

## 1   **Title**

---

2                    GERAN Design

## 3   **Source**

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4                    Lucent Technologies

## 5   **Abstract**

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6                    This contribution proposes a layered design for GERAN. The proposal  
7                    derives from the existing stage-2 description and from 3G TS 25.301  
8                    (*Radio Interface Protocol Architecture*).

9                    Tdoc 2g00-081 (*GERAN Example Scenarios*), which this document  
10                  supplements, shows the signaling and data flows between layers.

## 11   **Recommendation**

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12                  Adopt the proposed design as a basis for further development.

13                  Complete detailed block diagrams of the physical, MAC, and RLC  
14                  layers. GERAN-003 is an example of a detailed block diagram.

15                  Don't worry too much about detailed document structure until the  
16                  GERAN design firms up. The GERAN design shouldn't be considered  
17                  firm until detailed block diagrams of all layers are available, interlayer  
18                  service primitives are adopted, and a reasonable number of detailed  
19                  sequence diagrams have been prepared.

20                  Based on the design presented in this contribution, we propose the  
21                  high-level document structure in § 7.

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## Revision History

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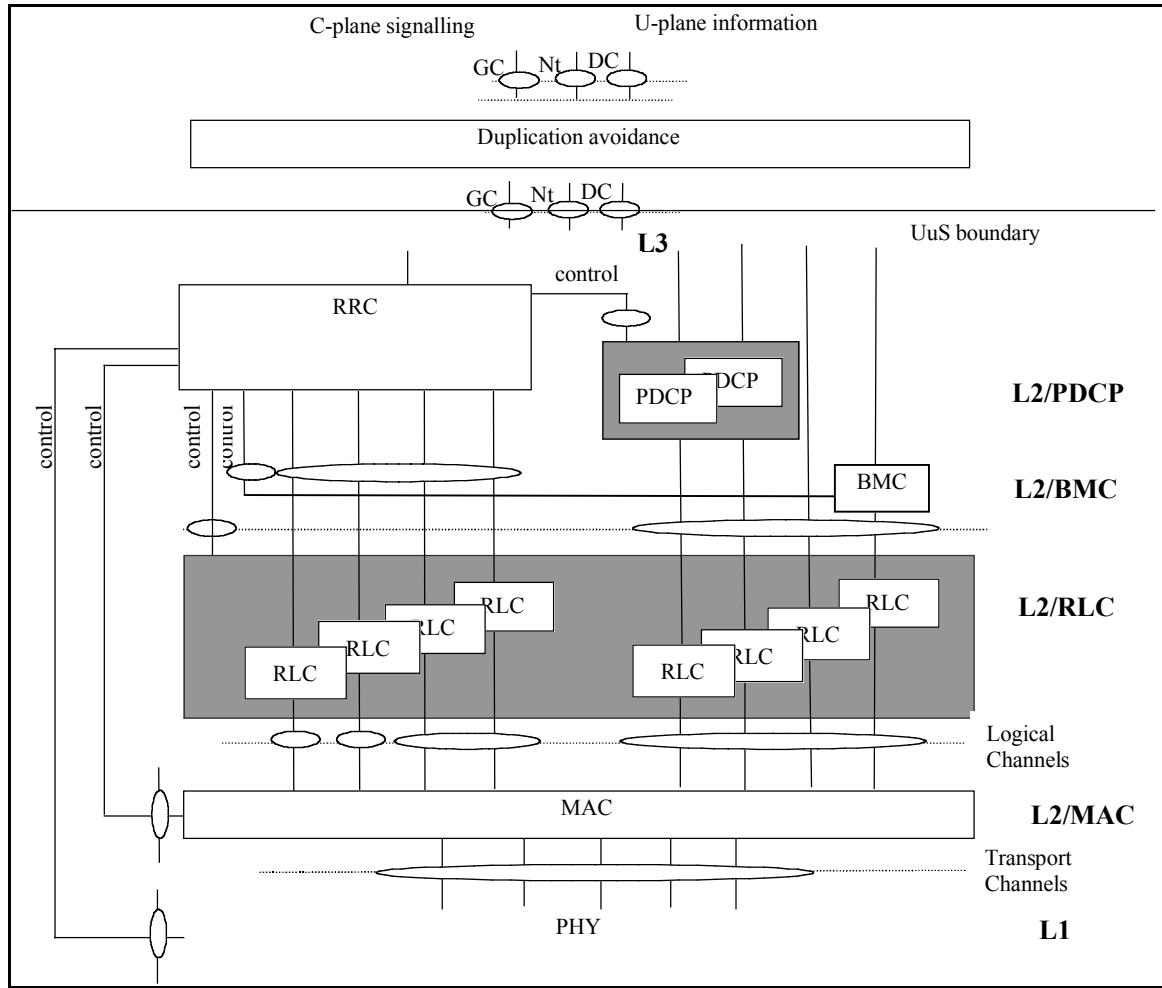
Date	Description
07 August 2000	First release.

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# 1. Overview

Figure 1 reproduces Figure 2 from 3G TS 25.301 [1]. The figure shows the radio protocol architecture for UTRAN (Universal Mobile Telecommunications System Terrestrial Radio Access Network). The GERAN design proposed in this document derives from this figure.

Figure 1 Radio Interface Protocol Architecture (from 3G TS 25.301)



Drawing GERAN-002 presents a layer diagram for the mobile-station side of GERAN. The diagram shows the following layers:

- Layer 1 comprises the physical layer.
- Layer 2 comprises the medium-access-control layer (MAC), the data-link-control layer (DLC), the radio-link-control layer (RLC), and the packet-data-control layer (PDCP).
- Layer 3 comprises radio-resource control (RRC). RRC manages and controls the other layers.

1           The diagram also shows three snapshots. Each snapshot captures the  
2           configuration of the layers at one point in time:

- 3           • Snapshot 1 is immediately after RRC has configured broadcast  
4           and common control channels.
- 5           • Snapshot 2 is immediately after RRC has obtained radio  
6           resources and set up a temporary block flow to send an *Attach*.
- 7           • Snapshot 3 is immediately after RRC has set up an optimized  
8           speech bearer (RAB1) and a data bearer (RAB2). RAB2  
9           normally transports data when RAB1 isn't transporting speech.

## 1      **2. Physical Layer**

---

2            Under control of RRC, the physical layer provides transport channels.  
3            Transport channels, in turn, comprise elementary channels. Drawing  
4            GERAN-003 presents a detailed block diagram of the physical layer  
5            (This diagram is incomplete).

### 6      **2.1 Elementary Channels**

---

7            An elementary channel is the smallest unit of radio resource that the  
8            physical layer exposes to the upper layer.

9            In general, physical structure, not content, characterizes an elementary  
10          channel; however for some content, such as optimized speech, the  
11          resulting physical structure precludes the channel's use for anything  
12          else.

13          Any combination of the following physical characteristics may define  
14          an elementary channel:

- 15            • Direction of transmission.
- 16            • Carrier frequency.
- 17            • Modulation.
- 18            • Burst type within a timeslot.
- 19            • Timeslot within a frame.
- 20            • Frames within a multiframe.
- 21            • Physical-layer header (stealing bits).
- 22            • Encryption.
- 23            • Channel coding.

24          These various characteristics can be seen in Drawing GERAN-003,  
25          roughly in order from bottom to top.

26          The physical layer need only expose to layer 2 a subset of possible  
27          elementary channels. The physical layer in Drawing GERAN-002  
28          exposes the following: DECH (Data Elementary Channel), SACH  
29          (Slow Associated Channel), SECH (Speech Elementary Channel), and  
30          USFCH (Uplink-State-Flag Channel).

31          Each elementary channel has a connection endpoint within a service  
32          access point.

## 1      2.1.1      DECH (Data Elementary Channel)

---

2      DECH has the following physical characteristics:

<b>Transmission direction</b>	Up or down.
<b>Carrier frequency</b>	Any.
<b>Burst type</b>	Normal.
<b>Timeslot</b>	0, 1 ... 7.
<b>Frames</b>	<b>Full-Rate</b> All except frames 12 or 25 in any 26-multiframe. <b>Half-Rate</b> All even frames less than 13 and all odd frames more than 13 in any 26-multiframe. All odd frames less than 13 and all even frames more than 13 in any 26-multiframe.
<b>Header</b>	11111111, 00010110, 00000000, 11100111.
<b>Encryption</b>	None.
<b>Modulation and coding</b>	CS-1, MCS-1 through MCS-9.

3  
4      DECH transports generalized data, including non-optimized speech. It  
5      provides the following services to the layer above:

- 6      • Data transport.  
7      • Forward error correction with incremental redundancy.

8      DECH provides these services via the following primitives:

Service Primitive	Description
PHY-Connect-IND	DECH indicates it is available.
PHY-Data-REQ {SDU, MCS}	The higher layer requests that DECH transmit the supplied data (Service Data Unit) using the indicated modulation and coding.
PHY-Data-IND {Header, CS-1 Data, MCS Data, Block ID}	DECH indicates data delivery to the higher layer. The delivered information comprises higher-layer header, CS-1 data if available, MCS data if available, or if no data is available, a block identifier. The block identifier allows a higher layer to specify which blocks should be combined for incremental redundancy.
PHY-Decode-REQ {Block List}	The higher layer requests that DECH decode the listed blocks as one set of convolutionally-coded data.
PHY-Decode-CON {MCS Data}	DECH confirms it has decoded the convolutionally-coded data.
PHY-EmptyFrame-REQ	The higher layer indicates it has no data to send.
PHY-RTS-IND	DECH indicates it is ready to send data. Half-rate channels send this primitive at half the rate of full-rate channels.

## 1      2.1.3      SACH (Slow Associated Channel)

---

2      SACH has the following physical characteristics:

<b>Transmission direction</b>	Up or down.
<b>Carrier frequency</b>	Any.
<b>Burst type</b>	Normal or Access.
<b>Timeslot</b>	0, 1 ... 7.
<b>Frames</b>	<b>Full-Rate</b> Frame 12 in every 26-multiframe. <b>Half-Rate</b> Frame 12 in every 26-multiframe. Frame 25 in every 26-multiframe.
<b>Header</b>	11111111
<b>Encryption</b>	None.
<b>Modulation and coding</b>	CS-1.

3

4      SACH transports data in association with a DECH or a SECH. It  
 5      provides the following services to the layer above:

- 6
- Data transport.
  - Forward error correction.
- 7

8      SACH provides these services via the following primitives:

Service Primitive	Description
PHY-Connect-IND	SACH indicates it is available.
PHY-Data-REQ <i>{Data}</i>	The higher layer requests that SACH transmit the supplied data.
PHY-Data-IND <i>{Data}</i>	SACH indicates data delivery to the higher layer.
PHY-RandomAccess-REQ <i>{Data}</i>	The higher layer requests that SACH transmit the supplied data using a random access.
PHY-RandomAccess-CON <i>{Frame Number}</i>	SACH confirms data transmission during the frame number indicated.
PHY-EmptyFrame-REQ	The higher layer indicates it has no data to send.
PHY-RTS-IND	SACH indicates it is ready to send data.

9

## 1 2.1.4 SECH (Speech Elementary Channel)

---

2 SECH has the following physical characteristics:

<b>Transmission direction</b>	Up or down.
<b>Carrier frequency</b>	Any.
<b>Burst type</b>	Normal.
<b>Timeslot</b>	0, 1 ... 7.
<b>Frames</b>	<b>Full-Rate</b> All except frames 12 or 25 in any 26-multiframe. <b>Half-Rate</b> All even frames less than 13 and all odd frames more than 13 in any 26-multiframe. All odd frames less than 13 and all even frames more than 13 in any 26-multiframe.
<b>Header</b>	11111111, 11110000, 00001111.
<b>Encryption</b>	Algorithm?
<b>Modulation and coding</b>	TCH/AFS, TCH/AHS.

- 3
- 4 SECH transports optimized speech. It provides the following services  
5 to the layer above:
- 6     • Transport of adaptive multirate speech.
- 7     • Forward error correction.

8 SECH provides these services via the following primitives:

Service Primitive	Description
PHY-Connect-IND	SECH indicates it is available.
PHY-Data-REQ <i>{Data, Speech, Coding}</i>	The higher layer requests that SECH transmit the supplied in-band data and speech frame using the indicated modulation and coding.
PHY-Data-IND <i>{Data, Speech}</i>	SECH indicates data delivery to the higher layer. The delivered information comprises in-band data and speech frame.
PHY-EmptyFrame-REQ	The higher layer indicates it has no data to send.
PHY-RTS-IND	SECH indicates it is ready to send data. Half-rate channels send this primitive at half the rate of full-rate channels.

## 1    2.1.5    USFCH (Uplink-State-Flag Channel)

---

2                    USFCH has the following physical characteristics:

<b>Transmission direction</b>	Down.
<b>Carrier frequency</b>	Any.
<b>Burst type</b>	Normal.
<b>Timeslot</b>	0, 1 ... 7.
<b>Frames</b>	<b>Full-Rate</b> All except frames 12 or 25 in any 26-multiframe. <b>Half-Rate</b> All even frames less than 13 and all odd frames more than 13 in any 26-multiframe. All odd frames less than 13 and all even frames more than 13 in any 26-multiframe.
<b>Header</b>	00010110, 00000000, 11100111.
<b>Encryption</b>	None.
<b>Modulation and coding</b>	MCS-1 through MCS-9.

3

4                    USFCH transports uplink-state flags. It provides the following services  
5                    to the layer above:

- 6
- Transport of uplink-state flags.
  - Forward error correction.
- 7

8                    USFCH provides these services via the following primitives:

Service Primitive	Description
PHY-Data-IND <i>{USF}</i>	USFCH indicates data delivery to the higher layer. The delivered information comprises uplink-state flags.

9

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## 1      **2.2 Transport Channels**

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2            A transport channel is a meaningful fixed combination of one or more  
3            elementary channels. In the GERAN working group, a transport  
4            channel is now known as a physical subchannel.

5            Each transport channel has a service access point comprising multiple  
6            connection endpoints. Each connection endpoint provides service via  
7            an elementary channel.

8            In addition to the channels in snapshot 1 of Drawing GERAN-002,  
9            GERAN provides the following transport channels: OSTCH  
10          (Optimized-Speech Transport Channel) and GTCH (General Transport  
11          Channel). There may be zero or more instances of each transport  
12          channel.

---

### 13        **2.2.1 OSTCH (Optimized-Speech Transport Channel)**

---

14          OSTCH is a transport channel optimized for transporting speech and  
15          associated elementary channels. Presently, an OSTCH transports  
16          dedicated traffic.

---

### 17        **2.2.2 GTCH (General Transport Channel)**

---

18          GTCH is a transport channel for transporting data and associated  
19          elementary channels. Data includes non-optimized speech. A GTCH  
20          may transport shared or dedicated traffic.

---

## 21        **2.3 Radio-Resource Control**

---

22          Based on information received from the various control channels and  
23          from other layers, RRC configures the physical layer using CPHY-  
24          Configure-REQ primitives. Configuration includes establishing one or  
25          more transport channels as needed.

## 1      3. Medium-Access-Control Layer

---

2            The MAC layer provides logical channels. A logical channel may  
3            comprise multiple logical subchannels.

4            Under control of RRC, the MAC controller establishes MAC blocks as  
5            needed. Each MAC block manages one or more logical channels and  
6            can operate in one of three modes: transparent, dedicated, or shared.

### 7      3.1 Logical Channels

---

8            Each logical channel has a service access point. A logical channel may  
9            provide logical subchannels via connection endpoints within its service  
10          access point.

11          In addition to the logical control channels shown in snapshot 1 of  
12         Drawing GERAN-002, the MAC layer provides the following logical  
13         channels: PACCH (Packet Associated Control Channel), PDTCH  
14         (Packet Data Traffic Channel), PTCCH (Packet Timing Control  
15         Channel), SACCH (Slow Associated Control Channel), and TCH/S  
16         (Speech Traffic Channel).

17          Each logical subchannel provides services via the following primitives:

Service Primitive	Description
MAC-Data-REQ <i>{Data}</i>	The higher layer requests that the logical channel or subchannel transmit the supplied data.
MAC-Data-IND <i>{Data}</i>	The logical channel or subchannel indicates data delivery to the higher layer.
MAC-Poll-IND <i>{Allocation}</i>	MAC indicates it is ready to transport a data allocation of sufficient priority.
MAC-Poll-RES <i>{Priority}</i>	The higher layer responds it wants to transport data of the indicated priority.
MAC-Ready-IND	MAC indicates it is ready to receive data from the higher layer.

### 18      3.2 Radio Resource Control

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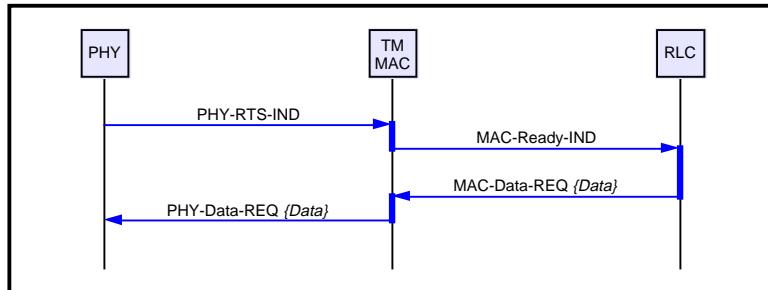
19          Based on information received from other layers, RRC configures the  
20         MAC layer using CMAC-Configure-REQ primitives. Configuration  
21         includes establishing one or more MAC blocks operating in the  
22         required modes.

### 23      3.3 Transparent Mode

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24          A MAC block operating in transparent mode passes higher-layer  
25         information to a transport channel without modifying the information  
26         and without adding a header. Figure 2 presents an illustrative example.

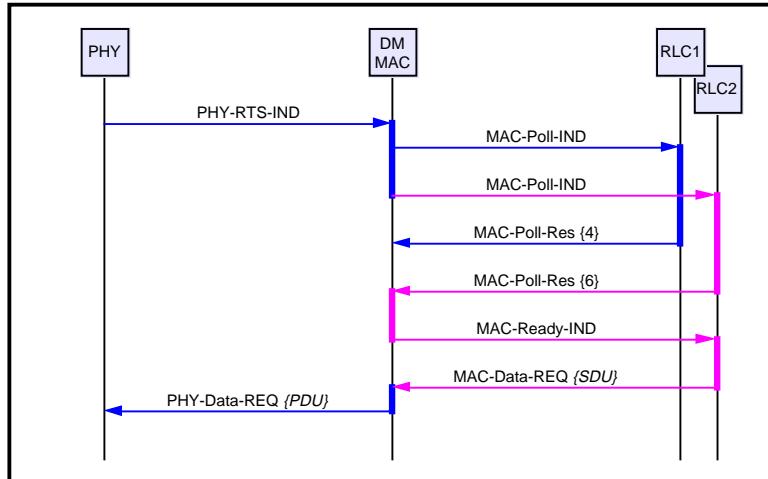
1    **Figure 2      MAC Transparent-Mode Operation**



2    **3.4      Dedicated Mode**

4                 A MAC block operating in dedicated mode handles priority multiplexing  
 5                 of multiple data streams (logical subchannels) on a transport  
 6                 channel. Since the transport channel isn't shared, no mobile-station  
 7                 addressing need be added; however, a MAC header is needed to iden-  
 8                 tify the logical subchannels. Figure 3 presents an illustrative example.

9    **Figure 3      MAC Dedicated-Mode Operation**



10    **3.5      Shared Mode**

11                 A MAC block operating in shared mode is similar to one operating in  
 12                 dedicated mode with the following exception: since the transport  
 13                 channel is shared, mobile-station addressing needs to be included in the  
 14                 MAC header.  
 15

## 4. Data-Link-Control Layer

---

1  
2 The data-link-control layer provides logical control channels as  
3 specified in GSM 04.05 [2] and 04.06 [3]. Each DLC block operates in  
4 one of the following modes: random access, unacknowledged, or  
5 acknowledged.

## 5. Radio-Link-Control Layer

---

The RLC layer provides radio bearers.

Under control of RRC, the RLC controller establishes RLC blocks as needed. Each RLC block manages a single radio bearer and can operate in one of three modes: transparent (TM), acknowledged (AM), or unacknowledged (UM).

### 5.1 Radio Bearers

---

Radio bearers may be managed by a TM, AM, or UM RLC.

#### 5.1.1 TM Radio Bearers

---

Radio bearers provided by an AM RLC provide services via the following primitives:

Service Primitive	Description
RLC-TMData-REQ <i>{Data}</i>	The higher layer requests that the radio bearer transmit the supplied data in transparent mode.
RLC-TMData-IND <i>{Data}</i>	The radio bearer indicates data delivery to the higher layer.

#### 5.1.2 AM Radio Bearers

---

Radio bearers provided by an AM RLC provide services via the following primitives:

Service Primitive	Description
RLC-AMData-REQ <i>{Data}</i>	The higher layer requests that the radio bearer transmit the supplied data in acknowledged mode.
RLC-AMData-IND <i>{Data}</i>	The radio bearer indicates acknowledged data delivery to the higher layer.
RLC-AMData-CON	The radio bearer confirms data delivery to the higher layer.
RLC-UMData-REQ <i>{Data}</i>	The higher layer requests that the radio bearer transmit the supplied data in unacknowledged mode.
RLC-UMData-IND <i>{Data}</i>	The radio bearer indicates unacknowledged data delivery to the higher layer.

### **5.1.3 UM Radio Bearers**

Radio bearers provided by a UM RLC provide services via the following primitives:

Service Primitive	Description
RLC-UMData-REQ <i>{Data}</i>	The higher layer requests that the radio bearer transmit the supplied data in unacknowledged mode.
RLC-UMData-IND <i>{Data}</i>	The radio bearer indicates unacknowledged data delivery to the higher layer.

## 5.2 Radio Resource Control

Based on information received from other layers, RRC configures the RLC layer using the following service primitives:

Service Primitive	Description
CRLC-Config-REQ <i>{RLC parameters, Encryption parameters}</i>	RRC requests configuration of RLC. Configuration includes establish, release, or reconfigure.
CRLC-Suspend-REQ	RRC requests suspension of RLC.
CRLC-Suspend-CON	RLC confirms suspension.
CRLC-Resume-REQ	RRC requests resumption of a suspended RLC.
CRLC-StartTBF-REQ <i>{RBid, TFI}</i>	RRC requests that RLC start the indicated temporary block flow (TBF) for the indicated radio bearer.
CRLC-StartTBF-IND <i>{RBid, Size}</i>	RLC indicates a need to start a TBF of the indicated size for the indicated radio bearer.
CRLC-ReleaseTBF-REQ	RRC requests that RLC release the indicated TBF and RBid-to-TFI mapping.

## 5.3 Transparent Mode

A TM RLC provides the following services to the higher layer:

- Data transfer.

## 5.4 Acknowledged Mode

An AM RLC provides the following services to the higher layer:

- Data transfer.
  - Segmentation and reassembly.
  - Blocking (Note that X.200 [4] defines *blocking* as the mapping of multiple SDUs into a single PDU. The stage-2 description incorrectly calls this *concatenation*.)
  - Padding.
  - Backward error correction.

- 1           • In-sequence delivery.
- 2           • Encryption.

### 3           **5.5 Unacknowledged Mode**

---

4           A UM RLC provides the following services to the higher layer:

- 5           • Data transfer
- 6           • Segmentation and reassembly.
- 7           • Blocking.
- 8           • Padding.
- 9           • Sequence-number check.
- 10          • Encryption.

## 6. Radio-Resource-Control Layer

---

RRC configures the other layers to provide radio bearers, in effect setting up the required layer functional blocks and interlayer plumbing:

- It establishes and releases control-plane radio bearers (*e.g.*, PBCCH, PPCH, PACCH, and RB0) for transporting broadcast information, common control, associated control, and signaling.
- It establishes and releases user-plane radio bearers (*e.g.*, RB1 and RB2) for transporting user speech and data.
- It establishes and releases TBFs (Temporary Block Flows) to support the radio bearers.

Tdoc 2g00-079 [6] describes radio-bearer control functions in more detail.

## 7. Recommendations

---

1. Adopt the proposed design as a basis for further development.
2. Complete detailed block diagrams of the physical, MAC, and RLC layers. GERAN-003 is an example of a detailed block diagram.
3. Don't worry too much about detailed document structure until the GERAN design firms up. The GERAN design shouldn't be considered firm until detailed block diagrams of all layers are available, interlayer service primitives are adopted, and a reasonable number of detailed sequence diagrams have been prepared.
4. Based on the design presented in this contribution, we propose the following high-level document structure:

### **Physical Layer**

---

Use 05.01, 05.02, and 05.03, amended as required.

### **MAC Layer**

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Develop a new standard reusing much of the MAC specification in 04.60. Add the functions identified in Tdoc 2g00-082 [7].

### **RLC Layer**

---

Develop a new standard reusing much of the RLC specification in 04.60. Add the functions identified in Tdoc 2g00-082.

### **DLC Layer**

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Use 04.05 and 04.06.

### **RRC**

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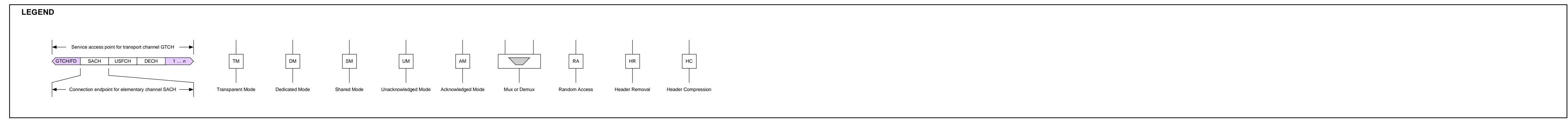
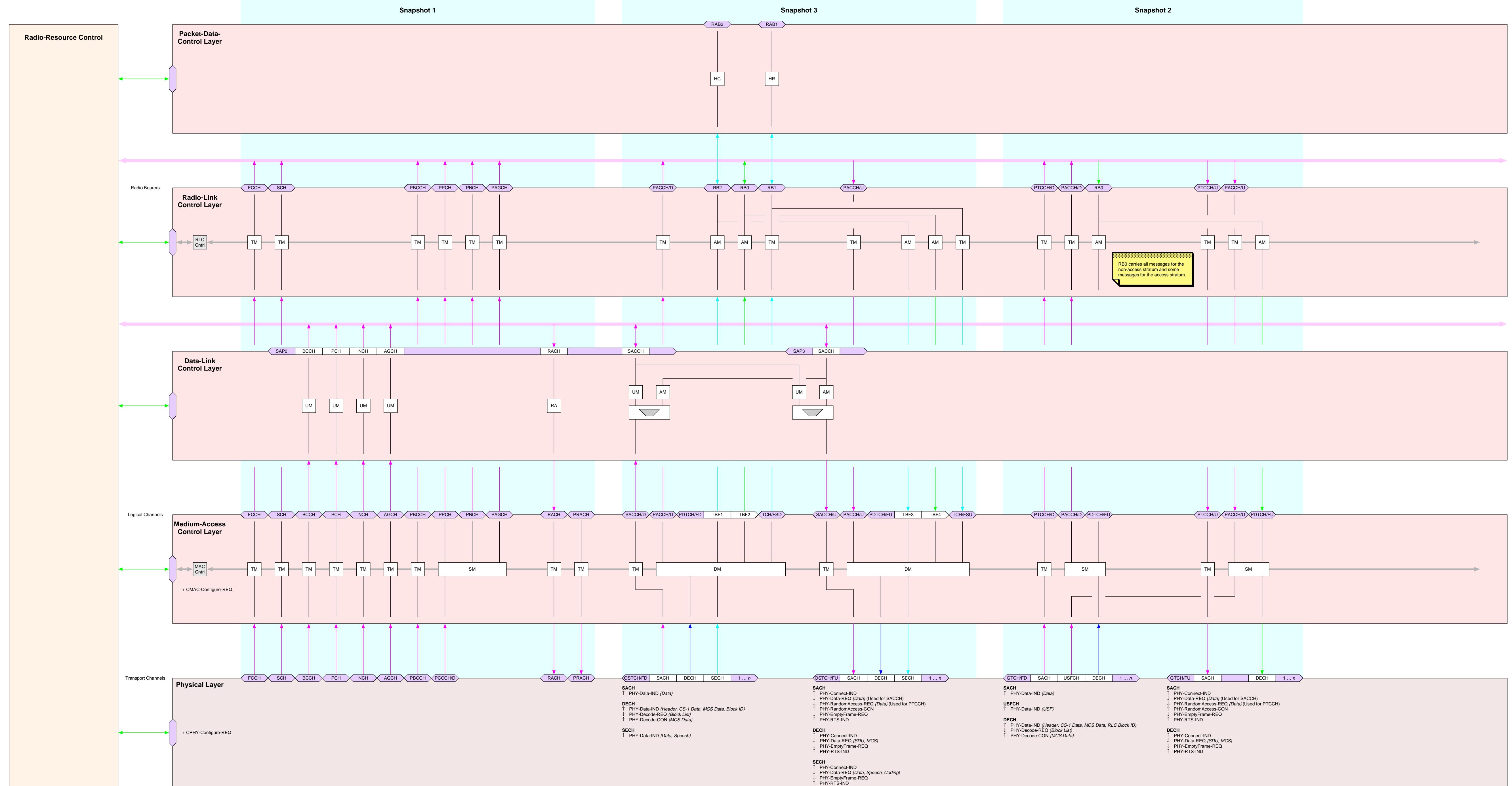
As recommended in Tdoc 2g00-079, move TBF establishment procedures from 04.60 to RRC. These procedures could be placed in the existing 04.18 or in a new standard. Add the functions identified in Tdoc 2g00-082.

## 8. References

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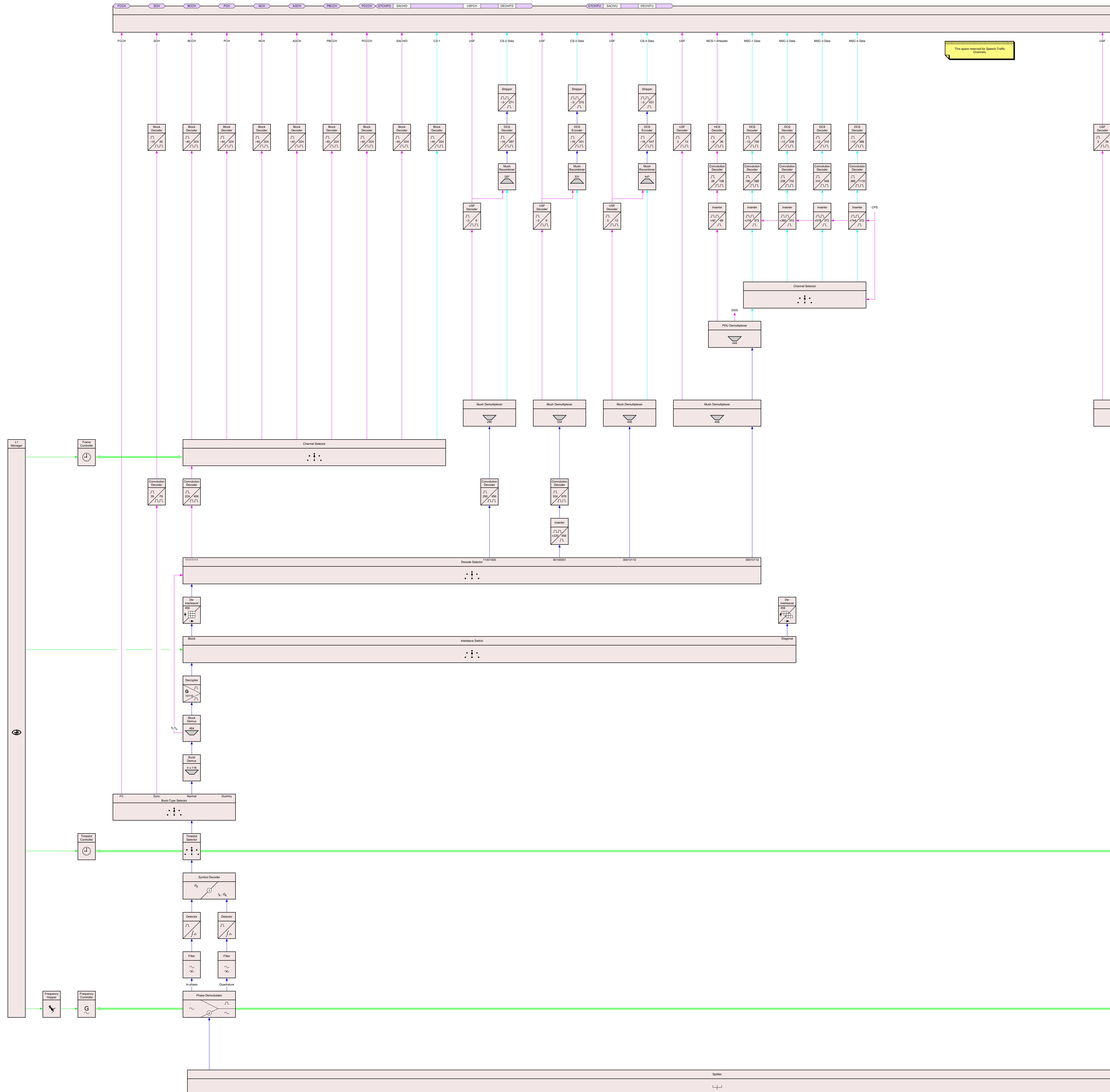
1. 3G TS 25.301.  
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6. Tdoc 2g00-079.  
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Helsinki: Lucent, August 2000.
7. Tdoc 2g00-082.  
*New RLC/MAC Functions for R2000.*  
Helsinki: Lucent, August 2000.


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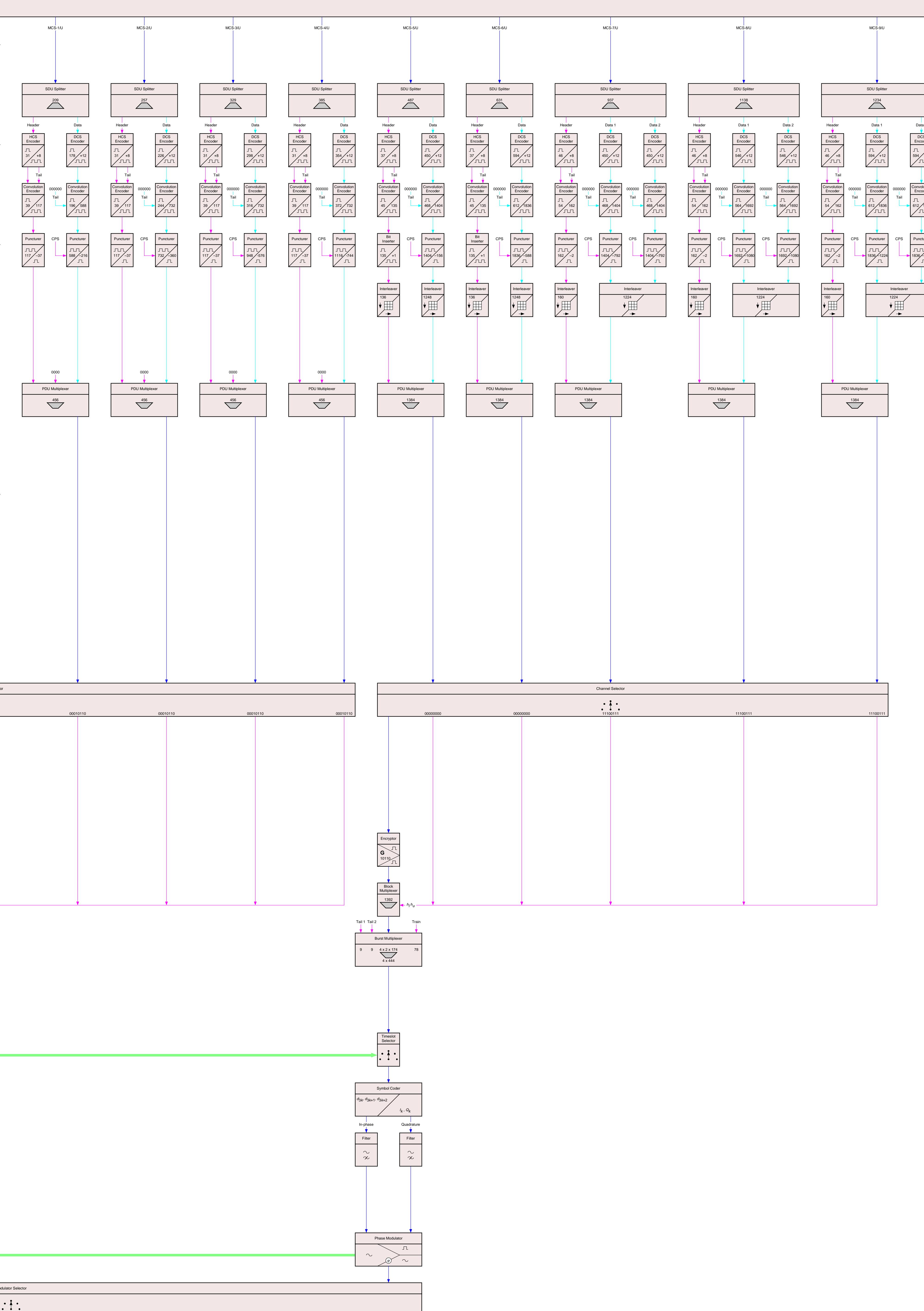


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