.....</i>	<i>55</i>
8.1.2	<i>R4_Measurement_Response</i>	<i>56</i>

LBS

1	8.1.3	<i>R4_Measurement_Request_ACK</i>	57
2	8.1.4	<i>R4_Measurement_Response_ACK</i>	58
3	8.1.5	<i>R6_Measurement_Request</i>	58
4	8.1.6	<i>R6_Measurement_Request_ACK</i>	59
5	8.1.7	<i>R6_Measurement_Response</i>	59
6	8.1.8	<i>R6_Measurement_Response_ACK</i>	60
7	8.1.9	<i>R8_Measurement_Request</i>	60
8	8.1.10	<i>R8_Measurement_Response</i>	61
9	8.1.11	<i>R8_Measurement_Request_ACK</i>	62
10	8.1.12	<i>R8_Measurement_Response_ACK</i>	62
11	8.1.13	<i>LBS R4/R6/R8 message TLVs</i>	62
12	8.2	<i>LS-AAA INTERACTION</i>	70
13	8.2.1	<i>RADIUS message definition</i>	70
14	8.2.2	<i>DIAMETER message definition</i>	72
15	8.2.3	<i>Accounting messages</i>	79
16	8.3	<i>LBS R3</i>	80
17	8.3.1	<i>RADIUS message definitions</i>	80
18	8.3.2	<i>DIAMETER R3 Measurement Request/Response message definitions</i>	82
19	8.3.3	<i>WiMAX RADIUS VSAs Definitions</i>	86
20	8.3.4	<i>LBS Diameter VSA Definition</i>	103
21	8.4	<i>LBS R2</i>	113
22	8.4.1	<i>WiMAX Location Protocol (WLP)</i>	113
23	8.4.2	<i>OMA SUPL</i>	114
24	8.4.3	<i>R2 Location Security Keying</i>	115
25			
26			

TABLE OF FIGURES

Figure 1 : Functional Reference model for Location based services	10
Figure 2 : MS managed location.....	12
Figure 3 : LBS Authentication Procedure.....	13
Figure 4 : RADIUS based control plane location procedure for network managed location.....	16
Figure 5 : Diameter based control plane location procedure for network managed location.....	19
Figure 6 : Identifying and updating the LC: MS in idle mode.....	22
Figure 7 : MS Initiated Location Request in WiMAX using HELD	26
Figure 8 : Network Initiated Location Request in WiMAX using HELD	27
Figure 9 : MS Initiated Location request in WiMAX using SUPL 2.0.....	29
Figure 10 : Network Initiated Location Request in a WiMAX Network using SUPL 2.0 and UDP NI messaging	30
Figure 11 : Mixed Plane location determination.....	32
Figure 12 : MS initiated capabilities negotiation	33
Figure 13 : MS managed intra-NAP location procedure	35
Figure 14 : WiMAX Omni-Directional Base Station	37
Figure 15 : WiMAX BS-ID based-location.....	37
Figure 16 : Intra-NAP procedure based on BS-ID, MS in ACTIVE mode	38
Figure 17 : Intra-NAP procedure based on BS-ID, MS in IDLE mode	39
Figure 18 : NAP procedure for network managed location where MS measures and network calculates.	40
Figure 19 : Intra-NAP procedure for network managed location where network measures and network calculates.	41
Figure 20 : Location Procedure for Unavailable (e.g., Powered-off) MSes	43
Figure 21 : E2E procedures, Authentication or Authorization failure	44
Figure 22 : E2E procedures, Privacy failure, R2 interface	45
Figure 23 : E2E procedure, paging failure.....	46
Figure 24 : Accounting architecture for LBS	48
Figure 25 : Offline LBS Accounting Procedure for one-time location, non-roaming scenario	50
Figure 26 : E2E Roaming procedure for LBS with standalone location capability on the MS.....	51
Figure 27 : LBS Roaming procedure for LBS with standalone location capability on the MS – Connection to hLS ..	53

LBS

LIST OF TABLES

Table 1 – Timers and Timing Considerations.....	21
Table 2 – Actions after Timer Max Retry.....	21
Table 3 – LBS Error scenarios summary.....	47
Table 4 – R6/R4/R8 LBS messages.....	55
Table 5 – MS Info of R4_Measurement_Request	55
Table 6 – MS Info of R4_Measurement_Response	56
Table 7– R4_Measurement_Request ACK.....	57
Table 8 – R4_Measurement_Response ACK	58
Table 9 – R6_Measurement_Request	58
Table 10 – R6_Measurement_Request_ACK.....	59
Table 11 – R6_Measurement_Response.....	59
Table 12 – R6_Measurement_Response_ACK	60
Table 13 – R8_Measurement_Request	60
Table 14 – R8_Measurement_Response.....	61
Table 15 – R6_Measurement_Request_ACK.....	62
Table 16 – R6_Measurement_Response_ACK	62
Table 17 – Location Server Attributes in Final RADIUS Access-Accept from HAAA to ASN.....	100

1. Revision History

November 6, 2009	Initial version of Release 1.5.
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2. Document Scope

This document describes the Location based services for the WiMAX network.

In WiMAX Networks, location capability can be used to

- enable Location Based Services, which are value added services, typically associated with applications providing special information to the subscriber of the service, through knowledge of the SS/MS location, e.g., directory of, and perhaps driving direction to, local stores/restaurants.
- enable support for Emergency calls and provide user's location to the emergency service provider to assist in the response..
- to make use of the user's location information within access network internal operations, such as location assisted handover, and traffic and coverage measurement.

This document specifies Stage 2 and Stage 3 specifications for the location based services in WiMAX networks.

3. Abbreviations and Definitions

Only acronyms and definitions having special relevance to LBS are presented here. See [3] for more information.

3.1 Abbreviations

(Some of these terms are discussed further in Section 3.2).

AAA	Authentication Authorization and Accounting (server)
CINR	Carrier Interference to Noise Ratio
EOTD	Enhanced Observed Time Difference
GNSS	Global Navigation Satellite Systems
GPS	Global Positioning System
GRIP	GNSS Reference Information Protocol
HELD	HTTP Enabled Location Delivery
hLS	Home Location Server
iASP	Internet Application Service Provider
LA	Location Agent
LBS	Location-based services
LC	Location Controller
LR	Location Requester
LS	Location Server
MLP	Mobile Location Protocol
MO-LR	Mobile Originated Location request
MS	Mobile Station
MSR	Mobile Scanning Report
PSAP	Public Safety Answering Point
RD	Relative Delay
RSSI	Receive Signal Strength Indicator
RTD	Round-Trip Delay
SS	Subscriber Station
SUPL	Secure User Plane Location
SV	Satellite Vehicle
TDOA	Time-Difference of Arrival
TTF	Time to First Fix
U-TDOA	Uplink Time-Difference of Arrival
UDR	Usage Detail Record
ULP	User Plane Location Protocol
vLS	Visited Location Server

3.2 Terms & Definitions

Almanac: Data parameters that coarsely describe the orbital trajectory of the GPS satellites. Given approximate time and approximate user position, the almanac allows the GPS receiver to know which GPS SVs to acquire.

Autonomous GPS: Refers to traditional GPS techniques where the GPS receiver must scan for and acquire GPS signals without assistance data from an external source, such as a wireless network. It must also demodulate all the ephemeris, clock correction, and other SV data, and compute the user's location; this process often takes 30 seconds or more.

A-GPS: Assisted GPS, where the GPS receiver obtains aiding data from an external source such as a wireless network. The aiding can be in the form of SV ephemeris data, precise or coarse time aiding, approximate user position, Doppler offsets of the satellites in view, or corrections to the GPS receiver's local oscillator. This allows the GPS receiver to improve its TTFF and acquisition sensitivity significantly. The position of the A-GPS device can be computed by the MS or the LS. This is also commonly known as A-GPS or Assisted GPS.

CINR: Carrier to Interference + Noise Ratio, see [16] spec for further details. CINR is one of the Mobile Scan Report parameters that MAY be sent from the MS to the LS for location determination.

Control Plane Location: refers to procedures where MAC-layer or other inherent signaling is used to send control messages to the MS triggering location-related measurements, and to receive messages from the MS reporting the measurement data or actual location. In WiMAX, Control Plane Location utilizes the R3, R4, R6, R8, and R1 interfaces.

D-TDOA: Downlink Time Difference of Arrival: equivalent to EOTD in this context.

EOTD: Enhanced Observed Time Difference, refers to a location method where user position is computed based on measured time differences of arrival of preamble (or other reference symbols) between a single MS and multiple BS. The MS receiver is used to compute the measurements, typically using timing preamble signals sent by each BS. BS positions must be known. Actual user location MAY be computed by the MS or the LS.

Ephemeris: Data parameters that describe the orbital trajectory of the GPS satellites. Required for user position computation via GPS

GNSS: Global Navigation Satellite System. The current LBS specification refers only to GPS, as it is the only fully deployed GNSS system as of Dec. 2008. Nonetheless, the concepts and parameters defined in this LBS spec can be applied to other systems such as Galileo and Glonass once they become fully operational.

GPS: Global positioning system. This is the GNSS deployed by the United States Government.

LBS Measurement Report: This parameter in WiMAX provides measurement data for a single BS from an MS.

LBS Measurement Set: This parameter in WiMAX refers to a measurement set that contains up to 7 LBS measurement reports.

RSSI: Received Signal Strength Indicator, see [16] for further details. RSSI is one of the Mobile Scan Report parameters that MAY be sent from the MS to the LS for location determination.

RD: Relative Delay, see [16] spec for further details. Relative Delay is one of the Mobile Scan Report parameters that MAY be sent from the MS to the LS for location determination. Given RTD, Relative Delay allows the radial distance between the MS and neighboring BS to be estimated.

RTD: Round Trip Delay, refers to the total signal transit time between MS to Serving BS and back. Round Trip Delay is one of the Mobile Scan Report parameters that MAY be sent from the MS to the LS for location determination. See [16] for further details. RTD allows the radial distance between the MS and the Serving BS to be estimated.

SV: Satellite Vehicle, referring to one of the GPS satellites in the constellation.

LBS

1 TTFF: Time to First Fix, referring to the time interval between when the LR first requests a fix, and when the fix is
2 actually returned to the LR. “Localized” definitions of TTFF are possible, e.g., the time it takes for a GPS receiver
3 in the MS to determine the MS location.

4 User Plane Location: refers to procedures where a direct connection between the MS and the LS is used to transfer
5 GPS or GNSS assist data to the MS from the LS, to send messages from the LS to the MS to trigger location-related
6 measurements, and to receive messages from the MS to the LS reporting the measurement data or actual computed
7 location. An IP-based protocol is usually used in User Plane Location. In WiMAX, User Plane Location utilizes the
8 R2 interface.

9 U-TDOA: Uplink Time Difference of Arrival, a method complementary to EOTD, where the pseudo ranges are
10 measured by multiple BS using the MS transmissions as a reference. Unlike the EOTD method, the MS is required
11 to be transmitting a frame (e.g., RNG-REQ) in order to determine location.

12 WLP: refers to the suite of IETF HELD specifications that are applicable to WiMAX and used in this specification.

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- [1] "RADIUS (Remote Authentication Dial In User Service) Support For Extensible Authentication Protocol (EAP)", RFC 3579, B. Aboba, P. Calhoun, September 2003.
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- [7] "GEOPRIV PIDF-LO Usage Clarification, Considerations and Recommendations", [RFC 5491](#), Winterbottom, Thomson, and Tschofenig, March 2009
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- [13] "Device Capability Negotiation for Device-Based Location Determination and Location Measurements in HELD", [draft-thomson-geopriv-held-capabilities-05](#), Thomson and Winterbottom, January 2009
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- [15] "HTTP Enabled Location Delivery (HELD)", [draft-ietf-geopriv-http-location-delivery-13](#), M. Barnes, J. Winterbottom, M. Thomson, B. Stark, February 2009
- [16] IEEE 802.16Rev2/D7 (October 2008), "Draft Standard for Local and metropolitan area networks, Part16: Air Interface for Broadband Wireless Access Systems", Draft 7, October 2008.
- [17] "RADIUS Attributes for Tunnel Protocol Support", RFC 2868, G. Zorn et al, June 2000
- [18] "HELD Protocol Context Management Extensions", [draft-winterbottom-geopriv-held-context-03](#), J. Winterbottom, H. Tschofenig, M. Thomson, September 2008.

5. Requirements and Principles

5.1 Overall LBS Requirements for WiMAX

The following table is composed of LBS requirements for WiMAX as specified by SPWG.

General Location Requirements	Support Status: Self Evaluation
The following location requirements apply to all WiMAX networks.	
R-[395] The WiMAX Network SHALL be able to provide the location of the serving BS and sector to which the SS/MS is connected.	
R-[396] The WiMAX Network supporting Nomadic usage scenario and/or Mobility Access SHALL be able to advertise serving BS and neighbor BSs' location information to allow applications on the MS to determine its location on a best effort basis independent of network's location determination capability.	
R-[397] The WiMAX Network SHALL provide a mechanism for the user to deny access to its location information except for cases required by regulation.	
R-[398] The WiMAX Network SHALL have mechanisms to ensure secure transfer of user location information across the air link as well as within the access and core networks.	
R-[399] The WiMAX Network SHALL have mechanisms to ensure that user location information is revealed only upon request from authenticated and authorized agents.	
Conditional Requirements: The support for Enhanced Location Capability in the network in general is an optional feature but if supported these enhanced location capability requirements define expected behavior. Enhanced Location determination: Enhanced location determination refers to networks ability to locate a SS with a resolution that is higher than the BS or sector area. Such enhanced location determination MAY be required in specific cases such as emergency services associated with commercial VoIP	
R-[400] The location capability in WiMAX Network supporting Mobility Access SHALL maximize reuse of existing protocols and procedures defined in 3GPP TS 04.30, "Location Services (LCS); Supplementary service operations; Stage 3", October 2002, http://www.3gpp.org/ftp/Specs/html-info/0430.htm and 3GPP2 X.S0002-0 v1.0, "TIA/EIA-41-D Location Services Enhancements". March 2003, http://www.3gpp2.org	
R-[401] The location determination in WiMAX Network supporting Mobility Access SHOULD allow interworking with standard application layer location protocols, such as technologies defined in OMA Mobile Location Protocol, November 2005 (Status: Candidate) http://www.openmobilealliance.org/ftp/Public_documents/LOC/Permanent_documents/OMA-TS-MLP-V3_2-20051124-C.zip and Secure User Plane Location Requirements, July 2006 (Status: Draft), http://www.openmobilealliance.org/ftp/PD/OMA-RDRR-SUPL-V2_0-20060821-I.zip	

LBS

R-[402] The WiMAX Network supporting Nomadic usage scenario and/or Mobility Access SHALL allow location determination procedures to be triggered by the user or by the network.	
R-[403] The WiMAX network SHALL be capable of delivering location information to location services upon request. Such request MAY come from the user, lawful/emergency agencies or other authorized agents on the network.	
R-[404] If commercial VoIP is supported in WiMAX Networks supporting Nomadic and/or Mobility Access usage, enhanced location determination SHALL be supported, and the enhanced location determination SHALL be able to meet the location accuracy specified in E911 Phase 2 requirement FCC Docket no 94-102 this includes order numbers 96-264, 99-96, 99-245.	
R-[405] If commercial VoIP is not supported in WiMAX Networks supporting Nomadic and/or Mobility Access usage, enhanced location determination MAY be supported, and the enhanced location determination MAY be able to meet the location accuracy specified in E911 Phase 2 requirement FCC Docket no 94-102 this includes order numbers 96-264, 99-96, 99-245 .	
R-[406] When enhanced location determination is supported, the WiMAX network SHALL determine the location of an individual WiMAX SS/MS using network based or terminal based location determination mechanisms, or both mechanisms.	
R-[407] When enhanced location determination is supported the WiMAX network SHALL be able to locate the SS/MS regardless of whether the SS/MS is initially in idle, sleep, or active mode.	
R-[408] When enhanced location determination is supported the WiMAX network SHALL be able to determine SS/MS location without requiring an independent positioning capability (such as GPS) capability at the SS/MS.	
R-[409] When enhanced location determination is supported the WiMAX network SHALL be able to determine if the SS/MS has special position measurement and determination capabilities (such as being able to make GPS measurements with or without the assistance of the network or calculate its position from such measurements) and use those capabilities to enhance location determination.	
R-[410] When Location Based Services (LBS) are supported, the WiMAX network SHALL be able to identify, authenticate and authorize users upon accessing designated LBS services.	
R-[411] When Location Based Services (LBS) are supported, the WiMAX network SHALL enable multiple priority levels for LBS flows, so that if contention for resources arises, a higher-priority LBS flow or an Emergency Service SHALL have precedence over lower-priority flows.	

1

2 **5.2 R2 interface specific requirements**

3 The protocol(s) used for the R2 interface:

- 4 • SHALL support trigger based location (e.g., Periodic location)
- 5 • SHALL support one time location
- 6 • SHALL support capability to adopt WiMAX specific primitives like BSID and MS scan reports
- 7 • SHALL be aligned well with AAA framework for security
- 8 • SHOULD work well for all classes of WiMAX devices
- 9 • SHALL support roaming

LBS

- 1 • SHALL provide support for GPS assistance
- 2 – Ephemeris
- 3 – Almanac
- 4 – Broadcast (this feature is optional)
- 5 • SHALL support controllable dependencies with the external entity defining the protocol.
- 6 • SHALL support civic and geodetic location
- 7 • SHALL support LS discovery
- 8 – Capabilities advertisement by MS and capabilities negotiation between LS and MS.

9 **5.3 Privacy Protection**

10 The privacy of the subscriber's location information SHOULD be protected. The AAA or the LS SHOULD have the
11 function of authentication or authorization check to guarantee privacy protection for the target MS. The LS can
12 negotiate with the target MS to control the location privacy for value added services. However, for emergency
13 services and lawful interception services, the target MS MAY be positioned regardless of privacy settings.

6. Network Reference Model

The LBS architecture is a functional model consistent with the WiMAX network reference model (NRM). The architecture has support for control plane, user plane and mixed plane location determination.

Figure 1 shows the functional reference model for LBS operations in the WiMAX network.

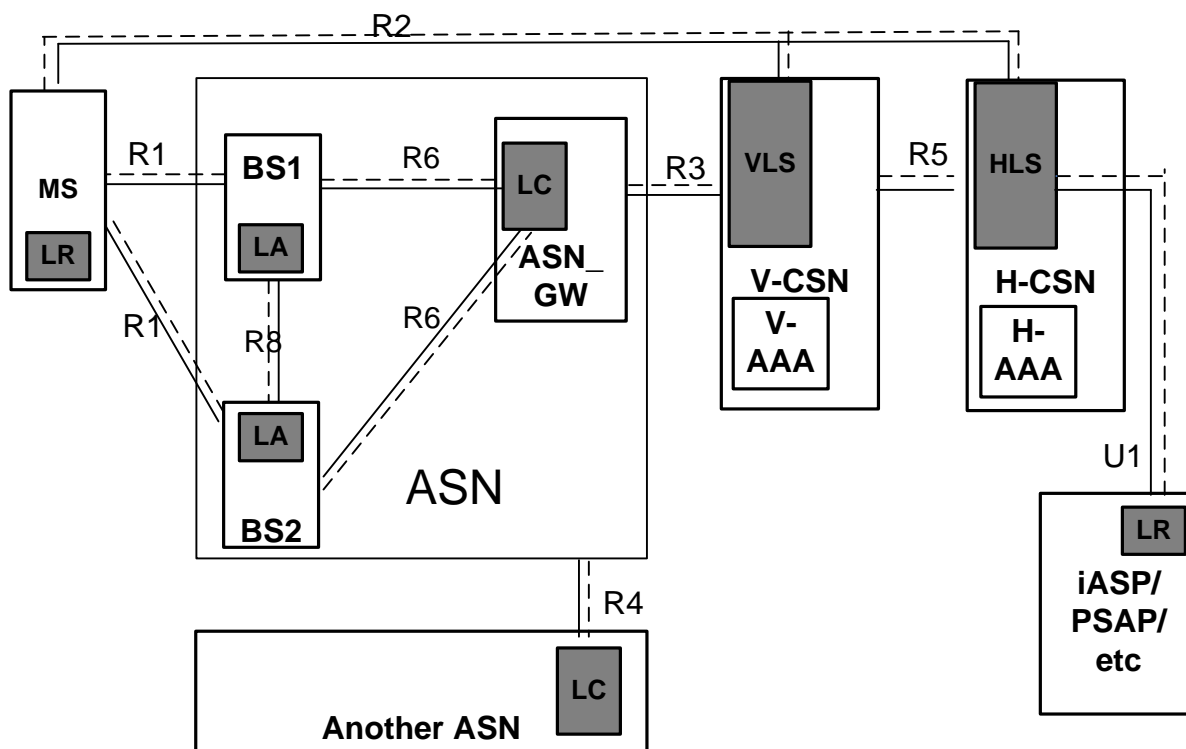


Figure 1 : Functional Reference model for Location based services

6.1 Functional Entities

Location Server (LS): in a WiMAX network, the LS determines and provides the location of the MS. The LS can determine the MS location based on several mechanisms – these include: triangulation measurements, BS-ID obtained from the Anchor Authenticator or from the MS, GPS measurements from the MS, or a hybrid of these measurements. The LS MAY provide GPS or GNSS assistance data to the MS, and the MS may actually compute location itself. The LS provides the determined MS location to authorized entities internal or external to operator's network. The LS triggers network initiated LBS process based on external requests. The LS is located in the CSN. In the roaming scenario, the home LS (hLS) is located in the H-CSN and the visited LS (vLS) is located in the V-CSN.

Location Controller (LC): The LC is located in the ASN. The LC is responsible for coordinating the location measurements of the MS. The LC provides the location measurements for the MS to the LS upon request. Upon request from the LS, the LC SHALL trigger the location related measurements and collect all relevant data needed to make a location determination. The LC is always aware of the mobile's serving BS.

Location Agent (LA): The LA is located in the BS and is responsible for measuring, collecting, and reporting of measurement data to the LC over the R6 interface. The LA function communicates with the MS over R1 and over R8 to other LAs when it collects location measurements.

Location Requester (LR): The LR is an entity or function that originates a request for location information of a particular MS. The LR MAY reside outside the WiMAX network, (e.g., an external application server (AS) requesting the user location) or in the WiMAX network including the MS.

LBS

Mobile Station (MS): The MS executes various procedures related to LBS. The LR in the MS MAY request location information from the LS. The MS MAY request GPS assistance data from the LS and send back GPS pseudo ranges to the LS. In other scenarios, the MS MAY send WiMAX scan report data to the LS using R2, or to the LA using R1. If the MS determines its own location (with or without assistance from the LS or LA), it MAY report the location back to the LS or other applications.

6.2 Reference Points

The R2 reference point MAY be based on OMA SUPL. The R2 reference point or MAY be based on WiMAX Location Protocol (WLP). See Section 8.4 for further details. This reference point supports User-Plane location capabilities.

The R3 reference point MAY be based on RADIUS or Diameter and uses the AAA protocol for security, depending on the operator's deployment. This reference point supports Control-Plane location capabilities.

The R4, R6 and R8 protocols are UDP based where the message headers as specified at [1] in [3] are reused.

The R5 reference point MAY be based on RADIUS or Diameter, depending on the operator's deployment.

The LBS U1 reference point is not defined in this specification. There are existing protocols that MAY be utilized for this reference point, for example Parlay X, MLP, ESP, HELD etc.

7. LBS Procedures

There are two main usage models for LBS:

a) MS Managed Location:

- Mobile measures, calculates and uses the location information with minimal interaction with the network.

b) Network Managed Location

- Network is involved in triggering, determining or reporting the location.

7.1 MS Managed Location

The MS managed location procedure is optional for both the MS and the BS. MS managed location means that the MS takes the necessary measurements, calculates the location and uses it. Each BS broadcasts its geo-location as well as its neighboring BS's location. This information is broadcast periodically by the serving BS as an L2 LBS-ADV message. The MS uses the LBS-ADV information or measurements, and calculates the location on its own. The MS does not need to report its location to the WiMAX network. The MS MAY send its location to applications, e.g., for local search etc. The exact algorithms used by the MS to determine its location are outside the scope of this specification. The MS MAY have a standalone location capability like a GPS or it MAY rely on the geo-location broadcast from the WiMAX network. No LBS specific functional support is required in either the ASN or the CSN.

Figure 2 provides the call flow for the MS managed location.

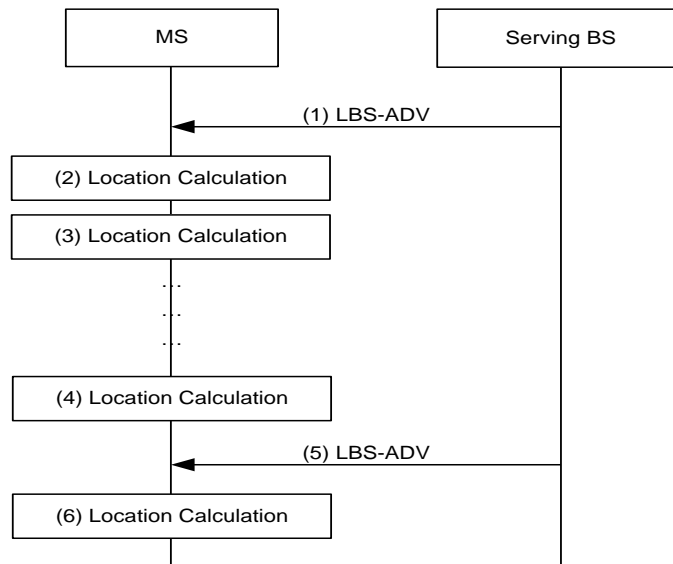


Figure 2 : MS managed location

STEP 1

Serving BS broadcasts its geo-location information together with neighbor BS's location information.

STEP 2 – STEP 4

The MS calculates its own location either with the help of information in LBS-ADV or by other means. This is done as required by the applications that are using the location. LBS-ADV messages are received and location is calculated in mixed order.

LBS

STEP 5

Another periodic broadcast of LBS-ADV message occurs.

STEP 6

MS calculates its location.

7.2 LBS Authentication and Authorization

LBS Security is required to ensure secure transfer of MS location information and guarantee the location service is accessed by authenticated and authorized users.

This procedure also provides the LS with the information it needs in order to obtain network measurements through the Location Controller (LC).

The network SHALL authenticate the LR (over R2 or U1) when it requests the location of a target MS. Upon successful authentication and authorization of the LR, the LS can provide the LR access to location services. Otherwise, the LS will reject the LR request.

Refer to Section 8.4.3 for more details on R2 security.

The following figure shows the typical procedure of LBS Authentication and Authorization.

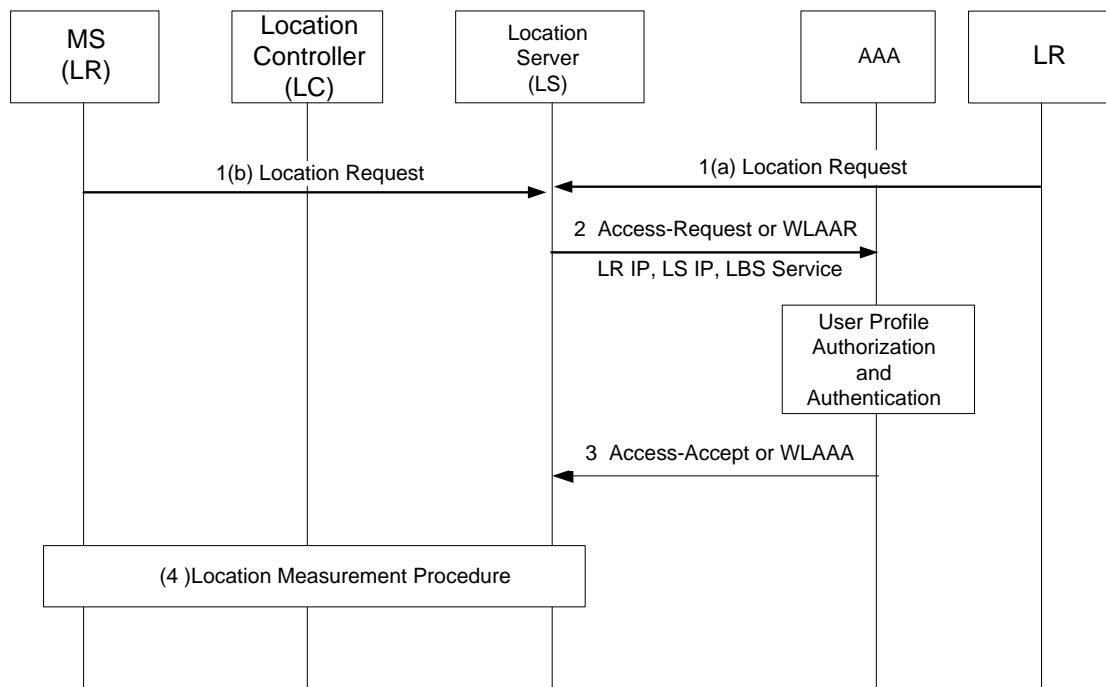


Figure 3 : LBS Authentication Procedure

STEP 1

The Location Requestor (LR) sends a location request to the Location Server. The Location Requestor could be either an external entity or could be the MS. In the case where the LR is an external entity, the LR provides the LS (over U1), with its identity assertion, the identity of the target MS or an authorization assertion that was granted to the LR for acquiring location information. These assertions are not in scope of this specification but MUST be recognized by the AAA. In the case where the MS is seeking its own location, it provides the LS with its identity

LBS

(the same identity used during the WiMAX network access authentication), and the SPI of the shared secret key known to the MS and the AAA.

STEP 2

The LS contacts the AAA to authenticate the location requestor and determine if it is authorized to use the service and locate the target MS. The LS uses the AAA protocol (RADIUS Access-Request or Diameter WLAAR command) and sends the attributes received from the LR to the AAA. In the case of an external LR, connected over U1, the LS needs to determine the home realm of the user on the target MS. How this is determined is out of scope; it could be information specified by the LR explicitly or contained as part of the MS identity assertion or authorization assertion information elements.

STEP 3

The AAA authorizes and authenticates the location request and responds with Access Accept (RADIUS) or WLAAA (DIAMETER). In the case of an external LR connected over U1, the RADIUS Access-Accept or Diameter WLAAA command authorizes the LS to obtain the location of the target MS. In the case the LR is located in the MS connected over R2, the AAA response contains the security association used by the LS to authenticate the MS over R2. In both cases, the LS receives the Anchor Authenticator and IP address for the MS allowing the LS to obtain measurements used for location determination.

STEP 4

The LS initiates the location measurement procedure as defined in subsequent sections 7.3.

7.3 Network managed location

Here, the network is involved in some aspect of location determination and manages the process. There are three categories, control-plane location, user-plane location, and mixed-plane location.

The location procedures inside the WiMAX network are always triggered by the LS. For network managed location, all applications requiring location data, MUST request location via the LS.

When the LS receives a location request it authenticates the LR and then obtains authorization to provided the location of the MS using the procedure described in Section 7.2. Based on the authorization policy, the QoS in the location request, and the MS capabilities, the LS selects the location determination mechanism(s) to invoke, which MAY be user-plane, control-plane, or a combination of both.

Control-Plane Location

With control-plane location determination the LS obtains measurements from the LC over the R3 interface and location determination is performed on the LS. The location request MAY have been initiated by the MS or by an external third-party.

WiMAX provides three mechanisms for control-plane location determination:

- serving base station identity
- mobile scanning reports (e.g., EOTD)
- base station measurement reports (e.g., UTDOA)

Serving base station identity (BS-ID) and mobile scanning reports are mandatory to implement when claiming compliance to this specification. Base station reports are optional and MAY be supported by the LC.

The determination mechanism invoked by the LS depends on various factors including requested quality of service, ASN network support, and level of service subscription.

User-Plane Location

LBS

User-plane location uses the R2 interface between the MS and the LS. Measurements, GPS assistance and access network information is passed between the MS and the LS to assist with location determination. Location determination MAY be done at the LS or the MS depending on the determination mechanism invoked and the number and quality of the measurements available.

Location requests MAY be sent to the LS by either the MS or an external third-party. Requests MAY be for a one-time location report or for the generation of reports to occur at regular intervals or when certain trigger conditions are met.

WiMAX supports two protocol options over the R2 interface, these are OMA SUPL 2.0 and WiMAX Location Protocol (WLP) based on IETF HELD. R2 protocols are described in more detail in section 8.4.

WiMAX support for assisted GPS location determination techniques, such as A-GPS, requires the implementation of one the supported user-plane location protocols.

Mixed-Plane Location

An LS that is capable of both user-plane and control-plane location determination mechanisms MAY combine them to provide a final position for the MS.

7.3.1 Control Plane location procedures

In this section, the baseline procedure for network managed control plane location determination is described. This assumes no standalone location capability in the MS (like GPS for example).

Location Service Initiation: This can be mobile and/or network initiated. The Location procedures inside the WiMAX network are always triggered by the LS. All location requests from the LR(s) that require the invocation of control-plane techniques MUST be directed to the LS..

Based on the request from an authorized entity, the LS sends a measurement request to the LC. The LC only accepts measurement requests from the LS. The LC MAY also provide MS measurements to some internal functions within ASN to optimize various radio resource allocations and management. Communication procedures between the LS and the LC are outlined in the section below.

When the LS receives a location request it authenticates the requesting entity and then obtains authorization to provide the location of the MS using the procedure described in Section 7.2. Based on the authorization policy and the QoS in the location request message, the LS invokes one of the location determination mechanisms.

For control-plane location determination, the LS sends a measurement request message over R3 in the form of RADIUS CoA or Diameter WLMQR to the Anchor Authenticator containing a request for network measurements.

Please note that in this architecture, control plane messages are supported by the LC and the Anchor Authenticator. For R3, the AAA protocols (RADIUS or Diameter) SHALL be used to exchange information between the LC/Anchor Authenticator and the LS. The LC MAY send an R4 *Measurement Response* message to the Anchor Authenticator which forwards them over R3 to the LS when a direct trust relationship between the LC and the LS does not exist. In this architecture the R3 AAA control plane messages exchanged between the LS and the LC/Anchor Authenticator are used in addition to the LBS accounting messages that are exchanged between the LS and the Accounting server for the purpose of charging and billing.

7.3.1.1 Communication between LS and LC (RADIUS based messages)

This section describes control plan location procedure using RADIUS accounting packets.

RADIUS based call flow

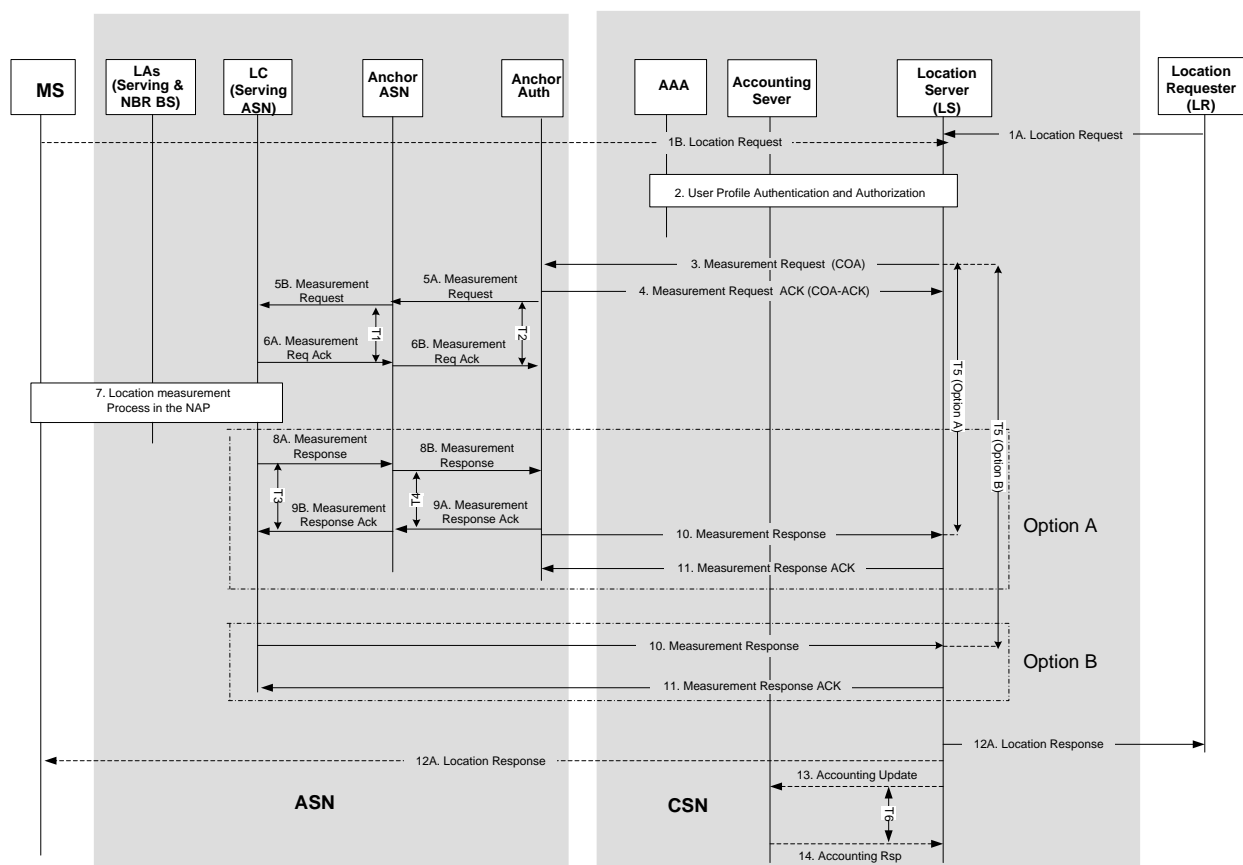


Figure 4 : RADIUS based control plane location procedure for network managed location

STEP 1

Location Request: This message is the trigger message for initiating the location procedure. This request MAY be a periodic or a one time request for the MS's location. The message MUST comply with the R2 or U1 protocol used to make the request.. Acceptable R2 protocols for WiMAX and example U1 protocols are described in Section 6.2.

STEP 2

User Profile, authorization and authentication: The LS and the AAA perform authentication and authorization procedure for the LR. This procedure is described in section 7.2. As part of this authorization, the MS profile and policy will be checked before authorization is granted.

STEP 3

Measurement Request: The LS sends a measurement request (in a COA RADIUS packet) to the Anchor Authenticator over R3. The RADIUS COA packet contains the attributes described in section **Error! Reference source not found.**. After receiving the measurement request acknowledgment over R3, the LS sets timer T5.

STEP 4

Measurement Request Acknowledgement: The Anchor Authenticator responds back with a RADIUS COA-ACK packet indicating receipt of the request. The RADIUS COA-ACK packet contains the attributes described in section **Error! Reference source not found.**

STEP 5 (5A and 5B)

R4 Measurement Request: If the LC is not co-located with the Anchor Authenticator, the Anchor Authenticator sends an *R4 Measurement Request* message (see section 8.1) to the LC in the Serving ASN (via the Anchor ASN if not co-located) requesting a location measurement. It includes the fully qualified domain name of the LS in the LS-ID attribute as received from the LS. Note, that if the measurement request is only for the BSID information, the Anchor Authenticator SHALL return the BSID information. The FQDN of the LS MAY be used by the LC to route the Measurement Response message back to the LS directly over R3. After sending the request, the Anchor Authenticator and the Serving ASN set timers T2 and T1 respectively.

STEP 6 (6A and 6B)

R4 Measurement Req Ack. The LC in the Serving ASN and the Anchor ASN acknowledge the *R4 Measurement Request* by sending back an *R4 Measurement Req Ack*. (see section 8.1). When this message arrives, the Serving ASN and the Anchor Authenticator stop timers T1 and T2 respectively.

STEP 7

Location Measurement Process in the NAP. In this step a location measurement procedure is performed in the ASN. The LC starts the intra-NAP procedure for the location measurement of the MS. There are various types of procedures and they are described in section 7.4

From here on, either Option A is followed where the Measurement Response is sent over Reference Point R4 to the Anchor Authenticator and then over Reference Point R3 from the Anchor Authenticator to the LS, or Option B is followed where the LC sends the Measurement Response directly to the LS over R3. If the LC does not support a AAA client or does not have a direct security association with the LS, the LC SHALL use option A.

STEP 8 (8A and 8B Option A)

R4 Measurement Response. Once the location measurement is completed, the LC sends *R4 Measurement Response* message back to the Anchor Authenticator. The *R4 Measurement Response* message contains the attributes described in section 8.1. After sending the *R4 Measurement Response* message, the Serving ASN and Anchor Authenticator set timers T3 and T4 respectively.

STEP 9 (9A and 9B Option A)

R4 Measurement Response Ack. The Anchor Authenticator and the Anchor ASN acknowledge the *R4 Measurement Response* by sending an *R4 Measurement Response Ack*. When the *R4 Measurement Response Ack* message is received, the Anchor ASN and Serving ASN (LC) stop timers T4 and T3 respectively. The *R4 Measurement Response Ack* message is described in section 8.1.

STEP 10 (Option A)

Measurement Response. The Anchor Authenticator sends a *Measurement Response* message to the LS over R3 contained within a RADIUS accounting packet. The *Measurement Response* message contains the attributes listed in the RADIUS accounting packet and described in section 8.1. When this message is received, the LS stops timer R5.

STEP 11 (Option A)

Measurement Response Ack. The LS acknowledges step 10 by sending *Measurement Response Ack* back to the Anchor Authenticator. The *Measurement Response Ack* message is contained in a RADIUS accounting response message as described in RFC 2866 and described in section 8.1.

STEP 10 (Option B)

Measurement Response. Once the location parameters are determined, the LC directly sends its measurements to the LS in a *Measurement Response* message contained within a RADIUS accounting packet. The *Measurement Response* contains the attributes described in section 8.1. When this message is received, the LS stops timer R5.

STEP 11 (Option B)

LBS

1 *Measurement Response Ack*. The LS acknowledges step 10 by sending *Measurement Response Ack* back to the LC.
2 The *Measurement Response Ack* is contained in a RADIUS accounting response packet and described in section 8.1
3 and conforms to RFC 2866.

STEP 12

5 *Location Response*: Once the LS obtains the location measurement, it SHALL calculate the location of the MS and
6 respond back to the LR. If periodic location data was requested by the LR, the LS periodically initiates steps 3
7 through 10 and responds to the LR with a *Location Response* containing the updated MS location. The *Location*
8 *Response* message is specific to the protocol used to request location on either the R2 or U1 interface.

STEP 13

10 *Accounting Update*. As an optional step, the LS MAY send an *Accounting Update* packet to the accounting server
11 with the location request/response transaction for billing purposes (i.e., the requester MAY be billed by the NSP for
12 the MS's location information) and sets timer T6. The RADIUS *Accounting Update* packet contains the attributes
13 described in section 8.2.3.

STEP 14

15 *Accounting Response*. The Accounting Server responds back to the LS with an *Accounting Response* message
16 contained in a RADIUS *Accounting Response* packet. The RADIUS *Accounting Response* packet is defined in RFC
17 2866 and contains the attributes described in section 8.2.3.

18 Accounting timer T6 is the same as $T_{R3_Accounting}$ specified in Stage 3 [3] sub-clause 4.5.2.4

7.3.1.2 Communication between LS and LC (Diameter based messages)

21 This section describes control plane location procedure using Diameter messages.

Diameter call flow

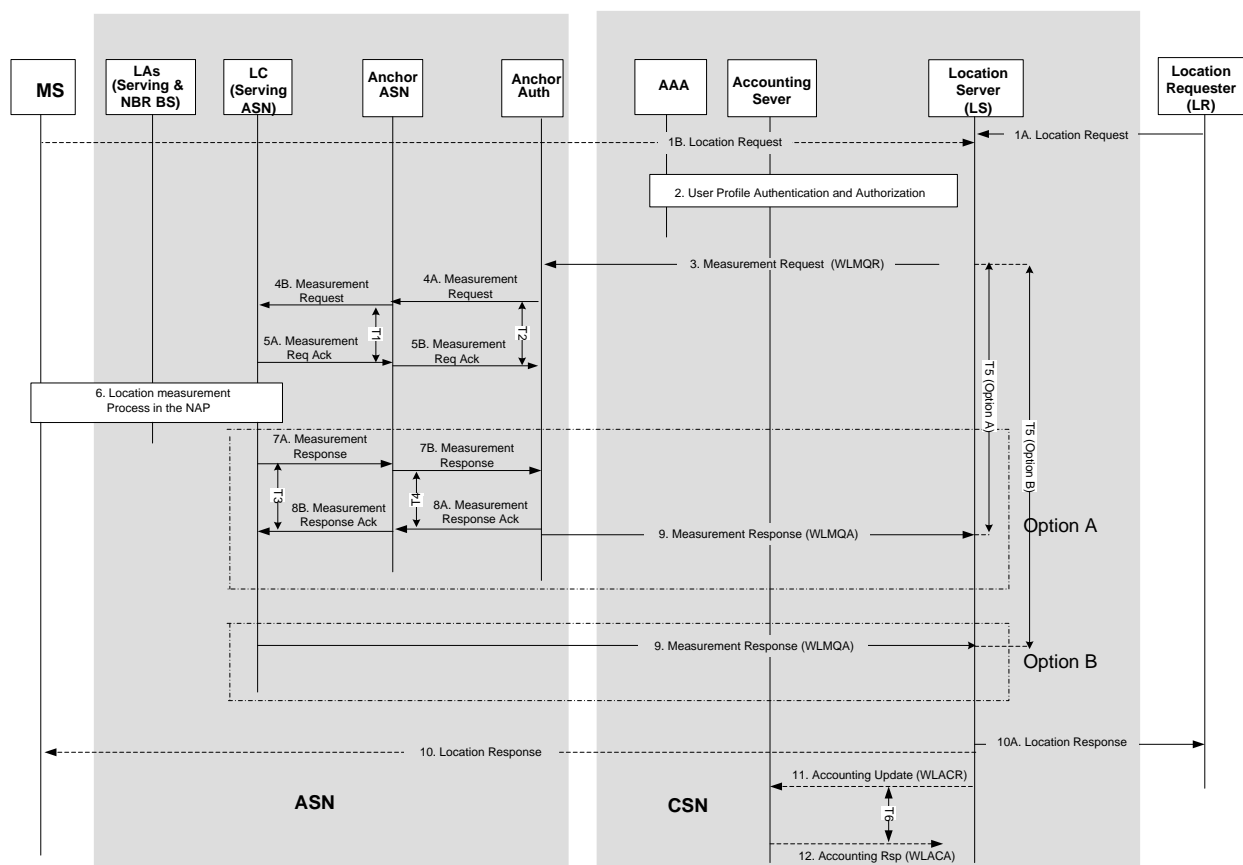


Figure 5 : Diameter based control plane location procedure for network managed location

STEP 1

Location Request: This message is the same as step 1 in section 7.3.1.1.

STEP 2

User Profile, authorization and authentication: This message is the same as step 2 in section 7.3.1.1.

STEP 3

Measurement Request: The LS sends a *Measurement Request* (in the WLMQR Diameter message) to the Anchor Authenticator. The *WiMAX Location-Measurement-Query-Request* message (WLMQR) contains the attributes discussed in section 8.3.2. After receiving the Measurement Request, the LS sets timer T5.

STEP 4 (4A and 4B)

R4 Measurement Request If the LC is not co-located with the Anchor-Authenticator, the Anchor Authenticator sends an R4 *Measurement Request* message. This step is the same as described in section 7.3.1.1 step 5.

STEP 5 (5A and 5B)

R4 Measurement Request Ack. This R4 message is the same step 6 described in section 7.3.1.1

LBS

STEP 6

Location Measurement Process in the NAP. This process is the same as described in section 7.3.1.1 step 7.

From here on, either Option A is followed where the report is sent over Reference Point R4 to the Anchor Authenticator and then over Reference Point R3 from the Anchor Authenticator to the LS, or Option B is followed where the LC sends the *Measurement Response* directly to the LS over R3. If the LC does not support a AAA client or does not have a direct security association with the LS, the LC SHALL use option A.

STEP 7 (7A and 7B Option A)

R4 Measurement Response. This R4 message is the same as described in section 7.3.1.1 step 8.

STEP 8 (8A and 8B Option A)

R4 Measurement Response Ack. This R4 message is the same as described in section 7.3.1.1 step 9.

STEP 9 (Option A)

Once the Anchor Authenticator receives the R4 *Measurement Response* from the LC, it sends *Measurement Response* message directly to the LS contained within the Diameter WLMQA message. The *WiMAX Location-Measurement-Query-Answer* message (WLMQA) contains the attributes described in section 8.3.2. When this message is received, the LS stops timer R5.

STEP 9 Option B

Once the measurements are taken, the LC directly sends its measurement to the LS in a *Measurement Response* message contained within the Diameter WLMQA message. The *WiMAX Location-Measurement-Query-Answer* message (WLMQA) contains the attributes described in section 8.3.2. When this message is received, the LS stops timer R5.

STEP 10

Location Response: This LS to LR message is described in section 7.3.1.1 step 12.

STEP 11

As an optional step, the LS MAY send an accounting update message (WLACR Diameter message) to the accounting server with the location measurement transaction for billing purposes (i.e., the requester MAY be billed by the NSP for the MS location measurement service). The *WiMAX-Location-Accounting-Request* message contains the attributes described in section 8.3.2.

STEP 12

The Accounting Server responds back to the LS with accounting reply message (WLACA Diameter message).

The *WiMAX-Location-Accounting Answer* message contains the attributes described in section 8.3.2.

7.3.1.3 LBS Timers and Timing Considerations**7.3.1.3.1 Timers Description**

This section defines the timers used by the entities participating in the LBS procedure. The LBS procedure uses four timers:

- T1: is started by the Anchor ASN when it sends an R4 *Measurement Request* message to the Serving ASN (LC). Timer T1 is stopped upon receiving the corresponding R4 *Measurement Request Ack* message from the LC.

LBS

- T2: is started by the Anchor Authenticator when it sends an R4 *Measurement Request* message to the Anchor ASN. Timer T2 is stopped upon receiving the corresponding R4 *Measurement Request Ack* message.
- T3: is started by the Serving ASN (LC) when it sends an R4 *Measurement Response* message to the Anchor ASN. Timer T3 is stopped upon receiving the corresponding R4 *Measurement Response Ack* message.
- T4: is started by the Anchor ASN when it sends an R4 *Measurement Response* message to the Anchor Authenticator. Timer T4 is stopped upon receiving the corresponding R4 *Measurement Response Ack* message.
- T5: is started by the LS when the RADIUS COA is sent or in the case of Diameter after the Measurement Request (WLMQR) is sent. T5 is stopped when the LS receives a Measurement response message over R3.
- T6: Accounting timer T6 is the same as $T_{R3_Accounting}$ specified in Stage 3 sub-clause 4.5.2.4.

Table 1 defines the default timer values and also indicates the range of the recommended duration of these timers.

Table 1 – Timers and Timing Considerations

Timers	Recommended Values (msec)	Maximum Timer Value (msec)	Minimum Timer Value (msec)
T ₁	TBD	TBD	TBD
T ₂	TBD	TBD	TBD
T ₃	TBD	TBD	TBD
T ₄	TBD	TBD	TBD
T ₅	Position Latency	Position Latency	Position Latency

7.3.1.3.2 Timer Expiry

Table 2 shows the details of the corresponding action(s) associated with timer expiry. Upon each timer expiry, if maximum retries has not exceeded, the related message is retransmitted and the timer is restarted. Otherwise the corresponding action(s) SHOULD be performed as indicated in the table.

Table 2 – Actions after Timer Max Retry

Timers	Entity where Timer Started	Action(s)
T1	Anchor ASN	Anchor ASN indicates a failure in the R4 <i>Measurement Request Ack</i> message (as described in 8.1).
T2	Anchor Authenticator	Anchor Authenticator sends LBS Error as described in section Error! Reference source not found.
T3	Serving ASN (LC)	LC indicates a failure in the R4 <i>Measurement Response Ack</i> message (as described in 8.1).
T4	Anchor ASN	Anchor ASN indicates a failure in the R4 <i>Measurement Response</i> message (as described in 8.1).
T5	Location Server (LS)	LS indicates to the Location Requester a failure in the <i>Measurement Response</i> message (as described in 8.3).

7.3.1.4 Location Determination for the MS – Idle mode

This sub section details the location determination for the MS, when the MS is in idle mode, as shown in Figure 6.

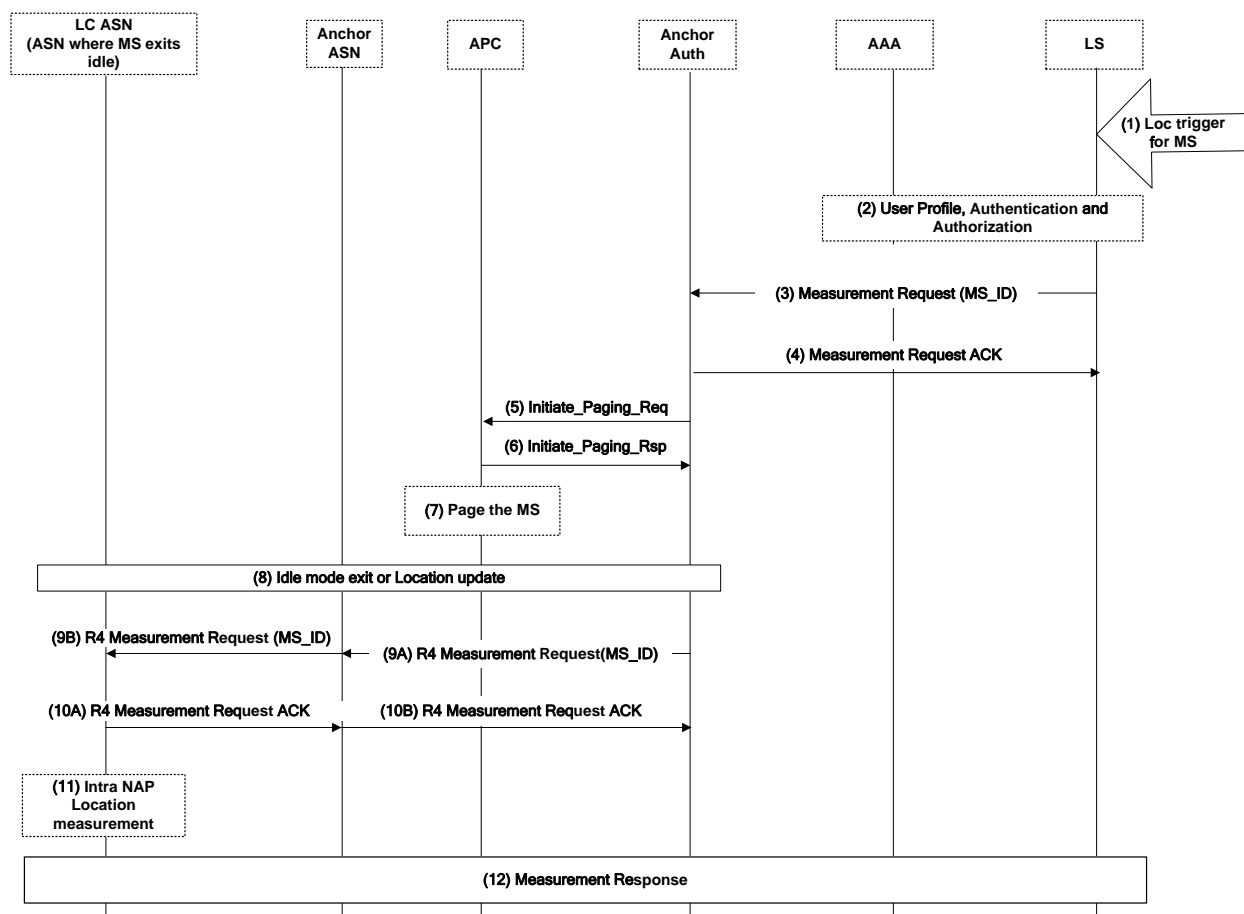


Figure 6 : Identifying and updating the LC: MS in idle mode

STEP 1

The LS gets the location trigger from the LR requesting the location of the MS.

STEP 2

Refer to the step 2 through 3 of Figure 3.

STEP 3

The LS sends a Measurement Request message in the form of RADIUS CoA or Diameter WLMQR message to the Anchor Authenticator requesting network measurements.

STEP 4

The Anchor Authenticator responds back to the LS with Measurement Request Ack. This step is only applied to RADIUS.

LBS

STEP 5

The Anchor Authenticator contacts the Anchor Paging Controller (APC) to page the MS.

STEP 6

The Anchor Paging Controller retrieves the information related to the MS and sends an *Initiate_Paging_Rsp* message to the Anchor Authenticator indicating whether the paging request is authorized.

STEP 7

The Anchor Paging Controller tries to page the MS.

STEP 8

After being paged successfully, the MS exits idle mode in the Serving ASN. This MAY be a different ASN to that of the Anchor Paging Controller ASN and/or the Anchor Data Path Function (DPF) ASN.

STEP 9 (9A and 9B)

If the MS was paged and exited idle mode successfully, the Anchor Authenticator sends the R4 Measurement Request message to the LC (via the Anchor ASN if the serving LC and Anchor ASN are not collocated).

STEP 10 (10A and 10B)

Upon receipt of the R4 Measurement Request, the LC responds back to the Anchor Authenticator with the R4 Measurement Request ACK (via the Anchor ASN if the serving LC and Anchor ASN are not collocated).

STEP 11

The LC performs the Intra-NAP location measurement procedure for the MS.

STEP 12

Refer to the steps 7 through 10 of Figure 4.

7.3.1.5 Control Plane Location Requirements**7.3.1.5.1 LS requirements**

The LS SHALL contact the AAA for the authentication and authorization of the incoming location request for the MS if the Location Server does not already have a valid authentication and authorization for the given MS and/or the requesting entity. If the Location Requestor is not the MS (the location request comes over U1) the NAI MAY be set to the outer NAI used by the MS when it performed WiMAX Network access authentication. The NAI MAY not always identify the user but is required for routing purposes. Therefore as a minimum, the NAI SHALL contain the home realm of the MS e.g., @example.com. In the Access-Accept the AAA SHALL include the User-Name attribute set to the value of the User-Name received in an Access-Request from the Anchor- Authenticator during network entry authentication procedures.

When the Location Requestor is the mobile itself (the location request comes over R2), the user-name SHALL be set to the user identity and the home realm SHALL be set to the one used during the network access authentication.

The LS SHALL send a *Measurements Request* to the LC in the form of a COA RADIUS packet or a Diameter WLMQR message via the Anchor Authenticator to the LC. In this architecture, the AAA messages are used by the LS for the measurement requests and responses. The LS SHALL include its fully qualified domain name in the LS-ID attribute. The FQDN of the LS is used in option B when the *Measurement Response* is routed back directly to the LS.

Upon receiving *Measurement Response* message from the LC or the Anchor Authenticator, the LS SHOULD reply with a *Measurement Response Ack* message to the sending entity.

LBS

1 Upon receiving the *Measurement Response* message, the LS MAY send an Accounting Update (Accounting-Stop)
2 message to the accounting server providing accounting information for the entire location request.

3 In the case of RADIUS, the LS sends a RADIUS *Accounting-Response* packet to the LC/Anchor Authenticator to
4 acknowledge the successful receipt of the *Measurement Response*.

5 If the LS does not receive sufficient measurements from the LC to allow it to calculate the location of the Target-MS
6 then it MAY, depending on the requested response time, request additional measurements from the LC.

7 When requesting measurements from the LC, the LS MAY first request the serving base station identifier from the
8 LC and, based on information internal to the LS, the LS MAY then request the LC to provide multiple
9 measurements in a single measurement response message. This improves location results provided by the LS and
10 reduces network load.

11 The LS SHALL start timer T5 when it sends the COA packet in the case of RADIUS or after sending the WLMQR
12 message in the case of Diameter. The LS SHALL stop Timer T5 when a *Measurement Response* message is
13 received.

14

15 7.3.1.5.2 AAA requirements

16 Upon receiving and authentication and authorization request from the LS, the AAA SHALL perform the necessary
17 checks against the operator's policy for the LR and MS and respond to the LS with an Access-Accept indicating
18 successful authorization or, in the case of failure, an Access-Reject.

19 The AAA SHALL include the Anchor Authenticator (NAS) Identifier in the Access-Accept message. The LS uses
20 the Anchor_Auth ID to communicate with the Anchor Authenticator and the LC. The AAA SHALL also include the
21 IP address of the MS and session key information so the LS can invoke user-plane location (using R2 interface)
22 techniques if available.

23

24 7.3.1.5.3 Anchor Authenticator Requirements

25 The Anchor Authenticator SHALL receive measurement requests from the LS using either the RADIUS or the
26 Diameter protocol.

27 The Anchor Authenticator validates the integrity protection field and the WiMAX Session ID in the *Measurement*
28 *Request* sent in the form of a RADIUS COA packet or a Diameter WLMQR message. If either of these attributes is
29 not valid, then the Anchor Authenticator SHALL reject the message by sending RADIUS COA NACK Packet or a
30 Diameter WLMQA message with an error code = 0x00001001

31 If the mobile is in active mode and the LC is not co-located with the Anchor Authenticator, the Anchor
32 Authenticator SHALL send an R4 *Measurement Request* message (see section 8.1) to the LC.

33 If the mobile is in idle mode, the Anchor Authenticator MAY initiate the paging procedure if the operators' policy
34 permits it. After the mobile exits idle mode, the Anchor Authenticator SHALL send an R4 *Measurement Request*
35 message (see section 8.1) to the LC unless the request was for the BS-ID in which case the Anchor Authenticator
36 SHALL provide this to the LS directly. The R4 Measurement Request SHOULD include the fully qualified domain
37 name of the LS as received in the LS-ID attribute from the LS.

38 In the case of RADIUS, the user-name in the accounting message SHOULD be set to the FQDN of the LS. In the
39 case of a Diameter message, the destination-host AVP SHOULD be set to the fully qualified domain name of the
40 LS. The MS session identifier, WiMAX-Session-ID, is included in the Acct-Multi-Session-ID VSA. The
41 transaction-ID for the measurement request SHALL be included in the response.

42 If the Anchor Authenticator receives an R4 *Measurement Response* message from the LC, it SHALL forward a
43 *Measurement Response* message over R3 to the LS before the expiration of T5. In the case of a Duplicate Request
44 (i.e., repeated MSID/Transaction ID measurement pair), the LC responds to the R4 *Measurement Request* with a R4
45 *Measurement Request Ack* containing error code = 0x05 "Duplicate Request", and the Anchor Authenticator
46 SHALL respond with a RADIUS Accounting-Stop packet or with a Diameter WLMQA message containing an LBS
47 Error Cause of 0x00001010 "Duplicate Request".

LBS

1 The Anchor Authenticator SHALL set timer T2 after sending an R4 *Measurement Request* to the LC (or the Anchor
2 ASN) and SHALL stop timer T2 when it receives an R4 *Measurement Request Ack*.

7.3.1.5.4 LC requirements

5 Upon receiving an R4 *Measurement Request* message, the LC SHOULD trigger the Intra NAP location
6 measurement procedure. The MS-ID and Transaction-ID in the measurement request identify the transaction
7 uniquely and should prevent a race condition if another measurement request message is sent upon timer expiry
8 while the initial response is being sent. The LC SHALL validate a measurement request to ensure that the MS-ID
9 and Transaction-ID are not bound to an outstanding request

10 If the MS-ID and transaction-ID are bound to an existing request, the LC SHALL respond to the R4 *Measurement*
11 *Request* with a R4 *Measurement Request Ack* containing error code = 0x05 "Duplicate Request" In the case of
12 Option B, The LC SHALL send a *Measurement Response* message in the form of a RADIUS Accounting-Stop
13 packet or a Diameter WLMQA message to report the measurement data. In the case of RADIUS, the user-name in
14 the accounting message SHOULD be set to the FQDN of the LS as received from the Anchor-Authenticator with the
15 '@' prepended as in: @ls1.example.com. In the case of Diameter message, the destination-host AVP SHOULD be
16 set to the fully qualified domain name of the LS as received from the Anchor Authenticator. The MS session
17 identifier, WiMAX-Session-ID, is included in the Acct-Multi-Session-ID VSA. The transaction-ID for the
18 measurement request SHALL be included in the response.

19 If the LC does not have the means (either it does not support a AAA client function or does not have the security
20 association directly with the LS), then the LC SHALL send the measurements to the Anchor Authenticator using the
21 R4 *Measurement Response* message.

22 If the LC does not support the requested measurement type then it SHALL respond with an LBS error cause of
23 0x00000111 "Unsupported measurement type".

24 The LC SHALL set timer T3 when sending an R4 *Measurement Response* and SHALL stop timer T3 upon receiving
25 an R4 *Measurement Response Ack*.

7.3.1.5.5 Anchor ASN requirements

28 When the Anchor ASN and the Anchor Authenticator are not collocated, the Anchor ASN SHALL forward the R4
29 *Measurement Request* messages from the Anchor Authenticator to the LC. Likewise the Anchor ASN SHALL
30 forward the R4 *Measurement Response* messages from the LC to the Anchor Authenticator.

31 When the Anchor ASN and the Anchor Authenticator are not collocated, the Anchor ASN SHALL set timer T1
32 when sending R4 *Measurement Requests* and SHALL stop timer T1 upon receiving R4 *Measurement Request Acks*
33 from the LC.

34 When the Anchor ASN and the Anchor Authenticator are not collocated, the Anchor ASN SHALL set timer T4
35 when sending R4 *Measurement Responses* and SHALL stop timer T4 upon receiving R4 *Measurement Response*
36 *Acks* from the Anchor Authenticator.

7.3.2 User Plane Location Procedures

39 User-plane location refers to direct communication between the LS and the MS in order to obtain location
40 information; assistance data (e.g. GPS assistance data), device measurements, a final location, or a simple location
41 request. The MS requesting GPS assistance data can significantly improve fix times by improving the sensitivity of
42 the GPS receiver.

43 There are four basic data flows for user-plane location, two for each supported R2 location protocol. These are MS
44 Initiated and the Network Initiated cases and because these have WiMAX specific components, they are described in
45 the subsequent sections.

LBS

7.3.2.1 MS Initiated Location Request in WiMAX using HELD

Figure 7 shows the message flow of an MS initiated location request in WiMAX using the HELD protocol. The example shows a request for GPS assistance data but could equally apply to other device-based measurements.

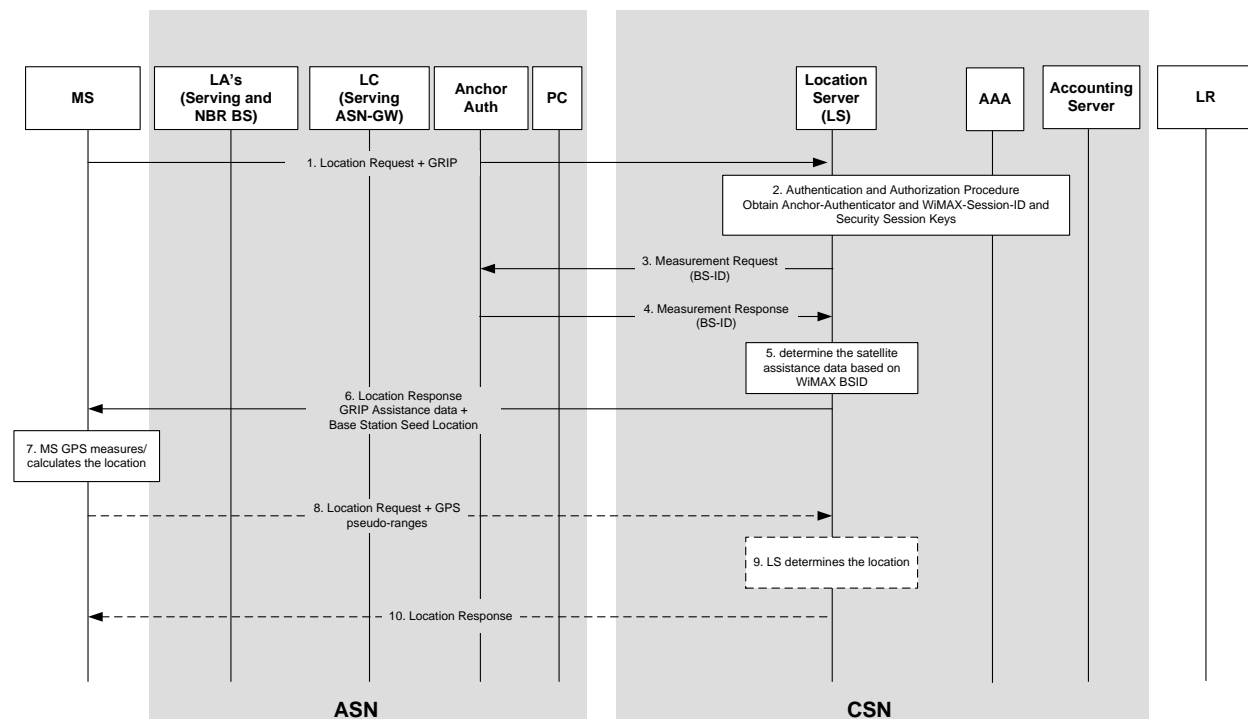


Figure 7 : MS Initiated Location Request in WiMAX using HELD

STEP 1

The MS discovers the address of the LS using the LS discovery procedure. The MS sends a location request to the LS including a request for GPS assistance data [10].

STEP 2

The LS receives the request and contacts the AAA to obtain the WiMAX sessions keys so that it can communicate with the MS securely. It also acquires the MS WiMAX Session ID and the Anchor Authenticator-ID.

STEP 3

The LS sends a Measurement Request message to the Anchor Authenticator requesting the serving base station identifier for the MS.

STEP 4

The Anchor Authenticator responds with a Measurement Response message containing the serving base station identifier.

STEP 5

The LS uses the location of the serving base station to generate GPS assistance data for the MS.

STEP 6

The LS sends a location response to the MS including the GPS assistance data and the location of the serving base station as a seed location [10].

STEP 7

The GPS in the MS uses the assistance data to determine its location. Optionally the MS may not have been provided the GPS navigation model, in which case it will only be able to measure satellite pseudo-ranges. For this case steps 8, 9 and 10 are required.

STEP 8 (optional)

The MS initiates a location request to the LS for location information and includes the satellite pseudo-ranges [12] measured in step 7.

STEP 9 (optional)

The LS uses the pseudo-ranges provided by the MS to calculate the location of the MS.

STEP 10 (optional)

The LS sends a location response to the MS containing the location calculated in step 9.

7.3.2.2 Network Initiated Location Request in WiMAX using HELD

Figure 8 shows how a network initiated location request is handled using HELD in a WiMAX network. The example shows a request for GPS assistance data but could equally apply to other device-based measurements.

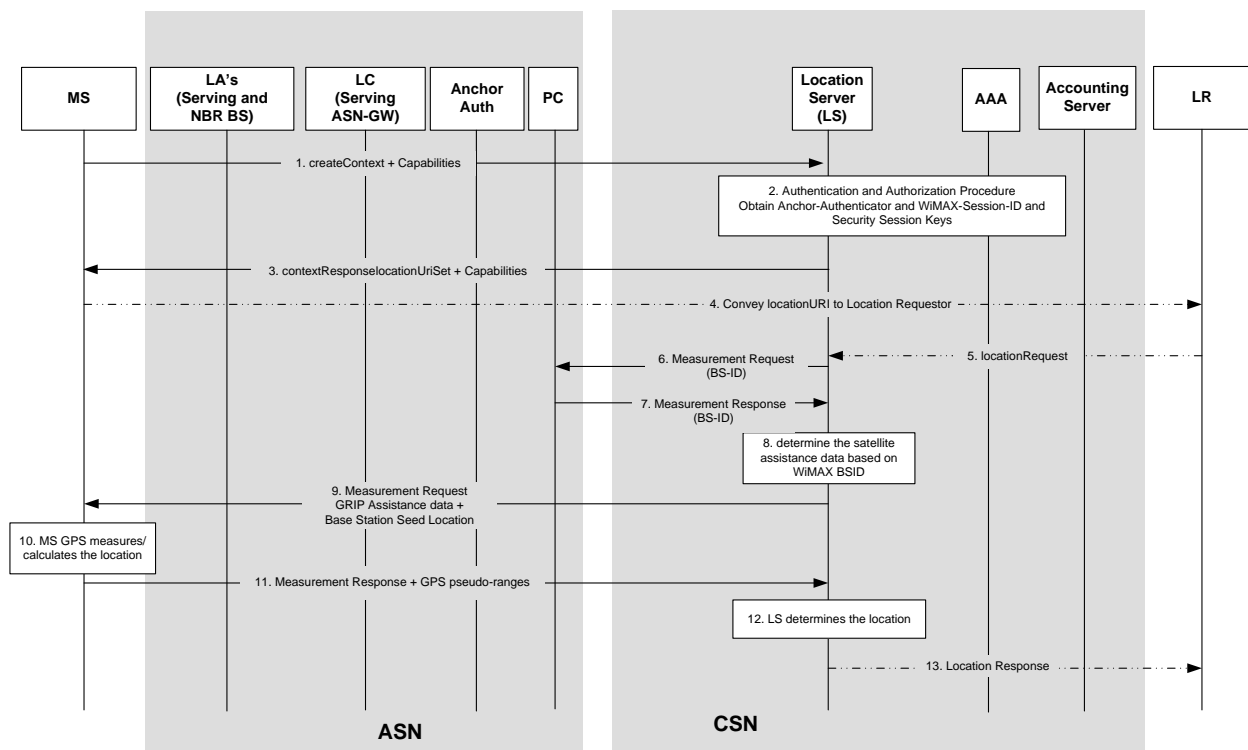


Figure 8 : Network Initiated Location Request in WiMAX using HELD

STEP 1

The MS discovers the v-LS using the LS discovery procedure and creates a context [18] with the v-LS indicating that it has the capability [13] provide A-GPS pseudo-range measurements [11].

STEP 2

The LS performs the authentication and authorization procedures with the AAA. The LS obtains the WiMAX session id, session keys, and the Anchor-Authenticator.

STEP 3

The LS creates the context, generates a locationURI set and indicates that it can use A-GPS pseudo-ranges by sending a contextResponse message to the MS.

STEP 4 (out of scope)

The MS conveys a location URI to a location requestor.

STEP 5(out of scope)

The LR makes a location request to the LS for the MS associated with the location URI.

STEP 6

The LS looks up the context associated with the location URI and requests the serving base station identifier from the Anchor-Authenticator.

STEP 7

The Anchor-Authenticator responds with the identifier of the base station serving the MS.

STEP 8

The LS uses the location of the serving base station to determine GPS assistance data.

STEP 9

The LS sends a HELD measurement request [13] for GPS pseudo-ranges to the MS. This message includes the GPS assistance data and the seed location.

STEP 10

The MS measures the GPS pseudo-ranges.

STEP 11

The MS sends the measured GPS pseudo-ranges back to the LS in a HELD measurement response message [13].

STEP 12

The LS uses the GPS pseudo-ranges to determine the location of the MS.

STEP 13 (out of scope)

The LS returns the location of the MS to the LR in a location response message.

7.3.2.3 MS Initiated Location Request in WiMAX using SUPL 2.0

Figure 9 shows how a SET initiated location request is handled using SUPL 2.0 in a WiMAX network.

LBS

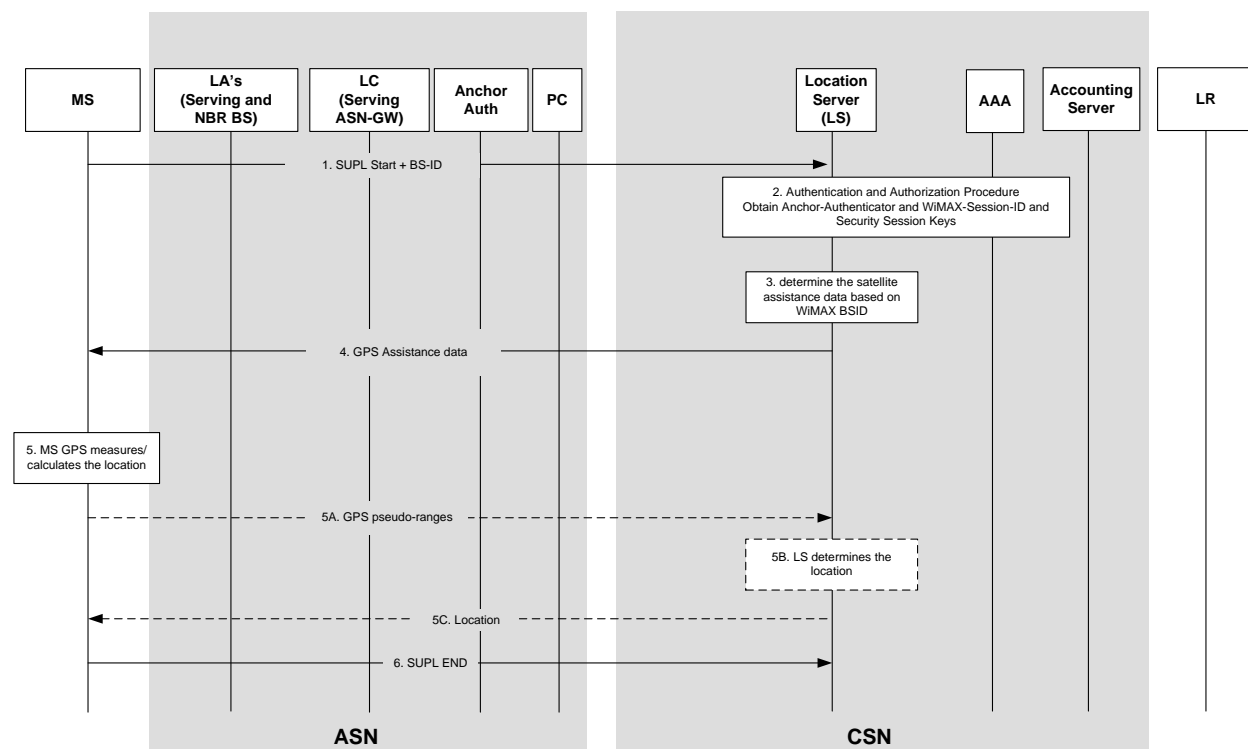


Figure 9 : MS Initiated Location request in WiMAX using SUPL 2.0

STEP 1

The SUPL application in the MS send a SUPL Start message contain the serving base station identify to the pre-configured LS in the home network.

STEP 2

The LS performs the authentication and authorization procedures with the AAA. The LS obtains the WiMAX session keys so that it communicate securely with the MS.

STEP 3

The LS uses the location of the serving base station to generate GPS assistance data for the MS.

STEP 4

The LS sends the GPS assistance data to the MS.

STEP 5

The MS uses the GPS data to improve its ability to detect satellite signals. The MS may get sufficient information to enable it to determine its own location, if it does then proceed to Step 6.

STEP 5A

The MS sends the measured pseudo ranges to the LS so that it can calculate the location.

STEP 5B

The LS uses the measured pseudo-ranges to calculate the location of the MS.

STEP 5C

LBS

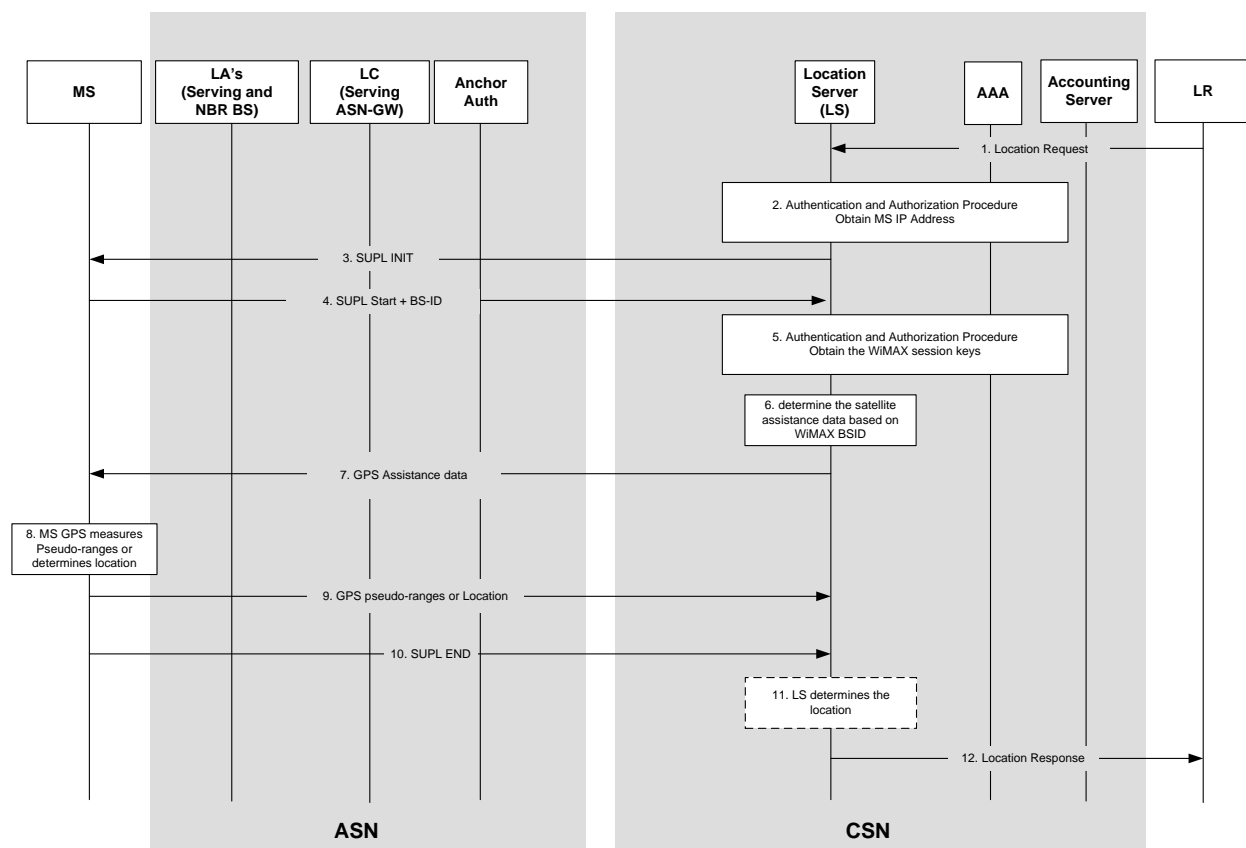
1 The LS returns the calculated location to the MS.

2 **STEP 6**

3 The MS sends a SUPL END message to the LS, which may terminate the connection.

4 **7.3.2.4 Network Initiated Location Request in WiMAX using SUPL 2.0**

5



6

7 **Figure 10 : Network Initiated Location Request in a WiMAX Network using SUPL 2.0 and UDP NI**
8 **messaging**

9 **STEP 1 (out of scope)**

10 A LR sends a location request to the LS for the location of an MS. The MS identifier must be present in the location
11 request.

12 **STEP 2**

13 The LS contacts the AAA to obtain the IP address of the MS.

14 **STEP 3**

15 The LS sends a UDP packet to the MS containing a SUPL INIT message.

16 **STEP 4**

17 The MS responds to the SUPL INIT message by establishing a connection back to the home LS and sending a SUPL
18 Start message that include the serving base station identifier.

STEP 5

The LS contacts the AAA to obtain the WiMAX session keys for the MS.

STEP 6

The LS uses the location of the serving base station to determine assistance data for the MS.

STEP 7

The LS sends the assistance data to the MS

STEP 8

The MS measures the satellite pseudo-ranges using the assistance data provided by the LS.

STEP 9

The MS sends the measure pseudo-range information or the computed location to the LS.

STEP 10

The MS sends a SUPL END message to the LS and closes the connection.

STEP 11

If pseudo-ranges are received, the LS calculates the location of the MS using the pseudo-range information provided by the MS.

STEP 12 (out of scope)

The LS returns the location to the LR.

7.3.3 Mixed Plane Location

In this scenario, the network MAY further enhance the location obtained via the standalone location capability in the MS. This is sometimes referred to as “Hybrid Location”. Both R2 and R3 interfaces are used by the LS to procure location measurements or fixes. The procedure for this scenario is shown in Figure 11.

LBS

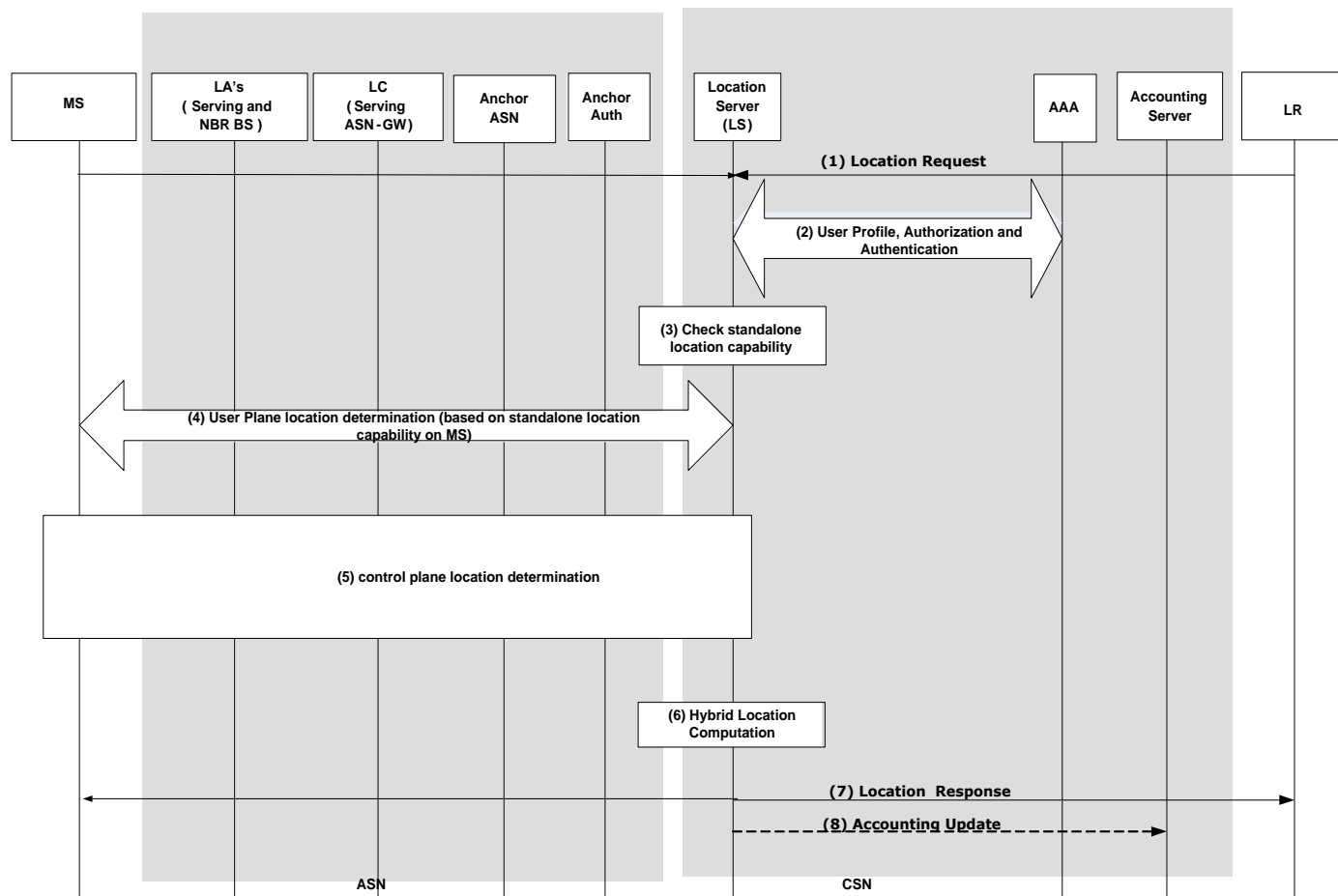


Figure 11 : Mixed Plane location determination

STEP 1

The LS receives a *Location Request* from the LR.

STEP 2

User Profile, authorization and authentication: In this step the LS contacts the AAA for the authorization and authentication of the incoming location request for the MS. The details are shown in section 7.2. If the LS already has the authorization and authentication for the MS and LR, and the associated session timer has not expired, then this step MAY be skipped.

STEP 3

The LS checks the MS capabilities profile (as detailed in section 7.3.4) to see if the MS has standalone location capability.

STEP 4

The LS retrieves the user plane location information. The LS uses R2 protocols to do this as defined in 8.4.

STEP 5

In this step the LS retrieves control plane location measurements as defined in 7.3.1.

STEP 6

The LS performs a hybrid location calculation of the MS using the LC and MS-provided measurements.

STEP 7

LS conveys the location of the MS to the requester.

STEP 8

Accounting update: As an optional step, the accounting client in the LS MAY update the accounting server with the above transaction for billing purposes. The user or the LR MAY be billed by the NSP for the location service.

7.3.4 MS' LBS Capabilities negotiation

In this section, we describe the basic capabilities negotiation procedure between the LS and the MS. The procedure is always initiated by the MS to the LS and MAY be updated by the MS at any time. Capabilities MAY be added or revoked by the MS and the LS is bound to adhere to the MS advertised capabilities. The LS should store the advertised location capabilities of the MS until the MS further advertises a change in its capabilities.

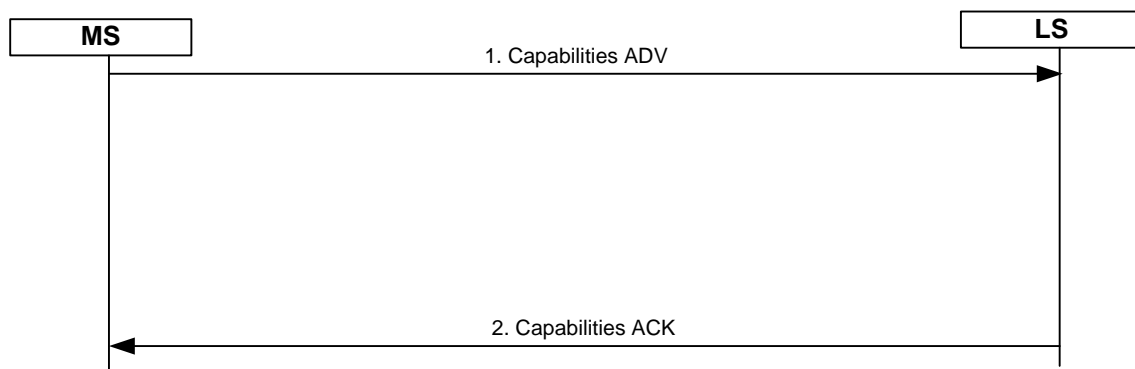


Figure 12 : MS initiated capabilities negotiation

This is shown in Figure 12.

STEP 1

The MS advertises its capabilities to the LS.

STEP 2

The LS responds back with a subset of capabilities that it will use for location determination.

7.4 Intra-NAP measurement procedures.

In this section, we describe the related intra-NAP procedures for location measurement. In the event that these BSs span across different ASNs, the R4 interface will be involved for communication between them.

7.4.1 R6/R4/R8 LBS messages.

The intra NAP procedures require the definition of NWG specific LBS primitives for the R6, R8 and R4 interfaces. The following are the LBS messages for the R6, R4 and R8 interfaces:

- **R4 measurement request:**

LBS

- 1 – Request from the Anchor Authenticator to the LC.
- 2 – Mimics the data included in the Measurement Request over R3
- 3 • **R4 measurement request ACK:**
- 4 – ACK to R4 measurement request.
- 5 • **R4 measurement Response:**
- 6 – The complete set of measurements captured by the LC or an error code..
- 7 • **R4 measurement Response ACK:**
- 8 – ACK to R4 measurement response.
- 9 • **R6 measurement request:**
- 10 – Request to LA to start location measurement.
- 11 – Type and number of radio measurement required (RD/RTD/RSSI/CINR).
- 12 • **R6 measurement request ACK:**
- 13 – ACK to R6 measurement request.
- 14 • **R6 measurement Response:**
- 15 – Measured values that can be used to compute the exact location of the user. E.g., measured time of
- 16 arrival of the signal at the LA, angle of arrival at the LA etc.
- 17 • **R6 measurement Response ACK:**
- 18 – ACK to R6 measurement response.
- 19 • **R8 measurement request:**
- 20 – Sent from serving LA to neighbor LA
- 21 – Request for radio information required for the preparation phase before starting the measurement
- 22 (e.g., DL/UL frame number, DL/UL sub channel number, symbol range etc on which the
- 23 transmission of the signal to be measured will happen; neighbor base stations for this MS).
- 24 • **R8 measurement request ACK:**
- 25 – ACK to R8 measurement request.
- 26 • **R8 measurement response:**
- 27 – Response to R8 Measurement Request sent from serving LA to neighbor LA.
- 28 – Actual radio Information required for the preparation phase before starting the measurement (e.g.,
- 29 frame number, sub channel number, symbol range etc, neighbor base stations for this MS).
- 30 • **R8 measurement response ACK:**
- 31 – ACK to R8 measurement response.

7.4.2 Reference signals for measurement

On the downlink, the MS SHALL perform the required location measurements (RTD/RD/RSSI/CINR) on the preamble of the serving and reference BSs.

On the uplink, the serving and reference BSs MAY perform the required location measurements based on the UL sounding or the RNG-REQ message sent by the MS.

7.4.3 MS managed location.

In this scenario, the MS measures and calculates its location. The measurement could be based on Relative Delay (RD for TDOA) or Round trip delay (RTD for TOA) or RSSI or a hybrid of these metrics. The procedure for this is shown in Figure 13. The call flow shows only one reference BS (BS2) for the sake of simplicity, but in reality there MAY be multiple reference BSs involved in the measurements.

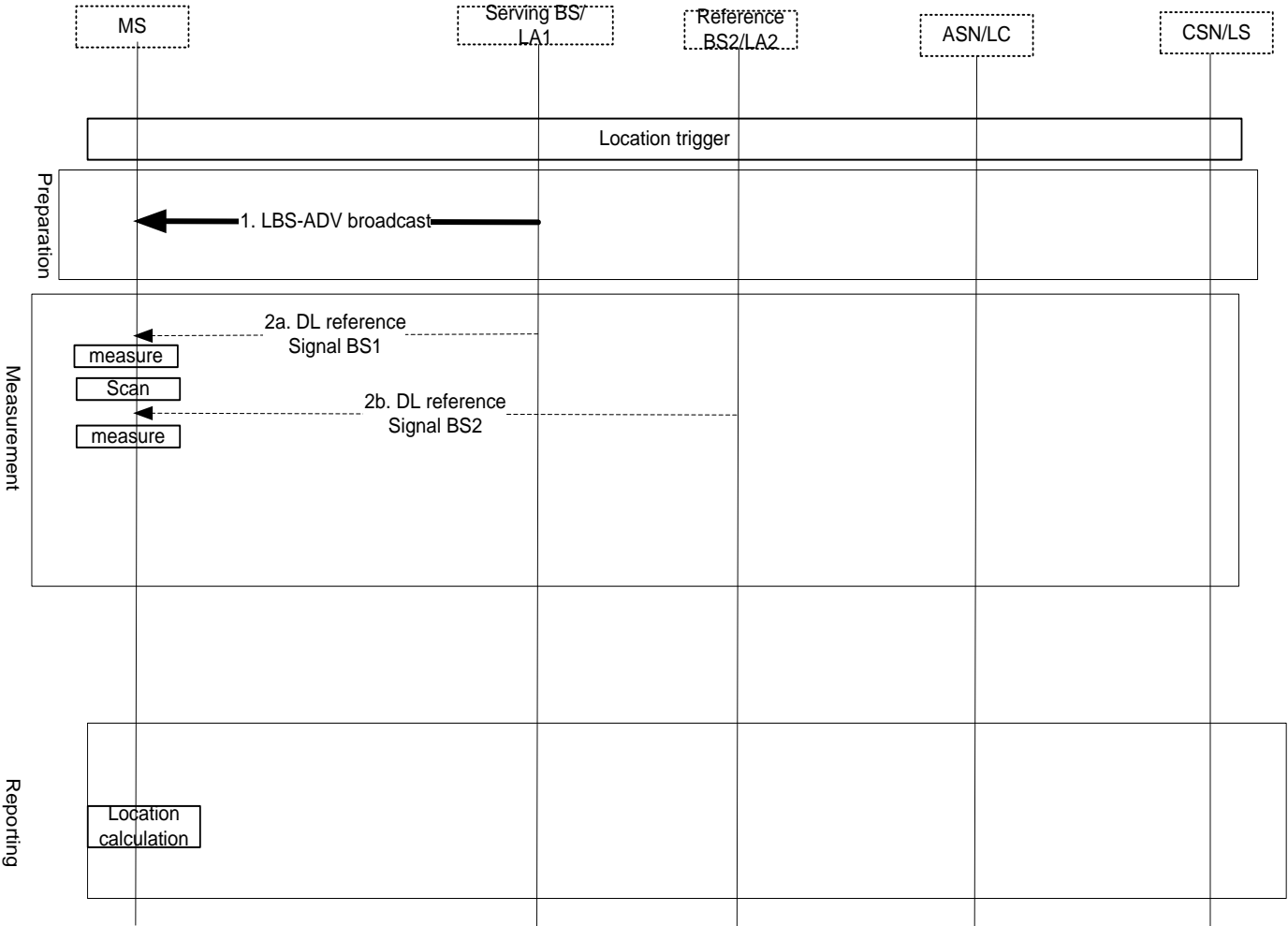


Figure 13 : MS managed intra-NAP location procedure

STEP 1

As part of the preparation phase, the MS MAY receive the LBS-ADV broadcast which contains the co-ordinates of the serving and the reference BSs.

STEP 2

The MS measures the required location metric on DL reference signal from the serving BS and the reference BSs. Once the metrics are measured, the MS calculates the location based on the measurements as well as the location of the serving and reference BSs.

The MS MAY also optionally enhance the location accuracy using GPS if it is available on the device.

7.4.4 Network managed location.

For network managed location, intra-NAP procedures are needed for control plane location and mixed plane location only. There are 3 prominent mechanisms.

- a) Base-Station Identifier (BS-ID)
- b) MS measures and the network calculates (based on Mobile scan reports)
- c) Network measures and network calculates. (For example, UTDOA, etc)

The measurement could be based on Relative Delay (RD for TDOA) or Round trip delay (RTD for TOA) or RSSI or a hybrid of these metrics. The call flow in Figure 19 shows only one reference BS (BS2) for the sake of simplicity, but in reality there MAY be multiple reference BSs involved in the measurements.

7.4.4.1 Base-station Identifier (aka BS-ID)

By default, the location of the MS is estimated as that of the BS and the accuracy is determined by the size of the cell covered by the BS, Format 1 below. The location information of the BS is pre-configured. The BS location database SHALL include Z-height (this is the antenna height above the WGS-84 geoid), but this need not be reported during transmission of BS-ID MS location.

The BS-ID location and uncertainty can be reported in one of three ways. The mandatory format is:

Format 1: Ellipsoid point with uncertainty circle, centered on base station. In Figure 14 below, this refers to point P1 and radius R. This report is appropriate for omni-sectored base stations but MAY also be used for sectored cells. Support for this reporting format is mandatory, and this is the default format. The details of the field descriptor are given in Annex A, “Ellipsoid Point with uncertainty Circle” description.

The other two optional reporting formats are also described below.

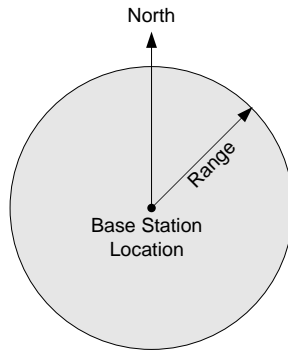
The geographical location of the BS can be obtained by some external mechanisms such as the coverage of the BS, which has been determined by the NAP during network planning and optimization. The coverage is impacted by the transmission power, terrain type, and the CINR threshold for receiving. The determination of the coverage radius R, in Figure 14 below, is outside the scope of this document.

Note that methods referred to as “Enhanced BS-ID” which purport to give an even more accurate MS location estimate, are covered in the Annex below.

The location of the MS can be estimated by using the location and range of the serving base station. This information is configured in the LS. The LS obtains the identity of the serving base station from the Anchor Authenticator located in the ASN, and subsequently maps that to the BS location. The BS location SHALL be represented at a minimum, as latitude, longitude and altitude, e.g., expressed using the WGS84 coordinate reference system.

The location information MAY be reported in the any of the forms suitable for conveyance over R2 or U1. The LS MUST be capable of expressing a base station location as an ellipsoid point with uncertainty circle.

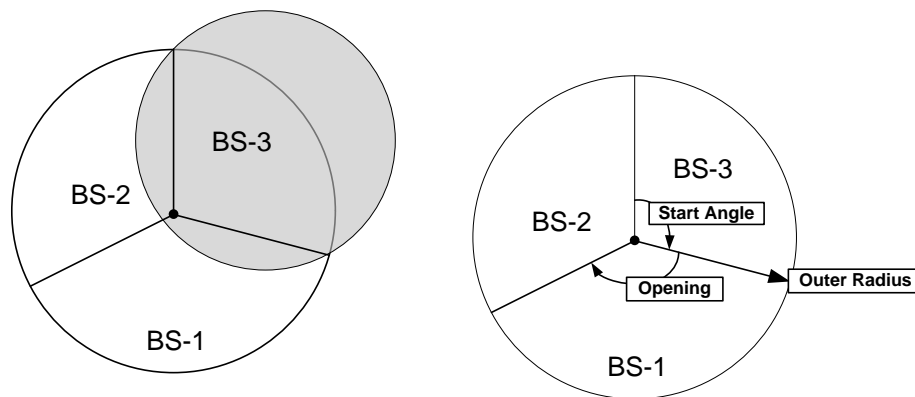
For an Omni-directional base station, the area is expressed with the base station at the centre of the circle.



WiMAX
Omni-Directional
Base Station

Figure 14 : WiMAX Omni-Directional Base Station

For a multi-sector base station, the location MAY be expressed as the circle with the minimum area encapsulating the intended coverage area of a sector. Alternatively, the area of a sector can be expressed as an arcband that is constructed by specifying a start-angle, opening angle, inner-radius and outer-radius; for a base station location the inner-radius is zero.



Tri-Sector Circle
Representation

Tri-Sector Arcband
Representation

Figure 15 : WiMAX BS-ID based-location

7.4.4.1.1 MS in active mode

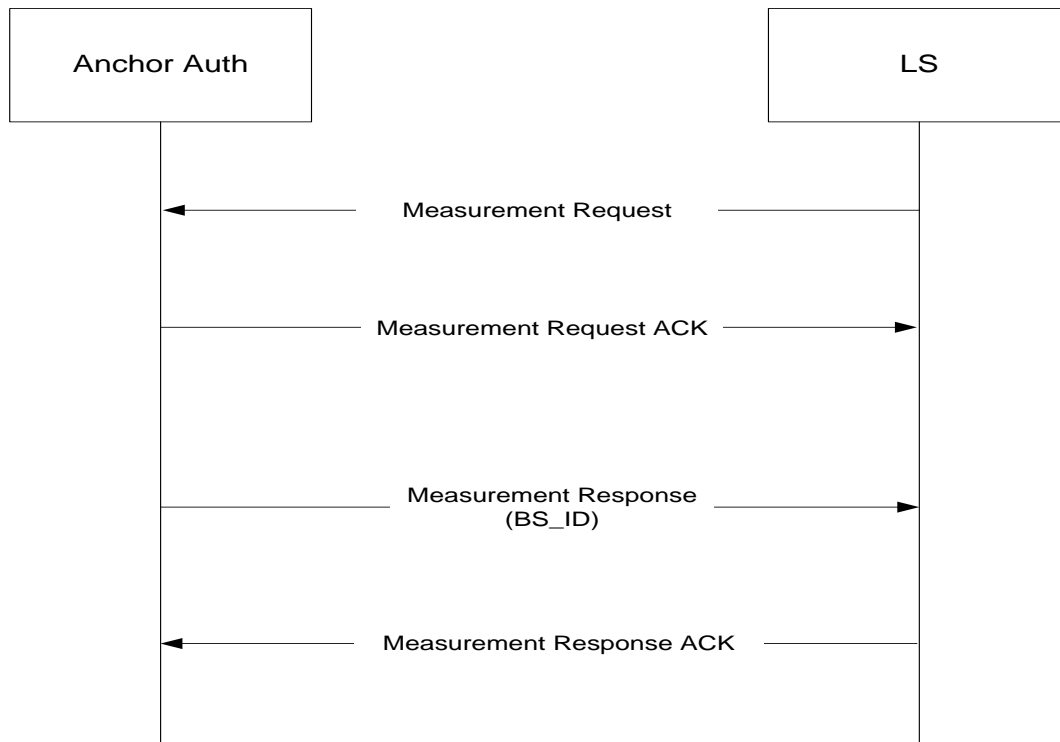


Figure 16 : Intra-NAP procedure based on BS-ID, MS in ACTIVE mode

In this mode, the BS/LA is not involved during location estimation because the Anchor Authenticator knows exactly the BS-ID to which the MS is currently attached. The ACK messages in the above figure are applicable to only RADIUS.

7.4.4.1.2 MS in idle mode

When the MS is in idle mode the Anchor Authenticator, which is aware of the MS state, requests the PC to trigger the paging of MS, based on operator policy. After the MS exits idle mode, the Anchor Authenticator receives the BS-ID of the serving BS, and provides that to the LS. The actual procedure is as follows:

LBS

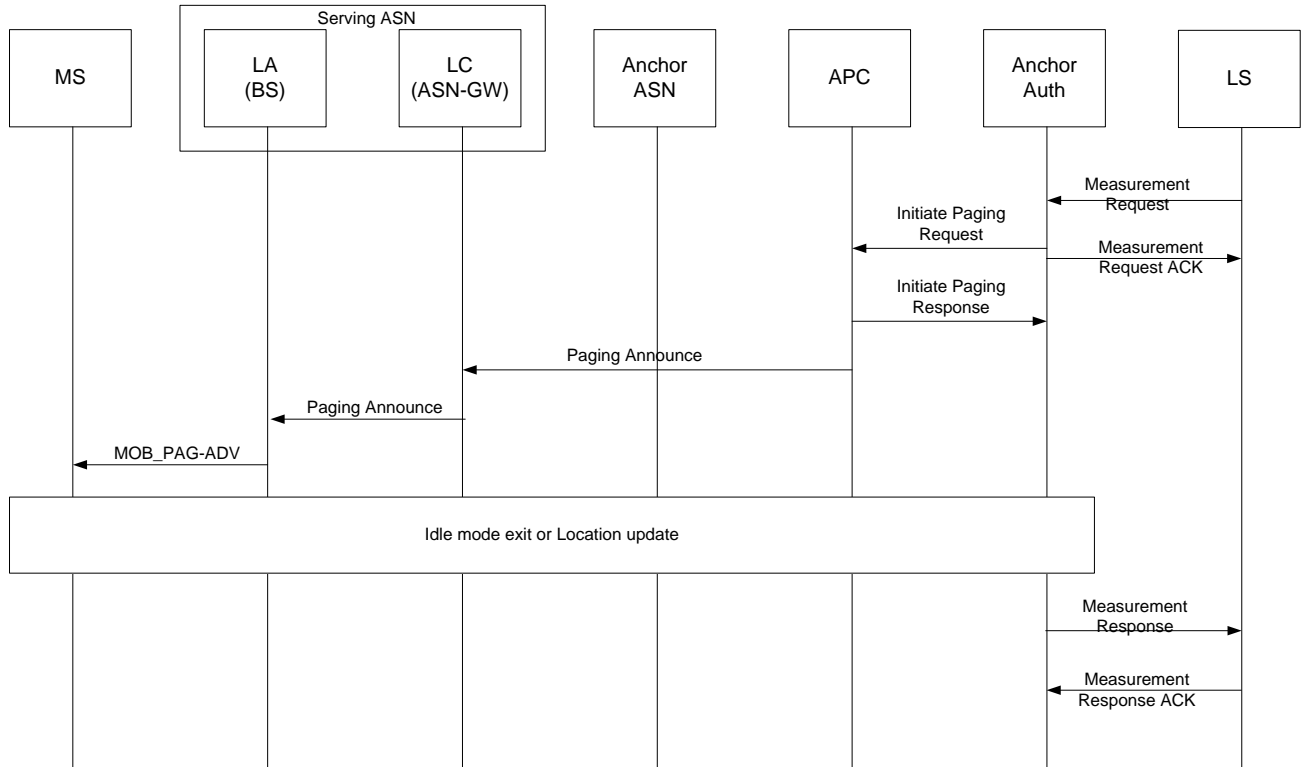


Figure 17 : Intra-NAP procedure based on BS-ID, MS in IDLE mode

The ACK messages in the above figure are applicable to only RADIUS.

7.4.4.2 MS measures and network calculates

The procedure for this is shown in Figure 18. The call flow shows only one reference BS (BS2) for the sake of simplicity, but in reality there MAY be multiple reference BSs involved in the measurements.

LBS

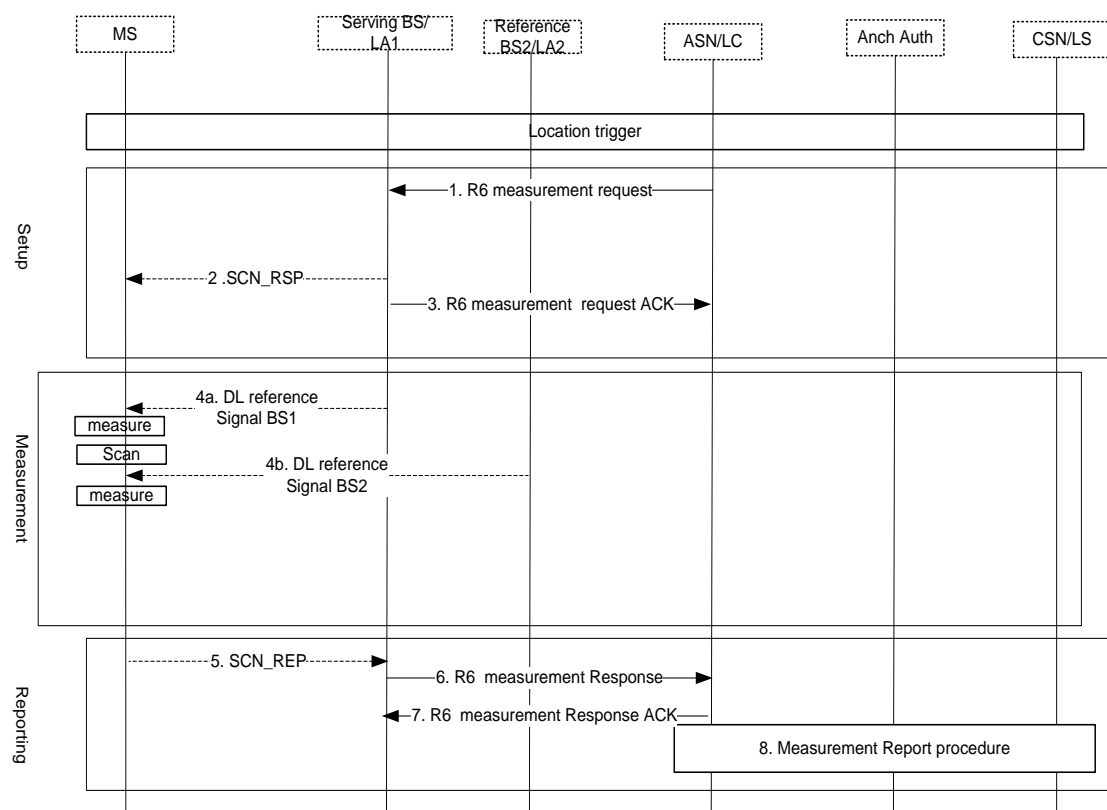


Figure 18 : NAP procedure for network managed location where MS measures and network calculates.

STEP 1

As part of the preparation phase, the serving BS SHALL receive the R6 *Measurement Request* message from the LC asking the serving BS to trigger the location measurement at the MS.

STEP 2

The serving BS sends a trigger to the MS to start the SCAN procedure in order to collect the measurements.

STEP 3

The serving BS acknowledges the R6 *Measurement Request* using a R6 *Measurement ACK*.

STEP 4

The MS performs the required measurements from the serving and the reference BSs.

STEP 5

The MS reports the results back to the serving BS.

STEP 6

The BS reports the measurements to the LC

STEP 7

The LC sends back a R6 *Measurement Response ACK*

LBS

Steps 1 through 7 may be repeated depending on the number of measurement sets requested in the R4 measurement request.

STEP 8

The LC reports the measured parameters to the LS either directly or via the Anchor Authenticator, as defined in section 7.3.1.

7.4.4.3 Network measures and network calculates

The procedure for this is shown in Figure 19 . The call flow shows only one reference BS (BS2) for the sake of simplicity, but in reality there MAY be multiple reference BSs involved in the measurements.

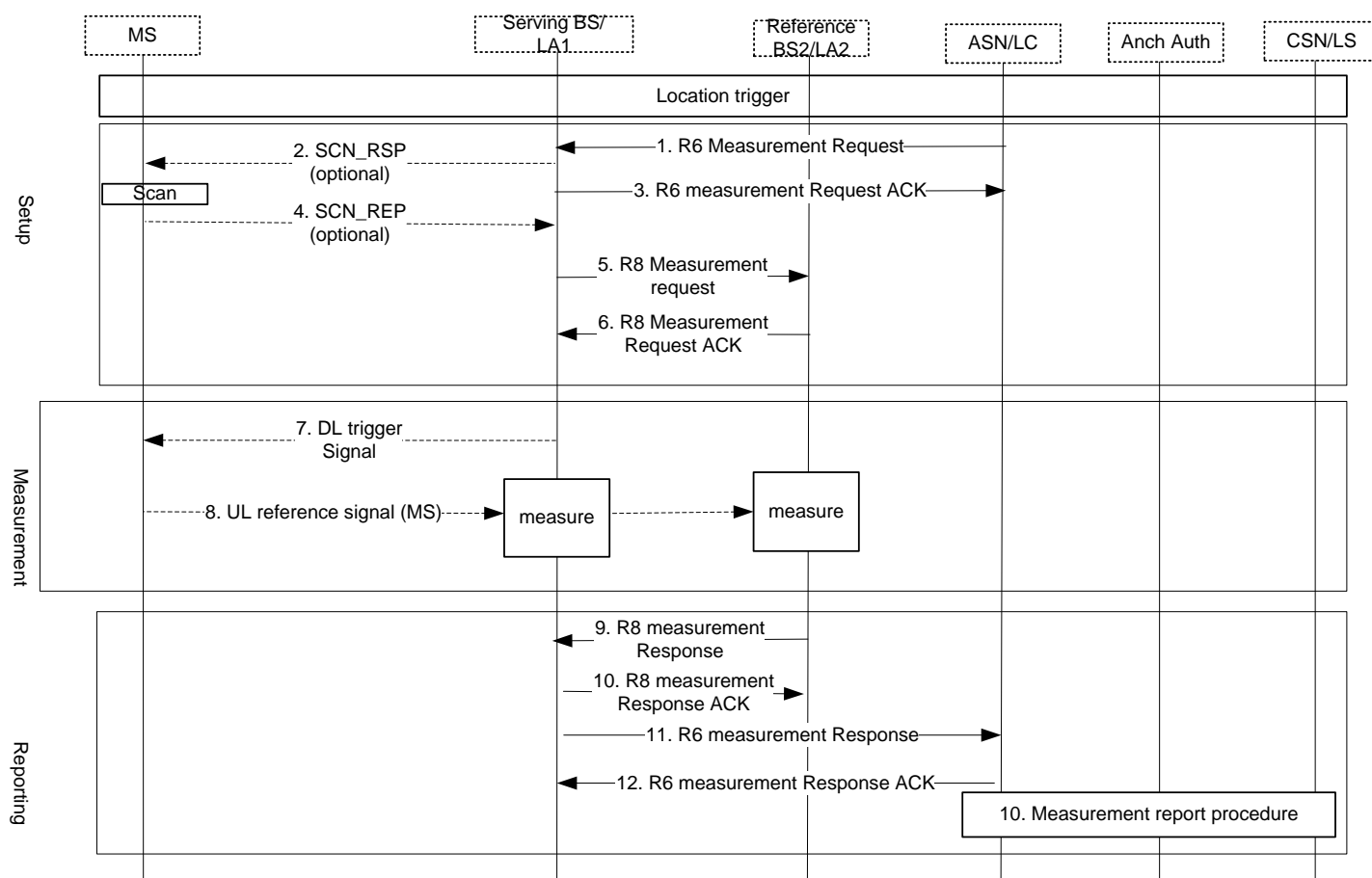


Figure 19 : Intra-NAP procedure for network managed location where network measures and network calculates.

STEP 1

The LC sends a measurement request to the serving BS over R6.

STEP 2

The serving BS MAY in turn request the MS to scan for the best neighbors the MS sees at this point in time.

LBS

STEP 3

The serving BS also ACKs the incoming request from the LC.

STEP 4

The MS responds back with the scanned parameters containing the set of the reference BSs for the location calculation.

STEP 5

The serving BS contacts the reference BSs using R8 measurement request, asking the reference BSs to measure the UL signal from the MS at the given time (symbol) and frequency (sub-channel).

STEP 6

The reference BSs acknowledge the request from the serving BS and avoid scheduling UL data for other MSs, for the time and frequency that they are supposed to measure.

STEP 7

The serving BS MAY send a DL trigger signal to the MS on R1 to initiate a UL signal response from the MS at the pre-set time and frequency, For details please refer to [16]

STEP 8

The reference BSs and the serving BS measure the UL signal from the MS at the preset time and frequency. The reference BSs and the serving BS MAY also measure RD from each others signals for better timing accuracy. This is an optional step.

STEP 9

The reference BSs send their measurements back to the serving BS.

STEP 10

The serving BS acknowledges the received measurements.

STEP 11

The serving BS sends the collected UL measurements to the LC.

STEP 12

The LC acknowledges the received measurements.

STEP 13

The LC reports the measured parameters to the LS either directly or via the Anchor Authenticator, as defined in section 7.3.1.

7.5 LBS Error handling

The LBS procedure MAY encounter some errors which will cause the procedure to be abnormally terminated. Generally, these errors MAY include the following scenarios:

- The MS is powered-off or has otherwise de-registered, e.g., entered Airplane mode.
- The LR does not pass the authentication and authorization.
- The MS is unavailable currently, such as paging failure.

LBS

- The target MS does not allow the current LR which requests the location data of the MS to access the MS's location information. This would be the result of an MS application or service layer function that performs a privacy check, in which certain or all location applications MAY be blocked from receiving the MS location.

7.5.1 Location Procedure for Unavailable/Powered-off MSes

In WiMAX networks, if an MS is unavailable (e.g., powered-off), the AAA, after a period of time, recognizes the MS unavailability condition through key expiry, lack of profile, or other known procedures. A powered-off MS can not be located. In this case, the LR should be notified.

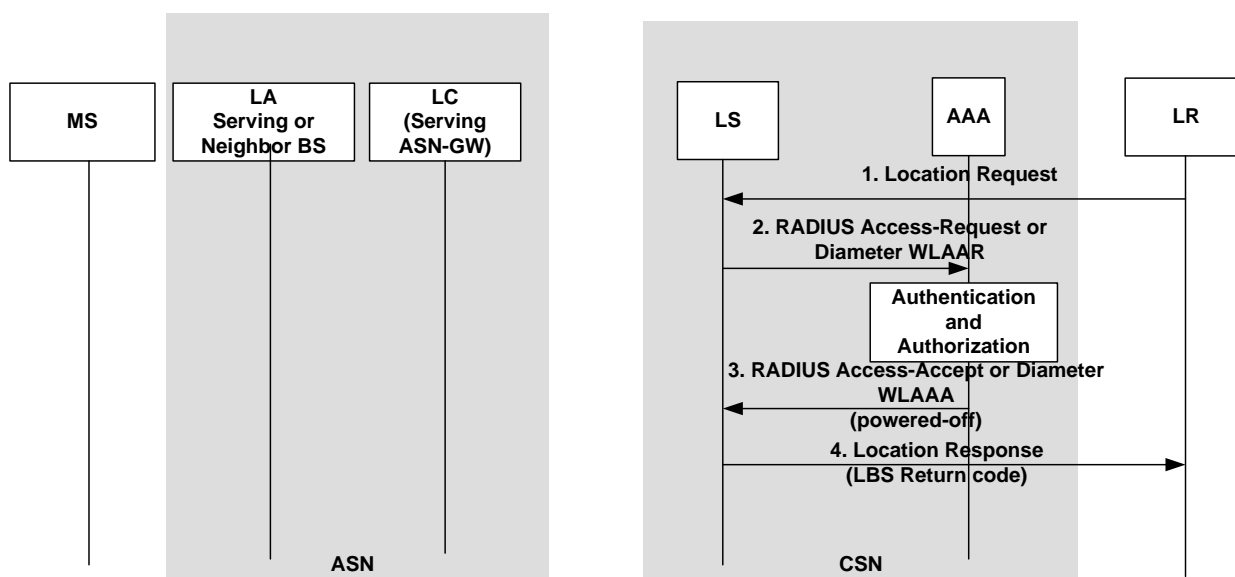


Figure 20 : Location Procedure for Unavailable (e.g., Powered-off) MSes

STEP 1

The external LR sends a Location Request message to the LS in order to locate the MS.

STEP 2

The LS receives the Location Request and sends the LR Authentication and Authorization Request to the AAA.

STEP 3

Assuming the LR Authentication/Authorization request is successful, the AAA checks the state of MS and finds that the MS is powered-off, therefore, it sends a RADIUS Access-Accept or a Diameter WLAAA message with a powered-off indication to the LS.

STEP 4

After receiving the negative response from the AAA in STEP 3, the LS SHALL provide an error code to the LR indicating that the MS is unavailable, the details of which are out of scope of the LBS specification.

7.5.2 Authentication, Authorization, or Privacy Failure

To enhance LBS service security or privacy protection for subscribers, Authentication and Authorization checking SHALL be done in the AAA. When Authentication or Authorization checking fails, the LS SHALL reject

LBS

the LBS service request. Figure 21 illustrates the end-to-end procedure in the case that authentication and authorization checking of the LR fails.

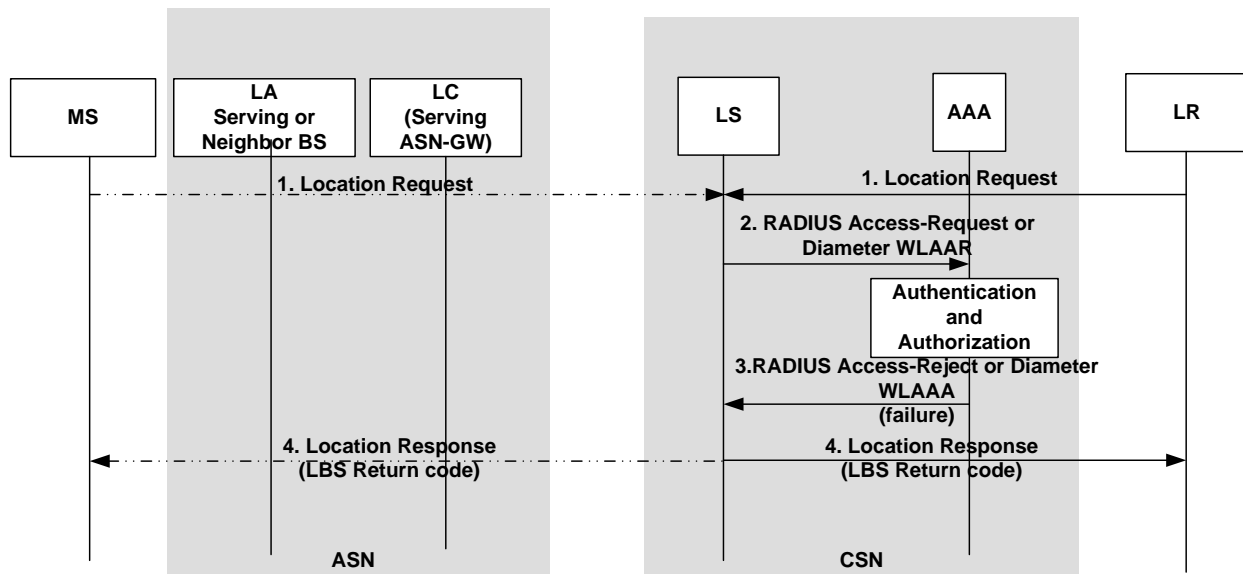


Figure 21 : E2E procedures, Authentication or Authorization failure

STEP 1

The external LR sends a Location Request to LS in order to locate the MS. The Location Request can also come from the MS.

STEP 2

The LS receives the Location Request and sends a RADIUS Access-Request or Diameter WLAAR message to the AAA for the purpose of Authentication and Authorization.

STEP 3

The AAA checks the state of the MS and sends a RADIUS Access-Reject or Diameter WLAAA message with failure indication to the LS. The failure can be due to either the external LR or the MS not being Authorized for LBS, or the external LR failing the Authentication check.

STEP 4

The LS receives the authentication and authorization failure from the AAA and sends a Location Response message to the LR indicating that the location request has been denied.

LBS

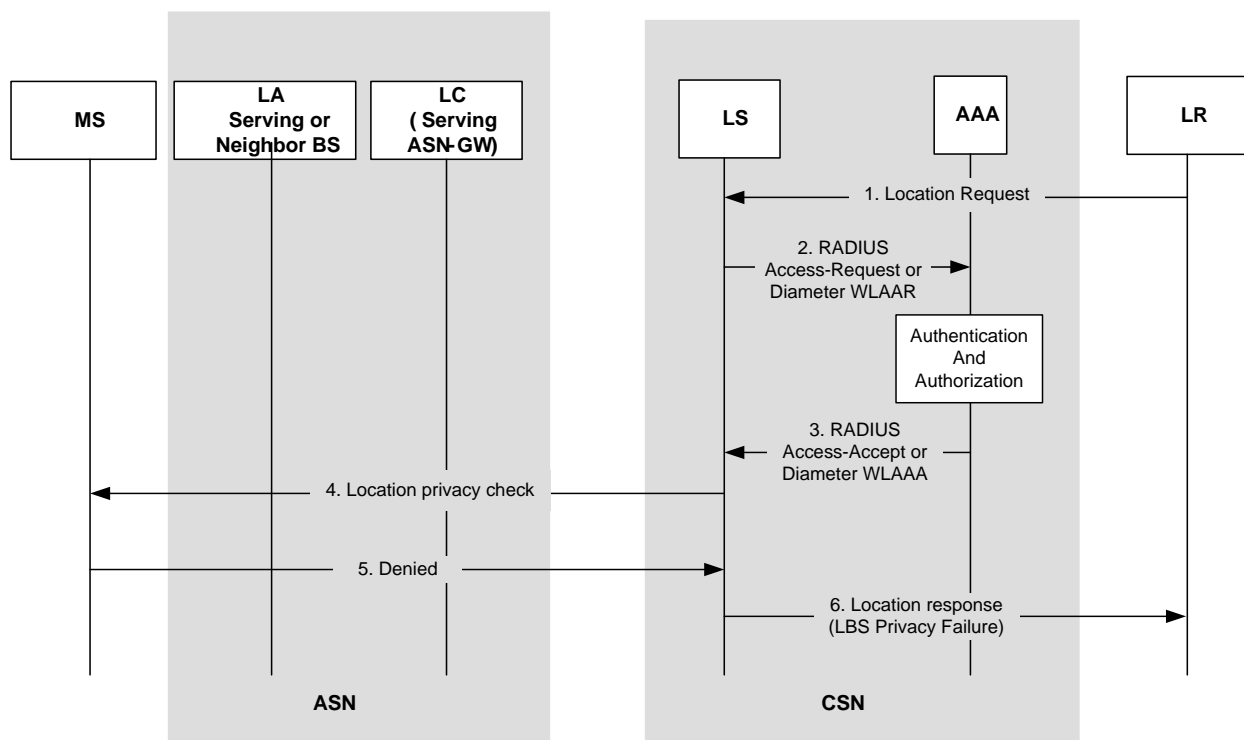


Figure 22 : E2E procedures, Privacy failure, R2 interface

STEP 1

The external LR sends a Location Request to the LS in order to locate the MS

STEP 2

The LS receives the Location Request and sends a RADIUS Access-Request or Diameter WLAAR message to the AAA for the purpose of Authentication and Authorization.

STEP 3

The AAA checks the state of the MS and sends a RADIUS Access-Accept or Diameter WLAAR message with authentication/authorization accept indication to the LS, along with the IP address of the MS and the WiMAX session keys needed to communicate with the MS

STEP 4

The LS contacts the MS via R2 requesting a location privacy check.

STEP 5

The MS denies the request for location information over the R2 interface.

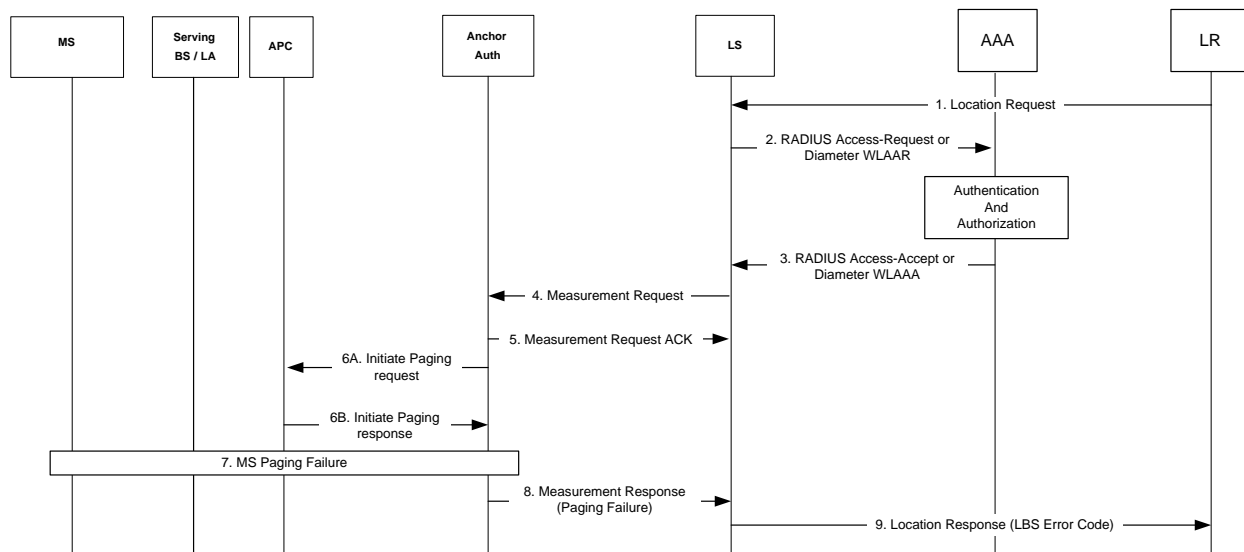
STEP 6

The LS receives this location request rejection and SHALL provide an error code to the LR indicating a Privacy failure, the details of which are out of scope of the LBS specification. (Note: at present there is no method defined in [16] or WiMAX for the MS to reject location measurements request over R3).

LBS

7.5.3 Paging Failure Procedure

In WiMAX networks, the MS MAY be unavailable to the network for various reasons (e.g., power off error, out of coverage, low battery, etc). In this case, the Paging controller that holds the context of the MS will fail in an attempt to page it. When an MS can not be paged, it can not be located. The LR SHOULD be notified accordingly when this occurs.

**Figure 23 : E2E procedure, paging failure****STEP 1**

An external LR sends a Location Request to the LS in order to locate an MS

STEP 2

The LS receives the Location Request and sends a RADIUS Access-Request or Diameter WLAAR message to the AAA for Authentication/Authorization purposes. If the LS already has the authorization and authentication for the MS, then step 2 and step 3 MAY be skipped.

STEP 3

The AAA checks the state of the MS and sends a RADIUS Access-Accept or Diameter WLAAA message to the LS along with the Anchor Authenticator ID.

STEP 4

The LS sends an R3 Measurement Request to the Anchor Authenticator.

STEP 5

After receiving the Measurement Request from the LS over R3, the Anchor Authenticator responds to the LS with a *Measurement Request ACK* message indicating that it received the *Measurement Request* and that the MS is in idle mode.

STEP 6 (6a and 6b)

If Operator policy allows removing the MS from idle mode, the Anchor Authenticator sends an *Initiate_Paging_Request* to the APC in order to page the MS.

LBS

STEP 7

The paging of the MS fails. The detection of failure can be determined from a timer expiration or from an explicit notification message.

STEP 8

The Anchor Authenticator sends a *Measurement Response* message over R3 to the LS with a Paging failure indication.

STEP 9

The LS sends a *Location Response* to the LR with an error code indicating that an MS Paging Failure occurred, the details of this message are out of scope of the LBS specification.

7.5.4 Error scenarios summary

The above error scenarios illustrate the main error scenarios that will return errors when processing LBS procedures.

The following table illustrates the scenarios with corresponding returned error codes.

SCENARIO	COMMENTS
Normal return	Normal return means the location procedure is successful.
The target is currently powered-off or otherwise de-registered (e.g., in Airplane mode)	Net result is that the MS is unavailable in the network.
The LR does not pass the authentication and authorization	AAA failure OR the target MS does not allow the requesting LR to access the MS's location information
The target is unavailable currently	One example is paging failure for the target, due to weak signal conditions.
Privacy Check does not pass	The target MS does not allow the requesting LR to access the MS's location information
Target MS is unknown	Invalid MS identification

Table 3 – LBS Error scenarios summary

Note:

- The above table is just a demonstration of current scenarios which are considered.

7.6 LBS Accounting**7.6.1 Accounting Architecture**

The Figure 24 below depicts the accounting reference model for LBS:

LBS

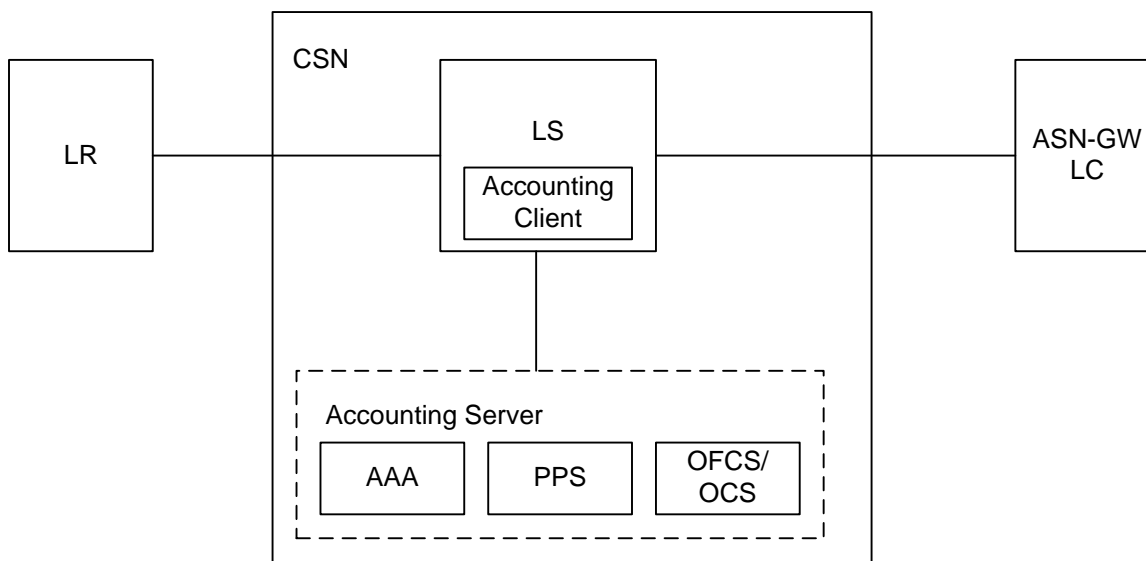


Figure 24 : Accounting architecture for LBS

A new functional entity, the LBS Accounting Client, is introduced for LBS accounting.

LBS Accounting Client: The LBS Accounting Client which resides in the LS is responsible for collecting the accounting information about the LBS services requested by an LR or an MS. It generates UDRs based on the collected accounting information and transmits them to an accounting server, such as AAA or OFCS/OCS.

7.6.2 LBS Accounting Requirements and Principles

The following requirements and principles are applied to LBS accounting:

- Event based accounting should be supported for LBS services. Event based accounting should be triggered by some specified events, when these events take place, the accounting information should be recorded.
- The location requestor (LR) that initiates the location request MAY be charged depending on the type of location requestor and the policy of LBS service providers and the network operators.
- The located MS MAY be charged, depending on the policy of the LBS service providers and network operators.
- The LS accounting client should collect accounting information and generate UDRs.
- The accounting for LBS should support different location modes: MO-LR (Mobile Originated Location Request), NI-LR (Network Initiated Location Request), Periodic Location Request, One Time Location Request.
- Offline accounting should be supported for LBS. Online accounting for LBS is optional.
- The accounting for LBS should be associated with granted LBS QoS. The location result should be classified into different granted LBS QoS (e.g., accuracy, latency) levels, a location request with higher level should be charged more than the one with lower level. The location requestor should indicate requirement of desired LBS QoS (e.g., accuracy, latency) in the location request message.
- All of the granted LBS QoS (e.g., accuracy, latency) from the network calculation should be recorded in the UDRs. A UDR should include information if the calculated location result has a lower granted LBS QoS than that of the desired one for some reason, e.g., a crowded network status, a complex geography environment to allow suitable changing.

LBS

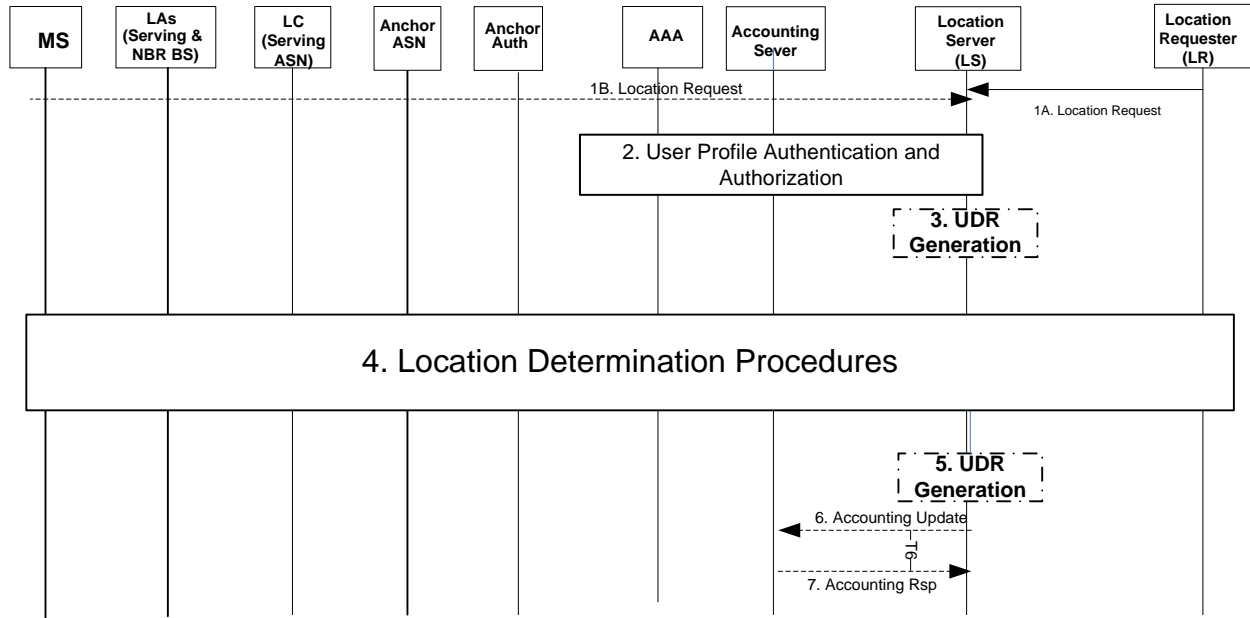
7.6.3 LBS Accounting Procedures

In LBS accounting, the events which trigger the accounting information to be recorded is the location request received by the LS, and the location response that sent by the LS. When the LS sends a location response it should also update the LBS accounting information sent in the UDR. The Accounting Client is part of the Location Server.

7.6.3.1 LBS Offline Accounting Procedures

Figure 25 illustrates the accounting procedure for offline accounting in non-roaming scenario, non-periodically:

RADIUS based call flow



Diameter call flow:

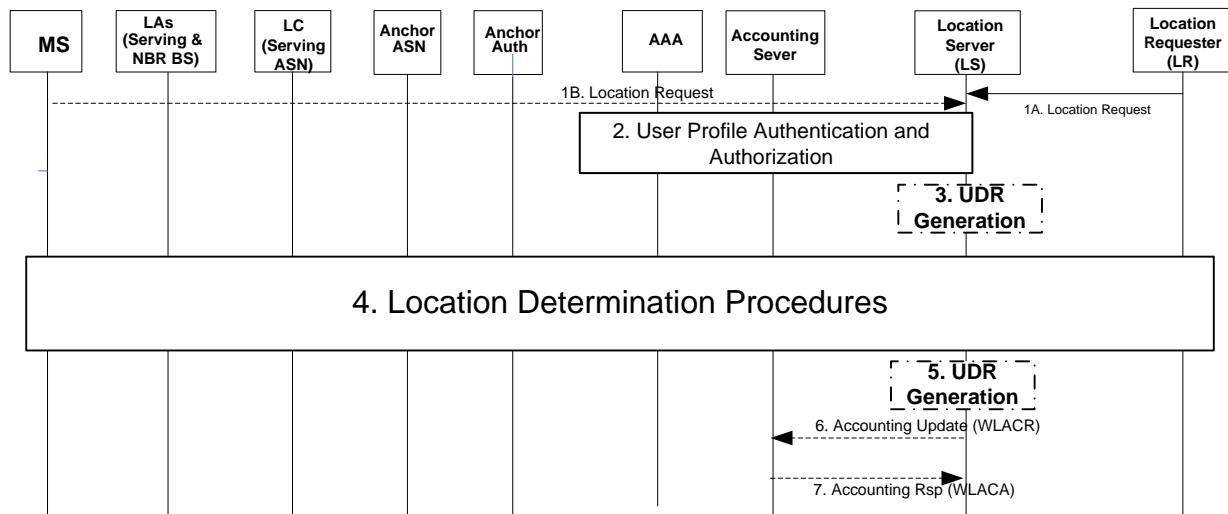


Figure 25 : Offline LBS Accounting Procedure for one-time location, non-roaming scenario

Step -1: The LS gets a location request message from the LR.

Step-2: User profile authentication and authorization is performed as described in section 7.2

LBS

Step-3: The Accounting Client in the LS records the accounting information and creates Uniform Data Records (UDRs). A UDR should include: the identity^[1] of the location requestor and the MS, location type, measurement method, the record timestamp, the requested LBS QoS, etc.

Step-4: Location of the MS is determined using procedures described earlier in the document.

Step-5: When sending a *Location Response* message, the Accounting Client in the LS records the UDR information, including the identity^[1] of the location requestor and the MS, location type, measurement method, the granted LBS QoS, the record timestamp, etc.

Step-6: Accounting update is performed by the LS to the accounting server.

Step-7: Accounting server sends back Accounting response message to the LS.

Note: The accounting Client MAY record the UDR information at Step 3 or Step 5.

[1]	Access to the Accounting client must be restricted and monitored where required by Regulatory requirements for LEA, and Privacy (ES). No UDR SHALL be decodable by unauthorized entities
-----	--

7.7 LBS Roaming

7.7.1 Location determination at the visited network

The scenario below applies to the case when the LR has not been provided any vLS contact details. If the LR has been provided a location URI or other vLS contact details then the scenario described in 7.3.2.2 can be used.

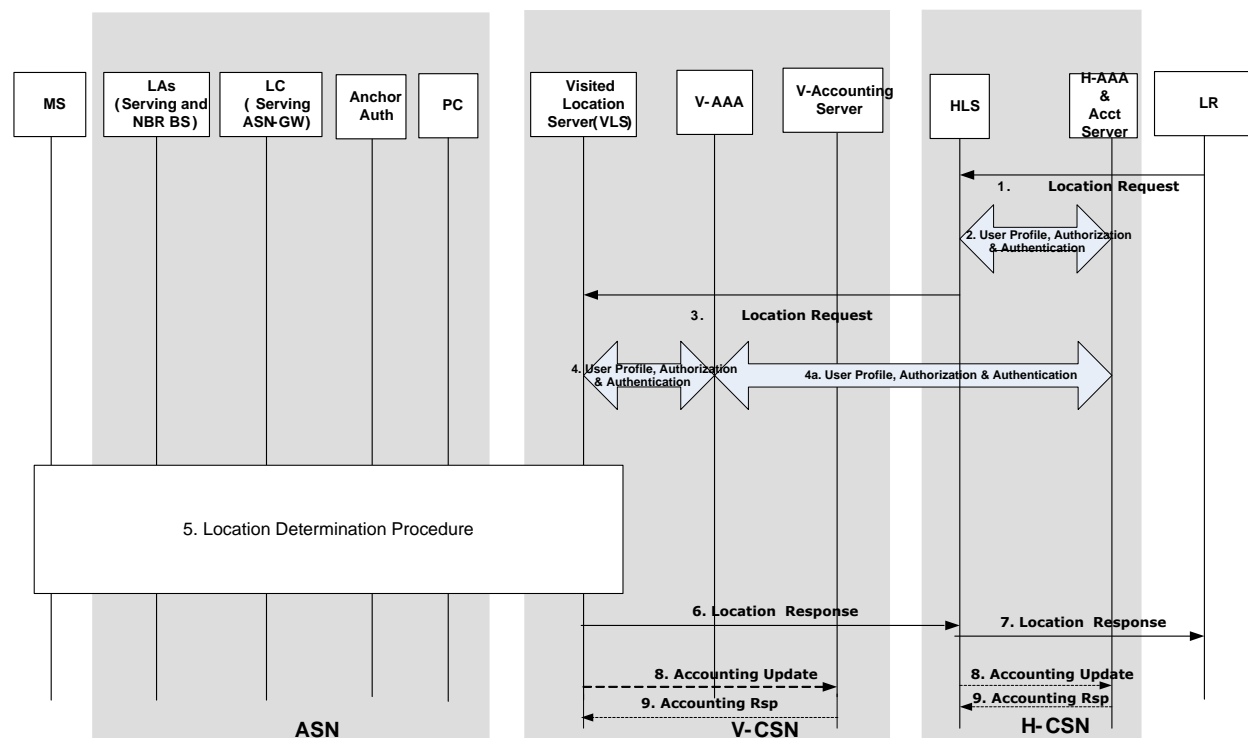


Figure 26 : E2E Roaming procedure for LBS with standalone location capability on the MS

STEP 1

The LR contacts the Home LS (hLS) on the U1 interface.

LBS

STEP 2

The hLS contacts the H-AAA to authenticate the incoming LBS request as shown, and the user profile in the AAA SHALL include the security options e.g., Subscription to Location Based Services (levels/types) etc.

STEP 3

The hLS directs the incoming request to the Visited LS (vLS). The hLS MAY then optionally provide a response back on U1 to the LR indicating that the user is roaming.

STEP 4

The V-AAA MAY authorize the incoming LBS request. The V-AAA MAY need to be contacted by the H-AAA for authentication or user profile as shown in step 4a. Step 4 and 4a are optional according to the local policies or roaming agreements.

STEP 4a

This step does not need to be executed every time – once at the beginning of the roaming user session is sufficient. Once the V-AAA obtains the user profile and the security credentials of the user from the H-AAA, the V-AAA can cache this information locally till the user's roaming session is terminated.

STEP 5

Location determination procedure is performed as detailed in section 7.3.

STEP 6

The vLS responds back to the hLS with *Location Response*.

STEP 7

The hLS responds back to the LR with *Location Response*.

STEP 8 and 9

Optional accounting updates are performed in the VCSN and, based on roaming policies separately, in the H-CSN.

7.7.2 Location determination at the home network

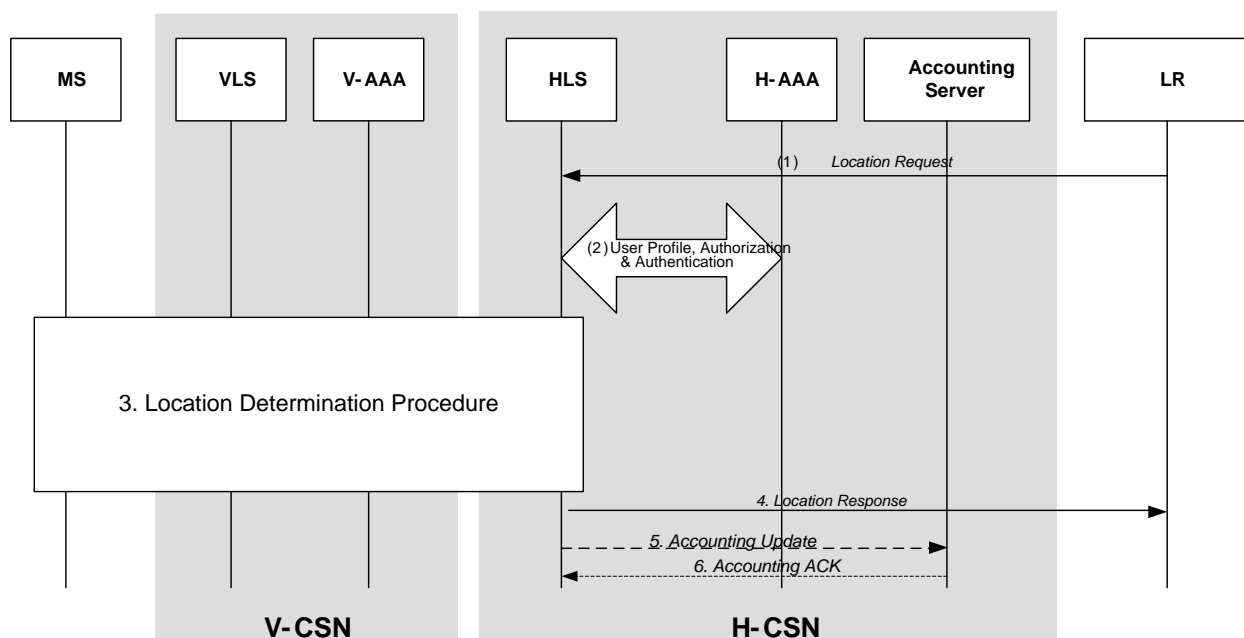


Figure 27 : LBS Roaming procedure for LBS with standalone location capability on the MS – Connection to hLS

Figure 27 describes the LBS roaming case where the MS has a standalone location capability and the MS connects directly to the hLS. This procedure is very similar to the non-roaming procedure having the only difference in Step 4.

STEP 1

The LR contacts the hLS to request location of a particular MS.

STEP 2

The hLS contacts the H-AAA to authenticate and authorize the incoming location request.

STEP 3

Location determination procedure is performed by the hLS, as in section 7.3.

STEP 4

The hLS responds back to the LR with *Location Response*.

STEP 5

Accounting information is optionally sent to the Accounting Server.

STEP 6

The Accounting Server acknowledges the accounting update message.

7.8 LBS Quality of Service

LBS Quality of Positioning (QoS) characterizes the positioning result or measuring data by following attributes:

LBS

1 - Horizontal Accuracy

2 - Vertical Accuracy

3 - Latency

4 - QoS Class

5 - LBS Priority

6 - Age (Freshness of Location Information).

7 Horizontal and Vertical Accuracy parameters provide a maximum uncertainty (expressed in meters) that a returned
8 location fix should meet before being passed to a requesting application. These parameters describe the positioning
9 quality required by an LR and should be used by the LS for the positioning method selection. Note that the
10 uncertainty is determined by the location measurement engine itself based on factors such as GPS or WiMAX signal
11 S/N, geometric dilution of precision, etc. As this uncertainty is determined by statistical variance estimation
12 algorithms, a fix that is determined to be within the Horizontal and Vertical accuracy parameter limits MAY, in fact,
13 actually not be (with respect to surveyed positional ground truth) due to statistical confidence limitations.

14 The Latency attribute denotes the handling time for a location request in LBS system, i.e., the time difference
15 between LS receiving location request and sending the corresponded location response. The latency measuring and
16 controlling between LS and LR is out of the scope. In a roaming scenario, latency is measured by the LS directly
17 connected to the LR.

18 The QoS Class attribute is used by requestor to denote the required degree of adherence of the accuracies and
19 latencies in the request and result. This attribute consists of 3 class indicators corresponding to horizontal accuracy,
20 vertical accuracy and latency attributes separately. There are 2 QoS Classes defined:

21 - Best effort QoS Class, which means location result with lower accuracy or longer latency than the desired one is
22 accepted and should be returned to the requestor.

23 - Assured QoS Class, which means location result with lower accuracy or longer latency than the desired one is not
24 accepted and should not be returned to the requestor.

25 The Age of the location applies to information that MAY be cached at the LS. This cached information, e.g., the
26 location itself, MAY be directly returned to the requestor, or (if the cached information is location measurements)
27 MAY be used to compute the location of the MS providing it is no older than the value specified in the Age
28 parameter.

29

8. LBS specific messages and TLVs

8.1 LBS R4/R6/R8 definition

For LBS specific messages, the Function type field for LBS SHALL be defined as follows:

Table 4 – R6/R4/R8 LBS messages

Function Type	Message Type	Message	R4	R6	R8
12 (LBS)	1	<i>R6_Measurement_Request</i>		X	
	2	<i>R6_Measurement_Request_ACK</i>		X	
	3	<i>R6_Measurement_Response</i>		X	
	4	<i>R6_Measurement_Response_ACK</i>		X	
	5	<i>R4_Measurement_Request</i>	X		
	6	<i>R4_Measurement_Request_ACK</i>	X		
	7	<i>R4_Measurement_Response</i>	X		
	8	<i>R4_Measurement_Response_ACK</i>	X		
	9	<i>R8_Measurement_Request</i>			X
	10	<i>R8_Measurement_Request_ACK</i>			X
	11	<i>R8_Measurement_Response</i>			X
	12	<i>R8_Measurement_Response_ACK</i>			X

8.1.1 R4_Measurement_Request

Table 5 – MS Info of R4_Measurement_Request

IE	Reference	M/O	Notes
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LBS

IE	Reference	M/O	Notes
MS Info		M	
> MS ID		M	MSID of the subscriber to which this request is originated to.
>LBS Transaction ID		M	Unique transaction ID used by the LS to correlate this measurement request with a specific location request for this MS
> LBS Loc Info		M	Provides information for the requested location information.
>> LBS QoS		M	
>>> Positioning Latency		M	Indicates the positioning latency required by the LS.
>>>LBS Priority and QoS Class/Parameter Attributes		M	Specifies QoS.
>>Measurement Method		M	The method which SHALL be used to get location measurements.
>>Number Measurement Sets		M	Specifies the number of measurement sets to be captured for the report

8.1.2 R4_Measurement_Response

Table 6 – MS Info of R4_Measurement_Response

IE	Reference	M/O	Notes
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LBS

IE	Reference	M/O	Notes
MS Info			
> MS ID		M	MSID of the subscriber to which this request is originated to.
>LBS Transaction ID		M	Unique transaction ID used by the LS to correlate this measurement request with a specific location request for this MS
> LBS Loc Info		O	Provides the requested location information.
>>Measurement Method		CM	The type of measurements being reported. This is mandatorily included when LBS Loc Info is included.
>> BSID	[3]	O	Serving BSID
>> LBS Measurement Set		O	This element MAY appear more than one time.
>>>Timestamp		CM	Based on the inclusion of LBS measurement set.
>>> LBS Measurement Report		CM	This element MAY appear more than one time. Based on the inclusion of LBS measurement set.
>>>>BSID	[3]	CM	BS to which the measurements relate. This is mandatorily included when LBS Measurement report is included.
>>>>CINR	[16]	O	
>>>>RSSI	[16]	O	
>>>>RTD	[16]	O	
>>>>RD	[16]	O	
>> LBS Error Cause		O	Only present in case of error.

8.1.3 R4_Measurement_Request_ACK

Table 7– R4_Measurement_Request ACK

IE	Reference	M/O	Notes
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LBS

IE	Reference	M/O	Notes
MS Info		M	
> MS ID		M	MSID of the subscriber to which this request is originated to.
>LBS Transaction ID		M	Unique transaction ID used by the LS to correlate this measurement request with a specific location request for this MS
> LBS Result Code		M	Provides information for the requested location information.
Failure Indication	[3]	O	The Failure Indicator will be used for generic ASN/R4 error cases.

8.1.4 R4_Measurement_Response_ACK

Table 8 – R4_Measurement_Response ACK

IE	Reference	M/O	Notes
MS Info		M	
> MS ID		M	MSID of the subscriber to which this request is originated to.
>LBS Transaction ID		M	Unique transaction ID used by the LS to correlate this measurement request with a specific location request for this MS
> LBS Result Code		M	Provides information for the requested location information.
Failure Indication	[3]	O	The Failure Indicator will be used for generic ASN/R4 error cases.

8.1.5 R6_Measurement_Request

Table 9 – R6_Measurement_Request

IE	Reference	M/O	Notes
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LBS

IE	Reference	M/O	Notes
BS Info	[3]	M	Contains relevant Serving BS context
> BS ID	[3]	M	The identifier of Serving BS ID
MS Info		M	
> MS ID		M	The identifier of the target MS
> LBS Loc Info		M	Provides information for the requested location information.
>> LBS QoS		M	
>>> Positioning Latency		M	This value should be equal to the number of milliseconds given to the LC divided by the number of measurements requested.
>>>LBS Priority and QoS Class/Parameter Attributes		M	Specifies QoS.
>>Measurement Method		M	Indicates the measurements which should be performed.

8.1.6 R6_Measurement_Request_ACK

Table 10 – R6_Measurement_Request_ACK

IE	Reference	M/O	Notes
Failure Indication	[3]	O	The Failure Indicator will be used for generic ASN/R4 error cases.

8.1.7 R6_Measurement_Response

Table 11 – R6_Measurement_Response

IE	Reference	M/O	Notes
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LBS

IE	Reference	M/O	Notes
BS Info	[3]	M	Contains relevant Serving BS context
> BS ID	[3]	M	The identifier of Serving BS ID
MS Info		M	
> MS ID		M	The identifier of the target MS
> LBS Loc Info		O	Provides information for the requested location information.
>>Measurement Method		CM	Mandatory if LBS Loc Info is present
>> LBS Measurement Set		O	This element MAY only appear once.
>>>Timestamp		CM	Mandatory if LBS Measurement Set is present
>>> LBS Measurement Report		CM	This element MAY appear more than one time. Mandatory if LBS Measurement Set is present
>>>>BSID	[3]	CM	BS where the measurements relate to. Mandatory if LBS Measurement Report is present
>>>>CINR	[16]	O	
>>>>RSSI	[16]	O	
>>>>RTD	[16]	O	
>>>>RD	[16]	O	
>>LBS Error Cause		O	Indicates if an LBS error occurred

8.1.8 R6_Measurement_Response_ACK

Table 12 – R6_Measurement_Response_ACK

IE	Reference	M/O	Notes
Failure Indication	[3]	O	The Failure Indicator will be used for generic ASN/R4 error cases.

8.1.9 R8_Measurement_Request

Table 13 – R8_Measurement_Request

IE	Reference	M/O	Notes
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LBS

IE	Reference	M/O	Notes
BS Info	[3]	M	Contains relevant Serving BS context
> BS ID	[3]	M	The identifier of Serving BS ID
MS Info		M	
>MS ID		M	The identifier of the target MS
> LBS Loc Info		M	
>>Preparation info		M	Preparation info for the UL LBS measurements.
>>>UL transmission time		M	Transmission time of the UL signal from the MS
>>>UL slot number		M	Slot number in which UL signal will be transmitted.

8.1.10 R8_Measurement_Response

Table 14 – R8_Measurement_Response

IE	Reference	M/O	Notes
MS Info		M	The identifier of the target MS
> MS ID		M	The identifier of the target MS
>LBS Loc Info		M	Provides information for the requested location information.
>>Measurement Method		CM	Mandatory if LBS Loc Info is present
>> LBS Measurement Set		O	This element MAY only appear once.
>>>Timestamp		CM	Mandatory if LBS Measurement Set is present
>>>LBS Measurement Report		CM	This element MAY appear more than one time. Mandatory if LBS Measurement Set is present
>>>>BSID	[3]	M	BS where the measurements relate to
>>>>RSSI	[16]	O	
>>>>RD	[16]	O	
>>>>CINR	[16]	O	
>>>>RTD	[16]	O	
>>LBS Error Cause		O	Indicates if an LBS error occurred

LBS

8.1.11 R8_Measurement_Request_ACK**Table 15 – R6_Measurement_Request_ACK**

IE	Reference	M/O	Notes
Failure Indication	[3]	O	The Failure Indicator will be used for generic ASN/R4 error cases.

8.1.12 R8_Measurement_Response_ACK**Table 16 – R6_Measurement_Response_ACK**

IE	Reference	M/O	Notes
Failure Indication	[3]	O	The Failure Indicator will be used for generic ASN/R4 error cases.

8.1.13 LBS R4/R6/R8 message TLVs**8.1.13.1 LBS Loc Info**

Type	410	
Length in octets	Variable	
Value	Compound	
Description	This compound TLV contains information related to the LBS service.	
Elements (Sub-TLVs)	TLV Name	M/O
	LBS QoS	M
	LBS Error Cause	O
	LS FQDN	O
	Measurement Method	M
	Serving BSID	O
	LBS Measurement Set	O
	Number Measurement Sets	O
	Preparation Info	O
Parent TLV	MS Info	

LBS

8.1.13.2 LS FQDN

Type	413
Length in octets	variable
Value	ASCII string
Description	FQDN of the LS
Message Primitives That Use This TLV	LBS Loc Info

8.1.13.3 LBS Error Cause

Type	411																								
Length in octets	1																								
Value	1 byte Integer where the value specifies the error cause as described below.																								
Description	<p>This information element defines the LBS Cause. Coding of LBS cause:</p> <table> <tr> <td>0x00000000</td><td>No Error</td></tr> <tr> <td>0x00000001</td><td>target MS is unavailable</td></tr> <tr> <td>0x00000010</td><td>Reserved</td></tr> <tr> <td>0x00000011</td><td>target MS is unknown</td></tr> <tr> <td>0x00000100</td><td>Reserved</td></tr> <tr> <td>0x00000101</td><td>system failure</td></tr> <tr> <td>0x00000110</td><td>protocol failure</td></tr> <tr> <td>0x00000111</td><td>Unsupported measurement type</td></tr> <tr> <td>0x00001000</td><td>MS is powered off</td></tr> <tr> <td>0x00001001</td><td>LR not Authorized</td></tr> <tr> <td>0x00001010</td><td>Duplicate request</td></tr> <tr> <td>0x00001011 to 0x11111111</td><td>Reserved</td></tr> </table>	0x00000000	No Error	0x00000001	target MS is unavailable	0x00000010	Reserved	0x00000011	target MS is unknown	0x00000100	Reserved	0x00000101	system failure	0x00000110	protocol failure	0x00000111	Unsupported measurement type	0x00001000	MS is powered off	0x00001001	LR not Authorized	0x00001010	Duplicate request	0x00001011 to 0x11111111	Reserved
0x00000000	No Error																								
0x00000001	target MS is unavailable																								
0x00000010	Reserved																								
0x00000011	target MS is unknown																								
0x00000100	Reserved																								
0x00000101	system failure																								
0x00000110	protocol failure																								
0x00000111	Unsupported measurement type																								
0x00001000	MS is powered off																								
0x00001001	LR not Authorized																								
0x00001010	Duplicate request																								
0x00001011 to 0x11111111	Reserved																								
Parent TLV	LBS Loc Info																								

1 **8.1.13.4 LBS QoS**

Type	412	
Length in octets	Variable	
Value	Compound	
Description	Provides a list of attributes with further information on the requested quality of information like the accuracy.	
Elements (Sub-TLVs)	TLV Name	M/O
	Positioning Latency	M
	LBS Priority and QoS class/Parameter Attributes.	M
Parent TLV	LBS Loc Info	

2

1 **8.1.13.5 Measurement Method**

Type	414
Length in octets	1
Value	Octet formatted as an enumeration indicating the measurement type: 0x00 Reserved 0x01 Serving BS ID (return serving BS ID) 0x02 MS-Measured: requesting one or more scan measurements by the MS 0x03 BS-Measured: requesting measurement by the serving and reference BSes 0x04 to 0xFF Reserved
Description	This information element defines the method which should be used to get location measurements.
Parent TLV	LBS Loc Info

2 **8.1.13.6 LBS Measurement Set**

Type	417	
Length in octets	Variable	
Value	Compound	
Description	This parameter can have between 1 and 7 LBS measurement reports.	
Elements (Sub-TLVs)	TLV Name	M/O
	Timestamp	M
	LBS Measurement Report	M
Parent TLV	LBS Loc Info	

3

LBS

8.1.13.7 LBS Measurement Report

Type	484	
Length in octets	Variable	
Value	Compound	
Description	Provides measurement data for a single BS from an MS.	
Elements (Sub-TLVs)	TLV Name	M/O
	BSID [a]	M
	CINR	O
	RSSI	O
	RTD	O
	RD	O
Parent TLV	LBS Measurement Set	

[a] as specified in [3]

8.1.13.8 LBS Priority and QoS class/Parameter Attributes

Type	415
Length in octets	1
Value	<p>This attribute value is an Octet it may have one of the following values:</p> <p>0x01 = lowest priority request</p> <p>0x02 = medium priority request</p> <p>0x03 = high priority request</p>
Description	Provides guidance to the LC and LA as to what priority the measurement request should be given.
Parent TLV	LBS QoS

LBS

1 8.1.13.9 LBS Transaction ID

Type	485
Length in octets	2
Value	Unsigned 16-bit integer.
Description	An integer value used for the correlation of LBS related requests. The response message SHALL include the same value as reviewed by the corresponding request.
Parent TLV	MS Info

2 8.1.13.10 Number Measurement Sets

WType-ID	416
Length in octets	1
Value	An 8 bit unsigned number. The number of measurement sets to be provided in each measurement response. It SHALL have a value 0x01 to 0x0F inclusive. Any value greater than 0x0F is an error.
Description	This information element specifies how many measurement sets to send in the resulting measurement response.
Parent TLV	LBS Loc Info

3 8.1.13.11 Positioning Latency

Type	486
Length in octets	1
Value	This attribute contains one Octet with values ranging from 0 to 127. It represents an exponent k used in the formula below. The value represents the requested LS handling response time in milliseconds. The value 0 means no latency requirement.
Description	<p>This information element defines the LS handling response time in milliseconds for a location request, including the time to obtain location measurements and compute a fix.: $L = \text{Positioning Latency} = 100 * ((1 + 0.05)^k - 1)$ in msec. k=0 will be interpreted as no latency requirement. To determine the desired value of k for a given Latency value in msec, use the inverse formula $k = \ln((L/100) + 1) / (\ln 1.05)$, then round k to the closest integer value. Any octet values sent > 127 will be treated as 127.</p> <p>This provides values for</p> <p>k=1; L= 5ms</p> <p>k=127; L=49 seconds</p>
Parent TLV	LBS QoS

LBS

1 8.1.13.12 CINR

Type	487
Length in octets	1
Value	Octet String encoded as per [16].
Description	Carrier to Interference noise ratio.
Parent TLV	LBS Measurement Report

2 8.1.13.13 RD

Type	488
Length in octets	1
Value	Octet String encoded as per [16].
Description	The relative delay between the BSID and the paired BSID.
Parent TLV	LBS Measurement Report

3 8.1.13.14 RTD

Type	489
Length in octets	1
Value	Octet String encoded as per [16].
Description	The round trip delay between the MS and the BSID.
Parent TLV	LBS Measurement Report

4 8.1.13.15 RSSI

Type	490
Length in octets	1
Value	Octet String encoded as per [16].
Description	Relative Signal Strength Indicator.
Parent TLV	LBS Measurement Report

5 8.1.13.16 Timestamp

Type	491
Length in octets	4

LBS

Value	Unsigned 32-bit Integer in milli seconds since January 1 st 1970.
Description	The time the BS generated the report.
Parent TLV	LBS Measurement Set.

1 **8.1.13.17 LBS Result Code**

Type	492
Length in octets	1
Value	Octet enumerated to LBS result code: 0x00 Okay 0x01 T1 Expired 0x02 T2 Expired 0x03 T3 Expired 0x04 T4 Expired 0x05 Duplicate request
Description	Used to express the results of LBS messages across the R4 interface.
Parent TLV	MS Info

2 **8.1.13.18 Preparation Info**

Type	493	
Length in octets	Variable	
Value	Compound	
Description	Contains information about the time slot to measure and the subsequent measurement	
Elements (Sub-TLVs)	TLV Name	M/O
	UL transmission time	M
	UL slot number	M
Parent TLV	LBS Loc Info	

3

8.1.13.19 UL slot number

Type	494
Length in octets	2
Value	Unsigned 8-bit integer.
Description	The uplink slot number within the frame.
Parent TLV	Preparation Info

8.1.13.20 UL transmission time

Type	495
Length in octets	2
Value	Unsigned 16-bit integer.
Description	This is the frame number measured in milliseconds.
Parent TLV	Preparation Info

8.2 LS-AAA interaction

The LBS related communication between the LS and the HAAA are specified in this section.

8.2.1 RADIUS message definition

The following table lists the RADIUS attributes and commands used by the LS to interact with the HAAA. RADIUS Challenge packets are not used for the interaction between the LS and HAAA.

It is FFS whether the AAA should authorize the location qos being requested by the requestor. In this case the LS would pass the QoS object back to the AAA. The AAA will either reject or propose an alternative QoS.

It is FFS whether the AAA should authorize whether the Requestor is allowed to make periodic or one shot requests. Related to this should the AAA have a say on how frequently the Location are returned to the Requestor.

Attribute	TYPE	Description	AR	AA	Reject
User-Name	1	The user portion and/or realm portion of the MS about which the LS wants to fetch user measurements.	1	1	0
Location-Requestor-Authentication-Protocol [Sec 8.3.3.17]	26/231	Identify the authentication protocol to be used.	1	0	0
WiMAX-Session-ID [NWG Stage 3]	26/4	The WiMAX Session-ID of the MS.	0-1[1]	1	0
MS-Identity-Assertion [Sec 8.3.3.6]	26/212	An Identity Assertion about the MS id for which location information is required as received from the Location-Requestor.	0-1[2]	0	0
Requestor-Identity-Assertion [Sec 8.3.3.7]	26/213	An Identity Assertion about the Entity making the request for location.	0-1[2]	0	0

LBS

Attribute	TYPE	Description	AR	AA	Reject
Requestor-Location- Authorization-Assertion[Sec 8.3.3.8]	26/214	An authorization assertion presented by the requestor that authorizes the requestor for obtaining location information.	0-1[2]	0	0
NAS-Identifier	32	The FQDN of the LS.	1	0	0
NAS-IP		The IP address of the LS	0-1	0	0
Anchor-Authenticator-NAS- Identifier[Sec 8.3.3.9]	26/215	The FQDN of the Anchor Authenticator for the MS.	0	1	0
Anchor-Authenticator-NAS- IP [Sec 8.3.3.10]	26/216	The IP address of the Anchor Authenticator for the MS.	0	0-1	0
Message-Authenticator	89		1	1	0
LBS Error cause	101	Error codes describing why the authentication/authorization failed	0	0	0-1
vLS-ID	26/232	The visited LS-ID serving the mobile in the visited network.	0	0-1	0
LS-PSK [Sec 8.1.13.13]	26/218	The Preshared key to be used for authenticating R2 location protocol communication that is generated by the AAA as per section 8.4.3.2.	0	0-1[3]	0
LS-PSK-ID [Sec 8.3.3.13]	26/219	The Identifier associated with the LSK that is generated by the AAA as per section 8.4.3.2.	0	0-1[3]	0
LS-PSK-Lifetime [Sec 8.3.3.14]	26/220	The lifetime of the LSK	0	0-1[3]	0
MS IP Address		The IP address of the MS	0	1[3]	0

- 1
- 2 Notes:
 - 1 If the LS knows the WiMAX-Session-ID it SHALL be included in all transactions with the AAA.
 - 2 LS MUST include these attributes if they were received from the Location-Requestor.
If the LS does have the Location-Requestor-Authorization-Assertion it MUST include the MS-Identity-Assertion and the Requestor-Identity-Assertion.
If the LS possesses the outer NAI of the MS that was used for WiMAX Network Access Authentication then the MS-ID-Assertion is not required in the Access-Request packet.
 - 3 All of these attributes SHALL be returned if the R2 interface is supported.

8.2.2 DIAMETER message definition

This section lists the Diameter commands used to authenticate the LS requests with the HAAA. The LS and AAA servers compliant with this specification SHALL advertise support for the WiMAX-Location-Authentication-Authorization Application with assigned application identifier of TBDWLAA. The WiMAX-Location-Authentication-Authorization-Application is derived from Diameter Network Access Server Application [RFC4005].

The command used by the WiMAX-Location-Authentication-Authorization application are listed in the following table:

Command-Name	Abbrev.	Code
WiMAX LAA-Request	WLAAR	TBDWLAA
WiMAX LAA-Answer	WLAAA	TBDWLAA
WiMAX-Location-Accounting-Request	WLACR	TBDWLAC
WiMAX-Location-Accounting-Answer	WLACA	TBDWLAC

EDITORS note:

We MAY need Session-Termination-Request (STR) Command/Session-Termination-Answer (STA) Command.

8.2.2.1 WiMAX-LAA-Request/Answer command

WiMAX LAA-Request command

The WiMAX AA-Request command is used by the LS to authenticate a Location Requestor with the AAA. The Location Requestor can be the MS or an external Location Requestor.

<WiMAX LAA-Request command> ::= < Diameter Header: TBDWLAA REQ, PXY >

<Session-Id>

{ Auth-Application-Id } SHALL be set to TBDWLAA

{ Origin-Host }

{ Origin-Realm }

{ Auth-Request-Type }

{Location-Requestor-Authentication-Protocol}

{User-Name}

The user portion and/or realm portion of the MS about which the LS wants to fetch user measurements. In the case the Location Requestor is not the MS (comes over U1 to the LS) the NAI MAY be set to the outer NAI used by the MS when performing WiMAX Network access authentication. The NAI MAY not always identify the user but is required for routing

purposes. Therefore as a minimum, the NAI SHALL contain the home realm of the MS e.g., @example.com. In the Access-Accept the AAA SHALL include User-Name attribute set to the value of the User-Name received in an Access-Request from the Anchor-Authenticator during network entry authentication procedures.

In the case where the Location Requestor is the mobile itself (authentication R2 transaction) the user-name SHALL be set the user identity and home realm used during network access authentication.

[WiMAX-Session-Id]

If the LS knows the WiMAX-Session-ID it SHALL be included in all transactions with the AAA.

[MS-Identity-Assertion]

LS MUST include these attributes if they were received from the Location-Requestor.

If the LS does have the Location-Requestor-Authorization-Assertion it MUST include the MS-Identity-Assertion and the Requestor-Identity-Assertion.

If the LS possesses the outer NAI of the MS that was used for WiMAX Network Access Authentication then the MS-ID-Assertion is not required in the Access-Request packet.

[Requestor-Identity-Assertion]

LS SHALL include these attributes if they were received from the Location-Requestor.

If the LS does have the Location-Requestor-Authorization-Assertion it MUST include the MS-Identity-Assertion and the Requestor-Identity-Assertion.

If the LS possesses the outer NAI of the MS that was used for WiMAX Network Access Authentication then the MS-ID-Assertion is not required in the Access-Request packet.

These attributes SHALL NOT be used when the Location Requestor is the mobile itself over R2.

[Location-Requestor-Authorization-Assertion]

LS SHALL include these attributes if they were received from the Location-Requestor.

If the LS does have the Location-Requestor-Authorization-Assertion it SHALL include the MS-Identity-Assertion and the Requestor-Identity-Assertion.

If the LS possesses the outer NAI of the MS that was used for WiMAX Network Access Authentication then the MS-ID-Assertion is not required in the Access-Request packet.

These attributes SHALL NOT be used when the Location Requestor is the mobile itself over R2.

LBS

[LS-SA]

If included contains the pre shared key LSK to be used to authenticate the R2 location protocol communication between LS and MS with the associated key identifier and lifetime.

[Destination-Host]

[Origin-State-Id]

*[Proxy-Info]

*[Route-Record]

*[AVP]

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Session-Id	263	UTF8String	RFC3588	M			V
Auth-Application-Id	258	Unsigned32	RFC3588	M			V
Origin-Host	264	DiamIdentity	RFC3588	M			V
Origin-Realm	296	DiamIdentity	RFC3588	M			V
Auth-Request-Type	274	Enumerated	RFC3588	M			V
Auth-Session-State	277	Enumerated	RFC3588	M			V
Destination-Host	293	DiamIdentity	RFC3588	M			V
Origin-State-Id	278	Unsigned32	RFC3588	M			V
Proxy-Info	284	Grouped	RFC3588	M			V
Route-Record	282	DiamIdentity	RFC3588	M			V
User-Name	1	UTF8String	RFC3588	M			V
WiMAX-Session-Id	4	OctetString		M,V			
MS-Identity-Assertion	212	OctetString		M,V			
Requestor-Identity-Assertion	213	OctetString		M,V			
Requestor-Location-Authorization-Assertion	214	OctetString		M,V			
LS-SA	430	Grouped		M,V			
Location-Requestor-Authentication-Protocol	231	Enumerated		M,V			

WiMAX-LAA-Answer command

LBS

The WiMAX-LAA-Answer command is sent by the HAAA to the LS in response to a WiMAX AA-Request command.

< WiMAX-LAA-Answer command > ::= < Diameter Header: **TBD**WLAA, PXY >

<Session-Id>

{ Result-Code }

{ Origin-Host }

{ Origin-Realm }

{ User-Name }

{ WiMAX-Session-ID }

{Anchor-Authenticator-NAS-
Identifier}

[Anchor-Authenticator-NAS-IP]

[vLS-ID]

[LS-SA]

SHALL be returned when the R2 interface is supported.

MS IP Address

The MS IP address SHALL be returned if user-Plane location procedures are supported.

[Error-Message]

[Error-Reporting-Host]

* [Failed-AVP]

* [Redirected-Host]

[Redirected-Host-Usage]

[Redirected-Max-Cache-Time]

*[Proxy-Info]

*[Route-Record]

*[AVP]

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Session-Id	263	UTF8String	RFC3588	M			V
Result-Code	268	Unsigned32	RFC3588	M			V
Origin-Host	264	DiamIdent	RFC3588	M			V

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Origin-Realm	296	DiamIdent	RFC3588	M			V
Auth-Session-State	277	Enumerated	RFC3588	M			V
Error-Message	281	UTF8String	RFC3588				M,V
Error-Reporting-Host	294	DiamIdent	RFC3588				M,V
Failed-AVP	279	Grouped	RFC3588	M			V
Redirected-Host	292	DiamURI	RFC3588	M			V
Redirected-Host-Usage	261	Enumerated	RFC3588	M			V
Redirected-Max-Cache-Time	262	Unsigned32	RFC3588	M			V
Proxy-Info	284	Grouped	RFC3588	M			V
Route-Record	282	DiamIdent	RFC3588	M			V
User-Name	1	UTF8String		M			V
WiMAX-Session-ID	4	OctetString		M,V			
Anchor-Authenticator-NAS-Identifier	215	DiamIdent		M,V			
Anchor-Authenticator-NAS-IP	216	Address		M,V			
vLS-ID	232	DiamIdent		M,V			
LS-SA	430	Grouped		M,V			
MS IP Address		Address	RFC3588	M			

8.2.2.2 WiMAX-Location-Accounting-Request/Answer command

The WiMAX-Accounting-Request/Answer commands are used to record the number of location reports generated by the LS. This messages are sent between the LS and the HAAA. The message are extension of the accounting messages defined by Diameter base [RFC3588]

WiMAX-Location-Accounting-Request command

The command is generated by the LS to report location reports occurrences to the HAAA. The command is defined as follows:

< WiMAX-Location-Accounting-Request > ::= < Diameter Header: TBDWLAC, REQ, PXY >

< Session-Id >

{ Origin-Host }

{ Origin-Realm }

LBS

{ Destination-Realm }

{ Accounting-Record-Type }

The values supported SHALL be set to EVENT-RECORD in case of a one time location report. MAY be set to START-RECORD, INTERIM-RECORD and STOP-RECORD for periodic events.

{ Accounting-Record-Number }

{ Vendor-Specific-Application-Id }

Acct-Application-Id SHALL be set to TBDWLAC.

{ User-Name }

Set to the User-Name value received in the WiMAX-LAA-Answer command.

{ Acct-Multi-Session-Id }

SHALL be set to WiMAX-Session-Id.

{ Location Mode }

{ Periodic-Location-Info }

{ LBS QoS }

SHALL be present to indicate the Location event to the AAA even if no QoS parameters are provided.

[Granted LBS QoS]

{ Measurement Method }

[Report-Counts]

SHALL be present if reports were generated.

[LS-Error-Cause]

SHALL be present if an error occurred.

[Origin-State-Id]

[Event-Timestamp]

* [Proxy-Info]

* [Route-Record]

* [AVP]

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Session-Id	263	UTF8String	RFC3588	M			V
Origin-Host	264	DiamIdentity	RFC3588	M			V
Origin-Realm	296	DiamIdentity	RFC3588	M			V
Destination-Realm	283	DiamIdentity	RFC3588	M			V
Vendor-Specific-Application-Id	260	Grouped	RFC3588	M			V

1

2

LBS

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Accounting-Record-Type	480	Enumerated	RFC3588	M			V
Accounting-Record-Number	485	Unsigned32	RFC3588	M			V
User-Name	1	UTF8String	RFC3588	M			V
Acct-Multi-Session-Id	287	Unsigned64	RFC3588	M			V
Location-Mode	221	Enumeration					
LBS-QoS	102	Grouped					
Granted-LBS QoS							
Measurement-Method	103	Unsigned32					
LBS-Error-Cause	101						
Origin-State-Id	278	Unsigned32	RFC3588	M			V
Proxy-Info	284	Grouped	RFC3588	M			P,V
Route-Record	282	DiamIdentity	RFC3588	M			P,V

- 1
- 2 WiMAX-Location-Accounting-Answer command.
- 3 The WiMAX-Location-Accounting-Answer command is sent by the HAAA to the LS to acknowledge receipt of the
- 4 WiMAX-Location-Accounting-Request command.
- 5 < WiMAX-Location-Accounting-Answer > ::= < Diameter Header: TBDWLAC, PXY >

< Session-Id > SHALL be set to the Session-Id value in the WACR command

{ Result-Code }

{ Origin-Host }

{ Origin-Realm }

{ Accounting-Record-Type } SHALL be set to the same value in the WACR command

{ Accounting-Record-Number }

[Vendor-Specific-Application-Id] SHALL be set to TBDWLAC

[User-Name] If included SHALL be set to the value of User-Name set in WLACR

[Acct-Multi-Session-Id] SHALL be set to the WiMAX-Session-Id

[Error-Reporting-Host]

[Accounting-Realtime-Required]

[Origin-State-Id]

LBS

[Event-Timestamp]

* [Proxy-Info]

* [AVP]

1

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Session-Id	263	UTF8String	RFC3588	M			V
Result-Code	268	Unsigned32	RFC3588	M			V
Origin-Host	264	DiamIdentity	RFC3588	M			V
Origin-Realm	296	DiamIdentity	RFC3588	M			V
Accounting-Record-Type	480	Enumerated	RFC3588	M			V
Accounting-Record-Number	485	Unsigned32	RFC3588	M			V
User-Name	1	UTF8String	RFC3588	M			V
Acct-Multi-Session-Id	287	Unsigned64	RFC3588	M			V
Error-Reporting-Host	294	DiamIdentity	RFC3588	M			V
Origin-State-Id	278	Unsigned32	RFC3588	M			V
Timpstamp	457	Unsigned64		M			V
Proxy-Info	284	Grouped	RFC3588	M			P,V

2

3 **8.2.3 Accounting messages**

4 The following table describes the RADIUS attributes contained in Accounting (Start, Interim and Stop) packets sent
5 from the Accounting Client to the Accounting Server when reporting location service usage. The Accounting Client
6 SHALL be collocated in the LS. Accounting messages MUST comply with RFC 2866.

Attribute	TYPE	Description	Start	Interim	Stop
User-Name	1	The identity and realm of the user used in the outer NAI during access authentication and authorization.	1	1	1
WiMAX-Session-ID	26/4	Set to the value of WiMAX-Session-ID of the MS.	1	1	1
Location-Modes	26/221	Set to the location mode – Mobile initiated, or Network Initiated Location request.	1	1	1
LBS-QoS	26/102	Specifies requested quality of positioning information.	1[1]	1[1]	1[1]

LBS

Granted-LBS-QoS	26/100	Specifies granted quality of positioning information.	0-1	0-1	0-1
Measurement-Method	26/103	Defines the method which should be used to get location measurements.	1	1	1
Time-Stamp		The time the event occurred.	1	1	1
NAS-Identifier	32	The FQDN of the LS.	1	1	1
NAS-IP		The IP address of the LS.	0-1	0-1	0-1
Anchor-Authenticator-NAS-Identifier	26/215	The FQDN of the Anchor Authenticator for the MS.	1	1	1
Anchor-Authenticator-NAS-IP	26/216	The IP address of the Anchor Authenticator for the MS.	0-1	0-1	0-1

1 SHALL be present to indicate the Location event to the AAA even if no QoS parameters are provided.

8.3 LBS R3

For the communication between LS and LC as well as LS and Anchor-Authenticator on R3 RADIUS or Diameter can be used. The connections to the LS are only specific for each LC / Anchor-Authenticator. They are not specific to a MS.

8.3.1 RADIUS message definitions

The following table lists the RADIUS packet types that are exchanged between the LS and the Anchor-Authenticator and the LC.

Packet Type	Source	Destination	Section
Change of Authorization (COA)	LS	Anchor Authenticator	8.4.1.1
Change of Authorization (ACK/NAK)	Anchor Authenticator	LS	8.4.1.1
Accounting Request (Stop)	Anchor Authenticator/LC	LS	8.4.1.2
Accounting Response	LS	Anchor Authenticator/LC	Note 1

Note 1: Accounting Response packets which are sent from the LS to the Anchor Authenticator or LC in order to acknowledge the reception of Accounting Request packets comply to RFC 2866 and are not discussed in this specification.

8.3.1.1 RADIUS R3 Measurement Request

The LBS related RADIUS communication over R3 for CSN triggered requests is based on the Dynamic Authorization Extensions of RADIUS as specified in [RFC5176]. LBS related COA messages SHALL NOT be combined with COA messages of different purpose. For privacy reasons, any involved RADIUS Relay or Proxy SHALL NOT store location related information which was passed that traverses it.

LBS

The following table list the attributes that are included in the RADIUS COA, COA-ACK and COA-NAK exchanged between the LS and the LC/Anchor-Authenticator.

Attribute	TYPE	Description	COA	COA-ACK	COA-NAK
User-Name	1	The NAI of the MS as received from the HAAA during the Authentication/Authorization phase. or just the realm of the user.	1	0-1	0-1
WiMAX-Session-ID	26/	Identifies the WiMAX Session for which location measurement(s) is requested.	1	0	0
NAS-Identifier	32	The FQDN of the Anchor-Authenticator hosting the WiMAX Session for which location information is requested.	1	0-1	0-1
NAS-IP-Address	4	The IP address of the Anchor Authenticator hosting the WiMAX Session for which location information is requested	0-1	0-1	0-1
Message-Authenticator	89	Integrity protection for the message.	1	0	0
LS-ID	26/233	The FQDN of the LS making the request. The value will be used to route reports back to the LS.	1	0	0
LBS-QoS	26/102	Specifies requested quality of positioning information.	1[1]	0	0
Measurement Method	26/103	Defines the method which will be used to get location measurements.	1	0	0
LBS-Transaction-ID	26/222	Unique identifier assigned by the LS used to correlate a measurement request to measure report.	1	0	0
Number Measurement Sets	26/104	This is the number of measurement sets being requested in the report.	1	0	0
Error-Cause	101	Error Codes indicating reason why the request was not fulfilled.	0	0	1

Notes:

- SHALL be present to indicate the Location Request to the AAA-Client even if no QoS parameters are

LBS

provided.

8.3.1.2 RADIUS R3 Measurement Response

The following table describes the RADIUS attributes contained in Accounting Request (Stop) packets sent from the Anchor Authenticator or the LC to the LS to report MS measurement.

The table includes that WiMAX specific measurement reporting attributes. The Accounting message MUST comply to RFC 2866.

Attribute	TYPE	Description			Stop
User-Name	1	Set to the FQDN of the LS as received in the COA packet in the LS-ID attribute.			1
Acct-Multi-Session-Id	50	Set to the value of WiMAX-Session-ID received in the COA packet from the LS.			1
NAS-Identifier	32	The FQDN of the entity (LC or Anchor Authenticator) that is generating the report.			1
LBS-Transaction-Id	26/222	The transaction identifier received by the LC in the measurement request.			1
Measurement-Report	26/217	Provides a set of attributes reporting the scan measurements from a given base station for the MS.			0-n[1]
LBS-Error-Cause	26/101	This indicates the cause of the unsuccessful LC ID request.			0-1

Notes:

- SHALL be present when the requested Measurement-Type is set to MS-Measured or BS-Measured. The BSID SHALL NOT be present. If it is present it SHALL be ignored by the receiver.

8.3.2 DIAMETER R3 Measurement Request/Response message definitions

This section defines the commands used by the LS to request measurement reports from the LC/Anchor-Authenticator as part of the WiMAX-Location-Authentication-Authorization Application with assigned application identifier of TBDWLAA. The LS and Anchor Authenticator/LC supporting this application SHALL advertise support for the WiMAX-Location-Authentication-Authorization Application with assigned application identifier of TBDWLAA.

The commands exchanged between the LS and the LC/Anchor Authenticator are listed in the table below.

Command-Name	Abbrev.	Code
WiMAX Location-Measurement-Query-Request	WLMQR	TBDWLMQ

LBS

Command-Name	Abbrev.	Code
WiMAX Location-Measurement-Query-Answer	WLMQA	TBDWLMQ

8.3.2.1 WiMAX Location-Measurement-Query Request/Answer command

WiMAX Location Measurement Query Request

This command is sent by the LS to the LC/Anchor Authenticator to request a measurement report for the specified MS.

< WiMAX Location-Measurement-Query-Request > ::= < Diameter Header, TBDWLMQ, REQ, PXY >

<Session-Id>

{ Auth-Application-Id } SHALL be set to TBDWLAA

{ Origin-Host }

{ Origin-Realm }

{ User-Name }

The NAI of the MS as received from the HAAA during the Authentication/Authorization phase. or just the realm of the user

{ WiMAX-Session-Id }

Set to the value of WiMAX-Session-ID of the MS

{ LBS-QoS }

Specifies requested quality of positioning information.

{ Measurement Method }

Defines the method which should be used to get location measurements.

{ Number Measurement Sets }

{ LBS-Transaction-ID }

Unique identifier assigned by the LS used to correlate a measurement request to measure report.

[Destination-Host]

[Origin-State-Id]

*[Proxy-Info]

*[Route-Record]

*[AVP]

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Session-Id	263	UTF8String	RFC3588	M			V
Auth-Application-Id	258	Unsigned32	RFC3588	M			V

LBS

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Origin-Host	264	DiamIdentity	RFC3588	M			V
Origin-Realm	296	DiamIdentity	RFC3588	M			V
Auth-Session-State	277	Enumerated	RFC3588	M			V
Destination-Host	293	DiamIdentity	RFC3588	M			V
Origin-State-Id	278	Unsigned32	RFC3588	M			V
Proxy-Info	284	Grouped	RFC3588	M			V
Route-Record	282	DiamIdentity	RFC3588	M			V
User-Name	1	UTF8String	RFC3588	M			V
WiMAX-Session-Id	4	OctetString		M,V			
LBS-QoS	102	Grouped		M,V			
Measurement Method	103	Enumerated		M,V			
Number-Measurement-Sets	104	Unsigned32		M,V			

- 1
- 2 WiMAX Location Measurement Query Answer
- 3 This command is sent by the LC/Anchor Authenticator in response to the reception of a WiMAX Location
- 4 Measurement Query Request.
- 5 < WiMAX Location-Measurement-Query-Answer > ::= < Diameter Header, TBDWLMQ, PXY >
- 6

< Session-Id >

{ Result-Code }

{ Origin-Host }

{ Origin-Realm }

{ User-Name }

{ WiMAX-Session-ID }

*[Measurement-Report]

SHALL be present when the requested Measurement-Type is set to MS-Measured or BS-Measured. The BS-ID SHALL NOT be present. If it is present it SHALL be ignored by the receiver.

[BS-ID]

SHALL be present when and requested Measurement-Type is set to BSID. The Measurement-Report SHALL NOT be present. If it is present it SHALL be ignored by the receiver.

[Origin-State-Id]

LBS

[Error-Message]

[Error-Reporting-Host]

* [Failed-AVP]

* [Redirect-Host]

[Redirect-Host-Usage]

[Redirect-Host-Cache-Time]

* [Proxy-Info]

* [AVP]

AVP Name	AVP Code	Value Type	Reference	AVP Flag rules			
				Must	May	Should not	Must not
Session-Id	263	UTF8String	RFC3588	M			V
Result-Code	268	Unsigned32	RFC3588	M			V
Origin-Host	264	DiamIdentity	RFC3588	M			V
Origin-Realm	296	DiamIdentity	RFC3588	M			V
Destination-Realm	283	DiamIdentity	RFC3588	M			V
Destination-Host	293	DiamIdentity	RFC3588	M			V
Auth-Application-Id	258	Unsigned32	RFC3588	M			V
User-Name	1	UTF8String	RFC3588	M			V
Origin-State-Id	278	Unsigned32	RFC3588	M			V
Proxy-Info	284	Grouped	RFC3588	M			P,V
Route-Record	282	DiamIdentity	RFC3588	M			P,V
Error-Message	281	UTF8String	RFC3588				V,M
Error-Reporting-Host	294	DiamIdentity	RFC3588				V,M
Failed-AVP	279	Grouped	RFC3588	M			V
Redirect-Host	292	DiamURI	RFC3588	M			V
Redirect-Host-Usage	261	Enumerated	RFC3588	M			V
Redirect-Host-Cache-Time	262	Unsigned32	RFC3588	M			V

WiMAX-Session-ID	4	OctetString		M,V			
------------------	---	-------------	--	-----	--	--	--

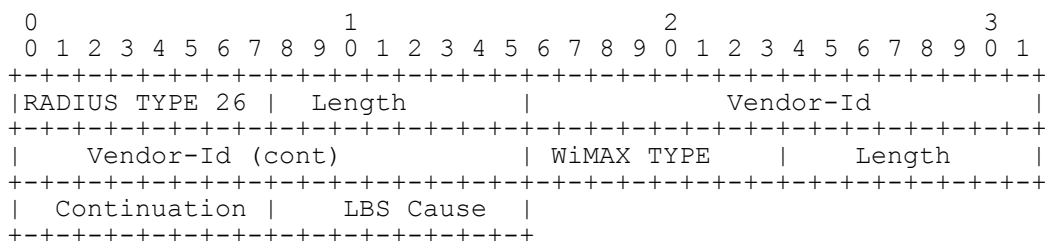
LBS

Measurement-Report	217	Grouped		M,V			
BS-ID	46	OctetString		M,V			

8.3.3 WiMAX RADIUS VSAs Definitions

WiMAX RADIUS VSAs are transported in a RADIUS Vendor Specific Attribute. Please see chapter “5.4.2 WIMAX RADIUS VSAs Definitions” in [3].

8.3.3.1 LBS-Error-Cause

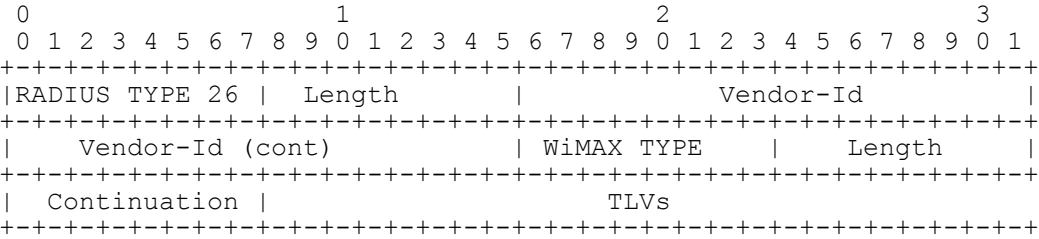


WType-ID	101 for LBS-Error-Cause
Description	This information element defines the LBS Cause.
Length	6+3+1
Continuation	C-bit=0
Value	1 byte Integer where the value specifies the error cause as described below.

Coding of LBS cause:

0x00000000	no error
0x00000001	target MS is unavailable
0x00000010	Reserved
0x00000011	target MS is unknown
0x00000100	Reserved
0x00000101	system failure
0x00000110	protocol failure
0x00000111	Unsupported measurement type
0x00001000	MS is powered off
0x00001001	LR not Authorized
0x00001010	Duplicate Request
0x00001011 to 0x11111111	Reserved

8.3.3.2 LBS-QoS



WType-ID	102 for LBS-QoS
Description	Provides a list of attributes with further information on the requested quality of information like the accuracy.
Length	6 + 3 + TLVs
Continuation	C-bit = 0
Value	One or more of the following sub-TLVs.

TLV ID	TLV Name	Length Octets	COA	COA-ACK	COA-NAK
1	LBS Priority and QoS Class/Parameter Attributes.	3	0-1	0	0
2	Positioning Latency.	3	0-1	0	0

LBS

TLV-ID	1 for LBS Priority and QoS Class/Parameter Attributes.
Description	This information element defines the LBS Priority and QoS Class/Parameter Attributes for a location request.
Length	2+1 octet
Value	This attribute value is an Octet that may have one of the following values: 0x01 = lowest priority request 0x02 = medium priority request 0x03 = high priority request
TLV-ID	2 for Latency
Description	This information element defines the LS handling response time in milliseconds for a location request.
Length	2+1 octet
Value	This information element defines the LS handling response time in milliseconds for a location request, including the time to obtain location measurements and compute a fix.: $L = \text{Positioning Latency} = 100 * ((1+0.05)^k - 1)$ in msec. $k=0$ will be interpreted as no latency requirement. To determine the desired value of k for a given Latency value in msec, use the inverse formula $k = \ln((L/100)+1)/(\ln 1.05)$, then round k to the closest integer value. Any octet values sent > 127 will be treated as 127. This provides values for $k=1$; $L=5$ ms $k=127$; $L=49$ seconds

8.3.3.3 Granted-LBS-QoS

```

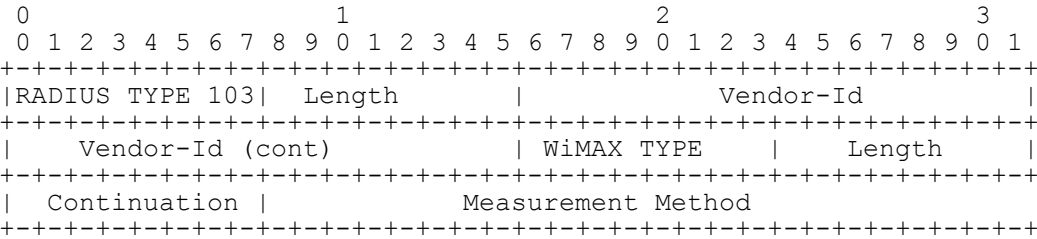
0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+-----+-----+-----+-----+
|RADIUS TYPE 26 | Length | Vendor-Id |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Vendor-Id (cont) | WiMAX TYPE | Length |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Continuation | TLVs
+-----+-----+-----+-----+-----+-----+-----+-----+

```

WType-ID	100 for Granted-LBS-QoS
Description	Provides a list of attributes with further information on the granted quality of information like the accuracy.
Length	6 + 3 + TLVs
Continuation	C-bit = 0
Value	One or more of the following sub-TLVs.

TLV ID	TLV Name	Length Octets	COA	COA-ACK	COA-NAK
1	LBS Priority and QoS Class/Parameter Attributes.	3	0-1	0	0
2	Positioning Latency.	3	0-1	0	0

8.3.3.4 Measurement-Method



WType-ID	103 for Measurement-Method
Description	This information element defines the method which SHALL be used to get location measurements.
Length	2+1 octet
Continuation	C-bit=0
Value	Octet indicating one of the following methods to be used for location determination: 0x00 = Reserved 0x01 = Serving BS ID (return serving BS ID). 0x02 = MS-Measured: requesting one or more scan measurements by the MS. 0x03 = BS-Measured: requesting measurement by the serving and reference BSes. Values 0x04 to 0xFF are reserved

WType-ID	104 for Number-Measurement-Sets
Description	This is the number of measurement sets to include in the report.
Length	6+3+4
Continuation	C-bit=0
Value	Unsigned integer minimum value of 1 and a maximum of 15 measurement sets.

8.3.3.6 MS-Identity-assertion

0																1																2																3															
0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9																								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+															
RADIUS TYPE 26																Length																Vendor-Id																															
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+															
Vendor-Id (cont)																WiMAX TYPE																Length																															
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+															
Continuation																String																																															
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+																+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+															

LBS

WType-ID	212 for MS-Identity-Assertion
Description	An attribute containing the mobile station identity assertion as received by the LS from the Location Requestor. The LS provides this identity to the AAA which uses this attribute to identify the mobile.
Length	6+3+Length of String
Continuation	C-bit=0
Value	Octet String. Format is not in scope of this specification.

8.3.3.7 Requestor-Identity-Assertion

```

0          1          2          3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|RADIUS TYPE 26 | Length          | Vendor-Id          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Vendor-Id (cont) | WiMAX TYPE    | Length          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Continuation | String
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

WType-ID	213 for Requestor-Identity-Assertion
Description	An attribute containing the requestor identity assertion as received by the LS from the Location Requestor. The LS provides this identity to the AAA which uses this attribute to identify the requestor.
Length	6+3+Length of String
Continuation	C-bit=0
Value	Octet String. Format is not in scope of this specification.

8.3.3.8 Requestor-Location-Authorization-Assertion

```

0          1          2          3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|RADIUS TYPE 26 | Length          | Vendor-Id          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Vendor-Id (cont) | WiMAX TYPE    | Length          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Continuation | String
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

LBS

WType-ID	214 for Requestor Location Authorization Assertion
Description	An attribute containing an authorization assertion as received by the LS from the Location Requestor. The LS provides this assertion to the AAA which uses this attribute to verify that the Location Requestor is authorized to obtain location information about the MS.
Length	6+3+Length of String
Continuation	C-bit=0
Value	Octet String. Format is not in scope of this specification.

8.3.3.9 Anchor-Authenticator-NAS-Identifier

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|RADIUS TYPE 26 | Length          | Vendor-Id          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Vendor-Id (cont) | WiMAX TYPE    | Length          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Continuation | String
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

WType-ID	215 for Anchor-Authenticator-NAS-Identifier
Description	This attribute is returned from the AAA and contains the identity of the Anchor-Authenticator. When the LS sends a COA-Request to the Anchor Authenticator the LS set the value of NAS-Identifier to the value received in the Anchor-Authenticator-NAS-Identifier VSA.
Length	6+3+Length of String
Continuation	C-bit=0
Value	String value of the FQDN of the Anchor Authenticator as per RFC 2865.

8.3.3.10 Anchor-Authenticator-NAS-IP

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|RADIUS TYPE 26 | Length          | Vendor-Id          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Vendor-Id (cont) | WiMAX TYPE    | Length          |
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
| Continuation | Address
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
|
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

LBS

WType-ID	216 for Anchor-Authenticator-NAS-IP
Description	This attribute is returned from the AAA and contains the IP of the Anchor-Authenticator. When the LS sends a COA-Request to the Anchor Authenticator the LS set the value of NAS-IP to the value received in the Anchor-Authenticator-IP VSA.
Length	6+3+4
Continuation	C-bit=0
Value	32-bit value containing the IPv4 address of the Anchor Authenticator.

8.3.3.11 Measurement-Report

```

      1           2           3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
6 |RADIUS TYPE 26 | Length           | Vendor-Id           |
7 +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
8 | Vendor-Id (cont) | WiMAX TYPE     | Length           |
9 +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
10 | Continuation | TLVs
11 +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

WType-ID	217 for Measurement-Report
Description	Provides a set of attributes reporting the scan measurements for a given base station.
Length	6 + 3 + TLVs
Continuation	C-bit = 0
Value	One or more of the following sub-TLVs.

TLV ID	TLV Name	Length Octets	Acct-Request
1	WiMAX-Session-ID	Variable	0-1[1]
2	Report-Type	3	1
3	Serving-BS-ID	8	1
4	BS-ID	Variable	1-n
5	Report-Field-Mask	Variable	1-n
6	CINR	Variable	1-n
7	RSSI	Variable	1-n
8	RTD	Variable	1-n
9	RD	Variable	0-n[2]
10	Timestamp	Variable	1-n[3]

LBS

Notes

- 1 MUST be specified if the Scan Measurement attribute is appears multiple times in a packet for different WiMAX session. For example, when a packet MAY be used to report the Scan Measurements for different mobiles.
- 2 When the Report-Type is set to BS-Measured then the RD attribute SHALL NOT appear in the Measurement-Report.
- 3 When the Report-Type is set to MS-Measurement then the Timestamp SHALL only appear once in the Measurement-Report

TLV-ID	1 for WiMAX-Session-ID
Description	The AAA-Session-ID that is associated with this Scan-Measure. MUST be used when reporting multiple Scan-Measures for multiple mobile nodes. Otherwise, it MAY appear in the Scan Measure.
Length	2+Length of AAA-Session-ID
Value	As defined in section 5.4 in stage 3.

TLV-ID	2 for Report-Type
Description	Specifies the type of measure the LS is requesting to be provided by the LC.
Length	2+1
Value	A 1-octet enumeration (Most Significant Bit first) containing the following values <ul style="list-style-type: none"> • 0x00 RESERVED. • 0x01 Serving BS-ID • 0x02 MS-Measured: requesting one or more scan measurements by the MS. • 0x03 BS-Measured: requesting measurement by the serving and reference BSes. • Values 0x04 to 0xFF RESERVED.

TLV-ID	3 for serving BS-ID
Description	The serving BSID. It MUST also be one of the base station appearing in the BSID TLV.
Length	2+6 octet
Value	6 octet presentation of the BS-ID as per [3].

LBS

TLV-ID	4 for BS-ID
Description	The BSIDs making up to report.
Length	2+6 octet
Value	6 octet presentation of the BS-ID as per [3].

1

TLV-ID	5 for Report-Field-Mask
Description	For each row in the report, indicates which of the measurements in that row have valid values (bits are set) and which of the measurements for that row SHALL be ignored (bit is cleared).
Length	2+1 octet
Value	<p>A one octet Octet String coded as a bit field (Most Significant Bit first) as follows:</p> <ul style="list-style-type: none"> • Bit-0 CINR • Bit-1 RSSI • Bit-2 RTD • Bit-3 RD <p>Bits 4 to 7 are RESERVED. RESERVED Bits SHALL be set to zero by the sender and ignored by the receiver.</p>

2

TLV-ID	6 for CINR
Description	Carrier to Interference noise ratio.
Length	2+1 octet
Value	Octet String encoded as per [16].

3

TLV-ID	7 for RSSI
Description	Relative Signal Strength Indicator
Length	2+1 octet
Value	Octet String encoded as per [16].

4

LBS

TLV-ID	8 for RTD
Description	The round trip delay between the MS and the BSID.
Length	2+1 octet
Value	Octet String encoded as per [16].

1

TLV-ID	9 for RD
Description	The relative delay between the BSID and the paired BSID.
Length	2+1 octet
Value	Octet String encoded as per [16].

2

TLV-ID	10 for Timestamp
Description	The time the BS generated the report.
Length	2+4 octets
Value	Unsigned 64-bit Integer in milli seconds since January 1 st 1970.

3

8.3.3.12 LS-PSK

4

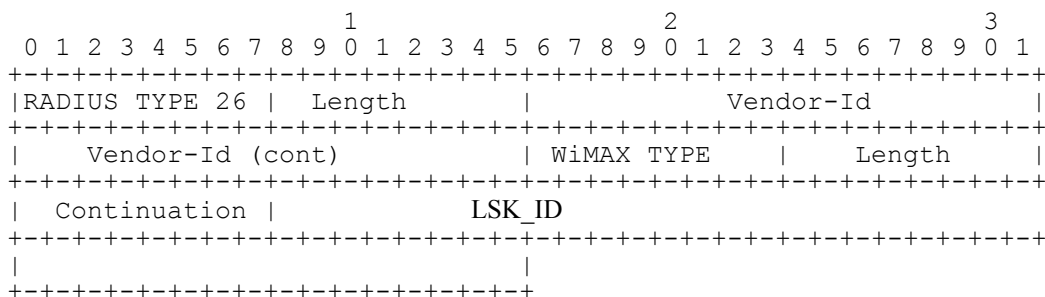
```

5          1          2          3
6      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
7      +-----+-----+-----+-----+-----+-----+-----+-----+
8      |RADIUS TYPE 26 | Length          | Vendor-Id          |
9      +-----+-----+-----+-----+-----+-----+-----+-----+
10     | Vendor-Id (cont)          | WiMAX TYPE          | Length          |
11     +-----+-----+-----+-----+-----+-----+-----+-----+
12     | Continuation |          SALT          |          LSK          |
13     +-----+-----+-----+-----+-----+-----+-----+-----+

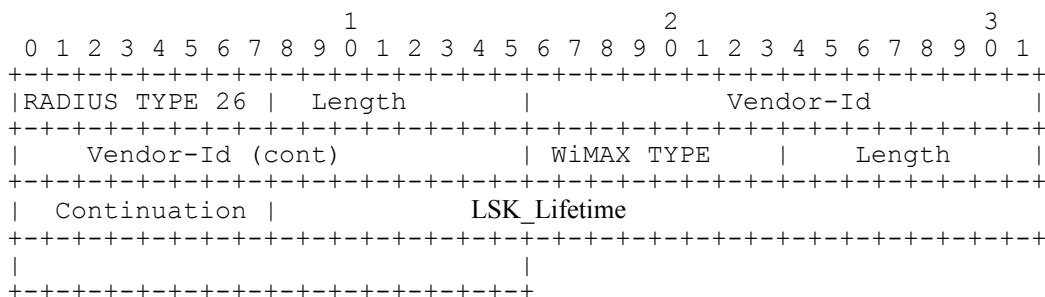
```

WType-ID	218 for LS-PSK
Description	The pre shared key LSK to be used to authenticate R2 location protocol communication between LS and MS.
Length	6 + 3 + 2(SALT) + length of the String containing the LSK
Continuation	When following the procedures defined in [17] if the resulting encrypted string will be greater than 244 (255-11) octets then the plaintext SHALL be split into two attributes each encrypted separately with the C-bit of the second attribute set to 1 to indicate that this attribute is a fragment of the previous VSA. Otherwise, if no fragmentation is required, then the C-bit is set to '0' zero.
Value	The value consists of 2 octet SALT (see [17]) and String containing the encrypted LSK key as generated by the AAA server per section 8.3.3.2, with the encryption. formulated as per [17].

LBS

8.3.3.13 LS-PSK-ID

WType-ID	219 for LS-PSK-ID
Description	The Identifier LSK_ID generated by the AAA as per section 8.4.3 associated with the pre shared key to be used for protecting the R2 location protocol between the MS and the LS.
Length	6 + 3 + 4
Continuation	C-bit = 0
Value	Octet String encoded as per [16].

8.3.3.14 LS-PSK-Lifetime

WType-ID	220 for LS-PSK-Lifetime
Description	The lifetime of the LSK to be used for protecting the R2 location protocol between the MS and the LS.
Length	6 + 3 + 4
Continuation	C-bit = 0
Value	Unsigned 32-bit integer representing a time in seconds.

LBS

8.3.3.15 Location-Modes

```

0      0      1      2      3
1  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
2  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
3  |RADIUS TYPE 26 | Length          | Vendor-Id          |
4  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
5  | Vendor-Id (cont) | WiMAX TYPE | Length          |
6  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
7  | Continuation | Location Modes |
8  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
9
10

```

WType-ID	221 for Location-Modes
Description	Specifies the modes of location requests
Length	6+3+1
Value	A 1-octet enumeration containing the following values <ul style="list-style-type: none"> • 0 MS Initiated (R2) location Request • 1 Network Initiated Location request • 2 to 255 RESERVED. All other values RESERVED.

8.3.3.16 Transaction-Id

WType-ID	222 for Transaction-Id
Description	A unique identifier assigned to a location request for a given mobile. The 3-tuple home-realm (from username) , WiMAX-Session-Id and Transaction-Id is globally unique.
Length	6+3+4
Value-Type	Unsigned32
Value	Unsigned 32-bit Integer.

8.3.3.17 Location-Requestor-Authentication-Protocol

```

0      0      1      2      3
1  0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
2  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
3  |RADIUS TYPE 26 | Length          | Vendor-Id          |
4  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
5  | Vendor-Id (cont) | WiMAX TYPE | Length          |
6  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
7  | Continuation | Loc Req Auth P. |
8  +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
9
10

```

LBS

WType-ID	231 for Location-Requestor-Authentication-Protocol.
Description	Specifies the authentication protocol to be used.
Value-Type	Enumeration
Value	Enumerated field with the following values: <ul style="list-style-type: none"> • 1 U1 authentication protocol (out of scope). • 2 HELD based authentication using PSK. • 3 ULP based authentication using PSK. • 4 HELD IP-based authentication. All other values RESERVED.

8.3.3.18 vLS-ID

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+-----+-----+-----+-----+
|RADIUS TYPE 26 | Length          |                               Vendor-Id |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Vendor-Id (cont) | WiMAX TYPE      | Length          |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Continuation | String
+-----+-----+-----+-----+-----+-----+-----+-----+

```

WType-ID	232 for vLS-ID
Description	This attribute is returned from the AAA and contains the identity of the visited Location Server.
Length	6+3+Length of String
Continuation	C-bit=0
Value	String value of the FQDN of the Visited Location Server as per RFC 2865.

8.3.3.19 LS-ID

```

0                               1                               2                               3
0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-----+-----+-----+-----+-----+-----+-----+-----+
|RADIUS TYPE 26 | Length          |                               Vendor-Id |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Vendor-Id (cont) | WiMAX TYPE      | Length          |
+-----+-----+-----+-----+-----+-----+-----+-----+
| Continuation | String
+-----+-----+-----+-----+-----+-----+-----+-----+

```

LBS

WType-ID	233 for LS-ID
Description	This attribute contains the identity of the Location Server.
Length	6+3+Length of String
Continuation	C-bit=0
Value	String value of the FQDN of the Location Server as per RFC 2865.

8.3.3.20 Radius Attributes for Location Server Discovery by MS

The following Radius attributes for the address(es) or a list of fully qualified domain names (FQDN) of Location Server(s) are downloaded from the HAAA server to the ASN during access authentication in the Access-Accept message when LBS service is supported.

Table 17 – Location Server Attributes in Final RADIUS Access-Accept from HAAA to ASN

Attribute	Type	Description	Access Request	Access Challenge	Access Accept	Access Reject
hLS-Server-IPv4	26/223	The IPv4 address of hLS Server(s)	0	0	0-1[1][2][4]	0
hLS-Server-FQDN	26/224	The FQDN of hLS Server(s)	0	0	0-1[1][2][4]	0
hLS-Server-IPv6	26/225	The IPv6 address of hLS Server(s)	0	0	0-1[1][2][4]	0
hLS-Server-URI	26/226	The URI for the hLS server	0	0	0-1[1][2][4]	0
vLS-Server-IPv4	26/227	The IPv4 address of vLS Server(s)	0-1[3]	0	0-1[1][2][4]	0
vLS-Server-FQDN	26/228	The FQDN of vLS Server(s)	0-1[3]	0	0-1[1][2][4]	0
vLS-	26/229	The IPv6	0-1[3]	0	0-1[1][2]	0

LBS

Server-IPv6		address of vLS Server(s)			[4]	
vLS-Server-URI	26/230	The URI of the vLS server	0-1[3]	0	0-1[1][2][4]	0

1 Notes

- [1] This attribute is only present when the MS has subscribed LBS service.
- [2] Attributes SHALL NOT appear in the Access Accept sent associated with the Device Authentication phase.
- [3] Sent to HAAA by VAAA to let HAAA know that VAAA can assign the address. If policies allow and HAAA authorizes the assignment by the vAAA, this attribute is returned in the Access Accept.
- [4] Only one amongst the 8 attributes SHALL appear in the Access Accept

2

3 **8.3.3.21 WiMAX Radius VSA Definition for LOCATION SERVER Discovery by MS**

4 The following VSAs specify IP addresses or FQDNs of LBS Server(s) provided to the ASN for the MS. The
5 Location Server(s) SHALL be provided in order of preference.

6

```

7      0              1              2              3
8      0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
9      +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
10     |RADIUS TYPE 26 | Length           | Vendor-Id           |
11     +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
12     | Vendor-Id (cont)           | WiMAX TYPE           | Length           |
13     +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+
14     | Continuation | Location Server TLVs
15     +---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+---+

```

16

WType-ID	223 for hLS-Server-IPv4
Description	The IPv4 address of hLS Server(s).
Length	6 + 3 + 4
Continuation	C-bit = 0
Value	Octet string containing one or a list of IPv4 addresses (most significant octet first)

17

WType-ID	224 for hLS-Server-FQDN
Description	The hLS Server Domain Names for LBS service.
Length	6 + 3 + (variable)

LBS

Continuation	C-bit = 0
Value	Octet string containing a Domain Name (most significant octet first).

1

WType-ID	225 for hLS-Server-IPv6
Description	The IPv6 address of hLS Server(s).
Length	6 + 3 + 16
Continuation	C-bit = 0
Value	Octet string containing a IPv6 addresses (most significant octet first).

2

WType-ID	226 for hLS-Server-URI
Description	The URI hLS Server.
Length	6 + 3 + (variable)
Continuation	C-bit = 0
Value	Octet string containing the URI of the hLS.

3

WType-ID	227 for vLS-Server-IPv4
Description	The IPv4 address of vLS Server(s).
Length	6 + 3 + 4
Continuation	C-bit = 0
Value	Octet string containing one or a list of IPv4 addresses (most significant octet first).

4

WType-ID	228 for vLS-Server-FQDN
Description	The vLS Server Domain Names for LBS service.
Length	6 + 3 + (variable)
Continuation	C-bit = 0
Value	Octet string containing a Domain Name (most significant octet first).

5

WType-ID	229 for vLS-Server-IPv6
Description	The IPv6 address of vLS Server(s).
Length	6 + 3 + 16
Continuation	C-bit = 0
Value	Octet string containing a IPv6 addresses (most significant octet first).

6

LBS

WType-ID	230 for vLS-Server-URI
Description	The URI vLS Server.
Length	6 + 3 + (variable)
Continuation	C-bit = 0
Value	Octet string containing the URI of the vLS.

8.3.4 LBS Diameter VSA Definition

8.3.4.1 LBS Error Cause

WType-ID	101 for LBS-Error-Cause																								
Description	This information element defines the LBS Cause.																								
Value-Type	Enumeration																								
Value	<p>The value specifies the error cause as described below:</p> <table> <tr><td>0</td><td>No error</td></tr> <tr><td>1</td><td>target MS is unavailable</td></tr> <tr><td>2</td><td>Reserved</td></tr> <tr><td>3</td><td>target MS is unknown</td></tr> <tr><td>4</td><td>Reserved</td></tr> <tr><td>5</td><td>system failure</td></tr> <tr><td>6</td><td>protocol failure</td></tr> <tr><td>7</td><td>Unsupported measurement type</td></tr> <tr><td>8</td><td>MS is powered off</td></tr> <tr><td>9</td><td>LR not Authorized</td></tr> <tr><td>10</td><td>Duplicate Request</td></tr> <tr><td>11 and above</td><td>Reserved</td></tr> </table>	0	No error	1	target MS is unavailable	2	Reserved	3	target MS is unknown	4	Reserved	5	system failure	6	protocol failure	7	Unsupported measurement type	8	MS is powered off	9	LR not Authorized	10	Duplicate Request	11 and above	Reserved
0	No error																								
1	target MS is unavailable																								
2	Reserved																								
3	target MS is unknown																								
4	Reserved																								
5	system failure																								
6	protocol failure																								
7	Unsupported measurement type																								
8	MS is powered off																								
9	LR not Authorized																								
10	Duplicate Request																								
11 and above	Reserved																								

8.3.4.2 LBS-QoS

WType-ID	102 for LBS-QoS
Description	Provides a list of attributes with further information on the requested quality of information like the accuracy.
Value-Type	Grouped

LBS-QoS ::= < AVP Header: 102>

[LBS-Priority-QoS-Parameters]

LBS

[Positioning-Latency]

*[AVP]

AVP	TLV Name	Request	Answer
337	LBS-Priority-QoS-Parameters	0-1	0
338	Positioning-Latency	0-1	0

8.3.4.3 Granted-LBS-QoS

WType-ID	100 for Granted LBS-QoS
Description	Provides a list of attributes with further information on the granted quality of information like the accuracy.
Value-Type	Grouped

LBS-QoS ::= < AVP Header: 100 >

[LBS-Priority-QoS-Parameters]

[Positioning-Latency]

*[AVP]

AVP	TLV Name	Request	Answer
337	LBS-Priority-QoS-Parameters	0-1	0
338	Positioning-Latency	0-1	0

1 **8.3.4.4 Measurement-Method**

WType-ID	120 for Measurement Method
Description	This information element defines the method which SHALL be used to get location measurements.
Value-Type	Enumeration
Value	Formatted as an enumeration indicating the following methods to be used for location determination: 0 is reserved 1: Serving BS ID (return serving BS ID) 2: MS-Measured: requesting one or more scan measurements by the MS. 3: BS-Measured: requesting measurement by the serving and reference BSes. Values 4 and greater are reserved.

2

8.3.4.5 Number-Measurement-Sets

WType-ID	104 for Number-Measurement-Sets
Description	This is the number of measurement sets to include in the report.
Value-Type	Unsigned32 minimum value of 1 and a maximum of 15 measurement sets.

8.3.4.6 MS-Identity-Assertion

WType-ID	212 for MS-Identity-Assertion
Description	An attribute containing the mobile station identity assertion as received by the LS from the Location Requestor. The LS provides this identity to the AAA which uses this attribute to identify the mobile.
Value-Type	OctetString
Value	Format is not in scope of this specification.

8.3.4.7 Requestor-Identity-Assertion

WType-ID	213 for Requestor-Identity-Assertion
Description	An attribute containing the requestor identity assertion as received by the LS from the Location Requestor. The LS provides this identity to the AAA which uses this attribute to identify the requestor.
Value-Type	OctetString
Value	Format is not in scope of this specification.

8.3.4.8 Requestor Location Authorization Assertion

WType-ID	214 for Requestor Location Authorization Assertion
Description	An attribute containing an authorization assertion as received by the LS from the Location Requestor. The LS provides this assertion to the AAA which uses this attribute to verify that the Location Requestor is authorized to obtain location information about the MS.
Value-Type	OctetString
Value	Format is not in scope of this specification.

1 **8.3.4.9 Anchor-Authenticator-NAS-Identifier**

WType-ID	215 for Anchor-Authenticator-NAS-Identifier
Description	This attribute is returned from the AAA and contains the identity of the Anchor-Authenticator. When the LS sends a COA-Request to the Anchor Authenticator the LS set the value of NAS-Identifier to the value received in the Anchor-Authenticator-NAS-Identifier VSA.
Value-Type	DiameterIdentity
Value	Value of the FQDN of the Anchor Authenticator as per RFC 3588

2 **8.3.4.10 Anchor-Authenticator-NAS-IP**

WType-ID	216 for Anchor-Authenticator-NAS-IP
Description	This attribute is returned from the AAA and contains the IP of the Anchor-Authenticator. When the LS sends a COA-Request to the Anchor Authenticator the LS set the value of NAS-IP to the value received in the Anchor-Authenticator-IP VSA.
Value-Type	Address
Value	Contains the IPv4 address of the Anchor Authenticator

3 **8.3.4.11 Measurement-Report**

WType-ID	217 for Measurement-Report
Description	Provides a set of attributes reporting the scan measurements for a given base station.
Value-Type	Grouped
Value	One or more of the following sub-TLVs

4

Measurement-Report::= < AVP Header: 217>

{ Report-Type }

{Serving-BS-ID}

*{BS-ID}

*{ Report-Field-Mask{

*{CINR}

*{RSSI}

*{ RTD}

*{Timestamp}

When the Report-Type is set to MS-Measurement then the Timestamp

SHALL only appear once in the Measurement-Report

*[RD]

When the Report-Type is set to BS-Measured then the RD attribute SHALL NOT appear in the Measurement-Report.

*[AVP]

1

AVP	TLV Name	Request	Answer
450	{ Report-Type }	0	1
451	{Serving-BS-ID}	0	1
46	*{BS-ID}	0	1-n
452	*{ Report-Field-Mask{	0	1-n
453	*{CINR}	0	1-n
454	*{RSSI}	0	1-n
455	*{ RTD }	0	1-n
457	*{Timestamp}	0	1-n
456	*[RD]	0	0-n

2

3 8.3.4.12 LS-SA

WType-ID	430 for LS-SA
Description	The pre shared key LSK to be used to authenticate the R2 location protocol communication between LS and MS with the associated key identifier and lifetime.
Value-Type	Grouped

4

LS-SA ::= < AVP Header: 430>

{LSK_ID }

In a request this represents the LSK_ID of the key being requested.
In an answer, this is the LSK_ID of the key being returned.

[LSK]

The key.

[LSK-Lifetime]

The lifetime of the security association.

*[AVP]

LBS

AVP	TLV Name	Request	Answer
337	LSK-ID	1	1
338	LSK	0	1
339	LSK-Lifetime	0	1

8.3.4.13 Location-Mode

WType-ID	221 for Location-Mode
Description	Specifies the modes of location requests.
Value-Type	Enumeration
Value	Enumerated field with the following values: <ul style="list-style-type: none"> 1 MS Initiated (R2) location request. 2 Network Initiated Location request. All other values RESERVED.

8.3.4.14 Location-Requestor-Authentication-Protocol

WType-ID	231 for Location-Requestor-Authentication-Protocol.
Description	Specifies the authentication protocol to be used.
Value-Type	Enumeration
Value	Enumerated field with the following values: <ul style="list-style-type: none"> 1 - U1 authentication protocol (out of scope). 2 - HELD based authentication using PSK. 3 - ULP based authentication using PSK. 4 - HELD IP-based authentication. All other values RESERVED.

1 **8.3.4.15 LBS-Priority-QoS-Parameters**

WType-ID	432 for LBS-Priority-QoS-Parameters
Description	This information element defines the LBS Priority and QoS Class/Parameter Attributes for a location request.
Value-Type	Unsigned32
Value	This attribute value has one of the following values: 0x01 = lowest priority request 0x02 = medium priority request 0x03 = high priority request

2 **8.3.4.16 Positioning-Latency**

WType-ID	433 for Position-Latency
Description	This information element defines the LS handling response time in mseconds for a location request.
Value-Type	Unsigned32
Value	This information element defines the LS handling response time in milliseconds for a location request, including the time to obtain location measurements and compute a fix.: $L = \text{Positioning Latency} = 100 * ((1+0.05)^k - 1) \text{ in msec.}$ $k=0 \text{ will be interpreted as no latency requirement. To determine the desired value of } k \text{ for a given Latency value in milliseconds, use the inverse formula } k = \ln((L/100)+1)/(\ln 1.05), \text{ then round } k \text{ to the closest integer value. Any octet values sent } > 127 \text{ will be treated as } 127.$ <p>This provides values for</p> $k=1; L= 5\text{ms}$ $k=127; L=49 \text{ seconds}$

3 **8.3.4.17 Number-Of-Measurements-Per-Report**

WType-ID	434 for Number-Of-Measurements-Per-Report
Description	The number of measurement reports to be provided in each accounting message.
Value-Type	Unsigned32
Value	Value ranges from 0 to 15. All other values are considered an error.

4

1 **8.3.4.18 Report-Type**

WType-ID	450 for Report-Type
Description	Specifies the type of measure the LS is requesting to be provided by the LC.
Value-Type	Unsigned32
Value	An enumeration (Most Significant Bit first) containing the following values <ul style="list-style-type: none"> • 0x00 RESERVED. • 0x01 Serving Base Station ID • 0x02 MS-Measured: requesting one or more scan measurements by the MS. • 0x03 BS-Measured: requesting measurement by the serving and reference BSes. • 0x04 to 0xFF RESERVED.

2 **8.3.4.19 Serving-BS-ID**

WType-ID	451 for Serving BS-ID
Description	The serving BSID. It MUST also be one of the base station appearing in the BSID TLV.
Value-Type	OctetString
Value	6 octet presentation of the BSID as per [3].

3 **8.3.4.20 Report-Field-Mask**

WType-ID	452 for Report-Field-Mask
Description	For each row in the report, indicates which of the measurements in that row have valid values (bits are set) and which of the measurements for that row SHALL be ignored (bit is cleared).
Value-Type	Unsigned32
Value	Coded as a bit field (Most Significant Bit first) as follows: <ul style="list-style-type: none"> • Bit-0 CINR • Bit-1 RSSI • Bit-2 RTD • Bit-3 RD Bits 4 to 32 are RESERVED. RESERVED Bits SHALL be set to zero by the sender and ignored by the reserver.

4

8.3.4.21 CINR

WType-ID	453 for CINR
Description	Carrier to Interference noise ratio.
Value-Type	OctetString
Value	Encoded as per [16].

8.3.4.22 RSSI

WType-ID	454 for RSSI
Description	Relative Signal Strength Indicator.
Value-Type	OctetString
Value	Encoded as per [16].

8.3.4.23 RTD

WType-ID	455 for RTD
Description	The round trip delay between the MS and the BSID.
Value-Type	OctetString
Value	Encoded as per [16].

8.3.4.24 RD

WType-ID	456 for RD
Description	The relative delay between the BSID and the paired BSID.
Value-Type	OctetString
Value	Encoded as per [16].

8.3.4.25 Timestamp

WType-ID	457 for Timestamp
Description	The time the BS generated the report.
Value-Type	Unsigned64
Value	Unsigned 64-bit Integer in milli seconds since January 1 st 1970.

8.3.4.26 vLS-ID

WType-ID	232 for vLS-ID
Description	This attribute is returned from the AAA and contains the identity of the visited Location Server.
Value-Type	DiameterIdentity
Value	Value of the FQDN of the Visited Location Server as per RFC 3588

8.3.4.27 MS IP Address

WType-ID	XXX for the MS IP Address
Description	This attribute is returned from the AAA and contains the IP of the MS for communication over the R2 interface.
Value-Type	Address
Value	Contains the IPv4/6 address of the MS

8.4 LBS R2

This Section describes LBS R2 protocol alternatives as well as security aspects of R2 protocols. User plane is used for all LBS R2 protocols.

8.4.1 WiMAX Location Protocol (WLP)**8.4.1.1 LS Discovery**

The LS discovery SHALL use DHCP options.

8.4.1.2 Transport mechanism

The WLP transport SHALL be based on HTTP Enabled Location Delivery [15].

8.4.1.3 WLP Objects

There are 3 different types of objects in WLP. These include:

- a) Location objects, which express the physical position of a device or user. The location objects use Presence Information Data Format Location Object (PIDF-LO). The location format could be either:
 - a. Geodetic information (shape, volume, point) or
 - b. Civic information (street address)
- b) GPS assistance data, which consists of
 - a. Global assistance data and
 - b. Local assistance data
- c) Measurement data, which include:

LBS

- a. Satellite pseudo-ranges
- b. Base station identifiers
- c. Mobile scanning report data for the WiMAX air interface (RSSI, CINR, RTD, RD)

WLP SHALL use Geodetic location object as defined in [6], [7], [8].

WLP SHALL use Civic location object as defined in [6], [7], [9].

WLP SHALL use GPS assistance object as defined in [10].

WLP SHALL use satellite pseudo ranges object as defined in [11]. (Sections 5.1, 5.7)

WLP SHALL use WiMAX Scan object and WiMAX BSID as defined in [6 (Section 5.1)] [12].

8.4.1.4 WLP capabilities

When the MS first establishes a relationship with the LS it MAY send an indication of its capabilities to the LS. The capabilities are transported in a container element that MAY house one or more specific capability elements. Each specific capability element is defined by a URN (Uniform Resource Name), depending on the capability specific operating parameters MAY also be reported. Capability negotiation is achieved by the MS first indicating to the LS which capabilities it can support, and the LS subsequently indicating which subset of these it can support. The resulting subset passed from the LS to the MS identifies the capabilities that MAY be invoked between the two entities.

WLP SHALL use the capability objects as defined in [13]

WLP satellite pseudo-range capabilities SHALL use the namespace defined in [11] (Section 5.7)

WLP MSR capabilities SHALL use the namespace defined in [12] (Section 4)

The WLP responses will be the same as those previously defined.

8.4.1.5 Security Aspects for WLP

A general overview of the threats surrounding HELD are described in [2], specifically the HELD security model targets three specific aspects:

- The MS must connect to the correct LS
- The LS must be able to identify the MS by its IP address or other suitable identifier
- exchanges must be transmitted secretly and unmodified between the MS and the LS.

Message exchanges between the MS and LS occur over a PSK-TLS [RFC4279] transport.

Connection between MS and LS is protected using the pre-shared key based TLS method [RFC4279] with LSK as the pre-shared key. LSK derivation from EMSK SHALL be performed as per section 8.4.3. This specification does not preclude the use of other security such as those described in the HELD specification [2].

8.4.2 OMA SUPL

This Section provides information about OMA SUPL, specifically the UserPlane Location Protocol (ULP). For detailed description, of the SUPL Enabler see [4].

8.4.2.1 Userplane Location Protocol (ULP)

The UserPlane Location Protocol (ULP) [5] is utilized between the SET and SLP.

Mapping of ULP abbreviations and terms into WiMAX:

LBS

- SET (SUPL Enabled Terminal): Location Requester in MS.

- SLP (SUPL Location Platform): Location Server.

ULP 2.0 [5] now offers explicit support for uploading of the relevant WiMAX scan reports from MS to LS. Both MS-initiated and network-initiated triggers for location are supported. Assisted GPS, EOTD, and other location determination methods are provided for, with the actual determination performed on either the MS or the LS. Numerous other LBS features are offered, as described in [4] and [5].

8.4.2.2 Transport Protocol

Transport protocol for ULP is TCP/IP with specific port. However, the initial SUPL INIT message SHALL be transported over OMA Push or SIP Push or Mobile Terminated SMS or UDP/IP in network initiated cases.

8.4.2.3 WiMAX Parameters

The following WiMAX specific parameters exist in ULP [5] messages:

- WiMAX BS Info: Information about serving and neighboring WiMAX BSs including measurements. Information includes BS ID, BS Location, RSSI, CINR, RD, RTD, etc.
- WiMAX Area Id: ID of the area used in area triggered events. This is BS ID for WiMAX.

8.4.2.4 Addressing SLP

MS knows H-SLP address either via pre-configuration or via configuration by service provider using SUPL management object [5a] in OMA DM.

8.4.2.5 Security

Connection between SET (MS) and SLP (Location Server) is protected as per [5] using the pre-shared key based TLS method [RFC4279]. SEK (SUPL Encryption Key) is used as a pre-shared key and it is derived from LSK. LSK derivation from EMSK SHALL be performed as per section 8.4.3.

More information about SUPL security can be found from Chapter 6 of [5].

8.4.3 R2 Location Security Keying

For keying PSK-TLS protected communication over WiMAX R2 a temporary pre-shared secret key and associated key identifier is required between the MS and the LS. This key MAY be derived from the Extended Master Session Key (EMSK) generated during EAP-based network access authentication in the MS and AAA server. If R2 security is keyed based on EMSK-derived keys, the procedure described in this section SHALL be used.

A location root key (LBS-RK) is computed at the MS and the AAA server responsible for MS/subscriber authentication. LBS-RK forms the root for further derivation of all location specific key material. From LBS-RK, further Location Server Key (LSK) with associated key identifier LSK-ID bound to the LSK are derived in the AAA server and in the MS to be used by a specific LS and MS, respectively. LSK-ID can be used by the location server and MS e.g., to handle re-keying.

The LSK and LSK-ID will be transferred from the AAA server to the location server on request.

The level of cryptographic protection applied to any transfer of location keys between AAA server and Location Server SHALL at least match the one that is applied to transfer of cryptographic keys within WiMAX AAA signaling.

8.4.3.1 Location Root Key Derivation

The 64-octet location root key (LBS-RK) SHALL be derived in the AAA server and MS from the EMSK as follows:

LBS-RK1 = HMAC-SHA256(EMSK, usage-data | 0x01)

LBS-RK2 = HMAC-SHA256(EMSK, LBS-RK1 | usage data | 0x02)

LBS

1 LBS-RK = LBS-RK1 | LBS-RK2

2 where:

3 - usage-data = key label + “\0” + length

4 - key label = lbs-rk@wimaxforum.org in ASCII

5 - length = 0x0200 the length in bits of the LBS-RK expressed as a 2 byte unsigned integer in network order.

6 The LBS-RK is stored in the AAA server and SHALL NOT be transported outside the AAA server. The lifetime of
7 the LBS-RK SHALL NOT exceed the lifetime of the EMSK key the LBS-RK is derived from.

8.4.3.2 Location Key Derivation and Identifier

10 From the location root key LBS-RK further location keys LSK that are specific to one location server SHALL be
11 derived in the AAA server and MS as follows:

12 LSK-1 = HMAC-SHA256(LBS-RK, usage-data-lsk | LS-IP | MS-NAI | 0x01)

13 LSK-2 = HMAC-SHA256(LBS-RK, LSK1 | usage-data-lsk | LS-IP | MS-NAI | 0x02)

14 LSK = LSK-1 | LSK-2

15 where:

16 - usage-data-lsk = key label + “\0” + length

17 - key label = lsk-supl@wimaxforum.org in ASCII (if the MS and LS use OMA-SUPL as R2 location protocol), or

18 key label = lsk-held@wimaxforum.org in ASCII (if the MS and LS use HELD as R2 location protocol)

19 - length = 0x0200 the length in bits of the LSK expressed as a 2 byte unsigned integer in network order

20 - LS-IP is the IP address of the LS as seen from the MS (that is either an IPv4 address expressed as a 32-bit value in
21 case IPv4 is used, or an IPv6 address expressed as a 128-bit value in case IPv6 is used). The LS-IP MAY need to be
22 discovered by the MS from FQDN or URI.

23 - MS-NAI is the NAI that is provided by the MS as outer NAI during initial network entry, without decoration.

24 A key identifier value LSK-ID SHALL be generated for each LSK in the form of a NAI by taking a base64 encoded
25 128bit value L-ID as the username part and the FQDN of the AAA server’s CSN as the realm part of the NAI,
26 where:

27 L-ID = the 16 most significant bytes of HMAC-SHA256(LSK, “Location Key Identifier”).

28 The lifetime of the LSK SHALL NOT exceed the lifetime of the LBS-RK key the LSK is derived from.