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Comments on the proposed RACH sequence structure

Introduction

In the meeting No. 3 Tdoc R1-99205 presented a new solution for the PRACH signature sequences with improved autocorrelation properties and solution for a receiver with specific matched filter for those sequences. In this paper some concerns from the implementation perspective are raised taking into account the overall system aspects, including packet mode operation in the uplink. A more suitable RACH preamble spreading code is presented that would harmonise the receiver structure for both DPDCH and RACH.

Comments on the complexity reduction

EGC improves only the MF part of the receiver, the impulse response averaging is the same and hence the overall complexity reduction is quite small. If the same HW is used for both RACH and DPDCH the EGC actually increases complexity.

Co-existence with uplink CPCH

Recently a promising method has been proposed to deal with the packet mode connections in the uplink direction from T1P1 side. The concept of uplink common packet channel (Uplink CPCH) uses the RACH process to initiate the transmission over several frames with fast power control active, where the “normal” RACH operation uses typically only one frame without fast power control.

The proposal has been recently optimised to work with all scenarios together with a low rate dedicated channel in the downlink.

Looking at the implementation aspects the following is desirable from Uplink CPCH point of view

- It should be possible to transfer dedicated channel receiver resources for CPCH use (and vice versa)
- It should be from modular implementation point of view possible to have single physical resource for detecting both CPCH request (identical to RACH phase) and as well as demodulating the CPCH and sending the downlink DCH. This facilitates fast L1 acknowledgement and channel activation with CPCH operation.

The proposed solution aims for optimised PRACH specific receiver resource but on the other hand makes the implementation of the Uplink CPCH type operation less attractive due to desired separate physical resources for PRACH specific operation.

Therefore the PRACH signature sequences (or signature in general) should be optimised without forgetting the packet access capabilites in the uplink direction and not to focus on optimising only a single RACH receiver as such.

More suitable solutions for PRACH operation

One possibility is to use long code of length 4096 (same generator as for DPDCH can be used to reduce both MS & BS complexity) as RACH preamble spreading code and a set of orthogonal sequences of length 16 for signatures. The autocorrelation function of a long code is depicted in figure 1. As can be seen, the MAS is around 250 which is better than that of orthogonal Gold sequences and in practice good enough for detecting the preamble correctly (though the acf is worse than acf of Golay sequences).

Figure 1. Aperiodic autocorrelation function of a random code of length 4096 modulated by a 16 bit sequence.

But what is more important than autocorrelation is the ability to use the same HW resources for both RACH and other channels. Consider a large cell where cell radius is more than what one RACH receiver can handle. In this case two or more RACH receivers are needed to cover the time uncertainty. If the same HW can be used for both RACH and DPDCH, only SW configuration is needed to reconfigure the BS for all cell sizes.

Another issue is redundancy. If RACH receiver fails and is unable to continue operation, any other receiver may be automatically configured to take care of RACH reception. If separate HW is used for RACH, there has to be at least one redundant unit for RACH only which isn't very efficient.

Conclusions

It is proposed in this paper not to adopt a solution optimising a single RACH receiver but rather to work for solution that allows modular implementation of advanced features such as Uplink CPCH and harmonising the receiver structure for both RACH and other channels.

Following proposal for RACH was outlined:

- Use of long random code for RACH preamble providing adequate autocorrelation and crosscorrelation properties.

- Allows efficient use of HW resources which is more important than very good autocorrelation function.