TSG-RAN Working Group1 meeting #4
Yokohama 19-20, April 1999

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Agenda Item:

Source: Nokia

Title: Text proposal for downlink long scrambling codes

Document for: Discussion (AdHoc 10)

7.2.2 Scrambling code

The total number of available scrambling codes is 512, divided into 32 code groups with 16 codes in each group.

[In order to avoid code limitation in some cases, e.g. when increasing the capacity using adaptive antennas, the possibility to associate several scrambling codes with one cell (BCH area) has been identified as one solution. The exact implementation of such a scheme is still to be determined.]

<Editor's note: Use of multiple downlink scrambling codes to aid adaptive antennas are ffs.>

The scrambling code sequences are constructed by combining two real sequences into a complex sequence. Each of the two real sequences are constructed as the position wise modulo 2 sum of [40960 chip segments of] two binary *m*-sequences generated by means of two generator polynomials of degree 18. The resulting sequences thus constitute segments of a set of Gold sequences. The scrambling codes are repeated for every 10 ms radio frame.

Let *A* be an m-sequence generated by the polynomial $X^{18} + X^7 + 1$ and let *B* be that one by $X^{18} + X^{10} + X^7 + X^5 + 1$ over GF(2) with the following initial conditions: $A(0) = B(0) = 1$ and $A(i) = B(i) = 0$ for *each* $i = 1, 2, \ldots, 17$. Then the sequences *A* and *B* satisfy the recurrence relations:

$A(i + 18) = A(i + 7) + A(i)$ *modulo 2,* $i = 0, 1, 2, \ldots, 2^{18} - 20$, and
$B(i + 18) = B(i + 10) + B(i + 7) + B(i + 5) + B(i)$ *modulo 2,* $i = 0, 1, 2, \ldots, 2^{18} - 20$.

The long scrambling code parametrization is one dimensional, denoted by *m*, and *m* takes values from 0 to 511 when one downlink scrambling code is used. For multiple downlink scramling codes the code parameter *m* runs from 512 to $(2^{18} - 4) / 2 = 131\,070$. The in phase component, I_m, and the quadrature component, Q_m, for the m^{th} long scrambling code are given by

$I_m(k) = A(k + 2*m) \oplus B(k + 182269)$ and
$Q_m(k) = A(k + 1 + 2*m) \oplus B(k + 182269)$,

where *k* is a chip index, $k = 0, 1, 2, \ldots, 40960 - 1$, and the symbol $\oplus$ stands for modulo 2 addition. The chip with $k = 0$ corresponds to the chip scrambled first in each radio frame. These binary code words are converted to real valued sequences by the transformation '0' -> '+1', '1' -> '-1'.

Finally, the m:th complex scrambling code sequence $C_{scramb,\,m}$ is defined as:
$C_{scramb,\,m}(k) = I_m(k) + j\,Q_m(k)$, $k = 0, 1, \ldots, 40960 - 1$.

<Editor's note: the value 40960 is based on an assumption of a chip rate of 4.096 Mcps.>
<Editor's note: however, this parametrization works for all chip rates up.>

<Editor's note: if 131 071 downlink long codes are not enough then the degree of the two polynomials should be increased.>

Note that the pattern from phase 0 up to the phase of 10 msec is repeated. The index *m* runs from 0 to 511 giving 512 distinct 40960 chip sequences.

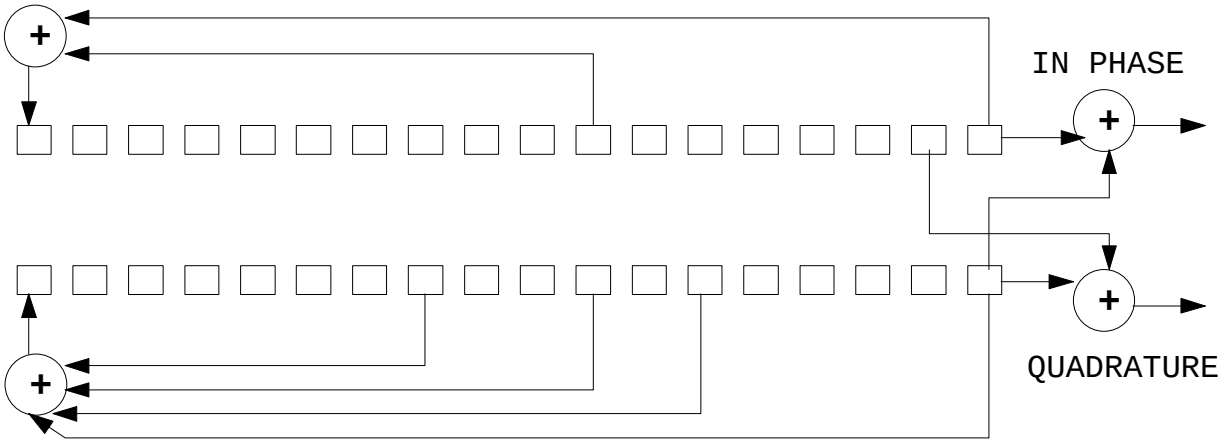

Figure 1. Configuration of downlink scrambling code generator. (This is an example only, there are other possibilities as well.)