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Additional results on SSC modulation to indicate STTD encoding of the PCCPCH

Texas Instruments, May 25th, 1999

1.0 Introduction

In [1], T.I. proposed to modulate the SCH with a +1/-1 pattern to indicate the presence/absence of STTD encoding on PCCPCH, instead of the 1 bit L3 message transmitted on the PCCPCH. There were three concerns raised during WG1 # 4:

(1) Impact of the non-orthogonality of the SCH with the rest of the BTS channels, due to the absence of the long code was not taken into account in the simulations in [1].

(2) Whether an error rate of 10^{-3} as assumed in [1], is sufficient for satisfactory performance.

(3) A concern was raised that removing the 1 bit L3 message in the PCCPCH indicating the presence/absence of the diversity antenna will lead to the mobile entering an erroneous state.

This submission makes the following contributions to address the above issues:

(a) We show that the non-orthogonality of the SCH with the rest of the BTS channels does not have an effect on the performance of the algorithm presented in [1].

(b) It was decided in WG1 # 4, to use TSTD for the SCH. This implies that the performance of the algorithm presented in [1], will benefit from diversity in the presence of the diversity antenna, further improving the error rate in [1]. Our simulation shows that the worst case probability of missing the diversity antenna is less than $3*10^{-5}$.

(c) We agree with the third issue raised above. Hence, the 1 bit information on the PCCPCH indicating the presence/absence of the diversity antenna should not be removed. However, note that the SCH modulation does not require any additional bandwidth, power for transmission. Further, SCH modulation does not have any degrading effect on any other mobile algorithm.

Hence, we propose to include SCH modulation in addition to the 1 bit L3 message to indicate the presence/absence of the diversity antenna. A mobile can use both, the demodulation of the SCH and the 1 bit L3 message to further confirm the presence/absence of the diversity antenna.

2.0 Simulation results

Referring back to the simulations in [1], we can see that the 1-path fading scenario was the worst case (figure 5 of [1]). Hence we only consider the worst case 1-path fading scenario for the simulations in this submission. The same parameters as that specified in [2] for stage 1 and stage 2 acquisition performance are used for the orthogonal channel noise source (OCNS) and the other cell interference (I_{OC}) powers.

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	Single path model
Doppler	5 Hz.
N, number of slots for averaging	64
Channel estimation	2 slot WMSA from PCCPCH
PCCPCH power	Assumed to be the same as SCH
Non-orthogonality of the other channels of the BTS with respect to the SCH	Taken into account by an AWGN noise source added to the SCH and passed through a fading channel.
Primary BTS/Other cell interference power	-8 to –2 dB [2]
SCH power as a ratio of the BTS power	10 %
SCH power/Other cell interference power (CNR)	-18 to – 12 dB
Performance: probability of *falsely detecting* the presence of the diversity antenna	< $\boldsymbol{2*10^{-3}}$ (Figure 1)
Performance: probability of *missing* the presence of the diversity antenna	< $\boldsymbol{3*10^{-5}}$ (Figure 2)

Table 2: *Simulation parameters for demodulating the SCH to detect STTD encoding of PCCPCH.*

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Figure 1: *The probability of false detection of the diversity when the diversity antenna is absent, using the SCH modulation is shown for a single path channel and a Doppler of 5 Hz. Even for an SCh CNR of –18 dB we can see that with a 4 frame averaging (N = 64), the probability of false detection is less than 2* 10^(-3).*

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Figure 2: *The probability of miss when the diversity antenna is present, using the SCH modulation is shown for a single path channel and a Doppler of 5 Hz. For a SCH CNR of -18 dB we can see that with a 4 frame averaging (N = 64), the probability of error less than 3*10^(-5).*

Based upon the simulations in figures 2, 3 we can conclude that taking into account the OCNS, for a 64 msec. averaging, the probability of falsely detecting the diversity antenna (figure 1) is less than $2*10^{-3}$, and the probability of miss is less than $3*10^{-5}$. From the simulations presented in [3], recall that even if the mobile falsely assumes the presence of the diversity antenna, it can still STTD decode the PCCPCH with a minor degradation of 0.2-0.3 dB. On the other hand, the case of missing the presence of the diversity antenna is not very good. But, as can be seen from above, the probability of miss is much lower (3*10^(-5)) because of the TSTD diversity on the SCH.

As mentioned in point (C) in section 1.0, we propose to keep the 1 bit L3 information indicating the presence/absence of the diversity antenna. The SCH modulation in conjunction with this 1 bit L3 information can be used to further improve the probability of detecting STTD encoding of PCCPCH.

3.0 Conclusions

We have proposed to modulate the SCH with a +1/-1 symbol to allow the mobile to detect the presence/absence of the STTD encoding of PCCPCH. Even after taking into account the OCNS, simulations show that the probability of falsely detecting the diversity antenna for a single path 5 Hz. fading channel is less than $2*10^{-3}$ and the probability of missing the presence of the diversity antenna is less than $3*10^{-5.}$

Thus the mobile can reliably detect the presence/absence of STTD encoding of PCCPCH in a very short time (less than 40 msec.) by demodulating the SCH. This technique can be further used in conjunction with the 1 bit L3 message on the PCCPCH, to further improve the detection of the presence/absence of the diversity antenna.

References

[1] Texas Instruments, "Fast reliable detection of STTD encoding of PCCPCH with no Tdoc 372/99, 3Gpp RAN WG1#4, April, 1999, Yokohama, Japan.
[2] AdHoc 12, "Report from A Hoc 12: Cell Search", Tdoc 237/99, 3Gpp RAN WG1#3, March 1999, Nynashamn, Sweden.
[3] Texas Instruments, "STTD encoding of PCCPCH", Tdoc 83/99, 3Gpp RAN WG1#2, February, 1999, Yokohama, Japan.

Text proposal

----------------------------------Begin modification for S1.11 document text section 5.3.3.1.1--------------------

5.3.3.1.1 Primary CCPCH structure with STTD encoding

In case the diversity antenna is present at the base station and the PCCPCH is to be transmitted using open loop transmit diversity, the data symbols of the PCCPCH are STTD encoded as given in section 5.3.1.1.1, figure 7 and figure 8. The base station transmits a L3 message on the broadcast channel (BCH) indicating whether STTD encoding is used for the PCCPCH or not. ~~During power on and hand over between cells the UE determines the presence of STTD encoding on the PCCPCH, by receiving the L3 message or by detecting the diversity antenna pilot symbol pattern.~~ In addition, the base station indicates the presence/absence of STTD encoding on PCCPCH, by modulating the SCH. During power on and hand over between cells the UE determines the presence of STTD encoding on the PCCPCH, by either receiving the L3 message, by demodulating the SCH channel or by detecting the diversity antenna pilot symbol pattern or by a combination of all the above three schemes.

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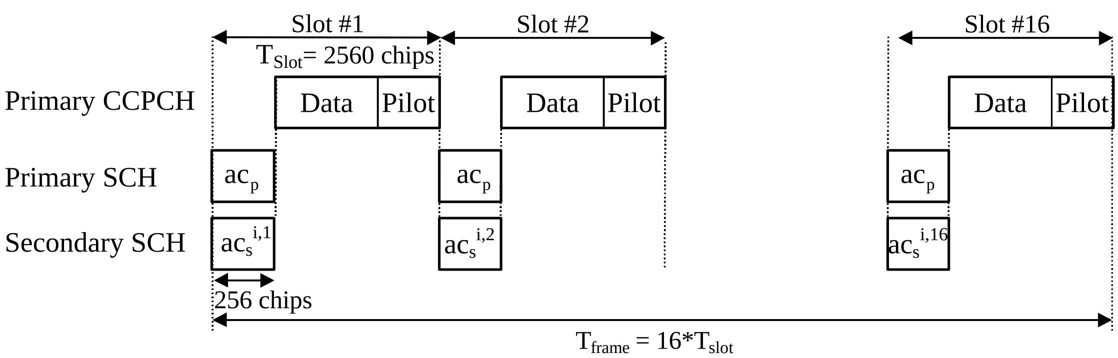
----------------------------------Begin modification for S1.11 document section 5.3.3.3--------------------

5.3.3.3.Synchronisation Channel

The Synchronisation Channel (SCH) is a downlink signal used for cell search. The SCH consists of two sub channels, the Primary and Secondary SCH. Figure 15 illustrates the structure of the SCH and the transmission timing relationship with the Primary CCPCH:



c_p : Primary Synchronization Code
$c_s^{i,k}$: One of 17 possible Secondary Synchronization Codes
$(c_s^{i,1}, c_s^{i,2}, \ldots, c_s^{i,16})$ encode cell specific long scrambling code group i
a: Modulation on primary and secondary synchronization codes to indicate STTD encoding on PCCPCH

Figure 15: Structure of Synchronisation Channel (SCH).

The Primary SCH consists of an un***modulated* code** of length 256 chips, the Primary Synchronisation Code, transmitted once every slot. The Primary Synchronisation Code is the same for every cell in the system and is transmitted time-aligned with the period where the Primary CCPCH is not transmitted as illustrated in- Figure ( )Figure 1.

The Secondary SCH consists of repeatedly transmitting a length 16 sequence of un ***modulated* codes** of length 256 chips, the Secondary Synchronisation Codes, transmitted in parallel with the Primary Synchronisation channel. Each Secondary Synchronisation code is chosen from a set of 17 different codes of length 256. This sequence on the Secondary SCH indicates which of the 32 different code the cell's downlink scrambling code belongs. 32 sequences are used to encode the 32 different code groups each containing 16 scrambling codes.

The primary and secondary synchronization codes are modulated by the symbol *a* shown in figure 15, which indicates the presence/ absence of STTD encoding on the PCCPCH and is given by the following table:

PCCPCH STTD encoded	a = +1
PCCPCH not STTD encoded	a = -1

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