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Multipath Wireless Network Coding: An Augmented Potential Game Perspective

ABSTRACT :

We consider wireless networks in which multiple paths are available between each source and destination. We allow each source to split traffic among all of its available paths, and we ask the question: How do we attain the lowest possible number of transmissions per unit time to support a given traffic matrix? Traffic bound in opposite directions over two wireless hops can utilize the "reverse carpooling" advantage of network coding in order to decrease the number of transmissions used. We call such coded hops "hyper-links." With the reverse carpooling technique, longer paths might be cheaper than shorter ones. However, there is a peculiar situation among sources-the network coding advantage is realized only if there is traffic in both directions of a shared path. We consider the problem of routing with network coding by selfish agents (the sources) as a potential game and develop a method of state-space augmentation in which additional agents (the hyper-links) decouple sources' choices from each other by declaring a hyper-link capacity, allowing sources to split their traffic selfishly in a distributed fashion, and then changing the hyper-link capacity based on user actions. Furthermore, each hyper-link has a scheduling constraint in terms of the maximum number of transmissions allowed per unit time. We show that our two-level control scheme is stable and verify our analytical insights by simulation.