EMERGING TECHNOLOGIES FOR NEXT GENERATION TELECOMMUNICATION SYSTEMS

Editors
Sharifah Hafizah Syed Ariffin
Omar Abdul Aziz

UTM
UNIVERSITI TEKNOLOGI MALAYSIA

EMERGING TECHNOLOGIES FOR NEXT GENERATION TELECOMMUNICATION SYSTEMS

New technologies have emerged in recent years for communication engineering, which contributed in many ways to the connection of the borderless environment. This book presents the implementation and evaluation of these emerging technologies that includes front-endsystems and backbone networks. Divided into 7 chapters, the firstchapter presents preliminary introduction of the contents. Chapter 2 presents design analysis of antenna array using graphene-based material. Chapter 3 examines user association to cellular network's base station for the case of a hybrid microwave and millimetre wave operation. Chapter 4 discusses on overview of base stations handover for the scenario of high-speed train. Chapter 5 demonstrates a case study of internet-of-things (IoT) applications. Chapter 6 studies prospective technique to ensure a balance data traffic load management for fog network. Finally, chapter 7 reviews slicing management for network virtualisation.

UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Penerbit
UTM Press

UTM PRESS

ISBN 978-983-52-2114-9
9 789835 221149
RM50.00

EMERGING TECHNOLOGIES FOR NEXT GENERATION TELECOMMUNICATION SYSTEMS

EMERGING TECHNOLOGIES FOR NEXT GENERATION TELECOMMUNICATION SYSTEMS

Editors
Sharifah Hafizah Syed Ariffin
Omar Abdul Aziz

Penerbit UTM Press
UNIVERSITI TEKNOLOGI MALAYSIA
www.penerbit.utm.my
2024

First Edition 2024

Editor: **SHARIFAH HAFIZAH SYED ARIFFIN & OMAR ABDUL AZIZ**
Editor Penyelaras/*Acquisition Editor*: **RASYIQAH ABDUL RANI**
Pereka Kulit /*Cover Designer*: **FAHAMIN ABDUL GHANI**

Diatur huruf oleh /*Typeset by*:
SHARIFAH HAFIZAH SYED ARIFFIN & OMAR ABDUL AZIZ
Faculty of Electrical Engineering
UNIVERSITI TEKNOLOGI MALAYSIA
81310 UTM Johor Bahru,
Johor Darul Ta'zim, MALAYSIA

Diterbitkan di Malaysia oleh/
Published in Malaysia by:
PENERBIT UTM PRESS
UNIVERSITI TEKNOLOGI MALAYSIA
81310 UTM Johor Bahru,
Johor Darul Ta'zim, MALAYSIA
(Ahli Majlis Penerbitan Ilmiah Malaysia (MAPIM) dan Persatuan Penerbit Buku Malaysia (MABOPA) no. keahlian 9101)

Dicetak di Malaysia oleh/
Printed in Malaysia by:
JASAMAX ENTERPRISE
No.16, Jalan Kebudayaan 2,
Taman Universiti,
81310 Skudai,
Johor Darul Ta'zim,
MALAYSIA

Cataloguing-in-Publication Data
Perpustakaan Negara Malaysia
A catalogue record for this book is available from the National Library of Malaysia
ISBN 978-983-52-2114-9

CONTENTS

CONTRIBUTORS

Chee Yen Leow *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Khairun Nisa Samaruddin *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mohamed Khalafalla Hassan *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mohammed Mehdi Saleh *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mohd Aliff Najmi Norizan *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mohd Haizal Jamaluddin *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mohd Haizal Jamaluddin *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mohd Husaini Mohd Fauzi *SyncMind Consulting and Services*

Muhammad Ariff Baharudin *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Mutaz Hamad *The Future University, Khartoum, Sudan*

Noorhazirah Sunar *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Nor Aishah Muhammad *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Norhudah Seman *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Nurzal Effiyana Ghazali *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Omar Abdul Aziz *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Sharifah Hafizah Syed Ariffin *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Siti Nor Hafizah Sa'don *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

Wee Kiat New *Faculty of Electrical Engineering, Universiti Teknologi Malaysia, Johor Bahru, Malaysia*

PREFACE

Emerging technologies in the communication system are important to enable advancement of devices and instruments in the market. Artificial intelligence is becoming more useful to communication systems as it learns the behaviour of the network, which improves decision making.

Wireless communication is impossible without an antenna. Modern antenna design has allowed latency reduction and improved power efficiency. Fifth-generation (5G) antenna with good characteristics can support new features such as larger bandwidth for heterogeneous usage by modern clients. Other innovations including massive multiple inputs multiple outputs (MIMO), millimetre-wave communications, full-duplex communications, energy harvesting, and wireless power transmission, will operate alongside newly deployed 5G networks. Incorporating these technologies alleviates the spectrum crunch issue and greatly increases network capacity.

We would like to thank Universiti Teknologi Malaysia and Ministry of Higher Education (MOHE) Malaysia for the resources and financial support of our research and studies. We specifically want to thank all contributors to this book, titled *Emerging Technologies for Next Generation Telecommunication Systems.*

Sharifah Hafizah Syed Ariffin
Omar Abdul Aziz
Universiti Teknologi Malaysia
2024