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**Digital cellular telecommunications system (Phase 2+);
Universal Mobile Telecommunications System (UMTS);
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(3GPP TS 23.121 version 3.6.0 Release 1999)**



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1 Scope

The present document covers issues related to the evolution of the GSM platform towards UMTS with the overall goal of fulfilling the UMTS service requirements, the support of the UMTS role model, support of roaming and support of new functionality, signalling systems and interfaces.

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.

- [1] 3GPP TS 22.001 : « Services Principles ».
- [2] 3GPP TS 23.002: "Network Architecture".
- [3] 3GPP TS 23.060: "General Packet Radio Service (GPRS) Service description; Stage 2".
- [4] ETSI TC-SMG GSM 11.14: "Specification of Subscriber Identity Module – Mobile Equipment (SIM – ME) Interface for SIM Application Toolkit".
- [5] (void)
- [6] 3GPP TS 23.101: "3rd Generation mobile system Release 1999 Specifications"
- [7] (void)
- [8] UMTSYY.01, UE-UTRAN Radio Interface Protocol Architecture – Stage 2.
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- [13] <http://www.ietf.org/html.charters/mobileip-charter.html>
- [14] 3GPP TR 21.905: "3G Vocabulary".
- [15] 3GPP TS 24.007: "Digital cellular telecommunications system (Phase 2+); Mobile radio interface signalling layer 3 General aspects".

3 Definitions

For the purposes of the present document, the terms defined in 3GPP TR 21.905 apply:

4 Working assumptions

Information flows provided in the present document are for information only. They do not constrain implementation.

4.1 General

The phase 1 UMTS/Release '99 GSM standards should provide the capability to support:

- a core network based on an evolved 2G MSC and an evolved SGSN;
- an optionally evolved Gs interface;
- mobile Ipv4 with Foreign Agent care-of addresses to end users over the UMTS/GPRS network, where the FA is located in the GGSN;
- class A GSM' mobiles;
- transcoder location shall be according to 23.930;
- UMTS/IMT2000 Phase1 (Release 99) network architecture and standards shall allow the operator to choose between Integrated and Separated core networks for transmission (including L2);
- the UMTS standard shall allow for both separated and combined MSC/VLR and SGSN configurations;
- the UE shall be able to handle separated or combined MSCs and SGSNs;
- there can be several user planes to these CN nodes.

The following general concepts should be followed:

- separate the layer 3 control signalling from the layer 2 transport discussion (do not optimise layer 3 for one layer 2 technology);
- MSC-MSC layer 3 call control is out of scope of standardisation in SMG;
- as future evolution may lead to the migration of some services from the CS-domain to the PS-domain without changes to the associated higher-layer protocols or functions. UMTS release 99 shall provide the flexibility to do this in a way that is backwards compatible with release 99 Ues provided this does not introduce significant new complexity or requirements in the system.

4.2 Iu Interface

- Transport protocol across the Iu interface for UTRAN shall be according to 23.930.
- The UTRAN shall support two logically separate signalling flows via Iu to combined or separate network nodes of different types (MSC and SGSN).
- The UTRAN shall contain a "domain distribution function" to route transparent application-level control signalling from the UE to the correct core network domain. The UE shall indicate the type of application being addressed (e.g. via a protocol discriminator). The UTRAN shall map this on to the correct Iu instance to forward the signalling.
- UTRAN-services (including radio access bearers) shall be independent from the core network domain used to access them. Either core network domain can access any appropriate UTRAN-service (e.g. it should be possible to access a "speech" radio access bearer from the PS-domain).
- The protocol architecture for the User Plane of the Iu interface towards the IP domain shall be based on the same principles as for the (evolved) Gn interface, i.e. the user plane part of GTP over UDP/IP shall be used for ignalling of end user data packets over the Iu interface. If the Iu data transport bases on ATM PVCs then the Iu IP layer provides the Iu network layer services, e.g. routing, addressing, load sharing and redundancy. In this case an IP network may be configured to transfer Iu data units between RNSs and 3G-SGSNs.

- One or several AAL5/ATM Permanent VCs may be used as the common layer 2 resources between the UTRAN and the 'IP domain' of the CN. The reason for usage of several permanent AAL5/ATM VCs may e.g. be for load sharing and redundancy. It is also possible to use one switched VC per user flow (PDP context or radio access bearer). Switched VCs may be used, however the standardization of the procedures and protocols for use of Switched VCs is outside the scope of the 3GPP. If operators use switched VC, the specification of procedures and protocol for switched VCs are up to operators and out of scope of the UMTS/IMT-2000 specification.

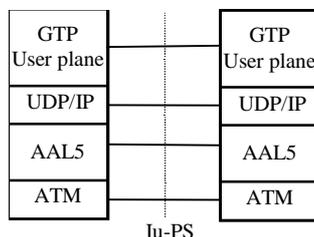


Figure 4.1: Protocol Architecture for the Iu user plane towards the IP domain

- Charging functionality is located at the 3G-SGSN. On the other hand, only RNC can identify the actual packet volume successfully transferred to a UE. In order for 3G-SGSN to provide the volume based charging for IP domain, the standard shall support the following procedures over Iu interface.
- The RNC indicates the volume of all not transferred downlink data (discarded or forwarded to 2G-SGSN) to the 3G-SGSN so that the 3G-SGSN can correct its counter. Partially transferred packets are handled as not transferred.
- The RNC delivers to the 3G-SGSN the discarded or forwarded volume accumulated over an implementation dependent time and not per discarded or forwarded packet.
- The 3G-SGSN can ask the RNC to provide the volume of buffered downlink data to correct its counter at any time the 3G-SGSN wants.

4.2.1 Iu Control Plane

For transport of RANAP messages over Iu an SCCP protocol shall be used for both packet and circuit switched domains. The SCCP protocol shall fully comply with ITU-T white book. RANAP protocol shall be designed to use this service according to the ITU-T standard. Iu shall be designed so that RANAP is not impacted by alternatives for SCCP message transport on layers below SCCP.

In the circuit switched domain SCCP messages shall be transported on a broadband SS7 stack comprising MTP3b on top of SAAL-NNI. In this domain no other alternatives are standardised in release 99.

In the packet switched domain the UMTS standard shall allow operators to choose one out of two standardised protocol suites for transport of SCCP messages.

- 1) Broadband SS7 stack comprising MTP3b on top of SAAL-NNI.
- 2) IETF/Sigtran CTP protocol suite for MTP3 users with adaptation to SCCP. The protocol suite shall fully comply with the IETF standards developed by the Sigtran working group. No UMTS specific adaptations shall be standardised below the SCCP protocol.

The grey colour denotes protocols being developed by the IETF sigtran group.

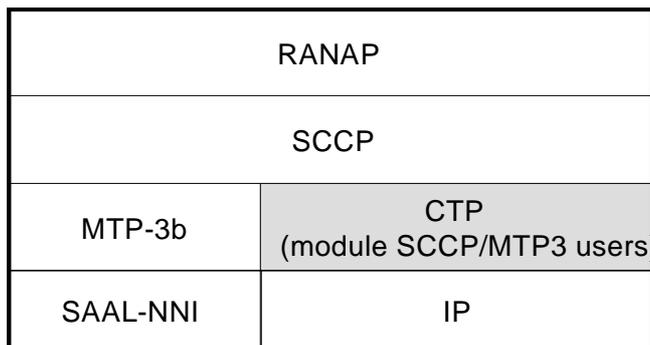


Figure 4.2: RANAP protocol stack options

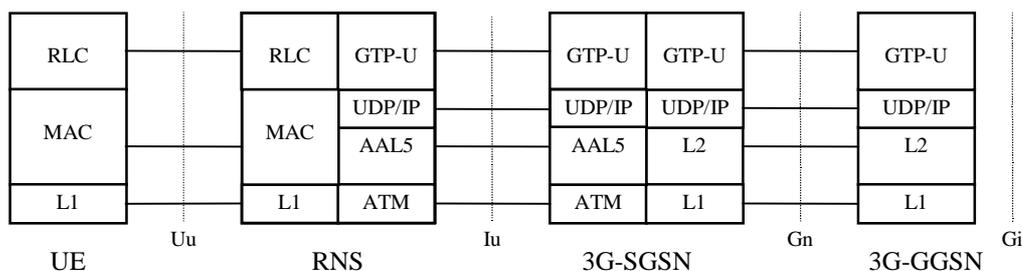
4.2.2 Iu User plane

- The standard shall support that the user data flows transported over the Iu reference point to/from the 'IP domain' shall be multiplexed on top of common layer 2 resources.
- If the Iu data transport bases on ATM PVCs then the Iu IP layer provides the Iu network layer services, e.g. routing, addressing, load sharing and redundancy. In this case an IP network may be configured to transfer Iu data units between RNSs and 3G-SGSNs.
- One or several AAL5/ATM Permanent VCs may be used as the common layer 2 resources between the UTRAN and the 'IP domain' of the CN. The reason for usage of several permanent AAL5/ATM VCs may e.g. be for load sharing and redundancy. It is also possible to use one switched VC per user flow (PDP context or radio access bearer).
- A tunnelling protocol is used on top of this common layer 2. This tunnelling protocol corresponds to an evolution of the user plane part of the GTP protocol used in GPRS put on top of UDP/IP.
- The user data plane in the UMTS network is made up of two tunnels:
 - a first IP/UDP/GTP tunnel between RNC and 3G SGSN on Iu;
 - a second IP/UDP/GTP tunnel between GGSN and 3G SGSN on Gn.

This architecture:

- provides hierarchical mobility;
- allows having the RNC directly connected on the IP domain backbone;
- ensures that all traffic is routed through 3G-SGSN that may perform functions such as charging and Lawful Interception;
- would allow to have different protocols (or protocol version) on Gn and Iu if needed in the future.

The protocol stack is shown in figure 4.3.



Note: Protocol layers above RLC and GTP-U are FFS

Figure 4.3: Protocol Architecture for IP domain user plane

4.2.2.1 Principles of User Data Retrieve in UMTS and at GSM-UMTS Hand-Over for PS Domain

4.2.2.1.1 Requirements for Data retrieve at GPRS/UMTS handover

The same reliability as in inter 2G-SGSN RA update case has to be provided at GPRS to/from UMTS handover. Therefore, the data retrieval should be ensured between 2G-SGSN and SRNC as it is ensured between two 2G-SGSNs.

Between two 2G-SGSNs, data retrieve is carried out via the Gn interface i.e. via GTP-u¹/UDP/IP. In order that the 2G-SGSN is not modified for data retrieve with the SRNC, the 2G-SGSN should keep the same protocol stack.

4.2.2.1.2 Adopted solution for data retrieve at GPRS-UMTS handover

For Control Plane: Since some parameters transported by GTP-c are CN related only (e.g. CN classmark,...), it is necessary to terminate GTP-c signalling exchanged with the 2G-SGSN in the 3G-SGSN, and to use RANAP signalling on Iu between 3G-SGSN and SRNC.

For User plane: As Charging of the retrieved data is to be carried out at 3G-SGSN, data exchanged between SRNC and 2G-SGSN are handled by the 3G-SGSN (two GTP pipes: SRNC – 3G-SGSN and 3G-SGSN – 2G-SGSN). This ensures that:

- 3G-SGSN can increment charging counters for user data sent from 2G-SGSN to SRNC;
- 3G-SGSN can decrement charging counters for user data sent from SRNC to 2G-SGSN avoiding that such data are charged twice (in 3G-SGSN and in 2G-SGSN).

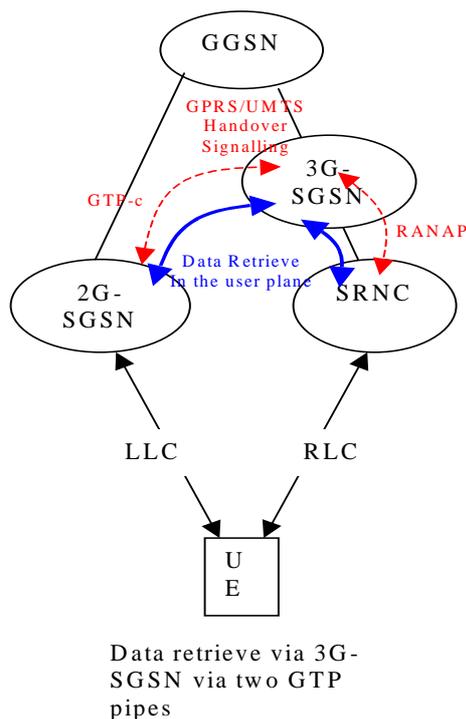


Figure 4.4: Data retrieve between GPRS and UMTS

4.2.2.1.3 Requirements for data retrieve in UMTS

NOTE: This subclause deals with the case of SRNS relocation and of UMTS hard hand-over (when this hard hand-over involves also the CN i.e. involves a change of Serving RNC).

¹ GTP-u stands for GTP user plane protocol

Since:

- there is no buffering in the 3G-SGSN;
- there is an ARQ mechanism in the Serving RNC (the RLC layer) similar to the LLC layer in the 2G-SGSN;
- the data reliability is ensured by the transfer of non-acknowledged user data from the Source RNC to the Target RNC. This transfer ("data retrieve") can be performed with a mechanism similar to the one used between 2G-SGSNs in GPRS;
- the Data retrieve between two RNCs belonging to the same UTRAN is required for non real-time data services during a SRNS relocation procedure;
- regarding the SRNS Relocation procedure Control Plane, SRNS relocation procedure uses both RANAP signalling over the Iu and RNSAP signalling over the Iur.

Regarding the user plane, some requirements can be listed:

Synchronisation:

Since the 3G-SGSN does not buffer downstream data, the source RNC may have to buffer all GTP frames that are not yet transmitted or acknowledged at RLC layer. It also has to buffer all GTP frames that continue to arrive from the GGSN (the GGSN continues to send them to the source RNC as long as its PDP context has not been updated by the SGSN. Furthermore, data that are sent by the GGSN may take a certain time to get to the source RNC).

This means that:

The target RNC has to start as Serving RNC just after having received SRNS Relocation Commit message from the source RNC even if all downstream data have not been retrieved yet.

The user data retrieve may last a relatively long time. A timer is armed in the Source SRNC at the beginning of the data transfer phase. The contexts related to the UE in the Source SRNC will be released when the timer expires, i.e. when downstream data from GGSN is considered as finished.

Data reliability:

Depending upon the required reliability, there could be a need for a layer 2 protocol or not. In the GPRS, the user data is transfer via GTP/UDP/IP if the user-to-user data is IP-based, and via GTP/TCP/IP if the user-to-user data is X25-based. Here, only GTP/UDP/IP is considered.

Multiplexing of PDP contexts during data retrieve:

Several SRNS Relocation procedures for different users and/or different bearers may be carried out simultaneously and independently. GTP is used to differentiate the data retrieve contexts.

Associated signalling:

Considering signalling, there are two kinds of signalling:

Signalling linked with transmission of CN parameters. This corresponds to signalling exchanged on Gn between 3G-SGSNs during the (first) phase of resources for the SRNS relocation.

Signalling linked with the transmission of the sequence numbers of the acknowledged protocol (RLC) between SRNC and UE. This can be done over Iur when the source SRNC actually hands-over the role of SRNC (when sending the RNSAP "Relocation commit" to the target SRNS).

4.2.2.1.4 Adopted solution for data retrieve in UMTS

Data Retrieve procedure at SRNS relocation shall be carried out through the Iu interface: data exchanged between source and target SRNC are carried over Iu at ATM layer. They are routed at IP layer towards the target SRNC and there is one single GTP tunnel between the source SRNC and the target SRNC.

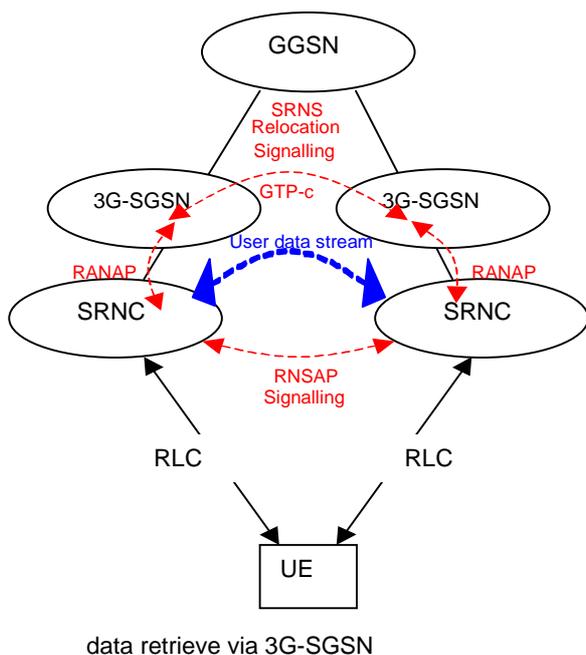


Figure 4.5: User data Retrieve in UMTS

4.2.2.1.5 User plane protocol stacks for UMTS data retrieve

The user plane for data retrieve between two RNCs is based on GTP-u/UDP/IP. The GTP connections are terminated in the source SRNC and the target SRNC as described in figure 4.6.

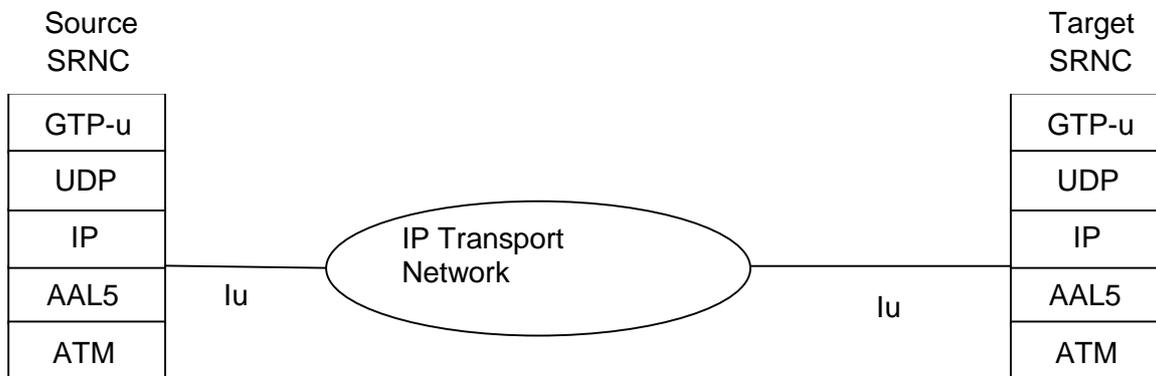


Figure 4.6: User plane protocol stack for data retrieve in UMTS

4.2.2.1.6 User plane protocol stacks for data retrieve between UTRAN and 2G-SGSN

The user plane for data retrieve between UTRAN and 2G-SGSN is based on GTP-u/UDP/IP. The protocol stack and the GTP connections termination points are described in figure 4.7.

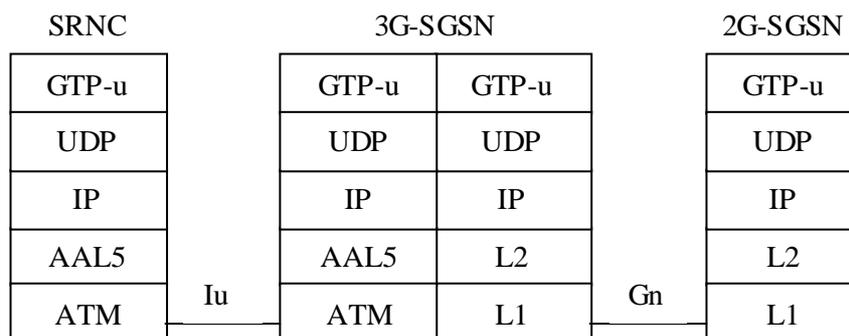


Figure 4.7: User plane protocol stack for data retrieve between GPRS and UMTS

4.2.2.2 Packet buffering in SRNC and transmission of not yet acknowledged downstream packets at SRNC relocation

Due to the bursty nature of IP traffic and due to the limited amount of downstream radio resources, some (large) buffering capacity is needed in the network to absorb the traffic peaks that arrive as there are not enough radio resources to send them to the UE(s). Only this kind of buffering is considered in the rest of this subclause.

Large buffering capacity in both CN and SRNC would add to the:

- cost of the network (duplication of memory resources);
- transit delay (packets may have to stay in 2 large queues);
- complexity of the system (coordination between CN and SRNC for buffer management and associated packet scheduling according to QoS).

As a consequence such (large) buffers should only be put in one place (CN or SRNC).

RNC-UE procedures (ARQ RLC) ensure data reliability as long as SRNS relocation or GSM <-> UMTS Hand-Over are not needed. Large buffering capacities as well as procedures to ensure data reliability at SRNS relocation and GSM <-> UMTS Hand-Over (transmission between old and new nodes of downstream packets not yet acknowledged by the UE) should be put where ARQ procedures are located.

Hence the acknowledgement layer LLC that is needed in GSM/GPRS is not needed between CN and UE in UMTS because data reliability is provided between UE and SRNC. In case of SRNS relocation or GSM <-> UMTS Hand-Over, transmission of not yet acknowledged downstream packets between (old and new) SRNC or between SRNC and 2G-SGSN provide the necessary reliability.

Hence large buffers to absorb peaks of downstream traffic as well are not needed in the CN and no flow control between CN and UTRAN needs to be defined in order to control the IP domain user plane flow.

4.2.2.3 Load sharing

To ensure the necessary load sharing on the Iu_PS interface.

When the CN requests the establishment of a Radio Access Bearer (associated with a PDP context) or at SRNS relocation for all Radio Access Bearers (associated with PDP contexts) of an UE, the CN specifies the IP address of the packet processing function allocated to this / each of these PDP context(s) in the CN.

In the response to the CN request, the RNC specifies the IP address of the packet processing function allocated to this / each of these Radio Access Bearer(s) in the RNC.

When it sends downstream traffic in a RAB, the packet processing function in the CN sends the packet to the RNC IP @ received from the SRNC at RAB establishment or at SRNS relocation.

When it sends upstream traffic in this RAB, the packet processing function in the RNC sends the packet to the CN IP @ received from the CN at RAB establishment or at SRNS relocation.

4.3 UMTS Mobility Management (UMM)

From a logical point of view, the CN encompasses two domains, a PSTN/ISDN domain and an IP domain. It shall be possible to connect the UTRAN either to both these CN domains or to one of the CN domains.

A single RRC connection (between UTRAN and UE) shall carry all user plane and signalling flows to/from a UE. This is regardless of where in the CN they originate/terminate.

UMTS shall support compatibility with GSM network from the point of view of roaming and handover. For the LM/MM functionality point of view this implies among other things the following:

- a) IMSI shall be used as the common user identity in the two CN domains;
- b) common MAP signalling will be applied to both GSM and UMTS. The GSM MAP mobile service operations shall be evolved and re-used as far as possible (including extensions if required). This should not stop new MAP signalling operations being developed and applied to both GSM and UMTS;
- c) radio network parameters and radio resource management should be isolated in the UTRAN.

The LM/MM techniques used in UMTS should minimise radio resource usage of the UTRA.

4.3.1 Location Management and Mobility Management concept overview

From a logical point of view, the Core Network (CN) consists of two service domains, a CS service domain (earlier named PSTN/ISDN domain) and a PS service domain (earlier named IP domain) or one of these domains.

Each service domain has its own service state machine. An UE, that is supporting both CS services and PS services, has a CS service state machine and a PS service state machine. The two peers of the service state machine are working independently to each other, although associated to the same UE. The UE-CN signalling aims to keep the peer entities synchronised.

As an introduction, figure 4.8 and figure 4.9 give an overview of the UE registration and connection principles within the UMTS when the CN consists of two separate PS and CS service nodes or one combined CS and PS service node.

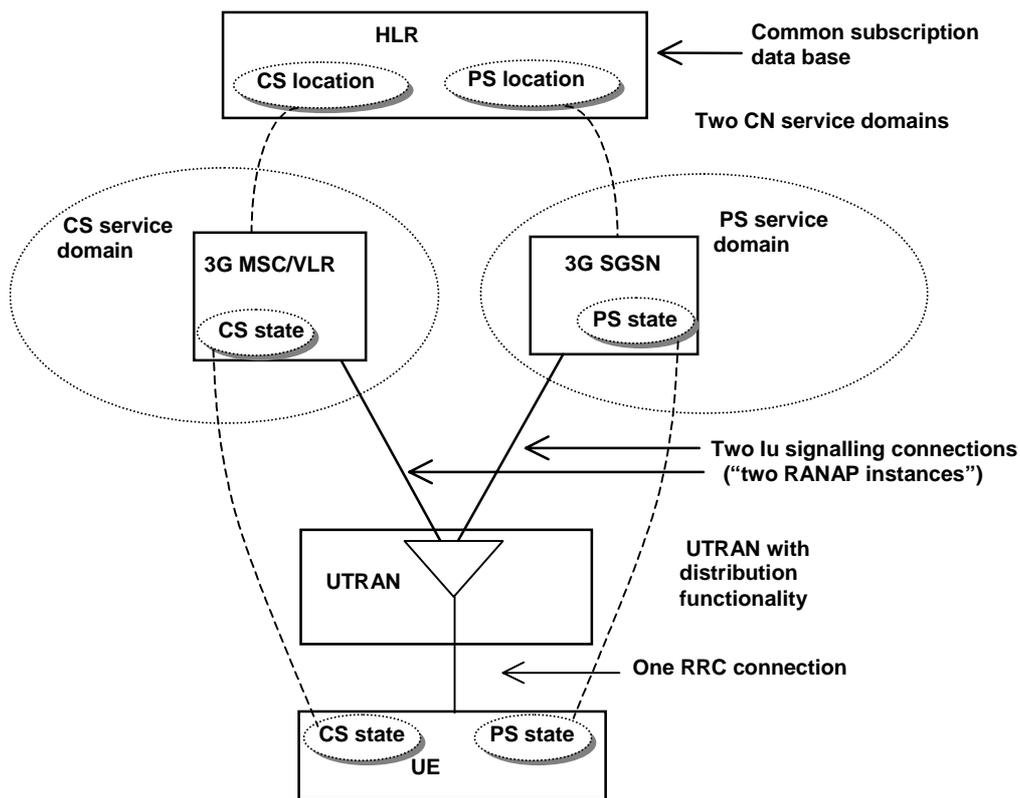


Figure 4.8: Overview of the UE registration and connection principles within UMTS for the separate CN architecture case

In the separate CN architecture case, the CN consists of both a CS service domain with evolved MSC/VLR, 3G_MSC/VLR, as the main serving node and an PS service domain with evolved SGSN/GGSN, 3G_SGSN and 3G GGSN, as the main serving nodes.

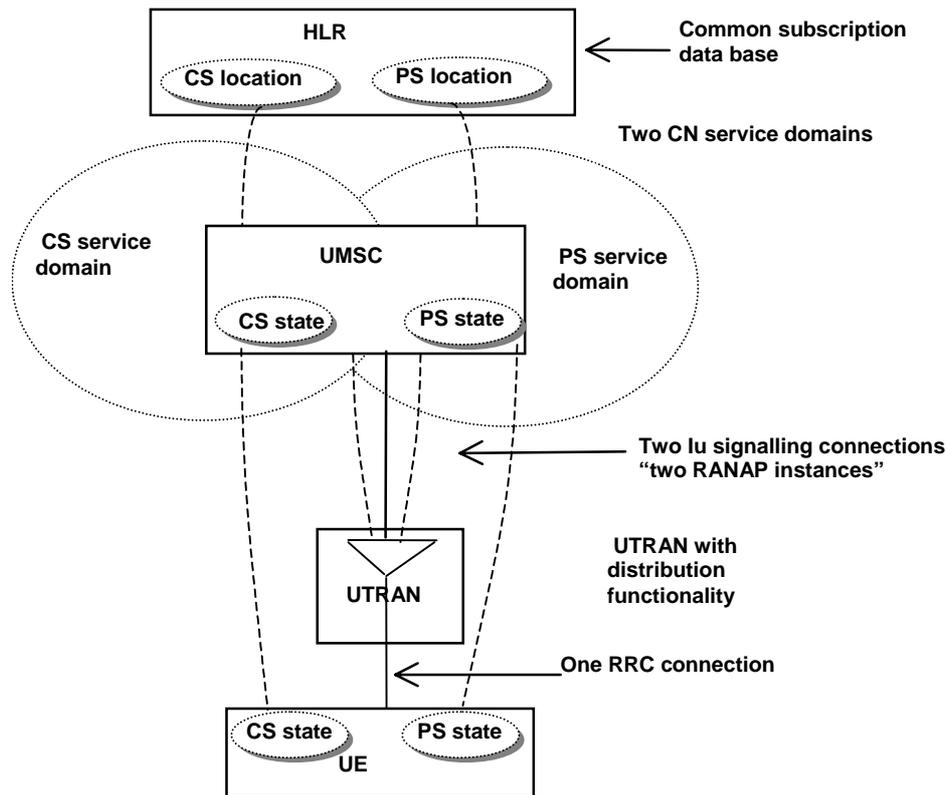


Figure 4.9: Overview of the UE registration and connection principles within UMTS for the integrated CN architecture case

In the integrated CN architecture case, the CN consists of both a CS service domain and an PS service domain with an UMSC as the main serving node.

The main PS service states are PS-DETACHED, PS-IDLE and PS-CONNECTED. The main CS service states are CS-DETACHED, CS-IDLE and CS-CONNECTED. For the respective service domain there are specific related MM system information controlling the Mobility Management functionality of the UE.

The aim of UTRAN is to offer one unified set of radio bearers which may be used for bursty packet traffic and for traditional telephony traffic. This leads to the conclusion that only one logical control channel structure will be used for all kind of traffic. The radio resource handling is UTRAN internal functionality and the CN does not define the type of radio resource allocated.

The Radio Resource Control (RRC) has two modes, RRC Connected mode and RRC Idle mode. The RRC mode describes which identity is used to identify the UE. In RRC Idle mode the UE is identified by a CN associated identity. In RRC Connected mode the UE is assigned a Radio Network Temporary Identity to be used as UE identity on common transport channels. When the UE is allocated dedicated transport channels, it uses the inherent addressing provided by these transport channels.

In PS-CONNECTED state the UE is in RRC Connected mode. In CS-CONNECTED state the UE is in RRC Connected mode.

For the mobility functionality, four different area concepts are used. Location Areas and Routing Areas are used in the Core Network. UTRAN Registration Areas and Cell Areas are used in UTRAN. Location Areas are related to CS services. Routing Areas are related to PS services.

One Location Area is handled by one CN node. For an UE that is registered in a Location Area, this implies that the UE is registered in the specific CN node handling this specific Location Area. One Routing Area is handled by one CN node. For an UE that is registered in a Routing Area, this implies that the UE is registered in the specific CN node handling this specific Routing Area. Location Area is used by the 3G_MSC/VLR for paging the UE. Routing Area is used by the 3G_SGSN for paging the UE. UTRAN Registration Areas and Cell Areas are only visible in UTRAN and used in RRC-Connected mode.

For the relations between Location Area (LA) and Routing Area (RA) is described in subclause 4.3.2.

In RRC Idle mode it is the broadcasted MM system information (e.g. information about the present Location Area and present Routing Area) that determines when the UE initiates a location registration procedure towards the CN. An UE in state CS-IDLE will in RRC Idle mode, initiate Location Area update towards the CN when crossing LA border. An UE in state PS-IDLE will in RRC Idle mode initiate Routing Area update towards the CN when crossing RA border.

In RRC Connected mode, the UE receives the MM system information on the established RRC connection. (I.e. the broadcasted MM system information is not used by the UE in the RRC connected mode.) An UE in state CS-IDLE will, in RRC Connected mode, initiate Location Area update towards the CN when receiving information indicating a new Location Area. An UE in state PS-IDLE will, in RRC Connected mode, initiate Routing Area update towards the CN when receiving information indicating a new Routing Area. An UE in state CS-CONNECTED will, in RRC Connected mode, not initiate Location Area update towards the CN. An UE in state PS-CONNECTED will, in RRC Connected mode, not initiate Routing Area update towards the CN.

In CS-DETACHED mode the UE will not initiate any Location Area update and this independent of the RRC mode. In PS-DETACHED mode the UE will not initiate any Routing Area update and this independent of the RRC mode.

In addition to normal location registration when changing registration area, the UE may (network options) perform CS periodic registration when in CS-IDLE state and PS periodic registration when in PS-IDLE state. The respective periodic registration may be on/off on Location Area respective Routing Area level.

On the Mobility Management level, IMSI and CS related TMSI are used as UE identities in the CS service domain, and IMSI and PS related TMSI are used as UE identities in the PS service domain. The IMSI is the common UE identity for the two CN service domains.

A signalling connection between the UE and the CN refers to a logical connection consisting of an RRC connection between UE and UTRAN and an Iu signalling connection ("one RANAP instance") between the UTRAN and the CN node. The CS service domain related signalling and PS service domain related signalling uses one common RRC connection and two Iu signalling connections ("two RANAP instances"), i.e. one Iu signalling connection for the CS service domain and one Iu signalling connection for the PS service domain.

4.3.1.1 Use of combined procedures for UMTS

The use of separated PS and CS mobility mechanisms within the UE and within the CN may lead to non-optimal usage of the radio resource (for example a UE in PS idle and CS idle state would perform both location updates (for the CS mechanism) and Routing area updates (for PS mechanisms)).

UMTS should optimise the use of radio resources. The use of combined updates (similar to the current GSM/GPRS Gs combined update mechanism) may enable this. To offer flexibility in the provision of mobility management for UMTS, it should be possible to use combined mechanisms for location management purposes as well as for attach/detach status purposes.

From the UE perspective it should be possible for the UE to perform combined update mechanisms (operator option). UMTS Phase 1 R99 terminals should support the use of both combined and separate mechanisms. The support of this feature by all UMTS mobiles will also ease evolution of UMTS MM in the future.

In the UMTS specifications the RAN will not co-ordinate mobility management procedures that are logically between the core network and the MS. This includes: location management, authentication, temporary identity management and equipment identity check.

4.3.2 Description of the Location Management and Mobility Management Concept

4.3.2.1 Area concepts

For the mobility functionality four different area concepts are used. Location Area and Routing Area in the CN as well as UTRAN Registration Area and Cell areas in the UTRAN.

4.3.2.1.1 Location areas

For CS services, the CN uses Location Areas (LA). Location Area is used e.g. at CN initiated paging related to CS services. A CS service related temporary identity, CS-TMSI, may be allocated to the UE. This temporary identity is then unique within a LA.

4.3.2.1.2 Routing areas

For PS services, the CN uses Routing Areas (RA). Routing Area is used e.g. at CN initiated paging related to PS services. A PS service related temporary identity, PS-TMSI, may be allocated to the UE. This temporary identity is then unique within a RA.

4.3.2.1.3 UTRAN internal areas

UTRAN internal areas are used when the terminal is in RRC-Connected mode (see chapter 3.3). The areas are used at e.g. UTRAN initiated paging. UTRAN internal area updating is a radio network procedure and the UTRAN internal area structure should not be visible outside UTRAN. In RRC connected mode, the UE position is known on cell level or on UTRAN Registration Area (URA) level. RNTI is used as a temporary UE identifier used within UTRAN and allocated at RRC connection establishment.

4.3.2.1.4 Relationship between the different areas

The following area relations exist:

- there may not be any relation between URA and LA respectively between URA and RA. The URA concept is defined in TS 25.331;
- one RA consists of a number of cells belonging to RNCs that are connected to the same CN node;
- one LA consists of a number of cells belonging to RNCs that are connected to the same CN node;
- one RA is handled by only one CN serving node, i.e. one UMSC or one 3G_SGSN;
- one LA is handled by only one CN serving node, i.e. one UMSC or one 3G_MSC/VLR.

The GSM defined relations between LA and RA applies i.e. the following relations between LA and RA are possible:

- RA and LA is equal;
- one RA is a subset of one, and only one, LA, meaning that a RA do not span more than one LA.

The mapping between one LA and RNCs is handled within the MSC/VLR owning this LA. The mapping between one RA and RNCs is handled within the SGSN owning this RA. The mapping between LA and cells respective between RA and cells is handled within RNC.

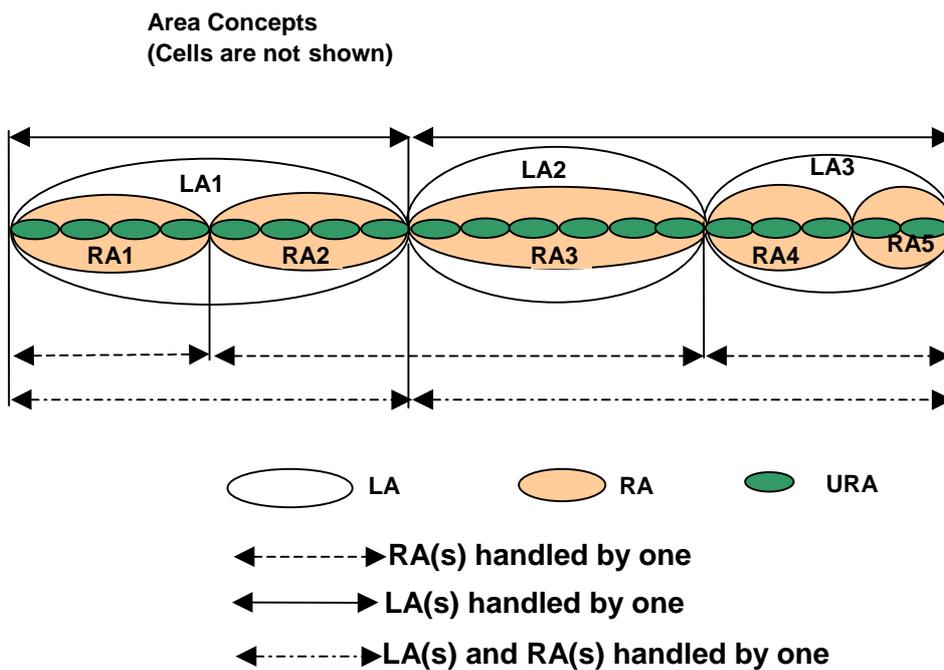


Figure 4.10: Relationship between different areas

4.3.2.1.5 Hierarchical tracking concept

A packet UE (in RRC connected mode) is tracked at the cell level by RNC during an active connection.

A packet UE (in RRC connected mode) is tracked at the URA level by RNC when no data are actively transfer, and the probability of data transfer is quite high.

A packet UE (in PS-Idle state) is tracked at the Routing Area level by SGSN when no data is actively *signalling* and the probability of data transfer is quite low. The network operator should be able to optimise paging and updating load by *signalling* the size of the different areas and the probability of data transfer (controlled by the RRC_connection_release timer). For example, one operator may decide that URA are small, and that RRC connection are released after a relatively short time of inactivity, so that most attached packet UE are tracked in the Routing Area level (optimum for packet UE mainly using client-server type of service).

Another operator may decide that URA are large, and that RRC connection are released only if RRC connection is lost, so that most attached packet UE are tracked at the URA level.

The procedure for the releasing of the RRC connection can be found in 23.060 under the Iu release procedure. The URA update procedures can be found in 25.331.

4.3.3 Relationship between MM and SM states for an UE

When a UE is attached to PS service, it may have or not some PDP context established.

If the UE has no PDP context established (SM-Inactive), no radio access bearer are established for PS service. The UE is in RRC connected mode, only if the state is UMTS CS-CONNECTED state or UMTS PS-CONNECTED state (i.e. only a PS *signalling* connection is established).

If the UE has at least one PDP context established (SM-Active), the UE may be in UMTS PS-CONNECTED state or in UMTS PS-IDLE state.

NOTE: The PDP context status is not modified by the release of the RRC connection, except if the release of the connection is due to an RRC failure which do not permit to maintain the negotiated QoS (e.g. a real time connection).

4.3.4 Requirement in case of temporarily loss of coverage of packet UE

A packet attached UE using non-real time bearer shall not lose its PDP context in case of temporarily loss of coverage. A UE specific Mobile Reachable Timer should monitor how long PDP context(s) are kept after a UE has lost coverage.

4.3.5 MM functionality in different UE service states

Below are the main UE service states and related MM functionality described. For the determination on when LA or RA is changed, see chapter on "Handling of MM system information".

CS service states and related MM functionality:

- CS-DETACHED: The UE is not reachable by the network for CS services. The UE does not initiate LA updates at LA changes and no periodic CS service updates;
- CS-IDLE: The UE is reachable by paging for CS services. The UE initiates LA updates at LA changes. The UE may initiate periodic CS service updates and this depending on the CS periodic update state of the present LA;
- CS-CONNECTED: The UE has a signalling connection for CS services established between the UE and the CN. The UE does not initiate LA update (even not when the present LA changes) and no periodic CS service updates.

PS service states and related MM functionality:

- PS-DETACHED: The UE is not reachable by the network for PS services. The UE does not initiate RA updates at RA changes and no periodic PS service updates;
- PS-IDLE: The UE is reachable by paging for PS services. The UE initiates RA updates at RA changes. The UE may initiate periodic PS service updates and this depending on the PS periodic update state of the present RA;

- **PS-CONNECTED:** The UE has a signalling connection for PS services established between the UE and the CN. The UE initiates RA update when RAI in MM system information changes. No periodic PS service updates.

There may also be a NULL state. In the UE, this state corresponds to power off or maybe a "no SIM" condition. In the CN, the NULL state correspond to CS-DETACHED and PS-DETACHED.

For each state transition there can be several events that triggers the transition. Some of them are described below.

NOTE: Some of these may coincide, e.g. moving from CS-IDLE to CS-DETACHED and moving from PS-IDLE to PS-DETACHED.

Moving from CS-IDLE to CS-CONNECTED:

The state transition from CS-IDLE to CS-CONNECTED is performed when a signalling connection is established between UE and CN for CS services. In GSM this state transition is triggered by the message CM_SERVICE_REQUEST or PAGE_RESPONSE.

Moving from CS-CONNECTED to CS-IDLE:

The state transition from CS-CONNECTED to CS-IDLE is performed when the signalling connection for CS services is released, e.g. at call release and no other CS service is ongoing. A radio link failure may also trigger this state transition.

Moving from CS-IDLE to CS-DETACHED:

The transition from CS-IDLE to CS-DETACHED may be triggered by some action from the user of the UE but an expiring timer in the network could also trigger it. The UE is marked as CS_DETACHED in the CN and then as a consequence no CS service establishment is possible.

Moving from PS-IDLE to PS-CONNECTED:

The state transition from PS-IDLE to PS-CONNECTED is performed when a signalling connection is established between UE and CN for PS services.

Moving from PS-CONNECTED to PS-IDLE:

The state transition from PS-CONNECTED to PS-IDLE is performed when the signalling connection for PS services is released, e.g. at release of a PS service, no other PS service is ongoing and at release of the RRC connection in case of very low level of activity. A radio link failure may also trigger this state transition.

Moving from PS-IDLE to PS-DETACHED:

The transition from PS-IDLE to PS-DETACHED may be triggered by some action from the user of the UE but an expiring timer in the network could also trigger it. The UE is marked as PS_DETACHED in the CN and then as a consequence no PS service establishment is possible.

4.3.6 The RRC state machine

The RRC state machine is a description model of how the UE and the UTRAN co-operate regarding RRC functionality. The RRC state describes the state of the UE in the UTRAN. Here follows a brief description of the RRC state machine, for more information see [UMTS YY.01] and [UMTS YY.03].

NOTE: RRC idle mode and RRC connected mode refer to the UE idle mode and UE connected mode respectively in [UMTS YY.01] and [UMTS YY.03].

The RRC state machine exists as peer entities, one in the UE and one in UTRAN. Apart from transient situations and error cases they are synchronised. The figure below illustrates the main modes/states of the RRC state machine.

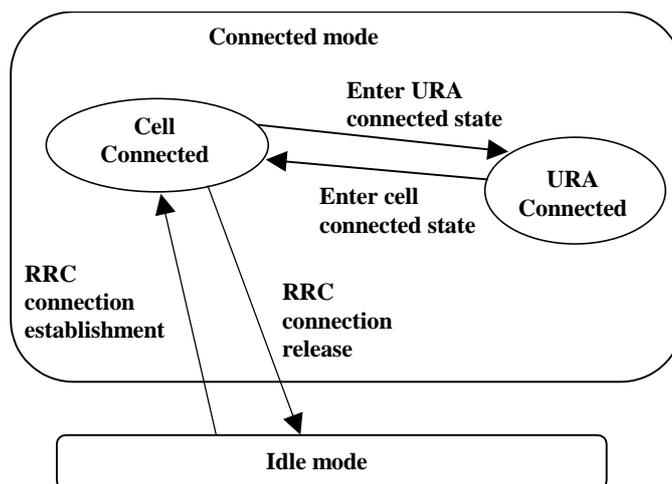


Figure 4.11: RRC modes, main RRC states and main mode/state transitions

RRC-Idle_mode:

In the Idle mode there is no connection established between UE and UTRAN. There is no signalling between UTRAN and the UE except for system information that is sent from UTRAN down link on a Broadcast channel to the UE. The UE can also receive paging messages with a CN identity on the PCH. There is no information on the UE stored in UTRAN in this state.

RRC-Connected_mode:

In the Connected mode the main states are Cell Connected state and URA connected state. In this mode there is one RNC that is acting as Serving RNC (SRNC), and an RRC connection is established between the UE and this SRNC.

- When the UE position is known on cell level, the UE is in the cell connected state. When in cell connected state, the RRC connection mobility is handled by handover procedures.
- When the UE position is known on URA level, the UE is in the URA connected state. The URA contains a set of cells. URA updating procedures provides the mobility functionality in this state. In URA connected state no dedicated radio resources are used.

4.3.7 Relationship between CS and PS service states and RRC state for an UE

During non-transient conditions the following relations are valid between service states and RRC modes for an UE:

- when in either CS-CONNECTED state or PS-CONNECTED state, or in both CS-CONNECTED state and PS-CONNECTED state, then the UE is in RRC connected mode;
- when in neither CS-CONNECTED state nor PS-CONNECTED state, then the UE is in RRC idle mode.

Figure 4.12 and figure 4.13 illustrate two examples on the relations between the RRC states and CS/PS service states. These figures illustrate the separated CN case.

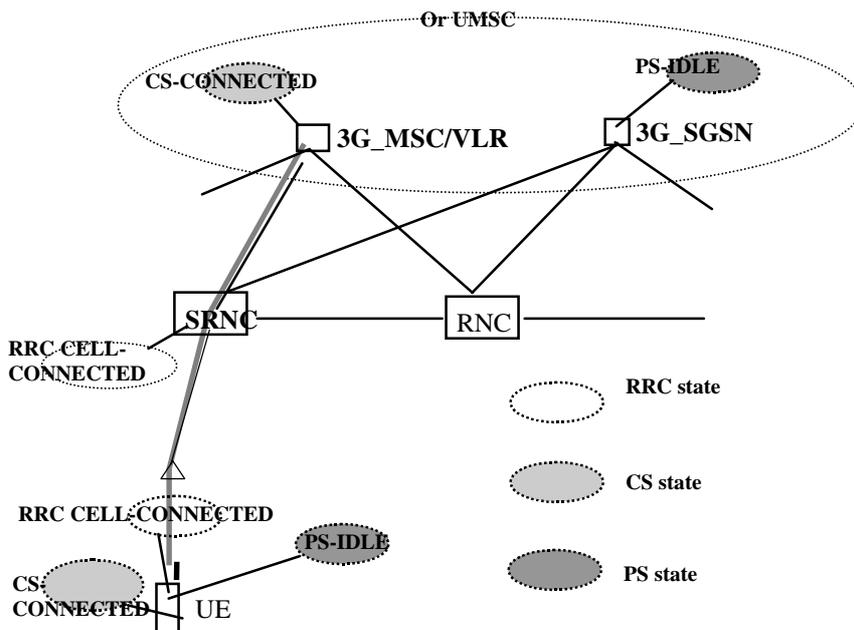


Figure 4.12: UE in CS-CONNECTED state and PS-IDLE state

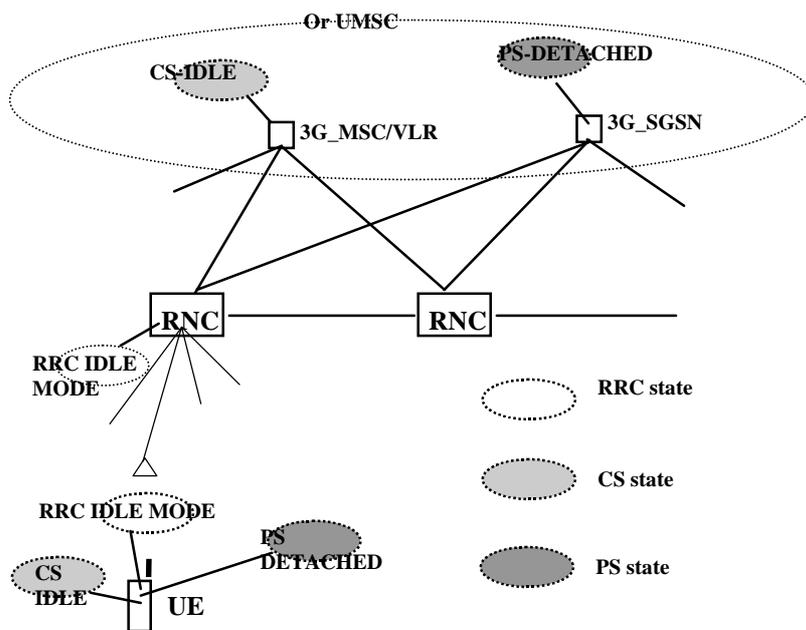


Figure 4.13

4.3.8 Service registration and location update

Service registration (attach) in the respective CN service domain is done initially (after UE being detached due to e.g. power off). When a registration area is changed a location update is performed. In addition, periodic registration can be performed. Here follows descriptions of when the respective CN registration area is changed.

NOTE: It is not here defined which different registration procedures that are needed.

4.3.8.1 Location area update

Location area update is initiated by the UE to inform the CS service domain of the core network that the UE has entered a new location area. In case the new location area is in an area served by another CN node, the location area update also triggers the registration of the subscriber in the new CN node and a location update for CS services towards the HLR.

Location area update is only initiated by the UE when the UE is in state CS-IDLE, and this independently of the PS state. If the UE is CS-IDLE but RRC connected, which means that the UE is in PS-CONNECTED state, location area update is initiated by the UE when it receives information indicating a new location area (see also the chapter "Handling of MM system information").

4.3.8.2 Routing area update

Routing area update is initiated by the UE to inform the PS service domain of the core network that the UE has entered a new routing area. In case the new routing area is in an area served by another CN node, the routing area update also triggers the registration of the subscriber in the new CN node and a location update for PS services towards the HLR.

Routing area update is initiated by the UE when the UE is in state PS-IDLE, and this independently of the CS state. If the UE is PS-IDLE but RRC connected, which means that the UE is in CS-CONNECTED state, routing area update is initiated by the UE when it receives information indicating a new routing area (see also the chapter "Handling of MM system information").

When the UE is in PS-CONNECTED state the UE initiates RA update when RAI in MM system information changes.

4.3.8.3 Combined updates

The GSM radio interface combined procedures and their support via the Gs interface is the starting point for the support of combined updates.

4.3.9 Paging initiated by CN

Here follows a possible solution with a page co-ordination within the UTRAN. Other alternatives are possible.

- A CN node requests paging only for UE in CS-IDLE state or PS IDLE state. In the separate CN architecture, paging from a CN node is done independent of the service state of the UE in the other CN service domain.
- In this alternative with page co-ordination in UTRAN, the UE does not need to listen to the PCH (Page Channel) in RRC connected mode (at least not when UE is allocated a dedicated channel).
- At each page request received from a CN node, the RNC controls whether the UE has an established RRC connection or not. For this, the context that is build up in the SRNC for UE in RRC connected mode must contain the IMSI, i.e. the UE identity common for the two CN domains.
- If no context is found for the UE, "normal PCH paging" is performed. This implies transfer on the Paging channel of a page message indicating the UE paging identity received from the CN and a CN service domain type indication.
- If a context is found, a "CN paging message" is transferred using the existing RRC connection. This message indicates then the UE paging identity received from the CN and a CN service domain type indication.
- In case of a single CN element, paging may be (but not mandatory) co-ordinated at the CN.

NOTE: The RNC might use another identity e.g. TMSI, P-TMSI, or other radio related identity, to page the mobile.

4.3.10 Signalling connection establishment

A signalling connection between the UE and a CN node refers here to a logical connection consisting of an RRC connection between UE and UTRAN and an Iu signalling connection between UTRAN and the CN node. The signalling connection is used for transfer of higher layer (MM, CM) information between the UE and the CN node.

At a CM service request to one of the CN service domains, UE will only request establishment of a new signalling connection when no such connection exists towards the applicable CN service domain.

If no RRC connection exists, this is established in conjugation with (before) the transfer of the signalling establishment request. At the RRC connection establishment, an UE context is built up in the SRNC.

If an RRC connection is already established, the UE will send the signalling establishment request using that RRC connection.

At reception of the signalling establishment request, the SRNC will establish an Iu connection towards the CN node indicated by the CN service domain type received from UE.

4.3.10a CS Domain Signalling Requirements (in particular relating to handover)

Correct operation of the Call Control, Mobility Management and Call Independent Supplementary Service protocols requires that downlink messages from the MSC shall not be lost, duplicated or delivered in error.

The RAN and Iu/A interfaces shall provide this functionality in all cases except for when the Iu/A interface SCCP connection is being changed, eg at SRNS relocation or inter-BSC (external) handover.

When the SCCP connection is being changed, the MSC shall buffer downlink CC, MM and CISS messages. Specifically, the MSC shall buffer messages from these protocols after transmission of a (BSSMAP) Handover Command or RANAP-Relocation Command message and until receipt of a Handover Complete, Relocation Complete, Handover Failure or Relocation Cancel message.

In the uplink, the UE is responsible for delivering the CS domain messages across the radio interface. Once the message has been received by part of the network, it is the network's responsibility to deliver the message to the MSC. This can result in duplicate message delivery to the CN. The RAN shall ensure that the protocol used between UE and RAN permits any duplicate messages that are delivered to the CN, to be correctly discarded by N(SD) mechanism specified in 3GPP TS 24.007 [15] for the uplink CC, MM and CISS messages.

4.3.11 Relations between SRNS relocation and Location registration

This chapter is included in order to clarify the need for separate handling of MM registration area (LA and RA) information in RRC idle mode respective in RRC connected mode. The following example illustrates relations between SRNC relocation, registration area (LA/RA) change and location/routing area updates. As shown in the example, this is equally applicable for a UMSC as well as the 3G-MSC/VLR and 3G-SGSN.

NOTE 1: The example is based on the assumptions that one RNC can set up Iu connections to only one 3G_MSC/VLR (or UMSC) and only one 3G_SGSN (or UMSC), and that the CN node is configured to only send page to the RNC(s) that is controlling cells within the relevant LA/RA.

Preconditions:

- LA1 (Location Area 1) is handled by 3G_MSC/VLR1 (or UMSC1) and LA2 is handled by 3G_MSC/VLR2 (or UMSC2);
- RA1 (Routing Area 1) is handled by 3G_SGSN1 (or UMSC1) and RA2 is handled by 3G_SGSN2 (or UMSC2);
- UE is registered in LA1 in 3G_MSC/VLR1 and in RA1 in 3G_SGSN1;
- the UE is in PS-CONNECTED state and a signalling connection exists between UE and 3G_SGSN1;
- the UE is in CS-IDLE state and no signalling connection exists between UE and 3G_MSC/VLR1;
- RNC1 is acting as SRNC and RNC2 is acting as DRNC;
- UE is in RRC cell connected state and with dedicated channels established to cells within both RNC1 and RNC2. UE does not listening to the PCH;
- the registration area information sent to the UE indicates LA1 and RA1.

The UE can always (at least in normal working states) identify the present available registration area (LA respective RA) associated with the respective CN service domain. The determination of the present area differs depending on the state of the UE. For UE in RRC idle mode (UE with no ongoing communication with the network) it is the cell selection mechanism in the UE that is used. For UE in RRC connected mode it is the UTRAN that determines the area (although a change can implicit be initiated by the UE).

It is the network that supplies the MM system information to the UE. For UE in RRC idle mode the MM system information is provided by the system information broadcasting function. For UE in RRC connected mode, the MM system information is supplied by the SRNC to the UE at each change of this information. This leads to that in RRC connected mode, the MM registration area (e.g. LA and RA) information sent on broadcast channel is not used.

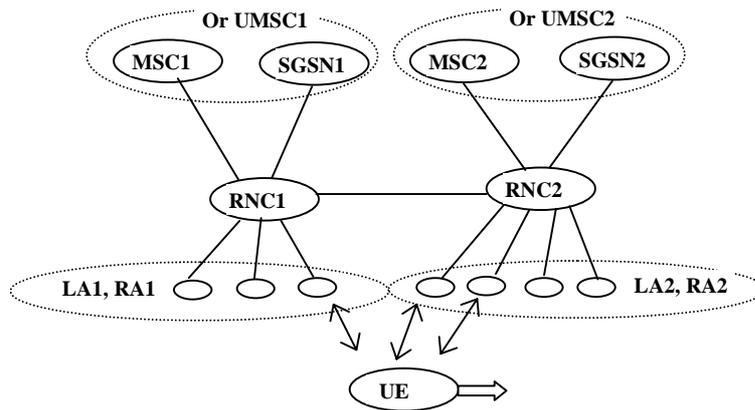


Figure 4.14: Illustration of the preconditions in the described example

In figure 4.14 MSC stands for 3G_MSC/VLR and SGSN for 3G_SGSN.

The UE moves now further towards right, leaving the coverage area of cells controlled by RNC1, and resulting in that the UE has dedicated channel(s) established to cell(s) within only RNC2. This may result in the following sequence of events:

- the SRNC (RNC1) may decide to perform an SRNC relocation resulting in that the RNC2 becomes SRNC. The change of SRNC will in this example also imply a change of SGSN (or UMSC) with an update of the UE location registration for the PS service domain;
- after this SRNC relocation or combined with this procedure, the MM registration area information sent to the UE is changed and indicates now LA2 and RA2;

NOTE 2: The MM registration area information need not be sent for every SRNS relocation, nor does it preclude MM registration area information being sent in other occasions.

- the changed MM registration area information will result in that the UE initiates a location update, which results in a registration change from LA1 in 3G_MSC/VLR1 to LA2 in 3G_MSC/VLR2.

The area information can not be changed to indicate LA2 unless SRNC relocation has been performed. This since the location update signalling will be sent from the UE, by using the established RRC connection to SRNC, and then to the 3G_MSC/VLR to which the SRNC belongs.

4.3.12 Requirements on Identifiers for UMTS and GSM

- 1a) The format of the UMTS Location Area Identifier and UMTS TMSI shall not prevent a dual mode GSM-UMTS mobile which was last location updated over the GSM radio interface (i.e. has a GSM LAI and GSM TMSI), from performing a location update (or other signalling) over the UMTS radio interface to a UMTS MSC.
 - 1b) The format of the UMTS Location Area Identifier and UMTS TMSI shall not prevent a dual mode GSM-UMTS mobile which was last location updated over the UMTS radio interface (i.e. has a UMTS LAI and UMTS TMSI), from performing a location update (or other signalling) over the GSM radio interface to a GSM MSC.
 - 1c) The format of the UMTS Routing Area Identifier and UMTS P-TMSI shall not prevent a dual mode GSM-UMTS mobile which was last routing area updated over the GSM radio interface (i.e. has a GSM RAI and GSM P-TMSI), from performing a routing area update (or other signalling) over the UMTS radio interface to a UMTS SGSN.
 - 1d) The format of the UMTS Routing Area Identifier and UMTS P-TMSI shall not prevent a dual mode GSM-UMTS mobile which was last routing area updated over the UMTS radio interface (i.e. has a UMTS RAI and UMTS P-TMSI), from performing a routing area update (or other signalling) over the GSM radio interface to a GSM SGSN.
- 2) The standard shall support means by which an operator can configure GSM and UMTS cells to be members of the same registration area (i.e. the mobile can receive paging from whichever cell it is camped on and does not need to location update (or routing update) just because the mobile has changed from a UMTS to a GSM cell).

- 3a) The standard shall support means by which an operator can allocate GSM and UMTS LAIs which enable GSM MSCs to be able to contact UMTS MSCs and vice versa.
- 3b) The standard shall support means by which an operator can allocate GSM and UMTS RAIs which enable GSM SGSNs to be able to contact UMTS SGSNs and vice versa.
- 4) The standard shall support means by which an operator can ensure that the IMSI does not need to be sent over the radio interface when the mobile station moves from a GSM cell to a UMTS cell (and vice-versa).
- 5) The standard shall support means by which an operator can ensure that the IMSI does not need to be sent over the radio interface when a USIM is moved from a UMTS mobile station to a GSM mobile station (and vice-versa).
- 6) The standard need not support means by which an operator can ensure that the IMSI is not sent over the radio interface when a GSM SIM is moved from a GSM mobile station to a UMTS mobile station (and vice-versa).

4.3.13 Use of TMSI signature

Void.

Figures 4.15 and 4.16: (void).

4.3.13.1 IMSI attach

Void.

4.3.13.2 Location Area update

Void.

4.3.13.3 MM System Information

The system information that is needed for the Mobility Management functionality contains parameters such as:

- MCC, MNC, LAC, RAC, Periodic Location Area Update timer, and Periodic Routing Area Update timer;
- in each UMTS cell (UTRAN cell) the network broadcasts MM system information on the broadcast channel. In RRC idle mode, when the UE camps on one cell, it receives all MM system information valid for this cell on the broadcast channel of the cell. The received MM system information is then the "current MM system information";
- in RRC connected mode, it is the responsibility of the SRNS to control the current MM system information valid for the UE. At any changes, the established RRC connection is used for transferring the new MM system information to the UE. E.g. at SRNS relocation, the new SRNS shall have logic for sending applicable MM system information to the UE. This information is determined by e.g. the Location Areas and the Routing Areas handled by the respective CN node to which the SRNS can set up Iu signalling connections. At reception of new MM system information from the SRNC on the established RRC connection, the UE uses this new information as the "current MM system information";

NOTE: The MM system information need not necessarily be sent for every SRNSs relocation, nor does it preclude MM system information being sent on other occasions.

- at the RRC connection establishment, the UE uses the broadcasted MM system information of the cell where the establishment is made as the "current MM system information";
- when the UE leaves the RRC connected mode and enters RRC idle mode, the UE uses the broadcasted MM system information of the chosen cell, which is determined by the UE idle mode cell selection/re-selection process that is then performed, as the "current MM system information";
- the "current MM system information" is used by the MM functionality in the UE respecting the rules for the UE service state of the respective MM state machine, see subclause 7.3.3;
- MM functionality in different UE service states and subclause 7.3.6 Service registration and location update.

4.3.13.4 IMSI detach procedure

Void.

4.3.14 Signalling procedures

4.3.14.1 Idle mode procedures

The signalling procedures shown in the following subclauses do not represent the complete set of possibilities, nor do they mandate this kind of operation. The standard will specify a set of elementary procedures for each interface, which may be combined in different ways in an implementation. Therefore these sequences are merely examples of a typical implementation. By default the combined procedures as defined in GSM 03.60 are also applicable when using Gs.

Furthermore the list of parameters may not be complete, but should only be seen as examples of possible information carried by the messages.

4.3.14.1.1 Location Area update

This example shows location registration when changing Location Area including change of 3G-MSC/VLR and when the UE is in MM idle state towards the 3G_MSC/VLR.

The illustrated transfer of MM signalling to/from the UE uses an established RRC connection. This RRC connection can have been established beforehand due to ongoing interwork between UE and 3G-SGSN or be established only for this location registration procedure towards the 3G_MSC/VLR.

For each indicated MM message sent in this case to/from UE, the CN discriminator indicates 3G_MSC/VLR.

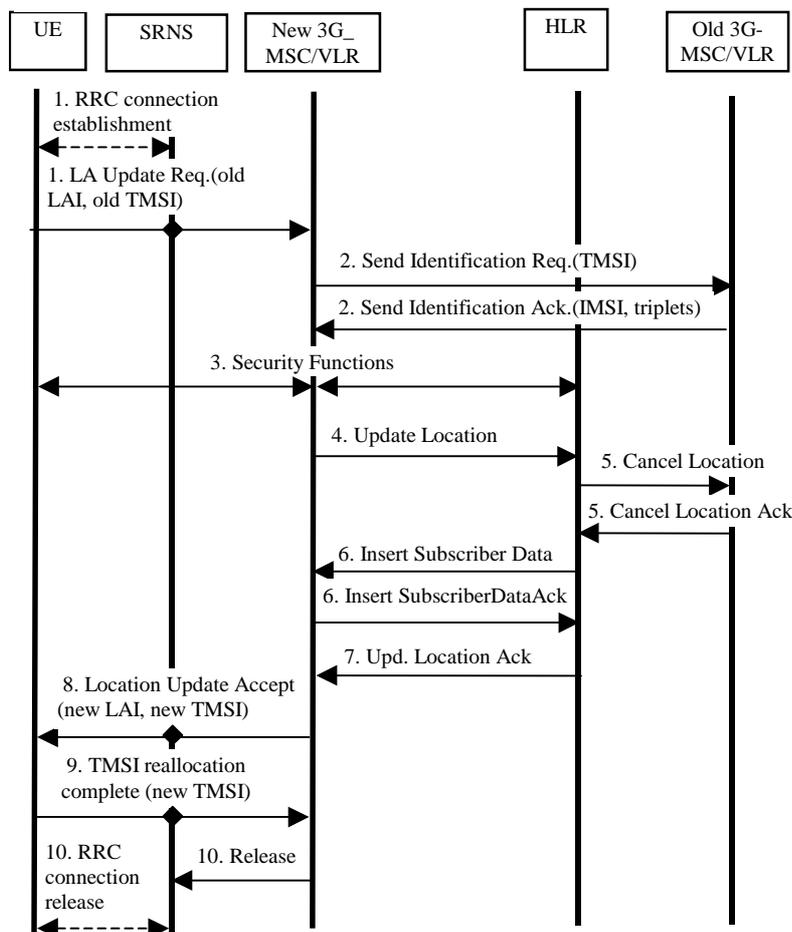


Figure 4.17: Interface information transfer for location update when changing VLR area

- The RRC connection is established, if not already done. The UE sends the initial message Location Area Update Request (old TMSI, old LAI, etc.) to the new 3G_MSC/VLR. The old TMSI and the old LAI are assigned data in UMTS. The SRNS transfers the message to the 3G_MSC/VLR. The sending of this message to 3G_MSC/VLR will also imply establishment of a signalling connection between SRNS and 3G_MSC/VLR for the concerned UE. The UTRAN shall add the RAC and the LAC of the cell where the message was received before passing the message to the MSC.
- The new 3G_MSC/VLR sends an Send Identification Request (old TMSI) to the old 3G_MSC/VLR to get the IMSI for the UE. (The old LAI received from UE is used to derive the old 3G_MSC/VLR identity/address.) The old 3G_MSC/VLR responds with Send Identification Ack. (IMSI and Authentication triplets).
- Security functions may be executed.
- The new 3G_MSC/VLR inform the HLR of the change of 3G_MSC/VLR by sending Update Location (IMSI, MSC address, VLR number) to the HLR.
- The HLR cancels the context in the old 3G_MSC/VLR by sending Cancel Location (IMSI). The old 3G_MSC/VLR removes the context and acknowledges with Cancel Location Ack.
- The HLR sends Insert Subscriber Data (IMSI, subscription data) to the new 3G_MSC/VLR. The new 3G_MSC/VLR acknowledges with Insert Subscriber Data Ack.
- The HLR acknowledges the Update Location by sending Update Location Ack. To the new 3G_MSC/VLR.
- The new 3G_MSC/VLR validates the UE presence in the new LA. If due to regional, national or international restrictions the UE is not allowed to attach in the LA or subscription checking fails, then the new 3G_MSC/VLR rejects the location area update with an appropriate cause. If all checks are successful, then the new 3G_MSC/VLR responds to the UE with Location Area Update Accept (new TMSI, new LAI).
- The UE acknowledges the new TMSI with a TMSI reallocation Complete. (TMSI can optionally be reallocated with the TMSI reallocation procedure).
- When the location registration procedure is finished, the 3G_MSC/VLR may release the signalling connection towards the SRNS for the concerned UE. The SRNS will then release the RRC connection if there is no signalling connection between 3G_SGSN and SRNS for the UE.

4.3.14.1.2 Routing Area update

This example shows location registration when changing Routing Area including change of 3G_SGSN when the UE is in MM idle state towards the 3G_SGSN.

The illustrated transfer of MM signalling to/from the UE uses an established RRC connection. This RRC connection can have been established beforehand due to ongoing interwork between UE and 3G_MSC/VLR or be established only for this location registration procedure towards the 3G_SGSN.

For each indicated MM message sent in this case to/from UE, the CN discriminator indicates 3G_SGSN.

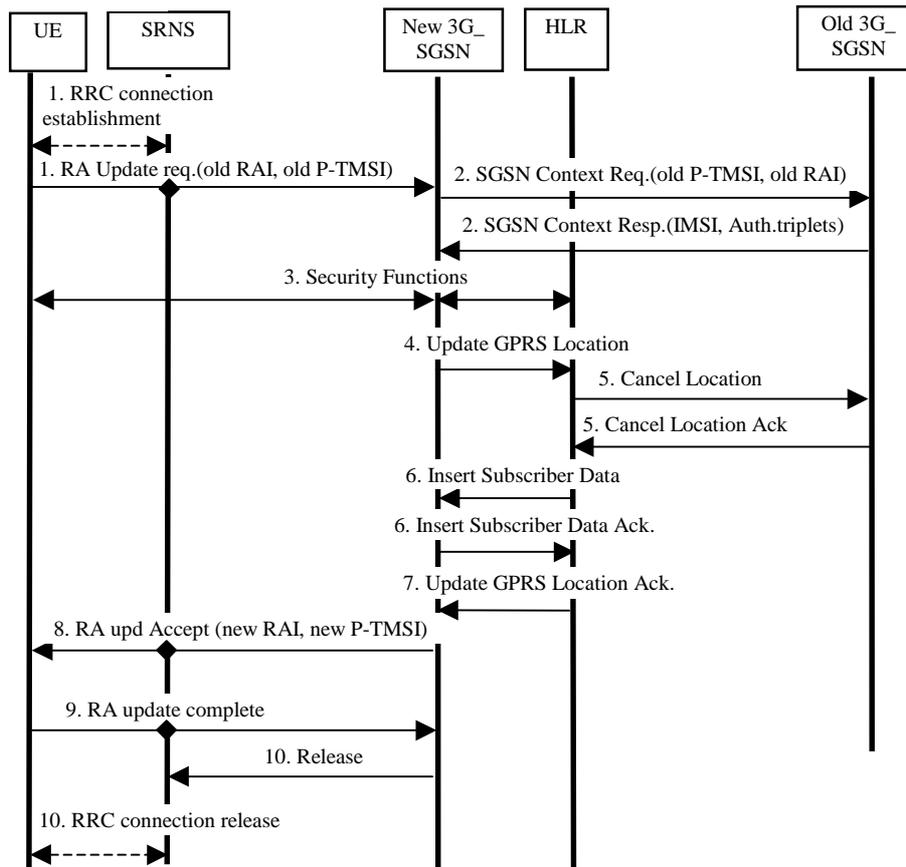


Figure 4.18: Interface information transfer for Routing Area update when changing SGSN area (successful case)

- The RRC connection is established, if not already done. The UE sends the initial message Routing Area Update Request (old P-TMSI, old RAI, etc.) to the new 3G_SGSN. The old P-TMSI and the old RAI are assigned data in UMTS. The SRNS transfers the message to the 3G_SGSN. The sending of this message to 3G_SGSN will also imply establishment of a signalling connection between SRNS and 3G_SGSN for the concerned UE. The UTRAN shall add the RAC and the LAC of the cell where the message was received before passing the message to the SGSN.
- The new 3G_SGSN send an SGSN Context Request (old P-TMSI, old RAI) to the old 3G_SGSN to get the IMSI for the UE. (The old RAI received from UE is used to derive the old 3G_SGSN identity/address.) The old 3G_SGSN responds with SGSN Context Response (e.g. IMSI, PDP context information and Authentication triplets).
- Security functions may be executed.
- The new 3G_SGSN informs the HLR of the change of 3G_SGSN by sending Update GPRS Location (IMSI, SGSN number, SGSN address) to the HLR.
- The HLR cancels the context in the old 3G_SGSN by sending Cancel Location (IMSI). The old 3G_SGSN removes the context and acknowledges with Cancel Location Ack.
- The HLR sends Insert Subscriber Data (IMSI, subscription data) to the new 3G_SGSN. The new 3G_SGSN acknowledges with Insert Subscriber Data Ack.
- The HLR acknowledges the Update GPRS Location by sending Update GPRS Location Ack. To the new 3G_SGSN.
- The new 3G_SGSN validate the Ues presence in the new RA. If due to regional, national or international restrictions the UE is not allowed to attach in the RA or subscription checking fails, then the new 3G_SGSN rejects the Routing Area Update Request with an appropriate cause. If all checks are successful, then the new 3G_SGSN responds to the UE with Routing Area Update Accept (new P-TMSI, new RAI, etc.).

- The UE acknowledges the new P-TMSI with Routing Area Update Complete.
- When the location registration procedure is finished, the 3G_SGSN may release the signalling connection towards the SRNS for the concerned UE. The SRNS will then release the RRC connection if there is no signalling connection between 3G_MSC/VLR and SRNS for the UE.

4.3.14.1.3 Periodic Registration towards both CN nodes without use of Gs

This example shows Periodic Registration to both the 3G_MSC/VLR and the 3G-SGSN (i.e. no change of registration areas) when the UE is in MM idle state and registered in both the 3G_SGSN and the 3G_MSC/VLR.

The illustrated transfer of MM signalling to/from the UE uses an established RRC connection. This RRC connection will be established, is in this case, only for the two registration procedures towards the 3G_SGSN and 3G_MSC/VLR.

For each indicated MM message sent to/from UE, the CN discriminator indicates either 3G_SGSN or 3G_MSC/VLR.

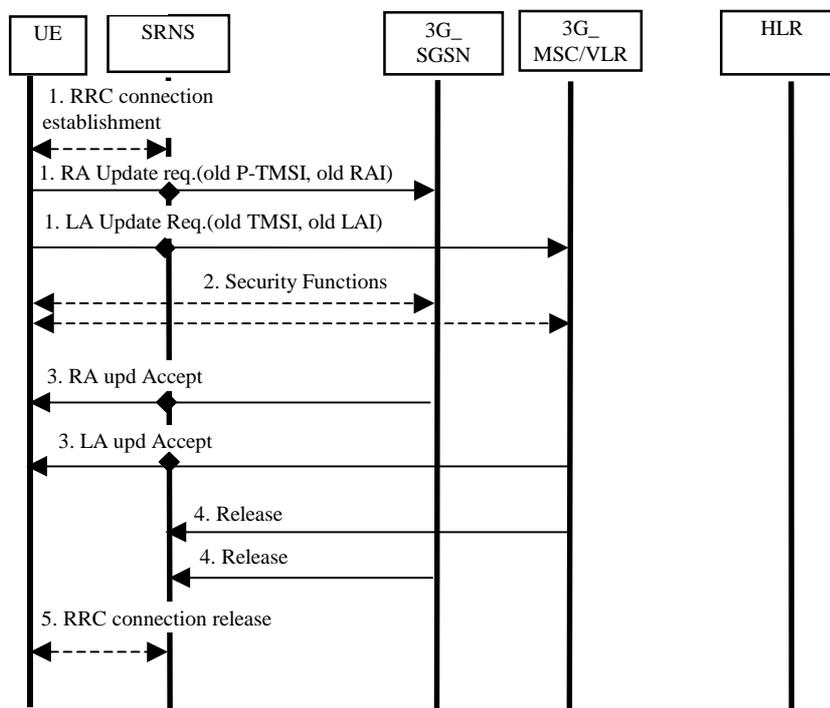


Figure 4.19: Interface information transfer for periodic registration to 3G_SGSN and 3G_MSC/VLR (successful case)

- The RRC connection is established. The UE sends the initial messages Routing Area Update Request (old P-TMSI, old RAI, etc.) to the 3G_SGSN and Location Area Update Request (old TMSI, old LAI, etc.) to the 3G_MSC/VLR. In both cases, the UE will indicate the cause periodic registration. The sending of the respective message to SGSN respective to MSC/VLR will also imply establishment of a signalling connection between SRNS and SGSN and a signalling connection between SRNS and MSC/VLR for the concerned UE.
- Security functions may be executed.
- The 3G_SGSN respective the 3G_MSC/VLR validates the Ues presence. If all checks are successful, then the 3G_SGSN responds to the UE with Routing Area Update Accept and 3G_MSC/VLR responds to the UE with Location Area Update Accept.
- When the periodic registration procedure is finished, the 3G_SGSN respective the 3G_MSC/VLR may release the signalling connection towards the SRNS for the concerned UE. If both CN nodes release the signalling connection towards the SRNS for the concerned UE, then the SRNS will release the RRC connection towards the UE.

4.3.14.1.4 Periodic Registration with use of Gs/UMSC

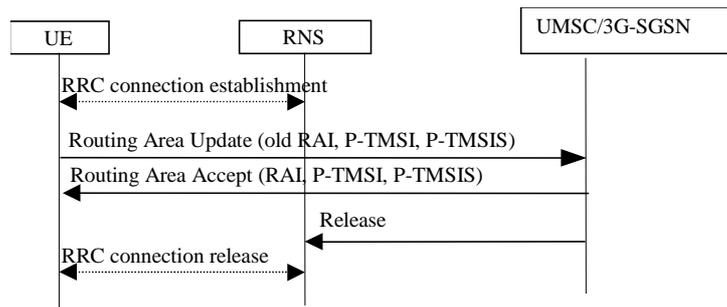


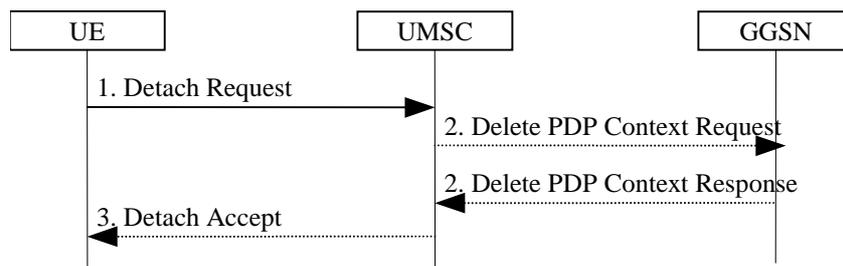
Figure 4.20: Periodic update procedure when the MS is attached for both CS and PS services

An RRC connection is established for the periodic registration.

NOTE: This procedure is invoked only when the UE is in MM-idle state. The UE sends a Routing Area Update to the UMSC. The UMSC authenticates the P-TMSI signature. If the update is successful it sends a Routing Area Accept message. The RRC connection is then released.

4.3.14.1.5 UE initiated Combined Detach Procedure when using Gs/UMSC

The UE-Initiated Detach procedure when initiated by the UE is illustrated in figure 4.21. Each step is explained in the following list.



**Figure 4.21: UE-Initiated Combined Detach Procedure
(the procedure for combined detach when using Gs is as defined in GSM 03.60)**

- The UE detaches by sending Detach Request (Detach Type, Switch Off) to the UMSC. Detach Type indicates which type of detach that is to be performed, i.e., PS Detach only, CS Detach only or combined Detach. Switch Off indicates whether the detach is due to a switch off situation or not.
- If PS detach, any active PDP contexts in the GGSNs regarding this particular UE may be deactivated.
- If Switch Off indicates that the detach is not due to a switch off situation, the UMSC sends a Detach Accept to the UE.

4.3.14.2 SRNS Relocation

4.3.14.2.1 SRNS relocation principles

To carry out SRNS relocation, the source SRNC must launch the SRNS relocation procedure, since it is not the target SRNC but the source SRNC that knows the current services of an user. This is done only when this procedure has the least adverse effect on user traffic.

The SRNC relocation procedures shall ensure that there is only one Serving RNC for an user even if this user has services through more than one (IP or ISDN) domain.

The SRNS relocation procedure is split in 2 phases. In the first one resources are reserved on the new Iu interfaces and (if needed) inside the CN. Only when this first phase has been successfully carried out for all domains on which the user

has currently some services, the source SRNC can launch the second phase i.e. hand-over the role of SRNC to the target SRNC.

The signalling procedures shown in the following subclauses do not represent the complete set of possibilities, nor do they mandate this kind of operation. The standard will specify a set of elementary procedures for each interface, which may be combined in different ways in an implementation. Therefore these sequences are merely examples of a typical implementation. In these examples MSC stands for 3G_MSC/VLR and SGSN stands for 3G_SGSN.

Furthermore the list of parameters may not be complete, but should only be seen as examples of possible information carried by the messages.

4.3.14.2.2 SRNS relocation (UE connected to a single CN node, 3G_MSC/VLR) followed by Location Registration in new Routing Area

This example shows SRNS relocation when source RNC and target RNC are connected to different 3G_MSC/VLR. This is then followed by a Routing Area update procedure towards a new SGSN. Figure 4.22 and figure 4.23 illustrate the situation before respective after the SRNS relocation and location registration. Figure 4.24 illustrates the signalling sequence where each step is explained in the following list.

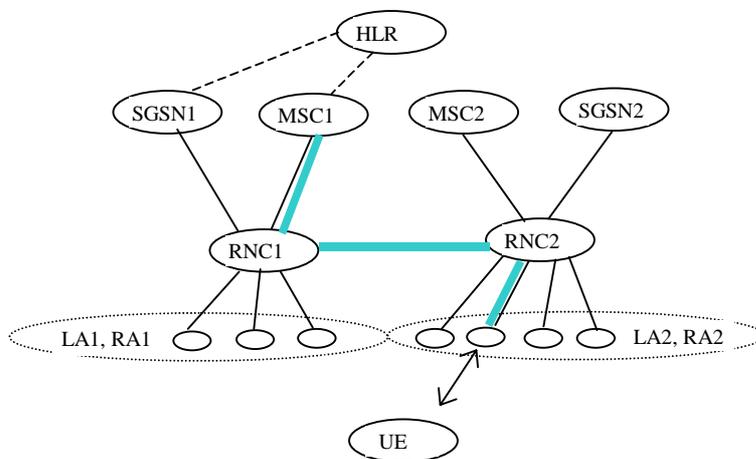


Figure 4.22: Before the SRNS relocation and location registration

Before the SRNS relocation and location registration the UE is registered in SGSN1 and in MSC1. The UE is in state MM idle towards the SGSN1 and in state MM connected towards the MSC1. The RNC1 is acting as SRNC and the RNC2 is acting as DRNC.

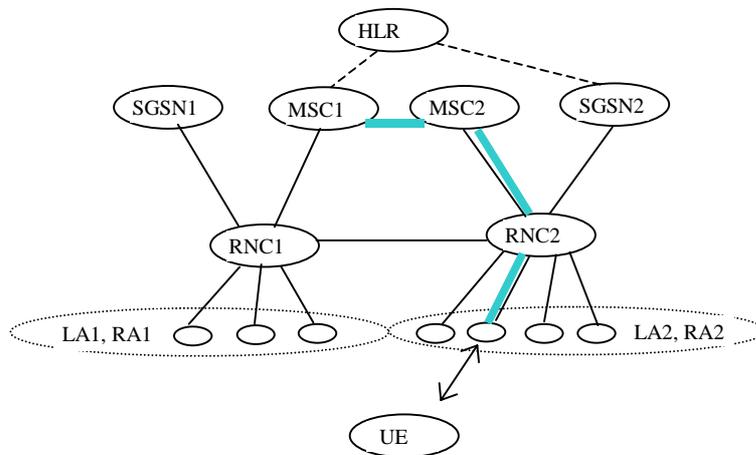


Figure 4.23: After the SRNS relocation and location registration

After the SRNS relocation and location registration the UE is still registered in MSC1 while the registration in the IP domain has changed from SGSN1 to SGSN2. The UE is in state MM idle towards the SGSN2 and in state MM connected towards the MSC1. The RNC2 is acting as SRNC.

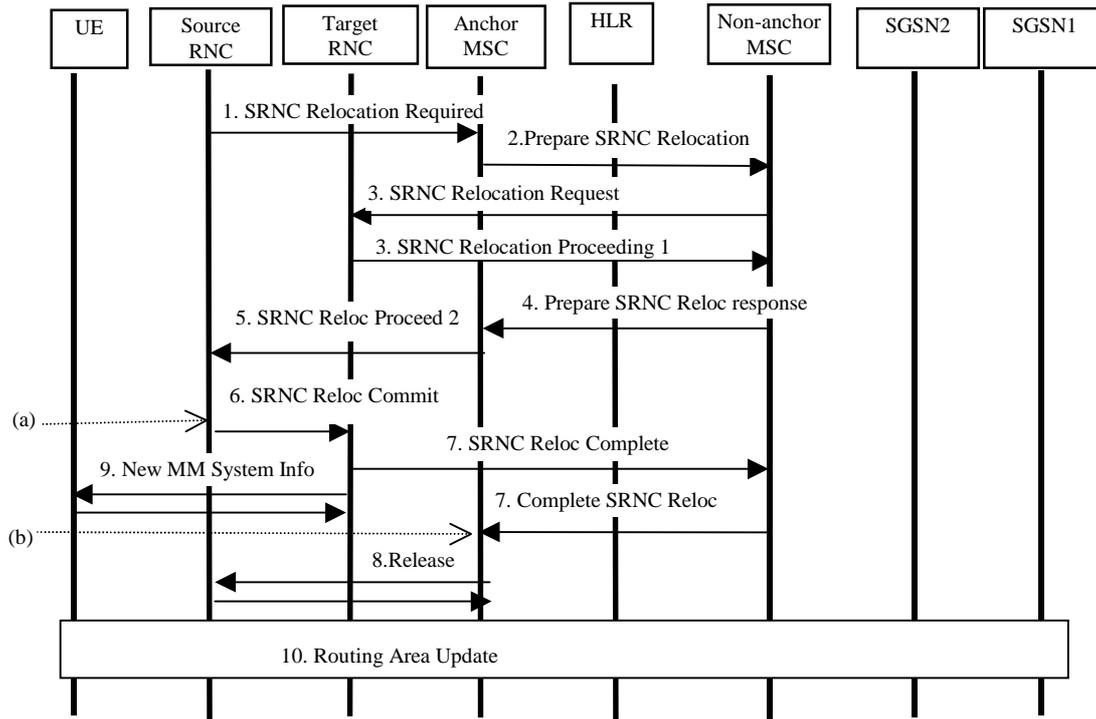


Figure 4.24: Interface information transfer for SRNS relocation when UE connected to 3G_MSC/VLR followed by location registration in new Routing Area.

- UTRAN makes the decision to perform the Serving RNC relocation procedure. This includes decision on into which RNC (Target RNC) the Serving RNC functionality is to be relocated. The source SRNC sends SRNC Relocation required messages to the MSC. This message includes parameters such as target RNC identifier and an information field that shall be passed transparently to the target RNC.
- Upon reception of SRNC Relocation required message the Anchor MSC (MSC1) prepares itself for the switch and determines from the received information that the SRNC relocation will (in this case) involve another MSC. The Anchor MSC will then send a Prepare SRNC Relocation Request to the applicable non-anchor MSC (MSC2) including the information received from the Source RNC.
- The non-anchor MSC will send a SRNC Relocation Request message to the target RNC. This message includes information for building up the SRNC context, transparently sent from Source RNC (UE id., no of connected CN nodes, UE capability information), and directives for setting up Iu user plane transport bearers. When Iu user plane transport bearers have been established, and target RNC has completed its preparation phase, SRNC Relocation Proceeding 1 message is sent to the non-anchor MSC.
- The Prepare SRNC Relocation Response that is sent from non-anchor MSC to Anchor MSC will contain the SRNC Relocation Proceeding 1 received from target RNC.
- When the SRNC Relocation Proceeding 1 has been received in the Anchor MSC, the user plane transport bearers has been allocated the whole path between target RNC and Anchor MSC and the Anchor MSC is ready for the SRNC move, then the Anchor MSC indicates the completion of preparation phase at the CN side for the SRNC relocation by sending the SRNC relocation proceeding 2 message to the Source RNC.
- When the source RNC has received the SRNC Relocation Proceeding 2 message, the source RNC sends a SRNC Relocation Commit message to the target RNC. The target RNC executes switch for all bearers at the earliest suitable time instance.
- Immediately after a successful switch at RNC, target RNC (=SRNC) sends SRNC Relocation Complete message to the non-anchor MSC. This message is included by the non-anchor MSC in the Complete SRNC relocation message that is sent to the anchor MSC. Upon reception of this message, the Anchor-MSC switches from the old Iu transport bearers to the new ones.

- After a successful switch at the Anchor MSC, a release indication is sent towards the Source RNC. This will imply release of all UTRAN resources that were related to this UE.
- When the target RNC is acting as SRNC, it will send New MM System Information to the UE indicating e.g. relevant Routing Area and Location Area. Additional RRC information may then also be sent to the UE, e.g. new RNTI identity.
- When receiving new MM system information indicating a new Routing Area, the UE will in this case initiate a Routing Area update procedure towards the SGSN.
- Before point (a), in figure 4.24, the connection is established between UE and Anchor MSC via Source RNC.
- After point (b), in figure 4.24, the connection is established between UE and Anchor MSC via Target RNC and Non-anchor MSC.

4.3.14.2.3 SRNS relocation (UE connected to a single CN node, 3G_SGSN) followed by Location Registration in new Location Area

This is described in TS 23.060.

Figures 4.25, 4.26, 4.27, 4.28, 4.29 and 4.30: (void).

4.3.14.3 Comparison between UMTS and GSM

For the PSTN/ISDN domain, the proposed UMTS MM concept is in principle identical to the GSM MM.

For the IP domain, the differences between the proposed UMTS MM concept and the GSM GMM are more extensive, such as:

- GSM GMM-Ready state where "Cell update" is replaced in UMTS by UMTS PS-CONNECTED state where SGSN is signalling a connection toward UTRAN and the UE location is tracked by UTRAN (i.e. not on MM level);
- GSM GMM-standby state corresponds to UMTS PS-IDLE state. In both case, "Routing area update" is performed and SGSN is paging in the routing area;
- a UMTS PS-CONNECTED state is introduced and in this state the UE mobility towards the CN will be handled by UTRAN-CN procedures, i.e. not on MM level.

Figure 4.31 provides illustration of the above bullets.

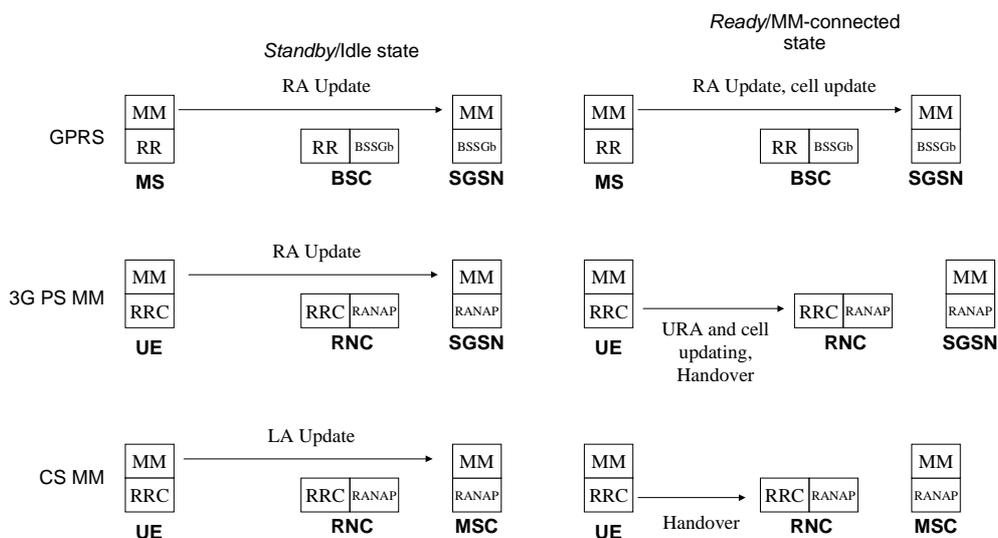


Figure 4.31: The states written in italics correspond to those defined in GSM with GPRS

4.3.14.3.1 PS –idle state

The RA update procedure is utilised to update the whereabouts of the UE into SGSN. The updating into SGSN takes place irrespectively of the CS MM state in MSC.

4.3.14.3.2 PS –connected state

The URA and cell updating and handover procedures presented in figure 4.31 are based on UMTS YY.03 [2]. In brief, the aim in [2] is to introduce functionality that caters for the same functionality as standby/ready in GPRS. The RRC shall be designed in such a fashion, which allows the state of the RRC connection to define the level of activity associated to a packet data connection. The key parameters of each state are the required activity and resources within the state and the required signalling prior to the packet transmission. The operator configurable RRC_connection_release timer can be used to release RRC connections in case of very low level of activity and in case the QoS requirements e.g. delay requirement allow the release of the RRC connection.

The cell update and URA update between UE and RNC are used when the UE is in RRC common channel state, i.e. when the above mentioned parameters allow to scale down the resources reserved for the UE (for a more detailed description on this, see [2]). For example, the purpose of the cell update procedure is to allow the UE to inform its current location in the corresponding RRC state. According to [2] the cell update procedure replaces handover in the corresponding RRC substate.

A significant deviation from GPRS is the introduction of the handover procedures for connections supporting traffic into IP domain (in RRC cell connected state, see [2]).

The UE moves to PS-IDLE state in case of expiry of RRC_connection_release timer or an RRC connection failure.

4.3.14.4 Issues for further study

List of issues that are for further study related to this chapter and is the following:

- more details are required with regards to the differences with regards to the "IP-domain" MM compared to GPRS MM, especially considering roaming and handover to/from UMTS to GSM/GPRS;
- more details should be provided with regards to the logical relations between UE-CN and UTRAN-CN, and how these relate to the physical interconnection between UTRAN and the CN nodes(s), namely whether one logical/physical Iu can be used to interconnect the UTRAN with the CN.

4.3.15 (void)

4.3.16 UTRAN coordination

The UTRAN coordinates the resource allocation of an UE attached to both PS and CS services. The UTRAN shall reject or downgrade a connection which cannot be granted [3]. The cause might be congestion on the radio interface, or the existence of other connections between this UE and the other CN.

The UTRAN use the IMSI to identify a UE. The IMSI is transferred from the Core Network to the UTRAN with the common ID procedure. When an Iu connection is established, the Core Network shall perform the RANAP common ID procedure toward UTRAN as soon as the UE is identified (IMSI). The IMSI is only stored in the UTRAN for the duration of the RRC Connection.

4.4 UMTS call control

4.4.1 Technical Requirements

The following technical requirements are applied to support multimedia in GSM/UMTS.

- P1) GSM/UMTS shall enable the provisioning of multimedia services and multivendor interworking between UE and network.
- P2) Basic voice and PDP-context establishment shall be based on GSM CC/SM respectively.
- P3) Handover and roaming to and from GSM shall be supported provided GSM is capable of supporting the ongoing media service.
- P4) Ideas, concepts and procedures developed by other fora e.g. other standards bodies such as ITU, IETF etc. shall be included or referenced in GSM/UMTS when found suitable.
- P5) To ensure multi-vendor inter-working and UE roaming, a single standardised multimedia protocol for CS domain and a single standardised multimedia protocol for PS domain shall be selected for GSM / UMTS R99. This does not preclude the selection of other protocols by UMTS in the future.

H.323 shall be the multimedia call control model for the PS domain in UMTS R99.

- P6) For multimedia services the standardized multimedia protocol shall be run transparently via a PDP-context or a circuit-switched connection established using GSM SM/CC . This allows transparent hand-over and roaming between GSM and UMTS provided that GSM supports the QoS requirements.

Figure 4.36 illustrates the realisation of the multimedia service based on P6). 'Multimedia Protocol' indicates the functionality either inside the communicating user's terminal or a gateway (e.g. H.323 Gateway)/GK. It is essentially a control function both for user plane and control plane for the multimedia communication.

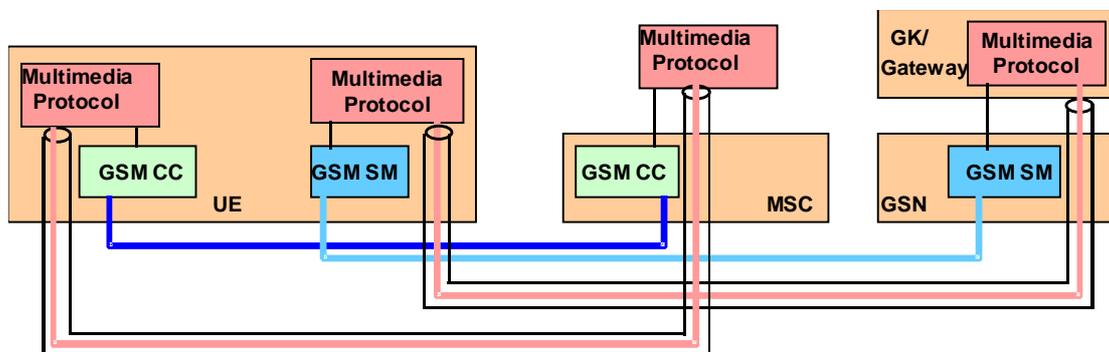


Figure 4.36: Support of multimedia making use of GSM SM/CC

Based on the requirements listed above, GSM CC/SM represented by GSM 04.08 forms a solid foundation for UMTS CC/SM for Release 99. UMTS CC/SM for Release 99 is to be developed from GSM CC/SM by introducing some well defined enhancements.

Existing (and future) multimedia protocols can be supported by the UMTS CC/SM as application layer protocols, with no (or in some instances only minor) impact to UMTS CC/SM.

4.4.2 Architecture for Multimedia

In order to include multimedia in release 99 an architecture for multimedia is required. Subclauses 4.4.2.1 and 4.4.2.2 detail the architecture for UMTS multimedia. It is recognised that it may not be possible to include all the functionality included in this architecture in release 99.

4.4.2.1 Packet Switched Domain

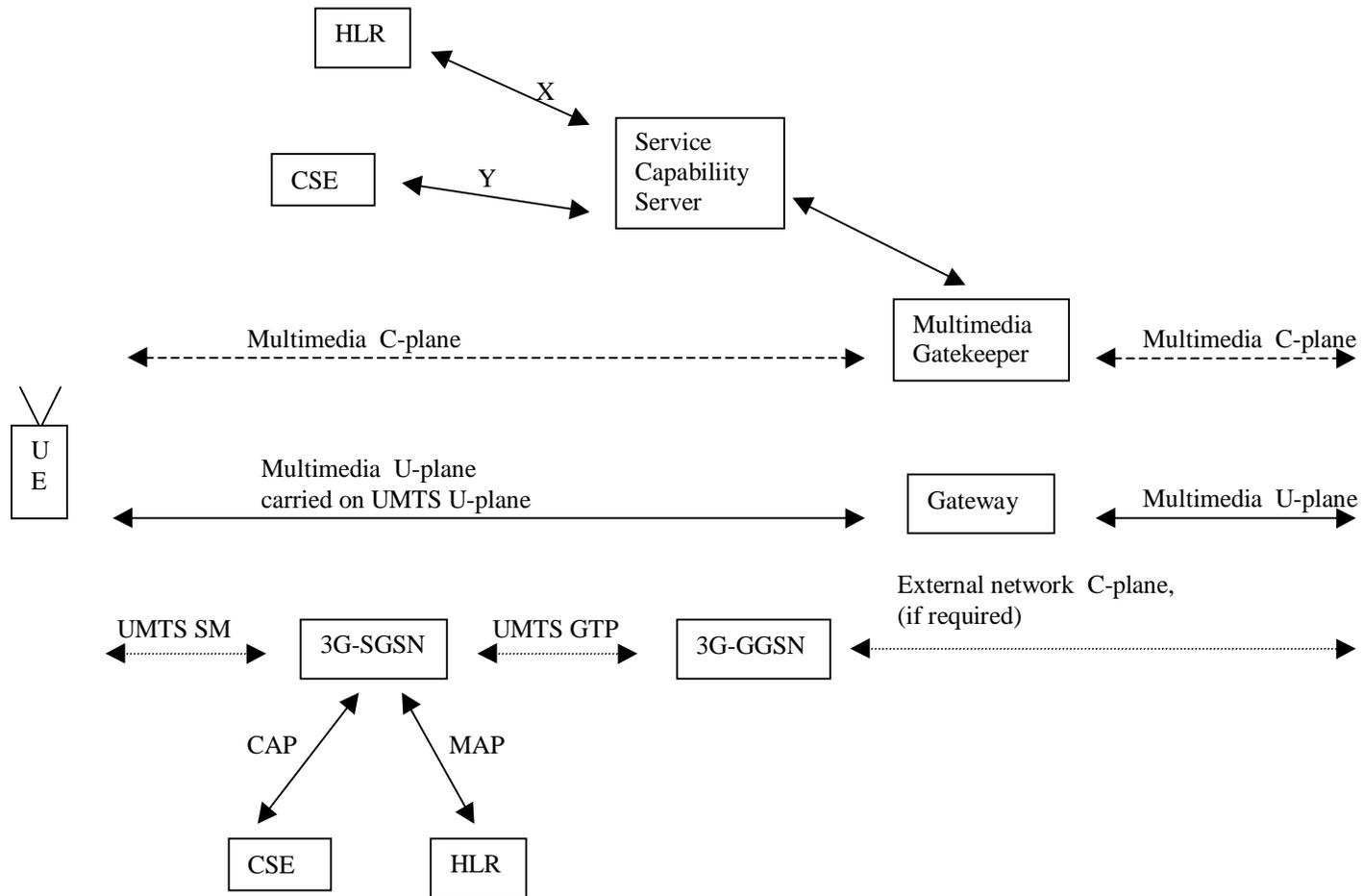


Figure 4.37: Multimedia architecture PS Domain

The multimedia C-plane and U-plane are run transparently over a PDP-context between the UE and multimedia gatekeeper and gateway.

The multimedia U-plane runs between the UE and the multimedia gateway. The multimedia gateway maps the multimedia U-plane on to the U plane in the external network eg. Internet, PSTN. In some cases, such as a UMTS to UMTS call this may unnecessary.

The multimedia control protocol is run between the UE and multimedia gatekeeper. The multimedia gatekeeper is responsible for establishing a multimedia C plane connection on the terminating network.

The service capability server is functionally distinct from the multimedia gatekeeper. It is responsible for creating multimedia services. The standardisation of the interface between the service capability server and the multimedia gatekeeper is for further study. The service capability server may require interfaces to the HLR and CSE (Camel Service Environment) in order to enable interactions between multimedia services and the services provided by these platforms. In this case the interfaces X and Y in figure 4.37 will require standardisation, (It is not proposed that this be included in release 99). The handling of MT communications is for further study.

Services can be delivered at two levels:

- bearer level services are those which correspond to the UMTS bearer service and are delivered via the SGSN, HLR and CSE. Examples of bearer level services are pre-paid or barring of PDP context establishment (for the UMTS bearer service);
- multimedia level services are delivered via the multimedia gatekeeper and service capability server possibly in combination with the HLR and CSE. Examples of multimedia services are video conferencing, call forwarding and pre-paid (of the multimedia component).

The multimedia gatekeeper and service capability server may be located within or external to the UMTS PLMN. The implications of the location of the multimedia gatekeeper and service capability server are for further study.

4.4.2.2 Circuit Switched Domain

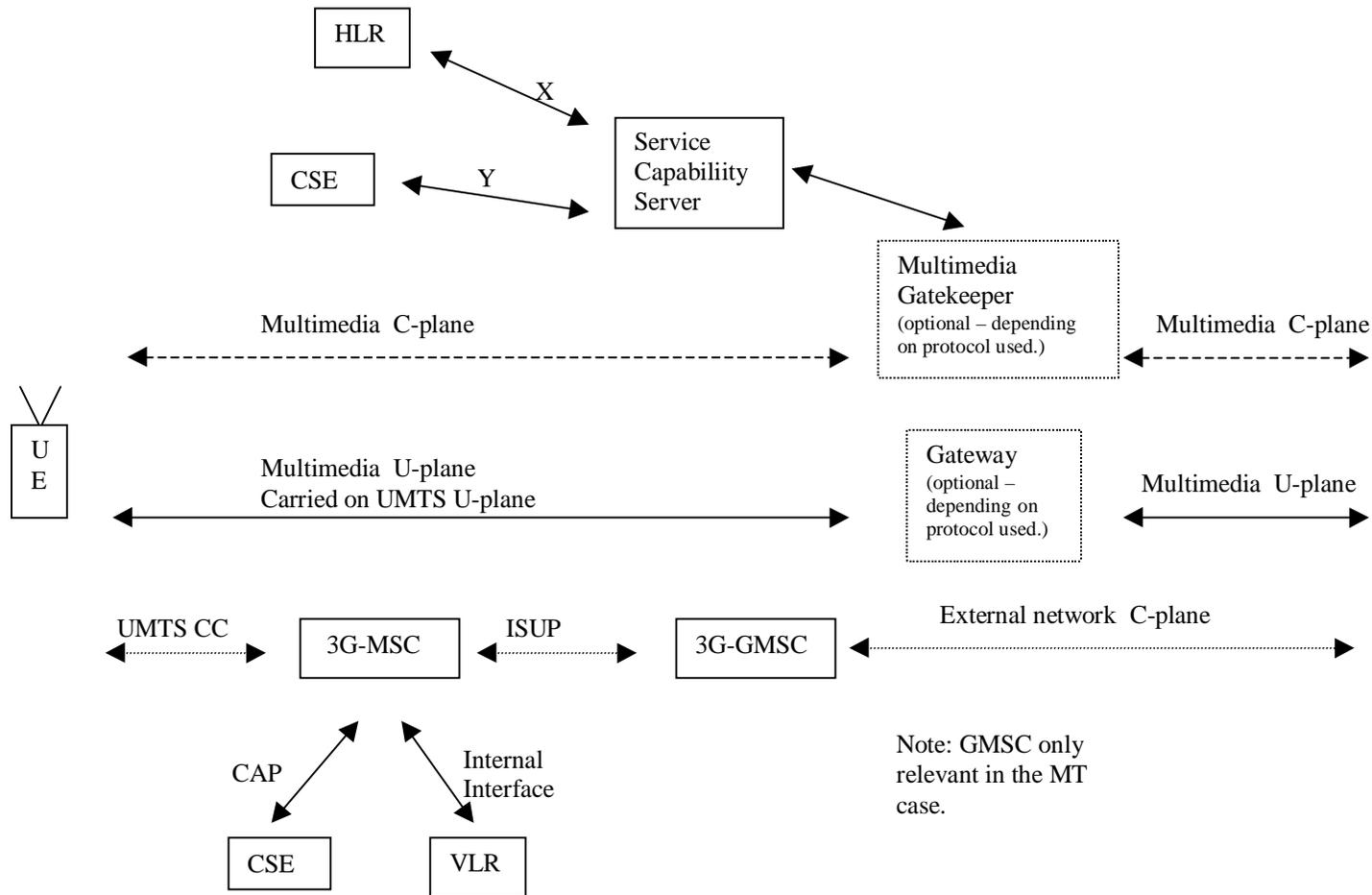


Figure 4.38: Multimedia architecture CS Domain

The multimedia C-plane and U-plane are run transparently over a bearer between the UE and destination or signalling the multimedia gatekeeper and/or gateway if present.

The multimedia U-plane runs between the UE and destination. Optionally the multimedia U-plane is terminated at the the multimedia gateway, which interworks with the external network.

The multimedia control protocol is run between the UE and the destination. Optionally the multimedia gatekeeper is responsible for establishing a multimedia C plane connection on the fixed network.

The service capability server is functionally distinct from the multimedia gatekeeper. It is responsible for creating multimedia services. The standardisation of the interface between the service capability server and the multimedia gatekeeper is for further study. The service capability server may require interfaces to the HLR and CSE (Camel Service Environment) in order to enable interactions between multimedia services and the services provided by these platforms. In this case the interfaces X and Y in figure 4.38 will require standardisation, (It is not proposed that this be included in release 99). The handling of MT communications is for further study.

Services can be delivered at two levels:

- bearer level services are those which correspond to the UMTS bearer service and are delivered via the MSC, HLR and CSE. Examples of bearer level services are pre-paid or call barring (for the UMTS bearer service);
- multimedia level services are delivered via the multimedia gatekeeper (if present) and service capability server possibly in combination with the HLR and CSE. Examples of multimedia services are video conferencing, call forwarding and pre-paid (of the multimedia component). If there is no multimedia gatekeeper network level multimedia services can not be provided.

The multimedia gatekeeper and service capability server may be located within or external to the UMTS PLMN. The implications of the location of the multimedia gatekeeper and service capability server are for further study.

4.4.3 Typical Scenarios for Multimedia Control and User Plane

Two typical call scenarios to support multimedia services, H.324 and H.323, respectively, are presented as examples. As an assumption, the calls are between the peer multimedia terminals over an IMT-2000 network. As shown in the following subclauses, the multimedia signalling protocol and data transmission for both call scenarios can be performed end-to-end on the IMT-2000 user plane and is thereby transparent to the IMT-2000 Core Network. The IMT-2000 operators still control the multimedia service towards the end-user by providing the service via a service node (gateway, gatekeeper or application server) inside its own domain. Some other call scenarios e.g. IMT-2000 to ISDN/PSTN and/or IMT-2000 to the IP network can also be illustrated in a similar fashion.

4.4.3.1 H.324M to H.324M Call

In figure 4.39, the H.324M IMT-2000 terminal initiates the call set-up procedure by sending a 04.08 SET-UP message to the originating MSC/VLR.

After the received 04.08 SETUP message, the originating MSC/VLR sends an ISUP Initial Address Message (IAM) to the terminating MSC/VLR. The terminating MSC/VLR performs a 04.08 SETUP procedure towards the H.324M UMTS terminal. The communication link is now established between the two H.324M endpoints.

The logical channels can now be established using the H.245 open logical channel procedure.

No gateway is needed in this case. This case is simple to support and requires little standardization.

The 04.08 Bearer Capability is used to indicate 64 kbits/s bit transparent case described in GSM 07.01 can be used, as well as H.223/H.245.

The 04.08 LLC is used to indicate H.223/H.245. This makes the called IMT-2000 mobile terminal activate its H.324M application when receiving the SETUP (LLC:H.223/H.245).

Table 4.2

Information Transfer Capability	Unrestricted Digital Information
Sync/Async	Synchronous
Connection Element	Transparent
Fixed Network User Rate	64 kbit/s

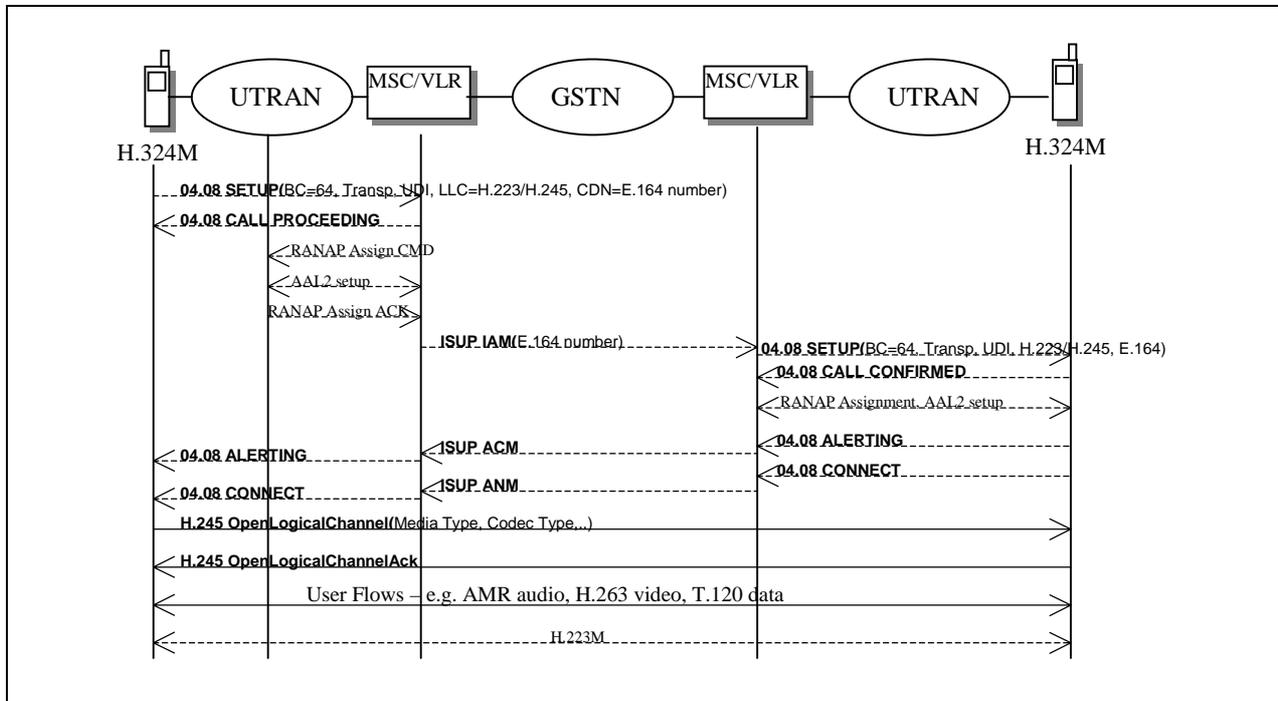


Figure 4.39: UMTS H.324M – UMTS H.324M call example

4.4.3.2 IMT-2000 H.323 to H.323 call

Figure 4.40 shows a Multimedia Call between two H.323 terminals within an IMT-2000 operator domain. It is assumed that a PDP Context using a Best Effort (BE) Radio Access Bearer (RAB) from terminal A towards the Gatekeeper (GK) and one from terminal B towards GK have already been established for H.323 registration in this figure. Terminal A and B now performs Gatekeeper Identification and Gatekeeper Registration using a BE RAB. Thereafter, the terminal A sets up a Real Time (RT) Radio Access Bearer (RAB) to decrease the time for the H.323 control signalling. This need of a Real Time Radio Access Bearer can be indicated from the terminal application to the mobile terminal through the Application Programming Interface (API). The terminal A performs PDP Context activation (see figure below) to set up the Real Time Radio Access Bearer. From now on, the established Real Time Radio Access Bearer can be used for H.225.0 RAS control signalling and Q.931 control signalling. After the Real Time Radio Access Bearer is established, the H.323 terminal A performs an Admission Request (ARQ) towards the Gatekeeper. If the terminal A is admitted the Gatekeeper answers with AdmissionConfirm (ACF) otherwise AdmissionReject (ARJ). Terminal A initiates the H.323 connection by sending a Q.931 Setup message to the Gatekeeper when the ACF has been received. The Gatekeeper answers with a Q.931 Call Proceeding to terminal A and sends a Q.931 Setup message to terminal B on a Best Effort (BE) Radio Access Bearer (RAB). Terminal B performs PDP Context Activation to SGSN and GGSN to set up a Real Time Radio Access Bearer and performs an Admission Request towards the Gatekeeper on this Real Time Radio Access Bearer. After this terminal B answers the received Q.931 Setup message with a Q.931 Alert and Connect message to the Gatekeeper on receipt of the Admission Confirm (ACF) message. The Gatekeeper forwards these two messages to the terminal A. The Real Time Protocol (RTP) is now established between the terminal A and B for transmission of audio, video or data streams (see figure 4.40). The Gatekeeper relays the data streams but is not always completely transparent. The Gatekeeper can perform interworking functions e.g. Network Address Translation (NAT) etc between different networks. The voice transcoding is performed end-to-end in the H.323 terminal.

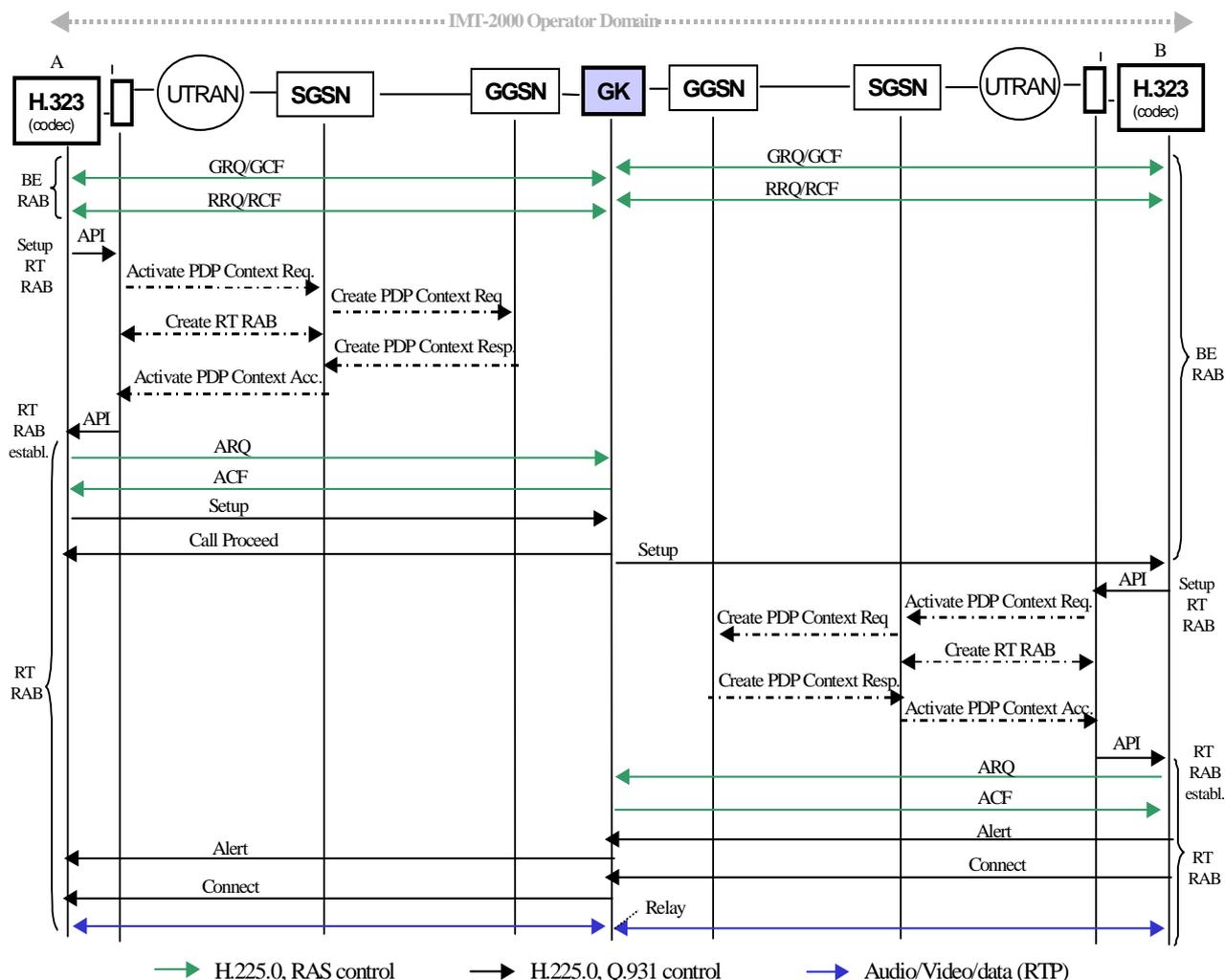


Figure 4.40: IMT-2000 H.323 – H.323 call example

4.5 Core network layer 3

In UMTS/GPRS, it should be possible for operators to use different packet switching protocol (e.g. ATM-SVC) under single GTP standard.

Between GSNs GTP uses UDP/IP (or TCP/IP) for addressing regardless whether IP routing or ATM-SVC switching is used. The use of ATM-SVC will not impact on GTP standardisation.

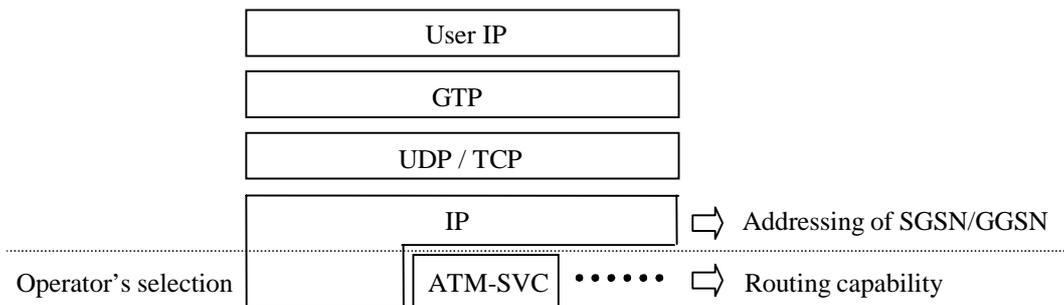


Figure 4.41: Core network layer 3

4.7.2 HIPERLAN 2 UMTS Interworking

UMTS will incorporate a new generic radio access network, the UMTS Radio Access Network (URAN). The URAN may include several different realisations, of which the UTRAN (UMTS Terrestrial Radio Access Network) is one. The Iu reference point forms the boundary between URAN and the UMTS core network. By connecting HIPERLAN 2 to the Iu interface, HIPERLAN 2 will form a complimentary realisation of the URAN concept for broadband data services. UMTS interworking will provide HIPERLAN 2 with roaming support using the UMTS mobility infrastructure.

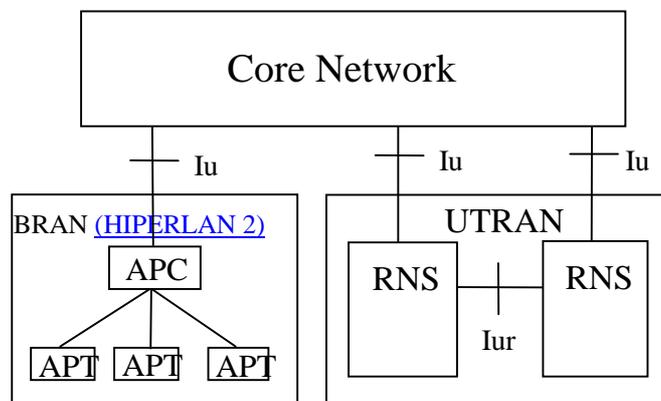


Figure 4.43: HIPERLAN 2 UMTS interworking

A HIPERLAN 2 realisation of URAN should provide the same logical interface to the higher layers (i.e. layers belonging to the non-access stratum) as UTRAN. Hence, no changes in higher layers should be required. UMTS authentication, security and location management can be used over HIPERLAN 2. UMTS bearer setup requests should be mapped to the corresponding HIPERLAN 2 DLC connection. A USIM (User Service Identity Module) may be needed in a BRAN terminal supporting UMTS interworking. Handovers within a HIPERLAN 2 subsystem should be invisible to the core network. Handovers between UTRAN and HIPERLAN 2, in case of dual mode terminals, should be supported via the core network.

4.7.3 Related Actions

The same protocols over the Iu interface should be used for both UTRAN and HIPERLAN 2. However, some impact of connecting a broadband access network, capable of bit rates in the order of 100 Mbit/s, can be expected. Therefore the Iu must be flexible and future proof. Guidance and co-operation with EP BRAN on these matters should be sought.

4.8 Location of the IP compression function in UMTS

4.8.1 Functional role of SNDSCP / PDCP

Out of the functions devoted to SNDSCP in 2G network, only header compression and XID negotiation functions need to be considered in UMTS. Hence the term Packet Data Convergence Protocol (PDCP) is introduced.

4.8.2 Position for header compression

RNC position for header compression is the best place because:

- differential header compression algorithms work better if they are located in the place where packets are more likely to be discarded (after having discarded packets the compression algorithm can send a packet with full header¹). This place is the RNC (where the queues for downstream packets waiting for radio resources are located);

- the compression entity is as close as possible to the reliable link (as in 2G) which in this case is the RLC. Therefore it can be stated that a faster recovery of packets is possible after loss of packets in the radio interface and this solution will therefore minimize the amount of buffering in the UE and network;
- the compression can be signalled for the used RAN.
- it increases the possible data rates that can be achieved: Locating the compression function in the RAN defers the SGSN from the task of opening and processing packets;
- efficient inter-system hand-over can be supported.

4.8.3 Implied protocol stack

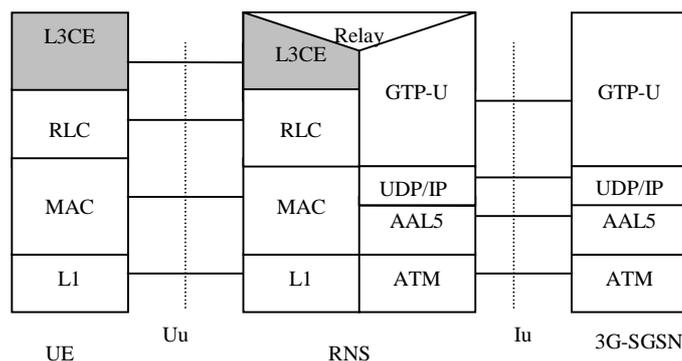


Figure 4.44: User Plane Protocol Architecture with header compression mechanisms

4.9 Short Message Service for UMTS

UMTS will continuously support Short Message Service which already exists for GSM/GPRS system.

4.9.1 Protocols and architecture

The LLC layer is only applicable for GPRS and not for UMTS. Due to that, there is a need to reconsider the functionality which is done at LLC in GPRS. There are two alternatives described below.

- Use U-plane as the alternative of LLC functionality.
- Use C-plane as the alternative of LLC functionality.

It is too much to establish U-plane connection to transfer small amount of data when focusing on the resource of the entire system.

If C-plane was used for data transfer, it can save resource compared with establishing U-plane connection (by using common channel, efficient use of radio resource is possible). It also possesses the advantage of making it possible to use same SMS transfer procedure for CS domain and PS domain. Therefore, it comes to a conclusion that the C-plane shall be used for SMS transfer in UMTS system.

The C-plane is a signalling connection between UE and MSC or SGSN, respectively. Establishment of a secure signalling connection is offered by the GMM in the PS domain and by the MM in the CS domain. SMS is a user of that secure signalling connection.

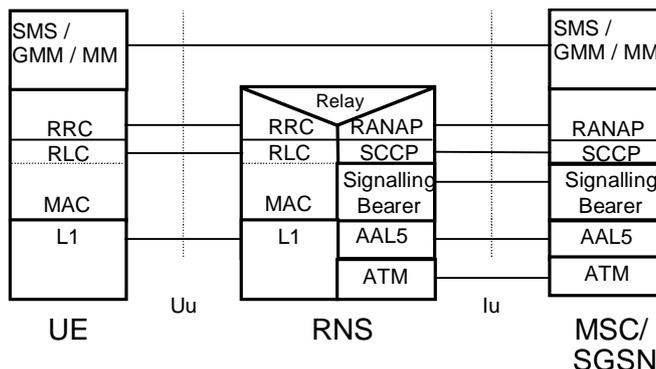


Figure 4.45: Protocol architecture for 3G SMS for both a CS service domain and a PS service domain

4.10a Cell Broadcast Service in UMTS

The *Cell Broadcast Service (CBS)* is defined as a UMTS R99 requirement to guarantee the continuity of the corresponding GSM services. It shall be provided seamlessly (as far as the user or the users terminal equipment is concerned) across the UMTS and GSM network.

4.10a.1 Network Architecture

Figure 4.45a proposes a straight forward adoption of the GSM cell broadcast architecture in UMTS.

The basic network structure replaces the GSM BSS with the UTRAN containing the RNC and the Node B. The cell broadcast center (CBC) is part of the core network and connected via the IuBC reference point to the RNC. On the logical interface between the CBC and the RNC a mandatory protocol shall be defined to meet the requirements defined in 3GPP TS 23.041. Based on this architecture and the current requirements for cell broadcast the core network elements like MSC, VLR, HLR etc are not involved for the service delivery.

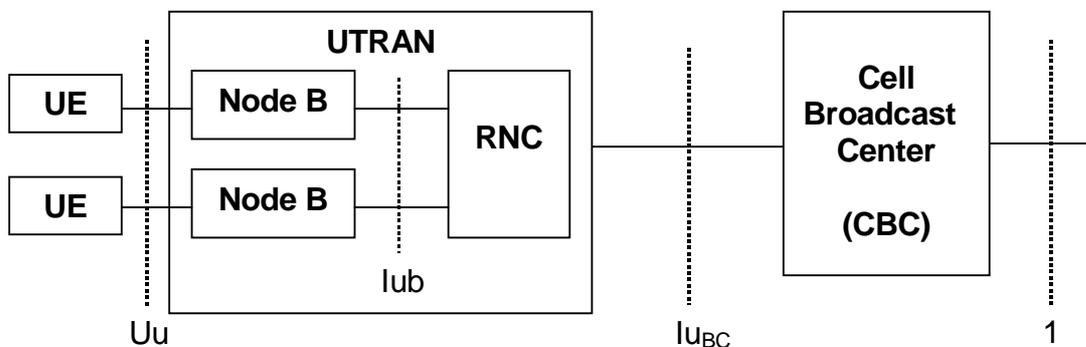


Figure 4.45a: Architecture for the Cell Broadcast Service in UMTS

IuBC is the reference point between the CBC and the RNC. The protocol stack between the CBC and the RNC is given in figure 4.45b.

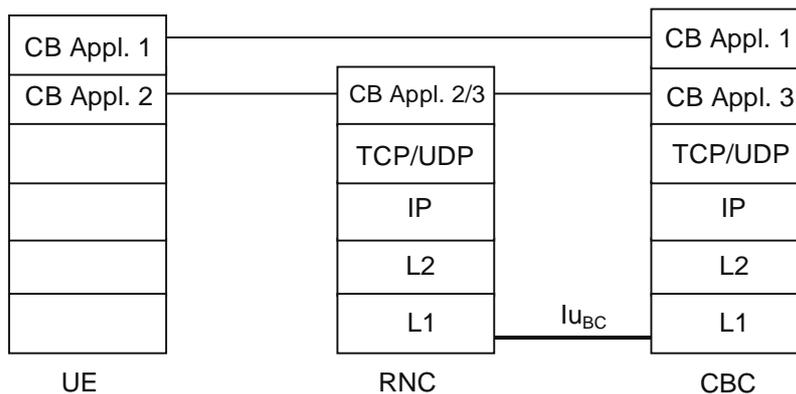


Figure 4.45b: Protocol architecture for the Cell Broadcast Service

CB Appl 1 provides the description of the information passed from the CBC to the UE at the highest layer. This is not changed by the RNC. CB Appl. 2 provides the lower level UE function and CB Appl 3 runs between the CBC and RNC. The protocol primitives of the CB application are described in TS23.041.

The Layer 4 between RNC and CBC (UDP or TCP) shall be selected depending on the requirements of the CB Application 3.

It should be possible for one CBC to reach every RNC of one PLMN. It should be possible that an RNC is connected to at least two CBC at the same time (the "normal" one as in GSM and a second one for LCS).

NOTE: Even if CBS is supported by a separate protocol suite over the IuBC reference point it shall be possible to share the transport resources of the Iu interface (i.e. ATM/AAL5/IP) as shown in figure 4.45c.

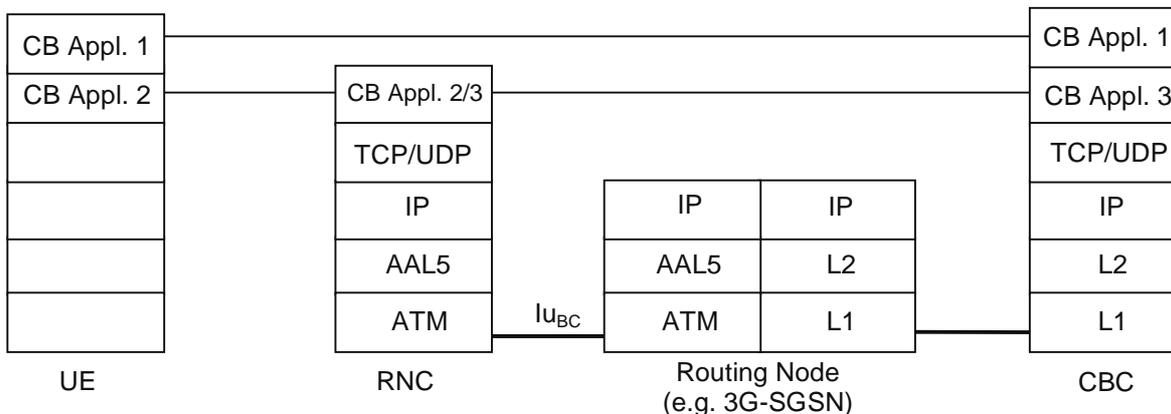


Figure 4.45c: Possible mapping of the IuBC reference point onto the transport resources of the Iu interface

4.10 Mobile IP for UMTS/GPRS End Users

4.10.1 Mobile IP for UMTS/GPRS End Users

A single generic mobility handling mechanism that allows roaming between all types of access networks would allow the user to conveniently move between fixed and mobile networks, between public and private as well as between PLMN's with different access technologies. The ongoing work in IETF Mobile IP working group [13] is targeted towards such a mechanism² and a set of standards are planned to be finalized during 1999. Thus, it is important to offer Mobile IP also to UMTS and GPRS users to allow them to roam to and from other access technologies while keeping ongoing data sessions, e.g. TCP or UDP. A typical UMTS network supporting Mobile IP is shown in figure 4.46.

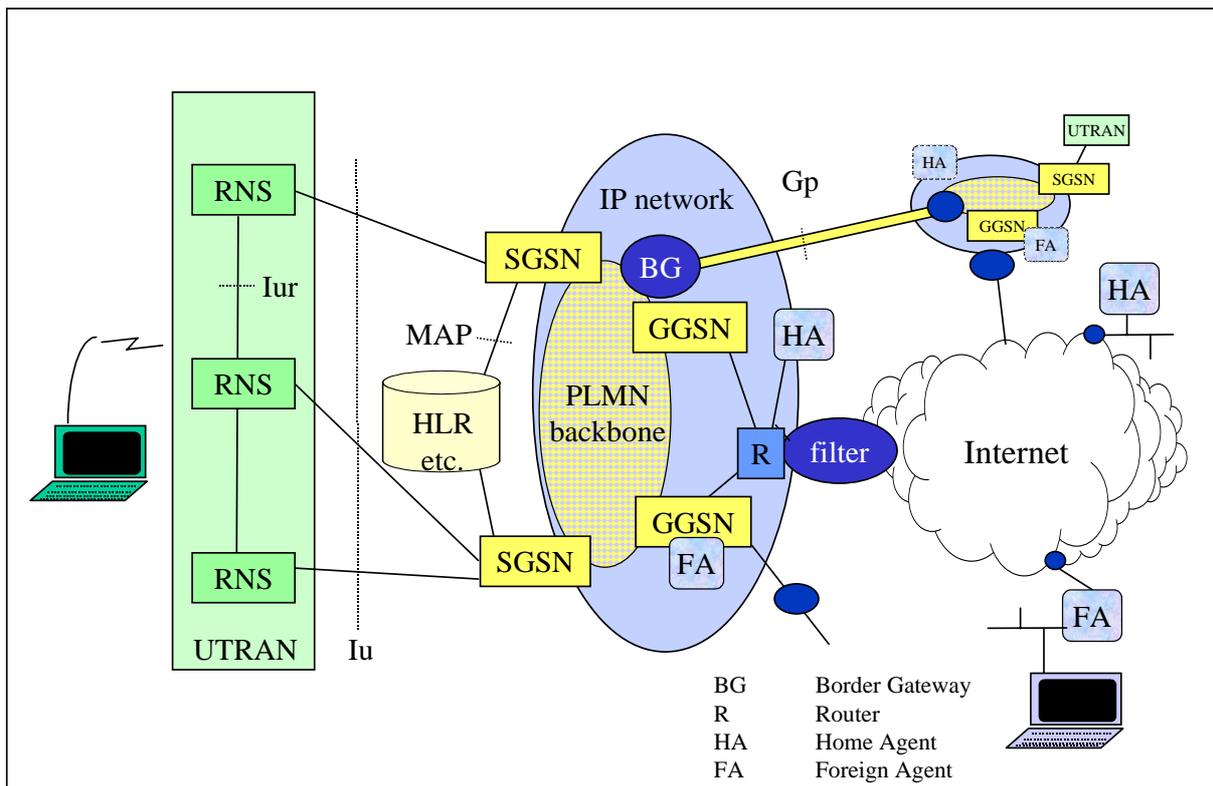


Figure 4.46: Core network architecture with GPRS MM within the PLMN's and Mobile IP MM between different types of systems

As IP addresses in Ipv4 are scarce, it has to be assumed that Mobile Ipv4 preferably will be used with the Foreign Agent (FA) care-of addresses [10]. Compared to using co-located care-of addresses, FA care-of addresses does not only conserve IP addresses, it is also more efficient over the radio interface. We assume here that the MS keeps the same care-of address as long as the PDP context is activated, i.e. does not change GGSN/FA during a UMTS/GPRS session. It is further assumed that PDP type "IP" is used. It is, however, likely that PDP type "PPP" also could be used. Roaming between PLMN's can be realized with GPRS roaming or Mobile IP.

To offer Mobile IP with FA care-of addresses over the UMTS/GPRS network, some requirements need to be fulfilled. Some of these will cause changes to the current GPRS standards.

A signalling scheme, shown in figure 4.47, is described below. The PPP setup and the UMTS/GPRS attach procedures and "GGSN-Initiated PDP Context modification procedure" have been omitted for clarity.

² Note that in this text, Mobile IP is used in a wide sense. It refers to [10] and the RFC's planed to be finalized this year.

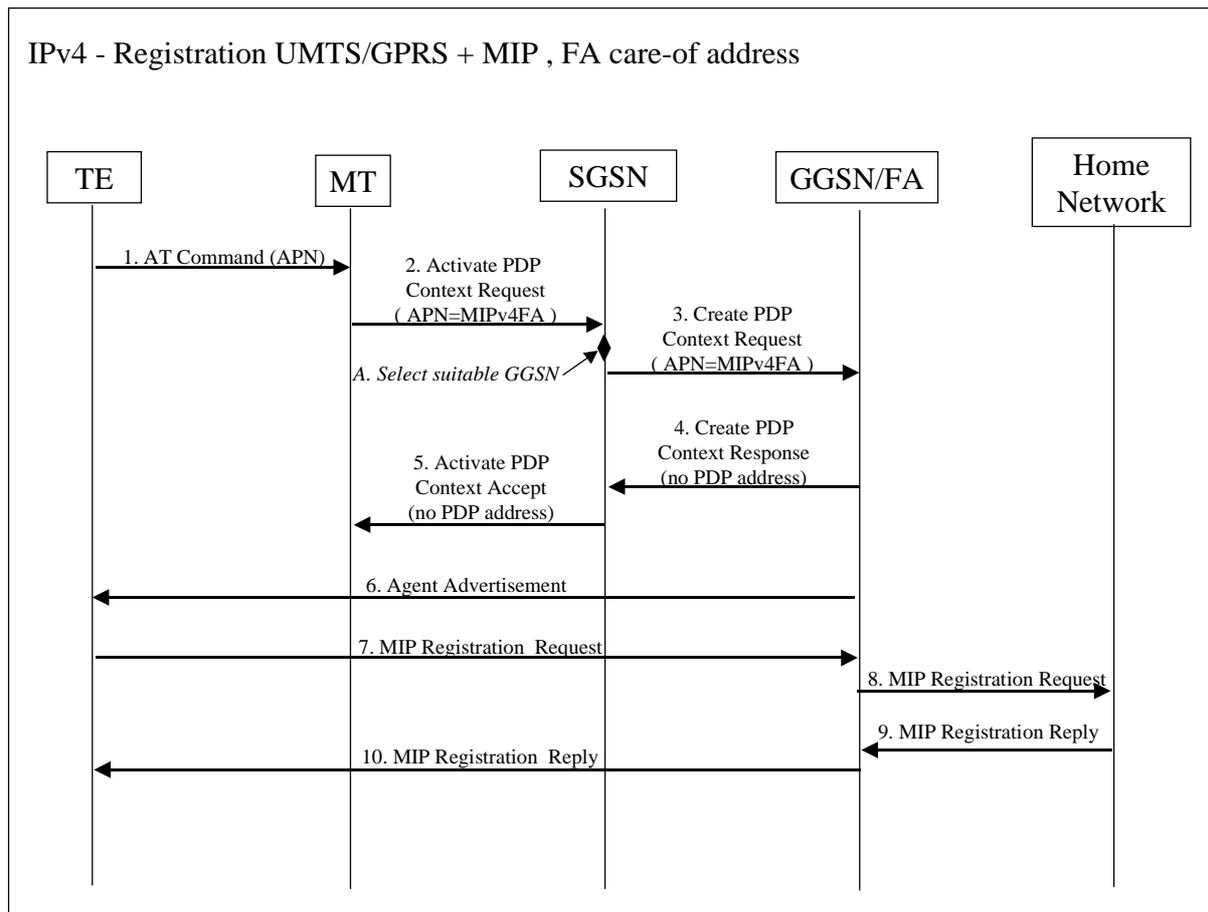


Figure 4.47: PDP Context activation with Mobile IP registration (the PPP setup and UMTS/GPRS attach procedures not included)

1. The AT command carries parameters that the MT needs to request the PDP Context Activation. The important parameter here, is the APN (Access Point Name), see clause A below. The AT command is followed by a setup of the PPP connection between the MT and the TE, which are not included in the figure.
2. The MT sends the "Activate PDP Context Request" to the SGSN. The message includes various parameters of which the "APN" (Access Point Name) and the "Requested PDP Address" are of interest here. The MS may use APN to select a reference point to a certain external network and/or to select a service. APN is a logical name referring to the external packet data network and/or to a service that the subscriber wishes to connect to. The "Requested PDP Address" should be omitted for all MS's using Mobile IP. This is done irrespective of if the MT has a permanently assigned Mobile IP address from its Mobile IP home network, a previously assigned dynamic home address from its Mobile IP home network or if it wishes the Mobile IP home network to allocate a "new" dynamic home address.
 - A. The SGSN will base the choice of GGSN on the APN that is given by the MS.

The APN consists of two parts: the Network ID and the Operator ID. If no APN is given and PDP type is "IP", the SGSN chooses a suitable GGSN according to operator's configuration of the SGSN. Similarly, a Network ID of the format vvv (one label, no dots) can be used to specify any GGSN with a specific service (vvv), e.g. Internet access, gateway for voice over IP, Mobile IP FA. If the SGSN is not configured to identify the requested service it may try with a DNS interrogation for vvv.current-operator.current-country.gprs or, if that is not successful, with vvv.home-operator.home-country.gprs, where the home parameters are taken from the subscription data.

3. The SGSN requests the selected GGSN to set up a PDP Context for the MS. The PDP address and APN fields are the same as in the "Activate PDP Context Request" message.
4. A Create PDP Context Response is sent from the GGSN/FA to the SGSN. If the creation of PDP Context was successful, some parameters will be returned to the SGSN, if not, error code will be returned. If the GGSN has been configured by the operator to use a Foreign Agent for the requested APN, the PDP address returned by the

GGSN shall be set to 0.0.0.0, indicating that the PDP address shall be negotiated by the MS with a Home Agent after the PDP context activation procedure.

5. The Activate PDP Context Accept message is sent by the SGSN to the MS and contains similar information as the Create PDP Context Response message.
6. The Agent Advertisement [10] is an ICMP (Internet Control Message Protocol) Router Advertisement message with a mobility agent advertisement extension. The latter part contains parameters of the FA that the mobile node needs, among those are one or more care-of addresses that the FA offers. This message should be sent, in the UMTS/GPRS user plane, as an IP limited broadcast message, i.e. destination address 255.255.255.255, however only on the TEID for the newly arrived MS to avoid broadcast over the radio interface.
7. The Mobile IP Registration Request is sent from the mobile node to the GGSN/FA across the GPRS/UMTS backbone as user traffic. The mobile node includes its (permanent) home address as a parameter [10]. Alternatively, it can request a temporary address assigned by the home network by including the Network Access Identifier (NAI) in a Mobile-Node-NAI Extension [12], [11].
8. The FA forwards the Mobile IP Registration Request to the home network of the mobile node, where it gets processed by a Home Agent (HA). Meanwhile, the GGSN/FA needs to store the home address of the mobile node or the NAI and the local link address of the MS, i.e. the TEID.
9. The Registration Reply is sent from the home network to the FA, which extracts the information it needs (e.g. the home address of the mobile node if allocated by the home network).
10. The FA forwards the message to the mobile node in the UMTS/GPRS user plane. As the FA/GGSN knows the TEID and the NAI or home address, it can pass it on to the correct MS. A home address of the MS allocated by the home network is sent to the SGSN by means of the "GGSN-Initiated PDP Context modification procedure" described in [23.060].

4.10.1.1 Alterations of and Additions to Current GPRS Standards

To support Mobile IP as described above, the following alterations and additions to the GPRS specifications are necessary:

- 1) the functionality of the GGSN needs to be enhanced with FA functionality, according to IETF specifications. For interoperability, a set of RFC's should be recommended. There is no need to standardize an interface between the GGSN and the FA, as it is considered being one integrated node;
- 2) the GGSN/FA node should send a FA Advertisement message after sending the Create PDP Context Response;
- 3) the GGSN should not give the MS a temporary UMTS/GPRS IP (PDP) address if the Mobile IP FA service has been requested;
- 4) the GGSN/FA and the MS shall exchange Mobile IP signalling messages in the UMTS/GPRS user plane;
- 5) allow the APN to mean a GGSN with a specific service, not only a physical node. To support this, the operator must have the possibility to configure the SGSN or DNS with the choice of GGSN depending on service. A default mechanism is also needed to use a GGSN in the MS's home network if the visited SGSN does not support the requested service. Finally, an agreement between operators is needed on the possible APN's.

4.11 Allowed network and terminal configurations

A UMTS network is divided into a radio access network and a core network, which are connected via an open interface over the Iu reference point. Furthermore, the core network is from a functional point of view divided into a Packet Switched Service Domain and a Circuit Switched Service Domain.

The following network configurations shall be allowed:

- a) networks which provide the functionality of CS Service Domain and PS Service Domain;
- b) networks which only provide the functionality of the CS Service Domain;
- c) networks which only provide the functionality of the PS Service Domain.

The following terminal configurations shall be allowed:

- a) terminals which are able to access both to the CS Domain and PS Domain;
- b) terminals which are only able to access to the PS Domain;
- c) terminals which are only able to access to the CS Domain.

It shall be noted that e.g. terminal which is only able to access to the PS Domain supports only mobility management, protocols etc. of that particular domain. The different configurations given above shall not prevent CS-type services from being delivered over the PS domain.

5 UMTS to UMTS handover for circuit switched services

For UMTS to UMTS Inter-MSC Hand-Over / SRNS relocation the MAP E interface transporting RANAP messages shall be used.

[Ed note: signalling flows are to be provided and be in line with "GSM to UMTS handover for circuit switched services"]

6 Interoperability between GSM and UMTS

The requirements for GSM – UMTS interoperability is defined in 22.129.

UMTS is a system supporting handovers between GSM and UMTS in both directions. To support these handovers effectively, the following is required from a dual mode MS/UE supporting simultaneous ISDN/PSTN and packet service in GSM/UMTS.

Depending upon the solution adopted for GSM-UMTS handover, the MS/UE supporting simultaneous ISDN/PSTN and packet service may be required to perform appropriate update into CN depending on the activity of the UE once the handover between GSM and UMTS is completed. This update is needed to avoid any severe interruptions on the accessibility of packet services after the handover.

The nature of the update to be made after the handover in both direction, i.e., from GSM to UMTS and from UMTS to GSM, from MS/UE depends on the activity of the UE in the following way:

- ISDN/PSTN connection: RA update only (if RA is changed);
- Packet connection: LA and RA update (if RA and LA are changed).

Both ISDN/PSTN and packet connection: RA update only (if RA is changed).

6.1 Circuit Switched Handover and Roaming Principles

Introduction of a UMTS Core Network necessitates the inter-connection with legacy systems to allow inter-PLMN roaming and handover.

For ease of convergence with the existing networks and the introduction of dual mode handsets, roaming and handover to/from UMTS should be performed in the simplest manner that requires as little change as possible to the legacy networks and standards, i.e. inter-MSC handover functionality.

These principles provide – from a user perspective – transparency of handover and roaming. In addition, operators providing UMTS services should also allow access to legacy networks using existing subscriber profiles and network interfaces.

Illustrated in figure 6.1 shows the introduction of a UMTS Core Network for UMTS phase 1 network configuration. Notice that it leaves the current GSM specifications mainly untouched whereupon the UMTS core network acts towards

the GSM MSC like a GSM MSC by providing for example MAP/E for handover purposes. Further, it should be observed that GSM subscriptions belong to the HLR whilst UMTS subscriptions exist in the HLR release 99.

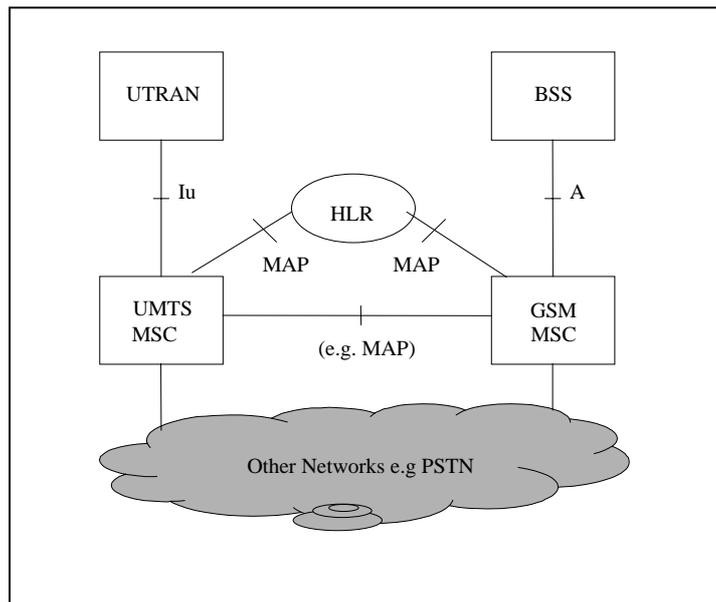


Figure 6.1: Inter-Operability between GSM and UMTS

NOTE 1: No physical implementation should be taken from the figure. As a further note, no interworking functions are shown to ease clarity, but however should not be precluded.

From figure 6.1 it can be seen that the information exchanged over the Iu must provide the necessary parameters to enable the core networks to communicate via for example the MAP interface for handover purposes.

NOTE 2: From the above diagram, existing interfaces are used towards the HLR to allow for subscription management based on today's principles using the already defined user profile, providing seamless roaming between the 2nd generation system and UMTS.

The existing GSM handover procedures should be re-used to minimise the effects on existing GSM equipment.

- The anchor concept in GSM for inter-MSC handover should be used for inter-system handover between UMTS and GSM.
- The signalling over the A-interface and over the MAP/E-interface should be the same as in GSM phase 2+ with possibly addition of some new or updated information elements in some messages.
- For the set up of the handover leg (user plane) standard ISUP/POTS should be used in line with the principles used in GSM.
- The control signalling over the Iu-interface at handover between UMTS and GSM should be based on the A-interface signalling at inter-MSC handover in GSM.
- The signalling over the Iu-interface at call set up to/from a dual mode UMTS/GSM mobile station, shall include GSM information elements needed for handover from UMTS to GSM. In the corresponding way the signalling over the A-interface at call set up to/from a dual mode UMTS/GSM mobile shall include UMTS elements needed for handover from GSM to UMTS. The data are needed to initiate the handover towards the new BSS/RNC.
- A target cell based on CGI is sent to the MSC from UTRAN at handover from UMTS to GSM. The CGI points out the target MSC and target BSC.
- A target cell based on CGI is sent to the MSC from the BSS at handover from GSM to UMTS. The CGI points out the target UMTS MSC and target RNC (UMTS MSC does the translation from CGI to RNC identity).

6.1.1 UMTS to GSM handover for circuit switched services

UMTS to GSM handover for circuit switched services is detailed in 23.009.

6.1.2 GSM to UMTS handover for circuit switched services

UMTS to GSM handover for circuit switched services is detailed in 23.009.

6.2 Packet Switched Handover and Roaming Principles

The introduction of a UMTS core Network illustrates the requirement for inter-connection with the legacy GSM system to allow inter-PLMN roaming and handover.

Even though there is no current GPRS deployment, the operator may decide to deploy a GPRS network prior to the deployment of a UMTS network. Therefore, the introduction of a UMTS Core Network may require to be inter-connected to the legacy packet network.

As in the circuit switched case, roaming and handover to/from UMTS should be performed in the simplest manner that requires as little change as possible to the GPRS network and standards, i.e. inter-GSN handover functionality. In addition, access is provided to the GPRS network using the existing subscriber profiles and current network interfaces.

A similar figure to figure 6.1 is illustrated in figure 6.2. Notice that it also leaves the current GPRS specifications mainly untouched whereupon the UMTS core network acts towards the GSN like a GSN by providing for example Gn. Further, it should be observed that GPRS subscriptions belong to the HLR whilst UMTS subscriptions exist in the HLR release 99.

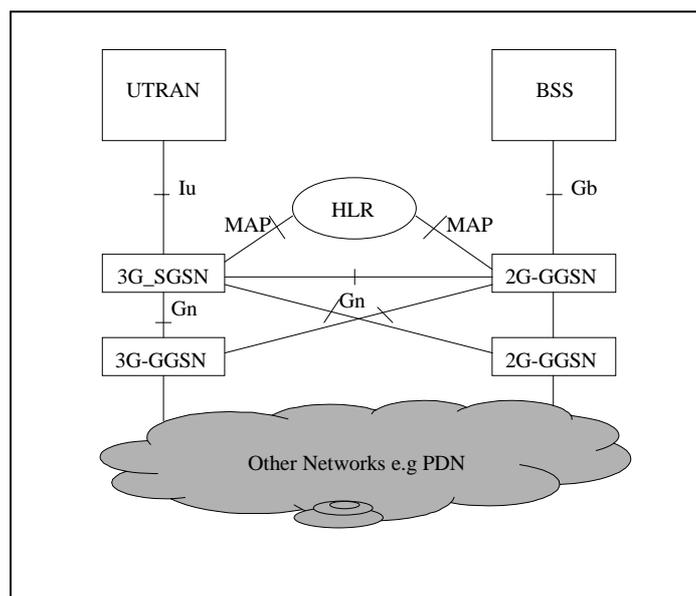


Figure 6.2: Inter-Operability between GSNs and UMTS

NOTE 1: No physical implementation should be taken from figure 6.2. As a further note, no interworking functions are shown to ease clarity, but however should not be precluded.

From figure 6.2 it can be seen that to provide inter-working between legacy packet switched and UMTS packet switched services, the information exchanged over the Iu must provide the necessary parameters to enable the core networks to communicate via for example the Gn interface for handover purposes.

NOTE 2: From the above diagram, the same principles are used as in the circuit switched services to provide seamless roaming.

6.2.1 Implications

- The active PDP context resides in the same GGSN even after a handover between GSM and UMTS (both directions). This corresponds in principle to the anchor concept on the circuit switched side, but note that whereas packet sessions are long lived, the anchor MSC remains only for the duration of a CS call (typically much shorter than a packet session).
- Assuming an internal structure in UMTS CN that contains logical GGSN and SGSN nodes, the signalling over the inter-system GGSN-SGSN interface should be a joint evolution of Gn for the GSM system and UMTS. I.e. when Gn evolves in the sequence of GSM releases, Gn should include any new or updated information necessary for interoperation.
- The corresponding SGSN-SGSN inter-system interface (also Gn) should also be evolved together. However, in this case the changes relative to the current GPRS release may possibly be more profound.

6.2.2 Signalling procedures

The signalling procedures shows how handover UMTS <-> GSM GPRS can be done. The parameters carried by each message is not complete and shall be seen as examples of important information carried by the messages.

The signalling sequences shows the case when the UMTS 3G_SGSN and the GPRS 2G_SGSN are located in separate "physical" nodes.

If the 3G_SGSN and 2G_SGSN are located within the same "physical" node, no signalling are needed between 3G_SGSN and 2G_SGSN.

For handover in the UMTS to GSM GPRS direction the intention is to re-use the handover principles of GSM GPRS today in order to limit the changes in GSM GPRS and to take the changes if any on the UMTS side. The below specified messages is standard GSM 2+ messages (when applicable).

6.2.2.1 Handover from UMTS to GSM GPRS

Handover from UMTS to GSM GPRS is detailed in 23.060.

6.2.2.2 Handover from GSM GPRS to UMTS

Handover from GSM GPRS to UMTS is detailed in 23.060.

Annex A (informative): Reduction of UMTS signalling

A.1 GLR Concept

The benefit of the Gateway Location Register (GLR) is the reduction in signalling traffic between networks. GLR is an optional network element which shall not affect the MAP protocol.

A.1.1 Overview of the GLR Concept

The GLR is a node between the VLR and the HLR, which may be used to optimise the handling of subscriber location data across network boundaries.

In figure A.1, the GLR interacts with HLRa and VLRb for roamers on Network B. The GLR is part of the roaming subscriber's Home Environment. When a subscriber to HLRa is roaming on Network B the GLR plays the role of an HLR towards VLRb and the role of a VLR towards HLRa. The GLR handles any location change between different VLR service areas in the visited network without involving HLRa.

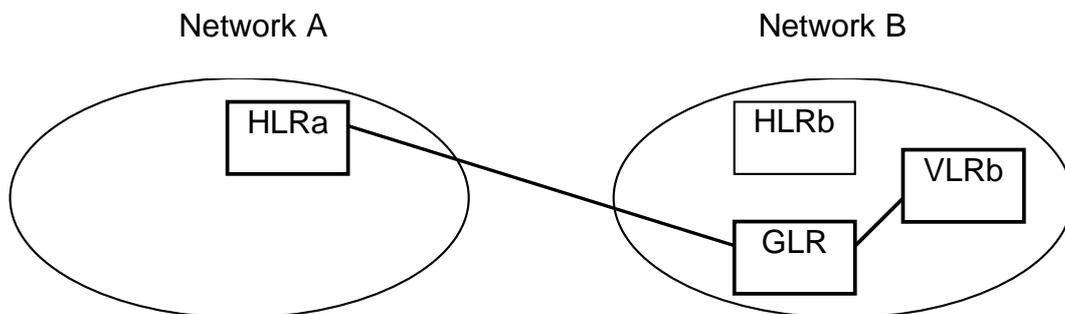


Figure A.1: GLR Overview

The sequence of events when the subscriber roams to network B is as follows:

- VLRb sends the registration message to HLRa via the GLR, (i.e. HLRa stores the GLR's SCCP address and the GLR stores VLRb's SCCP address);
- HLRa returns the subscriber profile data;
- the subscriber profile is stored in the GLR and VLRb.

As the roaming subscriber moves between VLRs in network B, then the GLR is updated, but no message is sent to HLRa, therefore the number of messages between Network A and Network B is reduced. The reduction in signalling traffic is a significant benefit when the two networks are far apart, e.g. between Europe and Japan.

Annex B (informative): Change History

Version	Date	Information about changes
V1.0.0	June 1999	Creation of document from clause 7 of 23.20
V1.0.1	June 1999	Diagram in subclause 7.9 had not been updated in line with S2-99384 in previous version
V2.0.0	June 1999	Some editorial changes in order to prepare the document for the approval by TSG SA, June 1999 meeting
V. 3.0.0	July 1999	Template changed, clauses and sub-clauses numbering corrected, administrative clauses added.
V.3.1.0	October 1999	Inclusion of all the CRs approved at SA#5

TSG SA#	Spec	Version	CR	Subject/Comment	New Version
SA#6	23.121	3.1.0	042r1	Gateway Location Register	3.2.0
SA#6	23.121	3.1.0	043r1	Clarification of SMS sending in UMTS	3.2.0
SA#6	23.121	3.1.0	044r1	SRNS Relocation for PS domain for the case of RT	3.2.0
SA#6	23.121	3.1.0	045r1	Cell Broadcast System Architecture	3.2.0
SA#6	23.121	3.1.0	046r1	Additional modifications related to UMTS area concept change	3.2.0
SA#6	23.121	3.1.0	047	Correction of criteria for data volume reporting from RNC to SGSN	3.2.0
SA#6	23.121	3.1.0	051	Mobile IP	3.2.0
SA#6	23.121	3.1.0	052	Termination point of the GTP-U tunnel	3.2.0
SA#7	23.121	3.2.0	053r1	Tunnel Endpoint Identifier	3.3.0
SA#7	23.121	3.2.0	054	Inter 3G MSC SRNS relocation	3.3.0
SA#7	23.121	3.2.0	055	Change of the reference point name according to 23.002	3.3.0
SA#7	23.121	3.2.0	056	Deletion of SRNS relocation procedure from 23.121	3.3.0
SA#7	23.121	3.2.0	057r1	Removal of "FFS" items	3.3.0
SA#7	23.121	3.2.0	058	Removal of L3CE references	3.3.0
SA#7	23.121	3.2.0	059	Removal of detailed text on handover	3.3.0
SA#9	23.121	3.3.0	062r2	Correction to data Retrieve protocol Stacks end points	3.4.0
SA#10	23.121	3.4.0	063	Removal of Combined update towards the HLR for a combined 3G (MSC/VLR + SGSN) configuration	3.5.0
	23.121	3.5.0		Resolution of a problem with MS Word automatic header numbering	3.5.1
SA#16	23.121	3.5.1	064r2	CS domain signalling requirements: MSC and RNC behaviour relating to handover and cell reselection	3.6.0

History

Document history		
V3.2.0	January 2000	Publication
V3.3.0	March 2000	Publication
V3.4.0	October 2000	Publication
V3.5.1	December 2000	Publication
V3.6.0	June 2002	Publication