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Contents

Foreword

This Technical Specification has been produced by the 3rd Generation Partnership Project (3GPP).

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Introduction

Network sharing is a way for operators to share the heavy deployment costs for mobile networks, especially in the roll-out phase. In the current mobile telephony marketplace, functionality that enables various forms of network sharing is becoming more and more important. These aspects have not really been addressed before Release 6 in 3GPP UTRAN based access networks, before Release 8 in 3GPP E-UTRAN based access networks and before Release 10 in 3GPP GERAN based access networks, although there has been functionality that supports a very basic type of network sharing since the Release 5 versions of the 3GPP specifications.

To cope with 3GPP pre-Release 6 UTRAN UEs and with non supporting 3GPP GERAN UEs, this specification describes extra functionality for MSCs, SGSNs, BSCs and RNCs in order to provide network sharing functionality to "non-supporting UEs".

In this Release of the specifications, all UTRAN and E-UTRAN capable UEs are required to support the UTRAN and E-UTRAN network sharing requirements. Hence the E-UTRAN and MMEs (which were introduced in 3GPP Release 8) do not need functionality to handle "non-supporting UEs".

Scenarios and user requirements are described in TR 22.951 [1], while the current document presents the stage 2 details and descriptions of how these requirements are supported in a 3GPP GERAN, UTRAN and/or E-UTRAN based network.

1 Scope

The present document covers the details of Network Sharing for GERAN, UTRAN and E-UTRAN. It shows how several core network operators can share one radio access network and details the impacts on the network architecture. All UEs shall comply with existing requirements, among them PLMN selection and system information reception. The present document also defines requirements for network-sharing supporting UEs.

2 References

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

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

[1] 3GPP TR 22.951: "Service Aspects and Requirements for Network Sharing".

[2] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[3] 3GPP TS 25.331: "RRC Protocol Specification".

[4] 3GPP TS 23.122: "NAS Functions related to Mobile Station (MS) in idle mode".

[5] 3GPP TS 32.250: "Telecommunication management; Charging management; Circuit Switched (CS) domain charging".

[6] 3GPP TS 32.251: "Telecommunication management; Charging management; Packet Switched (PS) domain charging".

[7] 3GPP TS 24.008: "Mobile radio interface Layer 3 specification; Core network protocols; Stage 3".

[8] 3GPP TS 23.236: "Intra-domain connection of Radio Access Network (RAN) nodes to multiple Core Network (CN) nodes".

[9] 3GPP TS 23.401: "Technical Specification Group Services and System Aspects; GPRS enhancements for E-UTRAN access".

[10] 3GPP TS 36.300: "Evolved Universal Terrestrial Radio Access (E-UTRA) and Evolved Universal Terrestrial Radio Access (E-UTRAN); Overall description; Stage 2".

[11] 3GPP TS 36.331: "Evolved Universal Terrestrial Radio Access (E-UTRA); Radio Resource Control (RRC); Protocol specification".

[12] 3GPP TS 24.301: "Non-Access-Stratum (NAS) protocol for Evolved Packet System (EPS); Stage 3".

[13] 3GPP TS 25.413: "UTRAN Iu interface, Radio Access Network Application Part (RANAP) signalling".

[14] 3GPP TS 36.413: "Evolved Universal Terrestrial Radio Access Network (E-UTRAN); S1 Application Protocol (S1AP)".

[15] 3GPP TS 23.272: "Circuit Switched (CS) fallback in Evolved Packet System (EPS); Stage 2".

[16] 3GPP TS 44.018: "Radio Resource Control RRC Protocol Specification".

[17] 3GPP TS 25.467: "UTRAN architecture for 3G Home Node B (HNB); Stage 2".

[18] 3GPP TS 22.042: "Network Identity and Time Zone (NITZ); Service description; Stage 1".

[19] 3GPP TS 44.064: "General Packet Radio Service (GPRS); Mobile Station - Serving GPRS Support Node (MS SGSN) Logical Link Control (LLC) layer specification".

[20] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[21] 3GPP TS 29.280: "3GPP Sv interface (MME to MSC, and SGSN to MSC) for SRVCC".

[22] 3GPP TS 23.060: "General Packet Radio Service (GPRS); Service description; Stage 2".

[23] 3GPP TS 22.011: "Service Accessibility".

[24] 3GPP TS 48.018: "General Packet Radio Service (GPRS); Base Station System (BSS) - Serving GPRS Support Node (SGSN); BSS GPRS Protocol (BSSGP)".

[25] 3GPP TS 48.008: "Mobile-services Switching Centre Base Station System (MSC BSS) interface; Layer 3 specification".

[26] 3GPP TS 29.018: "General Packet Radio Service (GPRS); Serving GPRS Support Node (SGSN) Visitors Location Register (VLR); Gs interface layer 3 specification".

[27] 3GPP TS 29.118: "Mobility Management Entity (MME) - Visitor Location Register (VLR) SGs interface specification".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definition below apply. Terms and definitions not defined below can be found in TR 21.905 [2].

Conventional network: A PLMN consisting of radio access network and core network, by which only one serving operator provides services to its subscriber. Subscribers of other operators may receive services by national or international roaming.

Common PLMN: The PLMN-id indicated in the system broadcast information as defined for conventional networks, which non-supporting UEs understand as the serving operator.

Core network operator: An operator that provides services to subscribers as one of multiple serving operators that share at least a radio access network. Each core network operator may provide services to subscriber of other operators by national or international roaming.

Gateway Core Network: A network sharing configuration in which parts of the core network (MSCs/SGSNs/MMEs) are also shared.

Multi-Operator Core Network: A network-sharing configuration in which only the RAN is shared.

Non-supporting UE: A UE that does not support network sharing in the sense that it ignores the additional broadcast system information that is specific for network sharing for 3GPP UTRAN and GERAN. In other specifications, the term "network sharing non-supporting UE" may be used.

Supporting UE: A UE that supports network sharing in the sense that it is able to select a core network operator as the serving operator within a shared network. In other specifications, the term "network sharing supporting UE" may be used.

Anchor PLMN: With regard to SRVCC from CS to PS, this Anchor PLMN points to the PS domain operator in which the voice media is anchored in Access Transfer Gateway as part of the SRVCC procedure.

3.2 Void

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [2].

BSC	Base Station Controller
CN	Core Network
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
eNodeB	E-UTRAN NodeB
gsmSCF	GSM Service Control Function
GERAN	GSM/EDGE Radio Access Network
GUTI	Globally Unique Temporary Identity
GWCN	Gateway Core Network
HLR	Home Location Register
HSS	Home Subscriber Server
MCC	Mobile Country Code
MME	Mobility Management Entity
MNC	Mobile Network Code
MOCN	Multi-Operator Core Network
MSC	Mobile Switching Centre
NITZ	Network Identity and Time Zone
PLMN	Public Land Mobile Network
RNC	Radio Network Controller
SGSN	Serving GPRS Support Node
TMSI	Temporary Mobile Subscriber Identity
UE	User Equipment
UTRAN	Universal Terrestrial Radio Access Network
VLR	Visitor Location Register

4 General Description

4.1 Overview

A network sharing architecture shall allow different core network operators to connect to a shared radio access network. The operators do not only share the radio network elements, but may also share the radio resources themselves. In addition to this shared radio access network the operators may or may not have additional dedicated radio access networks, like for example, 2G radio access networks. There are two identified architectures to be supported by network sharing. They are shown in the figures below.

In both architectures, the radio access network is shared. Figure 1 below shows reference architecture for network sharing in which also MSCs and SGSNs are shared. This configuration will be referred to as a Gateway Core Network (GWCN) configuration.

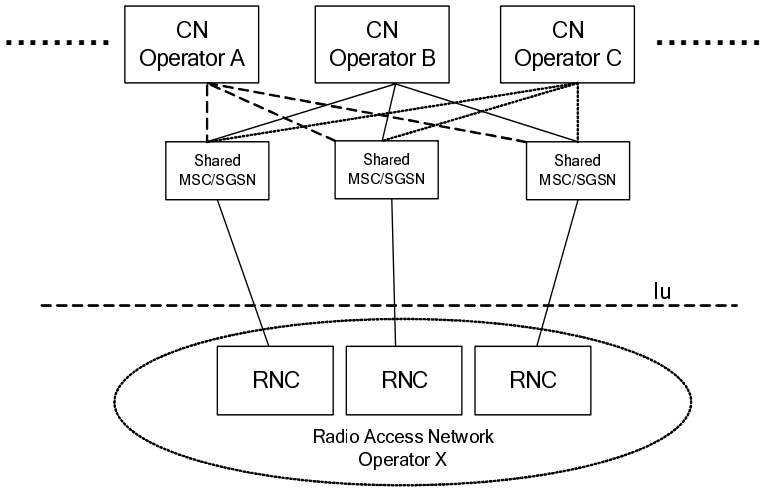

Figure 1: A Gateway Core Network (GWCN) configuration for network sharing. Besides shared radio access network nodes, the core network operators also share core network nodes

Figure 2 below shows the reference architecture for network sharing in which only the radio access network is shared, the Multi-Operator Core Network (MOCN) configuration.

Figure 2: A Multi-Operator Core Network (MOCN) in which multiple CN nodes are connected to the same RNC and the CN nodes are operated by different operators

The UE behaviour in both of these configurations shall be the same. No information concerning the configuration of a shared network shall be indicated to the UE.

For the Evolved Packet System, only the PS domain of the above figures is relevant. For E-UTRAN access Figures 1 and 2 both apply but with the MME replacing the SGSN, the eNodeB replacing the RNC, and the S1 reference point replacing the Iu interface.

For GERAN access, both GWCN and MOCN are applicable but with the BSC replacing the RNC and the A/Gb-Interfaces replacing the Iu interface.

4.2 Core Network Operator and Network Selection

Network sharing is an agreement between operators and shall be transparent to the user. This implies that a supporting UE needs to be able to discriminate between core network operators available in a shared radio access network and that these operators can be handled in the same way as operators in non-shared networks.

4.2.1 Core network operator identity

A core network operator is identified by a PLMN-id (MCC+MNC).

4.2.2 Broadcast system information for network sharing

If a shared RAN is configured to indicate available core network operators for selection by UEs, each cell in shared radio access network shall in the broadcast system information include information concerning available core network operators in the shared network.

The available core network operators shall be the same for all cells of a Location Area in a shared UTRAN or GERAN network.

For E-UTRAN, the Broadcast System Information broadcasts a basic set of PLMN IDs and optionally one or more additional set of PLMN IDs. All E-UTRAN UEs support reception of the basic set, only Release 14 and later E-UTRAN UEs are required to receive the additional set (see TS 36.331 [11]).

The available core network operators shall be the same for all cells of a Tracking Area in a shared E-UTRAN network. The basic and the additional sets allow different (sets of) PLMNs to have different cell ID and TAC.

A supporting UE decodes the broadcast system information and takes the information concerning available core network operators into account in network and cell (re-)selection procedures. Broadcast system information is specified in TS 44.018 [16] for GERAN, TS 25.331 [3] for UTRAN and TS 36.331 [11] for E-UTRAN.

4.2.3 Network selection in a shared network

4.2.3.1 Behaviour of supporting UEs (GERAN, UTRAN and E-UTRAN)

In some sharing scenarios, the sharing operators require the UTRAN/GERAN to broadcast, to non-supporting UEs, a PLMN ID that does not identify any of the sharing core network operators. In this case, it is necessary that a supporting UE does not select this "common PLMN ID".

In other sharing scenarios, the sharing operators may want the PLMN broadcast to non-supporting UEs to be selectable by supporting UEs.

A supporting UE decodes the broadcast system information to determine available core network operators in the shared network. The UE regards both the core network operators indicated in the broadcast system information and conventional networks as individual networks. The core network operators together with all conventional networks are candidate PLMNs for the PLMN selection procedure that shall be performed by the UE as specified in TS 23.122 [4].

In GERAN and UTRAN, non-supporting UEs use the broadcast "common PLMN-id" in their PLMN (re)selection processes.

In UTRAN, supporting UEs shall use the PLMN-ids that are broadcast in the Multiple PLMN ID List information element in their PLMN (re)selection processes. UTRAN AS signalling permits the Multiple PLMN ID List to indicate to supporting UEs whether to include or exclude the MCC+MNC of the "common PLMN-id" in their network (re)selection processes.

For supporting UEs, GERAN provides equivalent functionality to UTRAN.

For E-UTRAN, the UE uses all of the received broadcast PLMN-ids in its PLMN (re)selection processes.

4.2.3.2 Behaviour of non-supporting UEs (GERAN, UTRAN)

Non-supporting UEs ignore the broadcast system information that is relevant for network sharing. The common PLMN together with all conventional networks are candidate PLMNs for the PLMN selection procedure that shall be performed by the UE as specified in TS 23.122 [4].

It is recommended for the network and the UE to support the Network Identity part of the Network Identity and Time Zone (NITZ) feature (see TS 22.042 [18]) for providing the UE with the name of the serving PLMN operator.

4.2.4 Assignment of core network operator and core network node

When a UE performs an initial access to a shared network, one of available CN operators shall be selected to serve the UE. For non-supporting UEs, the shared network selects an operator from the available CN operators. For supporting

UEs, the selection of core network operator by the UE shall be respected by the network. Supporting UEs inform the BSC/RNC/eNodeB of the network identity of the chosen core network operator.

In a UTRAN GWCN configuration, the RNC relays the chosen network identity to the shared core network node (in UTRAN MOCN, the RNC indicates that the UE is a "supporting UE" by relaying the chosen network identity to the core network node). To permit GWCN operation, in E-UTRAN, the eNodeB always relays the chosen network identity to the shared MME. In a GERAN GWCN configuration, the BSC relays the chosen network identity to the core network node (in GERAN MOCN, the BSC indicates that the UE is a "supporting UE" by relaying the chosen network identity to the core network node).

In a MOCN configuration, the RAN routes the UE's initial access to the shared network to one of the available CN nodes. Supporting UEs shall inform the RAN of the chosen core network operator so that the RAN can route correctly. For non-supporting UEs the shared network selects an operator from the available CN operators. A redirection to another CN operator may be required for non-supporting UEs until an operator is found that can serve the UE. Redirection is described in clause 7.1.4.

After initial access to the shared network the UE does not change to another available CN operator as long as the selected CN operator is available to serve the UE's location. Only the network selection procedures specified in TS 23.122 [4] may cause a reselection of another available CN operator. Also the network does not move the UE to another available CN operator, e.g. by handover, as long as the selected CN operator is available to serve the UE's location. Furthermore the UE does not change to another CN node as long as the selected CN node is available to serve the UE's location.

In GERAN and UTRAN, when the network signals location/routing area identities to supporting UEs, e.g. in location updating accept messages, these identities shall contain the chosen core network operator identity. For non-supporting UEs, they shall contain the common PLMN. The UE stores the received LAI/RAI on the SIM/USIM, as already specified in TS 24.008 [7].

In E-UTRAN, the chosen core network operator identity is included in the GUTI in e.g. the Attach Accept message. The UE shall store the received GUTI on the USIM according to the rules specified in TS 24.301 [12].

4.2.5 PS and CS domain registration coordination in UTRAN and GERAN

In conventional networks, the same CN operator always serves the UE in CS and PS domains. In a shared network, supporting UEs shall behave as UEs in conventional networks with respect to registration with CS and PS domains and always register with the same operator for the CS and PS domains. CS/PS coordination should be performed at registration when a redirect attempt flag is included in A/Gb/Iu messages carrying the NAS registration message (see TS 48.008 [25], TS 48.018 [24], and TS 25.413 [13]). The term registration includes attach, and LA and RA updates.

When multiple PLMNs are available and SRVCC from UTRAN/GERAN CS domain to E-UTRAN/HSPA PS is deployed, the source BSC/RNC determines a core network operator to be used in the target network based on current PLMN in use, Anchor PLMN provided by PS core network, or other information present in the BSC/RNC. The source BSC/RNC shall at handover indicate the selected core network operator to the source core network node in the handover required message. The anchor MSC Server shall forward the selected core network operator chosen by the source BSC/RNC to the target MME/SGSN.

4.2.5a PS and CS domain registration coordination in E-UTRAN

When multiple core network operators share the E-UTRAN using a GWCN configuration, separate MSCs may still be used for the CS Fall Back functionality. In this case the MME uses the 'selected network' information received from the E-UTRAN to select an MSC from the already selected operator.

When multiple PLMNs are available for CS domain, the MME selects the MSC for CS Fallback functionality based on the 'selected network' information received from the E-UTRAN, current TAI, old LAI provided by the UE and operator selection policies as specified in TS 23.272 [15]. In this case, the selected PLMN-id for CS domain may be different to the PLMN-id for EPS domain. If the selected MSC is shared network configured, the MME selects the CS domain operator as specified in TS 23.272 [15]. If the UE is a GERAN network-sharing non-supporting UE and the preferred RAT of the selected CS network is GERAN with GWCN configuration, or the preferred RAT of the selected CS network is shared network in GWCN configuration not offering the broadcast of available Core Network operators for selection by the UE, the MME sends the 'selected CS domain operator' in addition to the Common PLMN-id included in the LAI to the VLR. If the MSC is GWCN configured, the MSC applies local policy (e.g. uses a fixed split of IMSI ranges or IMSI hash) to determines the CN operator when the PLMN-id included in the LAI contains Common PLMN-

id (i.e. does not identify any CS domain operator) and the 'selected CS domain operator' is absent. Otherwise, the MSC accepts the CS domain operator selected by the MME.

When multiple PLMNs are available for CS domain and SRVCC from E-UTRAN PS to UTRAN/GERAN CS domain is deployed, the MME sends the Handover Restriction List (see TS 23.401 [9]) to eNB including the currently serving PLMN and equivalent PLMNs together with information about which PLMNs are preferred for SRVCC. The eNB selects target PLMN for SRVCC from the list based on HRL and local policy and constructs the Neighbour Cell list (NCL) based on this knowledge of the target PLMN. The selected target core network PLMN should, if possible, be the same as the one in use.

4.2.5.1 Void

4.2.5.2 Void

4.2.5.3 CS/PS domain coordination and operator selection in GERAN and UTRAN

At combined or non-combined registration by a non-supporting UE the BSC/RNC routes the request to one of the available CN nodes. In all Attach Request/Routeing Area Update Request/Location Area Update Request messages from the BSC/RNC to CN a redirect attempt flag shall be included to indicate that the CN should either return a Reroute Command or a Reroute Complete message. If the BSC/RNC can determine that the UE is already served by a CN operator in the opposite domain, then a CN node from this operator shall be selected and the serving CN operator shall be indicated to the CN node together with an indication that the selected CN operator is already serving the UE in the opposite domain. If the BSC/RNC cannot determine a CN operator this way, the selection of CN node by the BSC/RNC is based on the NRI if provided by the UE. The RAN stores the NRI received from the UE.

If the UE is already served by the CN node that receives the registration request and this CN node can continue to serve the UE (for example if there are no regional roaming restrictions for the target area), or if the UE is a non-roaming subscriber, or if the BSC/RNC indicated a BSC/RNC selected CN operator and that the selected CN operator is serving the UE in the opposite domain then the CN node accepts the registration attempt and completes the registration procedure. Otherwise the CN node returns IMSI and a Reroute Command message to the BSC/RNC with an indication that it is for coordination purposes. The old LAI (for the CS domain) or old RAI (for the PS domain), or an indication whether the UE is attaching shall also be included.

Based on information received from CN node (old LAI or old RAI), UE (CS-NRI or PS-NRI, as stored in the RAN) and BSC/RNC internal configuration the BSC/RNC concludes whether:

(i) The UE is 'under operator coordination' i.e. if the UEs (CS-NRI, old LAI) tuple for the CS domain or (PS-NRI, old RAI) tuple for the PS domain can be used to uniquely identify one of the operators in the shared network. The old RAI/PS-NRI can be "native" (i.e. no RAT change) or "mapped" (i.e. RAT change).

(ii) The UE is not 'under operator coordination' i.e. the UEs (CS-NRI, old LAI) tuple for the CS domain or (PS-NRI, old RAI) tuple for the PS domain cannot uniquely identify any operator in the shared network. The old RAI/PS-NRI can be "native" (i.e. no RAT change) or "mapped" (i.e. RAT change).

(iii) The UE is attaching.

For case (i) the BSC/RNC selects serving CN operator based on the identified operator and routes the request to the selected operator. The IMSI and the BSC/RNC selected CN operator shall be indicated to the CN.

For case (ii) and (iii) the BSC/RNC shall for a (combined or non-combined) registration attempt in the PS domain query its connected MSCs, whether the UE is registered with any of the sharing operators in the CS domain. Similarly for a registration attempt in the CS domain the BSC/RNC shall query its connected SGSNs, whether the UE is registered at any of the sharing operators in the PS domain. For a registration attempt in the CS domain this means that the SGSNs on behalf of the BSC/RNC may be needed to query all MMEs that may hold the UEs context of the sharing operators whether the UE is registered at any of the MMEs of the sharing operators. Registration in MME but not in the CS domain can e.g. occur at cell reselection from LTE for a UE that is not SGs registered. If MMEs are not updated to support registration queries, it may not be possible to guarantee CS/PS coordination in certain scenarios.