- K_{eNB*} is given to Target eNB during the HO preparation phase;
- Both Target eNB and UE considers the new K_{eNB} equal to the received K_{eNB*}.

The handling of HFN and PDCP SN at handover depends on the type of radio bearer:

- SRB: HFN and PDCP SN are reset.
- RLC-UM bearers: HFN and PDCP SN are reset.
- RLC-AM bearers: PDCP SN and HFN are maintained (10.1.2.3).

NOTE: COUNT reusing avoidance is left to network implementation.

14.4 AS Key Change in RRC_CONNECTED

If AS Keys (K_{UPenc} , K_{RRCint} and K_{RRCenc}) need to be changed in RRC_CONNECTED, an intra-cell handover shall be used.

14.5 Security Interworking

Inter-RAT handover from UTRAN to E-UTRAN is only supported after activation of integrity protection in UTRAN. Security may be activated in the target RAN using null ciphering algorithms. If ciphering was not running in UTRAN, it will be activated at handover to E-UTRAN. Integrity protection shall be activated in E-UTRAN on handover from UTRAN/GERAN.

For E-UTRAN to UTRAN/GERAN mobility, the MME shall derive and transfer to the SGSN a confidentially key and an integrity key derived from K_{ASME} and other input parameters as specified in 3GPP TS 33.401 [22]. Based on this information, the SGSN can in turn derive appropriate keys to be used in the target RAN.

Similarly for UTRAN/GERAN to E-UTRAN mobility, the SGSN shall derive and transfer to the MME a confidentially key and an integrity key CK and IK. Based on this information and other input paramaters as specified in 3GPP TS 33.401 [22], the MME and UE can in turn derive K_{ASME}.

15 Void

16 Radio Resource Management aspects

The purpose of radio resource management (RRM) is to ensure the efficient use the available radio resources and to provide mechanisms that enable E-UTRAN to meet radio resource related requirements identified in sub-clause 10 of 3GPP TR 25.913 [2]. In particular, RRM in E-UTRAN provides means to manage (e.g. assign, re-assign and release) radio resources taking into account single and multi-cell aspects.

16.1 RRM functions

16.1.1 Radio Bearer Control (RBC)

The establishment, maintenance and release of Radio Bearers involve the configuration of radio resources associated with them. When setting up a radio bearer for a service, radio bearer control (RBC) takes into account the overall resource situation in E-UTRAN, the QoS requirements of in-progress sessions and the QoS requirement for the new service. RBC is also concerned with the maintenance of radio bearers of in-progress sessions at the change of the radio resource situation due to mobility or other reasons. RBC is involved in the release of radio resources associated with radio bearers at session termination, handover or at other occasions.

RBC is located in the eNB.

16.1.2 Radio Admission Control (RAC)

The task of radio admission control (RAC) is to admit or reject the establishment requests for new radio bearers. In order to do this, RAC takes into account the overall resource situation in E-UTRAN, the QoS requirements, the priority levels and the provided QoS of in-progress sessions and the QoS requirement of the new radio bearer request. The goal of RAC is to ensure high radio resource utilization (by accepting radio bearer requests as long as radio resources available) and at the same time to ensure proper QoS for in-progress sessions (by rejecting radio bearer requests when they cannot be accommodated).

RAC is located in the eNB.

16.1.3 Connection Mobility Control (CMC)

Connection mobility control (CMC) is concerned with the management of radio resources in connection with idle or connected mode mobility. In idle mode, the cell reselection algorithms are controlled by setting of parameters (thresholds and hysteresis values) that define the best cell and/or determine when the UE should select a new cell. Also, E-UTRAN broadcasts parameters that configure the UE measurement and reporting procedures. In connected mode, the mobility of radio connections has to be supported. Handover decisions may be based on UE and eNB measurements. In addition, handover decisions may take other inputs, such as neighbour cell load, traffic distribution, transport and hardware resources and Operator defined policies into account.

CMC is located in the eNB.

16.1.4 Dynamic Resource Allocation (DRA) - Packet Scheduling (PS)

The task of dynamic resource allocation (DRA) or packet scheduling (PS) is to allocate and de-allocate resources (including buffer and processing resources and resource blocks (i.e. chunks)) to user and control plane packets. DRA involves several sub-tasks, including the selection of radio bearers whose packets are to be scheduled and managing the necessary resources (e.g. the power levels or the specific resource blocks used). PS typically takes into account the QoS requirements associated with the radio bearers, the channel quality information for UEs, buffer status, interference situation, etc. DRA may also take into account restrictions or preferences on some of the available resource blocks or resource block sets due to inter-cell interference coordination considerations.

DRA is located in the eNB.

16.1.5 Inter-cell Interference Coordination (ICIC)

Inter-cell interference coordination has the task to manage radio resources (notably the radio resource blocks) such that inter-cell interference is kept under control. ICIC is inherently a multi-cell RRM function that needs to take into account information (e.g. the resource usage status and traffic load situation) from multiple cells. The preferred ICIC method may be different in the uplink and downlink.

ICIC is located in the eNB.

16.1.6 Load Balancing (LB)

Load balancing has the task to handle uneven distribution of the traffic load over multiple cells. The purpose of LB is thus to influence the load distribution in such a manner that radio resources remain highly utilized and the QoS of in-progress sessions are maintained to the extent possible and call dropping probabilities are kept sufficiently small. LB algorithms may result in hand-over or cell reselection decisions with the purpose of redistribute traffic from highly loaded cells to underutilized cells.

LB is located in the eNB.

16.1.7 Inter-RAT Radio Resource Management

Inter-RAT RRM is primarily concerned with the management of radio resources in connection with inter-RAT mobility, notably inter-RAT handover. At inter-RAT handover, the handover decision may take into account the

involved RATs resource situation as well as UE capabilities and Operator policies. The importance of Inter-RAT RRM may depend on the specific scenario in which E-UTRAN is deployed. Inter-RAT RRM may also include functionality for inter-RAT load balancing for idle and connected mode UEs.

16.1.8 Subscriber Profile ID for RAT/Frequency Priority

The RRM strategy in E-UTRAN may be based on user specific information.

The Subscriber Profile ID for RAT/Frequency Priority (SPID) parameter received by the eNB via the S1 interface is an index referring to user information (e.g. mobility profile, service usage profile). The information is UE specific and applies to all its Radio Bearers.

This index is mapped by the eNB to locally defined configuration in order to apply specific RRM strategies (e.g. to define RRC_IDLE mode priorities and control inter-RAT/inter frequency handover in RRC_CONNECTED mode).

16.2 RRM architecture

16.2.1 Centralised Handling of certain RRM Functions

16.2.2 De-Centralised RRM

16.2.2.1 UE History Information

The source eNB collects and stores the UE History Information for as long as the UE stays in one of its cells.

When information needs to be discarded because the list is full, such information will be discarded in order of its position in the list, starting with the oldest cell record.

The resulting information is then used in subsequent handover preparations by means of the Handover Preparation procedures over the S1 and X2 interfaces, which provide the target eNB with a list of previously visited cells and associated (per-cell) information elements. The Handover Preparation procedures also trigger the target eNB to start collection and storage of UE history Information and thus to propagate the collected information.

16.2.3 Load balancing control

17 RF aspects

17.1 Spectrum deployments

18 UE capabilities

RRC signalling carries AS capabilities and NAS signalling carries NAS capabilities. The UE capability information is stored in the MME. In the uplink, no capability information is sent early in e.g. RRCConnectionRequest message. In the downlink, enquiry procedure of the UE capability is supported.

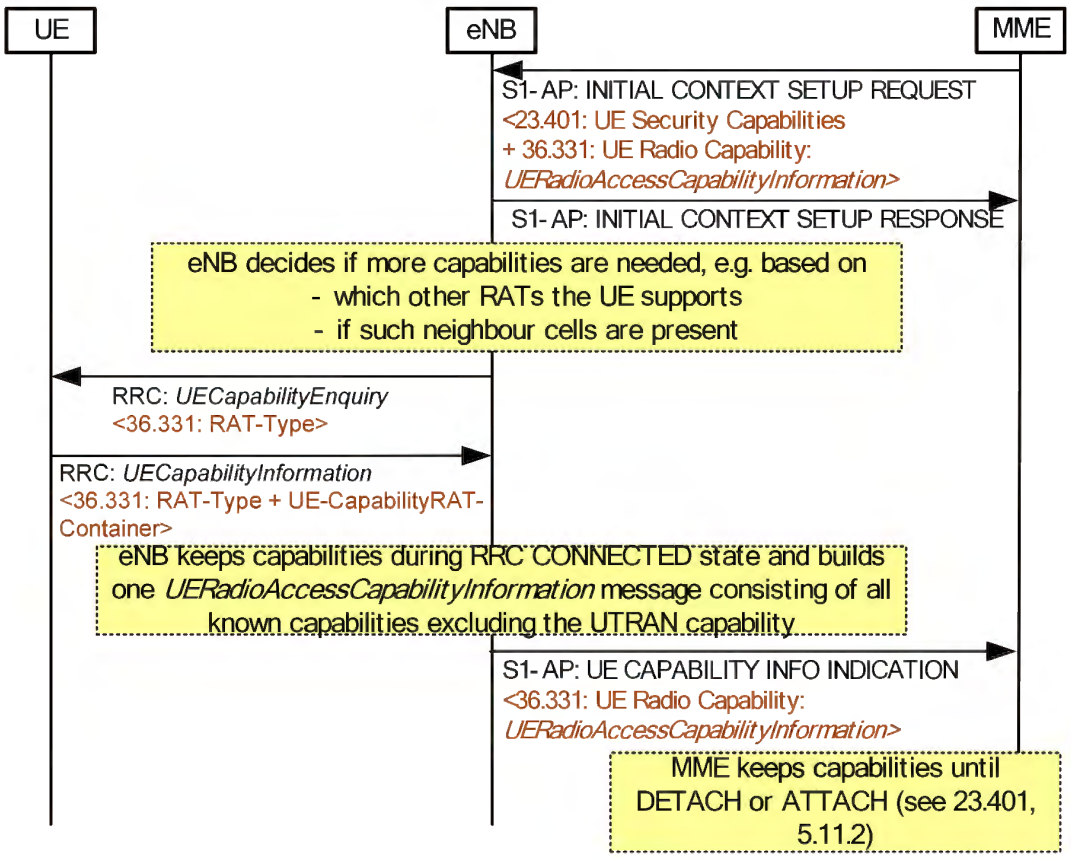


Figure 18-1: Initial UE Capability Handling

The MME stores the UE Radio Capability uploaded in the UE CAPABILITY INFO INDICATION message.

The possible RAT-Types in Rel-8 are: EUTRAN, UTRAN, GERAN-PS, GERAN-CS, CDMA2000-1XRTT. The GERAN capability is divided into separate parts. MS Classmark 2 and Classmark 3 are used for CS domain (in both AS and NAS) and MS Radio Access Capability is used for PS domain. The main part of CDMA2000 capabilities is not handled by the eNB or the MME, but is exchanged via tunnelling (see 10.3.2). The small part of CDMA2000 capabilities (for CDMA2000-1XRTT) is needed for the eNB to be able to build messages for the target CDMA2000 RNC (see 10.3.2).

The eNB may acquire the UE capabilities after a Handover completion. The UE capabilities are then uploaded to the MME.

Usually during handover preparation, the source RAN node transfers both the UE source RAT capabilities and the target RAT capabilities to the target RAN node, in order to minimize interruptions and to follow the principles in subclause 10.2.2. This is described in subclause 19.2.2.5.6. However at Handover from UTRAN to EUTRAN, it is optional to forward the UTRAN capabilities to the target RAN. The source RAN is not mandated to acquire other RAT capabilities (i.e. other than the source and target RAT capabilities) in order to start a handover preparation.

The UTRAN capabilities, i.e. the INTER RAT HANDOVER INFO, include START-CS, START-PS and "predefined configurations", which are "dynamic" IEs. In order to avoid the START values desynchronisation and the key replaying issue, the eNB always enquiry the UE UTRAN capabilities at transition from RRC_IDLE to RRC_CONNECTED and before Handover to UTRAN. The eNB does not upload the UE UTRAN capabilities to the MME.

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19 S1 Interface

19.1 S1 User plane

The S1 user plane interface (S1-U) is defined between the eNB and the S-GW. The S1-U interface provides non guaranteed delivery of user plane PDUs between the eNB and the S-GW. The user plane protocol stack on the S1 interface is shown in Figure 19.1-1. The transport network layer is built on IP transport and GTP-U is used on top of UDP/IP to carry the user plane PDUs between the eNB and the S-GW.

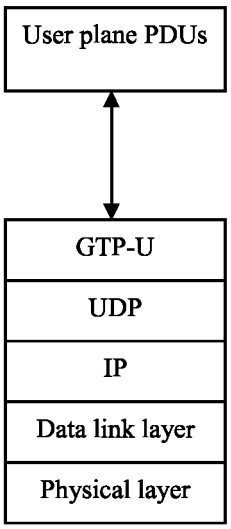


Figure 19.1-1: S1 Interface User Plane (eNB - S-GW)

19.2 S1 Control Plane

The S1 control plane interface (S1-MME) is defined between the eNB and the MME. The control plane protocol stack of the S1 interface is shown on Figure 19.2-1. The transport network layer is built on IP transport, similarly to the user plane but for the reliable transport of signalling messages SCTP is added on top of IP. The application layer signalling protocol is referred to as S1-AP (S1 Application Protocol).

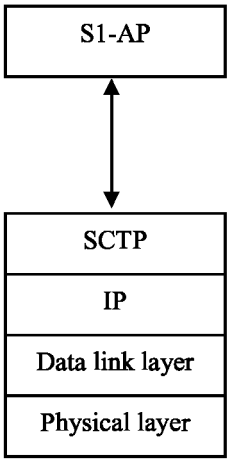


Figure 19.2-1: S1 Interface Control Plane (eNB-MME)

The SCTP layer provides the guaranteed delivery of application layer messages.

In the transport IP layer point-to-point transmission is used to deliver the signalling PDUs.

A single SCTP association per S1-MME interface instance shall be used with one pair of stream identifiers for S1-MME common procedures. Only a few pairs of stream identifiers should be used for S1-MME dedicated procedures. MME communication context identifiers that are assigned by the MME for S1-MME dedicated procedures and eNB communication context identifiers that are assigned by the eNB for S1-MME dedicated procedures shall be used to distinguish UE specific S1-MME signalling transport bearers. The communication context identifiers are conveyed in the respective S1-AP messages.

19.2.1 S1 Interface Functions

Note: The following list of S1 functions reflects the status of agreements in RAN3, might be extended in forthcoming meetings.

- E-RAB Service Management function:
  - Setup, Modify, Release.
- Mobility Functions for UEs in ECM-CONNECTED:
  - Intra-LTE Handover;
  - Inter-3GPP-RAT Handover.
- S1 Paging function:
- NAS Signalling Transport function;
- S1-interface management functions:
  - Error indication;
  - Reset.
- Network Sharing Function;
- Roaming and Area Restriction Support function;
- NAS Node Selection Function;
- Initial Context Setup Function;
- UE Context Modification Function;
- MME Load balancing Function;
- Location Reporting Function;
- ETWS Message Transmission Function;
- Overload function;
- RAN Information Management Function;
- Configuration Transfer Function.
- S1 CDMA2000 Tunnelling function.

19.2.1.1 S1 Paging function

The paging function supports the sending of paging requests to all cells of the TA(s) the UE is registered.

Paging requests are sent to the relevant eNBs according to the mobility information kept in the UE"s MM context in the serving MME.

19.2.1.2 S1 UE Context Management function

In order to support UEs in ECM-CONNECTED, UE contexts need to be managed, i.e. established and released in the eNodeB and in the EPC to support user individual signalling on S1.

19.2.1.3 Initial Context Setup Function

The Initial Context Setup function supports the establishment of the necessary overall initial UE Context including E-RAB context, Security context, roaming restriction, UE capability information, Subscriber Profile ID for RAT/Frequency Priority, UE S1 signalling connection ID, etc. in the eNB to enable fast Idle-to-Active transition.

In addition to the setup of overall initial UE Contexts, Initial Context Setup function also supports the piggy-backing of the corresponding NAS messages. Initial Context Setup is initiated by the MME.

19.2.1.3a UE Context Modification Function

The UE Context Modification function supports the modification of UE Context in eNB for UEs in active state.

19.2.1.4 Mobility Functions for UEs in ECM-CONNECTED

19.2.1.4.1 Intra-LTE Handover

The Intra-LTE-Handover function supports mobility for UEs in ECM-CONNECTED and comprises the preparation, execution and completion of handover via the X2 and S1 interfaces.

19.2.1.4.2 Inter-3GPP-RAT Handover

The Inter-3GPP-RAT Handover function supports mobility to and from other 3GPP-RATs for UEs in ECM-CONNECTED and comprises the preparation, execution and completion of handover via the S1 interface.

19.2.1.5 E-RAB Service Management function

The E-RAB Service management function is responsible for establishing, modifying and releasing E-UTRAN resources for user data transport once a UE context is available in the eNB. The establishment and modification of E-UTRAN resources is triggered by the MME and requires respective QoS information to be provided to the eNB. The release of E-UTRAN resources is triggered by the MME either directly or following a request received from the eNB (optional).

19.2.1.6 NAS Signalling Transport function

The NAS Signalling Transport function provides means to transport a NAS message (e.g. for NAS mobility management) for a specific UE on the S1 interface.

19.2.1.7 NAS Node Selection Function (NNSF)

The interconnection of eNBs to multiple MME/Serving S-GWs is supported in the E-UTRAN/EPC architecture. Therefore a NAS node selection function is located in the eNB to determine the MME association of the UE, based on the UE"s temporary identifier, which was assigned to the UE by the CN node (e.g. MME or SGSN).

NOTE: In case the UE"s temporary identifier is assigned by the SGSN, respective mapping rules are defined in [26].

Depending on the actual scenario the NNSF determines the UE"s MME association either based its S-TMSI (e.g. at service request) or based on its GUMMEI and selected PLMN (e.g. at attach or tracking area update in non-registered TA).

This functionality is located in the eNB only and enables proper routing via the S1 interface. On S1, no specific procedure corresponds to the NAS Node Selection Function.

19.2.1.8 S1-interface management functions

The S1-interface management functions provide

- means to ensure a defined start of S1-interface operation (reset)
- means to handle different versions of application part implementations and protocol errors (error indication)

19.2.1.9 MME Load balancing Function

MME Load balancing is the function which achieves load-balanced MMEs with respect to their processing capacity within a pool area during system operation. The means to load-balance MMEs is to distribute UEs newly entering the pool to different MMEs in the MME pool. In addition the MME load balancing function is able to achieve equally loaded MMEs within a pool area after the introduction of a new MME and after the removal of a MME from the network.

The support of the MME load balancing function is achieved by indicating the relative MME capacity in the S1 Setup procedure to all eNBs served by the MMEs of the pool area per MME. In order to support the introduction and/or removal of MMEs the MME initiated S1 setup update procedure may be used by the operator indicating relative MME capacity value changes. The indicated relative MME capacity steers the UE assignment for UEs newly entering the MME pool.

19.2.1.10 Location Reporting Function

The Location Reporting function supports the MME requests to the eNB to report the location information of the UE.

19.2.1.11 Warning Message Transmission function

The warning message transmission function provides means to transfer warning message via S1 interface.

19.2.1.12 Overload Function

The overload function comprises the signalling means:

- to indicate to a proportion of eNBs that the serving MME is overloaded
- to indicate to the eNBs that the serving MME is back in the "normal operation mode"

19.2.1.13 RAN Information Management Function

The RAN Information Management (RIM) function is a generic mechanism that allows the request and transfer of information (e.g. GERAN System information) between two RAN nodes via the core network.

19.2.1.14 S1 CDMA2000 Tunnelling function

The S1 CDMA2000 Tunnelling function transports CDMA2000 signalling between UE and CDMA2000 RAT over the S1 Interface for mobility from E-UTRAN to CDMA2000 HRPD and CDMA2000 1xRTT and for circuit switched fallback to CDMA2000 1xRTT.

19.2.1.15 Configuration Transfer Function

The Configuration Transfer function is a generic mechanism that allows the request and transfer of RAN configuration information (e.g. SON information) between two RAN nodes via the core network.

19.2.2 S1 Interface Signalling Procedures

Note: The following list of S1 procedures reflects the status of agreements in RAN3, might be extended in forthcoming meetings.

- E-RAB signalling procedures:
  - E-RAB Setup procedure;
  - E-RAB Modification procedure;
  - E-RAB Release procedure;
  - E-RAB Release Indication procedure.
- Handover signalling procedures;
  - Handover Preparation procedure;
  - Handover Resource Allocation procedure;
  - Handover Completion procedure;
  - Handover Cancellation procedure.
- Paging procedure;
- NAS transport procedure:
  - UL direction (Initial UE Message);
  - UL direction (Uplink NAS transport);
  - DL direction (Downlink NAS transport).
- Error Indication procedure:
  - eNB initiated error indication procedure;
  - MME initiated error indication procedure.
- Reset procedure:
  - eNB initiated Reset procedure;
  - MME initiated Reset procedure.
- Initial Context Setup procedure;
- UE Context Modification procedure;
- S1 Setup procedure;
- eNB Configuration Update procedure;
- MME Configuration Update procedure;
- Location Reporting procedures:
  - Location Reporting Control procedure;
  - Location Report procedure;
  - Location Report Failure Indication procedure.
- Overload Start procedure;
- Overload Stop procedure;
- Write Replace Warning procedure;
- Direct Information Transfer procedure;
- eNB Configuration Transfer procedure;

- MME Configuration Transfer procedure.
- S1 CDMA2000 Tunnelling procedure:
  - Downlink S1 CDMA2000 Tunnelling procedure;
  - Uplink S1 CDMA2000 Tunnelling procedure.

19.2.2.1 Paging procedure

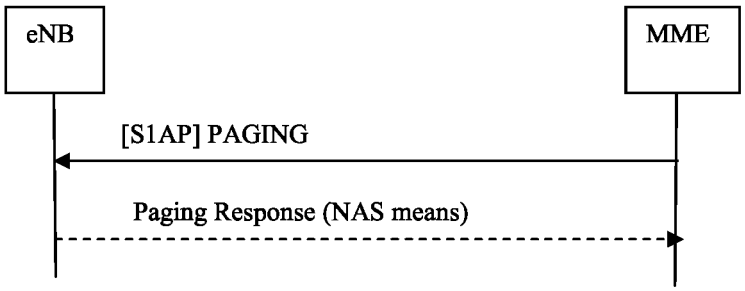


Figure 19.2.2.1-1: Paging procedure

The MME initiates the paging procedure by sending the PAGING message to each eNB with cells belonging to the tracking area(s) in which the UE is registered. Each eNB can contain cells belonging to different tracking areas, whereas each cell can only belong to one TA.

The paging response back to the MME is initiated on NAS layer and is sent by the eNB based on NAS-level routing information.

19.2.2.2 S1 UE Context Release procedure

The S1 UE Context Release procedure causes the eNB to remove all UE individual signalling resources and the related user data transport resources. This procedure is initiated by the EPC and may be triggered on request of the serving eNB.

19.2.2.2.1 S1 UE Context Release (EPC triggered)

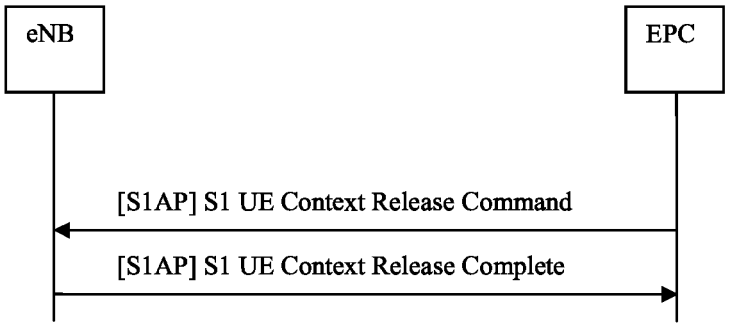


Figure 19.2.2.2.1-1: S1 UE Context Release procedure (EPC triggered)

- The EPC initiates the UE Context Release procedure by sending the S1 UE Context Release Command towards the E-UTRAN. The eNodeB releases all related signalling and user data transport resources.
- The eNB confirms the S1 UE Context Release activity with the S1 UE Context Release Complete message.
- In the course of this procedure the EPC releases all related resources as well, except context resources in the EPC for mobility management and the default EPS Bearer/E-RAB configuration.

19.2.2.2.2 S1 UE Context Release Request (eNB triggered)

The S1 UE Context Release Request procedure is initiated for E-UTRAN internal reasons and comprises the following steps:

- The eNB sends the S1 UE Context Release Request message to the EPC.
- The EPC triggers the EPC initiated UE context release procedure.

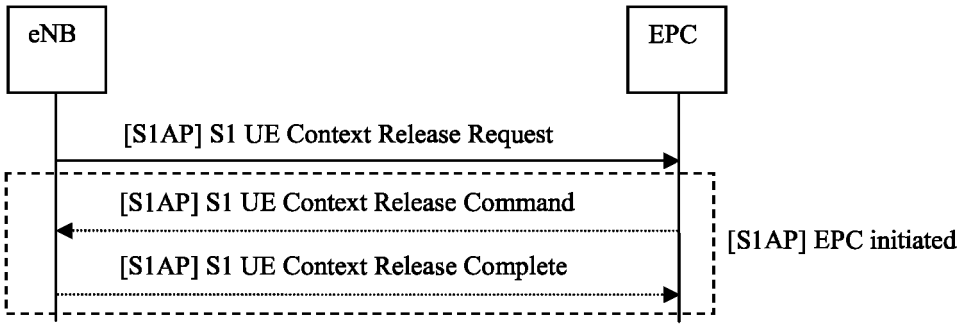


Figure 19.2.2.2.2-1: S1 UE Context Release Request procedure (eNB triggered) and subsequent S1 UE Context Release procedure (EPC triggered)

If the E-UTRAN internal reason is a radio link failure detected in the eNB, the eNB shall wait a sufficient time before triggering the S1 UE Context Release Request procedure in order to allow the UE to perform the NAS recovery procedure [17].

19.2.2.3 Initial Context Setup procedure

The Initial Context Setup procedure establishes the necessary overall initial UE context in the eNB in case of an Idle-to Active transition. The Initial Context Setup procedure is initiated by the MME.

The Initial Context Setup procedure comprises the following steps:

- The MME initiates the Initial Context Setup procedure by sending INITIAL CONTEXT SETUP REQUEST to the eNB. This message may include general UE Context (e.g. security context, roaming restrictions, UE capability information, UE S1 signalling connection ID, etc.), E-RAB context (Serving GW TEID, QoS information), and may be piggy-backed with the corresponding NAS messages. When there are multiple NAS messages in the INITIAL CONTEXT SETUP REQUEST message, the MME shall ensure that the NAS messages in the E-RAB to be Setup List are aligned in the order of reception from the NAS layer to ensure the in-sequence delivery of the NAS messages.
- Upon receipt of INITIAL CONTEXT SETUP REQUEST, the eNB setup the context of the associated UE, and perform the necessary RRC signalling towards the UE, e.g. Radio Bearer Setup procedure. When there are multiple NAS messages to be sent in the RRC message, the order of the NAS messages in the RRC message shall be kept the same as that in the INITIAL CONTEXT SETUP REQUEST message.
- The eNB responds with INITIAL CONTEXT SETUP COMPLETE to inform a successful operation, and with INITIAL CONTEXT SETUP FAILURE to inform an unsuccessful operation.

NOTE: In case of failure, eNB and MME behaviours are not mandated. Both implicit release (local release at each node) and explicit release (MME-initiated UE Context Release procedure) may in principle be adopted. The eNB should ensure that no hanging resources remain at the eNB.

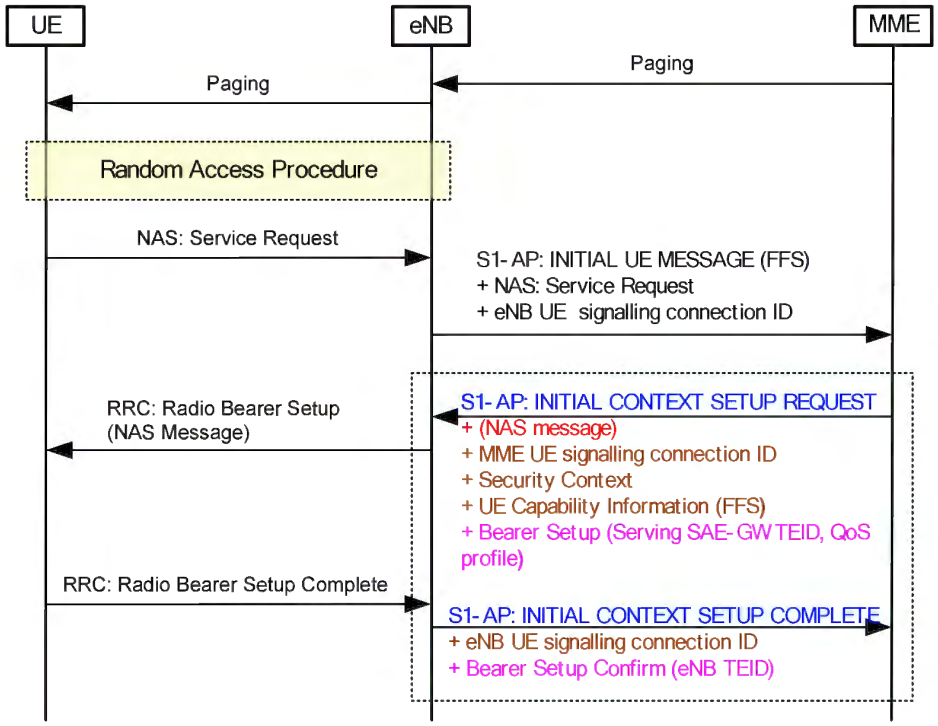


Figure 19.2.2.3-1: Initial Context Setup procedure (highlighted in blue) in Idle-to-Active procedure

19.2.2.3a UE Context Modification procedure

The UE Context Modification procedure enables the MME to modify the UE context in the eNB for UEs in active state. The UE Context Modification procedure is initiated by the MME.

The UE Context Modification procedure comprises the following steps:

- The MME initiates the UE Context Modification procedure by sending UE CONTEXT MODIFICATION REQUEST to the eNB to modify the UE context in the eNB for UEs in active state.
- The eNB responds with UE CONTEXT MODIFICATION RESPONSE to inform a successful operation, and with UE CONTEXT MODIFICATION FAILURE to inform an unsuccessful operation.

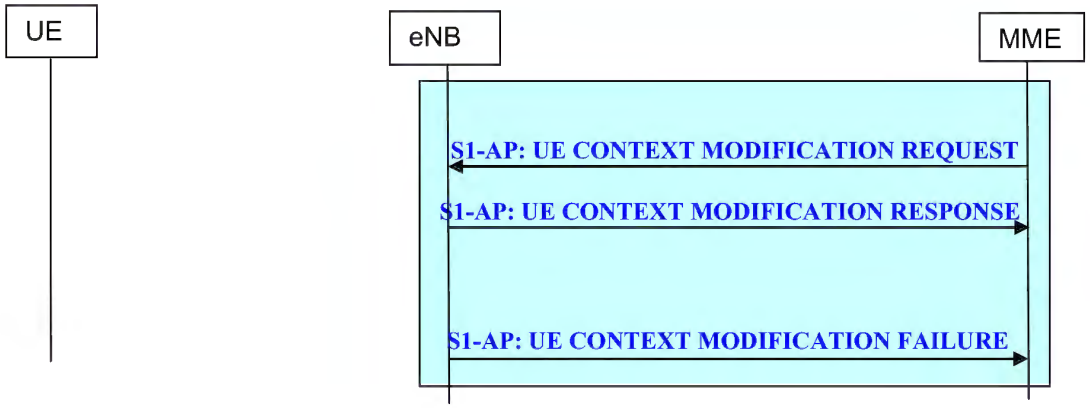


Figure 19.2.2.3a-1: UE Context Modification procedure

19.2.2.4 E-RAB signalling procedures

19.2.2.4.1 E-RAB Setup procedure

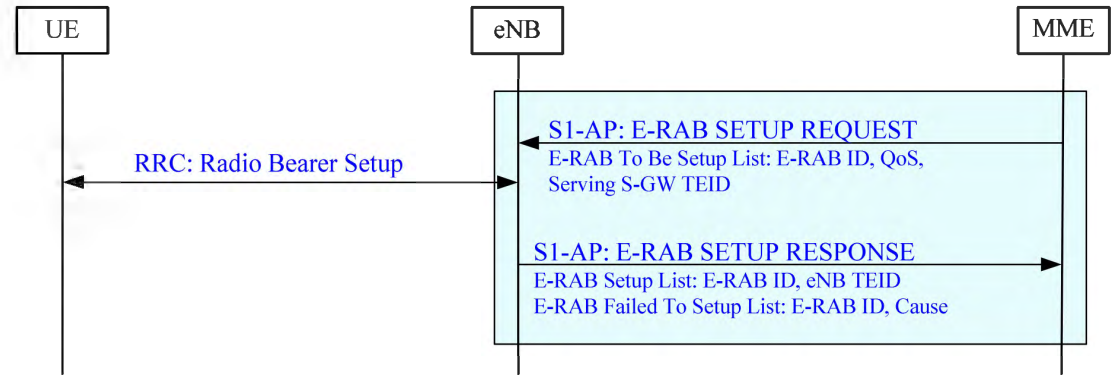


Figure 19.2.2.4.1-1: E-RAB Setup procedure

The E-RAB Setup procedure is initiated by the MME to support:

- Assignment of resources to a dedicated E-RAB.
- Assignment of resources for a default E-RAB.
- Setup of S1 Bearer (on S1) and Data Radio Bearer (on Uu).

The E-RAB Setup procedure comprises the following steps:

- The E-RAB SETUP REQUEST message is sent by the MME to the eNB to setup resources on S1 and Uu for one or several E-RAB(s). The E-RAB SETUP REQUEST message contains the Serving GW TEID, QoS indicator(s) and the corresponding NAS message per E-RAB within the E-RAB To Be Setup List. When there are multiple NAS messages in the E-RAB SETUP REQUEST message, the MME shall ensure that the NAS messages in the E-RAB to be Setup List are aligned in the order of reception from the NAS layer to ensure the in-sequence delivery of the NAS messages.
- Upon receipt of the E-RAB SETUP REQUEST message the eNB establishes the Data Radio Bearer(s) (RRC: Radio Bearer Setup) and resources for S1 Bearers. When there are multiple NAS messages to be sent in the RRC message, the order of the NAS messages in the RRC message shall be kept the same as that in the E-RAB SETUP REQUEST message.
- The eNB responds with a E-RAB SETUP RESPONSE messages to inform whether the setup of resources and establishment of each E-RAB was successful or unsuccessful, with the E-RAB Setup list (E-RAB ID , eNB TEID) and the E-RAB Failed to Setup list (E-RAB ID, Cause) The eNB also creates the binding between the S1 bearer(s) (DL/UL TEID) and the Data Radio Bearer(s).

Interactions with UE Context Release Request procedure:

In case of no response from the UE the eNB shall trigger the S1 UE Context Release Request procedure.

19.2.2.4.2 E-RAB Modification procedure

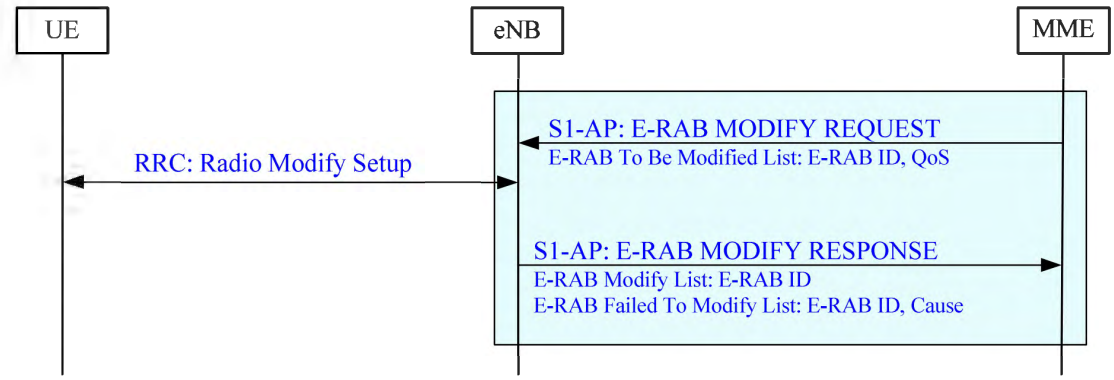


Figure 19.2.2.4.2-1: E-RAB Modification procedure

The E-RAB Modification procedure is initiated by the MME to support the modification of already established E-RAB configurations:

- Modify of S1 Bearer (on S1) and Radio Bearer (on Uu)

The EPS Bearer Modification procedure comprises the following steps:

- The E-RAB MODIFY REQUEST message is sent by the MME to the eNB to modify one or several E-RAB(s). The E-RAB MODIFY REQUEST message contains the QoS indicator(s), and the corresponding NAS message per E-RAB in the E-RAB To Be Modified List. When there are multiple NAS messages in the E-RAB MODIFY REQUEST message, the MME shall ensure that the NAS messages in the E-RAB to be Modified List are aligned in the order of reception from the NAS layer to ensure the in-sequence delivery of the NAS messages.

- Upon receipt of the E-RAB MODIFY REQUEST message the eNB modifies the Data Radio Bearer configuration (RRC procedure to modify the Data Radio bearer). When there are multiple NAS messages to be sent in the RRC message, the order of the NAS messages in the RRC message shall be kept the same as that in the E-RAB MODIFY REQUEST message.

- The eNB responds with an E-RAB MODIFY RESPONSE message to inform whether the E-RAB modification has succeeded or not indicating with the E-RAB Modify list and E-RAB Failed to Modify list. With E-RAB ID(s) in the E-RAB Modify List or E-RAB Failed to Modify List the eNB identifies the E-RAB(s) successfully modified or failed to modify.

Interactions with UE Context Release Request procedure:

In case of no response from the UE the eNB shall trigger the S1 UE Context Release Request procedure.

19.2.2.4.3 E-RAB Release procedure

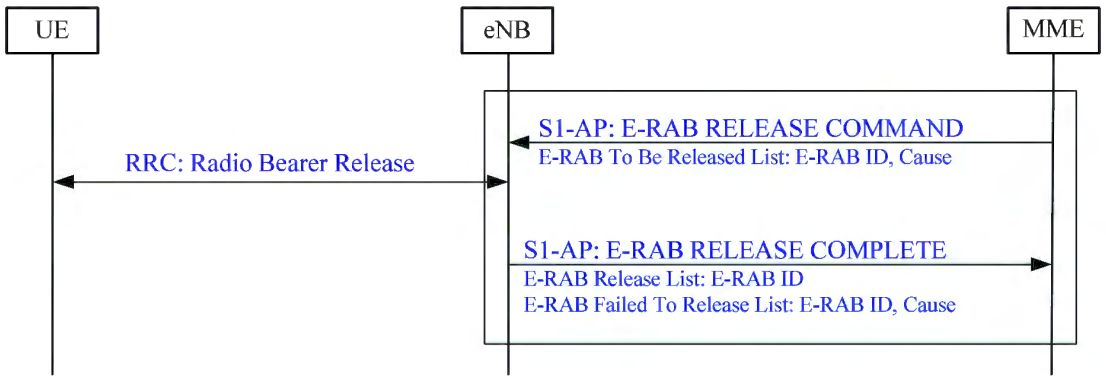


Figure 19.2.2.4.3-1: E-RAB Release procedure

The E-RAB Release procedure is initiated by the MME to release resources for the indicated E-RABs.

The E-RAB Release procedure comprises the following steps:

- The E-RAB RELEASE COMMAND message is sent by the MME to the eNB to release resources on S1 and Uu for one or several E-RAB(s). With the E-RAB ID(s) in the E-RAB To Be Released List contained in E-RAB RELEASE COMMAND message the MME identifies, the E-RAB(s) to be released.
- Upon receipt of the E-RAB RELEASE COMMAND message the eNB releases the Data Radio Bearers (RRC: Radio bearer release) and S1 Bearers.
- The eNB responds with an E-RAB RELEASE COMPLETE message containing E-RAB Release list and E-RAB Failed to Release list. With the E-RAB IDs in the E-RAB Release List/E-RAB Failed to Release List the eNB identifies the E-RAB(s) successfully released or failed to release.

Interactions with UE Context Release Request procedure:

In case of no response or negative response from the UE or in case the eNB cannot successfully perform the release of any of the requested bearers, the eNB shall trigger the S1 UE Context Release Request procedure, except if the eNB has already initiated the procedures associated with X2 Handover.

19.2.2.4.4 E-RAB Release Indication procedure

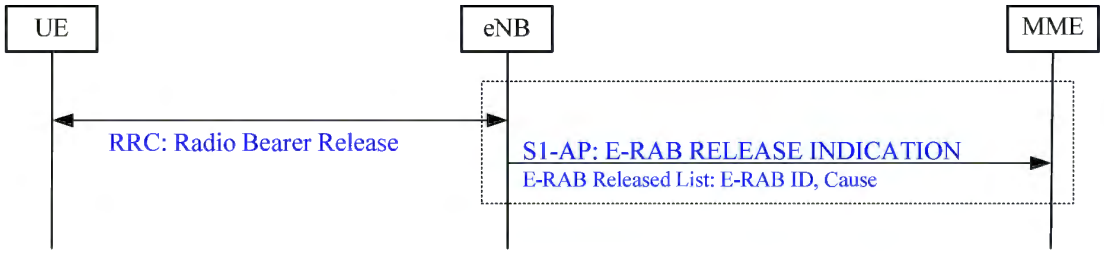


Figure 19.2.2.4.4-1: E-RAB Release Indication procedure

The E-RAB Release Indication procedure enables the E-UTRAN to send information about released resources for one or several E-RABs to the MME. The eNB initiates the procedure by sending the E-RAB RELEASE INDICATION message to the MME. The E-RAB ID(s) in the E-RAB Released List identifies the released E-RAB(s) in the eNB.

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19.2.2.5 Handover signalling procedures

Handover signalling procedures support both, inter-eNB handover and inter-RAT handover.

Inter-RAT handovers shall be initiated via the S1 interface.

Inter-eNB handovers shall be initiated via the X2 interface except if any of the following conditions are true:

- there is no X2 between source and target eNB.
- the source eNB has been configured to initiate handover to the particular target eNB via S1 interface in order to enable the change of an EPC node (MME and/or Serving GW).
- the source eNB has attempted to start the inter-eNB HO via X2 but receives a negative reply from the target eNB with a specific cause value.

Inter-eNB handovers shall be initiated via the S1 interface, if one of the above conditions applies.

19.2.2.5.1 Handover Preparation procedure

The Handover preparation procedure is initiated by the source eNB if it determines the necessity to initiate the handover via the S1 interface.

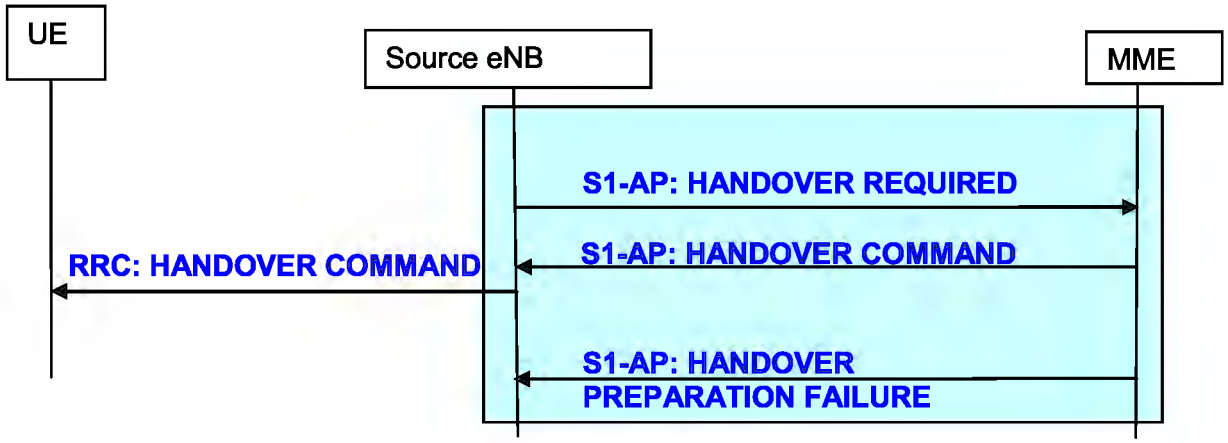


Figure 19.2.2.5.1-1: Handover preparation procedure

The handover preparation comprises the following steps:

- The HANDOVER REQUIRED message is sent to the MME.
- The handover preparation phase is finished upon the reception of the HANDOVER COMMAND message in the source eNB, which includes at least radio interface related information (HO Command for the UE), successfully established E-RAB(s) and E-RAB(s) which failed to setup.
- In case the handover resource allocation is not successful (e.g. no resources are available on the target side) the MME responds with the HANDOVER PREPARATION FAILURE message instead of the HANDOVER COMMAND message.

19.2.2.5.2 Handover Resource Allocation procedure

The handover resource allocation comprises the following steps:

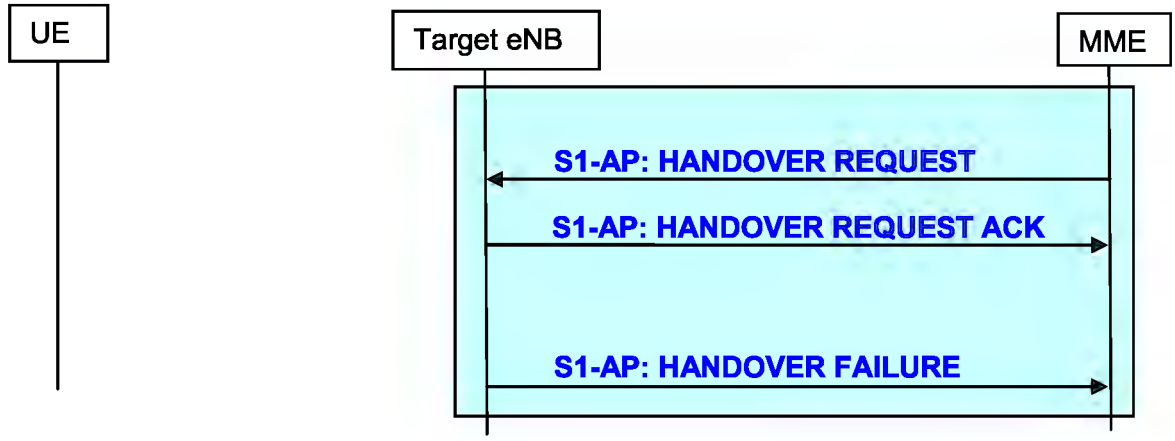


Figure 19.2.2.5.2-1: Handover resource allocation procedure

- The MME sends the HANDOVER REQUEST message including the E-RAB(s) which needs to be setup by the target eNB.
- The target eNB responds with the HANDOVER REQUEST ACK message after the required resources for all accepted E-RABs are allocated. The HANDOVER REQUEST ACK message contains successfully established E-RAB(s), E-RAB(s) which failed to setup and radio interface related information (HO Command for the UE), which is later sent transparently via the EPC/CN from the target RAT to the source RAT.

  If no resources are available on the target side, the target eNB responds with the HANDOVER FAILURE message instead of the HANDOVER REQUEST ACK message.

19.2.2.5.3 Handover Notification procedure

The Handover Completion for S1 initiated handovers comprises the following steps:

- The HANDOVER NOTIFY message is sent by the target eNB to the MME when the UE has successfully been transferred to the target cell.

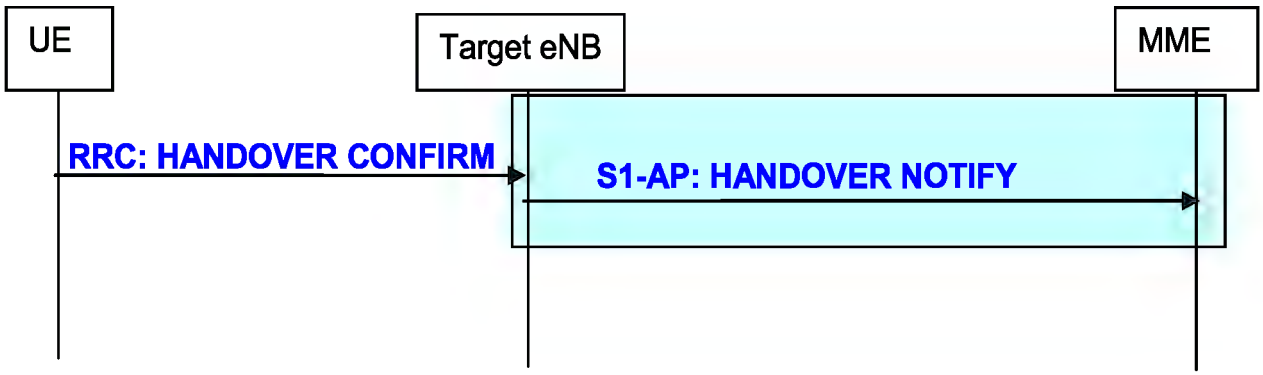


Figure 19.2.2.5.3-1: Handover completion procedure

19.2.2.5.4 Handover Cancellation

This functionality is located in the source eNB to allow a final decision regarding the outcome of the handover, i.e. either to proceed or to cancel the handover procedure.

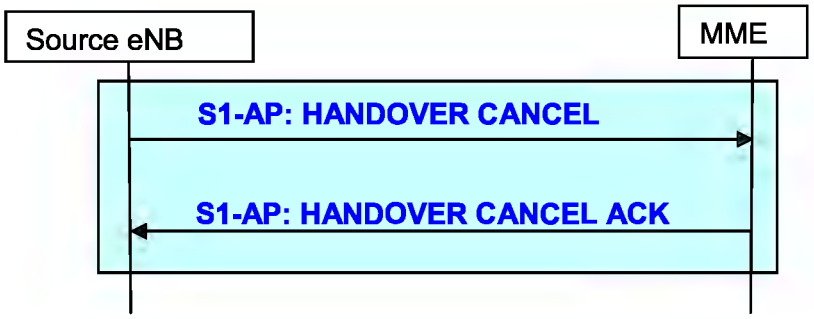


Figure 19.2.2.5.4-1: Handover cancellation procedure

- The source eNB sends a HANDOVER CANCEL message to the MME indicating the reason for the handover cancellation.
- The MME confirms the reception of the HANDOVER CANCEL message by returning the HANDOVER CANCEL ACK message.

19.2.2.5.5 Path Switch procedure

The handover completion phase for X2 initiated handovers comprises the following steps:

- The PATH SWITCH message is sent by the target eNB to the MME when the UE has successfully been transferred to the target cell. The PATH SWITCH message includes the outcome of the resource allocation: successfully established E-RAB(s).
- The MME responds with the PATH SWITCH ACK message which is sent to the eNB.
- The MME responds with the PATH SWITCH FAILURE message in case a failure occurs in the EPC.

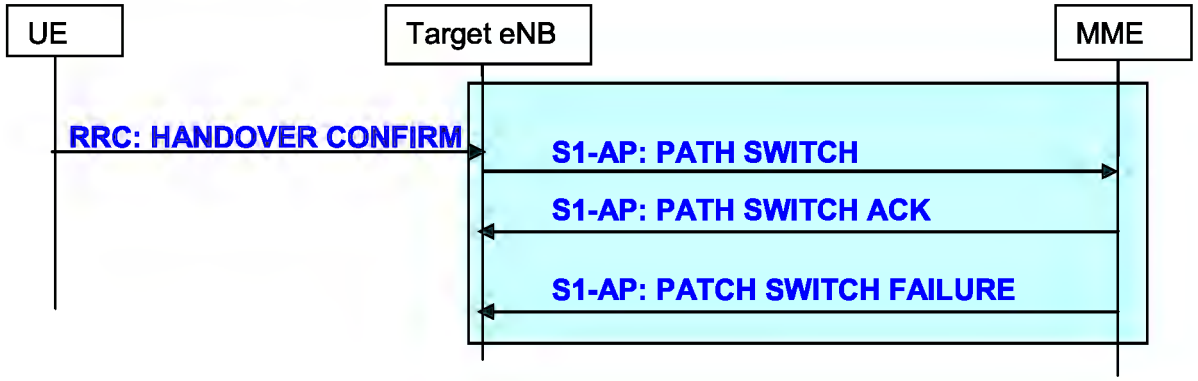


Figure 19.2.2.5.5-1: Path Switch procedure

19.2.2.5.6 Message sequence diagrams

This subclause complements TR 25.922 [27] subclause 5.1.7.2 regarding the E-UTRAN handling of containers.

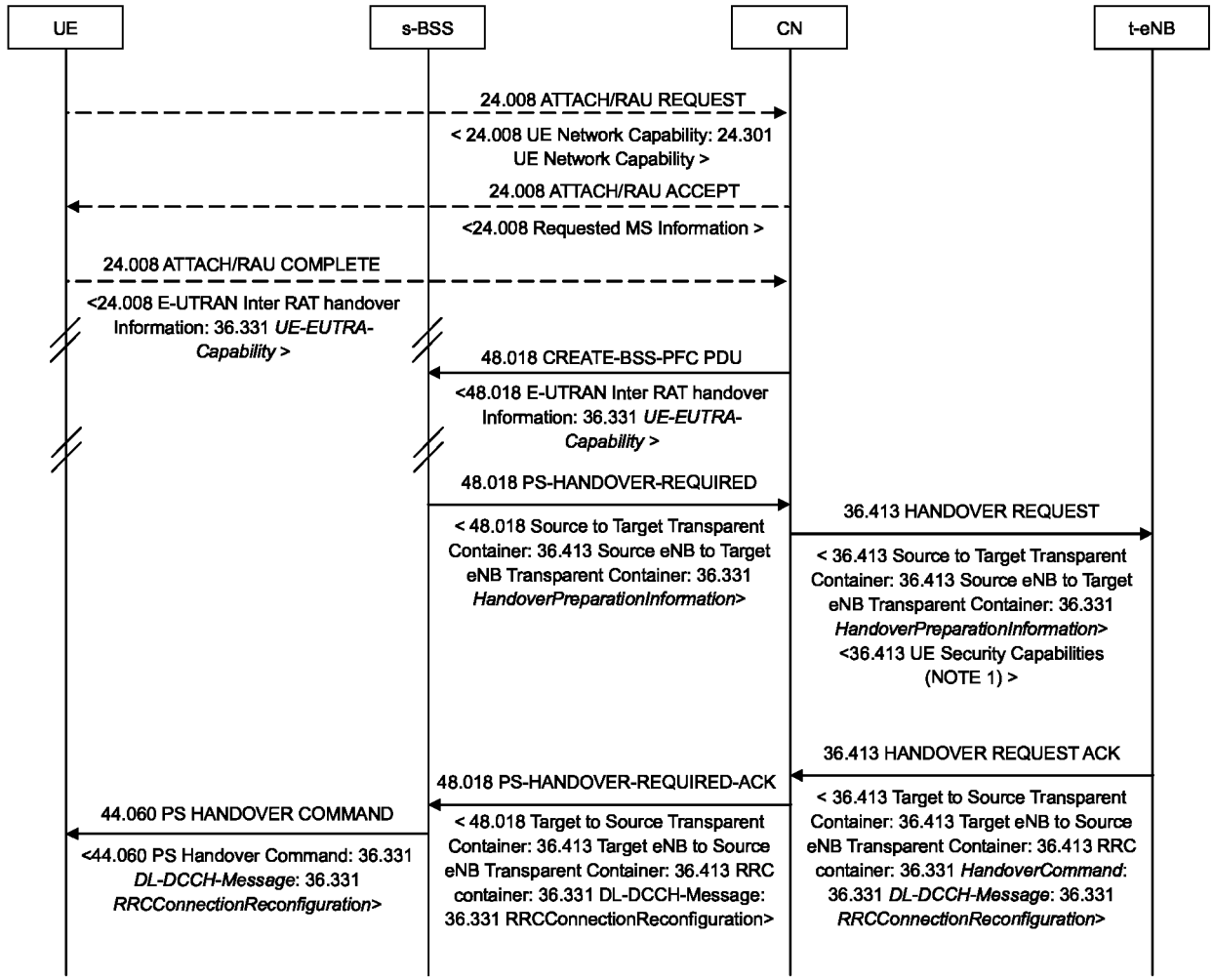
Most RRC information is carried by means of containers across interfaces other than Uu. The following sequence diagrams illustrate which RRC information should be included within these containers used across the different network interfaces.

NOTE: In order to maintain independence between protocols, no requirements are included in the interface protocols that are used to transfer the RRC information.

In Rel-8 SRVCC (see TS 23.216 [28]) is supported from EUTRAN to UTRAN or GERAN A/Gb mode, but not in the other direction.

There is no support for interworking between EUTRAN and GERAN Iu-mode and between EUTRAN and GAN.

Figure 19.2.2.5.6-1 illustrates the message sequence for the PS handover from GERAN to EUTRAN procedure:

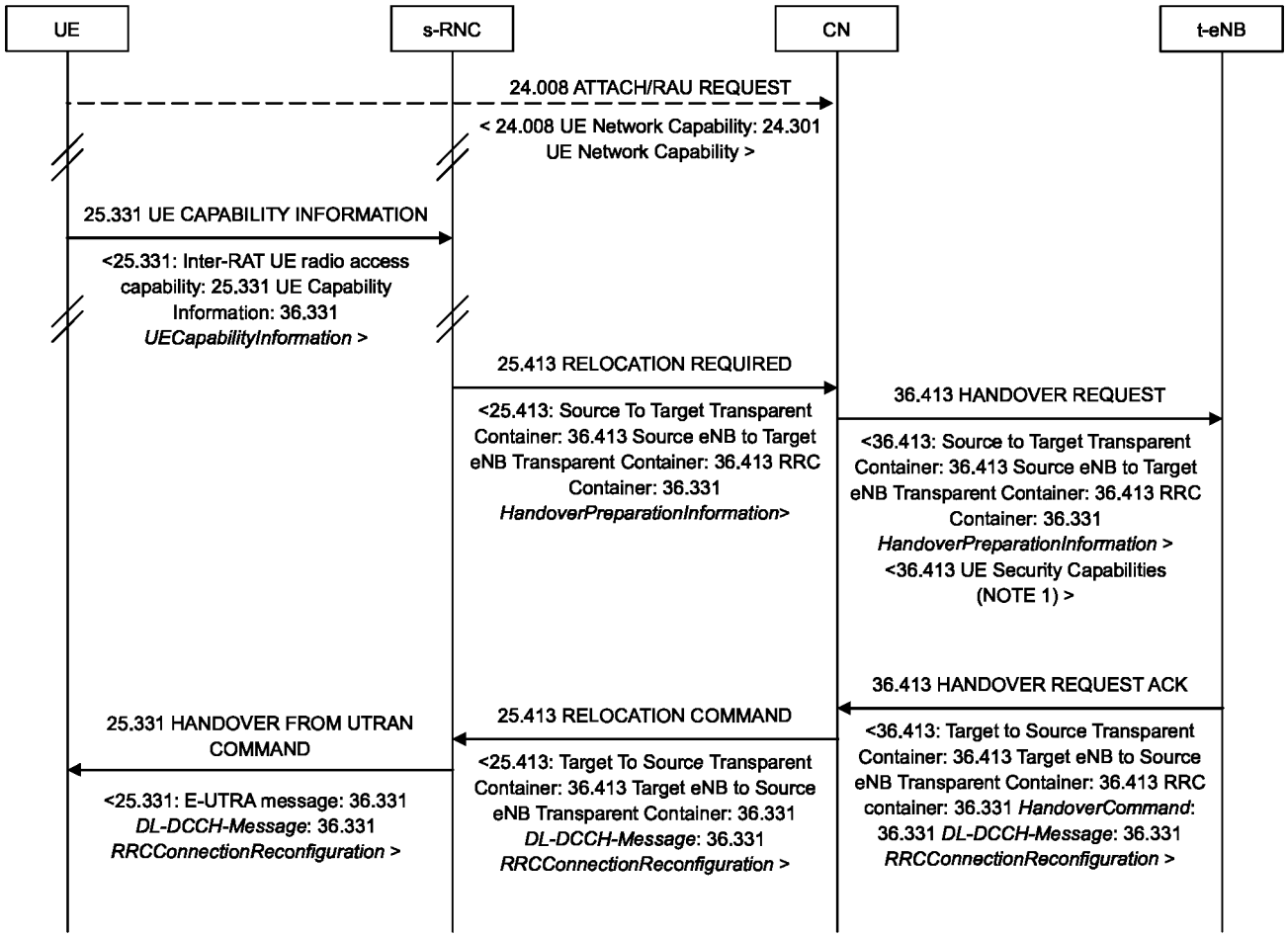


NOTE 1: The information included in this IE is derived from the information provided in the "UE Network Capability" IE during network attach / RAU

Figure 19.2.2.5.6-1. Handover of PS domain service from GERAN A/Gb mode to EUTRAN, normal flow

The first two signalling arrows indicate how capability information, which is needed by the target eNB, is provided by NAS.

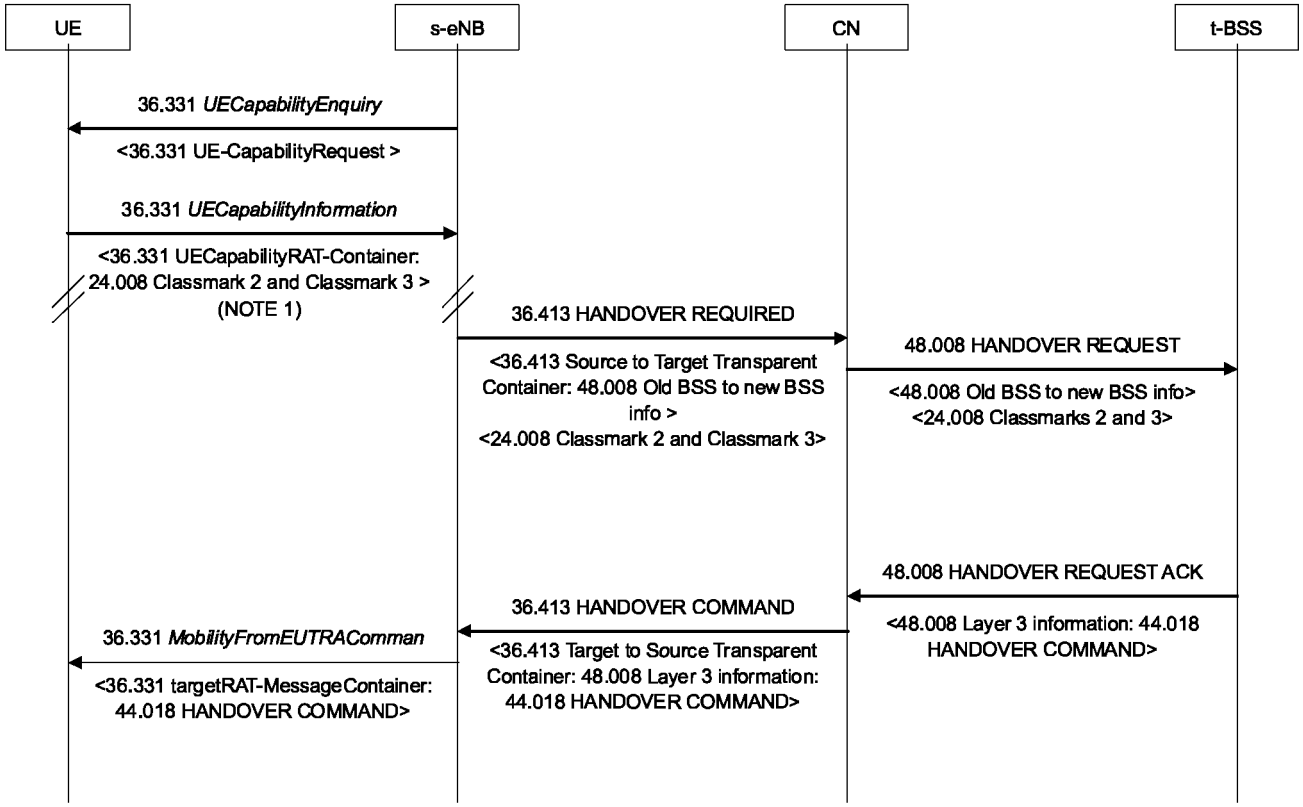
Figure 19.2.2.5.6-2 illustrates the message sequence for the PS handover from UTRAN to EUTRAN procedure:



NOTE 1: The information included in this IE is derived from the information provided in the "UE Network Capability" IE during network attach / RAU

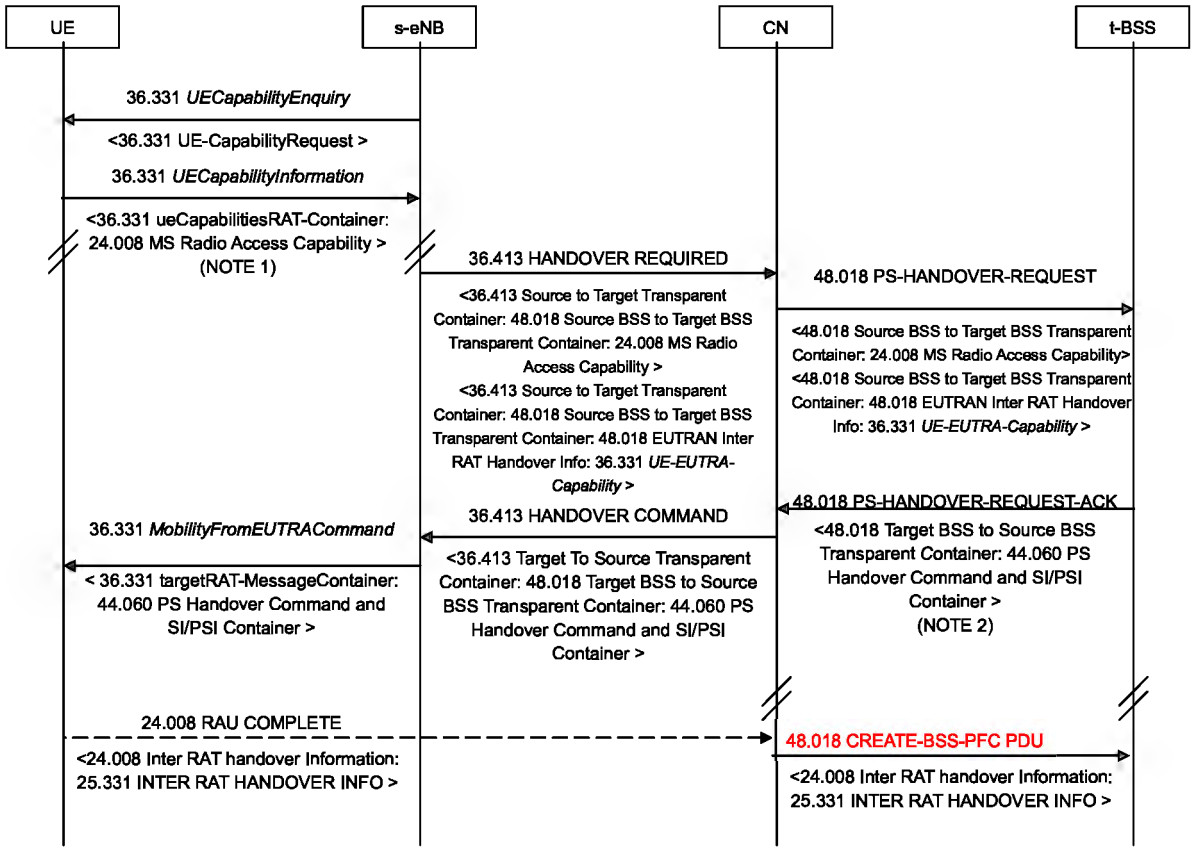
Figure 19.2.2.5.6-2: Handover of PS domain service from UTRAN to EUTRAN, normal flow

Figure 19.2.2.5.6-3 to Figure 19.2.2.5.6-5 illustrate the message sequence for the handover from EUTRAN to GERAN A/Gb mode procedure:



NOTE 1: the GERAN capabilities can be stored by the MME at an earlier opportunity, as shown in Figure 18-1, and transferred to the eNB at connection setup.

Figure 19.2.2.5.6-3: Handover of CS domain service from EUTRAN to GERAN A/Gb mode, normal flow

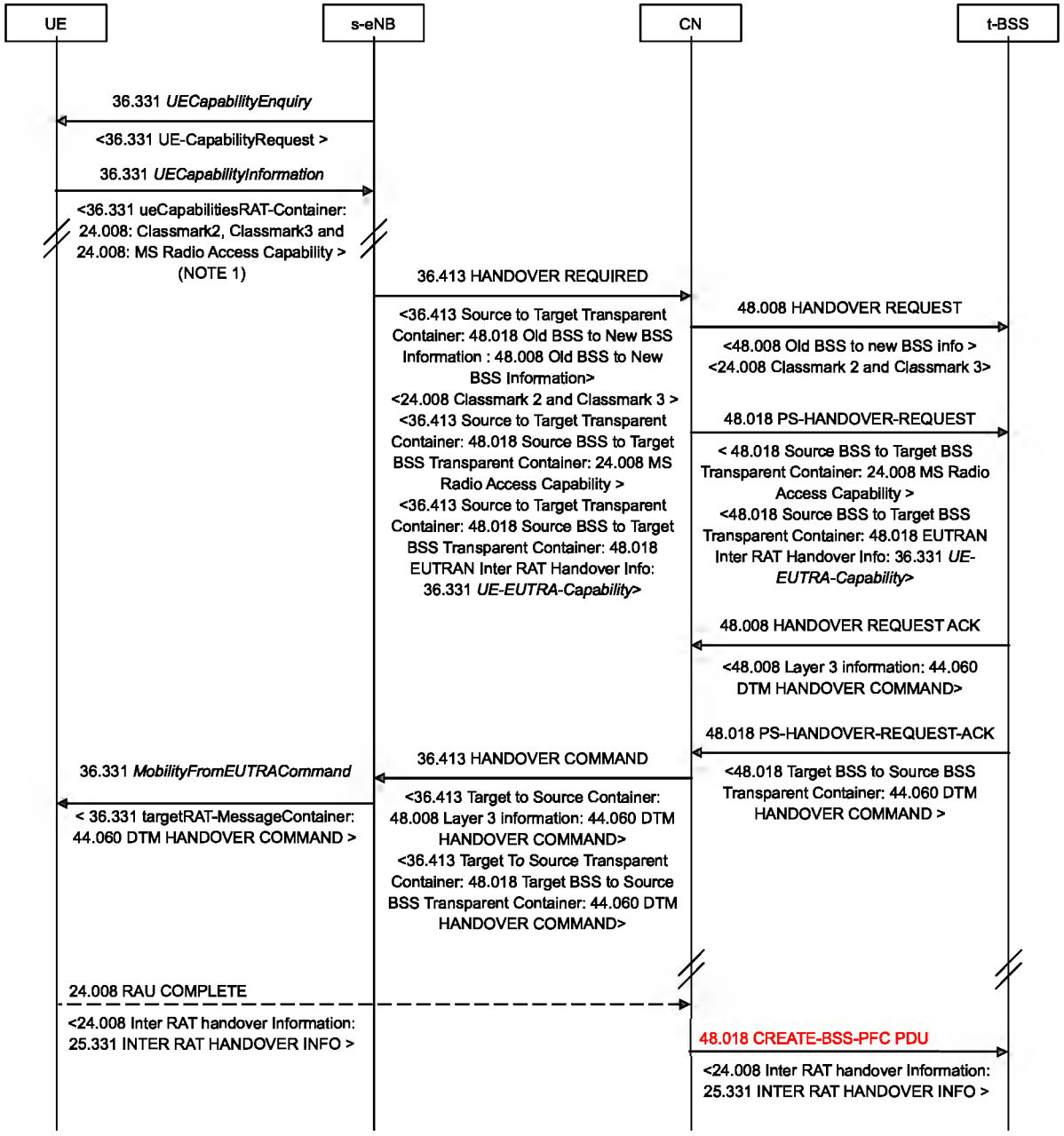


NOTE 1: the GERAN capabilities can be stored by the MME at an earlier opportunity, as shown in Figure 18-1, and transferred to the eNB at connection setup.
NOTE 2: the inclusion of GERAN SI/PSI is dependent on the PS Handover Indication in the Source BSS to Target BSS Transparent Container in the HANDOVER REQUIRED message.

Figure 19.2.2.5.6-4. Handover of PS domain service from EUTRAN to GERAN A/Gb mode, normal flow

Editor"s note: TSG GERAN has not decided if inclusion of *UE-EUTRA-Capability* shall be mandated. If that will be the case, then it will be captured in 43.129.

Editor"s note: TSG GERAN has not decided if CREATE-BSS-PFC or another message will be used.



NOTE 1: the GERAN capabilities can be stored by the MME at an earlier opportunity, as shown in Figure 18-1, and transferred to the eNB at connection setup.
NOTE 2: the 36.413 HANDOVER COMMAND includes two identical copies of the 44.060 DTM HANDOVER COMMAND message i.e. the eNB can forward either of the two

Figure 19.2.2.5.6-5: Handover of CS and PS domain services from EUTRAN to GERAN A/Gb mode, normal flow

Figure 19.2.2.5.6-6 and Figure 19.2.2.5.6-7 illustrate the message sequence for the handover from EUTRAN to UTRAN procedure:

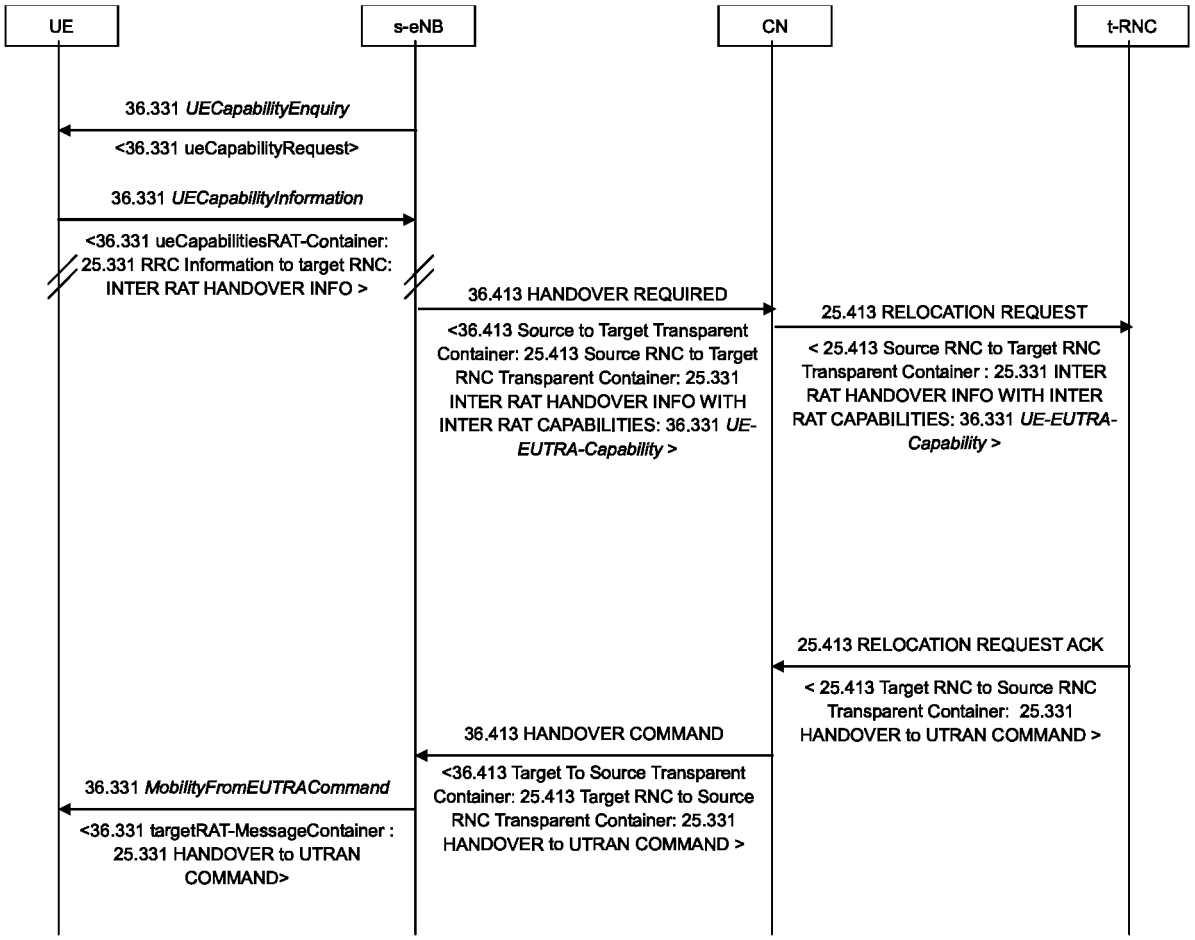


Figure 19.2.2.5.6-6. Handover of PS or CS domain service from EUTRAN to UTRAN, normal flow

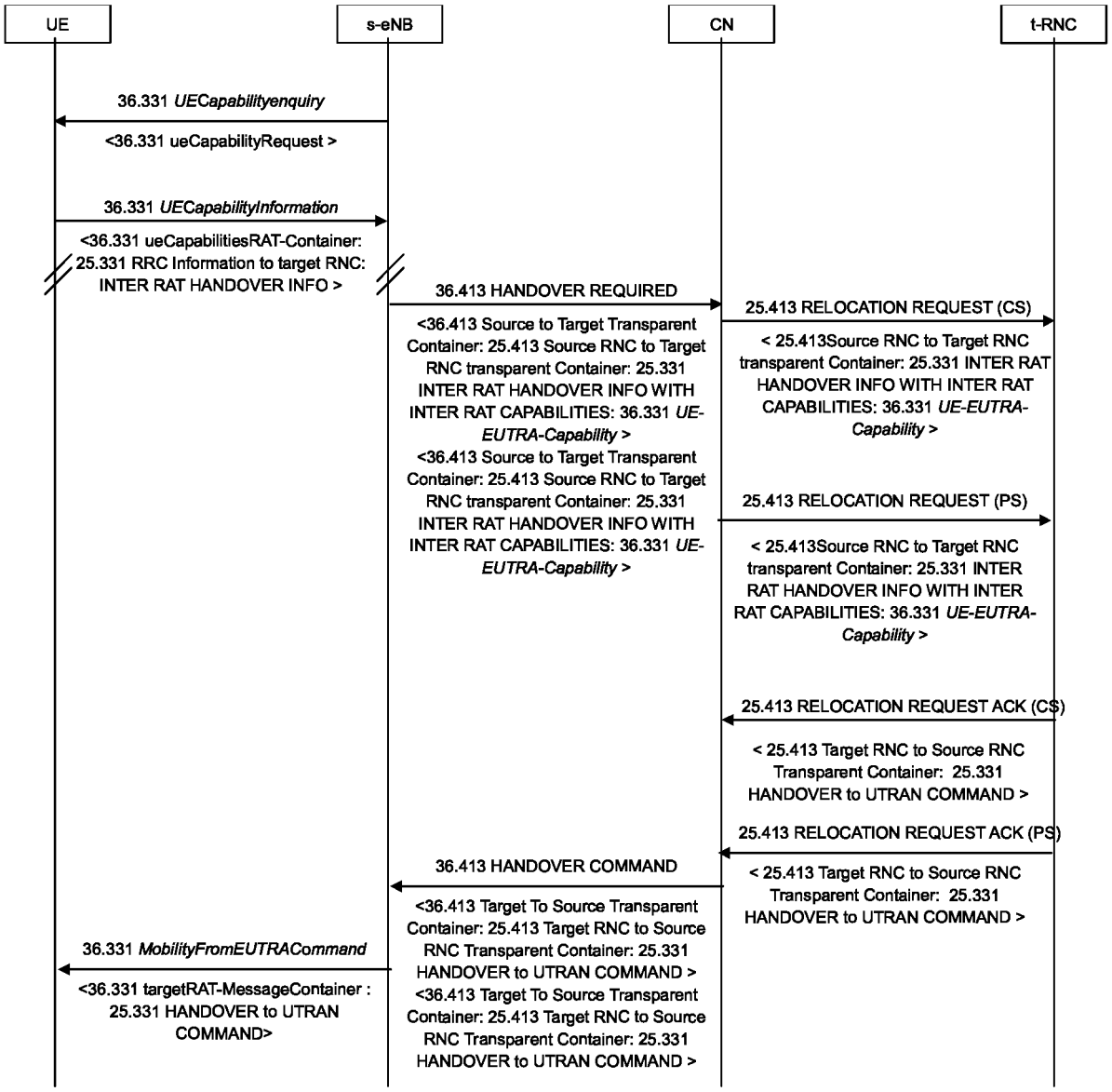


Figure 19.2.2.5.6-7. Handover of PS and CS domain service from EUTRAN to UTRAN, normal flow

19.2.2.6 NAS transport procedures

A NAS signalling message is transferred on the S1 interface in both directions. The procedures providing this functionality are

- Initial UE Message procedure (eNB initiated)
- Uplink NAS transport procedure (eNB initiated)
- Downlink NAS transport procedure (MME initiated)
- Downlink NAS non delivery indication procedure

i) Initial UE Message procedure

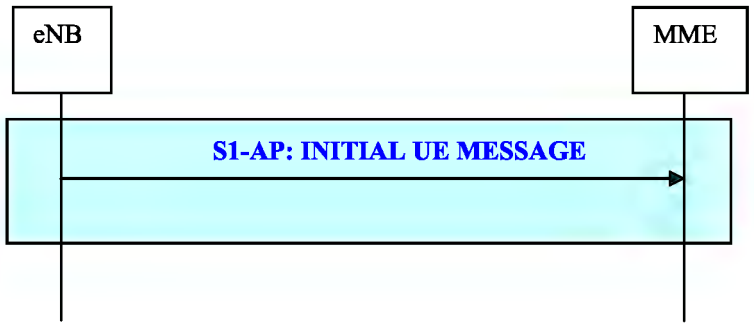


Figure 19.2.2.6-1: Initial UE Message procedure

- The INITIAL UE MESSAGE procedure is initiated by the eNB by sending the INITIAL UE MESSAGE message to the MME. The INITIAL UE MESSAGE contains a NAS message (e.g. Service Request), the UE signalling reference ID and other S1 addressing information.

ii) NAS Transport procedure (eNB initiated).

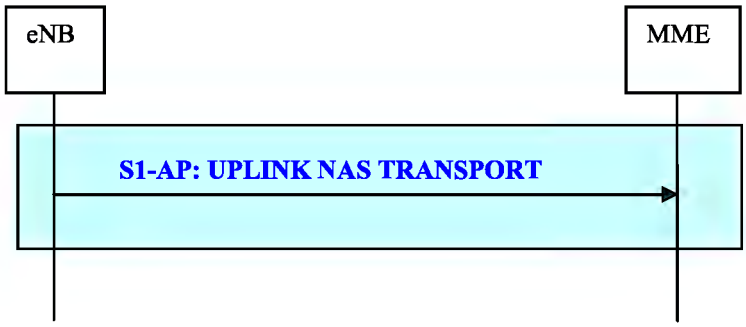


Figure 19.2.2.6-2: Uplink NAS Transport procedure

- The Uplink NAS Transport procedure is initiated by the eNB by sending the UPLINK NAS TRANSPORT message to the MME. The UPLINK NAS TRANSPORT message contains a NAS message, UE identification and other S1 related addressing information.

iii) NAS Transport procedure (MME initiated)

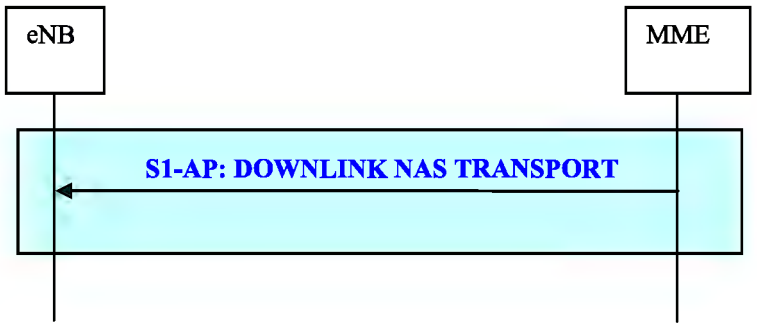


Figure 19.2.2.6-3: Downlink NAS Transport procedure

- The Downlink NAS Transport procedure is initiated by the MME by sending the DOWNLINK NAS TRANSPORT message to the eNB. The DOWNLINK NAS TRANSPORT contains a NAS message, UE identification and other S1 related addressing information.

iv) Downlink NAS non delivery procedure



Figure 19.2.2.6-4: Downlink NAS Non Delivery Indication procedure

- When the eNB decides to not start the delivery of a NAS message that has been received from MME, it shall report the non-delivery of this NAS message by sending a DOWNLINK NAS NON DELIVERY INDICATION message to the MME including the non-delivered NAS message and an appropriate cause value.

19.2.2.7 S1 interface Management procedures

19.2.2.7.1 Reset procedure

The purpose of the Reset procedure is to initialize the peer entity after node setup and after a failure event occurred. This procedure is initiated by both the eNB and MME.

19.2.2.7.1a eNB initiated Reset procedure

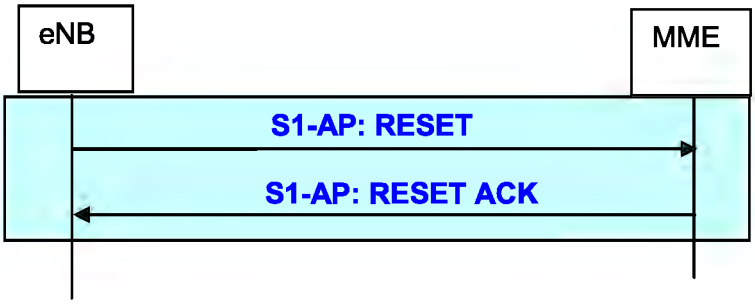


Figure 19.2.2.7.1a-1: eNB initiated Reset procedure

- The eNB triggers the RESET message to indicate that an initialisation in the MME is required. The MME releases the corresponding references and resources.
- Afterwards the MME sends the RESET ACK message to confirm that the resources and references are cleared.

19.2.2.7.1b MME initiated Reset procedure

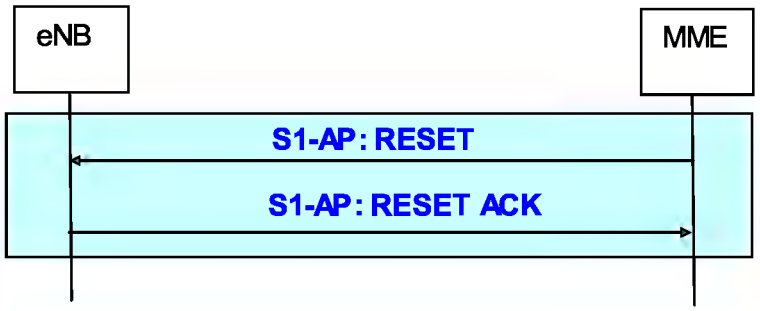


Figure 19.2.2.7.1b-1: MME initiated Reset procedure

- The MME triggers the RESET message to indicate that an initialisation in the eNB is required. The eNB releases the corresponding references and resources.
- Afterwards the eNB sends the RESET ACK message to confirm that the resources and references are cleared.

19.2.2.7.2 Error Indication functions and procedures

The Error Indication procedure is initiated by the eNB and the MME, to report detected errors in one incoming message, if an appropriate failure message cannot be reported to the sending entity.

19.2.2.7.2a eNB initiated error indication

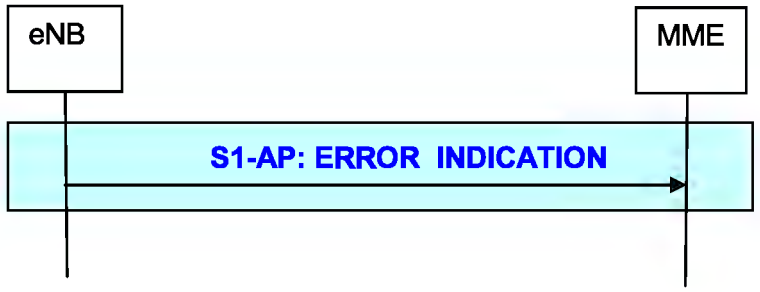


Figure 19.2.2.7.2a-1: eNB initiated Error Indication procedure

- The eNB sends the ERROR INDICATION message to report the peer entity which kind of error occurs.

19.2.2.7.2b MME initiated error indication

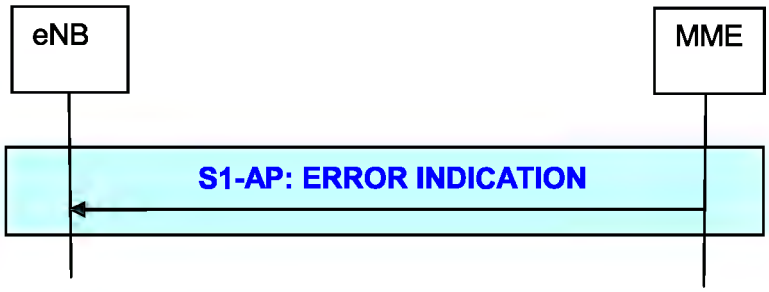


Figure 19.2.2.7.2b-1: MME initiated Error Indication procedure

- The MME sends the ERROR INDICATION message to report the peer entity which kind of error occurs.

19.2.2.8 S1 Setup procedure

The S1 Setup procedure is used to exchange configured data which is required in the MME and in the eNB respectively to ensure a proper interoperation. The S1 Setup procedure is triggered by the eNB. The S1 Setup procedure is the first S1AP procedure which will be executed.

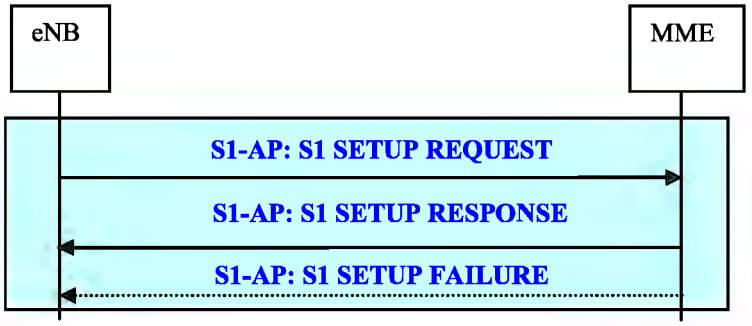


Figure 19.2.2.8-1: S1 Setup procedure

- The eNB initiates the S1 Setup procedure by sending the S1 SETUP REQUEST message including supported TAs and broadcasted PLMNs to the MME.
- In the successful case the MME responds with the S1 SETUP RESPONSE message which includes served PLMNs as well as a relative MME capacity indicator to achieve load balanced MMEs in the pool area.
- If the MME cannot accept the S1 Setup Request the MME responds with the S1 SETUP FAILURE message indicating the reason of the denial. The MME optionally indicates in the S1 SETUP FAILURE message when the eNB is allowed to re-initiate the S1 Setup Request procedure towards the same MME again.

19.2.2.9 eNB Configuration Update procedure

The eNB Configuration Update procedure is used to provide updated configured data in eNB. The eNB Configuration Update procedure is triggered by the eNB.

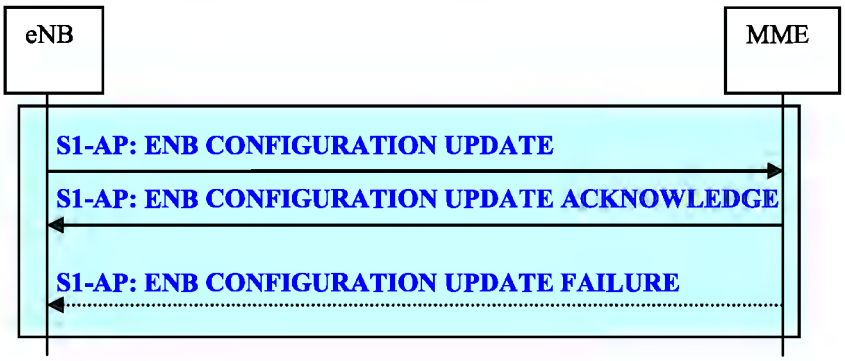


Figure 19.2.2.9-1: eNB Configuration Update procedure

- The eNB initiates the eNB Configuration Update procedure by sending the ENB CONFIGURATION UPDATE message including updated configured data like supported TAs and broadcasted PLMNs to the MME. In case one or more supported TA(s) needs to be updated, the eNB shall provide the whole list of TA(s), including those which has not been changed, in the ENB CONFIGURATION UPDATE message.
- The MME responds with the ENB CONFIGURATION UPDATE ACKNOWLEDGE message to acknowledge that the provided configuration data are successfully updated.
- The MME shall overwrite and store the received configuration data which are included in the ENB CONFIGURATION UPDATE message. Configuration data which has not been included in the ENB

CONFIGURATION UPDATE message are interpreted by the MME as still valid. For the provided TA(s) the MME shall overwrite the whole list of supported TA(s).

- In case the MME cannot accept the received configuration updates the MME shall respond with the ENB CONFIGURATION UPDATE FAILURE message including an appropriate cause value to indicate the reason of the denial. The MME optionally indicates in the ENB CONFIGURATION UPDATE FAILURE message when the eNB is allowed to re-initiate the eNB Configuration Update procedure towards the same MME again. For the unsuccessful update case the eNB and the MME shall continue with the existing configuration data.

19.2.2.9a eNB Configuration Transfer procedure

The eNB Configuration Transfer procedure is initiated by the eNB to request and/or transfer RAN configuration information via the core network.

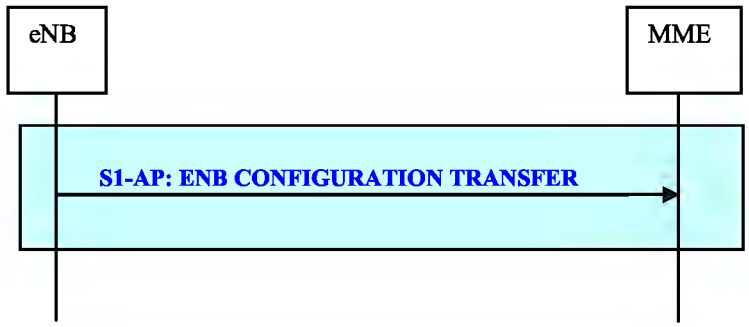


Figure 19.2.2.9a-1: eNB Configuration Transfer procedure

- The eNB Configuration Transfer procedure is initiated by the eNB by sending the eNB CONFIGURATION TRANSFER message to the MME. The eNB CONFIGURATION TRANSFER message contains RAN configuration information (e.g. SON information) and other relevant information such as the routing address which identifies the final RAN destination node.

19.2.2.10 MME Configuration Update procedure

The MME Configuration Update procedure is used to provide updated configured data and changes of the relative MME capacity values in the MME. The MME Configuration Update procedure is triggered by the MME.

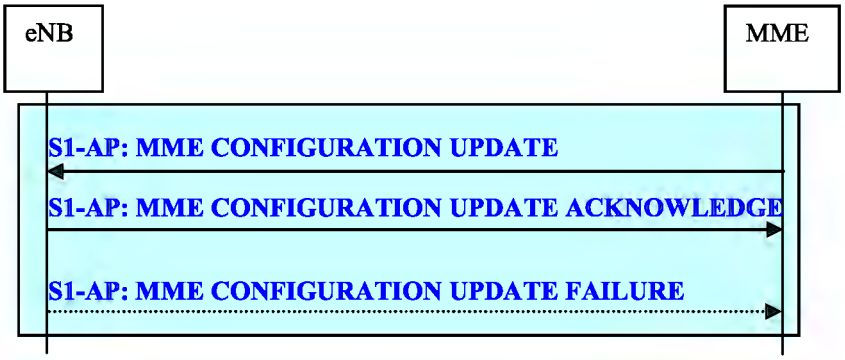


Figure 19.2.2.10-1: MME Configuration Update procedure

- The MME initiates the MME Configuration Update procedure by sending the MME CONFIGURATION UPDATE message including updated configured data like served PLMNs and changes of the relative MME capacity values to the eNB.

- The eNB responds with the MME CONFIGURATION UPDATE ACKNOWLEDGE message to acknowledge that the provided configuration data and the relative MME capacity values are successfully updated.
- The eNB shall overwrite and store the received configuration data and relative MME capacity values which are included in the MME CONFIGURATION UPDATE message. Configuration data which has not been included in the MME CONFIGURATION UPDATE message are interpreted by the eNB as still valid.
- In case the eNB cannot accept the received configuration updates the eNB shall respond with the MME CONFIGURATION UPDATE FAILURE message including an appropriate cause value to indicate the reason of the denial. The eNB optionally indicates in the MME CONFIGURATION UPDATE FAILURE message when the MME is allowed to re-initiate the MME Configuration Update procedure towards the same eNB again. For the unsuccessful update case the eNB and the MME shall continue with the existing configuration data and relative MME capacity values.

19.2.2.10a MME Configuration Transfer procedure

The MME Configuration Transfer procedure is initiated by the MME to request and/or transfer RAN configuration information to the eNB.

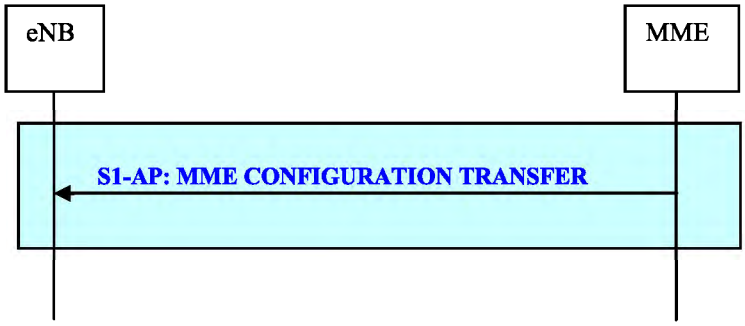


Figure 19.2.2.10a-1: MME Configuration Transfer procedure

- The MME Configuration Transfer procedure is initiated by the MME by sending the MME CONFIGURATION TRANSFER message to the eNB. The MME CONFIGURATION TRANSFER message contains RAN configuration information (e.g. SON information) and other relevant information.

19.2.2.11 Location Reporting procedures

The Location Reporting procedures provide the means to report the current location of a specific UE.

The procedures providing this function are:

- Location Reporting Control procedure
- Location Report procedure
- Location Report Failure Indication procedure

19.2.2.11.1 Location Reporting Control procedure

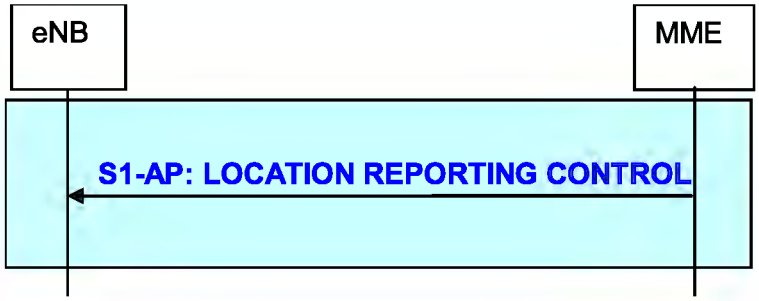


Figure 19.2.2.11.1-1: Location Reporting Control procedure

The Location Reporting Control procedure is initiated by the MME sending the LOCATION REPORTING CONTROL to the eNB to request the current location information, e.g. Cell ID, of a specific UE, and how the information shall be reported, e.g. direct report, report every cell change. The Location Reporting Control procedure is also used to terminate reporting on cell change.

If the Location Reporting Control procedure fails, e.g. due to an iteraction with an initiated hand over then the eNB shall indicate the failure using the Location Report Failure Indication procedure.

If the Location Reporting Control procedure is on going for a specific UE and the eNB received an UE CONTEXT RELEASE COMMAND message from MME this specific UE then the eNB shall terminate the on-going Location Reporting.

19.2.2.11.2 Location Report procedure

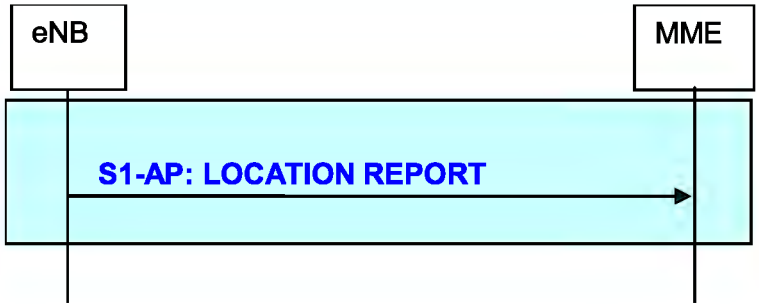


Figure 19.2.2.11.2-1: Location Report procedure

The Location Report procedure is initiated by the eNB by sending the LOCATION REPORT to the MME to report the current location information of a specific UE as a standalone report, or every time UE changes cell.

19.2.2.11.3 Location Report Failure Indication procedure

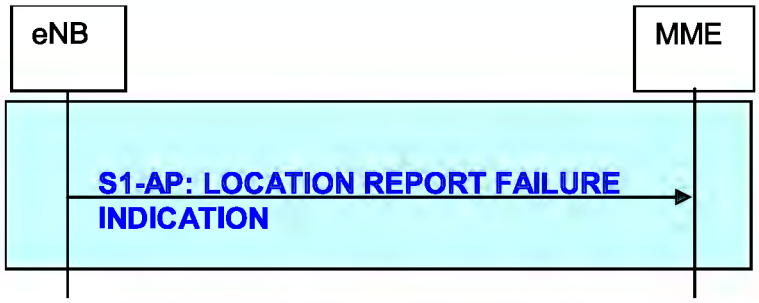


Figure 19.2.2.11.3-1: Location Report Failure Indication procedure

The Location Report Failure Indication procedure is initiated by the eNB by sending the LOCATION REPORT FAILURE INDICATION to the MME to indicate that the Location Report Control procedure has failed due to e.g. UE has performed inter-eNB handover.

19.2.2.12 Overload procedure

19.2.2.12.1 Overload Start procedure

The Overload Start procedure is used by the MME to indicate to a proportion of eNBs to which the MME has an S1 interface connection that the MME is overloaded. The Overload Start procedure is used to provide an indication which signalling traffic needs to be rejected/permitted only.

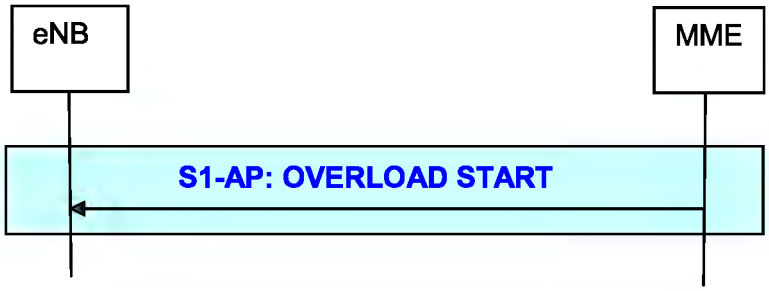


Figure 19.2.2.12.1-1 Overload Start procedure

If the Overload Start message is received whereas there is already an ongoing overload action, the eNB shall replace the ongoing overload action with the newly requested one.

19.2.2.12.2 Overload Stop procedure

The Overload Stop procedure is used by the MME to indicate the concerned eNB(s) that the MME is no longer overloaded.

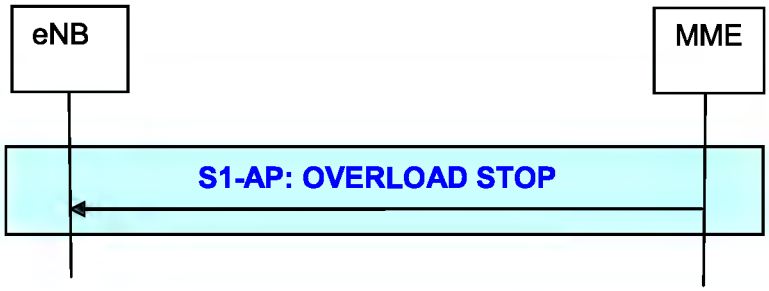


Figure 19.2.2.12.2-1: Overload Stop procedure

19.2.2.13 Write-Replace Warning procedure

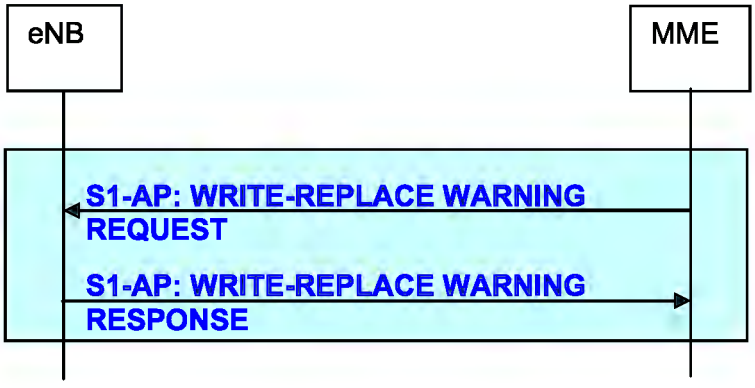


Figure 19.2.2.13.1-1: Write-Replace Warning procedure

The Write-Replace Warning procedure is used to start the broadcasting and to overwrite the ongoing broadcasting of a warning message.

ETWS is an example of warning system using this procedure.

This procedure is initiated by the MME by sending WRITE-REPLACE WARNING REQUEST message containing at least the Message Identifier, Emergency Area list, information on how the broadcast should be performed, and the contents of the warning message to be broadcast.

The eNB responds with WRITE-REPLACE WARNING RESPONSE message to acknowledge that the requested ETWS message broadcast was initiated.

19.2.2.14 eNB Direct Information Transfer procedure

The eNB Direct Information Transfer procedure is initiated by the eNB to request and transfer information to the core network.

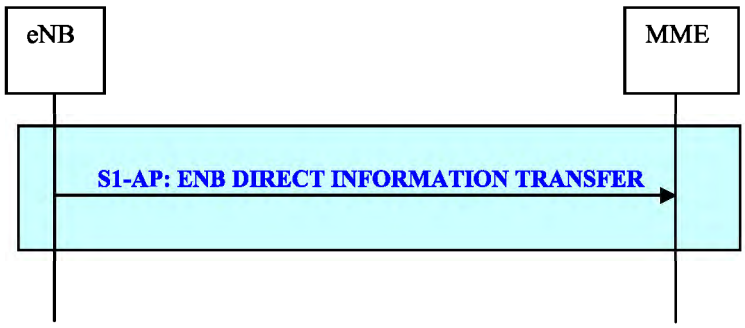


Figure 19.2.2.14-1: eNB Direct Information Transfer procedure

- The eNB Direct Information Transfer procedure is initiated by the eNB by sending the eNB DIRECT INFORMATION TRANSFER message to the MME. The eNB DIRECT INFORMATION TRANSFER message contains RIM information and RIM routing address which identifies the final RAN destination node.

19.2.2.15 MME Direct Information Transfer procedure

The MME Direct Information Transfer procedure is initiated by the MME to request and transfer information to the core network.

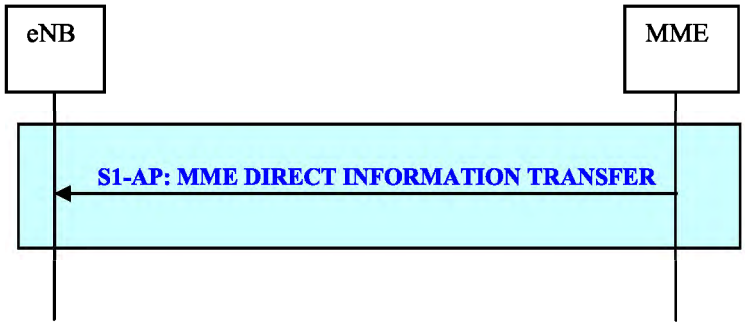


Figure 19.2.2.15-1: MME Direct Information Transfer procedure

- The MME Direct Information Transfer procedure is initiated by the MME by sending the MME DIRECT INFORMATION TRANSFER message to the eNB. The MME DIRECT INFORMATION TRANSFER message contains RIM information.

19.2.2.16 S1 CDMA2000 Tunnelling procedures

The S1 CDMA2000 Tunnelling procedures carry CDMA2000 signalling messages between UE and CDMA2000 RAT over the S1 Interface. This includes signalling for pre-registration and handover preparation for optimized mobility from E-UTRAN to CDMA2000 HRPD, signalling for handover preparation for mobility from E-UTRAN to CDMA2000 1xRTT and signalling to support CS fallback to CDMA2000 1xRTT for mobile originated and mobile terminated CS domain services. The CDMA2000 messages are tunnelled transparently to the eNB and MME, however, additional information may be sent along with the tunnelled CDMA2000 message to assist the eNodeB and MME in the Tunnelling procedure. The procedures providing this functionality are:

- Downlink S1 CDMA2000 Tunnelling procedure;
- Uplink S1 CDMA2000 Tunnelling procedure.

19.2.2.16.1 Downlink S1 CDMA2000 Tunnelling procedure

The MME sends the DOWNLINK S1 CDMA2000 TUNNELLING message to the eNB to forward a CDMA2000 message towards an UE for which a logical S1 connection exists (see Figure 19.2.2.16.1-1 below).



Figure 19.2.2.16.1-1: Downlink S1 CDMA2000 Tunnelling procedure

19.2.2.16.2 Uplink S1 CDMA2000 Tunnelling procedure

The eNB sends the UPLINK S1 CDMA2000 TUNNELLING message to the MME to forward a CDMA2000 message towards the CDMA2000 RAT (HRPD or 1xRTT) as depicted on Figure 19.2.2.16.2-1 below.

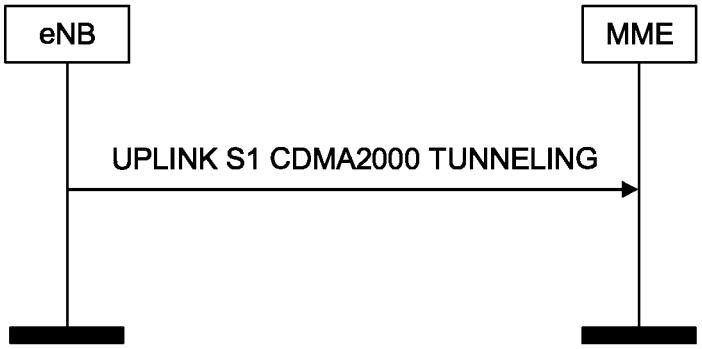


Figure 19.2.2.16.2-1: Uplink S1 CDMA2000 Tunnelling procedure

20 X2 Interface

20.1 User Plane

The X2 user plane interface (X2-U) is defined between eNBs. The X2-U interface provides non guaranteed delivery of user plane PDUs. The user plane protocol stack on the X2 interface is shown in Figure 20.1-1. The transport network layer is built on IP transport and GTP-U is used on top of UDP/IP to carry the user plane PDUs.

The X2-UP interface protocol stack is identical to the S1-UP protocol stack.

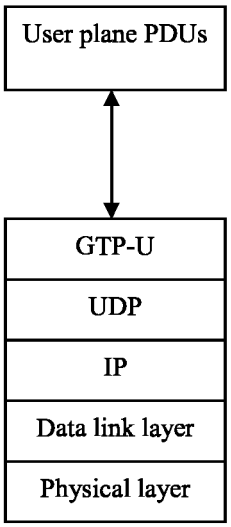


Figure 20.1-1: X2 Interface User Plane (eNB-eNB)

20.2 Control Plane

The X2 control plane interface (X2-CP) is defined between two neighbour eNBs. The control plane protocol stack of the X2 interface is shown on Figure 20.2-1 below. The transport network layer is built on SCTP on top of IP. The application layer signalling protocol is referred to as X2-AP (X2 Application Protocol).

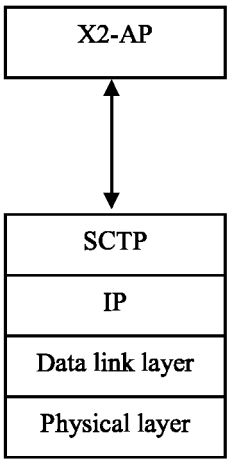


Figure 20.2-1: X2 Interface Control Plane

A single SCTP association per X2-C interface instance shall be used with one pair of stream identifiers for X2-C common procedures. Only a few pairs of stream identifiers should be used for X2-C dedicated procedures.

Source-eNB communication context identifiers that are assigned by the source-eNB for X2-C dedicated procedures, and target-eNB communication context identifiers that are assigned by the target-eNB for X2-C dedicated procedures, shall be used to distinguish UE specific X2-C signalling transport bearers. The communication context identifiers are conveyed in the respective X2AP messages.

20.2.1 X2-CP Functions

The X2AP protocol supports the following functions:

- Intra LTE-Access-System Mobility Support for UE in ECM-CONNECTED:
  - Context transfer from source eNB to target eNB;
  - Control of user plane tunnels between source eNB and target eNB;
  - Handover cancellation.
- Load Management;
- General X2 management and error handling functions:
  - Error indication;
  - Setting up the X2;
  - Resetting the X2;
  - Updating the X2 configuration data.

20.2.2 X2-CP Procedures

The elementary procedures supported by the X2AP protocol are listed in Table 20.2.2-1 below:

Table 20.2.2-1: X2-CP Procedures

Elementary Procedure	Initiating Message	Response Message of Successful Outcome	Response Message of Unsuccessful Outcome	Description & comments
Handover Preparation	HANDOVER REQUEST	HANDOVER REQUEST ACKNOWLEDGE	HANDOVER PREPARATION FAILURE	Used by source eNB to request a handover to the target eNB
Handover Cancellation	HANDOVER CANCEL			Used by the source eNB to cancel a previously requested handover in a target eNB
UE Context Release	UE CONTEXT RELEASE	-	-	Used by the target eNB to signal to source eNB that control plane resources for the handed over UE context can be released.
SN Status Transfer	SN STATUS TRANSFER	-	-	Used to manage forwarding of user plane data.
Error Indication	ERROR INDICATION	-	-	Used by the eNB to report errors in a received message provided they cannot be reported by an appropriate response message.
Load Indication	LOAD INFORMATION	-	-	Used by the eNB to report interference coordination information to its neighbour eNBs.
X2 Setup	X2 SETUP REQUEST	X2 SETUP RESPONSE	X2 SETUP FAILURE	Used to exchange necessary configuration data for the eNB to setup the X2 interface.
eNB Configuration Update	ENB CONFIGURATION UPDATE	ENB CONFIGURATION UPDATE ACKNOWLEDGE	ENB CONFIGURATION UPDATE FAILURE	Used to update necessary data concerning the configuration of the X2 interface.
Reset	RESET REQUEST	RESET RESPONSE	-	Used to completely reset the X2 interface.
Resource Status Reporting Initiation	RESOURCE STATUS REQUEST	RESOURCE STATUS RESPONSE	RESOURCE STATUS FAILURE	Used by the eNB to request load measurements from another eNB.
Resource Status Reporting	RESOURCE STATUS UPDATE	-	-	Used to report load information to another eNB.

20.2.2.1 Handover Preparation procedure

The Handover preparation procedure is initiated by the source eNB if it determines the necessity to initiate the handover via the X2 interface.

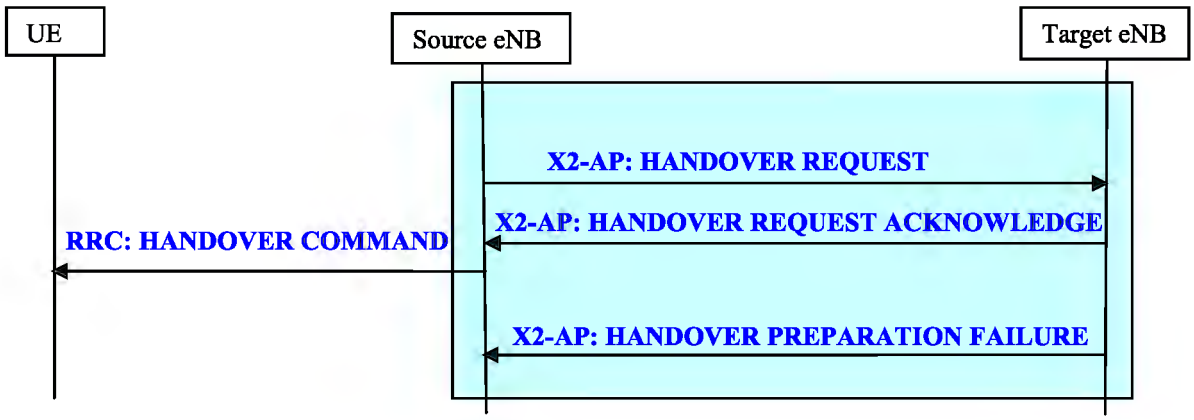


Figure 20.2.2.1-1: Handover Preparation procedure

The source eNB sends a HANDOVER REQUEST to the target eNB including the bearers to be setup by the target ENB.

The handover preparation phase is finished upon the reception of the HANDOVER REQUEST ACKNOWLEDGE message in the source eNB, which includes at least radio interface related information (HO Command for the UE), successfully established E-RAB(s) and failed established E-RAB(s).

In case the handover resource allocation is not successful (e.g. no resources are available on the target side) the target eNB responds with the HANDOVER PREPARATION FAILURE message instead of the HANDOVER REQUEST ACKNOWLEDGE message.

If eNB received NAS message from MME during X2 handover procedure, it shall be acted as specified in subclause 19.2.2.6.

20.2.2.2 Handover Cancel procedure

This functionality is located in the source eNB to allow cancellation of the handover procedure.

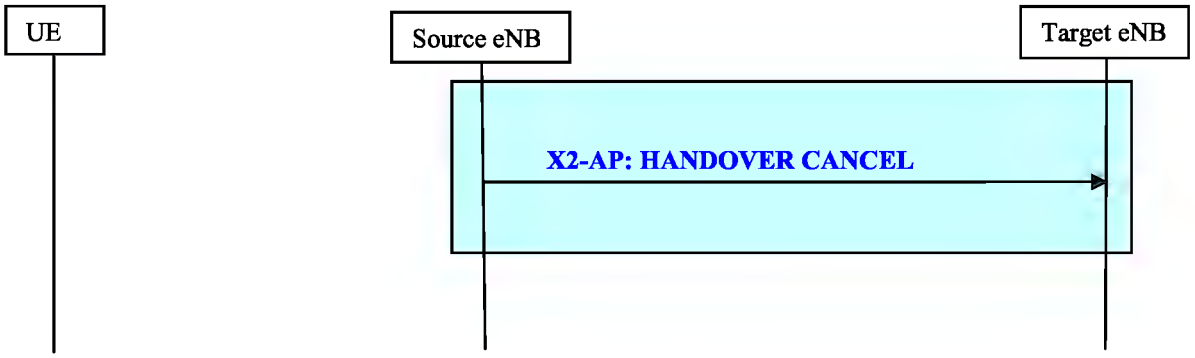


Figure 20.2.2.2-1: Handover Cancel procedure

The source eNB sends a HANDOVER CANCEL message to the target eNB indicating the reason for the handover cancellation.

20.2.2.3 UE Context Release procedure

The UE Context Release procedure is initiated by the target eNB to signal to the source eNB that resources for the handed over UE context can be released.

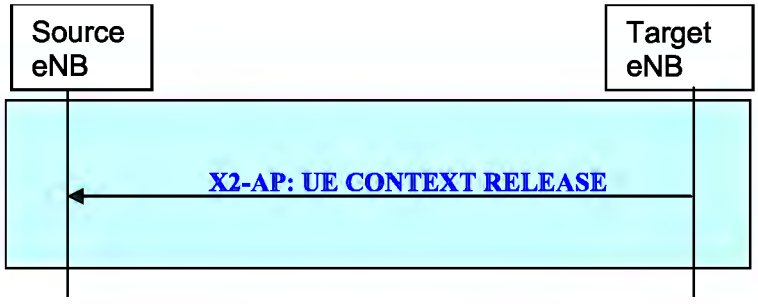


Figure 20.2.2.3-1: UE Context Release procedure

By sending UE CONTEXT RELEASE the target eNB informs the source eNB of Handover success and triggers the release of resources.

20.2.2.4 SN Status Transfer procedure

The purpose of the SN Status Transfer procedure is to transfer the uplink PDCP SN and HFN receiver status and the downlink PDCP SN and HFN transmitter status from the source to the target eNB during an X2 handover for each respective E-RAB for which PDCP SN and HFN status preservation applies.

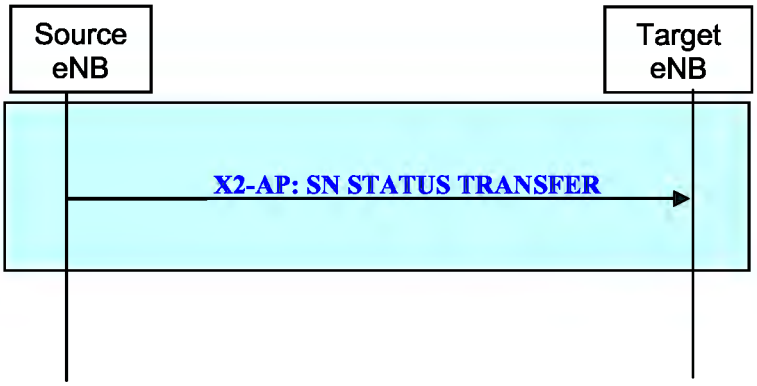


Figure 20.2.2.4-1: SN Status Transfer procedure

20.2.2.5 Error Indication procedure

The Error Indication procedure is initiated by an eNB to signal to a peer eNB an error situation in a received message, provided it cannot be reported by an appropriate failure message.

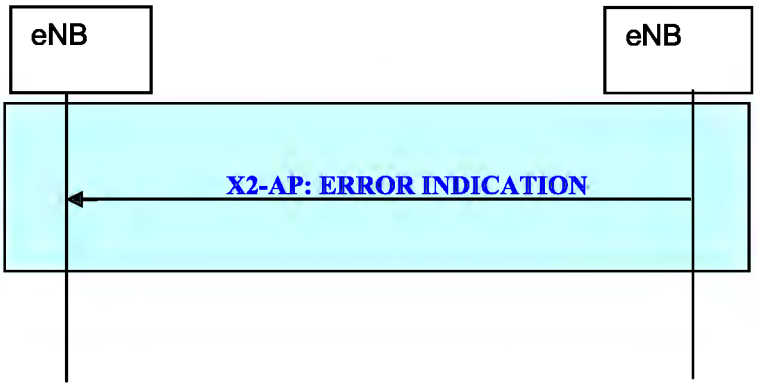


Figure 20.2.2.5-1: Error Indication procedure

20.2.2.6 Load Indication procedure

Inter-cell interference coordination in E-UTRAN is performed through the X2 interface. In case of variation in the interference conditions, the eNB signals the new lcondition to its neighbour eNBs e.g. the neighbour eNBs for which an X2 interface is configured due to mobility reasons.

The Load Indication procedure is used to transfer interference co-ordination information between neighboring eNBs managing intra-frequency cells.

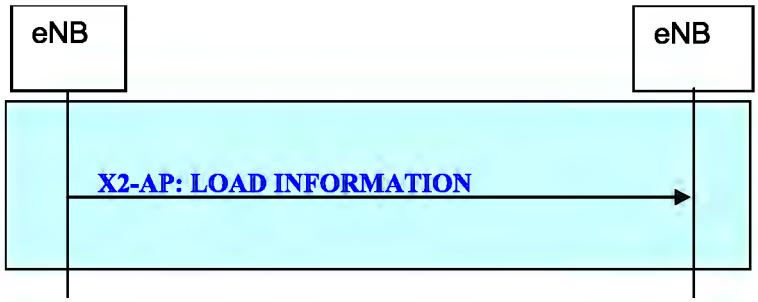


Figure 20.2.2.6-1: Load Indication procedure

20.2.2.7 X2 Setup procedure

The purpose of the X2 Setup procedure is to exchange application level data needed for two eNBs to interoperate correctly over the X2 interface.

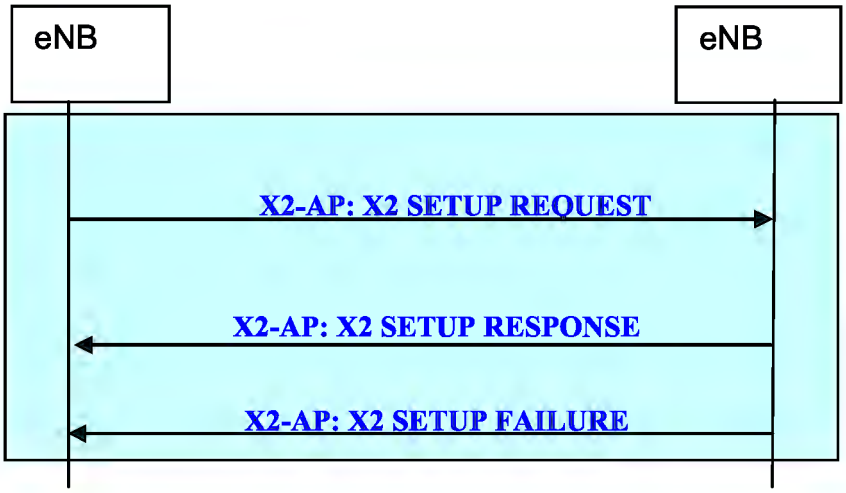


Figure 20.2.2.7-1: X2 Setup procedure

20.2.2.8 eNB Configuration Update procedure

The purpose of the eNB Configuration Update procedure is to update application level configuration data needed for two eNBs to interoperate correctly over the X2 interface.

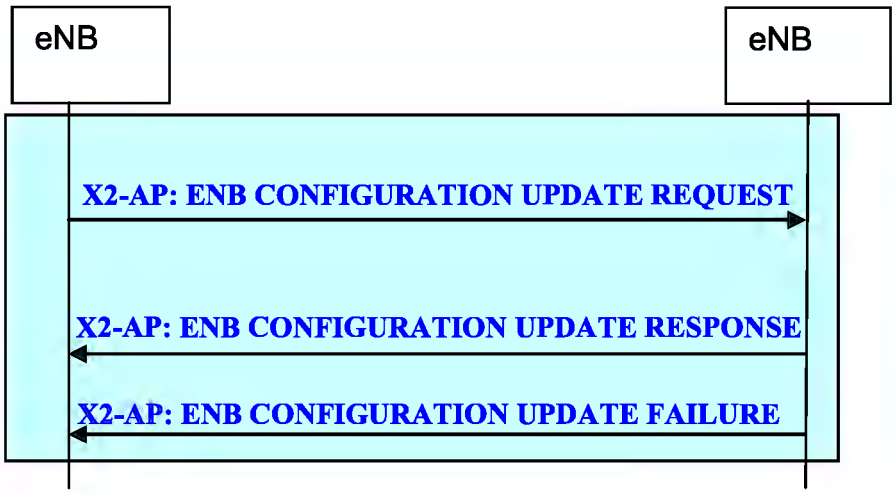


Figure 20.2.2.8-1: eNB Configuration Update procedure

20.2.2.9 Reset procedure

The Reset procedure is initiated by an eNB to align the resources with a peer eNB in the event of an abnormal failure. The procedure resets the whole X2 interface.

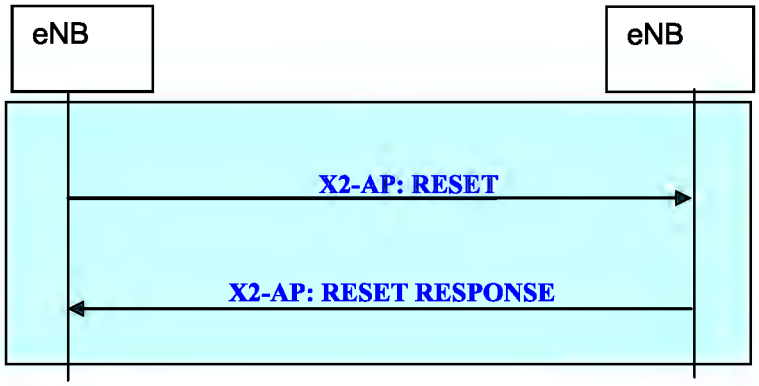


Figure 20.2.2.9-1: Reset procedure

20.2.2.10 Resource Status Reporting Initiation procedure

The Resource Status Reporting Initiation procedure is used by an eNB to request load measurements from another eNB.

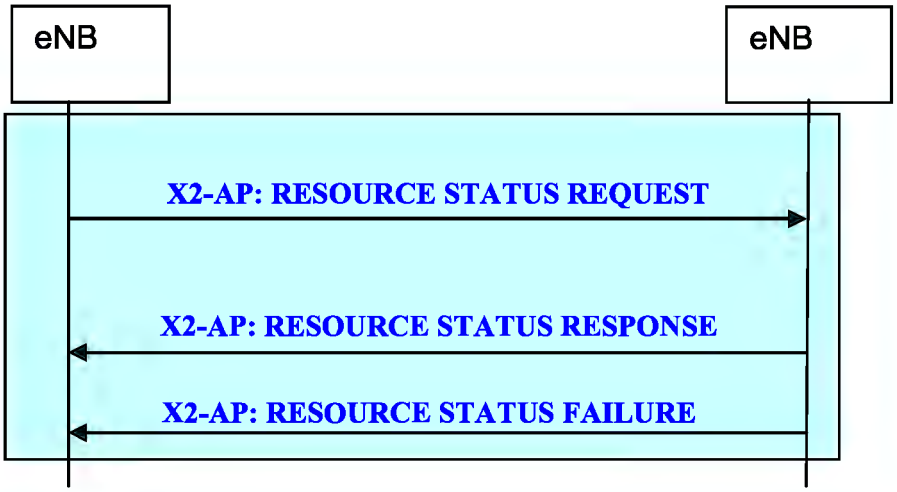


Figure 20.2.2.10-1: Resource Status Reporting Initiation procedure

20.2.2.11 Resource Status Reporting procedure

The Resource Status Reporting procedure reports measurement results requested by another eNB.

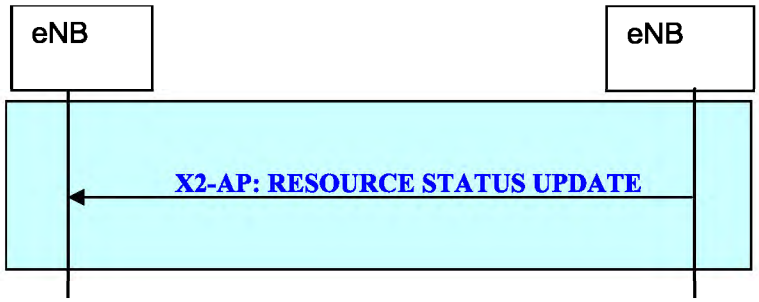


Figure 20.2.2.11-1: Resource Status Reporting procedure

20.2.3 Void

21 System and Terminal complexity

21.1 Overall System complexity

21.2 Physical layer complexity

21.3 UE complexity

22 Support for self-configuration and self-optimisation

22.1 Definitions

This concept includes several different functions from eNB activation to radio parameter tuning. Figure 22.1-1 is a basic framework for all self-configuration /self-optimization functions.

Self-configuration process is defined as the process where newly deployed nodes are configured by automatic installation procedures to get the necessary basic configuration for system operation.

This process works in pre-operational state. Pre-operational state is understood as the state from when the eNB is powered up and has backbone connectivity until the RF transmitter is switched on.

As described in Figure 21.1, functions handled in the pre-operational state like:

- Basic Setup and
- Initial Radio Configuration

are covered by the Self Configuration process.

NOTE: depending on the final chosen functional distribution in RAN, the feasibility of following items should be studied e.g.:

- To obtain the necessary interface configuration;
- Automatic registration of nodes in the system can be provided by the network;
- Alternative possibilities for nodes to obtain a valid configuration;

- The required standardization scope.

Self-optimization process is defined as the process where UE & eNB measurements and performance measurements are used to auto-tune the network.

This process works in operational state. Operational state is understood as the state where the RF interface is additionally switched on.

As described in Figure 21.1, functions handled in the operational state like:

- Optimization / Adaptation

are covered by the Self Optimization process.

NOTE: depending on the final chosen functional distribution in RAN the feasibility of following items should be studied e.g.:

- The distribution of data and measurements over interfaces relevant to RAN3;
- Functions/entities/nodes in charge of data aggregation for optimization purpose;
- Dependencies with O&M and O&M interfaces, in the self optimization process;
- The required standardization scope.

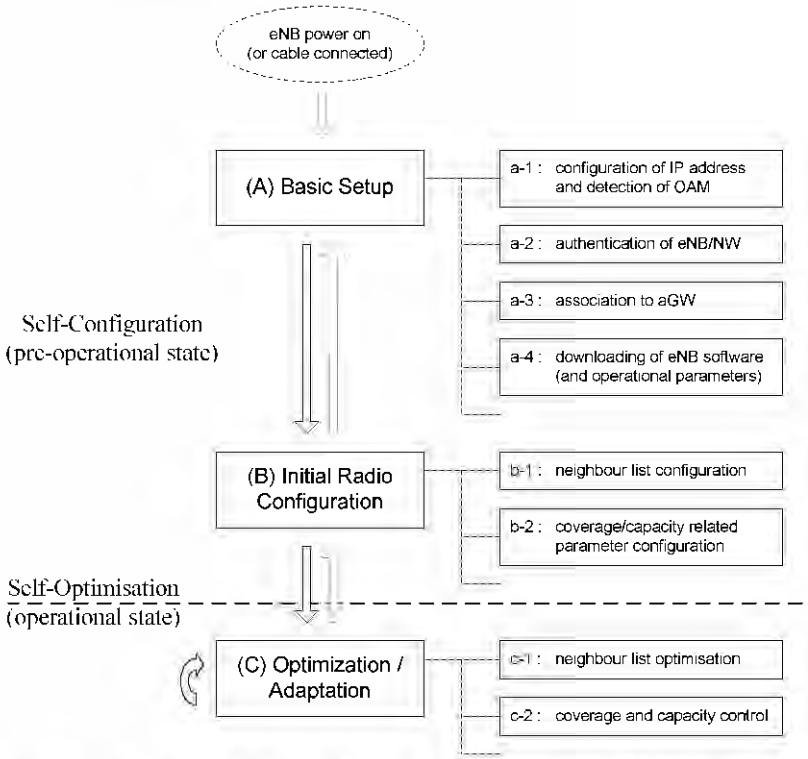


Figure 22.1-1: Ramifications of Self-Configuration /Self-Optimization functionality

22.2 UE Support for self-configuration and self-optimisation

UE shall support measurements and procedures which can be used for self-configuration and self-optimisation of the E-UTRAN system.

- UE shall support measurements and measurement reporting to support self-optimisation of the E-UTRAN system. Measurements and reports used for the normal system operation, should be used as input for the self-optimisation process as far as possible.

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NOTE: the UE impact should be carefully investigated and taken into account.

- The network is able to configure the measurements and the reporting for self-optimisation support by RRC signalling messages.

22.3 Self-configuration

22.3.1 Dynamic configuration of the S1-MME interface

22.3.1.1 Prerequisites

The following prerequisites are assumed:

- An initial remote IP end point to be used for SCTP initialisation is provided to the eNB for each MME. The eNB may be in pre-operational or operational state when this occurs.

How the eNB gets the remote IP end point(s) and its own IP address are outside the scope of this specification.

22.3.1.2 SCTP initialization

- For each MME the eNodeB tries to initialize a SCTP association as described in [8], using a known initial remote IP Endpoint as the starting point, until SCTP connectivity is established.

22.3.1.3 Application layer initialization

Once SCTP connectivity has been established, the eNodeB and MME shall exchange application level configuration data over the S1-MME application protocol with the S1 Setup Procedure, which is needed for these two nodes to interwork correctly on the S1 interface.

- The eNodeB provides the relevant configuration information to the MME, which includes list of supported TA(s), etc.
- The MME provides the relevant configuration information to the eNodeB, which includes PLMN ID, etc.
- When the application layer initialization is successfully concluded,the dynamic configuration procedure is completed and the S1-MME interface is operational.

22.3.2 Dynamic Configuration of the X2 interface

22.3.2.1 Prerequisites

The following prerequisites are assumed:

- An initial remote IP end point to be used for SCTP initialisation is provided to the eNB.

22.3.2.2 SCTP initialization

For candidate eNB the eNB tries to initialize a SCTP association as described in [8], using a known initial remote IP Endpoint as the starting point, until SCTP connectivity is established.

22.3.2.3 Application layer initialization

Once SCTP connectivity has been established, the eNB and its candidate peer eNB are in a position to exchange application level configuration data over the X2 application protocol needed for the two nodes to interwork correctly on the X2 interface.

- The eNB provides the relevant configuration information to the candidate eNB, which includes served cell information, etc.

- The candidate eNB provides the relevant configuration information to the initiating eNB, which includes served cell information, etc.
- When the application layer initialization is successfully concluded, the dynamic configuration procedure is completed and the X2 interface is operational.

22.3.2a Automatic Neighbour Relation Function

The purpose of the **Automatic Neighbour Relation** (ANR) function is to relieve the operator from the burden of manually managing Neighbour Relations (NRs). Figure 22.3.2a-1 shows ANR and its environment:

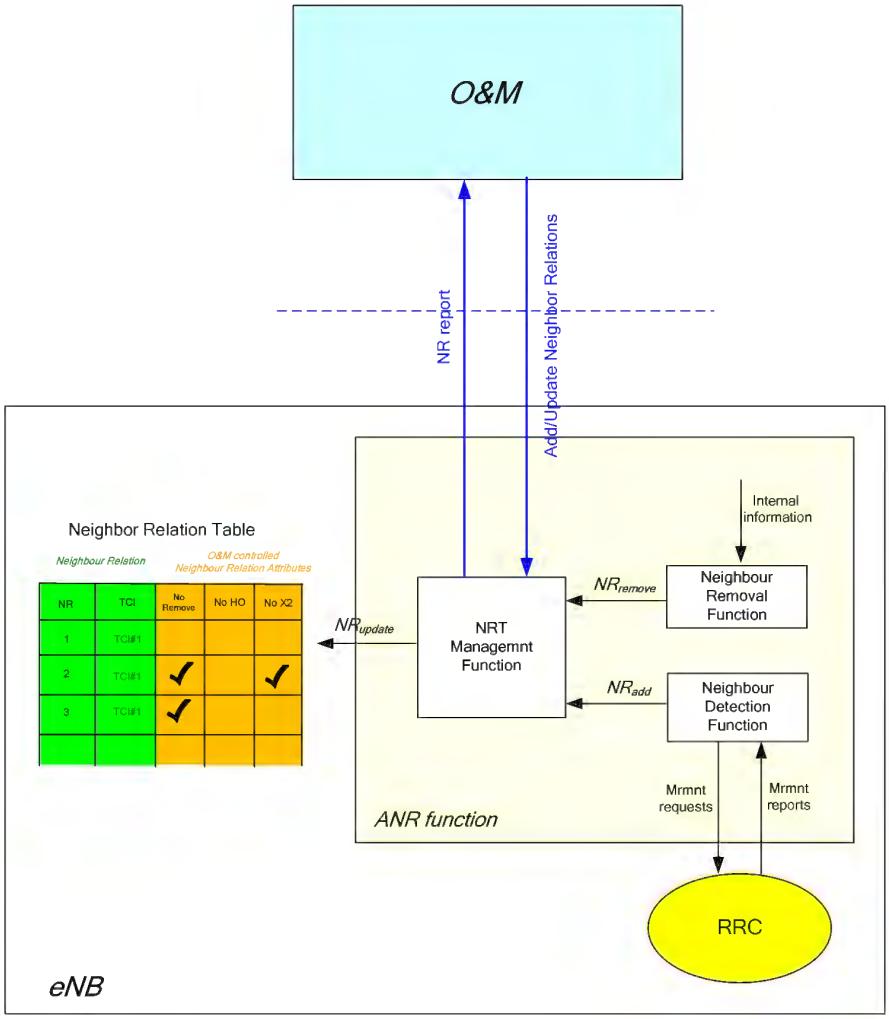


Figure 22.3.2a-1: Interaction between eNB and O&M due to ANR

The ANR function resides in the eNB and manages the conceptual Neighbour Relation Table (NRT). Located within ANR, the Neighbour Detection Function finds new neighbours and adds them to the NRT. ANR also contains the Neighbour Removal Function which removes outdated NRs. The Neighbour Detection Function and the Neighbour Removal Function are implementation specific.

A **Neighbour cell Relation** (NR) in the context of ANR is defined as follows:

An existing Neighbour Relation from a source cell to a target cell means that eNB controlling the source cell:

a) Knows the ECGI/CGI and PCI of the target cell.

b) Has an entry in the Neighbour Relation Table for the source cell identifying the target cell.

c) Has the attributes in this Neighbour Relation Table entry defined, either by O&M or set to default values.

For each cell that the eNB has, the eNB keeps a NRT, see Figure 22.3.2a-1. For each NR, the NRT contains the Target Cell Identifier (TCI), which identifies the target cell. For E-UTRAN, the TCI corresponds to the E-UTAN Cell Global Identifier (ECGI) and Physical Cell Identifier (PCI) of the target cell. Furthermore, each NR has three attributes, the NoRemove, the NoHO and the NoX2 attribute. These attributes have the following definitions:

- **No Remove:** If checked, the eNB shall not remove the Neighbour cell Relation from the NRT.
- **No HO:** If checked, the Neighbour cell Relation shall not be used by the eNB for handover reasons.
- **No X2:** If checked, the Neighbour Relation shall not use an X2 interface in order to initiate procedures towards the eNB parenting the target cell.

Neighbour cell Relations are cell-to-cell relations, while an X2 link is set up between two eNBs. Neighbour cell Relations are unidirectional, while an X2 link is bidirectional.

The ANR function also allows O&M to manage the NRT. O&M can add and delete NRs. It can also change the attributes of the NRT. The O&M system is informed about changes in the NRT.

22.3.3 Intra-LTE/frequency Automatic Neighbour Relation Function

The ANR (Automatic Neighbor Relation) function relies on cells broadcasting their identity on global level, E-UTRAN Cell Global Identifier (ECGI).

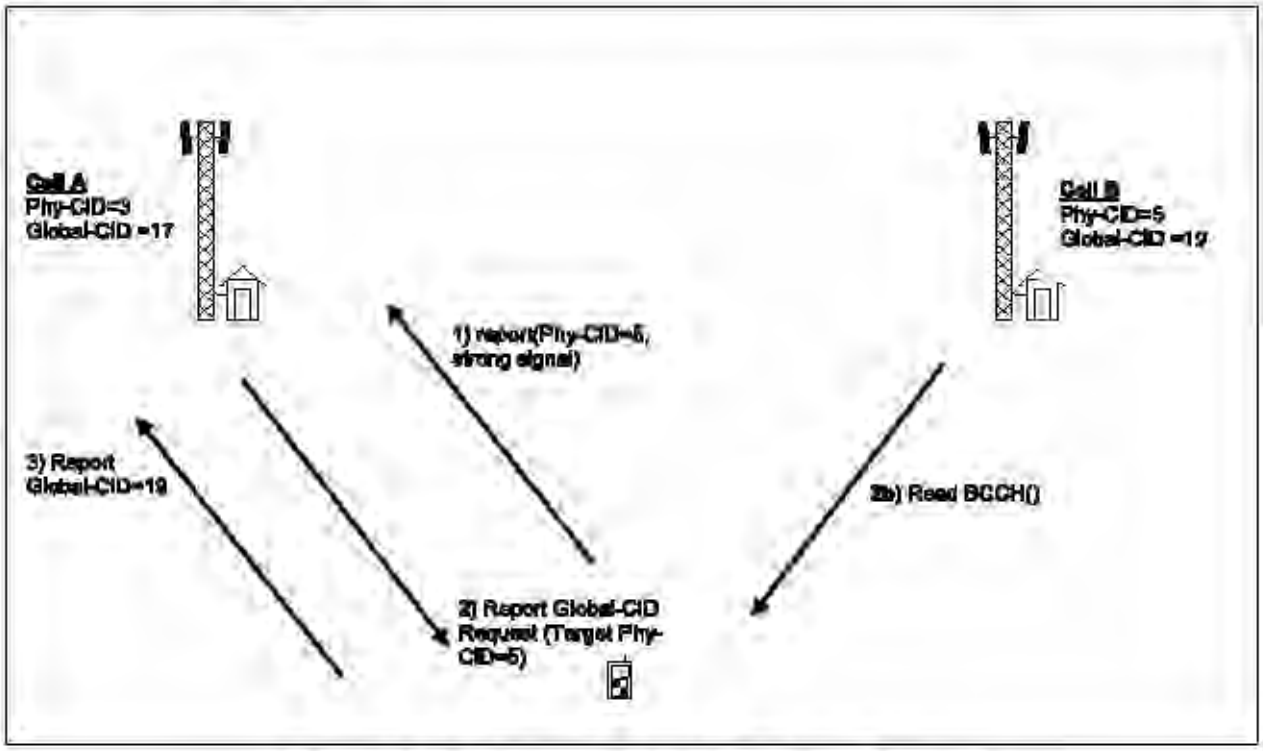


Figure 22.3.3-1: Automatic Neighbor Relation Function

The function works as follows:

The eNB serving cell A has an ANR function. As a part of the normal call procedure, the eNB instructs each UE to perform measurements on neighbor cells. The eNB may use different policies for instructing the UE to do measurements, and when to report them to the eNB. This measurement procedure is as specified in [16].

1. The UE sends a measurement report regarding cell B. This report contains Cell B"s PCI, but not its ECGI.

When the eNB receives a UE measurement report containing the PCI, the following sequence may be used.

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2. The eNB instructs the UE, using the newly discovered PCI as parameter, to read the ECGI, the TAC and all available PLMN ID(s) of the related neighbour cell. To do so, the eNB may need to schedule appropriate idle periods to allow the UE to read the ECGI from the broadcast channel of the detected neighbour cell. How the UE reads the ECGI is specified in [16].
3. When the UE has found out the new cell's ECGI, the UE reports the detected ECGI to the serving cell eNB. In addition the UE reports the tracking area code and all PLMN IDs that have been detected.
4. The eNB decides to add this neighbour relation, and can use PCI and ECGI to:
   a. Lookup a transport layer address to the new eNB.
   b. Update the Neighbor Relation List.
   c. If needed, setup a new X2 interface towards this eNB. The setup of the X2 interface is described in section 22.3.2.

22.3.4 Inter-RAT/Inter-frequency Automatic Neighbour Relation Function

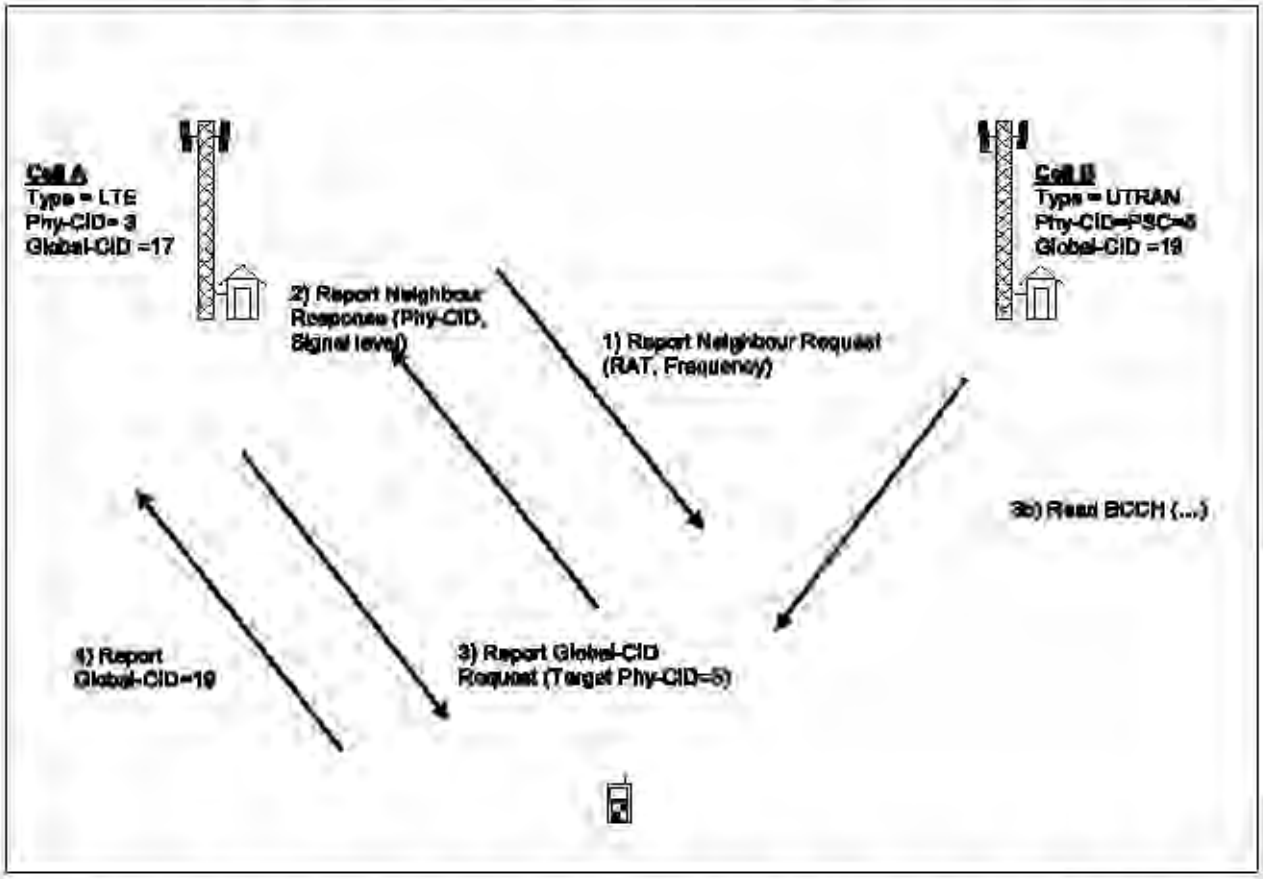


Figure 22.3.4-1: Automatic Neighbor Relation Function in case of UTRAN detected cell

For Inter-RAT and Inter-Frequency ANR, each cell contains an Inter Frequency Search list. This list contains all frequencies that shall be searched.

For Inter-RAT cells, the NoX2 attribute in the NRT is absent, as X2 is only defined for E-UTRAN.

The function works as follows:

The eNB serving cell A has an ANR function. During connected mode, the eNB can instruct a UE to perform measurements and detect cells on other RATs/frequencies. The eNB may use different policies for instructing the UE to do measurements, and when to report them to the eNB.

1. The eNB instructs a UE to look for neighbour cells in the target RATs/frequencies. To do so the eNB may need to schedule appropriate idle periods to allow the UE to scan all cells in the target RATs/frequencies.

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2 The UE reports the PCI of the detected cells in the target RATs/frequencies. The PCI is defined by the carrier frequency and the Primary Scrambling Code (PSC) in case of UTRAN FDD cell, by the carrier frequency and the cell parameter ID in case of UTRAN TDD cell, by the Band Indicator + BSIC + BCCH ARFCN in case of GERAN cell and by the PN Offset in case of CDMA2000 cell.

When the eNB receives UE reports containing PCIs of cell(s) the following sequence may be used.

3 The eNB instructs the UE, using the newly discovered PCI as parameter, to read the CGI and the RAC of the detected neighbour cell in case of GERAN detected cells, CGI, LAC and, RAC in case of UTRAN detected cells and CGI in case of CDMA2000 detected cells. For the Interfrequency case, the eNB instructs the UE, using the newly discovered PCI as parameter, to read the ECGI, TAC and all available PLMN ID(s) of the inter-frequency detected cell. The UE ignores transmissions from the serving cell while finding the requested information transmitted in the broadcast channel of the detected inter-system/inter-frequency neighbour cell. To do so, the eNB may need to schedule appropriate idle periods to allow the UE to read the requested information from the broadcast channel of the detected inter-RAT/inter-frequency neighbour cell.

4 After the UE has read the requested information in the new cell, it reports the detected CGI and RAC (in case of GERAN detected cells) or CGI, LAC and RAC (in case of UTRAN detected cells) or CGI (in case of CDMA2000 detected cells) to the serving cell eNB. In the inter-frequency case, the UE reports the ECGI, the, tracking area code and all PLMN-ID(s) that have been detected.

5 The eNB updates its inter-RAT/inter-frequency Neighbour Relation Table.

In the inter-frequency case and if needed, the eNB can use the PCI and ECGI for a new X2 interface setup towards this eNB. The setup of the X2 interface is described in section 22.3.2.

22.3.5 Framework for PCI Selection

The eNB shall base the selection of its PCI either on a centralized or distributed PCI assignment algorithm:

[Centralized PCI assignment] The OAM signals a specific PCI value. The eNB shall select this value as its PCI.

[Distributed PCI assignment] The OAM signals a list of PCI values. The eNB may restrict this list by removing PCI-s that are:

a) reported by UEs;

b) reported over the X2 interface by neighboring eNBs; and/or

c) acquired through other implementation dependent methods, e.g. heard over the air using a downlink receiver.

The eNB shall select a PCI value randomly from the remaining list of PCIs.

22.3.6 TNL address discovery

22.3.6.1 TNL address discovery of candidate eNB via S1 interface

If the eNB is aware of the eNB ID of the candidate eNB (e.g. via the ANR function) but not a TNL address suitable for SCTP connectivity, then the eNB can utilize the Configuration Transfer Function to determine the TNL address as follows:

- The eNB sends the eNB CONFIGURATION TRANSFER message to the MME to request the TNL address of the candidate eNB, and includes relevant information such as the source and target eNB ID.
- The MME relays the request by sending the MME CONFIGURATION TRANSFER message to the candidate eNB identified by the target eNB ID.
- The candidate eNB responds by sending the eNB CONFIGURATION TRANSFER message containing one or more TNL addresses to be used for SCTP connectivity with the initiating eNB, and includes other relevant information such as the source and target eNB ID.
- The MME relays the response by sending the MME CONFIGURATION TRANSFER message to the initiating eNB identified by the target eNB ID.

23 Others

23.1 Support for real time IMS services

23.2 Subscriber and equipment trace

Support for subscriber and equipment trace for E-UTRAN and EPC shall be as specified in [29], [30] and [31].

23.2.1 Signalling activation

All traces are initiated by the core network, even if the trace shall be carried out in the radio network.

If the eNB has received an UE CONTEXT RELEASE COMMAND message where the UE is associated to an E-UTRAN Trace Id then the eNB shall terminate the on-going Trace.

The following functionality is needed on the S1 and X2 interface:

- Support for inclusion of subscriber and equipment trace information in INITIAL CONTEXT SETUP REQUEST message over the S1 interface.
- Support for an explicit TRACE START message over the S1 interface.
- Support for inclusion of subscriber and equipment trace information in the HANDOVER REQUEST message over the X2 interface.
- Support for inclusion of subscriber and equipment trace information in the HANDOVER REQUEST message over the S1 interface.

A trace setup in the radio network will be propagated on the X2 interface at handover and on the S1 interface if the handover is carried out between MMEs.

23.2.2 Management activation

All conditions for Cell Traffic Trace are defined by the O&M. When the condition to start the trace recording is fulfilled the eNB will allocate a Trace Recording Session Reference and send it together with the Trace Reference to the MME in a CELL TRAFFIC TRACE message over the S1 interface.

Cell Traffic trace will not be propagated on the X2 interface or on the S1 interface in case of handover.

23.3 E-UTRAN Support for Warning Systems

The E-UTRAN provides support for warning systems through means of system information broadcast capability. The E-UTRAN performs scheduling and broadcasting of the "warning message content" received from the CBC, which is forwarded to the E-UTRAN by the MME. The schedule information for the broadcast is received along with the "warning message content" from the CBC. The E-UTRAN is also responsible for paging the UE to provide indication that the warning notification is being broadcast. The "warning message content" received by the E-UTRAN contains an instance of the warning notification. Depending on the size, E-UTRAN may segment the secondary notification before sending it over the radio interface.

23.3.1 Earthquake and Tsunami Warning System

ETWS is a public warning system developed to meet the regulatory requirements for warning notifications related to earthquake and/or tsunami events. ETWS warning notifications can either be a primary notification (short notifications delivered within 4 seconds [32]) or secondary notification (providing detailed information). The ETWS primary notification is broadcast in *SystemInformationBlockType10* while the secondary notification is broadcast in *SystemInformationBlockType11*.

Annex A (informative): NAS Overview

This subclause provides for information an overview on services and functions provided by the NAS control protocol..

A.1 Services and Functions

The main services and functions of the NAS sublayer include:

- EPS Bearer control (see 3GPP TR 23.401 [17]);
- ECM-IDLE mobility handling;
- Paging origination;
- Configuration and control of Security.

A.2 NAS protocol states & state transitions

The NAS state model is based on a two-dimensional model which consists of EPS Mobility Management (EMM) states describing the mobility management states that result from the mobility management procedures e.g. Attach and Tracking Area Update procedures, and of EPS Connection Management (ECM) states describing the signalling connectivity between the UE and the EPC (see 3GPP TS 23.401 [17]).

NOTE: The ECM and EMM states are independent of each other and when the UE is in EMM-CONNECTED state this does not imply that the user plane (radio and S1 bearers) is established.

The relation between NAS and AS states is characterised by the following principles:

- EMM-DEREGISTERED & ECM-IDLE ⇒ RRC_IDLE:
  - Mobility: PLMN selection:
  - UE Position: not known by the network.
- EMM-REGISTERED & ECM-IDLE ⇒ RRC_IDLE:
  - Mobility: cell reselection;
  - UE Position: known by the network at tracking area level.
- EMM-REGISTERED & ECM-CONNECTED with radio bearers established ⇒ RRC_CONNECTED.
  - Mobility: handover;
  - UE Position: known by the network at cell level.

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Annex B (informative): MAC and RRC Control

The E-UTRA supports control signalling in terms of MAC control signalling (PDCCH and MAC control PDU) and RRC control signalling (RRC message).

B.1 Difference between MAC and RRC control

The different characteristics of MAC and RRC control are summarized in the table below.

Table B.1-1: Summary of the difference between MAC and RRC control

	MAC control		RRC control
Control entity	**MAC**		**RRC**
Signalling	PDCCH	MAC control PDU	RRC message
Signalling reliability	~ 10^{-2} (no retransmission)	~ 10^{-3} (after HARQ)	~ 10^{-6} (after ARQ)
Control delay	Very short	Short	Longer
Extensibility	None or very limited	Limited	High
Security	No integrity protection No ciphering	No integrity protection No ciphering	Integrity protected Ciphering (FFS)

The main difference between MAC and RRC control lies in the signalling reliability. Due to the signalling reliability, signalling involving state transitions and radio bearer configurations should be performed by RRC. Basically, all signalling performed by RRC in UTRA should also be performed by RRC also for E-UTRA.

B.2 Classification of MAC and RRC control functions

The table below illustrates the classification of MAC and RRC control functions for E-UTRAN.

Table B.2-1: Classification of MAC and RRC control functions

		Controlled configuration/parameters
MAC control signalling	**PDCCH**	Short-lived (PRB) and dynamic (MCS) allocation Long-lived (PRB) and fixed (MCS) allocation (FFS) Timing Advance (FFS)
	MAC control PDU	Timing Advance (FFS) RLC related control PDU (FFS)
RRC control signalling	**RRC message**	Long-lived (PRB) and fixed (MCS) allocation (FFS) Activation/deactivation of long-lived (PRB) and/or fixed (MCS) allocation (FFS) TTI configuration for variable TTI length control (FFS) Static parameter configuration for UE inactivity control within RRC_ACTIVE (e.g. DRX/DTX periods)

Annex C (informative): System Information

This annex provides an overview of the classification and division of system information between static and flexible parts. Considerations about dedicated distribution of system information are also included.

C.1 SI classification

Five categories are identified for system information classification:

1. Information valid across multiple cells;
2. Information needed at cell/PLMN search;
3. Information needed prior to cell camping;
4. Information needed before cell access;
5. Information needed while camping on a cell.

From UEs" point of view, the information that is needed at cell selection and prior to camping are very similar. Before a UE can camp on a cell, it needs to know if the access is allowed in that cell. Thus it would be very beneficial to know all access restrictions already at cell search phase.

C.1.1 Information valid across multiple cells

The pieces of information that can be valid across multiple cells are:

- A-GNSS assistance data;
- PLMN identity(ies);
- Tracking area identity;

Note: the above text will be revised if it is agreed that a cell can be a member of more than one tracking area.

- Predefined configuration information;
- System Frame Number if it does not change from cell to cell (in case of synchronized network);
- Some measurement/mobility information (FFS).

C.1.2 Information needed at cell/PLMN search

In order to support full mobility within the serving frequency layer, the UEs need to perform cell search rather often and thus it is seen very important that the information needed in cell search phase is readily available, thereby improving cell search times and minimizing UE power consumption. If system information decoding is needed for identifying a cell, fast system information reception is needed in order to avoid too long identification times. For optimising PLMN search and make PLMN search fast and non-complex, the information needed for PLMN search should be easily available. The pieces of information that are needed at cell/PLMN search are:

- PLMN identity(ies): in order to acquire information to which PLMN the cell belongs, UEs need to receive PLMN identity(ies);

NOTE: There may be multiple PLMN identities for one cell.

- Measurement cell identity (FFS): there needs to be a cell identity in the system information, in order to allow UEs to identify the cell reliably for measurement purposes.

NOTE: UEs may identify the cell also based on the reference sequence detection;
There is another cell identity that identifies the cell within e.g. PLMN.

NOTE: UEs may have to check possible cell access restrictions before selecting cell/PLMN;
For cell/PLMN search UEs might need some L1 parameters.

C.1.3 Information needed prior to cell camping

Before a UE can camp on a cell, it needs to know any access related parameters in order to avoid camping on cells where access is forbidden. Thus prior to camping on a cell, a UE needs to know the following information:

- Any cell access restriction parameters, e.g.:
  - Tracking area identity: if the forbidden TA concept is adopted from legacy systems, then the UE needs to know whether the cell belongs to such forbidden TA.

Note: the above text will be revised if it is agreed that a cell can be a member of more than one tracking area.

  - Cell barring status and cell reservation status (FFS if needed per PLMN): the UE needs to know whether the cell is barred or reserved in order to avoid camping on a barred cell. Possibly also barring time might be needed in order to avoid UE to poll barring time frequently from the system information. Another option is that barring status is indicated also in the neighbour cell list.
  - Radio access limitation parameters:
    - Any radio condition parameters that limit the access to the cell e.g. similar to GSM C1/S criteria;
    - It is FFS if we need to have some band information indication also, in order to allow UEs to check possible band support before camping on the cell.

NOTE: UE may need some L1 parameters prior to camping.

C.1.4 Information needed prior to cell access

Once a UE has camped on a cell, the information needed prior to cell access (transmission/reception) includes at least:

- System Frame Number (SFN) (FFS)
  - SFN is probably needed by the UE to understand the scheduling parameters (e.g. scheduling information for secondary SI, RACH, PCH, E-MBMS etc.)
- L1 information, example set of needed L1 parameters:

Note: RAN1 needs to define what parameters are needed at this phase.

  - Carrier Bandwidth: FFS if separate bandwidths for UL and DL are needed;
  - Carrier center frequency (FFS);
  - Cyclic Prefix parameters: in order to decode DL-SCH UE needs to know the CP length arrangements;
  - MIMO related parameters: in order to take advantage of the multi-antenna transmissions like MIMO, the UE needs to know parameters of number of TX antennas, DL/UL pre-coding matrices, etc...;
  - Band Information: may be needed if the same DL carrier frequency has variable UL carrier frequency;
  - PDCCH, PHICH and PUCCH structure parameters: if PDCCH has variable configurations, the UE may need to know its channel structure at least partly. PDCCH is crucial to receive any allocation information. If Random Access Response is transmitted without PDCCH (e.g. synchronous transmission with Random Access Preamble), this information might not be required;
- RACH parameters (needed by the UE to start usage of RACH):

- RACH scheduling information: UE needs to know where in time (sub-frame) and frequency (Physical Resource Units) the RACH channel is located;
- RACH sequences: UE needs to know the RACH set of sequences to choose from. The sequences may not be fully of equal meaning (e.g. CQI can be classified for the sequences in a specific way);
- Access class restrictions: access class restrictions might be needed to limit the number of possible UEs using RACH;
- Persistence values: possible persistence value scheme parameters are needed for RACH usage;
- Other parameters related to RACH: UE needs to know the timers and parameters related to RACH e.g. how often the UE retransmits RACH and how many times the retransmission is allowed etc;
- RACH power control parameters: UE needs to know parameters related to UL power control.

C.1.5 Information needed while camping on a cell

When a UE has camped on a cell, it needs to continue measuring the neighbouring cells in order to stay camped. The pieces of information required for that are:

- Measurement parameters:
  - In order for the UE to start mobility procedures, it needs to receive parameters e.g. of reporting periods, reporting event parameters, time to trigger etc. UEs in RRC_IDLE state need cell reselection parameters. UEs in RRC_CONNECTED state need parameters of the neighbour cells e.g. for handover and for error recovery cases.
  - Neighbour cell lists are needed to start neighbour cell measurements. UEs in different states may use different sets of neighbour cell lists. Neighbour cell list may contain following parameters:
    - Some L1 parameters: FFS what parameters are needed in the neighbour cell list;
    - All information that is needed for camping: see sub-clauses C.2.2 and C.2.3 (FFS);
    - Synchronization information: indicating whether the neighbouring cell is synchronized to the current cell i.e. the cell sending the neighbour cell list (FFS);
    - PLMN identity(ies) & tracking area identity (FFS);

Note: The above text will be revised if it is agreed that a cell can be a member of more than one tracking area.

  - Other 3GPP RAT information: e.g. neighbour cell information of GERAN/UTRAN cells;
  - Information of non-3GPP access systems (e.g. WIMAX).
- Secondary NAS parameters:
  - An y NAS parameters that were not presented earlier e.g. cell identity uniquely identifying cell within wide area e.g. PLMN;
  - Cell identity (PLMN level) (FFS if this should be in category 'Information needed prior to cell access').
- Secondary UE timer values: any timer values that affect UE"s behaviour.
- Paging parameters: UEs in ECM-IDLE state need to receive paging parameters e.g. DRX periods and scheduling.
- Clock time (FFS): the network might send system clock in order to let UEs update their clock time e.g. in the user interface;
- MBMS service parameters: any parameters needed for MBMS reception e.g. MBMS multiplexing parameters, MBMS frequency;

NOTE: the presence of these parameters also indicate the presence of MBMS service in the cell (dedicated or mixed cell).

- Signalling Radio Bearer parameters: may be broadcasted unless they are standardized.

C.1.6 Thoughts about category division

From UEs" point of view the categories in sub-clauses C.1.2 and C.1.3 are very similar. Thus it is questionable whether we need to differentiate procedures between cell search/selection/camping and PLMN search.

From UEs" point of view, the difference between the procedure for cell search during RRC_CONNECTED and the procedure for cell search during RRC_IDLE state maybe small. When the UE is in RRC_CONNECTED state, it measures the neighbour cell and executes handovers commanded by the network.

C.2 Division of SI between static and flexible parts

System information distribution can be classified into two distinctive parts: static and flexible. Static part is sent more often, say once per frame, in the cell and has quite a limited capacity for information transfer. The flexible part has flexible amount of scheduled resources available and thus most of the SI information is contained there.

C.2.1 Static part

The static parts of the System Information are:

- L1 information in order to decode the rest of the information

Note: detailed information on the required information will be defined by RAN1;

- Measurement Cell identity (FFS): it may be possible that L1 channels do not identify the cell. Then some Cell identity needs to be sent on system information part;
- Any cell access restriction parameters e.g.:
  - Tracking area identity: if forbidden TA concept is adopted from legacy systems then UEs need to know whether the cell belongs to forbidden TA;

Note: the above text will be revised if it is agreed that a cell can be a member of more than one tracking area.

  - Cell barring and cell reservation status (FFS if needed per PLMN): UEs need to know whether cell is barred or reserved in order to avoid camping on barred cell. Possibly also barring time might be needed in order to avoid UEs to poll barring time frequently from the system information;
  - Radio access limitation parameters: any radio condition parameters that limit the access to the cell e.g. similar to GSM C1/S criteria;
  - PLMN identity(ies): in order to acquire information to which PLMN cell belongs, UEs need to receive PLMN identity(ies).

NOTE: there may be multiple PLMN identities for one cell.

- Scheduling parameters:
  - All of the scheduling information of flexible part or part of scheduling information (e.g. scheduling block) of flexible part. If static part consists of multiple SI blocks then it may be necessary to have scheduling information of those blocks in the static part.
    - Scheduling block defines, from where (time and frequency resources) to decode the SI blocks of the scheduled flexible part. It may be possible that scheduling of scheduling block is standardized, then this information can be omitted from the static part. If several types of scheduling blocks are defined , scheduling information might be sent for each scheduling block.
- Value_tag(s): informs whether the information transmitted on the flexible part has changed. This is needed in order to avoid UEs from reading any unchanged information repeatedly. Another possibility is to send this information in PDCCH, but possibly it would cause too much overhead.

NOTE: It also is possible to include Value_tag for SI on the flexible part indicating more precisely what changes have occurred in the system information.

NOTE: There may be a need for indicating changes in static part with value tag also, if static part consists of multiple SI blocks.

Table C.2.1-1 gives an estimate of the size of the elements mentioned above.

Table C.2.1-1: Initial rough estimates for static part capacity requirement

Information element	Bits
Cyclic Prefix (FFS)	2
Carrier BW (FFS)	3-8
MIMO parameters (FFS)	2 (+ 3)
Cell Id (FFS)	9
Tracking Area Id (+ FFS how many additional)	[16-28]
Cell Barring status+ possible Time of barring	1+4
Cell reservation status	[2]
Radio access limitation parameters	12
PLMN id(s) maximum of 5 (24 bits per one) - see Note	120
Scheduling parameters	(12-108)
Value Tag	4
SFN (FFS)	11

NOTE: It might not be necessary to send the Mobile Country Code part of the PLMN identity for each indicated PLMN to limit the number of bits.

C.2.2 Flexible part

The flexible part has different types of Information Elements which require independent scheduling in order to allow fast enough reception and not to waste transmission capacity. For example, the requirement to receive cell access parameters is very different than e.g. the clock time. Thus following flexible part division should be considered:

- Scheduling block: scheduling information of the secondary part of the System Information.
- Access parameters:
  - All parameters not present in the primary part (e.g. some L1 parameters);
  - RACH parameters;
  - Power control parameters;
  - Paging parameters;
  - Any timer values needed for operating in the cell and in the network.
- Measurement related parameters:
  - Neighbour cell lists;
  - Cell selection/reselection parameters;

NOTE: Some of these parameters are included in the static part element 'Radio access limitation parameters.'

  - Measurement control information;
- Non vital information:
  - Clock time;
  - Positioning (A-GNSS etc.) information;

- Service parameters (e.g. MBMS parameters);
- Secondary NAS parameters.

C.2.3 Information whose location is FFS

The location of the following information is FFS:

- System Frame Number: SFN might be needed very fast i.e. for HO purposes. SFN might be needed also for decoding scheduling block parameters, but on the other hand it might be requested not to send often changing information on the static part in order to be able to make time soft combining. Further investigation on the SFN broadcasting is thus needed.

C.2.4 Dedicated part

The dedicated part is embedded in the RRC message that is meant for sending System Information Elements in unicast mode e.g. for HO purposes, positioning purposes …. The UE needs some information for the neighbouring cell to access it, this is needed to limit the interruption times caused by HO execution. When a UE receives a HO COMMAND it needs at least following information from the target cell:

- All information in the static part (see sub-clause C.2.1): may be received by the UE by itself;
- Most of the information from the access parameters (see sub-clause C.2.2): is favourably delivered by dedicated manner via the source cell, because the UE might not have time to get all the necessary secondary SI from the target cell;
- System Frame Number is needed to minimize the interruption times during the HO procedure. Most probably the UE needs to receive (at least confirm) the SFN directly by the neighbour cell SI reading, because giving the SFN via source cell may cause some inaccuracy to the SFN.

Annex D (informative):
Void

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Annex E (informative): Drivers for Mobility Control

Table E-1 lists the drivers, limitations, and their applicability to intra-frequency, inter-frequency, and inter-RAT scenarios. Each driver and limitation is described in Section E.1 and E.2, respectively. For inter-frequency and inter-RAT scenarios, the applicable drivers are shown in detail for IDLE/ACTIVE modes and their transitions in Section E.3.

Table E-1: Drivers and limitations for mobility control and applicability to mobility scenarios.

	#	Drivers/limitations	Intra-frequency	Inter-frequency	Inter-RAT
Drivers	1	Best radio condition	X	X	X
	2	Camp load balancing		X	X
	3	Traffic load balancing		X	X
	4	UE capability		X	X
	5	Hierarchical cell structures		X	X
	6	Network sharing		X	X
	7	Private neworks/home cells		X	X
	8	Subscription based mobility control		X	X
	9	Service based mobility control		X	X
	10	MBMS		X	X
Limitations	11	UE battery saving	X	X	X
	12	Network signalling/processing load	X	X	X
	13	U-plane interruption and data loss	X	X	X
	14	OAM complexity	X	X	X

As shown in Table E.1, the applicable drivers depend on the mobility scenario, i.e., intra-frequency, inter-frequency, and inter-RAT:

- **Intra-frequency mobility**: intra-frequency mobility is the most fundamental, indispensable, and frequent scenario. With the frequency reuse being one in E-UTRAN, applying any driver other than the 'best radio condition' to intra-frequency mobility control incur increased interference and hence degraded performance. As such, only the 'best radio condition' driver is applicable to intra-frequency mobility. Note that the exact definition of 'intra-frequency mobility' is yet unclear, and shall be clarified with RAN1.

- **Inter-frequency mobility**: as in UTRAN, an operator may have multiple carriers/bands for E-UTRAN working in parallel. The use of these frequency layers may be diverse. For example, some of these frequency layers may utilise the same eNB sites and antenna locations (i.e., co-located configuration), whereas some may be used to form a hierarchical cell structure (HCS), or even be used for private networks. Some frequency layers may provide MBMS services, while some may not. Moreover, E-UTRAN carriers/bands may be extended in the future to increase capacity. For example, as E-UTRAN gains popularity, an operator may decide to convert existing UTRAN carriers into E-UTRAN ones. The operator may also acquire additional carriers/bands, that are not necessarily contiguous. As a consequence, different UE band capabilities may coexist and different carriers/bands may operate at different areas within a network. The E-UTRAN standard should readily support such carrier/band extensions and diverse network configurations, providing flexibility and efficiency. Therefore, a number of drivers apply to inter-frequency mobility control, in addition to the 'best radio condition' driver.

- **Inter-RAT mobility**: the aspects that need to be considered for inter-RAT are similar to those for inter-frequency. For mobility solutions to be complete with the inter-RAT drivers, relevant updates would be necessary on the legacy (UTRAN/GERAN) specifications. This will add to the limitations, which are evidently more effective in inter-RAT. Although the drivers/limitations need to be assessed per objective RAT (UTRAN/GERAN), the solutions should be made common as much as possible to reduce any complexity.

E.1 Drivers

The drivers for mobility control are described in the following sections.

E.1.1 Best radio condition

The primary purpose of cell reselection, regardless of intra-frequency, inter-frequency, or inter-RAT, is to ensure that the UE camps on/connects to the best cell in terms of radio condition, e.g., path loss, received reference symbol power, or received reference symbol Es/I0. The UE should support measurements to suffice this aspect. For E-UTRAN cells, the frequency domain scheduling and channel/symbol mapping may have some implications to designing the measurements and reselection/reporting criteria. The UE would also have to check that the selected cell falls within the accessible range (in terms of signal strength and possibly also in terms of propagation delay, i.e., check if it falls within the dynamic range of timing advance, FFS).

E-UTRAN should support good mobility even when the radio environment changes suddenly, e.g., when the UE enters a tunnel or in a Manhattan-like street cell scenario. It should be discussed whether a special mechanism is needed to cope with such sudden changes in radio environment or it can be handled with good radio network planning practices. In either case, the system design should minimise any side effects of counteracting the sudden changes in the radio environment (e.g., ping-pongs).

For inter-frequency/RAT mobility, the UE needs idle gaps to perform measurements on other frequency layers/RATs. In addition, for inter-RAT, E-UTRAN measurements while the UE is in another RAT (UTRAN/GERAN) need to be supported. It should be discussed whether in certain cases (e.g., co-located E-UTRAN cells within the same frequency band) the measurements can be omitted.

E.1.2 Camp load balancing

This is to distribute idle state UEs among the available bands/carriers/RATs, such that upon activation, the traffic loading of the bands/carriers/RATs would be balanced. At least the path loss difference between different bands should be compensated to avoid UEs concentrating to a certain frequency layer (e.g., lower frequency bands due to the propagation nature). A deliberate mechanism would be necessary to avoid UEs concentrating to a certain RAT (e.g., E-UTRAN). Various solutions have been presented including the use of Qoffset and an approach of limiting the frequency layers for camping.

For inter-RAT, this driver also includes the aspect of balancing the loading of core network nodes of different RATs. Nevertheless, for intra- E-UTRAN, the core network load aspect is out of scope, since MME/Serving Gateway relocation by itself should not cause any radio mobility procedure (but only NAS procedures like NAS ID and security updates).

E.1.3 Traffic load balancing

This is to balance the loading of active state UEs, using redirection for example. In E-UTRAN, traffic load balancing is essential because of the shared channel nature. That is, the user throughput decreases as the number of active UEs in the cell increases, and the loading directly impacts on the user perception. A solution is desired that causes minimum impact on the user perception. This implies that inter-layer transitions are preferably done during data inactivity (e.g., DRX) or transition to the idle state. Although this driver is also applicable to inter-RAT, for inter-RAT, the 'service dependent control' driver may be more dominant than the load balancing aspect.

E.1.4 UE capability

As E-UTRAN bands/carriers may be extended in the future, UEs having different band capabilities may coexist within a network. It is also likely that roaming UEs have different band capabilities. Overlaying different RATs adds to this variety. The mobility solution should cope with the coexistence of various UE capabilities in an efficient manner.

E.1.5 Hierarchical cell structures

As in UTRAN, hierarchical cell structures (HCS) may be utilised in E-UTRAN to cover for example, indoors and hot spots efficiently. It is possible that E-UTRAN is initially deployed only at hot spots, in which case this driver becomes essential for inter-RAT, not just for inter-frequency. Another use case would be to deploy a large umbrella cell to cover a vast area without having to deploy a number of regular cells, while providing capacity by the regular cells on another frequency. While HCS can be seen as a solution to reduce measurement and signalling loads, to optimise HCS usage, mobility control should take into account the UE mobility (e.g., speed). This however implies that sufficient mobility detection is also required. Although HCS is not addressed as a mobility driver for intra-frequency mobility, intra-frequency HCS deployment should not be restricted.

E.1.6 Network sharing

At the edge of a shared portion of a network, it will be necessary to direct UEs belonging to different PLMNs to different target cells. The mobility solutions in both idle and active states should therefore support differentiation between UEs of different operators.

E.1.7 Private networks/home cells

Cells that are part of a sub-network should prioritise the camping on that sub-network. UEs that do not belong to private sub-networks should not attempt to camp or access them. Although this could be resolved by the use of forbidden TAs as in UTRAN, a more deliberate mechanism may be needed as some of these sub-networks could be very small, e.g., one home.

E.1.8 Subscription based mobility control

This mobility driver aims to limit the inter-RAT mobility for certain UEs, e.g., based on subscription or other operator policies. The system should provide means to disallow access on certain RATs (including E-UTRAN) as done with "LA reject" in legacy systems. It should be possible for the operator to trigger a subsequent UE action such as a cell or PLMN selection.

E.1.9 Service based mobility control

An operator may have different policies in allocating frequencies to certain services. For example, the operator may concentrate VoIP UEs to a certain frequency layer or RAT (e.g., UTRAN or GERAN), if evaluations prove this effective. UEs requiring higher data rates may better be served on a frequency layer or RAT (e.g., E-UTRAN) having a larger bandwidth. The operator may also want to accommodate premium services on a certain frequency layer or RAT, that has better coverage or larger bandwidth.

This driver is essential for inter-RAT, due to the different QoS levels provided by different RATs. The nature of the service being requested (e.g., QoS and traffic behaviour) should be considered in controlling mobility, so that services are accommodated in the best suitable RAT. Note that such service dependent control shall only be based on network decisions and not on UE decisions (i.e., no UE based service dependent cell reselection), except for MBMS scenarios.

E.1.10 MBMS

As MBMS services may be provided only in certain frequency layers, it may be beneficial/necessary to control inter-frequency/RAT mobility depending on whether the UE receives a particular MBMS service or not. For MBMS scenarios only, UE based service dependent cell reselection might be considered acceptable. This aspect also depends on the UE capability for simultaneous reception of MBMS and unicast.

E.2 Limitations for mobility control

While the issues mentioned above drive E-UTRAN towards 'aggressive' mobility control, the limiting factors also have to be considered. The factors listed below apply to all intra-frequency, inter-frequency, and inter-RAT mobility scenarios.

E.2.1 UE battery saving

The mobility solution should not consume excessive UE battery, e.g., due to measurements, measurement reporting, BCH reception, or TA update signalling. This could be achieved for example by setting appropriate measurement rules such as S-criteria, hysteresis, and time-to-trigger. Adaptive control of some measurement/mobility parameters (e.g., based on DRX, cell size, or mobility) may also be considered as a countermeasure. To reduce TA update signalling, TA allocations can be differentiated depending on the UE speed or the mobility vector, on top of appropriate TA planning. Effects on additional delays (e.g., paging) should also be investigated if means such as 'long DRX' are used to achieve these savings.

It should be investigated together with RAN4 if a coupling between measurements accuracy and DRX (as in UTRAN) is also acceptable for E-UTRAN.

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E.2.2 Network signalling/processing load

The mobility solution should not cause excessive network signalling/processing load. This includes over-the-air signalling, S1/X2 signalling, and processing load at network nodes. Unnecessary handovers and cell reselections should be avoided, and PCH and BCH signalling, as well as dedicated signallings, should be limited. This could be achieved by similar countermeasures as for UE battery saving.

E.2.3 U-plane interruption and data loss

U-plane interruption and data loss caused by the mobility solution should be limited. The required QoS should be satisfied in any case.

E.2.4 OAM complexity

The mobility solution should not demand excessive efforts in operating/maintaining a network. For example, when a new eNB is added or an existing eNB fails, the mobility solution should not incur excessive efforts to set up or modify the parameters. Means should be studied to integrate the mobility solutions in the concept of 'self-optimisation' to minimise manual processes. Reducing the neighbour list information in E-UTRAN would also be a countermeasure to this requirement.

E.3 Inter-frequency/RAT drivers

E.3.1 Mobility control during IDLE mode

This is to control the mobility of UEs during IDLE mode, i.e., cell reselection. Table E.3.1-1 summarises applicability of the drivers for different inter-frequency/RAT scenarios and necessary features to support the drivers. Note that in Tables E.3.1-1, E.3.2-1, E.3.3-1, E.3.4-1, an 'X' in the table indicates that the driver is essential, whereas an "(X)" indicates that the driver may be reduced in support depending on the complexity incurred. Furthermore in Tables E.3.1-1, E.3.2-1, E.3.3-1, E.3.4-1, the following abbreviations are used:

- L→L: LTE to LTE inter-frequency mobility;
- L→U: LTE to UTRAN inter-RAT mobility;
- U→L: UTRAN to LTE inter-RAT mobility;
- L→G: LTE to GERAN inter-RAT mobility;
- G→L: GERAN to LTE inter-RAT mobility.

Table E.3.1-1: Mobility control during IDLE (cell reselection).

#	Drivers	Applicability					Necessary features to support drivers
		L→L	L→U	U→L	L→G	G→L	
1	Radio condition	X	X	X	X	X	Inter-frequency/RAT measurements (solutions to mitigate measurement load should be considered, e.g., S-criteria); Cell reselection and reselection criteria.
2	Camp load balancing	X	X	X	(X)	(X)	Mechanism to prioritise cell reselection to certain layer/RAT, depending on the loading of layers/RATs; Load information exchange (not needed if balancing is inadaptive, i.e., only based on subscriber penetration on each band/RAT.).
3	Traffic load balancing						N/A
4	UE capability	(X)	X	X	X	X	Mechanism to prioritise cell reselection to certain layer/RAT, depending on the UE capability.
5	HCS	(X)	(X)	(X)	(X)	(X)	Mobility detection (e.g., number of crossed cells);

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							Mechanism to prioritise cell reselection to certain layer/RAT, depending on the UE speed (e.g., HCS mechanism as in UTRAN).
6	Network sharing	X	X	X	X	(X)	Mechanism to direct the UE to the appropriate PLMN at a network sharing border; Mechanism to restrict UE measurements and reselection to cells that are entitled to access.
7	Private networks / home cells	X	(X)	X		(X)	Mechanism to prioritise reselection to private/home cells that are entitled to access; Mechanism to restrict UE measurements and reselection to cells that are entitled to access; Other unidentified features, FFS.
8	Subscription / Policy based mobility control	X	X	X	(X)	(X)	Mechanism to prioritise cell reselection to certain layer/RAT, depending on the subscription information or any other operator policy (e.g., for L→L there may be cases where an operator has policy in allocating UEs to certain frequencies due to different carrier bandwidths).
9	Service based mobility control						N/A
10	MBMS	X	(X)	X			Mechanism to prioritise cell reselection to the layer/RAT, depending on whether the UE requires reception of a certain MBMS transmission.

E.3.2 Mobility control upon IDLE to ACTIVE transition

This is to control the mobility of UEs upon IDLE to ACTIVE transition, i.e., redirection upon RRC or U-plane establishment. Table E.3.2-1 summarises applicability of the drivers for different inter-frequency/RAT scenarios and necessary features to support the drivers.

Table E.3.2-1: Mobility control upon IDLE to ACTIVE transition (redirection upon RRC/U-plane establishment)

#	Drivers	Applicability					Necessary features to support drivers
		L→L	L→U	U→L	L→G	G→L	
1	Radio condition	(X)	(X)				Inter-frequency/RAT measurements (during IDLE mode or upon IDLE to ACTIVE transition) and measurement reporting upon RRC establishment (it should be investigated whether measurements can be omitted in some or all cases, e.g., co-located cells).
2	Camp load balancing						N/A
3	Traffic load balancing	X	(X)	(X)	(X)		Redirection to a certain layer/RAT (cell) upon RRC establishment, depending on the loading of layers/RATs; Load information exchange (not needed if balancing is inadaptive, i.e., only based on subscriber penetration on each band/RAT).
4	UE capability	X	(X)		(X)		Redirection to a certain layer/RAT (cell) upon RRC establishment, depending on the UE capability.
5	HCS						N/A
6	Network sharing	(X)	(X)	(X)	(X)		Redirection to a certain layer/RAT (cell) of the preferred PLMN, upon RRC establishment.
7	Private neworks / home cells	(X)					Redirection from a certain private/home cell.
8	Subscription / Policy based mobility control	X	X	(X)	(X)	(X)	Redirection to a certain layer/RAT (cell) upon RRC establishment, depending on the subscription information (if available upon establishment) or any other operator policy.
9	Service based mobility control	X	X	(X)	(X)	(X)	Redirection to a certain layer/RAT (cell) upon RRC establishment, depending on the requested service (if the service information is available

							upon establishment).
10	MBMS						N/A

E.3.3 Mobility control during ACTIVE mode

This is to control the mobility of UEs during ACTIVE mode (ECM-CONNECTED or UTRAN RRC Connected), i.e., handover. Table E.3.3-1 summarises applicability of the drivers for different inter-frequency/RAT scenarios and necessary features to support the drivers.

Table E.3.3-1: Mobility control during ACTIVE (handover)

#	Drivers	Applicability					Necessary features to support drivers
		L→L	L→U	U→L	L→G	G→L	
1	Radio condition	X	X	X	X	(X)	Gap assisted inter-frequency/RAT measurements (network controlled); Measurement reporting and reporting criteria; Inter-frequency/RAT handover (UE assisted network controlled).
2	Camp load balancing						N/A
3	Traffic load balancing	X	(X)	(X)	(X)		Inter-frequency/RAT handover (network controlled); Load information exchange (not needed if balancing is inadaptive, i.e., only based on subscriber penetration on each band/RAT).
4	UE capability	(X)	(X)	(X)	(X)		Inter-frequency/RAT handover (network controlled), depending on the UE capability.
5	HCS	(X)	(X)	(X)			Mobility detection (e.g., number of crossed cells); Inter-frequency/RAT handover (network controlled), depending on the UE speed.
6	Network sharing	X	X	X	X		Inter-frequency/RAT handover (network controlled) to a cell of the appropriate PLMN at network sharing border; Mechanism to restrict UE measurements to cells that are entitled to access.
7	Private networks /home cells	X	X	X	X	X	Inter-frequency/RAT handover (network controlled) to a private/home cell on another layer/RAT, where the UE is entitled to access; Mechanism to restrict UE measurements and reselection to cells that are entitled to access; Other unidentified features, FFS.
8	Subscription / Policy based mobility control	(X)	X	X	X	X	Inter-frequency/RAT handover (network controlled), depending on the subscription information or any other operator policy.
9	Service based mobility control	(X)	X	X	X	X	Inter-frequency/RAT handover (network controlled), depending on the service or combination of services being used or requested.
10	MBMS	X	X	X			Inter-frequency/RAT handover (network controlled), depending on whether the UE requires reception of a certain MBMS transmission.

E.3.4 Mobility control upon ACTIVE to IDLE transition

This is to control the mobility of UEs upon ACTIVE to IDLE transition, i.e., redirection upon RRC or U-plane release. Table E.3.4-1 summarises applicability of the drivers for different inter-frequency/RAT scenarios and necessary features to support the drivers.

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Table E.3.4-1: Mobility control upon ACTIVE to IDLE transition (redirection upon RRC/U-plane release)

#	Drivers	Applicability					Necessary features to support the driver
		L→L	L→U	U→L	L→G	G→L	
1	Radio condition	X	X	X	X	X	Gap assisted inter-frequency/RAT measurements (it should be investigated whether measurements can be omitted in some or all cases, e.g., co-located cells), OR Cell search upon redirection.
2	Camp load balancing	X	X	X	(X)	(X)	Redirection to a certain layer/RAT upon RRC release, depending on the loading of layers/RATs; Load information exchange (not needed if balancing is inadaptive, i.e., only based on subscriber penetration on each band/RAT).
3	Traffic load balancing						N/A
4	UE capability	X	X	X	(X)	(X)	Redirection to a certain layer/RAT upon RRC release, depending on the UE capability.
5	HCS						N/A
6	Network sharing	X	X	X	X		Redirection to a certain layer/RAT of the preferred PLMN, upon RRC release.
7	Private networks / home cells						N/A
8	Subscription / Policy based mobility control	X	X	X	(X)	(X)	Redirection to a certain layer/RAT upon RRC release, depending on the subscription information or any other operator policy.
9	Service based mobility control	(X)	(X)		(X)		Redirection (or maintaining) to a certain layer/RAT upon RRC release, depending on the service that has been used (predicting that the UE uses the same service in the future).
10	MBMS	(X)	(X)		(X)		Redirection to a certain layer/RAT upon stop of an MBMS service reception.

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Annex F (informative): Mobility and Access Control Requirements associated with Closed Subscriber Group (CSG) Cells

F.1 Access Control

The following description is provided from the perspective of the Home cell deployment, and is used as an example to understand the general requirements of Closed Subscriber Group (**CSG**) Cells.

If an operator uses the 2G or 3G systems for a deployment in a home, there are some limitations imposed by mandating that only a UE from a specific User Group can access the cell. This access restriction is needed because some backhaul links for this type of deployment are not considered to provide adequate QoS to support a large numbers of UEs, or there may be regulatory issues with sharing the backhaul link/eNB access in that location, and additionally the backhaul maybe owned by the subscriber and they may not be happy to share the link with other subscribers.

In 3G, the Access Control would work based on the Location Updating or Routing Area Updating Reject for the LA or RA which is being signalled on the cell. Each unique User Group would require its Location Area ID, however the LAC of the LA ID is only 2 octets, which needs to be shared with the normal LAs of the PLMN.

There is an additional drawback with this solution in 3G, which is that all terminals would attempt to perform the Location Updating procedure on a cell advertising a LA not on the list of forbidden LAs in the UE. The network would reject the location updating procedure of those UEs which are not in the User Group associated with the LA. This would lead to the scenario in a densely populated area, where a UE moving down the street could attempt to access a home cell at each house, before being rejected causing a wastage of battery in the terminal, and unnecessary signalling/processing load in the core network.

1. **A UE should not camp on or access a CSG Cell if it is not part of the User Group which is allowed to access that CSG Cell.**

It shall be possible to update the User Group associated with a specific Home-eNB, e.g. based on request by the registered owner of the Home-eNB, under the supervision of the network operator. When a subscriber is added to the User Group for the Home-eNB, the UE of the newly added subscriber should be able to (almost) immediately camp on the cell(s) of Home-eNB and then may acquire service through the Home-eNB. This is especially important in the deployment scenario where this subscriber has no other means to access the network, i.e. there is no Macro-layer coverage available. For this it might be necessary to update the list of allowed CSG cells for a particular UE by network signalling or other means.

2. **The subscriber registered as the owner of a CSG Cell or group of Cells, under supervision of the operator, shall be able to control/modify quickly which other subscribers form part of the User Group associated with its CSG Cell(s).**

F.2 Mobility

The Home-eNB/CSG cells should form part of the network of the operator, and therefore the design needs to support mobility of UEs between the Macro-Layer network and the Home-eNB/CSG cells. In the following text, what is called Macro layer encompasses all the cells which are not from the CSG being considered i.e. it is not about their size/coverage but the fact that they are not closed.

3. **The system shall support bidirectional handover between CSG Cells and any eNodeB (E-UTRAN) or RNC (UTRAN) or BSS (GERAN) or with another CSG Cell of the same or different CSG.**

The Home-eNBs will be deployed to improve network coverage, improve network capacity as well as offer differential billing models. As the User billing could be dependent on whether the UE is using the Home-eNB, it is important that the UE when it is range of the Home-eNB automatically camps on the Home-eNB.

4. **It shall be possible to allow UEs which are allowed to access a given CSG cell, to prioritise their camping towards the CSG Cells when in coverage of the CSG cells. To achieve this it should be possible either to set the reselection parameters accordingly or other means should allow this.**

It is important that UEs camped on the Home-eNB do not cause excessive signalling load or processing load if/when the UE moves frequently between the Macro-Layer network and the Home-eNB.

5. **The system shall avoid excessive signalling and processing load from a UE frequently reselecting in LTE Idle between the CSG Cells and the non-CSG cells of eNodeB (E-UTRAN) or RNC (UTRAN) or BSS (GERAN).**

As discussed above, the Home-eNBs will have an associated User Group describing which UEs can access the Home-eNB. The handover procedures needs to take the User Group of the Target Home-eNB into account when deciding whether to handover a UE to a specific Home-eNB. The solution for the mobility to/from the Home-eNB should avoid unnecessary signalling between the RAN nodes.

6. **The handover procedures shall take into account whether a UE is part of the User Group of the target CSG Cell. The mobility procedures should allow for prioritisation of the CSG Cells in ECM-CONNECTED when the UE enters coverage of a CSG Cell and the UE is part of the User Group of this cell.**

As the number of Home-eNBs in the network will become large, the proportion of measurements made by a UE which could be wasted may become large, to the point where it affects the mobility performance of the UE/system, as well as draining the battery of the UE. It is therefore necessary for the UE to be able to avoid unnecessary measurements of Home-eNBs where the UE does not belong to the User Group of the Home-eNB.

7. **It shall be possible to minimise the quantity of measurements which UEs perform on CSG Cells, if the UE does not belong to the User Group of a specific CSG Cell.**

Due to the high number of Home-eNBs and the nature of their deployment, it would not be practical to change the configuration for the mobility procedures (measurements, handover, etc.) in the macro layer nodes when a Home-eNB is deployed/dismissed.

8. **The mobility procedures shall allow a large number of (small) CSG Cells to be deployed within the coverage of e-UTRAN, UTRAN and GERAN macro-layer cells. Deployment of (additional) CSG Cells shall not require reconfiguration of other eNodeB (E-UTRAN) or RNC (UTRAN) or BSS (GERAN).**

In order to minimise the impact on UEs not allowed to use CSG cells or not allowed to use a particular CSG cell, means shall be provided which allow the UE to either identify prior to cell reselection that the configured neighbour cell is a CSG cell or means shall be provided which do not impact the UEs on the macro cells.

9. **The mobility procedures for moving UEs to CSG cells shall minimise impact to other UEs on the same macro cells not entitled to use CSG cells or a given CSG cell.**

It is expected that the CSG identity of a Home-eNB is static and this identity can be used by the UE to clearly identify the Home-eNB. In contrast the Physical Cell Identity (PCI) of a Home-eNB might change at power up. For example, a Home-eNB may scan the neighbour environment at every switch on, and a PCI unused by the neighbours can be selected. In most cases this will end up on the same PCI being used, as the neighbour environment did not change. During operation the Home-eNB might also change the PCI on a slow basis, in case high interference is detected. If the PCI changes, mobility shall still be supported without user intervention. It might be necessary that the change is notified to the UEs belonging to the CSG through network signalling or other means.

10. **The Physical Cell Identity (PCI) of a Home-eNB might change at each power up of the Home-eNB. Although a change of PCI is expected to be infrequent, if it changes, mobility shall still be supported without user intervention.**

The carrier frequency of a Home-eNB might only be changed during Home-eNB power up, out of a preconfigured range of frequencies. Often the pre-configured frequency range would be limited to one. If the frequency is changed, mobility shall still be supported without user intervention.

11. **The carrier frequency of a Home-eNB might be changed at power up of the Home-eNB, out of a preconfigured range of frequencies. Often the preconfigured frequency range would be limited to one. Although a change of frequency is expected to be infrequent, if it changes, mobility shall still be supported without user intervention.**

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F.3 Mobility performance guidelines

For outbound mobility from CSG cells to non-CSG cells, normal mobility procedures shall apply, i.e., network controlled mobility. As such, the normal mobility performance requirements as for non-CSG mobility should apply.

12. **For outbound mobility from CSG cells to non-CSG cells, both for idle and active mode mobility, the normal mobility performance requirements as for non-CSG mobility shall apply.**

For inbound mobility to CSG cells in active mode, it is important that the overall handover time perceived by the user, i.e., from the time the user arrives at home till the UE is connected to the CSG cell, is sufficiently short, considering that different charging policies may be applicable to CSG. However, this should not cause severe impacts on the battery consumption. It is thought that the time taken depends largely on UE implementation of the autonomous CSG search, as it is expected that the UE will apply means to reduce battery consumption in verifying the location (to trigger CSG search, based e.g., on 'fingerprint'). However, this factor is thought to be existent only in the case the CSG cell is deployed on a different frequency as the serving cell, as for intra-frequency case the UE should be able to detect the CSG cell naturally through normal intra-frequency cell search. Therefore, in case of intra-frequency mobility, the handover should be completed in the order of 1 s. In case of inter-frequency mobility, 10-30 s is expected including the autonomous CSG search time.

13. **For inbound mobility to CSG cells in active mode, the cell search, CSG identification, and handover process shall be completed in the order of 1 s in case of intra-frequency mobility. In case of inter-frequency mobility, 10-30 s is expected including the autonomous CSG search time.**

For inbound mobility to CSG cells in idle mode, in case of intra-frequency mobility, the same requirements as for non-CSG reselection should apply also to inbound reselection to CSG cells. For inter-frequency mobility, the inbound mobility is not as time critical. However, considering applicability of different tariffs and CSG/ Home-eNB identifiers to be displayed on the terminal screen, it is desirable that the UE camps on the suitable CSG cell without excessive delay. It is desirable that inbound cell reselection is possible within 20-60 s. If UE battery consumption becomes a critical issue, this requirement can be revisited.

14. **For inbound mobility to CSG cells in idle mode, cell reselection shall be completed as for normal non-CSG reselection in case of intra-frequency mobility. In case of inter-frequency mobility, it is desirable that inbound cell reselection is possible within 20-60 s.**

If the PCI or the carrier frequency of the CSG cell changes, the UE shall be able to detect this change autonomously. It is expected that the UE would look for the CSG cell based on the PCI/ carrier frequency as last stored in its memory and based on the fingerprint. Then, the UE would detect absense of the CSG cell from where it was expected, and initiate a full scan of the CSG cell. By checking the global cell identity of detected CSG cells, the UE should eventually find the CSG cell on a new PCI or carrier frequency. Such autonomous procedure shall be completed within [6 min, FFS]. Once the CSG cell has been found, the requirements 12 and 13 shall apply then on.

15. **If the PCI or the carrier frequency of the CSG cell changes, the UE shall be able to detect this change within [6 min, FFS]. The performance requirements 11 and 12 shall apply then on.**

Annex G (informative): Guideline for E-UTRAN UE capabilities

Each radio access technology has defined specific 'classes' of terminals in terms of radio capabilities. E.g. in GPRS the 'multislot classes' are defined, in UMTS R"99 different dedicated bearer classes are defined and for HSDPA and HSUPA 12 respectively 6 physical layer categories are defined. The definition of UMTS R"99 UE classes lead to 7 DL classes and 7 UL classes for FDD out of which only 2 DL and 3 UL classes were commercially realized. Furthermore the lower end classes (e.g. 64 UL and 64 DL) disappeared from the market with commercialization of the UMTS networks quite soon. Besides these class definitions a huge number of possible parameter combinations (to achieve certain data rates) exist with UMTS R"99 which lead to the huge number of RAB and RB combinations defined. Further activities in the early phase of UMTS standardization aimed to reduce the number of possible combinations significantly.

For HSDPA two 'simple' DL categories (11 & 12) with lowered complexity were defined with the intent to speed up commercialization of HSDPA. Originally those categories should have been removed for Rel-6. Out of the 12 defined categories only approx. 4 will be realized in commercial HSDPA platform products. A similar situation is likely for HSUPA as well as for the combinations of HSDPA/HSUPA.

Generally the aim to mandate certain essential functions/requirements can help to simplify the system definition as well as the realization options (e.g. mandating 20 MHz of DL reception as well as 20 MHz UL transmission bandwidth significantly reduced the E-UTRAN system complexity). Especially mandating certain terminal functions could be useful for the system design if a defined subset of parameter combinations are also supported by the systems, e.g. the eNB scheduler. However, there is also a risk that not all the defined E-UTRA features are deployed in the networks at the time when terminals are made commercially available on the market place. Some features are likely to be rather large and complex, which further increases the risk of interoperability problems unless these features have undergone sufficient interoperability testing (IOT) on real network equipment, and preferably with more than one network in order to improve the confidence of the UE implementation. Thus, avoiding unnecessary UE mandatory features but instead defining a limited set of UE radio classes allows simplification for the interoperability testing.

Given the discussion above, it seems beneficial for the introduction of E-UTRAN to limit the combination of radio capabilities to a clearly defined subset and ensure that a given set of parameters is supported by certain UE classes as well as networks for rapid E-UTRAN deployment. It seems unrealistic to mandate only one single UE class which always mandates the maximum capability.

In order to address the different market requirements (low end, medium and high end), the definition of the following UE classes are proposed:

Table G-1: E-UTRAN UE Classes

Class	UL	DL
A	[50] Mbps	[100] Mbps
B	[25] Mbps	[50] Mbps
C	[2] Mbps	[2] Mbps

NOTE: For simplification reasons, the table only depict the UE capabilities in terms of uplink and downlink peak data rates supported. However, it should be noted that further discussion on other features is expected once the work progresses.

It may require further discussion whether there be a need for an additional terminal class between 2 Mbps and 50 Mbps classes. It might make sense, since up to 5 MHz band allocations may be rather common in real deployments for several years. This would point to bit rate class of 25 Mbps in DL and 10 Mbps in UL.

The above given data rates are indicative and should be subject for further discussions in 3GPP RAN working groups. Depending on the different solutions to reach those data rates, the target should be to define [3..4] UE classes in different data rate ranges, and other parameters affecting device complexity and cost. The definition of the required parameters/features is for further study for each of the classes. For instance, half-duplex UEs form a specific category that may be frequency band specific.

NOTE: the support of half-duplex UEs is mandatory for the eNB where such a category is allowed in the frequency band supported by the eNB.

The aim is to ensure on the one hand that high end E-UTRAN UEs, supporting data rates representing state of the art level and competitive with other radio technologies are defined, while the medium and lower data rates aim to reduce implementation cost for chipset/terminal vendors and allow adoption of most cost efficient solutions for different market segments. It is expected that the support of the high end data rate terminals is ensured from the very beginning.

Another clear exception from this exercise is that on the low end very cheap product implementation is possible (e.g. for the machine-to-machine market or the voice and very low data rate only segment – to substitute GSM in the medium term) while top end performance is needed for data applications in notebooks, wireless gateways ('wireless DSL'), etc.

Another important aspect that must be ensured is that a higher capability UE can be treated in exactly the same way as for a lower capability UE, if the network wishes to do so, e.g., in case the network does not support some higher capability features. In HSDPA, there has been problems in this respect due to 2-stage rate matching in HARQ. Such problems should be avoided in E-UTRAN, and E-UTRAN UE capabilities should provide the compatibility to ease implementation and interoperability testing.

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Annex H (informative): PDCCH, PHICH and PUCCH Performance

The target qualities on PDCCH, PHICH and PUCCH of E-UTRAN are summarized respectively in the two tables below:

Table H-1: PDCCH and PHICH

Event	Target quality
DL scheduling information miss detection	(10^{-2})
UL scheduling grant miss detection	(10^{-2})
NACK to ACK error (for UL-SCH)	(10^{-4} – 10^{-3})
ACK to NACK error (for UL-SCH)	(10^{-4} – 10^{-3})

Table H-2: PUCCH

Event	Target quality
ACK miss detection (for DL-SCH)	(10^{-2})
DTX to ACK error (for DL-SCH)	(10^{-2} – 10^{-1})
NACK to ACK error (for DL-SCH)	(10^{-4} – 10^{-3})
CQI block error rate	FFS (10^{-2} – 10^{-1})

Annex I (informative): Change history

Change history (before approval)							
Date	TSG #	TSG Doc.	CR	Rev	Subject/Comment	Old	New
2006-06	RAN2 Ad.	R2-062020			First version.		0.0.0
2006-06	RAN2 Ad.	R2-062026			RLC operation clarified; High priority and low priority SRBs listed in RRC; New section on RRC procedures; Organisation of paging groups explained; New section on Support for self-configuration and self-optimisation.	0.0.0	0.0.1
2006-06	RAN2 Ad.	R2-062036			Four possible types of allocation added to section 11; New section for the support for real time IMS services.	0.0.1	0.0.2
2006-08	RAN2#54	R2-062206			Annex B on RRC and MAC control added. Minor editorial clarifications.	0.0.2	0.0.3
2006-09	RAN#34	RP-060603			Section 4 on 'Overall Architecture' reorganised; Details on RLC operation included (segmentation, PDU size); Overview of System Information and RACH procedure added.	0.0.3	0.0.4
2006-10	RAN2#55	R2-063012			Ciphering for RRC signalling required in eNB as agreed in SA3; Agreements on RLC operation included: concatenation, discard, polling and status reports; Agreed text proposal in R3-061428 on Self Configuration added to section 19; Context transfer of header compression at UPE relocation listed as FFS. Outline of the RACH procedure described.	0.0.4	0.0.5
2006-10	RAN2#55	R2-063039			Miscellaneous editorial corrections; Agreed text proposal R3-061606 on Current status of E-UTRAN Architecture description added to section 4; Agreed text proposal in R3-061613 on Support for self-configuration and self-optimisation added to section 19. Agreed Physical layer model R2-063031 added to section 5	0.0.5	0.1.0
2006-11	RAN2#56	R2-063656			Annex C on system information classification added (R2-063064); Integrity protection for the control plane only (SA3 agreement); Agreements on PDCP and RLC PDU structure/handling reflected; Decisions on mobility aspects such as load balancing, handover, radio link failure and random access procedure added; Agreed MBMS deployment scenarios listed together with MBMS transmissions and principles from 25.813; Agreed text proposal R3-061936 on Radio Resource Management added to section 15; Agreed text proposal R3-061940 on RAN Sharing added to section 10; Agreed text proposal R3-061943 on Roaming/Area Restrictions in SAE/LTE added to section 10; Agreed text proposal R3-062008 on S1 C-Plane Functions and procedures added to section 18; Agreed text proposal R3-062011 on X2 interface added to section 19.	0.1.0	0.2.0
2006-11	RAN2#56	R2-063680			Incorporation of RAN1 agreement regarding the mandatory support of 20Mhz DL bandwidth for UEs i.e. removal of sub-clause 16.1; Editorial corrections.	0.2.0	0.3.0
2006-11	RAN2#56	R2-063681			Removal of the SA3 agreement on integrity protection for the user plane; Addition of Annex D on MBMS Transmission; Editorial corrections.	0.3.0	0.3.1
2006-11	RAN#34	RP-060806			Clean version	0.3.1	0.3.1
2007-01	RAN2#56 bis	R2-070403			SA3 agreement on integrity protection for the user plane included (R2-070016); Annex E on drivers for mobility control added (R2-070276); Agreements on the details of the random access procedure added in section 10.1.5 (R2-070365); New section on UL rate control included (R2-070410); RRC security principles listed in section 13.1 (R2-070044); Agreement on MAC security added to section 13 (R2-062100); Basis for DL scheduling put in section 11.1; Assumptions on neighbour cell list included in section 10.	0.3.1	0.4.0
2007-02	RAN2#57	R2-070451			Number of bits for RACH in TDD clarified; Miscellaneous editorial corrections.	0.4.0	0.5.0

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2007-02	RAN2#57	R2-071073			Architecture updated according to R3-070397; Agreements from R2-070802.	0.5.0	0.6.0
2007-02	RAN2#57	R2-071120			RACH model for initial access described; Mapping of the BCCH and System Information principles added; Agreements on DRX included in section 12.	0.6.0	0.7.0
2007-02	RAN2#57	R2-071122			Miscellaneous clarifications	0.7.0	0.7.1
2007-02	RAN2#57	R2-071123			CCCH in DL listed as FFS; SAE Gateway ID removed from section 8.2; PDCP for the control plane listed as FFS in section 4.3.2; Agreements on intra-E-UTRAN handover procedure included in section 10.1.2 (R3-062020).	0.7.1	0.8.0
2007-03	RAN2#57	R2-071124			Agreement on Radio Access Network Sharing (R2-070551) added to section 10.1.7; Overview of the physical layer (R1-071251) included to section 5; Agreed text proposals on *S1 interface* included in Section 19 (R3-070289, R3-070402); Agreed text proposal R3-070409 on *network sharing* included in section 10.1.7; Agreed text proposal R3-070411 on *Area Restrictions* included in section 10.4; Agreed text proposal R3-070448 on *Assembly of Intra-E-UTRAN handover command* included in section 10.1.2.1.1; Agreed text proposal R3-070451 on *inter RAT HO principles* included in section 10.2.2; Agreed text proposal R3-070472 on *Addressing on S1-C and X2-C* added to sections 19.2 and 20.2; Agreed text proposal R3-070494 on *Initial Context Setup Function and Procedure* added to section 19; Agreed text proposal R3-070495 on *S1 Paging function and procedure* added to section 19 Figures for mapping between channels split into Uplink and Downlink parts in section 5.3.1 and 6.1.3.	0.8.0	0.9.0
2007-03	RAN#35	RP-070136			S1-U and S1-MME used throughout the document; aGW replaced by EPC when still used; Clean version for information	0.9.0	1.0.0

Change history (after approval)							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2007-03	RP-35	RP-070136	-		Approved at TSG-RAN #35 and placed under Change Control	1.0.0	8.0.0
2007-06	RP-36	RP-070399	0001	1	Changes to management-, handover-, paging- and NAS functions, node- synchronization, X2 UP protocol stack, X2 inter cell load management, IP fragmentation, intra-LTE HO, and TA relation to cells in eNB	8.0.0	8.1.0
	RP-36	RP-070494	0002	1	Update on Mobility, Security, Random Access Procedure, etc…	8.0.0	8.1.0
	RP-36	RP-070399	0003	-	Update on MBMS	8.0.0	8.1.0
2007-09	RP-37	RP-070637	0004	1	Update on Security, System Information, Mobility, MBMS and DRX	8.1.0	8.2.0
	RP-37	RP-070637	0005	1	Correction of synchronization, handover, trace, eMBMS architecture, and S1 common functions and procedures	8.1.0	8.2.0
2007-12	RP-38	RP-070913	0006	1	Clean up and update on security, scheduling, mobility, MBMS and DRX	8.2.0	8.3.0
	RP-38	RP-070913	0007	-	Mobility management	8.2.0	8.3.0
	RP-38	RP-070913	0008	-	Correction of eMBMS functions and NAS handling during X2 handover	8.2.0	8.3.0
	RP-38	RP-071048	0009	-	Update of Stage 2 to incorporate Interworking with cdma2000	8.2.0	8.3.0
2008-03	RP-39	RP-080192	0010	-	CR to 36.300 on NAS States, Persistent Scheduling, C-RNTI Allocation at Handover…	8.3.0	8.4.0
	RP-39	RP-080192	0011	-	RAN3 corrections to 36.300 (CR0011)	8.3.0	8.4.0
2008-05	RP-40	RP-080406	0012	1	Introduction of optimized FS2 for TDD	8.4.0	8.5.0
	RP-40	RP-080406	0013	1	System Information, Mobilty, QoS and miscellaneous updates	8.4.0	8.5.0
	RP-40	RP-080406	0014	-	Updates to Stage 2 based on Stage 3 progress on CDMA inter-working	8.4.0	8.5.0
	RP-40	RP-080406	0016	1	CR 0016r1 to 36.300 on CSG mobility performance guidelines	8.4.0	8.5.0
	RP-40	RP-080406	0017	-	CR to 36.300 on AS-NAS interaction	8.4.0	8.5.0
	RP-40	RP-080420	0018	1	RAN3 agreed changes to TS 36.300	8.4.0	8.5.0
	RP-40	RP-080463	0019	-	Network Interface for ETWS support based on CBS solution	8.4.0	8.5.0
2008-09	RP-41	RP-080688	0020	-	Correction for Rename of L1/L2 control channel	8.5.0	8.6.0
	RP-41	RP-080688	0021	-	CR to 36.300 on Paging Channel Description	8.5.0	8.6.0
	RP-41	RP-080688	0022	-	Proposed updates to Stage 2 for CDMA2000 handover	8.5.0	8.6.0
	RP-41	RP-080688	0023	-	CR to 36.300 on Semi-Persistent Scheduling	8.5.0	8.6.0
	RP-41	RP-080688	0024	-	CR to 36.300 on System Information	8.5.0	8.6.0
	RP-41	RP-080688	0026	-	Clarification of PDCCH description	8.5.0	8.6.0

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	RP-41	RP-080688	0027	-	Removal of DRX interval threshold in 36.300	8.5.0	8.6.0
	RP-41	RP-080688	0028	-	CR on Randon Access procedure	8.5.0	8.6.0
	RP-41	RP-080688	0032	1	Transport of NAS messages by AS during Handover	8.5.0	8.6.0
	RP-41	RP-080688	0034	-	CR to 36.300 capturing home eNB conclusions of RAN2 #63	8.5.0	8.6.0
	RP-41	RP-080688	0035	-	Changes to TS36.300 agreed in RAN3#61	8.5.0	8.6.0
2008-12	RP-42	RP-081016	0036	-	CR0036 to 36.300 [Rel-8] on Contention Resolution	8.6.0	8.7.0
	RP-42	RP-081016	0037	-	CR0037 to 36.300 [Rel-8] on ETWS SIB	8.6.0	8.7.0
	RP-42	RP-081016	0038	-	Alignment of 36.300 with stage 3 on 1xRTT CSfallback	8.6.0	8.7.0
	RP-42	RP-081016	0039	1	Data handling in UE during Inter-RAT mobility	8.6.0	8.7.0
	RP-42	RP-081016	0040	-	Removing of end time for dedicated preamble	8.6.0	8.7.0
	RP-42	RP-081016	0041	-	Remove the Note about RA preamble for FS2	8.6.0	8.7.0
	RP-42	RP-081016	0042	-	Clarification of AS-NAS concatenation - Stage 2	8.6.0	8.7.0
	RP-42	RP-081016	0044	-	CR 0044 to 36.300 on Miscellaneous corrections	8.6.0	8.7.0
	RP-42	RP-081016	0046	1	Proposed CR to 36.300 [Rel-8] on Security Overview	8.6.0	8.7.0
	RP-42	RP-081016	0047	-	Proposed CR to 36.300 [Rel-8] on MBMS	8.6.0	8.7.0
	RP-42	RP-081016	0050	-	PDCP reordering function removal	8.6.0	8.7.0
	RP-42	RP-081016	0052	-	Align Number of Cell Identities	8.6.0	8.7.0
	RP-42	RP-081016	0055	2	Periodic Updates In Connected Mode DRX	8.6.0	8.7.0
	RP-42	RP-081016	0056	-	Cleaning of the figure w.r.t Handover Control Plane - CR to TS 36.300	8.6.0	8.7.0
	RP-42	RP-081016	0057	-	CR to 36.300 to capture measurement model for EUTRAN	8.6.0	8.7.0
	RP-42	RP-081016	0058	2	CSG Mobility Updates from RAN2 #63bis and RAN2 #64	8.6.0	8.7.0
	RP-42	RP-081016	0059	-	CR to 36.300 on Correction of the Description of FS2	8.6.0	8.7.0
	RP-42	RP-081016	0060	-	Changes to TS36.300 agreed in RAN3#61bis and RAN3#62	8.6.0	8.7.0
2009-03	RP-43	RP-090123	0061	1	CR to 36.300 - Clarification on RAPreambles	8.7.0	8.8.0
	RP-43	RP-090123	0062	-	CR to 36.300 on E-UTRAN Identities	8.7.0	8.8.0
	RP-43	RP-090123	0063	1	CR to 36.300 - MME in temporary UE identity	8.7.0	8.8.0
	RP-43	RP-090123	0064	-	UE with SIM in EUTRA	8.7.0	8.8.0
	RP-43	RP-090123	0065	-	Collected 36.300 corrections	8.7.0	8.8.0
	RP-43	RP-090123	0066	-	CR for 36.300 on Local NACK feature	8.7.0	8.8.0
	RP-43	RP-090123	0067	-	CR for allowed CSG list	8.7.0	8.8.0
	RP-43	RP-090123	0068	3	UE capability transfer upon handover to E-UTRA	8.7.0	8.8.0
	RP-43	RP-090123	0069	1	Inter-RAT ANR Function for CDMA2000	8.7.0	8.8.0
	RP-43	RP-090123	0070	-	Corrections to Handover Scenario	8.7.0	8.8.0
	RP-43	RP-090123	0071	-	Corrections to Security for alignment with 33.401	8.7.0	8.8.0
	RP-43	RP-090134	0072	-	Establishment of X2 Interface to HeNB GW	8.7.0	8.8.0
	RP-43	RP-090134	0073	-	Clarification of PLMN id to be used in E-CGI and Global eNB ID	8.7.0	8.8.0
	RP-43	RP-090134	0074	-	Specification of UL PDUs handling	8.7.0	8.8.0
	RP-43	RP-090134	0075	-	Update of AMBR Concept with UE-AMBR and APN-AMBR	8.7.0	8.8.0
	RP-43	RP-090134	0076	-	Aligning E-RAB release request procedure with E-RAB release indication in 36.413	8.7.0	8.8.0
	RP-43	RP-090134	0077	-	Stage 2 CR on S1 CDMA2000 Tunnelling Function	8.7.0	8.8.0
	RP-43	RP-090134	0078	-	Finalisation of dynamic configuration of the X2 and S1 interfaces	8.7.0	8.8.0
	RP-43	RP-090134	0079	-	Addition and correction of X2 procedures in stage 2 specification	8.7.0	8.8.0
	RP-43	RP-090134	0080	-	NNSF Description	8.7.0	8.8.0
	RP-43	RP-090134	0081	-	Collection of minor corrections to 36.300 agreed by RAN3	8.7.0	8.8.0
	RP-43	RP-090134	0082	-	Data Forwarding Resource Release	8.7.0	8.8.0
	RP-43	RP-090134	0083	-	Support of Paging Optimisation for CSG cells	8.7.0	8.8.0
	RP-43	RP-090134	0084	-	Handling of trace session and location reporting during UE context release	8.7.0	8.8.0
2009-06	RP-44	RP-090507	0085	-	Proposed CR to 36.300 on RLC status report triggers	8.8.0	8.9.0
	RP-44	RP-090507	0086	2	Updates on UE capability transfer and container handling for E-UTRA	8.8.0	8.9.0
	RP-44	RP-090507	0089	-	Proposed CR to 36.300 Rel-8 on FFS and outdated statements	8.8.0	8.9.0
	RP-44	RP-090508	0096	-	Removal of no longer necessary notes	8.8.0	8.9.0
	RP-44	RP-090508	0097	-	Introduction of support for Cell traffic trace	8.8.0	8.9.0
	RP-44	RP-090508	0098	-	Correction the text about the UE History Information	8.8.0	8.9.0
	RP-44	RP-090538	0102	-	Configuration transfer	8.8.0	8.9.0
2009-09	RP-45	RP-090906	0105	-	Correction regarding SRVCC	8.9.0	8.10.0
	RP-45	RP-090906	0107	-	Clarification on UE behaviour in case of L2 buffer overflow	8.9.0	8.10.0
	RP-45	RP-090906	0109	-	Removal of MBMS	8.9.0	8.10.0
	RP-45	RP-090906	0125	-	Corrections to ECGI Specification	8.9.0	8.10.0
	RP-45	RP-090919	0131	-	Addition of missing Resource Status Reporting procedures	8.9.0	8.10.0
	RP-45	RP-090919	0135	-	Handling of Radio Link Failure and S1 UE Context Release Request	8.9.0	8.10.0
	RP-45	RP-090919	0139	-	Introduction of informative text on Initial Context Setup failure	8.9.0	8.10.0
2009-12	RP-46	RP-091314	0144	-	CR on the usage of Transparent Mode MAC	8.10.0	8.11.0
	RP-46	RP-091331	0147	1	ETWS correction to 36.300	8.10.0	8.11.0
	RP-46	RP-091314	0149	-	Inclusion of INTER RAT HANDOVER INFO at HO from UTRAN to GERAN	8.10.0	8.11.0

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	RP-46	RP-091314	0155	1	Correction on the precondition for cell reselection to HRPD	8.10.0	8.11.0
	RP-46	RP-091332	0176	-	Overload reduction	8.10.0	8.11.0
	RP-46	RP-091332	0181	-	In order delivery of the multiple NAS PDUs	8.10.0	8.11.0

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History

Document history		
V8.0.0	March 2007	Publication
V8.1.0	June 2007	Publication
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