

Thesis Title: Feedback-Based Network Coding for Next-Generation Wireless Broadcast

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Abstract of the Thesis

The conventional approach of sender queue (SQ) management in feedback-based network-coded broadcast is to drop the packets which are decoded by the receivers, and this policy is termed as the *drop when decoded* (DWD) scheme. The key issue with DWD is the high blocking probability of the incoming packets. The *drop when seen* (DWS) scheme was proposed based on the notion of *seeing* a packet that reduces the expected SQ length. While providing an efficient SQ management technique, the throughput of the system is not compromised with optimal DWS encoding. To execute the DWS algorithms, exact *knowledge space* information of the receivers is needed, which is kept in the form of matrices. Consequently, DWS ends up being computationally expensive.

In this thesis, we propose the randomized version of the DWS scheme (rDWS) by converting the deterministic encoding procedure into a randomized one, and rDWS is shown to be a reduced-complexity, lightweight variant that only needs the dimension of the *knowledge spaces*. The throughput efficiency of rDWS is investigated in the form of the probability of *innovativeness* of the network-coded packets. Obtaining a closed-form expression of the probability is found to be difficult, although we obtain the minimum value of the same that corresponds to the worst-case behavior of rDWS. Next, performance analyses of DWS and rDWS are carried out in the form of packet dropping and packet decoding statistics, where an absorbing discrete-time Markov chain is constructed. For the dropping statistics, an additional tensor-algebraic formulation, and for the decoding statistics, the fundamental matrix-based techniques are employed. The analysis of rDWS is performed with respect to the Independent Markov-state Model (IMM), and it is shown to be accurate in most cases. Finally, we demonstrate the generalized rDWS technique in a non-generation-based scenario, and a queueing analysis is performed to find the expected SQ length.

The obtained analytical results of this thesis (which are supported by simulation plots) yield, rDWS is indeed a lightweight and less-complex variant of DWS that is suitable for next-generation wireless applications, where the performance is not compromised in the form of throughput, packet dropping, and packet decoding statistics while availing the queue management benefit of the *drop when seen* policy.