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Technical Report

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Contents

Foreword

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- x the first digit:
  - 1 presented to TSG for information;
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1 Scope

The present document investigates architecture solutions for making the Network Provided Location Information (NPLI) related to the access network that the UE is camped on available to the IMS nodes whenever the IMS operator needs to record this information either to fulfil legal obligations, for charging or for other purposes.

This study will gather the various existing regulatory and operator requirements that the solution needs to fulfil, in particular:

- whether the provision of the Network Provided Location (NPLI) Information and local time are applicable to all the users served by a network (i.e. "non-roaming" subscribers and inbound roamers) or only to the network operator subscribers;
- whether Network Provided Location (NPLI) and local time need to be made available also if EPS/GPRS and IMS services of a subscriber are provided by different networks;
- what events trigger the need to retrieve the Network Provided Location (NPLI) and local time.

The study is then expected to produce solution candidates which detail the necessary Stage 2 message flows, architecture enhancements and new functionality needed in the EPS and GPRS networks. The solution candidates will also describe what IP Multimedia Subsystem elements are affected in order to obtain the Network Provided Location (NPLI).

The solutions produced will then be assessed against the criteria identified in section 7 where recommendations for normative work will also be made.

2 References

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

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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

[2] Void.

[3] 3GPP TS 23.167: "IP Multimedia Subsystem (IMS) emergency sessions".

[4] 3GPP TS 23.292: "IP Multimedia Subsystem (IMS) centralized services; Stage 2".

[5] 3GPP TS 29.328: "IP Multimedia (IM) Subsystem Sh interface; Signalling flows and message contents".

[6] 3GPP TS 23.271: "Functional stage 2 description of Location Services (LCS)".

[7] 3GPP TS 23.228: "IP Multimedia Subsystem (IMS); Stage 2".

[8] 3GPP TS 23.078: "Customized Applications for Mobile network Enhanced Logic (CAMEL) Phase 4; Stage 2".

[9] 3GPP TS 23.401: "General Packet Radio Service (GPRS) enhancements for Evolved Universal Terrestrial Radio Access Network (E-UTRAN) access".

[10] 3GPP TS 24.229: "IP multimedia call control protocol based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Network Provided Location Information: Information provided by the network. Specifically, this can be the Cell Global Identity (CGI), CSG Identity (CSGID), Geographical Identifier (GI) and/or PLMN ID, depending on the type of access network that the UE is camped on and on the level of granularity that is provided. Based on operator policy and/or roaming agreement, local time of visited network is included.

Geographical Identifier: Identifier of a geographical area defined within a country or territory. The Geographical Identifier may be described in a geospatial manner (e.g. geodetic coordinates) or as civic location information (e.g. a postcode), or use an operator-specific format. It may be generated by the access network, or by an IMS node. It is assumed that a given cell cannot belong to more that one area identified by a Geographical Identifier.

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

GI	Geographical Identifier
NPLI	Network Provided Location Information

4 Scenarios for Network Provided Location Information Provision

4.1 Lawful interception

A legal obligation exists for network operators to record the Cell-ID when lawful interception is applied. Though the UE currently provides the Cell-ID information, some regulators do not to trust this information because it may have been tampered with, therefore they require a network provided Cell-ID.

For an originating or terminating IMS session involving an intercepted UE, both the Cell-ID where intercepted UE has initiated the session and the Cell-ID where the session was released are required. There is no requirement to be able to track the changes in the Cell-ID value during the session.

4.2 Charging

The CDRs generated within IMS have to contain Network Provided Location Information (NPLI) in order to guarantee correct billing. This applies for all CDRs from any user/session regardless of whether the session is successfully established or not.

In case the UE to be located is camped on a visited network (that is not an equivalent PLMN to the HPLMN), the level of granularity of the NPLI (Cell ID, CSG ID, GI, PLMN ID) provided between PLMNs depends on roaming agreements. In all cases, the Cell-ID or CSGID needs to be provided to IMS nodes in the VPLMN when the UE to be located is camped on that same VPLMN or equivalent PLMN to the VPLMN.

In the case of an IMS voice session, for example, the NPLI of the UE needs to be recorded for an originating or terminating IMS session establishment. The NPLI need to be provided when the session is successfully connected/released and when the session is dropped due to, for instance, radio condition changes.

When an IMS Session is modified, e.g. when a new media component is added to an MMTel call, the NPLI also needs to be stored as the location of the user at the time when the session is modified may generate a charging event.

NPLI is also needed to correctly charge for localized services. NPLI needs to be available to any IMS node that generates charging records. The network that the IMS node is located in will determine if Cell-ID, CSGID, GI or PLMN ID is needed. For example, on an IMS session origination where the P-CSCF is in a VPLMN and the S-CSCF is in the Home or equivalent PLMN, the Cell-ID or CSGID would be in the P-CSCF CDR and the PLMN ID would be in the S-CSCF CDR.

The NPLI of the serving cell is likewise needed by IMS elements involved in online charging. In the case of online charging, it is needed at the time of the IMS service request, or when the IMS service request being processed form mobile terminated services, because it may be taken into consideration for service authorization.

The local time of the serving cell is likewise needed for both offline and online charging, to be provided to the IMS elements in either case at the same time as the NPLI.

Editor's note: It is FFS which IMS functional entities are required to include the NPLI in the CDR and for which events. Currently TS 23.228 [7] identifies the following as generating CDRs: P-CSCF, I-CSCF, S-CSCF, BGCF, MRF, IBCF and transit functions. TS 23.228 [7] also identifies charging information can be conveyed on Ma and ICS reference points.

4.3 IMS Emergency Calls Routing

In order to be able to route an emergency call to the appropriate PSAP, the NPLI is required. The NPLI shall be provided to the E-CSCF before it performs PSAP selection. The Cell-ID of the cell where the emergency call is originated is considered to provide sufficient accuracy for a correct routeing of the call. In some instances, depending on the specific PSAP configuration and based on regulatory requirements, a lower level of accuracy than that provided by the Cell-ID may be preferable, e.g. GI.

If local regulation requires support for UEs which have insufficient credentials (e.g. UICC-less), network provided Cell-ID must also be obtained for these UEs.

Existing mechanisms as defined in TS 23.167 [3] may be used for the PSAP selection, those can be LCS based if the operator supports LCS or non-LCS based if the operator does not support LCS.

In all cases, minimal impact on the session set-up time for obtaining the network provided location information is important as in some countries stringent requirements exist on emergency call set up time.

4.4 Retention of Location Information Data

Network operators have a legal obligation to record and store for a certain amount of time information about their subscribers such as events, services used as well as location where the service was consumed. It is expected that when a service is provided by IMS the same requirements that exist today for CS services will continue to apply.

4.5 Special Call Routing for Localised Services

For localised services and for routeing of originating or terminating sessions dependent on the current location of the UE, the NPLI needs to be available to the IMS before deciding on whether or where to route the session. It is expected that localised services are provided by IMS with minimal impact regarding session set-up time and in the same way as provided by the CS domain today.

4.6 Location-based service triggering

Network operators implement services that need to be triggered based on the location of the user. For example, an anti-fraud AS may be triggered when a user is roaming. In order to allow this for IMS services, certified location

information needs to be available at the time of triggering Application Servers, with at least the granularity of a PLMN ID, while processing requests for originating or terminating session establishment and requests for SMS.

5 Architecture Requirements

5.1 General

The solution for the provision of trusted location information to the IMS nodes is expected to fulfil the following architecture requirements. These requirements are derived from the scenarios described in section 4 of this document.

NOTE: Although the aim is to achieve a single solution, more than one architecture solution may be specified if it is discovered that not all use cases are efficiently fulfilled by a single solution.

5.2 High Level Requirements

- It shall be possible for the NPLI to be provided by the access network to the IMS for the purpose of charging, lawful interception and retention of location information and potentially PSAP selection to be determined by the network. The information shall be provided for the originating UE in the originating record, and for the terminating UE in the terminating record.
- For the purpose of charging, the NPLI and local time of the serving cell shall be provided to the IMS.
  - For offline charging purpose the NPLI and local time shall also be provided at the beginning of chargeable communication session or event.
  - For online charging purpose, the NPLI and local time shall be provided at the receiving of the IMS service requests.
  - in the case of a communication originated by a roamer or terminating to a roamer, the serving network shall provide the NPLI and local time of the serving cell to the home network, based on the roaming agreement.
  - The local time may be represented as an explicit time stamp or as the UTC with indication of UTC time zone offset and indication as to whether daylight savings time is in effect.
- For PSAP selection in the case of an IMS emergency call, the provision of the NPLI shall be based on functions specified in TS 23.167 [3].
- The solution shall minimize the additional signalling.
- The solution shall not require modifications of the UE.
- The solution shall allow for the network to provide NPLI if the UE has insufficient credentials (e.g. UICC-less case).
- The solution for providing the NPLI of the UE to the IMS shall not degrade the service level, e.g. session setup delay, compared to the degradation resulting from providing location in the corresponding CS service and shall not be perceptible to the end user.
- The solution should allow for the provision of NPLI to IMS nodes for IMS subscribers using ICS in IMS Centralized Services scenarios as specified in TS 23.292 [4].
- The number IMS entities required to do the retrieval of the NPLI should be minimized.
- NPLI shall be present in the SIP headers of SIP requests when iFCs are evaluated by the S-CSCF, when this is needed for the events listed in clause 5.3.

5.3 Location Characteristics Requirements

- In case the UE to be located is camped on a visited network (that is not an equivalent PLMN to the HPLMN), depending on roaming agreements, either the Cell-ID or only the GI identity of the visited PLMN where the UE

is registered for bearer services may be provided to the IMS nodes in the HPLMN. In all cases, the Cell-ID or CSGID needs to be provided to IMS nodes in the VPLMN when the UE to be located is camped on that same VPLMN or equivalent PLMN to the VPLMN.

- IMS nodes may require the network to provide the NPLI of the UE upon the following events:
  - Session establishment (e.g. during the SIP INVITE for IMS Voice);
  - Session release;
  - Session modification (e.g. addition / removal of a media component during an MMTel session);
  - SIP MESSAGE for SMS.
- The network should be able to control which IMS nodes can obtain trusted network provided NPLI and the network shall not provide it to non trusted entities.

Editor's note: It needs to be determined if a network operator has a legal obligation and/or operational need (e.g. CDRs) for IMS to obtain the NPLI from the IP-CAN or if correlation between IMS records and IP-CAN records meets the legal obligation and/or operational need.

Editor's note: If IMS is required to obtain the NPLI, it needs to be determined what IMS entity (or entities) that needs to explicitly retrieve such information from the access network.

5.4 Overview of IMS Functional Entities Requiring Location

Figure 5.4-1 gives a simplified overview of functional entities in IMS requiring location information to support charging, data retention, special call routing for localised services, emergency and lawful intercept.

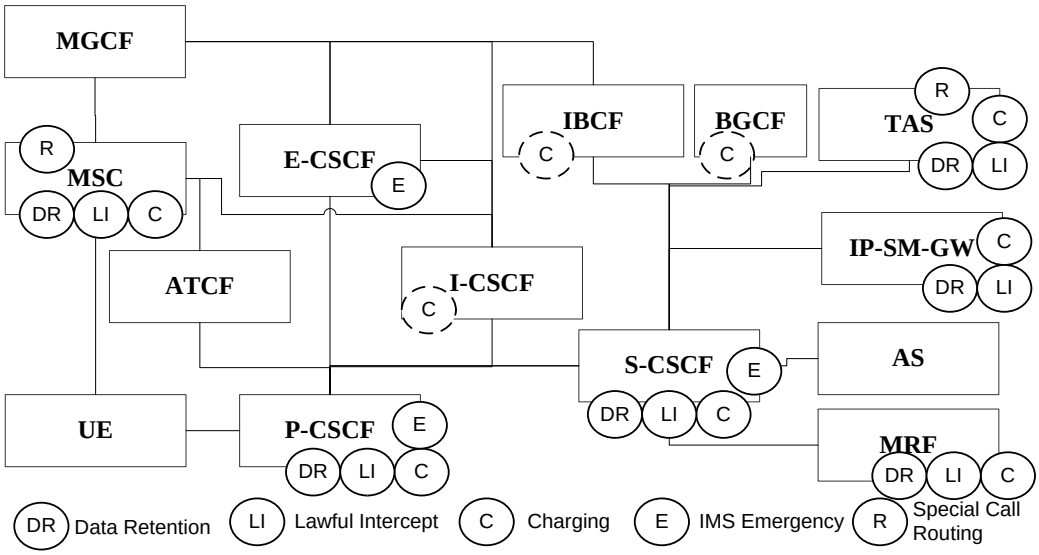

Figure 5.4-1: Overview of IMS Functional Entities Requiring Location

Table 5.4-1 lists the IMS Functional entities involved in the call case and the entities where location may needed due to LI, Charging, DR, special call routing for localised services and Emergency.

Table 5.4-1: Summary of where the location may be needed in the network for a particular call case

Call case	P-CSCF	MSC	E-CSCF	S-CSCF	TAS	AS	MGCF
Basic Call over PS: Origination	R	-	-	R	R	O	-
Basic Call over PS: Termination	R	-	-	R	R	O	-
Basic Call using ICS I2: Origination	-	R	-	R	R	O	-
Basic Call using ICS I2: Termination	-	R	-	R	R	O	-
Basic Call using ICS Mg: Origination	-	R	-	R	R	O	?
Basic Call using ICS Mg: Termination	-	R	-	R	R	O	?
Emergency call origination	R	-	R	R	-	-	-
Legend: "R": Needed to be known for at least one of LI, DR, Charging, special call routing for localised services or Emergency. "O": Optional, depending on service. "-": Not Applicable (Not used).							
NOTE 1: ICS Mg in the above call cases, denotes the usage of ICS using home routing via MGCF, where the MSC server is not enhanced for ICS; for origination, this relies on IN (e.g. CAMEL) triggers to redirect CS originated calls to IMS. NOTE 2: It is assumed that the MSC can rely on existing functionality for providing the features listed above.							

NOTE 3: The LRF has not been considered in the above assessment, and may need to be considered in future updates.

Table 5.4-2 shows for each of the identified scenarios whether NPLI is required, or not, during the execution of the corresponding IMS events (i.e. before session establishment/modification can be committed).

Table 5.4-2: When NPLI is Needed

	Session Initiation (Offer)	Session Response (Offer Response)
Lawful Interception (LI)	If available	Must
Data Retention (DR)	If available	Must
Charging	If available (NOTE 4)	Must
Emergency	Must	-
Routing Localized Services	Must	-
Location Based Service Triggering	Must	-

NOTE 4: For on-line charging using location-based fees, it may be required to have NPLI in real time already at session setup.

6 Architecture Alternatives

6.1 HSS based NPLI retrieval based on existing mechanisms

6.1.0 General

This clause describes current mechanism for NPLI retrieval that is provided over Sh. This scenario is applicable for location retrieval in home network scenarios and does not consider IMS emergency calls (as emergency is a visited NW service and the E-CSCF has no access to Sh).

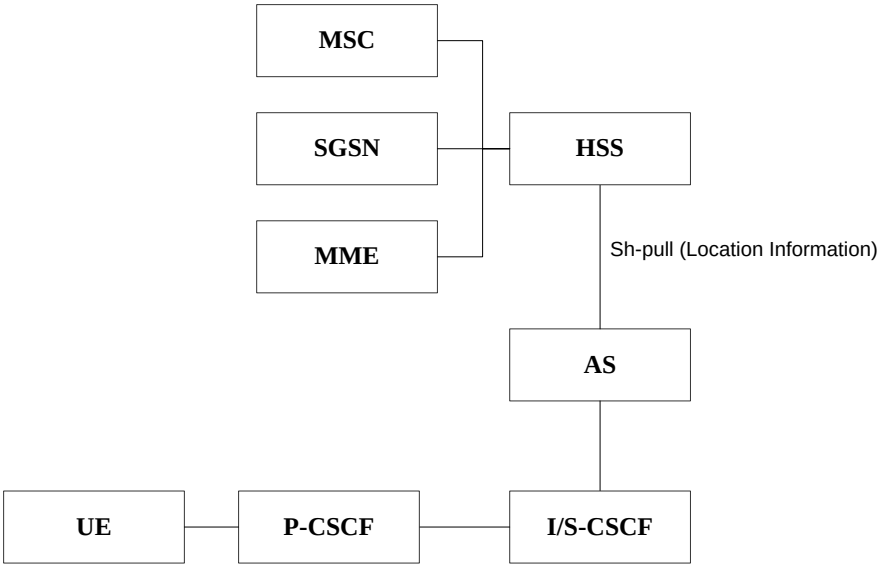

Figure 6.1-1

For an MT or MO session, the AS requests the location information from the HSS using the existing Sh-Pull (see TS 29.328 [5]). The AS can indicate, using the Current Location IE, whether active location retrieval has to be initiated or not. Furthermore, the AS should indicate the serving node(s) for which the location is required (e.g., whether it should be queried from SGSN, MME, or both).

Editor's note: Further enhancements may be needed to deal with terminating call cases (as, following Active Location Retrieval, the UE might be being released at the same time as the MT SIP signalling arrives in the VPLMN, potentially leading to a lower paging success rate).

6.1.1 NPLI provision for MT call based on HSS interrogation

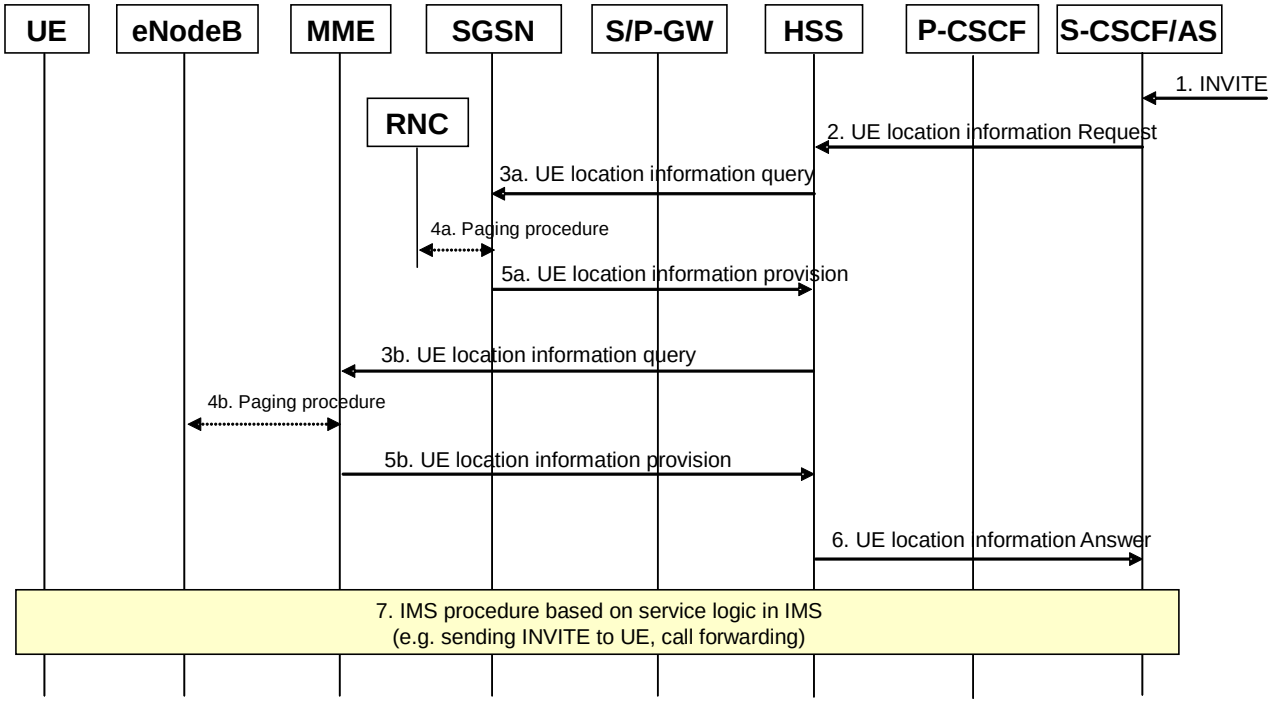

Figure 6.1.1-1: Information flow for Cell ID provision based on HSS interrogation

NOTE: In this flow, it is intended to reuse existing procedures/messages and specify new indications in existing messages and its related actions at receiving nodes.

1. S-CSCF receives the INVITE message and may interact with the AS according to the service logic applied as specified in TS 23.228 [7].

2. S-CSCF/AS sends the UE location information request message to the HSS over Cx/Sh interface.

3-5. HSS interrogates the UE location information to the serving nodes and indicates whether current serving cell of the UE in ACTIVE mode is needed. If current serving cell of the UE in ACTIVE mode is requested and the serving node is ISR active, it pages the UE and reports the HSS with the current serving cell of the UE. Otherwise the serving node does not page the UE and reply with the last known UE location information together with last UE access time.

6. Upon receiving UE location information from serving nodes, HSS determines information to be forwarded to the S-CSCF/AS. HSS does not wait for further reply from serving nodes if it has received the reply from one of serving nodes and it indicates UE has successfully connected (or already connected) to the network.

7. S-CSCF/AS utilizes the received location information and performs further IMS procedures based on applied service logics at S-CSCF/AS, e.g. normal terminating call handing, call forwarding, etc.

NOTE: HSS interrogation flow illustrated from step3 to step5 can be used for T-ADS purpose simultaneously.

6.1.2 NPLI provision during IMS emergency registration

This procedure enhances the existing IMS emergency call establishment procedure in order to allow IMS to determine PSAP as soon as INVITE is received from UE. It does not change the existing EPC/IMS architecture and the principle specified in TS 23.167 [3].

This procedure applies when the following condition is met:

- IMS emergency registration is used, as specified in TS 23.167 [3].

NOTE 1: If UE is roaming outside its home network, the emergency call set up delay might be considerable.

The information flow is described below.

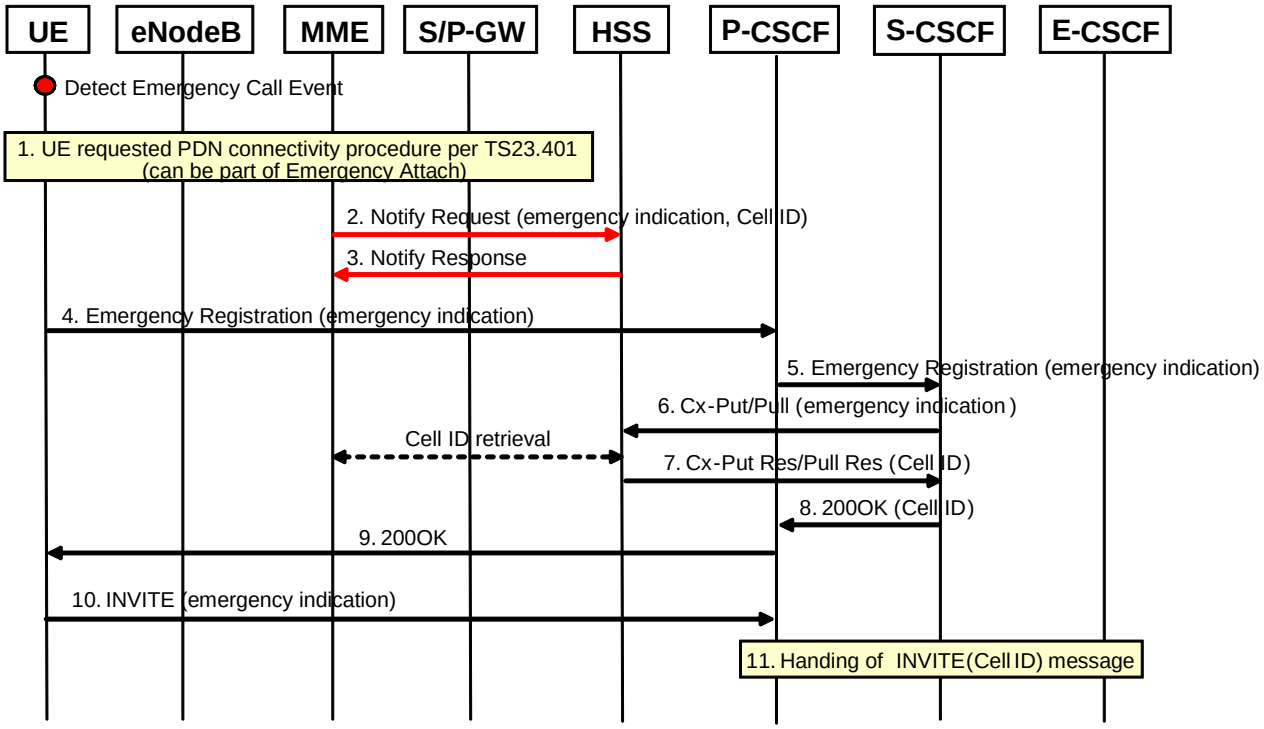

Figure 6.1.2-1 Cell ID provision during IMS emergency registration

1. UE detects the emergency call event and, if it decides to, requests a PDN connectivity request with Request Type "Emergency" to the MME as specified in TS 23.401 [9]. This procedure can be Emergency attach procedure if the UE is required to do so.

NOTE 2: If UE does not send a new PDN connectivity request, there is no trigger for MME to send the Notify Request in step2.

2. MME detects whether the UE has valid subscription in step1. If this condition is satisfied, MME sends the Notify Request to the HSS including an emergency indication and the NPLI pertaining to the UE.

3. The HSS stores the received NPLI together with the emergency indication as temporary data and sends the Notify Response to the MME.

4-5. The UE initiates the IMS Emergency Registration as specified in TS 23.167 [3].

6. The S-CSCF sends the Cx-Put/Pull to the HSS as specified in TS 23.167 [3] and TS 23.228 [7]. In this step, the S-CSCF includes an emergency indication to retrieve the stored NPLI.

7. The HSS informs the S-CSCF of the NPLI stored for the UE, if available, by sending Cx-Put Res/Pull Res message. If the HSS does not have NPLI for the UE, the HSS requests the MME to provide the NPLI.

8. The S-CSCF sends 200OK to the P-CSCF including the NPLI. If, as specified in TS 23.167 [3], the operator configures INVITE with emergency indication shall be forwarded from P-CSCF to S-CSCF, the S-CSCF sends 200OK to the P-CSCF as specified in TS 23.228 [7].

9. The P-CSCF sends 200OK to the UE as specified in TS 23.228 [7].

10-11. The UE initiates IMS emergency call session establishment procedure as specified in TS 23.167 [3]. For further routing, TS 23.167 [3] applies. In these steps, the P-CSCF or the S-CSCF informs E-CSCF of the pre-obtained NPLI for the UE in INVITE. The E-CSCF determines the PSAP according to the NPLI.

NOTE 3: The above mentioned procedure does not restrict the use of the LCS based location retrieval.

6.2 Enhanced PS domain location reporting

The current PS domain location reporting may continuously provide the PGW/GGSN with the UE's cell location. The P-CSCF may subscribe to get this information via PCC for being able to add that location information to the relevant SIP messages.

However up-to-date cell location is only available for UEs in connected state. Another problem of the current mechanism is that it provides the location information by continuous reporting towards PGW/GGSN once the functionality is activated. This may cause some heavy network signalling as every cell change is reported and not only changes that are relevant for IMS.

The CS domain has similar location reporting requirements and also location reporting functions for CS services. To some extent the RAN is not transparent for CS/NAS signalling and provides the cell information with certain NAS messages to the MSC. So the cell is available, for example, during CS call setup in the MSC for originating and terminating calls.

The PS domain cell reporting can obviously not require that the RAN analyses packets for SIP messages. However some enhancements are needed to limit the signalling traffic caused by the continuous cell reporting in PS domain for usage by IMS. Here it is proposed to enhance the current mechanism to report cell changes only when there is activity on the IMS signalling bearer, which makes it somehow comparable to CS domain behaviour. So the RAN would not report every cell change, but only cell changes when IMS signalling bearer data are transferred and the last reported cell is a different one. For GERAN access the SGSN can reduce updating the GGSN/P-GW based on activity on the IMS signalling bearer without involving the GERAN as the SGSN is aware of any cell changes.

Thereby the PS domain approach can be utilised and also the related network signalling can be kept at a reasonable level. The signalling reduction assumes the use of a signalling bearer, i.e. IMS signalling is not transferred on some other default bearer.

Some scenarios may require the current cell already for the first SIP message. On the originating side of the service the UE is in active state because it sent the SIP message. On the terminating side the current cell may be known first after

delivery of the first SIP message to the UE as the UE may be idle. So the cell will be available for the first SIP response message, which seems required anyhow as otherwise the Cell-ID or CSGID cannot be transferred to the S-CSCF.

6.2.1 Signalling Flow for the Enhanced PS Domain Location Reporting

The following procedure describes the location information provision for the enhanced PS domain location reporting.

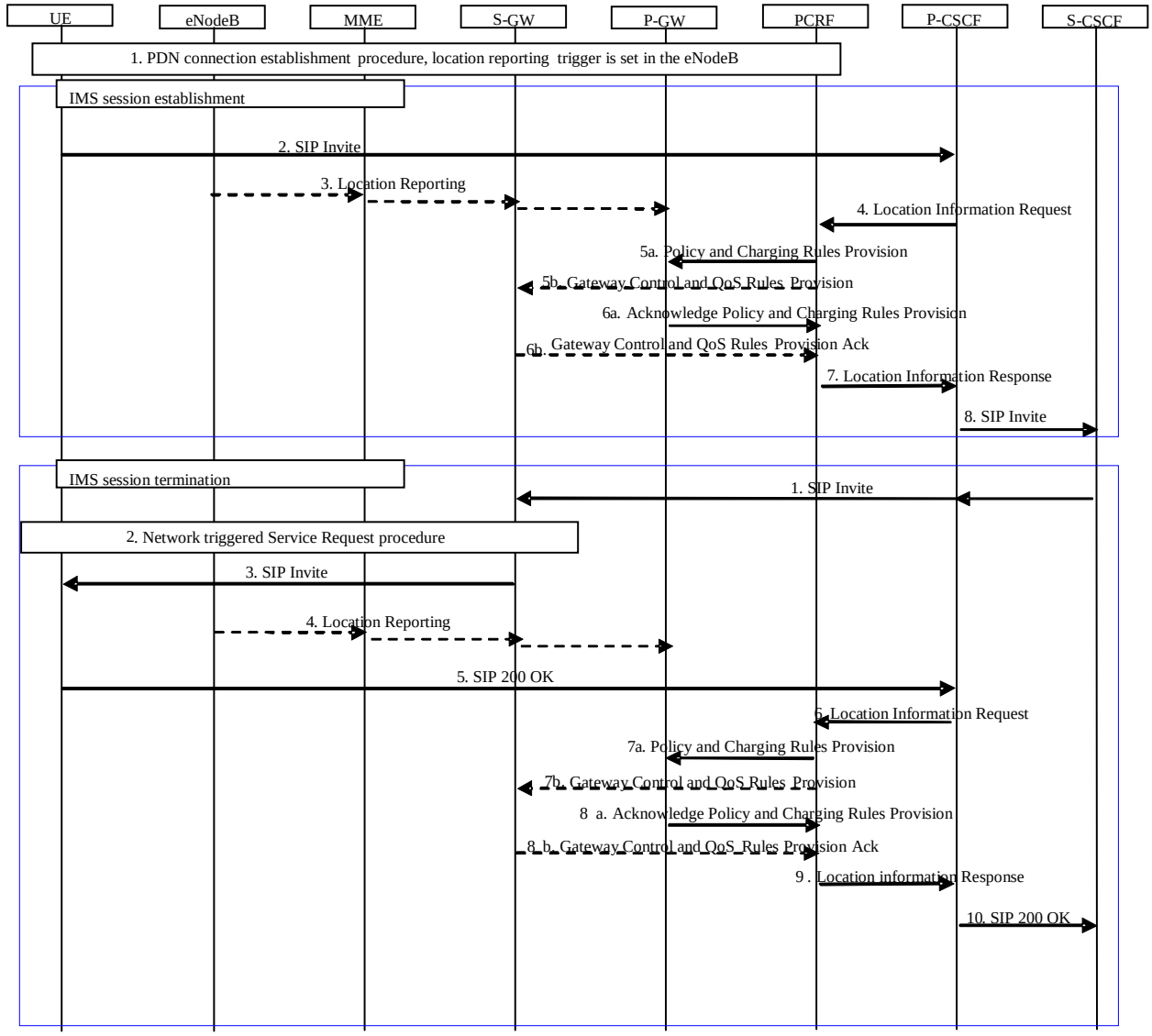

Figure 6.2.1-1: Signalling flow for enhanced PS domain location reporting

1. The PDN connection for IMS signalling is established. The PCRF requests user location information reporting for IMS signalling events, which the P-GW requests from MME. Any time the RABs are established the MME requests the eNodeB to report the location for IMS signalling events.

Mobile originating IMS session establishment:

2. An IMS level session establishment procedure is initiated. The SIP message INVITE is sent from the UE to the P-CSCF.

3. The transfer of the signalling message triggers the eNodeB to report user location information reporting if the location changed compared to the last reported cell. Reporting stops at P-GW, the P-GW does not forward the location information towards the PCRF. This is to reduce the amount of PCC reports and to adjust timing between the different paths.

4. After receiving the SIP message, the P-CSCF retrieves user location information from the PCRF by sending a Location Information Request message.

5a. In a GTP-based S5/S8 scenario, the PCRF sends Policy and Charging Rule Provision to the P-GW to request the user location information.

5b. In a PMIP-based S5/S8 scenario, the PCRF sends Gateway Control and QoS Rules Provision to the S-GW to request the user location information.

6a. In a GTP-based S5/S8 scenario, the P-GW reports the user location information to the PCRF.

6b. In a PMIP-based S5/S8 scenario, the S-GW reports the user location information to the PCRF.

7. The PCRF notifies the P-CSCF of the UE's location information received in step6.

8. The P-CSCF forwards the user location information to other IMS entities such as the S-CSCF. The added delay is the user location information retrieval procedure between the P-CSCF and the P-GW/S-GW.

Mobile terminating IMS session establishment:

1. The SIP message INVITE arrives at the S-GW.

2. If the UE is in ECM-IDLE state, network triggered service request procedure is performed due to inexistence of user plane connection. For more detail of this procedure refer to clause 5.3.4.3 of TS 23.401 [9].

3. The S-GW sends the SIP message INVITE to the UE.

4. The transfer of the signalling message triggers the eNodeB to report user location information reporting if the location changed compared to the last reported cell. Reporting stops at P-GW, the P-GW does not forward the location information towards the PCRF. This is to reduce the amount of PCC reports and to adjust timing between the different paths.

5. The UE sends the SIP message 200 OK back to the IMS.

6. After receiving the SIP message, the P-CSCF retrieves user location information from the PCRF by sending a Location Information Request message.

7a. In a GTP-based S5/S8 scenario, the PCRF sends Policy and Charging Rule Provision to the P-GW to request the user location information.

7b. In a PMIP-based S5/S8 scenario, the PCRF sends Gateway Control and QoS Rules Provision to the S-GW to request the user location information.

8a. In a GTP-based S5/S8 scenario, the P-GW reports the user location information to the PCRF.

8b. In a PMIP-based S5/S8 scenario, the S-GW reports the user location information to the PCRF.

9. The PCRF notifies the P-CSCF of the UE's location information received in step10a/step10b.

10. The P-CSCF forwards the user location information to other IMS entities such as the S-CSCF.

6.2.1a Using GTP-U Messages for Enhanced PS Domain Location Reporting

As an alternative to the location information reporting by signalling messages GTP-U messages may be used for the enhanced PS domain location reporting. This can offload the signalling plane and may bring advantages for the timing behaviour. The information is as described in clause 6.2.1 the only difference is for steps 3) of the mobile originating or steps 6) of the mobile terminating session initiation. The location reporting is moved from signalling to GTP user plane. Two alternatives are considered.

In alternative A the eNodeB adds the user location information to the GTP-U extension header. The P-GW or the S-GW, respectively retrieves the location information from the GTP-U extension header when it receives the PDUs. When there is no uplink G-PDUs, the eNodeB generates one empty packet with the user location information in the GTP-U header. Whether this is needed and how this is done is FFS. If, for example, the location is always only needed together with uplink signalling messages then it is not needed.

For alternative B a separate GTP user plane message is introduced for location reporting. In addition a GTP-U acknowledgment message is needed. Alternative A does not need a GTP-U acknowledgement message as the IMS message would be repeated if the GTP-U PDU with the location information header gets lost.

Table 6.2.1-1 shows the advantages and impacts of the two alternatives of GTP-U based Enhanced PS Domain Location Reporting.

Table 6.2.1-1: Analysis of Two Alternatives of GTP-U Messages for Enhanced PS Domain Location Reporting

	Alt A	Alt B
Advantage	No additional message transfer, NPLI can be put in the header of a data packet.	Shorter message path than in the control plane.
Impact	**Change to the eNodeB:** 1) The eNodeB insert the NPLI in the data packet GTP-U header; 2) When there is no uplink PDUs, the eNodeB may need to generate an empty packet with the user location information in the GTP-U header; 3) This can be achieved by newly defined GTP-U extension header type. This mechanism reuses the mechanism of extension header type and do not bring additional change to the network elements. **Change to the PGW:** The PGW needs to check each packet to find whether there is NPLI in the header. Suitable extension header type may alleviate some work from the PGW.	**There are two kinds of alternatives:** 1) New GTP-U messages need to be defined. This mechanism has impact in the eNodeB, the PGW, and also requires change in the SGW, since it shall forward these messages to the next hop, i.e., the eNodeB/PGW. 2) Existing GTP-U messages with new defined information element is needed. This mechanism requires change in the SGW, since it shall forward these messages to the eNodeB/PGW if the IE for location information is included.

6.3 LCS based NPLI provision from MME to GMLC

6.3.1 Overview

This alternative reuses LCS functionality for location information (i.e. Cell-ID) provision, only involving MME and GMLC . SLg interface between MME and GMLC is enhanced to indicate the location request is only for Cell-ID retrieval.

The figure below shows the architecture of this alternative. For Cell-ID level location information provision, only the enhanced GMLC is needed to be deployed, i.e. there is no need to deploy E-SMLC.

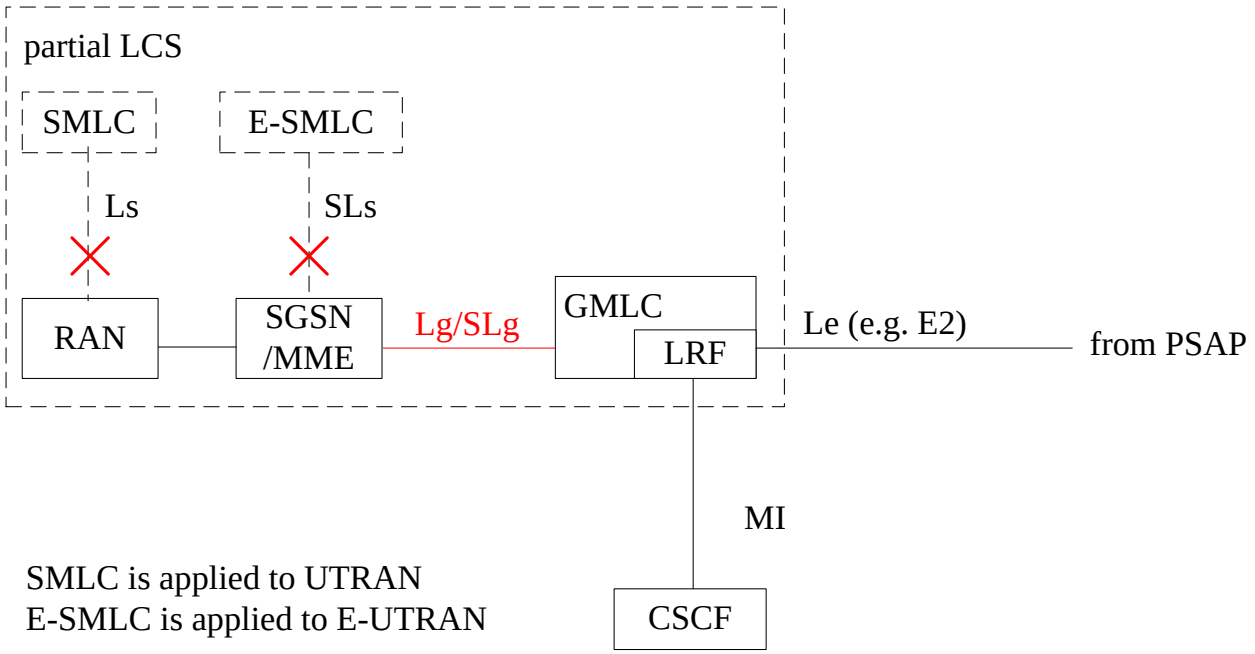

Figure 6.3.1-1 LCS based Cell-ID Provision without E-SMLC involved

The SLg interface is enhanced to allow GMLC to only request subscriber's Cell-ID from MME, without E-SMLC involved. This will be done by an explicit Cell-ID request indication in Provide_Location_Request (PLR) message sent from GMLC to MME. Such explicit Cell-ID request indication can be an individual parameter (e.g. Cell-ID-Only) in PLR message, or be a sub-parameter in LCS-QoS AVP.

When receiving PLR message which indicates only Cell-ID is requested, the MME shall not initiate SLs procedure to E-SMCL. Instead the MME sends back Provide_Location_Answer (PLA) message to GMLC, only including the Cell-ID of requested subscriber but no detail geography location information. As a result, the Cell-ID provision procedure will be accelerated as there is no complex location procedure involved (e.g. no further LPP procedure between E-SMLC and UE, or LPPa procedure between E-SMLC and eNodeB).

The Ml interface is utilized with enhancement to indicate that only Cell-ID is requested. When receiving IMS signalling, the IMS nodes (e.g. E/P-CSCF) retrieves subscriber's NPLI via Ml interface from the Location Retrieval Function (LRF) which may be internally provided by the GMLC. Another option is, the IMS nodes (e.g. E/P-CSCF) may act as LCS client to request NPLI directly from GMLC, using the enhanced Le interface which allows LCS client requesting subscriber's Cell-ID only.

With the enhancement to LCS procedure, this alternative can be used for the NPLI provision for PSAP selection, localized service call routing, and normal IMS service.

This procedure could also be applied to UTRAN with similar changes.

6.3.2 Procedure between GMLC and Serving Nodes

The figure below shows the detailed procedure between GMLC and serving node (e.g. SGSN/MME). In this procedure, GMLC requires only Cell-ID from SGSN/MME without triggering LCS procedures to SMLC/E-SMLC.

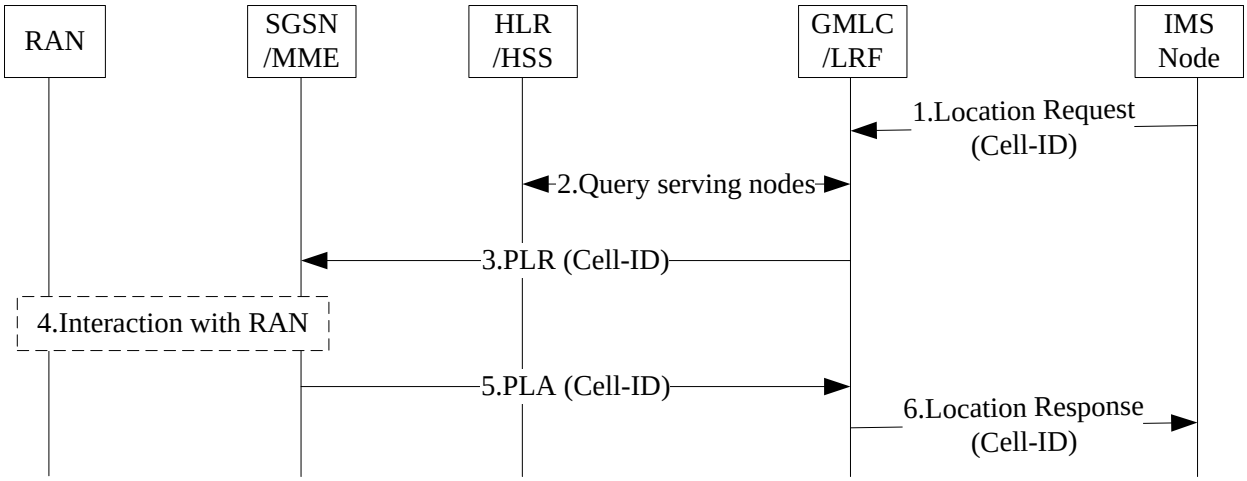

Figure 6.3.2-1: Location procedure between GMLC and SGSN/MME

1. The IMS node (e.g. P-CSCF/E-CSCF) decides to retrieve UE location information (i.e. Cell-ID). A location request is sent from IMS node to LRF/GMLC, including a Cell-ID request indication.

2. After receiving the Location request, the LRF transfers the location request to GMLC internally. The GMLC sends request to HLR/HSS for getting serving nodes.

   Common MT-LR procedures defined in TS 23.271 [6] are used by GMLC to find the serving nodes (e.g. SGSN/MME). The requesting GMLC may interact with HSS for obtaining the serving nodes (e.g. SGSN/MME). If multiple serving nodes' addresses are returned by the HSS, the GMLC will select the serving node based on local policy (e.g. the top of the return list). When sending multiple serving nodes, the HSS uses the TADS procedure to discover the prioritized serving node.

   For emergency service, the NI-LR is used for location provision. For UICC-less case, retrieving of the serving node address in HSS is not supported.

3. The GMLC sends Provide_Location_Request (PLR) message to SGSN/MME, carrying a Cell-ID request indication.

4. The SGSN/MME may interact with RAN node to retrieve updated Cell-ID.

5. The SGSN/MME responds with Provide_Location_Answer (PLA) message to GMLC, only including the Cell-ID of the UE.

6. The GMLC/LRF forwards the location information to the IMS node.

6.3.3 Pre-establish connection between GMLC and serving node

This procedure pre-establishes connection between SGSN/MME and GMLC, making the GMLC aware of the Cell-ID prior to the location query from IMS nodes. Subsequent location query from GMLC can directly go to SGSN/MME without querying HSS for serving nodes.

In non-emergency case, SGSN/MME can push the Cell-ID to the GMLC on the first detection of IMS signalling bearer / voice bearer (i.e. QCI=5 or 1), according to the operator policy and/or the subscription instruction. In roaming case the Cell-ID is pushed to H-GMLC via V-GMLC.

The figure below shows the enhanced procedures:

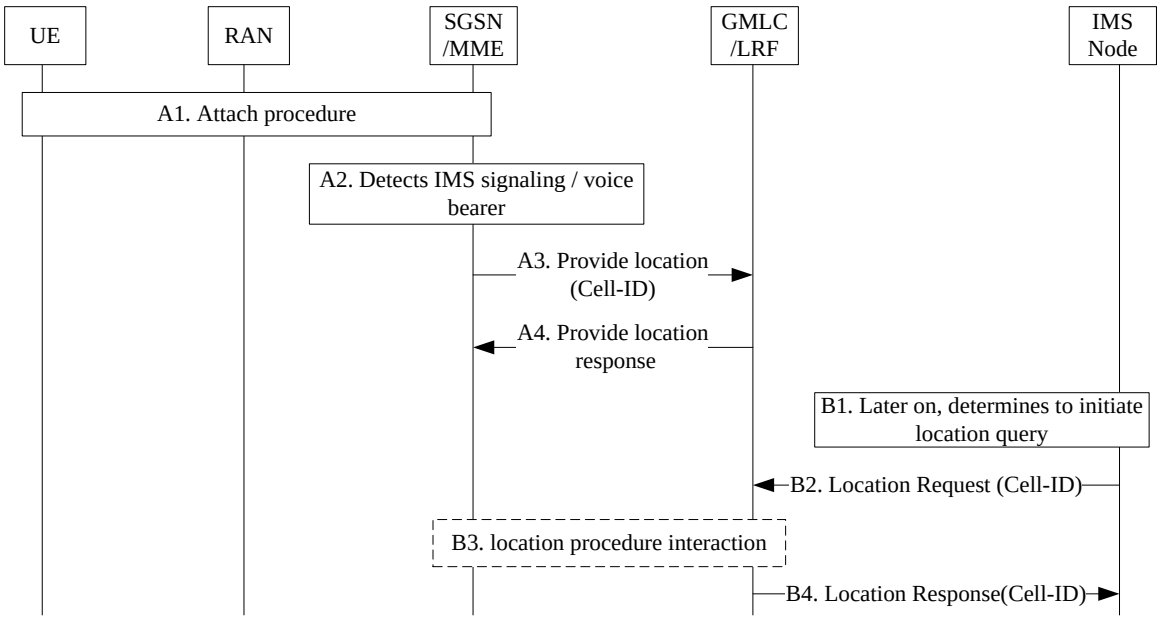

Figure 6.3.3-1: Pre-establishes connection between SGSN/MME and GMLC

A1) The UE performs attach procedure.

A2) The SGSN/MME detects the initiation of IMS signalling / voice bearer. This may occur during the attach procedure, PDP/PDN connection procedure or dedicated bearer establishment procedure.

For IMS signalling over dedicated bearer, the SGSN/MME may detect both establishment and release of IMS signalling, and sends Cell-ID to GMLC accordingly.

A3) According to the local policy or subscription instruction, the SGSN/MME sends Provide Location message to GMLC, including current Cell-ID of the UE.

A4) The GMLC responds with Provide Location Response message. After step A4, the SGSN/MME and GMLC store the addresses for each other and pre-establish connection.

B1) Later on, the IMS node (e.g. P/E-CSCF) determines to initiate location query, e.g. on the IMS session establishment.

B2) The IMS node (e.g. P/E-CSCF) sends location request to LRF/GMLC, indicating Cell-ID is required.

The IMS nodes shall select the same GMLC as the SGSN/MME has selected, which follows the same principle as EPC-NI-LR procedure used for emergency case described in TS 23.271 [6], clause 9.1.17.

B3) The GMLC may interact with SGSN/MME to query updated Cell-ID information.

B4) After getting the Cell-ID of UE, the GMLC/LRF sends location response back, including the Cell-ID of UE.

6.3.4 Procedures for localized call routing

This procedure is intended to be used for PSAP selection and localized services requiring special call routing where the NPLI is needed before the IMS level procedure continues. It is assumed that the alternative described in 6.4 is used for other purpose, e.g. charging. It is also noted that the mechanism described in this clause can be used for the case of SMS message delivery at IMS.

In this procedure, the E/S-CSCF can obtain the NPLI before selecting the correct PSAP or the destination of the call routing.

Editor's note: The support of localized service based on terminating user location is FFS.

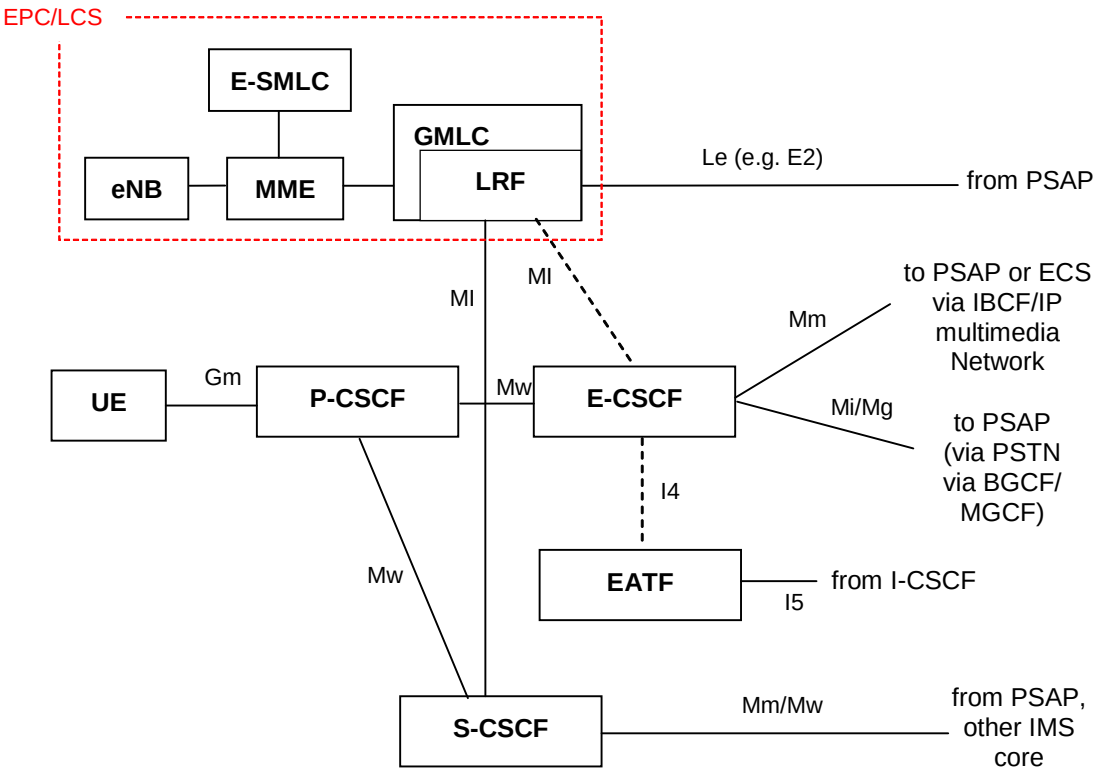

Figure 6.3.4-1: LCS based Location Provision Architecture

Editor's note It is FFS whether functionality of the S-CSCF - LRF Interface and E-CSCF - LRF Interface is the same.

The information flow of this procedure is described below.

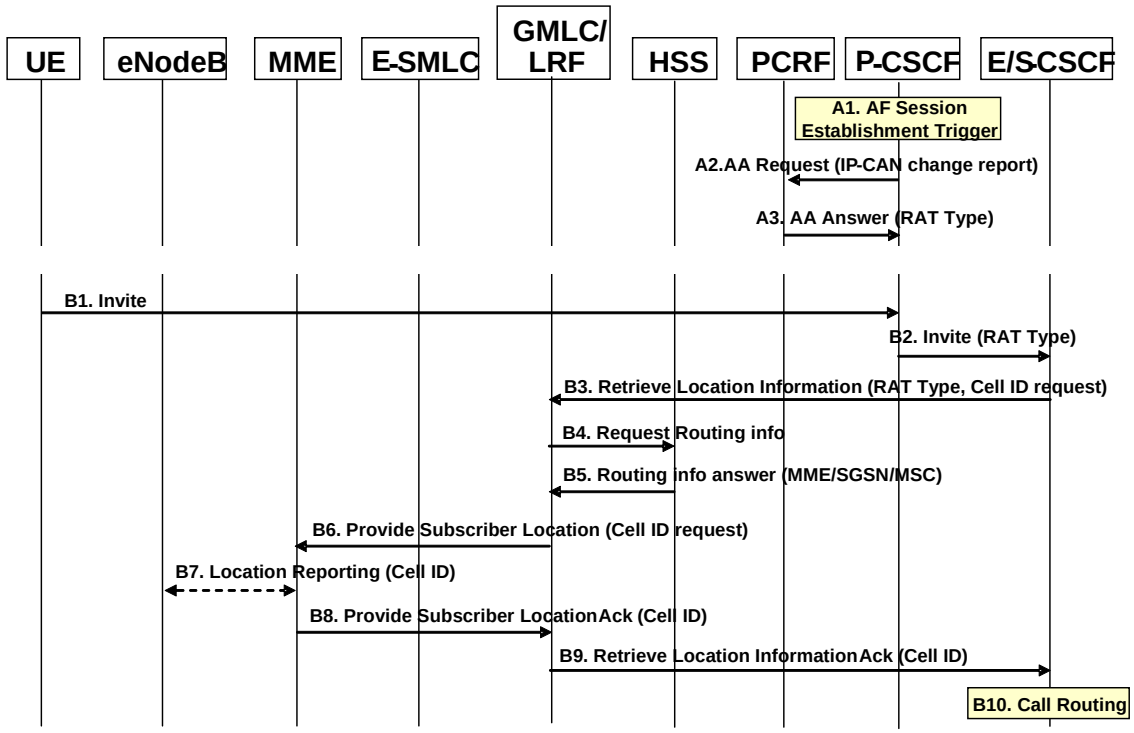

Figure 6.3.4-2 Location information provision for the special call routing based on the originating UE location

During the AF session establishment, P-CSCF obtains the RAT type information where UE is currently camping on.

A1) The P-CSCF detects the AF session establishment trigger, e.g. IMS registration.

A2) The P-CSCF sends the session establishment message (AA Request) to the PCRF requesting RAT type information if such is detected by the PCRF.

A3) The PCRF sends the session establishment Ack message (AA Answer) to the P-CSCF indicating current RAT type information.

NOTE 1: PCRF updates the P-CSCF of RAT type information if RAT change event occurs, e.g. IDLE mode mobility.

With these steps, P-CSCF maintains the current RAT information while UE is in ACTIVE state (P-CSCF may also obtain current RAT information in IDLE mode if ISR is not active).

B1) The UE sends an INVITE to the P-CSCF. This message contains an emergency indication if it is for emergency call.

B2) P-CSCF forwards the INVITE message to S-CSCF. If P-CSCF detects the call is an emergency call, the INVITE message is forwarded to the E-CSCF, instead. In sending INVITE message, P-CSCF sets the network obtained RAT type information where UE is currently connected.

Editor's note: It is FFS how to handle the case where UE moves to the different RAT after stepB2.

B3) In order to select the correct routing destination, e.g. PSAP, E/S-CSCF requests UE's location information to LRF/GMLC. This information indicates RAT type information where UE is currently connected and what type of location information is needed, e.g. Cell ID or location estimate.

NOTE 2: This step requires the modification to the Rel9 Ml interface.

B4) LRF/GMLC queries the serving node(s) of the UE.

B5) LRF/GMLC answers the serving node(s) information of the UE. The answer may contain multiple serving nodes information according to the registration status.

B6) LRF/GMLC selects the serving node address based on RAT type information received in stepB3, and sends the Provide Subscriber Location indicating the Cell ID is requested.

B7) MME performs the Location Reporting procedure to the eNodeB and obtain latest Cell ID information. This step may be skipped based on operator configuration and/or regulatory requirements. If Location Reporting procedure is not performed, the MME returns the stored Cell ID in step B8.

B8) MME sends Provide Subscriber Location Ack and informs the obtained Cell ID information to the LRF/GMLC.

B9) LRF/GMLC reports the Cell ID information received in step B8.

NOTE 3: This step requires the modification to the Rel9 MI Interface.

B10) E/S-CSCF selects the correct routing destination based on the Cell ID of the UE.

After these procedures, the call establishment procedure is continued, i.e. TS 23.167 [3] for the emergency and TS 23.228 [7] for the localized service.

6.4 NPLI provision using EPS and PCC Framework

6.4.0 General

This solution utilizes the EPS framework to provide the NPLI (optionally with local time) to the PDN GW/GGSN and the PCC framework to provide NPLI to the IMS.

Procedures described in clauses 6.4.1, 6.4.2 and 6.4.3 are used by EPC to provide NPLI to the IMS at the time of session establishment, session release and session modification. For IMS procedures without EPC bearer interaction, e.g. SMS delivery, the procedure described in clause 6.4.4, or, the procedure described in 6.7, is used for the IMS to request NPLI to be provided by the EPS.

In this alternative, no architecture change for EPC/IMS is needed.

6.4.1 NPLI provision at session establishment

The following procedure describes the location information provision at the time of IMS session origination and termination.

When the session is originated or terminated, the bearer establishment procedure. e.g. for voice media, is triggered by the P-CSCF in receiving the SIP message (Offer Response) from the IMS entity of terminating side or terminating UE, respectively. During this procedure, MME forwards NPLI to the P-CSCF via S-GW, P-GW (in case of GTP-based S5/S8) and PCRF.

This procedure does not require additional signalling for location information provision.

NOTE 1: This procedure does not apply for cases where no bearer establishment is required, e.g. SMS delivery.

NOTE 2: This procedure does not apply for services which require location information at S/E-CSCF for special call routing, e.g. PSAP selection and Localized Services.

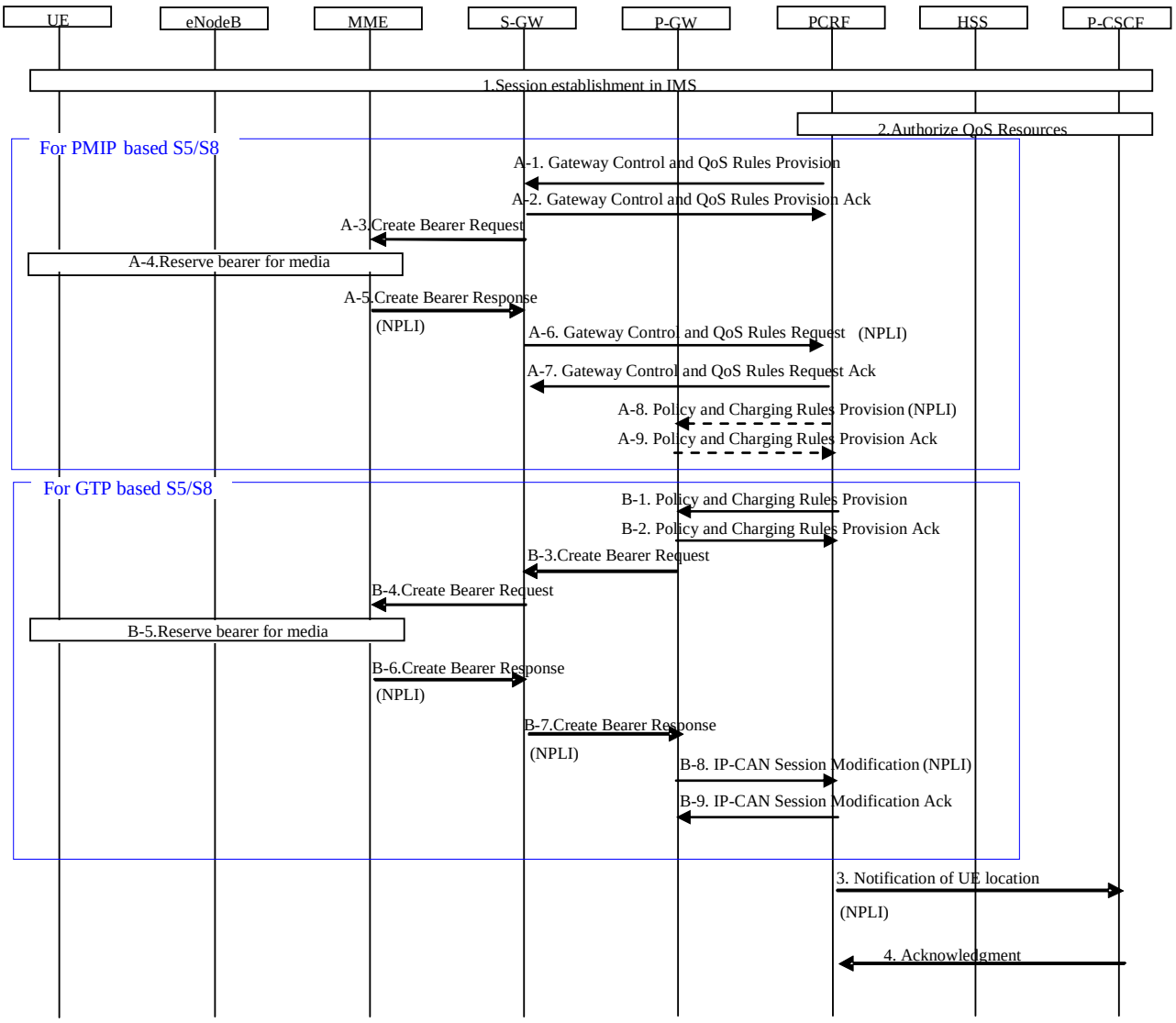

Figure 6.4.1-1: Location information provision at session establishment

1. IMS level session establishment procedure is initiated. This procedure is common for IMS MO call and MT call cases.

Editor's note: The interaction with the IMS procedure needs to be clarified based on the requirement, e.g. whether IMS procedure can continue in parallel with following steps.

2. P-CSCF authorizes the resources necessary for this session and provides the service information to the PCRF. In this step, depending on operator policy, the P-CSCF requests the notification of UE's NPLI when PCRF obtains it as part of bearer level event.

Steps for PMIP-based S5/S8 only (A-1 to A-9):

PCRF initiates the gateway control and QoS rules provision procedure and triggers the S-GW to allocate the dedicated bearer. PCRF requests UE's current location from S-GW and S-GW forwards the request to the MME. During this procedure, MME informs the S-GW of UE's NPLI and it is forwarded to the PCRF. Based on operator configuration, MME may interact with the eNodeB, e.g. via S1-AP messages, to retrieve specific location information such as E-UTRAN CGI where UE is currently connected. Otherwise MME replies NPLI stored at MME. Upon receiving NPLI from Create Bearer Response, the SGW initiates the Gateway Control and QoS rules Request procedure, sending the NPLI to the PCRF. The PCRF initiates the PCC Rules Provision Procedure and provides NPLI to the PCEF if needed.

Steps for GTP-based S5/S8 only (B-1 to B-9):

PCRF initiates the policy and charging rules provision procedure requesting NPLI from P-GW. P-GW initiates dedicated bearer activation procedure by receiving step3 and P-GW forwards the request to the MME via S-GW. During this procedure, MME informs the S-GW of NPLI and it is forwarded to the P-GW. Based on operator configuration, MME may interact with the eNodeB, e.g. via S1-AP messages, to retrieve specific location information such as E-UTRAN CGI where UE is currently connected. Otherwise MME replies NPLI stored at MME. Upon receiving NPLI from Create Bearer Response, the PGW initiates the IP-CAN Session Modification procedure, sending the NPLI to the PCRF.

3. When detecting the bearer level event on location information, PCRF notifies the P-CSCF of the NPLI retrieved in step A-6 (in case of PMIP-based S5/S8) or step B-8 (in case of GTP-based S5/S8).

4. P-CSCF acknowledges to the PCRF.

6.4.2 NPLI provision at session release

The following procedure describes the NPLI provision at the time of IMS session release.

The bearer deactivation procedure is triggered by the P-CSCF by receiving the BYE message from the UE or other IMS entity or by getting other bearer release trigger at P-CSCF, e.g. P-CSCF initiated bearer release due to O&M reason. During this procedure, similar to the session establishment procedure case, MME forwards the NPLI to the P-CSCF via S-GW, P-GW (in case of GTP-based S5/S8) and PCRF.

This procedure does not require additional signalling for NPLI provision.

NOTE 1: This procedure does not apply for cases where no bearer establishment is required, e.g. SMS delivery.

NOTE 2: This procedure does not apply for services which require NPLI at S/E-CSCF for special call routing, e.g. PSAP selection and Localized Services.

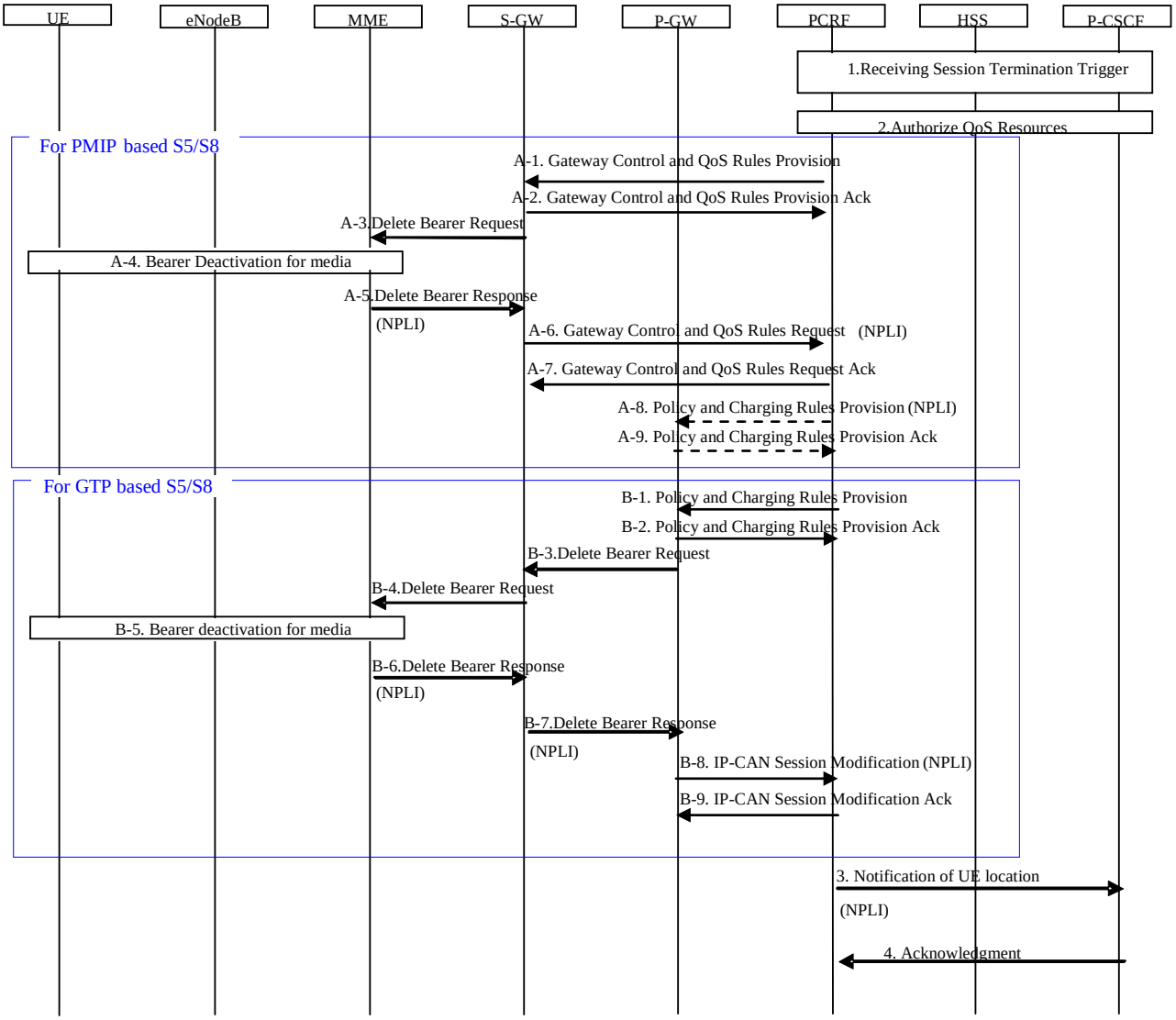

Figure 6.4.2-1: Location information provision at session release

1. IMS level session release procedure is initiated by P-CSCF detecting the session release event, e.g. receiving SIP BYE message.

Editor's note: The interaction with the IMS procedure needs to be clarified based on the requirement, e.g. whether IMS procedure can continue in parallel with following steps.

2. P-CSCF removes the authorization for the resources related to the bearer being released and inform to PCRF. In this step, depending on operator configuration, P-CSCF requests the notification of the NPLI when PCRF obtains it as part of bearer level event.

Steps for PMIP-based S5/S8 only (A-1 to A-9):

PCRF initiates the gateway control and QoS rules provision procedure and triggers the S-GW to deactivate the dedicated bearer. PCRF requests the NPLI from S-GW and S-GW forwards the request to the MME. During this procedure, MME informs the S-GW of the NPLI and it is forwarded to the PCRF. Based on operator configuration, MME may interact with the eNodeB, e.g. via S1-AP messages, to retrieve specific location information such as E-UTRAN CGI where UE is currently connected. Otherwise MME replies with the NPLI stored at MME. Upon receiving NPLI from Delete Bearer Response, the SGW initiates the Gateway Control and QoS rules Request procedure, sending the NPLI to the PCRF. The PCRF initiates the PCC Rules Provision Procedure and provides NPLI to the PCEF if needed.

Steps for GTP-based S5/S8 only (B-1 to B-9):

PCRF initiates the policy and charging rules provision procedure requesting the NPLI from P-GW. P-GW initiates dedicated bearer deactivation procedure by receiving step3 and P-GW forwards the request to the MME via S-GW. During this procedure, MME informs the S-GW of the NPLI and it is forwarded to the P-GW and PCRF. Based on operator configuration, MME may interact with the eNodeB, e.g. via S1-AP messages, to retrieve specific location information such as E-UTRAN CGI where UE is currently connected. Otherwise MME replies with the NPLI stored at MME. Upon receiving NPLI from Create Bearer Response, the PGW initiates the IP-CAN Session Modification procedure, sending the NPLI to the PCRF.

NOTE 3: In case of PMIP-based S5/S8, the NPLI is not reported.

3. By detecting the bearer level event on location information, PCRF notifies the P-CSCF of the NPLI retrieved in stepA-6 (in case of PMIP-based S5/S8) or step .B-8 (in case of GTP-based S5/S8).

4. P-CSCF acknowledges to the PCRF.

6.4.3 NPLI provision at session modification

In case of a session modification event at IMS, either of the following procedures will take place based on required procedure at bearer level, e.g. addition of bearer, removal of bearer, bearer QoS modification:

- NPLI provision procedure at session establishment (Figure 6.4-1), or
- NPLI provision procedure at session release (Figure 6.4-2), or
- NPLI provision procedure illustrated in Figure 6.4-3 in this clause;

Figure 6.4-1 is used when the bearer establishment is triggered, e.g. addition of a media component during an MMTel session.

Figure 6.4-2 is used when the bearer deactivation is triggered, e.g. deletion of a media component during an MMTel session.

Figure 6.4-3 is used when the bearer modification is triggered, e.g. QoS modification for the use of newly negotiated codec. Bearer modification procedure is triggered by the P-CSCF in receiving the SIP message (SDP Answer) from the IMS entity of terminating side or terminating UE, respectively. During this procedure, MME forwards the NPLI to the P-CSCF via S-GW, P-GW (in case of GTP-based S5/S8) and PCRF.

NPLI provision procedure illustrated in figure 6.4.3-1 does not require additional signalling for NPLI provision.

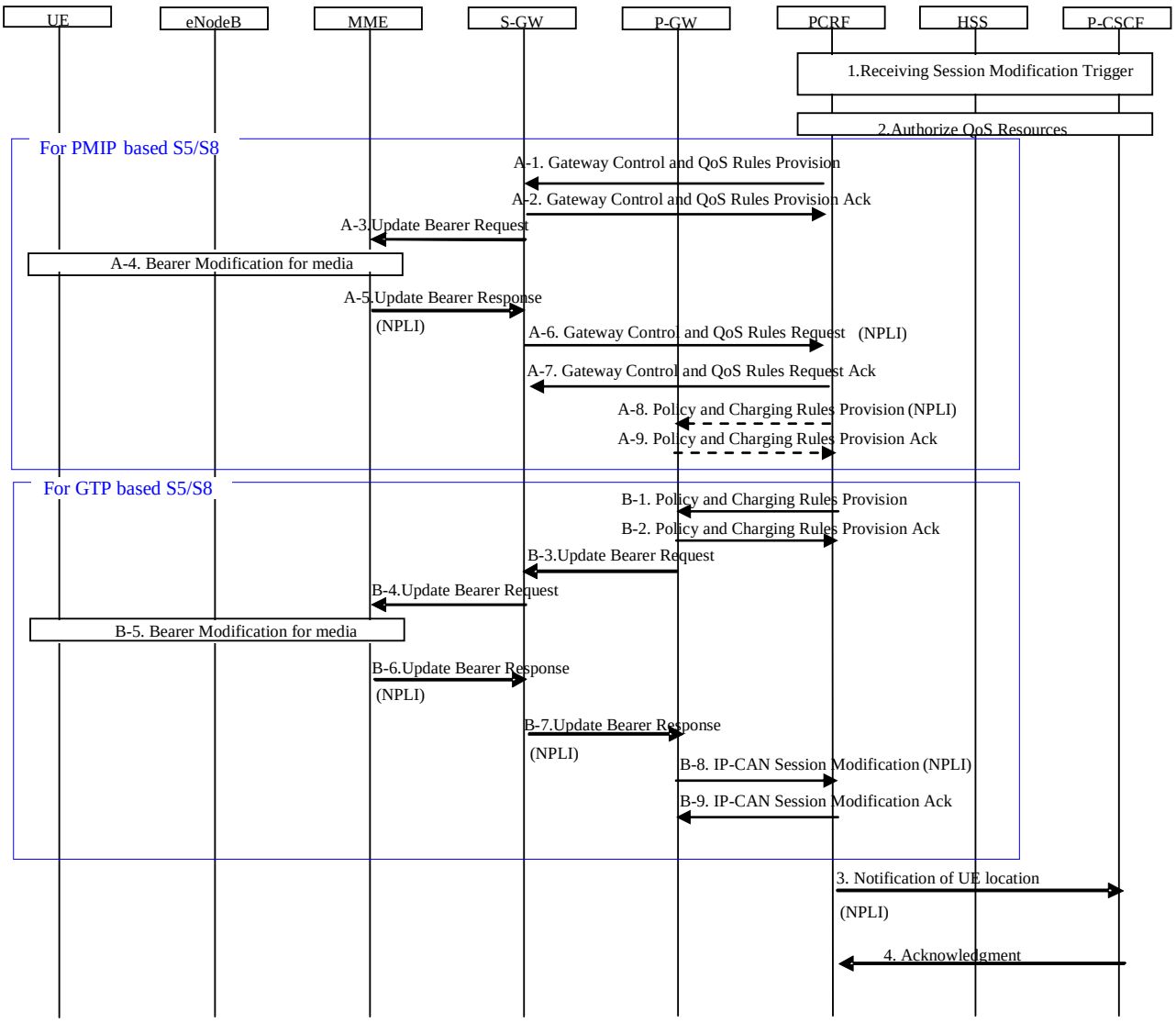

Figure 6.4.3-1: Location information provision in bearer level session modification

1. Session modification trigger is detected by the P-CSCF.

Editor's note: The interaction with the IMS procedure needs to be clarified based on the requirement, e.g. whether IMS procedure can continue in parallel with following steps.

2. P-CSCF authorizes the change in resources for this session and provides the service information to the PCRF. In this step, depending on operator policy, the P-CSCF requests the notification of the NPLI when PCRF obtains it as part of bearer level event.

Steps for PMIP-based S5/S8 only (A-1 to A-6):

Corresponding steps as described in Figure 6.4-1 are performed except that the create bearer procedure is replaced with update bearer procedure. Upon receiving NPLI from Delete Bearer Response, the SGW initiates the Gateway Control and QoS rules Request procedure, sending the NPLI to the PCRF. The PCRF initiates the PCC Rules Provision Procedure and provides NPLI to the PCEF if needed.

Steps for GTP-based S5/S8 only (B-1 to B-7):

P-CSCF initiates the policy and charging rules provision procedure requesting the NPLI from P-GW. Corresponding steps as described in Figure 6.4-1 are performed except that the create bearer procedure is replaced with update bearer procedure. Upon receiving NPLI from Create Bearer Response, the PGW initiates the IP-CAN Session Modification procedure, sending the NPLI to the PCRF.

3. When detecting the bearer level event on location information, PCRF notifies the P-CSCF of the UE location information retrieved in stepA-6 (in case of PMIP-based S5/S8) or step B-7 (in case of GTP-based S5/S8).

4. P-CSCF acknowledges to the PCRF.

6.4.4 Bearer Independent NPLI Fetch by P-CSCF

The following procedure describes the NPLI fetch when P-CSCF receives IMS signalling. The procedure is applicable for both scenarios where bearer creations/modifications/releases are required (e.g. for session establishment/release) or not required (e.g. for sending an IMS SMS). In this case the P-CSCF sends an on demand request to PCRF for NPLI retrieval.

To get the NPLI, the P-CSCF sends Provide Service Info message to the PCRF including NPLI Request indication. The bearer update procedure is reused to carry such NPLI Request Indication and bring back the NPLI to P-CSCF.

The figure below shows the NPLI retrieval when P-CSCF receives a SIP Message from the UE.

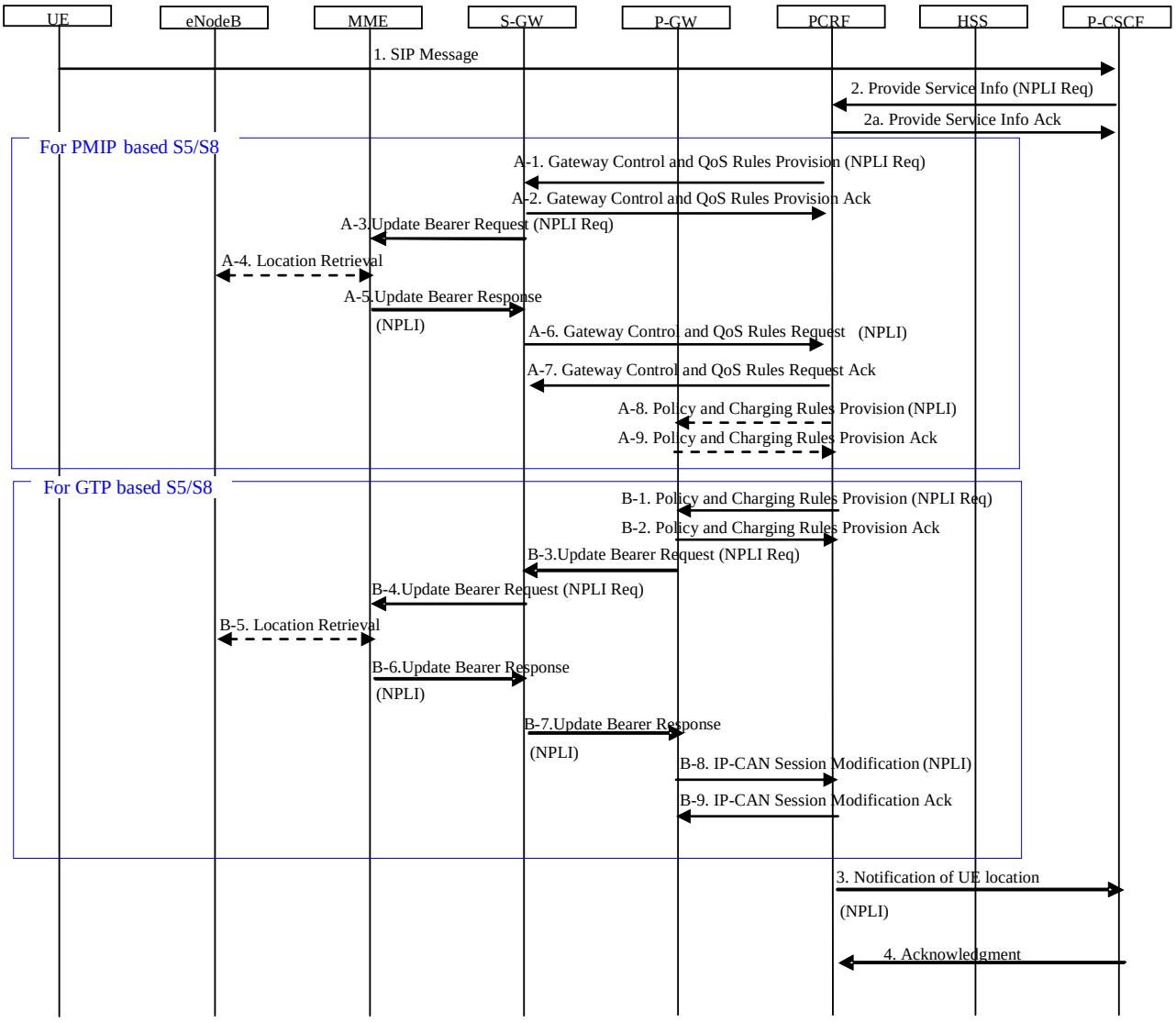

Figure 6.4.4-1: Bearer Independent NPLI fetch by P-CSCF

1. The P-CSCF receives a SIP Message. This procedure is common for MO and MT cases.

Editor's note: The interaction with the IMS procedure needs to be clarified based on the requirement, e.g. whether IMS procedure can continue in parallel with following steps.

2. From its configured operator policies, the P-CSCF determines whether this SIP message requires to obtain NPLI. The P-CSCF provides service information to the PCRF with a NPLI Request indication to request the notification of the NPLI when PCRF obtains it as part of bearer level event. The P-CSCF may subscribe the NPLI change events, according to operator's policy.

   Steps for PMIP-based S5/S8 only (A-1 to A-9):

   PCRF initiates the gateway control and QoS rules provision procedure. PCRF requests the NPLI from S-GW and S-GW forwards the notification to the MME. During this procedure, the NPLI Request indication is sent from PCRF to S-GW and MME, then MME informs the S-GW of the NPLI and it is forwarded to the PCRF. Based on operator configuration, MME may interact with the eNodeB, e.g. via S1-AP messages, to retrieve specific location information such as E-UTRAN CGI where UE is currently connected. Otherwise MME replies with the NPLI stored at MME. Upon receiving NPLI from Delete Bearer Response, the SGW initiates the Gateway Control and QoS rules Request procedure, sending the NPLI to the PCRF. The PCRF initiates the PCC Rules Provision Procedure and provides NPLI to the PCEF if needed.

   Steps for GTP-based S5/S8 only (B-1 to B-9):

   PCRF initiates the policy and charging rules provision procedure requesting the NPLI from P-GW. P-GW initiates bearer modification procedure after receiving step3 only for requesting the NPLI, and P-GW forwards the notification to the MME vis S-GW. During this procedure, MME informs the S-GW of the NPLI and it is forwarded to the P-GW and PCRF. Based on operator configuration, MME may interact with the eNodeB, e.g. via S1-AP messages, to retrieve specific location information such as E-UTRAN CGI where UE is currently connected. Otherwise MME replies with the NPLI stored at MME. Upon receiving NPLI from Create Bearer Response, the PGW initiates the IP-CAN Session Modification procedure, sending the NPLI to the PCRF.

NOTE: In case of PMIP-based S5/S8, the NPLI is not reported.

3. When detecting the bearer level event on location information, PCRF notifies the P-CSCF of the NPLI retrieved in stepA-6 (in case of PMIP-based S5/S8) or step B-8 (in case of GTP-based S5/S8).

4. P-CSCF acknowledges to the PCRF.

5. After receiving the NPLI, the P-CSCF adds the NPLI to the triggering SIP Message and forwards it to the S-CSCF if it is an originating message. For a terminating triggering SIP message the P-CSCF adds the NPLI to the corresponding SIP response message before forwarding the message to the S-CSCF.

6.4.5 NPLI provision during IMS emergency call

For IMS emergency service, either PCC-based procedures (as described in clauses 6.4.1 to 6.4.4) or LRF-based procedures based on LCS (as described in TS 23.167 [3]) can be used for location provision, according to operator policy.

P-CSCF can determine whether to trigger PCC based NPLI retrieval according to local policies. Upon receiving SIP INVITE for IMS emergency call, the P-CSCF queries NPLI from PCRF if there is no NPLI obtained or the NPLI is outdated. Procedures described in clauses 6.4.1 to 6.4.4 are used by PCRF for NPLI retrieval. After retrieving the NPLI, the P-CSCF forwards the SIP INVITE to E-CSCF carrying the NPLI, and the E-CSCF can use this NPLI for PSAP routing. If there is no NPLI provided the E-CSCF uses LRF-based procedure based on LCS (as described in TS 23.167 [3]) for location retrieval.

6.5 Void

6.6 Correlation of IMS and IP-CAN CDRs

6.6.1 General

According to TS 23.228 [7] clause 4.9, IMS and IP-CAN CDRs can be correlated:

"IM CN subsystem functional elements provide support for offline and online charging. This includes support for charging correlation, e.g. between IM CN subsystem and PS domain. The charging architecture, charging principles and charging data for IM CN subsystem are described in TS 32.240 [25] and TS 32.260 [26]. The charging correlation information between IM CN subsystem and PS domain are also described in TS 24.229 [10a] and TS 29.207 [11a]."

The following solutions are based on correlation between IMS and IP-CAN.

6.6.2 IP-CAN records all cell changes

Currently, the IP-CAN has the ability to record every cell change. This capability could be selectively activated for all connections to an IMS APN. This would ensure the serving Cell-ID/CSGID is recorded the entire time the UE is active on packet services associated with IMS. It may then be possible to determine the serving Cell-ID/GSGID during IMS events from correlation between IMS CDRs and IP-CAN CDRs. e.g. IMS CDRs indicate a UE established an IMS session at a certain time, with associated bearer(s) identification. IP-CAN CDRs corresponding to this(these) bearer(s) will have which cell the UE was on at that time, with associated IMS session identification. Through correlation, it is known which cell was serving the UE at the start of the IMS session.

NOTE: Recording every cell change can cause a significant increase in signalling.

Editor's note: IP-CAN recording of every cell change does not directly align with the objective of obtaining the serving Cell-ID/CSGID for the identified IMS events. It is FFS to determine if correlation of the CDRs of the IMS events with the IP-CAN CDRs that contain the serving Cell-ID/CSGID meets the objective.

6.6.3 IP-CAN records serving Cell-ID/CSGID for limited conditions

Having the IP-CAN record every cell change can have a significant signalling impact on the IP-CAN, since every change is requested to be reported to the PGW. Signalling can be optimized if the serving cell is only requested to be reported during IP-CAN events that correspond to IMS events. Some examples are:

- Establishment of IMS default bearer in IP-CAN may correlate with IMS Registration
- Establishment of dedicated bearer may correlate with IMS session establishment
- Release of dedicated bearer may correlate with IMS session end.

Editor's note: It is FFS to determine if all IMS charging events that need Cell-ID/CSGID can be correlated to IP-CAN events.

6.7 Void

6.8 NPLI via GTP-U request for non-Session based IMS

6.8.1 Using GTP S5/S8

For IMS services that are equivalent to GSM/UMTS SMS, it is unlikely that a dedicated bearer will be required. In this case, one proposal to consider is the use of modified GTP Echo Request/Response style user plane GTP packets.

When an IMS 'SMS' is detected, the IMS sub-system could request the PCRF to request the GGSN/P-GW to send a "GTP-U NPLI request" towards the RAN.

For LTE in the home network, this Request should terminate on the eNodeB. Static configuration of the eNodeB could be used to return the eNodeB ID. However, more dynamic interaction is needed if the actual cell ID is needed – however, it is not clear what granularity is required by the authorities. For other cases, e.g. when roaming, the S-GW needs to forward the GTP-U request on to the eNodeB.

In UMTS with direct tunnel, the RNC needs to insert the current NPLI in the response. Without direct tunnel, the SGSN needs to interact with the Iu interface Location Reporting feature.

In 2G, the SGSN responds with the NPLI.

If the UE is in Idle mode, the S-GW/SGSN can use the new GTP-U control packet to trigger paging to retrieve the Cell ID of the UE.

This proposal is not ideal: typically it involves a mix of control and user plane functionalities. However, it may be a relatively simple procedure to use in LTE, and, a lightweight procedure that can be readily extended for other purposes.

6.8.2 Using PMIP based S5/S8

Editor's note: This is FFS.

6.9 NPLI retrieval based on Intelligent Network exchange

This clause describes a mechanism for NPLI retrieval that is possible when the network is using ICS-Mg mechanism. This scenario is applicable for location retrieval in home or roaming network scenarios and does not consider IMS emergency calls.

6.9.1 ICS Mg origination

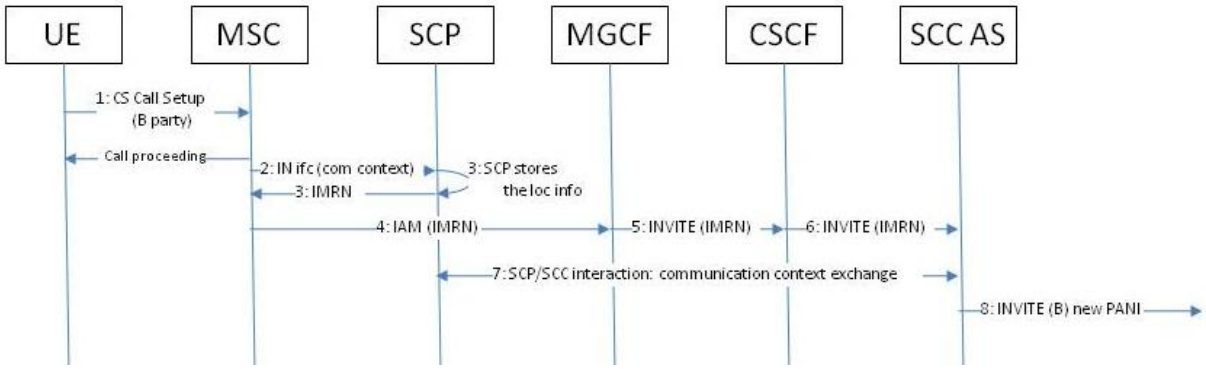

Figure 6.9.1-1: NPLI retrieval based on IN exchange upon ICS Mg origination

1. A UE sends a CS call setup message (as described in TS 23.292 [4], clause 7.3.2.1.3).
2. An IN (e.g. CAMEL) trigger present in the user profile causes the MSC Server to query the IN SCP to fetch an IMRN. NPLI is included in the query.

NOTE: The NPLI in this case consists of mandatory information elements "locationNumber", "locationInformation" and "mscAddress" of the "Initial DP" message, see TS 23.078 [8].

3. The IN SCP stores the NPLI and provides an IMRN.

4-6. The call is routed to SCC AS as specified in TS 23.292 [4], clause 7.3.2.1.3, steps 3 to 5.

7. The SCC AS interacts with the SCP to obtain the NPLI and sends the INVITE to the S-CSCF, containing NPLI in the NW PANI.

6.10 2-phase solution

6.10.1 Overview

The concept of this solution is to use the UE as the primary source of user location (the User Provided Location Information, or UPLI), where that is considered acceptable. NPLI information is also obtained and inserted in IMS messages for distribution to other IMS entities. The NPLI can also be used to verify the UPLI, depending on whether there is a local operator policy to do so.

Existing functionality described in TS 23.228 [7] and TS 24.229 [10] allows for the UE to send location information to the network (in the P-Access-Network-Info) . The information that the UE uses to populate the P-Access-Network-Info (containing e.g. the Cell ID) comes originally from the network. In the vast majority of cases the location information in the UPLI provided by the UE will be correct and valid.

Thus for some scenarios where it is necessary to process location information in the INVITE, this location information could be the UPLI. Using the UPLI in this way has the advantage that there is no impact on the session establishment delay. For scenarios where the location information is not required in the INVITE, the NPLI retrieved (using methods described elsewhere in the TR) is inserted in subsequent IMS messages and is available for any applications that require it. In this case the UPLI can be ignored, or may be included in CDRs, and/or may be stored for data retention purposes.

Therefore the approach is to use the UPLI provided in e.g. the INVITE for functionality that requires user location. In parallel with the handling of the INVITE, the NPLI is retrieved (by the P-CSCF, for example). The NPLI can then be inserted in subsequent IMS messages, e.g. for fraud detection purposes.

Optionally the NPLI can be compared with the UPLI, if it is operator policy to validate the UPLI against the NPLI. Since the UE could be moving from cell to cell there could of course be a difference between the UPLI and the NPLI. When the difference is small, due to the UE moving, the UPLI can still be considered valid. Operator policy will determine the behaviour of the network if the UPLI is considered not to be valid.

Editor's note: The criteria for comparing UPLI and NPLI are for further study.

The method used for retrieving the NPLI can be one of the alternatives described in the other clauses of the TR.

6.10.2 Call flows

6.10.2.1 Originating session establishment

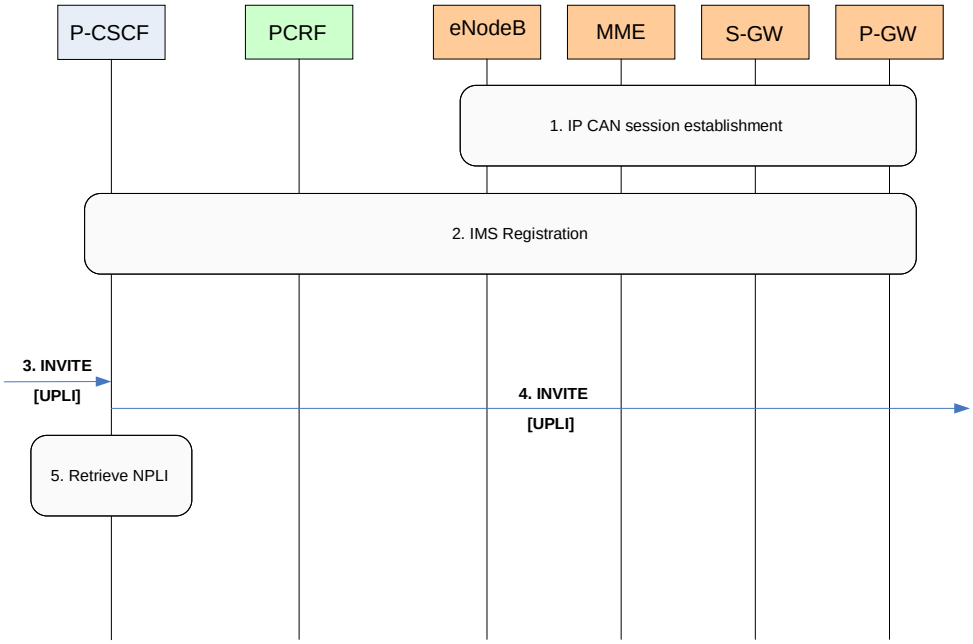

Figure 6.10.2.1-1: Originating session establishment

1. The PDN connection for IMS signalling is established. Depending on which solution is being used for NPLI retrieval the PCRF might request user location information reporting for IMS signalling events.

2. The UE performs IMS registration.

3. The UE initiates IMS session establishment by sending an INVITE towards the P-CSCF. It includes the UPLI (in the P-Access-Network-Info header field).

4. The P-CSCF forwards the INVITE. (Optionally, it will have interacted with the P-CRF to authorize the service information, as per existing procedures.)

5. The P-CSCF retrieves the NPLI, using one of the methods detailed in the other clauses of this TR and can insert the NPLI in subsequent IMS messages.

   - Optionally the NPLI can be compared with the UPLI and operator policy determines whether the UPLI can be considered valid, and what the behaviour should be if the UPLI is considered invalid.

6.10.2.2 Terminating session establishment

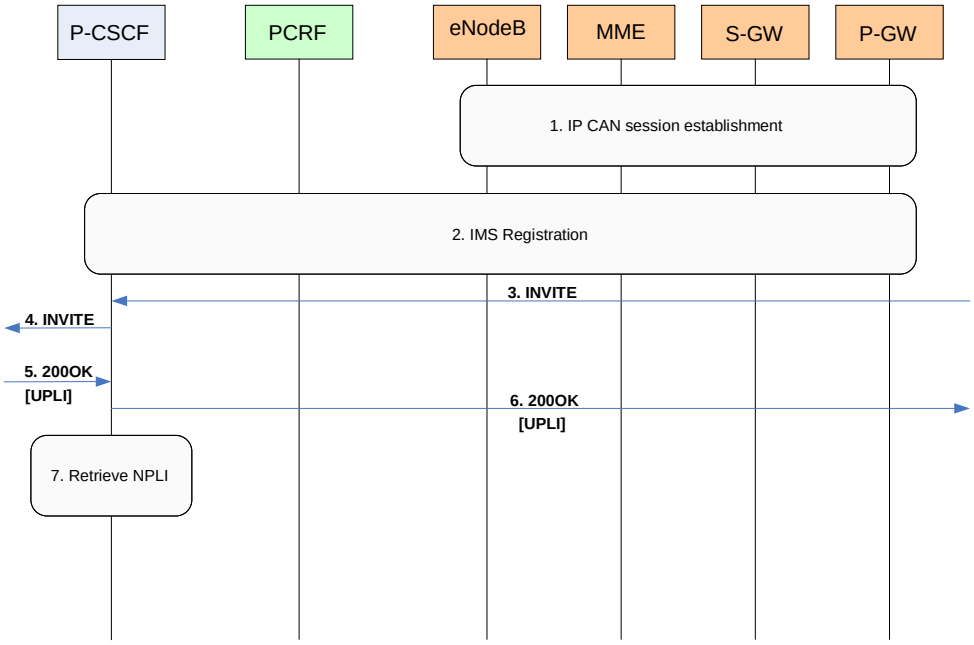

Figure 6.10.2.2-1: Terminating session establishment

1. The PDN connection for IMS signalling is established. Depending on which solution is being used for NPLI retrieval the PCRF might request user location information reporting for IMS signalling events.
2. The UE performs IMS registration.
3. An INVITE is received by the P-CSCF.
4. The P-CSCF forwards the INVITE.
5. The UE responds to the INVITE (e.g. 200OK), including the UPLI).
6. The P-CSCF forwards the 200OK.
7. The P-CSCF retrieves the NPLI, using one of the methods detailed in the other clauses of this TR.

- Optionally the NPLI can be compared with the UPLI and operator policy determines whether the UPLI can be considered valid, and what the behaviour should be if the UPLI is considered invalid.

6A Distribution of location information within the IMS

6A.1 Overview

This architectural alternative describes how location information can be distributed to IMS entities once it has been retrieved.

This architecture alternative assumes that in the general case, one IMS entity, the P-CSCF, MSC Server, MGCF, or AS, is responsible for retrieving location information. It further assumes that for I1- or I2-based ICS, the entity responsible for providing the location information to IMS is the MSC Server.

The exact mechanism for how the location information is obtained is not described in this alternative.

Simplified example call flows are provided. More detail on the existing origination and termination call flows can be found in TS 23.228 [7].

6A.2 Example call flows

The origination and termination call flows below (6A.2.1 to 6A.2.6) also apply in the case of session modification (re-INVITE's).

The session release call flow below (clause 6A.2.7) applies both for the originating and terminating case.

To simplify the call flows the AS shown in the figures can represent several AS's. For example, in the case of the ICS scenarios it can represent the SCC AS and the TAS. The CSCF represents the I-CSCF and/or the S-CSCF.

6A.2.1 Session Establishment/Modification – Mobile origination (1)

This call flow shows a procedure where the retrieval of location information is performed by the P-CSCF and added to the PANI before sending the INVITE towards the terminating side. If location information is required by subsequent IMS entities during their processing of the INVITE (e.g. for routing purposes, announcements for long distance calls, home zone services or location depending LI), this procedure is applied. Otherwise if P-CSCF can ensure that location information is not required for further processing the INVITE, the alternative as described in 6A.2.2 might be used.

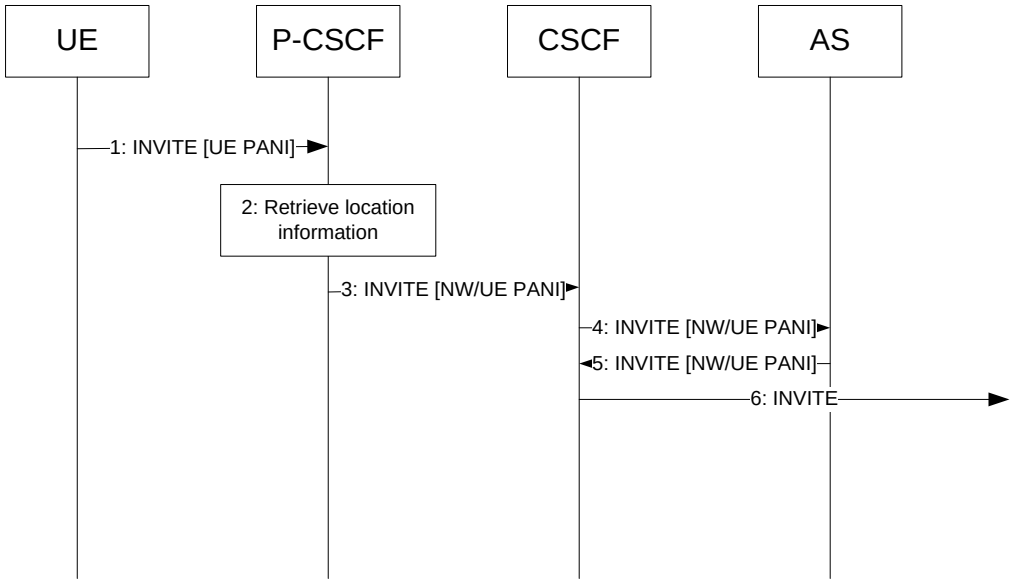

Figure 6A.2.1-1: Mobile origination

1. A UE sends a SIP INVITE request. It can contain a UE-originated P-Access-Network-Info (UE PANI) parameter.

2. The P-CSCF obtains the location information provided by the access network.

3. The P-CSCF populates the PANI parameter with the location information obtained from the access network and sends the INVITE towards the next CSCF, containing the NW PANI together with the UE PANI.

4. If an AS is to be invoked for this session the S-CSCF (or I-CSCF) sends the INVITE towards the AS, containing the NW PANI (assuming the AS is in the same trust domain).

5. The AS sends the INVITE towards the S-CSCF, containing the NW PANI.

6. The S-CSCF routes the INVITE towards the terminating side. The PANI may be removed or modified (e.g. to change location granularity to just indicate the serving PLMN) before routing outside the trust domain.

6A.2.2 Session Establishment/Modification – Mobile origination (2)

This procedure shows an alternative procedure where the retrieval of location information is performed by the P-CSCF and added to the PANI within the Response Confirmation message subsequent to the SDP Offer Response message. This procedure can be applied when subsequent IMS entities do not require NPLI for the processing of the INVITE during session set-up (e.g. for data retention).

Optionally, P-CSCF may initiate the fetching of NPLI already at reception of SDP Offer message in parallel with sending the INVITE towards the terminating side.

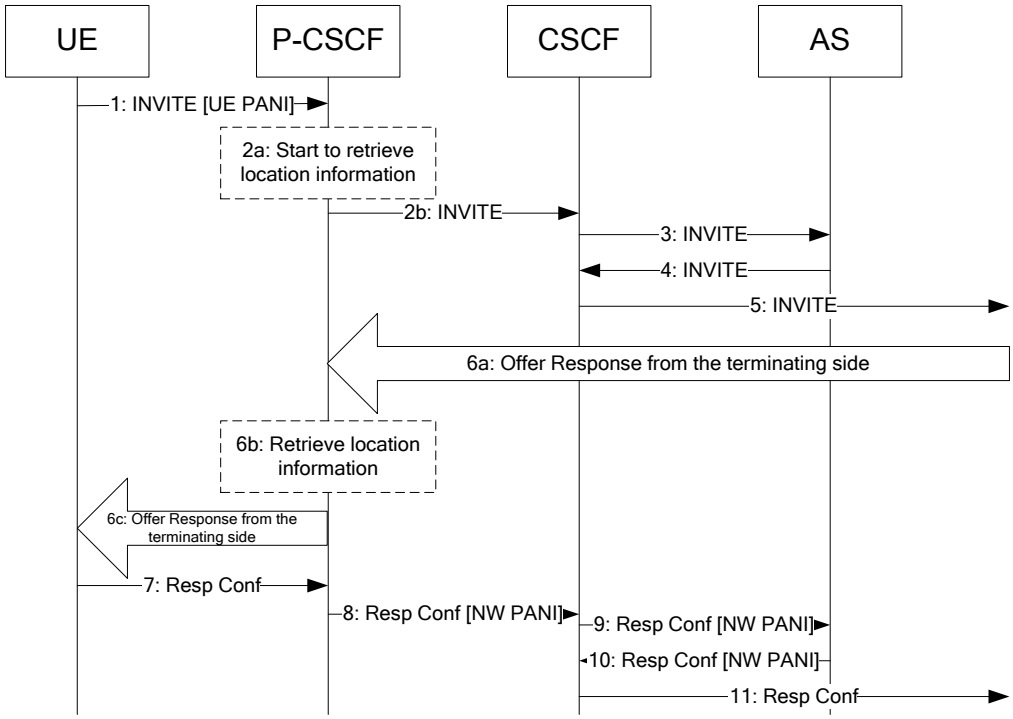

Figure 6A.2.2-1: Mobile origination

1. A UE sends a SIP INVITE request. It can contain a UE-originated P-Access-Network-Info (UE PANI) parameter.

2a. Optionally, the P-CSCF may start procedures to obtain the location information provided by the access network at reception of SDP Offer in parallel with steps 2b to 7.

2b. The P-CSCF sends the INVITE towards the next CSCF.

3. If an AS is to be invoked for this session the S-CSCF (or I-CSCF) sends the INVITE towards the AS.

4. The AS sends the INVITE towards the S-CSCF.

5. The S-CSCF routes the INVITE towards the terminating side.

6a. The P-CSCF receives an offer response sent by the terminating side (via the intervening nodes).

6b. If the P-CSCF did not initiate procedures to obtain the location information provided by the access network at step 2a, it will initiate them now. This step will be executed together with Authorization of QoS resources.

6c. The P-CSCF forwards the offer response to the UE.

7. The UE provides a response confirmation towards the P-CSCF.

8. The P-CSCF inserts the location information in the response confirmation, and this is routed towards the terminating side in steps 9 – 11. The PANI may be removed or modified (e.g. to change location granularity to just indicate the serving PLMN) before routing outside the trust domain.

6A.2.3 Session Establishment/Modification – Mobile termination

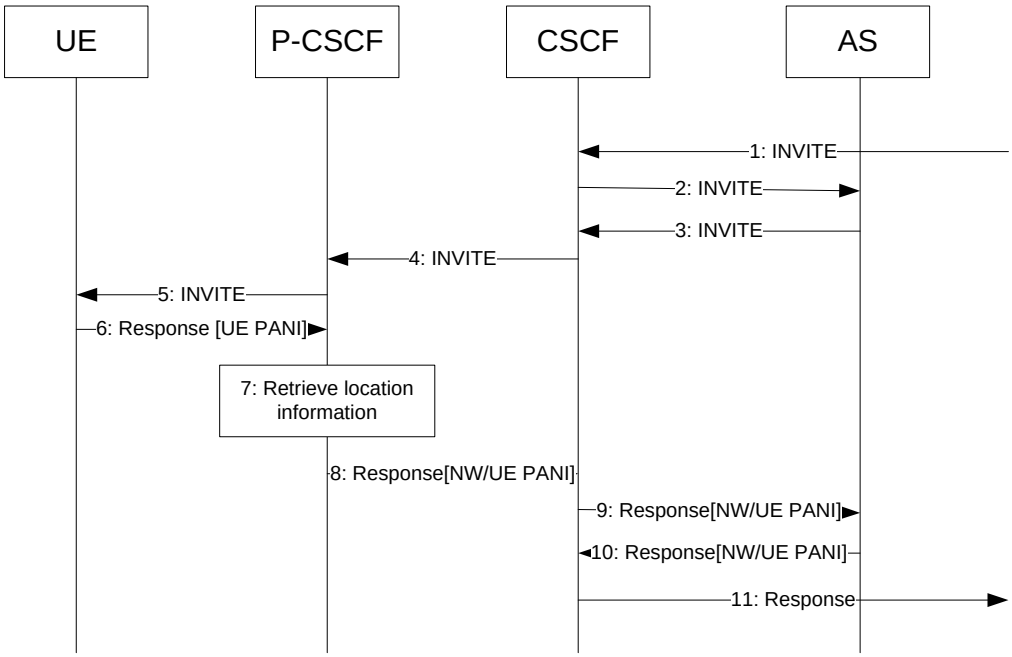

Figure 6A.2.3-1: Mobile termination

1. The CSCF receives an incoming INVITE.
2. Depending on filter criteria, an AS can be invoked.
3. The AS sends the INVITE to the CSCF.
4. The CSCF send the INVITE to the P-CSCF.
5. The P-CSCF sends the INVITE to the UE.
6. The UE sends a response to the INVITE. This can contain a UE-originated P-Access-Network-Info (UE PANI) parameter.
7. The P-CSCF invokes procedures to obtain the location information. This step will be executed together with Authorization of QoS resources. In some scenarios, and with some location retrieval alternatives, it might possible to obtain or at least initiate the fetching of the location already at step 5.
8. The P-CSCF populates the PANI parameter with the location information obtained from the access network and sends the INVITE towards the next CSCF, containing the NW PANI together with the UE PANI. The response is routed towards the originating party, as shown in steps 9, 10 and 11.

6A.2.4 I2 ICS origination

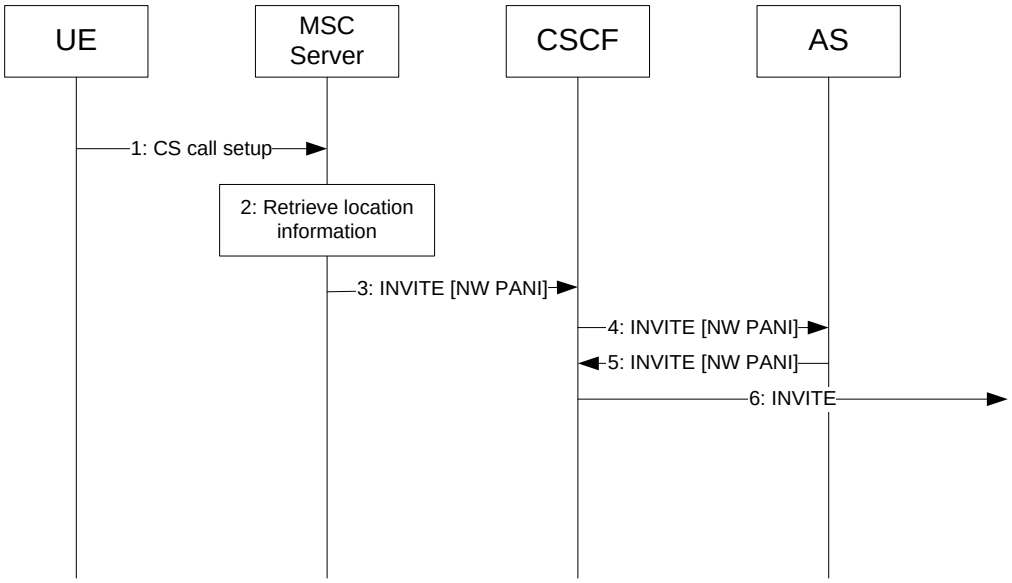

Figure 6A.2.4-1: I2 ICS origination

1. A UE sends a CS call setup message (as described in TS 23.292 [4], clause 7.3.2.1.2).
2. Using existing procedures, the MSC Server obtains the location information.
3. The MSC Server populates the PANI parameter with the location information and sends the INVITE towards the next CSCF, containing the NW PANI.
4. If an AS is to be invoked for this session the S-CSCF (or I-CSCF) sends the INVITE towards the AS, containing the NW PANI (assuming the AS is in the same trust domain).
5. The AS sends the INVITE towards the S-CSCF, containing the NW PANI.
6. The S-CSCF routes the INVITE towards the terminating side. The PANI may be removed or modified (e.g. to change location granularity to just indicate the serving PLMN) before routing outside the trust domain.

6A.2.5 I1 ICS origination

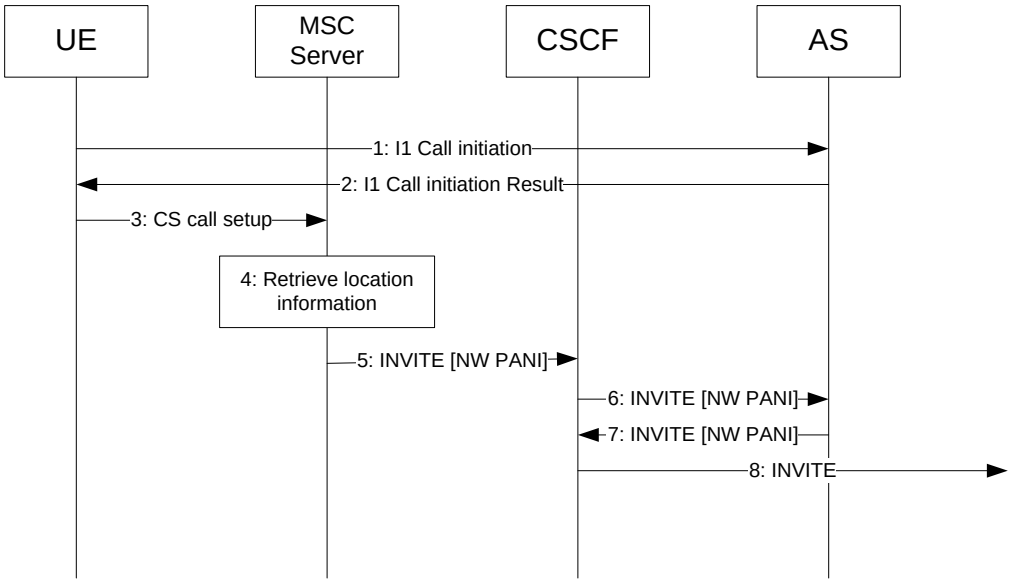

Figure 6A.2.5-1: I1 ICS origination

1. The UE sends an ICS call initiation request via the I2 reference point, as described in TS 23.292 [4], clause 7.3.2.2.2.
2. The SCC AS responds with the I1 call initiation result message.
3. The UE sends a CS call setup message to establish the CS bearer control signalling path.
4. Using existing procedures, the MSC Server obtains the location information.
5. The MSC Server populates the PANI parameter with the location information and sends the INVITE towards the next CSCF, containing the NW PANI. It is assumed here that the MSC Server supports the I2 reference point.
6. If an AS is to be invoked for this session the S-CSCF (or I-CSCF) sends the INVITE towards the AS, containing the NW PANI (assuming the AS is in the same trust domain).
7. The AS sends the INVITE towards the S-CSCF, containing the NW PANI.
8. The S-CSCF routes the INVITE towards the terminating side. The PANI may be removed or modified (e.g. to change location granularity to just indicate the serving PLMN) before routing outside the trust domain.

6A.2.6 ICS Mg origination

The following information flow shows the distribution of location information when the procedure specified in TS 23.292 [4], clause 7.3.2.1.3 "Origination when using an MSC Server" is used.

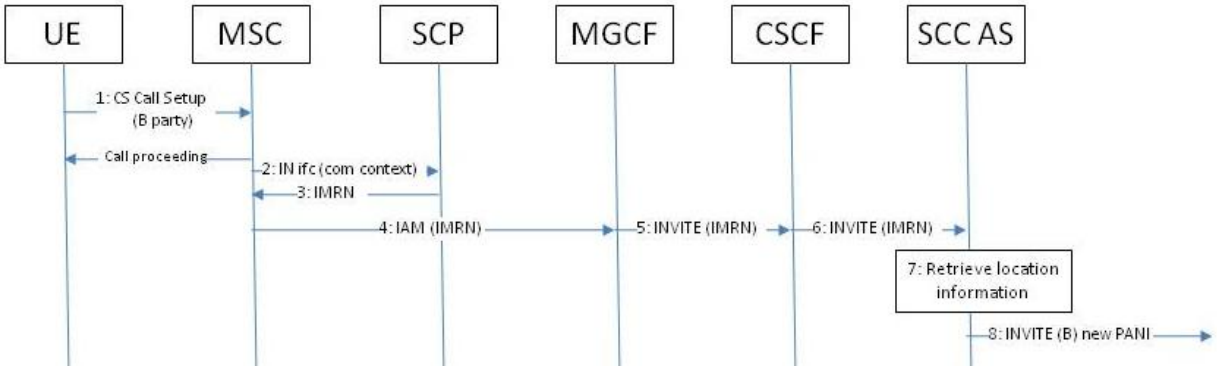

Figure 6A.2.6-1: ICS Mg origination

1. A UE sends a CS call setup message (as described in TS 23.292 [4], clause 7.3.2.1.3).
2. An IN (e.g. CAMEL) trigger present in the user profile causes the MSC Server to query the IN SCP to fetch an IMRN. NPLI is included in the query.
3. The IN SCP stores the NPLI and provides an IMRN.

4-6. The call is routed to SCC AS as specified in TS 23.292 [4], clause 7.3.2.1.3, steps 3 to 5.

7. The SCC AS obtains the location information provided by the access network (interacts with the SCP to obtain the NPLI)
8. The SCC AS sends the INVITE to the S-CSCF, containing NPLI in the NW PANI.

6A.2.7 Session Release

Figure 6A.2.7-1 presents the mobile or network initiated IMS session release for both the Mobile Originating (MO) side and the Mobile Terminating (MT) side. The session release may be signalled by a SIP BYE message, or any SIP 3xx redirect response, or any 4xx, 5xx, or 6xx SIP final error response to an initial INVITE request. If any 4xx, 5xx, or 6xx SIP final error response to Re-INVITE or UPDATE request just terminates the transaction, then the session is not released, otherwise if the error response terminates the dialog then the session is released.

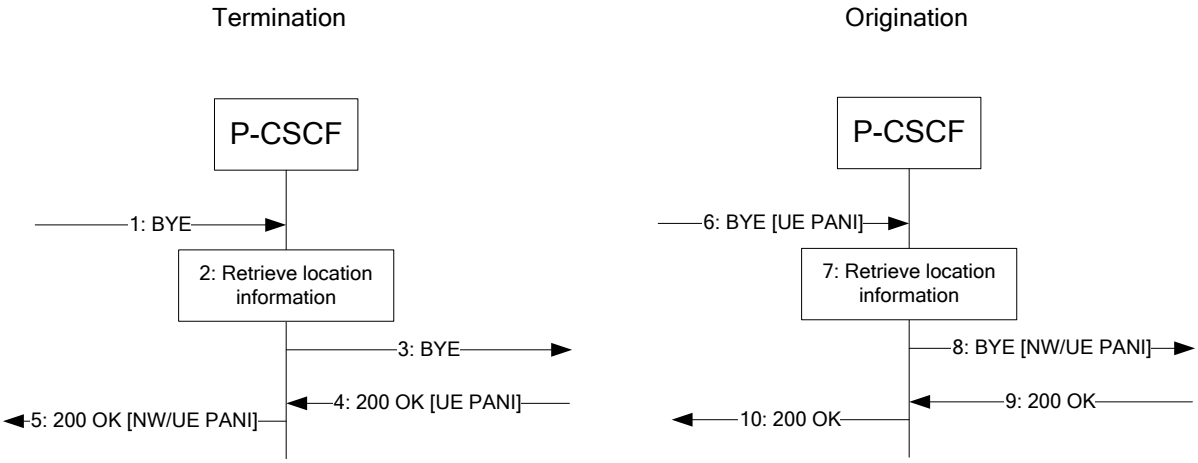

Figure 6A.2.7-1: IMS Session Release

Terminating Side

1. A SIP BYE message, a SIP 3xx redirect response, or any 4xx, 5xx, or 6xx SIP final error response to an initial INVITE or any 4xx, 5xx, or 6xx SIP final error response to Re-INVITE or UPDATE which terminates the dialog is received by the P-CSCF.

2. The P-CSCF invokes procedures to obtain the location information. This step will be executed together with the procedure to release corresponding QoS resources in the IP-CAN.

3. The P-CSCF forwards the BYE message, or the SIP 3xx redirect response, or any 4xx, 5xx, or 6xx SIP final error response to the UE.

4. The UE provides a response to the P-CSCF.

5. The P-CSCF inserts the location information in the response confirmation, and this is routed towards IMS Core.

Originating Side

6. A SIP BYE message, a SIP 3xx redirect response, or any 4xx, 5xx, or 6xx SIP final error response to an initial INVITE or any 4xx, 5xx, or 6xx SIP final error response to Re-INVITE or UPDATE which terminates the dialog is received by the P-CSCF from the UE originating the session release procedure.

7. The P-CSCF invokes procedures to obtain the location information. This step will be executed together with the procedure to release corresponding QoS resources in the IP-CAN.

8. The P-CSCF forwards the BYE message, or the SIP 3xx redirect response, or any 4xx, 5xx, or 6xx SIP final error response within IMS Core containing the NW PANI together with the UE PANI. PANI may be removed or modified (e.g. to change location granularity to just indicate the serving PLMN) if routing outside the trust domain is needed.

9-10. The Session Release procedure is completed.

6A.2.8 NPLI Distribution using HSS based approach

This section shows an alternative procedure where the retrieval of location information is performed by an AS so NPLI can be distributed to the S-CSCF. This procedure can be applied when AS and/or S-CSCF require NPLI for the processing of the INVITE during session set-up (e.g. for Special Call Routing for Localized Services).

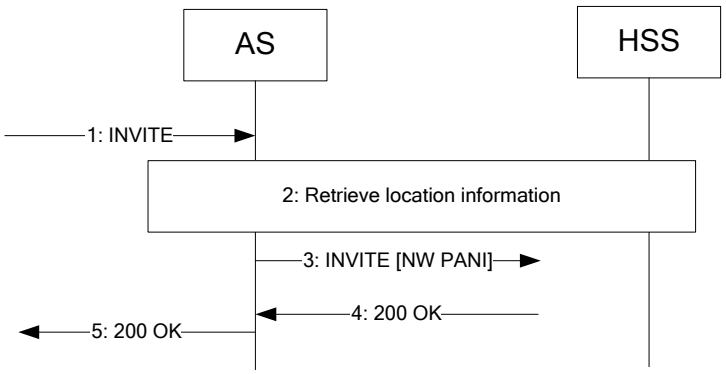

Figure 6A.2.8-1: NPLI Distribution using HSS based Approach

1. A SIP INVITE request is received bv an AS.

2. The AS retrieves location information from HSS.

3. The AS populates the PANI parameter with the location information obtained from the HSS and sends the INVITE towards the next CSCF, containing the NW PANI.

NOTE: The S-CSCF may further distribute NW PANI to other ASs within the trust domain. The S-CSCF shall not distribute the NW PANI to the P-CSCF.

4-5. The Session Release procedure is completed.

6A.2.9 I2 ICS termination

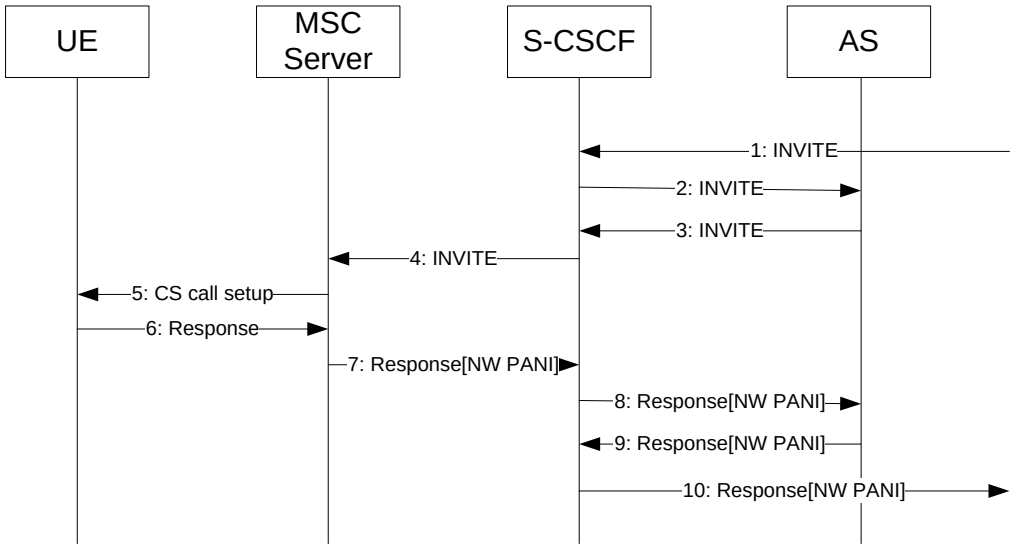

Figure 6A.2.9-1: I2 ICS termination

1. The S-CSCF receives an incoming INVITE.

2-3. Application Server(s) (including SCC AS) are invoked based on filter criteria.

4. The S-CSCF send the INVITE to the MSC Server.

5-6. The MSC Server performs the CS call setup with the UE and obtains the location information while doing this.

7. The MSC Server populates the PANI parameter with the location information and sends the response towards the S-CSCF, containing the NW PANI.

8-10. The response is routed towards the originating party.

6A.2.10 ICS Mg termination

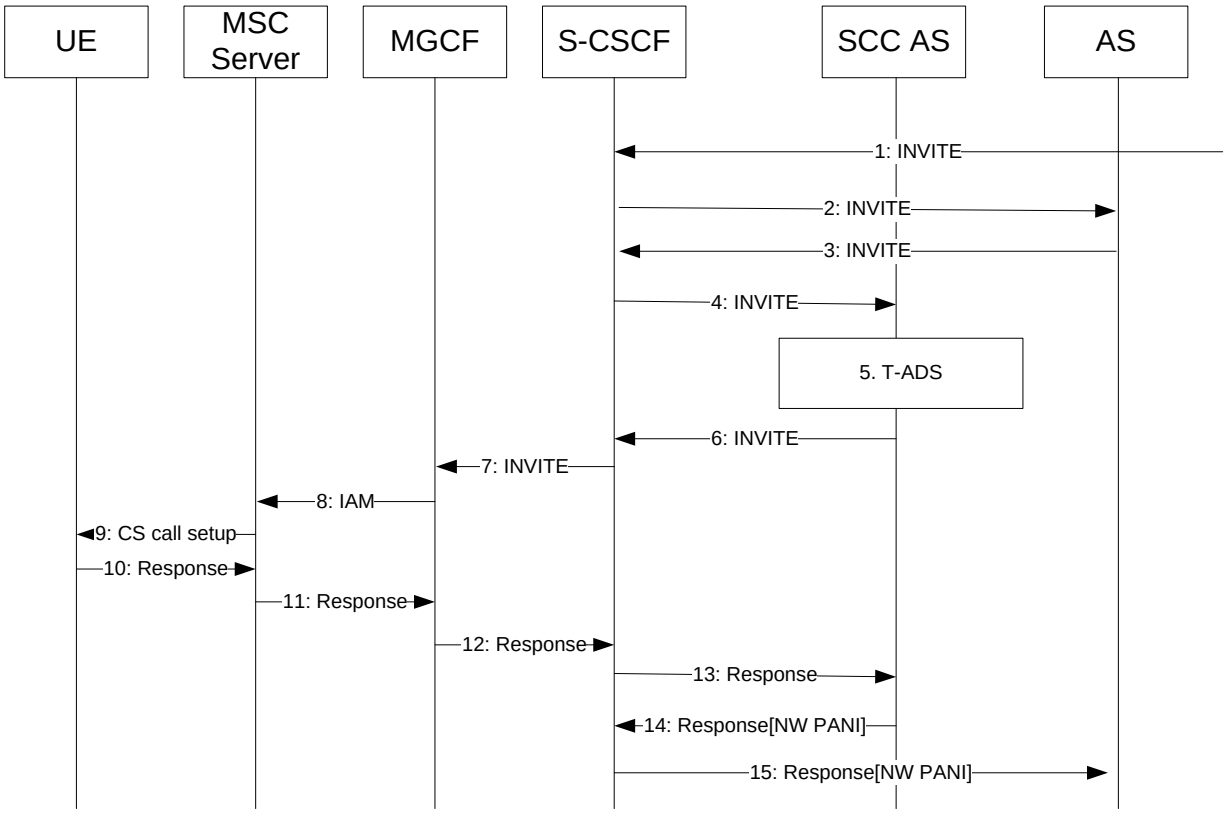

Figure 6A.2.10-1: ICS Mg termination

1. The S-CSCF receives an incoming INVITE.

2-4. Application Server(s) (including SCC AS) are invoked based on filter criteria.

5. The T-ADS function of the SCC AS chooses breakout to the CS domain. A CSRN is fetched for routing to the CS domain.

NOTE: At this point, the SCC AS can, as an implementation option, interact with the HLR/HSS to obtain location information, e.g. MSRN.

6. The SCC AS establishes a new session by sending an INVITE containing the CSRN towards the S-CSCF.

7. The S-CSCF then performs CS breakout according to existing IMS procedures. The call is routed to the CS domain via the BGCF/MGCF.

8. The MGCF sends an IAM to the MSC Server using existing procedures.

9-10. The MSC Server performs the CS call setup with the UE.

11. The MSC Server sends the response to the MGCF.

12. The MGCF sends the response towards the S-CSCF.

13. The response is routed to the SCC AS.

14. If the SCC AS has NPLI available (e.g. from step 5, or by interacting with the HLR/HSS at this time), it populates the network PANI. The SCC AS forwards the response to S-CSCF.

15. The response is routed towards the originating party.

6A.3 Generation of the Geographical Identifier

A network which requires the GI to be generated in the IMS may implement the mapping table between CGI/CSGID and GI in the LRF.

When the GI is not provided by the access network, the E-CSCF or S-CSCF may, based on operator policy, query the LRF to obtain the mapping from CGI or CSGID to GI, and insert the GI SIP signalling before forwarding it to other IMS nodes.

7 Conclusions

7.1 Alternatives evaluation criteria and scoring

The following table provides a summary of the solutions currently described in the TR and their characteristics when measured against compliance to the requirements as well as impact on the system.

Table 7.1-1

		LCS-based	PCC-based	
	HSS based retrieval	**LCS based NPLI provision from MME to GMLC**	**PCC-based**	**Enhanced PS domain location reporting**
TR clause	**6.1**	**6.3**	**6.4**	**6.2**
Description	The IMS AS uses Sh-pull towards the HSS to obtain the NPLI. This is an existing procedure.	The P-CSCF contacts the GLMC in order to obtain the Cell-ID from the MME. This is existing functionality except that there is an indication that the request is for Cell-ID information only. This indication could be implicit (e.g. derived from the requestor identity and the QoS) The solution relies on the PCC-based approach except for the PSAP selection (ECSCF queries the LRF, that may interact with a separate GMLC or contain an integrated GMLC) and session establishment (SCSCF queries the GMLC).	P-CSCF obtains location information by using the PCRF, and associated PCC signalling. The PCRF obtains location information from the PS domain (S-GW/MME). For session based services the location information is carried from the eNodeB to the P-GW (GTP) or to the S-GW (PMIP) in the Create Bearer Response. (in 6.4 it is assumed that the location has been reported by the eNodeB to the P-GW already). I.e. the location is first available when session setup is signalled. For other services (e.g. messaging) the PGW (GTP) or the S-GW (PMIP) needs to request the location from MME/eNB when asked by the PCRF.	P-CSCF obtains location information by using the PCRF, and associated PCC signalling. The PCRF obtains location information from the PS domain (S-GW/MME). The eNB will always reports the ECGI or CSGID when the signalling bearer transfers data and the location changed compared to the last reported location. Signalling is either via S1 to MME or via GTP to PGW. MME decides to send them on to the PGW, basically to filter repeated reporting that might happen due to RAB release/establsihment. (See 23.401 clause 5.9.2.) The P-GW doesn't report the location to the PCRF, to save signalling and to align runtime between IMS signalling on UP and location signalling on control plane..
Impacts on PS domain	None	SLg reference point and MME updated	A standalone location retrieval in PS domain is also needed for services without media and probably for session based services that fail.	Detection of signalling bearer activity. In the GTP-U alternatives the P-GW or S-GW are impacted, and GTP-U is modified.
Impacts on IMS	Insertion of PANI by (all) Application Servers	P-CSCF, S-CSCF, E-CSCF need to populate the PANI with information received from LRF or GMLC. There are impacts on the MI ref point	NOTE 1	None

		LCS-based	PCC-based	
	HSS based retrieval	**LCS based NPLI provision from MME to GMLC**	**PCC-based**	**Enhanced PS domain location reporting**
TR clause	**6.1**	**6.3**	**6.4**	**6.2**
		(between S/E-CSCF and LRF).		
Impacts on the UE	None	None	None	None
Other impacts	None	GMLC updated	Rx and PCRF updated	Rx and PCRF updated
Additional signalling	new MAP/Diameter signalling Sh-pull procedure	new MAP/Diameter signalling Query over MI from the P-CSCF	Possible additional signalling for location based service/routing and for call attempt records.	None
Support for PSAP selection	Support only guaranteed in Home network (cannot be assumed that any roaming partner delivers detailed location/cell information to other networks. Whether the PSAP selection works for unauthenticated UEs is FFS	Allows the E-CSCF to have the location information before PSAP routing is performed.	Yes, assuming P-CSCF will wait for location response before forwarding INVITE.	Yes, assuming P-CSCF will wait for location response before forwarding INVITE.
Support of location information delivery to the PSAP	Whether NPLI delivery to PSAP works for unauthenticated UEs is FFS	Yes. The PSAP can retrieve location information by querying the GMLC.	Yes for a SIP-based PSAP. Otherwise a GLMC-based solution needs to be used in parallel.	Yes for a SIP-based PSAP. Otherwise a GLMC-based solution needs to be used in parallel.
LI support	Requires use of PANI in SIP messages (clause 6A)	Requires use of PANI in SIP messages (clause 6A)	Requires use of PANI in SIP messages (clause 6A)	Requires use of PANI in SIP messages (clause 6A)
Charging support	Requires use of PANI in SIP messages (clause 6A)	Requires use of PANI in SIP messages (clause 6A)	Requires use of PANI in SIP messages (clause 6A)	Requires use of PANI in SIP messages (clause 6A)
Roaming scenario support	Home network support only guaranteed as it may not be assumed that any roaming partner delivers detailed location/cell info to every other network	Yes (IBCF update needed to allow PANI to be sent). (But what if the P-CSCF is in the HPLMN?)	Yes (IBCF update needed to allow PANI to be sent)	Yes (IBCF update needed to allow PANI to be sent)
SMSoIP support	Yes	Yes	Yes. Need new request for non-session signalling.	Yes
Impacts on session establishment performance	Arrival of INVITE triggers request from AS -> HSS -> MME, and then paging via the eNB (for termination). Could be part of T-ADS interaction.	Arrival of INVITE triggers request from P-CSCF -> LRF -> GMLC -> MME. The GMLC must also query the HSS to find the correct MME.	Arrival of INVITE triggers request from P-CSCF -> PCRF -> P-GW -> S-GW -> MME (normal dedicated bearer activation signalling) for GTP. Arrival of INVITE triggers request from P-CSCF -> PCRF -> S-GW -> MME (normal dedicated bearer activation signalling) for PMIP. The location is provided by the MME, but might involve interaction with the eNB.	Arrival of INVITE triggers request from P-CSCF -> PCRF -> P-GW for GTP Arrival of INVITE triggers request from P-CSCF -> PCRF -> S-GW for PMIP

		LCS-based	PCC-based	
	HSS based retrieval	**LCS based NPLI provision from MME to GMLC**	**PCC-based**	**Enhanced PS domain location reporting**
TR clause	**6.1**	**6.3**	**6.4**	**6.2**
Support for ICS	Location provided by MSC to the HSS	MSC provides location	MSC provides location	MSC provides location
Impacts on session establishment time				
Issues	Terminating call issues (pre-paging results in slower session set up) Difficulty to meet regulatory requirements as well as to create records in VPLMN since the P-CSCF does not get location information.	Support of localized services for the terminating session case is FFS.	Can session establishment continue in parallel with Rx signalling? Probably not, if special routing decisions need to be made. P-CSCF cannot know which IMS message is last, especially when service setup fails. The P-CSCF may need to always retrieve NPLI when the first IMS message for a service arrives. In the terminating session case, location information is only for the first SIP response, and not when the INVITE arrives at the P-CSCF. Not possible to retrieve the NPLI for call attempt CDRs (required for LI or data retention)	Need to select between GTP signalling or GTP-U alternatives. In the terminating session case, location information is only for the first SIP response, and not when the INVITE arrives at the P-CSCF. Continuous NPLI update signalling towards P-GW (GTP) or S-GW (PMIP) when there is activity on IMS signalling bearers and when location changed. This issue is less severe when user plane solution is used to determine cell changes
Main advantages	May benefit from optimised TADS procedures Can retrieve the NPLI prior the IMS service processing Works also when no bearer is set up (e.g. call attempts) NPLI available with first INVITE. Lowest number of total messages because of lowest number of nodes involved.	Works also when no bearer is set up (e.g. call attempts) NPLI available with first INVITE.	For successful session establishment no additional PS signalling whwn acceptable to have NPLI available later in service signalling flow In case of connecting to/from external ISUP-based networks, no additional PS signalling. Can provide new NPLI when session is modified for successful sessions.	Minimal delay: NPLI available at P-GW (GTP) or S-GW (PMIP) for PCC at the same theme when the P-CSCF requests it works also when no bearer is set up (e.g. call attempts) Continuous update at PLMN, RAT, time zone change
MO side NPLI based service/routing (AS needs NPLI)	HSS based retrieval by AS, roaming case assumed to get adequate location granularity	P-CSCF queries GMLC. Roaming expected to get adequate location granularity.	For this NPLI may be already needed with the INVITE using the "bearer independent NPLI fetch" as it cannot wait for bearer establishment. A differentiator is needed for the P-CSCF as it is may be needed only for some of the UEs. If used for all UEs the bearer dependent fetch may become obsolete.	P-CSCF fetches NPLI for every INVITE, roaming case assumed to get adequate location granularity
MT side NPLI based	AS requested HSS	AS to query LRF. LCS	AS requested HSS	AS requested HSS

		LCS-based	PCC-based	
	HSS based retrieval	**LCS based NPLI provision from MME to GMLC**	**PCC-based**	**Enhanced PS domain location reporting**
TR clause	**6.1**	**6.3**	**6.4**	**6.2**
service/routing (AS needs NPLI)	based retrieval with paging, roaming case assumed to get adequate location granularity	active location retrieval with paging. roaming expected to get adequate location granularity	based retrieval with paging may be used, roaming case assumed to get adequate location granularity	based retrieval with paging may be used, roaming case assumed to get adequate location granularity
MO side Successful media/bearer addition/modification	S-CSCF retrieves when there is modification/addition. No solution for P-CSCF described.	P-CSCF queries GMLC for NPLI and transfers with INVITE to S-CSCF	After bearer activation/modification P-CSCF transfers NPLI with UPDATE to S-CSCF	P-CSCF fetches NPLI for every INVITE and provides NPLI with it to S-CSCF
MT side Successful media/bearer addition/modification	S-CSCF retrieves when there is modification/addition. No solution for P-CSCF described.	P-CSCF queries GMLC for NPLI and transfers with 183 Session Progress to S-CSCF	After bearer activation/modification P-CSCF transfers NPLI with the next SIP message to S-CSCF	P-CSCF fetches NPLI for every INVITE and provides NPLI with next SIP message to S-CSCF
Bearer independent location, service release/termination and media/bearer release/termination	S-CSCF retrieves when there is modification/addition. No solution for P-CSCF described.	P-CSCF needs to identify every SIP message that requires sending NPLI to S-SCSF. If that specific message is in direction towards S-SCSF then the P-CSCF delays it until NPLI is received. If that specific message is towards UE the P-CSCF adds the NPLI to the related response message. The P-CSCF always retrieves the NPLI from PCEF.	P-CSCF needs to identify every SIP message that requires sending NPLI to S-SCSF. If that specific message is in direction towards S-SCSF then the P-CSCF delays it until NPLI is received. If that specific message is towards UE the P-CSCF adds the NPLI to the related response message. If the release/termination includes bearer release/termination the P-CSCF gets the NPLI during bearer handling, otherwise the P-CSCF retrieves it from PCEF.	P-CSCF needs to identify every SIP message that requires sending NPLI to S-SCSF. If that specific message is in direction towards S-SCSF then the P-CSCF delays it until NPLI is received. If that specific message is towards UE the P-CSCF adds the NPLI to the related response message. The P-CSCF always retrieves the NPLI from PCEF.

NOTE: How will failed service setup be handled if the location comes not with INVITE but first with the SDP? If the service is rejected there is no further signalling to S-CSCF. For location based services on MO side first SDP and then decide on service delivery/routing?! Or always early media setup?

7.2 Specification work recommendation

The following aspects are proposed to be specified:

- Support a PCC-based solution as defined in clause 6.4 (procedure invoked by the P-CSCF) to obtain the NPLI. Policies in the P-CSCF determine whether the NPLI needs to be retrieved for a particular scenario (of clause 6.4).
  - The P-CSCF policy for retrieving the NPLI can be specific per HPLMN.
  - In the originating case, P-CSCF policy is needed for whether to provide the NPLI in the INVITE request or within a subsequent message of the dialog.
- When a MSC Server enhanced for ICS is used, the solution as defined in clauses 6A.2.4 and 6A.2.9 shall be used.

- HSS based retrieval according to TS 29.328 [5] can be used when NPLI is required but not already available (e.g. when required in an INVITE request, when it is needed prior to session delivery, or when call is broken out to a MGCF).
    - The level of NPLI granularity that can be retrieved by the AS via the HSS-based procedures in roaming scenarios depends on inter-operator agreement, and needs to be aligned with policies in the P-CSCF.
- Enhancement of the Network Provided P-Access-Network-info header to include NPLI (including the optional local time) and to be distributed according to the guidance in clause 6A.
    - Transfer of NPLI by IMS signalling shall not affect the transfer of any UPLI.
    - The level of granularity of NPLI may be changed at network/trust boundaries.
- For emergency sessions where network provided location is required, either existing LRF-based procedures based on LCS according to TS 23.167 [3] are used, or the PCC-based solution as defined in clause 6.4 is used to provide NPLI with the INVITE to the E-CSCF for usage according to TS 23.167 [3]. Local policies in the P-CSCF determine whether to provide the NPLI using the PCC-based procedures for an INVITE for an emergency session. Use of LRF-based procedures is based on the policies of the E-CSCF according to TS 23.167 [3].
- Regarding to the GI, clause 5.3 should be referred to.

Annex A:
Analysis on the Operator Dependent Location Information

A.1 General

In the current CDR in CS, it can contain location information other than the NPLI such as Location Area Code (LAC) and Service Area Identifier (SAI), Especially, the SAI is the service specific information that operator can define.

- **SAI = PLMN-Id || LAC || SAC**

The SAC is defined by the operator, and set in the RNC via O&M.

To maintain the same level of service operation in IMS, the operator dependent location information may be required at IMS.

NOTE: This means the "transportation" of such information is needed but does not need to "specify" the coding detail of the operator dependent location information.

A.2 Use Cases

Followings are the use cases of operator dependent location information.

Use Case1: Exchange between operators as part of the charging information

- TTC (Telecommunication Technology Committee) in Japan, regionally defines the area code information (i.e., Charging Area Code: CA code) for charging purpose. Such information is exchanged between operators. Operator dependent location information provided to IMS can be used to derive CA code at IMS.

Use Case2: Robust and efficient PSAP selection

- In Japan, the number of the fire departments (i.e. PSAP), to which the call requesting the help is routed, are more than 2000. The operator shall determine the PSAP based on the location information of the call originating UE. Operator dependent location information provided to IMS can be used to resolve the PSAP at IMS.

A.3 Analysis

In this clause, the benefit of the operator dependent location information in addition to the NPLI is explained.

1. Do not violate the IMS design principle "IP-CAN agnostic".

   The above mentioned information, e.g. CA code, is considered as Service Specific Information (SSI) and technically it is possible to derive such from the Cell-ID. However the IMS is designed to be "IP-CAN agnostic" in principle. If we require the IMS to have the "Cell-ID to Service Specific Information mapping" database, it means the IMS has to be aware of the radio dependent location information. Cell-ID information could be about both UTRAN and E-UTRAN cells and in fact, the number of those information are pretty large.

   If we use radio independent location information, hereafter we call it "Geographical Identifier (GI)", which is configured by the operator and provided to the IMS by the NetLoc solution, for the retrieval of the service specific information, such as CA code, can be IP-CAN agnostic and keep the basic IMS principle unchanged (IMS just maintain "GI to SSI mapping" database).

2. Do not need to update data base at IMS when RAN configuration changes.

   Figure A.3-1 illustrates the cases where Cell-ID and GI are used for as key-parameters in IMS configuration data.

If the IMS configuration data uses the Cell-ID for key to derive SSI, the data base has to be updated when RAN configuration data have been changed, e.g. in case of Cell-ID has been re-numbered and/or its geographical location has been changed.

If the IMS configuration data uses the GI for the key-parameters to derive SSI, the data base does not affected by the RAN configuration data update as RAN always forward "GI" to the IMS by a NetLoc solution.

This makes IMS configuration data be independent from the RAN configuration update and the network operation can be simplified.

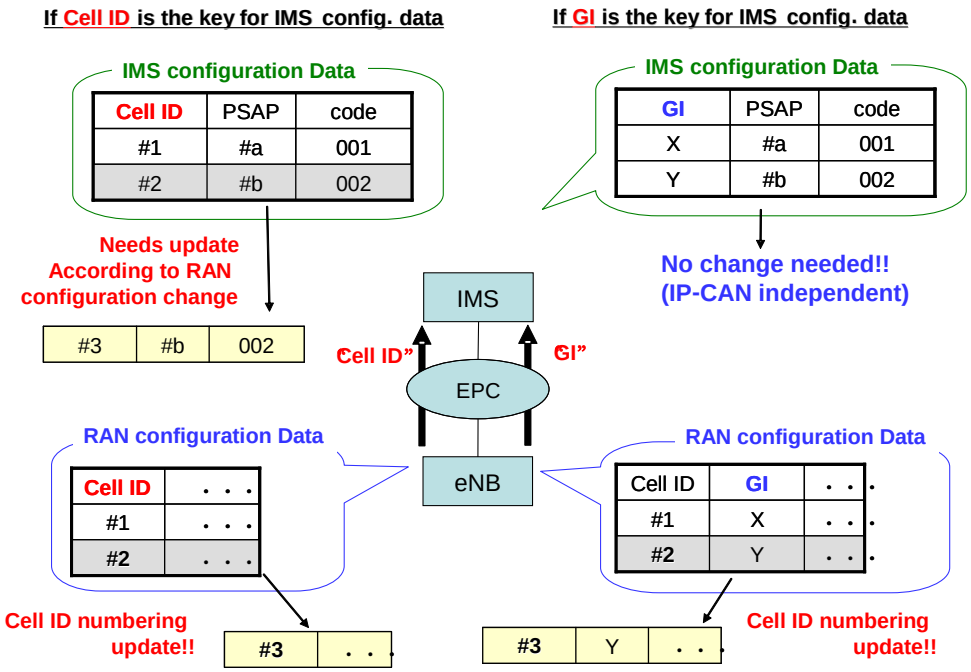

Figure A.3-1 Relationship between RAN and IMS configuration Data

3. Cell ID does not have sufficient bit space to be used for service specific identity other than Cell-ID itself.

   The Cell ID length is 28bit as specified in TS36.331 and for macro cell, 8bit is used to identify the cell/sector within an eNodeB and 20 bit is used for eNodeB identification.

   If NetLoc tries to use some parts of Cell-ID bit string to directly derive the SSI, it shall be done within 20bit. As discussed in previous clause A.2, to be selected PSAP in Japan is more than 2000 and that requires 11bit. It is not realistic to use 11bit as 9bit only means 512 in decimal and cannot far meet the above mentioned operator requirement.

Editors note: Application of Time Zone and/or Time related information is FFS.

Editor's note: It is expected in Japan the size of the GI would be around 14 bits in binary format and in France some more bits might be needed. The size of the GI is decided depending on the regional needs.

Conclusion

With above analysis, it is concluded that IMS shall be able to obtain the operator dependent location information which is independent from the RAN configuration parameters. Therefore, NetLoc will allow the EPC to carry such information by the transparent container, yet the actual coding of the operator dependent location information is not necessary to be specified by 3GPP.

Annex B:
Change history

Change history							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2011-08	SP-53	SP-100478	-	-	MCC Editorial update to version 1.0.0 for presentation to TSG SA for Information	0.6.0	1.0.0
2011-12	SP-54	SP-100755	-	-	MCC Editorial update to version 2.0.0 for presentation to TSG SA for Approval	1.2.0	2.0.0
2011-12	SP-54	-	-	-	MCC Update to version 11.0.0 after TSG SA approval	2.0.0	11.0.0