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Dear Sir:

Enclosed application parts are:

___	Spec w/Claims	Number of Pages ___
X	Spec w/o Claims	Number of Pages 3
___	Formal drawings	Number of Sheets ___
___	Informal drawings	Number of Sheets ___
___	Other:	

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TITLE OF INVENTION: *(Random access channel) RACH PREAMBLES FOR WCDMA WITH GOOD CORRELATION PROPERTIES*

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Was this invention made under a Government contract? X No ___ Yes

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Please charge $150 to Deposit Account No. 20-0668. An original and two copies are enclosed.

Respectfully submitted,

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6/11/99
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PROVISIONAL APPLICATION ONLY

(Random access channel) RACH preambles for WCDMA with good correlation properties

Anand Dabak

In [1] Nokia has given further clarification of their proposed RACH preambles. The RACH preamble structure as proposed by Nokia is given in figure (1) below:

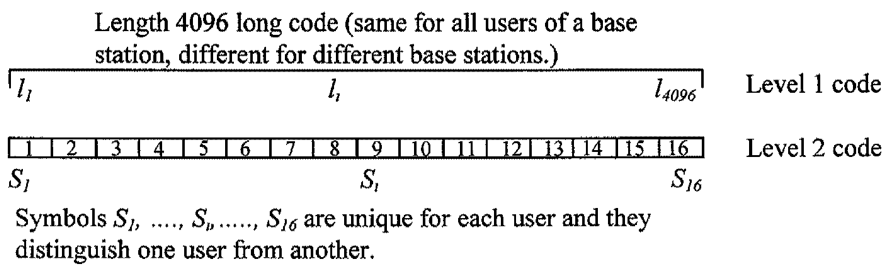

Figure (1): The structure of the RACH preambles as proposed by Nokia is [1] is shown. The RACH preamble consists of a two level code, the top code (level 1 code l_1, ..., l_i, ..., l_{4096} shown above) is a long code of length 4096 and it is unique for each base station. The second code (level 2 code shown above) is a 16 symbols code (S_1, ..., S_i,...., S_{16}) which identifies each mobile user in the random access burst. The 16 symbol code is chosen by a user randomly whenever it wants to transmit on the random access burst.

As shown in figure (1) of [1], the base station has a preamble detector to detect the transmitted RACH preambles. The RACH preambles have to have the following properties.

(1) They should have good aperiodic auto and cross correlation properties for lags of atleast +/- 1024 chips corresponding to a cell radius of more than 50 Km. The maximum aperiodic auto and cross correlation side lobes (MAS) should be much more than 10 dB down. The reason for this is that the open loop power control error can be as much as 9 dB implying that an MAS of only 10 dB or so could mistaken for the presence of two users when actually a single user is transmitting.

(2) The above good correlation properties should be maintained in the presence of carrier frequency offsets of more than 1000 Hz.

While the Nokia proposed sequences satisfy the first constraint given above, it does not satisfy the second constraint. In the presence of a large frequency offset the length 4096 correlator at the base station has to be broken into 4 correlators of length 1024 each (as an example). For a 1000 Hz. frequency error, the phase change over 1024 chips is 90 degrees implying that 4 correlators each of length 1024 summed non-coherently can be used to generate correlation outputs.

We propose the following RACH preamble sequences because they have the following advantages over the Nokia proposed sequences:

(1) The complexity of correlations is still the same as the Nokia proposed sequences.
(2) The sequences give a more than 20 dB MAS for both the conditions (1) and (2) given above.

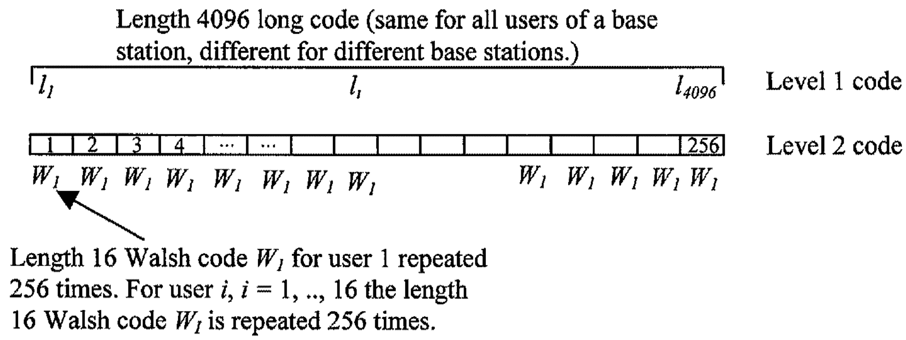

Figure (2): The proposed RACH preamble sequences. Again the RACH preamble consists of a two level code with the top level being a long code $l_1, \ldots, l_i, \ldots, l_{4096}$ of length 4096 and is unique for each base station. The second level codes consist of 256 times repeated length 16 Walsh codes. One length 16 Walsh code corresponds to each user.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	-26	-26	-26	-24	-23	-24	-23	-26	-26	-25	-25	-26	-25	-24	-25	-25
2	-27	-26	-24	-26	-24	-23	-26	-23	-25	-25	-25	-24	-25	-25	-25	-24
3	-26	-24	-25	-26	-23	-27	-23	-24	-25	-26	-25	-26	-25	-26	-25	-24
4	-24	-26	-26	-25	-27	-23	-24	-23	-26	-25	-26	-25	-26	-25	-24	-25
5	-23	-24	-23	-27	-25	-24	-25	-25	-25	-24	-25	-26	-25	-26	-25	-25
6	-24	-23	-27	-23	-24	-25	-25	-25	-24	-25	-26	-25	-26	-25	-25	-25
7	-23	-26	-23	-24	-25	-25	-26	-24	-24	-26	-25	-24	-25	-26	-25	-26
8	-26	-23	-24	-23	-25	-25	-24	-24	-26	-25	-24	-26	-25	-24	-25	-25
9	-25	-24	-25	-26	-24	-25	-24	-24	-25	-25	-24	-25	-26	-24	-25	-24
10	-25	-25	-25	-26	-24	-25	-24	-24	-25	-24	-25	-24	-25	-24	-25	-24
11	-25	-24	-24	-26	-26	-24	-25	-25	-24	-26	-25	-24	-25	-26	-25	-24
12	-26	-25	-24	-25	-26	-24	-25	-24	-26	-24	-25	-24	-25	-24	-26	-25
13	-26	-25	-24	-25	-24	-25	-26	-26	-24	-25	-24	-24	-25	-24	-25	-26
14	-24	-25	-26	-25	-24	-24	-25	-24	-24	-25	-26	-25	-25	-26	-25	-26
15	-25	-25	-24	-24	-26	-26	-25	-26	-24	-25	-26	-25	-25	-26	-25	-25
16	-25	-24	-25	-24	-26	-24	-25	-25	-26	-24	-25	-26	-25	-24	-25	24

Table 1: The MAS for all the combinations of the proposed sequences is given in dB for a frequency error on 0 Hz. and coherent addition over 4096 chips. The main lobe has a value of 4096.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	-20	-22	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-22	-23	-23	-23
2	-23	-20	-22	-23	-22	-23	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23
3	-23	-22	-20	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-22	-23	-22
4	-22	-23	-22	-20	-22	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-22
5	-22	-23	-22	-23	-20	-23	-22	-23	-22	-23	-23	-22	-23	-22	-22	-22
6	-22	-23	-22	-23	-23	-20	-23	-22	-23	-22	-23	-23	-22	-23	-22	-22
7	-23	-23	-22	-23	-22	-23	-20	-23	-22	-23	-22	-23	-23	-23	-23	-23
8	-23	-23	-22	-23	-22	-23	-22	-20	-23	-22	-23	-23	-22	-23	-22	-22
9	-23	-22	-23	-22	-23	-23	-22	-23	-20	-22	-23	-22	-23	-22	-23	-22
10	-22	-23	-22	-23	-23	-22	-23	-22	-23	-20	-22	-23	-23	-23	-23	-23
11	-22	-23	-22	-23	-22	-23	-23	-22	-23	-22	-20	-22	-23	-22	-23	-23
12	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-22	-20	-22	-23	-22	-23
13	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-22	-23	-20	-22	-23	-22
14	-22	-23	-22	-23	-23	-22	-23	-22	-23	-23	-22	-23	-22	-20	-23	-22
15	-22	-23	-22	-23	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-20	-23
16	-23	-22	-23	-22	-23	-23	-22	-23	-22	-23	-22	-23	-22	-22	-23	-20

Table 2: The MAS for all the combinations of the proposed sequences is given in dB for a frequency error of 1000 Hz. and coherent addition over 1024 chips and non-coherent over the 4 sets of 1024 chips. The main lobe has a value of 1851.

The total number of operations for the proposed scheme for a total time lag 2048 chips (+/- 1024) is

16*256*2048+16log2(16)*2048 = $(8.3+0.13)*10^6$ = 8.43 Million operations which are about the same as the proposed Nokia sequences. A length 16 Walsh Hadamard transform is used.

Conclusions:

The proposed RACH preamble sequences give very good aperiodic auto and cross correlation properties even in the presence of very high frequency error due to high Doppler or carrier frequency offset. Both coherent (over 4096 chips) and non-coherent (coherent over 1024 and non-coherent over the 4 sets of 1024 chips for example) implementations of the proposed sequences are possible.

Variations of the above scheme:

Instead of a Walsh code of length 16 repeated 256 times, a Walsh code of length 32 could be repeated 128 times. This will allow 32 users to be supported simultaneously in the RACH preamble.

[1] TSGR 1 # 599/99, Nokia, "Further clarification of Nokia's RACH preamble proposal", June 1999, Cheju, Korea.