TSG-RAN Meeting #7
Madrid, Spain, 13 – 15 March 2000

RP-000049

Title:　　　　**Agreed CRs to TR 25.922**

Source:　　　　**TSG-RAN WG2**

Agenda item:　**6.3.3**

Doc-1st-	Spec	CR	Rev	Subject	Cat	Version	Versio
R2-000348	25.922	001		PDSCH code usage and signalling	F	3.0.0	3.1.0

CHANGE REQUEST

Please see embedded help file at the bottom of this page for instructions on how to fill in this form correctly.

25.922	CR	**001**	Current Version:	3.0.0

GSM (AA.BB) or 3G (AA.BBB) specification number ↑   *↑ CR number as allocated by MCC support team*

For submission to:	TSG-RAN#7	for approval	**X**	strategic		*(for SMG*
list expected approval meeting # here ↑		for information		non-strategic		*use only)*

Form: CR cover sheet, version 2 for 3GPP and SMG   The latest version of this form is available from: ftp://ftp.3gpp.org/Information/CR-Form-v2.doc

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Proposed change affects: (U)SIM ☐   ME **X**   UTRAN / Radio **X**   Core Network ☐
(at least one should be marked with an X)

Source:	TSG-RAN WG2		**Date:**	28 Feb 2000

Subject:	PDSCH code usage and signalling

Work item:	Release 99

Category: *(only one category shall be marked with an X)*

				Release:		
F	Correction	**X**		Phase 2		
A	Corresponds to a correction in an earlier release			Release 96		
B	Addition of feature			Release 97		
C	Functional modification of feature			Release 98		
D	Editorial modification			Release 99	**X**	
				Release 00		

Reason for change:	Provides a description of the different ways in which the DSCH may be used and discusses the different options for signalling the table mapping TFCI(field 2) values to TFC and PDSCH channelisation code.

Clauses affected:	8.1

Other specs affected:

|		→ List of CRs:	
Other 3G core specifications	☐	→ List of CRs:	
Other GSM core specifications	☐	→ List of CRs:	
MS test specifications	☐	→ List of CRs:	
BSS test specifications	☐	→ List of CRs:	
O&M specifications	☐	→ List of CRs:	

Other comments:	

help.doc

<--------- double-click here for help and instructions on how to create a CR.

8 Dynamic Resource Allocation

8.1 Code Allocation Strategies for FDD mode

8.1.1 Introduction

Code allocation deals with the problem how different codes are allocated to different connections. The channelisation codes used for spreading are Orthogonal Variable Spreading Factor (OVSF) codes that preserve the orthogonality between a user's physical channel. The OVSF code is shown in the following figure:
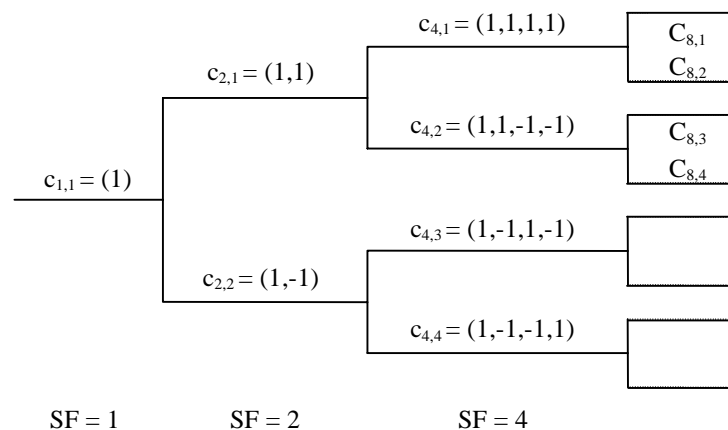
Figure 8-1: OVSF Code Tree

Each level in the code tree is described as $C_{SF,code\ number}$, where the spreading factor (SF) is ranging from 4 to 512 for the chip rate of 3.84 Mcps. A code can be assigned to a UE if and only if no other code on the path from the specific code to the root of the tree or in the sub-tree below the specific code is assigned. For example, a random assignment of large-SF codes to low data rate channels may preclude a large number of small-SF codes. It inefficiently limits the number of remaining codes that could be used by other users. On the contrary, it will be advantageous to assign codes to low data rate users in such a way as to minimise the number of unavailable small-SF codes. Moreover, it is expected to be advantageous to assign users operative at a particular data rate to closely related codes so as to minimise the number of small-SF codes being marked as unavailable. A proper code allocation algorithm is used to find the "closely related code" to prevent the BS from running out of codes and to utilise the system resource effectively. The so-called "closely related code" would be obtained via a code allocation strategy according to the available codes of the BS and the capability of the UE.

8.1.2 Criteria for Code Allocation

OVSF codes are valuable resources in CDMA system. The objective of the code allocation is to support as many users as possible with less complexity.

In the application, different UEs may request for different types of services with different transmission rates. Each UE may have the capability to use more than one code to support different data rates. The following criteria can be envisaged:

1. Utilisation. The utilisation is defined as the ratio of assigned bandwidth and overall bandwidth. A code allocation scheme that preserves more small-SF codes has a higher chance to provide a higher utilisation. For example, $C_{4,1}$ and $(C_{8,1},C_{8,3})$ are the available codes of a BS resulting from two different code allocation schemes. $C_{4,1}$ (which is equivalent to codes $C_{8,1}$ and $C_{8,2}$) can support a symbol rate up to 960 kbps. $(C_{8,1},C_{8,3})$ can also support the same symbol rate as $C_{4,1}$ does. However, only $C_{4,1}$ can support the UE that requests for 960 kbps symbol rate using only one code (due to the capability of the handset). In this example, the former has more small-SF codes than the latter, thus, it will result in a better utilisation.

2. Complexity. The more codes are used, the complexity of the system will be increased. In some cases, there are more than one way to meet the first criterion mentioned above. For example, one UE can use either one code ($C_{4,1}$) or two codes ($C_{8,1}$ and $C_{8,2}$) as the channelisation codes. Under this situation, the code allocation scheme that requires the least codes should be chosen.

8.1.3   Example of code Allocation Strategies

An example of code allocation algorithm based on the two above criteria is presented in the following. In order to indicate the available OVSF codes of the system, an order pair C, called a code-word, is introduced. Let $C=(a_1,a_2,a_3,a_4,a_5,a_6,a_7)$ denote the available codes for SF=(4,8,16,32,64,128,256), respectively, where $a_1 \leq 4$, $a_2 \leq 8$, $a_3 \leq 16$, $a_4 \leq 32$, $a_5 \leq 64$, $a_6 \leq 128$, and $a_7 \leq 256$. The total data rate (*i.e.* it has been normalised by a data rate of an OVSF code with SF=256) supported by C is called the weight W and can be obtained by

$$W(C)= a_1 \cdot 2^6 + a_2 \cdot 2^5 + a_3 \cdot 2^4 + a_4 \cdot 2^3 + a_5 \cdot 2^2 + a_6 \cdot 2^1 + a_7.$$

$S(n)$ is a set of code-words that can support a total data rate up to n and it can be obtained by

$$S(n)=\{C|W(C)=n, \ \forall \ C\}.$$

The number of codes $N(C)$ required for transmitting a code-word C can be calculated by

$$N(C)= a_1+a_2+a_3+a_4+a_5+a_6+a_7.$$

Consider a UE which requests for a data rate of n. Define $C_t=(a_1,a_2,a_3,a_4,a_5,a_6,a_7)$ and $C_{t'}=(a_{1'},a_{2'},a_{3'},a_{4'},a_{5'},a_{6'},a_{7'})$ are the code-words of the system before and after code allocation, respectively. For $W(C_t)=m$, we can find that $W(C_{t'})=W(C_t)-n=m-n$.

For example, $m=13$ and $n=6$ $C_t=(0,0,0,0,2,1,3)$.

The possible candidates for the allocated codes is one of the element of set $S(6)$, where

$S(6)=\{(0,0,0,0,0,0,6), (0,0,0,0,0,1,4), (0,0,0,0,0,2,2), (0,0,0,0,1,0,2),(0,0,0,0,0,3,0), (0,0,0,0,1,1,0)\}$

$\equiv\{C1,C2,C3,C4,C5,C6\}$.

Thus, the possible code-words of the system after allocating the codes to the UE can be obtained by

$T(7) =\{C_t$-$C1, C_t$-$C2, C_t$-$C3, C_t$-$C4, C_t$-$C5, C_t$-$C6\}$

$=\{(0,0,0,0,1,1,1), (0,0,0,0,1,1,1), (0,0,0,0,1,1,1), (0,0,0,0,1,1,1), (0,0,0,0,1,0,3),(0,0,0,0,1,0,3)\}$.

According to the first criterion, $(0,0,0,0,1,1,1)$ is the preferred code-word (denoted as C_{opt}) after the allocation and $C1$, $C2$, $C3$, and $C4$ are possible candidates for the allocated code-words. The number of codes required for these code-words are $N(C1)=6$, $N(C2)=5$, $N(C3)=4$, and $N(C4)=3$. According to the second criterion, $C4$ would be chosen because it uses the least codes.

In general, it is not feasible to examine all of the possible code-words from the set $S(n)$ as illustrated above, especially for a large value of n. It is also a time-consuming process to find $T(m-n)$ by subtraction of the code-words individually. Here, a fast code allocation algorithm can be used to find the preferred code-word C_{opt}, where

$$C_{opt} = C_t - (C_t-(0,0,0,0,0,0,n)).$$

In the above example, $C_t=(0,0,0,0,2,1,3)$, $n=6$, and $C_t-(0,0,0,0,0,0,6)=(0,0,0,0,1,1,1)$. Therefore, $C_{opt}=(0,0,0,0,2,1,3)-(0,0,0,0,1,1,1)=(0,0,0,0,1,0,2)=C4$.

In a particular implementation of the code allocation algorithm, the BS could maintain a list of available codes. When UE requests for channel codes, the number of codes of different SF required supporting the required data rate could be identified by the code allocation algorithm. Upon identification of codes of suitable SFs, the BS will assign the codes from the table.

In the real system, the MS can use only k codes for transmitting data. In some cases, the fast code allocation algorithm cannot be applied. Therefore, two situations may occur:

Situation I. $N(C_{opt}) \leq k$:

-    The procedure described above can be used and the allocated code-word $C = C_{opt}$.

Situation II. $N(C_{opt}) > k$:

- In this situation, the fast code allocation algorithm may not be applied because the MS can not support as many codes as that determined by C_{opt}. In this case, the allocated code-word C is the one that $N(C)=k$. However, the new call requests will be blocked if the MS can not support the requested data rate with the given number of codes k.

8.1.4 PDSCH code management

In this section two typical examples are given of the way in which the UTRAN might configure usage of the DSCH.

Where the DSCH is supported the information provided on TFCI(field 2) has to enable the UE to look up both the TFC used on the DSCH CCTrCH as well as the PDSCH channelisation code. Hence this section also provides guidance on how to use the various options provided in the RRC protocol for signalling this mapping table.

PDSCH code management is simplified if a bearer is configured such that in any one TTI it is possible to select codes for transmission toward a single user from a wide range of the available set of PDSCH codes. However, since the length of the TFCI(field 2) is limited this can mean that the number of possible transport format combinations which can be used for this user at a given spreading factor is limited. In Table 1 an example of a possible mapping table is shown, where as discussed the bearer has been configured to give the UTRAN a high degree of flexibility in code assignment but with a restricted number of TFC options per spreading factor. In the example the TFCI (field 2) is assumed to be 5 bits long, the PDSCH code sub-tree is 5 spreading factors deep and the UTRAN allows only one possible TFC per spreading factor.

TFCI (field 2)	CTFC	PDSCH Channelisation code
0	α	SF=128, Code number = 0
1	α	SF=128, Code number = 1
2	α	SF=128, Code number = 2
3	α	SF=128, Code number = 3
⋮	⋮	⋮
15	α	SF=128, Code number = 15
16	β	SF=64, Code number = 0
17	β	
⋮	⋮	⋮
23	β	SF=64, Code number = 7
24	χ	SF=32, Code number = 0
⋮	⋮	⋮
27	χ	SF=32, Code number = 3
28	δ	SF=16, Code number = 0
29	δ	SF=16, Code number = 1
30	ε	SF=8, Code number = 0

Table 1) Example of a table which the UE must build to map TFCI (field 2) to CTFC and PDSCH channelisation code

In order to signal this mapping table it is possible to make use of 'for' loops in order to reduce the amount of signalling information which has to be transferred in order to describe the mapping, this would be done as follows :

for TFCI2 range 0 to 15

Channelisation codes have SF=128, and the code numbers corresponding to the TFCI2 values range
 from 0 to 15

for TFCI2 range 16 to 23

Channelisation codes have SF=64, and the code numbers corresponding to the TFCI2 values range
 from 0 to 7

:

:

for TFCI2 range 0 to 15

          CTFC = α

for TFCI2 range 16 to 23

          CTFC = •

:

:

This method for signalling the mapping table is possible by using the 'code range' CHOICE in the RRC 'PDSCH code mapping' IE and by using the 'TFCI range' CHOICE in the RRC 'Transport format combination set' IE.

It is also possible that under some circumstances an operator may prefer or need to configure the bearer such that there are only a restricted set of PDSCH codes which may be used for a certain UE but where a large number of possible transport format combinations must be supported on each code. This approach might be taken if for example a large number of services are being multiplexed toward the user. In this case, given the limited number of TFCI (field 2) bits the only option may be to restrict the range of PDSCH codes which can be assigned to the UE.   An example of the mapping table for this case is shown in Table 2, the 5 bits of TFCI(field2) in this case being used to differentiate between different TFC's.

TFCI (field 2)	CTFC	PDSCH Channelisation code
0	α	SF=32, Code number = 0
1	•	SF=32, Code number = 0
2	•	SF=32, Code number = 0
3	•	SF=32, Code number = 0
4	•	SF=32, Code number = 0
5	•	SF=32, Code number = 0
:	:	:
31	•	SF=32, Code number = 0

Table 2) Another example of the table which the UE must build to map TFCI to CTFC and channelisation code

In this case in order to signal the mapping between TFCI (field 2) and CTFC it is most efficient to use explicit signalling , ie. to have the CTFC identified individually for each possible value of TFCI(field 2).   With regards to identifying the mapping between TFCI(field 2) and the channelisation code, it is on this occasion most efficient to identify the range of TFCI(field2) values for which the PDSCH channelisation code should be applied. This method for signalling the mapping table is possible by using the 'TFCI range' CHOICE in the RRC 'PDSCH code mapping' IE and by using the 'Explicit' CHOICE in the RRC 'Transport format combination set' IE.