Wireless Broadcasting with Network Coding

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Abstract

Wireless digital broadcasting applications such as digital audio broadcast (DAB) and digital video broadcast (DVB) are becoming increasingly popular since the digital format allows for quality improvements as compared to traditional analogue broadcast. The broadcasting is commonly based on packet transmission. In this thesis, we consider broadcasting over packet erasure channels. To achieve reliable transmission, error-control schemes are needed. By carefully designing the error-control schemes, transmission efficiency can be improved compared to traditional automatic repeat-request (ARQ) schemes and rateless codes. Here, we first study the application of a novel binary deterministic rateless (BDR) code. Then, we focus on the design of network coding for the wireless broadcasting system, which can significantly improve the system performance compared to traditional ARQ. Both the one-hop broadcasting system and a relay-aided broadcasting system are considered.

In the one-hop broadcasting system, we investigate the application of systematic BDR (SBDR) codes and instantaneously decodable network coding (IDNC). For the SBDR codes, we determine the number of encoded redundancy packets that guarantees high broadcast transmission efficiencies and simultaneous low complexity. Moreover, with limited feedback the efficiency performance can be further improved. Then, we propose an improved network coding scheme that can asymptotically achieve the theoretical lower bound on transmission overhead for a sufficiently large number of information packets.

In the relay-aided system, we consider a scenario where the relay node operates in half duplex mode, and transmissions from the BS and the relay, respectively, are over orthogonal channels. Based on random network coding, a scheduling problem for the transmissions of redundancy packets from the BS and the relay is formulated. Two scenarios; namely instantaneous feedback after each redundancy packet, and feedback after multiple redundancy packets are investigated. We further extend the algorithms to multi-cell networks. Besides random network coding, IDNC based schemes are proposed as well. We show that significant improvements in transmission efficiency are obtained as compared to previously proposed ARQ and network-coding-based schemes.

Key Words

wireless broadcasting, relay-aided system, systematic binary deterministic rateless codes, random network coding, instantaneously decodable network coding