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Agenda Item : Ad hoc 14

Source : LG Information & Communications, Ltd.

Title : The Secondary Collision Detection for CPCH

Document for : Proposal

Abstract

This document proposes the Secondary Collision Detection reinforcing the capability of collision detection of CPCH with low complexity, no additional delay and no effects on the current collision detection configuration.

Introduction

In the existing CPCH [1], CD preamble and CD-AICH are used to prevent collision. If 16 signature sequences are used for CD preamble and CD-AICH, the possibility that two UEs will pick the same signature sequence is 1/16. In this case, the increase of UEs trying to access the BS would cause the increase of the probability of collision, and then the probability of collision would be more than 1/16. That eventually leads to a demand for more intensive scheme.

The document describes the scheme of improving the collision detection capability of current CD scheme, called the Secondary Collision Detection. Since it operates in only PC (Power Control) preamble part, it makes no effect on the access preamble and CD preamble and has no additional delay. Furthermore, it has low complexity because it utilizes the existing L1 configuration.

Proposal

We propose a new secondary collision detection scheme. It works after the collision detection of the current CD preamble and CD-AICH and dramatically reduces the probability of collision. The suggested Secondary Collision Detection simultaneously operates with PC preamble and uses dummy field of the data and control parts on PC preamble because there are some dummy parts on PC preamble of current CPCH [1].

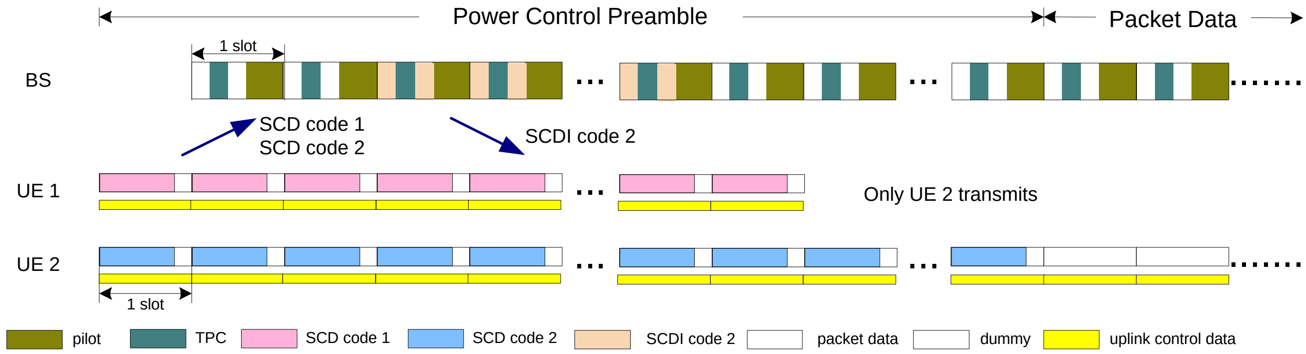
In the document, we consider the case that the spreading factor of DL-PC preamble is 512, the spreading factor of the control part of UL-PC preamble is 256 and the spreading factor of the data part of UL-PC preamble is less than 64. But regardless of the change of spreading factor, the proposed scheme is feasible.

(1) Basic concept

In this scheme, two kinds of orthogonal codes called SCD (Secondary Collision Detection) code and SCDI (Secondary Collision Detection Indicator) code are defined. SCD code is randomly picked up among the predetermined SCD code set and transmitted by UE. It helps BS detect collision. On the other hand, SCDI code is used for BS to acknowledge each UE. SCDI code is deliberately determined and transmitted by BS. Each BS and each UE have the same SCD and SCDI code set.

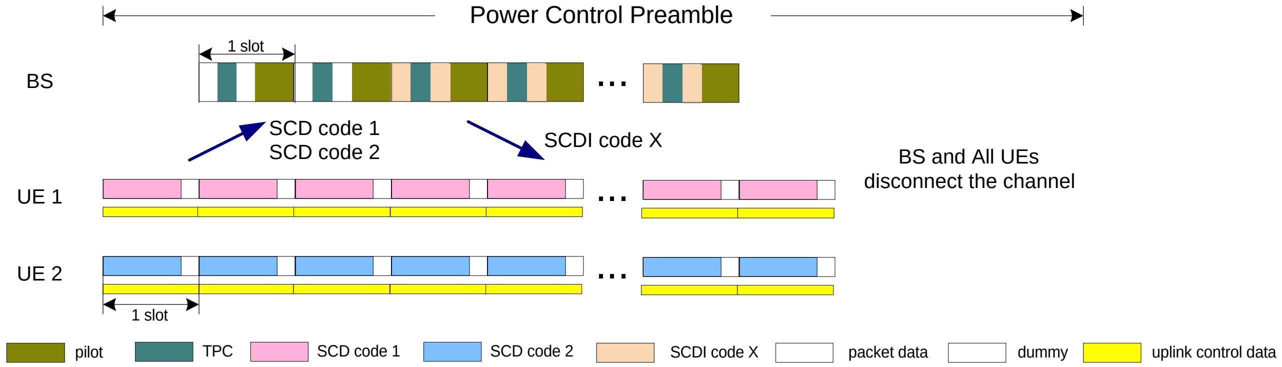
According to the process of BS after secondary collision detection, the scheme is classified into two operating modes. At the mode 1, BS picks up one UE after detecting collision. On the other hand, At the mode 2, BS takes away all UEs and disconnect the channel when detecting collision.

Figure 1 shows the configuration of the Secondary Collision Detection in the mode 1 and assumes collision between two UEs happens. When PC preamble starts, Two UEs transmit SCD code 1 and 2. Then BS receives SCD codes and measures their powers regarding SCD codes in the first slot on UL-PC preamble. If the power of SCD code 2 is higher than that of SCD code 1, then BS picks up UE 2 and transmits SCDI code 2. Since UE 2 is selected, UE 2 transmits its packet data after the power control preamble ends, but UE 1 disconnects the channel and re-transmits AP (Access Preamble).



[Fig. 1] The configuration of the Secondary Collision Detection (Mode 1)

We recommend the mode 1. However, an optional scheme, the mode 2 shown in figure 2 can be also applied. In the mode 2, when BS detects collision, it removes the channel. Two UEs shown in figure 2 transmit SCD code 1 and 2. If BS detects two or more SCD codes, it repeatedly transmits SCDI code X that indicates all UEs must disconnect the channel and continually step down UE power by TPC-DOWN command. After transmitting SCDI code X, BS disconnects the DL-DPCCH and All UEs stop transmitting the UL-PC preamble. Subsequently, UEs apply a short random back-off period before re-transmitting AP. Unlike SCDI codes in the mode 1, SCDI code X should not correspond to any SCD codes.



[Fig. 2] The configuration of the Secondary Collision Detection (Mode 2)

(2) SCD code & SCDI code

SCD and SCDI code use the same Hadamard codes of length 16 or 32. We recommend that SCD and SCDI code are from the set of 16 or 32 Hadamard codes of length 16 or 32. It depends on operators whether the length of Hadamard codes is 16 or 32. The SCD and SCDI codes of length 16, SC_{16} are listed in Table 1.

	16 SCD & SCDI codes															
	h_0	h_1	h_2	h_3	h_4	h_5	h_6	h_7	h_8	h_9	h_{10}	h_{11}	h_{12}	h_{13}	h_{14}	h_{15}
$SC_{16,1}$	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
$SC_{16,2}$	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1	1	-1
$SC_{16,3}$	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1
$SC_{16,4}$	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1	1	-1	-1	1
$SC_{16,5}$	1	1	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1
$SC_{16,6}$	1	-1	1	-1	-1	1	-1	1	1	-1	1	-1	-1	1	-1	1
$SC_{16,7}$	1	1	-1	-1	-1	-1	1	1	1	1	-1	-1	-1	-1	1	1
$SC_{16,8}$	1	-1	-1	1	-1	1	1	-1	1	-1	-1	1	-1	1	1	-1
$SC_{16,9}$	1	1	1	1	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1
$SC_{16,10}$	1	-1	1	-1	1	-1	1	-1	-1	1	-1	1	-1	1	-1	1
$SC_{16,11}$	1	1	-1	-1	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1
$SC_{16,12}$	1	-1	-1	1	1	-1	-1	1	-1	1	1	-1	-1	1	1	-1
$SC_{16,13}$	1	1	1	1	-1	-1	-1	-1	-1	-1	-1	-1	1	1	1	1
$SC_{16,14}$	1	-1	1	-1	-1	1	-1	1	-1	1	-1	1	1	-1	1	-1
$SC_{16,15}$	1	1	-1	-1	-1	-1	1	1	-1	-1	1	1	1	1	-1	-1
$SC_{16,16}$	1	-1	-1	1	-1	1	1	-1	-1	1	1	-1	1	-1	-1	1

[Table 1.] The set of SCD and SCDI code of length 16

The SCD and SCDI codes of length 32, SC_{32} are generated by means of the following:

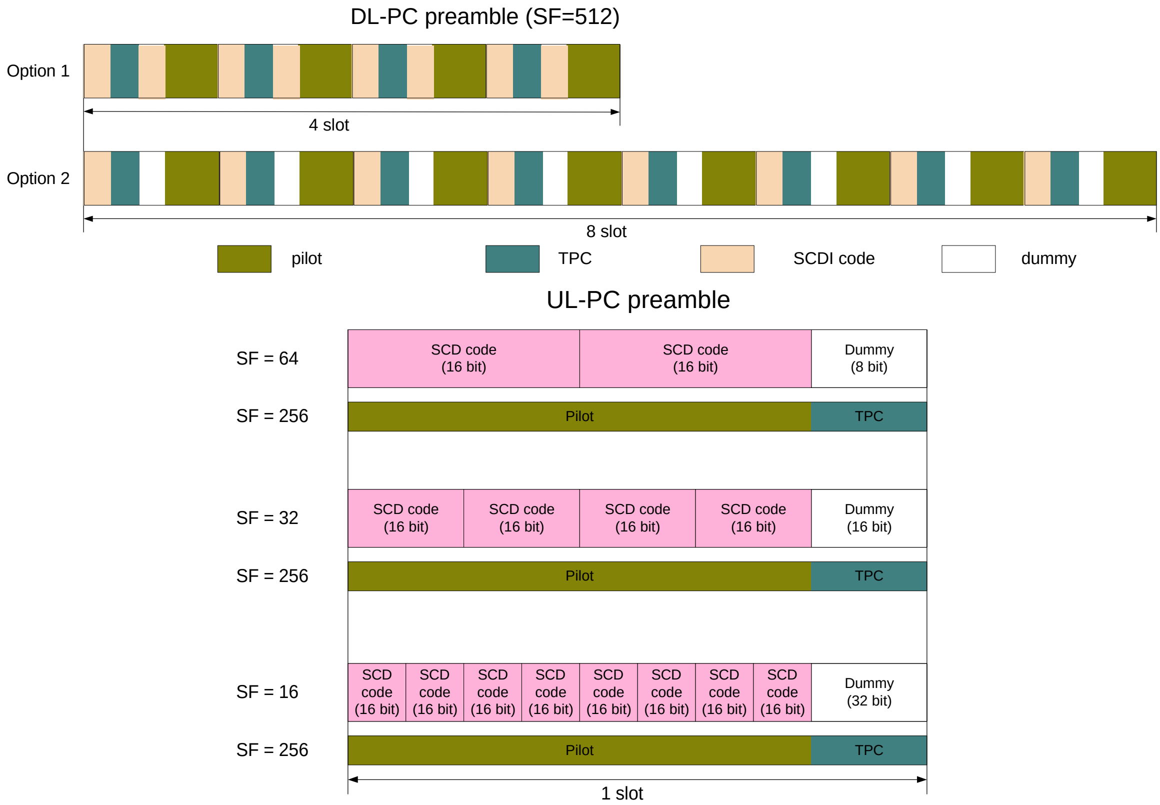
$$SC_{32} = \begin{bmatrix} SC_{16} & SC_{16} \\ SC_{16} & \overline{SC_{16}} \end{bmatrix}$$

The data part of UL-PC preamble consists of one or more repetitions of a length 16 codes, $SC_{16,i}$ where i = 1,2,…,16 or a length 32 codes, $SC_{32,i}$ where i = 1,2,…,32 and dummy data, as shown in figure 3.

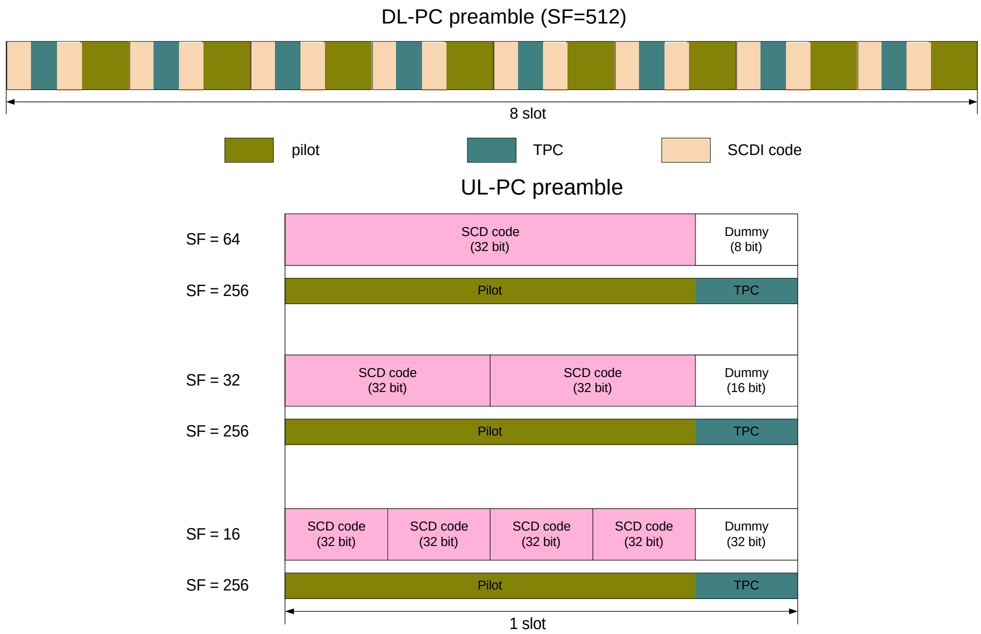
In mode 1, UE and BS can unlimitedly choose one code among 16 or 32 codes. On the other hand, in mode 2, one code among 16 or 32 codes is assigned to SCDI code X. Therefore, UE should randomly choose one code among 15 or 31 codes except predetermined SCDI code X. Information about SCDI code X would be broadcast by BS.

For the SCDI code of length 16, there are two structures of DL-PC preamble according to whether DPDCH field is used or not, as shown in figure 3(a). In the option 1, TFCI and DPDCH field are used and then the number of slots needed for transmitting one SCDI code is 4 slot. Whereas, in the option 2 where DPDCH field is not used, only TFCI field is used and then the number of slots needed for transmitting one SCDI code is 8 slot.

For the SCDI code of length 32, DPDCH field is used and the number of slots needed for transmitting one SCDI code is 8 slot, as shown in figure 3(b). It is because if DPDCH field is not used the total number of slots needed for the proposed scheme exceed 15 slot, that is 10 ms.



(a) The SCD and SCDI code of length 16



(b) The SCD and SCDI code of length 32

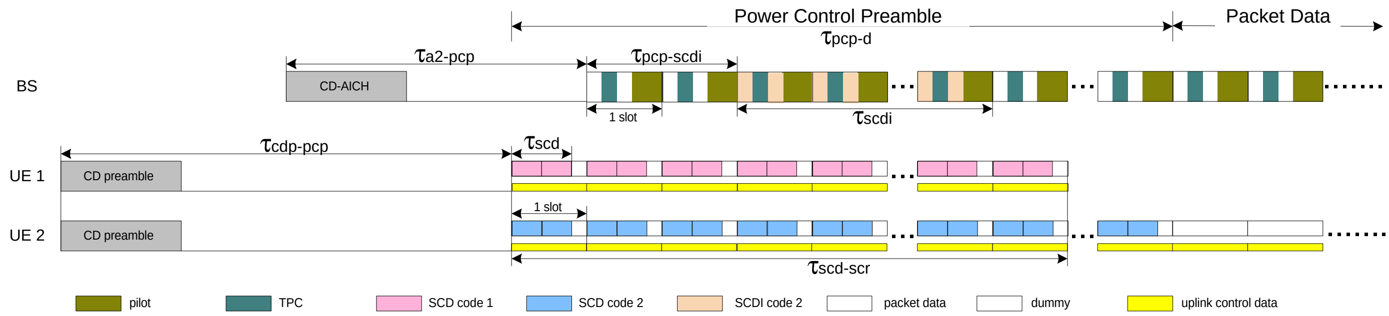
[Fig. 3] The possible structure of the power control preamble in the proposed scheme

The structure of the data part of UL-PC preamble varies according to the spreading factor of UL-PC preamble. Though the suggested structures vary according to the spreading factor of UL-PC preamble, they have the same timing, as shown in figure 3. In a slot, during the first 4/5 slot SCD codes are repeatedly transmitted and during the remaining 1/5 slot dummy data are transmitted. Since it is normally considered that the spreading factor of CPCH is less than 64, the case that SF=64, 32, 16 are described in figure 3.

The SCD and SCDI code are spread by a channelization code and subsequently scrambled by a scrambling code. The spreading and scrambling of SCD code on UL-PC (Up Link Power Control) preamble are the same scheme as that of data on UL-DPDCH. The spreading and scrambling of SCDI code on DL-PC (Down Link Power Control) preamble are the same scheme as that of data on DPDCH and DPCCH. Consequently, our proposed scheme demands only minor change at receiver structure.

(3) Timing

Figure 4 shows the possible timing of the proposed scheme. All parameters are set referring to the existing CPCH and RACH timing [2], [3].



[Fig. 4] The timing diagram of the proposed scheme

The meaning of each parameter in figure 4 are the followings:

$t_{cdp-pcp}$ = Time between the start of CD Preamble and the start of the UL-PC Preamble

= Time between AP to the next AP = t_{p-p} [2]

t_{a2-pcp} = Time between the start of CD-AICH and the start of DL-PC Preamble

= Time between the start of AP-AICH and the start of CD-AICH = $t_{a1-cdp} + t_{cdp-a2}$ [2]

$t_{pcp-scdi}$ = Time between the start of DL-PC Preamble and the start of transmitting SCDI code

= 2 slot

t_{scd} = The chip duration of transmitting SCD codes in a slot

= 2048 chips (= 4/5 slot)

t_{scdi} = The number of slots needed for transmitting one SCDI code

= 4 or 8 slot

$t_{scd-scr}$ = Time between the start of transmitting the first SCD code and

the end of the secondary collision detection

= 8 or 12 slot

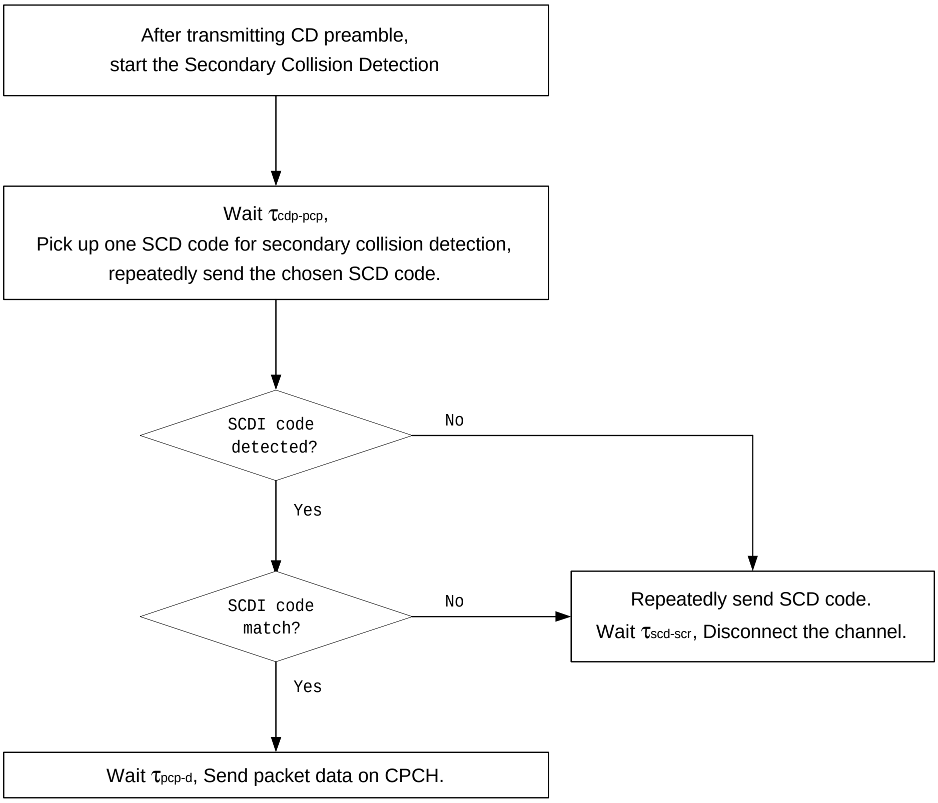
t_{pcp-d} = Time between the start of PC preamble and the end of PC preamble

$t_{cdp-pcp}$ corresponds to t_{p-p} and t_{a2-pcp} corresponds to $t_{a1-cdp} + t_{cdp-a2}$ defined in [2]. According to two options in figure 3(a), t_{scdi} will be 4 or 8 slot. For t_{scdi} = 4 slot, $t_{scd-scr}$ will be 8 slot and for t_{scdi} = 8 slot, $t_{scd-scr}$ will be 12 slot. Since the total processing time of the scheme is 8 or 12 slot, the modification of the duration of current PC preamble is not required.

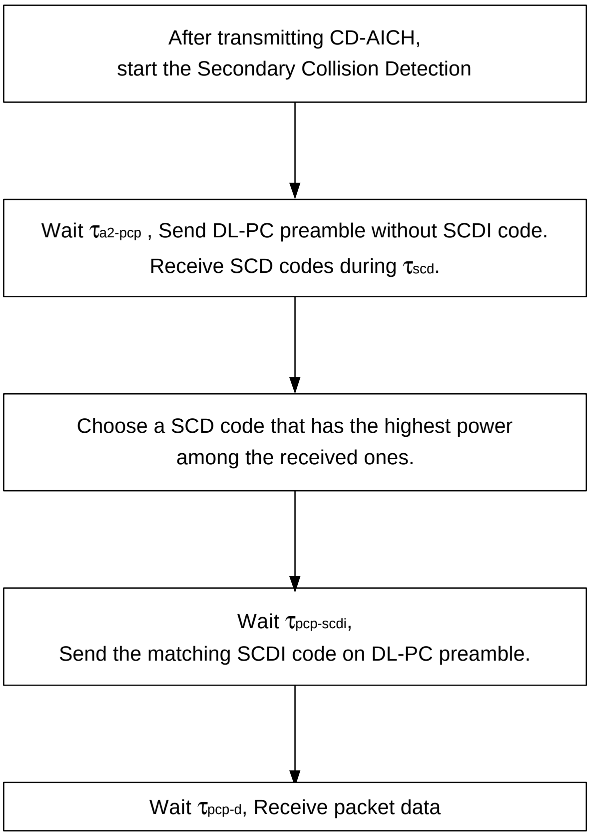
For secondary collision detection, BS receives a series of SCD code during the first 2048 chips, t_{scd} in the first slot on UL-PC preamble and determines which SCD code has the highest power. A series of SCD code in the remaining slots after the first slot on UL-PC preamble is used only for channel estimation.

(4) Procedures

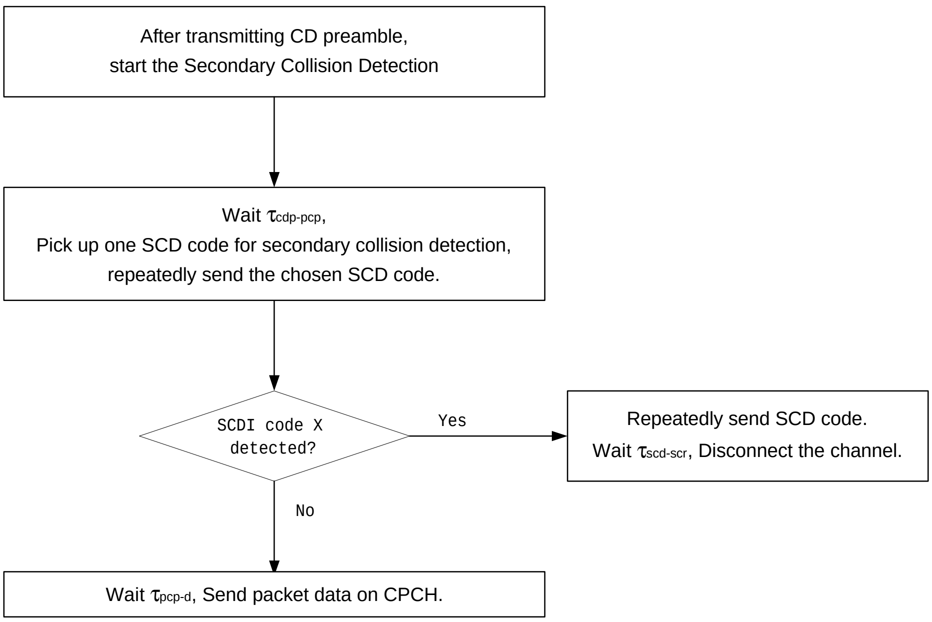
The flowcharts as shown in Figure 5~8 describe the simple procedure of the proposed scheme. Figure 5 and 6 show the procedure of the mode 1 and Figure 7 and 8 show the procedure of the mode 2.



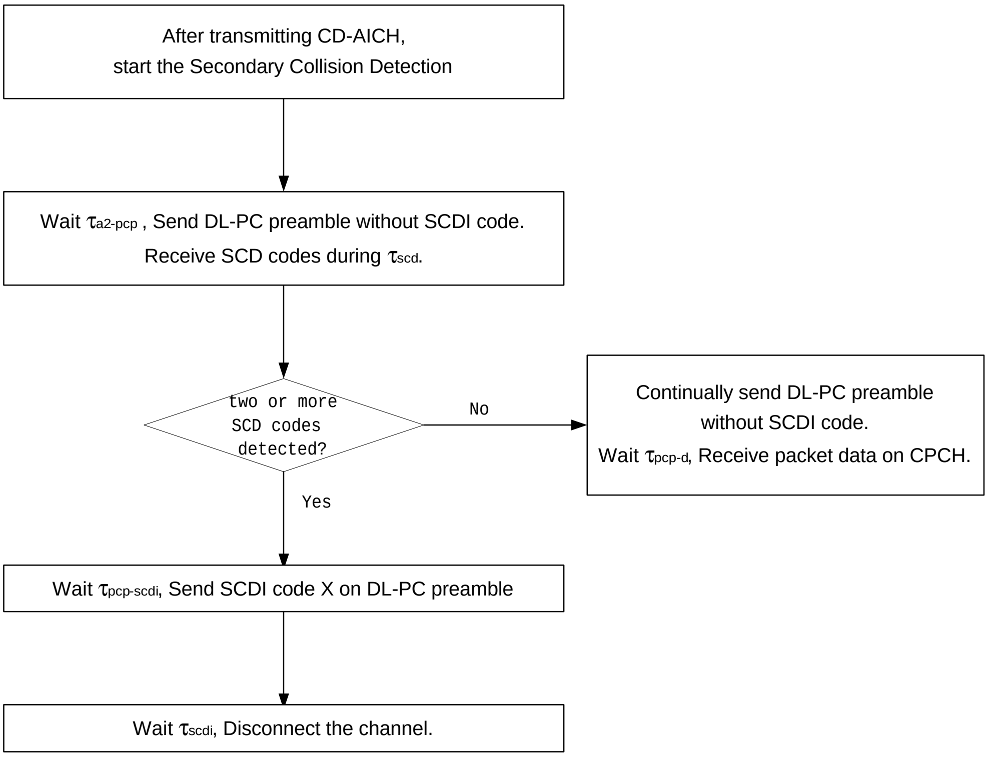
[Fig. 5] The procedure of the Secondary Collision Detection on the UE side (Mode 1)



[Fig. 6] The procedure of the Secondary Collision Detection on the BS side (Mode 1)



[Fig. 7] The procedure of the Secondary Collision Detection on the UE side (Mode 2)



[Fig. 8] The procedure of the Secondary Collision Detection on the BS side (Mode 2)

Conclusion

We proposed the Secondary Collision Detection. CPCH with the proposed scheme would diminish collision more and more. This has no additional delay and no effects on the current collision detection configuration. Moreover, this scarcely burdens the current system since the transmission of SCD code and SCDI uses the dummy field on current PC preamble. We recommend the scheme described above be adopted as working assumptions for CPCH.

Reference

[1] GBT, “CPCH physical layer procedures”, TSGR1#5(99)592

[2] GBT, “CPCH Access Procedures”, TSGR2#6(99)797

[3] TS 25.211 (V2.2.1): “Physical channels and mapping of transport channels onto physical channels (FDD)”