Efficient Multi-Carrier Communication over Doubly Selective Channels

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Abstract

Orthogonal frequency division multiplexing (OFDM) is a digital communication scheme in which information is streamed in parallel over numerous orthogonal subcarriers. The principle advantage of multi-carrier schemes like OFDM, relative to single-carrier schemes, is that they facilitate simple equalization of frequency-selective (i.e., delay-spreading) channels. The importance of this is not to be underestimated: for today's wideband wireless and underwater acoustic receivers, equalization consumes the vast majority of receiver circuitry/power. The classical implementation of OFDM, however, leaves room for improvement. In particular, the use of rectangular pulses with a cyclic-prefix guard interval leads to losses in spectral efficiency and non-robustness to channel time variations (i.e., Doppler spread), properties which are unappealing for the tomorrow's spectrally crowded and highly mobile wireless and acoustic applications.

In this talk, we show that, with optimized non-rectangular pulses and more sophisticated (yet still low complexity) equalization, multicarrier-modulation can be made robust to Doppler effects and at the same time more spectrally efficient. For an intuitive explanation of how this can be, consider that classical OFDM puts the entire burden of interference cancellation on the (linear) pulse-shaping operation, whereas we shift a small but essential part of the burden to the equalizer, where the finite-alphabet property and/or code structure can be leveraged. In addition to describing our approach to pulse optimization, we will discuss various options for equalization, joint equalization/decoding, and joint equalization/decoding/channel-estimation.

Biography

Philip Schniter received the B.S. and M.S. degrees in Electrical and Computer Engineering from the University of Illinois at Urbana-Champaign in 1992 and 1993, respectively. From 1993 to 1996 he was employed by Tektronix Inc. in Beaverton, OR as a systems engineer. In 2000, he received the Ph.D. degree in Electrical Engineering from Cornell University in Ithaca, NY. Subsequently, he joined the Department of Electrical and Computer Engineering at The Ohio State University in Columbus, OH, where he is now an Associate Professor and a member of the Information Processing Systems (IPS) Lab. He serves on the IEEE Signal Processing for Communications and Networking (SPCOM) Technical Committee, as well as on technical program committees for many IEEE conferences. He is currently spending a one-year sabbatical in France with visiting professor positions at Eurecom and Supélec.

Dr. Schniter's areas of research include signal processing, communication theory, estimation theory, wireless networks, and underwater acoustic communication.