

Utilizing Beamforming Antennas for Improving the Performance of Wireless Mesh Networks

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Outline

- Introduction
- Objectives
- MAC Protocols
- Simulation Scenario
- Results
- Conclusion
- Future Works

Introduction (1/3)

- Wireless Mesh Networks (WMNs)
 - dynamic setup
 - mobile/static nodes
- Omnidirectional Antenna (OA)
 - IEEE802.11 standard
 - saturation in larger network or denser scenario
- Directional Antenna (DA) → **Rationale?**

Introduction (2/3)

- **Gain of Directional Antenna**
 - multi small hop → single long hop transmissions
 - lower the transmission delay
- **Interference Reduction Capability**
 - avoid interference from unwanted directions
 - increases the signal to noise ratio (SNR)
- **Utilization of Network**
 - increased capacity
 - more users utilizing the network.

Throughput
Delay
Fairness

Introduction (3/3)

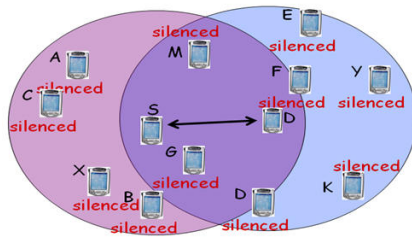


Figure 1 –
Omnidirectional Antenna

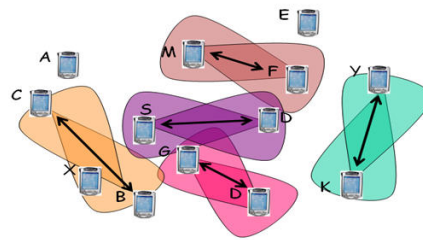
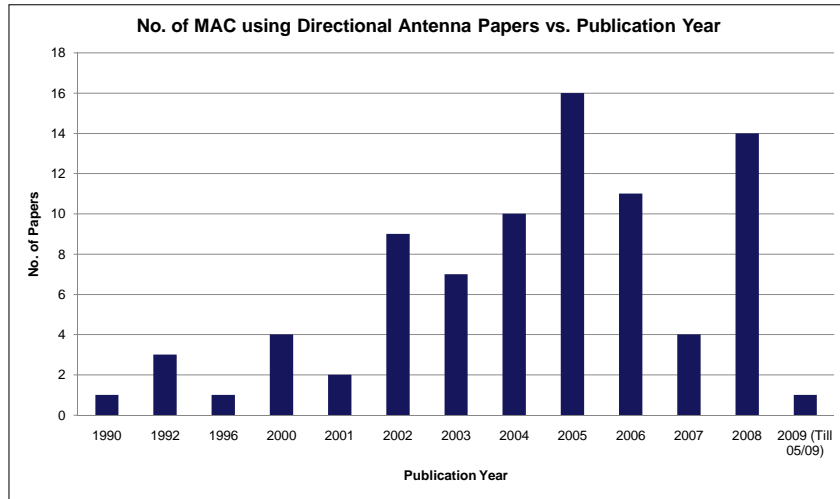


Figure 2 –
Directional Antenna

Objectives

- i. To study various MAC protocols available utilizing directional antenna to understand its values.
- ii. To study the performance of WMN improved using **directional antenna**
 - throughput, delay and fairness

MAC Protocols



Simulation Scenario (1/3)

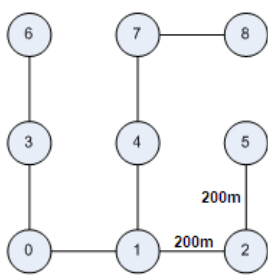


Figure 3 – 3x3 Grid Network

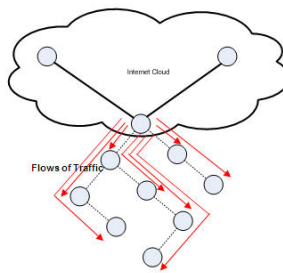


Figure 4 – Data Flows from the root Node

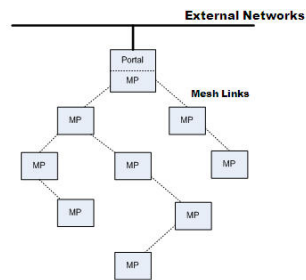


Figure 5 – Typical Static Mesh Network

Simulation Scenario (2/3)

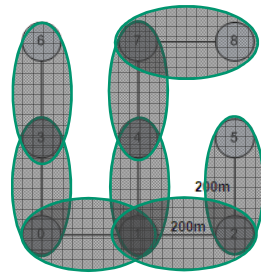


Figure 6 –
Directional Antenna

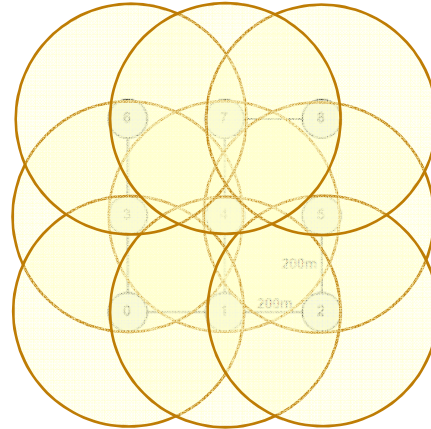


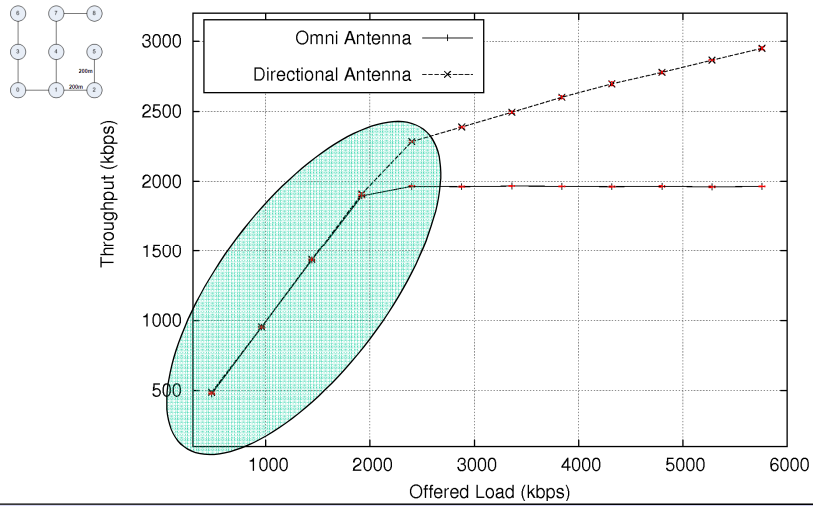
Figure 7 –
Omnidirectional Antenna

Simulation Scenario (3/3)

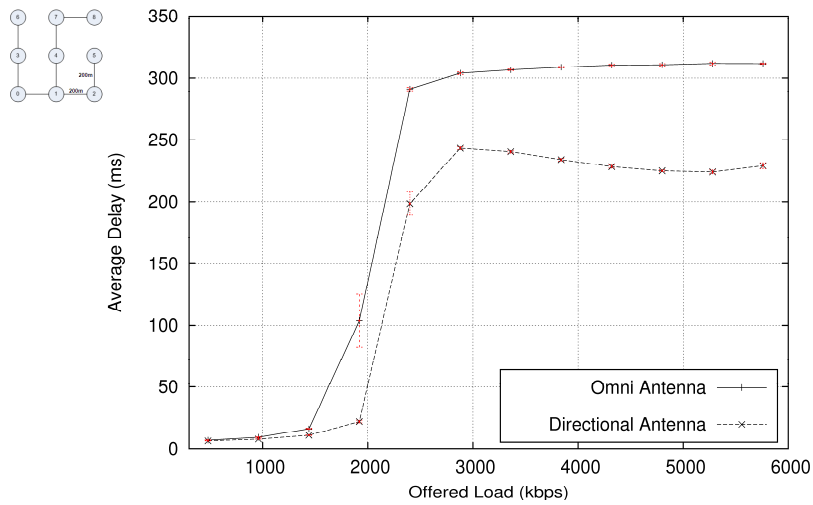


Parameters	
Topology	3 x 3 Grid Network
Simulation Time	60 sec
Number of DA	4
Beamwidth DA	60°
Packetsize (bytes)	1500
Modulation Scheme	BPSK
Node Mobility	Static
Distance between nodes	200m
Channel	1
IFQLen	50pkts
Power - OA	158mW (22dBm)
Power - DA	40mW (16dBm)
Offered Load	[40-480] , steps 40 pkts/sec
Traffic Arrival	Poisson Distributed
Traffic Distribution to Nodes	Uniform Distributed
Channel Access Scheme	IEEE 802.11 DCF
RX and CS Threshold Ratio	1:1, single hop
Channel Bandwidth	11Mbps
Routing	Static Routing

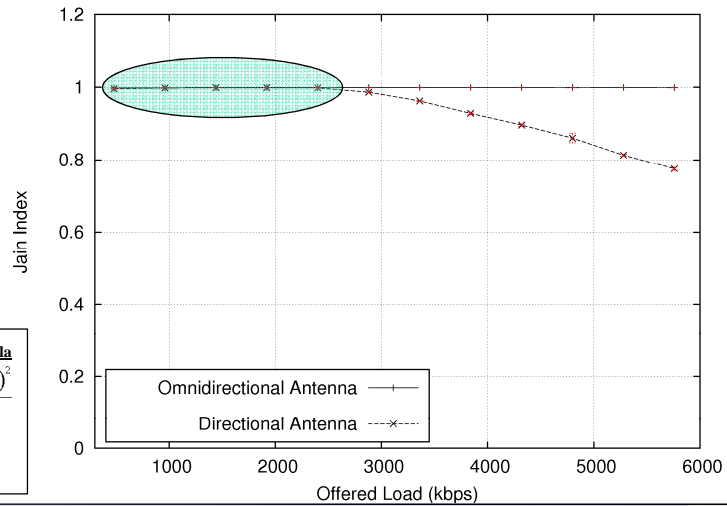
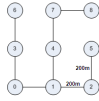
Results - Throughput



Results - Delay



Results - Fairness



Jain's Fairness Index Formula

$$f(x_1, x_2, x_3, \dots, x_n) = \frac{(\sum_{i=1}^n x_i)^2}{n \sum_{i=1}^n x_i^2}$$

x_i = throughput of flow i
 n = number of competing flow

Conclusion

- Directional Antenna improved the performance
 - average throughput - increased ~16%
 - average delay - reduced ~31%
 - fairness - same

- Significant results
 - OA operated at 158mW (22dBm)
 - DA operated at 40mW (16dBm)



Future Works

- MAC Protocol - Directional Antenna
- Routing - AODV
- Energy saving mechanism
- Mobility
- Testbed Setup to evaluate theoretical result

THANK YOU