Questions and Answers on "A Method for Broadband Full-Duplex MIMO Radio" by Y. Hua, P. Liang, Y. Ma, A. Cirik and Q. Gao, IEEE SPL, Vol. 19, No. 12, Dec 2012 (Published Oct 2012)

Question: From a practical perspective, estimation of the self-interference channel matrix H might be a big challenge in time varying channels because the proposed scheme requires the real-time information of H.

Answer: We only need to estimate a fundamental waveform, which is generally short on a scale of tens of nano seconds for broadband applications (also for the same reason mentioned below). The interference channel is on the same radio (or radio station). It is easy to detect such a "needle-like" window of silence (such as following each received data or control packet) for self-interference channel estimation in real time.

Question: Considering the proximity between transmit antennas and receive antennas at the same device, the self-interfering signals are not likely to have the same frequency selectivity as the received signals at other receivers located far from the transmitter. That is, the effective number of taps L at the receive antennas might be very small for the self-interfering signals. Therefore, the prefix problem of the frequency domain transmit beamforming (FDTB) methods, shown by (7) in the paper, could be insignificant in many cases.

Answer: You are right from a conventional point of view. But the precision we need here is **high** due to the level of RF frontend interference cancellation we need (e.g., 50 dB in addition to passive antenna attenuation and baseband receiver-side DSP cancelation). So, for the precision we need, even a small tail of pulse response also matters.

Question: The defect of the frequency domain transmit beamforming (FDTB) seems to come from not taking CP into account for beamformer design. I am not sure if there is really no way of taking CP into account for FDTB design.

Answer: At MAC layer, you can do something to mitigate the prefix problem to some extend for some situations. But we believe that the time domain transmit beamforming (TDTB) shown in this paper is a better choice for self-interference cancelation for wide range of situations.

Question: Related to the above comment, the authors argue that the frequency-domain solutions are naturally suited for narrowband applications for which the channel frequency responses must be completely flat within the bandwidth of interest around a given f. However, MIMO beamforming desing can easily be extended to frequency selective channels by constructing an effective channel matrix after dividing the frequency band into frequency flat sub-channels.

Answer: Dividing a broadband into multiple narrow frequency bands using some physical filters is known to be poor in efficiency (the passband-to-stopband transition regions cannot be reduced arbitrarily). This is why OFDM is great, which mathematically (or at the information-only level) performs a virtual and ideal partition of a broadband into many subbands without any

overlap between adjacent subbands. But OFDM needs prefix. TDTB works with or without OFDM since TDTB operates underneath the data frame structure.

Question: The rank of the self-interference channel matrix H is likely to be low since there are few scatters between transmit antennas and receive antennas at the same device. Correspondingly, the null space of H is likely to be large. This might help increase the number of independent transmit streams.

Answer: It is desirable for power efficiency and other reasons to have a full rank and well-conditioned self-interference channel matrix H, we can easily ensure such condition by placing the Tx and Rx antennas or/and power combiners on the radio properly as discussed in the paper.