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Contents

Foreword

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Introduction

Network sharing is becoming more and more popular as a means to provide coverage quickly and in a cost efficient way. The high price paid for the license in some countries as well as mergers, acquisitions have raised recently high interest in this topic. For these reasons 3GPP has decided to investigate what shortcomings currently in the technical specifications may prevent a standardized approach to the deployment of shared networks. This TR is aimed to describe a wide variety of possible network sharing and highlight the expected user experience for each of the scenarios. Charging aspects, terminal aspects and security are also investigated.

The purpose of this technical report is to collate in a single document the requirements, considerations and deployment scenarios that operators as well as users need to see fulfilled for a successful use of a shared network. Particular attention has been given in making possible the avoidance of proprietary solutions particularly for what concerns the terminals.

Furthermore, the concepts discussed in this report may be applied to sharing a GERAN and UTRAN infrastructure, in this sense the interest in network sharing tools extends to the vast majority of the existing GSM operators who intend to deploy a UMTS Terrestrial Radio Access Network layer to complement the existing GSM/GPRS coverage.

1 Scope

In the current dynamic market place, as a result of partnerships, acquisitions, creative agreements among operators and so on, the need for tools that enable various degrees of network sharing is becoming more and more important.

When GSM and then UMTS were specified, the possibility of sharing part or all of the network by two or more separated commercial entities was not considered and as a result the standards lack some functionalities that enable the realisation of such commercial agreements.

GSM was designed under the principle "one operator, one radio access network". The GSM network has some possibilities of infrastructure sharing, but it does not support true radio access network sharing. The initial design of 3GPP system has followed the same principle.

This technical report is aimed to capture the service and user requirements that must be fulfilled by the 3GPP system in order to enable network sharing in a standardised way. Section 5 describes various Network sharing includes various scenarios e.g. spanning from common radio access network connected to multiple core networks toor multiple radio access networks sharing one core network. Section 6 contains a summary of the user classification and network identities. In section 7 the user requirements are described, while section 8 deals with the network operator requirements. Section 9 describes the mobility requirements in a shared network. The rest of the document is covering security (section 10) and charging (section 11). Some conclusions can be found in section 12 and an annex with examples of practical realisation of network sharing is provided.

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.
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- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

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

3 Definitions, symbols and abbreviations

3.1 Definitions

Core Network Operator: Operator that offers core network services.

Iu-flex: Routing functionality for intra domain connection of RAN nodes to multiple CN nodes.

Radio Access Network Operator: Operator that offers radio access to one or more core network operators.

RAN sharing: Two or more CN operators share the same RAN, i.e. a RAN node (RNC or BSC) is connected to multiple CN nodes (SGSNs and MSC/VLRs) belonging to different CN operators.

Roaming: The ability for a user to function in a serving network different from the home network. The serving network could be a shared network operated by two or more network operator.

Shared Network: When two or more network operator sharing network elements.

3.2 Symbols

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

4 General Aspects

5 Network Sharing Scenarios

Sharing networks and network infrastructure has become a very important part of 3GPP systems. There are many network-sharing scenarios possible depending on different operator strategies but also on rules and legislation in different countries. 3GPP systems are originally not fully designed for network sharing between different operators however some limited support exists in the 3GPP Release 99.The equivalent PLMN feature in Release 99 allows operators to share a common UTRAN, with certain parts of the core networks also shared between the operators, see Figure 1.

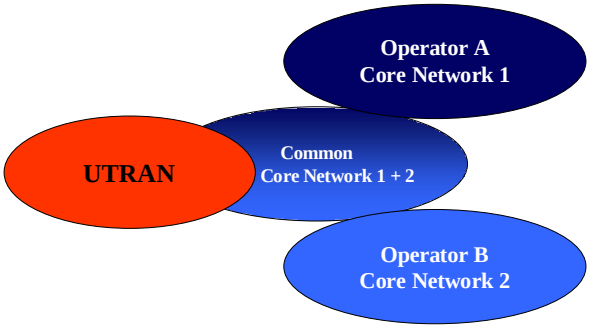

Figure 1: Two operators sharing the same UTRAN. To make this work, parts of the core network need to shared as well.

Important to note here is that this network-sharing scenario allows operators without a UMTS license to share the network and supply its customers with 3G services. For example, a 2G operator may supply its subscribers with 3G services using another operator's allocated spectrum. A geographically split network, i.e. a scenario in which cooperating operators cover different parts of a country, is also possible in Release 99. One operator's core network may also be connected to several UTRANs, see Figure 1.

Different kinds of evolution paths are essential for shared networks. For example, it is not only the sharing solution at a certain time that is important, but also how it is possible for the sharing partners to evolve either to a more dedicated network or to a more joint network. That is, the set of infrastructure sharing solutions and scenarios that is discussed in the industry cover alternatives that together include:

- solution alternatives targeting at dedicated networks in the near future,
- solutions for infrastructure sharing not targeting at immediate exit, but at exit when for example the network capacity demand so requires,
- infrastracture sharing targeting at long term sharing, which for example is the case when one of the operators lacks a frequency license.

Although these network-sharing scenarios are possible in Release 99 of 3GPP systems, the solutions are far from optimised. Identifying, changing, and adding appropriate functionality in the network will definitely lead to a better shared-network operation.

5.1 Scenario1: Multiple core networks sharing common radio access network in R99

For operators that have multiple frequency allocations it is possible to share the RAN elements, but *not* to share the radio frequencies. In this case the operators connect directly to their own dedicated carrier layer in the shared RNC in the shared RAN. This solution is possible with 3GPP Release 99 and is illustrated below in Figure 2 for the case when two operators have one license each.

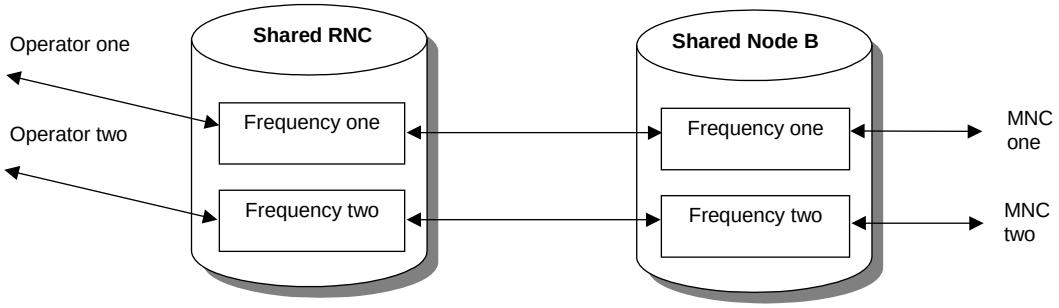

Figure 2: The figure illustrates how it is possible to within the 3GPP Release 99 framework have dedicated carrier layers in the RAN for multiple operator. The operators transmit their own mobile network code (MNC) on their dedicated carrier

5.1.1 Limitations

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5.2 Scenario 2: Geographically split networks sharing

In this scenario, two (or more) operators with individual 3G licenses will with their respective radio access networks cover different parts of a country but together provide coverage of the entire country.

This scenario can be divided into following cases:

1) When two (or more operators) employ national roaming for the users, which implies that only one core network will be associated with each radio access network. Care is obviously needed when coverage regions overlap, which makes this a valid shared-networks scenario. This case is shown in Figure 3.

2) The operators can have their individual core networks connected to both radio access networks throughout the entire coverage area, but utilizing the different operator's allocated spectrum in different parts of the coverage area. There will thus be multiple core network operators in each of the shared radio access networks. The connection of the core networks to the radio access networks can either be done by connecting the radio network controllers to both operators' core network elements or by sharing parts of the core network, e.g. SGSNs and/or MSCs. The work on shared networks in Rel-6 should not make any of these possibilities mandatory and it should be the choice of the operator which one is implemented. Additionally it should, be possible to introduce Iu-flex functionality between the common core network parts and the radio access network for purely load-sharing purposes.

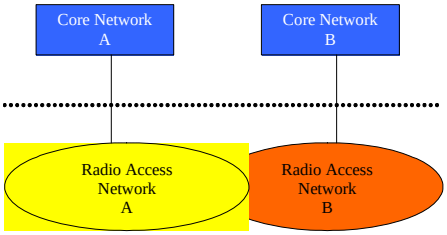

Figure 3: Geographically split network using national roaming between operators.

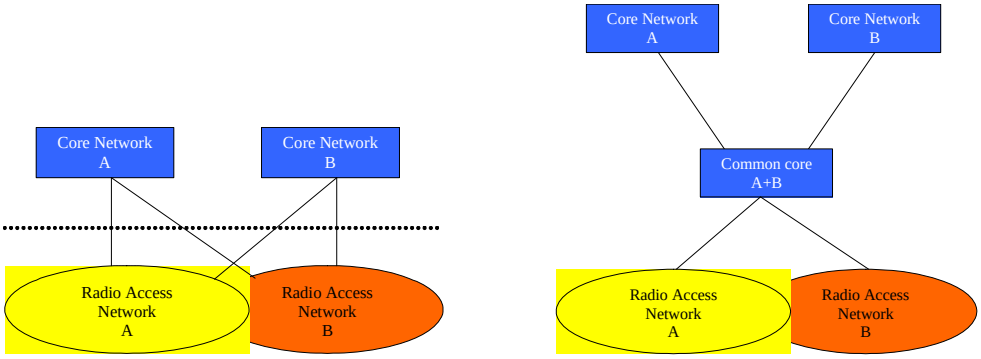

Figure 4: Geographically split shared radio networks scenarios with dedicated or common core networks

The national roaming scenario and the common core network scenario in Figure 4 can be deployed already today using R99 functionality and are therefore important in the future work of 3GPP. The scenario with dedicated core networks in Figure 4 is not supported by Rel-5 specifications.

In areas where more than one of the operators provide coverage, it should be possible to restrict the access rights so that the users are only allowed to use the radio access network provided by their home operator.

5.3 Scenario 3: Common Network Sharing

In this scenario, one operator will deploy coverage in a specific geographical area, and other operators will be allowed to use this coverage for their subscribers. Outside this geographical area, coverage is provided by each of the operators.

For example, in the case of two operators, a third-party could provide UTRAN coverage to operators A and B' subscribers in areas with high population density. In less dense areas, GERAN coverage is provided by operator A and operator B and in these areas the subscribers should connect to the access network of their operator.

5.4 Scenario 4: Common spectrum network sharing

Common spectrum network sharing is applicable when

- one operator has a 3G license and shares the allocated spectrum with other operators.
- a number of operators decide to pool their allocated spectrums and share the total spectrum (operators without allocated spectrum may also share this pooled spectrum).

The scenario can be realized as follows.

1. Connecting each operator's core networks and to the shared radio access network(s), see case 1 in Figure 5 below (only 1 radio network controller for simplicity). In this case it should be possible that one or more of the core network operators use Iu Flex between their core network and the shared radio access network. The

technical realisation of this scenario may reuse some of the mechanisms already specified in REL-5 Iu Flex. Described in the figure below are three network operators, A, B and C. Operators A and C are not using multiple core network nodes (CN) and therefore may not need to use Iu-Flex. Operator B is using multiple CNs and has decided to use Ie-Flex to enable the intra-domain sharing of CNs

2. The core network entities connected to radio access network can be shared, see case 2 in Figure 5 below.

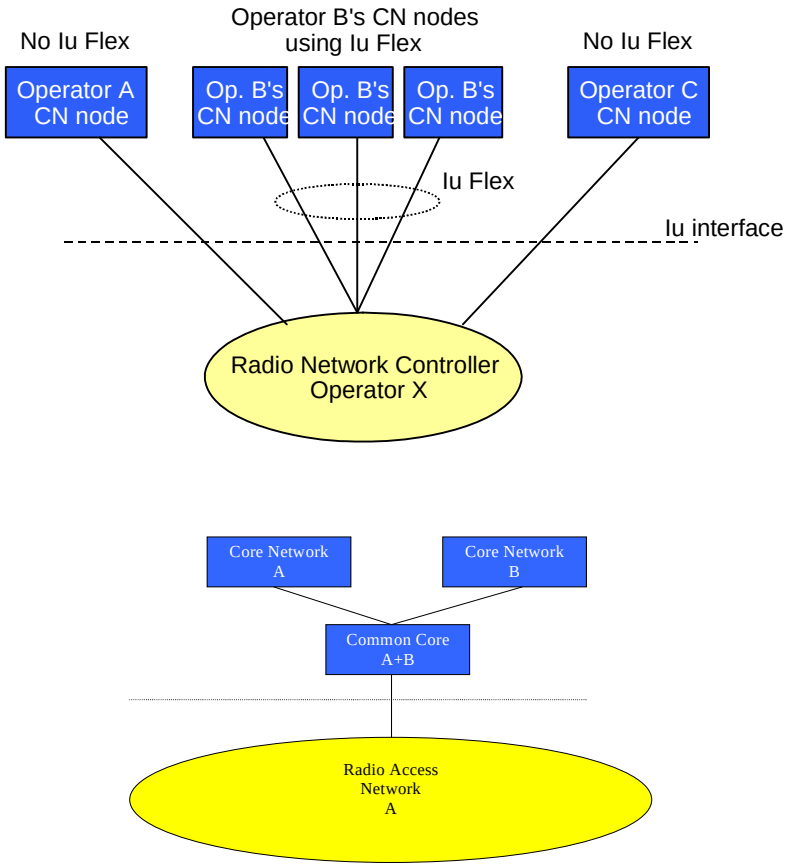

Figure 5: Two different cases of common spectrum network sharing

The work on shared networks in Rel-6 should not make any of these possibilities mandatory and it should be the choice of the operator which one is implemented.

5.5 Scenario 5: Multiple radio access networks sharing common core network

In this scenario multiple radio access networks share a common network. The multiple RANs can belong to different PLMNs and network operators. Due to operators' deployment different nodes or part of the common core network i.e. HSS/HLR, SGSN etc can be shared.

The scenario is depicted in the figure below:

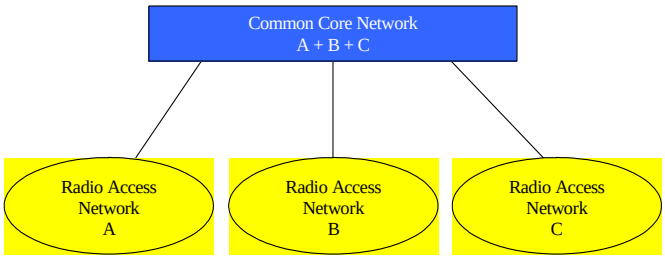

Figure 6: Multiple RANs sharing a common CN

6 Network Identities and User Classification

To fully support for example handover, service differentiation and access rights in shared networks it is occasionally necessary to identify to which operator that a user belongs to and possibly group the users according to this information. To avoid complicated operation and maintenance procedures, such user classification should be general for all the functions in the shared network that needs information about the user identity.

7 User Requirements

Network sharing is an agreement between network operators and is transparent to the user.

7.1 Network selection

When network sharing exists between different operators and a user roams into the shared network it should be possible for that user to register with a core network operator (among the network sharing partners) that either

(i) the user has a subscription with, or

(ii) the user's home operator has a roaming agreement with,

even if the operator is not offering radio coverage.

This requirement implies that it is possible to discriminate between core network operators connected to a shared radio access network. The selection of a core network operator among those connected to the shared radio access network can either be manual (i.e. performed by the user after receiving a list of available core network operators) or automatic (i.e. performed by the UE according to user and operator preferred settings).

7.2 Network name display

The terminal always displays the name of the core network operator the user has registered with. It should be noted that for pre-Rel-6 UEs the network name display for roaming users in Scenarios 2 and 4 are not supported.

7.3 UE requirements

A Rel-6 network sharing solution should support legacy (pre-Rel-6) UEs. This requirement is important since a Rel-6 network sharing solution may imply changes in the UEs.

Without changes to pre-Rel 6 specifications, pre-Rel-6 UEs may in certain cases not be able to support the full set of Rel-6 enhancements. The following two cases have currently been identified:

- Manual network selection for roaming users in Scenario 2 and Scenario 4.
- Network name display for roaming users in Scenario 2 and Scenario 4.

8 Network requirements

The service capabilities and requirements should not be restricted by network sharing scenarios.

It should be possible for a network operator to differentiate its service offering from other network operators within shared network.

The services and service capabilities offered should not be restricted by the existence of network sharing.

It should be possible for a network operator to differentiate its service offering from other network operators within shared network.

The provision of services and service capabilities that is possible to offer in a network should not be restricted by the existence of the network sharing It should be possible for a core network operator to differentiate its service offering from other core network operators within the shared network.

It should be possible to control the access to service capabilities offered by a shared network according to the core network operator the user is subscribed to.

9 Mobility Requirements

9.1 Service continuity

The mobility in a shared network, both when controlled by the UE and when controlled by the network should not cause any undue interruption of service.

It should be possible for a subscriber to roam between the different parts of a shared network without requiring the user intervention. The user experience while roaming in a shared network should be no worse than the user experiences in a non-shared network.

NOTE: in some instances the user intervention may be required, for example it maybe required in cases where the change to a different part of the shared network causes a change in the service tariff.

9.2 Handover

Seamless handover should be supported between a shared network and a non-shared network. The user should be able to receive the same service level during and after a handover between the networks.

The network should be able to access the relevant subscriber information in order to determine the appropriate candidate for handover. Examples of information that may be required in order to take the decision on the candidate could include (non exhaustive list):

- type of subscription (e.g. prepay / postpay)
- home network of the subscriber (for roaming subscribers)
- service(s) to be handed over
- subscribed quality of service

9.3 Roaming

When the user is registered on a shared network, the control of the PLMN and radio access technology (e.g. UTRA, GERAN) employed within that shared network is under the sole control of the network operator. This does not imply any limitation on the manual or automatic selection of a PLMN that does not belong to the shared network where the user is registered.

The standards should specify mechanisms necessary to enable flexible allocation of inbound roamers among core network operators that have roaming agreements with the same roaming partners. The core network operators should be

able to pre-define their relative share of inbound roamers and the network should distribute the inbound roamers that apply automatic network selection to different core networks connected to the radio access network accordingly. It should also be possible for the core network operator to allow or force the subscribers to reselect to another part of the shared network so that the relative share of inbound roamers is maintained.

In case the mobility in the shared network is controlled by the UE (e.g. cell reselection) the operator should be able to set parameters, other than radio parameters that determine the most appropriate candidate. Examples of these parameters are: subscription information, requested service, network load and so on.

10 Security Requirements

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11 Charging Requirements

Charging solutions should support the shared network architecture so that both end users and network sharing partners can be correctly charged for their usage of the shared network.

12 Conclusions

This technical report has identified various scenarios, service and user requirements that should be fulfilled by 3GPP specifications in order to enable network sharing. The functionalities needed to enable network sharing in a standardized way will be added to existing or new specifications. Chapter 12.1 is a non-exhaustive list of the affected specifications. It is concluded that the further work in other groups within 3GPP on the requirements identified in this technical report is carried out.

12.1 Impacts on 3GPP Specifications

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Annex A (informative): Examples of network sharing realisations

In this annex some examples of how network sharing can be realised in real situations is described. Often the realisation of a shared network will encompass more than one scenario described in section 5. These examples aim to demonstrate how the functionalities needed identified in this technical report are applied.

A.1 Advanced Geographical split with seamless national roaming

Operators A and B, both licensed to operate a GSM network and a 3G network have agreed to share the 3G portion of the radio access network in some areas of the country where the traffic is expected to be low (Low Traffic Areas, or LTA) while building separate 3G networks in the areas with higher traffic density (High Traffic Areas or HTA). The LTA is split in two parts, one built by Operator A, the other by Operator B.

Note that a HTA may correspond to a subset of a Location Area (e.g. motorway, railway, shopping centre, train station…)

Operators A and B will not share their respective GSM networks anywhere in the country and will not share the 3G network in the HTA, but want to achieve seamless service continuity for subscribers moving among permitted networks.

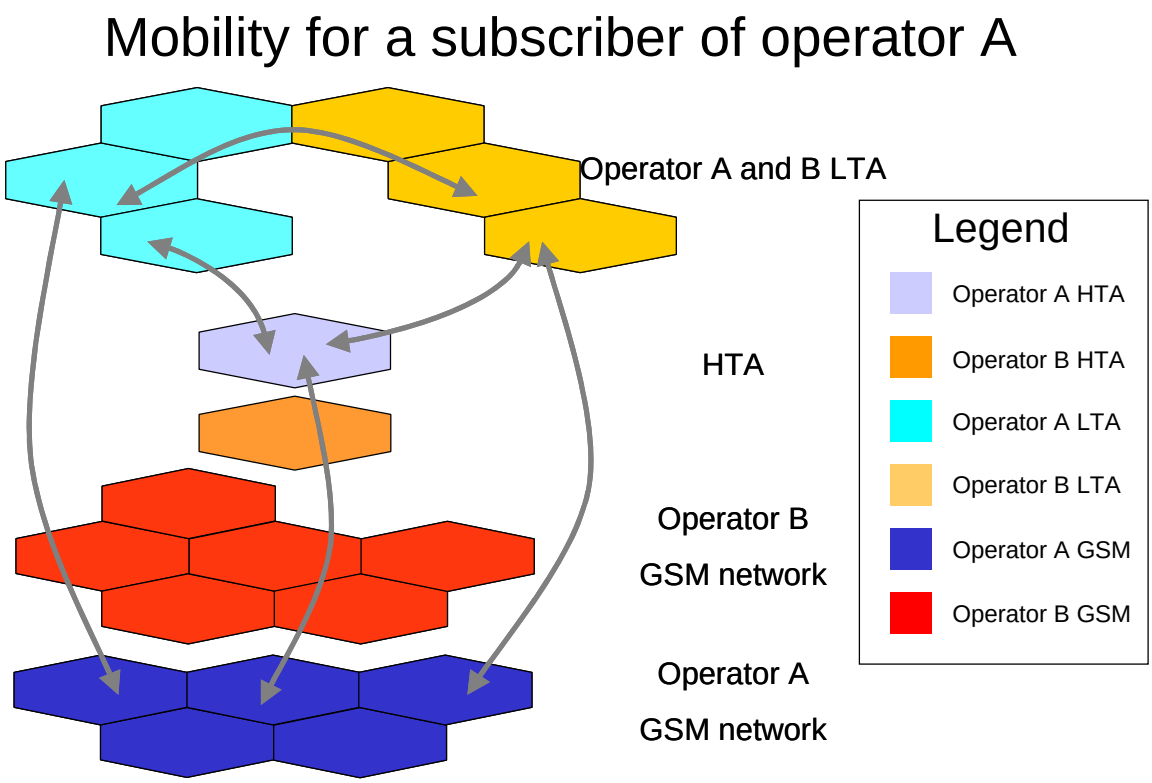

Figure A.1: mobility for a subscriber of operator A

Operator A and B aim to offer full mobility in the shared 3G network without loss of active services (both Circuit and Packet switched) when crossing the border between areas where coverage is provided by the other operator.

When the users exit the 3G coverage area, their UE are transferred to the 2G network of the home operator. Similarly, when the user enters an HTA coming from the home GSM network or from either of the LTA, the UE is transferred to the 3G network of the home operator.

Moreover, when the subscriber registered in the GSM network moves into the HTA it should be possible to move as soon as possible to the 3G network of the home PLMN. More generally the subscriber should move to a permitted 3G network as soon as it becomes available.

The network name displayed on the UE is that of the home operator regardless of the provider of the 3G coverage.

A.1.1 Functionalities needed

The need for the following functionalities can be identified by analysing the above architecture and mobility rules for network sharing

- Both operators will want to be able to apply different mobility rules according to the identity of the subscriber (IMSI). Examples of subscribers categories are:
  - subscribers of operator A
  - subscribers of operator B
  - inbound international roaming subscribers
    The latter category could be further divided in sub-categories
- The differentiated mobility behaviour needs to be supported both for UE controlled mobility (e.g. cell reselection) and for Network controlled mobility (e.g. handover).
  The differentiated mobility behaviour needs to be supported both in the UTRAN and in the GERAN.
- Both operators will want the display of the operator name on the terminal to be independent of the provider of the radio coverage
- Both operators will want the facility to steer the traffic to the preferred network and preferred radio access technology according to the subscriber profile, network status, service used
- Both operators will want to provide services to their subscribers from their respective core networks
- Both operators will want to have continuity for both Packet Switched and Circuit Switched services used while the subscriber roams from one part of the network to another.

A.2 Common shared spectrum scenario

Most of the functionalities needed for realisation of this scenario is related to scenario 4 common spectrum network sharing.

Two operators, A and B, each have their own countrywide 2G networks in operation. For 3G they agree to build a common countrywide radio access network and to connect this radio access network to the two existing, 3G enhanced, core networks. The two operators will continue with their own subscribers and compete with services and prices.

For the radio access there are three countrywide radio access networks involved: A, B, and C, where A is the 2G radio access network of operator A, B the 2G radio access network of operator B, and C the common 3G radio access network.

Each of these radio networks will broadcast their own PLMN id (PLMN Id = MCC+MNC). Let us allocate Id_A, Id_B and Id_C respectively to this parameter. Subscribers of operator A will have the MCC+MNC part of the IMSI equal to Id_A and subscribers of operator B will have the MCC+MNC part of the IMSI equal to Id_B. This means that the subscribers of operators A and B will regard the respective 2G radio access network as their respective HPLMN and radio access network C as a VPLMN. National roaming is assumed not to exist between the two operators.

There are two core networks present, namely the 2G core networks of operator A and of operator B, appropriately upgraded with the necessary 3G functionality. The nodes of the 2G radio access network A are only connected to nodes in CN_A and nodes of the 2G radio access network B are only connected to nodes in CN_B. The nodes of the 3G radio access network C are connected to both nodes in CN_A and to nodes in CN_B by some appropriately enhanced Iu interface.

The basic architecture is shown in Figure A.2. It must be assumed that all different combinations of radio coverage exist, this is also shown in the figure.

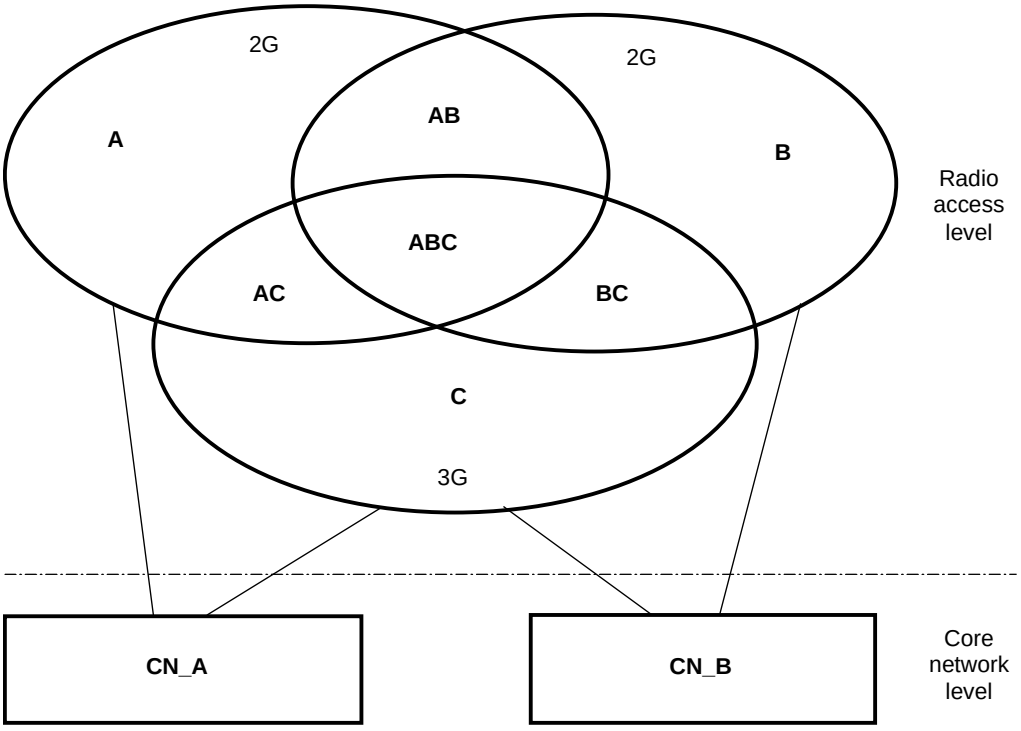

Figure A.2: Basic Network Sharing Architecture

A.2.1 Functionalities needed

Here we describe the different functionalities needed to be identified within the shared network scenario described in the Section above. The overall requirement is that it should be completely transparent to the users that operator A and operator B has chosen to share a 3G network.

Idle Mode Roaming

Subscribers of operator A

Subscribers of operator A should be served only by cells of radio networks A and C and only by core network CN_A, *i.e.* the service area of a subscriber of operator A is the sum of A, AB, AC, ABC, BC and C in Figure A.2. When the subscriber switches on his UE in this service area he is automatically registered in operator A's core network CN_A. The UE should display the service provider name and possibly the PLMN name according to the settings of the USIM/network/UE in the same way irrespective of the radio network used (A or C).

The possibilities are summarized in Table A.1 below.

to cell in → / From cell in ↓	A	B	C
other network	Allowed. Normal registration.	Not allowed (rejection by CN).	Allowed. Registration only to CN_A.
A	Allowed. Normal location updating.	Not allowed (rejection by CN).	Allowed. Registration only to CN_A.
B	Not applicable.	Not applicable.	Not applicable.
C	Allowed. Normal registration.	Not allowed (rejection by CN).	Allowed. Normal location updating only to CN_A.

Table A.1: Change of registered cell and network for an operator A subscriber

Subscribers of operator B

The handling of subscribers of operator B is exactly the same as for subscribers of operator A, with A and B interchanged.

Roaming users

There are three different types of roaming users to be considered (i) users who are allowed to roam on operator A's network, (ii) users allowed to roam on operator B's network, and (iii) users allowed to roam on both networks.

Visiting roaming users with roaming agreement with only operator A should be handled the same way as subscribers of operator A, see previous Section. Visiting roaming users with roaming agreement with only operator B should be handled the same way as subscribers of operator B

Visiting roaming users with roaming agreements with both operator A and operator B are entitled to receive service via all three radio networks (A, B and C) and from both core networks (CN_A and CN_B). This leads to some additional considerations.

- The two operators A and B may have different charging policies for roaming users. Thus one of the operators may be preferred by some roamers and the other operator preferred by other roamers. It must therefore be possible to indicate to the UE, at least when it is in radio network C, which core networks are available so that the user can perform an active selection. If such a manual selection is made, the UE should be treated the same as a subscriber of the chosen operator.

- If no such selection of core network is made, some filtering is required to select one of the core networks when the UE registers via radio network C. Unnecessary change of core network should be avoided. For example, if the UE is using radio network B and CN_B and changes radio network to C, the UE should remain registered in CN_B. Only when this UE has to change to radio network A (due to radio conditions) a change to CN_A has to be made.

After a core network operator has been chosen, the UE should display the PLMN name of the CN operator currently used and possibly the service provider name according to the settings of the USIM/network/ME.

The different possibilities are summarized in Table A.2 below.

Table A.2: Change of registered cell and network for a roaming user allowed to roam on both both networks.

to cell in → / From cell in ↓	A	B	C
other network	Allowed. Normal registration (in CN_A).	Allowed. Normal registration (in CN_B).	Allowed. Selection of core network made by the radio network or by interaction between the radio network and one or both of the core networks.
A	Allowed. Normal updating (within CN_A).	Allowed. Change to CN_B is necessary.	Allowed. Normal updating, stay in CN_A.
B	Allowed. Change to CN_A is necessary.	Allowed. Normal updating (within CN_B).	Allowed. Normal updating, stay in CN_B.
C	Allowed. If in CN_A, stay in CN_A. If in CN_B, change to CN_A is necessary.	Allowed. If in CN_B, stay in CN_B. If in CN_A, change to CN_B is necessary.	Allowed. Stay in the registered core network.

Note: The case when a user actively picks the core network operator is not covered in the table, see the text

Handover in the CS domain

Handovers between the three radio networks should follow the same principles as idle mode roaming between the radio networks. A basic difference, however, is that there is an anchor MSC and a serving MSC (MSC-B in GSM terminology) involved in the core networks. The anchor MSC will always be in the core network in which the UE is currently registered.

In order to avoid inter-MSC handovers between CN_A and CN_B, a basic requirement is that the serving MSC should be in the same core network as the anchor MSC. We should look at how this requirement can be fulfilled.

Subscribers of operator A

Subscribers of operator A should only be registered in CN_A and should only be handed over between cells belonging to radio network A or radio network C. With a suitable filtering mechanism in radio network C, the serving (target) MSC can also be chosen in CN_A. The possible handover cases for a subscriber of operator A are shown in Table A.3 below.

Table A.3: Handover cases for subscribers of operator A

to cell in → / From cell in ↓	A	B	C
other network	Not applicable.	Not applicable.	Not applicable.
A	Allowed. Normal handover (intra- and inter-MSC).	Not allowed.	Allowed. Intra-MSC and inter-MSC to MSC in CN_A only.
B	Not applicable.	Not applicable.	Not applicable.
C	Allowed. Normal handover (intra- and inter-MSC).	Not allowed.	Allowed. Intra-MSC and inter-MSC to MSC in CN_A only.

Roaming users

Visiting roaming users with roaming agreement with only operator A should be handled the same way as subscribers of operator A. Visiting roaming users with roaming agreement with only operator B should be handled the same way as subscribers of operator B.

Visiting roaming users with roaming agreements with both operator A and operator B are entitled to receive service via all three radio networks (A, B and C) and from both core networks (CN_A and CN_B). This would imply that all handover combinations between radio networks and core networks should be possible for these subscribers. However, from a technical and operational point of view it would simplify things if we still keep the requirement that the serving

(target) MSC should be in the same core network as the anchor MSC. This limitation means that once a call has been set up in the core network that was selected in idle mode (the registered core network), the handling of that call will stay completely within that core network until the call is terminated (i.e. no inter-MSC handovers between CN_A and CN_B). It also means that if the call is started in radio network A, then it can only be handed over to cells in radio network A or radio network C and if the call is started in radio network B, it can only be handed over to cells in radio network B or radio network C. The possible handover cases are summarized in Table A.4 below.

Table A.4: Handover cases for roaming users with roaming agreements with both operator A and operator B

to cell in ➔ From cell in ↓	A	B	C
other network	Not applicable.	Not applicable.	Not applicable.
A	Allowed. Normal handover (intra- and inter-MSC).	Not allowed.	Allowed. Inter-MSC handover only to CN_A.
B	Not allowed.	Allowed. Normal handover (intra- and inter-MSC).	Allowed. Inter-MSC handover only to CN_B.
C	Allowed only if anchor MSC in CN_A. Then inter-MSC handover only to CN_A.	Allowed only if anchor MSC in CN_B. Then inter-MSC handover only to CN_B.	Allowed. a) If anchor MSC in CN_A, then inter-MSC handover only to CN_A. b) If anchor MSC in CN_B, then inter-MSC handover only to CN_B.

Handover in the PS domain

The same principles and requirements as for circuit switched handover should apply.

Cell reselection in the PS domain

The same principles and requirements as for Idle mode roaming should apply.

Annex B (informative): Change history

Change history											
TSG SA#	**SA Doc.**	**SA1 Doc**	**Spec**	**CR**	**Rev**	**Rel**	**Cat**	**Subject/Comment**	**Old**	**New**	**Work Item**
12 /12/02	SA #18	SP-020668	22.951					Approved at SA #18	2.0.0	6.0.0	NTShar-TR
SP-19	SP-030034	S1-030203	22.951	001	-	Rel-6	C	Implementing Network Sharing Requirements in Rel-6	6.0.0	6.1.0	NTShar-CR
SP-19	SP-030034	S1-030235	22.951	002	-	Rel-6	B	CR to 22.951 (Network Sharing) Dynamic sharing of inbound roaming subscribers in a shared network	6.0.0	6.1.0	NTShar
SP-36			22.951			Rel-7		Updated from Rel-6 to Rel-7	6.1.0	7.0.0	
SP-42	-	-	22.951			Rel-8		Updated from Rel-7 to Rel-8	7.0.0	8.0.0	
SP-46	-	-	-	-	-	-	-	Updated to Rel-9 by MCC	8.0.0	9.0.0	
2011-03	-	-	-	-	-	-	-	Update to Rel-10 version (MCC)	9.0.0	10.0.0	
2012-09	-	-	-	-	-	-	-	Updated to Rel-11 by MCC	10.0.0	11.0.0	
2014-10								Updated to Rel-12 by MCC	11.0.0	12.0.0	
2015-12	-	-	-	-	-	-	-	Updated to Rel-13 by MCC	12.0.0	13.0.0	
2017-03	-	-	-	-	-	-	-	Updated to Rel-14 by MCC	13.0.0	14.0.0	
2018-06	-	-	-	-	-	-	-	Updated to Rel-15 by MCC	14.0.0	15.0.0	
SA#88e	-	-	-	-	-	-	-	Updated to Rel-16 by MCC	15.0.0	16.0.0	
2022-03	-	-	-	-	-	-	-	Updated to Rel-17 by MCC	16.0.0	17.0.0	

History

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