BANDWIDTH ALLOCATION AND CHANNEL ASSIGNMENT IN WIMAX MESH NETWORKS

DU PENG

DOCTOR OF PHILOSOPHY

CITY UNIVERSITY OF HONG KONG

AUGUST 2009

CITY UNIVERSITY OF HONG KONG
香港城市大學

Bandwidth Allocation and Channel Assignment in WiMax Mesh Networks
WiMax Mesh 網絡帶寬調度與信道分配問題的研究

Submitted to
Department of Computer Science
電腦科學系
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
哲學博士學位

by

Du Peng
杜鵬

August 2009

二零零九年八月

Abstract

World Interoperability for Microwave Access (WiMax) is one of the leading technologies in the context of Broadband Wireless Access (BWA). The PHY and MAC layer specifications of WiMax networks are defined by the IEEE standard 802.16-2004. According to this standard, WiMax systems can work in Point-to-Multipoint (PMP) mode or mesh mode. However, this standard does not specify the MAC layer bandwidth allocation and channel assignment algorithms for the mesh mode, which is decisive to the system performance in terms of throughput and quality of service. We investigate these issues in this thesis.

As specified in IEEE 802.16-2004, time slot allocation for end-to-end traffic flow in WiMax mesh networks is controlled by a centralized scheduling algorithm. To support high-quality multimedia services on the network, the scheduling algorithm should be able to minimize the total transmission time for all traffic flows. Chapter 2 studies the multi-channel scheduling problem in order to explore the potential of simultaneous transmissions and thus minimize the total transmission time. For a given network topology with fixed routing tree, we first analyze how many channels are sufficient for the avoidance of interference. Then we present an efficient scheduling algorithm along with the channel assignment strategy for time slot allocation. The simulation results show that our scheme can improve the system performance substantially as compared with the single channel system. Also, we observe that double channel settings may provide a performance similar to the multiple channels.

Chapter 3 studies the routing, time slot allocation and channel assignment problem in multi-transceiver WiMax mesh networks, where multiple transceivers are supported on each station and can switch between different channels. We develop an interference-aware route construction algorithm, which construct a

routing tree during the network entry process, in order to minimize the interference. We also propose a time slot allocation algorithm for multi-transceiver networks. The simulation results show the impact of channels and transceivers on total transmission time.

In WiMax mesh networks, transient traffic between neighbor stations can be controlled by an uncoordinated distributed scheduling algorithm. In this algorithm, a three-way handshake must be initiated before data transmission. If the handshake fails, the transmitter must wait for a certain period before its next transmission. In Chapter 4 we analyze the performance of this algorithm. Due to the complexity of this problem, we only consider infinite networks with grid topology where all stations are identical. The behavior of each station in stable stage can be described as a Markov regeneration process. We analyze the impact of neighbors on the transmission fail probability of a certain station, then calculate the system throughput. In the simulation part a custom simulator is used to validate the effectiveness of our analytical model.

Chapter 5 studies the problem of resource management on hybrid mesh networks, where WiMax is used as the backbone. We propose a cross-layer resource publishing/discovery schema for both grid resources and p2p resources. Besides, a time slot allocation algorithm is presented for the BS to coordinate all transmissions of resource management messages.

Although the PHY and MAC layer specifications of WiMax mesh networks have been well defined, there is still work to do to increase the system throughput and improve the quality of service. In final chapter, we summarize our main contribution and conclude this thesis by pointing out our future work.

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List of Abbreviations

AODV	Ad hoc On-Demand Distance Vector (Routing)
BS	Base Station
BTMA	Busy Tone Multiple Access
BWA	Broadband Wireless Access
CPS	Common Part Sublayer
CSMA	Carrier Sense Multiple Access
DFWMAC	Distributed Foundation Wireless Media Access Control
DSDV	Destination-Sequenced Distance-Vector (Routing)
DSR	Dynamic Source Routing
FOMA	Freedom of Mobile Multimedia Access
IEEE	Institute of Electrical and Electronics Engineers
IMT-2000	International Mobile Telecommunications-2000
ITU	International Telecommunication Union
LTE	Long Term Evolution
MAC	Media Access Control (Layer)
MACA	Multiple Access with Collision Avoidance
MCRP	Multi-Channel Routing Protocol
MR-LQSR	Multi-Ratio Link-Quality. Source Routing
OSPF	Open Shortest Path First (Routing)
RIP	Routing Information Protocol
P2P	Peer to Peer
PHY	Physical (Layer)
PMP	Point to Multipoint
PWRP	Predictive Wireless Routing Protocol
QoS	Quality of Service

SDU	Service Data Unit
SRMA	Split-channel Reservation Multiple Access
SS	Subscribe Station
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
TDS-CDMA	Time Division Synchronous Code Division Multiple Access
UWB	Ultra Wideband
VoIP	Voice over Internet Protocol
WCDMA	Wideband Code Division Multiple Access
WiMax	Worldwide Interoperability for Microwave Access
WLAN	Wireless Local Area Network
WMAN	Wireless Metropolitan Area Network
WMN	Wireless Mesh Network
WPAN	Wireless Personal Area Network
ZRP	Zone Routing Protocol