Weekly Report (2010-10-31)

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I. Literature Review

I have been reading some papers, which are published recently, on network coding. And I will go on reading some papers on **MAC-layer design** for network coding and the **cooperative diversity**, respectively, to clarify some questions I met this week.

A. Throughput Optimization with Network Coding

Cui et al. [1] exploit the throughput maximization for **multicast** in wireless networks with the consideration of **broadcast advantage** and **network coding**. The scheme of cross-layer optimization is utilized for joint rate control, network coding and scheduling. Distributed algorithms are derived by primal-dual decomposition. The interference model in the paper is very simple: **primary interference model**. And each broadcast is mapped into a hyperarc in a hypergraph. So the link scheduling problem is equivalent to the **maximum weighted hypergraph matching problem**. For the distributed subproblems, both locally greedy and randomized approximation algorithms are designed with guaranteed performance.

What we may learn from this paper is how to design a distributed randomized algorithm with guaranteed approximation ratio with regard to the optimal solution.

In [2], Thakur and Medard address on the rate optimization in **low-SNR** wireless networks with the help of **network coding**. Two channel models are adopted in the paper: **physically degraded broadcast channel** and **multiple access channel**. They first derive the capacity region as well as the formula to calculate the link rate with given SNR value for the two models, respectively. Then, the rate optimization problem is formulated and solved by primal-dual decomposition and subgradient method.

What we can learn from this paper is that, in low-SNR cases, the link rate is almost proportional to the SNR value for both physically degraded broadcast channel and multiple access channel.

B. Analog Network Coding

In [3], Maric et al. analyze the achievable capacity with analog network coding in **high-SNR** scenarios. They focus on a **layered relay network**, whose structure is quite similar with our CANC gadget (luckily, we are discussing two different topics on the structure). The authors have demonstrated that, in high-SNR cases, the rate at the receiver 1) approaches the **cut-set bound** when the received power increases; 2) is within a constant gap, which depends on the number of nodes, from the upper bound when the transmission power on each node increases.

What we can learn from the paper is that we may analyze the performance of our CANC scheme or future algorithms by comparing with the cut-set bound. This approach is much easier than analyzing the overall network capacity since the capacity of wireless networks even with a single source-destination pair is still unknown.

In [4], Gacanin and Adachi extend the analog network coding into **broadband** bi-directional transmissions in a **frequency-selective fading channel**. The motivation is that current analog network coding is designed for **narrow-band channel** without the consideration of frequency-selective fading. The **frequency domain equalization (FDE)** (I am not familiar with it and will learn more about it in coming week) is utilized on **OFDM** and **single carrier (SC) radio access**, respectively, to deal with the channel frequency-selectivity. Both BER and ergodic capacity are analyzed numerically.

What I learned from this paper is that current analog network coding is still not mature enough to be implemented in real applications. We may explore the application of ANC in more realistic channel models, just as the paper does in OFDM and SC radio access.

REFERENCES

[1] T. Cui, L. Chen and T. Ho, *On Distributed Scheduling in Wireless Networks Exploiting Broadcast and Network Coding*, In *IEEE Transactions on Communications*, vol. 58, NO. 4, Apr. 2010.

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[3] I. Maric, A. Goldsmith and M. Medard, *Analog Network Coding in the High-SNR Regime*, In proceedings of Wireless Network Coding Conference (WiNC), 2010 IEEE.

[4] H. Gacanin and F. Adachi, *Broadband Analog Network Coding*, In IEEE Transaction on Wireless Communications, vol. 9, no. 5, May 2010.