3GPP TS 25.823 V8.0.0 (2008-03)

Technical Report

3rd Generation Partnership Project;
Technical Specification Group Radio Access Network;
Feasibility study on synchronised E-DCH for UTRA FDD
(Release 8)

The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP.

The present document has not been subject to any approval process by the 3GPP Organizational Partners and shall not be implemented.
This Specification is provided for future development work within 3GPP only. The Organizational Partners accept no liability for any use of this Specification.
Specifications and reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices.

Keywords

<UTRA FDD, WCDMA, E-DCH>

3GPP

Postal address

3GPP support office address

650 Route des Lucioles - Sophia Antipolis
Valbonne - FRANCE
Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Internet

http://www.3gpp.org

Copyright Notification

No part may be reproduced except as authorized by written permission.
The copyright and the foregoing restriction extend to reproduction in all media.

© 2008, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TTA, TTC).
All rights reserved.

Contents

Foreword

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

- x the first digit:
  - 1 presented to TSG for information;
  - 2 presented to TSG for approval;
  - 3 or greater indicates TSG approved document under change control.
- y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.
- z the third digit is incremented when editorial only changes have been incorporated in the document.

1 Scope

The present document is the technical report for the Release 8 Study Item "Synchronised E-DCH" (see [1]).

This document is intended to gather all information in order to compare gains vs. complexity, and draw a conclusion on way forward. The document will describe likely impacts to the UTRA FDD specifications and system operation, estimate any changes to the UTRA FDD uplink data or control channel structure (including downlink control channels relating to the uplink and uplink control channels relating to the downlink) and evaluate potential performance gains

This activity involves the Radio Access work area of the 3GPP studies and has impacts both on the Mobile Equipment and Access Network of the 3GPP systems.

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] RP-070678, Nokia, Nokia Siemens Networks, Qualcomm, T-Mobile, Ericsson "Proposed New Study Item: Synchronised E-DCH", RAN #37, September 2007;

[2] 3GPP TR 25.854 v.5.0.0: "Uplink Synchronous Transmission Scheme".

[3] 3GPP TS 25.212 "Multiplexing and channel coding (FDD)"

[4] 3GPP TS 25.213 "Spreading and modulation (FDD)"

[5] 3GPP TS 25.215 "Physical Layer – Measurements (FDD)"

[6] R1-080910, "PAPR for Synchronized E-DCH", Ericsson

[7] R1-080428 "Impact of Imperfect synchronization on Sync-EDCH Link Performance", Qualcomm, RAN1#51bis, Seville

[8] R1-080394 "Impact of desynchronisation on S-EDCH performance", Nokia Siemens Networks, Nokia, RAN1#51bis, Seville

3 Definitions, symbols and abbreviations

DPCCH	Dedicated Physical Control Channel
DPDCH	Dedicated Physical Data Channel
E-DCH	Enhanced Dedicated (Transport) Channel
E-DPCCH	Enhanced Dedicated Physical Control Channel
E-DPDCH	Enhanced Dedicated Physical Data Channel
HARQ	Hybrid Automatic Repeat Request
HS-DPCCH	High Speed Dedicated Physical Control Channel
HSUPA	High Speed Uplink Packet Access
OVSF	Orthogonal Variable Spreading Factor
SHO	Soft Handover
TFC	Transport Format Combination

UTRA FDD	UMTS Terrestrial Radio Access, Frequency Division Duplex mode

4 Introduction

At 3GPP TSG RAN#37, a Study Item on "Synchronised E-DCH" was approved.

The aim of the study item was to examine the use of synchronisation & OVSF codes for improving the orthogonality of the UTRA FDD uplink. Synchronised E-DCH users would implement timing advance sufficient to ensure that the reception timings of the main receive paths are synchronised at chip and TTI level. Furthermore, synchronised E-DCH users may share a common scrambling code and be separated using OVSF codes that are allocated on a dynamic basis by a modified HSUPA scheduler. Thus, orthogonality between users can be improved in the code domain or achieved by time domain separation. The Synchronised E-DCH physical and transport channel design should aim to maintain commonality with Release 7 HSUPA. HARQ should be supported.

The study is similar to the Release 5 "Uplink Synchronous Transmission Scheme" [2]. However since Release 5, new features such as basestation scheduling and shorter TTI have been introduced and can act as enablers for OVSF domain scheduling.

The study item examined the impacts to the specification, the required signalling and the performance of the synchronised E-DCH in the context of HSDPA & HSUPA.

Three main proposals were studied:

- CDM based Synchronised E-DCH, in which time and OVSF multiplexing was assumed
- TDM based Synchronised E-DCH, in which pure TDM between users was assumed
- Interference cancellation algorithms, acting on the existing Release 7 HSUPA and also on the CDM and TDM proposals

In the TR, these proposals are referred to as the "CDM proposal", "TDM proposal" and "Interference Cancellation proposal"

5 Overview of issues relating to the synchronised E-DCH proposals

5.1 CDM Proposal

5.1.1 Scheduling & required control channels

5.1.1.1 Background: HSUPA scheduling

In Release 6 HSUPA, the Node B sets a maximum limit on the E-DPDCH/DPCCH power ratio that the UE is allowed to use, termed here as the maximum traffic to pilot power ratio (MT2PR). Given this MT2PR restriction, the UE TFC selection selects an appropriate transport format and a Hybrid ARQ offset, Δ_{HARQ}, which impacts the number of HARQ retransmissions. Associated with the transport format is an E-DPDCH/DPCCH ratio, that is further modified by Δ_{HARQ}; the TFC selection ensures that the composite power ratio with the selected TFC does not exceed the MT2PR. The selected E-TFC is indicated to the basestation using the UL E-DPCCH signalling channel.

From the indicated TFC, the receiving basestation is able to calculate the spreading factor used by the terminal by means of a well defined rate matching calculation [3]. Furthermore, when making an MT2PR assignment or updating the MT2PR, the basestation is able to predict the minimum spreading factor that might be selected by the terminal by assuming the smallest Δ_{HARQ} value and calculating the maximum selectable TFC that would not lead to the MT2PR being exceeded.

The MT2PR is signalled to the UE using one of two physical channels. The "Absolute Grant Channel" (E-AGCH) indicates in absolute terms an allowed MT2PR. The so-called "Relative Grant Channel" (E-RGCH) is a 1 bit indicator that shifts the MT2PR up or down from its previous value. Grants may be sent to individual UEs or groups of UEs.

When the 2msec TTI is configured, the E-AGCH may be used to activate or deactivate specific HARQ processes completely. Furthermore, the UE responds to 2 IDs on E-AGCH; the “primary” and ”secondary” IDs with a preference order.

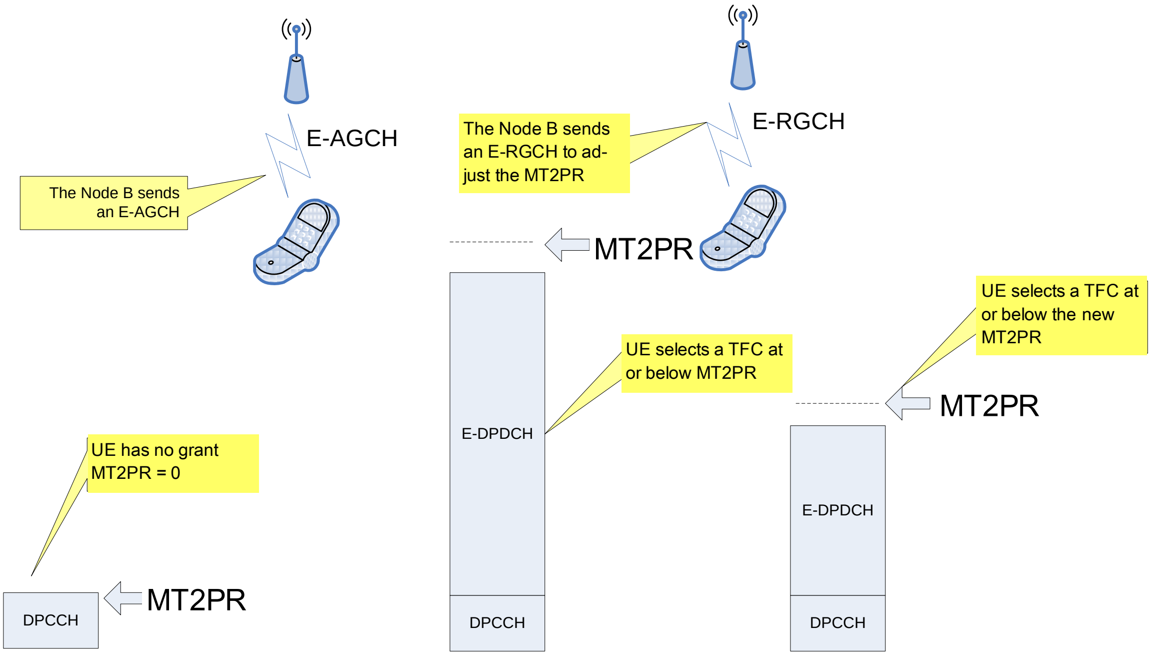


Figure 5.1.1.1-1 Basic HSUPA scheduling model

When the UE has not been allocated a scheduling grant, it may be necessary for the UE to inform the Node B scheduler that it has data to transmit. This is achieved through transmission of a MAC-e header of 18 bits. The MAC-e header may be transmitted by the UE without receiving a scheduling grant from the Node B.

So called “non scheduled” traffic is transmitted by the UE on an autonomous basis. The UE may be allowed to make autonomous transmissions up to a certain maximum MT2PR on some or all of the HARQ processes

5.1.1.2 Scheduling for synchronised E-DCH

For synchronised E-DCH using OVSF separation, it is necessary for the serving basestation to be able to control the portion of the code tree that is used by each UE. The portion of the code tree can be subdivided into 2 components; base code and spreading factor. The base code is an OVSF index assuming the highest allowable spreading factor to be used by the UE. When the base code is known, codes of a lower spreading factor can be calculated by selecting the portions of the code tree that contain the base code. In the example of figure 5.1.1.2-1, when the UE is assigned base code 7 at SF16, then it would use code 4 at SF8, code 2 at SF4 etc.

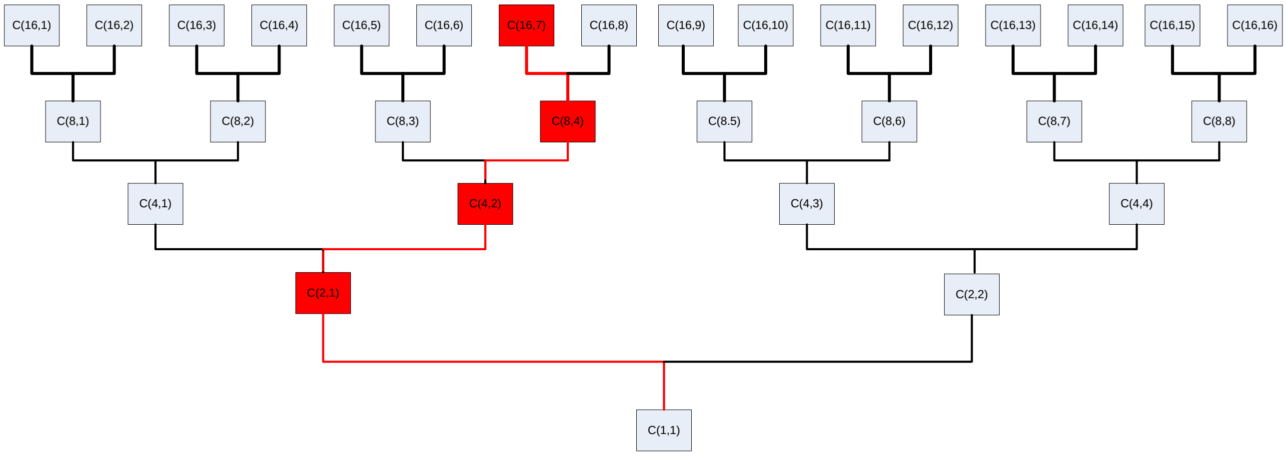


Figure 5.1.1.2-1 Example of the relationship between base code and used spreading codes

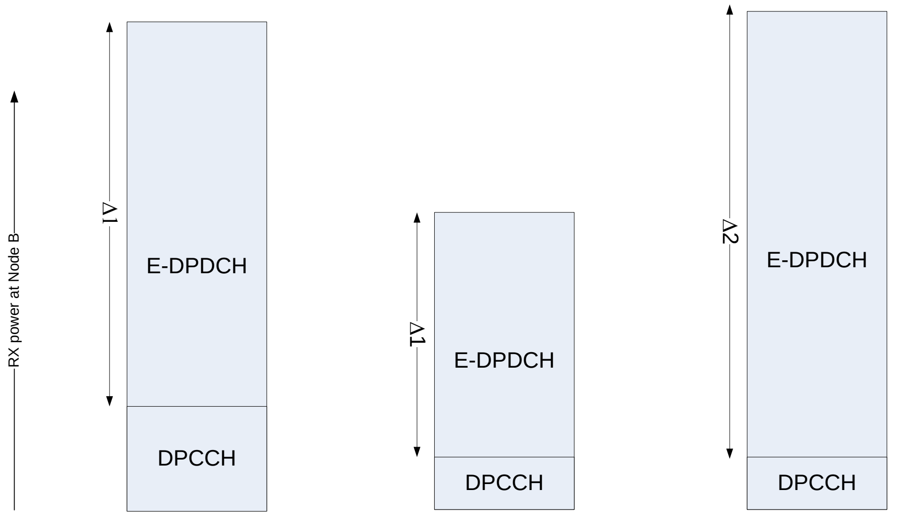
As indicated in section 5.1.1.1, the basestation can predict the minimum used SF from the MT2PR it has set for the terminal, and calculate the actually used SF from the TFCI.

Thus, assuming that a terminal is assigned (and possibly occasionally re-assigned) a base code, CDM based synchronised E-DCH scheduling can in principle be operated using the same basic mechanism for scheduled traffic as in Release 6. Means of indicating a base code to the terminal are discussed in section 5.1.1.4

5.1.1.3 Scheduling requests and unscheduled traffic

Scheduling requests and unscheduled traffic are handled using autonomous transmissions in Release 6 HSUPA. For a CDM synchronised E-DCH, a shared code space is employed and thus a method for handling scheduling requests and unscheduled traffic must be considered. Possible methods for doing this include:

- Polling of UEs for unscheduled traffic by the Node B. Such an approach would only be capable of managing a small number of UEs without incurring substantial overhead
- Contention based autonomous transmissions. The Node B could assign certain codes & TTIs for autonomous transmissions, for which UEs would contend. Such an approach would handle a larger number of UEs than polling, but would require additional collision detection functionality in the MAC and incur additional latency.
- Autonomous transmissions using an E-DPDCH under a user specific scrambling code. With this approach, the UE would make autonomous transmissions, but place the E-DPDCH under a user specific scrambling code. The power offset for the transmission would need to take into account the non orthogonality of the unscheduled traffic to the scheduled traffic. Such an approach would introduce non OVSF interference, but would allow a flexible tradeoff between the number of users supported in the system and the overhead for non scheduled transmissions.



1. WCDMA situation showing Δ1 offset between E-DPDCH & DPCCH

2. OVSF separation – RX power is now lower to achieve the required SINR. Δ1 between DPCCH & E-DPDCH remains the same to a first approximation

3. DPCCH on OVSF, E-DPDCH on user specific SC. DPCCH RX power achieves DPCCH SIR, E-DPDCH RX power achieves E-DPDCH SIR; interference for E-DPDCH is greater than for E-DPDCH. Δ2 needs to be greater

Figure 5.1.1.3-1 Example of setting the power offset when the E-DPDCH is under a user specific SC

5.1.1.4 Control channels required for scheduling

In HSUPA, 3 downlink control channels (E-AGCH, E-RGCH, E-HICH) and one uplink channel (E-DPCCH) were defined. These channels can also be used for CDM synchronised E-DCH scheduling and their use is discussed below. In addition, there is a need to signal the base code to the UE as described in section 5.1.1.2. Means of signalling the base code include:

- Use of L3 signalling to set the base code; this would then not involve new L1 signalling, although the flexibility of the scheduler would be somewhat more limited as a price (The scheduler would still be able to set the SF via the MT2PR and hence the amount of code tree used, but not the section of the code tree)
- Design of a new control channel with 4-5 bits for signalling the base code
- Use of a special E-AGCH identity for indicating the base code
- Use of a modified E-AGCH, in which the base code is quantised jointly with a (more limited range of) MT2PR

The impact to the existing channels and their operation may be as follows:

E-AGCH:

If a special E-AGCH method is used for indicating base code (e.g. special E-AGCH ID or jointly quantised base code & MT2PR), then a re-interpretation of the E-AGCH at least some of the time may be necessary. Scheduler flexibility to allocate and de-allocate could be increased by either increasing the number of E-AGCHs that a UE is required to receive (in order to allow flexibility to allocate and deallocate simultaneously between UEs) or by increasing the latency between reception of E-AGCH when a UE has no allocation and implementation of the grant

E-RGCH:

The interpretation of E-RGCH can remain unchanged. If E-RGCH is used for influencing the spreading factor, then the reliability requirement on E-RGCH may need to be examined. However an E-RGCH false detection or mis-detection will only cause a collision if (i) A "down" command is missed or "Up" is falsely detected and (ii) The step in MT2PR causes the selected TFC to move over an SF boundary. For a 5% missed/false detection probability, the probability of (i) and (ii) being correct is around 0.5% assuming equal probability of up/down commands and a 1 in 6 probability of an MT2PR step equating to an SF step.

E-HICH:

E-HICH interpretation and reliability requirements should remain unchanged.

E-DPCCH:

E-DPCCH interpretation and reliability requirements should remain unchanged.

5.1.2 Impact to L1 channel structure

5.1.2.1 Downlink channel structure

The Release 7 downlink channel structure contains the following physical channels and signals:

Control channels:

SCH, AICH, P-CPICH, S-CPICH, P-CCPCH, S-CCPCH, FACH, DPCCH, HS-SCCH, MICH, F-DPCH, E-AGCH, E-RGCH, E-HICH

Data Channels:

DPDCH, HS-PDSCH

With the exception of the SCH, all of the above channels are spread using OVSF codes, scrambled and modulated using QPSK, 16 or 64QAM modulation.

It is not expected that introduction of an uplink synchronised E-DCH would require any change to this downlink channel structure with the possible exception of any introduction of a new channel for signalling base codes (see section 5.1.1).

5.1.2.2 Uplink channel structure

The HSUPA Uplink channel structure consists of the parallel OVSF transmission of the control channels DPCCH, E-DPCCH, HS-DPCCH of spreading factor 256 and the data channels DPDCH & E-DPDCH of variable spreading factor. DPCCH is always required when the UE is transmitting whereas the other channels are optional. E-DPCCH & E-DPDCH are never transmitted independently. Rules specifying the OVSF code and I/Q branch assignment to each of these code channels are fixed in the standard [4]. A UE specific scrambling code is applied to the combination of transmitted channels.

For CDM synchronised E-DCH, the same set of uplink channels is envisaged. However due to the OVSF multiplexing of users, fixed rules on OVSF assignment are not possible. Furthermore, care must be taken that the uplink system does not become code limited. Possibilities for the uplink channel structure are as follows:

<u>Common scrambling code for all users and channels</u>

The most obvious channel structure is one in which a cell common scrambling code is defined and applied to all users. Each user is assigned a UE specific set of OVSF codes for the control channels. The DPCCH requires an SF256 code and cannot be I/Q multiplexed; the SF256 E-DPCCH & HS-DPCCH may be I/Q multiplexed.

The control channels are assigned within a specific region of the code space. The remainder of the code space is then used for E-DPDCH. Preferably, BPSK is used for E-DPDCH, however if the system becomes code limited then QPSK should be used in preference as it is preferable not to I/Q multiplex users on the same code.

The amount of code space available for the E-DPDCH will depend on the amount used for the control channels. Table 1 shows some estimates on the supportable peak rates and throughputs in dependence of the number of supportable users. Operated with a reasonable number of retransmissions support for a significant number of users is feasible without becoming code limited.

Assuming this uplink structure, if the system were to become code limited then a secondary scrambling code would be required, which would obviously have a detrimental effect on capacity.

Table 5.1.2.3-1 Supportable peak rates and number of users

Equivalent no of SF16 codes reserved for control	Number of supportable users	Maximum supportable peak data rate on E-DPDCH (Mbps)	Maximum possible cell throughput (Mbps)	Supportable throughput CR 0.5, QPSK, 1.5TX (Mbps)	Number of code combinations for E-DPDCH for a particular user if max SF16	Maximum number of simultaneous users in a TTI
2	16	11.52	13.44	2.24	26	14
3	24	11.52	12.48	2.08	24	13
4	32	11.52	11.52	1.92	23	12
5	40	7.68	10.56	1.76	19	11
6	48	7.68	9.60	1.60	18	10
7	56	7.68	8.64	1.44	16	9

User specific scrambling code for control

An alternative structure might be one in which the control channels are placed under a user specific scrambling code, whilst E-DPDCH is placed under a cell specific scrambling code. The number of supported users would then impact capacity but would not influence the supply of OVSF codes.

Since the channel estimation would be based on DPCCH, the power offsets for E-DPDCH would need to take into account the SIR difference between symbols received on the two scrambling codes. Variance in this SIR difference could lead to an increased need for updating the power offsets.

With such a structure, the possibility of becoming code limited on E-DPDCH would still exist.

5.1.3 PAPR impacts

This section outlines the impact of the OVSF code allocation to the PA linearity requirements.

PAPR and Cubic Metric were calculated on the transmitter side. For each code combination, the transmitter was run multiple times with randomly generated input data vectors. The signal level was logged every slot, in order to calculate the 99th percentile PAPR and CM.

In order to make a comparison of PAPR performance, a baseline from the existing specifications [4] was simulated. The baseline considered the cases of a single code and multicode UE.

Table 5.2.3.1-1 Baseline simulation assumptions

Simulation condition	Channels present	Code usage
Single code UE	DPCCH, E-DPCCH, HS-DPCCH, E-DPDCH (SF16, BPSK)	As per 25.213 [4]
Single code UE	DPCCH, E-DPCCH, HS-DPCCH, E-DPDCH (2*SF16, I/Q-BPSK)	As per 25.213 [4]
Multicode UE	DPCCH, E-DPCCH, HS-DPCCH, E-DPDCH (2*SF2+2*SF4)	As per 25.213 [4]

The Synchronised E-DCH simulations captured the worst case for Synchronised E-DCH PAPR. In principle, this required searching over all possible combinations of control channels and E-DPDCH codes. Assuming each user uses a SF256 code on I/Q branch for DPCCH and two codes for HS-DPCCH & E-DPCCH, then there are more than 8 million possible combinations of control channels alone. Considering DPCCH, HS-DPCCH & E-DPCCH and one SF16 code, the number increases to more than 200 million combinations.

Clearly, it was not possible to exhaustively test every possible combination of control channels, data channel and spreading factor. Therefore an estimate of the PAPR/CM variation for Synchronised E-DCH was computed using

Monte-Carlo approach. Multiple simulations were performed with random choices of DPCCH code, E-DPCCH code, HS-DPCCH code and E-DPDCH SF and code (assuming I/Q-BPSK for E-DPDCH).

During simulation codes combination was changed randomly every 3000 slots (2sec.). Invalid code selections were disallowed. For each simulation, 99th percentile PAPR/CM was calculated for each code combination.

The following channel configuration for Synchronised E-DCH simulations was assumed:

- Q: DPCCH (SF256) , HS-DPCCH (SF256),
- I: E-DPCCH (SF256) $B_{ec}/B_c = B_{hs}/B_c = 0$ dB,
- I/Q: E-DPDCH (SF16) $B_{ed}/B_c = 3$ dB; 6dB; 9 dB (per code).

PAPR and Cubic Metric 99th percentiles from 5000 code combinations are presented on PDF and CDF curves.Table 5.1.3-1 presents median value of the PAPR distribution for the baseline scenarios and for Synchronised E-DCH as well. Table 5.1.3-2 depicts the measured median of cubic metric distribution for all of the considered cases.

The results show that Synchronised E-DCH does not degrade PAPR and Cubic Metric characteristics for uplink signal. In all of the considered scenarios Cubic Metric was in the acceptable range (below 3.5) regardless of beta factor used.

Table 5.1.3-1 PAPR simulation results

Baseline HSUPA simulation	**PAPR value [dB]**		
	$B_{ed}/B_c = 3$ dB	**$B_{ed}/B_c = 6$ dB**	**$B_{ed}/B_c = 9$ dB**
BPSK	---	---	4.5
I/Q-BPSK	6.3	5.9	5.4
Multicodes	6.9	6.7	6.5
Synchronous E-DCH	**PAPR value [dB]**		
I/Q-BPSK	6.9	6.5	6

Table 5.1.3-2 Cubic Metric simulation results

Baseline HSUPA simulation	**CM value**		
	$B_{ed}/B_c = 3$ dB	**$B_{ed}/B_c = 6$ dB**	**$B_{ed}/B_c = 9$ dB**
BPSK	---	---	1.1
I/Q-BPSK	2.2	1.8	1.23
Multicodes	2.7	2.4	2.2
Synchronous E-DCH	**CM value**		
I/Q-BPSK	2.5	2	1.4

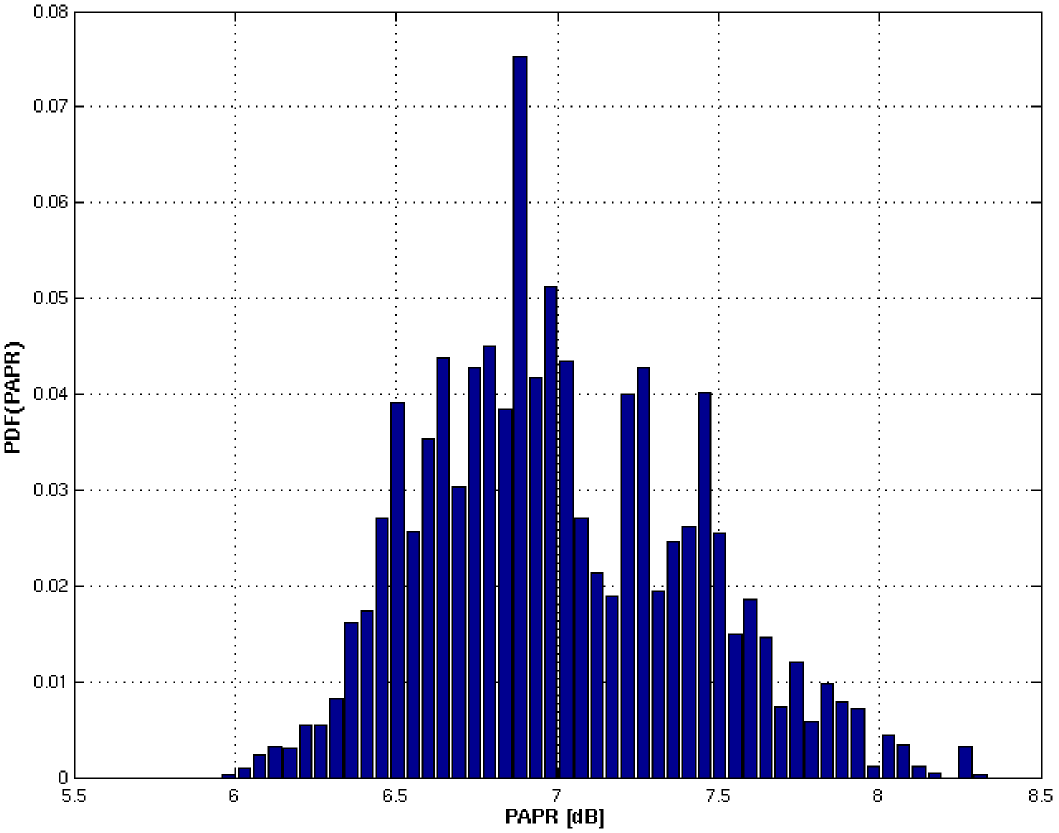


Figure 5.1.3-1 PDF of the PAPR based on 5000 codes combination, B_{ed}/B_c = 3 dB

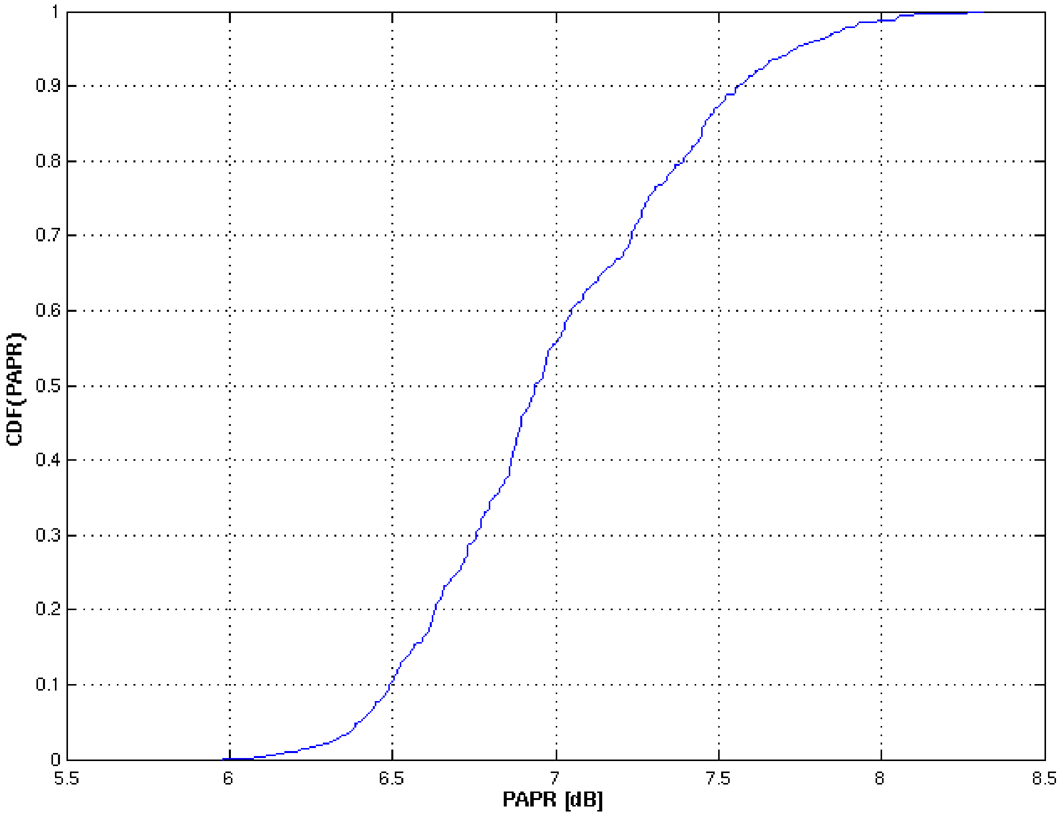


Figure 5.1.3-2 CDF of the PAPR based on 5000 codes combination, B_{ed}/B_c = 3 dB

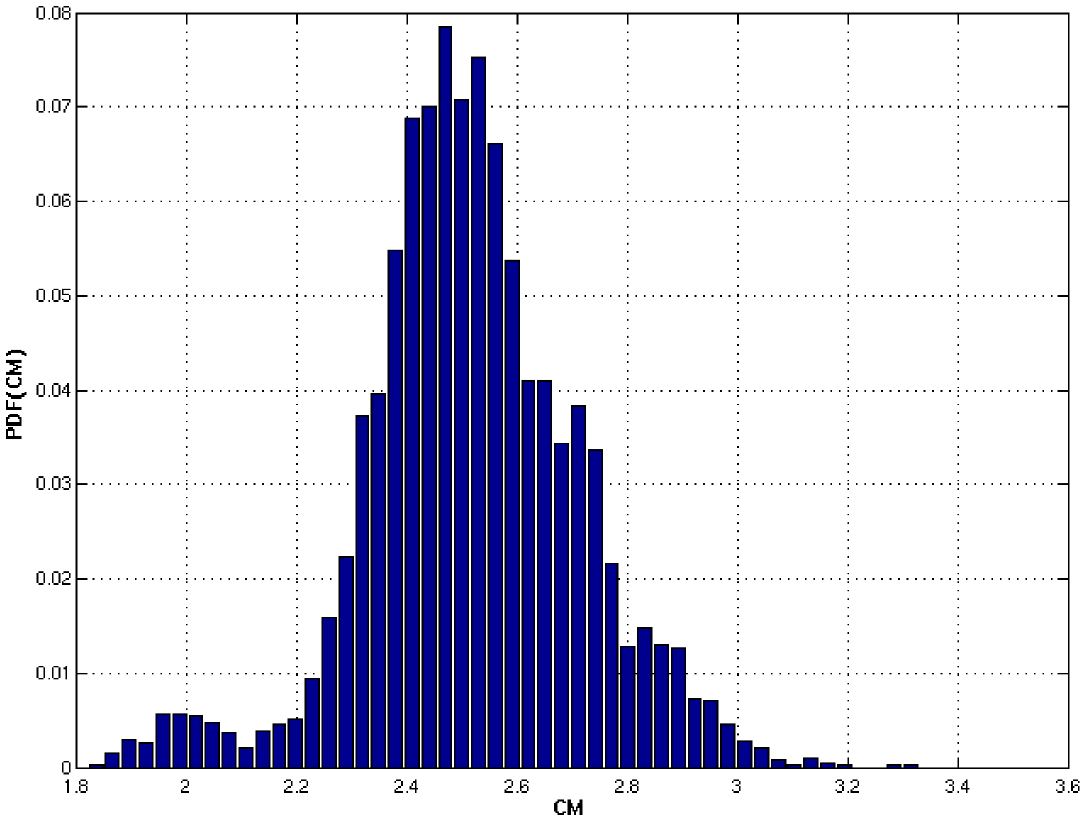


Figure 5.1.3-3 PDF of the CM based on 5000 codes combination, B_{ed}/B_c = 3 dB

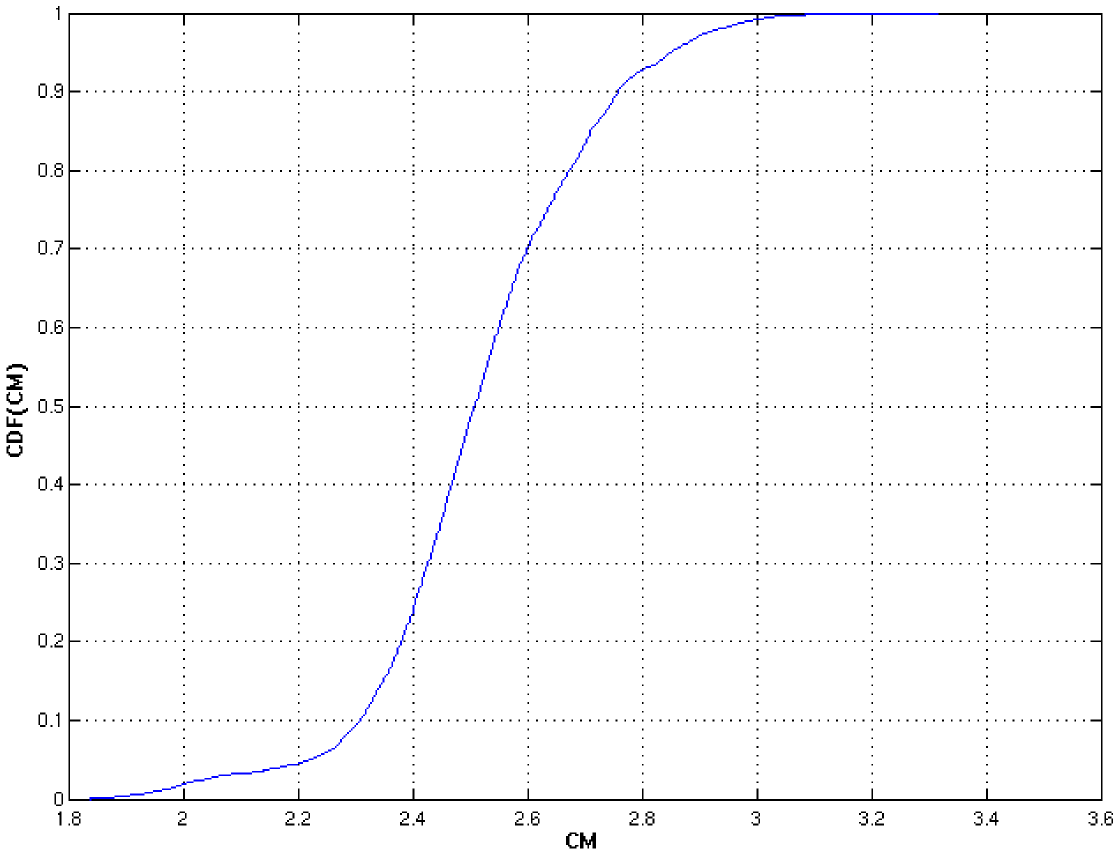


Figure 5.1.3-4 CDF of the CM based on 5000 codes combination, B_{ed}/B_c = 3 dB

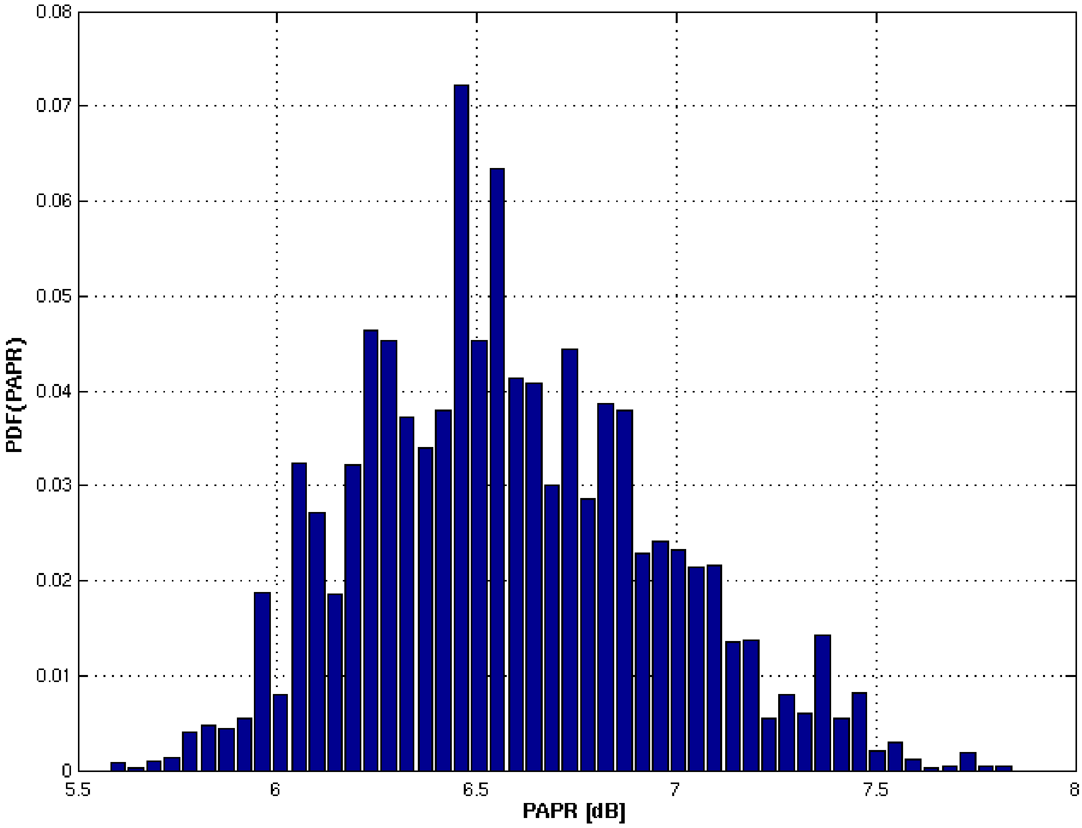


Figure 5.1.3-5 PDF of the PAPR based on 5000 codes combination, B_{ed}/B_c = 6 dB

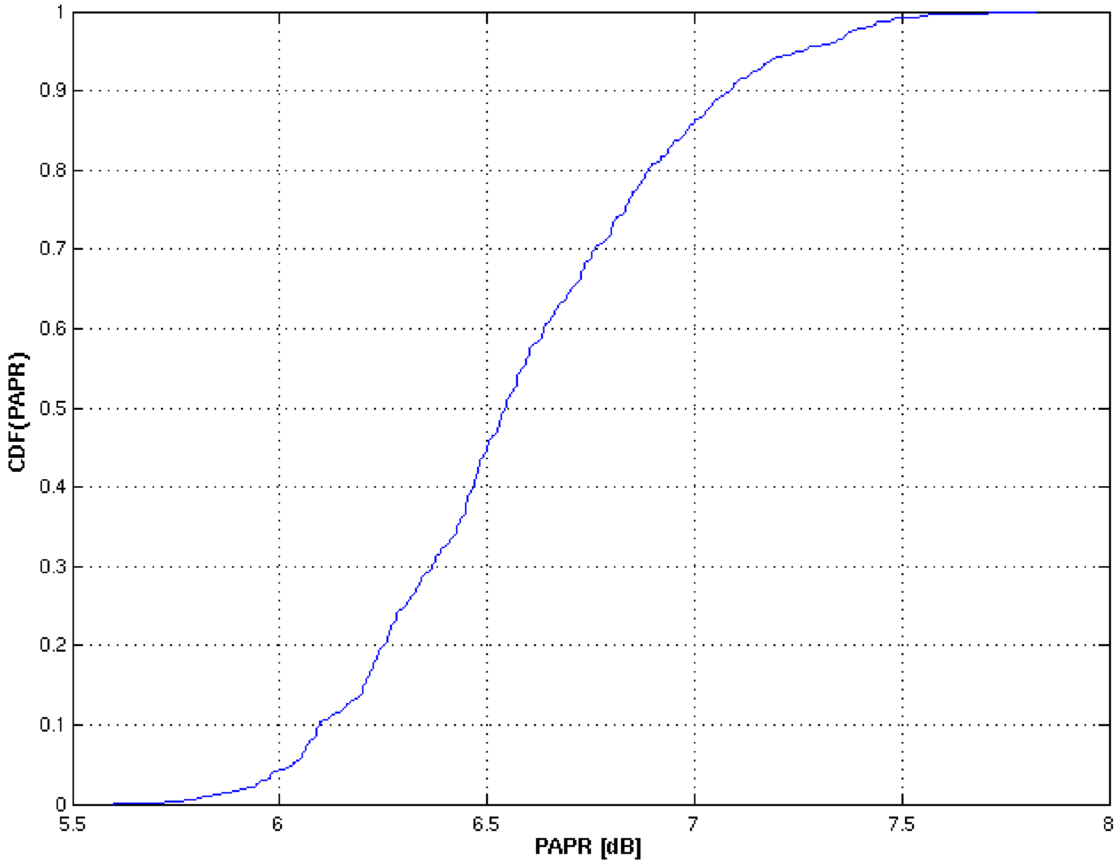


Figure 5.1.3-6 CDF of the PAPR based on 5000 codes combination, B_{ed}/B_c = 6 dB

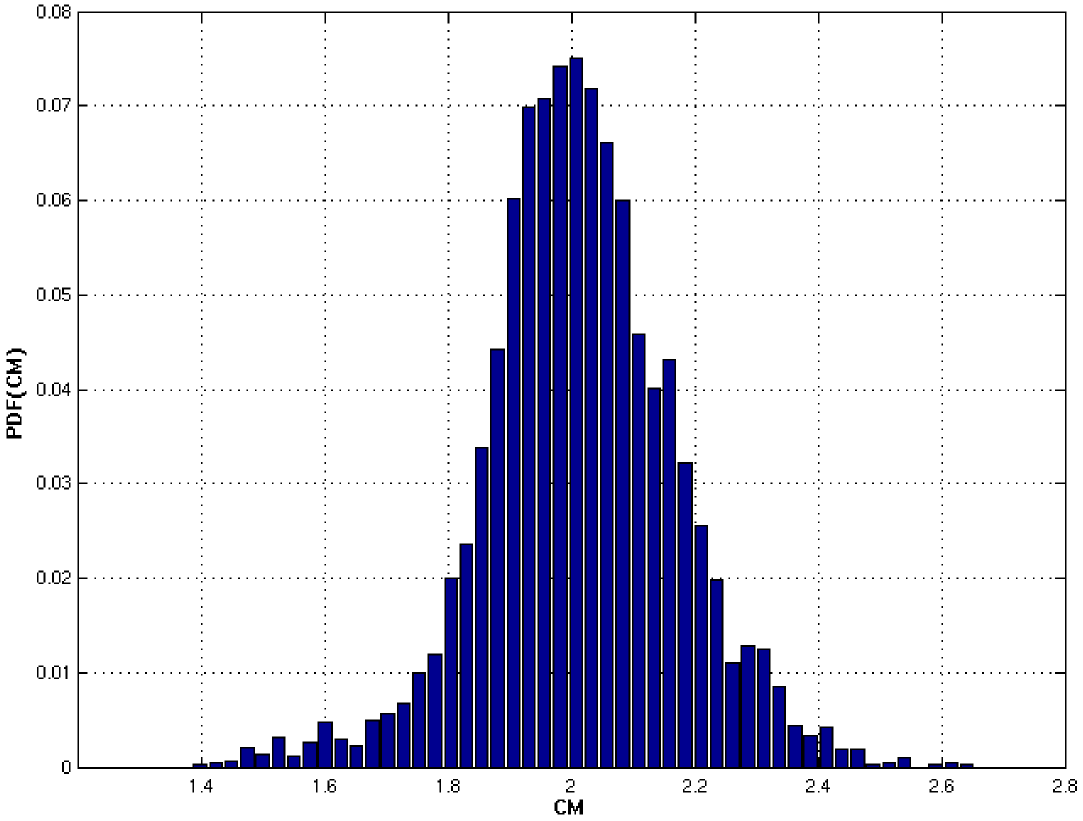


Figure 5.1.3-7 PDF of the CM based on 5000 codes combination, B_{ed}/B_c = 6 dB

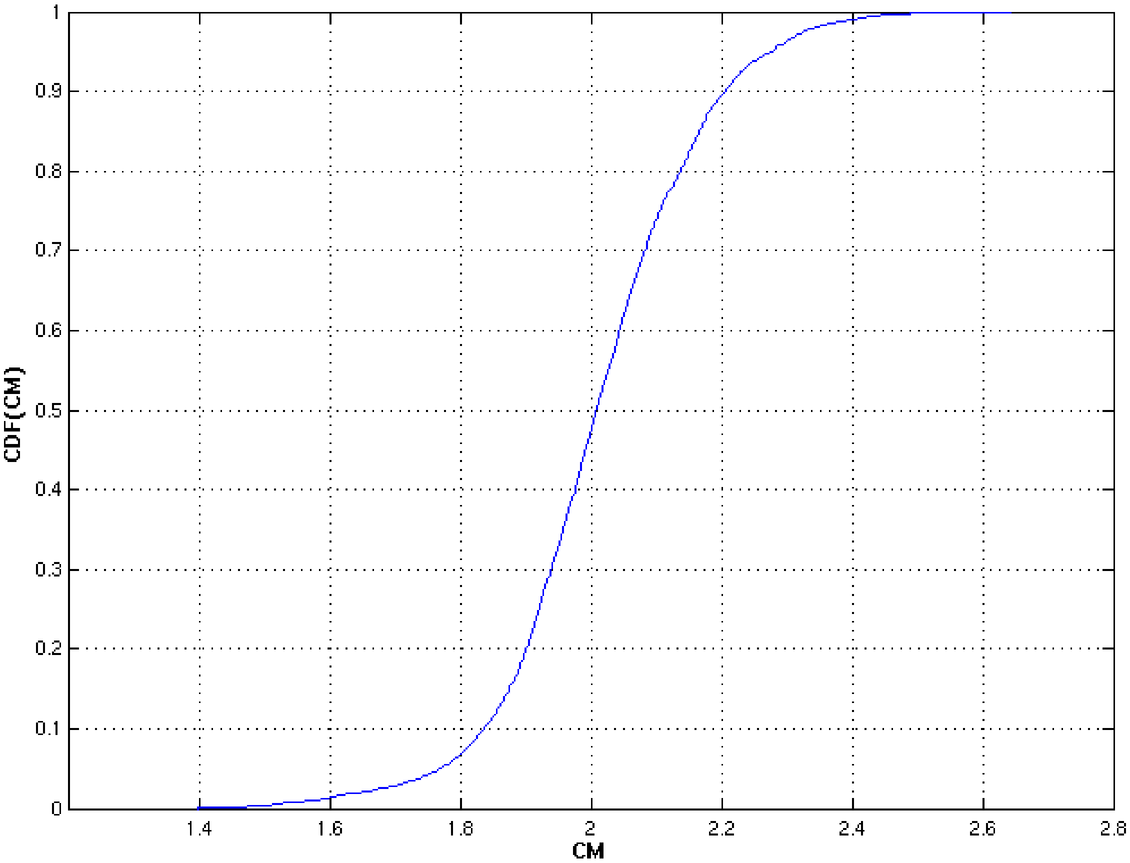


Figure 5.1.3-8 CDF of the CM based on 5000 codes combination, B_{ed}/B_c = 6 dB

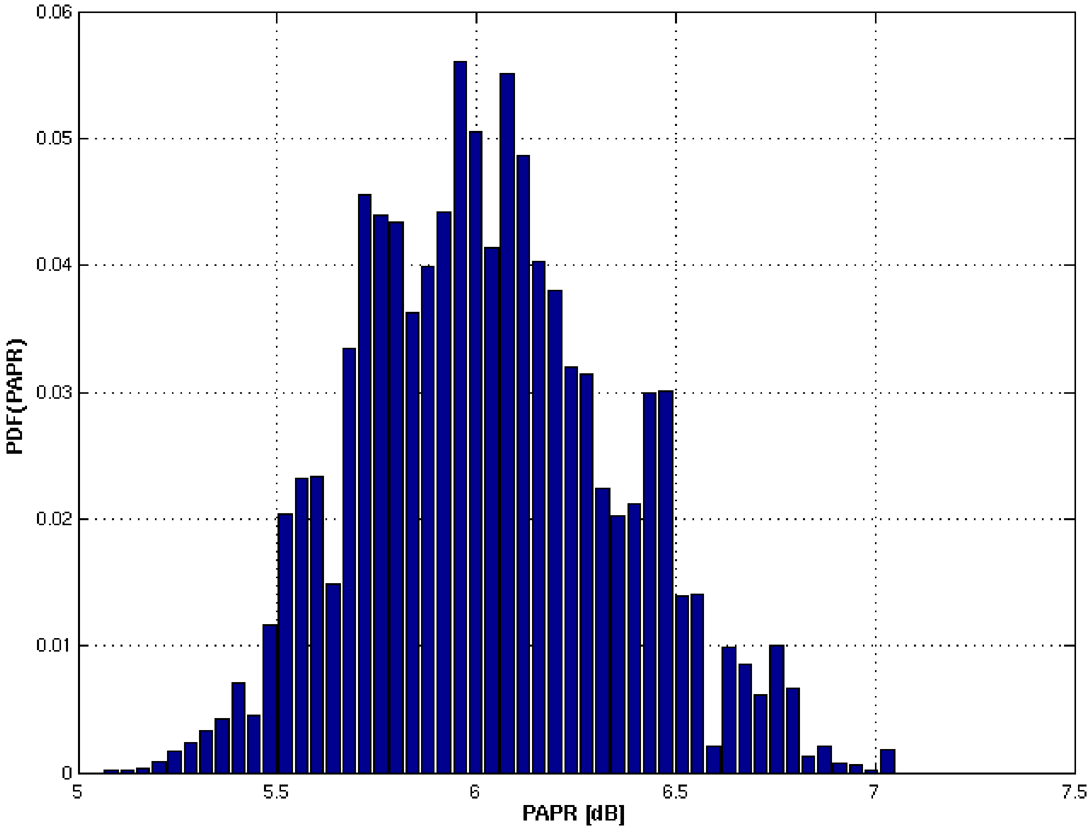


Figure 5.1.3-9 PDF of the PAPR based on 5000 codes combination, B_{ed}/B_c = 9 dB

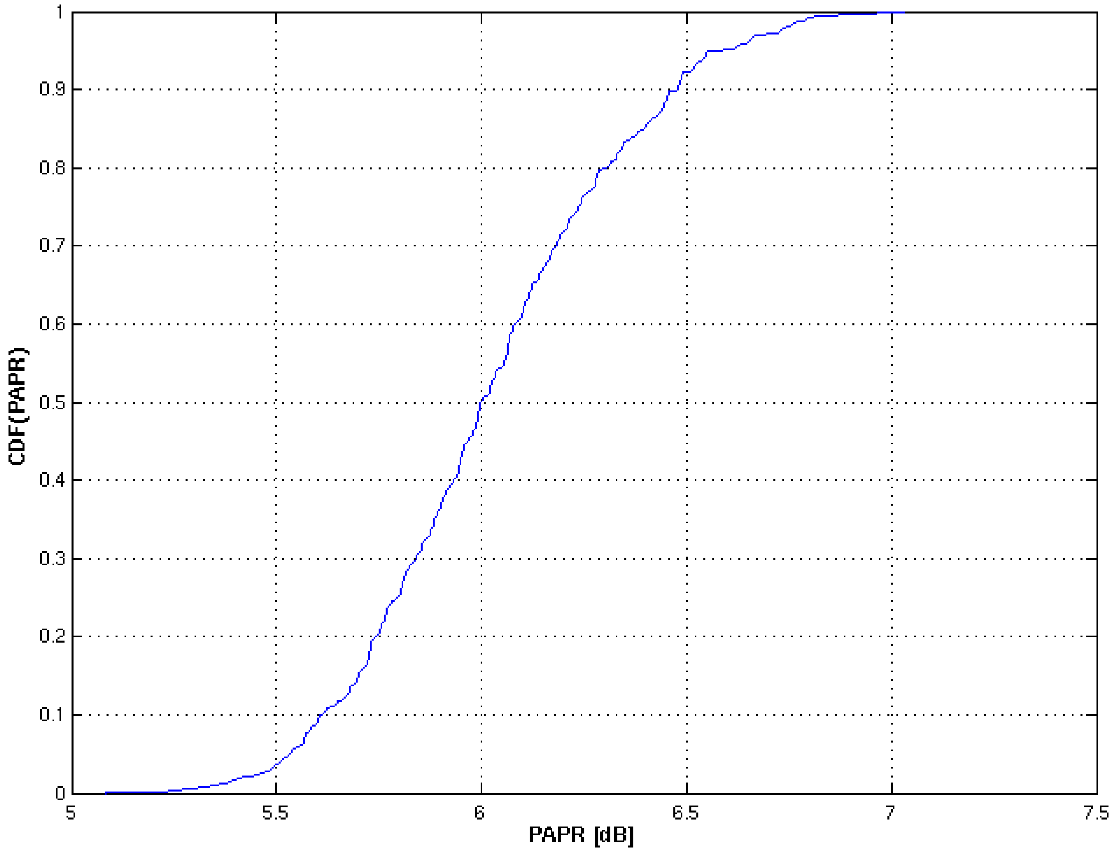


Figure 5.1.3-10 CDF of the PAPR based on 5000 codes combination, B_{ed}/B_c = 9 dB

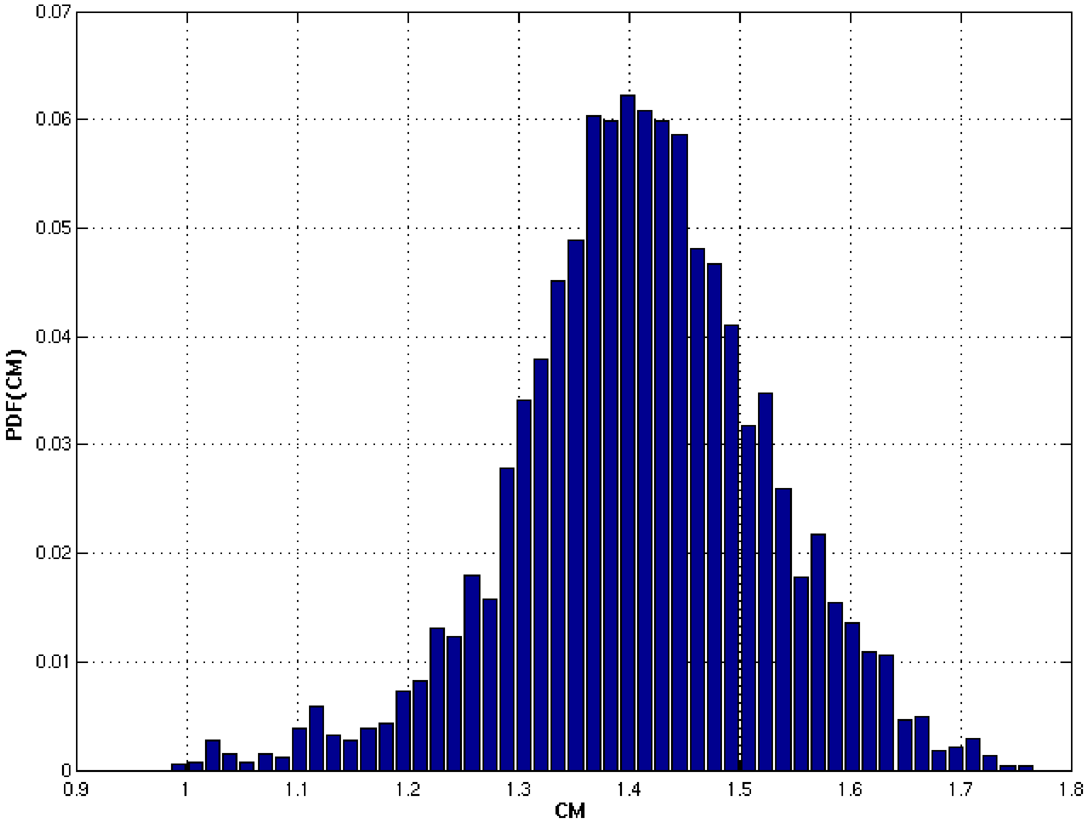


Figure 5.1.3-11 PDF of the CM based on 5000 codes combination, B_{ed}/B_c = 9 dB

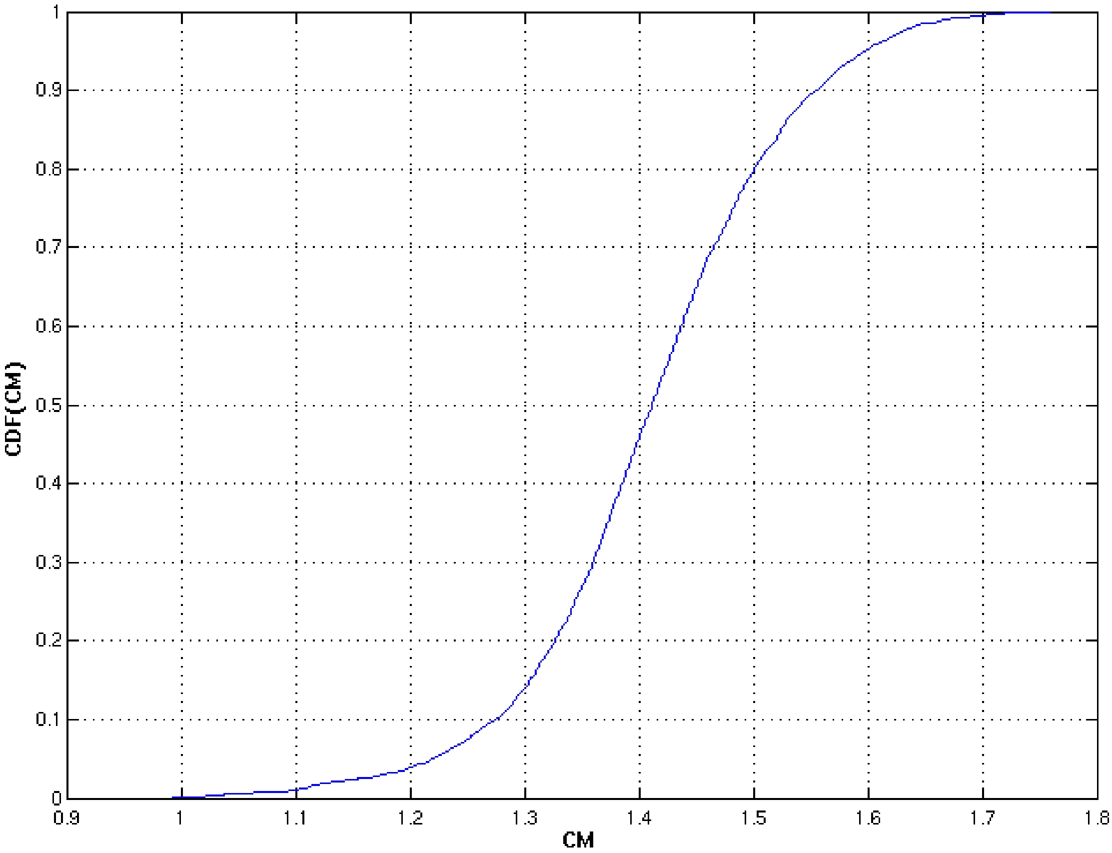


Figure 5.1.3-12 CDF of the CM based on 5000 codes combination, B_{ed}/B_c = 9 dB

It may, however be possible to do better than random code selection. Investigations were carried out into the impact of choosing "PAPR efficient" combinations of codes, with results as follows [6]:

- The difference between random and PAPR efficient selection of control channel codes is about 0.4dB PAPR. Efficient combinations of control codes are ones in which the DPCCH and the E-DPCCH/HS-DPCCH are in different blocks of 32 codes and the highest power channel of E-DPCCH & HS-DPCCH is placed on the opposite branch to the DPCCH
- For SF4, the difference between choosing E-DPDCH codes to be spreading factor efficient and to be PAPR efficient is about 1dB PAPR; PAPR efficient selection could lead to no increase in PAPR compared to HSUPA
- For SF16, the difference between non PAPR efficient and PAPR efficient code selection is about 1.5dB PAPR
- Of course, scheduler restrictions may prevent PAPR optimal codes from always being selected

Also, it was shown that if control channels & the E-DPDCH are placed on different scrambling codes, then there is no possibility for optimising PAPR.

5.1.4 Impact to L1 procedures

Introduction of the Synchronised E-DCH is not expected to influence existing Layer 1 procedures. However, an Synchronised E-DCH specific functionality will require some extension of the existing algorithms. Following factors should be considered:

Random Access procedure
It is not expected, that the Synchronised E-DCH will impact the existing Random Access Procedure. However, adapting the RACH procedure to allow for Synchronised E-DCH specific synchronization could enable quicker synchronization or even synchronized transmission of the RACH message parts from the different users.

Synchronisation
In order to enable chip level synchronisation, a new timing alignment procedure would be required

Power Control Procedure
In order to maintain the synchronisation obtained in the initial synchronisation process, some Timing Alignment Bits will be required. As proposed during the USTS SI, those bits could be sent in place on the PC bits every 20ms. For this purpose the existing PC procedure will have to be updated and will have to include the description of the new interpretation of some PC commands for the Synchronised E-DCH users. This will not influence the procedure for the legacy UEs.

Macrodiversity
The reasons for soft handover are twofold; firstly a capacity benefit arising from selective combining at the RNC and secondly an ability for basestations to quickly mitigate rising interference from a UE crossing the cell boundary by issuing power control commands.

Several alternatives to operating full SHO for synchronised E-DCH exist. These may include:

- Configure users within the SHO area to use Release 7 HSUPA. In this case, SHO would operate in the same manner as Release 7. The size of the SHO area could be reduced to the point at which the SHO gain for the user as a WCDMA user would outweigh the gain in the serving cell if the user is an Synchronised E-DCH user. Non OVSF interference would be introduced into the cell by the SHO/HSUPA users; if this were a problem it could be mitigated to some extent by further reducing the SHO area; i.e. trading off SHO gain and losses due to the introduction of non OVSF interference
- Operate SHO only on the DPCCH. Thus, non serving cells would decode the DPCCH and issue power control commands, but would not decode E-DPDCH. The selective combining gain would be lost, but surrounding cells would still have the chance to affect power control for an SHO UE. The SIR targets in surrounding cells would need to be increased compared to the WCDMA case in order to minimise the risk of the call being dropped in the serving cell. Nonetheless, call drop due to a non serving and non decoding cell reducing the UE TX power would still be a risk.

Synchronised E-DCH soft handover requires either restriction of the base code used by the scheduler in the Node B or additional uplink signalling.

In order for a non serving Node B to be able to decode synchronised E-DCH, it must know the codes that are used for the DPCCH/E-DPCCH and E-DPCDH, and it must update its receiver timing when the synchronised E-DCH UE timing is updated.

- Timing updates are expected to be infrequent and small, and hence not to cause a major problem;
- The DPCCH & E-DPCCH codes are expected to be semi-statically assigned and thus can be indicated to the non serving Node B over Iub
- The E-DPDCH base code and spreading factor would be dynamically managed by the serving Node B. The spreading factor can be calculated by a non serving Node B based on the TFCI indicated on E-DPCCH and the rate matching rule;
- The portion of the code tree used by a UE would not necessarily be known. Depending on the solution chosen for indicating the base code to the non-serving Node B (either L1 signalling or RRC controlled) the impact on the Layer 1 procedure will differ.

In the serving cell, intracell interference could be OVSF separated and hence the link would benefit from synchronised E-DCH gains. In non serving cells, the link would not be orthogonal to intracell interference and most intercell interference, and the OVSF separation from other UEs residing in the UEs own cell would be limited as timing alignment would not be preserved.

It may be assumed that different cells belonging to the same Node B can all be made aware of the base code that the UE has been allocated, thus softer handover for Synchronised E-DCH can inherently be supported. Assuming the cells are co-located, then the UEs of neighbour cells of the same site will remain synchronised in each cell. Thus, UEs from a neighbour cell will remain OVSF separated from one another although not from the intra-cell UEs.

The performance impacts of the different SHO options have not been evaluated.

5.1.5 Impact to L2 & L3 procedures

The following types of functional changes in the L2-L3 procedures are expected due to introduction of the Synchronised E-DCH:

Configuration Setting of Synchronised E-DCH (L3)
New and modified configuration parameters have to be provided to the UE. Therefore all configurations and reconfiguration procedures have to be extended to carry this information. UE and UTRAN actions when receiving synchronised E-DCH configurations have to be introduced in the RRC protocol in addition to the existing UE and UTRAN actions.

Serving cell change (L3)
Change of serving cell might require updating Synchronised E-DCH configuration and a new timing alignment to the target cell, which would need to be taken into account in the serving cell change procedures.

Macrodiversity (L3)
The requirements for Macrodiversity (Soft HO) will be covered with the changes for all reconfiguration procedures

UE capability (L3)
UTRAN has to be notified about the UE support of Synchronised E-DCH. Relevant RRC messages providing this information have to be extended.

Dynamic base code allocation (L2)
The E-DCH scheduler function in MAC has to be extended to provide dynamically to the UE not only the MT2PR, but in addition a based code and an appropriate channelization code tree portion. Rules for base code allocations have to be introduced, depending on the signalling mechanism chosen to provide this information to the UE via the physical layer.

5.1.6 Synchronisation

In order to obtain a reduction in inter user interference by means of OVSF code separation accurate alignment of the receive timing of at least the strongest received paths for each of the users needs to be performed.

5.1.6.1 Synchronisation requirements

To establish and maintain UL time synchronisation the following aspects need to be dealt with:

- initial propagation delay,
- synchronisation maintenance, and
- reacting to changes in the propagation environment.

Initial propagation delay
Initial propagation delay can be easy obtained from the PRACH Propagation Delay measured as described in [5]. The required timing corrections may be sent to the UE via higher layer signalling. The accuracy of the initial delay alignment will depend on the resolution for the PRACH propagation delay reporting.

Synchronisation maintenance
To consider the effect of the motion of the UE on synchronization, it is helpful to consider an example. At a speed of 100 km/h, the mobile is moving about 27.7 meters per second. During an interval of, say, 200 milliseconds, the change in timing due to the motion of the mobile is about 18 nanoseconds. This is obviously much smaller than the chip duration. Hence, adjusting the mobile timing in steps of 1/8th chip at a signaling interval of 200 milliseconds will obviously track timing changes due to motion of the mobile even at much higher speeds (see [2]). During the Synchronised E-DCH study item, the impact to Synchronised E-DCH performance of 1/8 and ¼ chip synchronization was investigated and found to be negligible [7], [8].

Changes in the propagation environment
In the mobile environment, the multi-path components may change both due to the motion of the mobile and over time due to motion of elements of the environment. These changes must also be tracked by the synchronous control signaling process. It may be expected that when there is a change of the strongest receive path, the timing difference between the old and new paths will be less than 16us and typically less than 1.5 us [2]. The synchronous signaling control process must thus be able to command step changes in transmission timing every few seconds of typically 1.5 us, but possibly up to 16 us, in this environment. For a typical timing change of 1.5 us, an example 1/8th chip tracking process with a 200 millisecond signaling rate would require many small step time alignment commands to be sent before the multipath component can be time aligned (synchronised). An extended signaling process that would re-align the timing of the strongest receive path when the propagation environment changes is thus likely to be necessary.

5.1.6.2 USTS Synchronisation

A two-step procedure for the synchronisation adjustments was considered during the USTS SI. The first step is “Initial synchronization” and the second is “Tracking process”.

- Initial synchronisation compensates the initial propagation delay by adjusting the UE transmission time according to the initial timing corrections given by higher layer signalling;
- Tracking process (Closed Loop Timing Control) compensates the synchronisation variations caused by the UE movement by adjusting the UE transmission time according to the so-called Time Alignment Bit (TAB).

Initial synchronisation
First, UTRAN obtains the round trip propagation delay (RTPD) by doubling the value of PRACH Propagation Delay measured in TS 25.215 and sets the amount of adjustment for initial synchronisation (T_{INIT_SYNC}) to compensate the difference between the RTPD and the reference time (T_{ref}). UE adjusts its transmission time according to T_{INIT_SYNC} delivered from UTRAN through FACH. Since T_0 is a constant (1024 chips) and T_{ref} is a given value and the same for all UEs in a cell, after initial synchronisation, the arrival in the Node B can be controlled to occur within $[\tau_{DPCH,n}+T_0+T_{ref}-1.5chips,\ \tau_{DPCH,n}+T_0+T_{ref}+1.5chips]$ due to 3 chip resolution for reporting PRACH Propagation delay. Of course, changes to the signalling procedure could be used to increase the initial timing accuracy.

Tracking process
For the Tracking process, which compensates the synchronisation variations caused by the UE movement, it was proposed to replace the TPC bits by Time Alignment Bits (TABs) every two frames (20 msec timing control interval) as shown on figure 5.1.6.2-1.

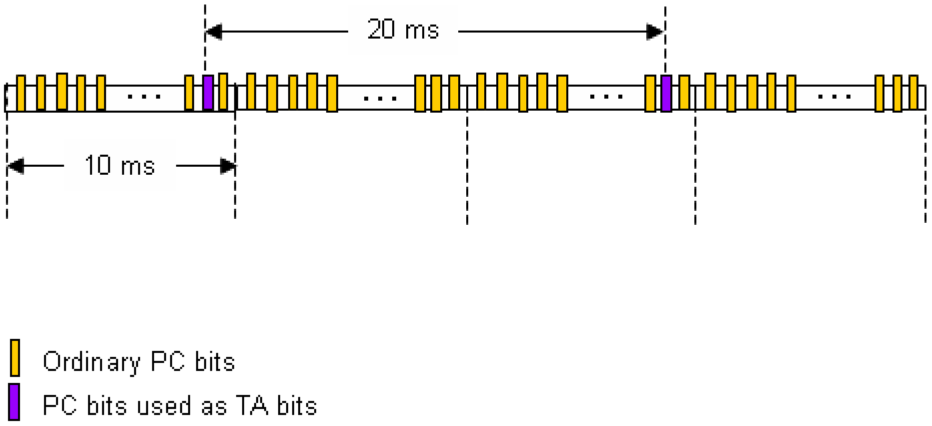


Figure 5.1.6.2-1: stealing PC bits for the purpose of timing alignment maintenance

The procedure proposed during the USTS SI was as follows:

- Node B compares the received arrival time with the desired arrival time from UE every 200 msec;
- When the received arrival time is earlier than the desired arrival time at a Node B, Time Alignment Bit (TAB) is set to "0". When this is later than the desired arrival time, TAB = "1".
- TAB replaces the TPC bit in slot #14 in frames with CFN mod 2 = 0.
- At the UE, a number of Time Alignment Bits are combined over a 200 ms interval, which increases the reliability of the time alignment process. When the combined time alignment command is judged as "0", the transmission time shall be delayed by δT, whereas if it is judged as "1", the transmission time shall be advanced by δT, where δT is the timing control step size, whose minimum value depends on the oversampling rate.

As an extension to the tracking process described above also an adaptive tracking scheme (with the TA step adaptively changed within the given range) was proposed.

The adaptive tracking scheme after initial synchronisation changes the TAB command period and timing control step size to reduce the impact of coarse initial synchronisation due to 3 chip resolution at initial synchronisation phase. In other words, when a UE enters USTS mode it can adjusts its uplink transmission time with the timing control step bigger in size than that of the normal tracking process and the TAB command period shorter than that of the normal tracking process during initial several frames.

The adaptive tracking process may also be use to accommodate bigger variations in the UL synchronisation caused by the propagation environment.

5.1.6.3 Issues to consider

Synchronisation & CPC
If a scheme similar to that discussed during USTS as described in section 5.1.6.2 were to be adopted, CPC bits used as TAB must be clearly recognisable i.e. must be send according to the fixed pattern. The alignment with the CPC gating pattern must be assured. TA bits must not fall in the CPC gap; however, the TP bits also have to be sent after the CPC gap and therefore some extension of the gating pattern may be needed.

Alternatively, if operation of Synchronised E-DCH is considered together with a low number of active users, the issue of interaction between Synchronised E-DCH and CPC could be avoided.

Obtaining initial synchronisation during the RACH procedure

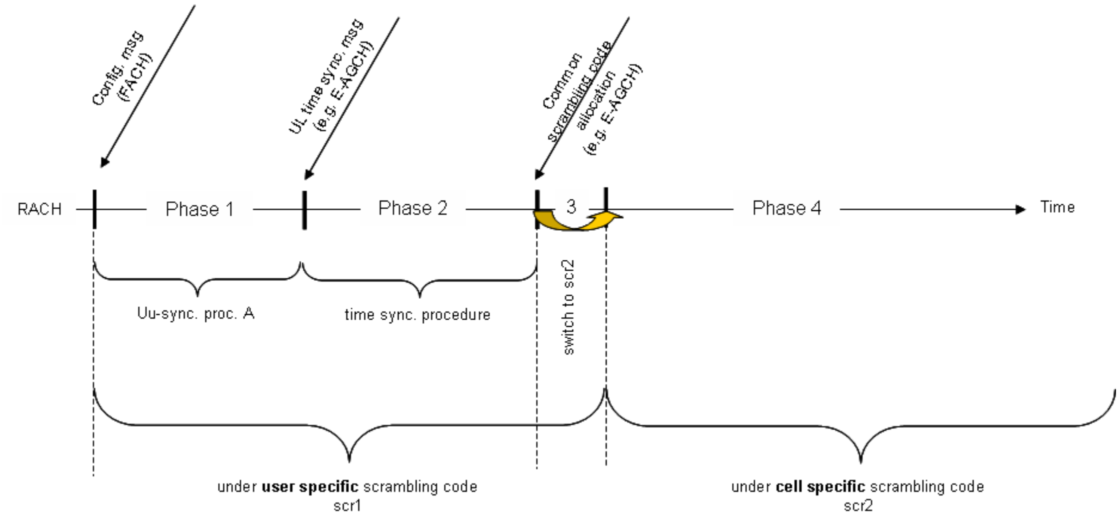


Figure 5.1.6.3-1: message sequence for the initial synchronisation

As depicted in figure 5.1.6.3-1, the timing synchronisation procedure may increase the call setup time for Synchronised E-DCH.

Adapting the RACH procedure to allow for Synchronised E-DCH specific synchronization could enable quicker synchronization or even synchronized transmission of the RACH message parts from the different users.

5.1.7 Backward compatibility

As detailed in section 5.2.2, the synchronised E-DCH channel structure is the same as the Release 6 HSUPA structure, with the exception that the mappings between physical channels and OVSF codes differ. Synchronised E-DCH users are placed under a common scrambling code, whilst terminals from previous releases will use a user specific scrambling code. Thus, at the receiver synchronised E-DCH users will appear noise like when performing decoding of legacy users.

WCDMA is sensitive to interference levels and thus it is important that interference from synchronised E-DCH users and RoT are managed accurately. Since Synchronised E-DCH will continue to use the Release 99 power control mechanism and, as described in section 5.1 the scheduler management of RoT will function in the same manner as Release 6 HSUPA, it is not expected that Synchronised E-DCH interference will disturb the operation of legacy users.

No special receiver algorithm is required in the Node B for Synchronised E-DCH reception; in principle the same type of receiver algorithm can be used for Synchronised E-DCH and legacy users.

Thus it is not expected that the presence of synchronised E-DCH users in a cell will impact reception from legacy UEs and will not impact the throughput and performance of legacy UEs. However the user throughput for legacy UEs will not benefit from the presence of Synchronised E-DCH users and Synchronised E-DCH gains will be impacted by the presence of legacy terminals.

5.2 TDM Proposal

5.2.1 Scheduling & required control channels

In order to avoid overlapping transmission instances for high data rate users, at least a relatively coarse time alignment on a TTI level is necessary. This can be done by setting the value of $\tau_{F\text{-}DPCH}$ for a high rate UE such that the TTIs of high rate users are aligned. The NodeB can track deviations in uplink timing in a similar way as with USTS, and the NodeB can ask the RNC to control the F-DPCH slot format and the value of $\tau_{F\text{-}DPCH}$ in steps of 256 chips, which then results in an adjustment of the corresponding uplink timing for E-DCH. In addition, the NodeB could adjust the E-DCH transmission timing on a chip level. For further details on the synchronization, see section 5.2.5.

As a result, it is possible for the NodeB scheduler of the serving cell to time multiplex high data rate users, which is especially attractive for several reasons. First, scheduling users one at a time allows for higher system throughput, as the sum of the user rates can be larger when users are orthogonal. Second, TDM scheduling facilitates advanced NodeB receiver structures with the possibility for interference cancellation of the high data rate users for the medium and low data rate users. This would improve e.g. the VoIP capacity in the presence of high data rate E-DCH users in a cell.

Once the users have been time aligned, HARQ process specific grants (available for the 2 ms E-DCH TTI since Rel-6) can be used to obtain the desired TDM operation by ensuring that the different users transmit in different HARQ processes.

Although not seen as absolutely necessary for supporting TDM operation, some enhancements related to the scheduling grant signaling may be beneficial, e.g. more efficient reassignment of a HARQ process specific grant or other grant from one user to another, HARQ process specific grants for 10 ms E-DCH TTI, or other forms of periodic grants (which could also be useful for VoIP traffic). The impact on HARQ retransmissions and non-serving RGs should be considered if/when changes to the grant signaling are introduced.

5.2.2 Impact to L1 channel structure

The TDM approach has no impact on the L1 channel structure.

5.2.3 Impact to L1 procedures

When the UE receives an HS-SCCH order for UL timing adjustment, it should adjust its UL timing accordingly.

5.2.4 Impact to L2 & L3 procedures

The TDM approach has no impact on the L2 & L3 procedures.

5.2.5 Synchronisation

The adjustments of the DL timing described in section 5.2.1 can serve as a coarse initial UL timing adjustment. Note that this coarse adjustment can also be made for legacy UEs, which is welcome since already Rel-6 and Rel-7 introduces high rates in uplink.

- ⇒ Use new Iub/Iur signaling of the desired DL timing adjustment from serving NodeB to SRNC to achieve a coarse UL timing adjustment for Rel-6 UEs and later. The SRNC can then modify the DL timing accordingly using existing Iub/Iur and RRC signaling.

For Rel-8 UEs, even finer NodeB-controlled UL timing adjustments should be possible, e.g. through UL timing adjustment commands via a new type of HS-SCCH orders.

- ⇒ Use a new HS-SCCH order type for UL timing adjustment commands to achieve a fine UL timing adjustment for Rel-8 UEs and later in addition to the coarse adjustment.

Since the required accuracy is quite low – in the order of several chips rather than sub-chip accuracy – the additional control signaling overhead from these UL timing adjustments can be considered moderate.

5.2.6 Backward compatibility

Channel structure, channel coding, modulation mapping, spreading, and procedures are the same for TDM based Synchronised E-DCH as for the Release 6/7 HSUPA structure.

The only difference will be the addition of an HS-SCCH order type for UL timing adjustment (similar to the CPC-related HS-SCCH order type already existing in Release 7).

TDM based Synchronised E-DCH (as opposed to the CDM based approach) supports HSPA channels as well as DCH.

In principle, legacy UEs will not be affected by TDM based Synchronised E-DCH, although rapid variation of inter-cell interference caused if high rate users are TDM scheduled could impact inner and outer loop power control to legacy users unless this interference is suppressed or otherwise taken into account by the network.

Note that if desired, the Iub/Iur signaling proposed in section 5.2.5 can be used to achieve a coarse TDM operation even for Release 6/7 UEs.

6 Performance Evaluation

6.1 Link level simulation analysis

6.1.1 Link level simulation assumptions

This section describes simulation assumptions valid for link level analysis. All of the parameters have been captured in 6.1.1-1

Table 6.1.1-1 Link level simulation assumptions

Parameter	Value
E-DPDCH TTI	2msec
Power control error rate	0%
E-DPCCH detection error rate	0%
Maximum number of transmissions	4
Spreading Factor	16, 8, 4, 2/4
Transport block size	292, 612, 1252, 2532
DPCCH SIR	Various, to achieve a range of HARQ throughput levels
Outer loop power control	None
Power control delay	3 slot
Receiver	LMMSE
Modulation for E-DPDCH	2*BPSK
Scrambling code type	Long
Number of receive antennas	2
Channel estimation	Realistic
Number of users	Variable
Channel Delay Profile	PA, TU6, ”Mixed”
Speed	3 kmph
Synchronisation between UEs	Perfect for main path

The “mixed” channel profile is designed to test link level performance in environments where users do not have exactly aligned multipaths (although the main paths are always synchronised) and is defined as follows:

Table 6.1.1-2 "Mixed" channel profiles

User	Channel
1	PEDA, 3km/h
2	PEDB, 3km/h
3	modTU6* , 3km/h
4	VEHA, 3km/h
5	modTU6*, 3km/h main path not delayed; other paths delayed by 0.52usec
6	PEDB, 3km/h main path not delayed; other paths delayed by 0.52usec
7	PEDA, 3km/h main path not delayed; other paths delayed by 0.52usec
8	VEHA, 3km/h main path not delayed; other paths delayed by 0.52usec

*modTU6 is defined as follows:

Table 6.1.1-3 Modified TU6 channel profile

Tap	Relative time (usec)	Average relative power (dB)
1	0,0	0,0
2	0,26	-3,0
3	0,5	-2,0
4	1,6	-6,0
5	2,3	-8,0
6	5,0	-10,0

6.1.2 Link level simulation results (CDM Proposal)

This section presents the link level simulation results, The simulations have been performed on the basis of assumptions listed in section 6.1.1. The performance of CDM Synchronised E-DCH users have been compared with regular E-DCH users and the simulation results are shown in sections 6.1.2.1-6.1.2.4. The figures plot Ec/user against No, where No consists of noise only and not interference between users.

For each simulation case, 2 sets of simulations have been performed independently, labelled "Set 1" and "Set 2".

The link level gain from CDM Synchronised E-DCH is dependent on the HARQ operating point. Where the HARQ operating point corresponds to 10-30% initial transmit BLER, Synchronised E-DCH gains are in the range 1-2dB for 8 SF16 users, 6 SF8 users, 3 SF4 users and 2 SF2&4users respectively in the Pedestrian A channel and 0.75-1dB for the same combinations in the TU6 and mixed channels. For smaller numbers of users, the gain decreases. Where the HARQ operating point is 1% after 4 transmissions, the gain is generally less then 0.5dB in PedA and 0.25dB in the TU and mixed channels.

6.1.2.1 Spreading factor 16 Simulations

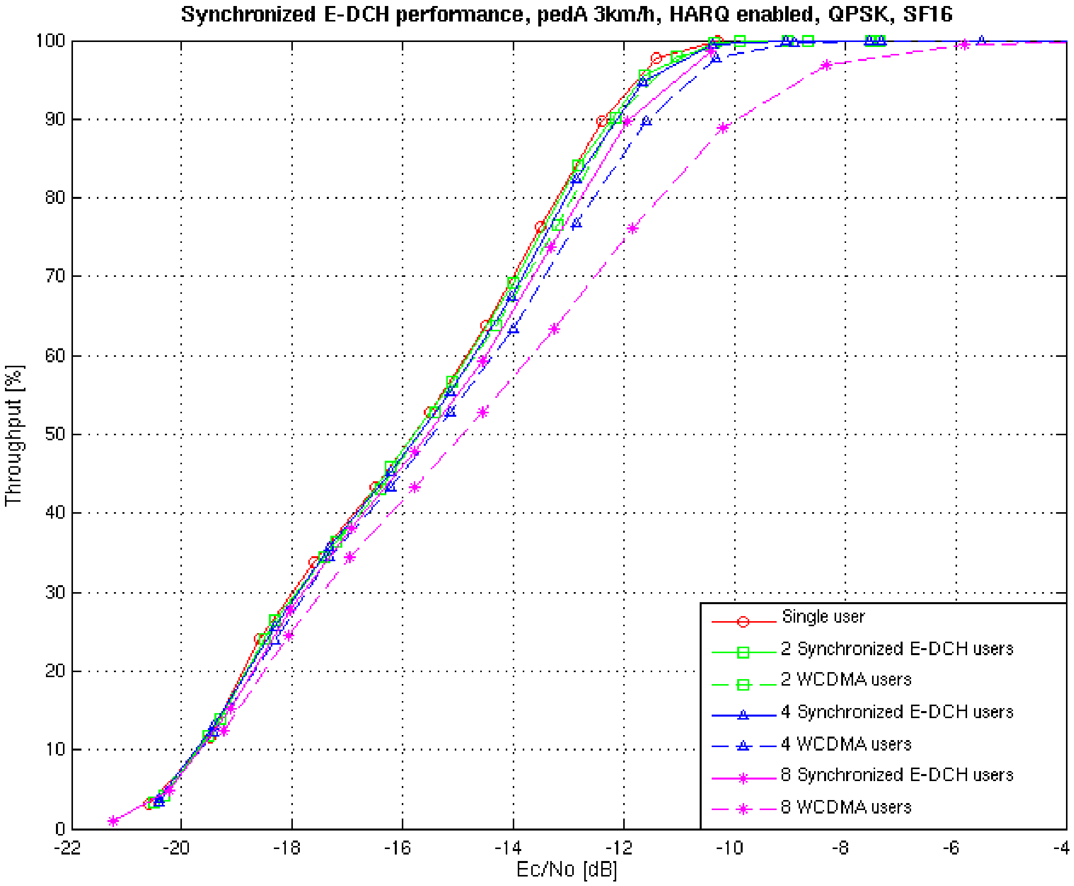


Figure 6.1.2.1-1 Throughput curves – TBS 292 bits, both HSUPA and S-EDCH 2*BPSK, SF16, pedestrianA, 3km/h (Set 1)

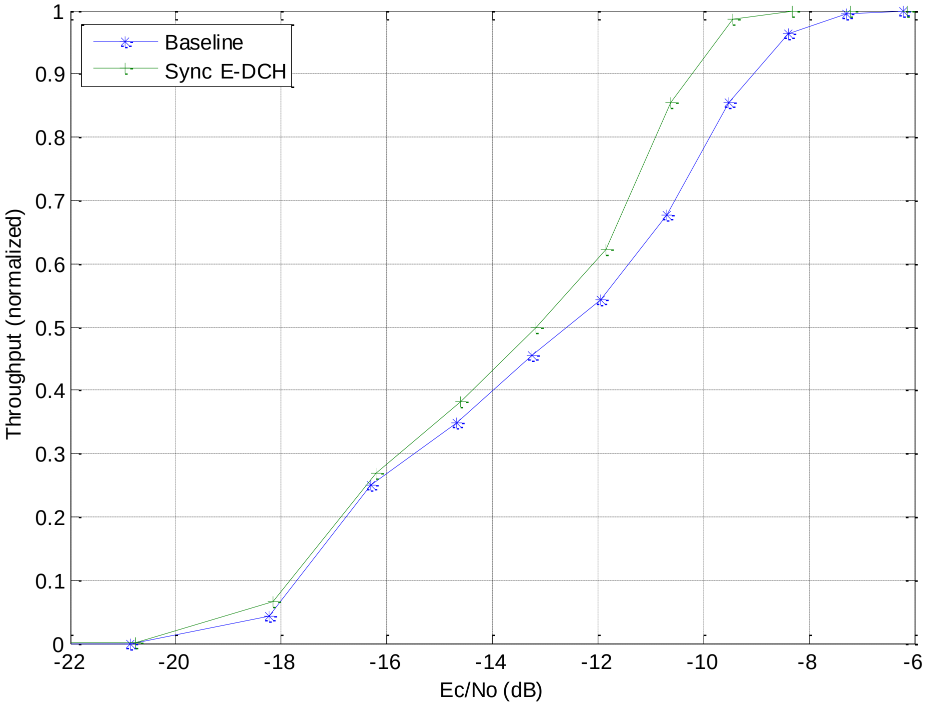


Figure 6.1.2.1-2 Throughput curves – TBS 292 bits, HSUPA BPSK SF8, S-EDCH 2*BPSK, SF16, pedestrianA, 3km/h, 8 (Set 2) users

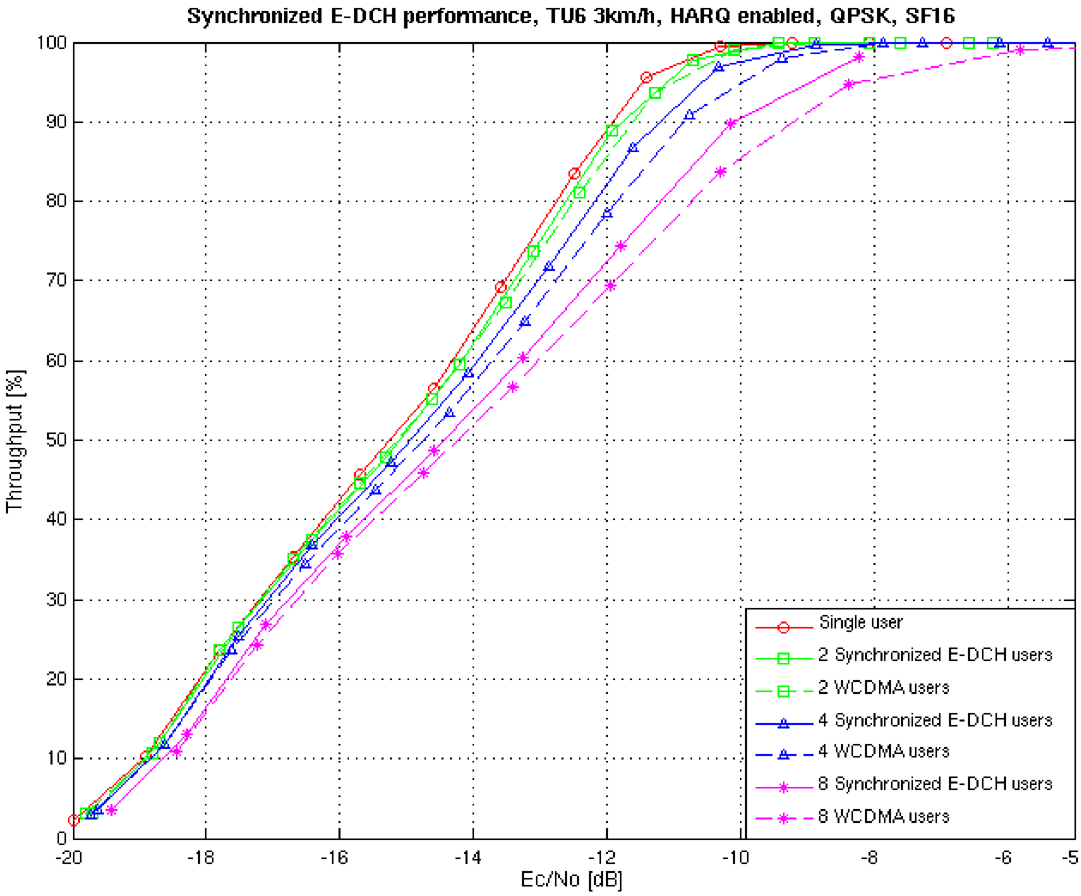


Figure 6.1.2.1-3 Throughput curves – TBS 292 bits, both HSUPA and S-EDCH 2*BPSK, SF16, TU6, 3km/h (Set 1)

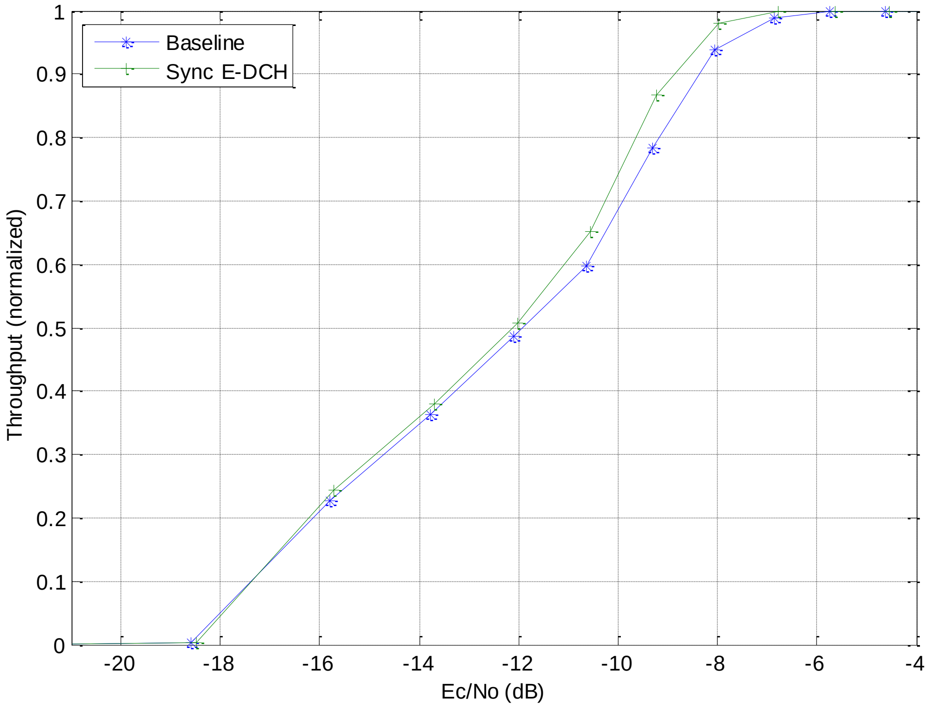


Figure 6.1.2.1-4 Throughput curves – TBS 292 bits, HSUPA BPSK SF8, S-EDCH 2*BPSK, SF16, TU6, 3km/h, 8 users (Set 2)

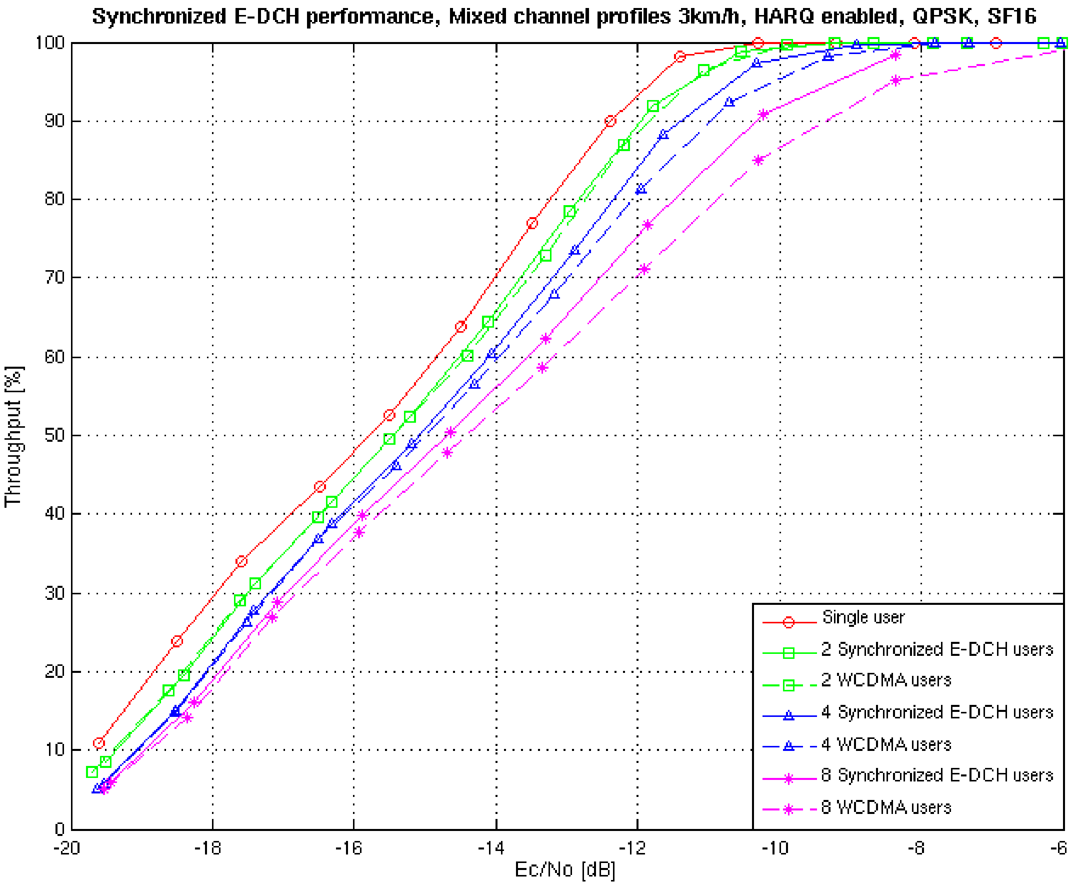


Figure 6.1.2.1-5 Throughput curves – TBS 292 bits, both HSUPA and S-EDCH 2*BPSK, SF16, Mixed, 3km/h (Set 1)

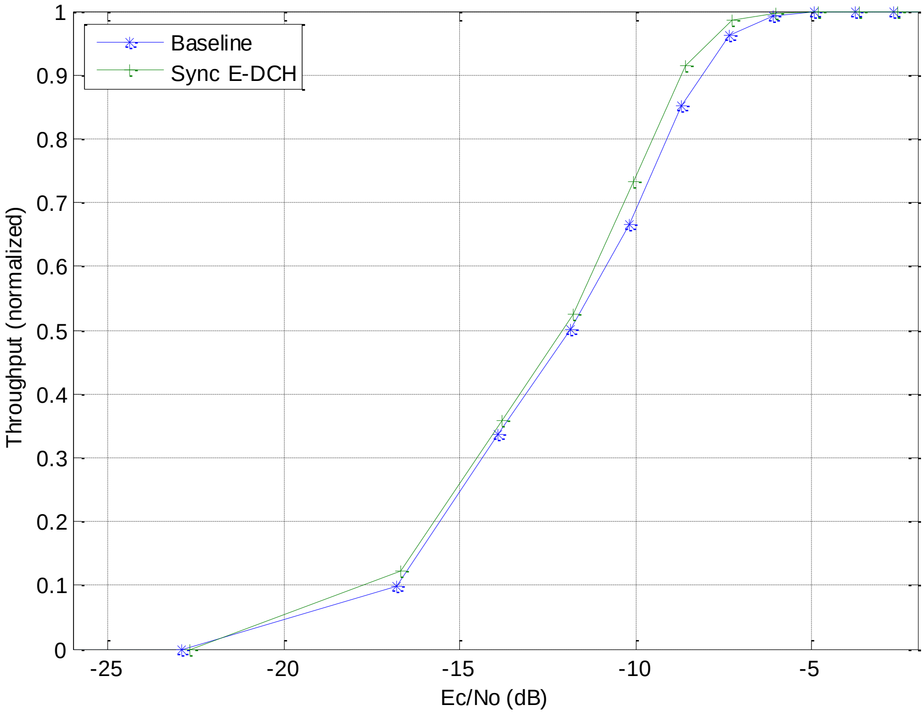


Figure 6.1.2.1-6 Throughput curves – TBS 292 bits, HSUPA BPSK SF8, S-EDCH 2*BPSK, SF16, Mixed, 3km/h, 8 users (Set 2)

6.1.2.2 Spreading factor 8 simulations

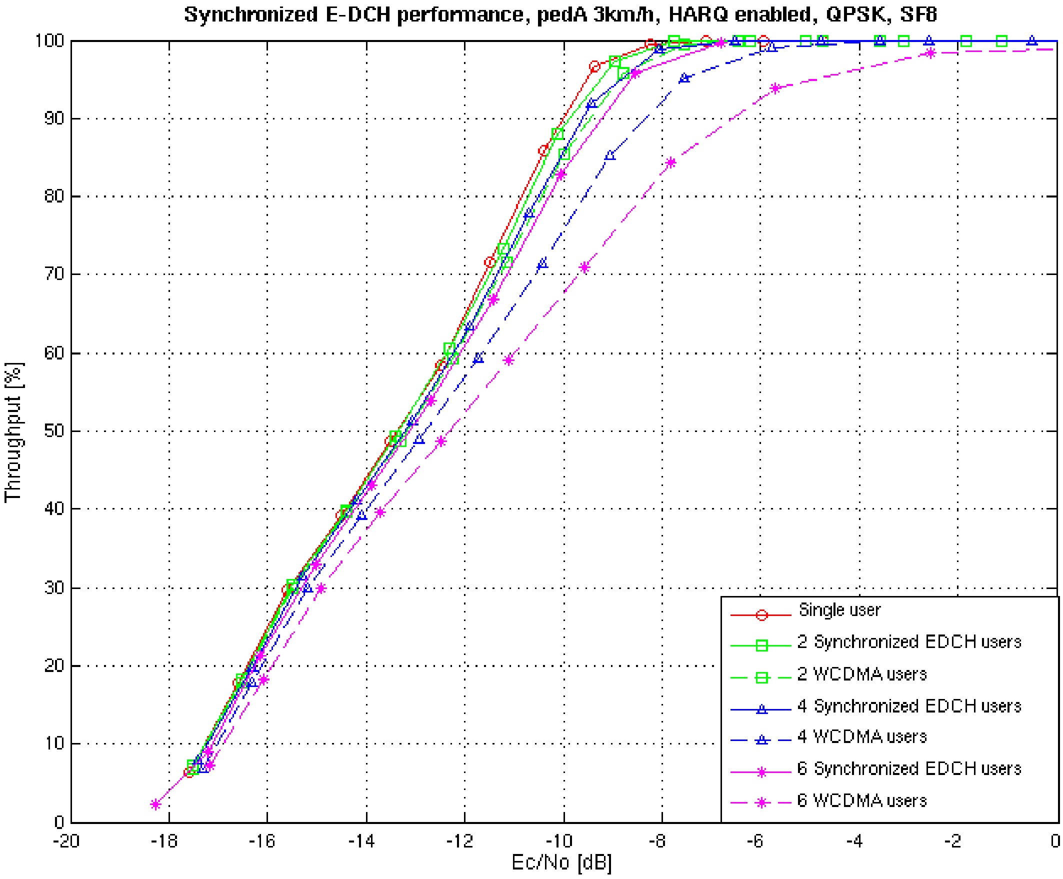


Figure 6.1.2.2-1 Throughput curves – TBS 612 bits, both HSUPA and S-EDCH 2*BPSK, SF8, pedestrianA, 3km/h (Set 1)

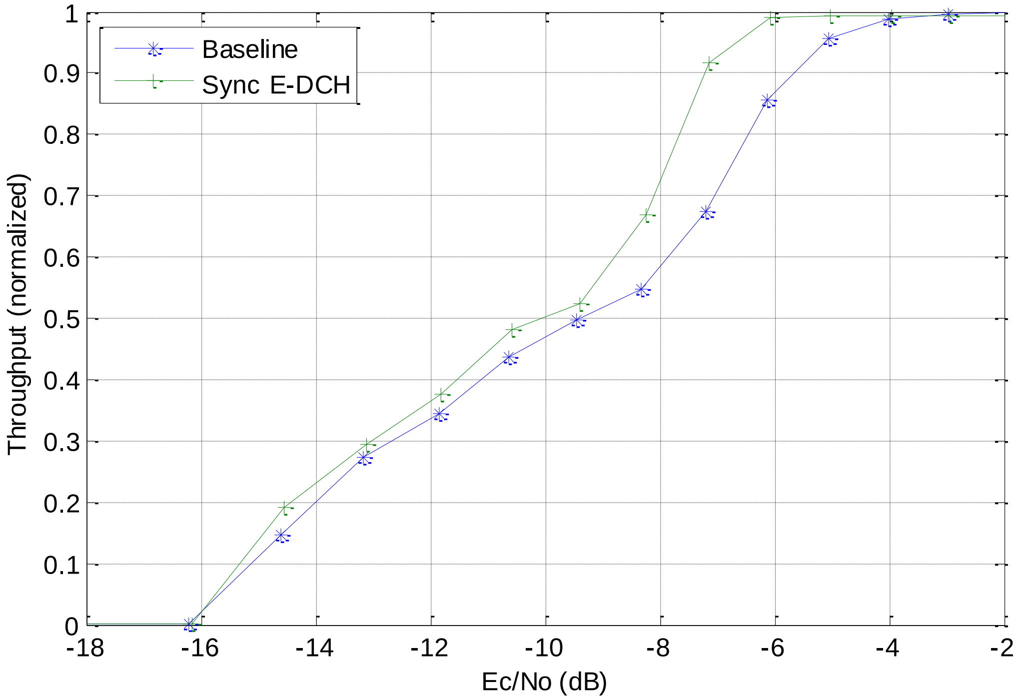


Figure 6.1.2.2-2 Throughput curves – TBS 612 bits, HSUPA BPSK SF4, S-EDCH 2*BPSK, SF8, PA3, 3km/h, 6 users (Set 2)

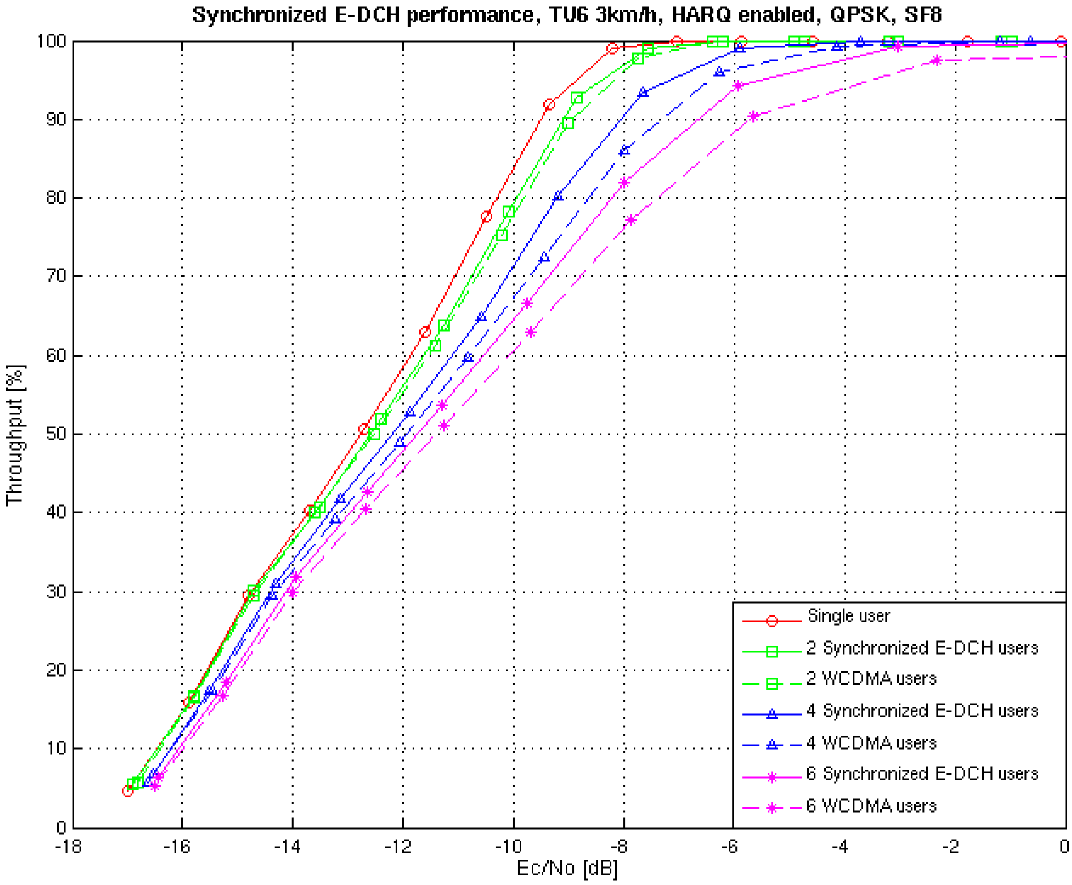


Figure 6.1.2.2-3 Throughput curves – TBS 612 bits, both HSUPA and S-EDCH 2*BPSK, SF8, TU6, 3km/h (Set 1)

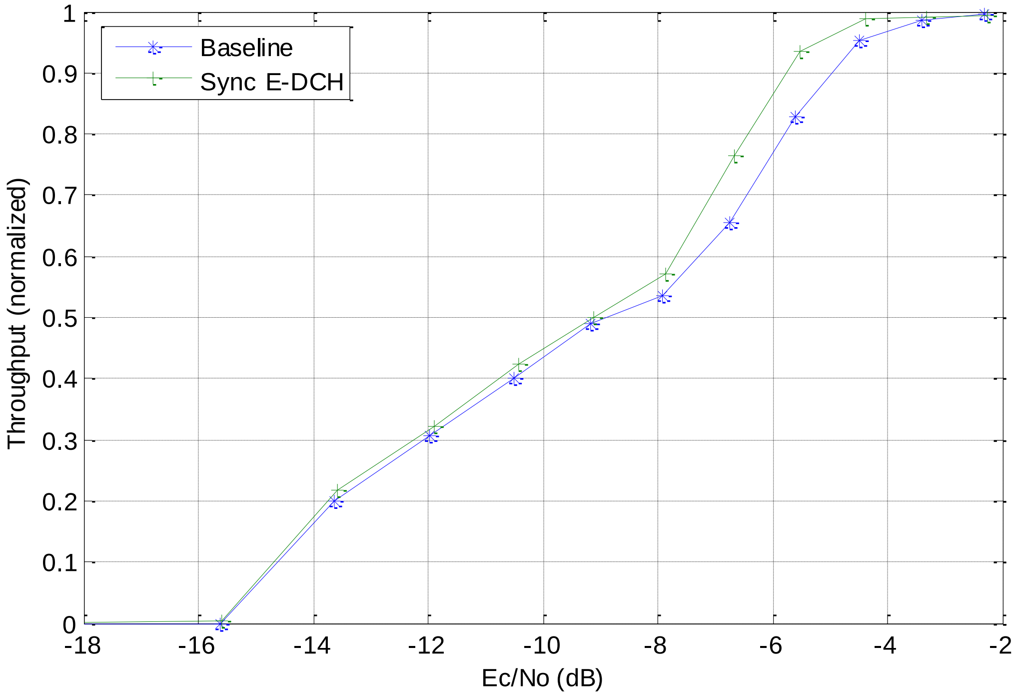


Figure 6.1.2.2-4 Throughput curves – TBS 612 bits, HSUPA BPSK SF4, S-EDCH 2*BPSK, SF8, TU6, 3km/h, 6 users (Set 2)

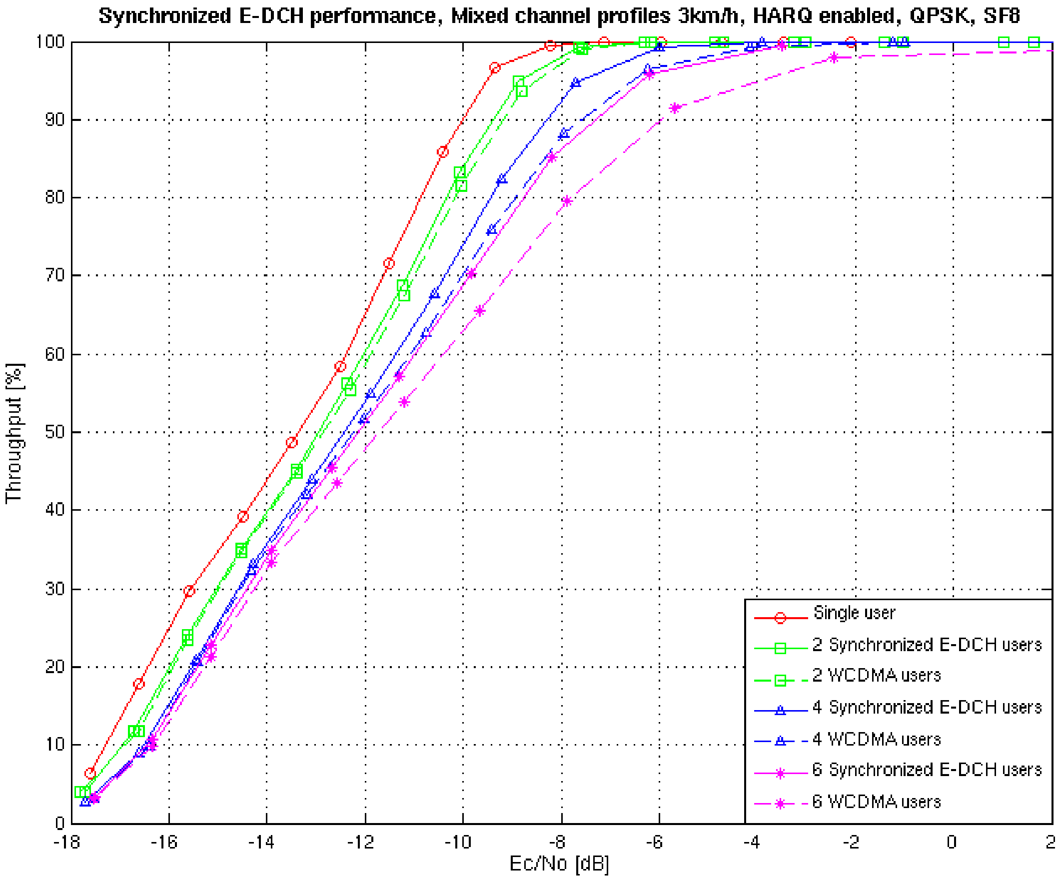


Figure 6.1.2.2-5 Throughput curves – TBS 612 bits, both HSUPA and S-EDCH 2*BPSK, SF8, mixed, 3km/h (Set 1)

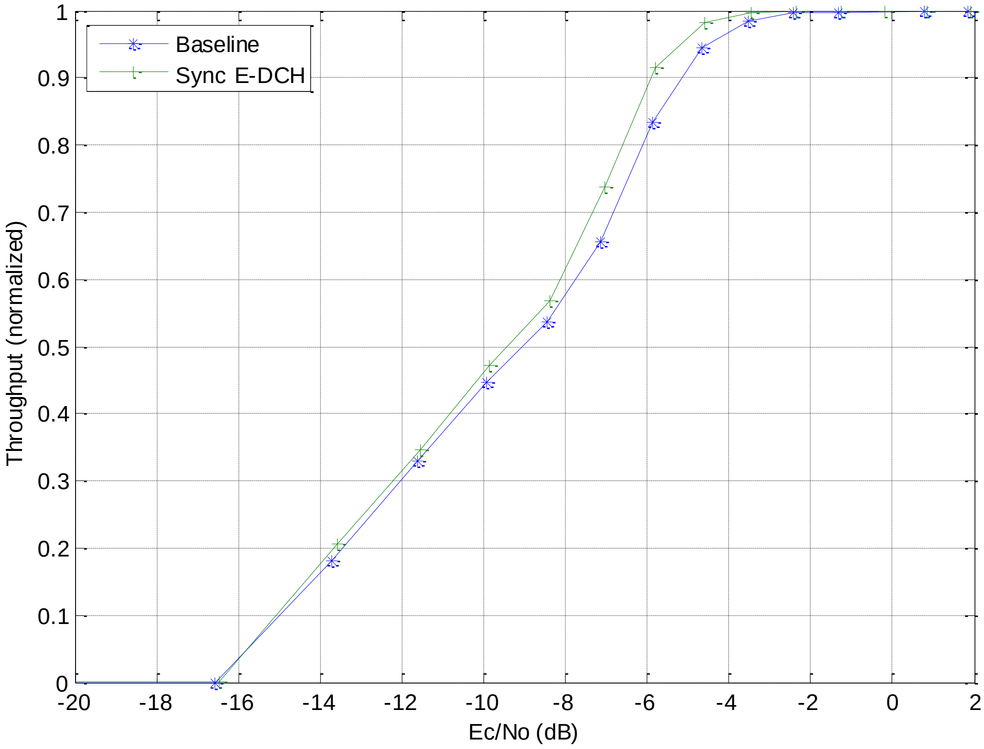


Figure 6.1.2.2-6 Throughput curves – TBS 612 bits, HSUPA BPSK SF4, S-EDCH 2*BPSK, SF8, Mixed, 3km/h, 6 users (Set 2)

6.1.2.3 Spreading factor 4 simulations

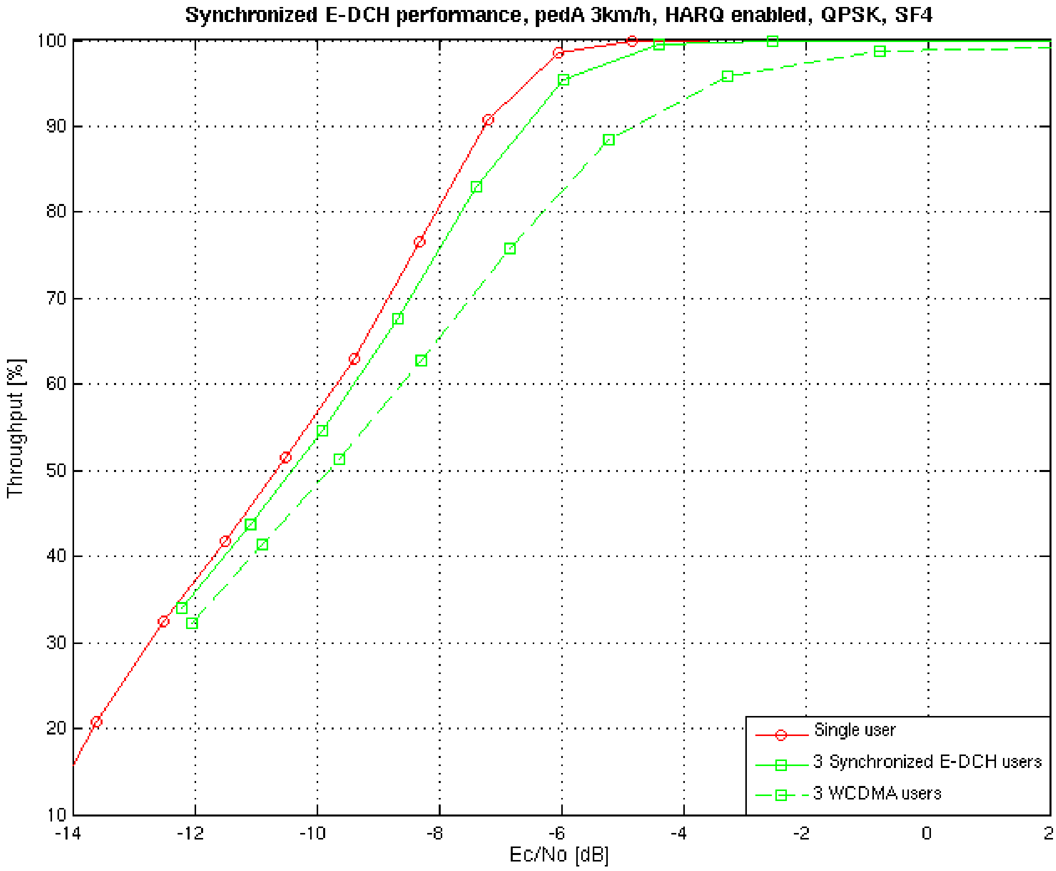


Figure 6.1.2.3-1 Throughput curves – TBS 1252 bits, both HSUPA and S-EDCH 2*BPSK, SF4, pedestrianA, 3km/h (Set 1)

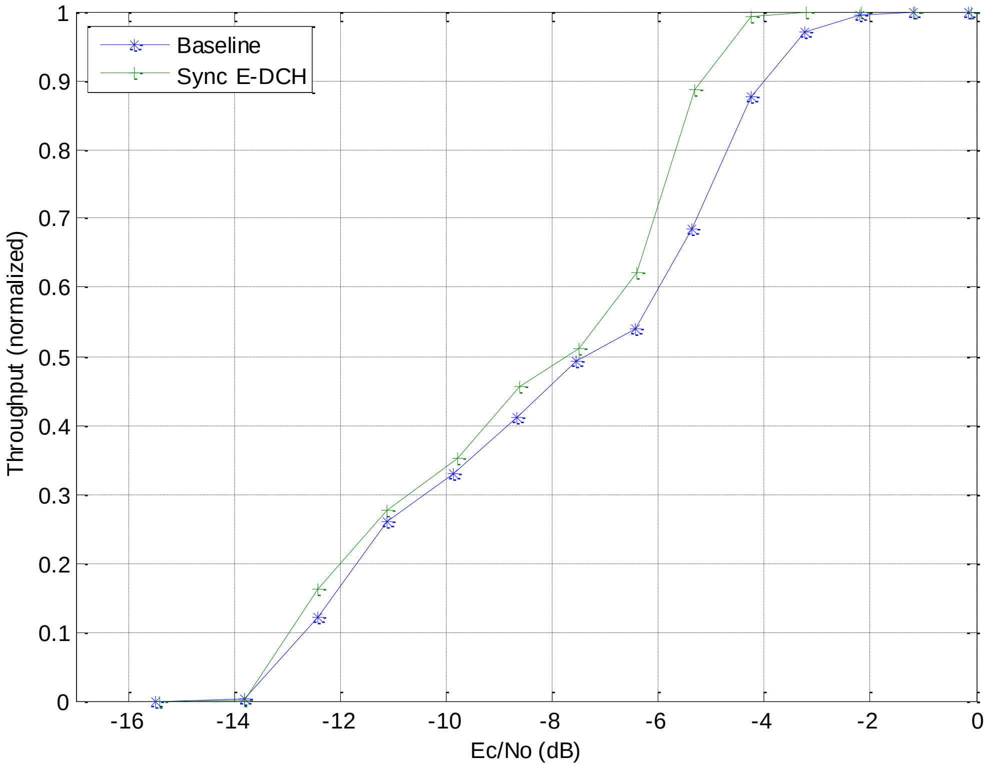


Figure 6.1.2.3-2 Throughput curves – TBS 1252 bits, HSUPA 2*BPSK SF4, S-EDCH 2*BPSK SF4, PA3, 3km/h, 3 users (Set 2)

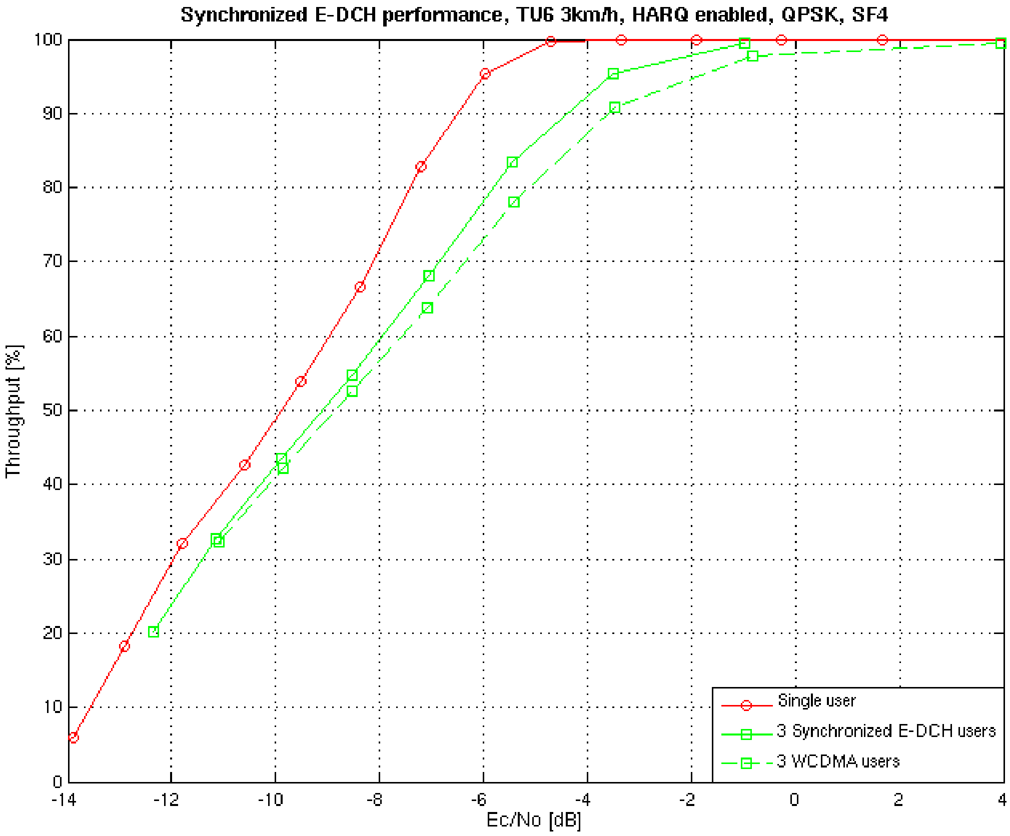


Figure 6.1.2.3-3 Throughput curves – TBS 1252 bits, both HSUPA and S-EDCH 2*BPSK, SF4, TU6, 3km/h (Set 1)

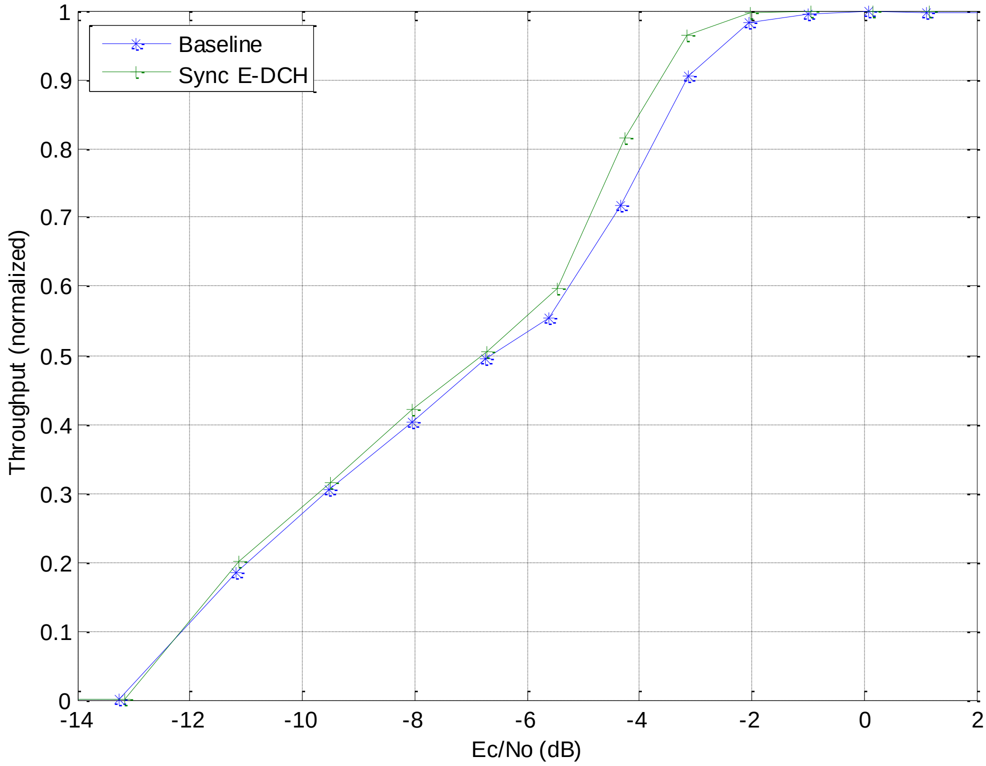


Figure 6.1.2.3-4 Throughput curves – TBS 1252 bits, HSUPA 2*BPSK SF4, S-EDCH 2*BPSK SF4, TU6, 3km/h, 3 users (Set 2)

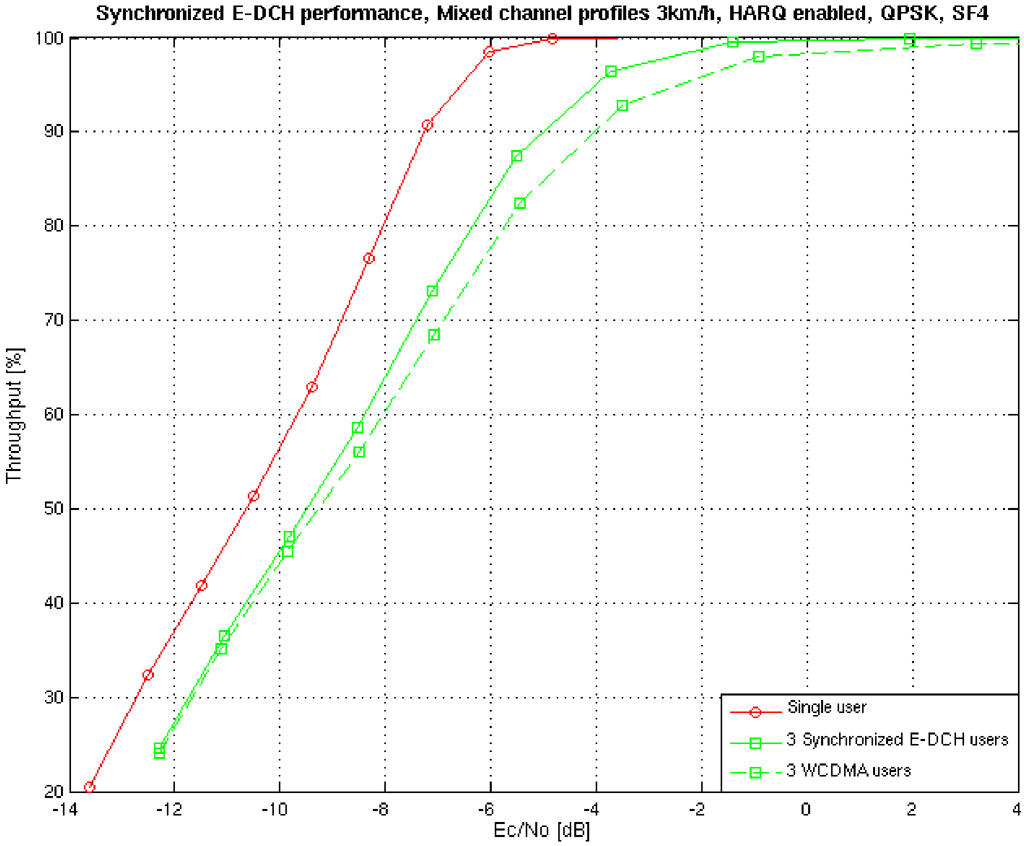


Figure 6.1.2.3-5 Throughput curves – TBS 1252 bits, both HSUPA and S-EDCH 2*BPSK, SF4, mixed, 3km/h (Set 1)

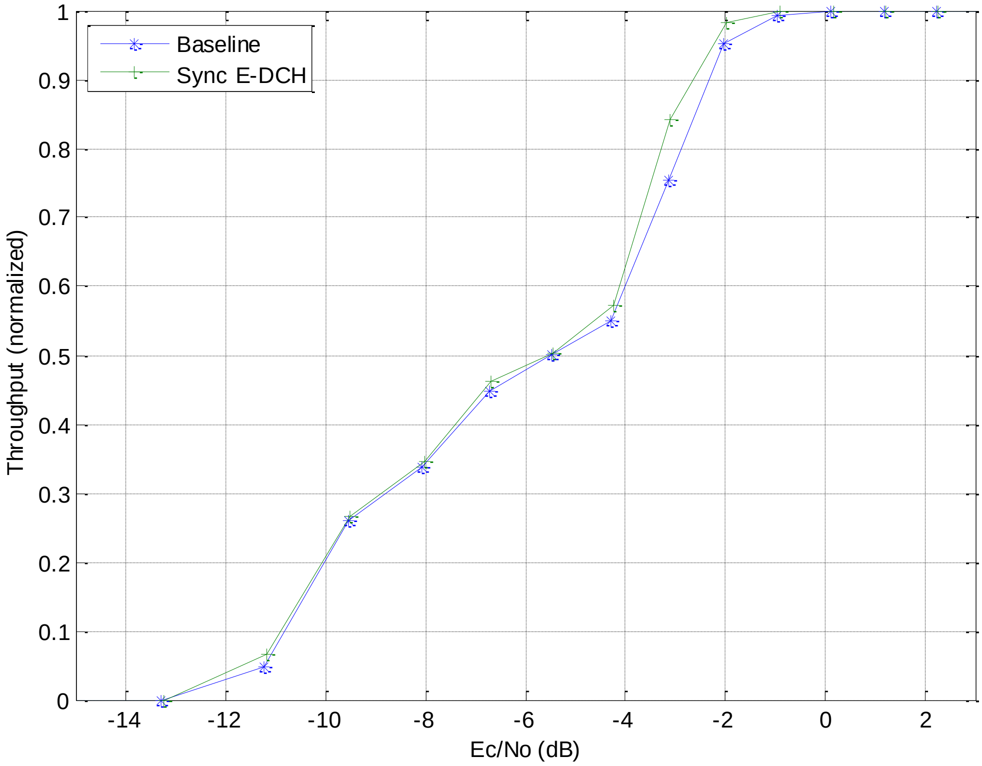


Figure 6.1.2.3-6 Throughput curves – TBS 1252 bits, HSUPA 2*BPSK SF4, S-EDCH 2*BPSK SF4, Mixed, 3km/h, 3 users (Set 2)

6.1.2.4 Spreading factor 2/4 simulations

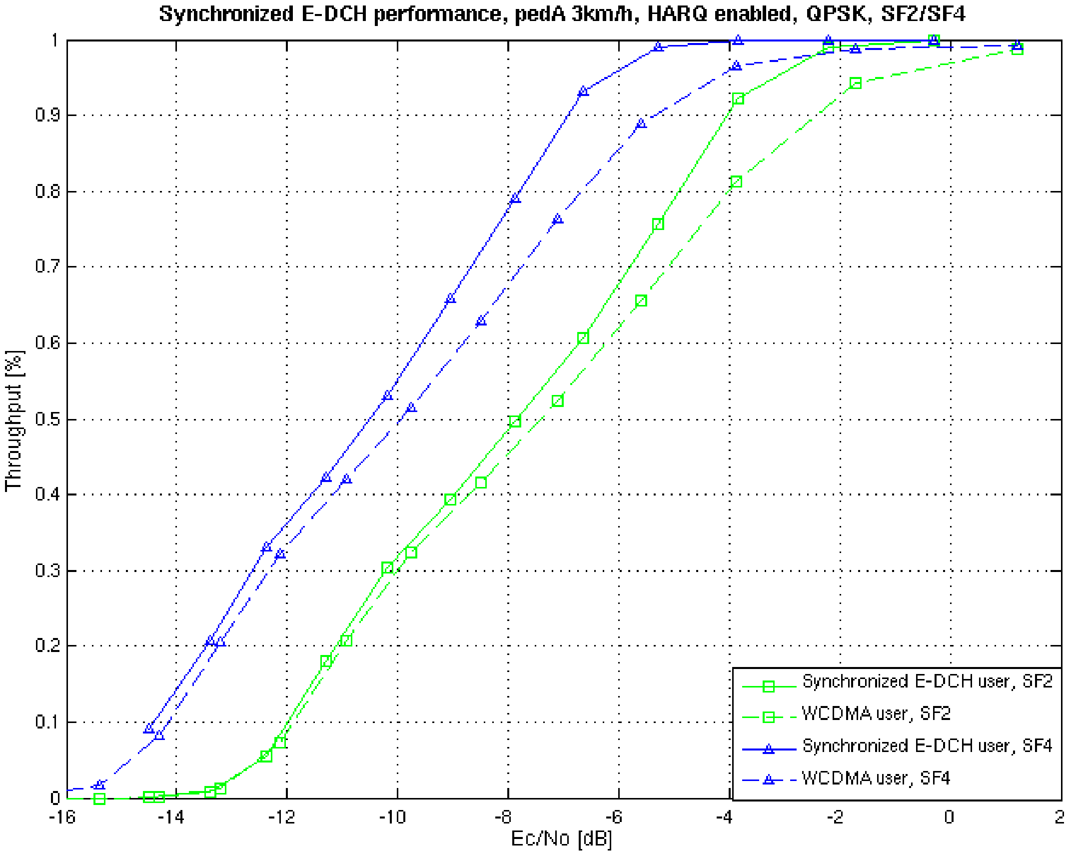


Figure 6.1.2.4-1 Throughput curves – TBS 2532/1252 bits, both HSUPA and S-EDCH 2*BPSK, SF2/4, pedestrianA, 3km/h (Set 1)

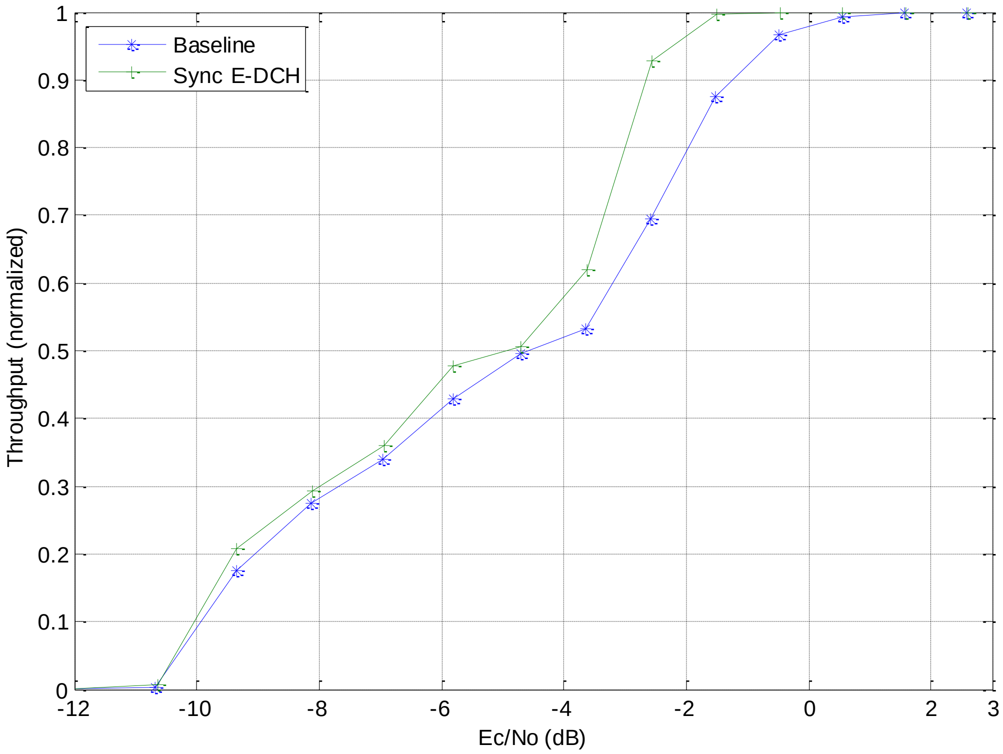


Figure 6.1.2.4-2 Throughput curves – TBS 2532/1252 bits, both HSUPA and S-EDCH, 2*BPSK SF2/4, PA3, 3km/h, 2 users (TBS 2532 user) (Set 2)

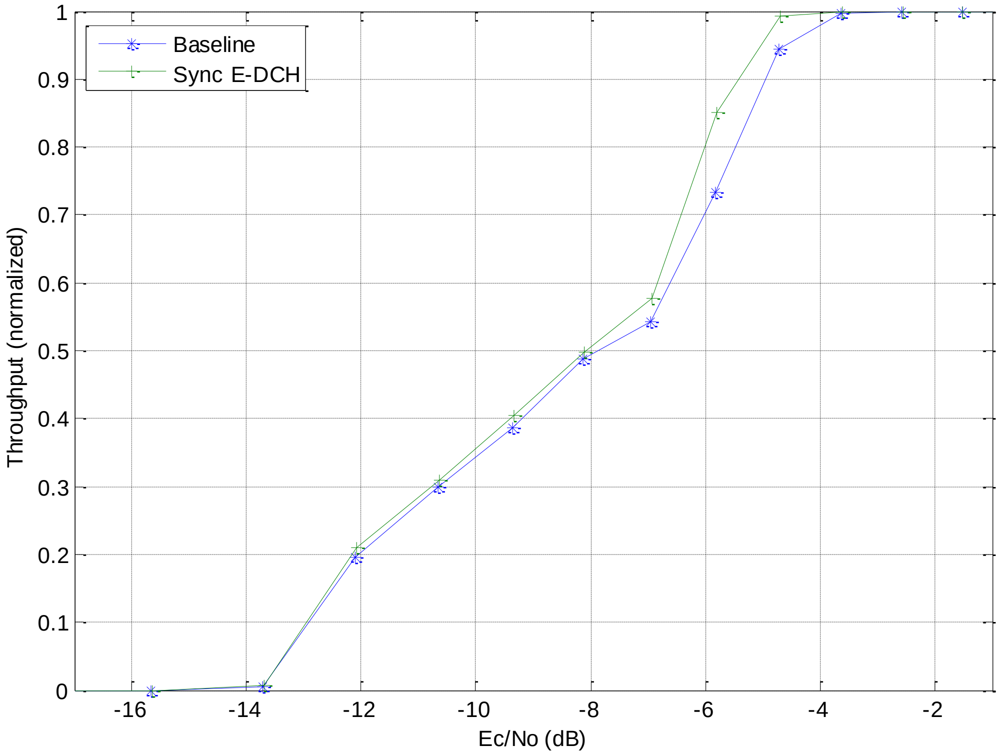


Figure 6.1.2.4-3 Throughput curves – TBS 2532/1252 bits, both HSUPA and S-EDCH, 2*BPSK SF2/4, PA3, 3km/h, 2 users (TBS 1252 user) (Set 2)

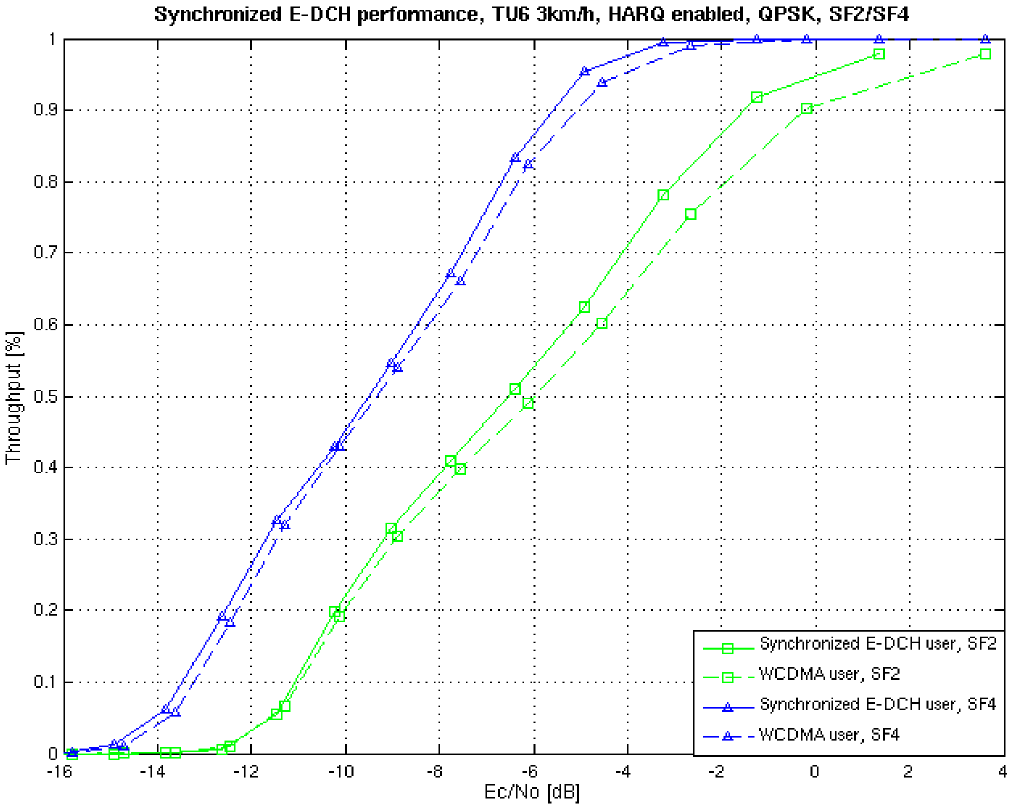


Figure 6.1.2.4-4 Throughput curves – TBS 2532/1252 bits, both HSUPA and S-EDCH 2*BPSK, SF2/4, TU6, 3km/h (Set 1)

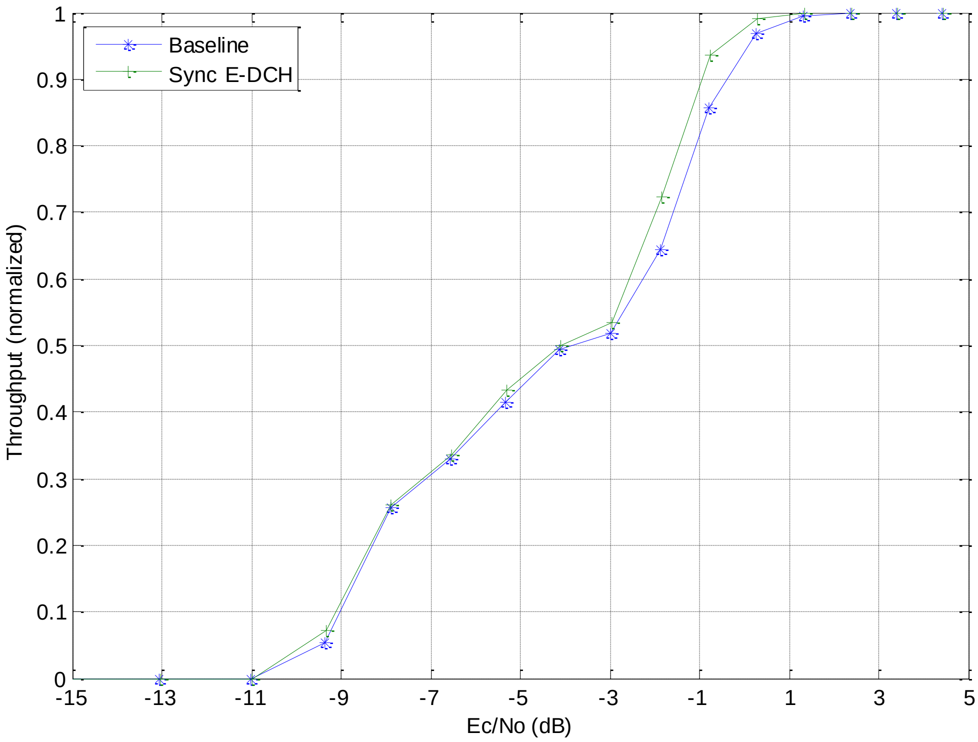


Figure 6.1.2.4-5 Throughput curves – TBS 2532/1252 bits, both HSUPA and S-EDCH, 2*BPSK SF2/4, TU6, 3km/h, 2 users (TBS 2532 user) (Set 2)

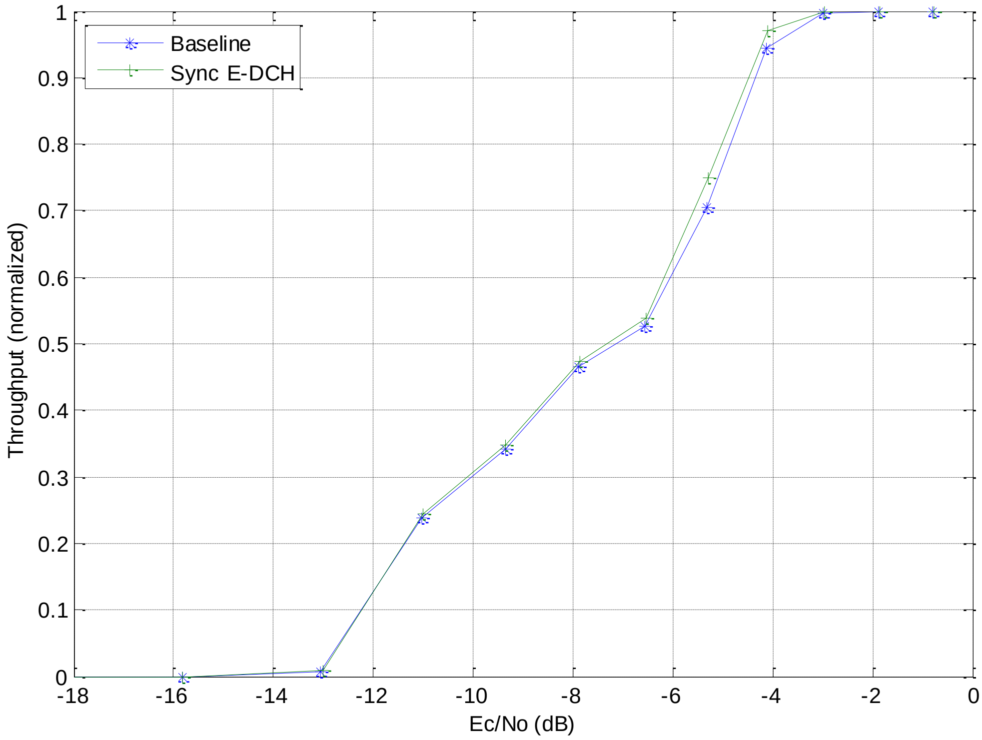


Figure 6.1.2.4-6 Throughput curves – TBS 2532/1252 bits, both HSUPA and S-EDCH, 2*BPSK SF2/4, TU6, 3km/h, 2 users (TBS 1252 user) (Set 2)

6.1.3 Link Level Simulation results (Interference Cancellation)

It is possible to apply interference cancellation in addition to Relsase 7 HSUPA or to Synchronised E-DCH. The figures below show a comparison of link level performance of rawbit based Parallel Interference Cancellation (PIC) with and without OVSF separation, considering 6 users and SF8 and up to 3 iterations of both interference cancellation, applied to both WCDMA and CDM based Synchronised E-DCH.

"Iterations" refers to the number of times that the RAKE receiver is operated. Hence 1 iteration is a single user RAKE receiver; 2 iterations refers to a RAKE receiver, a PIC cancellation stage and then a further RAKE receiver and so on.

The following can be observed:

- For the TU6 Channel:
    - PIC brings additive gains to Synchronised E-DCH
    - HSUPA with 1 stage PIC offers similar performance to Synchronised E-DCH
    - With an equivalent number of stages, Synchronised E-DCH combined with PIC offers superior performance to HSUPA combined with PIC
    - For both HSUPA and Synchronised E-DCH, most of the gain from PIC is obtained after 2 stages
- For the PA3 channel
    - PIC does not bring a significant advantage to Synchronised E-DCH
    - Synchronised E-DCH performance is always better than HSUPA & PIC
- PIC gains are observable at a HARQ operating point of 10-30% and reduce at lower HARQ operating points

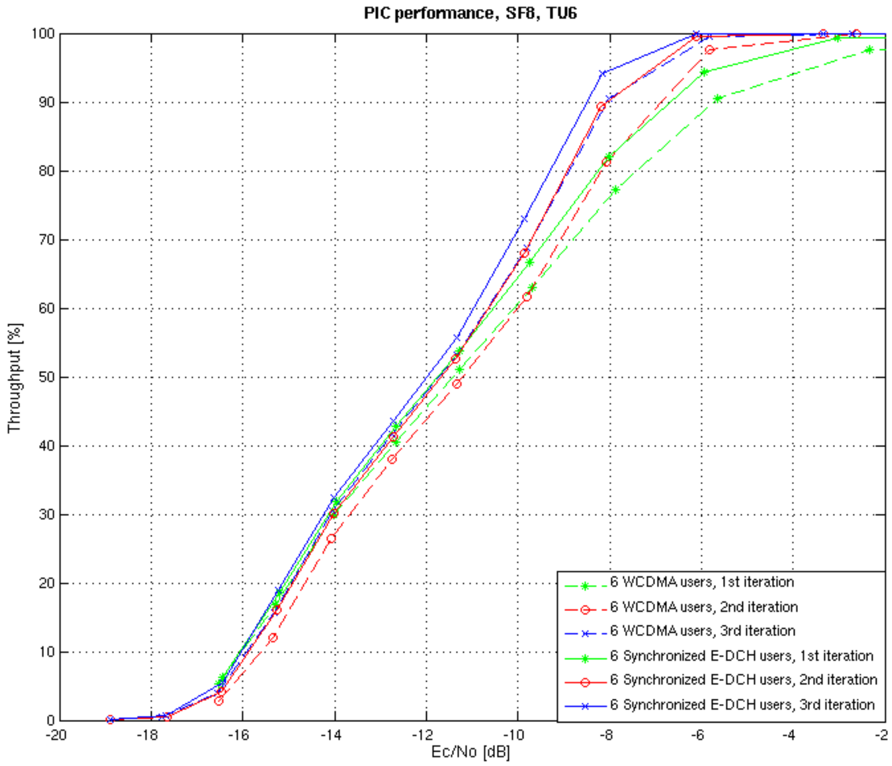


Figure 6.1.3-1 HSUPA & S-EDCH PIC performance (TU6 channel)

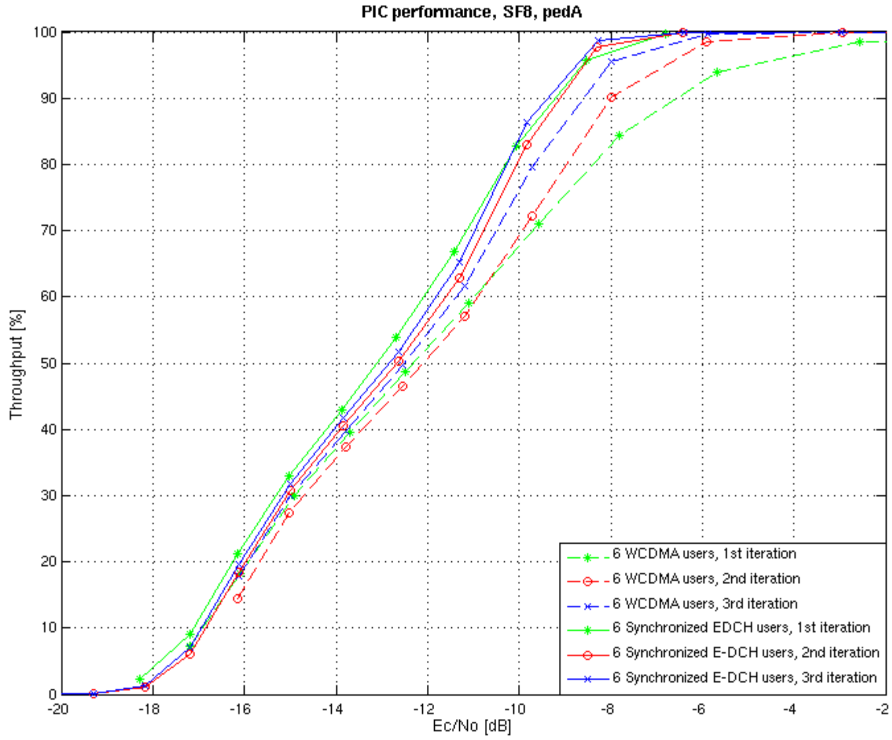


Figure 6.1.3-2 HSUPA & S-EDCH PIC performance (PA3 channel)

6.2 System level simulation analysis

6.2.1 System level simulation assumptions

This section describes simulation assumptions relevant for system level studies. Table 6.2.1-1 captures general system level parameters. Assumptions for reference system deployment are given in the following section.

Table 6.2.1-1 System level simulation assumptions

Parameter	Value
Traffic model	Full Buffer
Load Control	RoT based
Power control	ON
HARQ	ON
Maximum number of transmissions	4
Spreading Factor	16, 8, 4, 2
Code Rate	~0.33-0.4
Scrambling code type	Long
Channel estimation	Ideal
Number of users	Variable
Channel Delay Profile	PA, TU6, ”mixed” (see section 6.1.1)
Speed	3 kmph

6.2.1.1 Reference system deployments

The system simulation baseline parameters for the Macro-cell deployment model are given in table 6.2.1.1-2 and table 6.2.1.1-3. The simulation cases are given in table 6.2.2-1 along with additional assumptions related to carrier frequency (CF), Inter-site distance (ISD), operating bandwidth (BW), penetration loss (PLoss) and UE speed. Note that 100% of the users for a given simulation case are assigned the same ‘PLoss’ and speed.

Table 6.2.1.1-1 - Simulation cases

Simulation Cases	CF (GHz)	Scenario	ISD (meters)	PLoss (dB)
1	2.0	Macro	500	20
2	2.0	Micro Outdoor / Outdoor	130	-

Table 6.2.1.1-2 Macro-cell system simulation baseline parameters

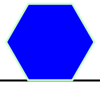
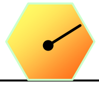
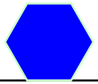
Parameter		**Assumption**
Cellular Layout		Hexagonal grid, 19 cell sites, 3 sectors per site
Inter-site distance		See Table 6.2.1.1-1
Distance-dependent path loss		L=128.1 + 37.6log$_{10}$(.R), R in kilometers
Lognormal Shadowing		Similar to UMTS 30.03, B 1.4.1.4
Shadowing standard deviation		8 dB
Correlation distance of Shadowing		50 m (See D,4 in UMTS 30.03)
Shadowing correlation	Between cells	0.5
	Between sectors	1.0
Penetration Loss		See Table 6.2.1.1-1
Antenna pattern [4] (horizontal) (For 3-sector cell sites with fixed antenna patterns)		$A(\theta) = -\min\left[12\left(\frac{\theta}{\theta_{3dB}}\right)^2, A_m\right]$ θ_{3dB} = 70 degrees, A_m = 20 dB
UE power class		21dBm (125mW)
Antenna Bore-sight points toward flat side of cell (for 3-sector sites with fixed antenna patterns)		
Users dropped uniformly in entire cell		
Minimum distance between UE and cell		>= 35 meters

Table 6.1.2.1-3 Micro-cell system simulation baseline parameters

Parameter		**Assumption**
Cellular Layout		Hexagonal grid, 19 cell sites, 1 sectors per site
Inter-site distance		See Table 6.2.1.1-1
Distance-dependent path loss		$L[dB] = \begin{cases} 39 + 20\log_{10}(d[m]) & 10m < d \leq 45m \\ -39 + 67\log_{10}(d[m]) & d > 45m \end{cases}$
Lognormal Shadowing		Similar to UMTS 30.03, B 1.41.4
Shadowing standard deviation		10dB
Correlation distance of Shadowing		25 m
Shadowing correlation	Between cells	0.0
	Between sectors	na
Antenna pattern (horizontal) (For omni cell sites with fixed antenna patterns)		$A(\theta) = 1$
UE power class		21dBm (125mW)
BS position in the middle of the hexagon		
Users dropped uniformly in entire cell		
Minimum distance between UE and cell		>= 10m (and minimum coupling loss of -53dB) The distance dependent pathloss + shadow fading is lower limited to free-space distance dependent pathloss

6.2.2 System level simulation results (CDM Proposal)

Figures 6.2.2-1 to 6.2.2-6 present sector throughput results with regard to the measured noise rise level, for an increasing number of users (4, 6 and 8 users). Figures 6.2.2-1 to 6.2.2-3 correspond to a Pedestrian A channel, whereas Figures 6.2.2-4 to 6.2.2-6 to a TU 6 channel. The synchronised E-DCH concept and the release 7 E-DCH, (refer to as WCDMA) are compared in the two deployment scenarios defined in Section 6.2.1, Case 1 and Microcell Outdoor-Outdoor.

The results show that for Pedestrian A, throughput gains of around 30% in Case 1 and up 50% in the microcell scenario are observed, although the microcell case becomes code limited at RoT > ~3.5 dB. For the TU6 link level channel, throughput gains of about 8-15% in Case 1 and ~12% in the microcell scenario are observed.

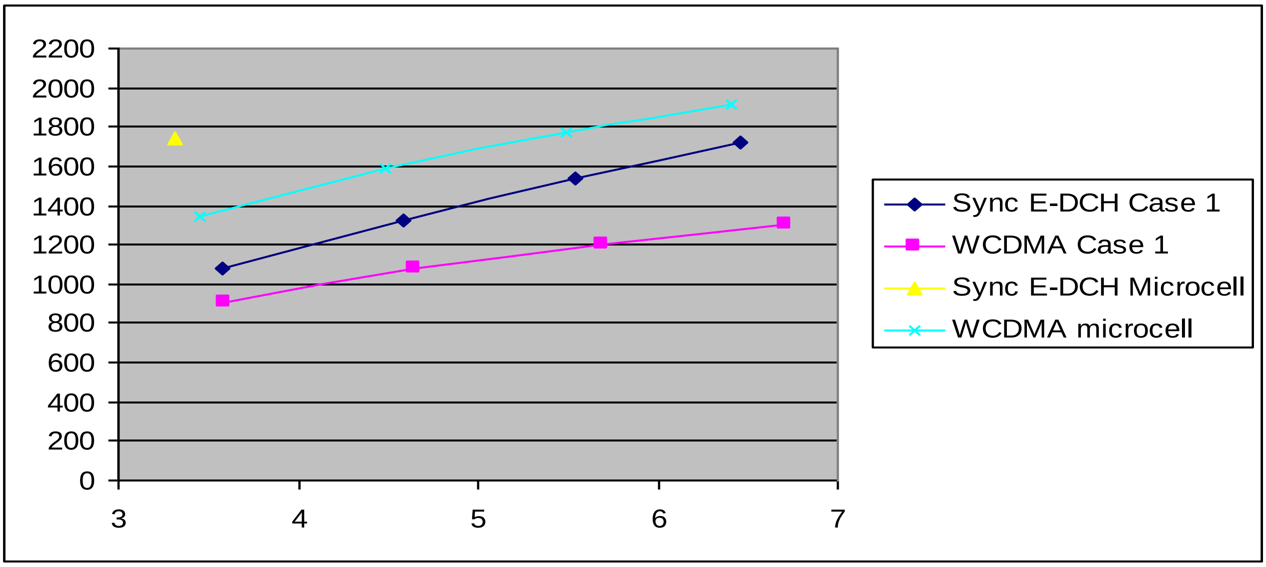


Figure 6.2.2-1. Sector throughput when 4 users, experiencing a pedestrian A channel model, are placed in each sector.

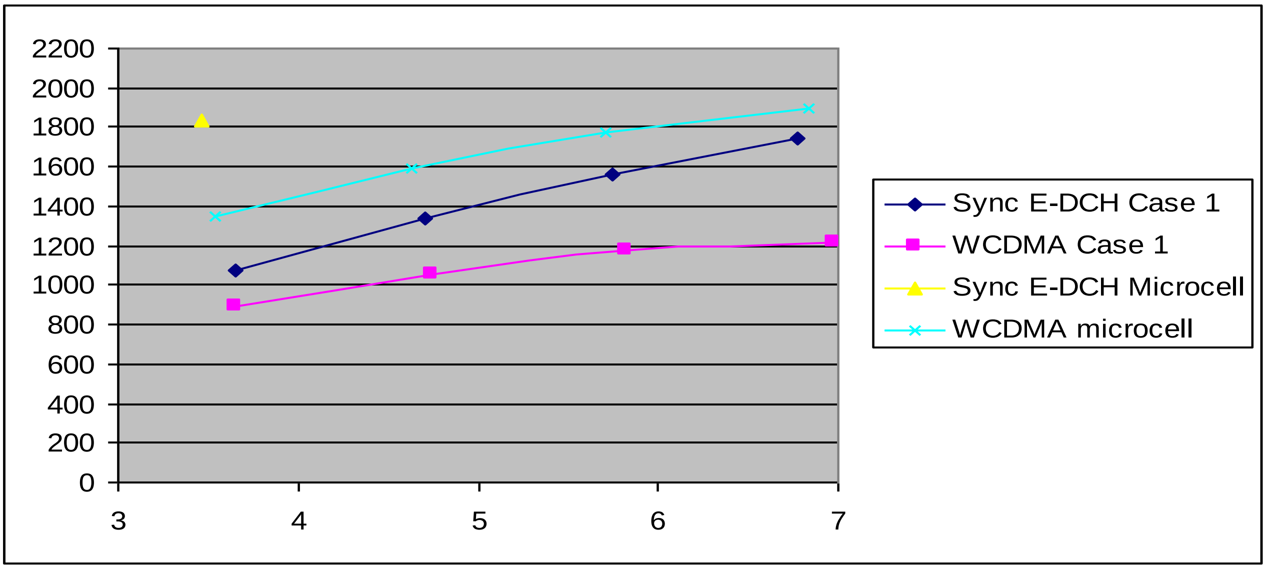


Figure 6.2.2-2. Sector throughput when 6 users, experiencing a pedestrian A channel model, are placed in each sector.

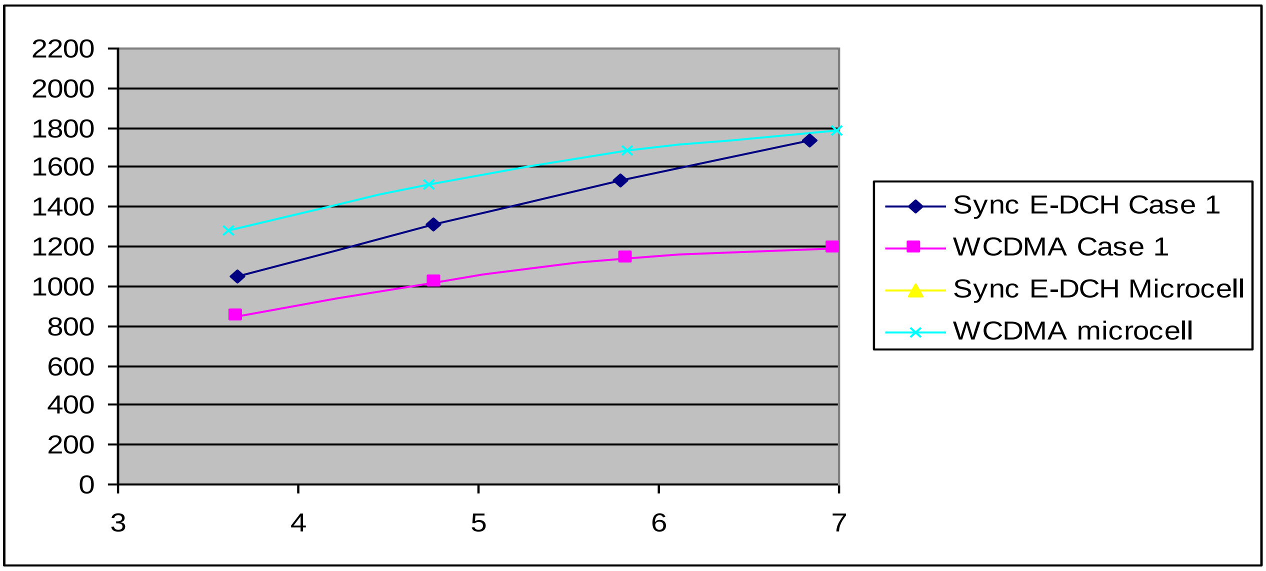


Figure 6.2.2-3. Sector throughput when 8 users, experiencing a pedestrian A channel model, are placed in each sector.

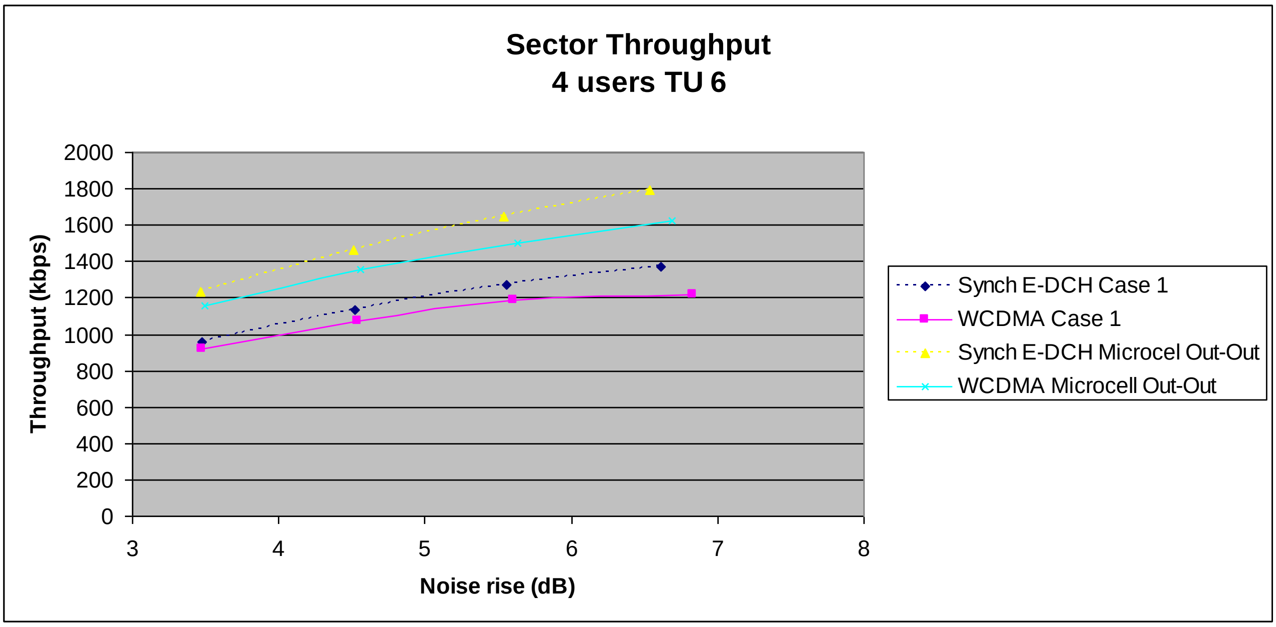


Figure 6.2.2-4. Sector throughput when 4 users, experiencing a TU 6 channel model, are placed in each sector.

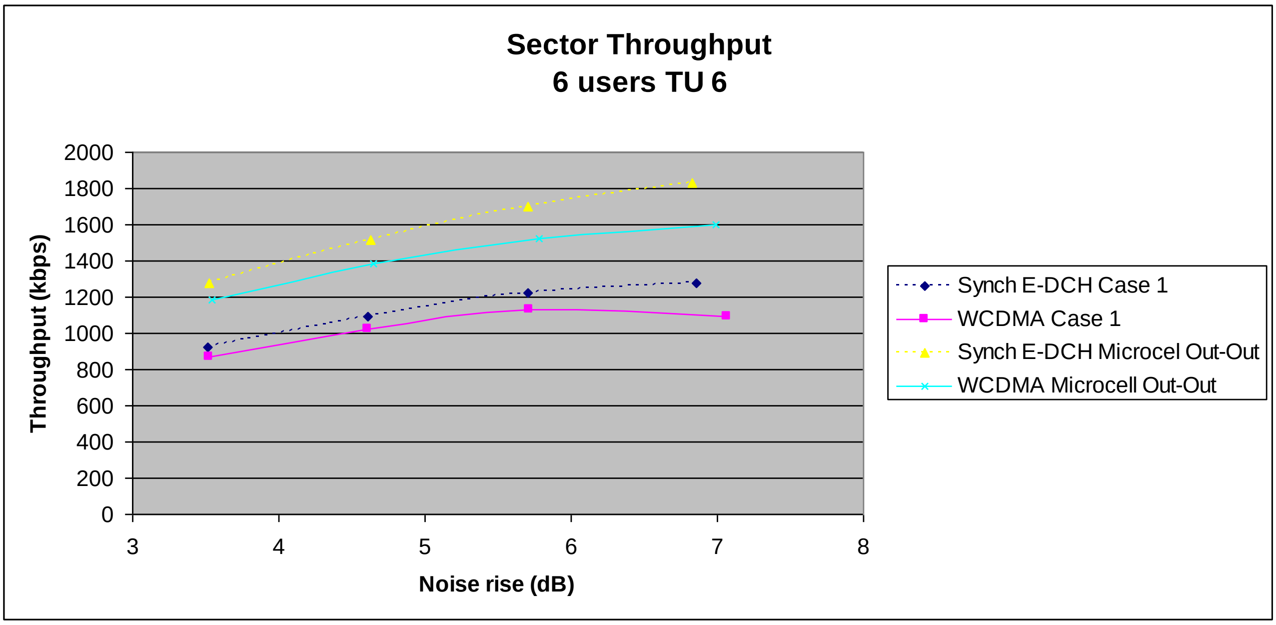


Figure 6.2.2-5. Sector throughput when 6 users, experiencing a TU 6 channel model, are placed in each sector.

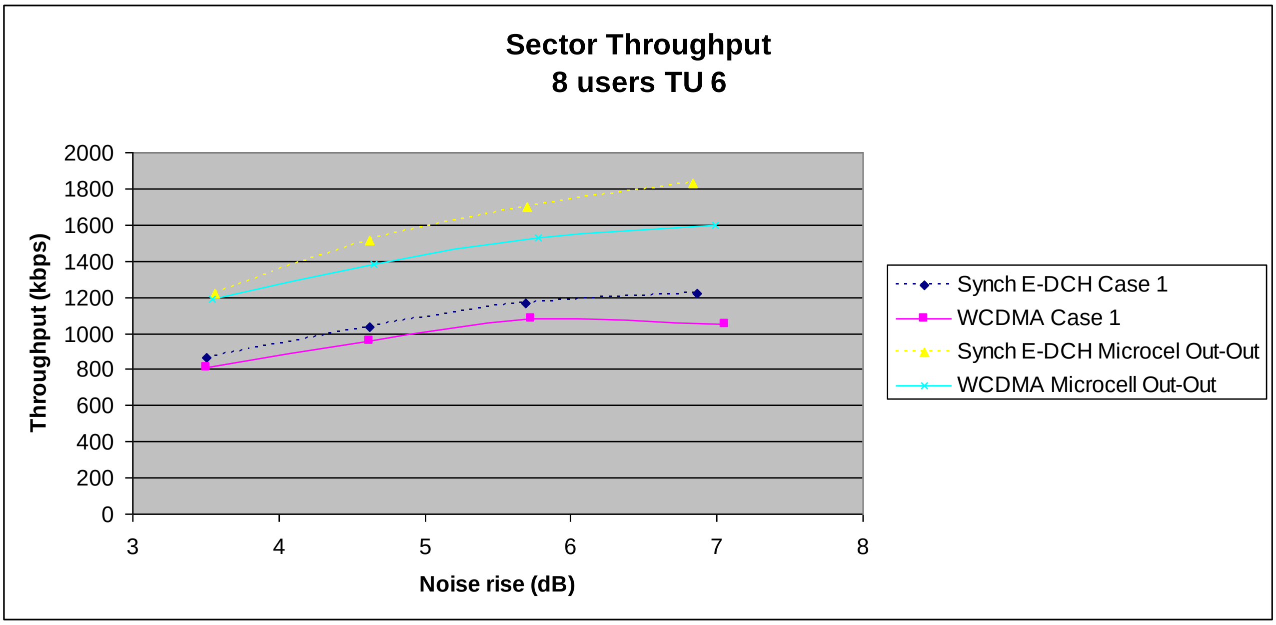


Figure 6.2.2-6. Sector throughput when 8 users, experiencing a TU 6 channel model, are placed in each sector.

6.2.3 System level simulation results (TDM Proposal)

The simulation parameters are listed in Table 6.2.3-1. These settings correspond approximately to the Macro simulation case described in section 6.2.1.

Table 6.2.3-1: System simulation parameters for TDM based Synchronised E-DCH.

Network layout	7 NodeB with 3 cells each, i.e. 21 cells in total
UE max TX power	21 dBm
Site-to-site distance	500 m

Antenna pattern	3D antenna model with 10 degrees down tilt
Penetration loss	20 dB
Number of simultaneous users per cell	4 (round robin scheduled in the TDM case)
Service	EUL only
EUL traffic model	Full buffer
16QAM	Enabled
Receiver	Ideal dual antenna LMMSE (no IC)
Channel Delay Profile	Pedestrian A / Typical Urban
Speed	3 km/h

Other simulation assumptions for TDM based Synchronised E-DCH:

- "Ideal TDM" is modeled as only one EUL user in each cell.
- "Real TDM" is modeled as only one EUL user can be scheduled to transmit data while there are several EUL users in the same cell, and the users are scheduled in a Round Robin way. Scheduling interval is 2ms.

Other simulation assumptions for CDM based Synchronised E-DCH:

- One uplink scrambling code is used in each cell.
- The UE is synchronized in the serving cell and non-synchronized in any other cells in the active set.
- A static factor expresses how much of the received power can be regarded as effective interference.
- Code limitation is considered, the peak rate is limited to one fourth of the HS-DSCH UE cat 7 peak rate, corresponding to 2.86 Mbps. However, the reduced performance due to increased coding rate has not been considered here.
- "Ideal CDM" is modeled as perfect orthogonality between UEs in the same cell.

The simulation results are shown in Figures 6.2.3-1 and 6.2.3-2. The "ortho factor" is a non-orthogonality factor expressing how much of the received power that can be regarded as effective interference. Ideal synchronization and flat channel is modeled when "ortho factor" is zero. The chosen non-zero values for "ortho factor" correspond to approximately 1/8-chip and 1/4-chip desynchronization, respectively. These "ortho factors" assume maximum (i.e. 1/8-chip or 1/4-chip) synchronization error between all users and so may be somewhat pessimistic.

The simulation results show that TDM and CDM can achieve similar gains compared to Rel7 under both ideal and more realistic assumptions in this scenario with low dispersion (PedA channel). The difference between "ideal TDM" and "ideal CDM" is due to the difference in peak rate. In a scenario with high dispersion (TU channel), the CDM performance degrades more than the performance for TDM, while in a scenario with high degree of UE transmit power limitation, the opposite may be true.

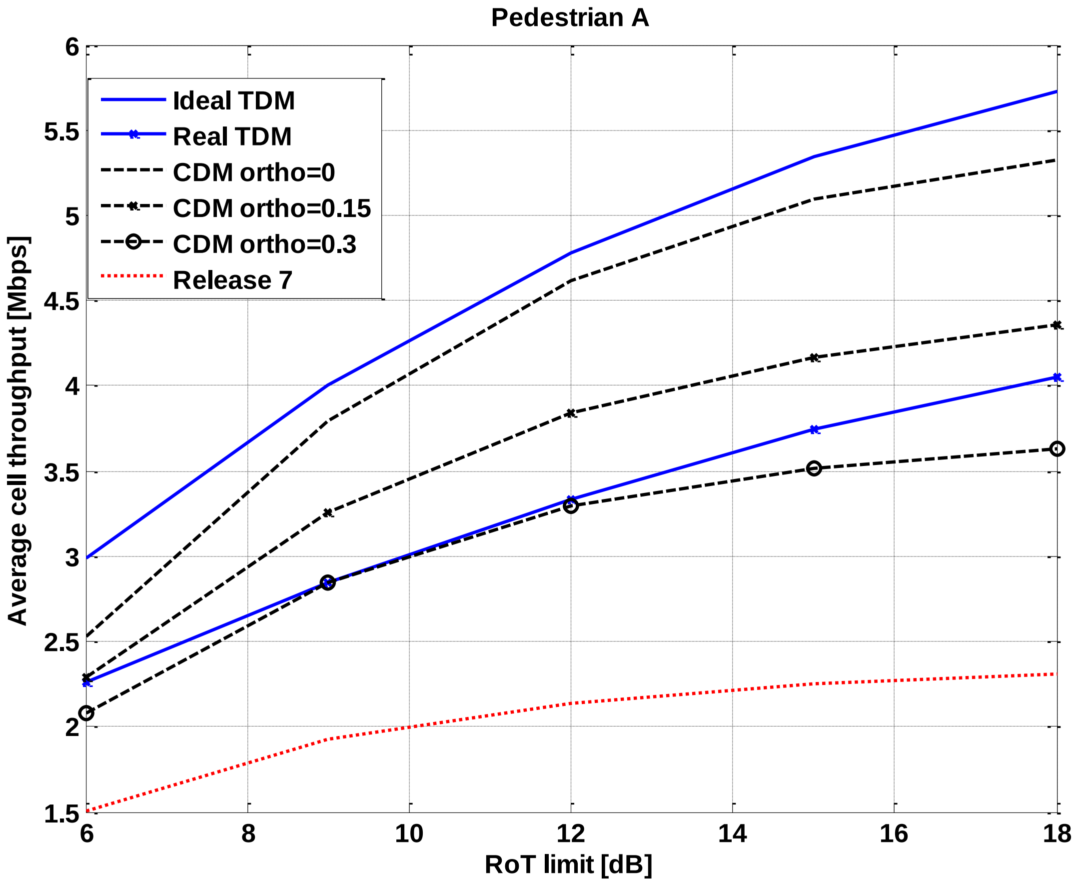


Figure 6.2.3-1: System simulation results for TDM based Synchronised E-DCH in PedA channel.

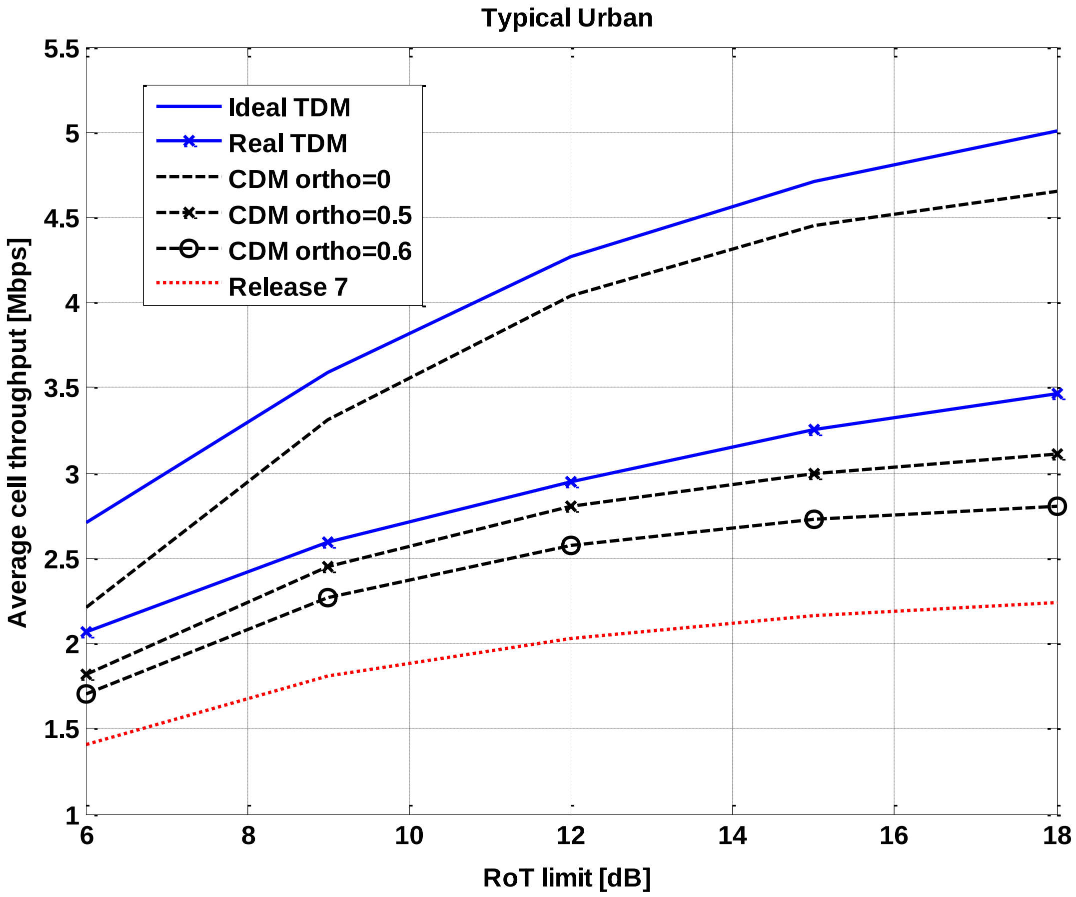


Figure 6.2.3-2: System simulation results for TDM based Synchronised E-DCH in TU channel.

6.2.4 System level simulation results (Interference Cancellation)

System performance of both intracell and intercell interference cancellation has been considered as part of the study. Intracell interference cancellation was considered by means of a model assuming a specific amount of cancelled interference without reference to specific algorithms, and by means of modeling an "Iterative parallel group cancellation" algorithm. Intercell interference cancellation was modeled by means of assuming a percentage of cancelled interference, without referring to a specific algorithm.

6.2.4.1 Intracell interference cancellation modeled using a percentage interference reduction

This section contains an approximate system comparison of CDM based synchronized E-DCH and interference cancellation based on a simplified model in which the interference cancellation algorithm is modeled as a percentage reduction in interference.

It is assumed that there are A users in a cell, each with power P, and that the own cell interference is $I_{own} = (A-1)\cdot P$. Other cell interference is modeled as a fixed ratio of the own cell interference as $I_{other} = \frac{1}{F}\cdot(A\cdot P)$.

The received SINR for a user is then

$$\frac{E_c}{N_0} = \frac{P}{I_{own}+I_{other}+N} = \frac{P}{\gamma_{IC}\cdot(A-1)\cdot P + \lambda\cdot\frac{1}{F}\cdot A\cdot P + \frac{1}{RoT-1}\cdot\left\{\gamma_{IC}\cdot(A-1)\cdot P+\lambda\cdot\frac{1}{F}\cdot A\cdot P\right\}}$$

where γ_{IC} is the interference cancellation efficiency factor for own cell interference and indicates the amount of interference that the IC receiver can cancel. Suppression of other cell interference is modeled simply as a reduction of the other cell interference power and λ depends on the interference scenario and on the receiver ($\lambda = 1$, if no IC of other cell interference.)

Table 6.2.4.1-1 gives the throughput for CDM based synchronized E-DCH with and without own cell interference cancellation, and Rel7 with and without own cell interference cancellation. The assumptions for both CDM based synchronized E-DCH and Rel7 are the same as in section 6.2.1, with CDM based synchronized E-DCH operating at a higher coding rate (0.75) than Rel7 (0.33). The different coding rate is justified by the fact that in the Rel7 case the system is likely to assign a lower SF especially for large transport block sizes, while for CDM based synchronized E-DCH it is assumed SF=16. However a system approach in which a secondary scrambling code is introduced rather than a higher coding rate might show an improved performance for CDM based synchronized E-DCH, but this has not been investigated.

Note that under the conservative assumption that the IC efficiency for own cell interference is 70%, Rel7+IC throughput is higher than CDM based synchronized E-DCH with perfect synchronization, but with higher code rate.

Table 6.2.4.1-1: Throughput for CDM based synchronized E-DCH and Rel7 with and without own cell interference cancellation.

RoT (dB)	6					
	CDM			*CDM+IC*	*Rel7*	*Rel7+IC*
Ioc, own cell	63%					
Isc, other cells	37%					
F'	1,7				1,7	1,7
IC eff. (own cell)				70%		70%
synch offset	0	1/8Tc	1/4Tc	0		
synch factor γs	0	0,055	0,225			
orth factor γo	0,1	0,1	0,1			
tot orth factor γ	0,1	0,1495	0,3025	0,07	1	
bit rate	358	kbps			336	
coding rate	0,75				0,33	
Ec/N0 (per ant.) dB	-8,5				-10,5	
Cell TP (kbps)	2810	2645	2252	2921	1989	3292

6.2.4.2 System modeling of a specific algorithm

This section contains simulation results based on a specific serial/parallel algorithm described in more detail in [R1-081067].

Specific assumptions are listed below

Table 6.2.4.1-1: Simulation Assumptions

Parameter	**Value**
Traffic Interference Cancellation	ON
Pilot Interference Cancellation	ON

Overhead Interference Cancellation	ON
Inter-cell Interference Cancellation	OFF
Algorithm for Interference Cancellation	Group Iteration (GICIter)
Number of Group Iterations	2
Algorithm for Mobile Ordering for IC	Order by Re-Transmission Number
Number of users/cell	10

The results of the simulations are summarized in Tables 6.4.2.5-1, 6.4.2.5-2 and 6.4.2.5-3.

Table 6.4.2.5-1: Macro Cell: Throughput @ 6 dB Effective ROT; 10 users

Channel Type	IC Scheme	Throughput (kbps)	% Gain over MF
PA3	MF (No IC) - Baseline	1730	0
	GICIter (2 Iter)	2665	54
TU6	MF (No IC) - Baseline	1725	0
	GICIter (2 Iter)	2582	50

Table 6.4.2.5-2: Micro Cell: Throughput @ 6 dB Effective ROT; 10 users

Channel Type	IC Scheme	Throughput (kbps)	% Gain over MF
PA3	MF (No IC) - Baseline	2651	0
	GICIter (2 Iter)	4290	62
TU6	MF (No IC) - Baseline	2440	0
	GICIter (2 Iter)	3773	55

Table 6.4.2.5-3: Macro Cell: Throughput @ 6 dB Effective ROT; 10 users

Channel Type		% Gain over MF at 10 percentile point
Macro Cell	**PA3**	**40**
	TU6	**38**
Micro Cell	**PA3**	**67**
	TU6	**77**

The following section indicates the system results in full. From the figures and above table, the following was observed with regards to system performance for Interference Cancellation:

- There are significant gains (50% to 62%) for the Iterative Parallel Group Cancellation scheme in both PA3 and TU6 channels and for both the Macro and Micro simulation scenarios.
- The performance trend shows that the gains improve as the RoT increases.
- Fairness for the IC simulations is identical to that of the MF (No-IC) case.
- The increase in user throughput is seen for all users including the ones at the cell edge. In particular, at the 10 percentile point, we observe the following gains in user throughput over the matched filter case:
  - ~ 40% gain in macro cell
  - 67% to 77% gain in micro cell

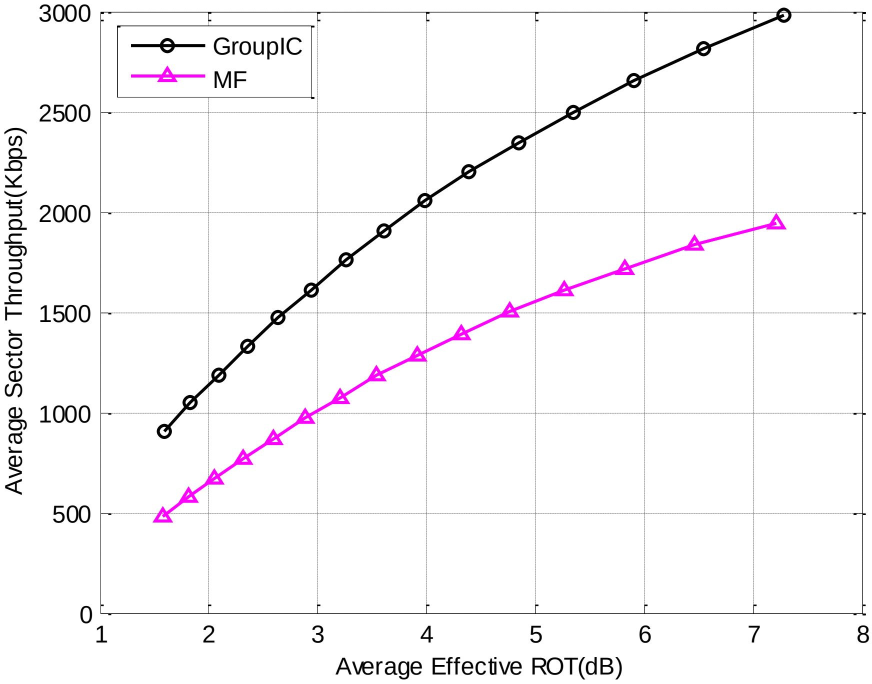


Figure 6.2.4.2-1: Average Sector Thrpt (kbps) vs Effective RoT (dB); 10 users; PA3; Macro Cell

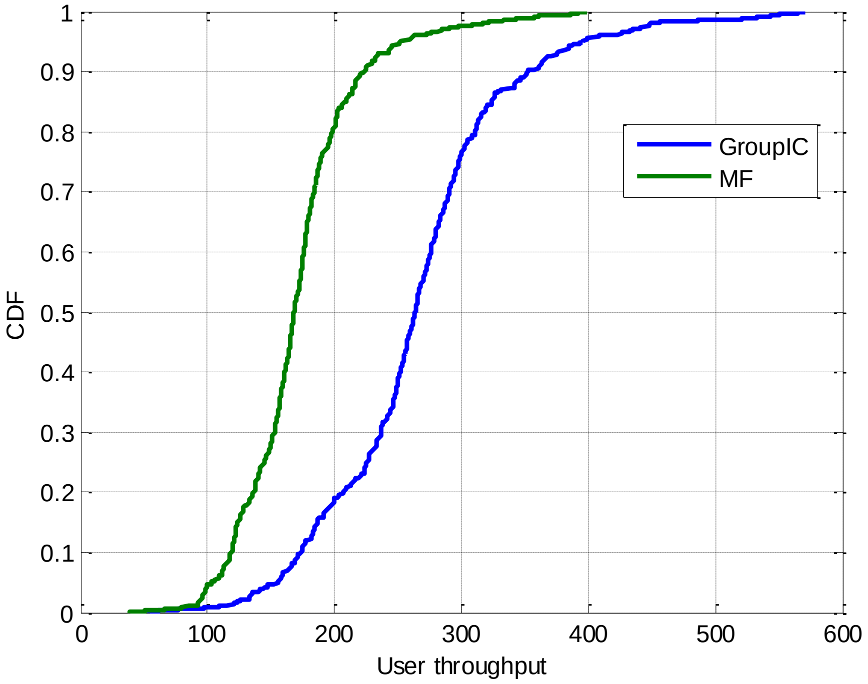


Figure 6.2.4.1-2: User Throughput (kbps); 10 users; PA3; Macro Cell

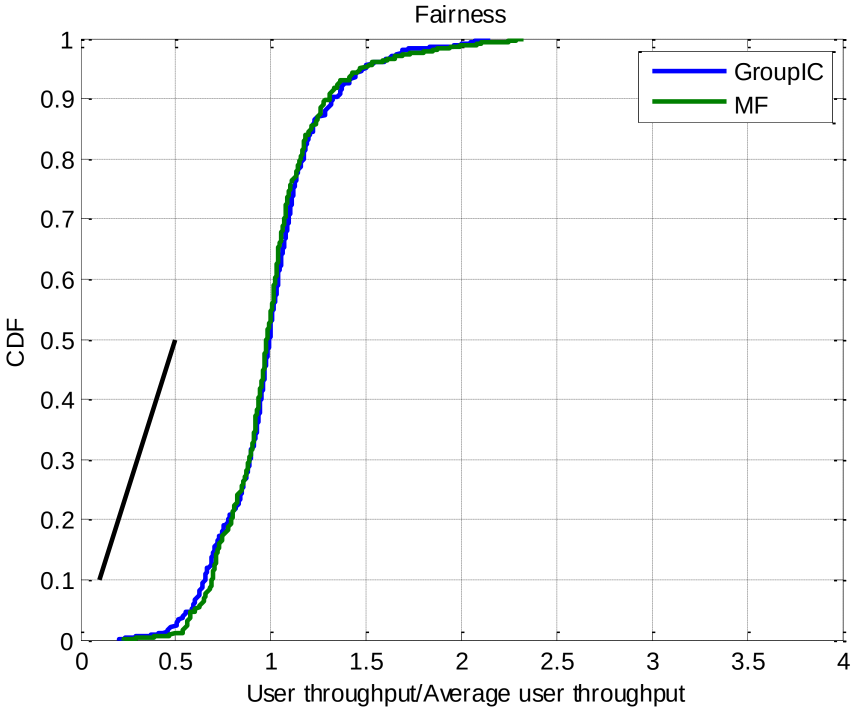


Figure 6.2.4.1-3: Fairness; 10 users; PA3; Macro Cell

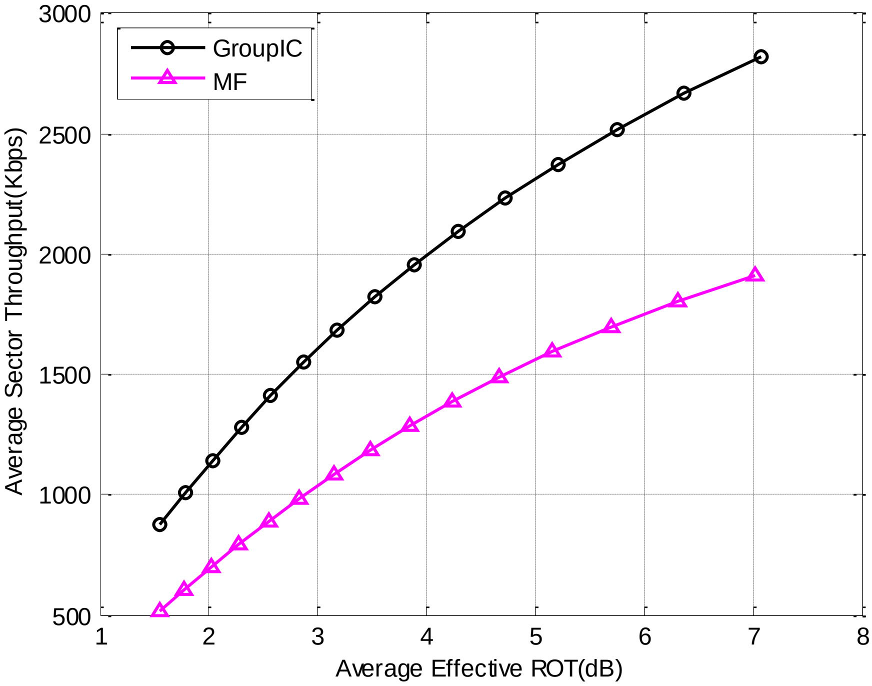


Figure 6.2.4.1-4: Average Sector Thrpt (kbps) vs Effective RoT (dB); 10 users; TU6; Macro Cell

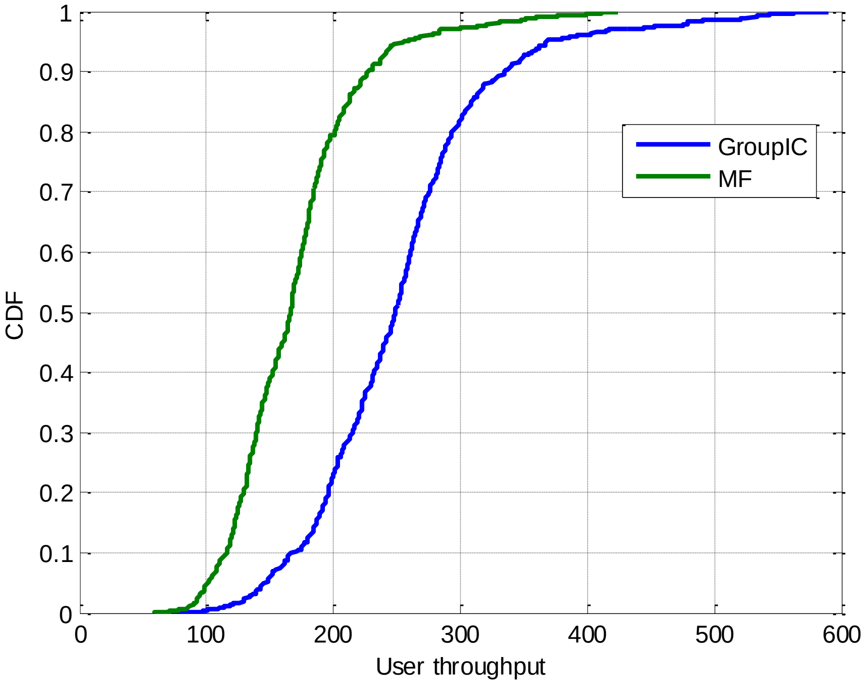


Figure 6.2.4.1-5: User Throughput (kbps); 10 users; TU6; Macro Cell

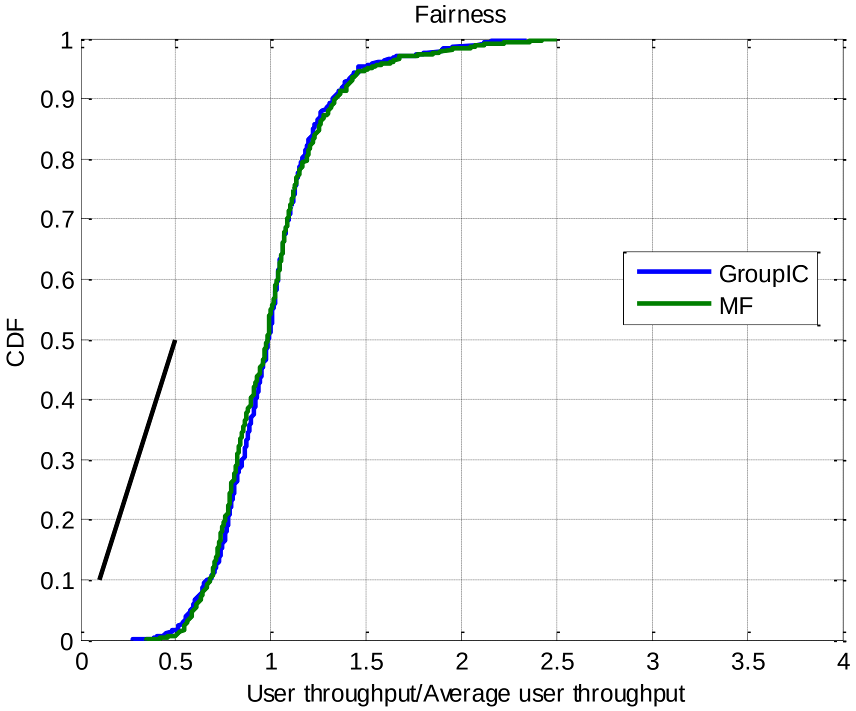


Figure 6.2.4.1-6: Fairness; 10 users; TU6; Macro Cell

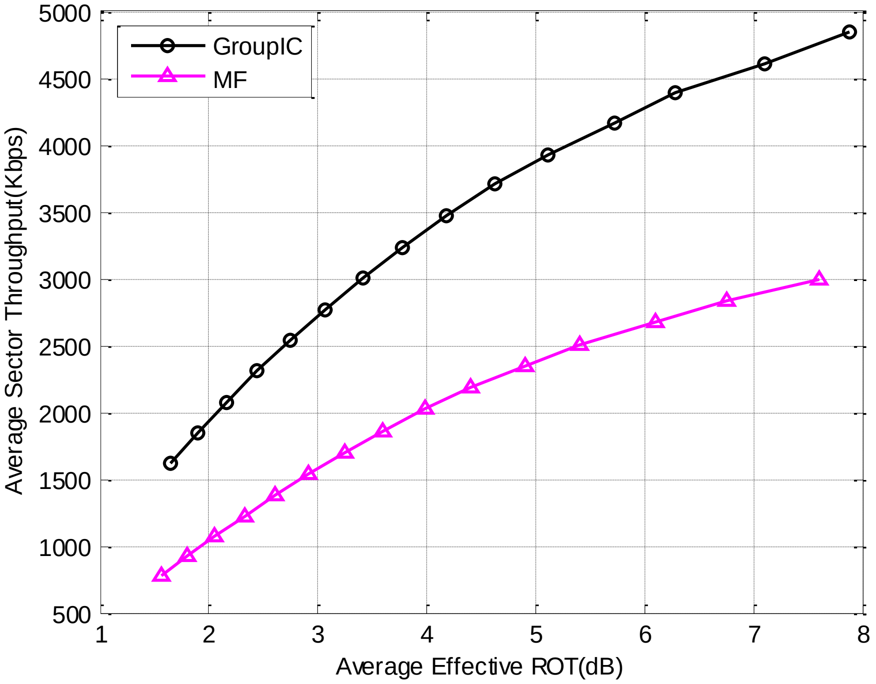


Figure 6.2.4.1-7: Average Sector Thrpt (kbps) vs Effective RoT (dB); 10 users; PA3; Micro Cell

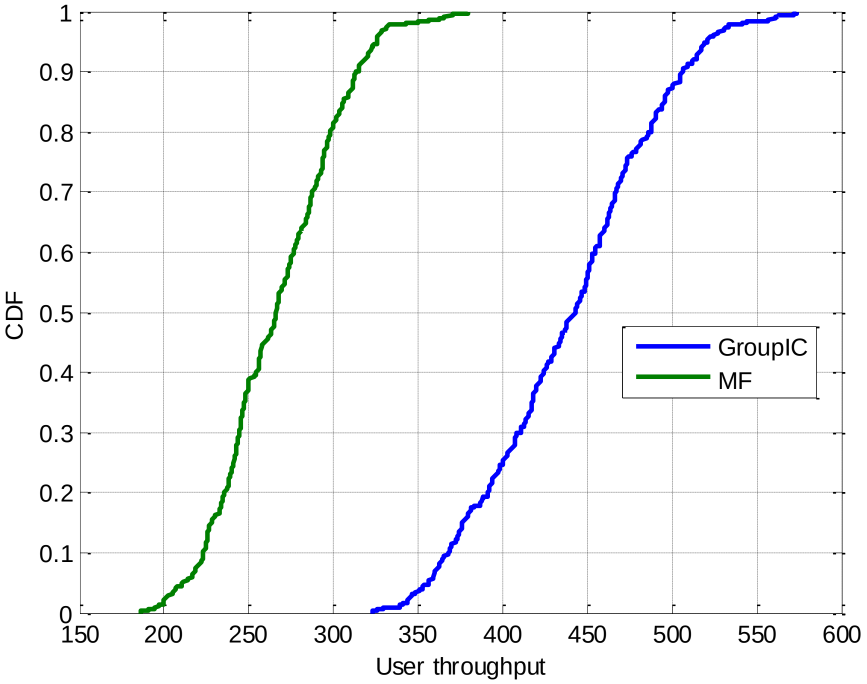


Figure 6.2.4.1-8: User Throughput (kbps); 10 users; PA3; Micro Cell

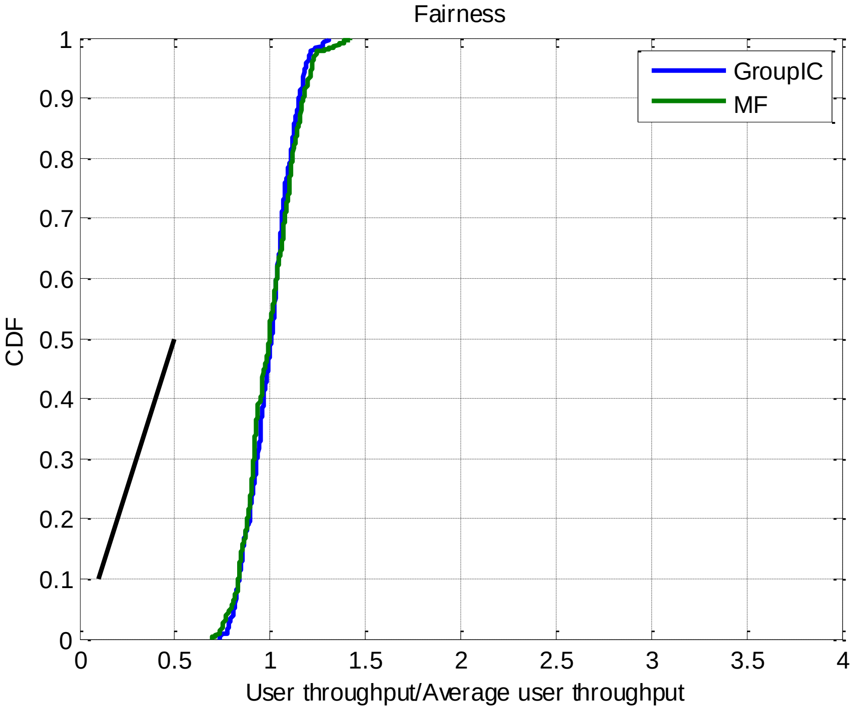


Figure 6.2.4.1-9: Fairness; 10 users; PA3; Micro Cell

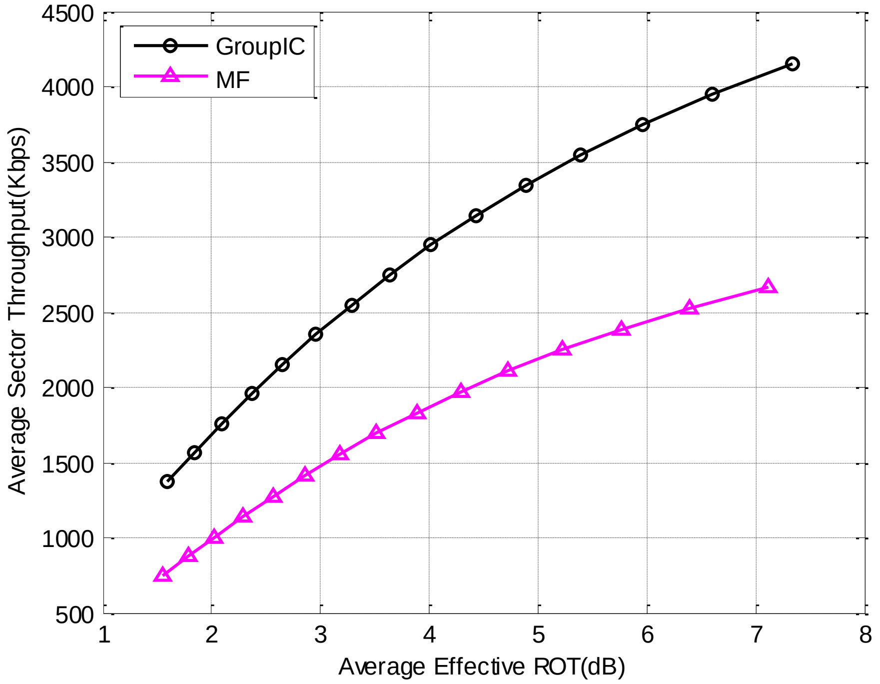


Figure 6.2.4.1-10: Average Sector Thrpt (kbps) vs Effective RoT (dB); 10 users; TU6; Micro Cell

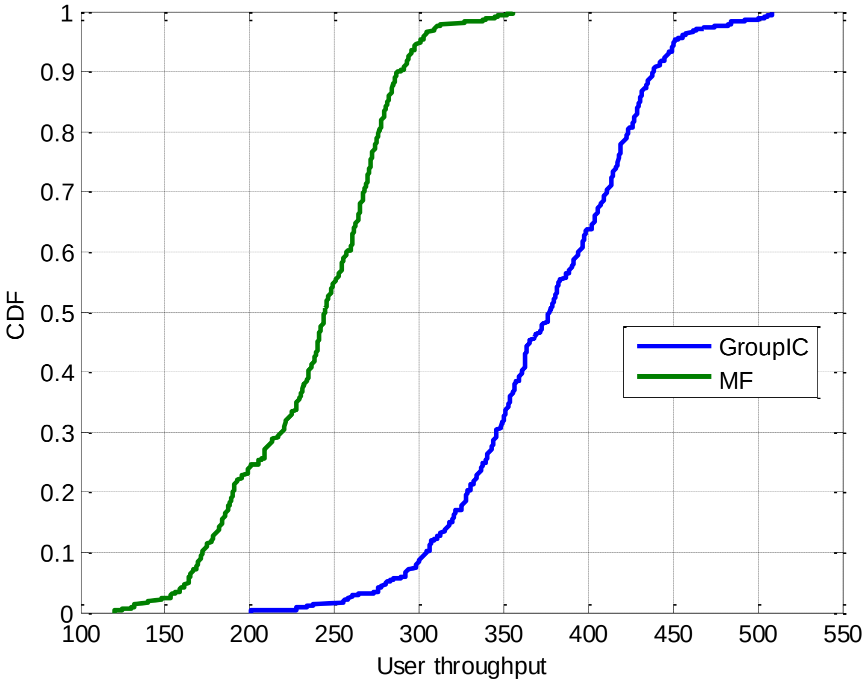


Figure 6.2.4.1-11: User Throughput (kbps); 10 users; TU6; Micro Cell

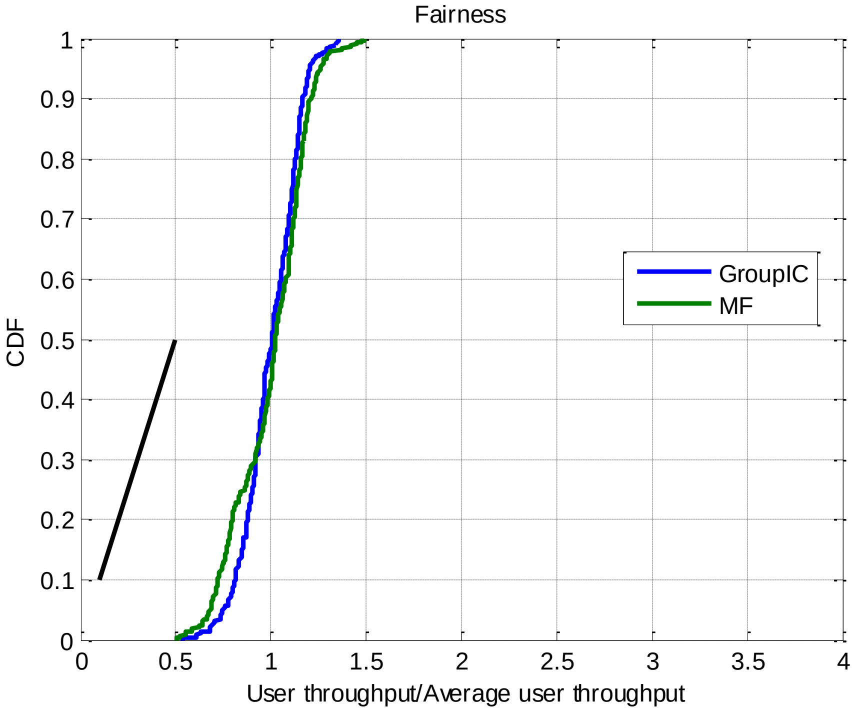


Figure 6.2.4.1-12: Fairness; 10 users; TU6; Micro Cell

6.2.4.3 Inter cell interference cancellation

TDM in particular has a good potential for intercell interference cancellation as the number of interferers is likely to be small. An estimate has been made as to the capacity improvements that might be obtained if an intercell IC algorithm were to be implemented, using the model described in section 6.2.4.1.

Table 6.2.4.3-1 shows throughputs for TDM with own and other cell interference suppression for two cases: F'=2.83 and F'=4.25, where F'=F/λ (F'=F when no other cell interference suppression is considered). These two cases model the scenarios that 40% and 60% of other cell interference is suppressed, respectively.

Table 6.2.4.3-1: Throughput for TDM with own cell interference cancellation and other cell interference suppression.

RoT (dB)	6					
	CDM			TDM+IC	TDM+IC+other cell IS	
Ioc, own cell	63%					
Isc, other cells	37%					
F	1,70			1,7	2,83	4,25
synch offset	0	1/8Tc	1/4Tc			
synch factor γs	0	0,055	0,225			
orth factor γo	0,1	0,1	0,1			
tot orth factor γ	0,1	0,1495	0,3025	0		
bit rate (kbps)	358			358		
coding rate	0,75			0,75		
Ec/N0 (per ant.) dB	-8,5			-8,5		
Cell TP (kbps)	**2809,5**	**2645,0**	**2252,2**	**3226,3**	**5377,2**	**8065,7**

6.3 Complexity considerations

This section should evaluate the degree of additional complexity that implementation of synchronised E-DCH is estimated to bring to the terminal and network

6.3.1 CDM Proposal

6.3.1.1 Terminal complexity

In order to operate a synchronised E-DCH, the terminal implementation would need to take into account the following:

- Update of UL timing advance
- Allocation of physical channels different OVSF codes
    - The allocation of the control channels would be likely to be semi-static. The update of the data channel base code would be likely to be fairly slow (at least in the order of several TTIs)
- Reception of potentially new DL channel for indicating base code

In addition, the CM of an Synchronised E-DCH signal would be somewhat increased as described in section 5.1.3

6.3.1.2 Network complexity

The Node B receiver could use the same technology as is currently used for HSUPA (Rake, LMMSE etc.) and an increase in receiver complexity is not required. The following would be required in the Node B:

- Measurements for and operation of the timing control loops
    - Measurement of timing offset would likely be obtained as part of channel estimation
- Allocation of different OVSF codes for the received physical channels
    - The allocation of the control channels would be likely to be semi-static. The update of the data channel base code would be likely to be fairly slow (at least in the order of several TTIs)
- Potentially new DL channel for indicating base code
- Base code allocation aware Node B scheduler

6.3.2 TDM Proposal.

6.3.2.1 Terminal complexity

In order to operate a synchronised E-DCH, the terminal implementation would need to take into account the following:

- Update of UL timing advance
- Any modifications or additions to the scheduling procedures to improve TDM resource utilisation

6.3.2.2 Network complexity

The Node B receiver could use the same technology as is currently used for HSUPA (Rake, LMMSE etc.) and an increase in receiver complexity is not required. The following would be required in the Node B:

- Measurements for and operation of the timing control loops
    - Measurement of timing offset would likely be obtained as part of path delay search or channel estimation
- Possibly an update to the scheduler to improve TDM resource utilisation

7 Impact of synchronised E-DCH to the specifications

This section should describe the estimated impact of the E-DCH proposal to the 3GPP specifications

7.1 CDM Proposal

This section outlines an estimation of the areas where work would be required on the standards in order to introduce a synchronised E-DCH. The estimation is based on the RAN1 discussions of channel structure and scheduling outlined elsewhere in this report and a USTS like synchronisation procedure.

7.1.1 WG1

The following changes may be required in the WG RAN1 UTRA FDD specifications:

TS 25.211 REL-7:

- Design of a new control channel with 4-5 bits for signalling the base code (an OVSF index assuming the highest allowable spreading factor to be used by the UE) in the case that a new control channel is selected as a solution indicating base code;
- description of the special (F)-DPCH format, needed for the time tracking process, which compensates the synchronisation variations, caused by the UE movement. The new format may consist of the Time Alignment Bits (TABs), which replace the PC bits every x-ms – as described during the USTS study;
- description of the Synchronised E-DCH timing relation to other physical channels.

TS 25.212 REL-7:

- If a special E-AGCH method is used for indicating base code (e.g. special E-AGCH ID or jointly quantised base code & MT2PR), then a re-interpretation of the E-AGCH at least some of the time may be necessary;
- coding and modulation description for the new (F-)DPCCH format including the TABs bits should be included;

TS 25.213 REL-7:

- Description of the Synchronised E-DCH specific UL code generation and allocation should be added.

TS 25.214 REL-7:

- New Synchronised E-DCH specific synchronisation procedure to be added;
- changes needed to the power control procedure, where some PC bits will be replaced by the TA bits (algorithm for processing TPC and TAB commands);
- details of the Synchronised E-DCH specific operation to be included.

7.1.2 WG2

TS 25.319 REL-7:.

- Stage 2 description of the Synchronised E-DCH operation needed

TS 25.321 REL-7:

- HARQ synchronisation to be checked;
- E-DCH scheduler function in MAC to be updated;
- new E-TFB size tables may need an update;
- if the base code signalled over a new physical channel then a new L2 channel is to be introduce (MAC-e);

TS 25.331 REL-7:

- All relevant Synchronised E-DCH specific parameters to be introduced, described and signalled;
- Messages containing physical layer & MAC configuration to be extended/updated;
- UE capability to be indicated either in RRC CONNECTION REQUEST or RRC CONNECTION SETUP message;
- new (F)-DPCH slot format to be indicated due to the corresponding change in the L1.

7.1.3 WG3

TS 25.423 REL-7:

- Procedure text to be added to Radio Link Setup/Reconfiguration/Addition
- Synchronised E-DCH parameters (e.g. info about the cell specific UL scrambling code) to be added to the Radio Link procedures;
- Synchronised E-DCH Support Indicator to be added to the Cell Capability Container FDD;
- update of the Information Elements for Synchronised E-DCH;

TS 25.433 REL-7:

- Procedure text to be added to Radio Link Setup/Reconfiguration/Addition
- Synchronised E-DCH parameters (e.g. info about the cell specific UL scrambling code) to be added to the Radio Link procedures;
- update of the Information Elements for Synchronised E-DCH;

7.1.4 WG4

TS 25.101 REL-7: It is very probable that changes to this specification will be needed.

- areas to be checked:
    - UL/DL power control;
    - demodulation requirements on Synchronised E-DCH
    - Timing accuracy requirements for the UE timing advance procedure

TS 25.104 Rel-7:

- Possibly demodulation requirements

TS 25.133 REL-7: Whether this specification is affected is ffs.

- changes in the scheduling principles for UL may impact the "Transport Format Selection in UE";

Additionally, functional tests on UE synchronisation performance may be required.

7.2 TDM Proposal

7.2.1 WG1

TS 25.211 REL-7:

- No change foreseen

TS 25.212 REL-7:

- Information mapping for HS-SCCH order type for UL timing adjustment

TS 25.213 REL-7:

- No change foreseen

TS 25.214 REL-7:

- UL timing adjustment procedure

If there are changes to the scheduling grant signaling for improved TDM support, this will have some impact on the specifications.

7.2.2 WG2

TS 25.319 REL-7:

- Stage 2 description of the Synchronised E-DCH operation

TS 25.321 REL-7:

- No impact foreseen

TS 25.331 REL-7:

- UE capability to be indicated either in RRC CONNECTION REQUEST or RRC CONNECTION SETUP message

If there are changes to the scheduling grant signaling for improved TDM support, this will have some impact on the specifications.

7.2.3 WG3

TS 25.423 REL-7:

- Synchronised E-DCH Support Indicator to be added to the Cell Capability Container FDD

TS 25.433 REL-7:

- Request for DL timing adjustment from NodeB to SRNC

7.2.4 WG4

TS 25.101 REL-7:

- Areas to be checked:
    - Timing accuracy requirements for the UE timing advance procedure

TS 25.104 Rel-7:

- No change foreseen

TS 25.133 REL-7:

- If there are changes to the scheduling principles for UL this may impact the "Transport Format Selection in UE"

Additionally, functional tests on UE synchronisation performance may be required.

7.3 Interference cancellation

7.3.1 WG1

Uplink intra-cell interference cancellation has zero impact on the WG1 specifications.

7.3.2 WG2

Uplink intra-cell interference cancellation has zero impact on the WG2 specifications.

7.3.3 WG3

Uplink intra-cell interference cancellation has zero impact on the WG3 specifications.

If uplink inter-cell interference cancellation feature is implemented in the NodeB, then changes are required on the Iub/Iur interface (NBAP/RNSAP protocols) to support this feature.

7.3.4 WG4

As such, uplink interference cancellation has no impact on WG4 specifications. However, if it is desired to introduce a test requirement for an enhanced NodeB receiver type that performs uplink interference cancellation then it may be necessary to introduce a demodulation performance requirement for the NodeB receiver in 25.104 and 25.141.

8 Conclusion

The Synchronised E-DCH study item has investigated methods for increasing the capacity of the WCDMA uplink, including CDM based Synchronised E-DCH, TDM based Synchronised E-DCH and interference cancellation.

Performance evaluation has been carried out at link and system level, comparing Synchronised E-DCH against Release 7 HSUPA. At 80-90% HARQ throughput, the CDM based Synchronised E-DCH showed link level gains of 0.75-1dB in a multipath rich channel and 1-2dB in low dispersion channel, while 3 stage parallel IC on HSUPA showed link level gains of 2dB in both kinds of channel. Parallel IC on CDM based Synchronised E-DCH showed additional gains of 1.8dB in TU6 and <0.1dB in PedA (the OVSF already removed most of the interference in the latter case). At low HARQ throughput levels (25%), Synchronised E-DCH and IC showed link level gains of <0.5dB.

System level full buffer simulations were also performed in order to assess the capacity gains available with each of the techniques. Comparing the simulations at 6dB RoT, CDM based Synchronised E-DCH showed capacity gains of 50% in Pedestrian A and 10-15% in TU6. TDM based Synchronised E-DCH showed gains of 50% in Pedestrian A and 30-40% in TU6. Interference cancellation on Release 7 HSUPA based on a realistic group serial/parallel algorithm showed gains of 50-60% in cell throughput and 40-75% in cell edge user throughput in both dispersive TU6 and non dispersive Pedestrian A channels.

It should be noted that the CDM and TDM approaches effectively share the time/OVSF code resources between users, whereas conventional HSUPA allows each user access to a full OVSF tree. At cell throughput levels of >~2Mbps, higher coding rates or higher order modulation compared to asynchronous HSUPA would be needed if pure CDM or TDM operation is to be maintained.

Interference cancellation may be applied to CDM based or TDM based Synchronised E-DCH or to HSUPA. Simulations indicated that application of IC to CDM based Synchronised E-DCH could reduce the number of interference cancellation stages required in a parallel interference canceller by 1 compared with an application to HSUPA. TDM based Synchronised E-DCH could benefit from the fact that the inter-cell interference is dominated by a low number of users in order to further boost capacity, e.g. by being able to operate at a higher RoT level by cancelling or suppressing these dominant interferers.

In terms of complexity, CDM based Synchronised E-DCH increases CM and PAPR at the UE transmitter and requires code scheduling and synchronisation at the Node B. TDM synchronisation requirements are looser, and scheduling may be more straightforward. Interference cancellation implies additional Node B baseband processing complexity.

Impact to the standards is greatest for CDM based Synchronised E-DCH, significantly lower for TDM and zero for interference cancellation on Release 7 HSUPA.

Annex A: Change history

Change history							
Date	**TSG #**	**TSG Doc.**	**CR**	**Rev**	**Subject/Comment**	**Old**	**New**
05/03/08	RAN_39	RP-080087	-	-	Approved version at RAN_39	0.2.0	8.0.0