TSG-RAN Working Group 1 meeting #4 **_TSGR1#4(99)345_**
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Agenda item:
Source: Ericsson
Title: Text proposal for new RACH preambles
Document for: Decision

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1 Introduction

In TSGR1#3(99)205, "New RACH preambles with low auto-correlation sidelobes and reduced detector complexity", a new set of RACH preambles were proposed for UTRA/FDD. This contribution provides a text proposal for introduction of the new preambles into S1.11 and S1.13.

2 Text proposal for S1.11

5.2.2.1.2 RACH preamble part

The preamble part of the random-access burst consists of a ~~*signature* of length 16 complex symbols ±1(+j). Each preamble symbol is spread with a 256 chip real Orthogonal Gold code. There are a total of 16 different signatures, based on the Orthogonal Gold code set of length 16 (see S1.13 for more details).~~ 4096 chip long preamble code. The 8192 RACH preamble codes are divided into 512 preamble groups, each group consisting of 16 signatures (see S1.13 for more details).

3 Text proposal for S1.13

It is proposed to replace the subclauses 6.3.3.1 and 6.3.3.2 in S1.13 with the following subclause:

6.3.3.1 Preamble codes

The 8192 RACH preamble codes are divided into 512 preamble groups, each group consisting of 16 signatures. Each preamble code is a Golay complementary sequence of length 4096 chips, which can be represented as a function of a pair of 256 chip long Golay complementary sequences.

For each preamble group p, $p = 0, 1, 2, \ldots, 511$, a specific preamble spreading code pair $X^{(p)}(k)$ and $Y^{(p)}(k)$ is used in conjunction with the signature s, $s = 0, 1, 2, \ldots, 15$, to create the 4096 chip long preamble code $Z^{(p,s)}(l)$, $l = 0, 1, 2, \ldots, 4095$. The preamble spreading code pair $X^{(p)}(k)$ and $Y^{(p)}(k)$ are Golay complementary sequences of length 256 chips, i.e. $k = 0, 1, 2, \ldots, 255$.

The 16 preamble codes $Z^{(p,s)}(l)$ corresponding to the 16 signatures and the preamble spreading code pair $X^{(p)}(k)$ and $Y^{(p)}(k)$ are defined in Table 1. The table describes what preamble spreading code to use during the corresponding period of the 4096 chip long preamble code. For example, $Z^{(p,8)}(l) = -Y^{(p)}(l \bmod 256)$ for $l = 768, 769, \ldots, 1023$.

The preamble code is transmitted on both the I and Q branches, i.e. the preamble signal transmitted is $Z^{(p,s)}(l) + jZ^{(p,s)}(l)$, $l = 0, 1, 2, \ldots, 4095$.

Table 1: The 16 preamble codes $Z^{(p,s)}(l)$ for the preamble spreading code pair $X^{(p)}(k)$ and $Y^{(p)}(k)$.

l	0 to 255	256 to 511	512 to 767	768 to 1023	1024 to 1279	1280 to 1535	1536 to 1791	1792 to 2047	2048 to 2303	2304 to 2559	2560 to 2815	2816 to 3071	3072 to 3327	3327 to 3583	3584 to 3839	3840 to 4095
$Z^{(p,0)}(l)$	X	X	Y	Y	X	-X	-Y	Y	X	-X	Y	-Y	X	X	-Y	-Y
$Z^{(p,1)}(l)$	X	X	Y	Y	X	-X	-Y	Y	-X	X	-Y	Y	-X	-X	Y	Y
$Z^{(p,2)}(l)$	X	-X	Y	-Y	X	X	-Y	-Y	X	X	Y	Y	X	-X	-Y	Y
$Z^{(p,3)}(l)$	X	-X	Y	-Y	X	X	-Y	-Y	-X	-X	-Y	-Y	-X	X	Y	-Y
$Z^{(p,4)}(l)$	X	X	Y	Y	-X	X	Y	-Y	X	-X	Y	-Y	-X	-X	Y	Y
$Z^{(p,5)}(l)$	X	X	Y	Y	-X	X	Y	-Y	-X	X	-Y	Y	X	X	-Y	-Y
$Z^{(p,6)}(l)$	X	-X	Y	-Y	-X	-X	Y	Y	X	X	Y	Y	-X	X	Y	-Y
$Z^{(p,7)}(l)$	X	-X	Y	-Y	-X	-X	Y	Y	-X	-X	-Y	-Y	X	-X	-Y	Y
$Z^{(p,8)}(l)$	X	X	-Y	-Y	X	-X	Y	-Y	X	-X	-Y	Y	X	X	Y	Y
$Z^{(p,9)}(l)$	X	X	-Y	-Y	X	-X	Y	-Y	-X	X	Y	-Y	-X	-X	-Y	-Y
$Z^{(p,10)}(l)$	X	-X	-Y	Y	X	X	Y	Y	X	X	-Y	-Y	X	-X	Y	-Y
$Z^{(p,11)}(l)$	X	-X	-Y	Y	X	X	Y	Y	-X	-X	Y	Y	-X	X	-Y	Y
$Z^{(p,12)}(l)$	X	X	-Y	-Y	-X	X	-Y	Y	X	-X	-Y	Y	-X	-X	-Y	-Y
$Z^{(p,13)}(l)$	X	X	-Y	-Y	-X	X	-Y	Y	-X	X	Y	-Y	X	X	Y	Y
$Z^{(p,14)}(l)$	X	-X	-Y	Y	-X	-X	-Y	-Y	X	X	-Y	-Y	-X	X	-Y	Y
$Z^{(p,15)}(l)$	X	-X	-Y	Y	-X	-X	-Y	-Y	-X	-X	Y	Y	X	-X	Y	-Y

$X^{(p)}(k)$ and $Y^{(p)}(k)$ are constructed from the Golay complementary sequences $A^{(v)}(k)$ and $B^{(v)}(k)$, $v = 0, 1, 2, \ldots, 255$ and $k = 0, 1, 2, \ldots, 255$, defined by the following recursive relation:

$a_0^{(v)}(0) = 1, \quad a_0^{(v)}(m) = 0, m = 1, 2, \ldots, 255$
$b_0^{(v)}(0) = 1, \quad b_0^{(v)}(m) = 0, m = 1, 2, \ldots, 255$

$a_n^{(v)}(k) = a_{n-1}^{(v)}(k) + W_n^{(v)} \cdot b_{n-1}^{(v)}(k-D_n),$
$b_n^{(v)}(k) = a_{n-1}^{(v)}(k) - W_n^{(v)} \cdot b_{n-1}^{(v)}(k-D_n),$

$A^{(v)}(k) = a_8^{(v)}(k), \qquad B^{(v)}(k) = b_8^{(v)}(k),$

where $n = 1, 2, \ldots, 8$ is the iteration number.

The variables D_n are delays: $D_1 = 1$, $D_2 = 4$, $D_3 = 2$, $D_4 = 32$, $D_5 = 64$, $D_6 = 16$, $D_7 = 128$, $D_8 = 8$.

$W_n^{(v)}$, $v = 0, 1, \ldots, 255$, are defined as the 8-bit binary representations of integers {0, 1, 2, …, 255}, i.e.

$$W_n^{(v)} = (-1)^{H_n(v)}, \quad v = 0, 1, \ldots, 255, \quad n = 1, 2, 3, \ldots, 8,$$

where $H_n(v)$ is the n-th bit in the 8-bits long binary representation of some positive integer v, i.e.

$$v = \sum_{n=1}^{8} H_n(v) \cdot 2^{n-1}.$$

Finally, $X^{(p)}(k)$ and $Y^{(p)}(k)$ are defined as:

$X^{(p)}(k) = A^{(p)}(k)$ and $Y^{(p)}(k) = B^{(p)}(k)$ for $p = 0, 1, 2, \ldots, 255$, and $k = 0, 1, 2, \ldots, 255$,
$X^{(p)}(k) = B^{(p-256)}(k)$ and $Y^{(p)}(k) = A^{(p-256)}(k)$ for $p = 256, 257, \ldots, 511$, and $k = 0, 1, 2, \ldots, 255$.