High Performance Broadband DS-CDMA via Carrier Interferometry Chip Shaping

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Abstract

This paper proposes a novel chip shaping method for DS-CDMA where chips are formed by the superpositioning of multiple carriers. This supports two significant enhancements when compared to DS-CDMA with traditional chip shaping:

- *High performance:*

  Conventional DS-CDMA systems employ a RAKE receiver in an attempt to make full use of the signal energy scattered in the time domain; however, the multipath effect causes a loss of orthogonality which degrades RAKE receiver performances. The literature on multi-carrier CDMA (MC-CDMA) has shown that receivers employing frequency diversity (in an effort to make full use of energy spread in the frequency domain) significantly outperform RAKE receivers [1]. To date, high-performance frequency-combining receivers have been unavailable to DS-CDMA systems.

  With the proposed chip shaping (wherein DS-CDMA chips are composed of multiple carriers), a novel detection strategy is employed at the receiver whereby each chip is broken down into its frequency components and optimally recombined. This enables DS-CDMA receivers to achieve frequency diversity benefits (rather than traditional path diversity benefits). Simulations over Raleigh fading channels indicate the new chip shaping and detection strategy *significantly* outperforms DS-CDMA using conventional chip shaping and RAKE receivers.

- *Broadband Capabilities:*

  "Ultra-Broadband" systems must be supported in a market traditionally limited to comparatively small, non-contiguous frequency bands. For example, a broadband system could be created by simultaneously occupying the unlicensed 902-928Mhz, 2400-2485Mhz, and 5725-5850Mhz bands, while leaving all the licensed frequencies between these bands untouched, i.e., the broadband system fills all the available "gaps" in the spectrum. DS-CDMA with traditional chip shaping is unable to exploit "gaps" in the spectrum since the chip shape spreads the energy over a single continuos frequency band.

  The novel DS-CDMA chip shaping proposed here, wherein a chip is composed of multiple carriers which may be unevenly spaced throughout the spectrum, allows DS-CDMA chips to be created which offer zero interference in licensed bands while exploiting all available frequencies.

The novel chip shaping method proposed here will allow DS-CDMA to act as high-performance broadband "pipe" providing a spectrum of wireless services to meet the demands of future wireless systems.

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2. References

[1] S. Hara and R. Prasad, "Overview of multicarrier CDMA," *IEEE Communications Magazine*, Vol.35, pp.126-137, Dec. 1997.