Cross-Layer Design for Multihop Wireless Networks

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Abstract:

The layered networking architecture has been instrumental in the proliferation of communication systems. The success of the layered architecture has been its ability to provide modularity and transparency. However, optimizing within layers is insufficient to obtain the orders-of -magnitude performance gains necessary to fuel major growth in next-generation wireless services. To achieve these performance gains, it is imperative that network protocols and designs are engineered by jointly optimizing across the layers (cross-layer design). However, the Achilles heel of cross-layer design is its potential to destroy modularity, hence making the overall system fragile. In this talk, we develop a "loose -coupling" approach to address this issue. By loose -coupling, we mean that the cross-layer solution only requires a minimal amount of interaction between the layers, and is robust to imperfect decisions made at each layer. Thus, we gain efficiency while still retaining modularity. We will focus on the cross-layer congestion control and scheduling problem in multi-hop wireless networks. We will show that the optimal solution to this cross-layer problem can be decomposed into a congestion control component and a scheduling component, with minimal coupling through queue-length updates. We will also investigate the impact on the performance of the cross -layer solution if the network can only use an imperfect (and potentially distributed) scheduling component that is easier to implement. We will establish desirable performance bounds for our solution with imperfect scheduling and show how the insights drawn from our analyses enable the design of a fully distributed cross-layer solution.