4.2 BPM-MIMO

The TDM-MIMO scheme previously described is simple to implement, however, it does not use the complete transmission capabilities of the device (because only one transmitter is active at any time). Techniques exist which are centered on modulating the initial phase of chirps in a frame, which allow simultaneous transmission across multiple TX antennas while still ensuring separation of these signals. In BPM-MIMO, these phases are either 0º or 180º (equivalent to multiplying each chirp by +1 or –1). One such variant of BPM-MIMO is described as follows.

Similar to TDM-MIMO, a frame consists of multiple blocks, each block consisting of N_{TX} consecutive transmissions. However, unlike TDM-MIMO (where only one TX antenna is active per time slot), all the N_{TX} antennas are active in each of the N_{TX} time slots of every block. For each block, the transmissions from multiple TX antennas are encoded with a spatial code (using BPM), which allows the received data to be subsequently sorted by each transmitter. In TDM-MIMO, the power that can be transmitted in each time slot is limited by the maximum power that can be radiated by one TX antenna. Allowing simultaneous transmission on all the N_{TX} transmitters (while still ensuring perfect separation by use of suitable spatial code) lets users increase the total transmitted power per time slot. This translates to an SNR benefit of 10log10 (N_{TX}).

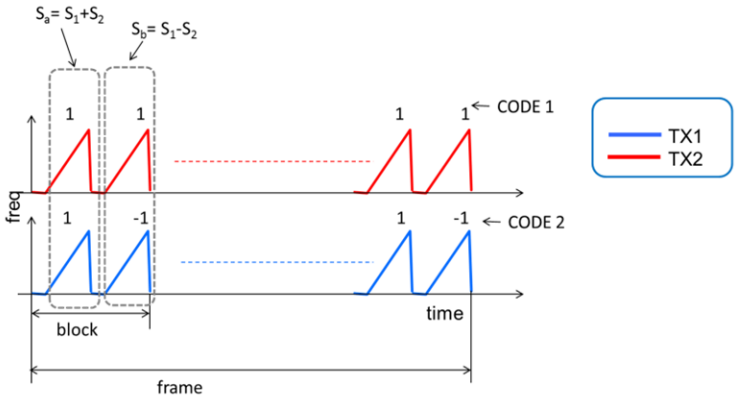

Figure 10. Spatially Encoded BPM-MIMO

Figure 10 shows the technique, for the case of N_{TX} = 2. Assume S_1 and S_2 represent chirps from the two transmitters. The first slot in a block transmits a combined signal of $S_a = S_1 + S_2$. Similarly the second slot in a block transmits a combined signal of $S_b = S_1 – S_2$. Using the corresponding received signals (S_a and S_b) at a specific received RX antenna, the components from the individual transmitters can be separated out using $S_1 = (S_a + S_b) / 2$ and $S_2 = (S_a - S_b) / 2$. For an example of N_{TX} = 4, where separation is achieved using a 4 × 4 Hadamard code, see [3].

The processing chain is almost identical to the flow as described earlier in the context of TDM-MIMO, with the exception of a decoding block which enables the signal contributions from the individual TX antennas to be separated in the received data. This decoding must be performed before the angle-FFT (and ideally after the Doppler-FFT, in order to enable phase corrections due to non-zero velocity to be applied prior to decoding).