Synchronization Issues in Ultra-Wideband Multi-Channel Digital Beam-Formers

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Traditional code division multiple access (CDMA) systems do not typically consider beamforming for antenna arrays. Nevertheless, CDMA coding can be highly advantageous as it provides processing gain of several 10s of dB above the one provided by the array itself. Recent developments in ultra-wideband (UWB) arrays and RF front-ends provide additional reasons for employing CDMA coding to provide significant processing gain. This is because long code sequences can be used in conjunction with CDMA systems. A challenge with such system is signal synchronization among the received antenna elements to allow reliable extraction of the CDMA coding sequence. This issue relates to time delays among the different antenna elements. These delays depend on the angle of incidence, implying that CDMA sequence decoding must be different for every antenna array elements to suppress signal distortions and enable maximum gain. To address this issue, we adapt a mechanism to synchronize the despreading process and, thus, align each received signals to the required CDMA sequences.

With this in mind, we propose a new communication system using 10 GHz of bandwidth for high data rate users. The goal is to employ CDMA code sequences with a spreading factor of 127 for a 10 MHz signal using BPSK modulation. The 10 GHz bandwidth is divided into 7 distinct channels, each 1.27 GHz in bandwidth, accommodating the 127 long code sequence. Preliminary results show that using this configuration, it is possible to have 7-8 overlapping users on the same channel with minimal degradation. At the conference, an implementation of this system will be shown. Also, the synchronization issues will be discussed along with possible solutions and their associated advantages/disadvantages.