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**Agenda Item:**

**Source:** Samsung Electronics & SK Telecom  
**Title:** OVSF code allocation rule for USTS (Uplink Synchronous Transmission Scheme)  
**Document for:** Information and Discussion

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## **Introduction**

USTS is a technology applicable to low mobility terminals, which can reduce uplink intra-cell interference by making UEs share a scrambling code and the cell receives orthogonalized signals from the UEs that share the same scrambling code. 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 [1-12].

In the USTS, the same scrambling code can be allocated to more than one UEs. Whenever more than one UEs share the same scrambling code, different channelisation codes should be allocated to each UE. A UL DPCH of a UE needs at least two channelisation codes: one for DPCCH and the others for DPDCH. The DPCCH part of a UL DPCH has SF 256 and the DPDCH part of a UL DPCH can have variable SF from 4, 8, 16, 32, 64, 128 and 256. 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 (peak to average power ratio) [13].

The performance gain of USTS improves as more UEs share the same scrambling code. If OVSF codes are allocated inefficiently, fewer UEs can share the scrambling code. For example, assume that Cch,8,0 and Cch,256,32 are allocated to a UE for DPDCH and DPCCH, respectively, and Cch,8,2 and Cch,256,120 are allocated to another UE for DPDCH and DPCCH, respectively. Then no more OVSF code with SF 8 can be allocated in the upper half code tree. Since the SF of OVSF code for DPCCH is always 256 while the SF of OVSF code for DPDCH can be between 4 and 256, a special OVSF code allocation rule can be introduced to allocate OVSF codes to more UEs. For example, with an efficient OVSF code allocation rule, up to three UEs can be allocated with channelisation codes with SF 8 (for DPDCH) from the upper half of the code tree only.

This contribution introduces and proposes an efficient OVSF code allocation rule for USTS.

## **Discussion**

### **1. Procedure for USTS**

When USTS is applied,

1. the network allocates the same scrambling code to multiple UEs that use USTS in a cell,
2. different channelization codes are allocated to all dedicated physical channels across all UEs which share the same scrambling code to orthogonalize the channels,
3. the spreading factor and the channelization code for uplink DPDCH are delivered from network to each UE,
4. the UE shall choose the channelization code for uplink DPCCH from the same upper or lower half of the OVSF code tree as the assigned DPDCH channelization code to reduce PAPR, and
5. the signal transmission timing of all UEs are synchronized by UTRAN.

The mapping rule of channelisation code between DPDCH and DPCCH is specified in the next section.

### **2. Mapping Rule of Channelisation Code between DPDCH and DPCCH**

- The sub-trees below the nodes  $C_{ch,8,3}$  and  $C_{ch,8,7}$  are reserved for DPCCH.
- ***In the upper half code tree***, for the channelisation code for the DPDCH, the index  $k$  of  $C_{ch,SF,k}$  shall be chosen from the following range.

$$k = \begin{cases} 0,1,\dots,(\lfloor 3 \times SF/8 \rfloor - 1) & \text{if } SF \leq 64 \\ 0,2,\dots,46 & \text{if } SF = 128 \\ 0,4,\dots,92 & \text{if } SF = 256 \end{cases}$$

And, the channelisation code for the associated DPCCH shall be  $C_{ch,256,127-n}$ , where  $n = 64 \times k / SF$

- ***In the lower half code tree***, for the channelisation code for the DPDCH, the index  $k$  of  $C_{ch,SF,k}$  shall be chosen from the following range.

$$k = \begin{cases} \lfloor 4 \times SF/8 \rfloor, (\lfloor 4 \times SF/8 \rfloor + 1), \dots, (\lfloor 7 \times SF/8 \rfloor - 1) & \text{if } SF \leq 64 \\ 64,66,\dots,110 & \text{if } SF = 128 \\ 128,132,\dots,220 & \text{if } SF = 256 \end{cases}$$

And, the channelisation code for the associated DPCCH shall be  $C_{ch,256,255-n}$ , where  $n = 64 \times k / SF$ .

Using the above mapping rule, maximum of 48 UEs can be assigned with channelisation codes.

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.

### 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 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  $C_{ch,256,0}$  is allocated to a UE for DPDCH, then OVSF code  $C_{ch,256,127}$  is allocated to the UE for DPCCH as shown in red.

Example 2: If one of  $C_{ch,64,3}$ ,  $C_{ch,128,6}$ , and  $C_{ch,256,12}$  is allocated to a UE for DPDCH, then OVSF code  $C_{ch,256,124}$  is allocated to the UE for DPCCH as shown in blue.

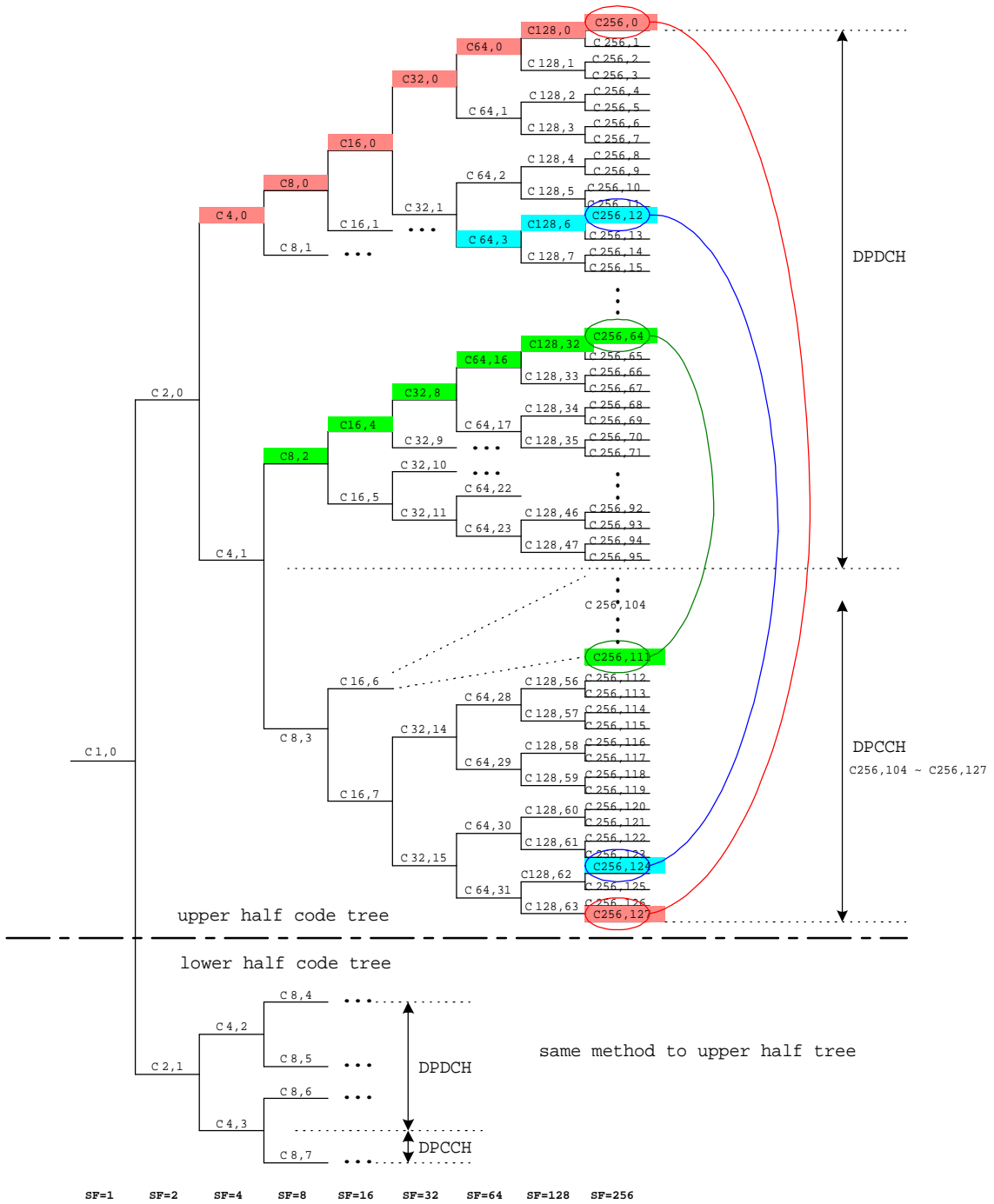
Example 3: If one of  $C_{ch,8,2}$ ,  $C_{ch,16,4}$ ,  $C_{ch,32,8}$ ,  $C_{ch,64,16}$ ,  $C_{ch,128,32}$ , and  $C_{ch,256,64}$  is allocated to a UE for DPDCH, then OVSF code  $C_{ch,256,111}$  is allocated to the UE for DPCCH as shown in green.

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.

### 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. Using the introduced channelisation code allocation rule, UTRAN can make more UEs share one scrambling code, which enhances the operation of USTS.



**Figure 1 OVFSF code tree and mapping rule**

## References

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