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On exploiting spatial reuse in wireless ad hoc networks

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On Exploiting Spatial Reuse in Wireless Ad Hoc Networks

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Statement of Originality

I, Ziguang Yan, declare that this thesis, submitted in partial fulfillment of the requirements for the award of Master of Engineering - Research, in the School of Electrical, Computer and Telecommunications Engineering, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

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Abstract

Wireless ad hoc networks have been increasingly popular in recent years with the development of mobile devices. However, both theoretical and simulation works show that the capacity of wireless ad hoc networks is bounded due to its nature of *distributed* and *multihop*. Spatial reuse is a promising technology to increase the capacity of wireless ad hoc networks by allowing more transmissions to occur simultaneously. In this thesis, we enhance 802.11 performances by exploiting the benefits of spatial reuse in wireless ad hoc networks which is achieved by *transmission power control* (TPC) and *directional antennas*.

We first propose *spatial TPC* based on basic TPC to fully exploit the benefits of spatial reuse achieved by transmission range control. Simulation results show that spatial TPC achieves higher throughput and lower power consumption compared to 802.11 and basic TPC. We also develop four schemes of directional MAC protocols with the intention of overcoming the new hidden node problem faced by directional antennas. By extensive simulations under different topologies and traffic patterns, we find the directional *RTS/CTS* (DD) scheme outperforms 802.11 as well as other three schemes by fully exploiting the benefits of spatial reuse achieved by directional antennas.

Keywords:

Wireless ad hoc networks, MAC, CSMA, 802.11 DCF, Spatial reuse, Power control, Directional antennas, OPNET simulation.

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Abbreviations

ACK	acknowledgement
AoA	angle of arrival
AP	access point
ATIM	announcement traffic indication message
BEB	binary exponential backoff
BER	bit error rate
BSS	basic service set
CCA	clear channel assessment
CFP	contention free period
CP	contention period
CS	carrier sense
CSMA	carrier sense multiple access
CTS	clear to send
CW	contention window
DCF	distributed coordination function
DIFS	distributed (coordination function) interframe space
DPSK	differential phase shift key
DMAC	basic directional MAC protocol
DNAV	directional network allocation vector
EIFS	extended interframe space
FSM	finite state machine
GPS	global positioning system
IFS	interframe space
LoS	line of sight

MAC	medium access control
MSDU	MAC service data unit
NAV	network allocation vector
PCF	point coordination function
PCS	physical carrier sensing
PLCP	physical layer convergence protocol
PS	power saving
RTS	request to send
RTT	round trip time
SIFS	shortest interframe space
SISO	single in single out
SNR	signal to noise ratio
STA	station
TPC	transmission power control
ToA	time of arrival
VCS	virtual carrier sensing
WLAN	wireless local area network
WM	wireless medium

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