

Min Chen
Shigang Chen

RFID Technologies for Internet of Things

Wireless Networks

Series editor

Xuemin (Sherman) Shen

University of Waterloo, Waterloo, Ontario, Canada

More information about this series at <http://www.springer.com/series/14180>

Min Chen • Shigang Chen

RFID Technologies for Internet of Things



Springer

Min Chen
Department of Computer and Information
University of Florida
Gainesville, FL, USA

Shigang Chen
Department of Computer and
Information Science
University of Florida
Gainesville, FL, USA

This work is supported in part by the National Science Foundation under grants CNS-1409797 and STC-1562485.

ISSN 2366-1186
Wireless Networks
ISBN 978-3-319-47354-3
DOI 10.1007/978-3-319-47355-0

ISSN 2366-1445 (electronic)
ISBN 978-3-319-47355-0 (eBook)

Library of Congress Control Number: 2016954315

© Springer International Publishing AG 2016

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, express or implied, with respect to the material contained herein or for any errors or omissions that may have been made.

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Contents

1	Introduction	1
1.1	Internet of Things	1
1.2	RFID Technologies	1
1.3	Tag Search Problem	2
1.4	Anonymous RFID Authentication	3
1.5	Identification of Networked Tags	4
1.6	Outline of the Book	5
	References	5
2	Efficient Tag Search in Large RFID Systems	9
2.1	System Model and Problem Statement	9
2.1.1	System Model	9
2.1.2	Time Slots	10
2.1.3	Problem Statement	10
2.2	Related Work	11
2.2.1	Tag Identification	11
2.2.2	Polling Protocol	13
2.2.3	CATS Protocol	13
2.3	A Fast Tag Search Protocol Based on Filtering Vectors	14
2.3.1	Motivation	14
2.3.2	Bloom Filter	15
2.3.3	Filtering Vectors	15
2.3.4	Iterative Use of Filtering Vectors	17
2.3.5	Generalized Approach	18
2.3.6	Values of m_i	19
2.3.7	Iterative Tag Search Protocol	22
2.3.8	Cardinality Estimation	23
2.3.9	Additional Filtering Vectors	24
2.3.10	Hardware Requirement	24

2.4	ITSP over Noisy Channel	25
2.4.1	ITSP with Noise on Forward Link	25
2.4.2	ITSP with Noise on Reverse Link	26
2.5	Performance Evaluation	29
2.5.1	Performance Metric	29
2.5.2	Performance Comparison	29
2.5.3	False -Positive Ratio	31
2.5.4	Performance Evaluation Under Channel Error	32
2.6	Summary	37
	References	37
3	Lightweight Anonymous RFID Authentication	39
3.1	System Model and Security Model	39
3.1.1	System Model	39
3.1.2	Security Model	40
3.2	Related Work	42
3.2.1	Non-tree-Based Protocols	42
3.2.2	Tree-Based Protocols	43
3.3	A Strawman Solution	43
3.3.1	Motivation	43
3.3.2	A Strawman Solution	44
3.4	Dynamic Token-Based Authentication Protocol	45
3.4.1	Motivation	45
3.4.2	Overview	46
3.4.3	Initialization Phase	46
3.4.4	Authentication Phase	47
3.4.5	Updating Phase	47
3.4.6	Randomness Analysis	49
3.4.7	Discussion	52
3.4.8	Potential Problems of TAP	53
3.5	Enhanced Dynamic Token-Based Authentication Protocol	53
3.5.1	Resistance Against Desynchronization and Replay Attacks	53
3.5.2	Resolving Hash Collisions	55
3.5.3	Discussion	58
3.6	Security Analysis	59
3.7	Numerical Results	60
3.7.1	Effectiveness of Multi-Hash Scheme	60
3.7.2	Token-Level Randomness	61
3.7.3	Bit-Level Randomness	61
3.8	Summary	64
	References	64
4	Identifying State-Free Networked Tags	67
4.1	System Model and Problem Statement	67
4.1.1	Networked Tag System	67
4.1.2	Problem Statement	68

4.1.3	State-Free Networked Tags	68
4.1.4	System Model	69
4.2	Related Work	70
4.3	Contention-Based ID Collection Protocol for Networked Tag Systems	71
4.3.1	Motivation	71
4.3.2	Request Broadcast Protocol	72
4.3.3	ID Collection Protocol	74
4.4	Serialized ID Collection Protocol	75
4.4.1	Motivation	75
4.4.2	Overview	75
4.4.3	Biased Energy Consumption	76
4.4.4	Serial Numbers	77
4.4.5	Parent Selection	78
4.4.6	Serialization at Tier Two	79
4.4.7	Recursive Serialization	80
4.4.8	Frame Size	82
4.4.9	Load Factor Per Tag	83
4.5	Improving Time Efficiency of SICP	85
4.5.1	Request Aggregation	85
4.5.2	ID-Transmission Pipelining	86
4.6	Evaluation	89
4.6.1	Simulation Setup	89
4.6.2	Children Degree and Load Factor	90
4.6.3	Performance Comparison	91
4.6.4	Performance Tradeoff for SICP and p-SICP	92
4.6.5	Time-Efficiency Comparison of SCIP and p-SICP	93
4.7	Summary	93
	References	95