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Editorial

Network Coding for Wireless Networks

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The main idea in network coding was introduced in 2000 by Ahlswede et al. With network coding, an intermediate node can not only forward its incoming packets but also encode them. It has been shown that the use of network coding can enhance the performance of wired networks significantly. Recent works have indicated that network coding can also offer significant benefits for wireless networks.

Communications over wireless channels are error-prone and unpredictable due to fading, mobility, and intermittent connectivity. Moreover, in wireless networks, transmissions are broadcasted and can be overheard by neighbors, which is treated in current systems as interference. Furthermore, security poses new challenges in wireless networks, where both passive and active attacks have quite different premises than in wired networks. Ideas in network coding promise to help toward all these issues, allowing to gracefully add redundancy to combat errors, take advantage of the broadcast nature of the wireless medium and achieve opportunistic diversity, exploit interference rather than be limited by it, and provide secure network communication against adversarial attacks.

In this special issue, we have been able to put together six original research articles which we believe can carry the momentum further and take the wireless network coding research to the next level. One article investigates the energy efficiency benefit of using network code. The other article exploits the superposition principle of radio waves in improving network coding performance. Two articles suggest various network coding strategies for relay networks. The last two aim to design minimal decoding delay network coding schemes for broadcast networks. While pointing detailed explanation to these individual articles, we will briefly introduce them here one by one.

J. Goseling et al., in the first paper of this special issue "*Lower bounds on the maximum energy benefit of network coding for wireless multiple unicast,*" investigate the benefit of using network coding for reducing energy consumption in wireless networks. The energy benefit of using network coding in d-dimensional networks, the paper indicates, is at least $2d/\lfloor\sqrt{d}\rfloor$-fold, compared to the case of using the plain routing solution.

S. Zhang and S. C. Liew in the second paper, "*Application of physical-layer network coding in wireless networks*," investigate the use of physical-layer network coding (PNC) for wireless networks. The idea of PNC is to exploit the inherent property of the radio channel that radio waves from different users superpose at the receiver antenna. This property can be used to carry out the addition operation needed in network coding and can be utilized to achieve substantial increase in throughput compared to conventional network coding schemes.

In the third paper, "*Joint channel-network coding for the Gaussian two-way two-relay network,*" P. Hu et al. investigate a two-way relay channel problem and consider five different network coding strategies made from a combination of basic ones such as Amplify-Forward (AF), Decode-Forward, and Decode-Amplify Forward. They have done extensive performance evaluations of these strategies for various relay channel environments.

B. Du and J. Zhang in the fourth paper, "*Parity-check network coding for multiple access relay channel (MARC) in wireless sensor cooperative communications,*" aim to design a parity-check network coding scheme for a two-source multiple access relay channel. The parity-check network code, they imply, is a multidimensional low-density parity-check (LDPC) code. Each user employs an LDPC code to encode one's own source data, and the relay adds extra parity-check bits. The extra bits can be used as a "binning" process and make the overall coding scheme to be stronger in its error correction capability.

X. Wang et al., in the fifth paper "*Data dissemination in wireless sensor networks with network coding*," aim at applying network coding in data dissemination problems which may arise in wireless sensor networks, such as software upgrades and an addition of new functionality. A package of data, often very large in its complete size, should be delivered in its entirety to each individual sensor. But the package of packets may not be delivered to all the sensors in a timely manner because some of them may have been put to operate in a sleep mode. Sleep scheduling is frequently used in wireless sensor networks as a means to save the battery, perhaps the most critical resource. The authors focus on the design of an effective XOR-based network coding strategy given a sleep scheduling information.

P. Sadeghi et al. investigate the design of feedback-based adaptive network coding schemes for packet erasure networks in the last paper "*An optimal adaptive network coding scheme for minimizing decoding delay in broadcast erasure channels*." The aim is to deliver high throughputs and low decoding delays. Two main throughput optimal schemes are fountain codes and random linear network codes since they do not require feedback about erasures. But their throughout optimality may come at the cost of large decoding delays. In the application layer, having to wait for the entire coded block to arrive can result in unacceptable delays. This paper focuses on designing network coding schemes with the help of feedback that can deliver innovative packets in any order to the destination and guarantee fast decoding.

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