SpringerBriefs in Computer Science

For further volumes:
http://www.springer.com/series/10028

Lu Wang • Kaishun Wu • Mounir Hamdi

Attachment Transmission in Wireless Networks

Springer

Lu Wang
Department of Computer Science and Engineering
Hong Kong University of Science and Technology
Kowloon, Hong Kong SAR

Kaishun Wu
Department of Computer Science and Engineering
Hong Kong University of Science and Technology
Kowloon, Hong Kong SAR

Mounir Hamdi
Department of Computer Science and Engineering
Hong Kong University of Science and Technology
Kowloon, Hong Kong SAR

ISSN 2191-5768 ISSN 2191-5776 (electronic)
ISBN 978-3-319-04908-3 ISBN 978-3-319-04909-0 (eBook)
DOI 10.1007/978-3-319-04909-0
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014932668

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Wireless penetration has witnessed explosive growth over the last two decades. Accordingly, wireless devices have become much denser per unit area, resulting in an overcrowded usage of wireless resources. To avoid radio interferences and packet collisions, wireless stations have to exchange control messages to coordinate well. The existing wisdoms of conveying control messages could be classified into three categories: explicit, implicit, or hybrid. However, all these methods consume valuable communication resources, for example, control frames and data packets are transmitted in an alternate manner, either in time domain or in frequency domain, which introduces massive coordination overheads. Therefore, providing cost-effective coordination mechanisms becomes a critical problem in wireless design.

In this book, we present a novel PHY layer technique termed Attachment Transmission, which provides an extra control panel to deliver control messages with minimum overhead. In a traditional transmission paradigm, control messages compete for communication resources with data packets. On the contrary, attachment transmission enables control messages to be transmitted along with data packets, without degrading the effective throughput of the original data packets. In addition to the basic design, this book presents the design challenges, the theoretical model, and demonstrates the implementation on a GNU radio testbed. Extensive experiments demonstrate that attachment transmission is capable of exploiting and utilizing channel redundancy to deliver control messages, thus providing significant support to numerous higher layer applications.

To demonstrate the effectiveness of the attachment transmission, we apply it to a number of classic problems in wireless networks, including the multichannel allocation problem in OFDMA-based networks, the hidden and exposed terminal problems in ad hoc networks, and the multiple access problem in wireless local area networks (WLANs). For the multichannel allocation problem, attachment transmission provides cost-effective identifier signals. These identifiers help mobile stations learn the channel allocation strategy by themselves, and thus achieve cooperation without coordination. For hidden and exposed terminal problems, attachment transmission offers accurate Channel Usage Information (CUI) on who

is transmitting or receiving nearby. Therefore, wireless stations can identify hidden and exposed nodes in real time, and thus make the right channel access decisions. For the multiple access problem, wireless clients deliver transmission requests to the access point (AP) through attachments. Since the requests are "attached" on high speed data transmission, control messages will not occupy any resources, such as the communication channel or the transmission air time. In this way we can achieve lightweight control in WLANs. Besides the above scenarios, we believe that attachment transmission can be further exploited and benefit more communication systems.

Kowloon, Hong Kong SAR Lu Wang
Kowloon, Hong Kong SAR Kaishun Wu
Kowloon, Hong Kong SAR Mounir Hamdi
July 2013

Acknowledgments

The authors would like to acknowledge the partial support of the HKUST Grant RPC10EG21, and Guangdong Natural Science Funds for Distinguished Young Scholar (No. S20120011468), Guangzhou Pearl River New Star Technology Training Project (No. 2012J2200081), Guangdong NSF Grant (No. S2012010010427), and China NSFC Grant 61202454.

The authors would also like to thank Prof. Sherman Shen. Without his help this book would not have been possible.

Contents

Acronyms

ACK	Acknowledge
AST	Access Strategy Table
AT	Attachment Transmission
AP	Access Point
BAM	Binary Amplitude Modulation
CAS	Carrier Allocation Scheme
CE	Correlated Equilibrium
CP	Cyclic Prefix
CSMA	Carrier Sense Multiple Access
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
CUI	Channel Usage Information
CRF	Current Receiver Field
CRN	Cognitive Radio Network
CSF	Current Sender Field
CTL	Current Transmission List
CVF	Current Victim Field
ET	Exposed Terminal
FFT	Fast Fourier Transform
FSK	Frequency Shift Keying
HT	Hidden Terminal
IC	Interference Cancelation
IFFT	Inverse Fast Fourier Transform
MAC	Media Access Control
MAI	Multiple Access Interference
MCM	Multi-Carrier Modulation
MS	Mobile Station
MTU	Maximal Transmit Unit
NE	Nash Equilibrium
NHL	Neighborhood Hash List
OFDM	Orthogonal Frequency-Division Multiplexing
OFDMA	Orthogonal Frequency-Division Multiple Access

PRR	Packet Reception Rate
Qos	Quality of Service
RTS/CTS	Request To Send/Clear To Send
SLA	Service Level Agreement
WLAN	Wireless Local Area Network
WMAN	Wireless Metropolitan Area network