Tutorial T-10: Towards Spectrum Efficient, Energy Efficient and QoE Aware 5G Wireless Systems

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Tutorial Overview

The recent surge of various new applications and rapid booming of mobile traffic are stressing the mobile and wireless network infrastructure, pushing its capacity beyond its limit. The fast growing data traffic and dramatic expansion of network infrastructures will also inevitably trigger tremendous escalation of energy demand and energy consumption in wireless networks, which will directly result in the increase of greenhouse gas emission and poses ever increasing threats to the environmental protection and sustainable development. Green evolution has become another urgent need for wireless networks today. The wireless network research should meet the challenges raised by the high demand of both wireless traffic and energy consumption. At the same time, streaming video is gradually becoming an integral part of typical daily activities in different settings, ranging from home applications and Internet services to video collaboration and video conferencing in business and academic environments. It is anticipated that this trend will continue in the future at a faster rate, with video traffic exceeding 80% of consumer Internet traffic. The exponential growth of video traffic will undoubtedly have a significant impact on the energy and bandwidth consumption of future wireless infrastructure, greatly challenging their ability to deliver the users' expected Quality-of-Service (QoS) and Quality-of-Experience (QoE). Addressing the stringent requirements of mobile video streaming is a daunting challenge that must be addressed in next generation wireless network infrastructure. In this tutorial we will first present an ultra-dense, highly heterogeneous 5G wireless communication system with coexistence of overlay and underlay deployments. Under such a 5G system framework, we will survey the state-of-the-art research activities on spectrum efficiency (SE), energy efficiency (EE) and QoE based mobile association, radio resource management, multi-layer interference management and power control, network wide cooperation and dynamic resource allocation. Moreover, we will consider QoS/QoE as one of the design objectives together with SE and EE, to characterize the design tradeoffs among perceived video quality, SE and EE. We will also identify the technical challenges and active research areas in such an ultra-dense, ultra-heterogeneous wireless network with overlay and underlay deployments towards the multi-objective system performance optimization. The tutorial is expected to advance the understandings of the critical technical issues towards energy and spectrum efficient 5G wireless multimedia communication systems. The tutorial is structured as follows:

1. Introduction
This part will give an introduction on some basic background, well as the scope of the tutorial.

2. Motivation
This part gives the motivations, challenges, performance needs and technology trends.
a. Market Trends and New usages
b. Proliferation of applications and service and Explosion of wireless data traffic
c. Spectrum and energy efficiency needs
d. Quality of Service and Quality of Experience needs
e. Technology trends

3. Highly Dense and Heterogeneous 5G Overlay system

This part gives the C-HetNet that can facilitate the highly dense and heterogeneous wireless overlay network. Detailed technical schemes on radio resource management proposed under this framework are presented.

a. C-HetNet architecture

b. SE, EE and QoE based mobile association in Cloud RAN

c. Multi-tier interference management and power control

d. Multi-tier cooperative dynamic resource allocation

4. Highly Dense 5G Underlay System

This part introduces 5G underlay system architecture and research challenges.

a. 5G Underlaying Cellular Networks - Challenges and Research Aspects

b. Interference management in D2D based underlay systems

c. Multi-hop D2D communications

d. D2D Communications in HetNet

e. mmWave in D2D communications

f. SE and EE tradeoffs in D2D communications

5. QoE Aware SE and EE in 5G systems

This part presents why and how SE and EE will be redefined when considering QoE in 5G underlay/overlay systems, possible technical solutions and performance tradeoffs.

a. QoE aware SE and EE definitions

b. Why QoE Aware SE and EE will impact 5G wireless system design

c. QoE aware SE and EE based mobile association and radio resource management

d. Performance tradeoffs among SE, EE and QoE

Presenter Biography

Rose Qingyang Hu (M'98-SM'06) [received a B.S. degree in electrical engineering from the University of Science and Technology of China, an M.S. degree in mechanical engineering from the Polytechnic Institute of New York University, and a Ph.D. degree in electrical engineering from the University of Kansas. From January 2002 to June 2004 she was an assistant professor with the Department of Electrical and Computer Engineering at Mississippi State University. She also has more than 10 years of R&D experience with Nortel, RIM, and Intel as a technical manager, a senior research scientist, and a senior wireless system architect. When in industry, she actively participated in industrial 3GPP/3GPP2/IEEE 4G wireless technology air interface standards and technology development and was leader of Nortel 4G system level simulation and performance evaluation. Currently she is an associate professor with the Department of Electrical and Computer Engineering at Utah State University. Her current research interests include next generation wireless communications, wireless network design and optimization, green radios, multimedia QoS/QoE, communication and information security, wireless system modeling, and performance analysis. She is author of more than 130 scientific journals and conference papers, holds more than 30 US and world patents. One of her co-authored papers received the Best Paper Award at IEEE GLOBECOM 2012. She is the leading author of the book, Resource Management for Heterogeneous Networks in LTE Systems, published by Springer in 2014, and the leading editor of the book, Heterogeneous

Cellular Networks, published by John Wiley & Sons, Ltd. She is currently serving on the editorial boards of IEEE Wireless Communications, IEEE Internet of Things Journal, IEEE Communications Tutorials and Surveys, Security and Communication Networks, Wireless Communications and Mobile Computing, and KSII Transactions on Internet and Information Systems. She has also served as a guest editor for several special issues of IEEE Network Magazine, IEEE Wireless Communications Magazine, and IEEE Communications Magazine, including feature topics in Wireless Heterogeneous Networks, Machine to Machine Communications, and Smart Grid Communication Networks. She is also serving as Symposium Co-Chairs of IEEE ICC 2014 & 2012, WCNC 2013, ICNC 2013, IEEE SmartGridComm 2012. Prof. Hu is a Senior Member of IEEE and a member of Phi Kappa Phi and Epsilon Pi Epsilon Honor Societies..