

In this paper, we investigate a rateless code design for a two-time slot two-way relay channel (TWRC), where network coding operation is employed at the relay. Rateless codes are used at both users and the relay nodes as they can cope with various channel conditions. We consider a general TWRC framework, where the two users may use different rateless code generator matrices, thus, the relay cannot directly recover the physical-layer network coded (PNC) message of the two users. We propose a hybrid estimate and forward (EF)/decode and forward (DF) protocol with rateless codes for the TWRC. In the proposed scheme, the relay uses a joint belief propagation decoding process to decode the messages of two users. Depending on whether the relay recovers both users' messages, only one user's message or no users' messages, the relay will generate three different types of signals, namely, NC, soft NC, and soft PNC, respectively. We design the degree distributions of the rateless codes for the three nodes of the TWRC, to make them suitable not only for decoding at two users at high signal-to-noise ratio (SNR), but also for decoding at the relay at low SNR. We show that the proposed hybrid EF/DF protocol with the designed rateless codes outperforms other schemes significantly in terms of bit error rate performance.