Technical Specification Group Services and System Aspects **TSGS#21(03)0388**

Meeting #21, Frankfurt, Germany, 22-25 September 2003

Presentation of Specification to TSG or WG

Presentation to:	**TSG SA Meeting #21**
Document for presentation:	**TR23.851, "Network Sharing; Architecture and Functional Description", Version 1.0.0**
Presented for:	**Information**

Abstract of document:

The presented document TR 23.851 describes the stage 2 description (architectural solution and description) for Network Sharing, which includes solutions to realise the stage 1 requirements as stated in 3GPP TR 22.951.

TR23.851 is now 50% complete and therefore ready for presentation for information to SA.

A number of working assumptions for network sharing have been agreed to. They are as follows:

- Cell selection and re-selection concepts are to be kept as they are, for as long as possible.
- LA / RA concepts are to be kept as they are, for as long as possible.
- All UEs accessing any of the PLMNs via the shared AN should see the same LA / RA identities and borders to avoid problems with old mobiles, cell planning interactions with LA, and National roaming and regional provision concepts.
- Network sharing partners should be able to use different Network Mode of Operation (NMO) within of the shared RAN since this allows the sharing partners to decide upon internal core network architecture individually.
- Legacy mobiles must be supported.

The TR describes solutions for network sharing based on these assumptions.

Changes since last presentation to TSG SA:

Not applicable. This is the first presentation.

Outstanding Issues:

After more details concerning the different proposed techniques and solutions have been specified, an evaluation shall be done and the most appropriate solution for network sharing support shall be chosen.

Contentious Issues:

None

3GPP TR 23.851 V1.0.0 (2003-09)

Technical Report

3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Network Sharing; Architecture and Functional Description (Release 6)

Select keywords from list provided in specs database.

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Foreword

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

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

Introduction

This clause is optional. If it exists, it is always the second unnumbered clause.

1 Scope

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 in either 2G or 3G systems, although there is functionality that supports a very basic type of network sharing in the current specifications within 3GPP. In [1], 3GPP has studied service requirements and functionality necessary for supporting a standardized network sharing.

The present document discusses issues and describes functionalities required for Network Sharing as outlined in [1]. The intention is to present one (or more) architectural alternatives for achieving the required functionality within a 3GPP network. An important part of the work is to adapt the network functionality so that pre-Rel-6 mobile telephones that do not have any of the possibly new functionality being introduced for Rel-6 (and later) handsets can be handled in a more efficient way than in pre-Rel-6 networks.

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.*

[<seq>] <doctype> <#>[([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

[1] 3GPP TR 22.951: “Service Aspects and Requirements for Network Sharing”

[2] 3GPP TS 23.060: “General Packet Radio Service (GPRS); Service description; Stage 2”

[3] 3GPP TS 23.122: “NAS Functions related to Mobile Station (MS) in idle mode”

[4] 3GPP TS 25.331: “RRC Protocol Specification”

[5] 3GPP TR 22.101: “Service Principles”

[6] 3GPP TS 22.115: "Charging and Billing"

[7] 3GPP TS 25.401: " UTRAN overall description ", Release 5

3 Definitions, symbols and abbreviations

Delete from the above heading those words which are not applicable.

Subclause numbering depends on applicability and should be renumbered accordingly.

3.1 Definitions

For the purposes of the present document, the [following] terms and definitions [given in ... and the following] apply.

Definition format

***<defined term>**: <definition>.*

example: text used to clarify abstract rules by applying them literally.

3.2 Symbols

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

Symbol format

<symbol> <Explanation>

3.3 Abbreviations

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

Abbreviation format

<ACRONYM> <Explanation>

4 General Description

[Editor's note: This chapter gives an overview of the requirements in 22.951 and requirements and solutions relating to architectural issues not covered by TR 22.951.]

Shared networks is a way for operators to share the heavy deployment costs for mobile networks, especially in the roll-out phase. It also gives operators that do not have licenses of their own the possibility of supplying their subscribers with mobile telephony services. Already R99 contains limited basic functionality, *e.g.* equivalent PLMNs, that makes the deployment of shared networks at least technically feasible within this release. The support for shared networks are then somewhat enhanced with the introduction of the shared network area (SNA) handover functionality in Rel-5. The different scenarios and requirements described in 3GPP TR 22.951 [1] provide an overview of the service and user requirements that are to be fulfilled for efficient network sharing within 3GPP. In this Section we describe the scenarios in TS 22.951 from an architectural point of view that will aid in the development of a shared network architecture to support the service requirements.

A network sharing architecture shall allow the 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, *e.g.* the operators' licensed 3G spectra. 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 . Since operators deploying shared networks using pre-Rel-6 network functionality will also have to share core network nodes (MSCs and SGSNs), such a scenario must be within the scope of the network sharing stage 2 work and be supported by any proposed architectural solution for network sharing. Examples of network sharing scenarios that shall (at least) be considered in this technical report are shown in the figures below.

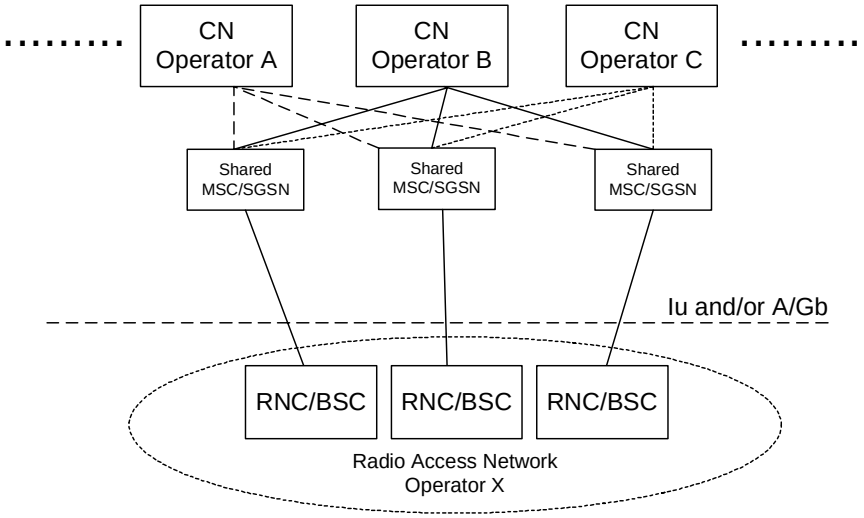


Figure 1: A shared-network architecture constrained by pre-Rel-6 functionality, which will be referred to as the Gateway Core Network (GWCN), where MSCs and SGSNs are also shared besides the radio access network . It shall be possible to use any enhanced Rel-6 network sharing functionality in this architecture since it is important for legacy shared networks. The RAN operator may or may not be one of the CN operators.

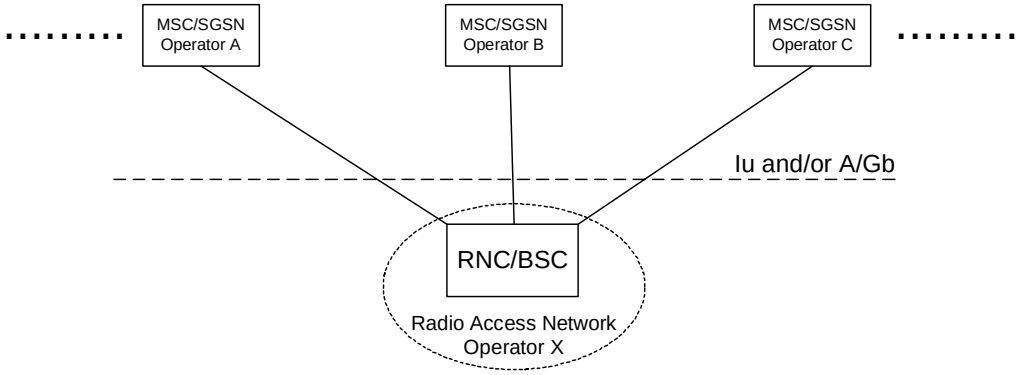


Figure 2: The Multi-Operator Core Network (MOCN) in which multiple CN nodes are connected to the same RNC and the CN nodes are operated by different operators. The RAN operator may or may not be one of the CN operators.

The scenario in Figure 1, the GWCN, is important for legacy shared networks, since this is how they need to be deployed with pre-Rel-6 network functionality. Figure 2 depicts a shared network, the MOCN, that is more cleanly divided in relation to the core network and the radio access network and may be preferrable from a technical and operational point of view. Since it is expected that standardized support for shared networks will introduce functionality that greatly enhances and simplifies the operation of shared networks, both of the scenarios in Figure 1 and Figure 2 (and combinations thereof) need to be taken into account and supported so that the use of these new functionalities are not just associated with the deployment of shared networks according to Figure 2. The introduction of the MOCN connections to RANs enables a few different use cases. For the geographical sharing scenario (described Scenario 2 in [1]) the MOCN solution could be an alternative to national roaming. The sharing partners could connect their core networks directly to the other operators RAN and they would not hence need to roam into the networks of the other operators.

4.1 CN operator and Network Selection

[Editor's note: TR 22.951 specifies certain requirements related to the selection of the CN operator. Those requirements are identified and principles for the solutions are described here. How the choice of CN operator relates to the pre-Rel-6 network selection procedure (e.g. is the selection of CN operator a separate procedure or part of the network selection procedure, or does it replace it) will be considered. This chapter considers issues related to how the RNC/BSC selects the CN operator to which it routes the Initial UE message and potential optimisations/enhancements associated with it.

Depends on the LS response from RAN2 and GERAN2]

4.1.1 Core network operator identity

Network sharing is an agreement between operators and should be transparent to the user. This implies that a UE and/or user 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.

A core network operator should be identified by a PLMN-id (MCC+MNC). This has the least impact on already stable procedures and functionalities in networks and UEs relating to network selection and handling of network identities.

4.1.2 System broadcast information for network sharing

The following system broadcast information is the same in all cells of a Location Area (LA) belonging to a shared RAN:

- Available CN operators,
- NMO, of each CN, if different,
- T3212 timeout value and Attach/detach, which are common for all the available CN operators.

It is noted that each CN might configure different NMOs for pre-Rel-6 UEs and for UEs of other releases. It is FFS whether the value of T3212 may be transmitted to UEs by way of mobility management signalling on a per-UE basis. This would allow CN operators to use different values of T3212 without affecting the broadcast system information.

When UE detects that the LA has changed, it shall check the identities of available CN operators and their associated network configuration information from the network before any potential re-registration to another network as specified in following chapters.

4.1.3 Network selection solution alternatives

This chapter outlines different network selection solution alternatives for REL-6 network sharing.

Editor's note: After reply for SA2 LS on broadcast based solution is received from RAN2 and GERAN2, further evaluation on solution alternatives can be made and the final solution can be selected.

4.1.3.1 UE based solution

In the UE based solution, the operator configures the operator identities for all LAs of all the roaming partners in the USIM. When UE camps on a particular PLMN, it decodes the LAI from the BCCH and retrieves the list of operator identities associated with the PLMN identity and this particular LA from the USIM. Subsequently it registers to the network and indicates the selected operator.

- not all USIM cards (even if the UE is REL-6) support this
- information in the USIM card becomes outdated when

- a new sharing partner joins shared network, or
- an existing partner quits shared network, or

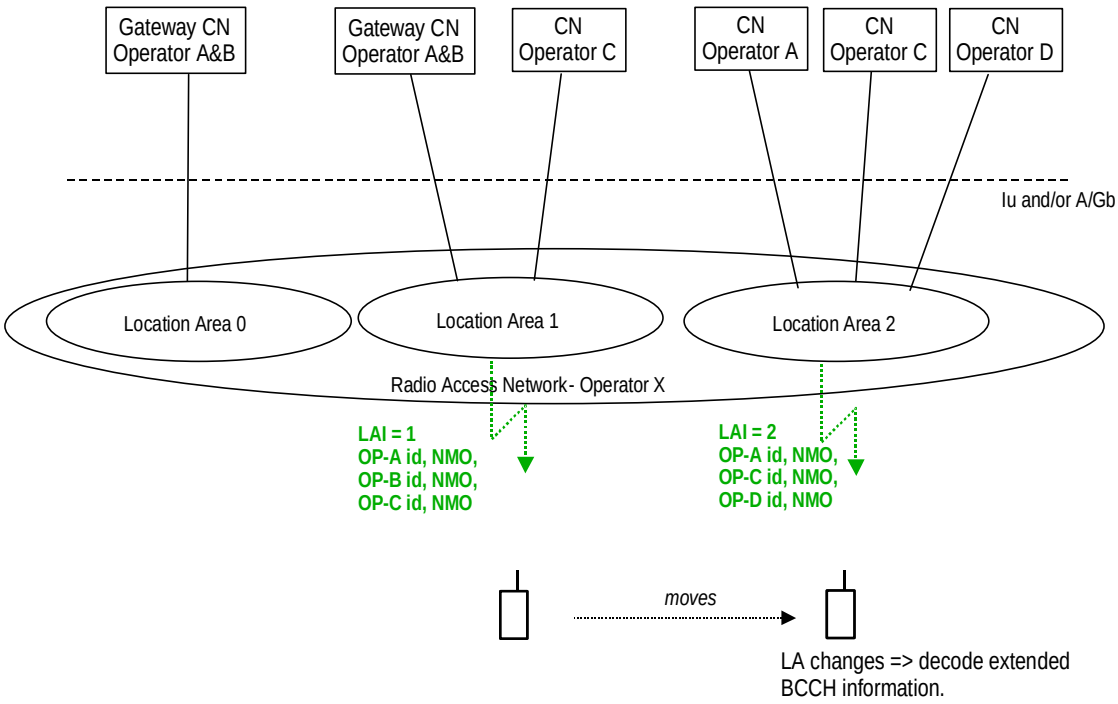
- keeping the information up to date in all the USIM cards is major burden

This alternative does not seem to be a feasible solution due to its difficulties to cope with changes in the shared networks.

4.1.3.2 Broadcast channel based solution

Each cell in REL-6 shared RAN broadcasts the operator identities and other relevant information, like NMO, about the CN operators providing service via the shared RAN. REL-6 UE decodes this information and uses it in the PLMN selection process. In automatic PLMN selection mode, the PLMN is selected based on the available operators behind the shared UTRAN and priorities in the USIM. In manual PLMN selection mode, UE indicates the available CN operators to the user. When UE performs registration procedure it indicates the selected operator to the network.

The figure below illustrates the solution.

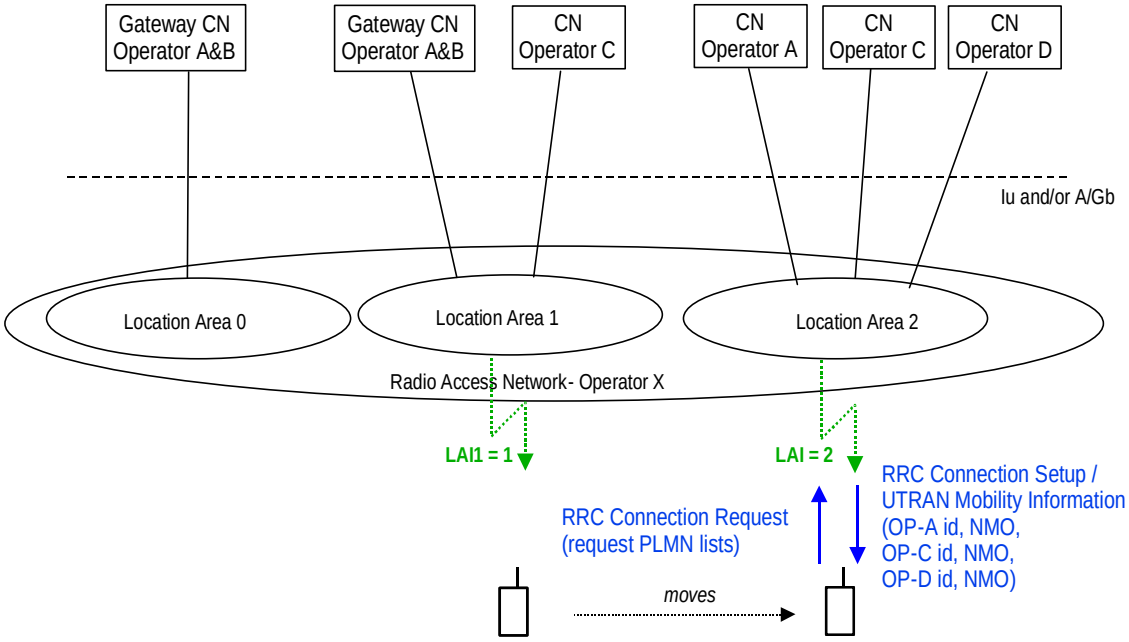


When UE identifies that the LA changes in the broadcast channel, it decodes also the extended BCCH information containing the operator identities and other relevant network configuration information. The broadcast information could be optimised to avoid broadcasting the network configuration information for all the operators sharing a particular gateway core network, because essentially this information is same for all these operators [see sub clause 4.1.4].

4.1.3.3 Connected mode based solution

In connected mode based solution the UE asks network to provide information about available CN operators and other relevant information, like their associated NMO settings.

The following figure illustrates the connected mode based solution.



When UE identifies that the LA has changed it initiates the LA updating procedure. During RRC connection establishment UE indicates to the network that the list of CN operator identities with associated other NAS information should be provided. RNC returns the relevant information to UE during or immediately after the RRC connection establishment. This information could be provided e.g. either in RRC Connection Setup or UTRAN Mobility Information depending on whether the information can fit into the former message.

4.1.4 Optimisation by Shared Network Domain areas

4.1.4.1 Description

A Shared Network Domain (SND) corresponds to the area for which the broadcasted system information by the shared RAN is the same i.e. the same CN operators are available behind the shared RAN with the same configuration i.e. Network Mode of Operation (NMO). A SND is set of one to several location areas. The SND optimisation compared to the existing LA based mechanism described in the sections above is working as follows:

Each cell in the REL-6 shared UTRAN broadcasts the identity of the Shared Network Domain. It is FFS whether these identities are unique within the shared RAN or whether these identities are of a “color-code” fashion (i.e. not unique within the shared RAN). When UE detects that SND has changed, it shall check the identities of available CN operators and their associated network configuration information from the network before registering to the network as specified in above chapters.

The procedure could be optimised such that the UE temporarily stores the information for later use, i.e. when the UE next time enters the same SND area it would identify the shared network domain identity and retrieve the associated information from either USIM or terminal equipment. This approach is not applicable to the “color-code” solution.

4.1.4.2 Advantages

The main advantage of the SND optimisation resides in the case when the UE does not have to check the identities of available CN operators when LA or RA changes, because the current SND the UE is moving under has not changed.

In specific network sharing scenarios for which the number of sharing partners (long list of PLMN-ids) is high and the SND very big e.g. big part of a country, the UEs will have check the full list of PLMN-ids at each LA/RA change,

although this information is likely to be always the same. However it remains FFS whether even in those specific cases this optimisation brings significant gains worth the complexity added.

4.1.4.3 Drawbacks

One main drawback of the SND concept is that it complicates network planning and management because of adding another area concept to existing RA, LA, and pool areas. The same functionality may be obtained based on Location Areas without introducing new area concepts. Furthermore, with SND the UE needs to store the SND identity and compare it at each LA change. For this purpose it needs to read and compare always the new SND identity at LA change.

4.1.5 Indication of selected core network operator to a shared CN

When several core network operators share the same MSC(s) and SGSN(s), so called Gateway Core Network, towards a shared RAN, the selected core network operator identity by the UE needs to be carried back to the CN for several purposes e.g. charging, roaming number allocation, GGSN selection, etc.

4.2 Relationship with Iu Flex

[Editor's note: Iu flex has certain similarities to the multi-operator CN described in TR 22.951. The relationship between the Iu Flex and multi-operator CN is described here. This chapter may also contain information about how Iu Flex may be enhanced to fulfil some of the requirements in TR 22.951.]

4.3 Routing of UE originated initial signalling

[Editor's note: It is anticipated that for MOCN some sort of rerouting/redirecting of the initial messages from the UE is required in the network. This chapter described the principles of rerouting/redirecting Initial UE messages.]

In case of pre-REL-6 UE, if the selected core network is not able to serve the UE, the core network may indicate to RNC that the initial NAS message should be forwarded to another core network.

4.4 Context transfer between CN nodes due to rerouting

[Editor's note: Rerouting of Initial UE messages may cause signalling between the CN node is registered and the CN nodes to which UE is attempting to register. There may be room to optimise the inter CN node signalling. Also e.g. state of protocol machines in the UE and CN may become out of sync due to rerouting. These kind of issues are identified and the principles for the solutions are outlined here.]

In this technical report context transfer refers to the process of transferring NAS information from old CN node to new CN node during rerouting.

During rerouting a CN node provides the possibility to the RNC to forward the initial NAS message and possibly the NAS reject cause to the next CN node. In addition, the CN node may also forward the current value of N(SD), subscriber's identity (IMSI), and unused authentication vectors to the next CN node.

4.5 Network name display

[Editor's note: TR 22.951 specifies certain requirements to network name display. Those requirements are identified and principles for the solutions are described here.]

The requirement on network name display in TR 22.951 states that the terminal shall always show the name of the core network operator the user has registered with.

Since core network operators are identified by ordinary PLMN-ids (MCC+MNC), no fundamentally new mechanisms or functionalities are needed for treating core network operators in shared networks in relation to network name display. If registration with a core network operator in a shared network is successful, the UE should follow exactly the same procedures for determining what should be shown on the display as if the chosen core network operator was not part of a shared network (see TS 22.101 [5]).

4.6 Handling of users in shared networks

[Editor's note: It is foreseen that the network will grant different users different access rights to an entire shared network or one or more parts of it, thereby restricting the users' mobility. The Rel-5 SNA functionality Handover may be used and enhanced for this purpose. These issues are identified and principles for solutions are outlined. Different aspects may have to be considered for subscribers of operators sharing the network and visiting roamers.]

4.6.1 Subscribers of shared network partners

4.6.2 Visiting roamers

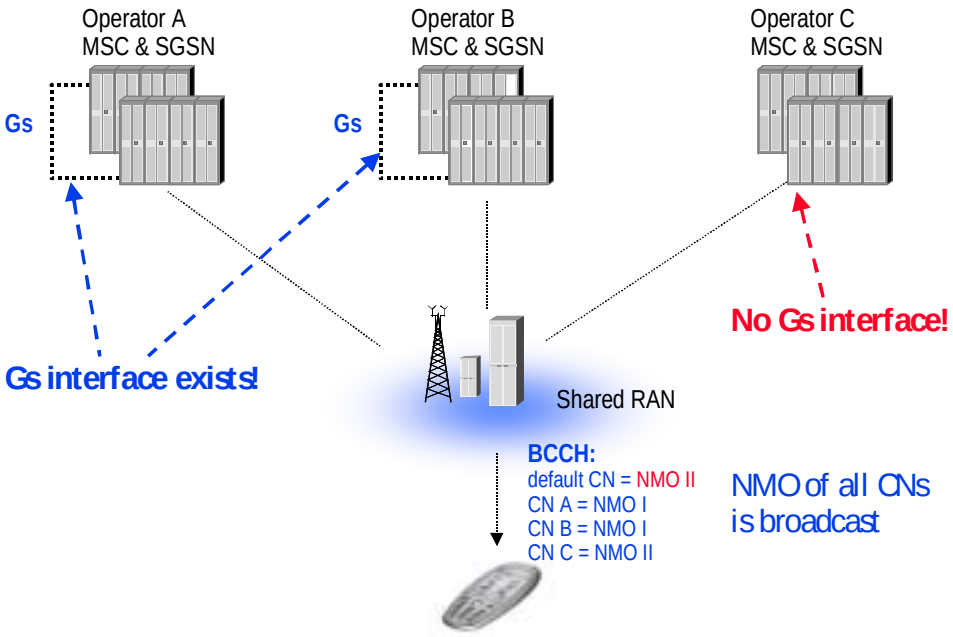
[Editor's note: TR 22.951 specifies certain requirements to how visiting roamers shall be handled in the multi-operator CN. Those requirements are identified and principles for the solutions are described here.]

4.7 Usage of Gs interface

[Editor's note: It seems that multi-operator CN has certain impacts to the usage of Gs interface. Currently only one network mode of operation can be broadcast over the radio interface whereas in multi-operator CN operators may have different network configurations. The problem and the principle of the associated solution is described here.]

If the CN networks for all the operators in the shared network have co-ordinated network mode of operation (NMO) then this single NMO is broadcast as in the case of non-shared networks today.

Core networks in MOCN may want to have different network configuration in terms of usage of Gs interface. If Gs interface is used in the core network, the associated network mode of operation (NMO) is I. If Gs interface is not used in the core network the associated network mode of operation (NMO) is II. In this case the network mode of operation of each core network is broadcast by UTRAN. If the selected core network uses NMO=I, REL-6 UE performs combined CS and PS registration procedures according to [2]. If the selected core network uses NMO=II, REL-6 UE performs separate CS and PS registration procedures according to [2]. Pre-REL-6 UEs behave according to the NMO broadcast in the pre-Rel 6 part of the system information (default NMO). Default NMO indication is used to enable backward compatibility with legacy mobile terminals. This is illustrated in the figure below.



4.8 Pre-Release 6 Functionality

4.8.1 Shared Networks Access Control

The Shared Networks Access Control functionality available from Rel-5 onwards and defined in [7] allows the CN to request the UTRAN to apply UE specific access control to LAs of the UTRAN and LAs of neighbouring networks. The Shared Networks Access Control function is based on either whole PLMNs or Shared Network Areas (SNAs). An SNA is an area corresponding to one ore more LAs within a single PLMN to which UE access can be controlled. In order to apply Shared Networks Access Control for the UTRAN or for a neighbouring system, the UTRAN shall be aware of whether the concerned LA belongs to one (or several) SNA(s) or not. If access for a specific UE needs to be restricted, the CN shall provide SNA Access Information for that UE. The SNA Access Information indicates which PLMNs and/or which SNAs the UE is allowed to access. Based on whether the LA belongs to the PLMNs or SNAs the UE is allowed to access, the UTRAN determines if access to a certain LA for a certain UE shall be allowed. If access is not allowed, the UTRAN shall prevent the UE to obtain new resources in the concerned LA.

4.9 HPLMN support

In a GWCN multiple operators share MSC/VLR or SGSN. From transparency required for the user follows that a shared VLR/SGSN has to be treated by the HLRs belonging to the sharing scenario like a VLR/SGSN in the HPLMN to prevent roaming restrictions, for example. As the HLR derives from VLR/SGSN number whether the subscriber roams in H- or V-PLMN two different approaches exist:

1) The HLR configures all VLR/SGSN numbers of shared networks and handles these like own numbers, or

2) A VLR or SGSN of the GWCN gets one specific number from each supported HPLMN, i.e. a VLR or SGSN has multiple numbers.

For 1) the HLR decision whether the VLR/SGSN in H- or VPLMN has to be modified. Without GWCN it is sufficient to check Country Code (CC) and Network Destination Code (NDC) of the VLR/SGSN number to derive whether the user roams in the HPLMN or not. The HLR has to implement a configurable list of CC+NDC for GWCN network sharing scenarios. This list is compared with the CC+NDC of the VLR/SGSN number.

For 2) a number from every HPLMN belonging to the sharing scenario is assigned to each VLR or SGSN. The VLR/SGSN indicates towards the HLR always the number of the corresponding HPLMN. The HLR can continue to check CC+NDC to derive whether the user roams in V- or HPLMN. The HPLMN has to perform global title translation

for some of the internal numbers that are assigned to VLRs/SGSNs in other networks. Without GWCN this is configuration dependent and typically not needed. The global title translation may be performed in a gateway node. When regional subscriptions are used the allocated zone codes have to be co-ordinated between operators.

One option requires HLR modifications and the other modifies VLR/SGSN. MSC/VLR and SGSN need already modifications for Network Sharing, e.g. configuration which PLMN IDs are part of the sharing scenario, HPLMN dependent routing of mobile originated services and others. For this reason approach 2) is preferred as it adds functionality to the anyhow impacted MSC/VLR and SGSN and avoids HLR modifications.

5 Functional Description

5.1 MS Functions

[Editor's note: This chapter describes MS functions.]

REL-6 UE shall behave according to the NMO of the selected core network. Pre-REL-6 UE behaves according to the default NMO of MOCN.

In Iu mode the UE selects the core network as described in [3] and provides the identity of the selected core network to the RNC in RRC signalling as described in [4].

5.2 RNC Functions

[Editor's note: This chapter describes RNC functions.]

The RNC routes the initial NAS signalling messages from REL-6 UE according to the selected core network. The RNC routes the initial NAS signalling messages from pre-REL-6 UE according to the IDNNS provided by UE.

In the case the selected core network operator shares also part of its CN i.e. MSC/SGSN, the RNC forwards the selected core network operator identity to CN.

RNC shall not perform rerouting for REL-6 UEs even if CN initiates rerouting.

RNC shall perform its routing functions including any rerouting in such a way, that the MM timers in the UE are not affected. RNC coordinates that whenever rerouting to another operator's CN is performed, it is always performed for both domains. RNC coordinates that the selected CS and PS CN nodes always belong to the same operator's core network.

When RNC knows that there are no CN nodes to which initial NAS message could be rerouted, the RNC may indicate to the last CN node in RANAP Initial UE message that further rerouting is not allowed. The decision for this optimization is for further study.

If default NMO=I, for pre-REL-6 UE RNC shall select a core network which uses Gs interface. If default NMO=II, RNC may select any of the core networks.

RNC broadcasts REL-6 UEs a dedicated set of NAS information (see 3GPP TS 24.008) for each core network in the MOCN.

5.3 BSC Functions

[Editor's note: This chapter describes BSC functions.]

5.4 MSC Functions

[Editor's note: This chapter describes MSC functions.]

5.4.1 TMSI Allocation

[Editor's note: TMSI allocation related functions are described here. It is anticipated that MOCN sets requirements to TMSI allocation to properly support pre-REL-6 UEs.

5.4.2 Rerouting

If MSC is not able to provide service to the UE, the MSC provides the initial NAS message to enable the RNC to possibly forward it to an MSC in another core network. MSC may also provide the cause why request was rejected and the current value of N(SD). If MSC has received the reject cause(s) from previously attempted MSCs, they shall be also provided to RNC (this item is FFS). This information shall be transparent to the RNC and if rerouting decision is taken by the RNC it shall forward the information to the next MSC if RNC subsequently selects another MSC. In addition, MSC may provide UE's IMSI if known and a NAS response message to be forwarded to UE in case RNC does not subsequently select any other MSC.

5.4.3 Shared MSC

In the case of a shared CN between core network operators, the MSC may use the received CN operator identity for e.g. charging, etc. The exact behavior of CN should be an implementation issue and configurable by the operator(s). It is FFS how an MSC which uses multiple operator identities shall use these identities when it communicates with other nodes.

5.5 SGSN Functions

[Editor's note: This chapter describes SGSN functions.]

[Editor's notes: If further network nodes are affected, e.g. HLR/HSS, they shall be added in this section along with appropriate functional descriptions. Exactly which network nodes are affected is FFS.]

5.5.1 P-TMSI Allocation

[Editor's note: P-TMSI allocation related functions are described here. It is anticipated that MOCN sets requirements to P-TMSI allocation to properly support pre-REL-6 UEs.

5.5.2 Rerouting

If SGSN is not able to provide service to the UE, the SGSN provides the initial NAS message to enable the RNC to possibly forward it to an SGSN in another core network. SGSN may also provide the cause why request was rejected. If SGSN has received the reject cause(s) from previously attempted SGSNs, they shall be also provided to RNC (this item is FFS). This information shall be transparent to the RNC and if rerouting decision is taken by the RNC it shall forward the information to the next SGSN if RNC subsequently selects another SGSN. In addition, SGSN may provide UE's IMSI if known and a NAS response message to be forwarded to UE in case RNC does not subsequently select any other SGSN.

5.5.3 Shared SGSN

In the case of a shared CN between core network operators, the SGSN may use the received CN operator identity for e.g. charging, GGSN selection, etc. The exact behavior of CN should be an implementation issue and configurable by the operator(s). It is FFS how an SGSN which uses multiple operator identities shall use these identities when it communicates with other nodes.

6 Charging and Accounting Aspects

In [6] it is stated that charging solutions shall 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.

6.1 Inter-operator charging and accounting

CN operators will presumably consume different amount of resources of the shared RAN. The RAN operator may therefore want to charge CN operators accordingly. Generally, volume/time based charging and accounting will not be sufficient because resource consumption is also dependent on quality parameters (e.g. Eb/No - power consumption) of the delivered resources. It is FFS whether the shared RNS therefore should be capable of generating the following charging and accounting information:

- Identity of CN Operator (probably PLMN-id), whose end user has consumed the resource of the RAN.
- Resource, e.g. radio bearer
- Start time – indicating the set up time of radio resource.
- Stop time – indicating the time the radio resource was released.
- Reference to geographical area where the radio resource was used, e.g. cell reference.
- IMSI of the end user, who has consumed radio resource.

[Editor's note: This should be considered as a non-exhaustive list, the inclusion of more items is FFS.]

It is noted that the information generated in the RNS is not intended for end-user charging. The format of the charging information ("RAN-CDR") should be standardized.

[Editor's note: It might be possible to provide this charging information by monitoring the Iu interface signalling. This needs further study, but solutions that minimise the impact on the RNC are desirable.]

6.2 End customer charging

End users should be correctly charged in a shared network. The charging system of the shared network should be able to separate the charging information generated by shared MSC/SGSN and send it to the correct CN operator, i.e. the CN operator that served the end user, based on available information in the CDRs generated by the shared MSC/SGSN.

Note: This section is only relevant in the GWCN, where MSC/SGSNs are shared.

7 Security Aspects

[Editor’s note: This chapter describes security aspects.]

8 Conclusions

[Editor’s note: This chapter provides the conclusion.]

9 Open Issues

Following open issues have been identified which need further studies:

- Optimisation of authentication vector usage in MOCN; In case of rerouting, the first attempted CN node may have retrieved authentication vectors from old CN node and authenticated the user before rerouting is initiated. This leads to a situation in which the next CN node authenticates the user with old authentication vectors and the authentication will fail. This could be avoided if the first attempted CN node forwards the unused authentication vectors to the next CN node during rerouting.
- The need for cause code coordination in MOCN needs to be evaluated. There is a trade off between impact of existing standards and benefit of the function.
- The network selection mechanisms in MOCN need to be defined when the LS response from RAN2 and GERAN2 is available.

Annex A (informative): Network configuration examples

[Editor's note: This chapter maybe needed to contain specific network configuration examples helping to identify and highlight certain issues related to the multioperator CN.]

A.1 Heading levels in an annex

Heading levels within an annex are used as in the main document, but for Heading level selection, the "A.", "B.", etc. are ignored. e.g. **A.1.2** is formatted using ***Heading 2*** style.

Bibliography

The Bibliography is optional. If it exists, it shall follow the last annex in the document.

The following material, though not specifically referenced in the body of the present document (or not publicly available), gives supporting information.

Bibliography format

- <Publication>: "<Title>".

OR

<Publication>: "<Title>".

Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2003-01					First draft of TR – creation of version 0.0.0 at TSG SA2#29 (S2-030190)	---	0.0.0
2003-01					Raised to version 0.1.0 at TSG SA2#29	0.0.0	0.1.0
2003-05					Revised as per approved documents at TSG SA2#31: - S2-031599 (Gs interface) - S2-031382 (Rerouting of registration signalling) - S2-031407 (Text in Sec 1 and Sec 2) - S2-031542 (Text in Sec 4) Between TSG SA2#31 and TSG SA2#32 the TR was assigned number 23.851. This change is included in version 0.2.0. The document containing the above changes and additions changes that was approved at TSG SA2#32 is S2-031973.	0.1.0	0.2.0
2003-05					Revised as per approved document S2-031973	0.2.0	0.2.1
2003-05					Revised as per approved documents at TSG SA2#32: - S2-032045 (network name display; removal of sentence, see meeting minutes) - S2-032132 (shared network domain introduction) - S2-032133 (network selection alternatives) - S2-032134 (core network operator identity)	0.2.1	0.3.0
2003-08					Revised as per approved documents at TSG SA2#33: - S2-032702 (charging) - S2-032703 (Introduction of GWCN) - S2-032704 (Signalling of selected operator identity from UE to CN)	0.3.0	0.4.0
2003-08					Editorial updates	0.4.0	0.4.1
2003-08					Revised as per approved documents at TSG SA2#34: - S2-033094 (Network Sharing with HPLMN Support) - S2-033199 (Shared Network Access) - S2-033250 (TR clarification and clean-up to SND definition and network selection solution alternatives)	0.4.1	0.5.0
2003-09					First presentation for Information	0.5.0	1.0.0