**3GPP TSG-CT WG1 Meeting #138-eC1-225558**

**E-Meeting, 10th – 14th October 2022**

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **23.122** | **CR** | **971** | **rev** | **1** | **Current version:** | **18.0.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network | **x** |

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| ***Title:*** | CP-SOR enhancement - extension of the SOR acknowledgement | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | NTT DOCOMO, Vodafone | | | | | | | | | |
| ***Source to TSG:*** | CT1 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | 5GProtoc18 | | | | |  | ***Date:*** | | | 2022-10-11 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | It is beneficial for the operator to make more use of the SOR ACK received from the UE by enhancing and extending the SOR ACK to carry new information from the UE towards the HPLMN UDM. This can be useful for the operator to collect statistics and for feeding and optimising the SOR algorithm. At the same time it can be useful for the user, mainly to reduce unnecessary processing and battery consumption, by receiving consecutive SOR requests resulting in no change for the UE's PLMN.  Upon sending a request to perform SOR to the UE, the HPLMN will not know why the UE has not moved immediately and may send a new SOR trigger to the UE.  Few examples on the benefits/impacts:  - If the UE is in Manual mode, the following SOR triggers will not help and would only increase the UE processing that consumes battery. On the other hand, the HPLMN may in this case select another user to perform SOR to gets the right number of users in a vPLMN. The HPLMN shall not request a UE in manual mode to perform SOR unless after a predefined time has expired, as part of the SOR algorithm.  - In case of emergency service, the HPLMN expects the UE to move to a higher priority PLMN upon the emergency PDU session is released.  - If the UE has triggered SOR-CMCI, then the HPLMN may estimate when the UE will leave depending on the timers sent in the SOR-CMCI. The HPLMN, depending on the it quota per PLMN in a country, select another UE and set timers shorter to ensure reaching the right number in that vPLMN in the estimated time.  - Also if the UE has and active voice session, and depending on the user profile (ex.Gold user) it may send another SOR-CMCI for example by setting voice session timer to infinity, and may not send the UE a SOR-CMCI indicating immediate leave of the vPLMN.  There are different ways that the HPLMN and the SOR algorithm can use this information. | | | | | | | | |
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| ***Summary of change:*** | | Introducing Steering of Roaming acknowledgement information; new SOR information carried in the SOR container of the acknowlegment.  UE support of sending SOR-ACK-information is mandatory for Rel-18.  HPLMN support for requesting the SOR-ACK-information is optional. | | | | | | | | |
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| ***Consequences if not approved:*** | | The HPLMN may resend SOR to the UE requesting it again to perform SOR, where the UE is not able to do so. This consumes UE battery and also does not allow the HPLMN to reach its quota per PLMN easily.  In addition, the HPLMN operator may ensure that a voice session is not interrupted early to perform SOR, for all or specific users. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 1.2, C.1.1, C.1.2, C.2, C.3, C.4.3, C.5, C.6, C.7, C.8 | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **x** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **x** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

## 1.2 Definitions and abbreviations

For the purposes of the present document, the abbreviations defined in 3GPP TR 21.905 [36] apply.

**(A/Gb mode only):** Indicates this clause applies only to a GSM system which operates in A/Gb mode. For multi system case this is determined by the current serving radio access network.

**(Iu mode only):** Indicates this clause applies only to UMTS. For multi system case this is determined by the current serving radio access network.

NOTE 1: In accordance with the description of packet services in Iu mode in 3GPPS TS 24.008 [23], the terms 'CS/PS mode of operation' and 'PS mode of operation' are not used in the present document. Instead the terms 'MS operation mode A' and 'MS operation mode C' are used.

**(S1 mode only):** Indicates this clause applies only to an EPS. For multi system case this is determined by the current serving radio access network.

**Acceptable Cell:** This is a cell that the MS may camp on to make emergency calls or to access RLOS. It must satisfy criteria which are defined for A/Gb mode in 3GPP TS 43.022 [35], for Iu mode in 3GPP TS 25.304 [32], for S1 mode in 3GPP TS 36.304 [43], and for NR access in N1 mode in 3GPP TS 38.304 [61] and for E-UTRA access in N1 mode in 3GPP TS 36.304 [43]. For an MS in eCall only mode, an acceptable cell must further satisfy the criteria defined in clause 4.4.3.1.1.

**Access Technology:** The access technology associated with a PLMN or SNPN. The MS uses this information to determine what type(s) of radio carrier to search for when attempting to select a specific PLMN or SNPN (e.g., GSM, UTRAN, GSM COMPACT, E-UTRAN, NG-RAN, satellite NG-RAN or satellite E-UTRAN). A PLMN may support more than one access technology. SNPNs only support NG-RAN.

NOTE 2: Access technology "E-UTRAN" maps to core network type "EPC" and access technology "NG-RAN" maps to core network type "5GCN", see 3GPP TS 24.501 [64].

**ACDC:** Application specific Congestion control for Data Communication, see 3GPP TS 22.011 [9].

**Allowable PLMN:** In the case of an MS operating in MS operation mode A or B, this is a PLMN which is not in the list of "forbidden PLMNs" in the MS. In the case of an MS operating in MS operation mode C or an MS not supporting A/Gb mode and not supporting Iu mode, this is a PLMN which is not in the list of "forbidden PLMNs" and not in the list of "forbidden PLMNs for GPRS service" in the MS.

**Allowable SNPN:** In the case of an MS operating in SNPN access mode, this is an SNPN which is not in the list of "permanently forbidden SNPNs" which is, if the MS supports access to an SNPN using credentials from a credentials holder, associated with the selected entry of the "list of subscriber data" or the selected PLMN subscription, and is not in the list of "temporarily forbidden SNPNs" which is, if the MS supports access to an SNPN using credentials from a credentials holder, associated with the selected entry of the "list of subscriber data" or the selected PLMN subscription.

**Allowable PLMN/access technology** **combination:** For an MS operating in MS operation mode C or an MS not supporting A/Gb mode and not supporting Iu mode, this is an allowable PLMN in any specific access technology. For an MS operating in MS operation mode A or B, this is a PLMN/access technology combination where:

- the PLMN is an allowable PLMN and the specific access technology is supporting non-GPRS services; or

- the PLMN is not in the list of "forbidden PLMNs" and not in the list of "forbidden PLMNs for GPRS service" in the MS and the specific access technology is only supporting GPRS services.

EXAMPLE: E-UTRAN, satellite E-UTRAN, satellite NG-RAN (see 3GPP TS 22.261 [74]) and NG-RAN are access technologies that are only supporting GPRS services.

**Available PLMN:** For GERAN A/Gb mode see 3GPP TS 43.022 [35]. For UTRAN see 3GPP TS 25.304 [32]. For E-UTRAN see 3GPP TS 36.304 [43]. For satellite E-UTRAN see 3GPP TS 36.304 [43]. For NG-RAN see 3GPP TS 36.304 [43] and 3GPP TS 38.304 [61]. For satellite NG-RAN, see 3GPP TS 38.304 [61]. For cdma2000® 1xRTT and cdma2000® HRPD see 3GPP2 C.S0016 [44].

**Available SNPN:** For NG-RAN see 3GPP TS 38.304 [61].

**Available PLMN/access technology** **combination:** This is an available PLMN in a specific access technology.

**Camped on a cell:** The MS (ME if there is no SIM) has completed the cell selection/reselection process and has chosen a cell from which it plans to receive all available services. Note that the services may be limited, and that the PLMN or the SNPN may not be aware of the existence of the MS (ME) within the chosen cell.

**Country:** A country is identified by a single MCC value defined in ITU-T recommendation E.212 [76], with the exception of the following MCC ranges that identify a single country:

- values 310 through 316 (USA);

- values 404 through 406 (India);

- values 440 through 441 (Japan);

- values 460 through 461 (China); and

- values 234 through 235 (United Kingdom).

**Permitted CSG list:** See 3GPP TS 36.304 [43].

**Current serving cell:** This is the cell on which the MS is camped.

**CTS MS:** An MS capable of CTS services is a CTS MS.

Discontinuous coverage: Deployment option for satellite E-UTRAN access, in which shorter periods of satellite E-UTRAN access radio coverage are followed by longer periods of satellite E-UTRAN access coverage gaps. During coverage gaps, the access stratum may be deactivated. For more details see 3GPP TS 23.401 [58].

**EAB:** Extended Access Barring, see 3GPP TS 22.011 [9].

**Extended Coverage in GSM for Internet of Things (EC-GSM-IoT):** Extended coverage in GSM for IoT is a feature which enables extended coverage operation. See 3GPP TS 43.064 [55].

**EHPLMN:** Any of the PLMN entries contained in the Equivalent HPLMN list.

**Equivalent HPLMN list:** To allow provision for multiple HPLMN codes, PLMN codes that are present within this list shall replace the HPLMN code derived from the IMSI for PLMN selection purposes. This list is stored on the USIM and is known as the EHPLMN list. The EHPLMN list may also contain the HPLMN code derived from the IMSI. If the HPLMN code derived from the IMSI is not present in the EHPLMN list then it shall be treated as a Visited PLMN for PLMN selection purposes.

**Generic Access Network (GAN):** See 3GPP TS 43.318 [35A].

**GAN mode:** See 3GPP TS 43.318 [35A].

**GPRS MS:** An MS capable of GPRS services is a GPRS MS.

**MS operation mode:** See 3GPP TS 23.060 [27].

**High quality signal:** The high quality signal limit is used in the PLMN selection procedure. It is defined in the appropriate AS specification: 3GPP TS 43.022 [35] for the GSM radio access technology, 3GPP TS 25.304 [32] for the UMTS radio access technology (FDD or TDD mode), 3GPP TS 36.304 [43] for the E‑UTRAN radio access technology (WB-S1 mode, NB-S1 mode, WB-N1 mode or NB-N1 mode), 3GPP TS 36.304 [43] and 3GPP TS 38.304 [61] for the NG-RAN radio access technology. For 3GPP2 access technologies the high quality signal limit is defined in 3GPP2 C.S0011 [45] for cdma2000® 1xRTT and in 3GPP2 C.S0033 [46] for cdma2000® HRPD. A mobile station attempting to find a cell that supports EC-GSM-IoT (see 3GPP TS 43.064 [55]) does not use high quality signal limit in the PLMN selection procedure, i.e. for the purpose of PLMN selection, when attempting to find a cell that supports EC-GSM-IoT, any found cell supporting EC-GSM-IoT is considered to be received with high quality signal. A UE attempting to find a cell that supports enhanced coverage when operating in any WB-S1 or WB-N1 enhanced coverage mode does not use high quality signal limit in the PLMN selection procedure, i.e. for the purpose of PLMN selection, when attempting to find a cell that supports enhanced coverage, any found cell supporting enhanced coverage and satisfying the coverage specific quality signal limit defined for CE mode (see 3GPP TS 36.304 [43]) is considered to be received with high quality signal.

**Home PLMN:** This is a PLMN where the MCC and MNC of the PLMN identity match the MCC and MNC of the IMSI. Matching criteria are defined in Annex A.

**In A/Gb mode,...:** Indicates this clause applies only to a GSM system which operates in A/Gb mode. For multi system case this is determined by the current serving radio access network.

**In Iu mode,...:** Indicates this clause applies only to UMTS. For multi system case this is determined by the current serving radio access network.

**In N1 mode,...:** Indicates this clause applies only to an 5GS. For multi system case this is determined by the current serving radio access network.

**In NB-N1 mode:** Indicates this paragraph applies only to a system which operates in NB-N1 mode. For a multi-access system this case applies if the current serving radio access network provides access to 5G network services via E-UTRA connected to 5GCN by NB-IoT (see 3GPP TS 36.300 [56], 3GPP TS 36.331 [42], 3GPP TS 36.306 [54]).

**In WB-N1 mode:** Indicates this paragraph applies only to a system which operates in WB-N1 mode. For a multi-access system this case applies if the system operates in N1 mode with E-UTRA connected to 5GCN, but not in NB-N1 mode.

**In S1 mode,...:** Indicates this clause applies only to an EPS. The S1 mode includes WB-S1 mode and NB-S1 mode. For multi system case this is determined by the current serving radio access network.

**In NB-S1 mode:** Indicates this paragraph applies only to a system which operates in NB-S1 mode. For a multi-access system this case applies if the current serving radio access network provides access to network services via E-UTRA by NB-IoT (see 3GPP TS 36.300 [56], 3GPP TS 36.331 [22], 3GPP TS 36.306 [54]).

**In WB-S1 mode:** Indicates this paragraph applies only to a system which operates in WB-S1 mode. For a multi-access system this case applies if the system operates in S1 mode, but not in NB-S1 mode.

**Limited Service State:** See clause 3.5.

**Localised Service Area (LSA):** A localised service area consists of a cell or a number of cells. The cells constituting a LSA may not necessarily provide contiguous coverage.

**Location Registration (LR):** An MS which is IMSI attached to non-GPRS services only performs location registration by the location updating procedure. A GPRS MS which is IMSI attached to GPRS services or to GPRS and non-GPRS services performs location registration by the routing area update procedure only when in a network of network operation mode I. Both location updating and routing area update procedures are performed independently by the GPRS MS when it is IMSI attached to GPRS and non-GPRS services in a network of network operation mode II (see 3GPP TS 23.060 [27]). An MS which is attached via the E-UTRAN performs location registration by the tracking area update procedure. An MS which is registered via the NG-RAN performs location registration by the registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]).

**MINT: Minimization of service interruption (see 3GPP TS 22.261 [71]).**

**MS:** Mobile Station. The present document makes no distinction between MS and UE.

**N1 mode capability:** Capability of the UE associated with an N1 NAS signalling connection between the UE and network. The present document refers to the N1 mode capability over 3GPP access only (see 3GPP TS 24.501 [64]).

**NarrowBand Internet of Things (NB-IoT):** NB-IoT is a non-backward compatible variant of E-UTRAN supporting a reduced set of functionality. NB-IoT allows access to EPC or 5GCN network services via E-UTRA with a channel bandwidth limited to 180 kHz (see 3GPP TS 36.300 [20], 3GPP TS 36.331 [42], 3GPP TS 36.306 [44]).

**Network Type:** The network type associated with HPLMN or a PLMN on the PLMN selector (see 3GPP TS 31.102 [40]). The MS uses this information to determine what type of radio carrier to search for when attempting to select a specific PLMN. A PLMN may support more than one network type.

**Onboarding services in SNPN**: Onboarding services in SNPN allow an MS to access an SNPN indicating that onboarding is allowed, using default UE credentials for primary authentication in order for the MS to be configured with one or more entries of the "list of subscriber data".

NOTE 3: When the MS is registered for onboarding services in SNPN, services other than the onboarding services in SNPN are not available. When the MS is not registered for onboarding services in SNPN, onboarding services in SNPN are not available.

**MS determined PLMN with disaster condition:** A PLMN to which a disaster condition applies, determined as described in clause 4.4.3.1.1.

**Registered PLMN (RPLMN):** This is the PLMN on which certain LR outcomes have occurred (see table 1). In a shared network the RPLMN is the PLMN defined by the PLMN identity of the CN operator that has accepted the LR.

**Registered SNPN (RSNPN):** This is the SNPN on which certain LR outcomes have occurred. In a shared network the RSNPN is the SNPN defined by the SNPN identity of the CN operator that has accepted the LR.

**Registration:** This is the process of camping on a cell of the PLMN or the SNPN and doing any necessary LRs.

**Registration Area:** A registration area is an area in which mobile stations may roam without a need to perform location registration. The registration area corresponds to location area (LA) for performing location updating procedure, to routing area for performing the GPRS attach or routing area update procedures, and to a list of tracking areas (TAs) for performing the EPS attach, tracking area update, or 5GS registration procedure.

The PLMN to which a cell belongs (PLMN identity):

- for GERAN, in the system information (MCC + MNC part of LAI) broadcast as specified in 3GPP TS 44.018 [34];

- for UTRA, see the broadcast information as specified in 3GPP TS 25.331 [33];

- for E-UTRA, see the broadcast information as specified in 3GPP TS 36.331 [42]; and

- for NR, see the broadcast information as specified in 3GPP TS 38.331 [65].

The SNPN to which a cell belongs (SNPN identity):

- for NR, see the broadcast information as specified in 3GPP TS 38.331 [65].

In a shared network, a cell belongs to all PLMNs given in the system information broadcasted as specified in 3GPP TS 44.018 [34] for GERAN, in 3GPP TS 25.331 [33] for UTRAN, and in 3GPP TS 36.331 [42] for E-UTRAN, and a cell belongs to all PLMNs, all SNPNs, or all PLMNs and all SNPNs, given in the system information broadcasted as specified in 3GPP TS 36.331 [42] for E-UTRA connected to 5GCN, and in 3GPP TS 38.331 [65] for NR.

**Secured packet:** In this specification, a secured packet contains one or both of the following:

- list of preferred PLMN/access technology combinations,

- SOR-CMCI,

encapsulated with a security mechanism as described in 3GPP TS 31.115 [67].

**Selected PLMN:** This is the PLMN that has been selected according to clause 3.1, either manually or automatically.

**Selected SNPN:** This is the SNPN that has been selected according to clause 3.9, either manually or automatically.

**Shared MCC:** MCC assigned by ITU-T as shared MCC according to ITU-T E.212 [76], except within this specification for PLMN selection purposes the MCC of value 999 is not considered a shared MCC.

**Shared Network:** An MS considers a cell to be part of a shared network, when multiple PLMN identities are received as specified in 3GPP TS 44.018 [34] for GERAN, in 3GPP TS 25.331 [33] for UTRAN, and in 3GPP TS 36.331 [42] for E-UTRAN, and when multiple PLMN identities, multiple SNPN identities or one or more PLMN identities and one or more SNPN identities are received as specified in 3GPP TS 36.331 [42] for E-UTRA connected to 5GCN, and in 3GPP TS 38.331 [65] for NR.

**SIM:** Subscriber Identity Module (see 3GPP TS 21.111 [38]). The present document makes no distinction between SIM and USIM.

**SNPN identity**: a PLMN ID and an NID combination.

**SoLSA exclusive access:** Cells on which normal camping is allowed only for MS with Localised Service Area (LSA) subscription.

**Subscribed SNPN:** An SNPN for which the UE has a subscription.

**Suitable Cell:** This is a cell on which an MS may camp. It must satisfy criteria which are defined for GERAN A/Gb mode in 3GPP TS 43.022 [35], for UTRAN in 3GPP TS 25.304 [32], for E-UTRAN in 3GPP TS 36.304 [43] and for NG-RAN see 3GPP TS 36.304 [43] and 3GPP TS 38.304 [61]. For 3GPP2 access technologies the criteria are defined in 3GPP2 C.S0011 [45] for cdma2000® 1xRTT and in 3GPP2 C.S0033 [46] for cdma2000® HRPD. For an MS in eCall only mode, a suitable cell must further satisfy the criteria defined in clause 4.4.3.1.1.

**Steering of Roaming (SOR):** A technique whereby a roaming UE is encouraged to roam to a preferred roamed-to-network indicated by the HPLMN.

**Steering of Roaming acknowledgment information (SOR-ACK-information):** Information sent from the UE to the UDM, in a secured manner, in the SOR container of the acknowledgment. It contains the reason(s) why the UE isnot performing SOR immidiately.

NOTE X: The parameters of the SOR-ACK-information are listed in 3GPP TS 24.501[64].

**Steering of Roaming application function (SOR-AF):** An application function that can provide UDM with one of the following:

a) one or more of the following:

- list of preferred PLMN/access technology combinations;

- SOR-CMCI, together with the "Store SOR-CMCI in ME" indicator if applicable;

- SOR-SNPN-SI;

b) a secured packet, together with the indicator, if applicable, that "the list of preferred PLMN/access technology combinations is not included in the secured packet"; or

c) neither of a) or b),

generated dynamically based on operator specific data analytics solutions.

**Steering of Roaming information:** This consists of the following HPLMN or subscribed SNPN protected information (see 3GPP TS 33.501 [66]):

a) the following indicators, of whether:

- the UDM requests an acknowledgement from the UE for successful reception of the steering of roaming information.

- the UDM requests the UE to store the SOR-CMCI in the ME, which is provided along with the SOR-CMCI in plain text; and

b) one of the following:

1) one or more of the following:

- list of preferred PLMN/access technology combinations with an indication that it is included;

- SOR-CMCI; or

- SOR-SNPN-SI;

2) a secured packet with an indication that it is included;

3) the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided'; or

4) the subscribed SNPN or HPLMN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided'.

**Steering of roaming connected mode control information (SOR-CMCI):** HPLMN information to control the timing for a UE in connected mode to move to idle mode in order to perform steering of roaming.

**Steering of roaming SNPN selection information (SOR-SNPN-SI):** Provisioning information for SNPN selection consisting of:

a) the credentials holder controlled prioritized list of preferred SNPNs;

b) the credentials holder controlled prioritized list of GINs; or

c) both of the above.

**Visited PLMN**: This is a PLMN different from the HPLMN (if the EHPLMN list is not present or is empty) or different from an EHPLMN (if the EHPLMN list is present).

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.167 [57] apply:

**eCall over IMS**

**EPC**

**E-UTRAN**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.401 [58] apply:

**eCall only mode**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.221 [69] apply:

**Restricted local operator services (RLOS)**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 23.501 [62] apply:

**Closed Access Group (CAG)**

**Credentials holder**

**Group ID for Network Selection (GIN)**

**Network identifier (NID)**

**NG-RAN**

**NR RedCap**

**Stand-alone Non-Public Network (SNPN)**

**SNPN access mode**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 24.501 [64] apply:

**5GCN**

**CAG cell**

**Emergency PDU session**

**Initial registration for emergency services**

**Initial registration for onboarding services in SNPN**

**Non-CAG cell**

**Registered for emergency services**

**Registered for onboarding services in SNPN**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 22.261 [74] apply:

**Disaster condition**

**Disaster roaming**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 33.501 [66] apply:

**Default UE credentials for primary authentication**

For the purposes of the present document, the following terms and definitions given in 3GPP TS 24.229 [84] apply:

**IMS registration related signalling**

## \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* NEXT CHANGE\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## C.1.1 Steering of roaming over the control plane in a PLMN

The purpose of the control plane solution for steering of roaming in 5GS procedure in a PLMN is to allow the HPLMN to update one or more of the following via NAS signalling:

a) the "Operator Controlled PLMN Selector with Access Technology" list in the UE by providing the HPLMN protected list of preferred PLMN/access technology combinations or a secured packet;

b) the SOR-CMCI; and

c) the SOR-SNPN-SI associated with the selected PLMN subscription in the ME.

If the selected PLMN is a VPLMN, the HPLMN can provide the steering of roaming information to the UE using the control plane mechanism during and after registration. If the selected PLMN is the HPLMN, the HPLMN can provide the steering of roaming information to the UE using the control plane mechanism after registration only. The HPLMN updates the "Operator Controlled PLMN Selector with Access Technology" based on the operator policies, which can be based on the registered VPLMN, the location of the UE, etc.

The HPLMN can configure their subscribed UE's USIM to indicate that the UE is expected to receive the steering of roaming information due to initial registration in 5GS in a VPLMN. At the same time the HPLMN will mark the UE is expected to receive the steering of roaming information due to initial registration in 5GS in a VPLMN, in the subscription information in the UDM. In this case, it is mandatory for the HPLMN to provide the steering of roaming information to the UE during initial registration in a VPLMN. Otherwise if such configuration is not provided in the USIM, it is optional for the HPLMN to provide the steering of roaming information to the UE during initial registration (based on operator policy). The HPLMN can provide the steering of roaming information to the UE during the registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]) and initial registration procedure for emergency services. In addition, the HPLMN can request the UE to provide an acknowledgement of successful reception of the steering of roaming information.

The HPLMN may request the UE to provide the SOR-ACK-information as part of the steering of roaming information of the acknowledgment. The UE shall indicate its support for SOR-ACK-info and provide the SOR-ACK-information, if any, to the HPLMN UDM over the SOR transparent container of the acknowledgment. The SOR-ACK-information can be used by the HPLMN operator for SOR algorithms optimisation and to collect operation related statistics.

Editor's Note: It is required to consolidate with SA3 in regard to the additional security required for the new SOR-ACK-information.

NOTE 1: In annex C of this specification, the User Data Repository (UDR) is considered as part of the UDM.

As the HPLMN needs to consider certain criteria including the number of customers distributed through multiple VPLMNs in the same country or region, the list of the preferred PLMN/access technology combinations is not necessarily the same at all times and for all users. The list of the preferred PLMN/access technology combinations needs to be dynamically generated, e.g. generated on demand, by a dedicated steering of roaming application function (SOR-AF) providing operator specific data analytics solutions.

NOTE 2: The functional description of this dedicated application function (SOR-AF) is out of scope of 3GPP.

The steering of roaming connected mode control information (SOR-CMCI) enables the HPLMN to control the timing of a UE in 5GS connected mode to move to idle mode to perform the steering of roaming. If the UE selects a cell of any access technology other than NG-RAN, the SOR procedure is terminated (see clause C.4.2). The UE shall support the SOR-CMCI. The support and use of SOR-CMCI by the HPLMN is based on the HPLMN's operator policy.

The following requirements are applicable for the SOR-CMCI:

- The HPLMN may configure SOR-CMCI in the UE and may also send SOR-CMCI over N1 NAS signalling. The SOR-CMCI received over N1 NAS signalling has precedence over the SOR-CMCI configured in the UE.

NOTE 3: Based on HPLMN policy, while setting the SOR-CMCI the HPLMN can take into consideration the user preference for the service(s) not to be interrupted due to SOR (e.g. MMTEL voice call, MMTEL video call, HPLMN defined services, among others). The user can communicate its preference for the service(s) not to be interrupted due to SOR to the HPLMN utilizing non-standard operator-specific mechanisms, e.g. web-based.

- The UE shall indicate ME's support for SOR-CMCI to the HPLMN.

NOTE 4: The HPLMN has the knowledge of the USIM's capabilities in supporting SOR-CMCI.

- While performing SOR, the UE shall consider the list of preferred PLMN/access technology combinations or secured packet received in the SOR information together with the available SOR-CMCI.

- The HPLMN may provision the SOR-CMCI in the UE over N1 NAS signalling. The UE shall store the configured SOR-CMCI in the non-volatile memory of the ME or in the USIM as described in clause C.4.

The following requirements are applicable for the SOR-SNPN-SI:

- If the UE supports access to an SNPN using credentials from a credentials holder, the UE shall indicate ME's support for SOR-SNPN-SI to the HPLMN.

In order to support various deployment scenarios, the UDM may support:

- obtaining a list of preferred PLMN/access technology combinations, and SOR-CMCI, if any (if supported by the UDM and required by the HPLMN), or a secured packet which is or becomes available in the UDM (i.e. retrieved from the UDR);

NOTE 5: A secured packet can be made available at the UDR via implementation specific means. In this case the implementation specific means are required to ensure that the secured packet satisfies the "Replay detection and Sequence Integrity counter" (see ETSI TS 102 225 [73]) every time it is sent out from the HPLMN to the UE.

- obtaining a list of preferred PLMN/access technology combinations and SOR-CMCI, if any (if supported by the UDM and required by the HPLMN), or a secured packet from the SOR-AF; or

- both of the above.

The HPLMN policy for the SOR-AF invocation can be present in the UDM only if the UDM supports obtaining a list of preferred PLMN/access technology combinations and SOR-CMCI, if any, or a secured packet from the SOR-AF.

The UDM discards any list of preferred PLMN/access technology combinations, SOR-CMCI, if any, or any secured packet obtained from the SOR-AF or which is or becomes available in the UDM (i.e. retrieved from the UDR), either during registration (as specified in annex C.2) or after registration (as specified in annex C.3 and C.4.3), when the UDM cannot successfully forward the SOR information to the AMF (e.g. in case the UDM receives the response from the SOR-AF with the list of preferred PLMN/access technology combinations, the SOR-CMCI, if any, or the secured packet after the expiration of the operator specific timer, or if there is no AMF registered for the UE).

The UE maintains a list of "PLMNs where registration was aborted due to SOR". If the UE receives steering of roaming information in the REGISTRATION ACCEPT or DL NAS TRANSPORT message and the security check to verify that the steering of roaming information is provided by HPLMN is successful, the UE shall remove the current selected PLMN from the list of "PLMNs where registration was aborted due to SOR". The UE shall delete the list of "PLMNs where registration was aborted due to SOR" when the MS is switched off, the USIM is removed or after a UE implementation dependent time.

If:

- the UE's USIM is configured to indicate that the UE shall expect to receive the steering of roaming information during initial registration procedure but did not receive it or security check on the steering of roaming information fails;

- the current chosen VPLMN is not contained in the list of "PLMNs where registration was aborted due to SOR";

- the current chosen VPLMN is not part of "User Controlled PLMN Selector with Access Technology" list; and

- the UE is not in manual mode of operation;

then the UE will perform PLMN selection with the current VPLMN considered as lowest priority.

It is mandatory for the VPLMN to transparently forward to the UE the steering of roaming information received from HPLMN and to transparently forward to the HPLMN the acknowledgement of successful reception of the steering of roaming information received from UE, both while the UE is trying to register onto the VPLMN as described in clause C.2, and after the UE has registered onto the VPLMN as described in clause C.3 and C.4.3.

If the last received steering of roaming information contains the list of preferred PLMN/access technology combinations then the ME shall not delete the "Operator Controlled PLMN Selector with Access Technology" list stored in the non-volatile memory of the ME when the UE is switched off.

The "Operator Controlled PLMN Selector with Access Technology" list shall be stored in the non-volatile memory of the ME together with the SUPI from the USIM. The ME shall delete the "Operator Controlled PLMN Selector with Access Technology" list stored in the ME when a new USIM is inserted.

The procedure in this annex for steering of UE in VPLMN can be initiated by the network while the UE is trying to register onto the VPLMN as described in clause C.2, or after the UE has registered onto the HPLMN or the VPLMN as described in clause C.3, C.7 and C.4.3.

## C.1.2 Steering of roaming over the control plane in an SNPN

The purpose of the control plane solution for steering of roaming in 5GS procedure in an SNPN is to allow the HPLMN or subscribed SNPN to update one or more of the following via NAS signalling:

a) the SOR-SNPN-SI associated with the selected entry of "list of subscriber data" or the selected PLMN subscription in the ME, for a UE which supports access to an SNPN using credentials from a credential holder; and

b) the SOR-CMCI.

The control plane solution for steering of roaming in 5GS procedure in an SNPN can also be used by the HPLMN to update the "Operator Controlled PLMN Selector with Access Technology" list in the UE by providing the HPLMN protected list of preferred PLMN/access technology combinations or a secured packet via NAS signalling.

The HPLMN or subscribed SNPN can provide the steering of roaming information to the UE using the control plane mechanism during and after registration. The HPLMN or subscribed SNPN updates the SOR-SNPN-SI based on the HPLMN or subscribed SNPN policies, which can be based on the registered SNPN, the location of the UE, etc. The control plane solution for steering of roaming in 5GS procedure in an SNPN is not applicable for credentials holder with AAA server.

If the UE supports access to an SNPN using credentials from a credentials holder:

a) the UE shall indicate ME's support for SOR-SNPN-SI when registering in a subscribed SNPN or in the HPLMN; and

b) the UE may indicate ME's support for SOR-SNPN-SI when sending an SOR transparent container including a UE acknowledgement in a PLMN.

When the UE indicates ME's support for SOR-SNPN-SI in the 5GMM capability in initial registration or emergency registration or when ME's support for SOR-SNPN-SI changes in mobility registration update, the AMF shall inform the UDM.

The HPLMN or subscribed SNPN can configure their subscribed UEs' SNPN configuration parameters associated with the PLMN subscription or the selected entry of the "list of subscriber data", respectively, to expect to receive the steering of roaming information due to initial registration in a non-subscribed SNPN. At the same time the HPLMN or subscribed SNPN will mark the UE as expecting to receive the steering of roaming information due to initial registration in a non-subscribed SNPN, in the subscription information in the UDM. In this case, it is mandatory for the HPLMN or subscribed SNPN to provide the steering of roaming information to the UE during initial registration in a non-subscribed SNPN. Otherwise if such configuration is not provided in the ME, it is optional for the HPLMN or subscribed SNPN to provide the steering of roaming information to the UE during initial registration (based on HPLMN or subscribed SNPN policy). The HPLMN or subscribed SNPN can provide the steering of roaming information to the UE during the registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]) and initial registration procedure for emergency services. In addition, the HPLMN or subscribed SNPN can request the UE to provide an acknowledgement of successful reception of the steering of roaming information.

The HPLMN or subscribed SNPN may request the UE to provide the SOR-ACK-information as part of the steering of roaming information of the acknowledgment. The UE shall indicate its support for SOR-ACK-info and provide the SOR-ACK-information, if any, to the HPLMN or subscribed SNPN UDM over the SOR transparent container of the acknowledgment. The SOR-ACK-information can be used by the HPLMN or subscribed SNPN for SOR algorithms optimisation and to collect operation related statistics.

NOTE 1: In annex C of this specification, the User Data Repository (UDR) is considered as part of the UDM.

As the HPLMN or subscribed SNPN needs to consider certain criteria including the number of customers distributed through multiple SNPNs in the same country or region, the SOR-SNPN-SI is not necessarily the same at all times and for all users.

NOTE 2: The functional description of this dedicated application function (SOR-AF) is out of scope of 3GPP.

The steering of roaming connected mode control information (SOR-CMCI) enables the HPLMN or subscribed SNPN to control the timing of a UE in connected mode to move to idle mode, if the UE decides to perform SNPN selection upon receiving the steering of roaming information. The UE shall support the SOR-CMCI. The support and use of SOR-CMCI by the HPLMN or subscribed SNPN is based on the HPLMN or subscribed SNPN policy.

The following requirements are applicable for the SOR-CMCI:

- The HPLMN or subscribed SNPN may configure SOR-CMCI in the UE and may also send SOR-CMCI over N1 NAS signalling. The SOR-CMCI received over N1 NAS signalling has precedence over the SOR-CMCI configured in the UE.

- The UE shall indicate ME's support for SOR-CMCI to the HPLMN or subscribed SNPN.

NOTE 3: If the credentials holder is the HPLMN, the HPLMN has the knowledge of the USIM's capabilities in supporting SOR-CMCI.

- While performing SOR, the UE shall consider the SOR-SNPN-SI received in the SOR information together with the available SOR-CMCI.

- The HPLMN or subscribed SNPN may provision the SOR-CMCI in the UE over N1 NAS signalling. The UE shall store the configured SOR-CMCI in the non-volatile memory of the ME or in the USIM as described in clause C.4.

In order to support various deployment scenarios, the UDM may support:

- obtaining the SOR-SNPN-SI which is or becomes available in the UDM (i.e. retrieved from the UDR);

- obtaining the SOR-SNPN-SI from the SOR-AF; or

- both of the above.

The HPLMN or subscribed SNPN policy for the SOR-AF invocation can be present in the UDM only if the UDM supports obtaining the SOR-SNPN-SI from the SOR-AF.

The UDM discards any SOR-SNPN-SI obtained from the SOR-AF or which is or becomes available in the UDM (i.e. retrieved from the UDR), either during registration (as specified in annex C.5) or after registration (as specified in annex C.6), when the UDM cannot successfully forward the SOR information to the AMF (e.g. in case the UDM receives the response from the SOR-AF with the SOR-SNPN-SI after the expiration of the HPLMN or subscribed SNPN specific timer, or if there is no AMF registered for the UE).

The UE maintains a list of "SNPNs where registration was aborted due to SOR" per entry of the "list of subscriber data" or the PLMN subscription. If the UE receives steering of roaming information in the REGISTRATION ACCEPT or DL NAS TRANSPORT message in an SNPN and the security check to verify that the steering of roaming information is provided by the HPLMN or subscribed SNPN is successful, the UE shall remove the current selected SNPN from the list of "SNPNs where registration was aborted due to SOR" for the selected entry of the "list of subscriber data" or the selected PLMN subscription. The UE shall delete the list of "SNPNs where registration was aborted due to SOR" when the selected entry of the "list of subscriber data" is updated or the UICC containind the USIM is removed.

If:

- the UE's ME is configured to indicate that the UE shall expect to receive the steering of roaming information during initial registration procedure for the selected entry of the "list of subscriber data" or the selected PLMN subscription but did not receive it or security check on the steering of roaming information fails;

- the current chosen non-subscribed SNPN is not contained in the list of "SNPNs where registration was aborted due to SOR" for the selected entry of the "list of subscriber data" or the selected PLMN subscription;

- the current chosen non-subscribed SNPN is not part of the user controlled prioritized list of preferred SNPNs for the selected entry of the "list of subscriber data" or the selected PLMN subscription; and

- the UE is not in manual mode of operation;

then the UE will perform SNPN selection with the current SNPN considered as lowest priority.

It is mandatory for the non-subscribed SNPN to transparently forward to the UE the steering of roaming information received from the HPLMN or subscribed SNPN and to transparently forward to the HPLMN or subscribed SNPN the acknowledgement of successful reception of the steering of roaming information received from the UE, both while the UE is trying to register onto the non-subscribed SNPN as described in clause C.5, and after the UE has registered onto the non-subscribed SNPN as described in clause C.6.

The ME shall delete the SOR-SNPN-SI stored in the ME when the subscriber identifier, the SNPN identity of the subscribed SNPN, or both, of the selected entry of the "list of subscriber data" are updated or the UICC containing the USIM is removed.

The procedure in this annex for steering of UE in an SNPN can be initiated by the network while the UE is trying to register onto a non-subscribed SNPN as described in clause C.5, or after the UE has registered onto the subscribed SNPN or a non-subscribed SNPN as described in clause C.6 and C.8.

# C.2 Stage-2 flow for steering of UE in VPLMN during registration

The stage-2 flow for the case when the UE registers with VPLMN AMF is described below in figure C.2.1. The selected PLMN is the VPLMN. The AMF is located in the selected VPLMN.

Figure C.2.1: Procedure for providing list of preferred PLMN/access technology combinations and the SOR-CMCI, if any, or secured packet during registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

1) The UE to the VPLMN AMF: The UE initiates initial registration, emergency registration or registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]) to the VPLMN AMF by sending REGISTRATION REQUEST message with the 5GS registration type IE indicating "initial registration", "emergency registration" or "mobility registration updating";

2) Upon receiving REGISTRATION REQUEST message, the VPLMN AMF executes the registration procedure as defined in clause 4.2.2.2 of 3GPP TS 23.502 [63]. As part of the registration procedure:

a) the AMF provides the registration type to the UDM using Nudm\_UECM\_Registration. As a consequence, in case of the 5GS registration type message indicates "initial registration" or "emergency registration" the UDM shall delete the stored "ME support of SOR-CMCI" indicator, if any, and the stored "ME support of SOR-SNPN-SI" indicator, if any, in UDR using Nudr\_DM\_Update service operation (see 3GPP TS 23.502 [63]).

NOTE 1: Nudr\_DM\_Update service operation corresponds to Nudr\_DR\_Update service operation (see 3GPP TS 29.504 [82] and 3GPP TS 29.505 [83]).

In addition:

a) if the VPLMN AMF does not have subscription data for the UE, the VPLMN AMF invokes Nudm\_SDM\_Get service operation to the HPLMN UDM to get amongst other information the Access and Mobility Subscription data for the UE (see step 14b in clause 4.2.2.2.2 of 3GPP TS 23.502 [63]); or

b) if the VPLMN AMF already has subscription data for the UE and:

i) the 5GS registration type IE in the received REGISTRATION REQUEST message indicates "initial registration" and the "SoR Update Indicator for Initial Registration" field in the UE context is set to 'the UDM requests the AMF to retrieve SoR information when the UE performs NAS registration type "initial registration"' as specified in table 5.2.2.2.2-1 of 3GPP TS 23.502 [63]); or

ii) the 5GS registration type IE in the received REGISTRATION REQUEST message indicates "emergency registration" and the "SoR Update Indicator for Emergency Registration" field in the UE context is set to 'the UDM requests the AMF to retrieve SoR information when the UE performs NAS registration type "emergency registration"' as specified in table 5.2.2.2.2-1 of 3GPP TS 23.502 [63]);

then the VPLMN AMF invokes Nudm\_SDM\_Get service operation message to the HPLMN UDM to retrieve the steering of roaming information (see step 14b in clause 4.2.2.2.2 of 3GPP TS 23.502 [63]);

otherwise the VPLMN AMF sends a REGISTRATION ACCEPT message without the steering of roaming information to the UE and steps 3a, 3b, 3c, 3d, 4, 5, 6 are skipped;

3a) If the user subscription information indicates to send the steering of roaming information due to initial registration in a VPLMN, then the HPLMN UDM shall provide the steering of roaming information to the UE when the UE performs initial registration in a VPLMN, otherwise the HPLMN UDM may provide the steering of roaming information to the UE, based on operator policy.

NOTE 2: Based on operator deployment and policy, if the UDM receives the list of preferred PLMN/access technology combinations from the UDR, and the UDM supports communication with the SP-AF, the UDM can send this list to the SP-AF requesting it to provide this information in a secured packet as defined in 3GPP TS 29.544 [71].

If the HPLMN UDM is to provide the steering of roaming information to the UE when the UE performs the registration in a VPLMN, and the HPLMN policy for the SOR-AF invocation is absent then steps 3b and 3c are not performed and the HPLMN UDM obtains the available list of preferred PLMN/access technology combinations or the available secured packet (i.e. all retrieved from the UDR). In addition, if the HPLMN UDM obtains the list of preferred PLMN/access technology combinations and the "ME support of SOR-CMCI" indicator is stored for the UE, then the HPLMN UDM shall obtain the SOR-CMCI, if available, otherwise the HPLMN UDM shall not obtain the SOR-CMCI. If the SOR-CMCI is provided then the HPLMN UDM may indicate to the UE to store the SOR-CMCI in the ME by providing the "Store SOR-CMCI in ME" indicator set to "Store SOR-CMCI in ME".

NOTE 3: The secured packet obtained by the UDM can include SOR-CMCI only if the "ME support of SOR-CMCI" indicator is stored for the UE and the USIM of the indicated SUPI supports SOR-CMCI. Otherwise if only the "ME support of SOR-CMCI" indicator is stored for the UE, then SOR-CMCI, if any, cannot be included in the secured packet.

If the HPLMN UDM is to provide the steering of roaming information to the UE when the UE performs the registration in a VPLMN, and the HPLMN policy for the SOR-AF invocation is present, then the HPLMN UDM obtains the list of preferred PLMN/access technology combinations, SOR-CMCI, if any, or the secured packet from the SOR-AF using steps 3b and 3c;

3b) The HPLMN UDM to the SOR-AF: Nsoraf\_SoR\_Get request (VPLMN ID, SUPI of the UE, access type (see 3GPP TS 29.571 [72])). The VPLMN ID and the access type parameters, indicating where the UE is registering, are stored in the HPLMN UDM;

3c) The SOR-AF to the HPLMN UDM: Nsoraf\_SoR\_Get response (the list of preferred PLMN/access technology combinations, the SOR-CMCI, if any, and the "Store SOR-CMCI in ME" indicator, if any, or the secured packet, or neither of them);

Based on the information received in step 3b and any operator specific criteria, the SOR-AF may either:

- include the list of preferred PLMN/access technology combinations, the SOR-CMCI, if any, and optionally the "Store SOR-CMCI in ME" indicator, if any;

- provide the secured packet in the Nsoraf\_SoR\_Get response; or

- provide the Nsoraf\_SoR\_Get response with neither of the information above.

If the SOR-AF includes the list of preferred PLMN/access technology combinations and the ME supports the SOR-CMCI, the SOR-AF may provide the SOR-CMCI and optionally the "Store SOR-CMCI in ME" indicator, otherwise the SOR-AF shall provide neither the SOR-CMCI nor "Store the SOR-CMCI in ME" indicator.

NOTE 4: In this version of the specification, when the access type where the UE is registering indicates 3GPP access, then the UE is registering over the NG-RAN access technology.

NOTE 5: Based on operator deployment and policy, if the UDM receives the list of preferred PLMN/access technology combinations, and the SOR-CMCI, if any, in the Nsoraf\_SoR\_Get response from the SOR-AF, and the UDM supports communication with SP-AF, it can send this list, and the SOR-CMCI, if any, to SP-AF requesting it to provide this information in a secured packet as defined in 3GPP TS 29.544 [71].

NOTE 6: The SOR-AF can include a different list of preferred PLMN/access technology combinations, different SOR-CMCI, if any, and different "Store SOR-CMCI in ME" indicator, if any, or a different secured packet for each Nsoraf\_SoR\_Get request even if the same VPLMN ID, the SUPI of the UE, and the access type are provided to the SOR-AF.

NOTE 7: The SOR-AF can subscribe to the HPLMN UDM to be notified about the changes of the roaming status of the UE identified by SUPI.

NOTE 8: The SOR-AF can determine that the ME supports the SOR-CMCI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-CMCI" indicator.

NOTE 9: Secured packet provided by the SOR-AF can include SOR-CMCI only if the SOR-AF has determined that the ME supports the SOR-CMCI and the USIM of the indicated SUPI supports SOR-CMCI. Otherwise if only the "ME support of SOR-CMCI" indicator is stored for the UE, then SOR-CMCI, if any, cannot be included in the secured packet.

NOTE 10: Secured packets do not include the "Store SOR-CMCI in ME" indicator.

3d) The HPLMN UDM forms the steering of roaming information as specified in 3GPP TS 33.501 [66] from:

- the list of preferred PLMN/access technology combinations, the SOR-CMCI, if any, and the "Store SOR-CMCI in ME" indicator, if any, or the secured packet obtained in step 3a; or

the list of preferred PLMN/access technology combinations and the SOR-CMCI, if any, and "Store the SOR-CMCI in ME" indicator, if any, or the secured packet, obtained in step 3c.

If:

- neither the list of preferred PLMN/access technology combinations nor the secured packet was obtained in steps 3a or 3c; or

- the SOR-AF has not sent to the HPLMN UDM an Nsoraf\_SoR\_Get response (step 3c) within an operator defined time after the HPLMN UDM sending to the SOR-AF an Nsoraf\_SoR\_Get request (step 3b);

NOTE 11: Stage 3 to define the timer needed for the SOR-AF to respond to the HPLMN UDM. The max time needs to be defined considering that this procedure is part of the registration procedure.

and the UE is performing initial registration in a VPLMN and the user subscription information indicates to send the steering of roaming information due to initial registration in a VPLMN, then the HPLMN UDM forms the steering of roaming information as specified in 3GPP TS 33.501 [66] from the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided';

If the "Store SOR-CMCI in ME" indicator was not obtained in step 3a or 3c and the "ME support of SOR-CMCI" indicator is stored for the UE in the HPLMN UDM, the HPLMN UDM forms the steering of roaming information with the "Store SOR-CMCI in ME" indicator set to "Do not store SOR-CMCI in ME";

4) The HPLMN UDM to the VPLMN AMF: The HPLMN UDM sends a response to the Nudm\_SDM\_Get service operation to the VPLMN AMF, which includes the steering of roaming information within the Access and Mobility Subscription data. The Access and Mobility Subscription data type is defined in clause 5.2.3.3.1 of 3GPP TS 23.502 [63]).

NOTE 12: The UDM cannot provide the SOR-CMCI, if any, to the VPLMN AMF which does not support receiving SoR transparent container (see 3GPP TS 29.503 [78]).

If the UE is performing initial registration or emergency registration and the HPLMN UDM supports SOR-CMCI, the HPLMN shall request the UE to acknowledge the successful security check of the received steering of roaming information, by providing the indication as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation. Otherwise, the HPLMN may request the UE to acknowledge the successful security check of the received steering of roaming information, by providing the indication as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation.

NOTE 13: If the UE is performing registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]) after inter-system change from S1 mode to N1 mode and the HPLMN UDM supports SOR-CMCI, the HPLMN requests the UE to acknowledge the successful security check of the received steering of roaming information, by providing the indication as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation, unless the HPLMN UDM has already received and stored the "ME support of SOR-CMCI" indicator for the UE during its former registration on the current VPLMN.

If the HPLMN UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info-request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation;

5) The VPLMN AMF to the HPLMN UDM: As part of the registration procedure, the VPLMN AMF also invokes Nudm\_SDM\_Subscribe service operation to the HPLMN UDM to subscribe to notification of changes of the subscription data (e.g. received in step 4) including notification of updates of the steering of roaming information included in the Access and Mobility Subscription data (see step 14c in clause 4.2.2.2.2 of 3GPP TS 23.502 [63]);

6) The VPLMN AMF to the UE: The VPLMN AMF shall transparently send the received steering of roaming information to the UE in the REGISTRATION ACCEPT message;

7) If the steering of roaming information is received and the security check is successful, then:

a) if the UDM has not requested an acknowledgement from the UE, then the UE shall send the REGISTRATION COMPLETE message to the serving AMF without including an SOR transparent container;

b) if the steering of roaming information contains a secured packet (see 3GPP TS 31.115 [67]):

- the ME shall upload the secured packet to the USIM using procedures in 3GPP TS 31.111 [41], if the service "data download via SMS Point-to-point" is allocated and activated in the USIM Service Table (see 3GPP TS 31.102 [40]);

NOTE 14: How the ME handles UICC responses and failures in communication between the ME and UICC is implementation specific and out of scope of this release of the specification.

- if the UDM has not requested an acknowledgement from the UE and:

A) the ME receives a USAT REFRESH with command qualifier (3GPP TS 31.111 [41]) of type "Steering of Roaming" and either a SOR-CMCI is included, or the UE is configured with the SOR-CMCI, the UE shall perform items a), b) and c) of the procedure for steering of roaming in clause 4.4.6, and if the UE is in automatic network selection mode then it shall apply the actions in clause C.4.2. In this case steps 8 to 11 are skipped; or

B) the ME receives a USAT REFRESH command qualifier (3GPP TS 31.111 [41]) of type "Steering of Roaming" and neither a SOR-CMCI is included, nor the UE is configured with the SOR-CMCI, it shall perform items a), b) and c) of the procedure for steering of roaming in clause 4.4.6 and if:

i) the UE has a list of available and allowable PLMNs in the area and based on this list or any other implementation specific means the UE determines that there is a higher priority PLMN than the selected VPLMN; or

ii) the UE does not have a list of available and allowable PLMNs in the area and is unable to determine whether there is a higher priority PLMN than the selected VPLMN using any other implementation specific means;

and the UE is in automatic network selection mode, then the UE shall either:

i) release the current N1 NAS signalling connection locally and then attempt to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired. In this case, steps 8 to 11 are skipped. The UE shall suspend the transmission of 5GSM messages until the N1 NAS signalling is released. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed. If the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]), the receipt of the steering of roaming information shall not trigger the release of the N1 NAS signalling connection. If camped on a NG-RAN cell, the UE shall release the current N1 NAS signalling connection locally subsequently after the emergency PDU session is released, otherwise the UE shall not take any further actions; or

ii) not release the current N1 NAS signalling connection locally (e.g. if the UE has established PDU session(s)) and skip steps 8 to 10;

c) if the steering of roaming information contains the list of preferred PLMN/access technology combinations, the ME shall replace the highest priority entries in the "Operator Controlled PLMN Selector with Access Technology" list stored in the ME with the received list of preferred PLMN/access technology combinations, and delete the PLMNs identified by the list of preferred PLMN/access technology combinations from the Forbidden PLMN list and from the Forbidden PLMNs for GPRS service list, if they are present in these lists. Additionally, if:

i) the UE has a list of available and allowable PLMNs in the area and based on this list or any other implementation specific means the UE determines that there is a higher priority PLMN than the selected VPLMN; or

ii) the UE does not have a list of available and allowable PLMNs in the area and is unable to determine whether there is a higher priority PLMN than the selected VPLMN using any other implementation specific means;

and the UE is in automatic network selection mode:

A) if the UE is configured with the SOR-CMCI or received the SOR-CMCI over N1 NAS signalling, the UE shall apply the actions in clause C.4.2. In this case steps 8 to 11 are skipped;

B) otherwise, the UE shall:

i) release the current N1 NAS signalling connection locally and then attempt to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired. In this case, steps 8 to 11 are skipped. The UE shall suspend the transmission of 5GSM messages until the N1 NAS signalling is released. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed. If the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]), the receipt of the steering of roaming information shall not trigger the release of the N1 NAS signalling connection. If camped on a NG-RAN cell, he UE shall release the current N1 NAS signalling connection locally subsequently after the emergency PDU session is released, otherwise the UE shall not take any further actions. If the UE needs to disable the N1 mode capability (see 3GPP TS 24.501 [64]) and there is no emergency service pending, the UE shall first attempt to obtain service on a higher priority PLMN as described in this step, and if no higher priority PLMN can be selected but the last registered PLMN is selected, then the UE shall disable the N1 mode capability; or

ii) not release the current N1 NAS signalling connection locally (e.g. if the UE has established PDU session(s)) and skip steps 8 to 10;

NOTE 15: When the UE is in the manual mode of operation or the current chosen VPLMN is part of the "User Controlled PLMN Selector with Access Technology" list, the UE stays on the VPLMN.

8) If the UE's USIM is configured with indication that the UE is to receive the steering of roaming information due to initial registration in a VPLMN, but neither the list of preferred PLMN/access technology combinations nor the secured packet nor the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided' is received in the REGISTRATION ACCEPT message, when the UE performs initial registration in a VPLMN or if the steering of roaming information is received but the security check is not successful, then the UE shall:

a) if the SOR transparent container is included in the REGISTRATION ACCEPT message, send the REGISTRATION COMPLETE message to the serving AMF without including an SOR transparent container;

b) if the current chosen VPLMN is not contained in the list of "PLMNs where registration was aborted due to SOR", and is not part of "User Controlled PLMN Selector with Access Technology" list and the UE is not in manual mode of operation:

i) if the steering of roaming information is received but the security check is not successful when the UE performs registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]) in a VPLMN and the UE has a SOR-CMCI stored in the non-volatile memory of the ME, and there are ongoing PDU sessions or services, the UE shall apply the actions in clause C.4.2. In this case, current PLMN is considered as lowest priority and steps 9 to 11 are skipped;

ii) otherwise, the UE shall release the current N1 NAS signalling connection locally and attempt to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired, with an exception that the current PLMN is considered as lowest priority, and skip steps 9 to 11. The UE shall suspend the transmission of 5GSM messages until the N1 NAS signalling is released. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed. If the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]), if camped on a NG-RAN cell, the UE shall release the current N1 NAS signalling connection locally after the release of the emergency PDU session, otherwise the UE shall not take any further actions. If the UE needs to disable the N1 mode capability (see 3GPP TS 24.501 [64]) and there is no emergency service pending, the UE shall first attempt to obtain service on a higher priority PLMN as described in this step, and if no higher priority PLMN can be selected but the last registered PLMN is selected, then the UE shall disable the N1 mode capability; and

c) if the current chosen VPLMN is not contained in the list of "PLMNs where registration was aborted due to SOR", store the PLMN identity in the list of "PLMNs where registration was aborted due to SOR";

NOTE 16: When the UE is in the manual mode of operation or the current chosen VPLMN is part of the "User Controlled PLMN Selector with Access Technology" list, the UE stays on the VPLMN.

9) The UE to the VPLMN AMF: If the UDM has requested an acknowledgement from the UE and the UE verified that the steering of roaming information has been provided by the HPLMN in step 7, then:

a) the UE sends the REGISTRATION COMPLETE message to the serving AMF with an SOR transparent container including the UE acknowledgement;

aa) the UE shall set the SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any;

b) the UE shall set the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container to "supported";

c) if the UE supports access to an SNPN using credentials from a credentials holder, the UE may set the "ME support of SOR-SNPN-SI" indicator in the header of the SOR transparent container to "supported"; and

d) if:

- the steering of roaming information contained a secured packet, then when the UE receives the USAT REFRESH command qualifier of type "Steering of Roaming" and neither a SOR-CMCI is included, nor the UE is configured with the SOR-CMCI, it performs items a), b) and c) of the procedure for steering of roaming in clause 4.4.6;

- the steering of roaming information contained a secured packet, then when the UE receives a USAT REFRESH with command qualifier (3GPP TS 31.111 [41]) of type "Steering of Roaming" and either a SOR-CMCI is included, or the UE is configured with the SOR-CMCI, the UE shall perform items a), b) and c) of the procedure for steering of roaming in clause 4.4.6 and if the UE is in automatic network selection mode then it shall apply the actions in clause C.4.2, and step 11 is skipped;

- the steering of roaming information contains the list of preferred PLMN/access technology combinations, the UE is configured with the SOR-CMCI or received the SOR-CMCI over N1 NAS signalling, and the UE is in automatic network selection mode, then the UE shall apply the actions in clause C.4.2, and step 11 is skipped; or

- the steering of roaming information contains an indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided', then step 11 is skipped;

10) The VPLMN AMF to the HPLMN UDM: If an SOR transparent container is received in the REGISTRATION COMPLETE message, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the HPLMN decided that the UE is to acknowledge the successful security check of the received steering of roaming information in step 4, the UDM verifies that the acknowledgement is provided by the UE as specified in 3GPP TS 33.501 [66]. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM receives the SOR-ACK-information, if any. If the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM shall store the "ME support of SOR-CMCI" indicator, otherwise the HPLMN UDM shall delete the stored "ME support of SOR-CMCI" indicator, if any. Additionally, if the "ME support of SOR-SNPN-SI" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM shall store the "ME support of SOR-SNPN-SI" indicator, otherwise the HPLMN UDM shall delete the stored "ME support of SOR-SNPN-SI" indicator, if any.

NOTE x: How the UDM uses the SOR-ACK-information for statistics reasons is out of scope for 3GPP.

NOTE 17: The UDM cannot receive the SOR-ACK-information, "ME support of SOR-CMCI" indicator or the "ME support of SOR-SNPN-SI" from the VPLMN AMF which does not support receiving SoR transparent container (see 3GPP TS 29.503 [78]).

10a) The HPLMN UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-CMCI" indicator, if any, "ME support of SOR-SNPN-SI" indicator, if any). If the HPLMN policy for the SOR-AF invocation is present and the HPLMN UDM received and verified the UE acknowledgement in step 10, then the HPLMN UDM informs the SOR-AF about successful delivery of the list of preferred PLMN/access technology combinations, or of the secured packet to the UE. If the SOR-ACK-information is received from the UE then the HPLMN UDM shall include the SOR-ACK-information. If the "ME support of SOR-CMCI" indicator is stored for the UE, the HPLMN UDM shall include the "ME support of SOR-CMCI" indicator. Additionally, if the "ME support of SOR-SNPN-SI" indicator is stored for the UE, the HPLMN UDM shall include the "ME support of SOR-SNPN-SI" indicator; and

NOTE 18: How the SOR-AF determines that the USIM for the indicated SUPI supports SOR-CMCI is implementation specific.

11) If the UE has a list of available PLMNs in the area and based on this list the UE determines that there is a higher priority PLMN than the selected VPLMN and the UE is in automatic network selection mode, then the UE shall attempt to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired after the release of the N1 NAS signalling connection. If within an implementation dependent time the N1 NAS signalling connection is not released, then the UE may locally release the N1 NAS signalling connection except when the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]). The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed.

When the UE performs initial registration for emergency services (see 3GPP TS 24.501 [64] and 3GPP TS 23.502 [63]) while the UE has a valid USIM and the AMF performs the authentication procedure, then based on HPLMN policy, the SOR procedure described in this clause may apply.

If:

- the UE in manual mode of operation encounters scenario mentioned in step 8 above; and

- upon switching to automatic network selection mode, the UE remembers that it is still registered on the PLMN where the missing or security check failure of SOR information was encountered as described in clause 8;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3, by acting as if timer T that controls periodic attempts has expired, with an exception that the current registered PLMN is considered as lowest priority. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed. If the UE has an established emergency PDU session, then the UE shall attempt to perform the PLMN selection subsequently after the emergency PDU session is released.

NOTE 19: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.

NOTE 20: The list of available and allowable PLMNs in the area is implementation specific.

NOTE 21: If the UE is served by any access technology other than NG-RAN, the HPLMN can initiate a steering of roaming procedure as specified in clause 4.4.6.

# C.3 Stage-2 flow for steering of UE in HPLMN or VPLMN after registration

The stage-2 flow for the steering of UE in HPLMN or VPLMN after registration is indicated in figure C.3.1. The selected PLMN can be the HPLMN or a VPLMN. The AMF is located in the selected PLMN. In this procedure, the SOR-CMCI, if any, is sent together with the list of preferred PLMN/access technology combinations in plain text or is sent within the secured packet.

The procedure is triggered:

- If the HPLMN UDM supports obtaining a list of preferred PLMN/access technology combinations and SOR-CMCI, if any, or a secured packet from the SOR-AF, the HPLMN policy for the SOR-AF invocation is present in the HPLMN UDM and the SOR-AF provides the HPLMN UDM with a new list of preferred PLMN/access technology combinations or a secured packet for a UE identified by SUPI. If the ME supports the SOR-CMCI, the SOR-AF may provide the SOR-CMCI and optionally provides the "Store SOR-CMCI in ME" indicator otherwise the SOR-AF shall provide neither the SOR-CMCI nor the "Store SOR-CMCI in ME" indicator.

The secured packet provided by the SOR-AF may include SOR-CMCI only if the SOR-AF has determined that the ME supports the SOR-CMCI and the USIM of the indicated SUPI supports SOR-CMCI. Otherwise if only the "ME support of SOR-CMCI" indicator is stored for the UE, then the SOR-AF shall not include the SOR-CMCI, if any, in the secured packet; or

NOTE 1: The SOR-AF can determine that the ME supports the SOR-CMCI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-CMCI" indicator. How the SOR-AF determines that the USIM for the indicated SUPI supports SOR-CMCI is implementation specific.

- When a new list of preferred PLMN/access technology combinations or a secured packet becomes available in the HPLMN UDM (i.e. retrieved from the UDR).

If the "ME support of SOR-CMCI" indicator is stored for the UE and the new list of preferred PLMN/access technology combinations becomes available in the HPLMN UDM (i.e. retrieved from the UDR), the HPLMN UDM shall obtain the SOR-CMCI and the "Store SOR-CMCI in ME" indicator, if available, otherwise the HPLMN UDM shall obtain neither the SOR-CMCI nor the "Store SOR-CMCI in ME" indicator.

NOTE 3: Based on operator deployment and policy, if the UDM receives the list of preferred PLMN/access technology combinations, SOR-CMCI, if any, the "Store SOR-CMCI in ME" indicator, if any, and the USIM of the indicated SUPI supports SOR-CMCI from the UDR, and the UDM supports communication with the SP-AF, the UDM can send this list and SOR-CMCI to the SP-AF requesting it to provide this information in a secured packet as defined in 3GPP TS 29.544 [71].

NOTE 4: Before providing the HPLMN UDM with a new list of preferred PLMN/access technology combinations or a secured packet for a UE identified by SUPI, the SOR-AF, based on operator policies or criteria, can obtain the user location information by triggering the unified location service exposure procedure as defined in 3GPP TS 23.273 [70] clause 6.5, or additionally based on implementation specific criteria, by requesting the UE location information from other application function using implementation specific method. This user location information can then be used in the SOR-AF algorithms.

NOTE 5: The secured packet obtained by the UDM can include SOR-CMCI only if the "ME support of SOR-CMCI" indicator is stored for the UE and the USIM of the indicated SUPI supports SOR-CMCI. Otherwise if only the "ME support of SOR-CMCI" indicator is stored for the UE, then the SOR-CMCI, if any, cannot be included in the secured packet.

Figure C.3.1: Procedure for providing list of preferred PLMN/access technology combinations and the SOR-CMCI, if any, or secured packet after registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

1) The SOR-AF to the HPLMN UDM: Nudm\_ParameterProvision\_Update request is sent to the HPLMN UDM to trigger the update of the UE with the new list of preferred PLMN/access technology combinations, the SOR-CMCI, if any, and the "Store SOR-CMCI in ME" indicator, if any, or a secured packet for a UE identified by SUPI.

2) The HPLMN UDM to the AMF: The UDM notifies the changes of the user profile to the affected AMF by the means of invoking Nudm\_SDM\_Notification service operation. The Nudm\_SDM\_Notification service operation contains the steering of roaming information that needs to be delivered transparently to the UE over NAS within the Access and Mobility Subscription data. If the HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information, the Nudm\_SDM\_Notification service operation also contains an indication that the UDM requests an acknowledgement from the UE as part of the steering of roaming information. If the SOR-CMCI was obtained, the HPLMN UDM shall include the SOR-CMCI into the steering of roaming information. If the "Store SOR-CMCI in ME" indicator was obtained, the HPLMN UDM shall include the "Store SOR-CMCI in ME" indicator; otherwise, the HPLMN UDM shall include the "Store SOR-CMCI in ME" indicator set to "Do not store SOR-CMCI in ME".

NOTE 6: The UDM cannot provide the SOR-CMCI, if any, to the VPLMN AMF which does not support receiving SoR transparent container (see 3GPP TS 29.503 [78]).

If the HPLMN UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info-request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation;

3) The AMF to the UE: the AMF sends a DL NAS TRANSPORT message to the served UE. The AMF includes in the DL NAS TRANSPORT message the steering of roaming information received from the UDM.

4) Upon receiving the steering of roaming information, the UE shall perform a security check on the steering of roaming information included in the DL NAS TRANSPORT message to verify that the steering of roaming information is provided by HPLMN, and:

- if the security check is successful and:

a) if the steering of roaming information contains a secured packet (see 3GPP TS 31.115 [67]):

- if the service "data download via SMS Point-to-point" is allocated and activated in the USIM Service Table (see 3GPP TS 31.102 [40]), the ME shall upload the secured packet to the USIM using procedures in 3GPP TS 31.111 [41].

If the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message and the ME receives UICC responses indicating that the UICC has received the secured packet successfully, then the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container to "supported". Additionally, if the UE supports access to an SNPN using credentials from a credentials holder, the UE may set the "ME support of SOR-SNPN-SI" indicator in the header of the SOR transparent container to "supported"; and

NOTE 7: How the ME handles UICC responses that do not indicate that the UICC has received the secured packet successfully and failures in communication between the ME and UICC is implementation specific and out of scope of this release of the specification.

- when the ME receives a USAT REFRESH command qualifier (see 3GPP TS 31.111 [41]) of type "Steering of Roaming" and neither a SOR-CMCI is included, nor the UE is configured with the SOR-CMCI, it performs the procedure for steering of roaming in clause 4.4.6 with an exception that if the UE is in automatic network selection mode, then the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN (specified in clause 4.4.6 bullet d); or

- when the ME receives a USAT REFRESH with command qualifier (see 3GPP TS 31.111 [41]) of type "Steering of Roaming" and either a SOR-CMCI is included, or the UE is configured with the SOR-CMCI, the UE shall perform items a), b) and c) of the procedure for steering of roaming in clause 4.4.6. If the UE is in automatic network selection mode it shall apply the actions in clause C.4.2;

b) if the steering of roaming information contains the list of preferred PLMN/access technology combinations, the ME shall replace the highest priority entries in the "Operator Controlled PLMN Selector with Access Technology" list stored in the ME with the received list of preferred PLMN/access technology combinations, and delete the PLMNs identified by the list of preferred PLMN/access technology combinations from the Forbidden PLMN list and from the Forbidden PLMNs for GPRS service list, if they are present in these lists.

If the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message, the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-CMCI" indicator to "supported". The UE shall set the SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any. Additionally, if the UE supports access to an SNPN using credentials from a credentials holder, the UE may set the "ME support of SOR-SNPN-SI" indicator in the header of the SOR transparent container to "supported".

If the UE is in automatic network selection mode and the selected PLMN is a VPLMN, then:

- if the UE has a SOR-CMCI stored in the non-volatile memory of the ME or received the SOR-CMCI over N1 NAS signalling, the UE shall apply the actions in clause C.4; or

- the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed.

If the selected PLMN is a VPLMN and the UE has an established emergency PDU session then the UE shall attempt to perform the PLMN selection subsequently after the emergency PDU session is released, if the UE is in automatic network selection mode.

If the UDM has not requested an acknowledgement from the UE, then step 5 is skipped; and

- If the selected PLMN is a VPLMN, the security check is not successful and the UE is in automatic network selection mode, then:

- if the UE has a SOR-CMCI stored in the non-volatile memory of the ME, the current PLMN is considered as lowest priority and the UE shall apply the actions in clause C.4.2; or

- if there are ongoing PDU sessions or services, the UE shall apply the actions in clause C.4.2; or

- the UE shall release the current N1 NAS signalling connection locally and attempt to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed;

- if the UE does not have a SOR-CMCI stored in the non-volatile memory of the ME, then:

- if there are ongoing PDU sessions or services, the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired, with an exception that the current PLMN is considered as lowest priority. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed. If the selected PLMN is a VPLMN and the UE has an established emergency PDU session, then the UE shall attempt to perform the PLMN selection after the emergency PDU session is released; or

- if there are no ongoing PDU sessions or services, the UE shall release the current N1 NAS signalling connection locally and attempt to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired, with an exception that the current PLMN is considered as lowest priority. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed.

Step 5 is skipped;

NOTE 8: When the UE is in the manual mode of operation or the current chosen VPLMN is part of the "User Controlled PLMN Selector with Access Technology" list, the UE stays on the VPLMN.

5) The AMF to the HPLMN UDM: If the UL NAS TRANSPORT message with an SOR transparent container is received, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information in step 1, the UDM verifies that the acknowledgement is provided by the UE. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM receives the SOR-ACK-information, if any.

NOTE x: How the UDM uses the SOR-ACK-information for statistics reasons is out of scope for 3GPP.

If the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM shall store the "ME support of SOR-CMCI" indicator, otherwise the HPLMN UDM shall delete the stored "ME support of SOR-CMCI" indicator, if any. Additionally, if the "ME support of SOR-SNPN-SI" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM shall store the "ME support of SOR-SNPN-SI" indicator, otherwise the HPLMN UDM shall delete the stored "ME support of SOR-SNPN-SI" indicator, if any; and

6) The HPLMN UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-CMCI" indicator, if any, "ME support of SOR-SNPN-SI" indicator, if any). If the HPLMN policy for the SOR-AF invocation is present and the HPLMN UDM received and verified the UE acknowledgement in step 5, then the HPLMN UDM informs the SOR-AF about successful delivery of the list of preferred PLMN/access technology combinations, SOR-CMCI, if any, or of the secured packet to the UE. If the "ME support of SOR-CMCI" indicator is stored for the UE, the HPLMN UDM shall include the "ME support of SOR-CMCI" indicator. Additionally, if the "ME support of SOR-SNPN-SI" indicator is stored for the UE, the HPLMN UDM shall include the "ME support of SOR-SNPN-SI" indicator. If the SOR-ACK-information is received from the UE then the HPLMN UDM shall include the SOR-ACK-information.

If the selected PLMN is a VPLMN and:

- the UE in manual mode of operation encounters security check failure of SOR information in DL NAS TRANSPORT message; and

- upon switching to automatic network selection mode, the UE remembers that it is still registered on the PLMN where the security check failure of SOR information was encountered;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3, by acting as if timer T that controls periodic attempts has expired, with an exception that the current registered PLMN is considered as lowest priority. The UE shall not initiate the establishment of a new N1 NAS signalling connection, unless for the purpose of initiating a registration procedure or establishing an emergency PDU session, until the attempts to obtain service on a higher priority PLMN are completed. If the selected PLMN is a VPLMN and the UE has an established emergency PDU session, then the UE shall attempt to perform the PLMN selection after the emergency PDU session is released.

NOTE 9: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.

NOTE 10: If the selected PLMN is the HPLMN, regardless whether the UE is in automatic network selection mode or manual network selection mode, regardless whether the UE has an established emergency PDU session or not, and regardless whether the security check is successful or not successful, the UE is not required to perform the PLMN selection.

## \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* NEXT CHANGE\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## C.4.3 Stage-2 flow for providing UE with SOR-CMCI in HPLMN, VPLMN, subscribed SNPN or non-subscribed SNPN after registration

The stage-2 flow for providing UE with SOR-CMCI in HPLMN, VPLMN, subscribed SNPN or non-subscribed SNPN after registration is indicated in figure C.4.3.1, when the ME supports the SOR-CMCI. The selected PLMN or SNPN can be the HPLMN, a VPLMN, the subscribed SNPN or a non-subscribed SNPN. The AMF is located in the selected PLMN or SNPN. The UDM is located in the HPLMN or the subscribed SNPN.

In this procedure, the SOR-CMCI is sent without the list of preferred PLMN/access technology combinations and the SOR-SNPN-SI. In this procedure, the SOR-CMCI is sent in plain text or is sent within the secured packet.

NOTE 1: The SOR-AF can determine that the ME supports the SOR-CMCI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-CMCI" indicator. The UDM can determine that the ME supports the SOR-CMCI if the "ME support of SOR-CMCI" indicator is stored for the UE. How the SOR-AF determines that the USIM for the indicated SUPI supports SOR-CMCI is implementation specific.

NOTE 2: The secured packet provided by the SOR-AF can include SOR-CMCI only if the SOR-AF has determined that the ME supports the SOR-CMCI and the USIM of the indicated SUPI supports SOR-CMCI. Otherwise if only the "ME support of SOR-CMCI" indicator is stored for the UE, then SOR-CMCI, if any, cannot be included in the secured packet.

The procedure is triggered:

- If the UDM supports obtaining the parameters of the list of preferred PLMN/access technology combinations, the SOR-SNPN-SI, the SOR-CMCI, and the "Store SOR-CMCI in ME" indicator, if any, or a secured packet from the SOR-AF, the HPLMN or subscribed SNPN policy for the SOR-AF invocation is present in the UDM and the SOR-AF provides the UDM with the SOR-CMCI for a UE identified by SUPI; or

- When the SOR-CMCI becomes available in the UDM (i.e., retrieved from the UDR).

Figure C.4.3.1: Procedure for configuring UE with SOR-CMCI after registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

1) The SOR-AF to the UDM: Nudm\_ParameterProvision\_Update request is sent to the UDM to trigger the update of the UE with the SOR-CMCI (in plain text or secured packet). In case of providing SOR-CMCI in plain text, include the "Store SOR-CMCI in ME" indicator, if applicable. In case of providing SOR-CMCI in a secured packet, include an indication that "the list of preferred PLMN/access technology combinations is not included in the secured packet".

2) The UDM to the AMF: The UDM notifies the changes of the user profile to the affected AMF by the means of invoking Nudm\_SDM\_Notification service operation. The Nudm\_SDM\_Notification service operation contains the steering of roaming information that needs to be delivered transparently to the UE over NAS within the Access and Mobility Subscription data. If the HPLMN or subscribed SNPN decided that the UE is to acknowledge successful security check of the received steering of roaming information, the Nudm\_SDM\_Notification service operation also contains an indication that the UDM requests an acknowledgement from the UE as part of the steering of roaming information. The UDM:

- upon receiving the SOR-CMCI (in plain text), shall:

i) if the UE is registered in the HPLMN or a VPLMN, include the SOR-CMCI, the "Store SOR-CMCI in ME" indicator, if any, and the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided';

ii) if the UE is registered in a non-subcribed SNPN, include the SOR-CMCI, the "Store SOR-CMCI in ME" indicator, if any, and the HPLMN or subscribed SNPN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided'; and

iii) if the UE is registered in a subcribed SNPN and the AMF has reported to the UDM that the UE supports SOR-SNPN-SI, include the SOR-CMCI, the "Store SOR-CMCI in ME" indicator, if any, and the HPLMN or subscribed SNPN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided'; or

- upon receiving the SOR-CMCI in secured packet, shall include the secured packet into the steering of roaming information.

NOTE 3: The UDM considers "the list of preferred PLMN/access technology combinations is not included in the secured packet" received together with the secured packet from the SOR-AF to indicate that the UE is not expected to perform SOR based on the associated steering of roaming information sent to the UE. However, the SOR-CMCI included in the secured packet can be applied by the UE if the UE has one or more Tsor-cm timers running as described in C.4.2.

NOTE 4: The UDM cannot provide the SOR-CMCI, if any, to the AMF which does not support receiving SoR transparent container (see 3GPP TS 29.503 [78]).

- If the UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info-request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation;

3) The AMF to the UE: the AMF sends a DL NAS TRANSPORT message to the served UE. The AMF includes in the DL NAS TRANSPORT message the steering of roaming information received from the UDM.

4) Upon receiving the steering of roaming information containing the SOR-CMCI and the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided' or the HPLMN or subscribed SNPN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided', or the secured packet, the UE shall perform a security check on the steering of roaming information included in the DL NAS TRANSPORT message to verify that the steering of roaming information is provided by HPLMN or subscribed SNPN, and:

a) if the security check is successful, the UE shall store the SOR-CMCI according to clause C.4.1. If the UE has one or more Tsor-cm timers running, the UE shall apply the received SOR-CMCI as described in C.4.2.

If the steering of roaming information contains a secured packet and the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message, the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-CMCI" indicator to "supported" only after the ME receives UICC responses indicating that the UICC has received the secured packet successfully. The UE shall indicate its support for SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any. Otherwise, if the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message, the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-CMCI" indicator to "supported". The UE shall indicate its support for SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any. Additionally, if the UE supports access to an SNPN using credentials from a credentials holder and the UE is in a PLMN, the UE may set the "ME support of SOR-SNPN-SI" indicator to "supported".

If the UDM has not requested an acknowledgement from the UE then step 5 is skipped; and

b) if the selected PLMN is a VPLMN or a non-subscribed SNPN, the security check is not successful and the UE is in automatic network selection mode, then:

- if the UE has a SOR-CMCI stored in the non-volatile memory of the ME, the current PLMN is considered as lowest priority and the UE shall apply the actions in clause C.4.2;

- otherwise, the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired, with an exception that the current PLMN is considered as lowest priority, or before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current registered SNPN is considered as lowest priority. If the selected PLMN or SNPN is a VPLMN or a non-subscribed SNPN and the UE has an established emergency PDU session then the UE shall attempt to perform the PLMN selection after the emergency PDU session is released and after the UE enters idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]).

Step 5 is skipped;

NOTE 5: When the UE is in the manual mode of operation or the current chosen VPLMN is part of the "User Controlled PLMN Selector with Access Technology" list or the current chosen non-subscribed SNPN is part of the user controlled prioritized list of preferred SNPNs for the selected entry of the "list of subscriber data" the selected PLMN subscription, the UE stays on the VPLMN or non-subscribed SNPN.

5) The AMF to the UDM: If the UL NAS TRANSPORT message with an SOR transparent container is received, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information in step 2, the UDM verifies that the acknowledgement is provided by the UE. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported", then the UDM receives the SOR-ACK-information, if any. The UDM shall store the "ME support of SOR-CMCI" indicator and the "ME support of SOR-SNPN-SI" indicator, if any; and

NOTE x: How the UDM uses the SOR-ACK-information for statistics reasons is out of scope for 3GPP.

6) The UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-CMCI" indicator, "ME support of SOR-SNPN-SI" indicator, if any). If the HPLMN policy for the SOR-AF invocation is present and the HPLMN UDM received and verified the UE acknowledgement in step 5, then the UDM informs the SOR-AF about successful delivery of the SOR-CMCI to the UE. The UDM shall include the "ME support of SOR-CMCI" indicator and the "ME support of SOR-SNPN-SI" indicator, if any. If the SOR-ACK-information is received from the UE then the UDM shall include the SOR-ACK-information.

If the selected PLMN is a VPLMN or a non-subscribed SNPN and:

- the UE in manual mode of operation encounters security check failure of SOR information in DL NAS TRANSPORT message; and

- upon switching to automatic network selection mode the UE remembers that it is still registered on the PLMN the non-subscribed SNPN where the security check failure of SOR information was encountered;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3, by acting as if timer T that controls periodic attempts has expired, with an exception that the current registered PLMN is considered as lowest priority, or before attempting to obtained service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current registered SNPN is considered as lowest priority. If the selected PLMN is a VPLMN or the selected SNPN is a non-subscribed SNPN and the UE has an established emergency PDU session then the UE shall attempt to perform the PLMN selection after the emergency PDU session is released and after the UE enters idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]).

NOTE 6: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.

# C.5 Stage-2 flow for steering of UE in SNPN during registration

The stage-2 flow for the case when the UE registers in a non-subscribed SNPN is described below in figure C.5.1. The AMF is located in the non-subscribed SNPN. The UDM is located in the HPLMN or subscribed SNPN.

Figure C.5.1: Procedure for providing SOR-SNPN-SI during registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

1) The UE to the AMF: The UE initiates initial registration, emergency registration or registration procedure for mobility and periodic registration update (see 3GPP TS 24.501 [64]) to the AMF by sending REGISTRATION REQUEST message with the 5GS registration type IE indicating "initial registration", "emergency registration" or "mobility registration updating";

2) Upon receiving the REGISTRATION REQUEST message, the AMF executes the registration procedure as defined in clause 4.2.2.2 of 3GPP TS 23.502 [63]. As part of the registration procedure:

a) the AMF provides the registration type to the UDM using Nudm\_UECM\_Registration. As a consequence, in case of the 5GS registration type message indicates "initial registration" or "emergency registration" the UDM shall delete the stored "ME support of SOR-CMCI" indicator, if any, in UDR using Nudr\_DM\_Update service operation (see 3GPP TS 23.502 [63]).

NOTE 1: Nudr\_DM\_Update service operation corresponds to Nudr\_DR\_Update service operation (see 3GPP TS 29.504 [82] and 3GPP TS 29.505 [83]).

In addition:

a) if the AMF does not have subscription data for the UE, the AMF invokes Nudm\_SDM\_Get service operation to the UDM to get amongst other information the Access and Mobility Subscription data for the UE (see step 14b in clause 4.2.2.2.2 of 3GPP TS 23.502 [63]); or

b) if the AMF already has subscription data for the UE and:

i) the 5GS registration type IE in the received REGISTRATION REQUEST message indicates "initial registration" and the "SoR Update Indicator for Initial Registration" field in the UE context is set to 'the UDM requests the AMF to retrieve SoR information when the UE performs NAS registration type "initial registration"' as specified in table 5.2.2.2.2-1 of 3GPP TS 23.502 [63]); or

ii) the 5GS registration type IE in the received REGISTRATION REQUEST message indicates "emergency registration" and the "SoR Update Indicator for Emergency Registration" field in the UE context is set to 'the UDM requests the AMF to retrieve SoR information when the UE performs NAS registration type "emergency registration"' as specified in table 5.2.2.2.2-1 of 3GPP TS 23.502 [63]);

then the VPLMN AMF invokes Nudm\_SDM\_Get service operation message to the HPLMN UDM to retrieve the steering of roaming information (see step 14b in clause 4.2.2.2.2 of 3GPP TS 23.502 [63]);

otherwise the AMF sends a REGISTRATION ACCEPT message without the steering of roaming information to the UE and steps 3a, 3b, 3c, 3d, 4, 5, 6 are skipped;

3a) If the user subscription information indicates to send the steering of roaming information due to initial registration in a non-subscribed SNPN, then the UDM shall provide the steering of roaming information to the UE when the UE performs initial registration in a non-subscribed SNPN. Otherwise:

a) If the UE is registering on the subscribed SNPN and the UE has not indicated support for SOR-SNPN-SI in the REGISTRATION REQUEST message, the UDM shall not provide the SOR-SNPN-SI to the UE; and

b) If the UE is registering on the subscribed SNPN and the UE has indicated support for SOR-SNPN-SI in the REGISTRATION REQUEST message, or the UE is not registering on the subscribed SNPN, the UDM may provide the SOR-SNPN-SI to the UE based on the subscribed SNPN or HPLMN policy.

If the UDM is to provide the steering of roaming information to the UE when the UE performs the registration in a non-subscribed SNPN and the subscribed SNPN or HPLMN policy for the SOR-AF invocation is absent then steps 3b and 3c are not performed and the UDM obtains the available SOR-SNPN-SI (i.e. all retrieved from the UDR). In addition, if the UDM obtains the SOR-SNPN-SI and the "ME support of SOR-CMCI" indicator is stored for the UE, then the UDM shall obtain the SOR-CMCI, if available, otherwise the UDM shall not obtain the SOR-CMCI. If the SOR-CMCI is provided then the UDM may indicate to the UE to store the SOR-CMCI in the ME by providing the "Store the SOR-CMCI in the ME" indicator.

If the UDM is to provide the steering of roaming information to the UE when the UE performs the registration in a non-subscribed SNPN and the subscribed SNPN or HPLMN policy for the SOR-AF invocation is present, then the UDM obtains the SOR-SNPN-SI, SOR-CMCI, if any, from the SOR-AF using steps 3b and 3c;

3b) The UDM to the SOR-AF: Nsoraf\_SoR\_Get request (SNPN identity, SUPI of the UE, access type (see 3GPP TS 29.571 [72])). The SNPN identity and the access type parameters, indicating where the UE is registering, are stored in the UDM;

3c) The SOR-AF to the UDM: Nsoraf\_SoR\_Get response (the SOR-SNPN-SI, the SOR-CMCI, if any, and the "Store the SOR-CMCI in the ME" indicator, if any);

Based on the information received in step 3b and any subscribed SNPN or HPLMN specific criteria, the SOR-AF may include the SOR-SNPN-SI, the SOR-CMCI, if any, and optionally the "Store the SOR-CMCI in the ME" indicator, if any.

If the SOR-AF includes the SOR-SNPN-SI and the ME supports the SOR-CMCI, the SOR-AF may provide the SOR-CMCI and optionally the "Store the SOR-CMCI in the ME" indicator, otherwise the SOR-AF shall provide neither the SOR-CMCI nor the "Store the SOR-CMCI in the ME" indicator.

NOTE 1: In this version of the specification, when the access type where the UE is registering indicates 3GPP access, then the UE is registering over the NG-RAN access technology.

NOTE 2: The SOR-AF can include a different SOR-SNPN-SI, different SOR-CMCI, if any, and different "Store the SOR-CMCI in the ME" indicator, if any, for each Nsoraf\_SoR\_Get request even if the same SNPN identity, the SUPI of the UE, and the access type are provided to the SOR-AF.

NOTE 3: The SOR-AF can subscribe to the UDM to be notified about the changes of the roaming status of the UE identified by SUPI.

NOTE 4: The SOR-AF can determine that the ME supports the SOR-CMCI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-CMCI" indicator.

3d) The UDM forms the steering of roaming information as specified in 3GPP TS 33.501 [66] from the SOR-SNPN-SI, the SOR-CMCI, if any, and the "Store the SOR-CMCI in the ME" indicator, if any, obtained in step 3a or the SOR-SNPN-SI, the SOR-CMCI, if any, and the "Store the SOR-CMCI in the ME" indicator, if any, obtained in step 3c.

If:

- the SOR-SNPN-SI was not obtained in steps 3a or 3c; or

- the SOR-AF has not sent to the UDM an Nsoraf\_SoR\_Get response (step 3c) within an operator defined time after the UDM sending to the SOR-AF an Nsoraf\_SoR\_Get request (step 3b);

NOTE 5: Stage 3 to define the timer needed for the SOR-AF to respond to the UDM. The max time needs to be defined considering that this procedure is part of the registration procedure.

and the UE is performing initial registration in a non-subscribed SNPN and the user subscription information indicates to send the steering of roaming information due to initial registration in a non-subscribed SNPN, then the UDM forms the steering of roaming information as specified in 3GPP TS 33.501 [66] from the subscribed SNPN or HPLMN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided';

4) The UDM to the AMF: The UDM sends a response to the Nudm\_SDM\_Get service operation to the AMF, which includes the steering of roaming information within the Access and Mobility Subscription data. The Access and Mobility Subscription data type is defined in clause 5.2.3.3.1 of 3GPP TS 23.502 [63]).

NOTE 6: The UDM cannot provide the SOR-SNPN-SI or the SOR-CMCI, if any, to the AMF which does not support receiving SOR transparent container (see 3GPP TS 29.503 [78]).

If the UE is performing initial registration or emergency registration and the UDM supports SOR-CMCI, the HPLMN shall request the UE to acknowledge the successful security check of the received steering of roaming information, by providing the indication as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation. Otherwise, the subscribed SNPN or HPLMN may request the UE to acknowledge the successful security check of the received steering of roaming information, by providing the indication as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation.

If the UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info-request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation;

5) The AMF to the UDM: As part of the registration procedure, the SNPN also invokes Nudm\_SDM\_Subscribe service operation to the UDM to subscribe to notification of changes of the subscription data (e.g. received in step 4) including notification of updates of the steering of roaming information included in the Access and Mobility Subscription data (see step 14c in clause 4.2.2.2.2 of 3GPP TS 23.502 [63]);

6) The AMF to the UE: The AMF shall transparently send the received steering of roaming information to the UE in the REGISTRATION ACCEPT message;

7) If the steering of roaming information is received and the security check is successful, then:

a) if the UDM has not requested an acknowledgement from the UE, then the UE shall send the REGISTRATION COMPLETE message to the serving AMF without including an SOR transparent container;

aa) the UE shall indicate its support for SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any; and

b) if the steering of roaming information contains the SOR-SNPN-SI, the ME shall replace the credentials holder controlled prioritized lists of preferred SNPNs for the selected entry of the "list of subscriber data" or the selected PLMN subscription with the received credentials holder controlled prioritized lists of preferred SNPNs, if any, and the ME shall replace the credentials holder controlled prioritized lists of GINs for the selected entry of the "list of subscriber data" or the selected PLMN subscription with the received credentials holder controlled prioritized lists of GINs, if any, and delete the SNPNs identified by the credentials holder controlled prioritized lists of preferred SNPNs or credentials holder controlled prioritized lists of GINs from the list of "temporarily forbidden SNPNs" and the list of "permanently forbidden SNPNs", if they are present in these lists. Additionally, the UE may perform SNPN selection. If the UE decides to perform SNPN selection:

i) if the UE has a list of available and allowable SNPN in the area and based on this list or any other implementation specific means the UE determines that there is a higher priority SNPN than the selected SNPN; or

ii) the UE does not have a list of available and allowable SNPN in the area and is unable to determine whether there is a higher priority SNPN than the selected SNPN using any other implementation specific means;

and the UE is in automatic network selection mode:

A) if the UE is configured with the SOR-CMCI or received the SOR-CMCI over N1 NAS signalling, the UE shall apply the actions in clause C.4.2. In this case steps 8 to 11 are skipped;

B) otherwise, the UE shall:

i) release the current N1 NAS signalling connection locally and then attempt to obtain service on a higher priority SNPN as specified in clause 4.9.3. In this case, steps 8 to 11 are skipped. The UE shall suspend the transmission of 5GSM messages until the N1 NAS signalling is released. If the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]), the receipt of the steering of roaming information shall not trigger the release of the N1 NAS signalling connection. The UE shall release the current N1 NAS signalling connection locally subsequently after the emergency PDU session is released. If the UE needs to disable the N1 mode capability (see 3GPP TS 24.501 [64]) and there is no emergency service pending, the UE shall first attempt to obtain service on a higher priority SNPN as described in this step, and if no higher priority SNPN can be selected but the last registered SNPN is selected, then the UE shall disable the N1 mode capability; or

ii) not release the current N1 NAS signalling connection locally (e.g. if the UE has established PDU session(s)) and skip steps 8 to 10;

NOTE 7: When the UE is in the manual mode of operation or the current chosen non-subscribed SNPN is part of the user controlled prioritized list of preferred SNPNs, the UE stays on the current chosen non-subscribed SNPN.

8) If the UE's ME is configured with an indication that the UE is to receive the steering of roaming information due to initial registration in a non-subscribed SNPN, but neither the SOR-SNPN-SI nor the subscribed SNPN or HPLMN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided' is received in the REGISTRATION ACCEPT message, when the UE performs initial registration in a VPLMN or if the steering of roaming information is received but the security check is not successful, then the UE shall:

a) if the SOR transparent container is included in the REGISTRATION ACCEPT message, send the REGISTRATION COMPLETE message to the serving AMF without including an SOR transparent container;

b) if the current chosen non-subscribed SNPN is not contained in the list of "SNPNs where registration was aborted due to SOR" for the selected entry in the "list of subscriber data" or the selected PLMN subscription, and is not part of the user controlled prioritized list of preferred SNPNs for the selected entry in the "list of subscriber data" or the selected PLMN subscription, and the UE is not in manual mode of operation, release the current N1 NAS signalling connection locally and attempt to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current SNPN is considered as lowest priority, and skip steps 9 to 11. The UE shall suspend the transmission of 5GSM messages until the N1 NAS signalling is released. If the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]), the UE shall release the current N1 NAS signalling connection locally after the release of the emergency PDU session. If the UE needs to disable the N1 mode capability (see 3GPP TS 24.501 [64]) and there is no emergency service pending, the UE shall first attempt to obtain service on a higher priority SNPN as described in this step, and if no higher priority SNPN can be selected but the last registered SNPN is selected, then the UE shall disable the N1 mode capability; and

c) if the current chosen non-subscribed SNPN is not contained in the list of "SNPNs where registration was aborted due to SOR" for the selected entry in the "list of subscriber data" or the selected PLMN subscription, store the SNPN identity in the list of "SNPNs where registration was aborted due to SOR" for the selected entry in the "list of subscriber data" or the selected PLMN subscription;

NOTE 8: When the UE is in the manual mode of operation or the current chosen non-suscribed SNPN is part of the user controlled prioritized list of preferred SNPNs, the UE stays on the current chosen non-subscribed SNPN.

9) The UE to the AMF: If the UDM has requested an acknowledgement from the UE and the UE verified that the steering of roaming information has been provided by the subscribed SNPN or HPLMN in step 7, then:

a) the UE sends the REGISTRATION COMPLETE message to the serving AMF with an SOR transparent container including the UE acknowledgement;

b) the UE shall set the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container to "supported"; and

c) if:

1) the steering of roaming information contains the SOR-SNPN-SI, the UE is configured with the SOR-CMCI or received the SOR-CMCI over N1 NAS signalling, the UE is in automatic network selection mode and the UE decides to perform SNPN selection, then the UE shall apply the actions in clause C.4.2, and step 11 is skipped; or

2) the steering of roaming information contains subscribed SNPN or HPLMN indication that 'no change of the SOR-SNPN-SI stored in the UE is needed and thus no SOR-SNPN-SI is provided', then step 11 is skipped;

10) The AMF to the UDM: If an SOR transparent container is received in the REGISTRATION COMPLETE message, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the subscribed SNPN or HPLMN decided that the UE is to acknowledge the successful security check of the received steering of roaming information in step 4, the UDM verifies that the acknowledgement is provided by the UE as specified in 3GPP TS 33.501 [66]. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall the UDM receives the SOR-ACK-information, if any. If the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container is set to "supported", then the UDM shall store the "ME support of SOR-CMCI" indicator, otherwise the UDM shall delete the stored "ME support of SOR-CMCI" indicator, if any.

NOTE 9: The UDM cannot receive the "ME support of SOR-ACK-Info" indicator, the SOR-ACK-information, or the "ME support of SOR-CMCI" indicator from the AMF which does not support receiving SoR transparent container (see 3GPP TS 29.503 [78]).

10a) The UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-CMCI" indicator, if any). If the subscribed SNPN or HPLMN policy for the SOR-AF invocation is present and the UDM received and verified the UE acknowledgement in step 10, then the UDM informs the SOR-AF about successful delivery of the SOR-SNPN-SI to the UE. If the "ME support of SOR-CMCI" indicator is stored for the UE, the HPLMN UDM shall include the "ME support of SOR-CMCI" indicator. If the SOR-ACK-information is received from the UE then the UDM shall include the SOR-ACK-information; and

11) If the UE has a list of available SNPNs in the area and based on this list the UE determines that there is a higher priority SNPN than the selected SNPN and the UE is in automatic network selection mode, then the UE may attempt to obtain service on a higher priority SNPN as specified in clause 4.9.3 after the release of the N1 NAS signalling connection. If within an implementation dependent time the N1 NAS signalling connection is not released, then the UE may locally release the N1 signalling connection except when the UE has an established emergency PDU session (see 3GPP TS 24.501 [64]).

When the UE performs initial registration for emergency services (see 3GPP TS 24.501 [64] and 3GPP TS 23.502 [63]) and the AMF performs the authentication procedure, then based on subscribed SNPN or HPLMN policy, the SOR procedure described in this clause may apply.

If:

- the UE in manual mode of operation encounters scenario mentioned in step 8 above; and

- upon switching to automatic network selection mode, the UE remembers that it is still registered on the where the security check failure of SOR information was encountered as described in step 8;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current registered SNPN is considered as lowest priority. If the UE has an established emergency PDU session, then the UE shall attempt to perform the SNPN selection subsequently after the emergency PDU session is released.

NOTE 10: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.

NOTE 11: The list of available and allowable SNPNs in the area is implementation specific.

# C.6 Stage-2 flow for steering of UE in SNPN after registration

The stage-2 flow for the steering of UE in SNPN after registration is indicated in figure C.6.1. The UE is registered on an SNPN which can be the subscribed SNPN or a non-subscribed SNPN. The AMF is located in the selected SNPN. The UDM is located in the HPLMN or subscribed SNPN.

The procedure is triggered:

- If the UDM supports obtaining SOR-SNPN-SI and SOR-CMCI, if any, from the SOR-AF, the subscribed SNPN or HPLMN policy for the SOR-AF invocation is present in the UDM and the SOR-AF provides the UDM with SOR-SNPN-SI for a UE identified by SUPI. If the ME supports the SOR-CMCI, the SOR-AF may provide the SOR-CMCI and optionally provides the "Store the SOR-CMCI in the ME" indicator otherwise the SOR-AF shall provide neither the SOR-CMCI nor the "Store the SOR-CMCI in the ME" indicator; or

NOTE 0: The SOR-AF can determine that the ME supports SOR-SNPN-SI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-SNPN-SI" indicator. The UDM determines that the ME supports SOR-SNPN-SI if the UE is in a non-subscribed SNPN or the UE is a subscribed SNPN and the AMF has indicated to the UDM that the UE supports SOR-SNPN-SI.

NOTE 1: The SOR-AF can determine that the ME supports the SOR-CMCI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-CMCI" indicator. How the SOR-AF determines that the USIM for the indicated SUPI supports SOR-CMCI is implementation specific.

- When a SOR-SNPN-SI becomes available in the UDM (i.e. retrieved from the UDR). If the "ME support of SOR-CMCI" indicator is stored for the UE, the HPLMN UDM shall obtain the SOR-CMCI and the "Store the SOR-CMCI in the ME" indicator, if available, otherwise the HPLMN UDM shall obtain neither the SOR-CMCI nor the "Store the SOR-CMCI in the ME" indicator.

NOTE 2: Before providing the UDM with SOR-SNPN-SI for a UE identified by SUPI, the SOR-AF, based on subscribed SNPN or HPLMN policies or criteria, can obtain the user location information by triggering the unified location service exposure procedure as defined in 3GPP TS 23.273 [70] clause 6.5, or additionally based on implementation specific criteria, by requesting the UE location information from other application function using implementation specific method. This user location information can then be used in the SOR-AF algorithms.

NOTE 3: Before providing the UDM with a new SOR-SNPN-SI for a UE identified by SUPI, the SOR-AF, based on subscribed SNPN or HPLMN policies or criteria, can obtain the user location information by triggering the unified location service exposure procedure as defined in 3GPP TS 23.273 [70] clause 6.5, or additionally based on implementation specific criteria, by requesting the UE location information from other application function using implementation specific method. This user location information can then be used in the SOR-AF algorithms.

Figure C.6.1: Procedure for providing SOR-SNPN-SI after registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

0) The SOR-AF to the UDM: Nudm\_ParameterProvision\_Update request is sent to the UDM to trigger the update of the UE with the SOR-SNPN-SI, the SOR-CMCI, if any, and the "Store the SOR-CMCI in the ME" indicator, if any, for a UE identified by SUPI.

1) The UDM to the AMF: The UDM notifies the changes of the user profile to the affected AMF by the means of invoking Nudm\_SDM\_Notification service operation. The Nudm\_SDM\_Notification service operation contains the steering of roaming information that needs to be delivered transparently to the UE over NAS within the Access and Mobility Subscription data. If the subcribed SNPN or HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information, the Nudm\_SDM\_Notification service operation also contains an indication that the UDM requests an acknowledgement from the UE as part of the steering of roaming information. If the SOR-CMCI was obtained, the UDM shall include the SOR-CMCI into the steering of roaming information and shall requests an acknowledgement from the UE as part of the steering of roaming information. If the "Store the SOR-CMCI in the ME" indicator was obtained, the HPLMN UDM shall include the "Store the SOR-CMCI in the ME" indicator.

NOTE 4: The UDM cannot provide the SOR-SNPN-SI or SOR-CMCI to the AMF which does not support receiving SOR transparent container (see 3GPP TS 29.503 [78]).

If the UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info--request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation;

2) The AMF to the UE: the AMF sends a DL NAS TRANSPORT message to the served UE. The AMF includes in the DL NAS TRANSPORT message the steering of roaming information received from the UDM.

3) Upon receiving the steering of roaming information, the UE shall perform a security check on the steering of roaming information included in the DL NAS TRANSPORT message to verify that the steering of roaming information is provided by the subcribed SNPN or HPLMN, and

- if the security check is successful, then:

a) if the steering of roaming information contains the SOR-SNPN-SI, the ME shall replace the credentials holder controlled prioritized lists of preferred SNPNs for the selected entry of the "list of subscriber data" or the selected PLMN subscription with the received credentials holder controlled prioritized lists of preferred SNPNs, if any, the ME shall replace the credentials holder controlled prioritized lists of GINs for the selected entry of the "list of subscriber data" or the selected PLMN subscription with the received credentials holder controlled prioritized lists of GINs, if any, and the ME shall delete the SNPNs identified by the credentials holder controlled prioritized lists of preferred SNPNs or credentials holder controlled prioritized lists of GINs from the list of "temporarily forbidden SNPNs" and the list of "permanently forbidden SNPNs", if they are present in these lists.

If the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message, the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-CMCI" indicator to "supported". The UE shall set the SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any.

If the UE is in automatic network selection mode, the selected SNPN is a non-subscribed SNPN and the UE decides to perform SNPN selection, then:

- if the UE is configured with the SOR-CMCI or received the SOR-CMCI over N1 NAS signalling, the UE shall apply the actions in clause C.4; or

- the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3.

If the selected SNPN is a non-subscribed SNPN and the UE has an established emergency PDU session then the UE may attempt to perform the SNPN selection subsequently after the emergency PDU session is released, if the UE is in automatic network selection mode.

If the UDM has not requested an acknowledgement from the UE, then steps 4 is skipped; and

- If the selected SNPN is a non-subscribed SNPN, the security check is not successful and the UE is in automatic network selection mode, then:

- if the UE has a SOR-CMCI stored in the non-volatile memory of the ME, then:

- if there are ongoing PDU sessions or services, the UE shall apply the actions in clause C.4.2, and the current SNPN is considered as lowest priority; or

- if there are no ongoing PDU sessions or services, the UE shall release the current N1 NAS signalling connection locally and attempt to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current SNPN is considered as lowest priority;

- if the UE does not have a SOR-CMCI stored in the non-volatile memory of the ME, then:

- if there are ongoing PDU sessions or services, the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current SNPN is considered as lowest priority. If the selected SNPN is a non-subscribed SNPN and the UE has an established emergency PDU session, then the UE shall attempt to perform the SNPN selection after the emergency PDU session is released; or

- if there are no ongoing PDU sessions or services, the UE shall release the current N1 NAS signalling connection locally and attempt to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current SNPN is considered as lowest priority.

If the UDM has not requested an acknowledgement from the UE, then step 4 is skipped;

NOTE 5: When the UE is in the manual mode of operation and the current chosen non-subscribed SNPN is part of the user controlled prioritized list of preferred SNPNs, the UE stays on the current chosen non-subscribed SNPN.

4) The AMF to the UDM: If the UL NAS TRANSPORT message with an SOR transparent container is received, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the subcribed SNPN or HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information in step 1, the UDM verifies that the acknowledgement is provided by the UE. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall, then the UDM receives the SOR-ACK-information, if any. If the "ME support of SOR-CMCI" indicator in the header of the SOR transparent container is set to "supported", then the HPLMN UDM shall store the "ME support of SOR-CMCI" indicator, otherwise the HPLMN UDM shall delete the stored "ME support of SOR-CMCI" indicator, if any.

If the present flow was invoked by the UDM after receiving from the SOR-AF the SOR-SNPN-SI, SOR-CMCI, if any, for a UE identified by SUPI using an Nudm\_ParameterProvision\_Update request, and the UDM verification of the UE acknowledgement is successful, then the UDM informs the SOR-AF about successful delivery of the SOR-SNPN-SI, SOR-CMCI, if any, using Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery); and

5) The UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-CMCI" indicator, if any). If the subscribed SNPN or HPLMN policy for the SOR-AF invocation is present and the UDM received and verified the UE acknowledgement in step 5, then the UDM informs the SOR-AF about successful delivery of the SOR-SNPN-SI, SOR-CMCI, if any, to the UE. If the "ME support of SOR-CMCI" indicator is stored for the UE, the HPLMN UDM shall include the "ME support of SOR-CMCI" indicator. If the SOR-ACK-information is received from the UE then the UDM shall include the SOR-ACK-information;

If the selected SNPN is a non-subscribed SNPN and:

- the UE in manual mode of operation encounters security check failure of SOR information in DL NAS TRANSPORT message; and

- upon switching to automatic network selection mode, the UE remembers that it is still registered on the where the security check failure of SOR information was encountered;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current registered SNPN is considered as lowest priority. If the selected SNPN is a non-subscribed SNPN and the UE has an established emergency PDU session, then the UE shall attempt to perform the SNPN selection after the emergency PDU session is released.

NOTE 6: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.

NOTE 7: If the selected SNPN is the subscribed SNPN, regardless of whether the UE is in automatic network selection mode or manual network selection mode, regardless of whether the UE has an established emergency PDU session or not, and regardless of whether the security check is successful or not successful, the UE is not required to perform the SNPN selection.

# C.7 Stage-2 flow for providing UE with SOR-SNPN-SI in HPLMN or VPLMN after registration

The stage-2 flow for providing UE with SOR-SNPN-SI in HPLMN or VPLMN after registration is indicated in figure C.7.1, when the ME and the HPLMN support the SOR-SNPN-SI. The selected PLMN can be the HPLMN or a VPLMN. The AMF is located in the selected PLMN. The UDM is located in the HPLMN.

In this procedure, the SOR-SNPN-SI is sent without the list of preferred PLMN/access technology combinations.

NOTE 1: The SOR-AF can determine that the ME supports the SOR-SNPN-SI if the Nsoraf\_SoR\_Info service operation has returned the "ME support of SOR-SNPN-SI" indicator. The UDM can determine that the ME supports the SOR-SNPN-SI if the "ME support of SOR-SNPN-SI" indicator is stored for the UE.

The procedure is triggered:

- If the UDM supports obtaining the SOR-SNPN-SI from the SOR-AF, the HPLMN policy for the SOR-AF invocation is present in the UDM and the SOR-AF provides the UDM with the SOR-SNPN-SI for a UE identified by SUPI; or

- When the SOR-SNPN-SI becomes available in the UDM (i.e., retrieved from the UDR).

Figure C.7.1: Procedure for configuring UE with SOR-SNPN-SI in a PLMN after registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

1) The SOR-AF to the UDM: Nudm\_ParameterProvision\_Update request is sent to the UDM to trigger the update of the UE with the SOR-SNPN-SI.

2) The UDM to the AMF: The UDM notifies the changes of the user profile to the affected AMF by the means of invoking Nudm\_SDM\_Notification service operation. The Nudm\_SDM\_Notification service operation contains the steering of roaming information that needs to be delivered transparently to the UE over NAS within the Access and Mobility Subscription data. If the HPLMN or subscribed SNPN decided that the UE is to acknowledge successful security check of the received steering of roaming information, the Nudm\_SDM\_Notification service operation also contains an indication that the UDM requests an acknowledgement from the UE as part of the steering of roaming information. Upon receiving the SOR-SNPN-SI, the UDM shall include the SOR-SNPN-SI and the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided'.

NOTE 2: The UDM cannot provide the SOR-SNPN-SI, if any, to the AMF which does not support receiving SoR transparent container (see 3GPP TS 29.503 [78]).

If the UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info-request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation;

3) The AMF to the UE: the AMF sends a DL NAS TRANSPORT message to the served UE. The AMF includes in the DL NAS TRANSPORT message the steering of roaming information received from the UDM.

4) Upon receiving the steering of roaming information containing the SOR-SNPN-SI and the HPLMN indication that 'no change of the "Operator Controlled PLMN Selector with Access Technology" list stored in the UE is needed and thus no list of preferred PLMN/access technology combinations is provided', the UE shall perform a security check on the steering of roaming information included in the DL NAS TRANSPORT message to verify that the steering of roaming information is provided by HPLMN, and:

a) if the security check is successful, the ME shall replace the credentials holder controlled prioritized lists of preferred SNPNs for the selected PLMN subscription with the received credentials holder controlled prioritized lists of preferred SNPNs, if any, the ME shall replace the credentials holder controlled prioritized lists of GINs for the selected PLMN subscription with the received credentials holder controlled prioritized lists of GINs, if any, and the ME shall delete the SNPNs identified by the credentials holder controlled prioritized lists of preferred SNPNs or credentials holder controlled prioritized lists of GINs from the list of "temporarily forbidden SNPNs" and the list of "permanently forbidden SNPNs", if they are present in these lists.

If the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message, the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-SNPN-SI" indicator to "supported". The UE shall set the SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any.

If the UDM has not requested an acknowledgement from the UE then step 5 is skipped; and

b) if the selected PLMN is a VPLMN, the security check is not successful and the UE is in automatic network selection mode, then:

- if the UE has a SOR-CMCI stored in the non-volatile memory of the ME, the current PLMN is considered as lowest priority and the UE shall apply the actions in clause C.4.2;

- otherwise, the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3 by acting as if timer T that controls periodic attempts has expired, with an exception that the current PLMN is considered as lowest priority. If the selected PLMN is a VPLMN and the UE has an established emergency PDU session then the UE shall attempt to perform the PLMN selection after the emergency PDU session is released and after the UE enters idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]).

Step 5 is skipped;

NOTE 3: When the UE is in the manual mode of operation or the current chosen VPLMN is part of the "User Controlled PLMN Selector with Access Technology" list, the UE stays on the VPLMN.

5) The AMF to the UDM: If the UL NAS TRANSPORT message with an SOR transparent container is received, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information in step 2, the UDM verifies that the acknowledgement is provided by the UE. The UDM shall store the "ME support of SOR-SNPN-SI" indicator. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported", then the UDM receives the SOR-ACK-information, if any.

NOTE x: How the UDM uses the SOR-ACK-information for statistics reasons is out of scope for 3GPP.

If the present flow was invoked by the UDM after receiving from the SOR-AF the SOR-SNPN-SI for a UE identified by SUPI using an Nudm\_ParameterProvision\_Update request, and the UDM verification of the UE acknowledgement is successful, then the UDM informs the SOR-AF about successful delivery of the SOR-CMCI using Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery); and

6) The UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-SNPN-SI" indicator). If the HPLMN policy for the SOR-AF invocation is present and the HPLMN UDM received and verified the UE acknowledgement in step 5, then the UDM informs the SOR-AF about successful delivery of the SOR-SNPN-SI to the UE. The UDM shall include the "ME support of SOR-SNPN-SI" indicator. If the SOR-ACK-information is received from the UE then the UDM shall include the SOR-ACK-information.

If the selected PLMN is a VPLMN and:

- the UE in manual mode of operation encounters security check failure of SOR information in DL NAS TRANSPORT message; and

- upon switching to automatic network selection mode the UE remembers that it is still registered on the PLMN where the security check failure of SOR information was encountered;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority PLMN as specified in clause 4.4.3.3, by acting as if timer T that controls periodic attempts has expired, with an exception that the current registered PLMN is considered as lowest priority. If the selected PLMN is a VPLMN and the UE has an established emergency PDU session then the UE shall attempt to perform the PLMN selection after the emergency PDU session is released and after the UE enters idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]).

NOTE 4: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.

# C.8 Stage-2 flow for providing UE with list of preferred PLMN/access technology combinations in SNPN after registration

The stage-2 flow for providing UE with the list of preferred PLMN/access technology combinations in an SNPN after registration is indicated in figure C.8.1. The selected SNPN is a non-subscribed SNPN. The AMF is located in the selected SNPN. The UDM is located in the HPLMN.

In this procedure, the list of preferred PLMN/access technology combinations is sent in plain text or sent within the secured packet, without the SOR-SNPN-SI.

Based on HPLMN policy, if the HPLMN supports sending the list of preferred PLMN/access technology combinations in plain text or secured packet to the UE when the UE is registered to an SNPN, then the procedure is triggered:

- If the UDM supports obtaining a list of preferred PLMN/access technology combinations or a secured packet from the SOR-AF, the HPLMN policy for the SOR-AF invocation is present in the UDM and the SOR-AF provides the UDM with a new list of preferred PLMN/access technology combinations or a secured packet for a UE identified by SUPI; or

- When a new list of preferred PLMN/access technology combinations or a secured packet becomes available in the UDM (i.e., retrieved from the UDR).

Figure C.8.1: Procedure for configuring UE with list of preferred PLMN/access technology combinations in an SNPN after registration

For the steps below, security protection is described in 3GPP TS 33.501 [24].

1) The SOR-AF to the UDM: Nudm\_ParameterProvision\_Update request is sent to the UDM to trigger the update of the UE with the new list of preferred PLMN/access technology combinations or a secured packet for a UE identified by SUPI.

2) The UDM to the AMF: The UDM notifies the changes of the user profile to the affected AMF by the means of invoking Nudm\_SDM\_Notification service operation. The Nudm\_SDM\_Notification service operation contains the steering of roaming information that needs to be delivered transparently to the UE over NAS within the Access and Mobility Subscription data. If the HPLMN or subscribed SNPN decided that the UE is to acknowledge successful security check of the received steering of roaming information, the Nudm\_SDM\_Notification service operation also contains an indication that the UDM requests an acknowledgement from the UE as part of the steering of roaming information.

If the UDM supports receiving the SOR-ACK-information from the UE it provides the indication "ACK-info-request" as part of the steering of roaming information in the Nudm\_SDM\_Get response service operation.

3) The AMF to the UE: the AMF sends a DL NAS TRANSPORT message to the served UE. The AMF includes in the DL NAS TRANSPORT message the steering of roaming information received from the UDM.

4) Upon receiving the steering of roaming information, the UE shall perform a security check on the steering of roaming information included in the DL NAS TRANSPORT message to verify that the steering of roaming information is provided by HPLMN, and:

a) if the security check is successful:

- if the steering of roaming information contains a secured packet (see 3GPP TS 31.115 [67]) and the service "data download via SMS Point-to-point" is allocated and activated in the USIM Service Table (see 3GPP TS 31.102 [40]), the ME shall upload the secured packet to the USIM using procedures in 3GPP TS 31.111 [41]; and

- if the steering of roaming information contains the list of preferred PLMN/access technology combinations, the ME shall replace the highest priority entries in the "Operator Controlled PLMN Selector with Access Technology" list stored in the ME with the received list of preferred PLMN/access technology combinations, and delete the PLMNs identified by the list of preferred PLMN/access technology combinations from the Forbidden PLMN list and from the Forbidden PLMNs for GPRS service list, if they are present in these lists.

If the UDM has requested an acknowledgement from the UE in the DL NAS TRANSPORT message, the UE sends an UL NAS TRANSPORT message to the serving AMF with an SOR transparent container including the UE acknowledgement and the UE shall set the "ME support of SOR-SNPN-SI" indicator to "supported". The UE shall set the SOR-ACK-info in the header of the SOR transparent container to "supported". If the UDM sets the indication "ACK-info-request" in steering of information header to "Acknowledgment information requested" then the UE shall provide the SOR-ACK-information, if any.

If the UDM has not requested an acknowledgement from the UE then step 5 is skipped; and

b) if the security check is not successful and the UE is in automatic network selection mode, then:

- if the UE has a SOR-CMCI stored in the non-volatile memory of the ME, the current SNPN is considered as lowest priority and the UE shall apply the actions in clause C.4.2;

- otherwise, the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current SNPN is considered as lowest priority. If the UE has an established emergency PDU session then the UE shall attempt to perform the SNPN selection after the emergency PDU session is released and after the UE enters idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]).

Step 5 is skipped;

NOTE 1: When the UE is in the manual mode of operation or the current chosen non-subscribed SNPN is part of the user controlled prioritized list of preferred SNPNs, the UE stays on current chosen non-subscribed SNPN.

5) The AMF to the UDM: If the UL NAS TRANSPORT message with an SOR transparent container is received, the AMF uses the Nudm\_SDM\_Info service operation to provide the received SOR transparent container to the UDM. If the HPLMN decided that the UE is to acknowledge successful security check of the received steering of roaming information in step 2, the UDM verifies that the acknowledgement is provided by the UE. The UDM shall store the "ME support of SOR-SNPN-SI" indicator. If the "ME support of SOR-ACK-Info" indicator in the header of the SOR transparent container is set to "supported", then the UDM receives the SOR-ACK-information, if any.

If the present flow was invoked by the UDM after receiving from the SOR-AF a list of preferred PLMN/access technology combinations or a secured packetI for a UE identified by SUPI using an Nudm\_ParameterProvision\_Update request, and the UDM verification of the UE acknowledgement is successful, then the UDM informs the SOR-AF about successful delivery of the steering of roaming information using Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery); and

6) The UDM to the SOR-AF: Nsoraf\_SoR\_Info (SUPI of the UE, successful delivery, SOR-ACK-information, "ME support of SOR-SNPN-SI" indicator). If the HPLMN policy for the SOR-AF invocation is present and the HPLMN UDM received and verified the UE acknowledgement in step 5, then the UDM informs the SOR-AF about successful delivery of the steering of roaming information to the UE. The UDM shall include the "ME support of SOR-SNPN-SI" indicator. If the SOR-ACK-information is received from the UE then the UDM shall include the SOR-ACK-information.

If:

- the UE in manual mode of operation encounters security check failure of SOR information in DL NAS TRANSPORT message; and

- upon switching to automatic network selection mode the UE remembers that it is still registered on non-subscribed SNPN where the security check failure of SOR information was encountered;

the UE shall wait until it moves to idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]) before attempting to obtain service on a higher priority SNPN as specified in clause 4.9.3, with an exception that the current registered SNPN is considered as lowest priority. If the UE has an established emergency PDU session then the UE shall attempt to perform the SNPN selection after the emergency PDU session is released and after the UE enters idle mode or 5GMM-CONNECTED mode with RRC inactive indication (see 3GPP TS 24.501 [64]).

NOTE 2: The receipt of the steering of roaming information by itself does not trigger the release of the emergency PDU session.