Heterogeneous and Hyper Small Cell Technologies in LTE Advanced and Beyond

Abstract: In this tutorial, we discuss how hyper small cells play a key role in next generation wireless systems. We first give an overview on various deployments scenarios of small cells and heterogeneous networks (HetNet) in the 3GPP LTE Advanced standard. HetNet faces a very complicated interference scenario because they utilize a mix of macrocells, remote radio heads (RRH) and low-power nodes such as picocells, femto-cells, and relay. Energy efficiency is also another critical issue for HetNet because of high operation costs. Thus we will focus on the following issues and their potential solutions:

- Current 3GPP enhanced Inter-cell interference cancellation techniques (eICIC);
- Other advanced interference mitigation techniques in HetNet, such as joint beamforming and power allocation, and interference alignment;
- Optimal small cell density analysis using stochastic geometry approach

Lastly, we highlight the potential research issues in radio access technologies for 5G wireless to conclude this tutorial.

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Li-Chun Wang (M'96 – SM'06 – F'11) received the B.S. degree from National Chiao Tung University, Taiwan, R. O. C. in 1986, the M.S. degree from National Taiwan University in 1988, and the Ms. Sci. and Ph. D. degrees from the Georgia Institute of Technology , Atlanta, in 1995, and 1996, respectively, all in electrical engineering. From 1990 to 1992, he was with the Telecommunications Laboratories of the Ministry of Transportations and Communications in Taiwan (currently the Telecom Labs of Chunghwa Telecom Co.). In 1995, he was affiliated with Bell Northern Research of Northern Telecom, Inc., Richardson, TX. From 1996 to 2000, he was with AT&T Laboratories, where he was a Senior Technical Staff Member in the Wireless Communications Research Department. In August 2000, he joined National Chiao Tung University in Taiwan, and is currently the Chairman of the Department of Electrical Engineering of NCTU since Aug. 2012. His current research interests are in the areas of radio resource management and cross- layer optimization techniques for wireless systems, heterogeneous wireless network design, and cloud computing for mobile applications.

He was elected to the IEEE Fellow grade in 2011 for his contributions in cellular architectures and radio resource management in wireless net- works. Dr. Wang was a co-recipient (with Gordon L. Stuber and Chin-Tau Lea) of the 1997 IEEE Jack Neubauer Best Paper Award for his paper "Architecture design, frequency planning, and performance analysis for a microcell/macrocell overlaying system," *IEEE Transactions on Vehicular Technology*, vol. 46, no. 4, pp. 836-848, 1997. He has published over 180 journal and international conference papers. He served as an Associate Editor for the *IEEE Trans. on Wireless Communications* from 2001 to 2005, the Guest Editor of Special Issue on "Mobile Computing and Networking" for *IEEE Journal on Selected Areas in Communications* in 2005 and on "Radio Resource Management and Protocol Engineering in Future IEEE Broadband Networks" for I*EEE Wireless Communications Magazine* in 2006. He holds nine US patents.

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