Evolution Toward 5G Cellular Networks: Radio Resource and Interference Management Issues and Approaches

Abstract: The evolving fifth generation (5G) cellular wireless systems will have a multi-tier architecture consisting of macrocells, different types of licensed small cells, relays, and device-to-device (D2D) networks to serve users with different quality-of-service (QoS) requirements in a spectrum and energy-efficient manner. In a co-channel deployment scenario (i.e., when the different network tiers coexist in the same licensed spectrum band), the existing algorithms for radio resource and interference management (RRIM) in single-tier wireless networks will not be efficient for prioritized multi-tier networks where users in different tiers may have different priorities for channel access. This tutorial will delve into the RRIM problem in 5G multi-tier and cognitive cellular networks. Starting with the visions and requirements for 5G cellular networks, several enabling technologies for these networks will be discussed. Then the challenges of radio resource and interference management (e.g. channel allocation and power control, user association) in these networks in co-channel deployment scenarios will be outlined. Open research issues and possible approaches to tackle those issues will be described. In particular, concepts of tier-aware resource allocation, distributed uplink cell association and power control, cognitive spectrum access by network tiers, mode selection and power control for D2D communication, radio frequency (RF) energy harvesting-based D2D communication, and interference management in multi-tier cellular networks in presence of energy harvesting will be discussed in detail.

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Ekram Hossain is a Professor in the Department of Electrical and Computer Engineering at the University of Manitoba, Canada. His current research interests include resource allocation and medium access control in wireless networks, cooperative and cognitive wireless systems, and green radio communications. He is an author/editor of several books in these areas including *Radio Resource Management in Multi-tier Cellular Wireless Networks* (Wiley, 2013), *Smart Grid Communications and Networking* (Cambridge University Press, 2012), *Green Radio Communication Networks* (Cambridge University Press, 2012), *Cooperative Cellular Wireless Networks* (Cambridge University Press, 2011), *Dynamic Spectrum Access and Management in Cognitive Radio Networks* (Cambridge University Press, 2009), *Cognitive Wireless Communication Networks* (Springer, 2007), *Wireless Mesh Networks: Architectures and Protocols* (Springer, 2007), *Introduction to Network Simulator NS2* (Springer, 2008), *Heterogeneous Wireless Access Networks* (Springer, 2008). Dr. Hossain served as the Area Editor for the *IEEE Transactions on Wireless Communications* (2009-2011) and an Editor for the *IEEE Transactions on Mobile Computing* (2007-2012). Currently, he serves as the Editor-in-Chief for the *IEEE Communications Surveys and Tutorials* and an Editor for *IEEE Wireless Communications*. He is also a member of the IEEE Press Editorial Board. He is a Distinguished Lecturer of the IEEE Communications Society for the term 2012-2015. He presented tutorials on different emerging wireless communications technologies in the IEEE conferences including ICC'14, ICC'13, ICC'12, Globecom'11, PIMRC'11, ICC'10, ICC'09, VTC'08-Fall, Globecom'07, and WCNC'07. Dr. Hossain has won several research awards including the University of Manitoba Merit Award in 2010 and 2014 (for Research and Scholarly Activities), the *2011 IEEE Communications Society Fred Ellersick Prize Paper Award*, and the *IEEE Wireless Communications and Networking Conference 2012 (WCNC'12) Best Paper Award*. He is a registered Professional Engineer in the province of Manitoba, Canada.