MOCA: Minimum-Overlap Channel Assignment for Multi-Radio Wireless Mesh Networks

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Introduction

Wireless Mesh Network (WMN)

Contains mesh clients, mesh routers and gateways forming the mesh topology such that WMN can extend wireless coverage

Mesh Routers

Form the backbone of the networks and work as relay to forward the information

Channel

It is assumed that 11 channels in IEEE802.11b/g standard can be used between the wireless links of mesh routers and 3 of them are non-overlapped (orthogonal)

Channel Assignment (CA)

Is the decision of which channel is to be used for which link of WMN

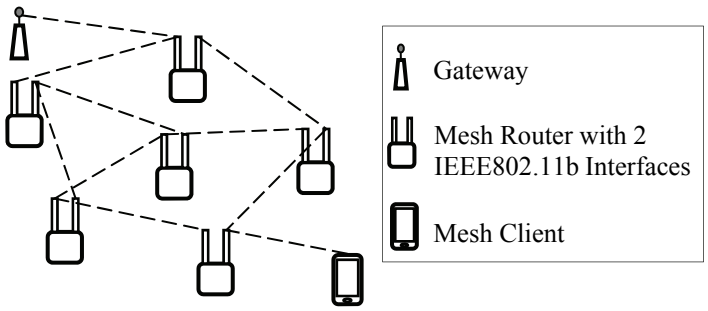


Fig. 1. A WMN Topology

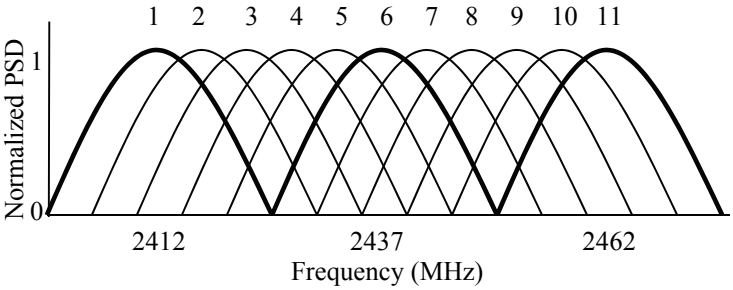


Fig. 2. IEEE802.11b Frequency Band

Motivation

- Previous study shows that **partially overlapped channels** can improve end-to-end throughput by factors between 1.6 – 2.7
- Testing with different channel separations ,for example, channel separation = 2 shows that the throughput per flow drops by about 20% only but not 50% for completely overlapped channel
- Past work only use non-overlapped channels (1, 6, 11) in WMN may
  - Limit choose
  - Increase interference level
- Using overlapped channels in WMN can potentially
  - Increase flexibility in wireless resource allocation
  - Decrease the interference level
  - Improve the throughput
  - Without additional wireless frequency band

MOCA Problem Formulation

Problem Statement

Make use of overlapped channels in CA of WMN to minimize total overlapped amount within WMN and provide better performance

Notation

V – set of mesh routers

C – set of channels that the routers using

I_i – neighbor channel list which interferes router v_i

MOCA Optimization Problem

• Objective function :

$$\min\left[\sum_{c_{ij}\in C}\left(\sum_{c_{mn}\in I_i\cup I_j} IF_{|c_{ij}-c_{mn}|}\right)\right]$$

where IF is interference factor taking count the overlapped amount between 2 different channels

• The goal is to minimize the total overlapped amount of the frequency spectrum of WMN by using overlapped channels

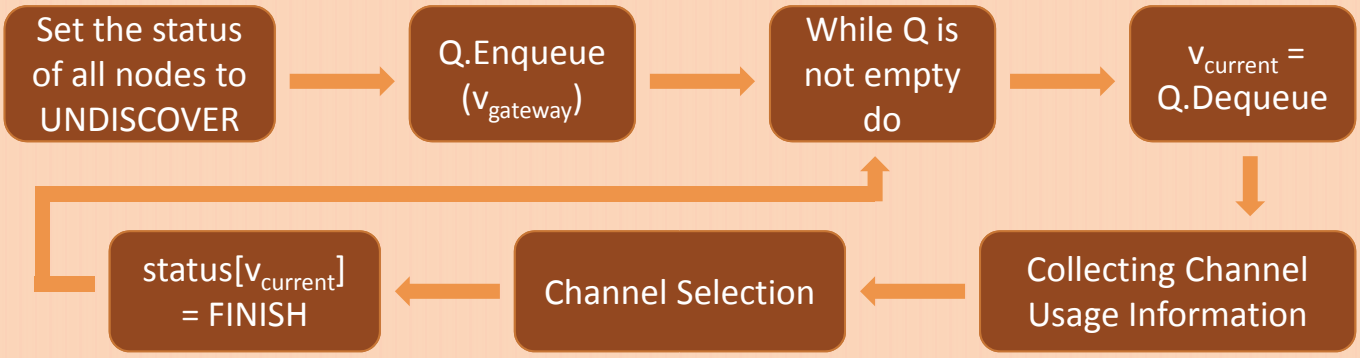
• MOCA Optimization problem is a NP-hard problem

Algorithm

Overview

- Greedy centralized algorithm
- Divide network interface cards (NICs) to either UP-NIC or DOWN-NIC
- BFS channel assignment starting at gateway

Flow of the Algorithm



Running Time

- The worst running time is $O(n^2)$

Simulation Results

Simulation Tool

• Network Simulator 3.6 (NS-3.6)

Simulated Scenario 1

Summary of Simulation Setting 1	
Topology	3x3 – 9x9 Grid
Inter-router Separation	50m
Number of Flows	3
Interference Range	about 200m
Transmission Range	about 100m
Interface	2 IEEE802.11b NICs

Results:

• Fig. 3 shows that the TCP throughput of using overlapped channels improves by 2 times

• Fig. 4 shows that the UDP packet loss rate reduces by 20%

Simulated Scenario 2

Summary of Simulation Setting 2	
Topology	Random with 30 nodes
Boundary	200m x 200m
Number of Flows	2 - 9

Results:

• Fig. 5 shows that the saturated network capacity increases by 5%

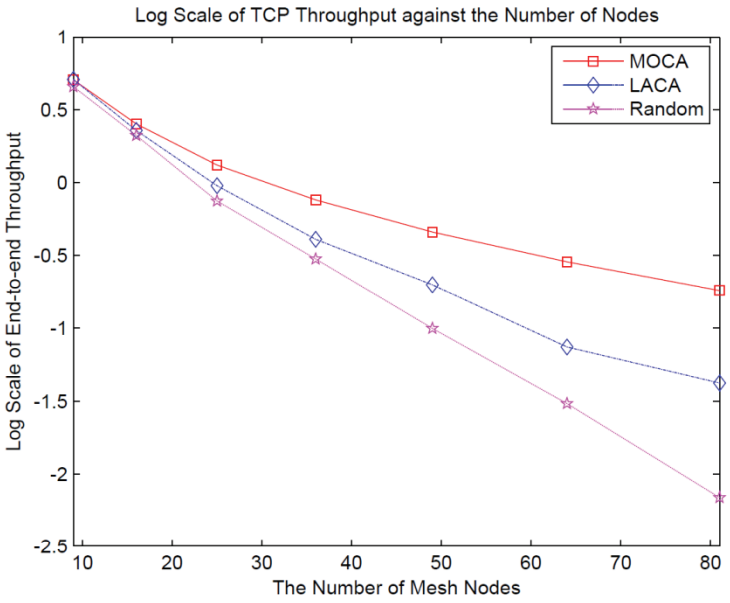


Fig. 3. TCP Throughput from Scenario 1

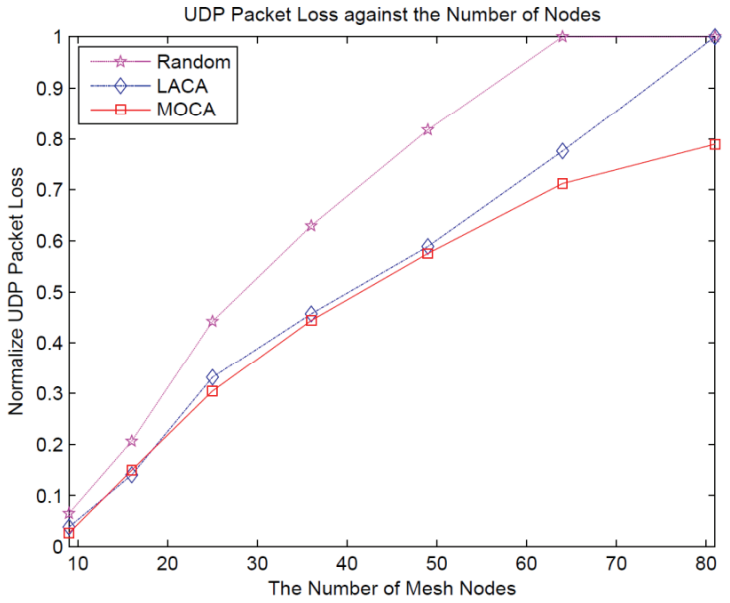


Fig. 4. UDP Packet Loss from Scenario 1

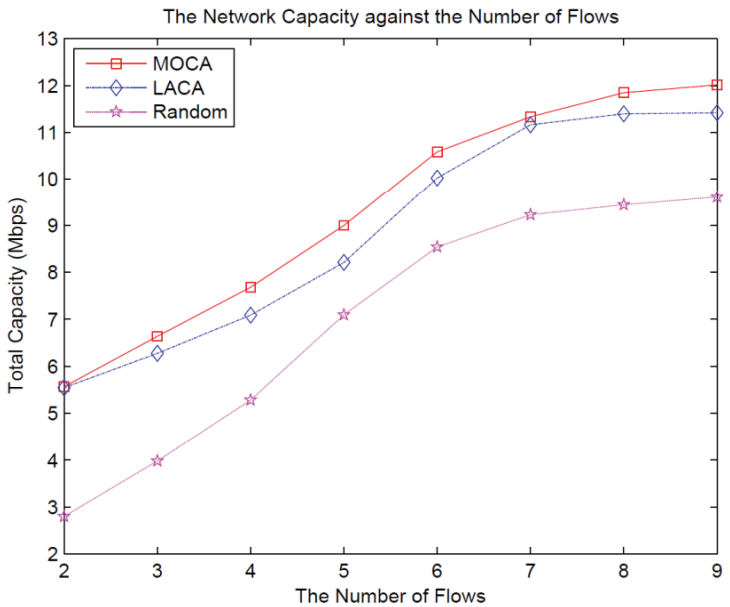


Fig. 5. Saturated Network Capacity from Scenario 2

Conclusion

• Formulate MOCA problem

• Propose efficient algorithm

• Achieve sub-total 20% - 100% improvement in WMNs depending on the size of networks