TSGRAN WG2#4
Berlin Germany,
May 25-28, 1999

TSGR#4(99)446

Source: **GBT**

Title: **S25.321 Request for CPCH-related modification**

Document for: **Approval**

Agenda Item: **6.7**

3GPP

TS RAN S2.21 (1999-04)

Technical Specification

3rd
Technical Specification Group (TSG) RAN;

MAC protocol specification
TSGR#3 (99)263

3GPP

Reference

<Workitem> (<Shortfilename>.PDF)

Keywords

<keyword[, keyword]>

3GPP

Postal address

Office address

Internet

secretariat@3gpp.org

Individual copies of this deliverable
can be downloaded from
http://www.3gpp.org

Contents

Intellectual Property Rights

Foreword

1. Scope

2. References

3. Definitions, abbreviations and symbols

3.1 Definitions

3.2 Abbreviations

ARQ	Automatic Repeat Request
ASC	Access Service Class
BCCH	Broadcast Control Channel
BCH	Broadcast Channel
C-	Control-
CC	Call Control
CCCH	Common Control Channel
CCTrCH	Coded Composite Transport Channel
CPCH	Common Packet Channel (UL)
CPCCH	CPCH Control Channel (DL) or Common Packet Control Channel (DL)
CN	Core Network
CRC	Cyclic Redundancy Check

3.3 Symbols

4. General

4.1 Objective

4.2 Overview of MAC architecture

4.2.1 MAC Entities

The diagrams that describe the MAC architecture are constructed from MAC entities. The entities are assigned the following names. The functions completed by the entities are different in the UE from those completed in the UTRAN:

- MAC-b, which identifies the MAC entity that handles the broadcast channel (BCH). There is one MAC-b entity in each UE and one MAC-b in the UTRAN for each cell.

  Note: The separation in two different BCCH is ffs, the control SAP may be split accordingly

- MAC-p, which identifies the MAC entity that handles the paging channel (PCH). There is one MAC-p entity in each UE and one MAC-p in the UTRAN for each cell.

- MAC-c, which identifies the MAC entity that handles the forward access channel (FACH) and the random access channel (RACH) , and Common Packet Channel (UL CPCH) for FDD,. There is one MAC-c entity in each UE and one in the UTRAN for each cell.

MAC-d, denotes the MAC entity that is responsible for handling of dedicated logical channels and dedicated transport channels (DCH) allocated to a UE. There is one MAC-d entity in the UE and one MAC-d entity in the UTRAN for each

UE. Note: *When a UE is allocated resources for exclusive use by the bearers that it supports the MAC-d entities dynamically share the resources between the bearers and are responsible for*

4.2.2 MAC-b , MAC-p and MAC-sy

4.2.3 Traffic Related Architecture - UE Side

Figure 4.2.3.1 illustrates the connectivity of MAC entities. The figure shows a MAC-d servicing the needs of several DTCH mapping them to a number of DCH. A MAC-sh controls access to a common transport channel. It is noted that because the MAC-sh provides additional capacity then it communicates only with the MAC-d rather than the DTCH directly. The MAC-c, which interfaces with the FACH and RACH common signalling channels, is connected with the MAC-d for transfer of data and RNTI. The MAC Control SAP is used to transfer Control information to each MAC entity. In the TDD implementation the MAC-sh transfers data from the DSCH to the MAC-d and from the MAC-d to the USCH under control of the FACH. In the FDD implementation, the MAC-c transfers data from the DSCH to the MAC-d and from the MAC-d to the CPCH.

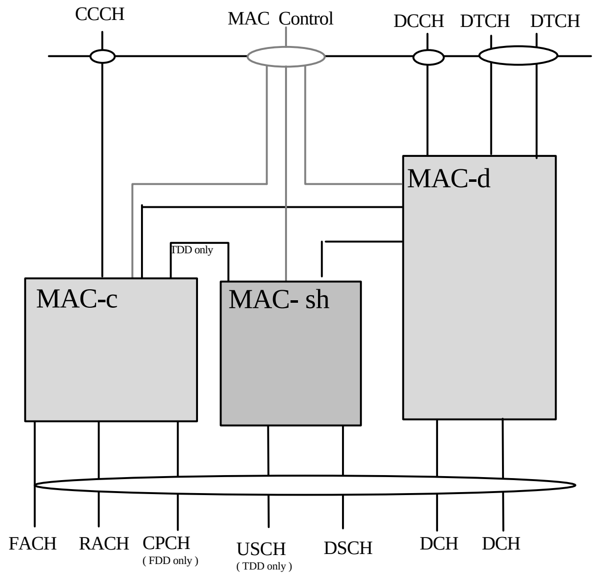


Figure 4.2.3.1 UE side MAC architecture

Figure 4.2.3.2 shows the UE side MAC-c entity. The following functionality is covered:

- The C/D MUX box represents the insertion and detection of the field in the MAC header, indicating whether a common or dedicated logical channel is used.
- The c-RNTI field in the MAC header is used to distinguish between UEs.
- In the uplink, the possibility of transport format selection exists.
- Selection of Access Service Classes (ASC) for RACH, details on definition of ASC and the relation to the RACH retransmission algorithm are ffs.
- Within the UE all MAC-d logical channels which use the CPCH UL are connected to MAC-c via a set of independent connections, one for each level of data priority.
- Multiplexing/scheduling /priority handling is used to transmit the received information on DSCH and DSCH Control Channel to the Mac-d, for TDD the multiplexing is used to transfer data from MAC-d to USCH and receives control information for shared operation from MAC-c. Scheduling/priority handling is used in FDD mode to managed the shared CPCH UL resource for multiple logical channels, each with a direct connection to MAC-c through MAC-d.
- Packet building is used to construct the largest packet possible from data available on all of the UL logical channels provided from MAC-d. Packet building is also used for TF selection for each transport block included in the UL packet. Finally Packet building adds the MAC header, including RNTI for UE identification, to all transport blocks.

- CPCH access is the multi-access procedure used to access and send the UL packet constructed by the packet building function. This access scheme uses the CPCH UL and CPCCH DL transport channels.
-

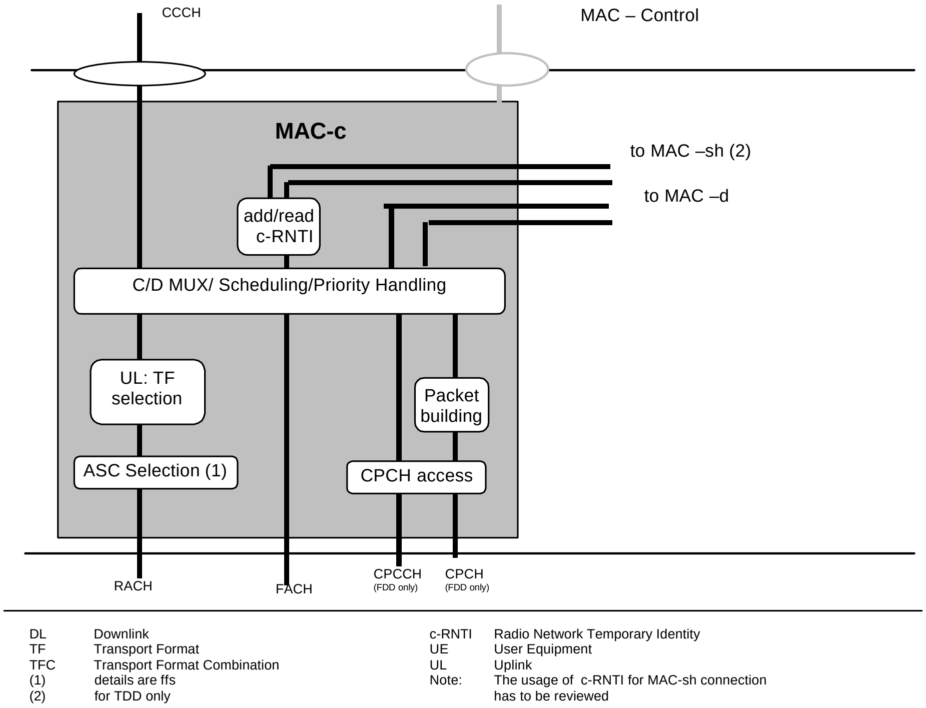


Figure 4.2.3.2. UE side MAC architecture / MAC-c details

4.2.4. Traffic Related Architecture - UTRAN Side

Figure 4.2.4.1 illustrates the connectivity between the MAC entities from the UTRAN side. It is similar to the UE case with the exception that there will be one MAC-d for each UE and each UE (MAC-d) that is associated with a particular cell may be associated with that cells MAC-sh. MAC-c controls UE access to the CPCH UL. MAC-c and Mac-sh are located in the controlling RNC while MAC-d is located in the serving RNC.The MAC Control SAP is used to transfer Control information to each MAC entity belongs to one UE.

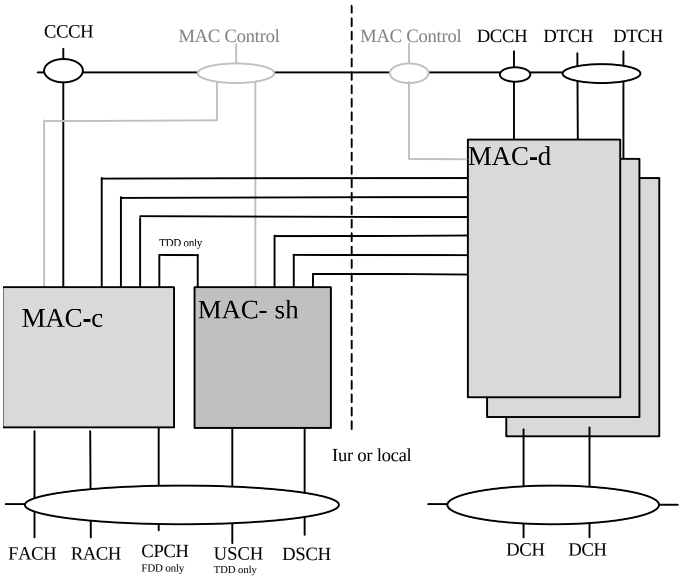


Figure 4.2.4.1: UTRAN side MAC architecture

Figure 4.2.4.2 shows the UTRAN side MAC-c entity. The following functionality is covered:

- The C/D box represents the insertion and detection of the field in the MAC header, indicating whether a common or dedicated logical channel is used.
- For dedicated type logical channels, the c-RNTI field in the MAC header is used to distinguish between UEs.
- In the downlink, transport format selection might be done if FACH is variable rate.
- CPCH access control is used to resolve access collisions and to grant/deny access to CPCH UL channels to requesting UEs.
- CPCH packets are demultiplexed using RNTI in MAC header to for data routing or switching.

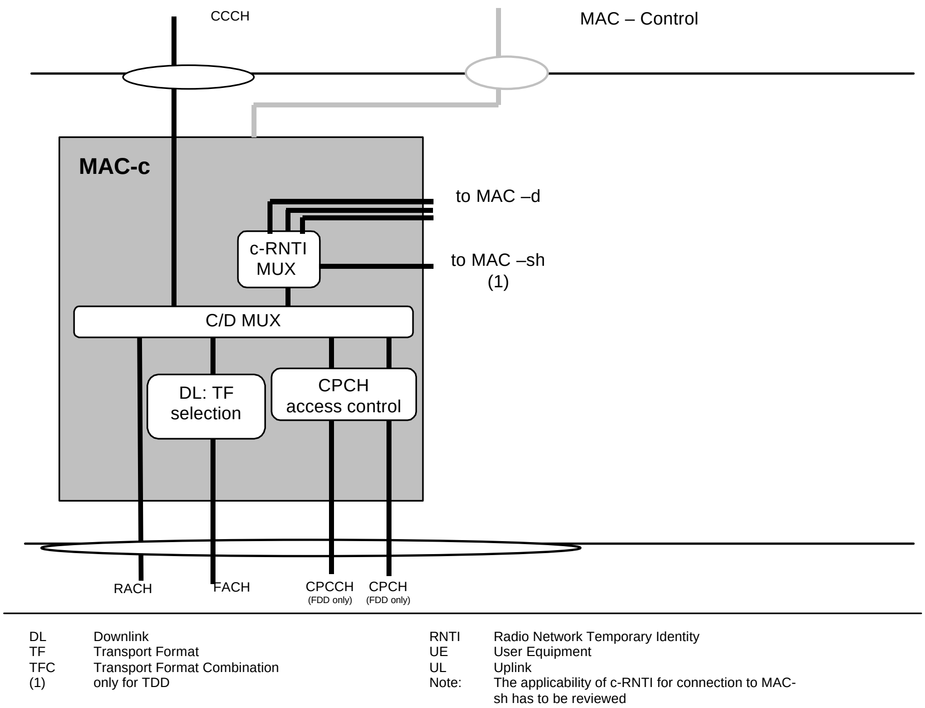


Figure 4.2.4.2 UTRAN side MAC architecture / MAC-c details

4.3 Channel structure

4.3.1 Transport channels

Common transport channel types are:

- Random Access Channel(s) (RACH)
- Forward Access Channel(s) (FACH)
- Downlink Shared Channel(s) (DSCH)
- DSCH Control Channel
- Common Packet Channel(s) (CPCH) for UL FDD operation only
- CPCH Control Channel(s) (CPCCH) DL, one for each CPCH
- Uplink Shared Channel(s) (USCH), for TDD operation only
- ODMA Random Access Channel(s) (ORACH)
- Broadcast Channel (BCH)
- Synchronisation Channel (SCH), for TDD operation only
- Paging Channel (PCH)

4.3.2 Logical Channels

4.3.2.1 Logical channel structure

4.3.2.2 Control Channels

4.3.2.3 Traffic Channels

4.3.3 Mapping between logical channels and transport channels

The following connections between logical channels and transport channels exist:

- SCCH is connected to SCH
- BCCH is connected to BCH
- PCCH is connected to PCH
- CCCH is connected to RACH and FACH
- DCCH and DTCH can be connected to either RACH and FACH, to CPCH and FACH, to RACH and DSCH, to CPCH and DSCH, to DCH and DSCH, or to a DCH,
- DCCH (DL) associated with control of CPCH is connected to CPCCH
- DCCH (UL) can be connected to FAUSCH
- ODCCH, OCCCH and ODTCH can be connected to ORACH, ODCCH and ODTCH can be connected to ODCH.
- CTCH may be mapped to FACH and DSCH or BCH, the mapping is ffs
- CTCH (UL) may be mapped to CPCCH and CPCH
- DCCH and DTCH can be mapped to the USCH (TDD only).

5. Services provided to upper layers

5.1 Description of Services provided to upper layers

6. Functions

6.1 Description of the MAC functions

The functions of MAC include:

- Mapping between logical channels and transport channels.
- Selection of appropriate Transport Format for each Transport Channel depending on instantaneous source rate
- Priority handling between data flows of one UE
- Priority handling between UEs by means of dynamic scheduling
- Priority handling between data flows of several users on the the DSCH and FACH
- Scheduling of broadcast, paging and notification messages
- Identification of UEs on common transport channels
- Multiplexing/demultiplexing of higher layer PDUs into/from transport blocks delivered to/from the physical layer on common transport channels
- Multiplexing/demultiplexing of higher layer PDUs into/from transport block sets delivered to/from the physical layer on dedicated transport channels
- Traffic volume monitoring
- Monitoring the links of the assigned resources
- Routing of higher layer signalling
- Maintenance of a MAC signalling connection between peer MAC entities
- Dynamic Transport Channel type switching
- Multi-access control of uplink CPCH channel(s) shared by multiple UEs.

6.2 Relation between MAC Functions / Transport Channels and UE

6.2.1 Relation between MAC Functions and Transport Channels

Associated MAC Functions	Logical Ch	Transport Ch	TF Selection	Priority handling between users	Priority handling (one user)	Scheduling	Identification of UEs	Mux/Demux on common transport CH	Mux/ Demux on dedicated transport CH	Dynamic transport CH switching
Uplink (Rx)	CCCH	RACH						X		
	DCCH	RACH					X	X		
	DCCH	CPCH					X	X		X
	DCCH	DCH							X	
	DTCH	RACH					X	X		
	DTCH	CPCH					X	X		X
	DTCH	DCH							X	
Downlink (Tx)	SCCH	SCH								
	BCCH	BCH				X				
	PCCH	PCH				X				
	CCCH	FACH		X				X		
	DCCH	FACH		X			X	X		
	DCCH	DSCH		X				X		
	DCCH	CPCCH	X(note5)		X(note4)			X		X
	DCCH	DCH	X		X				X	
	DTCH	FACH	X(note1)	X			X	X		X
	DTCH	DSCH	X(note2)	X				X		X
	DTCH	DCH	X		X				X	X

Table 1 UTRAN MAC functions corresponding to the transport channel (note3)

(Note1) On FACH channel, the transport format set is limited.
(Note2) Whether DSCH has the transport format set is under discussion.
(Note3) The functions not included in the table are listed below.
(Note4) The DCCH DL here is dynamically switched to the UE currently using the CPCH UL. This is dynamically assigned by UTRAN MAC-c.
(Note5) The CPCCH channel is a fixed 8Kbps channel with limited TF set.

6.2.2 Relation of UE MAC functions corresponding to the Transport Channel MAC Functions and Transport Channels

Functions	Logical Ch	Transport Ch	TF Selection	Priority handling data of one user	Identification	Mux/Demux on common transport channels	Mux/Demux on dedicated transport channels	Dynamic transport channel type switching
Uplink (Tx)	CCCH	RACH				X		
	DCCH	RACH	X(note1)		X	X		
	DCCH	CPCH	X	X	X	X		X
	DCCH	DCH	X	X			X	
	DTCH	RACH	X(note1)		X	X		X
	DTCH	CPCH	X	X	X	X		X
	DTCH	DCH	X	X			X	X
Downlink (Rx)	SCCH	SCH						
	BCCH	BCH						
	PCCH	PCH						
	CCCH	FACH				X		
	DCCH	FACH			X	X		
	DCCH	DSCH				X		
	DCCH	CPCCH				X(note2)		
	DCCH	DCH					X	
	DTCH	FACH			X	X		
	DTCH	DSCH				X		
	DTCH	DCH					X	

Table 2 UE MAC functions corresponding to the transport channel

(Note1) The RACH channel has the limited transport format set.
(Note2) The CPCCH channel is a fixed 8Kbps channel with limited TF set.

7. Services expected from physical layer

see S2.02

8. Elements for layer-to-layer communication

8.1 Primitives between layers 1 and 2

see S2.02

8.2 Primitives between MAC and RLC

8.2.1 Primitives

8.2.2 Parameters

8.3 Primitives between MAC and RRC

8.3.1 Primitives

8.3.2 Parameters

9. Elements for peer-to-peer communication

9.1 Protocol data units

9.1.1 MAC Data PDU

9.1.2 MAC Control PDU

9.1.3 MAC messages for MAC peer to peer communication

9.2 Formats and parameters

9.3 Protocol states

9.4 State variables

9.5 Timers

9.6 Protocol Parameters

9.7 Specific functions

10. Handling of unknown, unforeseen and erroneous protocol data

11. Elementary procedures

11.1 Dynamic radio bearer control in UE

12. History

13. Appendices: Examples of operation

14. Annex 1: MAC Functions

Note: This Annex contains information based from Tdoc TSG_RAN_WG2 009/99, the text has to be reviewed , the functions will then be moved into the main part of the document.

14.1 General functions

14.2 Common channel related functions

14.2.1 Control of BCH

14.2.1.1 Overview

14.2.1.2 Scheduling of BCH

14.2.2 Control of PCH

14.2.2.1 Overview

14.2.2.2 Scheduling of PCH

14.2.3 Control of FACH

14.2.3.1 Overview

14.2.3.2 Scheduling of ACK, control and user data transmission

14.2.3.3 Multiplexing/demultiplexing of higher layer PDUs to/from a FACH

14.2.3.4 Inband identification of MSs

14.2.4 Control of RACH

14.2.4.1 Overview

14.2.4.2 Scheduling of control and user data transmission

14.2.4.3 Multiplexing/demultiplexing of higher layer PDUs to/from a RACH

14.2.4.4 Inband Identification of MSs

14.2.5 MAC Control of CPCH

14.2.5.1 Overview

The Common Packet Channel (CPCH) service is provided by a multi-access UL channel (CPCH) which is paired with a dedicated control channel (CPCCH) used in the DL to carry control information from UTRAN to the UE currently accessing the CPCH on the UL. The CPCH UL may carry control and user traffic from mulitple logical channels in the same CPCH packet from the UE to UTRAN. The functions associated with the CPCH are

- Scheduling
- Multiplexing/demultiplexing
- Inband identification of MSs
- Packet building

Procedures associated with the CPCH are

- CPCH access procedure (see15.2)

14.2.5.2 Scheduling of control and user data transmission

This function provides mechanisms for efficient transfer of control and user traffic by means of appropriate scheduling of queued CPCH transport blocks into a CPCH packet. A CPCH packet consists of three segments: an Access Preamble/Acknowledgement Indication preamble (AP/AICH) segment which is followed by a Collision Detection preamble/Assignment preamble (CD/ASSIGN) segment which is followed by the Packet Data segment. Scheduling of these three segments are handled independently by the MAC. Each of the four preambles are characterised by a 256-bit preamble code and a 16-bit preamble signature. The AP/AICH and CD/ASSIGN segments act as MAC access control gates implemented in the MAC-c entities to resolve multi-access contention. There are multiple CPCH physical channels allocated to a particular cell. Each CPCH physical channel is characterised by a specific scrambling code, data rate (spreading factor), maximum allowed packet length, and a persistency parameter which is used by RNC for congestion control and load balancing among the multiple CPCH channels. In addition, associated with each CPCH channel is an AP preamble code, and CD preamble code, and a channelisation code used in the CPCCH (DL) paired with this CPCH (UL). All of these CPCH parameters are broadcast in BCCH to all UEs. The AP preamble acts as a request from the UE to the UTRAN for a particular CPCH physical channel. The 16 AP preamble signatures are mapped to a particular CPCH available on that cell. The AICH-ack from the UTRAN to the UE acknowledges the request for that particular CPCH. If the requested CPCH resource is busy at the time of this request, an AICH-nak is sent to indicate that the resource is not available. The CD preamble from the UE to the UTRAN allows the UTRAN to detect and resolve contention for the particular CPCH being requested. The ASSIGN response is sent from the UTRAN addressed to the UE which is granted access to the CPCH. After receiving the assignment to use the CPCH, the UE schedules the CPCH packet transmission.

14.2.5.2.1 Initial AP Transmission:

- When the UE schedules the first AP, the AP code, the AP signature, and the transmission timing offset shall be determined as follows:
  1. The AP code is assigned by the RNC to this cell and is used only for access to a CPCH Set of CCPCH channels. The same set of 16 16-bit signatures are used in the AP, AICH, CD and ASSIGN preambles. The assigned AP code, assigned CD code, the 16 signatures, the signature mapping to the cell site's CPCH physical channels in the assigned CPCH Set are determined by the RNC and are received by the UE via BCCH.
  2. The selection of the AP signature is an iterative process, as controlled by the persistency parameters for the CPCH channels at that cell site. The UE MAC function determines the size of the packet to be scheduled, selects an available, suitably sized and currently unused CPCH channel. Current CPCH channel utilisation is estimated in the MAC by timestamping the receipt of all AICH-ack preambles. (The receipt of an AICH-ack preamble which is followed by an ASSIGN premble on the CPCCH indicates that that particular CPCH channel will be in use for the maximum preamble length period.) The UE then picks a random number greater than 0 and less than one. This random number is compared to the persistency value assigned by the RNC to the selected channel. If the random number is less than the persistency value, the selected channel will be used for an access attempt. If the random number is greater than the persistency value, the UE selects another suitable CPCH channel to access. Once a CPCH channel has been chosen and passes the persistency check, then the UE randomly selects one of the signatures which is mapped to that channel.
  3. The transmission timing offset (frame and/or slot) is determined by randomly selecting an initial delay (number of access slots) within the range 0-Ni where Ni is a number assigned to traffic with priority level i. Higher priority traffic will use shorter initial delays and will have more immediate access to CPCH resources. After the initial delay the AP preamble is scheduled at a low open-loop level and the UE waits for an AICH response from the UTRAN. The AICH response will use the same preamble code and preamble signature as the AP. Receiving an AICH-nak indicates that the requested CPCH channel is busy and this access attempt for that CPCH is aborted. Receiving and AICH-ack permits the access procedure to continue.

14.2.5.2.2. Unacknowledged AP Retransmission:

- If the UE fails to receive an AICH-ack with matching signature within NS_p_aich msec it immediately reschedules the AP into the next access slot. The power level of each successive retransmission will be increased by a system defined power step size, P_ap_step. The maximum number of allowed retransmissions shall be set to $N_{AA\text{-}MAX}$ (access attempts).

14.2.5.2.3 CD Transmission following AICH:

- When the AICH with matching signature is received by the UE, the UE randomly selects a signature from the set of 16 and uses the assigned CD preamble code to create a CD. The UE then schedules the CD into the next access slot and waits for the ASSIGN response from the UTRAN. The ASSIGN response uses the CD code and the signature used indicates the UTRAN response to the UE CPCH request. The request for CPCH is granted if the ASSIGN signature matches the one chosen for the CD. If the ASSIGN signature does not match the one used in the CO, it indicates a collision and the other requesting UE is granted access to the CPCH.

14.2.5.2.4 CPCH Busy Retransmission:

- If the UE receives an AICH-nak response to an AP, the UE is denied access to the requested CPCH channel. The UE then selects an alternate available CPCH channel and schedules an initial AP transmission (Item 2 above) using the signature for the alternate CPCH channel. If no other CPCH channels are available, the UE waits a random backoff period and begins the access process again.

14.2.5.2.5 Collision Detected Retransmission:

- If the UE receives the ASSIGN response with a different signature code, a collision has occurred. The UE is denied use of the requested CPCH channel, and the other UE, whose CD signature matches the ASSIGN response signature, is granted the CPCH channel. The UE waits a random backoff period and begins the access process again.

14.2.5.2.6 CPCH Packet Transmission:

If the UE receives an ASSIGN with a signature matching the one transmitted in the CD, it immediately schedules the CPCH Packet Data into the next access slot. CPCH Packet Data segment is started by sending 10 msec of preambles on both the CPCH and CPCCH in order to establish closed loop power control.

14.2.5.3 Multiplexing/demultiplexing of higher layer PDUs to/from a CPCH packet

UE MAC supports service multiplexing for CPCH transport channels, since the physical layer does not support multiplexing of these channels. The UE packet building function multiplexes both control and traffic logical channels onto the CPCH transport channel.

The UE MAC multiplexes the transport blocks from several logical channels onto the CPCH packet. The UTRAN MAC demulitplexes this packet data to the appropriate logical channels using the MAC header information.

14.2.5.4 Inband Identification of UEs

The unambiguous separation of different UEs using the contention based CPCH channel is handled by MAC. When a particular UE is using the CPCH, there is a need for inband identification of the UE. Since the MAC layer handles the access to, and multiplexing onto, the transport channels, the identification functionality is naturally also placed in MAC. When several CPCH packets are received at the BS the physical layer detects them and delivers them to the MAC. The MAC distinguishes the UE source of the CPCH packets by different RNTIs embedded in each transport block MAC header. Thus the UE is unambiguously identified. The MAC header generation for transport blocks in the packet is described in the section on the PDU format (9.2.1).

14.2.5.5 UE MAC CPCH Packet Building

UE MAC attempts to build a packet which includes all available queued data from all logical channels. MAC accesses and concatenates CPCH transport blocks into a packet using the highest priority logical channel first. When all the data has been used from the highest priority logical channel, the next highest priority channel is used, and so on, until all queued data from all logical channels is used or the packet size has reached the maximum packet length for the available CPCH channels at that cell. If the maximum packet length has been reached, then MAC must request access to only the highest capacity CPCH channel(s) allocated to that cell. If access is denied to these channels, UE MAC requests successively lower capacity channels until being assigned access. Then the packet is segmented by removing transport blocks at the end of the packet (lower priority blocks) until the packet size becomes suitable for the assigned CPCH channel. The CPCH Packet Data transmission is then scheduled. Any remainder transport blocks are used to build the next CPCH packet using FIFO techniques within each priority level.

14.3 Control of DCH

14.4 Other functions

15. Annex 2: MAC Procedures / Elementary Procedures

15.1 Random access procedure

15.2 Channel type switching procedure

16 Annex 3: MAC parameters

17 Annex 4: CPCH Procedures / Elementary Procedures (RRC, RLC and MAC)

~~17~~17.1 Overview of MAC

- The Random Access procedure is based on a DSMA-CD multiple Access method..
- Access Preamble (AP) signatures are used to identify the particular CPCH resource which the UE ia attempting to access.
- The access preamble ramp-up is similar to the RACH mechanism. However, there is a collision detection/resolution mechanism that follows the access preamble ramp-up. The UEs receive AICH indicating their success in ramp-up and granting accessing to the CPCH. The UEs will refrain requesting a busy CPCH channel. All UEs log and timestamp all received AICHs in a recency table. This table allows the UE to estimate the probability that a given CPCH is unused at any particular time.. This models the DSMA-CD protocol.
- The MAC in the Base Node is responsible to Call Admission Control and resource management in s short time window assigned by the RNC.

~~1.~~17.2 Overview of RLC

- Selective Repeat ARQ procedure is applied to CPCH transmission. The UE transmits a packet containing several frames and transport blocks on the CPCH. UE transmits W tx-unacked packets before halting transmission to wait for ACKs for the transmitted packets. UE should wait to receive an acknowledgement(ACK) from a BSS on the CPCH Control Channel (CPCCH) within $RTO_{tx\text{-}unacked}$.
- The receiving side ACKs $W_{rx\text{-}ack}$ at a time. If the receiving RLC does not receive $W_{rx\text{-}ack}$ transport blocks in $T_{rx\text{-}ack}$, it will ACK whatever, it has received in that time window.

~~1~~17.3 Overview of RRC

- UTRAN assigns capacity to the base node every $T_{periodicty}$ based on the traffic volume measurement reports. It generates persistency parameters for each CPCH allocated to the Base Node..
- UTRAN transmit a CPCH System Message which entails the CPCH related parameters to the UEs in the cell.
- The UEs and the Base Nodes transmit the measurement reports (throuhput-base node, delay-UE, queue depth-UE) so that UTRAN can decide on the capacity allocation and persistency parameters.
- UTRAN transitions the UEs from RACH/FACH state to CPCH/DSCH or DCH/DCH states based on the queue-depth measurement reports.

17.4 Temporal Sequence of CPCH Events for Normal Access

The sequence of events regarding the operation of CPCH-UL/CPCCH-DL. Refer to the Flowcharts 1-2 for the CPCH Access Procedures in the UE and UTRAN. The following temporal description is normal access procedure and entails both the UE and UTRAN side.

~~1.~~Step 1: The UE will initiate RRC connection procedure and transition to the RRC connection mode. Trasnport Format Sets will be assigned to the UE by UTRAN.
~~2.~~Step 2:The UE enters the idle mode where it performs the following tasks:

- The UE monitors the CPCH cell resources and parameters in BCCH
- It executes the RLC ARQ procedure
- The UE monitors the AICH/ASSIGN to update CPCH availability table.
- The UE reports traffic measurement Data as required by UTRAN.

~~3.~~Step 3: UTRAN will be performing the following tasks in the idle mode:

- Collect traffic measurements from the UEs and the cells
- Reassign priorities to all UE RABs to maintain QoS
- Allocates CPCHs to Cells based on traffic measurements (cell demand)
- The UTRAN calculates the Persistency values fro all CPCHs to balance loads and relieve congestion.
- UTRAN broadcasts the CPCH parameters and resources on BCCH. The UTRAN transmits the system messages which contain the following information:

For each CPCH physical channel allocated to a cell the following parameters are included in the System Information message:

- Access Preamble (AP) code
- CD preamble code
- CPCH UL scrambling code
- CPCCH DL channelisation code
- Data rate (spreading factor)
- N_frames_max: Maximum packet length in frames
- Persistency value: assigned by RNC to coltrol congestion and for load balancing
- Signature set: set of preamble signatures (up to 16) for AP to access this CPCH

The following access, collision detection/resolution, prioritization and CPCH data transmission parameters:

$N_{I\ P}$ = Number of slots for the initial priority delay that the UE shall use before beginning the preamble ramp-up.N_ip is randomly chosen and will depend on the assigned priority level, l **PV_{cpch}** = The persistency value parameter which is transmitted in the BCCH for each CPCH.

$NF_{bo\text{-}collision}$ = Maximum number of frames that UE will back-off in case of a collision.. This parameter is a congestion control measure and relates to Bandwidth management

$NS_{bo\ no\ aich}$ = Maximum number of slots that UE will back-off after sendin N_access_attempts preambles without an AICH response. . This parameter is a congestion control measure and relates to Bandwidth management

$NS_{bo\text{-}busy}$ = Maximum number of slots that UE will back-off in case of an access attemp to CPCH which is currently busy. This parameter is a congestion control measure and relates to Bandwidth management

$NF_{bo\text{-}all\ busy}$ = Maximum number of frames that UE will back-off in case of an access attempt to the last available CPCH when all CPCHs are busy. This parameter is a congestion control measure and relates to Bandwidth management

$P_{cpch-open-loop}$ = Initial open loop power level for the first CPCH access preamble sent by the UE.

P_ap_step = Power step size for each successive CPCH access preamble.

NS_{p-p} = Number of slots between two successive access preambles

$NS_{aich-cd}$= Number of slots between start of of AICH and start of CD preamble

N_{aa_max} = Number of allowed successive access attempts (preambles) if there is no AICH response.

N_{access_fails} = Number of successive AP access ramp cycles without AICH before failure report.

Step 4: Once the UE enters a cell, it transmits a RR-Connection-Request message to UTRAN reporting the following traffic measurement parameters: average packet data bit rate in bps, average packet length in bytes. UTRAN will send the available TFCS to the UE. Once assigned to a particular CPCH set in a cell, , the UE will occasionally report other packet related traffic measurements such as queue-depth for UTRAN to decide whether to change the UE's assignement or not. CPCH assignments are provided to UEs in the RRC connected state, in the RACH/FACH substate.

Step 5:. Persistency parameters (PV_cpch) are transmitted by UTRAN in the BCCH System Information Message.

Step 6:. UE monitors the CPCCH DL transmission of AICHs and ASSIGNs once it is in an active session state. UE constructs an Availability Table (recency) which stores the last time (timestamp) that the CPCH was assigned by the cell to any UE. The UE also knows the available capacity of each CPCH (data rate X max packet length)..

Step 7:. Once the MAC receives an indication that one of the RLC logical connections has a transport block to transmit, it will poll all of the RLC buffers. MAC builds the transport blocks from all of the logical RLC buffers. The Packet Building function in MAC forms a packet within the allowed packet size range.

Step 8:. The UE selects a CPCH from a set of available CPCHs based on the persistency parameters, the status of the CPCH in the Availability Table, the status of the CPCH Busy Table (records which CPCH channels have already been requested and denied during this access cycle), and the capacity of the CPCH vs the size of the packet to schedule. If several CPCHs are available with the same desired capacity, then the UE selects one of these CPCHs randomly. If there are several AP signatures assigned to the selected CPCH, the UE selects one of these signatures randomly

Step 9:. The ramp-up procedure is similar to the RACH ramp-up procedure. In selecting the transmission offset time, the UE picks a random initial delay number from the [1, N_ip] range where N_ip is a number assigned by RNC for the ith priority level of the highest priority transport block in the packet. The UE backs off based on the result of a random test using the persistency parameter. If the UE fails the persistency test, the CPCH is marked busy in the Busy Table. The UE then transmits successive APs while waiting for an AICH response from UTRAN.

Step-10:. Upon reception of AICH, the access segment ends and the contention resolution segment begins. In this segment, the UE randomly selects one of 15 signatures and transmits a CD preamble, then waits for an ASSIGN preamble from the base Node.

Step-11:1. The UE transmit the packet NS_assign_pkt slots after the start of the ASSIGN preamble from the Base Node. In transmitting the packet portion of the burst, the UE has constructed a TFCS based on the received TF's from the MAC.

Step-12:. During CPCH Packet Data transmission, the UE and UTRAN perform closed loop power control on both the CPCH UL and the CPCCH DL.

Step 13:. During CPCH Packet Data transmission, the UTRAN provides ACK/NAK responses to the transmitting UE using the RLC algorithm appropriate for each transport block. The ACK/NAKs are sent using either the CPCCH DL channel or the FACH.

OTHER NOTES:

A. The UE backs off in cases of no AICH response after N_aa_max preamble transmissions, called an unsuccessful preamble ramp . If there is no success after N_access_failspreamble ramps, the UE enters a failure procedure state.

B. The UE reports the Queuing delay (RLC+MAC) and the Radio Access Delay to UTRAN.

C. If there are errors in the packet, the receiving side will NAK by indicating which transport blocks were in error. This is done on the CPCCH-DL during transmission of the uplink packet. At the end of the packet transmission, the UE will switch to FACH to listen to other RLC messages.

D. If there are no errors after $W_{rx\text{-}ack}$ packets or $T_{ack\text{-}rx}$, the receiving side will send an ACK back to the transmitting side.

E. The receiving side will transfer the ACKed packets to the Packet Re-Assembly state where the longer segmented packets are re-constructed before they are relayed to the higher application layers.

F. The UE transmits $W_{tx\text{-}unacked}$ packets even if it does not receive any RLC ARQ messages. The transmitting RLC waits for a $RTO_{tx\text{-}unacked}$. Upon expiry of the time-out, the transmitting RLC re-transmit the unACKed packet.

G. If there are errors after $N_{RLC\text{-}RT}$ consecutive transport blocks re-transmissions, the entire packet is re-transmitted. A NAK-all RLC message is sent to the transmitting side.

H. The UE is in the RACH/FACH substate using CPCH/CPCCH resources while transmitting an ulpink packet. The UE uses CPCH/FACH resources while waiting for an ACK from the Base Node, The CPCH resource may be used with DSCH in case of a DSCH Downlink transmission while in the RACH/FACH sub-state. When using these CPCH/DSCH resources, the uplink RLC messages can be quickly sent over the CPCH channel.

I. Figure 1 illustrates the physical layer procedure associated with CPCH while the flowcharts show the functional overview of the CPCH access procedure from the UE and UTRAN sides.

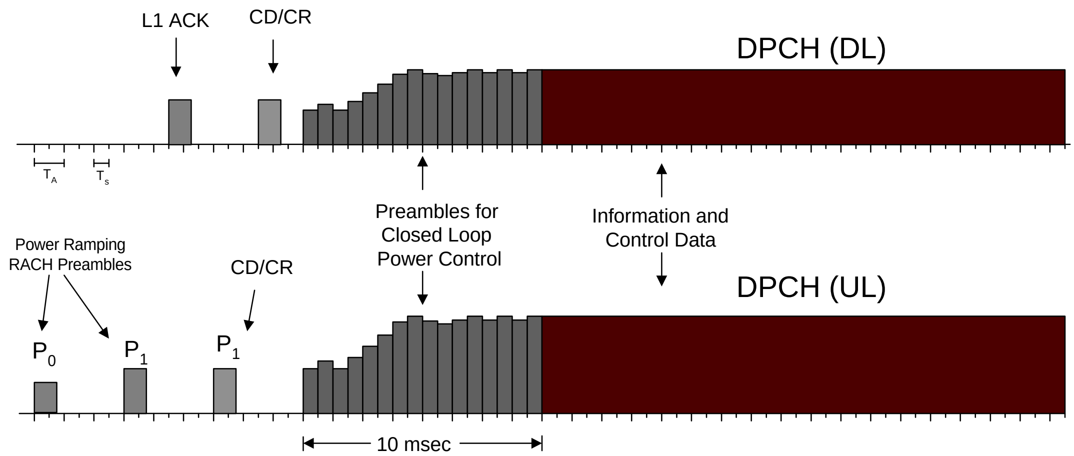
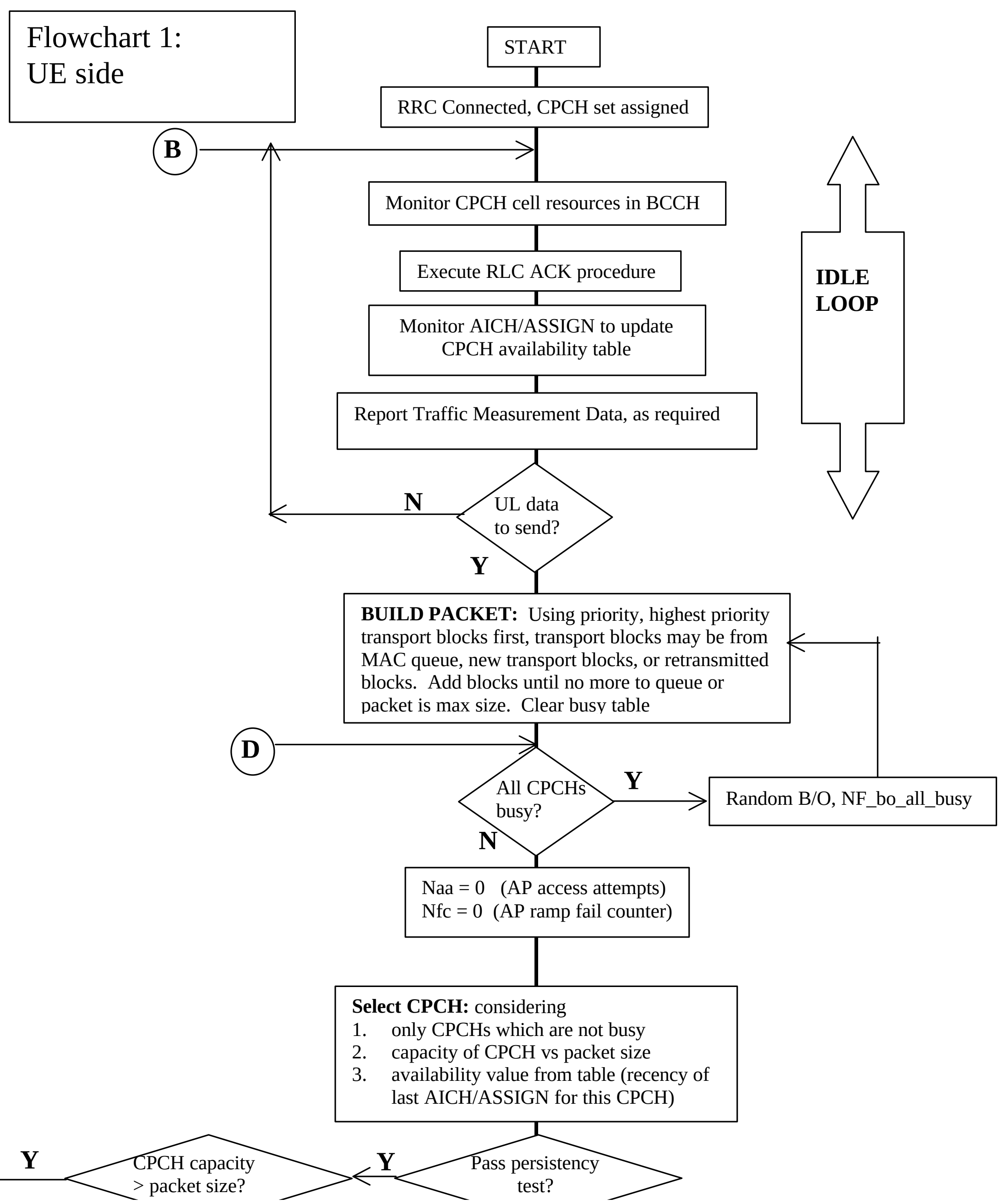
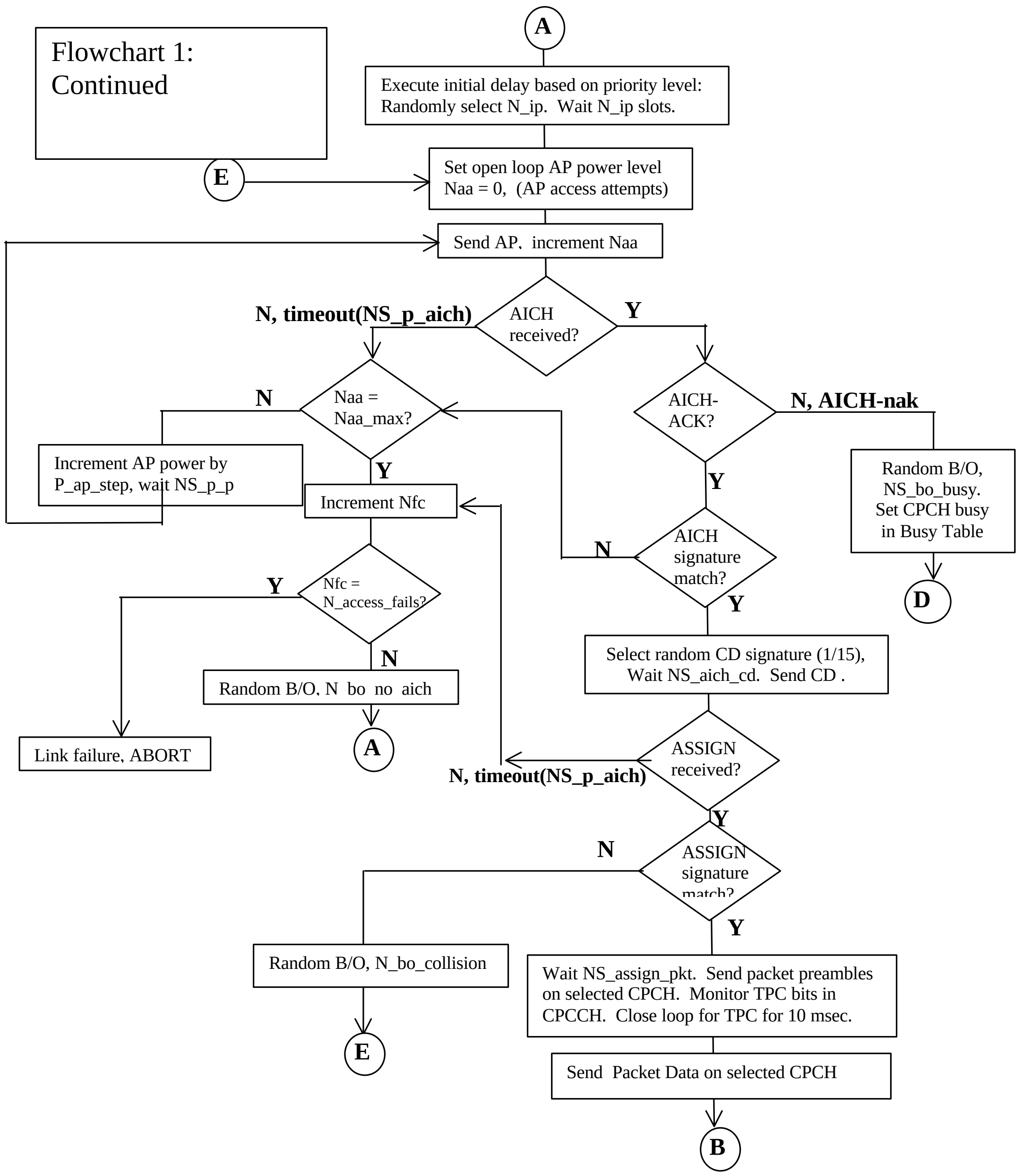
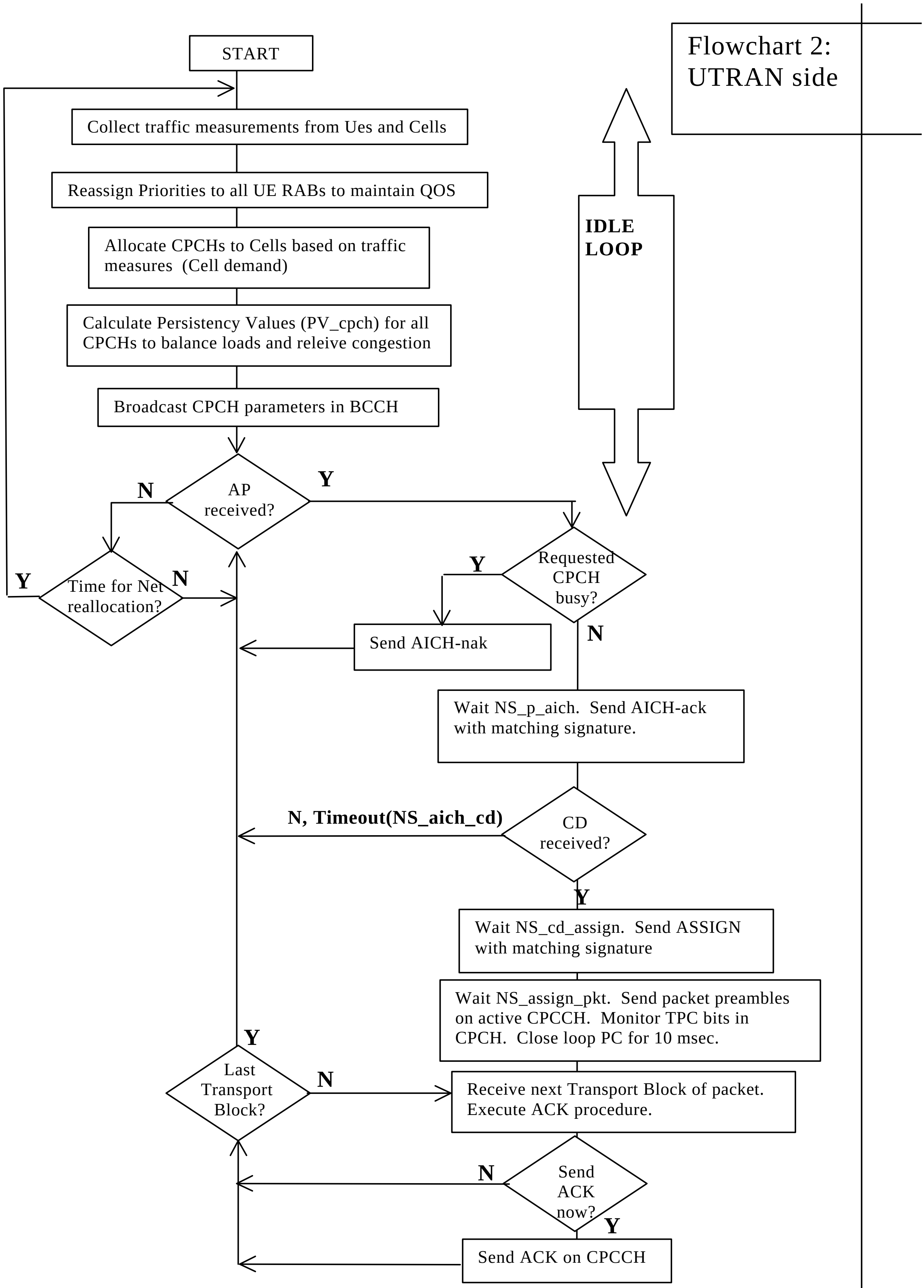


FIG 1. Common Packet Channel (CPCH) Timing Diagram with its Associated Downlink Dedicated Physical Channel.




Flowchart 1:
Continued
A
Execute initial delay based on priority level:
Randomly select N_ip. Wait N_ip slots.
E
Set open loop AP power level
Naa = 0, (AP access attempts)
Send AP, increment Naa
N, timeout(NS_p_aich)
AICH received?
Y
N
Naa = Naa_max?
AICH-ACK?
N, AICH-nak
Increment AP power by P_ap_step, wait NS_p_p
Y
Increment Nfc
Y
Random B/O, NS_bo_busy. Set CPCH busy in Busy Table
N
AICH signature match?
D
Y
Nfc = N_access_fails?
Y
N
Select random CD signature (1/15), Wait NS_aich_cd. Send CD .
Random B/O, N_bo_no_aich
Link failure, ABORT
A
ASSIGN received?
N, timeout(NS_p_aich)
Y
N
ASSIGN signature match?
Y
Random B/O, N_bo_collision
Wait NS_assign_pkt. Send packet preambles on selected CPCH. Monitor TPC bits in CPCCH. Close loop for TPC for 10 msec.
E
Send Packet Data on selected CPCH
B


Flowchart 2:
UTRAN side
START
Collect traffic measurements from Ues and Cells
Reassign Priorities to all UE RABs to maintain QOS
Allocate CPCHs to Cells based on traffic measures (Cell demand)
Calculate Persistency Values (PV_cpch) for all CPCHs to balance loads and releive congestion
Broadcast CPCH parameters in BCCH
IDLE LOOP
AP received?
N
Y
Time for Net reallocation?
Y
N
Requested CPCH busy?
Y
N
Send AICH-nak
Wait NS_p_aich. Send AICH-ack with matching signature.
N, Timeout(NS_aich_cd)
CD received?
Y
Wait NS_cd_assign. Send ASSIGN with matching signature
Wait NS_assign_pkt. Send packet preambles on active CPCCH. Monitor TPC bits in CPCH. Close loop PC for 10 msec.
Last Transport Block?
Y
N
Receive next Transport Block of packet. Execute ACK procedure.
Send ACK now?
N
Y
Send ACK on CPCCH

16 Annex 3: MAC parameters

16.1 RNTI (Radio Network Temporary Identifier)

16.2 LID (Logical Channel Identifier)

16.3 NR (The number of RNTI)

16.4 RNTI Field