TITLE Wireless Mesh Networks

***Abstract*—The abstract goes here.**

I. Introduction

Recently, there have been numerous research efforts, proposing many interesting power control, scheduling and routing mechanisms for wireless mesh networks with an ultimate objective of achieving better throughput.

II. Related Work

what is yet not been studied in related literature is how certain link characteristics can dominate the schedule length. This work investigates such limitation of link scheduling and motivates the need of joint routing, scheduling and power control for throughput improvement.

III. Background and Problem Description

A. Network Model

Every node in the network is assumed to have the ability to vary its transmission power level continuously over a wide range. This can result into a fully connected topology as every node can be direct reach of every other node.

B. Interference Model

4-way interference model - Simultaneous transmissions on any two links (uv and xy) in the network can be successful if and only if distances ux, uy, vx and vy are more than $\sigma \cdot uv$ and $\sigma \cdot xy$, where σ is the interference ratio.

C. Problem Formulation

1) Power Control: Power control mechanisms COMPOW and DirectTrans are in sharp contrast with each other. In COMPOW, nodes in the network uses a uniform constant minimum power level such that network connectivity is maintained. While in DirectTrans mechanism, every sender uses a transmission power which is minimum required to reach the intended receiver.

2) Link Scheduling: Considering the above mentioned DirectTrans power control mechanism and 4-way interference model, conflict graph can be derived from the communication graph of the network. In such case, link scheduling problem can be represented as problem of finding independent set in conflict graph.

3) Flow Routing: In DirectTrans power control mechanism, where every node is in one-hop reach of every other node, routing can be used in collaboration with topology control to mitigate effect of high interference links by routing their traffic on low interference links.

4) Interdependencies Between Problems: Power control, scheduling and routing problems display high amount interdependencies as changing one strategy also affects decisions of other two mechanisms. For example, changing node transmit power level changes the topology of the network. This affects the routing decisions based on connectivity relation in new topology and it also affects scheduling decisions because underlying link conflict relationships also change.

IV. Scheduling Algorithm

A. Interference Score

Interference score of a link indicates the difficulty in scheduling the link together with other links.

B. Scheduling Algorithm

Greedy independent set based scheduling algorithm takes link conflict graph and traffic demands on links as input and outputs a schedule for link transmissions. It chooses a link for particular time slot and finds all other links which can be scheduled in parallel in the same time slot to achieved better spatial reuse.

C. Criterions

1) First Criterion: Scheduler orders the transmission link requests based on their interference score (or randomly) and chooses the first link for transmission in a particular time slot.

2) Second Criterion: Once the first link is chosen for schedule, other links can be selected based on their difficulty measure of scheduling.

Choosing maximum interference score as first and second criterion outperforms all other criterions in terms of achieved schedule length.

V. Loner Links

It can be observed in the sample schedule (Figure. x) that some of the links give absolutely no opportunity of scheduling other links in parallel with it. Loner links, when scheduled, reduces the spatial reuse factor to 0.

A. Characterizing Loner Links

1) Square Area: In a square of side k and σ = 2, any link of length equal or less than $0.304k$ is non-loner and any link of length equal or more than $0.579k$ is loner with probability of 1.

2) Circular Area: In a circular area of diameter d and σ = 2, any link of length equal or less than $0.25d$ is non-loner and any link of length equal or more than $0.485d$ is loner with probability of 1.

B. Number of Loner Links

Theoretical estimation and empirical measurement data proves that upto 65% of total links can be loner and can not be scheduled with any other links.

C. Effect on Schedule Length

Any intelligent scheduling algorithm can achieve no better schedule length than 65% of total traffic demand because of the adverse effect of loner links in schedule. Loner links can be eliminated from the schedule only with aid of routing to achieve better schedule length.

VI. Joint Topology Control, Scheduling and Routing

A. Interference-aware Topology Control

Any links having length of $0.579k$ or more should be eliminated from the topology as such links are definitely loners.

B. Joint Topology Control, Scheduling and Routing Algorithm

Once the loner links are eliminated in topology control phase, traffic of these links can be routed on links with satisfied or simply no traffic demands.

VII. Numerical Results

A. Simulation Settings

Simulation have been performed for performance evaluation with different kinds of topologies like grid, uniform random and clustered and different kinds of traffic demands such as all-to-all, random and clustered.

B. Performance of Scheduling Algorithm

Scheduling algorithm achieves upto 85% schedule length of total traffic demand.

C. Numerical Analysis of Loner Link Characteristics

A typical schedule can be dominated by upto 65% by loner links.

D. Performance of Joint Topology Control, Scheduling and Routing

Eliminating loner links and routing their traffic demands on low interference links can reduce the schedule length.

VIII. Conclusion and Future Work

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References