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Technical Report

3rd Generation Partnership Project; Technical Specification Group Radio Access Network; Non Access Stratum (NAS) Node Selection Function (Release 5)



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Keywords

3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

<http://www.3gpp.org>

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Foreword

This Technical Report (TR) 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.

1 Scope

The purpose of the present document provides the current status of the work "*Intra Domain Connection of RAN Nodes to Multiple CN Nodes: Overall System Architecture*" within 3GPP TSG RAN WG3.

Currently an RNC can only be connected to one MSC and/or one SGSN. This can bring about inefficient usage of hardware and disproportionate spread of signalling loads across a network.

This Work Item concentrates primarily on a solution where a (standardised) routing *function* in the RNC enables the connection of multiple MSCs/SGSNs to an RNC. It is hoped that this will bring about a reduction in mobility management signalling and improved efficiency in hardware utilisation.

It describes agreed requirements related to the Work Task, and split the Work Task into "Study Areas" in order to group contributions in a consistent way. It discusses the impact upon RAN3 specifications, and identifies the affected specifications. If information needs to be communicated to groups outside of TSG RAN WG3, it is recorded in this document. When solutions are sufficiently stable, the CRs to the various impacted RAN3 specifications can be issued.

It also describes the schedule of the Work Task.

The present document is a 'living' document, i.e. it is continuously updated and presented to all TSG-RAN meetings.

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 and/or edition number or version number) 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] SP-000619 (TSGS#10): "Work Item Description: Intra Domain Connection of RAN Nodes to Multiple CN Nodes: Overall System Architecture"
(http://www.3gpp.org/ftp/tsg_sa/TSG_SA/TSGS_10/Docs/PDF/SP-000619.pdf).
- [2] 3GPP TS 23.236: "Intra-domain connection of Radio Access Network (RAN) nodes to multiple Core Network (CN) nodes".
- [3] 3GPP TS 25.331: "Radio Resource Control (RRC) protocol specification".
- [4] 3GPP TS 25.401: "UTRAN Overall Description".
- [5] 3GPP TS 25.410: "UTRAN Iu Interface: General Aspects and Principles".
- [6] 3GPP TS 25.413: "UTRAN Iu interface RANAP signalling".
- [7] R3-013067: "Reply to LS 'Update of Iu-Flex status'"
(http://www.3gpp.org/ftp/tsg_ran/WG3_Iu/TSGR3_24/Docs/).
- [8] R3-020012: "Reply to reply to LS 'Update of Iu-Flex status'"
(http://www.3gpp.org/ftp/tsg_ran/WG3_Iu/TSGR3_26/Docs/).

Editors Note: A formal review of the references is required.

3 Definitions, Symbols, and Abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply:

NAS Node Selection Function: function used to assign specific network resources (i.e. MSC-server or SGSN) to serve a UE and subsequently route the traffic to the assigned network resource

Network Resource Identifier (NRI): uniquely identifies an individual CN node out of all CN nodes are assigned to serve a UE

Pool Area: collection of one or more MSC or SGSN serving areas within which a UE may roam without need to change the serving CN node (i.e. MSC-server or SGSN)

A Pool Area is served by one or more CN nodes in parallel. All the cells controlled by a RAN node (i.e. RNC belong to the same one [or more] pool area[s]).

RAN node service area: this area contains all the cells controlled by the RAN node (i.e. RNC)

CN Node: MSC-Server/SGSN

RAN Node: RNC

3.2 Symbols

None.

3.3 Abbreviations

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

| | |
|-------|---------------------------------------|
| BSC | Base Station Controller |
| CN | Core Network |
| CS | Circuit Switched |
| IDNNS | Intra Domain NAS Node Selection |
| LAs | Location Areas |
| MSC | Mobile Switching Centre |
| NAS | Non Access Stratum |
| NNSF | NAS Node Selection Function |
| NRI | Network Resource Identifier |
| O&M | Operations and Maintenance |
| PS | Packet Switched |
| RANAP | Radio Access Network Application Part |
| RAs | Routing Areas |
| RNC | Radio Network Controller |
| SGSN | Serving GPRS Support Node |
| UE | User Equipment |

4 Introduction and Motivation

4.1 Task Description

The work task is described in the contribution [1], which has been agreed at TSG-RAN#10.

The purpose of this new work item is to enable a 'more flexible' Iu interface, whereby RNCs can be connected to more than one MSC-server/SGSN.

4.2 Rationale for NNSF

3GPP has incorporated the GSM architecture whereby one BSC can only connect to one MSC-server. Using this GSM based architecture approach, there could be a significant wastage of hardware e.g. where a BSC has 40 % of the capacity of an MSC-server, 2 BSCs may only be connected to that MSC-server – leaving 20 % MSC-server capacity not utilised.

Regarding network signalling traffic, with more MSC-server/SGSNs in a network, there are more inter-MSC-server/SGSN registration updates. The signalling associated with these inter MSC-server/SGSN updates causes additional load on CN signalling: MSC-servers, SGSNs, HLRs, and on the radio interface signalling channels.

The ability to connect RNCs to more than one MSC-server and to more than one SGSN could reduce this signalling load, and moreover, the ability to provide signalling load sharing between MSC-servers/SGSNs would further improve the efficiency of hardware utilisation.

An area where the possible outcome includes improved signalling load distribution and increased efficiency of network nodes, is one that is very appealing. Although this document shall not detail the impacts upon GSM/GPRS/GERAN it should be stated that any solution should consider both GSM and UMTS.

5 Requirements

This clause will contain the requirements to support the NNSF work item. Different subclauses may contain different types of requirements.

5.1 General Requirements

Where the NAS Node Selection Function is implemented, the following are requirements:

- 1) During initial access or if the NRI is not known within the RAN node, the RNC/BSC shall be able to select any CN node such as the SGSN/MSC-Server within a Pool Area or group of Pool Areas.
- 2) Once the UE belongs to a pool area the RNC/BSC using the NNSF shall be able to select the appropriate CN node i.e. an SGSN/MSC-Server - based on the routing information provided by the UE during the initial non-access stratum signalling.
- 3) All RNCs and SGSNs/MSC-Servers (using the NNSF) should be able to co-exist with all RNCs and SGSNs/MSC-Servers NOT using the NNSF.
- 4) The solution shall enable the reduction of signalling within the core network (e.g. reduction of the HLR signalling traffic).

6 Study Areas

This clause shall document the discussion(s) and solution(s) if a Network were to implement this function.

6.1 NNSF Overview

6.1.1 General

The Intra Domain Connection of RAN Nodes to Multiple CN Nodes introduces functionality e.g. a routing mechanism which enables the RAN nodes to route signalling messages to different CN nodes within the CS or PS domain, respectively.

The Intra Domain Connection of RAN Nodes to Multiple CN Nodes introduces the concept of "Pool Areas". Within a Pool Area a UE may roam freely (in either connected or idle mode) without the need to change the CN serving node.

The usage of this 'Pool Area' concept aims to reduce inter CN node updates , handovers/relocations and reduce HLR updating signalling.

6.1.2 Pool Area

A Pool Area:

- Is comparable to the serving area an MSC or SGSN , and may be a collection of one or more MSC or SGSN serving areas.
- Unlike an MSC or SGSN service area, a Pool Area is typically served by more than one CN node (MSCs or SGSNs) in parallel which share the traffic of this area between each other.
- Pool Areas may overlap.
- A Pool Area is an area within which a subscriber may roam without a need to change the serving CN node.
- The complete serving area of a RAN node (RNC or BSC) belongs to one or more Pool Area(s).
- The serving area of a RAN node may belong to multiple Pool Areas which can occur when multiple overlapping Pool Areas include this RAN node service area.
- The Pool Areas of the CS and of the PS domain are configured independently with the granularity of RAN node serving areas.
- If Location Areas (LAs) or Routing Areas (RAs) span over multiple RAN node serving areas then all these RAN node serving areas have to belong to the same Pool Area.

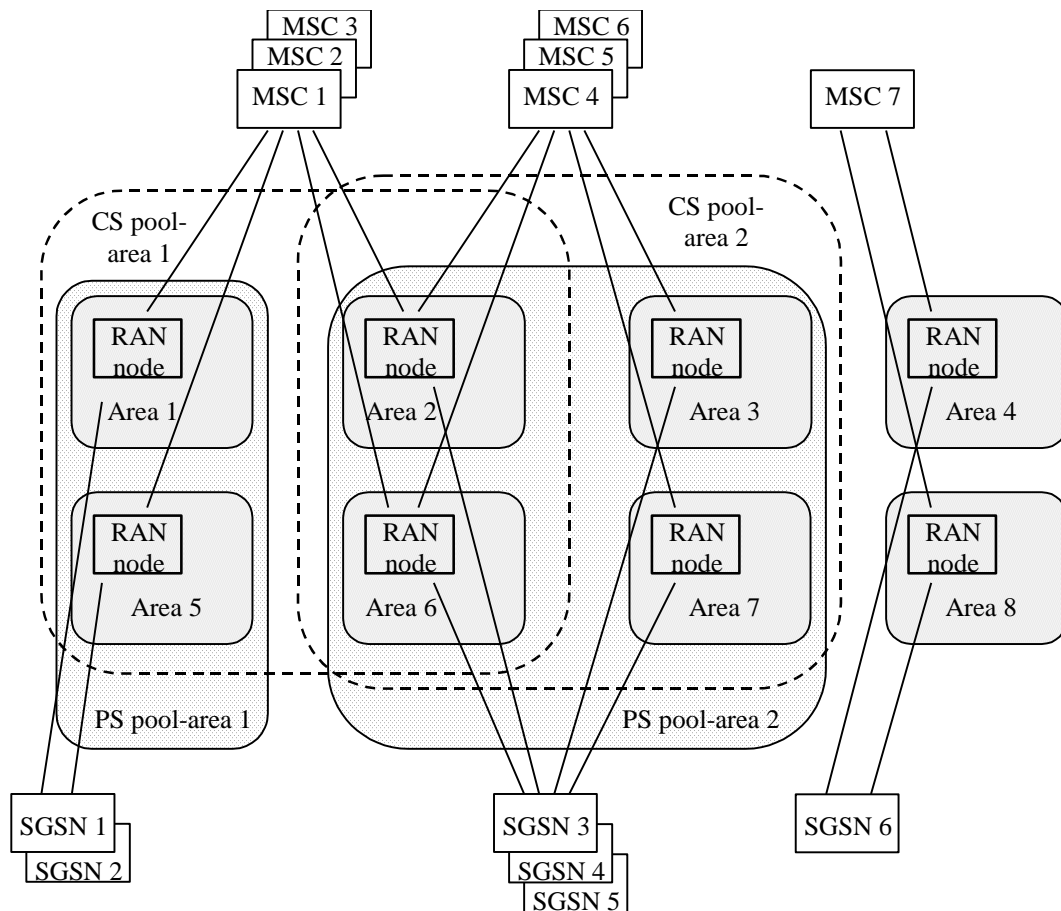


Figure 1: Pool Area configuration example

6.1.3 NAS Node Selection Function

The NAS Node Selection Function will be used in RAN nodes and potentially in CN nodes. In the RAN node the function selects the specific CN node (i.e. MSC or SGSN) to which initial NAS signalling messages are routed. The NRI identifies the specific CN node.

If no CN node address is configured for the derived NRI or if no NRI can be derived (e.g. the UE indicated an identity which contains no NRI) then the NAS Node Selection Function selects an available CN node (e.g. according to pre-determined signalling load balancing) and routes the message to the selected CN node.

The NAS Node Selection Function in the RAN node derives the NRI from the IDNNS IE (see TS 25.331) when the UE is supported in Iu mode.

6.1.4 Network Resource Identifier

The Network Resource Identifier (NRI) identifies uniquely an individual CN node out of all CN nodes which serve in parallel a Pool Area. In areas where Pool Areas overlap the NRI identifies uniquely a CN node out of all CN nodes which serve all these overlapping Pool Areas, i.e. an NRI identifies uniquely a CN node within a RAN node.

NOTE: The NRIs of the CS and the PS domain are independent of each other as the PS and the CS domain CN nodes are addressed independently. More than one NRI may be assigned to a CN node.

The NRI is part of the temporary identity TMSI (CS domain) or P-TMSI (PS domain) which is assigned by the serving CN node to the UE. Each CN node which supports the "Intra Domain Connection of RAN Nodes to Multiple CN Nodes" is configured with its specific one or more NRI(s). The (P-)TMSI allocation mechanism in the CN node generates (P-)TMSIs which contain a configured NRI in the relevant bit positions.

In Iu mode the MS provides an Intra Domain NAS Node Selection (IDNNS) [2] in the Access Stratum part of the [RRC] INITIAL DIRECT TRANSFER message to the RAN node (RNC or BSC). The IDNNS contains a routing parameter with a fixed length of 10 bits. This routing parameter transports the NRI value. In addition the IDNNS contains an indication from which identity (TMSI, IMSI, IMEI, ...) the routing parameter is derived.

6.1.5 Load Balancing

The aim of implementing the NNSF is to balance the signalling load between the available CN nodes. The signalling load-balancing algorithm is implementation specific.

6.2 Functional Impact

6.2.1 NNSF Impact

The role of the RNC in implementing the NAS Node Selection Function is described below.

6.2.1.1 RNC Functions

The RNC provides the NAS Node Selection Function. The NAS Node Selection Function derives from the NRI the address of the specific CN node for the relevant domain (CS or PS). The association between NRI values and CN node addresses is configured in the RNC (O&M).

The RNC routes the initial NAS signalling messages according to the NRI and the "domain indicator" (CS or PS) to the relevant CN node if a CN node address is configured in the RNC for the specific NRI and the requested domain (CS or PS).

If no CN node address is configured in the RNC for the requested NRI or if the provided identity contains no NRI then the RNC routes the initial NAS signalling message to a CN node selected from the available CN nodes which serve the related domain (CS or PS).

The selection mechanism is *implementation dependent* and should preferably balance the signalling load between the available CN nodes.

6.2.2 Impact on UTRAN Architecture

The addition of this *function* should be described in the appropriate UTRAN Architecture specification, however no direct impact on *actual* UTRAN architecture e.g. new interfaces, new network elements is foreseen in the introduction of this function (with the exception of Iu Connectivity - see below).

6.2.3 Impact on the Iu Interface

At present for R99/R4, there is a restriction on the connectivity of a UTRAN access point to the CN where by there may not be more than one Iu-CS (R99 only) or Iu-PS interface to the respective CS and PS domains. Should NNSF be implemented this restriction would need to be amended to state that multiple Iu interfaces (Iu-CS or Iu-PS) may be present.

6.2.4 Impact on RANAP - Paging

In case the RNC receives a CS PAGING message with IMSI only, the RNC may upon reception temporarily store the MSC/VLR-identity of the node that issued the paging message.

NOTE: The PAGING message containing a CS domain identifier may be sent via Iu-PS as well.

The *CN Global-ID* IE (recently added to RANAP (R4) for TrFO purposes) is appropriate in this situation.

6.2.5 Impact on RANAP - Initial UE Message

The RNC using the NNSF shall route the INITIAL UE MESSAGE according to the mechanism described in subclause 6.1.3. In the exceptional case described in subclause 6.2.4, the RNC may utilise the memorised MSC/VLR-identity for routing the INITIAL UE MESSAGE.

If the RNC receives a CS-paging via the Iu-PS interface it may use the MSC/VLR identity provided within the PAGING message for routing the INITIAL UE MESSAGE.

6.2.6 Impact on RANAP - Definition of the 'Default CN Node'

The definition of the *Default CN Node* IE needs to be re-evaluated. There might also be changes necessary in the respective Elementary Procedure (EP) description referring to the Default CN Node.

6.2.7 Impact on RANAP - Backwards compatibility

No impact upon previous releases of RANAP is foreseen with the implementation of this function.

7 Agreements

The solution outlined in the present document - as found in the referenced CRs - was the only proposal and thus no agreement was required with regards to deciding between more than one option.

8 Specification Impact and Associated Change Requests

8.1 TS 25.401 UTRAN Overall Description

Please refer to CR45, TS 25.401 V4.3.0.

8.2 TS 25.410 Iu General Aspects & Principles

Please refer to CR36, TS 25.410 V4.3.0.

8.3 TS 25.413 UTRAN Iu Interface RANAP Signalling

Please refer to CR 431, TS 25.413 V4.3.0.

9 Communication with Other Groups

9.1 Correspondence with TSG SA WG2

During RAN3 Meeting #24 a liaison was sent to SA WG2 regarding: 'The handling of Page responses in the event of MSC/VLR failure'.

This liaison can be found in T-doc R3-013067.

During RAN3 Meeting #26, a liaison was sent from SA WG2 to RAN (this liaison can be found in T-doc R3-020012) in response to the original liaison from RAN3 - T-doc R3-013067.

Annex A: Change History

| Change history | | | | | | | |
|----------------|-------|----------|----|-----|---|-----|-------|
| Date | TSG # | TSG Doc. | CR | Rev | Subject/Comment | Old | New |
| 03/2002 | 15 | - | - | | Approved at TSG RAN #15 and placed under Change Control | - | 5.0.0 |