TSG RAN Working Group 1meeting #20 **TSGR1#20(01)0510**
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Busan, Korea

Source: **InterDigital**

Title: **TDD P-CCPCH Transmit Diversity TR25.221CR 052**

Document for: **Approval**

Introduction

This contribuiton proposes Time Delay Transmit Diversity (TDTD) for the P-CCPCH for TDD, replacing Block Space Time Transmit Diversity (STTD).

The currently defined approach, STTD, has two serious problems.

- Proper implementation for reception in the UE introduces excessive comlexity, or unacceptable performance loss wil result.
- No opportunity will exist for transmit diversity for any other common channels in the same time slot.

Because of this concern, InterDigital conducted a study, based on simulation, to evaluate two alternatives:

- Time Switched Transmit Diversity (TSTD)
- Time Delay Transmit Diversity(TDTD)

The conclusion was that TDTD provided excellent performance, whicle TDTD provided some advantage over no diversity.

The results of that study are presented in the main body of this contribution.

Attached is a copy of Tdoc R1-99b45, which shows that TDTD and STTD have equivilent performance.

R1-99b45.zip

Simulation Results Using Time Switched and Time Delayed Transmit Diversity on P-CCPCH

1 Document Overview

The purpose of this document is to present simulation results for performance of UE when the BS has transmit diversity capability on P-CCPCH. The transmit diversity types concerned here are Time Switched (TSTD) and Time Delayed (TDTD).

2 Simulation Configuration

2.1 Simulation Parameters

General

Parameter	**Explanation/Assumption**
Chip Rate	3.84 Mcps
Duration of TDMA frame	10 ms
Number of time slots per frame	15
Closed loop power control	OFF
AGC	OFF
Number of samples per chip	1 sample per chip
Propagation Conditions	Modified ITU channel models: Indoor A, Indoor B, Pedestrian A, Pedestrian B, Vehicular A, Vehicular B
Numerical precision	Floating point simulations
BLER target	> 10E-2
BLER calculation	BLER will be calculated by comparing with transmitted and received bits.
DCCH model	Random symbols transmitted, not evaluated in the receiver
TFCI model	Random symbols, not evaluated in the receiver but it is assumed that receiver gets error free reception of TFCI information
Measurement Channels	As specified in Annex A of TS 25.102 and TS 25.105
Cell parameter	No Cell parameter cycling
Number of DCHs	1
Inter-cell interference channels	None

Additional downlink parameters

$\hat{I}_{or}/I_{oc}$	Ratio to meet the required BLER target	
PCCPCH_E_c/I_{or} [dB]	-3	
Number of timeslots per frame per user	TS=1	
Transmit diversity	None, TSTD and TDTD	
Receiver antenna diversity	OFF	
Midamble Code Index	10	
Midamble shift (chips)	P-CCPCH	(8-1) * 57 = 399 chips
	DPCH (12.2kbps)	(8-2) * 57 = 342 chips
Channelisation codes C(k; Q) (see TS25.223v3.1.0 chapter 6.2)	Phy Channel	C(k=i; Q=16)
	P-CCPCH	C(k=0; Q=16)
	DPCH	C(k=8; Q=16)

Parameters for Joint-Detector receiver:

Joint-Detector	ZF-BLE
Channel Estimation	Joint channel estimator according to article from Steiner and Baier in Freq., vol. 47, 1993, pp.292-298, based on correlation. Use realistic channel post-processing

2.2 Simulation Testbench

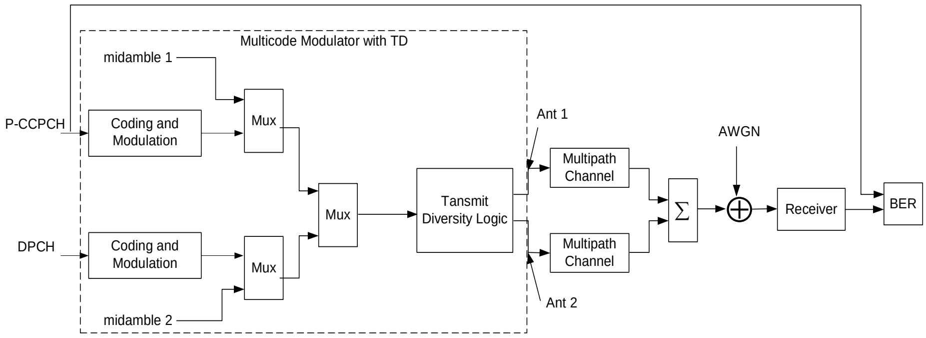


Figure 1. Simulation Testbench Block Diagram

The “Transmit Diversity Logic” block operates as follows:

1) If no transmit diversity (NTD), all data are sent via antenna 1 and 0s are sent via antenna 2.

2) If Time Switched Transmit Diversity (TSTD) is used, modulated P-CCPCH data is transmitted via antenna 1 if the data is in odd number frames and via antenna 2 if the data is in even number frames.

3) If Time Delayed transmit diversity (TDTD) is used, modulated P-CCPCH data is transmitted via antenna 1 with half of its total power and via antenna 2 with certain chips delay (parameter) and half of its total power.

4) In all cases above, the other channel data (e.g. PDCH) is transmitted via antenna 1 only.

3 Simulation Results

The performance of UE is measured by Raw BER and BLER viruses estimated $\frac{I_{or}}{I_{oc}}$.

3.1 Indoor A

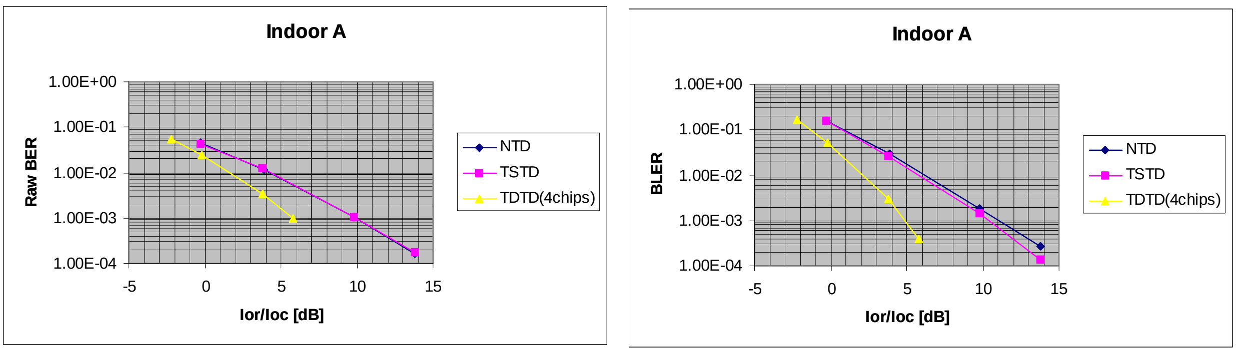
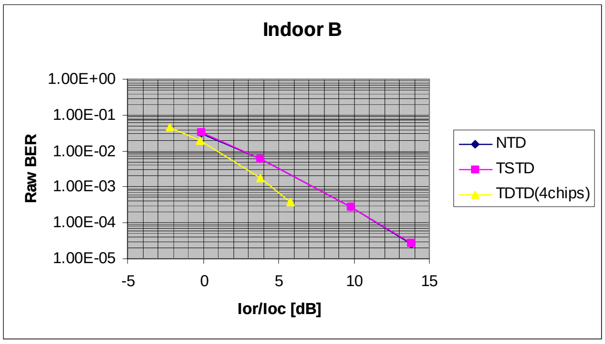


Figure 2. Raw BER and BLER for ITU Indoor A case

Table 1. Data for ITU Indoor A Case

NTD			TSTD			TDTD (4 chips delay)		
Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER
-0.314258	0.0455182	0.153139	-0.248965	0.0436014	0.153728	-2.18116	0.0536374	0.167504
3.84936	0.0117431	0.0295029	3.83769	0.0121468	0.0263609	-0.196859	0.0247224	0.0524659
9.83077	0.00106762	0.0018	9.83375	0.00107514	0.00146667	3.82123	0.00337377	0.00306667
13.8308	0.00016189	0.00026667	13.8337	0.00017213	0.00013333	5.8212	0.0009929	0.0004

3.2 Indoor B



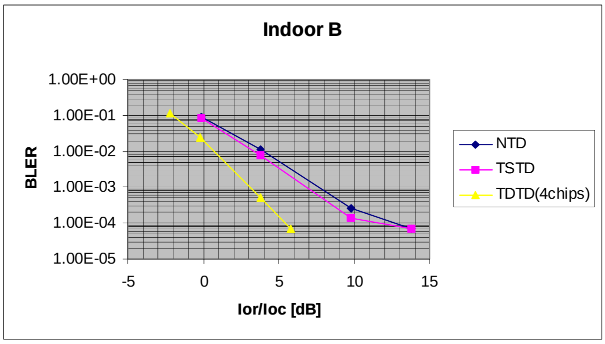


Figure 3. Raw BER and BLER for ITU Indoor B case

Table 2. Data for ITU Indoor B Case

NTD			TSTD			TDTD (4 chips delay)		
Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER
-0.144488	0.0315271	0.0894855	-0.140387	0.0324619	0.0843526	-2.21227	0.0449693	0.113314
3.83082	0.00618579	0.011	3.83408	0.00624891	0.00746667	-0.171463	0.0187758	0.024432
9.83082	0.00026995	0.00026667	9.83408	0.00027637	0.00013333	3.81521	0.00173675	0.00053333
13.8308	2.53E-05	6.67E-05	13.8341	2.68E-05	6.67E-05	5.81518	0.00036557	6.67E-05

3.3 Pedestrian A

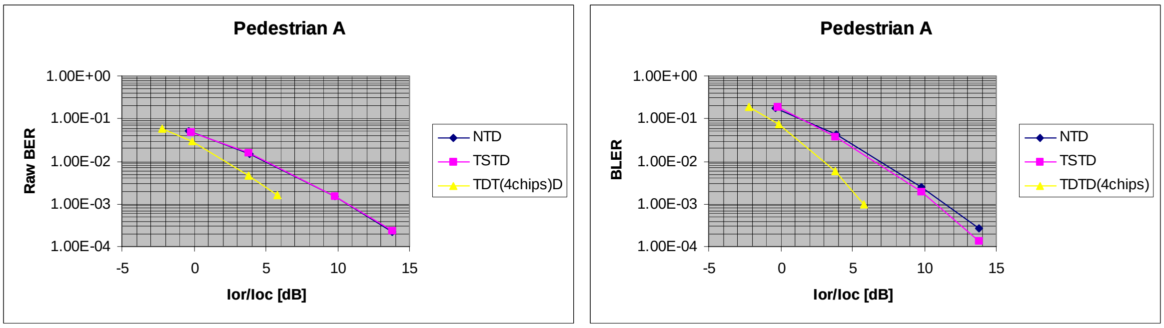


Figure 4. Raw BER and BLER for ITU Pedestrian A case

Table 3. Data for ITU Pedestrian A Case

NTD			TSTD			TDTD (4 chips delay)		
Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER
-0.331609	0.0530271	0.179211	-0.192519	0.0495572	0.184843	-2.19044	0.0579981	0.185357
3.85478	0.0149075	0.044082	3.81334	0.0158573	0.0387072	-0.145765	0.0289543	0.073692
9.8308	0.00153975	0.00246667	9.83366	0.00154877	0.002	3.82385	0.00470943	0.006
13.8308	0.0002235	0.00026667	13.8337	0.00023251	0.00013333	5.82382	0.00156817	0.001

3.4 Pedestrian B

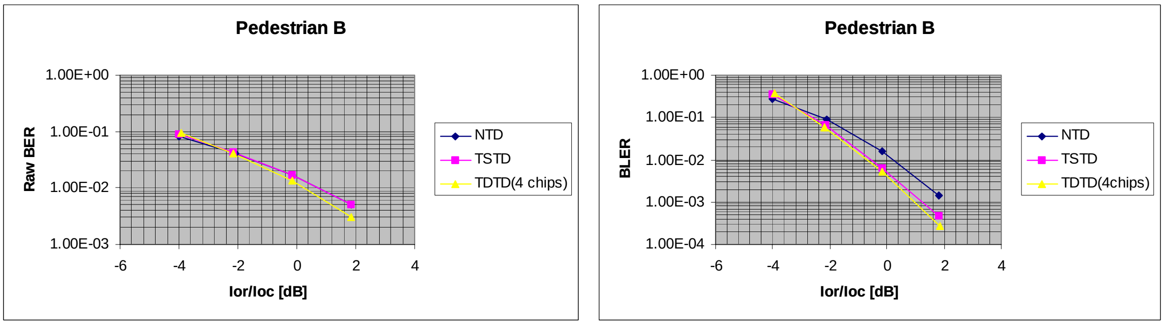


Figure 5. Raw BER and BLER for ITU Pedestrian B case

Table 4. Data for ITU Pedestrian B Case

NTD			TSTD			TDTD (4 chips delay)		
Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER
-4.01341	0.0833371	0.275103	-4.01274	0.088913	0.347826	-3.91767	0.0918623	0.364299

-2.09148	0.04103	0.0924642	-2.15742	0.0424584	0.0668226	-2.17121	0.0405949	0.0599341
-0.159886	0.0166855	0.0158028	-0.168062	0.0167217	0.00646667	-0.146826	0.0131503	0.00506667
1.83003	0.00496831	0.0014	1.83185	0.00496885	0.00046667	1.85309	0.00308607	0.00026667

3.5 Vehicular A

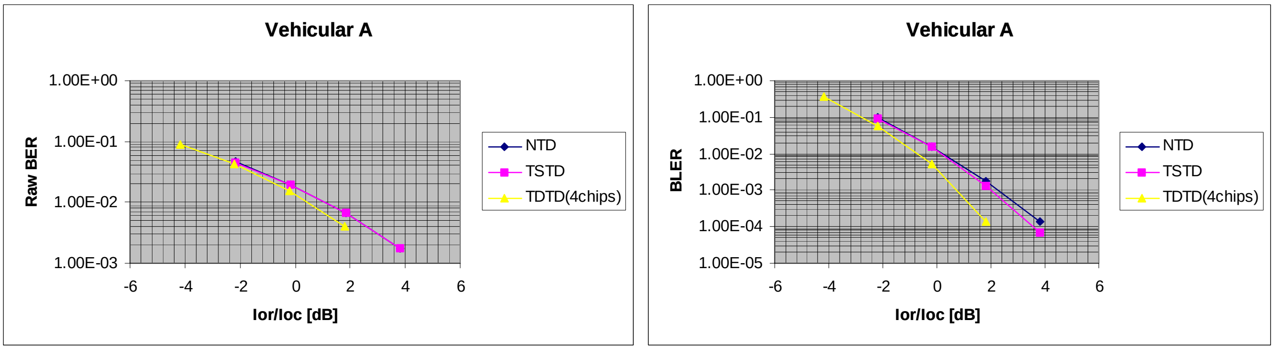
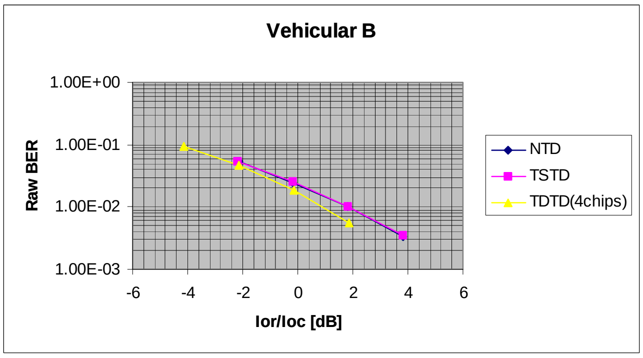


Figure 6. Raw BER and BLER for ITU Vehicular A case

Table 5. Data for Vehicular A Case

NTD			TSTD			TDTD (4 chips delay)		
Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER
-2.16449	0.0460847	0.0969932	-2.16144	0.0455185	0.0904568	-4.18669	0.0914636	0.36036
-0.166018	0.0193869	0.0150591	-0.168161	0.0195097	0.0154476	-2.19325	0.0423557	0.0585823
1.83352	0.00661257	0.00173333	1.83213	0.00669727	0.00133333	-0.193623	0.0151561	0.00526667
3.83358	0.00172719	0.00013333	3.83218	0.00174508	6.67E-05	1.80629	0.00397964	0.00013333

3.6 Vehicluar B



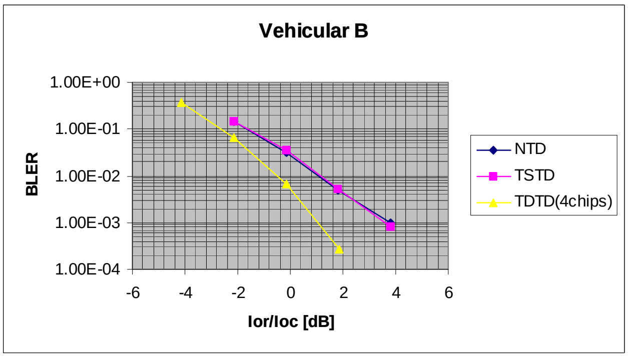


Figure 7. Raw BER and BLER for ITU Vehicular B case

Table 6. Data for Vehicular B Case

NTD			TSTD			TDTD (4 chips delay)		
Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER	Ior/Ioc	RawBER	BLER
-2.15375	0.053227	0.148368	-2.16363	0.0533514	0.144823	-4.14701	0.0957265	0.373134
-0.164831	0.0250646	0.0310366	-0.165846	0.0252643	0.0358551	-2.15491	0.0470426	0.0674992
1.83327	0.0101071	0.0048	1.83185	0.0102566	0.00526667	-0.155486	0.0185299	0.0066
3.83333	0.00338443	0.001	3.83191	0.00348197	0.0008	1.84443	0.00546653	0.00026667

4 Conclusion

Both transmit diversity techniques for P-CCPCH improve the performance at UE. In general the performance of UE using TDTD is better than the one using TSTD.

In the following table we summarize the improvement of performance in terms of BLER at 10^{-2} by using two simple transmit diversity techiques, in comparision with no transmit diversity.

Table 7. TD Improvement Measure (Unit dB)

	Indoor A	Indoor B	Pedestrian A	Pedestrian B	Vehicular A	Vehicular B
TSTD	0.3	0.6	0.4	0.8	0.0	0.0
TDTD	3.9	3.3	4.0	1.0	1.0	1.6

We also tested TDTD with 8 and 10 chips delays and found very little difference between them in terms of performance.

From Table 7 we see that, using TSTD, the performance improvement is very limited. In the case of UE moving with high speed, there is no gain to use TSTD. On the other hand, TDTD provides much better performance improvement, especially when there are few multipath in the propagation channel (e.g. Indoor A, Indoor B and Pedestrian A).

3GPP TSG RAN WG1#20
Busan, Korea, 21-25 May, 2001

Tdoc R1-01-0510

CR-Form-v4

CHANGE REQUEST

⌘ **25.221**	**CR 052**	⌘ ev **-** ⌘	Current version: **3.6.0** ⌘

For ***HELP*** *on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM ☐ ME/UE ☐ Radio Access Network ☐ Core Network ☐

Title:	⌘	Transmit Diversity
Source:	⌘	InterDigital
Work item code:	⌘	
Date:	⌘	21 May, 2001
Category:	⌘	**F**
Release:	⌘	R99

Use one of the following categories:
- ***F*** *(correction)*
- ***A*** *(corresponds to a correction in an earlier release)*
- ***B*** *(addition of feature),*
- ***C*** *(functional modification of feature)*
- ***D*** *(editorial modification)*

Detailed explanations of the above categories can be found in 3GPP TR 21.900.

Use one of the following releases:
- *2 (GSM Phase 2)*
- *R96 (Release 1996)*
- *R97 (Release 1997)*
- *R98 (Release 1998)*
- *R99 (Release 1999)*
- *REL-4 (Release 4)*
- *REL-5 (Release 5)*

Reason for change:	⌘	Existing approach (STTD) for CPCCH has two significant flaws 1)It imposes unnecessary complexity on UE 2)It precludes the application of Diversity to other common channels in the same slot.
Summary of change:	⌘	Remove STTD and identify Time Delay Transmit Diversity (TDTD) as recommended approach for CPCCH
Consequences if not approved:	⌘	1) Excessive complexity in UE 2) No opportunity to apply Transmit Diversity to other common channels in same slot.

Clauses affected:	⌘	5.3.1.3,5.4,5.5,B.3,B.4
Other specs affected:	⌘	[X] Other core specifications ⌘ 25.224,25.225,25.102 [ ] Test specifications [ ] O&M Specifications
Other comments:	⌘	

How to create CRs using this form:

Comprehensive information and tips about how to create CRs can be found at: http://www.3gpp.org/3G_Specs/CRs.htm. Below is a brief summary:

1) Fill out the above form. The symbols above marked ⌘ contain pop-up help information about the field that they are closest to.

2) Obtain the latest version for the release of the specification to which the change is proposed. Use the MS Word "revision marks" feature (also known as "track changes") when making the changes. All 3GPP specifications can be downloaded from the 3GPP server under ftp://ftp.3gpp.org/specs/ For the latest version, look for the directory name with the latest date e.g. 2001-03 contains the specifications resulting from the March 2001 TSG meetings.

3) With "track changes" disabled, paste the entire CR form (use CTRL-A to select it) into the specification just in front of the clause containing the first piece of changed text. Delete those parts of the specification which are not relevant to the change request.

5.3.1.3 P-CCPCH Training sequences

The training sequences, i.e. midambles, as described in subclause 5.2.3 are used for the P-CCPCH. For those timeslots in which the P-CCPCH is transmitted, the midambles $m^{(1)}$ and $m^{(2)}$ are is reserved for P-CCPCH. in order to support Block STTD antenna diversity and the beacon function, see 5.4 and 5.5. The use of midambles depends on whether Block STTD is applied to the P-CCPCH:

- If no antenna diversity is applied to P-CCPCH, $m^{(1)}$ is used and $m^{(2)}$ is left unused. The maximum number K of midambles in a cell may be 4, 8 or 16.
- If Block STTD antenna diversity is applied to P-CCPCH, $m^{(1)}$ is used for the first antenna and $m^{(2)}$ is used for the diversity antenna. The maximum number K of midambles in a cell may be 8 or 16. The case of 4 midambles is not allowed for Block STTD.

5.4 Transmit Diversity for DL Physical Channels

Table 8 summarizes the different transmit diversity schemes for different downlink physical channel types that are described in [9].

Table 8: Application of Tx diversity schemes on downlink physical channel types "X" – can be applied, "–" – must not be applied

Physical channel type	Open loop TxDiversity		Closed loop TxDiversity
	TSTD	Block STTDTime Delay Transmit Diversity TDTD	
P-CCPCH	–	X	–
SCH	X	–	–
DPCH	–	x–	X
PDSCH	–	x–	X

5.5 Beacon characteristics of physical channels

For the purpose of measurements, physical channels at particular locations (time slot, code) shall have particular physical characteristics, called beacon characteristics. Physical channels with beacon characteristics are called beacon channels. The locations of the beacon channels are called beacon locations. The ensemble of beacon channels shall provide the beacon function, i.e. a reference power level at the beacon locations, regularly existing in each radio frame. Thus, beacon channels must be present in each radio frame.

5.5.1 Location of beacon channels

The beacon locations are determined by the SCH and depend on the SCH allocation case, see subclause 5.3.4:

Case 1) The beacon function shall be provided by the physical channels that are allocated to channelisation code $c_{Q=16}^{(k=1)}$ and to TS#k, k=0,…,14.

Case 2) The beacon function shall be provided by the physical channels that are allocated to channelisation code $c_{Q=16}^{(k=1)}$ and to TS#k and TS#k+8, k=0,…,6.

Note that by this definition the P-CCPCH always has beacon characteristics.

5.5.2 Physical characteristics of beacon channels

The beacon channels shall have the following physical characteristics. They:

- are transmitted with reference power;
- are transmitted without beamforming;

- use burst type 1;
- use midamble $m^{(1)}$ ~~and $m^{(2)}$~~ exclusively in this time slot; and
- midambles $m^{(9)}$ and $m^{(10)}$ are always left unused in this time slot, if 16 midambles are allowed in that cell.

Note that in the time slot where the P-CCPCH is transmitted only the midambles $m^{(1)}$ to $m^{(8)}$ shall be used, see 5.6.1. Thus, midambles $m^{(9)}$ and $m^{(10)}$ are always left unused in this time slot.

The reference power corresponds to the ~~sum of the~~ power allocated to ~~both~~ midamble~~s~~ $m^{(1)}$ ~~and $m^{(2)}$~~. ~~Two possibilities exist:~~

- ~~If no Block STTD antenna diversity is applied to P-CCPCH, all the reference power of any beacon channel is allocated to $m^{(1)}$.~~
- ~~If Block STTD antenna diversity is applied to P-CCPCH, for any beacon channel midambles $m^{(1)}$ and $m^{(2)}$ are each allocated half of the reference power. Midamble $m^{(1)}$ is used for the first antenna and $m^{(2)}$ is used for the diversity antenna. Block STTD encoding is used for the data in P-CCPCH, see [9]; for all other beacon channels identical data sequences are transmitted on both antennas.~~

If TDTD antenna diversity is applied to P-CCPCH, both antennas are each allocated half of the reference power. For all other beacon channels identical data sequences are transmitted on both antennas with or without delay at the diversity antenna.

5.6 Midamble Allocation for Physical Channels

Midambles are part of the physical channel configuration which is performed by higher layers. Three different midamble allocation schemes exist:

- UE specific midamble allocation: A UE specific midamble for DL or UL is explicitly assigned by higher layers.
- Default midamble allocation: The midamble for DL or UL is allocated by layer 1 depending on the associated channelisation code.
- Common midamble allocation: The midamble for the DL is allocated by layer 1 depending on the number of channelisation codes currently being present in the DL time slot.

If a midamble is not explicitly assigned and the use of the common midamble allocation scheme is not signalled by higher layers, the midamble shall be allocated by layer 1, based on the default midamble allocation scheme. This default midamble allocation scheme is given by a fixed association between midambles and channelisation codes, see clause A.3, and shall be applied individually to all channelisation codes within one time slot. Different associations apply for different burst types and cell configurations with respect to the maximum number of midambles.

5.6.1 Midamble Allocation for DL Physical Channels

Beacon channels shall always use the reserved midamble~~s~~ $m^{(1)}$ ~~and $m^{(2)}$~~, see 5.5. For DL physical channels that are located in the same time slot as the P-CCPCH, midambles shall be allocated based on the default midamble allocation scheme, using the association for burst type 1 and K=8 midambles. For all other DL physical channels, the midamble is explicitly assigned by higher layers or allocated by layer 1.

5.7 Midamble Transmit Power

There shall be no offset between the sum of the powers allocated to all midambles in a timeslot and the sum of the powers allocated to the data symbol fields. The transmit power within a timeslot is hence constant.

The midamble transmit power of beacon channels is equal to the reference power. ~~If Block STTD is used for the P-CCPCH, the reference power is equally divided between the midambles $m^{(1)}$ and $m^{(2)}$.~~

The midamble transmit power of all other physical channels depends on the midamble allocation scheme used. The following rules apply

- In case of Default Midamble Allocation, every midamble is transmitted with the same power as the associated codes.
- In case of Common Midamble Allocation in the downlink, the transmit power of this common midamble is such that there is no power offset between the data parts and the midamble part of the overall transmit signal within one time slot.
- In case of UE Specific Midamble Allocation, the transmit power of the UE specific midamble is such that there is no power offset between the data parts and the midamble part of every user within one time slot.

The following figure depicts the midamble powers for the different channel types and midamble allocation schemes. For the UE Specific Midamble Allocation, as an example, code 1 and code 2 are both assigned to UE 1, whereas to UE m is assigned only the code n.

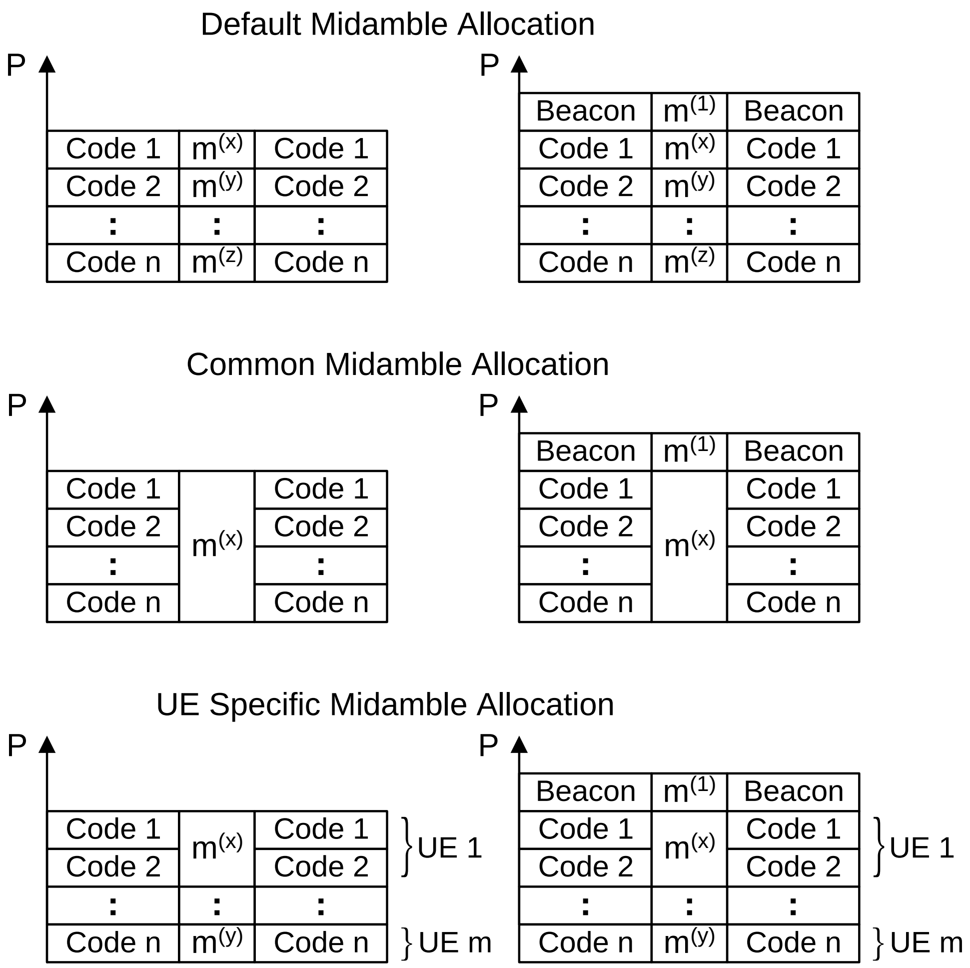


Figure 18: Midamble powers for the different midamble allocation schemes

B.4 Mapping scheme for beacon timeslots and K=16 Midambles.

m1	m2	m3	M4	m5	m6	m7	M8	m9	m10	m11	M12	m13	m14	m15	m16	
1	x(*)	**1**	0	0	0	0	0	0	0	0	0	0	0	0	0	1 codes or 13 codes
1	x(*)	0	**1**	0	0	0	0	0	0	0	0	0	0	0	0	2 codes or 14 codes
1	x(*)	0	0	**1**	0	0	0	0	0	0	0	0	0	0	0	3 codes or 15 codes
1	x(*)	0	0	0	**1**	0	0	0	0	0	0	0	0	0	0	4 codes or 16 codes
1	x(*)	0	0	0	0	**1**	0	0	0	0	0	0	0	0	0	5 codes
1	x(*)	0	0	0	0	0	**1**	0	0	0	0	0	0	0	0	6 codes
1	x(*)	0	0	0	0	0	0	0	0	**1**	0	0	0	0	0	7 codes
1	x(*)	0	0	0	0	0	0	0	0	0	**1**	0	0	0	0	8 codes
1	x(*)	0	0	0	0	0	0	0	0	0	0	**1**	0	0	0	9 codes
1	x(*)	0	0	0	0	0	0	0	0	0	0	0	**1**	0	0	10 codes
1	x(*)	0	0	0	0	0	0	0	0	0	0	0	0	**1**	0	11 codes
1	x(*)	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**	12 codes

~~(*) In case of Block-STTD encoding for the P-CCPCH, midamble shift 2 is used by the diversity antenna~~ Reserved for future use

B.5 Mapping scheme for beacon timeslots and K=8 Midambles.

m1	m2	m3	m4	m5	m6	m7	M8	
1	x(*)	**1**	0	0	0	0	0	1 or 7 or 13 codes
1	x(*)	0	**1**	0	0	0	0	2 or 8 or 14 codes
1	x(*)	0	0	**1**	0	0	0	3 or 9 or 15 codes
1	x(*)	0	0	0	**1**	0	0	4 or 10 or 16 codes
1	x(*)	0	0	0	0	**1**	0	5 codes or 11 codes
1	x(*)	0	0	0	0	0	**1**	6 codes or 12 codes

(*) ~~In case of Block-STTD encoding for the P-CCPCH, midamble shift 2 is used by the diversity antenna~~Reserved for future use.