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Contents

Foreword

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x the first digit:

1 presented to TSG for information;

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y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

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1 Scope

The present document captures the agreements of the different techniques for 1.28 Mcps TDD Enhanced Uplink, namely the support of Node-B controlled rate scheduling, Node-B controlled physical resource scheduling, hybrid ARQ, and higher order modulation, with regards to the overall support of UTRA TDD Enhanced Uplink for the 1.28Mcps mode.

The technical objective of this work item is the introduction of Enhanced Uplink functionality in UTRA 1.28Mcps TDD, to improve uplink performance for background, interactive and streaming-based traffic.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.
- For a specific reference, subsequent revisions do not apply.
- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 25.804 (V6.1.0): "Feasibility Study on Uplink Enhancements for UTRA TDD".

[2] 3GPP TR25.826(V1.0.0): “3.84Mcps TDD Enhanced Uplink, Physical Layer Aspects”

[3] 3GPP TR 30.301: "RAN WG2 Stage 2 Decisions".

[4] 3GPP TS 25.221 “Physical Channels and Mapping of Transport Channels onto Physical Channels (TDD)”

[5] 3GPP TS 25.222 “Multiplexing and Channel Coding (TDD)”

[6] 3GPP TS 25.223 “Spreading and Modulation (TDD)”

[7] 3GPP TS 25.331 “RRC Protocol Specification”

[8] 3GPP TS 25.224 “Physical layer procedures (TDD)”

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the following terms and definitions apply.

3.2 Symbols

For the purposes of the present document, the following symbols apply:

<symbol> <Explanation>

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

<ACRONYM> <Explanation>

4 Introduction

In TSG RAN plenary meeting #31, a work item for 1.28 Mcps TDD Enhanced Uplink was initiated, based upon the findings of the study item "Feasibility Study on Uplink Enhancements for UTRA TDD". The aim of the study was to look at the feasibility of enhancing uplink operation and performance by several techniques in order to efficiently support services such as web browsing, video clips, multimedia messaging and other IP based applications. The RAN study showed that various techniques such as Node-B controlled rate scheduling, Node-B controlled physical resource scheduling, higher-order modulation and a hybrid ARQ layer in the Node-B, can enhance the uplink packet transfer performance significantly compared to Release-99/Rel-4/Rel-5. The study item findings are captured in [1].

The technical objective of this work item is the introduction of Enhanced Uplink functionality in UTRA TDD 1.28Mcps, to improve the performance of the uplink for background, interactive and streaming-based traffic. The improvements should take into account backwards compatibility aspects.

For the physical layer, the 1.28 Mcps TDD Enhanced Uplink specification work includes:

- Physical and Transport Channel mapping
- Multiplexing and Channel Coding
- Physical Layer procedures
- Physical layer measurements
- UE physical layer capabilities

5 Basic Physical Layer Structure

5.1 CCTrCH and Transport Channel Structure

There is at most one CCTrCH of E-DCH type per UE and only one E-DCH per CCTrCH of E-DCH type. The E-DCH supports one transport block per E-DCH TTI. A 5ms TTI is supported by the E-DCH.

The performance of longer TTI, i.e. 20 ms TTI, has also been evaluated during this work item. Based on simulation results, the benefit of longer TTI can be seen in some circumstances. But longer TTI will not be introduced in this version due to the WI schedule. Longer TTI co-existence with 5ms TTI is FFS.

To support the uplink signalling for enhanced uplink, two types of E-DCH Uplink Control Channels are defined:

E-UCCH (E-DCH Uplink Control Channel): One E-UCCH is multiplexed with E-DCH onto one CCTrCH of E-DCH type. Multiple instances of the same E-UCCH information can be transmitted within an E-DCH TTI, the detailed number of instances can be set by NodeB MAC-e for scheduled transmissions and signalled by higher layers for non-scheduled transmissions.

E-RUCCH(E-DCH Random Access Uplink Control Channel):E-RUCCH is mapped to random access physical resources.

E-UCCH has a 5ms TTI , E-RUCCH's TTI length can be chosen as 5ms or 10ms according to the configuration of RACH's TTI length.

5.2 Overall Physical Channel Structure

E-PUCH are the physical resources allocated under the control of a scheduling entity in Node-B MAC-e, and are mapped from the CCTrCH of E-DCH type. A maximum of one E-PUCH can be transmitted in one timeslot. And when E-PUCH is transmitted, the UE can only transmit one code channel in one timeslot.

E-PUCH physical resources are defined as non-scheduled resources and scheduled resources. The non-scheduled resources are allocated by RNC through high-layer signalling while the scheduled resources are allocated under the control of a scheduling entity in Node-B MAC-e.

The E-RUCCH is mapped to the same random access physical resources defined by UTRAN.

6 Hybrid ARQ Scheme

6.1 HARQ Scheme for TDD Enhanced Uplink

6.1.1 General

A parallel stop-and-wait HARQ protocol is employed supporting incremental redundancy.

6.1.2 Timing Aspects

Transmission resources (timeslots/codes/power) are allocated by the Node-B scheduler by means of E-AGCH. The E-DCH transmission is acknowledged by a subsequent E-HICH using a synchronous timing relationship.

An overview of the general HARQ scheme is shown in figure 6.1.2.1.

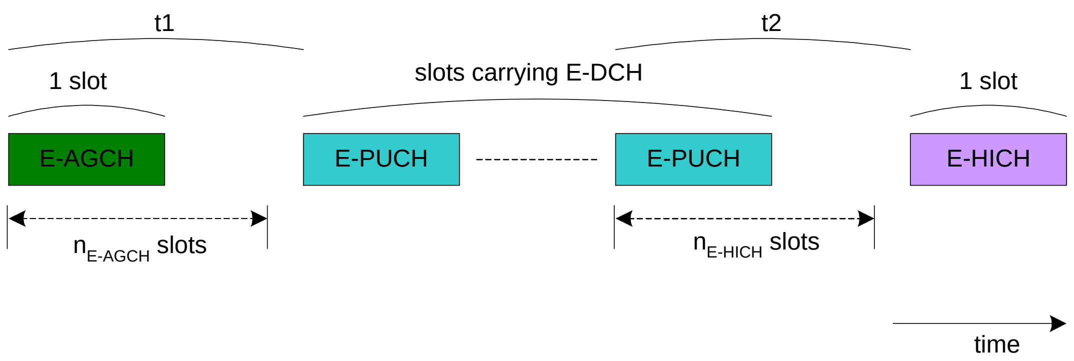

Figure 6.1.2.1: HARQ scheme

A minimum number of slots is required between the start of the E-AGCH and the start of the first active slot of the subsequent E-DCH transmission to allow for UE processing. This interval is denoted $n_{E\text{-}AGCH}$ and is equal to 6 slots (see figure 6.1.2.2). Upon receiving an E-AGCH, the UE shall assume that the transmission resources indicated are the first instances of those resources (timeslots/codes) existing after a time instant corresponding to the start of the E-AGCH timeslot plus 6 slots. Note that DwPTS and UpPTS are not considered here.

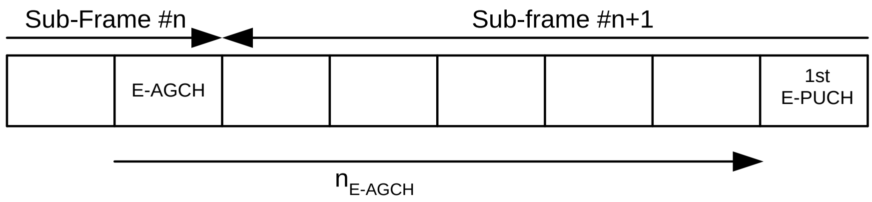

Figure 6.1.2.2: minimum timing relationship between E-AGCH and E-DCH transmission

A minimum number of slots is also required between the start of the last active slot of the E-DCH TTI and the start of the transmission of the ACK/NACK on E-HICH. This interval is denoted $n_{E\text{-}HICH}$ and is configurable by higher layers within the range 4 to 15 timeslots. Following transmission of an E-DCH TTI, the UE shall assume that the transmission will be acknowledged in the first instance of the E-HICH after a time instant corresponding to the start of the last E-DCH timeslot plus $n_{E\text{-}HICH}$ slots. Examples of variable $n_{E\text{-}HICH}$ are shown in figure 6.1.2.3, and DwPTS and UpPTS are not considered.

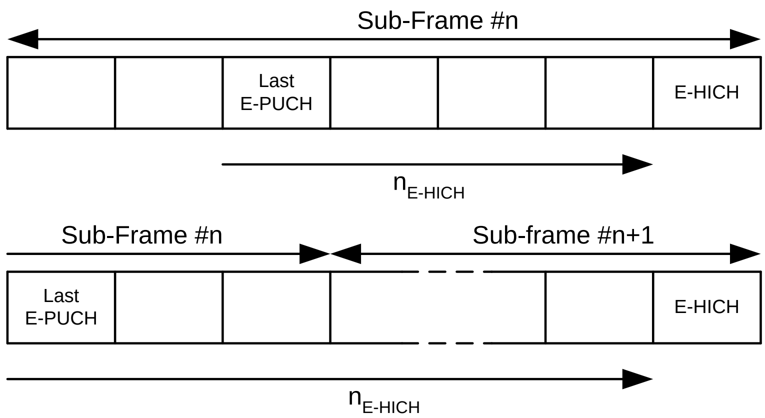

Figure 6.1.2.3: examples of variable $n_{E\text{-}HICH}$

6.2 Signalling Information Required for the Support of HARQ

E-UCCH is used to carry uplink signaling required for HARQ. The E-UCCH contains the following HARQ-related parameters:

- HARQ process ID (3 bits)
- Retransmission Sequence Number (RSN) – (2 bits)

HARQ-related parameters which are configured by higher layers include:

- $n_{E\text{-}HICH}$ in slots (see section 6.1.2)
- The number of HARQ processes (up to 4 which is the maximum number of HARQ processes for either scheduled transmission or non-scheduled transmission)

6.2.1 Retransmission Sequence Number

To indicate the redundancy version (RV) of each HARQ transmission and to assist the NodeB soft buffer management, a two bit retransmission sequence number (RSN) is signalled from the UE to the Node B. The value of RSN is set by higher layers depending on the transmission number (n) for the associated HARQ process, according to table 6.2.1.1 below. Thus, the RSN sequence for a given HARQ process follows the pattern 0,1,2,3,2,3,2,3,…

Table 6.2.1.1: RSN value for the initial transmission and for retransmissions

Transmission Number (n)	RSN value
0 (initial transmission)	0
1	1
2	2
≥3	2+(n mod 2)

The used RV is implicitly linked to the transmitted RSN, as such the Node-B is always able to determine the correct RV if the RSN information is correctly obtained.

The adopted mapping between E-DCH RV index and s/r parameters is kept the same as those for FDD E-DCH which is depicted below.

Table 6.2.1.2: mapping between RV and the s and r parameters used for rate matching

E-DCH RV Index	*s*	*r*
0	1	0
1	0	0
2	1	1
3	0	1

The proposed constellation rearrangement parameter linkage with RSN is shown in Table 6.2.1.3 below.

Table 6.2.1.3: mapping between RSN and b parameters for CoRe

RSN	Coding Rate <1/2	1/2≤ Coding Rate
	b	b
0	0	0
1	2	3
2	3	0
3	1	1

In addition to being associated with the value of RSN, the redundancy version (RV) of the E-DCH transmission is also associated with the coding rate of the E-DCH transmission according to Table 6.2.1.4 and Table 6.2.1.5 below.

Table 6.2.1.4: Relation between RSN and E-DCH RV index for QPSK

RSN	Coding Rate <1/2	1/2 ≤ Coding Rate
	E-DCH RV Index	E-DCH RV Index
0	0	0
1	2	3
2	0	2
3	2	1

Table 6.2.1.5: Relation between RSN and E-DCH RV index for 16QAM

RSN	Coding Rate <1/2	1/2 ≤ Coding Rate
	E-DCH RV Index	E-DCH RV Index
0	0	0
1	0	3
2	2	1
3	2	2

Considering the simplicity of Chase combining, the UE shall use either:

- an RV index linked to RSN according to the mapping Table6.2.1.4 and Table6.2.1.5

- or, if signalled by higher layers, only E-DCH RV Index 0 for all the transmissions independently of the value of RSN.

7 Support for Node B Controlled Uplink Scheduling

7.1 General

The UE receives grants controlling the E-DCH resources (code and timeslot) and max transmit power available to it from the serving cell. The Node-B scheduler is not only responsible for ensuring the intra-cell RoT under control, but also ensuring that the inter-cell interference created by UE's under its control is within the given acceptable limits. In order to control the inter-cell interference, the UE is responsible for performing serving-cell and neighbour-cell path loss measurements and for reporting a combined metric of these path losses to the serving cell scheduler via the associated uplink signalling channels（MAC-e header or E-RUCCH). In LCR TDD, if the smart antenna and the joint detection technology are introduced in the system, the interference depression should be taken into account in RoT controlled power scheduling.

7.2 Support for Node-B Controlled Rate and Physical Resource Scheduling

The UE can receive absolute grants of E-DCH power and physical resource per time interval. But the grants need not be continuously transmitted in every time interval.

The physical channel used to transmit grants to the UE is termed the Enhanced Uplink Absolute Grant Channel (E-AGCH). A single E-AGCH shall be capable of transmitting one complete grant to a UE.

The grant consists of:

- A power grant component (this is used to distribute available system interference resources)

- A physical channel grant component (this is used to distribute E-PUCH timeslot and code resources)

The duration over which a grant applies is equal to one E-DCH TTI(5ms). Support for variable length grants (greater than one TTI) is indicated by means of the optional configuration of resource duration indicator on E-AGCH.

The UE is informed by higher layer signalling on which physical resource (i.e: OVSF code and timeslot) grants to that UE will be transmitted. The network may group multiple UEs to monitor the same E-AGCH.

The serving E-DCH cell is the only cell responsible for E-DCH scheduling.The UE shall be capable of receiving one absolute grant from the serving E-DCH cell per time interval.

7.3 Signalling Information Required for the Support of the Scheduling

Scheduler grant information is signalled to the UE via the downlink channel termed E-AGCH. (see sections 8.2.1 and 9.2.1).

To enable the scheduler to control the uplink inter-cell interference, the information assist with the scheduling processes shall include information derived by the UE from its measurements of the serving-cell and neighbour-cell path losses. The information is transmitted to the serving cell scheduler within MAC-e PDU header or E-RUCCH.

7.3.1 E-AGCH

Signalling information carried to the UE by the E-AGCH in support of Node-B scheduling including the following items:

7.3.1.1 Power Grant

The power grant component of the E-AGCH specifies the maximum allowed E-PUCH power per resource unit relative to $P_{e\text{-}base}$ in the UE. In TDD, all the timeslots the UE be allocated have the same power grant. By this value, UE can detect each E-TFCI's state, supported or blocked.

7.3.1.2 Physical Resource Grant

The granted physical resources are denoted by means of a code and a timeslot component.

The code component of the physical resource grant the OVSF code tree has been allocated. For simplification, all the timeslots use the same OVSF code, so only one code grant in E-AGCH.

The timeslot component of the physical resource grant indicates which of the timeslots configured for E-DCH use by higher layers have been allocated. The number of slot can be used for E-DCH is configurable by higher layers on a per-cell basis up to a maximum of 5 slots.

7.3.1.3 E-RNTI

Because the E-AGCH is a shared channel, a user-specific identifier (the E-RNTI) is transmitted to facilitate user addressing. The E-RNTI is 16 bits and is allocated by higher layers.

7.3.1.4 Resource Duration Indicator

Optionally, the resource duration indicator (RDI) is introduced to reduce the scheduling grant frequency. UTRAN may configure, on a per-cell basis the presence of a resource duration indicator (RDI) field on E-AGCH. The number of TTIs granted and their inter-TTI spacing is defined by higher layers.

7.3.1.5 E-HICH Indicator

The E-HICH Indicator (EI) is used to indicate the UE which E-HICH will be used to convey the acknowledgement indicator in the following schedule period.

7.3.1.6 ECSN

ECSN consists of 3 bits used for E-AGCH power control purposes.

Note: ECSN should be considered when outer loop power control is used for E-AGCH.

7.3.2 Uplink scheduling Information

In order to request NodeB-b schedule, UE will send the scheduling information (SI) and E-RNTI via E-RUCCH. If the UE has been granted to send data in E-DCH, it can send the SI in MAC-e header. The component of SI including:

7.3.2.1 SNPL

The path loss information of serving cell and neighbour cells. It is proposed to use some combined metric of these path losses. In RoT controlled power scheduling, the path loss information is necessary to ensure the inter-cell interference be in control.

7.3.2.2 UPH

The maximum allowed transmit power relative to the sum of $P_{e\text{-}base}$ and serving cell path loss $_e$ in UE. It indicates the remaining power can be granted to this UE.

7.3.2.3 TEBS

The total E-DCH buffer state. This item indicates the buffer occupancy in Bytes by a given mapping table.

7.3.2.4 HLBS

The ratio of the highest priority MAC-d flow buffer occupancy to the total E-DCH channel buffer occupancy.

7.3.2.5 HLID

The highest priority logical channel ID. It can be mapped to a given schedule priority according a high layer indicated mapping scheme.

8 Physical Channel Structure

8.1 Physical Channel Structure for Uplink Data Transmission

CCTrCH of E-DCH type is mapped onto a new physical channel, termed E-PUCH. There shall be at least one E-UCCH in every E-DCH TTI. Whether E-PUCH may multiplex with E-UCCH or not depend on the configuration of higher layers. TPC shall always accompany E-UCCH. In a timeslot when E-UCCH is not transmitted, TPC is not transmitted either.

E-UCCH:

- is of length 32 physical channel bits
- is mapped to the data field of the E-PUCH
- is spread at SF appointed by CRRI
- uses QPSK modulation

The position of the E-UCCH information and the E-DCH data is proposed in figure 1. When an E-DCH data block is transmitted on multiple (N) timeslots in one TTI, there will be multiple E-PUCHs. It is proposed that all repeats of E-UCCH equably distribute on multiple E-PUCHs.

N is the number of E-PUCH, M is the number of E-UCCH instances in one TTI; K is the integral part of M/N; L is the residue of M/N. S is the number of E-UCCHs in one E-PUCH. And S equals K+1 for first L E-PUCHs and K E-UCCHs for the rest E-PUCHs.

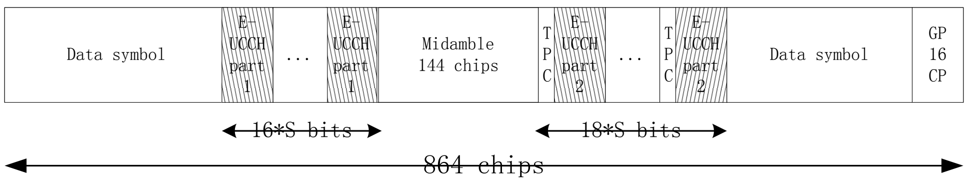

Figure 8.1.1 – Multiplexing for E-DCH and E-UCCH

P is the index of E-PUCH.

$$S = k + 1, P < L, P \in [0, N - 1]$$

$$S = k, P \geq L$$

$$S \in [0,8]$$

An E-UCCH is composed of 32 bits: k_0, k_1 … k_{31}.

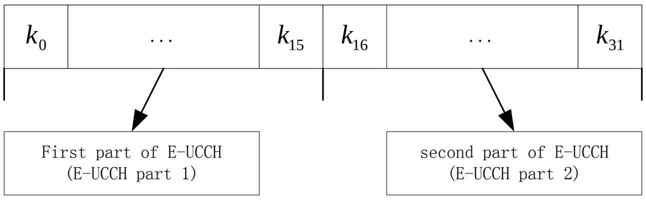

Figure 8.1.2 –E-UCCH code composition

Figures 8.1.3 and 8.1.4 show the E-PUCH data burst with and without the E-UCCH/TPC fields.

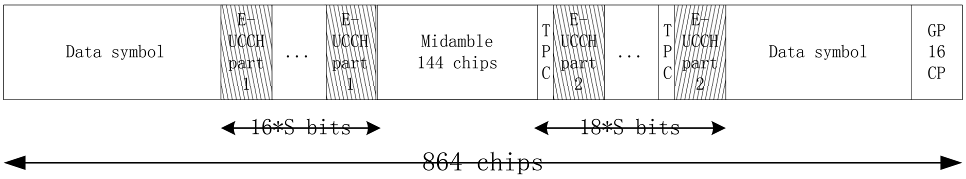

Figure 8.1.3 – E-PUCH data burst with EUCCH/TPC

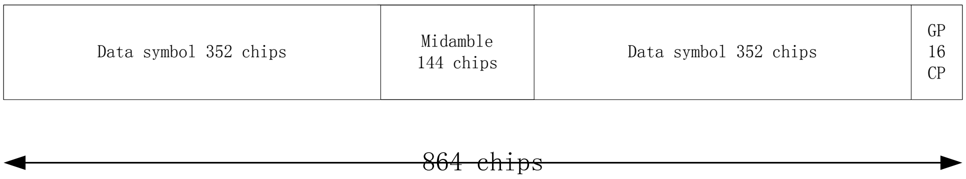

Figure 8.1.4 – E-PUCH data burst without EUCCH/TPC

The E-PUCH supports the following physical layer characteristics:

- Payload spreading factors 16,8,4,2 and 1
- Transmission of E-UCCH
- Transmission of TPC (use the same spreading factor and modulation scheme as for E-UCCH) – Note: this is used for E-AGCH power control purposes
- Guard period of 16 chips

Default and UE-specific midamble allocation schemes may be applied.

8.2 Physical Channel Structure for Downlink Control Signalling

8.2.1 Enhanced Uplink Absolute Grant Channel (E-AGCH)

The E-AGCH is a new downlink physical channel on which grant information is conveyed to the UE. The E-AGCH uses two separate physical channels (E-AGCH1 and E-AGCH2). The term E-AGCH refers to the ensemble of these physical channels.

E-AGCH1 shall use time slot format #5 and E-AGCH2 shall use time slot format #0 from table 8.2.1.1. E-AGCH shall carry TPC and SS for E-PUCH power control and synchronization but no TFCI.

Table 8.2.1.1 – Time slot formats for the E-AGCH

Slot Format #	Spreading Factor	Midamble length (chips)	$N_{TFCI\ code\ word}$ (bits)	N_{SS}&N_{TPC} (bits)	Bits/slot	$N_{Data/Slot}$ (bits)	$N_{data/data\ field\ (1)}$ (bits)	$N_{data/data\ field\ (2)}$ (bits)
0	16	144	0	0&0	88	88	44	44
5	16	144	0	2&2	88	84	44	40

Figure 8.2.1.1 and figure 8.2.1.2 show the burst structure for E-AGCH1 and E-AGCH2 respectively.

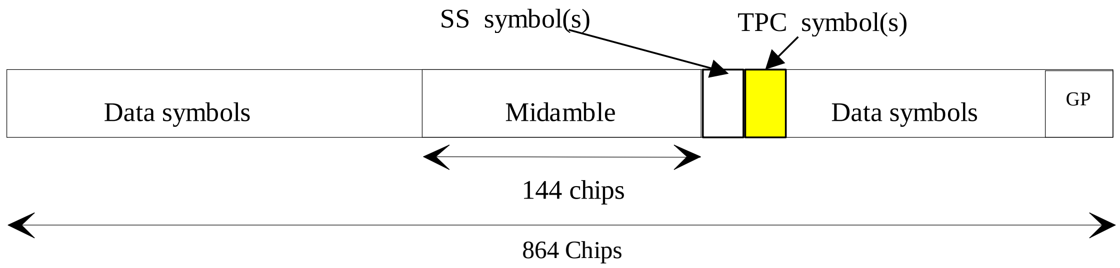

Figure 8.2.1.1 – E-AGCH1 Burst Structure

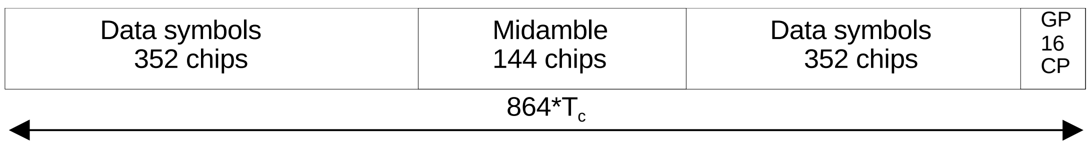

Figure 8.2.1.2 – E-AGCH2 Burst Structure

The E-AGCH supports the following physical layer characteristics:

- Payload spreading factor 16
- Transmission of TPC and SS for E-PUCH power control and synchronization.(always present on E-AGCH1)
- Guard period of 16 chips

The E-AGCH does not support transmission of TFCI.

As for other downlink physical channels, E-AGCH may use default, UE-specific or common midamble allocation.

8.3 Physical Channel Structure for Uplink Control Signalling

8.3.1 E-RUCCH

The following information is transmitted by means of the E-RUCCH channel.

- Serving and Neighbour Cell Pathloss (SNPL, 5bits):
  This may be used by the Node-B to assist with its estimation of the degree of intercell interference each UE will generate and hence the absolute grant power value and physical resources to assign.
- UE Power Headroom (UPH, 5bits):
  The UPH field indicates the ratio of the maximum UE transmission power and the corresponding the sum of $P_{e\text{-}base}$ and serving cell path loss code power.
- Total E-DCH Buffer Status (TEBS, 5bits):
  The TEBS field identifies the total amount of data available across all logical channels for which reporting has been requested by the RRC and indicates the amount of data in number of bytes that is available for transmission and retransmission in RLC layer. When MAC is connected to an AM RLC entity, control PDUs to

be transmitted and RLC PDUs outside the RLC Tx window shall also be included in the TEBS. RLC PDUs that have been transmitted but not negatively acknowledged by the peer entity shall not be included in the TEBS.

- Highest priority Logical channel Buffer Status (HLBS, 4bits):
  The HLBS field indicates the amount of data available from the logical channel identified by HLID, relative to the highest value of the buffer size range reported by TEBS.
- Highest priority Logical channel ID (HLID, 4bits):
  The HLID field identifies unambiguously the highest priority logical channel with available data. If multiple logical channels exist with the highest priority, the one corresponding to the highest buffer occupancy will be reported..
- E-DCH Radio Network Temporary Identifier (E-RNTI, 16bits) :
  The UE identity is the E-PUCH Radio Network Identifier.

The E-RUCCH supports the following physical layer characteristics:

- E-RUCCH Spreading:

The E-RUCCH uses spreading factor SF=16 or SF=8 as described in [4] section 5A.2.1. The set of admissible spreading codes used on the E-RUCCH is based on the spreading codes of PRACH.

- E-RUCCH Burst Format:

The burst format as described in [4] section 5A.2.2 is used for the E-RUCCH.

- E-RUCCH Training sequences:

The training sequences, i.e. midambles, as described in [4] section 5A.2.3 are used for E-RUCCH.

- E-RUCCH timeslot formats:

The time slot format is depending on the spreading factor SF of the E-RUCCH:

Spreading Factor	Slot Format #
16	0
8	10

The time slot formats taken from the uplink timeslot formats described in [4] section 5A.2.2.4.1.2.

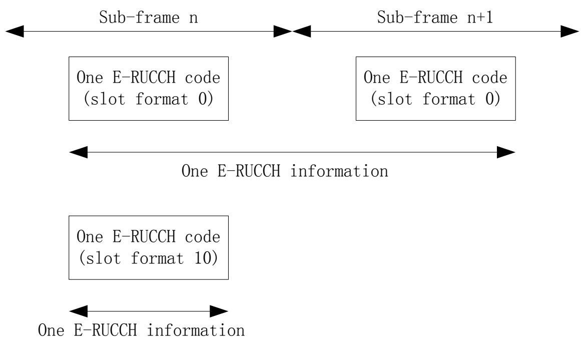

Figure 8.3.1.1 –E-RUCCH codes

8.4 HARQ Acknowledgement Indicator Channel (E-HICH)

The E-DCH HARQ Acknowledgement indicator channel (E-HICH) is a SF=16 downlink physical channel and uses timeslot format #0 defined in section 5A.2.2.4.1.1 in TS25.221 which is illustrated in Figure 8.4.1.

Table 8.4.1 Time slot format for E-HICH

Slot Format #	Spreading Factor	Midamble length (chips)	N_{TFCI} code word (bits)	N_{SS} & N_{TPC} (bits)	Bits/slot	$N_{Data/Slot}$ (bits)	$N_{data/data\ field(1)}$ (bits)	$N_{data/data\ field(2)}$ (bits)
0	16	144	0	0 & 0	88	88	44	44

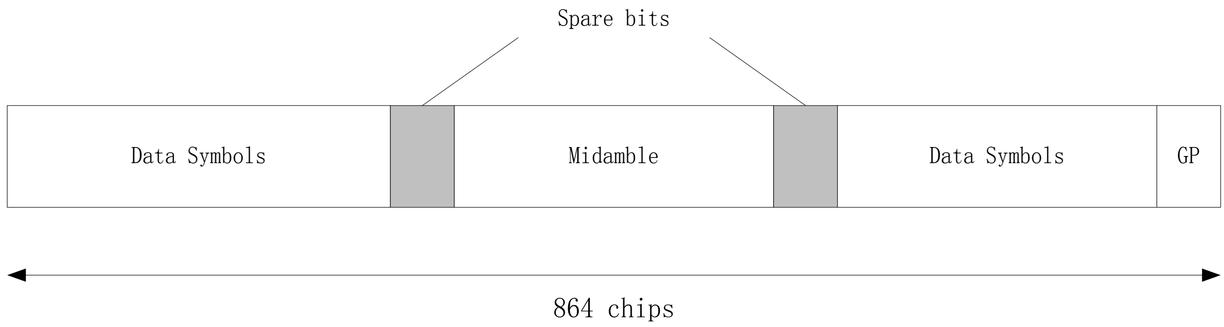

Figure 8.4.1 - E-HICH Structure

The number of E-HICHs in a cell is configured by the system. Scheduled users' and non-scheduled users' acknowledgement indicators are transmitted on different E-HICHs. At most four E-HICHs can be configured for one scheduled user's scheduled transmission. Which E-HICH is used to convey the acknowledgment indicator is indicated by the 2-bit E-HICH indicator on E-AGCH for the specific scheduled user while is informed by higher layer for the non-scheduled users. E-HICHs for non-scheduled users carry not only the acknowledgement indicators but also TPC and SS commands. The TPC/SS command for the non-scheduled users is indicated by selecting different orthogonal sequences. A single E-HICH may carry one or multiple HARQ acknowledgement indicator(s) decided by Node-B.

The E-HICH contains 8 spare bit locations. The spare bit values are undefined. The power of each user's acknowledgement indicator may be set independently by the Node-B.

The acknowledgement inidicator for an E-DCH transmission in TTI "N" is carried by the E-HICH in TTI "N+[T_A]"(T_A is determined according to the value of $n_{E\text{-}HICH}$). The E-HICH is thus synchronously related to those E-DCH transmissions for which it carries acknowledgement information.

9 Multiplexing, Channel Coding and Interleaving

9.1 Coding and Multiplexing for Uplink Data

Figure 9.1.1 shows the processing structure for the E-DCH transport channel mapped onto a separate CCTrCH. Data arrives to the coding unit in form of a maximum of one transport block once every transmission time interval (TTI). A 5ms TTI is used for 1.28 Mcps TDD E-DCH. The following coding steps for E-DCH can be identified:

- append CRC (length 24) to each transport block

- code block segmentation

- channel coding (1/3 rate turbo coding shall be employed)

- hybrid ARQ
- bit scrambling
- interleaving for E-DCH
- constellation re-arrangement for 16QAM
- mapping to physical channels

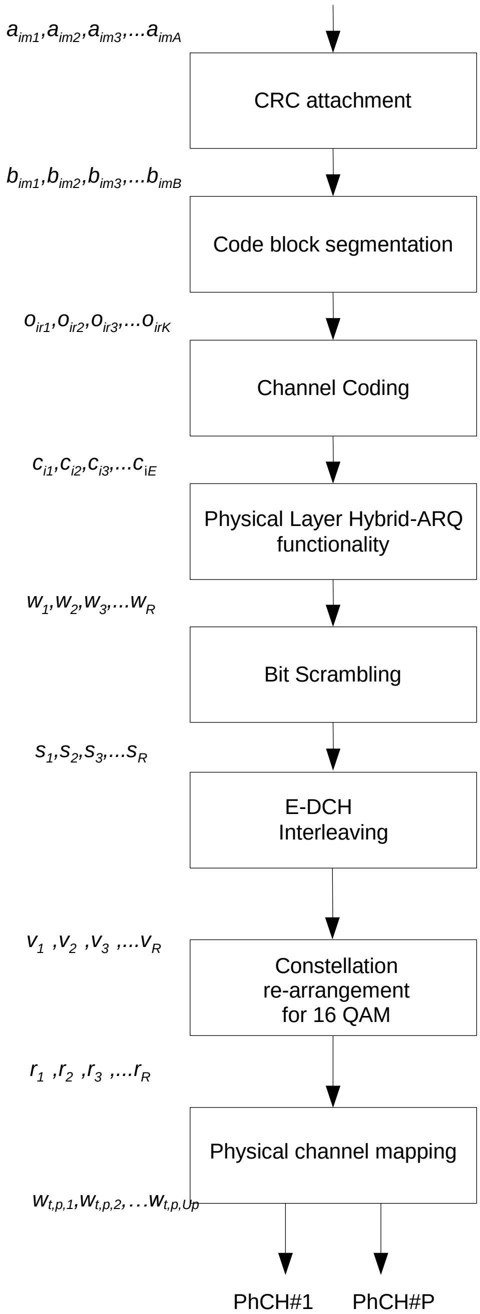

Figure 9.1.1 – Coding chain for E-DCH

Many of the processing functions of figure 9.1.1 for the E-DCH may follow the same general principles as those employed for HS-DSCH for TDD due to the similar use of QPSK and 16-QAM modulation along with 1/3 rate turbo coding in both cases.

9.1.1 CRC attachment

CRC attachment for the E-DCH transport channel shall be performed according to the general method described in section 4.2.1 of TS 25.222 with the following specific parameters:

- The CRC length shall always be L_i = 24 bits.

9.1.2 Code block segmentation

Code block segmentation for the E-DCH transport channel shall be performed according to the general method described in 4.2.2.2 of TS 25.222 with the following specific parameters:

- Maximum number of transport block is 1.
- The bits $b_{im1}, b_{im2}, b_{im3}, \ldots b_{imB}$ input to the block are mapped to the bits $x_{i1}, x_{i2}, x_{i3}, \ldots x_{iX_i}$ directly. It follows that X_i = B. Note that the bits x referenced here refer only to the internals of the code block segmentation function. The output bits from the code block segmentation function are $o_{ir1}, o_{ir2}, o_{ir3}, \ldots o_{irK}$.
- The value of Z = 5114 for turbo coding shall be used

9.1.3 Channel coding

Channel coding for the E-DCH transport channel shall be performed according to the general method described in section 4.2.3 of TS 25.222 with the following specific parameters:

- There will be a maximum of one transport block, i=1
- The rate 1/3 turbo coding shall be used.

9.1.4 Physical layer HARQ functionality and rate matching

The hybrid ARQ functionality matches the number of bits at the output of the channel coder to the total number of bits of the E-PUCH set to which the E-DCH transport channel is mapped. The hybrid ARQ functionality is controlled by the redundancy version (RV) parameters.

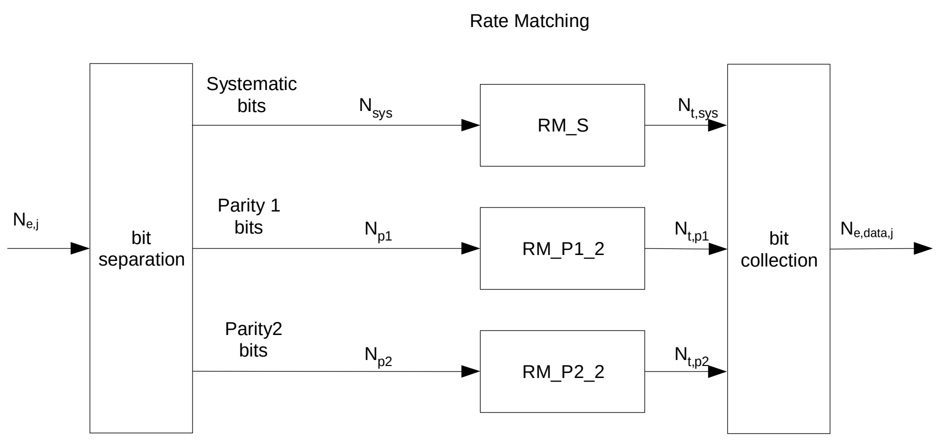

Figure 9.1.4.1 - E-DCH hybrid ARQ functionality

9.1.4.1 Determination of modulation and physical resources

The modulation type is determined by higher layers.

If a UE has both non-scheduled and scheduled resources in a TTI, then:

-- the UE may combine all the non-scheduled and the scheduled resources (including the timeslots, E-PUCH codes, power etc.) as a whole to transmit either the non-scheduled or the scheduled traffic.

Else:

-- UE should use the non-scheduled or the scheduled resources to transmit the non-scheduled or the scheduled traffic respectively;

9.1.4.2 HARQ bit separation

The HARQ bit separation function is performed in the same way as bit separation for turbo encoded TrCHs with puncturing as described in section 4.2.7.2 of TS 25.222.

9.1.4.3 HARQ Rate Matching Stage

The hybrid ARQ rate matching for the E-DCH transport channel is performed in accordance with the general method described in section 4.2.7.3 of TS 25.222 with the following specific parameters.

The parameters of the rate matching stage depend on the value of the RV parameters s and r. The s and r combinations corresponding to each RV allowed for the E-DCH are listed in table 9.1.4.3.1 below.

Table 9.1.4.3.1 - RV for E-DCH

E-DCH RV Index	*s*	*r*
0	1	0
1	0	0
2	1	1
3	0	1

The parameter e_{plus}, e_{minus} and e_{ini} are calculated with the general method described in section 4.5.4.3 of TS 25.222. The following parameters are used as input:

$N_{sys} = N_{p1} = N_{p2} = N_{e,j}/3$

$N_{data} = N_{e,data,j}$

$r_{max} = 2$ (for both QPSK and 16-QAM)

9.1.4.4 HARQ bit collection

HARQ bit collection for E-DCH is performed according to the general method described for HS-DSCH in subclause 4.5.4.4 of TS 25.222.

9.1.5 Bit scrambling

The bit scrambling for E-DCH is performed in accordance with the general method described in subclause 4.2.9 of TS 25.222.

9.1.6 Interleaving for E-DCH

Interleaving for E-DCH is performed in accordance with the general method described for HS-DSCH in subclause 4.5.6 of TS 25.222.

9.1.7 Constellation re-arrangement for 16 QAM

In the case of 16-QAM, constellation rearrangement is performed in accordance with the general method described for HS-DSCH in subclause 4.5.7 of TS 25.222. For QPSK this function is transparent.

The constellation version parameter b is associated with RSN as shown in table 9.1.7.1 below.

Table 9.1.7.1- mapping between RSN and b parameters for Constellation Re-arrangement

RSN	Coding Rate <1/2	1/2≤ Coding Rate
	b	**b**
0	0	0
1	2	3
2	3	0
3	1	1

9.1.8 Physical channel mapping for E-DCH

The bits input to the physical channel mapping are denoted by $r_1, r_2, ..., r_R$, where $R= N_{e,data,j}$ and is the number of physical channel data bits to be transmitted in the current TTI on the set of E-PUCHs. These bits are mapped to the physical channel bits, $\{w_{t,p,j} : t = 1, 2, ..., T; p=1; j = 1, 2, ..., U_t\}$, where t is the timeslot index, T is the number of timeslots in the allocation message, j is the physical channel bit index and U_t is the number of bits in the E-PUCH physical channel in timeslot t. The timeslot index, t, increases with increasing timeslot number and the physical channel bit index, j, increases with increasing physical channel bit position in time.

The bits $r_1, r_2, ..., r_R$ shall be mapped to the physical channel bits $w_{t,p,j}$ according to the following rule:

$w_{1,1,j} = r_j$ for $j = 1, 2, ..., U_1$

$w_{2,1,j} = r_{j+U_1}$ for $j = 1, 2, ..., U_2$

…

$w_{T,1,j} = r_{j+\sum_{t=1}^{T-1} U_t}$ for $j = 1, 2, ..., U_T$

9.2 Coding and Multiplexing for Downlink Signalling

9.2.1 E-AGCH

The E-AGCH carries the following fields multiplexed into w bits $x_{ag,1}, x_{ag,2},…, x_{ag,w}$:

PRRI (5 bits)

The power grant component of the E-AGCH is referred to as “PRRI” (Power Resource Related Information) which has a granularity of 1 dB and is represented by 5 bits.

CRRI (5 bits)

The code component of the physical resource grant “CRRI” (Code Resource Related Information) indicates which node on the OVSF code tree and whose spreading factor has been allocated and is represented by 5 bits. The mapping between the allocated OVSF and the enumerated node 0….30 on the OVSF code tree is as given in table 9.2.1.1 below, in which channelisation code “i” with spreading factor “Q” is denoted as $C_Q^{(i)}$.

Table 9.2.1.1 – Channelisation code to CRRI mapping

<table>
<tr><td rowspan="16">$C_1^{(1)}$ [0]</td><td rowspan="8">$C_2^{(1)}$ [1]</td><td rowspan="4">$C_4^{(1)}$ [3]</td><td rowspan="2">$C_8^{(1)}$ [7]</td><td>$C_{16}^{(1)}$ [15]</td></tr>
<tr><td>$C_{16}^{(2)}$ [16]</td></tr>
<tr><td rowspan="2">$C_8^{(2)}$ [8]</td><td>$C_{16}^{(3)}$ [17]</td></tr>
<tr><td>$C_{16}^{(4)}$ [18]</td></tr>
<tr><td rowspan="4">$C_4^{(2)}$ [4]</td><td rowspan="2">$C_8^{(3)}$ [9]</td><td>$C_{16}^{(5)}$ [19]</td></tr>
<tr><td>$C_{16}^{(6)}$ [20]</td></tr>
<tr><td rowspan="2">$C_8^{(4)}$ [10]</td><td>$C_{16}^{(7)}$ [21]</td></tr>
<tr><td>$C_{16}^{(8)}$ [22]</td></tr>
<tr><td rowspan="8">$C_2^{(2)}$ [2]</td><td rowspan="4">$C_4^{(3)}$ [5]</td><td rowspan="2">$C_8^{(5)}$ [11]</td><td>$C_{16}^{(9)}$ [23]</td></tr>
<tr><td>$C_{16}^{(10)}$ [24]</td></tr>
<tr><td rowspan="2">$C_8^{(6)}$ [12]</td><td>$C_{16}^{(11)}$ [25]</td></tr>
<tr><td>$C_{16}^{(12)}$ [26]</td></tr>
<tr><td rowspan="4">$C_4^{(4)}$ [6]</td><td rowspan="2">$C_8^{(7)}$ [13]</td><td>$C_{16}^{(13)}$ [27]</td></tr>
<tr><td>$C_{16}^{(14)}$ [28]</td></tr>
<tr><td rowspan="2">$C_8^{(8)}$ [14]</td><td>$C_{16}^{(15)}$ [29]</td></tr>
<tr><td>$C_{16}^{(16)}$ [30]</td></tr>
</table>

TRRI (5bits)

The timeslot component of the physical resource grant "TRRI" (Timeslot Resource Related Information) is composed of 5 bits which correspond to timeslot 1 to timeslot 5 respectively.

RDI (3 bits if present)

If RDI is configured as present in a cell, 3 bits are used to indicate the number of TTI allocated by a single grant. The mapping of the 3 bit field to the number of TTIs granted and their inter-TTI spacing is defined by higher layers.

ECSN (3 bits)

ECSN consists of 3 bits used for E-AGCH power control purposes.

Note: ECSN should be considered when outer loop power control is used for E-AGCH.

E-HICH Indicator (2 bits)

The E-HICH indicator (EI) consists of 2 bits used to indicate which E-HICH is used to convey the acknowledgement indicator.

E-UCCH Number Indicator (3 bits)

The E-UCCH Number Indicator (ENI) is composed of 3 bits which is used to indicate the detailed number of E-UCCH.

Figure 9.2.1.1 illustrates the overall coding chain for the E-AGCH.

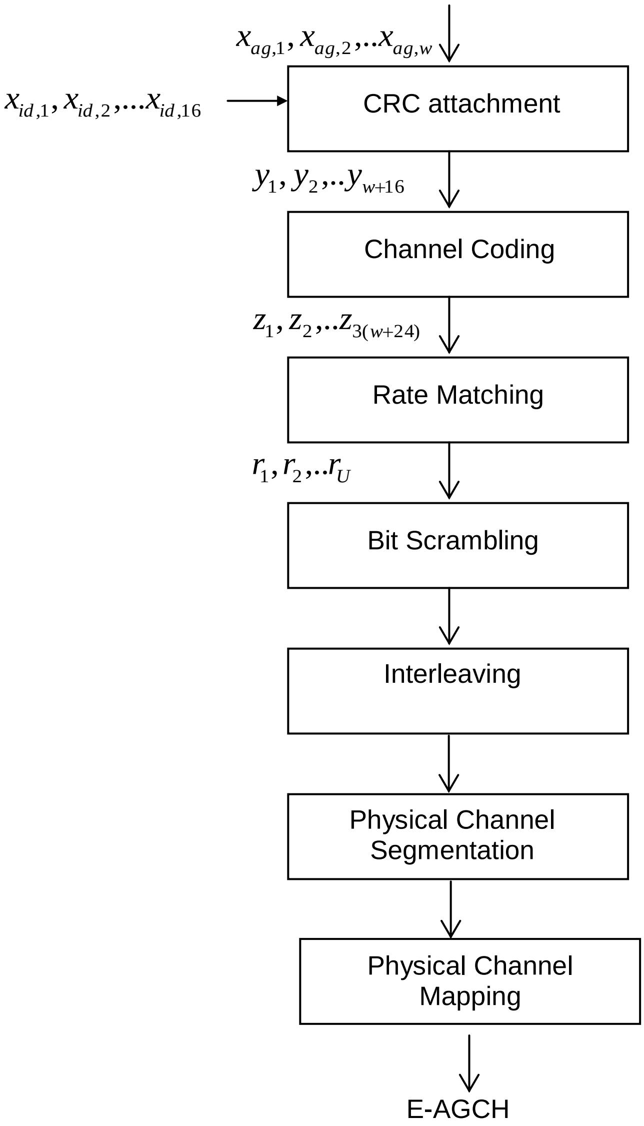

Figure 9.2.1.1 – TrCH processing of E-AGCH

9.2.1.1 Field Multiplexing

The PRRI, CRRI, TRRI, RDI (if presented) , ECSN and EI are concatenated before being applied for the remainder of the E-AGCH transport channel processing function. The output of the field multiplexing function is the sequence of bits $x_{ag,1}, x_{ag,2},\ldots, x_{ag,w}$.

9.2.1.2 CRC attachment

The E-RNTI ($x_{id,1}, x_{id,2}, \ldots, x_{id,16}$) is the E-DCH Radio Network Identifier defined in [7]. It is mapped such that $x_{id,1}$ corresponds to the MSB.

From the sequence of bits $x_{ag,1}, x_{ag,2},\ldots, x_{ag,w}$ a 16 bit CRC is calculated according to section 4.2.1.1 of [5]. . This gives the sequence of bits $c_1, c_2, \ldots, c_{16}$ where:

$$c_k = p_{im(17-k)} \qquad k=1,2,\ldots,16$$

This sequence of bits is then masked with $x_{id,2}, \ldots, x_{id,16}$ and appended to the sequence of bits $x_{ag,1}, x_{ag,2},\ldots, x_{ag,w}$ to form the sequence of bits $y_1,y_2,\ldots,y_{w+16}$ where

$y_i=x_{ag,i} \qquad i=1,2, ...,w$

$y_i=(c_{i-w} + x_{id,i-w}) \bmod 2 \qquad i=w+1, ..., w+16$

9.2.1.3 Channel Coding

1/3 rate convolutional channel coding is applied in accordance with section 4.2.3.1 of [5], resulting in the sequence of bits $z_1,z_2,\ldots,z_{3(w+24)}$.

9.2.1.4 Rate Matching

Rate matching is applied to the input sequence $z_1,z_2,\ldots,z_{3(w+24)}$ to obtain the output sequence $r_1,r_2,\ldots,r_{172}$.

9.2.1.5 Bit Scrambling

Bit scrambling is applied to the input sequence $r_1,r_2,\ldots,r_U$ in accordance with section 4.2.9 of [5].

9.2.1.6 Interleaving

Interleaving is performed as section 4.2.11.1 of [5] (frame-related 2nd interleaving).

9.2.1.7 Physical Channel Segmentation

Physical channel segmentation is performed as section 4.2.10 of [5].

9.2.1.8 Physical Channel Mapping

Physical channel mapping is performed as section 4.2.12 of [5].

9.2.2 E-HICH

The value of a binary HARQ acknowledgement indicator for user *h* is denoted "a_h" and may assume the value 0 or 1. The value of the indicator is mapped as shown in table 9.2.2.1.

Table 9.2.2.1 – Mapping of HARQ acknowledgement indicator

Command	HARQ acknowledgement indicator value (a_h)
NACK	0
ACK	1

Construction of the bit sequence for the h^{th} acknowledgement indicator is achieved via a spreading process using an orthogonal sequence which is the row of an orthogonal matrix of order 80. This orthogonal matrix(C_{80}) is Kronecker tensor product of one Hadamard matrix of order 20 (C_{20}) and another Hadamard matrix of order 4 (C_4),

$$C_{80} = C_{20} \otimes C_4$$

$\otimes$ is Kronecker tensor product. (note: Kronecker product is not commutative, i.e. $A \otimes B \neq B \otimes A$)

These two Hadamard matrices are given by table 9.2.2.2 and table 9.2.2.3.

Table 9.2.2.2 – Hadamard matrix of order 4

m	0	1	2	3
$C_{4,0,m}$	1	1	1	1
$C_{4,1,m}$	1	0	1	0

$C_{4,2,m}$	1	1	0	0
$C_{4,3,m}$	0	1	1	0

Table 9.2.2.3 – Hadamard matrix of order 20

k	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
$C_{20,0,k}$	1	0	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	1	1	0
$C_{20,1,k}$	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	0	1	1
$C_{20,2,k}$	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	1	0	1	0	1
$C_{20,3,k}$	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	1	1	0	1	0
$C_{20,4,k}$	0	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	1	1	0	1
$C_{20,5,k}$	0	1	1	1	1	1	0	0	0	0	0	1	0	0	1	1	1	0	0	1
$C_{20,6,k}$	1	0	1	1	1	0	1	0	0	0	1	0	1	0	0	1	1	1	0	0
$C_{20,7,k}$	1	1	0	1	1	0	0	1	0	0	0	1	0	1	0	0	1	1	1	0
$C_{20,8,k}$	1	1	1	0	1	0	0	0	1	0	0	0	1	0	1	0	0	1	1	1
$C_{20,9,k}$	1	1	1	1	0	0	0	0	0	1	1	0	0	1	0	1	0	0	1	1
$C_{20,10,k}$	0	0	1	1	0	1	0	1	1	0	1	0	0	0	0	0	1	1	1	1
$C_{20,11,k}$	0	0	0	1	1	0	1	0	1	1	0	1	0	0	0	1	0	1	1	1
$C_{20,12,k}$	1	0	0	0	1	1	0	1	0	1	0	0	1	0	0	1	1	0	1	1
$C_{20,13,k}$	1	1	0	0	0	1	1	0	1	0	0	0	0	1	0	1	1	1	0	1
$C_{20,14,k}$	0	1	1	0	0	0	1	1	0	1	0	0	0	0	1	1	1	1	1	0
$C_{20,15,k}$	0	1	0	0	1	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0
$C_{20,16,k}$	1	0	1	0	0	0	0	0	1	1	0	1	0	0	0	0	1	0	0	0
$C_{20,17,k}$	0	1	0	1	0	1	0	0	0	1	0	0	1	0	0	0	0	1	0	0
$C_{20,18,k}$	0	0	1	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	1	0
$C_{20,19,k}$	1	0	0	1	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	1

E-HICHs for scheduled users carry HARQ acknowledgement indicators only. The binary orthogonal sequence ($C_{80,r,n}$) used for spreading operation is selected from the r^{th} row of the orthogonal matrix of order 80 (C_{80}).

A HARQ acknowledgement indicator is synchronously linked with the E-DCH TTI transmission to which it relates. There is thus a one-to-one association between an E-DCH TTI transmission and its respective HARQ acknowledgement indicator. An allocation resource tag ID "r" (r=0,1,2,…,79) is calculated for the E-DCH resource allocation associated with the HARQ acknowledgement indicator.

$$r = 16(t_0 - 1) + (q_0 - 1)\frac{16}{Q_0}$$

where:

t_0 is the first (lowest-numbered) allocated timeslot (1,2,..,5)

q_0 is the lowest-numbered channelisation code index allocated in timeslot t_0 (1,2,…, Q_0)

Q_0 is the spreading factor of the lowest-numbered channelisation code index allocated in timeslot t_0

The output of the spreading stage is equal to $b_{h,n} = a_h \cdot C_{80,r,n}$, where n=0,1,…,79.

The bits $b_{h,0}$, $b_{h,1}$, …, $b_{h,79}$ are segmented into two halves corresponding to $b_{h,0}$, …, $b_{h,39}$ and to $b_{h,40}$, …, $b_{h,79}$. A sequence of 8 spare bits z_u (u=0,…,7) are inserted between the first and second half of the sequence to form:

$$d_h=\{b_{h,0}, b_{h,1},\ldots, b_{h,39}, z_0, z_1, \ldots, z_6, z_7, b_{h,40}, b_{h,41},\ldots, b_{h,79}\}$$

d_h is applied by bit scrambling (as per section 4.2.9 of TS 25.222) then subject to QPSK modulation and is amplitude-weighted prior to summation with other such sequences corresponding to other acknowledgement indicators active on the E-HICH.

Physical channel spreading and scrambling operations are then performed in the usual manner.

E-HICHs for non-scheduled users carry HARQ acknowledgement indicators and TPC/SS commands. The eighty orthogonal sequences are divided into 20 groups while each group includes 4 sequences. Each non-scheduled user is assigned one group by higher layer to indicate the HARQ acknowledgement indicators and TPC/SS command. One of the four sequences is used for the acknowledgement indicator's spreading operation and the other three are used to indicate TPC/SS command implicitly.

The HARQ acknowledgement indicator is spread by the assigned orthogonal sequence ($C_{80,s,n}$). The output of the spreading stage is equal to $c_{h,n} = a_h \cdot C_{80,s,n}$, where n=0,1,…,79.

The three sequences and their three reverse sequences are the possible sequences been chosen multiplexed on E-HICH to indicate the TPC and SS commands. The reverse sequence is constructed by reverse every bit of the sequence from 0 to 1 or from 1 to 0. Only one sequence is chosen to indicate the TPC/SS command according to the relation between the sequence index and TPC/SS command. Mapping between index and TPC/SS command is shown in table 9.2.2.4. The index is calculated according to the equation: index=2*A+B , (A=0,1,2;B=0,1), where A is the relative index of the three assigned sequences and B equals to 1 when the reverse sequence is chosen, otherwise, B equals to 0.

Table 9.2.2.4 Mapping between index and TPC/SS command

index	TPC command	SS command
0	'DOWN'	'DOWN'
1	'UP'	'DOWN'
2	'DOWN'	'UP'
3	'UP'	'UP'
4	'DOWN'	'Do Nothing'
5	'UP'	'Do Nothing'

The output sequence of the spreading stage $c_{h,n}$ and the sequence chosen to indicate TPC/SS command $e_{h,n}$ are segmented into two halves corresponding to $c_{h,0}$, …, $c_{h,39}$ and $c_{h,40}$, …, $c_{h,79}$ and $e_{h,0}$, …, $e_{h,39}$ and $e_{h,40}$, …, $e_{h,79}$ respectively. A sequence of 8 spare bits z_u (u=0,…,7) are inserted between the first and second half of the two sequences to form:

$$c_h=\{c_{h,0}, c_{h,1},\ldots, c_{h,39}, z_0, z_1, \ldots, z_6, z_7, c_{h,40}, c_{h,41},\ldots, c_{h,79}\}$$

$$e_h=\{e_{h,0}, e_{h,1},\ldots, e_{h,39}, z_0, z_1, \ldots, z_6, z_7, e_{h,40}, e_{h,41},\ldots, e_{h,79}\}$$

c_h and e_h is applied by bit scrambling (as per section 4.2.9 of TS 25.222) then subject to QPSK modulation. The symbols of e_h is multiplied by a factor set by Node-B before summation with symbols of c_h. The sum of each user is amplitude-weighted before being multiplexed together with other users' symbols.

Physical channel spreading and scrambling operations are then performed in the usual manner.

9.3 Coding and Multiplexing for Uplink Signalling

9.3.1 E-UCCH

The E-UCCH is used to convey the following information:

- The occupied code resources of the selected E-TFC – 0 bits (see note 1)
- The modulation type of the selected E-TFC – 0 bits (see note 1)
- The transport block size of the selected E-TFC –5 bits
- The retransmission sequence number (RSN) – 2 bits
- The HARQ process ID – 3bits

Note 1: The occupied code resources and the modulation type are not explicitly signaled, but may be inferred from the transport block size.

The E-UCCH is transmitted on the E-PUCH and is coded using a (32, 10) sub code of the second order Reed Muller code as defined in subclause 4.3.1.1 of [5].

9.3.2 E-RUCCH

The following coding/multiplexing steps can be identified:

1. Multiplexing of E-RUCCH information;
2. The E-RUCCH information bits are protected by 16 parity bits for error detection (see [5] 4.2.1.1);
3. Convolution code with constraint length 9 and coding rate ⅓ is applied (see [5] 4.2.3.1);
4. Rate matching (see [5] 4.2.7);
5. bit scrambling (see [5] 4.2.9);
6. Interleaving for E-RUCCH (see [5] 4.2.11.1);
7. Sub-frame segmentation (see [5]4.2.11A).
8. Mapping to physical channels (see [5] 4.2.12.2).

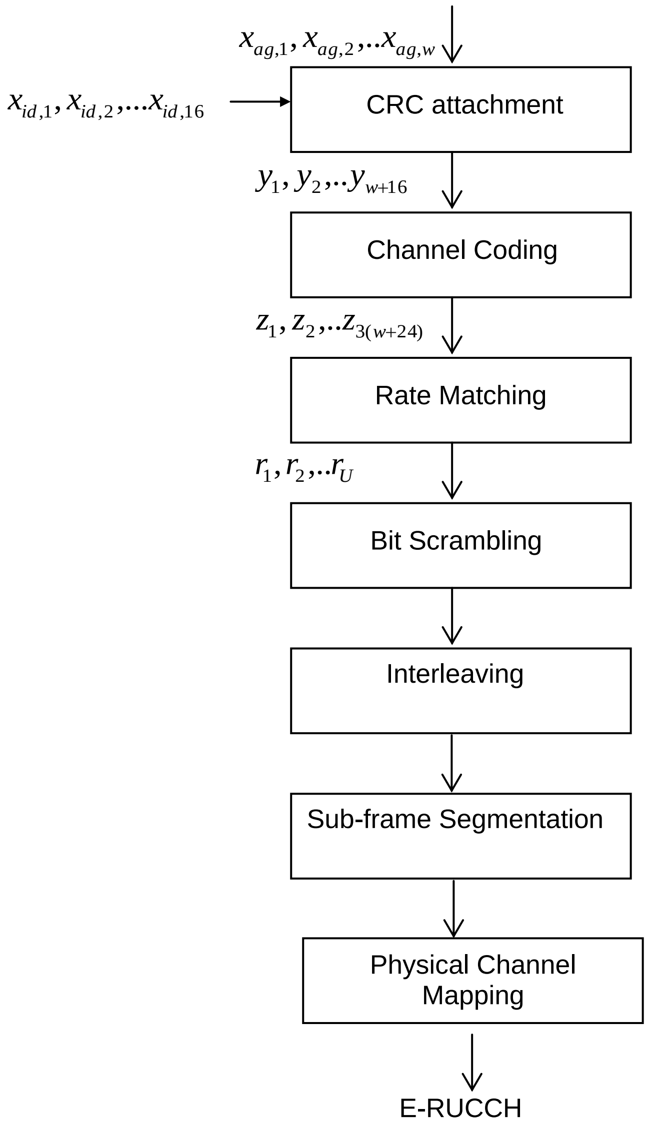

Figure 9.3.2.1 – CC processing of E-RUCCH

10 Spreading and Modulation

10.1 E-PUCH

QPSK and 16-QAM modulation are supported for E-PUCH. The modulation constellations shall be the same as those supported for QPSK and 16-QAM in [6].

Spreading of the E-PUCH follows the same general procedures as described in [6]. The complex symbols are multiplied by :

- A code specific multiplier
- A channelisation code spreading sequence (OVSF)
- A cell-specific scrambling code sequence

11 Physical Layer Procedures

11.1 Power control

11.1.1 E-PUCH

The basic principle of our proposed power control method of E-PUCH follows that used for DPCH/PUSCH in R4/5/6[7][8], i.e., the combination of open-loop power control and tranditional closed-loop power control:

- the initial transmit power of E-PUCH is set based on an open-loop power control scheme, then
- the transmission power control transits into closed-loop power control using TPC commands carried on E-AGCH for the scheduled transmission or on E-HICH for the non-scheduled transmission.

A *reference Desired RX power* is introduced for E-PUCH open-loop power control which is different from Desired DPCH RX power in R4/5/6.

A new set of beta factors is adopted within the specifications to provide the necessary granularity of power adjustment between E-TFC's.

The transmit power for E-DCH set in the UE is calculated as follows:

$$P_{E-PUCH} = P_{e-base} + L + \beta_e \qquad (1)$$

… where:

- P_{E-PUCH} is the transmit power of the E-DCH physical channel E-PUCH.
- P_{e-base} is a closed-loop quantity stored in the UE and which is incremented or decremented upon each reception of a TPC command carried on E-AGCH for scheduled transmissions and on E-HICH for non-scheduled transmissions. The TPC step size is configured by higher layers. P_{e-base} can be expressed as follows when *closed-loop power control* is used:

$$P_{e-base} = PRX_{des\_base} + step * \sum_i TPC_i = PRX_{des\_base} + P_{TPC} \qquad (2)$$

…where, PRX_{des_base} is the *reference Desired E-PUCH RX power* signalled by RRC signalling, $step$ is the power control step size configured by higher layers, and TPC_i is a closed-loop control command.

Note that, when setting the initial transmit power for E-PUCH or following an extended pause in the reception of TPC commands on E-AGCH, the UE shall set P_{e-base} equal to PRX_{des_base}, which means open-loop power control is used

When receipt of TPC commands, the TPC commands shall be used to modify P_{e-base} from its previously set value. When receipt of TPC commands on E-AGCH recommences, the TPC commands shall be used to modify P_{e-base} from its previously set value.

- L is a pathloss term derived from beacon function physical channels. According to [8], if indicated as allowed by higher layers, the UE may optionally take into account pathloss modification which is estimated from the most recently received beacon function physical channels in addition to the TPC commands when calculating the transmit power.

- β_e is the normalized gain factor for the selected E-TFC transport block size, the allocated E-PUCH physical resources, and the Modulation type and HARQ power offset.

Higher layers in the UE shall use the current calculated E-PUCH power in conjunction with the current absolute grant (power) value in order to determine the set of E-TFC's available.

11.1.1.1 Gain Factors for E-PUCH

A beta factor shall be derived by the UE as a function of:

- the selected E-TFC transport block size
- the E-PUCH resource occupation in the E-DCH TTI
- the modulation type (QPSK/16-QAM)
- the HARQ power offset

Higher layers shall provide a mapping function or a mapping table containing a set of reference points, which defines the relationship between the coderate of E-DCH transmission (λ_e) and the relative reference power per resource unit (β_λdB). The mapping function or mapping table is provided separately for each of QPSK and 16-QAM modulation.

The coderate of E-DCH transmission λ_e for the selected E-TFC, physical resource allocation and modulation type is defined as:

$$\lambda_e = \frac{S_e}{R_e}$$

… in which S_e is the transport block size of the selected E-TFC and R_e is the number of physical channel bits output from the physical channel mapping stage of E-DCH transport channel processing as described in [5].

The maximum and minimum values of λ signalled by higher layers for the appropriate modulation type are denoted λ_{max} and λ_{min} respectively. For a given λ_e there exists a λ_0 and a λ_1 such that:

- If $\lambda_{min} \le \lambda_e < \lambda_{max}$
  - λ_0 is the largest λ signalled by higher layers for the appropriate modulation type and for which $\lambda \le \lambda_e$
  - λ_1 is the smallest λ signalled by higher layers for the appropriate modulation type and for which $\lambda > \lambda_e$
- Else
  - If $\lambda_e < \lambda_{min}$ then $\lambda_0 = \lambda_{min}$ and λ_1 is the smallest signalled λ for which $\lambda > \lambda_{min}$.
  - If $\lambda_e \ge \lambda_{max}$ then λ_0 is the largest signalled λ for which $\lambda < \lambda_{max}$ and $\lambda_1 = \lambda_{max}$

Associated with λ_0 and λ_1 are the corresponding $\beta_{\lambda 0}$ and $\beta_{\lambda 1}$ which define the reference points signalled by higher layers. The normalised (per-resource-unit) beta value for the selected E-TFC and E-PUCH resource set is denoted $\beta_{0,e}$ and is:

$$\beta_{0,e} = \beta_{\lambda 0} + \frac{\beta_{\lambda 1} - \beta_{\lambda 0}}{\lambda_1 - \lambda_0}\left(\lambda_e - \lambda_0\right) dB$$

α_e is a logarithmic value set as a function of the E-PUCH spreading factor ($SF_{E\text{-}PUCH}$) according to table 1a.

Table 1a: Tabulated α_e values

$SF_{E\text{-}PUCH}$	α_e (dB)
1	12

2	9
4	6
8	3
16	0

β_e is then derived as $\beta_e = \beta_{0,e} + \alpha_e + \Delta_{harq}\ dB$.

Δ_{harq} is set by higher layers , which is the HARQ profile power offset of the highest priority logical channels mapped on the current E-DCH transmission.

For the transport block size of the selected E-TFC, there exist several coderate R with different SF and Modulation types. So there may be several methods to define the mapping relationship between the coderate and β_e, and the detail is FFS.

11.1.2 E-RUCCH

It is proposed that E-RUCCH is transmitted using an open-loop power control scheme similar to that used for PRACH[7].

Following the general procedure for PRACH, the power of the E-RUCCH would be set as follows:

$$P_{E\text{-}RUCCH} = L_{PCCPCH} + PRX_{E\text{-}RUCCHdes} + (i_{UpPCH}-1) * Pwr_{ramp} \qquad (9)$$

… where:

- L_{PCCPCH} is a pathloss estimate based on beacon function physical channels
- $PRX_{E\text{-}RUCCHdes}$: Desired E-RUCCH RX power at the cell's receiver in dBm signalled to the UE by the network in the FPACH response to the UE's successful SYNC_UL transmission.
- i is the number of transmission attempts on UpPCH, i=1…Max SYNC_UL Transmissions.
- i_{UpPCH} is the final value of i.
- Pwr_{ramp}: The UE shall increase its transmission power by the value of the IE "Power Ramp step" by every UpPCH transmission. Its value is signalled in the IE "SYNC UL info" in System Information Block type 5 and System Information Block type 6 or is signalled to the UE in the IE "Uplink Timing Advance Control" contained in a protocol message triggering a hard handover or a transition from cell FACH state to cell DCH state.

11.1.3 E-AGCH

It is suggested that the initial power of E-AGCH is set by Node-B, then can be adjusted using TPC commands from the UE carried on E-DCH transmissions (on the E-PUCH physical channel). This is similar in nature to HS-SCCH power control for TDD in which TPC commands are carried from the UE on the HS-SICH.

A maximum transmit power and a minimum transmit power is set by UTRAN, the transmit power of E-AGCH can not exceed this range.

The TDD HS-SCCH incorporates a cyclic sequence number (HCSN) to facilitate outer-loop control of the channel quality in the UE.

It is proposed that power control for the E-AGCH follows this same principle and as such the E-AGCH would include a cyclic sequence number (ECSN field) which shall be set to zero initially and shall be increased by the Node-B each time E-AGCH is transmitted.

11.1.4 E-HICH

The power of the E-HICH and the powers of the constituent HARQ acknowledgement indicator sequences carried by E-HICH are under the control of the Node B.

11.2 Synchronization control

11.2.1 E-PUCH

Uplink synchronization control procedure for E-PUCH remains the same as that used for DPCH[8], using SS commands carried on E-AGCH normally; for the non-scheduled transmission, how to transfer SS commands is FFS.

11.2.2 E-RUCCH

Uplink synchronization control procedure for E-RUCCH remains the same as that used for PRACH[8].

The Node B shall measure the received SYNC-UL timing deviation $UpPCH_{POS}$. $UpPCH_{POS}$ is sent in the FPACH and is represented as an 11 bit number (0-2047) being the multiple of 1/8 chips which is nearest to received position of the UpPCH.

Time of the beginning of the E-RUCCH $T_{TX\text{-}E\text{-}RUCCH}$ is given by:

$T_{TX\text{-}E\text{-}RUCCH} = T_{RX\text{-}E\text{-}RUCCH} - (UpPCH_{ADV} + UpPCH_{POS} - 8*16\ T_C)$

in multiple of 1/8 chips, where

$T_{TX\text{-}E\text{-}RUCCH}$ is the beginning time of E-RUCCH transmission with the UE's timing,

$T_{RX\text{-}E\text{-}RUCCH}$ is the beginning time of E-RUCCH reception with the UE's timing if the E-RUCCH was a DL channel,

$UpPCH_{ADV}$ is the timing advance of the UpPCH[8].

11.3 Random access procedure

The way differentiating the two access type on PRACH physical resource was proposed by partitioning the available eight SYNC_UL signatures in a cell into two subsets, one for the access of RACH information and the other for the access of E-RUCCH information.

When a Node B detects a SYNC_UL signature and acknowledges it on the related FPACH, it should do some recordings, including the FPACH channel number, the sub-frame on which the acknowledgement is sent and the SYNC_UL signature number. When a PRACH or E-RUCCH comes from a UE, the Node B should derive the related FPACH and the sub-frame on which the acknowledgement was sent for the UE and find the right record. The signature number in the record can help the Node B know the access type.

Random access procedure for enhanced uplink is basically same as random access procedure in [8]only adding some new definitions.

L_{iE} is the Length of E-RUCCH information transport blocks associated to FPACHi in sub-frames.

N_{RACHi} is the number of PRACHs associated to the ith FPACH.

$N_{E\text{-}RUCCHi}$ is the number of E-RUCCHs associated to the ith FPACH and $N_{E\text{-}RUCCHi}$ equals to $\min\{N_{RACHi}, L_{iE}\}$.

When SF of PRACH code equals to 16, L_{iE} will be 2, otherwise L_{iE} will be 1。

When SF of PRACH code equals to 4, SF of E-RUCCHwill be 8, otherwise E-RUCCHs has the same SF with PRACH.

When $n_{E\text{-}RUCCHi}$ equals to n_{RACHi}, E-RUCCH will share the same code resource with PRACH. And when SF of PRACH code equals to 4, the code resource assigned to PRACH including two codes (code i and code i+1) of SF 8, E-RUCCH can use the ith code of SF 8.

If $FPACH_i$ sent an acknowledgement for E-RUCCH information, the sub-frames on which an acknowledgement is sent on FPACHi is fulfilling the following relation:

(SFN’ mod L_{iE})=$n_{E\text{-}RUCCHi}$; $n_{E\text{-}RUCCHi}$=0,…, $N_{E\text{-}RUCCHi}$-1,

Where, SFN’ is the sub-frame number of the acknowledgement on FPACH

Accordingly, the code resource assigned to PRACH may be used by PRACH or E-RUCCH, we should make two prescript avoiding the collision between PRACH and E-RUCCH.

When Node B sent a $FPACH_i$ for $PRACH_{nRACHi}$ in sub frame K，Node B could not send a $FPACH_i$ for $E-RUCCH_{n_{E-RUCCHi}}$ before sub frame K+L_i；

When Node B sent a $FPACH_i$ for $E-RUCCH_{n_{E-RUCCHi}}$ in sub frame K，Node B could not send a FPACHi for $PRACH_{nRACHi}$ before sub frame K+L_{iE}。

The interval between the acknowledgement on FPACH and transmission of E-RUCCH is fixed for a UE. The UE will send at the sub-frame coming 2 sub-frames after the one carrying the signature acknowledgement. In case L_{iE} is bigger than one and the sub-frame number of the acknowledgement is odd the UE will wait one more sub-frame.

12 Physical Layer Measurements

To control inter-cell and intra-cell interference, UE shall supports measurements of the serving and neighbour cells path loss (SNPL) and reports it in Scheduling Information(SI). These may use serving and neighbour cell P-CCPCH RSCP measurements in current releases.

The UE shall supports power headroom measurements(UPH) to assist with Node B scheduling to control RoT stabilization in own cell and UPH needs to be added in release 7.

The Node-B shall support measurements of E-DCH interference and/or fractional loading to assist with RRM procedures and the relevant Node B measurements include: Received total wide band power (RTWP), which exists in current release4/5/6, and Transmitted carrier power of all codes not used for HS-PDSCH, HS-SCCH, E-AGCH or E-HICH transmission, which needs to be added in release 7.

The Node-B shall also support conventional measurements, such as Rx Timing Deviation for E-PUCH, BLER and SNR for Power Control, etc.

13 UE Physical Layer Capabilities

This section defines UE transmission capabilities in uplink in terms of E-DCH is configured.

Table 13.1 E-DCH UE category

E-DCH category	Maximum number of E – DCH timeslots per TTI	Maximum number of E – DCH transport channel bits that can be received within an E-DCH TTI
Category 1	2 NOTE1	2754
Category 2	3 NOTE1	4162
Category 3	3	8348
Category 4	4	11160
Category 5	5	11160

NOTE1: QPSK only.

Annex A: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
2006-05	RAN1#45				Initial draft presented for discussion		0.0.0
2006-08	RAN1#46				Inclusion of text proposals agreed at RAN1#45		0.0.1
2006-08	RAN1#46				Raised to v0.1.0 following presentation of v0.0.1 at RAN1#46	0.0.1	0.1.0
2006-10	RAN1#46 bis				Inclusion of text proposals agreed at RAN1#46	0.1.0	0.1.1
2006-10	RAN1#46 bis				Raised to v0.2.0 following presentation of v0.1.1 at RAN1#46bis	0.1.1	0.2.0
2006-10	RAN1#47				Inclusion of text proposals agreed at RAN1#46bis	0.2.0	0.2.1
2006-11	RAN1#47				Raised to v0.3.0 following email approval of v0.2.1 at RAN1#47	0.2.1	0.3.0
2006-11	RAN1#47				Inclusion of text proposals agreed at RAN1#47	0.3.0	0.3.1
2006-11	RAN1#47				Acceptance of changes in v0.3.1 to produce clean version 1.0.0	0.3.1	1.0.0
2007-01	RAN1#47 bis				Inclusion of text proposals agreed at RAN1#47bis	1.0.0	1.0.1
2007-01	RAN1#47 bis				Raised to v1.1.0 following email approval of v1.0.1 at RAN1#47bis	1.0.1	1.1.0
2007-02	RAN1#48				Acceptance of text proposals agreed via email approval at RAN1#47bis	1.1.0	1.1.1
2007-02	RAN1#48				Raised to v1.2.0 following presentation of v1.1.1 at RAN1#48	1.1.1	1.2.0
2007-03	RAN1#48				Raised to v2.0.0 after approval of v1.2.0	1.2.0	2.0.0
16/03/07	RAN_35	RP-070134	-	-	Doc in REL-7 under change control further to approval decision	2.0.0	7.0.0
30/05/07	RAN_36	RP-070383	001	-	Corrections to TR25.827 for LCR TDD EUL	7.0.0	7.1.0