TSG-RAN WG2#4
Berlin Germany
May 25-28, 1999

TSGR#4(99)445

Agenda Item: **6.7**

Source: **Golden Bridge Tech**

Title: S25.303 : Request for CPCH-related modification

Document for: Approval

TS RAN S2.03 V0.3.0 (1999-04)

Technical Specification

3rd Generation Partnership Project (3GPP);

Working Group 2 (WG2);

in Connected Mode

3GPP

Reference

<Workitem> (<Shortfilename>.PDF)

Keywords

<keyword[, keyword]>

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Foreword

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~~4.~~General Description of Connected Mode

The connected mode is entered when the RRC connection is established. The UE is assigned a radio network temporary identity (RNTI) to be used as UE identity on common transport channels. Two types of RNTI exist. The Serving RNC allocates an s-RNTI for all UEs having an RRC connection. The combination of s-RNTI and an RNC-ID is unique within a PLMN. c-RNTI is allocated by each Controlling RNC through which UE is able to communicate on DCCH. c-RNTI is always allocated by UTRAN when a new UE context is created to an RNC, but the UE needs its c-RNTI only for communicating on common transport channels.

The UE leaves the connected mode and returns to idle mode when the RRC connection is released or at RRC connection failure.

Within connected mode the level of UE connection to UTRAN is determined by the quality of service requirements of the active radio access bearers and the characteristics of the traffic on those bearers.

The UE-UTRAN interface is designed to support a large number of UE:s using packet data services by providing flexible means to utilize statistical multiplexing. Due to limitations, such as air interface capacity, UE power consumption and network h/w availability, the dedicated resources cannot be allocated to all of the packet service users at all times.

The UE state in the connected mode defines the level of activity associated to the UE. The key parameters of each state are the required activity and resources within the state and the required signalling prior to the data transmission. The state of the UE shall at least be dependent on the application requirement and the period of inactivity.

Common Packet Channel (CPCH) uplink resources are available to UE's with a fast-access protocol similar to the RACH. The CPCH resources support efficient uplink packet communication for numerous UEs with a set of shared, contention-based CPCH channels allocated to the cell. The RNC assigns theUE to a CPCH set using a RAB setup for each logical channel whose traffic statistics warrant CPCH services.

Packet Services can be supported also using the FAUSCH, by means of which a dedicated transport channel can be allocated for data transmission.

The different levels of UE connection to UTRAN are listed below:

- No signalling connection exists
  The UE is in idle mode and has no relation to UTRAN, only to CN. For data transfer, a signalling connection has to be established.

- Signalling connection exists
  When at least one signalling connection exists, the UE is in connected mode and there is normally an RRC connection between UE and UTRAN. The UE position can be known on different levels:

  - UTRAN Registration Area (URA) level
    The UE position is known on URA level. The URA is a set of cells

  - Cell level
    The UE position is known on cell level. Different transport channel types can be used for data transfer:
    - Common transport channels (RACH/FACH, CPCH, DSCH)~~)~~
    - Dedicated transport channels (DCH) (FAUSCH can be used to allocate a dedicated transport channel for data transmission.)

Assuming that there exists an RRC connection, there are two basic families of RRC connection mobility procedures, URA updating and handover. Different families of RRC connection mobility procedures are used in different levels of UE connection (cell level and URA level):

- URA updating is a family of procedures that updates the UTRAN registration are of a UE when an RRC connection exists and the position of the UE is known on URA level in the UTRAN.
- Handover is a family of procedures that adds or removes one or several radio links between one UE and UTRAN when an RRC connection exists and the position of the UE is known on cell level in the UTRAN.

~~5.~~Description of UE states and state transitions

~~5.1~~UE RRC States and State Transitions including GSM (PSTN / ISDN only)

~~5.2~~UE RRC States and State Transitions including GSM / GPRS (IP only)

~~5.3~~Transition from Idle Mode to Connecting State

The transition to the Connecting State from the Idle Mode can only be initiated by the UE by transmitting a request for an RRC Connection. The event is triggered either by a paging request from the network or by a request from upper layers in the UE.

~~5.4~~Connecting State

In the Connecting State (**Error! Reference source not found.**) the UE has transmitted a request for an RRC connection and it waits for a response. No mobility procedures take place in this state.

In this state, the UE transmits on RACH transport channel in the uplink and receives the FACH transport channel in the downlink. Only the logical channel CCCH can be used, since no RNTI is assigned. Connecting state is shown in **Error! Reference source not found.**.

~~5.4.1~~Transition to Connected Mode

~~5.4.2~~Transition to Idle Mode

~~5.5~~Connected Mode States and Transitions

~~5.5.1~~Cell Connected State

~~5.5.1.1.1~~Control only substate

[Editor's note: The applicability of the control only substate to the TDD-mode is FFS.]

~~5.5.1.1.2~~User data active substate

~~5.5.1.1.3~~Transition from DCH/DCH to DCH/DCH+DSCH substate

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~~5.5.1.1.8~~Transition from DCH/DCH or DCH/DCH+DSCH to RACH / FACH substate

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~~5.5.1.1.13~~Radio Resource Allocation tasks (DCH/DCH and DCH/DCH+DSCH)

~~5.5.1.1.14~~RRC Connection mobility tasks (DCH/DCH and DCH/DCH+DSCH)

~~5.5.1.1.14.1~~Localised Service Area (LSA) support

~~5.5.1.2~~RACH/FACH~~ and RACH+FAUSCH/FACH~~ substate~~s~~

The position of the UE is known by UTRAN on cell level. In the RACH / FACH substate the UE performs the following actions:

- listens to an FACH

- listens to the BCH transport channel of the serving cell for the decoding of system information messages (FFS)
- initiates a cell update procedure on cell change
- transmits uplink control signals and small data packets on the RACH.
- Transmits uplink control signals and larger data packets on CPCH when resources are allocate to cell and.UE is assigned use of those CPCH resources.

[Editor's note: The FFS on the decoding of BCH was requested by the editor and is now proposed to be removed.]

Shared CPCH resources may be assigned to a UE in RACH/FACH substate. The RNC uses RAB Setup (without dedicated physical channel) to assign the UE to a set of (up to 16) CPCH channels in use on the connected cell. Once the UE has been assigned the CPCH channel set, the UE may access the CPCH channels in a multi-access, contention-based fashion. The NB resolves contention and efficiently manages the CPCH resources at the cell level without the need for the RACH/FACH control messaging normally needed when DCHs are temporarily assigned by the RNC. The RNC continues to receive measurement reports and can reassign CPCH resources to/from UEs with changing traffic demand. The RNC also uses measurement data from NB cells to reallocate the number of CPCHs in each CPCH Set allocated to each cell. Downlink codes are assigned to CPCH Sets on a demand basis to conserve codes for other uses.

Furthermore, the UE can use the FAUSCH to trigger the allocation of a new DCH by RNC. Further rate adaptation can be done via the DCCH of the new DCH.

~~5.5.1.2.1~~Transition from RACH/FACH to RACH+FAUSCH/FACH substate

~~5.5.1.2.2~~Transition from RACH+FAUSCH/FACH to RACH/FACH substate

~~5.5.1.2.3~~Transition from RACH/FACH to DCH/DCH or DCH/DCH+DSCH substates

~~5.5.1.2.4~~Transition from RACH+FAUSCH/FACH to DCH/DCH or DCH/DCH+DSCH substates

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~~5.5.1.2.9~~Radio Resource Allocation Tasks (RACH/FACH and RACH+FAUSCH/FACH)

Radio Resource Allocation Tasks (CPCH/FACH and CPCH/DSCH)

The RNC can assign CPCH resources to the UE in RACH/FACH substate. When CPCH resources are assigned, the UE will continue to monitor FACHs. The UE uses the RACH to transmit uplink control signals and small data packets. The UE also may choose to transmit data packets, larger than those carried on the RACH, on the CPCH channel. Within the assigned CPCH Channel Set are mulitple CPCH channels with different capacities. The CPCH capacity is defined as the CPCH data rate multiplied by the maximum packet size for that CPCH (NF_max_pkt, in frames). The UE selects either the RACH or one of the CPCH channels to make maximum use of the capacity available on that channel. This minimizes the number of packet transmissions needed.

The UE provides the RNC with CPCH measurement data which includes data queue depth (current size of data buffers), average access time for each CPCH channel used, and average data throughput on each CPCH channel used. With these measurands and the cell aggregate traffic measurement reports, the RNC can reallocate network resources on a periodic basis. The RNC allocates CPCH Sets to each cell and assigns UEs to one of the cell's CPCH Sets. The UEs can dynamically access the CPCH resources without further RNC control. This CPCH resource allocation within RACH/FACH substate provides the RNC with a means to service low-medium UL traffic loads without the need for DCH resources. The RNC continues to evaluate the traffic load level at which the UE should be switched to the DCH/DCH substate (increased demand) or to deassign CPCH resources (decreased demand).

~~5.5.1.2.10~~RRC Connection mobility tasks (RACH/FACH, ~~and~~ RACH+FAUSCH/FACH, CPCH/FACH, and CPCH/DSCH)

In this substate the location of the UE is known on cell level. A cell update procedure is used to report to the UTRAN, when the UE selects a new cell to observe the common downlink channels of a new Node B. In this substate measurement reporting and hard handover procedures can be used. Downlink data transmission on the FACH can be started without prior paging.

~~5.5.1.3~~RACH/DSCH and RACH+FAUSCH/DSCH substates

~~5.5.1.4~~PCH substate

~~5.5.1.4.1~~Transition from PCH to URA Connected State

~~5.5.1.4.2~~Transition from PCH to RACH/FACH substate

~~5.5.1.4.3~~Transition from PCH to RACH+FAUSCH/FACH substate

~~5.5.1.4.4~~Transition from PCH to RACH/DSCH or RACH+FAUSCH/DSCH substates

~~5.5.1.4.5~~Radio Resource Allocation Tasks (PCH)

~~5.5.1.4.6~~RRC Connection mobility tasks (PCH)

~~5.5.2~~URA Connected State

~~5.5.2.1~~Transition from URA Connected State to Cell Connected State

~~5.5.2.2~~Radio Resource Allocation Tasks (URA Connected)

~~5.5.2.3~~RRC Connection mobility tasks (URA Connected)

~~6.~~Radio Access Bearer Control – Overview of Procedures

~~6.1~~Configurable parameters

The following layer 1, MAC and RLC parameters should be able to configure by RRC. The list is not complete.

- Radio access bearer parameters, e.g.
  - RLC parameters per RLC link (radio access bearer), which may include e.g. PDU size and timeout values. Used by RLC.

  - Multiplexing priority per DCCH/DTCH. Used by MAC in case of MAC multiplexing of logical channels.
- Transport channel parameters, e.g.
  - Scheduling priority per transport channel. Used by MAC in case of layer 1multiplexing of transport channels.
  - Transport format set (TFS) per transport channel. Used by MAC and L1.
  - Transport format combination set (TFCS) per UE. Used by MAC and L1.
  - Allowed subset of TFCS per UE. Used by MAC.
- Physical channel parameters, which may include e.g. carrier frequency and codes. Used by L1.
- CPCH parameters are broadcast in BCCH to all UEs within the cell. A separate set of parameters is included for each CPCH channel allocated to the cell. CPCH channel parameters include:
  - CPCH Set number (1 to N) in which this CPCH channel is a memeber
  - CPCH Access Preamble (AP) code
  - CPCH Collision Detection (CD) code
  - CPCH UL scrambling code
  - CPCCH DL channelisation code
  - CPCH data rate (spreading factor)
  - CPCH max packet length (NF_pkt_max, number of frames)
  - Persistency value (PV_cpch) for load balancing and congestion control
  - AP signature(s) to use to request this CPCH

~~6.2~~Typical configuration cases

The table below gives a proposal which main combination cases of parameter configuration that shall be supported, in terms of which parameters that shall be able to configure simultaneously (by one procedure). Note that the “Transport channel type switching” is not a parameter as such, it only indicates that switching of transport channel type may take place for that combination case.

Parameter		Layer	A	B	C	D	E	F
Radio access bearer parameters	RLC parameters	RLC	X					
	Logical channel multiplexing priority	MAC	X					
Transport channel parameters	Transport channel scheduling priority	MAC	X					
	TFS	L1+MAC	X	X				
	TFCS	L1+MAC	X	X				
	Subset of TFCS	MAC					X	X
	Transport channel type switching	MAC	X	X	X			
	~~Transpor~~tCPCH channel ~~type~~ switching	MAC	X	X	X			
Physical channel parameters		L1	X	X	X	X		

Table 1. Typical configuration cases. An “X” indicates that the parameter can (but need not) be configured.

Case A is typically when a radio access bearer is established or released, or when the QoS of an existing radio access bearer or the signalling link need to be changed (the necessity of change of QoS is FFS).

Case B is when the traffic volume of a radio access bearer has changed so the TFS used on the DCH need to be changed, which may in turn affect any assigned set of physical channels. Another example is to make the UE use a new transport channel and at the same time supplying the TFS for that channel.

Case C is when the traffic volume of one radio access bearer has changed so that the used transport channel type is changed~~, from~~ e.g. from RACH/FACH to DCH/DCH or when the CPCH Set assigned to a UE is switched .~~,~~ This case ~~which~~ includes the assignment or release of a set of physical channels.

Case D is e.g. the change of used DL channelization code, when a DCH is currently used. No transport channel type switching take place.

Case E is a temporary restriction and/or a release of restriction for usage of the TFCS by the UE (total uplink rate).

Case F is used to dynamically control the allocation of resources on uplink DCHs in the CRNC, using broadcast information such as transmission probability and maximum bit rate.

~~6.3~~RRC Elementary Procedures

~~6.3.1~~Category 1: Radio Access Bearer Configuration

The first category of procedures includes Case A and are characterized by:

- Are executed upon request by higher layers and the parameter configuration is based on QoS
- Affects L1, MAC and RLC.

There are three RRC procedures included in this category:

- **Radio Access Bearer Establishment.** This procedure establishes a new radio access bearer. The establishment includes, based on QoS, assignment of RLC parameters, multiplexing priority for the DTCH, CPCH Set assignment, scheduling priority for DCH, TFS for DCH and update of TFCS. It may also include assignment of a physical channel(s) and change of the used transport channel types / RRC state.
- **Radio Access Bearer Release.** This procedure releases a radio access bearer. The RLC entity for the radio access bearer is released. The procedure may also release a DCH, which affects the TFCS. It may include release of physical channel(s) and change of the used transport channel types / RRC state.
- **Bearer Reconfiguration.** This procedure reconfigures parameters for a radio access bearer or the signalling link to reflect a change in QoS. It may include change of RLC parameters, change of multiplexing priority for DTCH/DCCH, CPCH Set assignment, change of DCH scheduling priority, change of TFS for DCH, change of TFCS, assignment or release of physical channel(s) and change of used transport channel types. *[Note: The necessity of this procedure is FFS.]*

~~6.3.2~~Category 2: Transport Channel Configuration

The second category of procedures includes Case B and are characterized by:

- Configuration of TFS for a transport channel and reconfiguration of TFCS is done, but sometimes also physical channel parameters.

- Affects L1 and MAC.
- Switching of used transport channel(s) may take place.

There is one RRC procedure included in this category:

- **Transport Channel Reconfiguration.** This procedure reconfigures parameters related to a transport channel such as the TFS or CPCH Set assignment,. The procedure also assigns a TFCS and may change physical channel parameters to reflect a reconfiguration of a transport channel in use. *[Note: It is expected that the configuration of TFS/TFCS needs to be done more seldom than the assignment of physical channel. A "pre-configuration" of TFS/TFCS of a transport channel not in use can be done by this procedure, to be used after transport channel type switching when the physical channel is assigned.]*

~~6.3.3~~Category 3: Physical Channel Configuration

~~6.3.4~~Category 4: Transport Format Combination Restriction

~~6.3.5~~Category 5: Uplink Dedicated Channel Control in CRNC

~~7.1~~RRC Connection Establishment and Release Procedures

~~7.1.1~~RRC connection establishment - Case A

UE Initiated Signalling Connection Establishment

~~7.1.3~~Normal RRC Connection Release

RRC Connection Release from Dedicated Physical Channel

~~7.1.3.2~~RRC Connection Release without Dedicated Physical Channel

[Note: Depending on RLC design, the acknowledgement to RRC CONNECTION RELEASE could be piggybacked to the RRC CONNECTION RELEASE COMPLETE MESSAGE, resulting in no additional messages. Therefore acked / unacked transmission is considered FFS.]

Figure 1: RRC Connection Release without Dedicated Physical Channel

~~7.2~~Radio Access Bearer Procedures

~~7.2.1~~Radio Access Bearer Configuration

~~7.2.1.1~~Radio Access Bearer Establishment

Radio Access Bearer Establishment with Dedicated Physical Channel Activation

~~7.2.1.1.2~~Radio Access Bearer Establishment with Unsynchronised Dedicated Physical Channel Modification

~~7.2.1.1.3~~Radio Access Bearer Establishment with Synchronised Dedicated Physical Channel Modification

~~7.2.1.1.4~~Radio Access Bearer Establishment without Dedicated Physical Channel

Radio Access Bearer Establishment for CPCH services

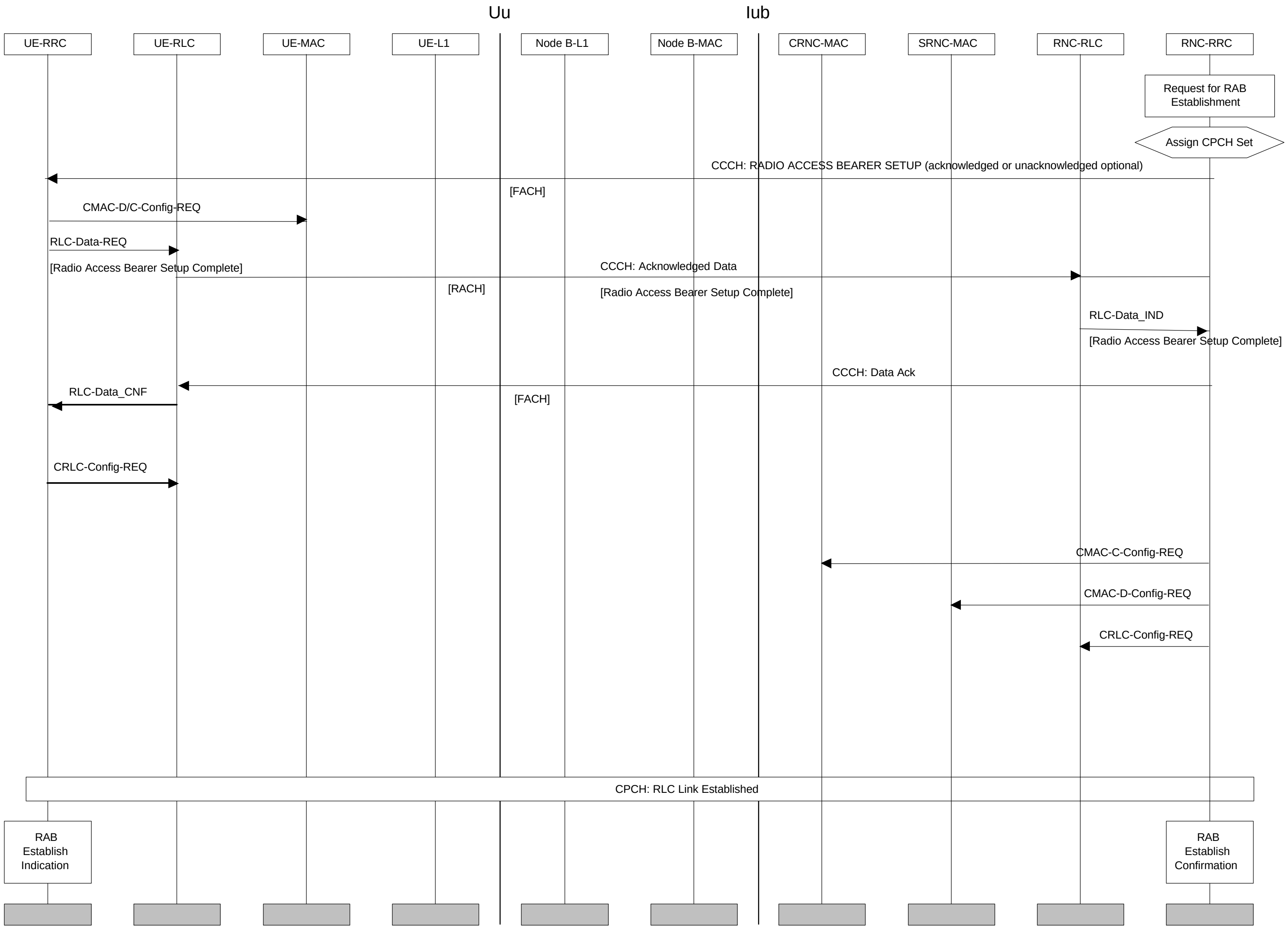

Figure 2: Radio Access Bearer Establishment for CPCH services

When the RNC determines the need to assign CPCH UL resources to a UE, the RNC sends a RAB Setup message to the UE. Since the CPCH physical parameters are broadcast in the BCCH, the RAB Setup message does not include a DPCH part. The Transport Channel information includes the CPCH set (CPCH Set ID#) to which the UE is to be assigned. MAC entities are configured: MAC-D and MAC-C in the UE, MAC-C in the CRNC, and MAC-D in the SRNC. Node B MAC controls access to the individual CPCH channels in the CPCH set. However, Node B MAC does not require configuration, since it was configured to control the CPCH set when the CPCH set was initially allocated to that cell. The Node B MAC can function indedpendantly of the number of UEs assigned to the CPCH set. Once the RAB setup is complete, the UE may access the CPCH when the logical channel for this RAB next presents data to send in the uplink direction.

The message flow diagram for RAB setup for CPCH is similar to the RAB Setup without Dedicated Physical Channel (cf 7.2.1.1.4).

~~7.2.1.2~~Radio Access Bearer Release

~~7.2.1.2.1~~Radio Access Bearer Release with Unsynchronised Dedicated Physical Channel Modification

~~7.2.1.3~~Bearer Reconfiguration

~~7.2.1.3.1~~Unsynchronised Radio Access Bearer And Signalling Link Reconfiguration

~~7.2.2~~Transport Channel Reconfiguration

~~7.2.2.1~~Unsynchronised Transport Format Set Reconfiguration

~~7.2.3~~Physical Channel Reconfiguration

~~7.2.3.1~~UE-Originated DCH Activation

~~7.2.3.2~~UE-terminated synchronised DCH Modify

~~7.2.3.3~~UE-terminated DCH Release

~~7.2.4~~Transport Format Combination Control

~~7.2.4.1~~Transport Format Combination Limitation

~~7.2.5~~Dynamic Resource Allocation Control of Uplink DCH:s

~~7.3~~Data transmission

~~7.3.1~~Acknowledged-mode data transmission in DCH / DCH + DSCH

Acknowledged-mode data transmission in CPCH/FACH

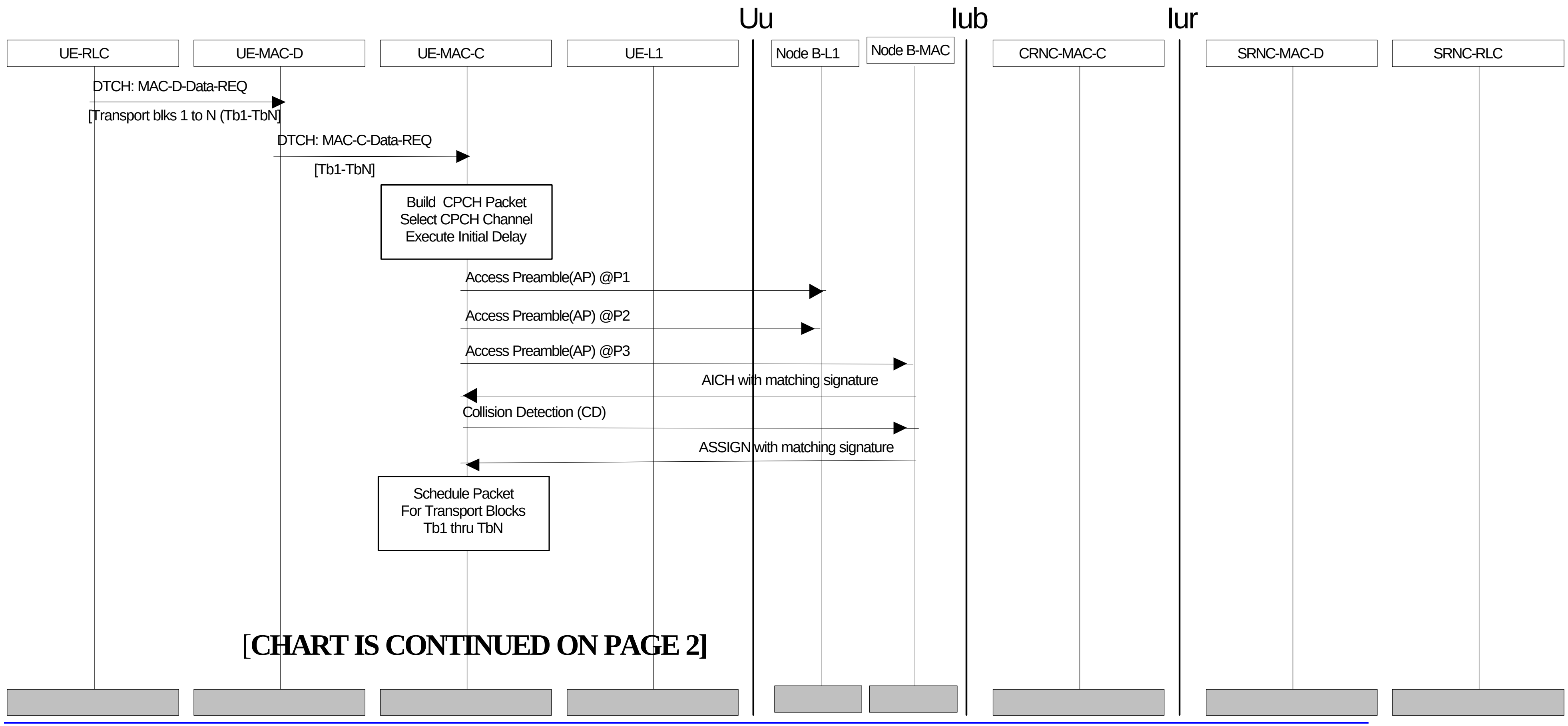

Figure 3: Example of acknowledged-mode data transmission on CPCH/FACH (page 1 of 2)

[Editor's note: This example is currently FFS, pending confirmation from WG1 on the use of independent parts of TFCI with different active sets.]

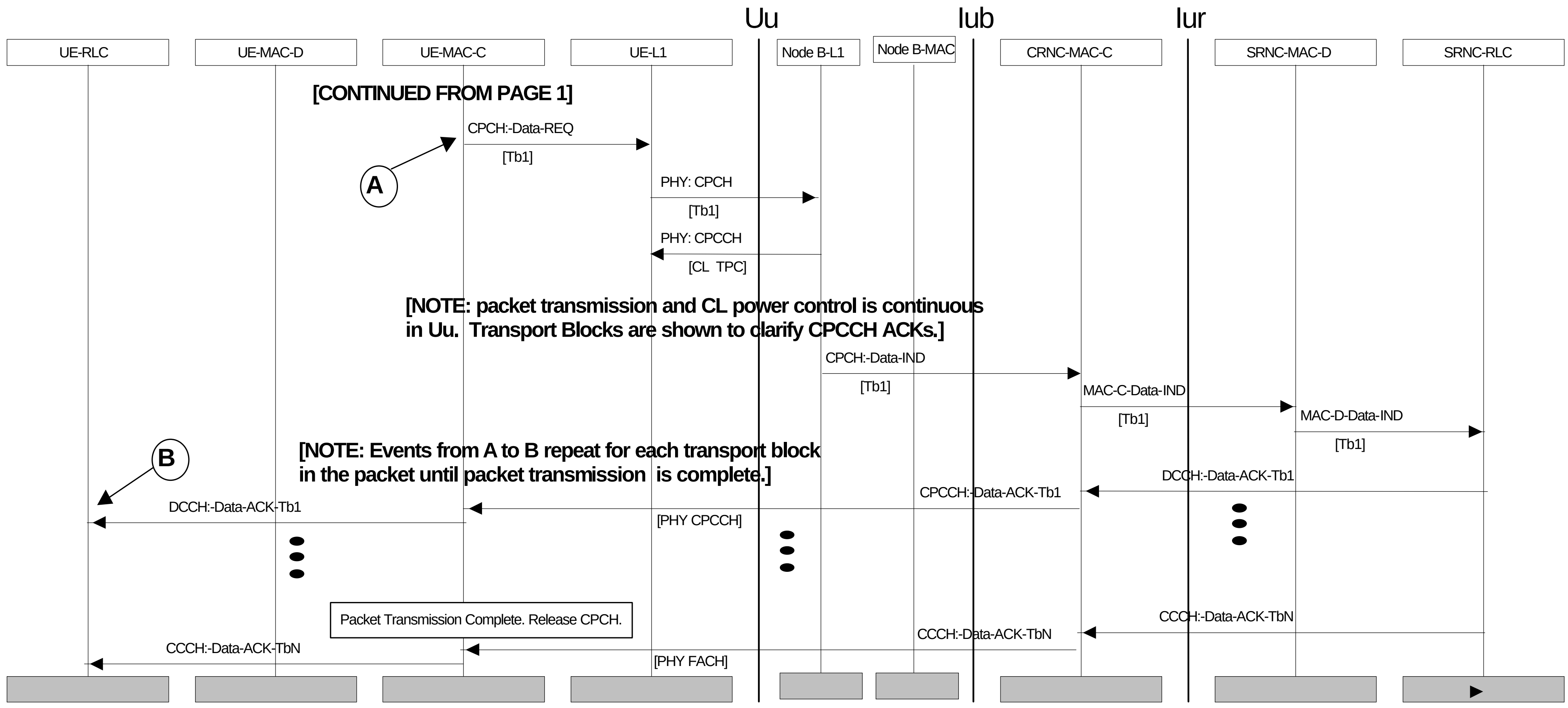

Figure 4: Example of acknowledged-mode data transmission on CPCH/FACH (page 2 of 2)

[Editor's note: This example is currently FFS, pending confirmation from WG1 on the use of independent parts of TFCI with different active sets.]

Figure 26 shows an example of acknowledged-mode data transmission on CPCH while in the RRC Connected state, the RACH/FACH substate with CPCH resources assigned to UE (CPCH/FACH mode). A RAB setup has allocated CPCH resources to the logical channel sourcing the data to be transmitted. First RLC in UE requests data transmission locally from

MAC-d. MAC-d routes the request to MAC-c, where CPCH packet building is done. When the packet size (bytes in PHY for TFI chosen by MAC-c) is known, MAC-c selects one of the available CPCH channels from the CPCH set it has been assigned to use for this logical channel. Priority access procedure is performed to execute an initial access delay. Then the CPCH access procedure is performed between UE and NB to request and obtain the CPCH for transmission. The CPCH access procedure includes an AP, AICH-ack, CD, and ASSIGN premable messages. When the CPCH channel has been assigned, MAC-c schedules the packet for transmission by L1. [NOTE: if the requested channel could not be assigned, MAC-c may select an alternate CPCH channel which may have lower capacity. If the lower rate CPCH channel were assigned by NB, MAC-c would segment the packet based on the CPCH capacity and schedule only the highest priority packet head. The lower priority packet tail would be saved in a MAC queue for later packet transmission.]

After the 10msec period to close the TPC loops on both the CPCH UL and CPCCH DL, transport blocks are transmitted, frame by frame, unitl all the packet data is sent. Figure 26 shows how the SRNC RLC uses the CPCCH to send RLC ACKs to the UE RLC. Since the CPCCHDL channel is only available while the UE is accessing the CPCH UL, any RLC ACKs which occur after the CPCH has been released will be sent from the SRNC RLC to the UE RLC using the FACH.