TSG-RAN Working Group 1 **_TSG R1#7 (99)a85_**
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Source: Lucent Technologies

Title: Comments on RACH preamble design

Document for: Agreement

Agenda item:

1 Introduction

During WG1 #6, it was agreed to update TS 25.213 [1] to reflect agreements made within Ad Hoc 3 concerning the RACH preamble structure. However, the exact structure of the scrambling code has not yet been agreed in WG1.

This contribution raises some questions over the Golay-Hadamard sequence based RACH preamble design. It also notes that the revised RAN Plenary workplan [2] requires that TS 25.213 is raised to version 3.0.0 by RAN #5 (scheduled for 6-8 October 1999).

The Golay-Hadamard based design has not been thoroughly studied in WG1. We present some initial simulation results which suggest that the Golay-Hadamard design does not perform as well as the Gold code based approach proposed previously [3]. Lucent can make extensive simulation results available when needed.

2 Comments on RACH preamble code properties

The proposed Golay-Hadamard sequence based RACH preamble design [4] claims a number of advantages. However, the simulation conditions under which these advantages are claimed are unclear. Further, the claimed advantages do not apply in all cases.

1) Claimed correlation properties advantages:

Depending on the choice of parameters Wn and Pn in the recursive equation for sequence generation, under section 5.1, the 256 chip long constituent Golay pairs A and B may exhibit very high cross correlation peaks. Also, it is not apparent that low cross correlation peaks are guaranteed between two 4096-sample sequences, even when the constituent pair A and B has low cross-correlation peaks through optimization over Wn and Pn.

A and B having low cross-correlation peaks does not translate automatically to low cross correlation peaks among the transformed pairs ($\overline{A}$, $\overline{B}$), (A^r, B^r), ($\overline{A}^r$, $\overline{B}^r$), ($A^{\$}$, $B^{\$}$), ($\overline{A}^{\$}$, $\overline{B}^{\$}$), ($A^{2r}$, B^{2r}), and ($\overline{A}^{2r}$, $\overline{B}^{2r}$). Also, when the search range is in excess of 256 chips, large peaks may occur between pairs of different transform pairs. For example, the constituent sequence A will have to be cross correlated with the sequences A, B, $\overline{A}$, $\overline{B}$ if the search range is 1024 chips, and there is no guarantee that A will have low cross-correlation peaks with all these four sequences.

2) Claimed code optimisation advantages:

Regardless of the type of code to be used for the preamble, such a code should be chosen from a set of codes that have been searched a priori to have 'good' correlation properties. Thus, the set of usable preambles must be identified (through optimisation) at the system level. Also, unless an exhaustive search of all codes is performed, it is not possible to state whether one code method has inherently better properties over another.

From an optimization point of view, the number of different combinations of parameters for optimization can be an indicator of whether codes with 'better' correlation properties can be found in relative abundance or not.

For the Golay-pair-based preamble, the number *N* of constituent Golay pairs (A,B) are determined as follows:

$$\begin{aligned} N &= N_{Wn} \times N_{Pn} \\ &= 2^8 \times 8! \\ &= 10{,}321{,}920 \end{aligned}$$

(Golay based preamble)

Since the transformations proposed are fixed, the total number of 4096-long preambles is N = 10,321,920.

For the 25-bit Gold-code-based code, the number *N* of combinations of codes is given by the different number of initial states 0:23 of the shift-register 1, i.e.:

$$\begin{aligned} N &= 2^{24} \\ &= 16{,}777{,}216 \end{aligned}$$

(25-bit Gold-code based preamble)

Thus, the number of 'possible' codes is actually larger in the case of the Gold based proposal, and assuming that on average the Gold and Golay based preambles have 'similar' correlation peak properties, then the set of all Gold code preambles will have 'more' codes with 'good' correlation properties than the set of all Golay based preambles.

Consequently, the performance benefits of the proposed Golay based design are unclear. In light of the need to approve TS 25.213, according to the revised RAN Plenary workplan, during early October 1999, it is proposed here that WG1 agrees on the RACH preamble design currently well described in TS 25.213 version 2.1.2 [1].

3 Conclusions

The Golay based RACH preamble design has been analysed. The simulation conditions under which the advantages are claimed are unclear. Further, the claimed advantages do not apply in all cases.

In view of the above and the need to adhere to the revised RAN Plenary workplan, it is proposed that the existing RACH preamble structure design, as is well described in TS 25.213 version 2.1.2, is agreed by RAN WG1.

4 References

[1] Tdoc R1#6(99)a66; TS 25.213 version 2.1.2; Spreading and Modulation (FDD).

[2] Tdoc TSG-RAN#4(99)412; Report of the 4th TSG RAN Meeting; Miami, 17-19 June 1999.

[3] Tdoc TSG-RAN1#6(99)893; Proposal for RACH preambles; Espoo, 13-16 July 1999.

[4] Tdoc R1#6(99)990; Golay-Hadamard sequence based RACH preamble design for large cell (Parts I & II); WG1 #6 Espoo, 13-16 July 1999.