**3GPP TSG-WG SA2 Meeting #155 *S2-23xxxx***

**Athens, Greece, Feb 20 – 24, 2023 (revision of S2-23xxxx)**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
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|  | **23.273** | **CR** | **-** | **rev** | **0** | **Current version:** | **18.0.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network |  | Core Network | **X** |

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|  |
| ***Title:***  | Inclusion of NWDAF as GMLC services |
|  |  |
| ***Source to WG:*** | vivo, KDDI |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | eLCS\_Ph3 |  | ***Date:*** | 2023-02-10 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-18 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | FS\_eNA\_Ph3 KI#9 and FS\_eLCS\_Ph3 KI#4 both had conclusion on the inclusion of NWDAF requesting LCS services via Ngmlc services.Current Ngmlc locaiton services only supports GMLC and NEF as the service consumer.It is recommened to include NWDAF as service consumer.Besides, the corresponding procedures that NWDAF can participate are also modified to give clear clur on how NWDAF interacts in eLCS system to obtain UE location. |
|  |  |
| ***Summary of change:*** | Include NWDAF as one kind of Ngmlc service consumer.Modify NWDAF participated procedures. |
|  |  |
| ***Consequences if not approved:*** |  It is now clear about how NWDAF requests UE location via LCS system. |
|  |  |
| ***Clauses affected:*** | 8.4.1, 6.1.2, 6.3, 6.8 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** |  | **X** |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\* \* \* \* First change \* \* \* \*

## 8.4 GMLC Services

### 8.4.1 General

The following table shows the GMLC Services and GMLC Service Operations.

Table 8.4.1-1: List of GMLC Services

|  |  |  |  |
| --- | --- | --- | --- |
| Service Name | Service Operations | OperationSemantics | Example Consumer(s) |
| Ngmlc\_Location | ProvideLocation | Request / Response | GMLC, NEF, NWDAF |
|  | LocationUpdate | Request / Response | AMF, GMLC |
|  | LocationUpdateNotify | Notify | NEF, NWDAF |
|  | CancellLocation | Request / Response | GMLC, NEF, NWDAF |
|  | EventNotify | Notify | GMLC, NEF, NWDAF |

\* \* \* \* Second change \* \* \* \*

### 6.1.2 5GC-MT-LR Procedure for the commercial location service

Figure 6.1.2-1 illustrates the general network positioning requested by the LCS clients, the AF or the NWDAF. In this scenario, it is assumed that the target UE may be identified using an SUPI or GPSI. This procedure is applicable to a request from an LCS client or AF for a current location of the target UE, and it is assumed that

- Privacy verification may be required for the location service request;

- The LCS client, the AF or NWDAF needs to be authorised to use the location service.



Figure 6.1.2-1: 5GC-MT-LR Procedure for the commercial location services

1. The LCS Client, the NWDAF, or the AF (via NEF) sends a request to the (H)GMLC for a location and optionally a velocity for the target UE which may be identified by an GPSI or an SUPI. The request may include the required QoS, supported GAD shapes and other attributes. (H)GMLC (for 1a, 1c) or NEF (for 1b) authorizes the LCS Client, the NWDAF or the AF for the usage of the LCS service. If the authorization fails, step 2-23 are skipped and (H)GMLC (for 1a, 1c) or NEF (for 1b) responds to the LCS Client, NWDAF or the AF the failure of the service authorization in step 24. In some cases, the (H)GMLC derives the GPSI or SUPI of the target UE and possibly the QoS from either subscription data or other data supplied by the LCS Client, NWDAF or AF.

 The LCS request may carry also the Service Identity (see TS 22.071 [2]) and the Codeword and the service coverage information. The (H)GMLC may verify that the Service Identity received in the LCS request matches one of the service identities allowed for the LCS client or AF. If the service identity does not match one of the service identities for the LCS client or AF, the (H)GMLC shall reject the LCS request. Otherwise, the (H)GMLC can map the received service identity in a corresponding service type.

 The LCS service request may include a scheduled location time if a current location of the UE is required at a specific time in the future.

 The LCS service request may include integrity requirements.

NOTE 1: In this release of specification, integrity requirements are only for GNSS integrity.

 If the LCS service request contains the pseudonym of the target UE and the (H)GMLC cannot resolve the PMD address from the pseudonym, the (H)GMLC itself determines the verinym (GPSI or SUPI) of the target UE. If the (H)GMLC can resolve the address of PMD from the pseudonym, the HGMLC requests the verinym from its associated PMD. If (H)GMLC is not able to obtain the verinym of the target UE, the (H)GMLC shall cancel the location request.

 If a scheduled location time is not included and the requested type of location is "current or last known location" and the requested maximum age of location information is available, the (H)GMLC verifies whether it stores the previously obtained location estimate of the target UE. If the HGMLC stores the location estimate and timestamp of the location estimate (if available) and the location estimate satisfies the requested accuracy and the requested maximum age of location, the (H)GMLC checks the result of the privacy check at step 2. If the result of the privacy check for call/session unrelated class is "Location allowed without notification" then steps 3-23 may be skipped.

1b-1 AF sends the Nnef\_EventExposure\_Subscribe to the NEF.

1b-2 The NEF identifies based on the QoS attribute received from the location request that higher than cell-ID level location accuracy is required and invokes the Ngmlc\_Location\_ProvideLocation\_Request service operation to the (H)GMLC, which contains the attributes received from the AF request. The NEF may also invoke the Ngmlc\_Location\_ProvideLocation\_Request service operation to the (H)GMLC for lower than cell-ID location accuracy as an implementation option or if a scheduled location time is included.1c The NWDAF invokes the Ngmlc\_Location\_ProvideLocation service operation to the (H)GMLC.

Editor’s Note: Whether requesting location of a roaming UE is applicable to NWDAF is FFS.

 If location is required for more than one UE, the steps following below may be repeated and in that case the NEF or HGMLC receiving location request, shall verify whether the number of Target UEs in the Nnef\_EventExposure\_Subscribe, or Ngmlc\_Location\_ProvideLocation or LCS request is equal to or less than the Maximum Target UE Number of the LCS client. If Maximum Target UE Number is exceeded, the NEF or HGMLC shall reject the Nnef\_EventExposure\_Subscribe, or Ngmlc\_Location\_ProviceLocation or LCS request, the steps 2-23 are skipped, and then GMLC respond to the client with proper error cause in the step 24.

NOTE 2: If cell-ID level or lower than cell-ID level location accuracy is required in the location request, the NEF may invoke an Namf\_EventExposure\_Subscribe service operation to subscribe location event reporting from the AMF for the target UE as further described in clause 6.5.2. The (H)GMLC invokes a Nudm\_SDM\_Get service operation towards the UDM of the target UE to get the privacy settings of the UE identified by its GPSI or SUPI. The UDM returns the target UE Privacy setting of the UE. The (H)GMLC checks the UE LCS privacy profile. If the target UE is not allowed to be located, steps 3-23 are skipped.

3. The (H)GMLC invokes a Nudm\_UECM\_Get service operation towards the UDM of the target UE with GPSI or SUPI of this UE. The UDM returns the network addresses of the current serving AMF and additionally the address of a VGMLC (for roaming case). If the location request is an immediate location request, the (H)GMLC checks the country codes of the serving node addresses. If the (H)GMLC finds the current AMF is out of the service coverage of the (H)GMLC, the (H)GMLC returns an appropriate error message to the LCS client or AF (via NEF).

NOTE 3: The UDM is aware of the serving AMF address at UE registration on an AMF as defined in clause 4.2.2.2.2 of TS 23.502 [19]. The UDM is aware of a serving VGMLC address at UE registration on an AMF as defined in clause 4.2.2.2.2 of TS 23.502 [19].

NOTE 4: The HGMLC can also query the HSS of the target UE for a serving MME address as described in clause 9.1.1 of TS 23.271 [4]. The EPC-MT-LR procedure described in clause 9.1.15 of TS 23.271 [4], excluding the UE availability event, may then be performed instead of steps 4-23, e.g. if the HSS returns an MME address but the UDM does not return an AMF address.

4. For a non-roaming case, this step is skipped. In the case of roaming, the HGMLC may receive an address of a VGMLC (together with the network address of the current serving AMF) from the UDM in step 3, otherwise, the HGMLC may use the NRF service in the HPLMN to select an available VGMLC in the VPLMN, based on the VPLMN identification contained in the AMF address received in step 3. The HGMLC then sends the location request to the VGMLC by invoking the Ngmlc\_Location\_ProvideLocation service operation towards the VGMLC. In the cases when the HGMLC did not receive the address of the VGMLC, or when the VGMLC address is the same as the HGMLC address, or when both PLMN operators agree, the HGMLC sends the location service request message to the serving AMF. In this case, step 4 is skipped. If the result of privacy check indicates that the verification based on current location is needed, the HGMLC shall send a location request to the VGMLC (in the case of roaming) or to the AMF (in the case of non-roaming) indicating “positioning allowed without notification” and VGMLC shall invoke an Namf\_Location\_ProvidePositioningInfo Request service operation towards the AMF at step 5. H-GMLC also provides the LCS client type of AF, if received in step 41b‑2, or LCS client type of LCS client and other attributes to be sent to AMF in step 5.

5. In the case of roaming, the VGMLC first authorizes that the location request is allowed from this HGMLC, PLMN or from this country. If not, an error response is returned. The (H)GMLC or VGMLC invokes the Namf\_Location\_ProvidePositioningInfo service operation towards the AMF to request the current location of the UE. The service operation includes the SUPI, the client type and may include the required LCS QoS, supported GAD shapes, scheduled location time, service type and other attributes as received or determined in step 1.

NOTE 5: The location request forwarded at step 4 and step 5 may also carry the result of the privacy check in step 2 which may include a codeword provided by the LCS Client or AF and an indication of a privacy related action as described in clause 5.4.

6. If the UE is in CM IDLE state, the AMF initiates a network triggered Service Request procedure as defined in clause 4.2.3.3 of TS 23.502 [19] to establish a signalling connection with the UE.

 If signalling connection establishment fails, step 7-13 are skipped and the AMF answers to the GMLC in step 14 with the last known location of the UE (i.e. Cell ID) together with the age of this location.

7. If the indicator of privacy check related action indicates that the UE must either be notified or notified with privacy verification and if the UE supports LCS notification (according to the UE capability information), a notification invoke message is sent to the target UE, indicating the identity of the LCS client and the , service type (if that is both supported and available) and whether privacy verification is required.

8. The target UE notifies the UE user of the location request and, if privacy verification was requested, waits for the user to grant or withhold permission. The UE then returns a notification result to the AMF indicating, if privacy verification was requested, whether permission is granted or denied for the current LCS request. If the UE user does not respond after a predetermined time period, the AMF shall infer a “no response” condition. The AMF shall return an error response in step 14 and if roaming VGMLC in step 15 to the HGMLC if privacy verification was requested and either the UE user denies permission or there is no response with the indication received from the (H)GMLC indicating barring of the location request and steps 10~13 are skipped.

 The notification result may also indicate the Location Privacy Indication setting for subsequent LCS requests; i.e whether subsequent LCS requests, if generated, will be allowed or disallowed by the UE. The Location Privacy Indication may also indicate a time for disallowing the subsequent LCS requests.

9. The AMF invokes the Nudm\_ParameterProvision\_Update (LCS privacy) service operation to store in the UDM the Location Privacy Indication information received from the UE. The UDM may then store the updated UE privacy setting information into the UDR as the “LCS privacy” Data Subset of the Subscription Data.

10-13. Step 10-13 are the same as steps 6-9 defined in clause 6.1.1 with the addition that service type may be indicated towards the LMF and the exception that the LMF may determine the UE location in local coordinates or geographical co-ordinates or both. If the supported GAD shapes is not received in step 11 or Local Co-ordinates is not included in the supported GAD shapes, the LMF shall determine a geographical location. If a scheduled location time is provided at step 5, steps 11 and 12 include the following additional differences.

11. The AMF includes the scheduled location time in the Nlmf\_Location\_DetermineLocation service operation sent towards the LMF.

12. When sending a location request to the UE, the LMF may include the scheduled location time.

NOTE 6: If integrity requirements are received in step 11, LMF may determine to use GNSS positioning method.

NOTE 7: LMF does not deliver the scheduled location time to NG-RAN as part of step 12.

NOTE 8: The LMF may send a location request to the UE at step 12 containing the scheduled location time sometime before the scheduled location time to allow the UE to enter CM Connected state shortly before the scheduled location time.

14. The AMF returns the Namf\_Location\_ProvidePositioningInfo Response towards the (V)GMLC (or HGMLC for roaming when the NL3 reference point is not supported) to return the current location of the UE. The service operation includes the location estimate, its age and accuracy and may include information about the positioning method and the timestamp of the location estimate.

15. In the case of roaming, the VGMLC forwards the location estimation of the target UE, its age, its accuracy and optionally the information about the positioning method received at step 14 to the HGMLC. For non-roaming scenario, this step is skipped.

16. If the privacy check in step 2 indicates that further privacy checks are needed, the (H)GMLC shall perform an additional privacy check in order to decide whether the (H)GMLC can forward the location information to the LCS client or AF or send a notification if the result of the privacy check requires the notification and verification based on current location. One example when this additional privacy check is needed is when the target UE user has defined different privacy settings for different geographical locations. When an additional privacy check is not needed, the (H)GMLC skips steps 17-23.

17. If the result of privacy checks in step 16 indicates that the notification (and verification) based on current location is needed, and in the case of roaming, the (H)GMLC shall send a location request to the VGMLC with location type indicating “notification only”.

18. The (H)GMLC or VGMLC invokes the Namf\_Location\_ProvidePositioningInfo service operation towards the AMF to request notification (and verification) based on current location.

19. If the UE is in CM IDLE state, the AMF initiates a network triggered Service Request procedure as defined in clause 4.2.3.3 of TS 23.502 [19] to establish a signalling connection with the UE.

20. If the indicator of privacy check related action indicates that the UE must either be notified or notified with privacy verification and if the UE supports LCS notification, the AMF sends a notification invoke message to the target UE, indicating the identity of the LCS client and the service type (if that is both supported and available) and whether privacy verification is required.

21. Step 21 is the same as step 8.

22. The AMF returns the Namf\_Location\_ProvidePositioningInfo Response towards the (V)GMLC (or HGMLC for roaming when the NL3 reference point is not supported) with an indication of the result of notification and verification procedure performed in steps 20-21.

23. In the case of roaming, the VGMLC forwards an indication of the result of notification and verification procedure to the HGMLC. For non-roaming scenario, this step is skipped.

24. The (H)GMLC sends the location service response to the LCS Client, or NWDAF or AF (via the NEF) if the target UE is allowed to be located by the LCS Client, or NWDAF or AF. Accordingly, NEF invokes Nnef\_EventExposure\_Notify or sends Nnef\_EventExposure\_Subscribe Response to the AF. If the location request from the LCS Client contained the pseudonym and the (H)GMLC resolved the verinym from the pseudonym in step 1, the (H)GMLC shall use the pseudonym of the target UE in the location response to the external LCS client. If the external LCS client or AF requires it, the (H)GMLC may first transform the universal location co-ordinates provided by the AMF into some local geographic reference system. The (H)GMLC may record charging information both for the LCS Client or AF and inter-network revenue charges from the AMF's network. The location service response from the (H)GMLC to the LCS Client, or NWDAF or AF may contain the information about the positioning method used and the indication whether the obtained location estimate satisfies the requested accuracy or not. If in step 2, step 15, step 16 or step 23 the (H)GMLC identifies that the target UE is not allowed to be located by the LCS Client, or NWDAF or AF, it rejects the LCS service request, and optionally indicate in the response the reason of the rejection, i.e. the target UE is not allowed to be located. If the LCS QoS Class is Assured and (H)GMLC detects that requested accuracy is not achieved, the (H)GMLC sends error response including failure cause.

\* \* \* \* Second change \* \* \* \*

## 6.3 Deferred 5GC-MT-LR Procedure for Periodic, Triggered and UE Available Location Events

### 6.3.1 Initiation and Reporting of Location Events

Figure 6.3.1-1 summarizes the initiation and reporting of location events for a deferred 5GC-MT-LR procedure for Periodic, Triggered and UE Available Location Events. The procedure supports mobility of a UE within a VPLMN 5GCN and from a 5GCN to an EPC.



Figure 6.3.1-1: Deferred 5GC-MT-LR for periodic, triggered and UE available location events

1. The external location services client, or the NWDAF, or the AF (via NEF) sends a request to the (H)GMLC for location reporting for periodic, triggered or UE available location events. The request is sent as described for step 1 in clause 6.1.2 with the differences described here. The LCS Service Request provides the type of periodic or triggered location reporting being requested and associated parameters. For periodic location, the LCS Service Request includes the time interval between successive location reports, the total number of reports and may include location QoS. For periodic location reporting, the LCS Service Request may include a scheduled location time for the first periodic location report. For area event reporting, the LCS Service Request includes details of the target geographical area, an indication to have an additional check whether UE is located within the requested target area, whether the event to be reported is the UE being inside, entering into or leaving the target area, the duration of event reporting, the minimum and maximum time intervals between successive event reports, the maximum event sampling interval, whether location estimates shall be included in event reports (and associated location QoS), and whether only one location report is required or more than one. If the target area is expressed by a local coordinate system or a geopolitical name, the (H)GMLC shall convert the target area to a geographical area expressed by a shape as defined in TS 23.032 [8]. For motion event reporting, the LCS Service Request includes the threshold linear distance, the duration of event reporting, the minimum and maximum time intervals between successive event reports, the maximum event sampling interval, whether location estimates shall be included in event reports (and associated location QoS), and whether only one location report is required or more than one.

1b-1 AF invokes the Nnef\_EventExposure\_Subscribe service operation to the NEF.

1b-2 The NEF forwards the request to the (H)GMLC. The NEF assigns a LDR refence number locally and sends it to (H-)GMLC,

1c The NWDAF invokes the Ngmlc\_Location\_ProvideLocation service operation to the (H)GMLC.

Editor’s Note: Whether requesting location of a roaming UE is applicable to NWDAF is FFS.

2. The (H)GMLC may verify UE privacy requirements as for step 2 in clause 6.1.2. The (H)GMLC may also subscribe to and receive notification of UE privacy profile updates according to steps 0 and 4 of clause 6.12.1.

3. The (H)GMLC queries the UDM for the AMF address and, in the case of roaming, a VGMLC address as for step 3 in clause 6.1.2.

NOTE 1: The HGMLC may also query the HSS of the target UE for a serving MME address as described in clause 9.1.1 of TS 23.271 [4]. The deferred EPC-MT-LR procedure for Periodic and Triggered Location described in clause 9.1.19 of TS 23.271 [4] or the EPC-MT-LR procedure for the UE availability event described in clause 9.1.15 of TS 23.271 [4] may then be performed instead of steps 4-31 - e.g. if the HSS returns an MME address but the UDM does not return an AMF address.

4. This step is skipped for a non-roaming UE. For a roaming UE, the HGMLC obtains a VGMLC address if not received at step 3 and invokes the Ngmlc\_Location\_Provide Location Request service operation to forward the location request to the VGMLC as described for step 4 of in clause 6.1.2. The (H)GMLC also includes a contact address for the (H)GMLC (Notification Target Address, e.g. a URI) and an LDR reference number (Notification correlation ID) to be used for event reporting at steps 20 and 29. The LDR reference number is either allocated by (H-)GMLC based on predefined rule, e.g. operator's policy if the location request is received in step 1a, or allocated by NEF, if the location request is received in step 1b.

5. The (H)GMLC or VGMLC invokes the Namf\_Location\_ProvidePositioningInfo Request service operation to forward the location request to the serving AMF as described for step 5 in clause 6.1.2 and includes the (H)GMLC contact address and LDR reference number. The LDR reference number is either allocated by (H-)GMLC based on predefined rule, e.g. operator's policy if the location request is received in step 1a, or allocated by NEF, if the location request is received in step 1b. For area event reporting, the target geographical area is converted into a corresponding list of cell and/or tracking area identities.

6-8. If the AMF supports a deferred location request, the AMF returns an acknowledgment to the external LCS client, via the (H)GMLC and, in the case of roaming, the VGMLC, indicating that the request for deferred location was accepted. The VGMLC, when used, may optionally release resources for the deferred location request at this point.

9. If the UE is not currently reachable (e.g. is using eDRX or PSM), the AMF waits for the UE to become reachable.

NOTE 2: In the event of mobility of the UE to another AMF or to EPC when the UE becomes reachable, the old AMF can return an event indication to the (H)GMLC as at steps 19 and 20 and may include the address of the new serving AMF or MME if known. If a new serving AMF or MME is not known, the (H)GMLC can repeat step 3 to query the UDM and HSS for the new AMF or MME address. If a new AMF address is received, the (H)GMLC can restart the procedure from step 4.

10. Once the UE is reachable, if the UE is then in CM IDLE state, the AMF initiates a network triggered Service Request procedure as defined in clause 4.2.3.3 of TS 23.502 [19] to establish a signalling connection with the UE.

NOTE 3: The AMF may decide to cancel the location request before the UE becomes reachable (e.g. due to lack of resources or due to a timeout on the UE becoming reachable) or when the UE becomes reachable (e.g. if the AMF executes NAS level congestion control on the UE, or for other reasons). The AMF then skips steps 10-18 and proceeds to step 19 to return an indication of location cancelation to the VGMLC or (H)GMLC.

11-12. The AMF performs steps 7-8 in clause 6.1.2 to notify the UE of the location request and verify privacy requirements if required by the location request received at step 5 and supported by the UE. The AMF includes in the notification to the UE the type of deferred location request in the case of periodic or triggered location.

13. The AMF selects an LMF as described for step 6 in clause 6.1.1. The selection may take into account the type of deferred location request (e.g. whether periodic or triggered) and any parameters for the deferred location request (e.g. the number of event reports required and/or the duration).

14. The AMF invokes the Nlmf\_Location\_DetermineLocation Request service operation towards the LMF to initiate a request for deferred UE location. For a request for periodic or triggered location, the service operation includes all the information received in step 4 or step 5 including the (H)GMLC contact address, LDR reference number, UE Positioning Capability if available and any scheduled location time and may include a list of allowed access types for event reporting at step 22. For a request for the UE available location event, the (H)GMLC contact address and LDR reference number are not included. In all cases, the service operation includes an LCS Correlation identifier, the AMF identifier, the serving cell identity, the client type and may include an indication if UE supports LPP, the required QoS and Supported GAD shapes.

15. The LMF performs one or more of the positioning procedures described in clause 6.11.1, 6.11.2 and 6.11.3 and as described for step 8 in clause 6.1.1. During this step, the LMF may request and obtain the UE positioning capabilities (e.g. which may indicate the type(s) of periodic and triggered location supported by the UE and the access types supported by the UE for event reporting). The LMF may also obtain the UE location - e.g. for a request for the UE available location event or when an initial location is requested for periodic or triggered UE location. For a request for the UE available location event, the LMF skips steps 16 and 17.

16. If periodic or triggered location was requested, the LMF sends a supplementary services LCS Periodic-Triggered Invoke Request to the UE via the serving AMF by invoking the Namf\_Communication\_N1N2MessageTransfer service operation. The LCS Periodic-Triggered Location Invoke carries the location request information received from the AMF at step 14, including the (H)GMLC contact address, LDR reference number and any scheduled location time. The LCS Periodic-Triggered Location Invoke also includes a deferred routing identifier, which can be the identification of the LMF when the LMF will act as a serving LMF or a default LMF identification otherwise. The LCS Periodic-Triggered Location Invoke may indicate the allowed access types for event reporting at step 25 (e.g. one or more of NR, E-UTRA connected to 5GC, non-3GPP access connected to 5GC, any of the RAT Types specified for NR satellite access) and may include embedded positioning message(s) which indicates certain allowed or required location measurements (or a location estimate and the timestamp of the location estimate if available) at step 24 for each location event reported (e.g. based on the positioning capabilities of the UE obtained in step 14 and the allowed access types). As part of NAS transport of the LCS Periodic-Triggered Location Invoke from the serving AMF to the UE, the serving AMF includes an immediate routing identifier in the NAS transport message containing an LCS Correlation identifier - e.g. according to clause 6.11.1.

NOTE 4: The deferred routing identifier may be global (e.g. an IP address, UUID or URI) or may be local. The deferred routing identifier is used for routing in step 25. However, the immediate routing identifier included by the AMF in step 15 is used for routing in step 17.

17. If the request in step 16 can be supported, the UE returns a supplementary services acknowledgment to the LMF, which is transferred via the serving AMF using the immediate routing identifier and delivered to the LMF using an Namf\_Communication\_N1MessageNotify service operation.

18. The LMF invokes the Nlmf\_Location\_DetermineLocation Response service operation towards the AMF to respond to the request at step 14. For a request for the UE available location event, the response includes any UE location obtained at step 15 and the LMF then releases all resources. For a periodic or triggered location request, the response includes any location obtained at step 15, a confirmation of whether periodic or triggered location was successfully activated in the UE according to steps 16 and 17 and the identification of the LMF in the case of successful activation with a serving LMF; the LMF also retains state information and resources for later steps if the LMF acts a serving LMF. If the multiple QoS class was used in the location request, the LMF provides the achieved Location QoS Accuracy in step 15. If the UE cannot support the periodic and triggered location request, the service operation returned to the AMF shall include a suitable error cause. The service operation also includes the UE Positioning Capability if the UE Positioning Capability is received in step 15 including an indication that the capabilities are non-variable and not received from AMF in step 14.

19. The AMF invokes the Namf\_Location\_EventNotify service operation towards the VGMLC for roaming, or (H)GMLC for non-roaming, and includes any location received at step 18 and, for periodic or triggered location, a confirmation of whether or not periodic or triggered location was successfully activated in the target UE. The VGMLC, if used, may be the same VGMLC used in steps 5 and 6 or may be a different VGMLC. In the case of a different VGMLC, the AMF includes the HGMLC contact address and LDR reference number. The AMF also includes the LMF identification and the achieved Location QoS Accuracy if received at step 18. The AMF may then release all resources for the location request and cease support for the procedure.

20. This step is skipped for a non-roaming UE. For a roaming UE, The VGMLC forwards the response received at step 19 to the HGMLC using the HGMLC contact address received at step 19 (for a different VGMLC) or received and stored at step 4 (for the same VGMLC) and includes the LDR reference number and any LMF identification that was received. The VGMLC may then release all resources for the location request and cease support for the procedure.

NOTE 5: As an optional optimization for a roaming UE, instead of performing steps 19 and 20, the AMF may invoke the Namf\_Location\_EventNotify service operation directly towards the HGMLC (e.g. if a VGMLC is not used or if the VGMLC ceases support after step 8).

21. The (H)GMLC forwards the response to the external LCS client, or NWDAF or AF (via the NEF). If the location request at step 1 was for the UE available location event, the procedure terminates here and further steps 22-31 are not performed.

22. For a periodic or triggered location request where steps 16 and 17 were successfully performed, the UE monitors for occurrence of the trigger or periodic event requested in step 16. For the area event or motion event, the UE monitors the requested event at intervals equal to or less than the maximum event sampling interval. An event trigger is detected by the UE when any of the following occur: (i) a requested area event or motion event has been detected and the minimum reporting time interval has elapsed since the last report (if this is not the first event report); (ii) a requested periodic location event has occurred; or (iii) the maximum reporting time for an area event or motion event has expired. When a trigger or periodic event is detected and if the UE is camped on or connected to (or can otherwise access) an access type allowed by the LMF at step 16, the UE proceeds to step 23. If the UE cannot access an allowed access type, the UE may skip reporting the trigger event or may report the trigger event at a later time when an allowed access type becomes available, according to requirements received from the LMF at step 16. When a scheduled location time is provided for periodic location request at step 16, a UE should perform steps 23-25 some time in advance of the scheduled location time for the first periodic event report or some time in advance of the periodic interval expiration for each succeeding periodic event report in order to enable location measurements at step 23 or step 27 to occur near to each of these times, respectively.

23. The UE obtains any location measurements or a location estimate that were requested or allowed at step 16.

NOTE 6: Obtaining a location estimate when requested also applies to the trigger event corresponding to expiration of the maximum reporting interval for an area event or motion event.

24. The UE performs a UE triggered service request as defined in clause 4.2.3.2 of TS 23.502 [19] if in CM-IDLE state in order to establish a signalling connection with the AMF.

25. The UE sends a supplementary services event report message to the LMF which is transferred via the serving AMF (which may be different to the original serving AMF for steps 14-16) and is delivered to the LMF using an Namf\_Communication\_N1MessageNotify service operation. The event report may indicate the type of event being reported (e.g. whether a normal event or expiration of the maximum reporting interval) and may include embedded positioning message(s) which includes any location measurements or location estimate and the timestamp of the location estimate if available obtained at step 23. The UE also includes the deferred routing identifier received in step 16 in the NAS Transport message used to transfer the event report from the UE to the AMF. The AMF then forwards the event report to either the serving LMF or any suitable LMF based on whether the deferred routing identifier indicates a particular LMF or any (default) LMF. If a different LMF than the serving LMF is used, procedure in clause 6.4 is used. The UE also includes the (H)GMLC contact address, the LDR reference number, whether location estimates are to be reported and if so the location QoS in the event report and any scheduled location time indicated at step 16 for periodic reporting.

NOTE 7: When forwarding the event report message to the LMF in step 25, the AMF includes the deferred routing identifier received in step 25 as the LCS Correlation Identifier. The deferred routing identifier can assist a serving LMF in identifying the periodic or triggered location session if the same serving LMF had assigned the deferred routing identifier at step 16 or can indicate to the LMF that it is acting as a default LMF.

NOTE 8: The scheduled location time included at step 25 equals T + (N-1)\*P, where T is the initial Scheduled Location Time, N is the Report Number (N≥1) and P is the time interval between successive periodic events.

26. When the LMF receives the event report and if it can handle this event report, the LMF updates the status of event reporting(e.g. the number of event reports so far received from the UE and/or the duration of event reporting so far) and returns a supplementary services acknowledgment for the event report to the UE. The acknowledgment may optionally include a new deferred routing identifier indicating a new serving LMF or a default (any) LMF. If the UE does not receive any response from the LMF after a predefined time, i.e. the current LMF does not support the deferred location request (for temporary or permanent reasons) or due to some radio access failures, the UE may re-send the report one or more times. If the UE sends the repeated event report more than the predefined maximum resending time and the UE still does not receive any response from AMF, the UE shall stop resending the report and reserve the event report, then record a corresponding flag to indicate that a report has been sent unsuccessfully. When the UE performs location update and detects the PLMN is changed, if the flag has been set, the UE shall send the report to the corresponding AMF, and the flag will be cleared upon a success of the sending.

NOTE 9: Inclusion of a new deferred routing identifier in the event report acknowledgment at step 26 may be used to change the serving LMF (e.g. if a UE moves into an area or to an access type that is better supported by a different LMF or if the serving LMF is overloaded) or to enable a default LMF to become a serving LMF.

27. If a location estimate is needed for event reporting, the LMF may perform one or more of the positioning procedures described in clause 6.11.1, 6.11.2 and 6.11.3 and as described for step 8 in clause 6.1.1 and step 12 in clause 6.1.2. The LMF then determines the UE location using the location measurements and/or location estimate(s) obtained at this step and/or received at step 25. The LMF may also determine the timestamp of the location estimate.

NOTE 10: A precondition for the procedure in clause 6.11.1 is that an LCS Correlation identifier assigned by the serving AMF has been previously passed to the LMF. The LCS Correlation identifier is used in steps 1, 3, 6 and 7 in clause 6.11.1 to ensure that during a positioning session between the LMF and UE, positioning response messages from the UE are returned by the AMF to the correct LMF and carrying an indication (the LCS Correlation identifier) which can be recognized by the LMF. To retain this capability in step 27, the LMF shall assign a Correlation identifier indicating the LMF (and optionally a positioning session) for use at step 1 in clause 6.11.1. To enable an AMF to distinguish a Correlation identifier assigned by an LMF (used in this procedure) from a Correlation identifier assigned by the AMF (used otherwise for clause 6.11.1), the two types of Correlation identifier could be selected from different ranges, with or without a flag.

28. In the case of roaming, the LMF selects a VGMLC (which may be different to the VGMLC for steps 3-8 and steps 19-21), The LMF then invokes an Nlmf\_Location\_EventNotify service operation towards the selected VGMLC or (H)GMLC with an indication of the type of event being reported, the (H)GMLC contact address and LDR reference number, the identification of the LMF if this is a serving LMF, and any location estimate and the timestamp of the location estimate (if available) obtained at step 27. If multiple QoS class was used in the initial location request, the LMF provides the achieved Location QoS Accuracy in step 27.

NOTE 11: In the case of roaming, the LMF may select the VGMLC for step 28 using the NRF service or using configuration information in the LMF or may use the same VGMLC as for steps 3-8 (e.g. if the LMF acts as a serving LMF and received the VGMLC address from the AMF as part of step 14).

29. This step is skipped for a non-roaming UE. For a roaming UE, the VGMLC invokes an Ngmlc\_Location\_EventNotify service operation to forward the information received in step 28 (e.g. including the type of event being reported, the LDR reference number and possibly the LMF identification) to the HGMLC which identifies the periodic and triggered location request from the LDR reference number.

NOTE 12: As an optional optimization for a roaming UE, instead of performing steps 28 and 29, the LMF may invoke the Nlmf\_Location\_EventNotify service operation directly towards the HGMLC.

NOTE 13: In the event of mobility of the UE to an access network for which event reporting at step 22 is not allowed (e.g. an access network in EPS) or if the UE is otherwise unable to send event reports (e.g. due to being powered off), the (H)GMLC may not receive event reports at step 28 or step 29 at fixed intervals for periodic location or at intervals equal to or less than the maximum reporting interval for triggered location. In such a case, the (H)GMLC may cancel the periodic or triggered location reporting using the procedures defined in clause 6.3.3. The UE may also cancel the periodic or triggered location reporting either locally or using the procedure defined in clause 6.3.2 once the UE can access an access network that is allowed for event reporting.

30. The (H)GMLC uses the LDR reference number received in step 28 or step 29 to identify the periodic and triggered location request received in step 1 and then sends the type of event being reported and any location estimate and the timestamp of the location estimate (if available) and used positioning methods to the external LCS client, or NWDAF or AF (via the NEF), and sends the LDR reference number to LCS client. The (H)GMLC may also verify UE privacy requirements before reporting the event and any location to the external LCS client, or NWDAF or AF. If multiple QoS class was used in the initial location request, the LMF provides the achieved Location QoS Accuracy in step 27. If an indication to have an additional check is received at step 1, the (H)GMLC will verify the UE location estimate is within the target area, and send the event report to the LCS client, or NWDAF or AF.

31. The UE continues to monitor for further periodic or trigger events as in step 22 and instigates steps 23-30 each time a trigger event is detected.

NOTE 14: Service continuity for reporting of periodic or trigger events when a UE moves between 5GS and EPS is not supported in this release of the specification.

### 6.3.2 Cancellation of Reporting of Location Events by a UE

Figure 6.3.2-1 summarizes a procedure to enable a UE to cancel a deferred 5GC-MT-LR procedure for periodic, or triggered location events (e.g. if the UE is powered off or if the UE cancels the location request based on user's input). It is assumed that a deferred 5GC-MT-LR for periodic or triggered location events has already been initiated in the UE according to steps 1-17 for the procedure in clause 6.3.1. If a network entity (e.g. (H)GMLC, AMF or LMF) cancels a deferred 5GC-MT-LR procedure for periodic or triggered location events, part of the procedure in clause 6.3.3 for cancellation by an AF or external LCS Client would be used to cancel towards the UE and part of the procedure in this clause would be used to cancel towards the AF or external LCS Client.



Figure 6.3.2-1: UE Cancellation of a Deferred 5GC-MT-LR for periodic or triggered location events

1. The UE performs a UE triggered service request as defined in clause 4.2.3.2 of TS 23.502 [19] if in CM-IDLE state in order to establish a signalling connection with the AMF.

2. The UE sends a Cancel Location request message to the LMF which is transferred via the serving AMF and is delivered to the LMF using an Namf\_Communication\_N1MessageNotify service operation. The UE includes the deferred routing identifier originally received in step 16 of the procedure in clause 6.3.1 (or as updated by step 26 in clause 6.3.1 or by the procedure in clause 6.4) in the NAS Transport message used to transfer the cancel location request from the UE to the AMF. The AMF then forwards the cancel location request to either the serving LMF or any suitable LMF based on whether the deferred routing identifier indicates a particular LMF or any (default) LMF. The UE also includes the (H)GMLC contact address and the LDR reference number.

3. In the case of roaming, the LMF selects a VGMLC. The LMF then invokes an Nlmf\_Location\_EventNotify service operation towards the selected VGMLC or (H)GMLC with an indication of the cancelation of location event reporting, the (H)GMLC contact address and LDR reference number.

NOTE 1: In the case of roaming, the LMF may select the VGMLC for step 3 using the NRF service or using configuration information in the LMF or may use the same VGMLC as for steps 3-8 of clause 6.3.1 (e.g. if the LMF acts as a serving LMF and received the VGMLC address from the AMF as part of step 14 of clause 6.3.1).

4. This step is skipped for a non-roaming UE. For a roaming UE, the VGMLC invokes an Ngmlc\_Location\_EventNotify service operation to forward the cancel location request (including the LDR reference number) to the HGMLC which identifies the periodic and triggered location request from the LDR reference number.

NOTE 2: As an optional optimization for a roaming UE, instead of performing steps 3 and 4, the LMF may invoke the Nlmf\_Location\_EventNotify service operation directly towards the HGMLC.

5. The (H)GMLC uses the LDR reference number received in step 3 or step 4 to identify the periodic and triggered location request received in step 1 of clause 6.3.1 and then forwards the cancel location to the external LCS client, or NWDAF or AF (via the NEF).

6. The LMF returns an acknowledgment to the UE via the serving AMF.

### 6.3.3 Cancellation of Reporting of Location Events by an AF or External LCS Client or GMLC

Figure 6.3.3-1 summarizes a procedure to enable an AF or External LCS Client or GMLC to cancel a deferred 5GC-MT-LR procedure for periodic, or triggered location. It is assumed that a deferred 5GC-MT-LR for periodic or triggered location events has already been requested according to the procedure in clause 6.3.1 up until at least step 20.



Figure 6.3.3-1: Cancellation of a Deferred 5GC-MT-LR for periodic or triggered location events by an AF or External LCS Client

1. The external LCS client, or NWDAF or AF (via an NEF) send a request to cancel the periodic or triggered location to the (H)GMLC, the external LCS client, or NWDAF or AF shall include the identity of the deferred request.

 The HGMLC may itself initiate the cancellation procedure, e.g. when it is notified that the UE LCS privacy profile stored in the UDM was changed. For every outstanding Deferred Location Request against that UE, the HGMLC shall perform a new privacy check based on the updated UE LCS privacy profile stored in the UDM. If the privacy check passes, i.e. the LCS Client is still allowed to position the target UE, the handling of the outstanding Deferred Location Request shall be continued. Otherwise, if the privacy check does not pass, i.e. the Location estimate of the target UE is not allowed to be provided to the LCS Client, the HGMLC shall initiate a cancellation procedure

NOTE: GMLC may perform privacy check for more than one location request as a bulk operation.

2. The (H)GMLC queries the UDM to determine the serving AMF address as in step 3 of clause 6.3.1.

3. For a roaming UE, the HGMLC obtains a VGMLC address if not received at step 2 and invokes an Ngmlc\_Location\_CancelLocation service operation to forward the cancellation request to the VGMLC. The (H)GMLC also includes the contact address for the (H)GMLC and the LDR reference number in the request and the latest LMF identification received in step 20 or step 29 in clause 6.3.1 if either step has occurred and included an LMF identification.

4. The (H)GMLC or VGMLC invokes the Namf\_Location\_CancelLocation service operation to forward the cancellation request to the serving AMF and includes the (H)GMLC contact address, LDR reference number and LMF identification if available.

5. If an LMF identification was included in step 4, the AMF forwards the cancelation request to the indicated LMF by invoking an Nlmf\_Location\_CancelLocation service operation and includes the (H)GMLC contact address and LDR reference number. The LMF then releases all resources for the location request.

6. If the UE is not currently reachable (e.g. is using eDRX or PSM), the AMF waits for the UE to become reachable.

7. Once the UE is reachable, if the UE is then in CM IDLE state, the AMF initiates a network triggered Service Request procedure as defined in clause 4.2.3.3 of TS 23.502 [19] to establish a signalling connection with the UE.

8. The AMF sends the cancelation request to the target UE and includes the (H)GMLC contact address and the LDR reference number. The UE then releases all resources for the location request.

9. The UE returns an acknowledgment to the AMF.

10. The AMF responds to Namf\_Location\_CancelLocation, then V-GMLC or (H)GMLC releases all resources for the location request. AMF releases all resources for the location request.

11. For a roaming UE, the VGMLC responds to Ngmlc\_Location\_CancelLocation, then HGMLC releases all resources for the location request.

12. [Conditional] If the cancellation procedure is requested by HGMLC (i.e. the procedure is triggered in step 1c) and the cancelled location event is reported to external client, or NWDAF or AF (via NEF).

\* \* \* \* Second change \* \* \* \*

## 6.8 Bulk Operation of LCS Service Request Targeting to Multiple UEs

The procedure described in this clause applies to 5GC\_MT\_LR and Deferred 5GC-MT-LR request targeting to a group of UE identified by an external/internal group ID, if available.



Figure 6.8-1: Bulk operation of LCS service request targeting to multiple UEs

1. This step is the same as step 1 of clause 6.1.2 and step 1 of clause 6.3.1, with the difference that the LCS request is targeting a group of UE identified by a group ID. The GMLC may map the external/internal group ID to the list of UE ID (i.e. SUPI) using Nudm\_SDM\_Get (Group Identifier Translation, External Group Identifier) service operation.

NOTE: Step 1b-1 assumes the LCS QoS provided by AF indicate "high-accuracy", and NEF determines the location request is handled by GMLC.

1b-2. The NEF shall send a Ngmlc\_Location\_ProvideLocation Request to the GMLC with the group of UE identified by a group ID to indicate a bulk operation procedure. If deferred location is requested the NEF shall include an Event type to indicate that deferred location is requested and provides an LDR reference number (Notification Correlation ID) to be used for event reporting at steps 6b-1 and 11b-1. If immediate location is requested the NEF shall not provide an Event type to indicate that immediate location is requested and provides a Notification Correlation ID to be used for reporting at steps 6b-1.

1c. The NWDAF shall send a Ngmlc\_Location\_ProvideLocation Request to the GMLC with the group of UE identified by a group ID to indicate a bulk operation procedure.

2a. If deferred location is requested from the LCS Client, the GMLC responds with an acknowledgment.

2b-1. The GMLC responds with a Ngmlc\_Location\_ProvideLocation Response.

 GMLC may decide whether completely or partially (i.e. accept part of the UE(s) within the group identified by the group ID in step 1) reject the location request. If GMLC decides to partially reject the location request, GMLC will respond to the LCS client /AF with a proper error cause.

2b-2. The NEF acknowledges the execution of the Nnef\_EventExposure\_Subscribe.

2c. If deferred location is requested from the NWDAF, the GMLC responds with an acknowledgment.

Steps 3 to 5 are carried out once per UE.

3. The GMLC invokes a Nudm\_SDM\_Get (LCS privacy, SUPI) service operation towards the UDM to get the UE LCS privacy profile of the target UE. The GMLC checks the privacy settings. For the UE whose privacy setting does not allow it to be located, steps 4 and 5 are skipped. The GMLC may also subscribe to and receive notification of UE privacy profile updates according to steps 0 and 4 of clause 6.12.1.

4. The GMLC invokes a Nudm\_UECM\_Get service operation towards the UDM of the target UE with SUPI of this UE. The UDM returns the current serving AMF ID to the GMLC.

5a. If no AMF ID is returned at step 4:

- if it is a deferred location request and the GMLC supports the storage of the LCS service request for a group of UE, the GMLC subscribes the UE reachability status to the UDM using Nudm\_EventExposure\_Subscribe service operation with the data key "SUPI";

- otherwise, this step is skipped and the GMLC returns an appropriate error cause to the LCS client or NEF at step 6.

5b. If the UDM returns the current serving AMF ID to the GMLC at step 4:

- the GMLC initiates 5GC\_MT\_LR procedure (from step 4 onwards) as described in clause 6.1.2, with the difference that Step 24 is skipped (as it is replaced by step 6 below); The GMLC shall not include the Notification Correlation ID received from NEF in step 1b-2.

- or the GMLC initiates Deferred 5GC-MT-LR Procedure (from step 4 onwards) as described in clause 6.3.1 with the difference that steps 8,21 and 30 are skipped (as it is replaced by steps 2, 6 and 11 below) and that GMLC assign LDR reference numbers (separate number for each UE) to be used for event reporting at steps 20 and 29.

6a. The GMLC receives response messages as defined in clause 6.1.2 step 22 or 23 or GMLC receives notification messages as defined in clause 6.3.1 step 28 or 29. The GMLC sends one or more LCS Service Responses to the LCS Client to convey UE locations or event reports.

6b-1. The GMLC receives response messages as defined in clause 6.1.2 step 22 or 23 or GMLC receives notification messages as defined in clause 6.3.1 step 28 or 29. The GMLC maps the messages to the Request received in step 1b-2 and invokes one or more Ngmlc\_Location\_EventNotify service operations towards the NEF to convey UE locations or event reports. GMLC may aggregate one or more UE location estimates / event reports in each message sent to NEF.

6b-2. The NEF invokes one or more Nnef\_EventExposure\_Notify service operations towards the AF, to convey UE locations or event reports , received from GMLC in step 6b-1.

6c. The GMLC receives response messages as defined in clause 6.1.2 step 22 or 23 or GMLC receives notification messages as defined in clause 6.3.1 step 28 or 29. The GMLC sends one or more Ngmlc\_Location\_EventNotify to the NWDAF to convey UE locations or event reports.

7. For the deferred location request, if any UE in the group didn't get its serving AMF ID at step 4, the GMLC may store the LCS service request locally if the GMLC supports the storage of the LCS service request for a group of UE; otherwise, this step is skipped.

Further steps apply to the UEs of the group who was not registered to the network when the LCS service request is received at GMLC.

8. UE performs the registration as described in clause 4.2.2 of TS 23.502, during which an AMF is selected to serve the UE, and the AMF ID is stored into UDM.

9. UDM notifies the GMLC who had subscribed the UE registration at step 5a using Nudm\_EventExposure\_Notify service operation, which includes "SUPI" and UE registration status.

10. GMLC initiates Deferred 5GC-MT-LR Procedure as described in step 5b.

11a. The GMLC receives notification messages as defined in clause 6.3.1 step 28 or 29. The GMLC sends one or more LCS Service Responses to the LCS Client to convey UE locations or event reports.

11b-1. The GMLC receives notification messages as defined in clause 6.3.1 step 28 or 29. The GMLC maps the messages to the Request received in step 1b-2 and invokes one or more Ngmlc\_Location\_EventNotify service operations towards the NEF to convey UE locations or event reports. GMLC may aggregate one or more UE location estimates / event reports in each message sent to NEF.

11b-2. The NEF invokes one or more Nnef\_EventExposure\_Notify service operations towards the AF, to convey event reports received from GMLC in step 11b-1.

11c. The GMLC receives notification messages as defined in clause 6.3.1 step 28 or 29. The GMLC sends one or more Ngmlc\_Location\_EventNotify to the NWDAF to convey UE locations or event reports.

\* \* \* \* End of changes \* \* \* \*