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Agenda Item:

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Title: **Code allocation rule for USTS**

Document for: **Information and Discussion**

Introduction

At the last WG1 meeting in Stockholm, an OVSF code allocation scheme for USTS was presented [1], and there were some comments regarding performance or improvement of the proposed scheme. In this contribution, we show the benefit of the proposed scheme comparing with other OVSF code allocation scheme.

This contribution gives a brief explanation of our code allocation scheme, and then shows the performance and advantage of the proposed scheme.

Discussion

1. Concept of USTS

USTS can reduce uplink intra-cell interference by making multiple UEs share a single scrambling code by using orthogonalized signals. This feature is intended to support uplink synchronous transmission with low overhead, good capacity characteristics, and minimal impact on hardware and software resources at the UE and in the UTRAN.

In USTS, same scrambling code can be allocated to more than one UEs, and different channelisation codes are allocated to each UE, by which UTRAN can distinguish the UEs. The performance gain of USTS improves as more UEs share the same scrambling code. If OVSF codes are allocated efficiently, more UEs can share the scrambling code, which will result in greater reduction of uplink intra-cell interference.

2. Channelisation Code allocation rule (Figure 1)

1. Separation of codes for DPDCH and DPCCH
   - The channelisation codes for DPDCH and DPCCH of a UE shall be chosen from either the upper half or the lower half of the OVSF code tree to reduce PAPR.
   - In the upper half code tree, the sub-trees below the nodes $C_{ch,8,0}$, $C_{ch,8,1}$, and $C_{ch,8,2}$ are reserved for DPDCH, and below the node $C_{ch,8,3}$ for DPCCH.
   - In the lower half code tree, the sub-trees below the nodes $C_{ch,8,5}$, $C_{ch,8,6}$,and $C_{ch,8,7}$ are reserved for DPDCH, and below the node $C_{ch,8,7}$ for DPCCH.
   - This scheme can allocate channelisation codes to more UEs. In fact, maximum of 64 UEs can be assigned with channelisation codes.

2. Mapping of the code for DPDCH and one for DPCCH

   - There is a mapping rule between the channelisation codes for DPDCH and DPCCH, which is described in the study report on USTS.
   - This scheme can reduce the signalling overhead in the sense that only the information for allocated node for DPDCH channelisation code should be transmitted from SRNC to Node B using NBAP/RNSAP message and to UE using RRC message. Node B and UE can get the information for DPCCH channelisation code allocated by using the proposed mapping rule instead of by receiving the additional information from SRNC.

✍✍ If more than one channelisation codes for DPDCHs are allocated to a UE, then the channelisation code for DPCCH corresponding to the first allocated channelisation code for DPDCH will be used as the channelisation code for the DPCCH.

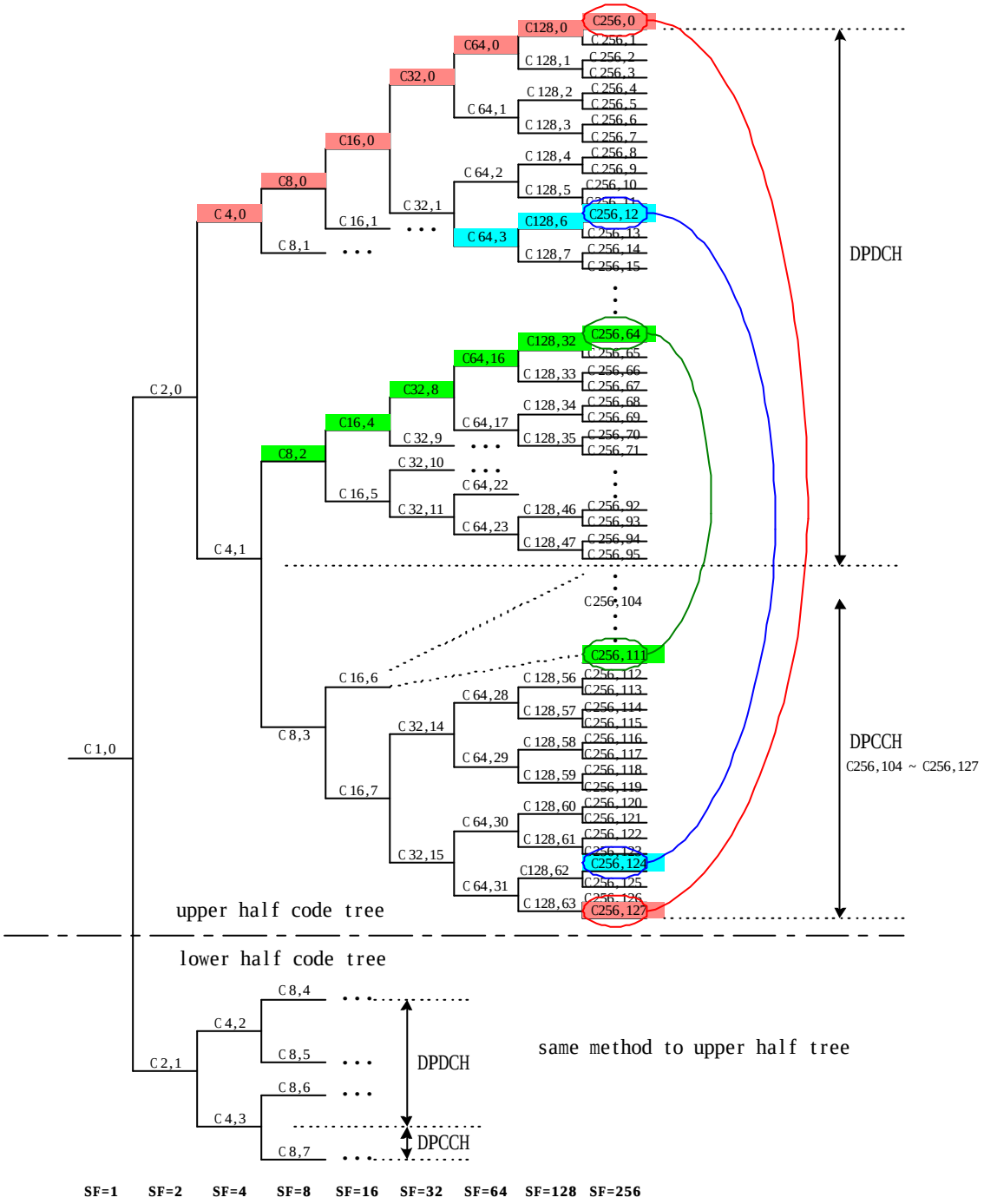

Figure 1 OVSF code tree and mapping rule

3. Examples

Figure 1 shows the OVSF code allocation rule described above. Coloured codes explain how to map the OVSF codes for a DPDCH and DPCCH.

Example 1: If the node of $C_{ch,4,0}$ is allocated to a UE, then one of $C_{ch,4,0}$, $C_{ch,8,0}$, $C_{ch,16,0}$, $C_{ch,32,0}$, $C_{ch,64,0}$, $C_{ch,128,0}$, and $C_{ch,256,0}$ can be used for DPDCH depending on SF and the code $C_{ch,256,127}$ is allocated to the UE for DPCCH as shown in red.
Example 2: If the node of $C_{ch,64,3}$ is allocated to a UE, then one of $C_{ch,64,3}$, $C_{ch,128,6}$, and $C_{ch,256,12}$ can be used for DPDCH depending on SF and the code $C_{ch,256,124}$ is allocated to the UE for DPCCH as shown in blue.

The examples consider the case when the OVSF codes for DPDCHs are in the upper half of the OVSF code tree. When the OVSF codes in the lower half of the OVSF code tree are allocated for DPDCHs, the same rule is to be applied.

4. Performance of other scheme

To compare the proposed method to other one, the code allocation rule used for PRACH is considered. The RACH channelisation code allocation rule is as follows.
If the preamble signature points to one of the 16 nodes in the code-tree that corresponds to channelisation codes of length 16, then the sub-tree below the specified node is used for the message part. The control part is spread with the channelisation code of spreading factor 256 in the lowest branch of the sub-tree. The data part uses any of the channelisation codes from spreading factor 32 to 256 in the upper-most branch of the sub-tree.
In RACH case, Just 16 channels with SF 32 can be used in one channel code tree. But, the proposed scheme can allocate the channelisation codes to maximum 24 channels with SF 32. And, though RACH method can allocate the channelisation codes to olny 32 channels with SF 64, the proposed scheme can allocate 48 channels with SF 64. Table 1 shows the code allocation capability of each scheme. It can be shown that in almost every case, proposed scheme can allocate channelisation codes to more UEs than the scheme used for RACH. In SF 256 case, RACH scheme is better. But since the UE using USTS has the property of low mobility and high data rate, SF 256 is not likely to be used so much in USTS.
The performance improvement of the proposed scheme over the RACH scheme comes from the fact that the OVSF codes for DPDCHs and DPCCHs are grouped and mapped onto different sub-trees of the OVSF code tree.

SF	4		8		16		32		64		128		256	
Scheme	P	R	P	R	P	R	P	R	P	R	P	R	P	R
Cap.	2	2	6	4	12	8	24	16	48	32	64	64	64	128

Table 1. Code allocation capability of each scheme
(P : proposed scheme, R : RACH scheme, Cap. : number of maximum codes that can be allocated)

Conclusion

In USTS, more than one UEs share the same scrambling code and the UEs are distinguished by channelisation codes. Since the number of channelisation codes is limited, an efficient channelisation code allocation rule is required.
In this contribution, we introduced a simple and efficient channelisation code allocation rule, and the proposed scheme was compared to RACH scheme. It was shown that by using the introduced channelisation code allocation rule, UTRAN can make more UEs share one scrambling code, which enhances the operation of USTS.

References

[1] R1-001160, “OVSF code allocation scheme for USTS”, Samsung Electronics Co., Ltd.

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