

## **T7. Heterogeneous Networks – Theory and Standardization in LTE**

### **Abstract:**

In this tutorial, we provide researchers and academicians with an overview and insight into the deployment of heterogeneous networks for indoor and outdoor environments within the framework of 3GPP-LTE and LTE-Advanced. We demonstrate the need for heterogeneous networks in order to improve capacity and coverage of cellular systems. We discuss the underlying communication theory of such a network and the practical challenges faced during deployment. We cover the standardization efforts that have gone into incorporating heterogeneous network deployments within 3GPP. We present case studies of real world heterogeneous networks to illustrate the challenges and engineering performance trade-offs. In this tutorial we thus focus on core theory and network design aspects as well as business case for the operators to illustrate why heterogeneous networks are expected to be an integral part of current and future cellular systems.

### **Speaker's Biography:**

**Joydeep Acharya, Wireless Research Lab., Hitachi America Ltd., USA**

**Long Gao, Wireless Research Lab., Hitachi America Ltd., USA**

**Sudhanshu Gaur, Wireless Research Lab., Hitachi America Ltd., USA**

**Joydeep Acharya** received his B.Tech. degree in Electronics and Electrical Communications from Indian Institute of Technology, Kharagpur in 2001 and M.S. and PhD. in Electrical Engineering from Rutgers University in 2005 and 2009 respectively. From 2001 - 2002, he worked as a research consultant in GS Sanyal School of Telecommunications, IIT Kharagpur on Physical Layer design of WCDMA. From 2003-2009, he did his doctoral research at the Wireless Information Networks Laboratory (WINLAB), Rutgers University. His doctoral research topics included spectrum regulation for wireless systems, resource allocation and microeconomics principles as applied to wireless communications, MIMO and OFDM systems. Currently he is a researcher at the Wireless Systems Research Lab (WSRL), Hitachi America Ltd. where he is involved in physical layer research and standardization of LTE/LTE-Advanced with emphasis on downlink multi-user MIMO algorithms and multi base station coordination.

**Long Gao** (S'06--M'10) received his B.S. degree from Beijing Jiaotong University, in 2003, and his M.S. degree from Beijing University of Posts and Telecommunications, Beijing, China, in 2006, both in Electrical Engineering. He graduated from Texas A&M University, College Station, TX, with his Ph.D. degree in Electrical Engineering and joined Hitachi America, Ltd, Santa Clara, CA, in 2009. Since then, he has been involved in 3GPP LTE/LTE-A standardization activities with focus on cooperative communication and heterogeneous networks.

**Sudhanshu Gaur** received his Bachelor of Technology degree in Instrumentation Engineering from the Indian Institute of Technology (IIT) in 2000. From 2000 to 2001, he worked on GPRS MAC design with Sasken Communication Technologies, Bangalore. Then he joined the Mobile and Portable Radio Research Group (MPRG) at Virginia Tech for graduate studies. Following his M.S. from Virginia Tech he received his Ph.D from Georgia Institute of Technology, both in Electrical and Computer Engineering. Since 2005, he has been with Hitachi's wireless research lab in Santa Clara where he leads MU-MIMO research activity targeting LTE-advanced standardization. Earlier he led a project on HD video transmission over WiFi and was also involved with IEEE 802.11aa standardization. His research includes work on MIMO signal processing, interference management, multiple access protocols, and performance analysis of cellular systems. He is a Senior Member of IEEE and Guest Editor for Journal of Communications (JCM).