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Title: Method and Algorithm for the GSM cell reconfirmation

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1. Abstract

In this contribution we present an enhanced method for the BSIC reconfirmation procedure for GSM neighbouring cells from UTRA during a connection. It is assumed that the UE has successfully decoded a first SCH burst of the GSM cells, which should be observed. The present scheme performs the BSIC reconfirmation procedure basically by capturing and decoding a SCH burst. This is done for a single receiver UE during a transmission gap in compressed mode. In the case, if no compressed mode is available it is up to the UE to indicate the SCH scheduling to the upper layers. The network decides the target time for reconfirmation and makes transmission gaps available. To confirm the BSIC of a GSM cell the SCH burst is decoded and the CRC is checked. If this check is passed the reconfirmation was successful.

We propose now to use the normal burst of the GSM broadcast and common control channel as well as the SCH burst. According to the GSM specifications [3] for broadcast and common control channels, the training sequence code must be equal to the BCC (base station colour code) which is part of the BSIC and known to the mobile after first SCH decoding. To perform the BSIC reconfirmation using the normal burst of the GSM broadcast and common control channel a correlation algorithm and the pre-knowledge concerning the training sequence code is used.

2. Introduction

The only way of monitoring available GSM cells properly during a UMTS connection with a single receiver UE is to use transmission gaps within a compressed mode pattern. For the first synchronisation with GSM cells from UTRA various schemes were evaluated. All efforts are done to minimise the idle period time and the unavoidable loss in channel capacity.

Aiming to the same goal of minimising the capacity loss and offering a more flexible way to distribute transmission gaps this paper presents an enhanced method for BSIC reconfirmation regarding GSM target cells. This implies that the first synchronisation is already performed [1].

The paper is organised as follows. First some background is described. Then our new method is presented and the performance of the proposed scheme is investigated. Therefore we have run computer simulations using a propagation profile for the rural area environment (RA50) as defined in GSM recommendations [4]. At last the conclusions are drawn and advantages are summarised.

3. Background

Whereas the UMTS UE monitors available GSM base stations for a possible intersystem handover to GSM a GSM mobile monitors 6 neighbour cells for a possible handover. Assuming that the initial neighbour cell search and detection was performed successfully the timing and the carrier frequency of the broadcast control channel as well as the BSIC of the target GSM cell is known. The BSIC data build by the base station colour code and the network colour code can be derived from the decoded SCH burst. The SCH burst contains two times 39 information bits, a unique 64 bit extended training sequence and some tail bits. The data - among other things the BSIC - carried by the information bits are convolutional coded by a rate of ½. A 10 bit CRC is used for error detection.

In order to recognise a required reselection, a reconfirmation of each monitored target cell must be performed from time to time. Therefore a periodical SCH evaluation of the monitored neighbour and serving cells is initiated by the network. Conventionally after the GSM channel equalizer and decoder a CRC error detection checks the received information bits, which surround the training sequence. If the CRC check is passed the reconfirmation of the specific cell is successful. If the CRC check fails repeatedly, the cell will be degraded. The cell will be replaced by an appropriate candidate and the neighbour cells list will be updated.

Regarding the time structure of the GSM broadcast and downlink common control channels the SCH is located one frame (8 burst periods) after the FCCH at frame number 1, 11, 21, 31 and 41. Each of those two channels uses 5 slots in each 51*8 burst period cycle. In all cells, the slots of these channels have the same position within the 8 burst period cycle, that is to say the same time slot number. This position is called TN 0. Frame number 3,4,5,6 at TN 0 within a 51 Frame cycle is occupied with the broadcast control channel. Frame number 7,8,..,10,13,14,..,20 and depending on the base station configuration 23,24,..,30,33,34,..,40,43,44,..,49 contain the paging channel. The burst structure of both the broadcast control channel and the paging channel is a normal burst. As defined in [3] for broadcast and common control channels, the training sequence code must be equal to the base station colour code.

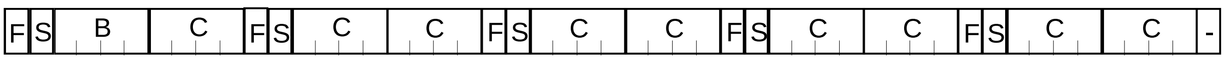

Figure 1: O*rganisation of the GSM broadcast and downlink common control channel (BCCH and CCCH configuration)*

New cell reconfirmation scheme

downlink common channels additionally to the synchronisation burst for the GSM cell reconfirmation within UTRA connected mode. As mentioned above the

decoding of the SCH burst the frame number and the training sequence number can be maintained.

A basic issue using the proposed reconfirmation is to find an adequate testing algorithm for the normal burst evaluation

training sequence a correlation algorithm is chosen and the following is evaluated:

$$\frac{\left[\sum_{k}^{25}\left((t-)+n_I(t\ \ k)\right)\cdot TR(\ -k)\right]^2+\left[\sum_{k=}^{25}\left((t-)\ \ n_Q(t\ \ k)\right)\cdot TR(\ -k)\right]^2}{\sum_{=0}^{25}\left[\left((t-)+n_I(t\ \ k)\right)^2+\left(r\ (-k)+\ _Q(t-)\right)^2\right]}$$

With:

	$r_I + n_I$	received inphase signal including the original sent bit r_I plus AWGN (n_I)
	$r_Q + n_Q$	received quadrature signal including the original sent bit r_Q plus AWGN (n_Q)
	TR	training sequence of the normal burst (length: 26 symbols)

The numerator of the equation represents the correlation with the training sequence of the normal burst, whereas the denominator computes the received power, which is added within a time range corresponding to the training sequence length.

Figure 2 presents the investigated normal burst detection and cell reconfirmation scheme in a comprehensive way. The first part represents the computation as described above, afterwards the maximum peak detection and threshold decision is done. The evaluation assumes a timing variance of some ten GSM symbols. Compared to the SCH principle at the end of the new scheme for normal bursts, instead of the CRC Parity check, a threshold query is executed. For our simulations a threshold of about 10.0 is chosen to be constant and delivers the best results. The performance of the SCH detection is used as reference even if a small error remains due to the CRC check. An achieved result below the threshold leads to the rejection of a cell and triggers after certain repeated failures a cell reselection. A result higher than the threshold causes an acknowledgement and a reconfirmation of the evaluated cell.

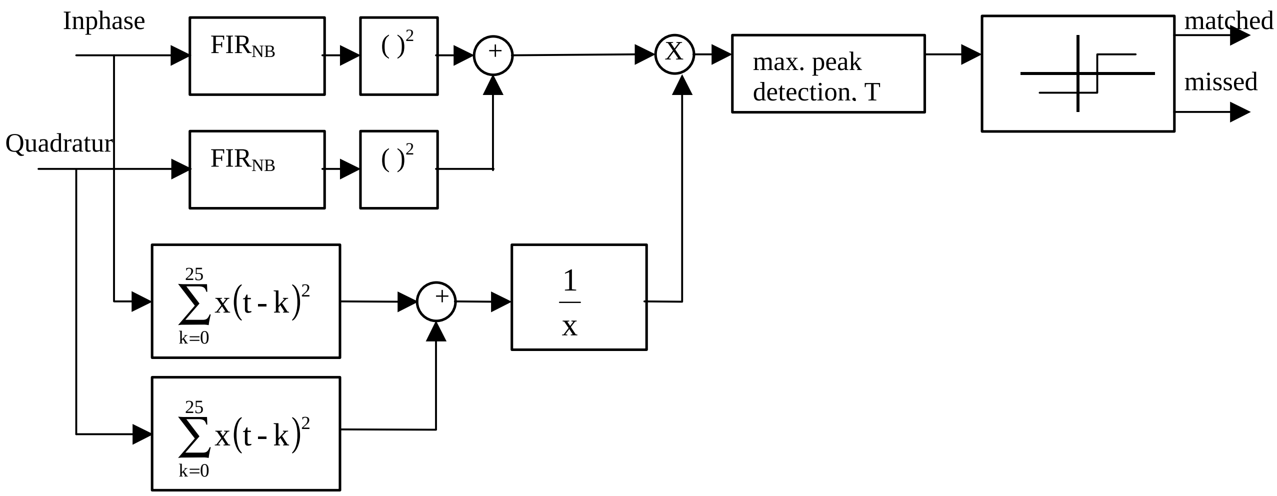

Figure 2: *Proposed NB detection for GSM cell reconfirmation*

5. Simulation results

The main task of our simulation was to compare the properties of our new scheme and the conventional BSIC reconfirmation. The simulations show that the normal burst detection delivers similar results in comparison to the CRC error detection method. To examine GSM reconfirmation properties from UTRA in connected mode we chose the rural area environment (RA50) propagation profile as defined in [4]. For all simulations presented in this chapter a consistent threshold for the normal burst reconfirmation procedure was applied.

The following table demonstrates two different probabilities assisting the comparison between the two reconfirmation methods. P(NB failed | SCH detected) represents the probability, that the normal burst reconfirmation method fails provided a successful SCH detection.

SNR	**5 dB**	**8 dB**	**11 dB**
P(NB failed | SCH detected)	0,082	0,039	0,022
P(NB detected | SCH failed)	0,116	0,115	0,135

Table 1: *Properties of new reconfirmation method*

Figure 3 shows the probability that a GSM cell reconfirmation is rejected using a rural area RA50 environment. An error is caused if a CRC Parity check is missed or if the result of the normal burst evaluation is below the threshold, respectively. The two curves behave similarly.

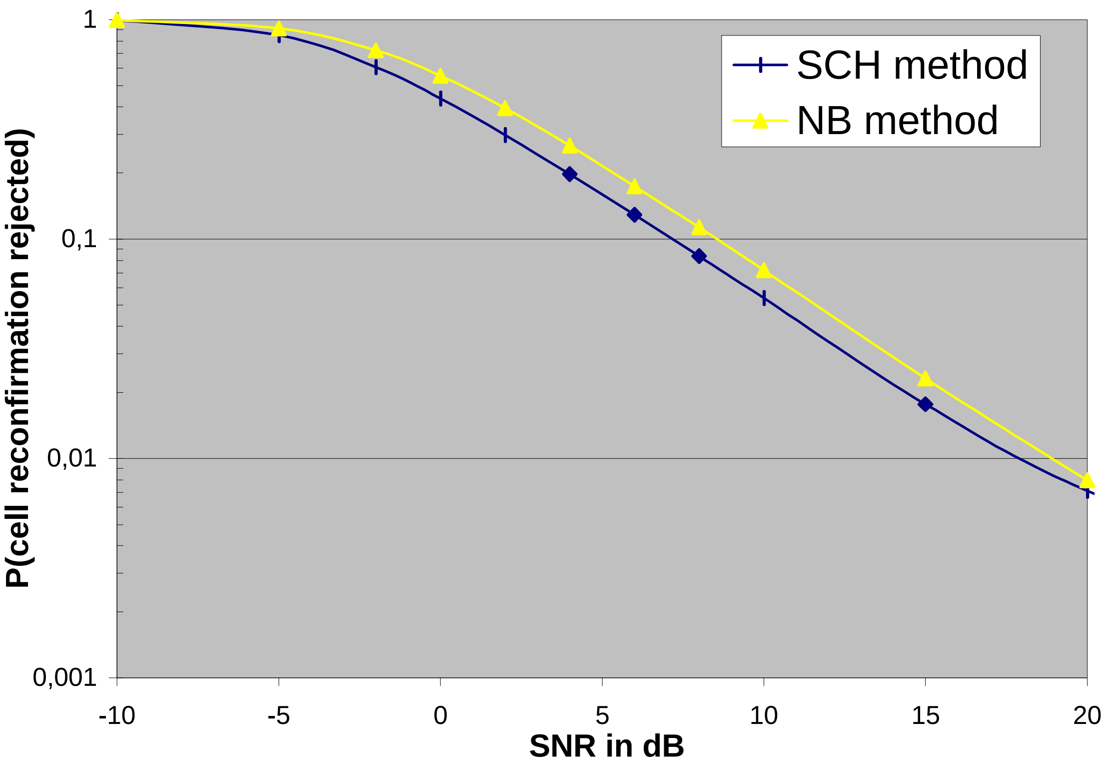

Figure 4: *Probability of rejecting a GSM cell reconfirmation (versus prevailing SNR)*

6. Advantages of the proposed scheme

The advantages of using the normal burst of the GSM broadcast and downlink common control channel in addition to the synchronisation burst (SCH) for the GSM cell reconfirmation are:

- The repetition rate of a normal burst is about 4 till 8 times higher than the SCH frequency depending on the GSM base station configuration
- The reconfirmation scheduling is simplified and a receivable GSM base station can be found and acknowledged faster
- A more flexible way of distributing downlink transmission gaps is obtained using the new method
- Less required computational and processing power because no decoding of data is needed
- TGL can be reduced

7. References

[1] Spec TSG RAN WG 1 TS 25.231 (V0.3.0); Physical layer – Measurements
[2] Spec TSG RAN WG 1 TS 25.212 V1.1.0; Multiplexing and channel coding (FDD)
[3] Digital cellular telecommunications system (Phase 2); Multiplexing and multiple access on the radio path (GSM 05.02 version 4.9.0)
[4] Digital cellular telecommunications system (Phase 2); Radio transmission and reception (GSM 05.05 version 4.21.0)