3GPP TSG-RAN Working Group 1, Meeting #6 **TDoc TSG RAN WG1 (99)855**
Espoo, Finland, July 13-16 1999

Agenda Item:
Source: Siemens AG
Title: Extension of Midamble to Allow 16 Users per Time Slot
Document for: Decision

---

1 Introduction

The specification document TS 25.221 [1] defines a 512 chip midamble for burst type 1 that is composed of a 56 chip pre-cursor plus a period $\mathbf{m}_\mathbf{p}$ of length 456 chips. The construction of the midamble is such that one basic midamble code can generate 8 different midambles for use within one timeslot, and that the construction of the midamble allows a computationally efficient way of obtaining the channel impulse response. The maximum size of the spreading code set is 16, and the present construction of the midamble allows for the use of the entire code set to be be shared amongst a maximum of 8 users per time slot in UL.

In this document a method of extending the current midamble construction to allow 16 different midambles is proposed. This allows to extend the maximum number of simultanous users to 16 per time slot. The extension is done in such a way that there is no change of the current eight midambles $\mathbf{m}^{(k)}$, k=1,2,...,8. The midambles $\mathbf{m}^{(k)}$, k=9,10,...,16 are intermediate shifted versions that will be used only if more than eight users are feasible. This depends on the momentary interference conditions and the stationary propagation environment (maximum delay spread) in the cell. The information, whether the possible number of users is eight or sixteen in a cell is broadcast via the BCH.

2 Extension of the Current Midamble Definition

The method for generating the midambles defined in §5.2.3 of [1] enables K midambles allowing channel estimation over W chips, providing KW P, P being the length of the period $\mathbf{m}_\mathbf{p}$. Each midamble is a time shifted version of one single periodic basic code, and this property means that an efficient channel estimation method can be implemented using an FFT/IFFT approach. For burst type 1 a midamble sequence is defined with K=8; W=57; and P=456. Reducing W, the channel estimation window length, to 28 allows K, the number of offsets, to be increased to 16 and the requirement that $KW\ \ P$ is still satisfied. The length of the pre-cursor and the period remain unchanged. Using the same period allows to use the same FFT/IFFT, both for the non-extended and the extended case.

A length of 28 chips of the channel estimation window will be sufficient in most application scenarios. To compare the performance for the non-extended and extended case, simulation results are provided showing the uncoded bit error rate for the vehicular A channel for the two channel estimation window lengths of 57 and 28 chips, see figure 1.

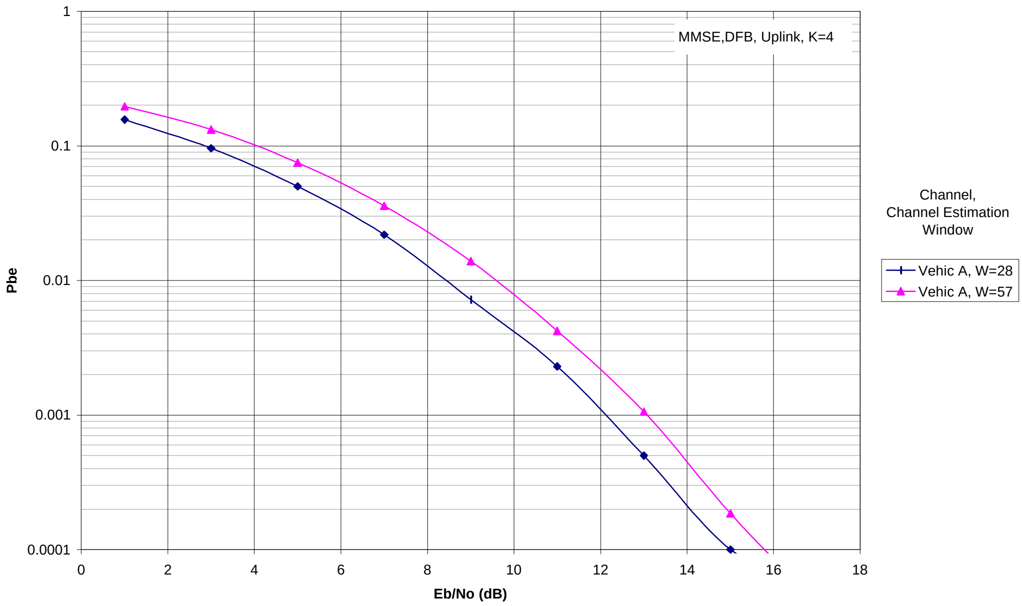

Figure 1 Burst Type 1 Performance with Channel Estimation Lengths of 57 and 28 Chips

The simulation results presented are for the uplink. The vehicular A channel model extends over an 8 chip period consequently the channel estimation window over-determines the channel impulse response length and most samples of the channel estimate contain purely noise. A simple threshold is applied to the channel impulse response estimates to determine whether a sample is entirely due to noise or not. The thresholding operation does not eliminate all pure noise estimates from the channel impulse response and consequently for the vehicular A channel a shorter channel window provides better performance, as shown in the results of Figure 1.

3 Mathematical Description

The new construction of the midamble is in fact a generalisation of the current method in [1]. The formula presented in [1] describing the generation of the midamble now has to be modified slightly. With $\mathbf{m} = \left(m_1, m_2, ..., m_{L_m+(K-1)W}\right)^{\mathrm{T}}$ $m_i \in \{1, -1\}$; $i = 1, ..., (L_m + (K-1)W)$, being the basic periodic code with a period of length P as defined in [1], the L_m binary elements $m_i^{(k)}$; $\mathrm{i} = 1, ..., \mathrm{L_m}$; $k = 1, ..., K$; of the midambles of the K users are generated by

$$m_i^{(k)} = \begin{cases} m_{i+(K/2-k)W} & : k = 1, ..., K/2 \\ m_{i+(K-k)W+\lfloor P/K \rfloor} & : k = K/2+1, ..., K \end{cases} \quad , i = 1, ..., L_m \, .$$

This formula takes already into account the increased number of users (K=16). However the window size W remains to be 57 in this formula. The first eight midamble offsets are generated by shifting the basic periodic code by 57 chips, as it is already defined in [1]. The additional midmables are generated by intermediate shifts, thus allowing the generation of K=16 different midambles. Only when more than eight midambles are used, the channel estimation window in the joint channel estimator has to be shortened to 28 chips.

4 Conclusion

In this paper we have presented a method that allows for the construction of 16 different midambles from one basic periodic code and, by this, 16 simultanous users in one time slot. In most system environments the use of 16 midambles will be feasible. Simulations results are given showing that there is no performance degradation in the vehicular A channel model for example. Therefore, we propose to include the extension of the midamble to 16 offsets in the specification.

5 References

[1] 3GPP TSG RAN, TS 25.221, “Phys. Channels and Mapping of Transport Channels onto Phys. Ch. (TDD)”.