Title

Updates to 44.060 § 4

Source

Lucent Technologies

Abstract

This contribution proposes the following changes to 44.060 § 4:

- It adds to the existing concept of layering the concepts of elements, interfaces, planes, and strata.
- It introduces the concepts of *Iu mode* and *A/Gb mode*.
- It provides layered overviews for all applicable planes instead of the existing one.
- It separately lists for RLC and MAC the services and functions each layer performs. This conforms to the new model presented in the stage-2 description.
- It adds the new services and functions supported in *Iu mode*.
- It explicitly lists service primitives supported by the RLC and MAC layers.
- It explicitly lists services expected from lower layers.
- It updates the format to comply with 3G TR 21.801.
- It rewords *strange* English. The rewording complies with *The Elements of Style* by William Strunk Jr. and E.B. White.

Editor's notes capture questions and comments. They are indicated by the prefix "ENote" or within angled brackets as follows: <*editor's note*>.

This contribution contains information from GAHW-010070 [Alcatel] and from GP-010676 [Motorola].

Recommendation

For information. When complete, adopt and incorporate in one of the 44.060 CR working drafts.

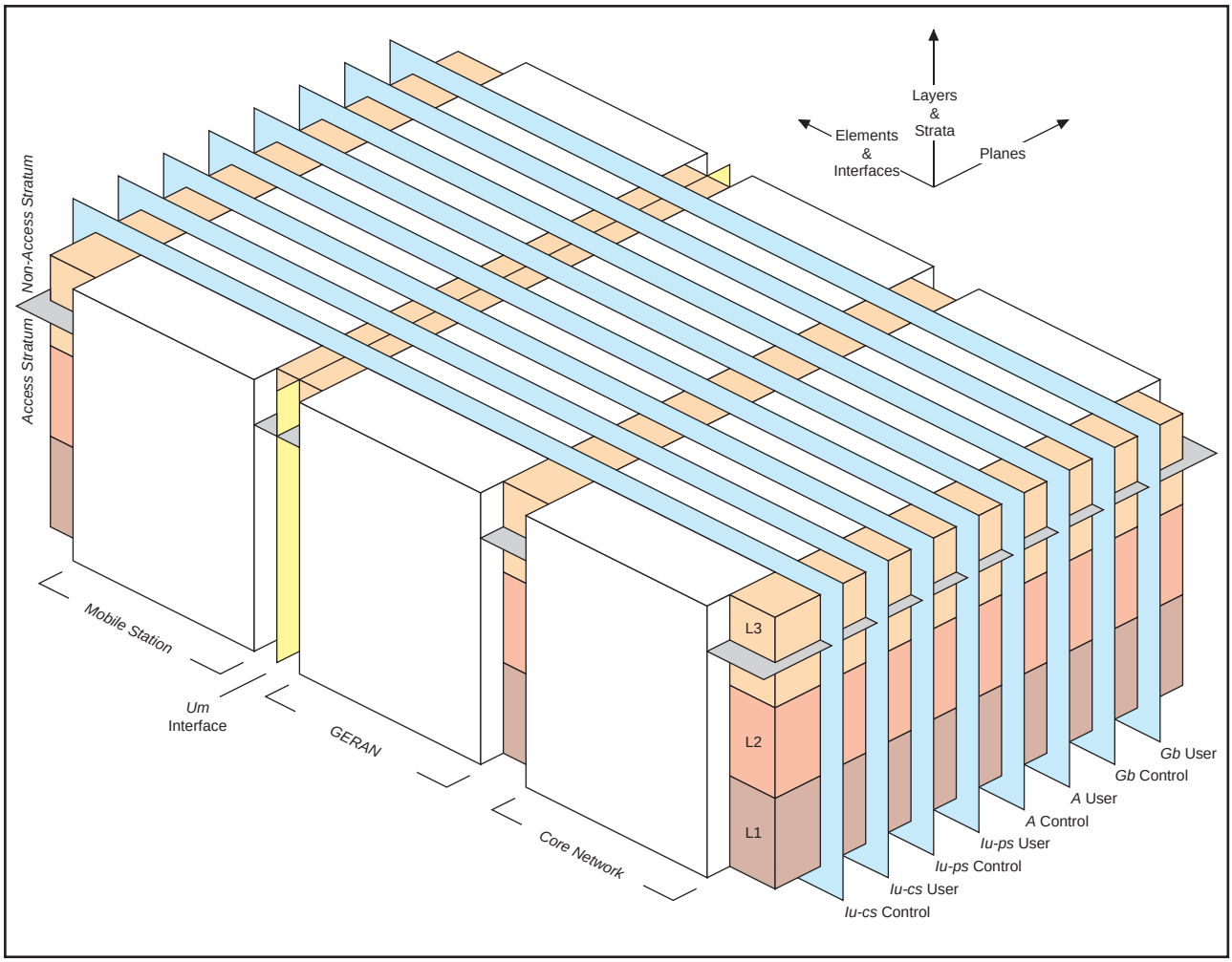
4 Layered overview of radio interface

4.a General

Figure 1 presents a layered overview of GERAN and its principle interfaces, including the air interface. The figure comprises the following:

- 3 layers: layer 1 (physical), layer 2 (data link), and layer 3 (network). These layers correspond to the layering specified in X.200 [x].
- 3 network elements: mobile station, GERAN, and core network.
- 4 network interfaces: *Iu-cs*, *Iu-ps*, *A*, and *Gb*.
- 1 air interface: *Um*.
- 8 planes: *Iu-cs* control, *Iu-cs* user, *Iu-ps* control, *Iu-ps* user, *A* control, *A* user, *Gb* control, and *Gb* user. In *Iu mode*, one or more of the *Iu* planes will be active; in *A/Gb mode*, one or more of the *A* or *Gb* planes will be active.
- 2 strata: the access stratum and the non-access stratum.

Figure 1: Overview



RLC and MAC peers reside as follows:

- On each side of the *Um* interface in the mobile station and the GERAN.
- Within layer 2.
- Within some of the planes.

For each of the eight planes, one of the figures 2 through 9 places RLC and MAC with respect to other key elements. As can be seen the figures, in *Iu mode*, RRC controls RLC and MAC; in *A/Gb mode*, RR controls RLC and MAC. Note that for the purposes of this overview, irrelevant elements may not be drawn or labelled.

Figure 2: RLC and MAC in *Iu-cs* control plane

<Insert new figure here.>

Figure 3: RLC and MAC in *Iu-cs* user plane

<Insert new figure here.>

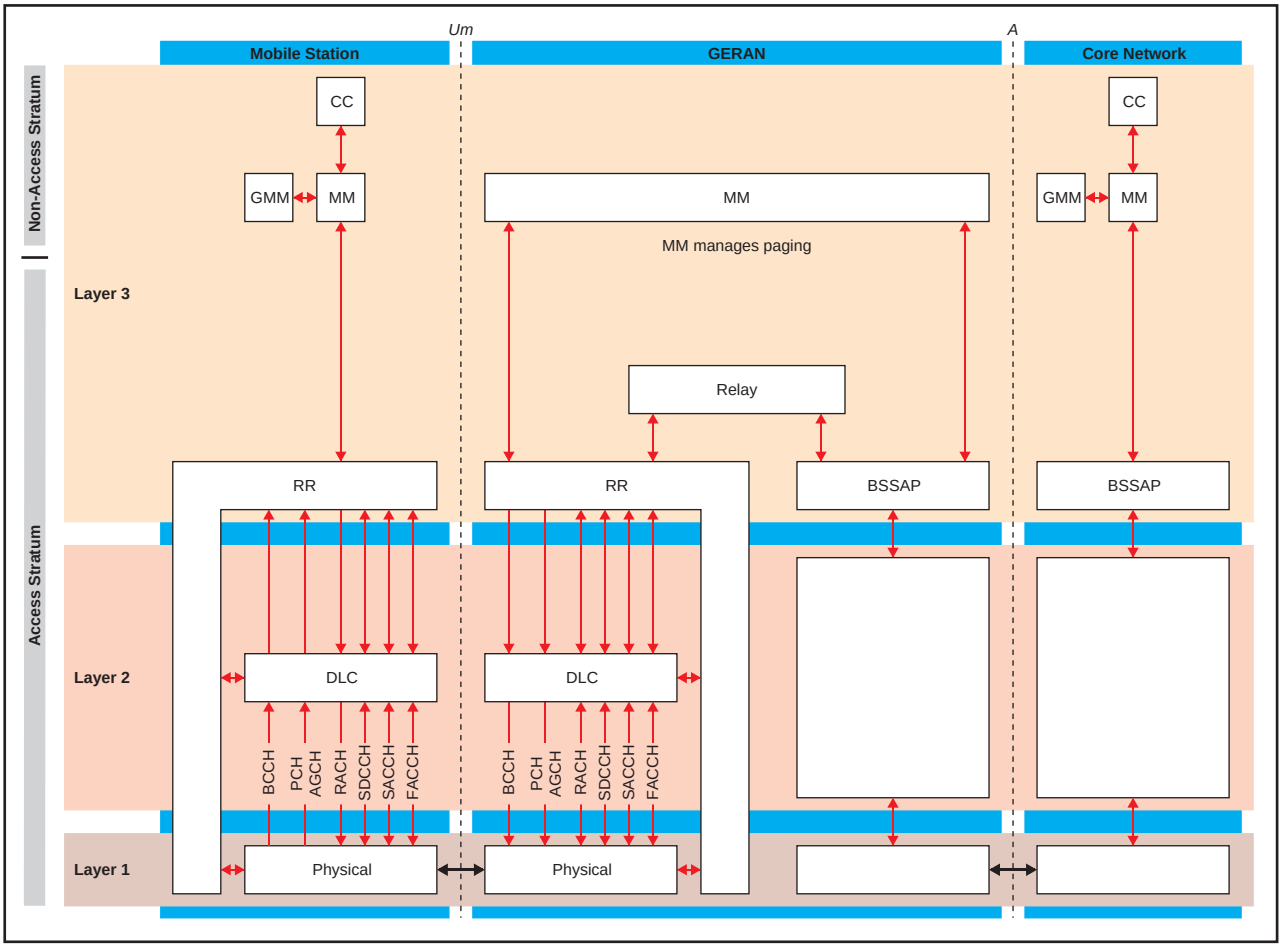
Figure 4: RLC and MAC in *Iu-ps* control plane

<Insert new figure here.>

Figure 5: RLC and MAC in *Iu-ps* user plane

<Insert new figure here.>

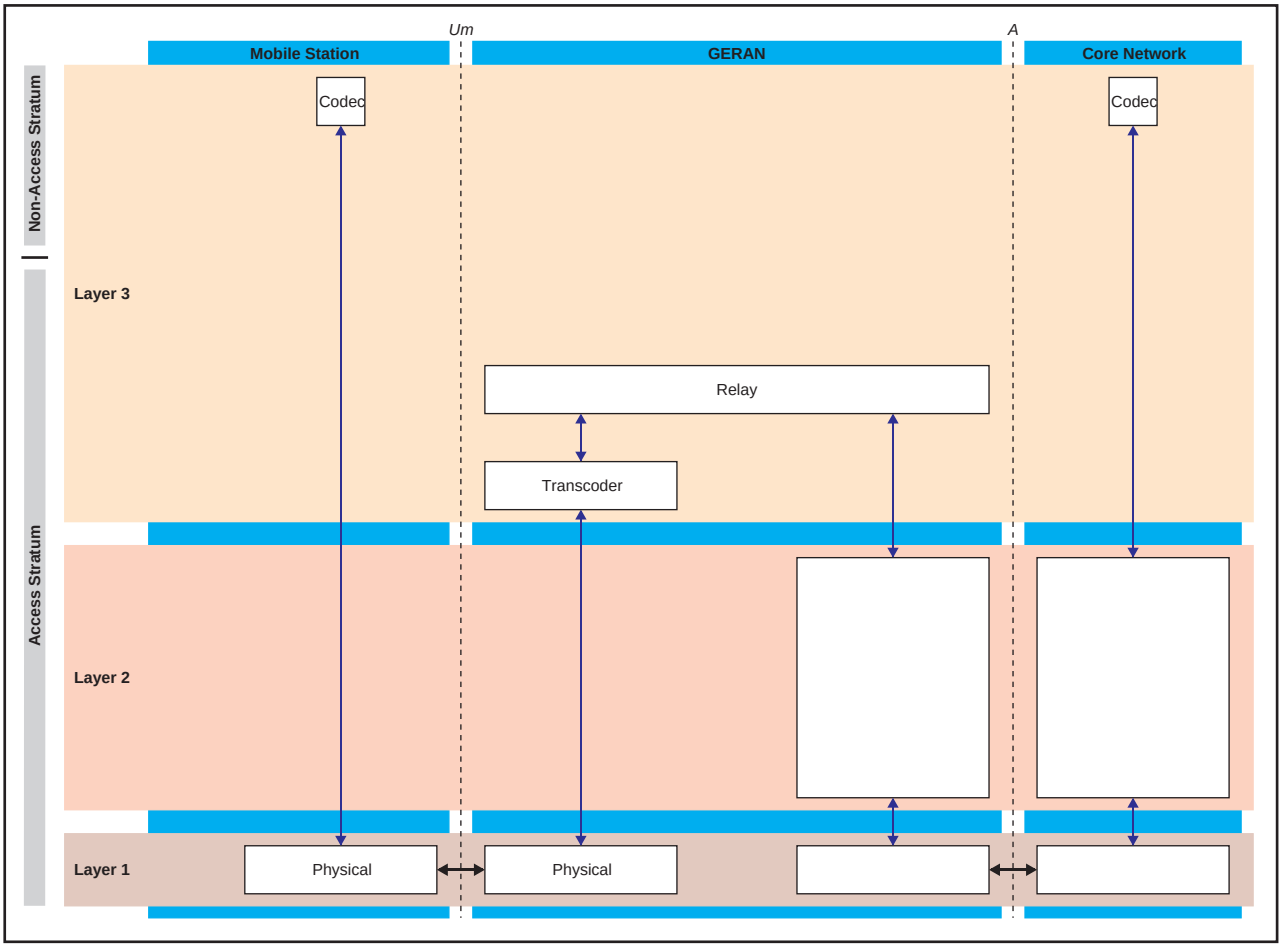
Figure 6: RLC and MAC in *A* control plane



As shown in figure 6, RLC and MAC provide no service in the *A* control plane. Via DLC, RR looks after non-packet control channels.

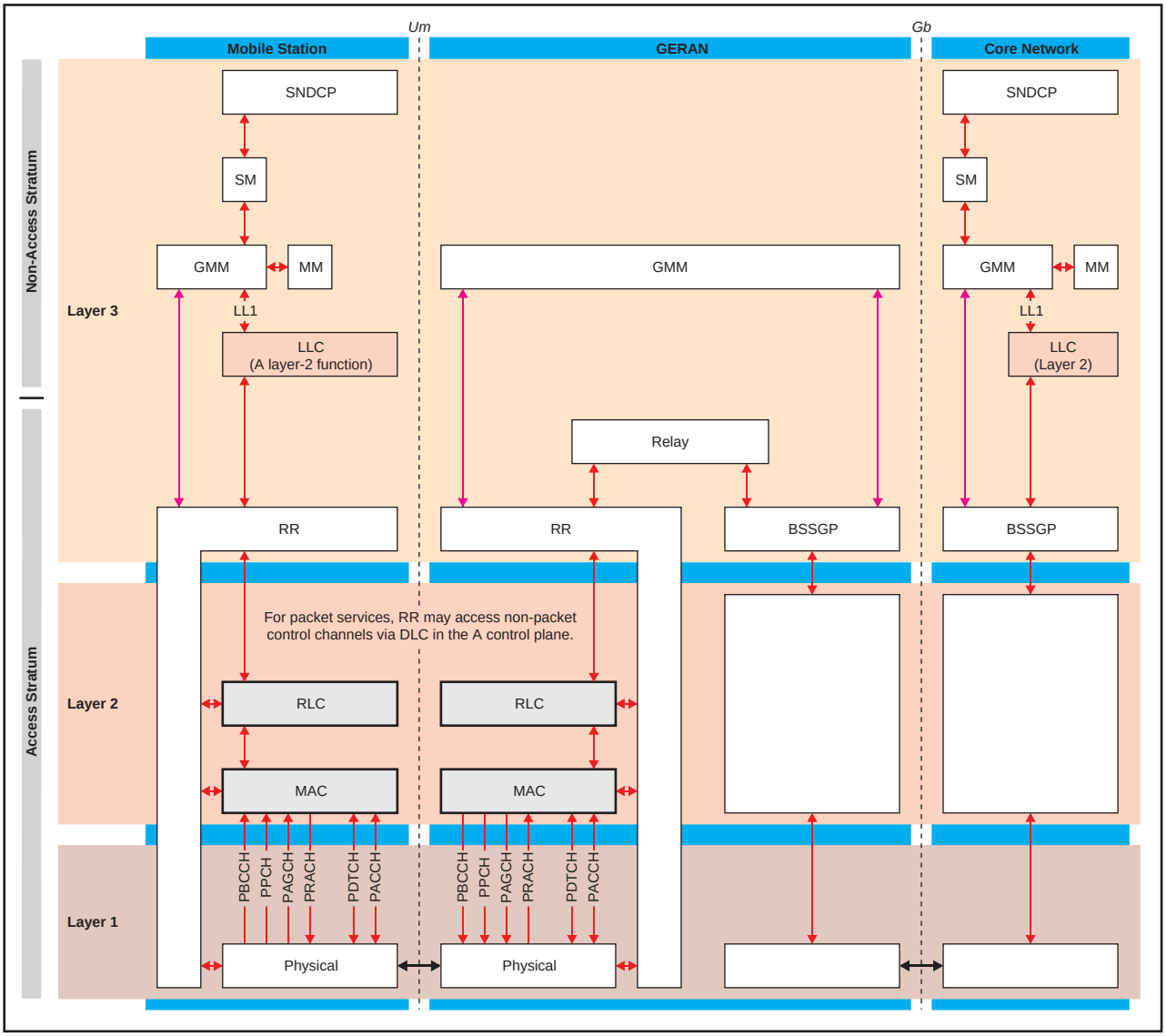
<An MM block appears in GERAN because 08.02 § 2 lists some MM functions performed by the BSS (GERAN). This also parallels the *Gb* control plane in figure 8.>

Figure 7: RLC and MAC in *A* user plane



As shown in figure 7, RLC and MAC provide no service in the *A* user plane.

Figure 8: RLC and MAC in *Gb* control plane



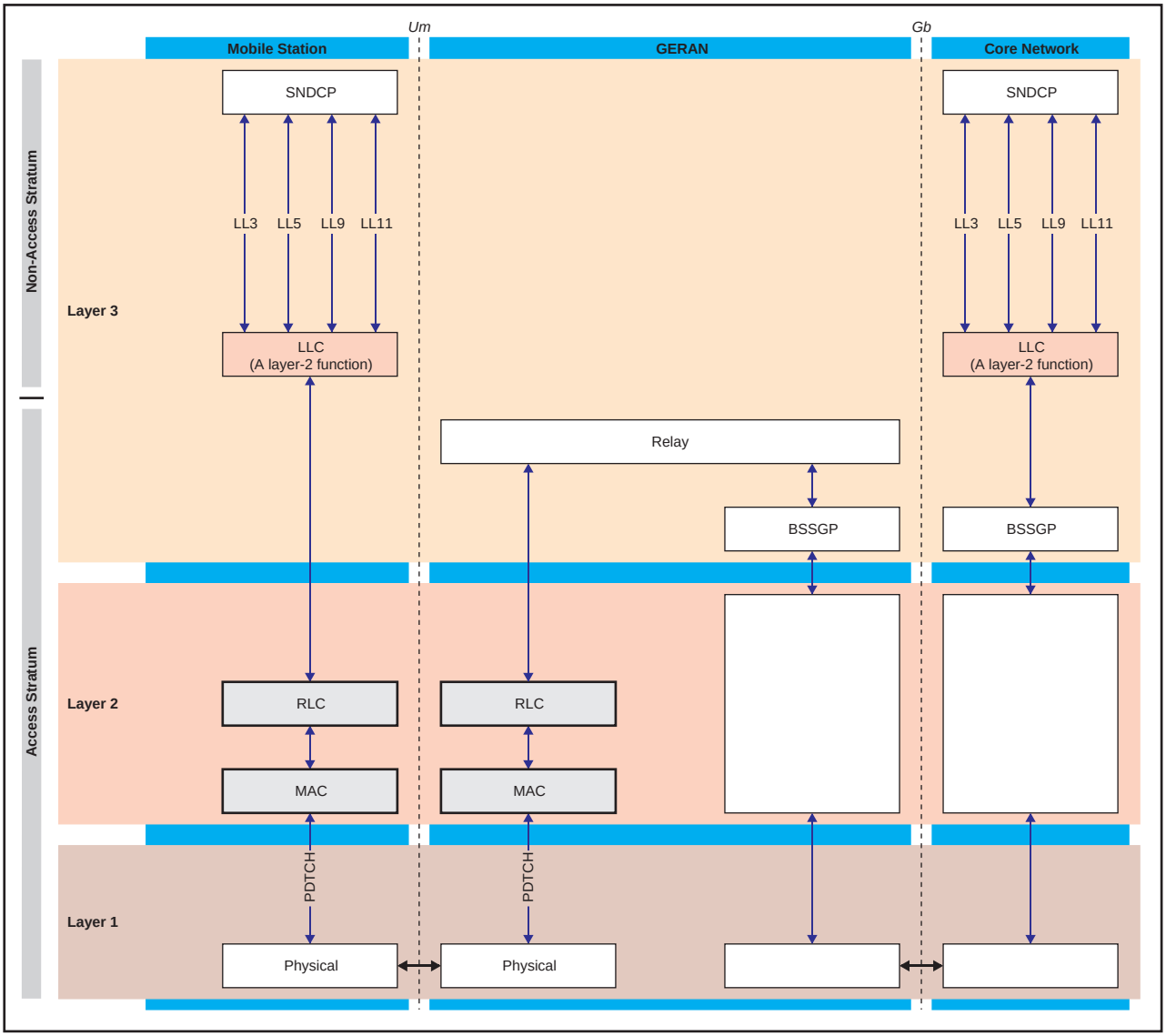
As shown in figure 8, RLC and MAC provide service in the *Gb* control plane.

Under RR control, MAC manages the packet control channels. Functions associated with these channels include broadcast of system information, paging, resource assignment, resource release, resource reconfiguration, measurement reporting, and timing-advance control. For packet services, RR may access non-packet control channels via DLC in the *A* control plane, *e.g.*, if no PBCCH is provided, the BCCH may be used to broadcast packet-service information.

Using one or more PDTCHs, RLC and MAC transport LLC PDUs between the GERAN relay function and the MS LLC layer. The LLC PDUs carry control data for logical link 1. This link serves the control-transport needs of GMM. LLC PDUs are routed via RR so that RR may steer the LLC PDUs to RLC (no RR connection exists) or to DLC (an RR connection exists) <48.018 § 6.1 and 44.018 § 3.4.26>. The physical layer may carry each PDTCH on a DPSCH or on a SPSCH.

<48.018 § 5.1 specifies that the BSS (GERAN) includes a GMM block. § 5.2 specifies the applicable service primitives.>

Figure 9: RLC and MAC in *Gb* user plane

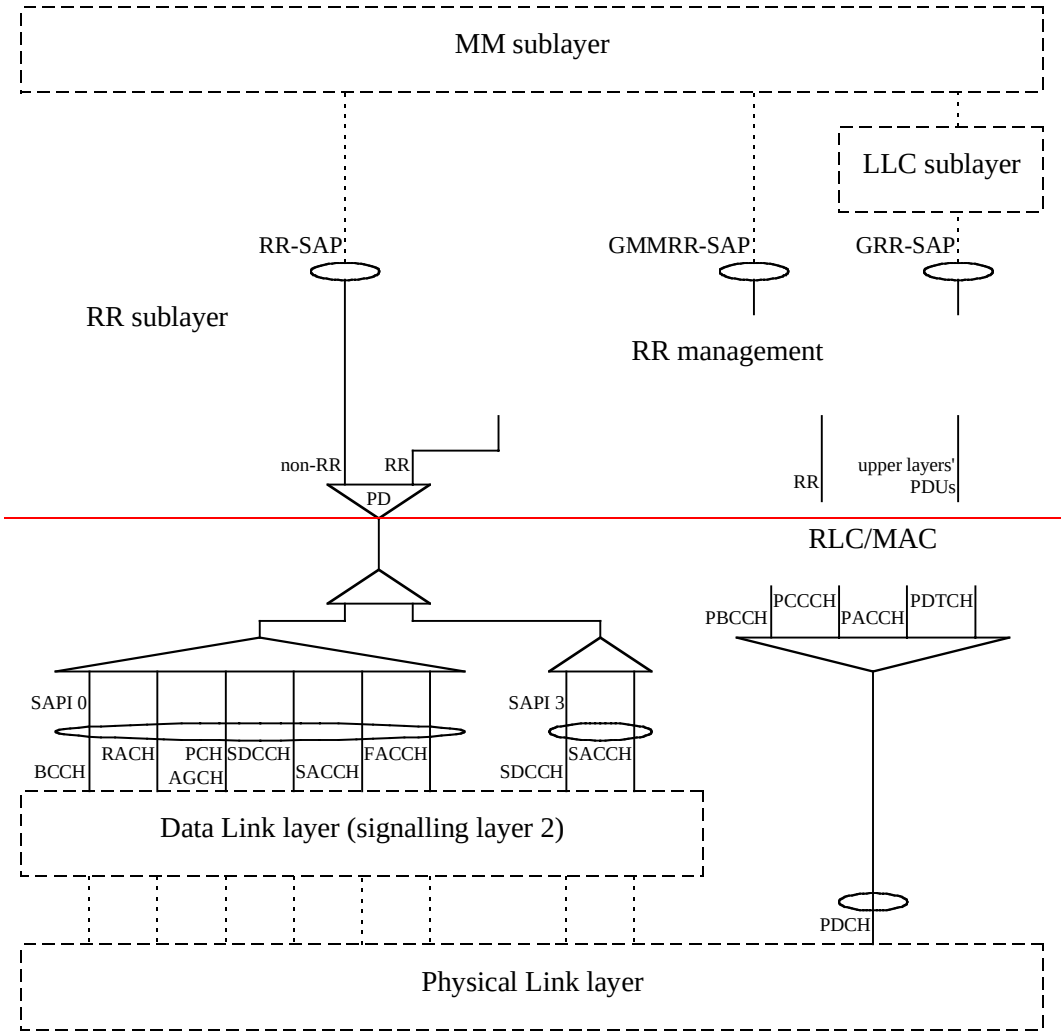


As shown in figure 9, RLC and MAC provide service in the *Gb* user plane. Using one or more PDTCHs, RLC and MAC transport LLC PDUs between the GERAN relay function and the MS LLC layer. The LLC PDUs carry user data for logical links 3, 5, 9, and 11. These links serve the data-transport needs of SNDCP. The physical layer may carry each PDTCH on a DPSCH or on a SPSCH.

~~The Radio Resource sublayer provides the functions necessary for~~

- ~~Radio Resource (RR) management of packet data physical channels (PDCHs); and~~
- ~~Radio Link Control and Medium Access Control (RLC/MAC) on packet data physical channels.~~

~~As shown in Figure , the RR sublayer provides services to the MM and LLC sublayers. The RR sublayer utilises the services of the Data Link layer (signalling layer 2) and the Physical Link layer. The packet logical channels PBCCH, PCCCH (including PPCH, PAGCH and PRACH), PACCH and PDTCH, are multiplexed onto the packet data physical channels on a per radio block basis.~~ <This is supposed to be an overview of RLC and MAC. Why are we talking about RR?>



~~Figure 1: Protocol architecture of Radio Resource (RR) sublayer and RLC/MAC function~~

4.1 Layer services

~~The RR sublayer provides services for the transfer of upper layer PDUs using a shared medium between multiple mobile stations and the network. Direct communication is only possible between the network and one or more mobile stations. The RLC/MAC function supports two modes of operation:~~

- ~~unacknowledged operation; and~~
- ~~acknowledged operation.~~

~~The RR sublayer further provides services for the paging of mobile stations.~~

4.1.1 RLC services

RLC provides the following services to upper layers:

– **Transparent data transport.**
This service transports RLC SDUs without adding any protocol information. Lower layers provide forward error correction, but the error correction does not assure reliable data transport. RLC offers this service in *Iu mode*, not *A/Gb mode*.

– **Unacknowledged data transport.**
This service transports RLC SDUs using added protocol information. Lower layers provide forward error correction, but the error correction does not assure reliable data transport. RLC offers this service in *Iu mode* and *A/Gb mode*.

- **Acknowledged data transport.**
  This service transports RLC SDUs using added protocol information. This protocol information supports backward error correction at the RLC layer; lower layers provide forward error correction. Together, these error-correction methods assure reliable data transport. RLC offers this service in *Iu mode* and *A/Gb mode*.

- **Notification of unrecoverable errors.**
  This service notifies higher layers of errors that cannot be corrected by RLC or its serving lower layers. RLC offers this service in *Iu mode* and *A/Gb mode*.

- **Notification of discard.**
  This service notifies higher layers that RLC has discarded specific RLC SDUs due to radio-bearer delay requirements.

4.1.2 MAC services

MAC provides the following services to the RLC layer:

- **Data transport.**
  This service transports MAC SDUs between MAC peers. The service provides no acknowledgement or segmentation.

4.2 Layer functions

4.2.1 RLC functions

In transparent mode, RLC has no function other than to transparently transfer data from input to output.

In one of the non-transparent modes, *unacknowledged mode*, RLC provides the following functions:

- Segmenting individual RLC SDUs into multiple transmitted RLC PDUs. Reassembling multiple received RLC PDUs into individual RLC SDUs.

- Blocking multiple RLC SDUs into individual transmitted RLC PDUs. Deblocking individual received RLC PDUs into multiple RLC SDUs.

- Padding to fill transmitted RLC PDUs. Stripping the padding from received RLC PDUs.

- Sequence-number checking of received RLC PDUs to detect missing PDUs.

- Link adaptation.

- Ciphering and Deciphering.

In the other non-transparent mode, *acknowledged mode*, RLC provides the following functions in addition to those for *unacknowledged mode*:

- Backward error correction via selective retransmission of RLC PDUs, and optionally, via incremental redundancy.

- Discard of unsegmented RLC SDUs according to the radio-bearer delay requirements.

- Sequencing to preserve RLC SDU order.

~~The RLC function defines the procedures for segmentation and reassemble of LLC PDUs into RLC/MAC blocks and, in RLC acknowledged mode of operation, for the Backward Error Correction (BEC) procedures enabling the selective retransmission of unsuccessfully delivered RLC/MAC blocks. In RLC acknowledged mode of operation, the RLC function preserves the order of higher layer PDUs provided to it.~~

~~The RLC function provides also link adaptation.~~

~~In EGPRS, in RLC acknowledged mode of operation, the RLC function may provide Incremental Redundancy (IR).~~

4.2.2 MAC functions

<This section would be cleaner if it followed a format similar to § 4.2.1. Where is MAC splitting?>

The MAC layer ~~function defines the procedures that~~ enables multiple mobile stations to share a common transmission medium.~~, which~~ This medium may consist of several physical channels. The ~~function~~ MAC layer may allow a mobile station to use several physical channels in parallel, *i.e.*, use several timeslots within the TDMA frame.

For ~~the~~ mobile-~~station originating~~originated access, the MAC ~~function~~ layer provides ~~the~~ procedures, including ~~the~~ contention-resolution procedures, for ~~the arbitration between~~arbitrating among multiple mobile stations that are simultaneously attempting to access the shared transmission medium.

For ~~the~~ mobile-~~station terminating~~terminated access, the MAC ~~function~~ layer provides ~~the~~ procedures for queuing and scheduling ~~of~~ access attempts.

In GERAN, the MAC layer sends information that controls MS measurement reporting. In the MS, the MAC layer may report such measurements to the GERAN.

The MAC handles packet-system-information messages and paging messages on packet control channels. The MAC layer controls timing advance when multiple users share a common transmission medium.

4.2.2.1 Additional MAC functions for RLC transparent mode

When the MAC layer offers services to a transparent-mode RLC entity, it ciphers transmitted user-data blocks and deciphers received user-data blocks.

4.2.2.2 Additional MAC functions for RLC non-transparent mode

When the MAC layer offers services to one or more non-transparent-mode RLC entities, it multiplexes and schedules transmitted data flows, and it demultiplexes received data flows. These flows may be from one or more mobile stations. The MAC layer also multiplexes and schedules transmitted user-data blocks and transmitted control blocks. The MAC layer demultiplexes received data blocks and received control blocks.

4.3 Service primitives

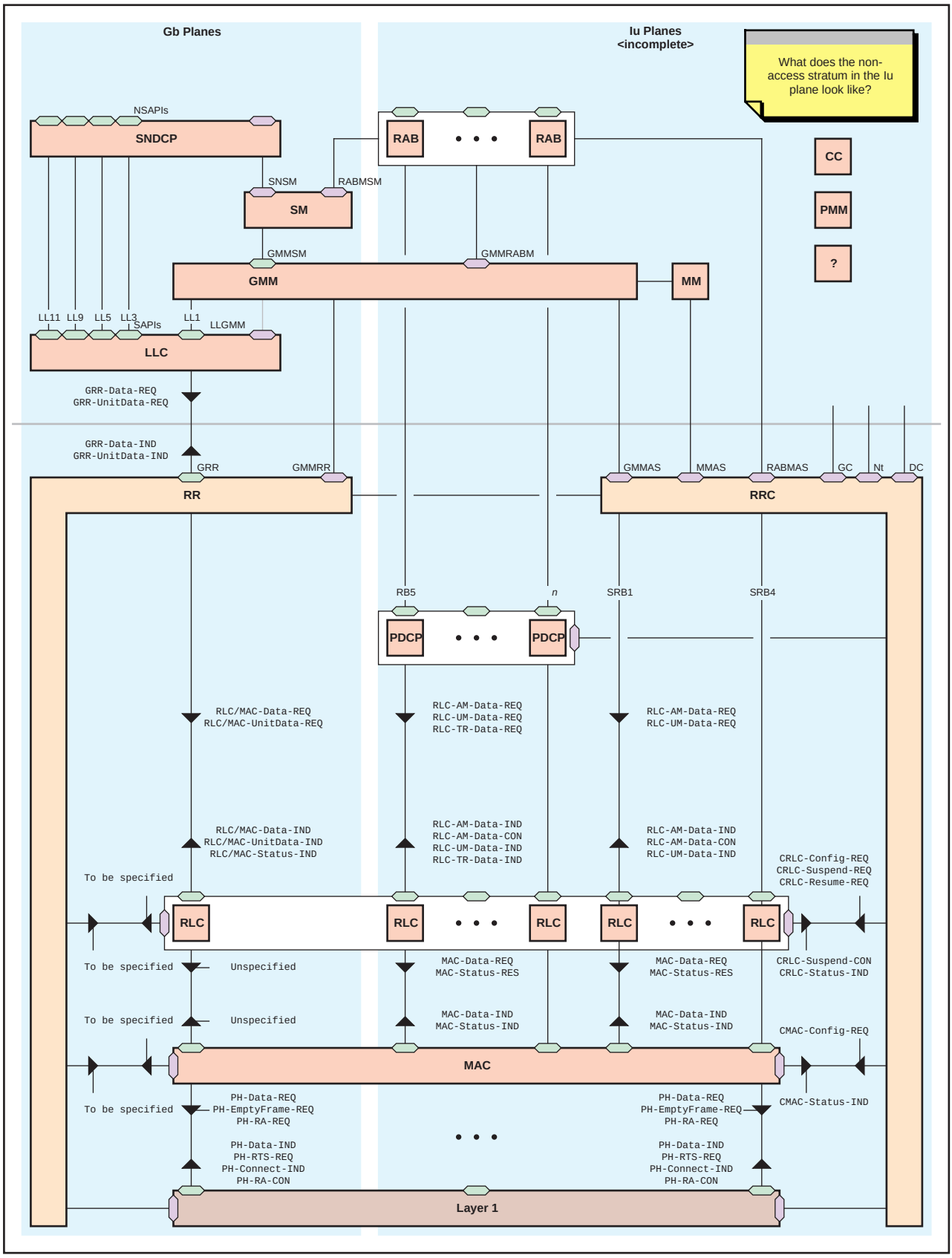
~~Information flow between layers is performed by the use of Service Primitives. Service Access Points (SAP) and their corresponding Service Primitives for the RR sublayer are defined in 3GPP TS 04.07.~~ <Interesting information, but irrelevant for this RLC/MAC specification.>

The mobile-station RLC and MAC use the service primitives shown in Figure 11. The GERAN RLC and MAC use similar primitives. Service primitives represent, in an abstract way, the exchange of data and control between a layer and adjacent layers and between entities within the same layer. They do not specify or constrain implementations.

<To be sufficiently obscure, and to increase the number of implementation errors, none of the procedures in this document use the service primitives summarized in this section.>

<Below each primitive, each of the tables in this section indicates the 3GPP specification that uses the primitive. Note that the GRR primitives specified in 04.64 appear to perform the same services as the RLC/MAC primitives specified in 43.064. PDCP expects to see the service primitives specified in 25.322.>

Figure 11: Service primitives used in mobile station <incomplete>



4.3.1 Service primitives in the *Iu* planes

Table 0.1 summarizes service primitives RLC uses to provide service to higher layers via each data SAP in the *Iu* planes.

Table 0.1: Service primitives exchanged via RLC data SAPs in the *Iu* planes

Primitive	Description
RLC-AM-Data-REQ <25.322>	The higher layer (PDCP or RRC) requests acknowledged transmission of an RLC SDU.
RLC-AM-Data-IND <25.322>	RLC indicates error-free reception of an RLC SDU or RLC indicates discard of an SDU received with errors.
RLC-AM-Data-CON <25.322>	RLC confirms acknowledged transmission of an RLC SDU.
RLC-UM-Data-REQ <25.322>	The higher layer requests unacknowledged transmission of an RLC SDU.
RLC-UM-Data-IND <25.322>	RLC indicates reception of an RLC SDU. The SDU may or may not have errors.
RLC-TR-Data-REQ <25.322>	The higher layer requests transparent transmission of an RLC SDU.
RLC-TR-Data-IND <25.322>	RLC indicates reception of an RLC SDU. The SDU may or may not have errors.

Table 0.2 summarizes service primitives MAC uses to provide service to RLC via each data SAP in the *Iu* planes.

Table 0.2: Service primitives exchanged via MAC data SAPs in the *Iu* planes

Primitive	Description
MAC-Data-REQ <25.321>	RLC requests transmission of a MAC SDU.
MAC-Data-IND <25.321>	MAC indicates reception of a MAC SDU.
MAC-Status-IND <25.321>	MAC indicates the rate at which PDUs may be transferred to MAC.
MAC-Status-RES <25.321>	RLC responds that it has nothing to send or that it is suspended.

Table 0.3 summarizes service primitives RLC uses to provide internal set up and configuration in the *Iu* control plane.

Table 0.3: Service primitives exchanged via the RLC control SAP in the *Iu* control plane

Primitive	Description
CRLC-Config-REQ <25.322>	RRC requests establishment, release, or reconfiguration of RLC.
CRLC-Suspend-REQ <25.322>	RRC requests RLC suspend transmission.
CRLC-Suspend-CON <25.322>	RLC confirms suspension.
CRLC-Resume-REQ <25.322>	RRC requests RLC resume transmission.
CRLC-Status-IND <25.322>	RLC indicates status information to RRC.

Table 0.4 summarizes service primitives MAC uses to provide internal set up and configuration in the *Iu* control plane.

Table 0.4: Service primitives exchanged via the MAC control SAP in the *Iu* control plane

Primitive	Description
CMAC-Config-REQ <25.321>	RRC requests establishment, release, or reconfiguration of MAC.
CMAC-Status-IND <25.321>	MAC indicates status information to RRC.

4.3.2 Service primitives in the *Gb* planes

Table 0.5 summarizes service primitives RLC/MAC uses to provide service to higher layers via the data SAP in the *Gb* user plane and *Gb* control plane. 3GPP TS 04.64 and 3GPP TS 43.064 specify these primitives.

Table 0.5: Service primitives exchanged via the RLC/MAC data SAP in the *Gb* planes

Primitive	Description
GRR-Data-REQ <04.64>	The higher layer (LLC) requests acknowledged (reliable) transmission of an RLC/MAC SDU (Service Data Unit). As per X.200, when delivered to RLC/MAC, an LLC PDU (Protocol Data Unit) becomes an RLC/MAC SDU. <The primitive names would indicate that RR provides the service, which is what 24.007 Annex C shows.>
GRR-Data-IND <04.64>	RLC/MAC indicates error-free reception of an RLC/MAC SDU.
GRR-UnitData-REQ <04.64>	The higher layer requests unacknowledged transmission of an RLC/MAC SDU.
GRR-UnitData-IND <04.64>	RLC/MAC indicates reception of an RLC/MAC SDU. The SDU may or may not have errors.
RLC/MAC-Data-REQ <43.064>	The higher layer requests acknowledged transmission of an RLC/MAC SDU.
RLC/MAC-Data-IND <43.064>	RLC/MAC indicates reception, without errors, of an RLC/MAC SDU.
RLC/MAC-UnitData-REQ <43.064>	The higher layer requests unacknowledged transmission of an RLC/MAC SDU.
RLC/MAC-UnitData-IND <43.064>	RLC/MAC indicates reception of an RLC/MAC SDU. The SDU may or may not have errors.
RLC/MAC-Status-IND <43.064>	RLC/MAC indicates an error has occurred.

<We seem to have two sets of primitives that do the same thing. Perhaps these primitives can work, or were expected to work, as follows:

- LLC (the higher layer with respect to RR) obtains service from RR using the GRR primitives.
- RR (the higher layer with respect to RLC) obtains service from RLC/MAC using the RLC/MAC primitives.

To send data, LLC would issue a GRR-Data-REQ to RR and RR would immediately issue an RLC/MAC-Data-REQ to RLC/MAC. If this is true, then only the RLC/MAC service primitives should appear in this standard.>

Table 0.6 summarizes service primitives RLC uses to provide internal set up and configuration in the *Gb* control plane.

Table 0.6: Service primitives exchanged via the RLC control SAP in the *Gb* control plane

Primitive	Description
	<We should probably define some control service primitives that RLC exchanges with RR. The following example could be used by RR to pass the TLLI received from GMM in a GMMRR-Assign-REQ.>
CRLC-Config-REQ	RR requests configuration of RLC. The primitive includes a TLLI assignment.

Table 0.7 summarizes service primitives MAC uses to provide internal set up and configuration in the *Gb* control plane.

Table 0.7: Service primitives exchanged via the MAC control SAP in the *Gb* control plane

Primitive	Description
	<We should probably define some control service primitives that MAC exchanges with RR.>

4.3.3 Service primitives exchanged with lower layers

Table 0.8 summarizes service primitives MAC uses to obtain service from lower layers. 3GPP TS 04.04 <check reference> specifies these primitives. Note that this document calls an RLC/MAC PDU (Protocol Data Unit) an *RLC/MAC block.*

<The specification of *radio block* appears to be inconsistent. 44.060 § 10 indicates a *radio block* does not include the BCS (Block Check Sequence); 43.064 indicates a *radio block* does include the BCS. Also, 05.03 specifies that the physical layer calculates the block code. It therefore appears that a *radio block* should be equivalent to an RLC/MAC block with an appended BCS.>

Table 0.8: Service primitives exchanged with lower layers via the physical-layer SAPs (all planes)

Primitive	Description
PH-Data-REQ <04.04, 43.064>	The RLC/MAC requests transmission of an RLC/MAC PDU (Protocol Data Unit). As per X.200, when delivered to the physical layer, an RLC/MAC PDU becomes a physical-layer SDU.
PH-Data-IND <04.04, 43.064>	The physical layer indicates reception of an RLC/MAC PDU.
PH-Ready-to-Send-REQ <04.04, 43.064>	The physical layer indicates it is ready to transmit a physical-layer SDU (Service Data Unit).
PH-Empty-Frame-REQ <04.04, 43.064>	RLC/MAC requests transmission of no RLC/MAC PDU (the empty frame).
PH-Connect-IND <04.04, 43.064>	The physical layer indicates connection of the control or data channel.
PH-RA-REQ <04.04>	The MS RLC/MAC requests random-access transmission of an RLC/MAC PDU.
PH-RA-IND <04.04>	The GERAN RLC/MAC indicates an RLC/MAC PDU received via a random-access channel.
PH-RA-CON <04.04>	The MS physical layer confirms random-access transmission of an RLC/MAC PDU.

4.4 Services required from lower layers

~~The~~ RLC/MAC ~~function~~ uses the services provided by the physical link layer as ~~defined~~ specified in 3GPP TS 04.04. In the MS and GERAN, these services are as follows: access (transmission service), error detection, and encryption (*A/Gb mode* only). In the MS, additional services are as follows: establishment of dedicated channels, establishment of shared channels, and cell/PLMN selection.

~~The RR sublayer may use the services provided by the data link layer as defined in 3GPP TS 04.05. Moreover, the RR sublayer directly uses services provided by the physical layer such as BCCH searching, as defined in 3GPP TS 04.04.~~
<Interesting information, but irrelevant for this RLC/MAC specification.>