CITY UNIVERSITY OF HONG KONG

香港城市大學

Throughput Optimization in Wireless Collaborative Relay Networks and MIMO Systems

無線協作中繼網絡與MIMO系統的性能優化

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Abstract

With the rapid deployment of the Internet and mobile devices in recent years, people have increasing traffic demands on wireless networks. However, due to the broadcast nature of wireless communications, and the limited wireless spectrum, it is a challenging problem to improve the performance of the wireless systems. In the thesis, we focus on the routing / scheduling algorithms and the analytical models for the following two important networking technologies that could increase the system throughput greatly: collaborative relay and Multiple-Input Multiple-Output (MIMO).

Collaborative relay is a promising idea in WLAN that could increase the system throughput significantly. It enables high data rate clients to relay traffic for the low data rate clients for better system performance. An important issue of collaborative relay is to decide when a client's traffic should be relayed and who relays it. In the thesis, we present a routing algorithm and a corresponding distributed protocol that enable multi-hop collaborative relay in WLAN systems. This routing algorithm helps to increase the system performance while preserving the throughput fairness among the clients. It also helps to solve the performance anomaly problem in WLAN systems efficiently. We also propose a performance analytical model and a refined routing algorithm of collaborative relay. The proposed analytical model takes the contention overhead into consideration, and is thus more accurate than the existing models, which enables us to make a better decision on relay topology. We further extend the idea of collaborative relay into a carry-and-forward algorithm for traffic routing and scheduling in vehicle networks. This algorithm takes advantage of regular vehicle movements and enables

the delay-tolerate traffic to be delivered at a specific time point with highest delivery efficiency.

MIMO is a powerful physical layer technology that could increase the link capacity greatly. There are two transmission strategies in MIMO networks, spatial multiplexing (SM) and interference cancellation (IC). SM allows multiple independent data streams to be transmitted over the same link simultaneously by multiple pairs of transmitting / receiving antennas. IC enables a receiving node to use its antennas to suppress the signals from interfering sources, and thus the intended signals can be received even in the presence of interferences. Proper control the use of SM and IC transmission strategies on MIMO links can help to increase the performance greatly. In the thesis, we propose a stream scheduling algorithm for multi-hop MIMO systems. The proposed algorithm enables the more data streams to be transmitted simultaneously through asymmetric MIMO links. We also present a joint routing and scheduling algorithm for MIMO systems to take the advantage of concurrent transmissions. This algorithm dynamically route the traffic through multiple interfering links using the IC transmission strategy for better transmission efficiency, and thus could improve the system throughput significantly.

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