Wideband and Multi-beam Angle of Arrival Estimation using On-Site Coding

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Ultra-wideband (UWB) systems with digital beamforming are essential to realize cognitive and software defined radio. However, there are several challenges in realizing UWB RF front ends and transceivers. Among them, scanning across wide bandwidths, scalable receivers and power-efficient digital back-ends. Nonetheless, advancements in digital technology and signal processing have reduced the complexity of digital beamformers.

Recently, a novel On-Site Coding Receiver (OSCR) architecture was proposed to significantly reduce the intense hardware requirement for digital beamforming [Alwan et al., IEEE APS, 2013]. The basis of OSCR is to encode each antenna signal to keep their identification prior to combining them for processing via a single analog-to-digital converter (ADC). As an example, Walsh Hadamard codes can be employed for coding the individual array element signals prior to combining them for digitization. Doing so, a single ADC can be employed for a group of array elements instead of having a separate ADC per antenna element. At the digital back-end, full signal recovery is done by decoding the summed digital signal of the latter. FPGAs can be used to decorrelate and recover the individual array element signals. Subsequently, beamforming can be carried out across large bandwidths. Concurrently, the size, weight, area, power and cost of the system was significantly reduced with minimal impact on receiver signal-to-noise ratio (SNR) and phase error.

At the conference, we will demonstrate an eight-channel OSCR system built using COTS components and in-house fabricated printed circuit boards (PCB). Various measurements in the anechoic chamber were carried out to evaluate OSCR's impact on the performance. Specifically, an experiment was carried out to evaluate angle of arrival of incoming signals using OSCR and without physical rotation of the array. At the conference, we will also address coherent signal combining at the digital domain to improve the SNR and sources of errors in signal recovery.