Tutorial T-19: Understanding Small Cell Networks: The Present and The Future

Presenters: David López-Pérez (Bell Labs, Alcatel-Lucent, Ireland) and Ming Ding (Data 61, Australia)

Tutorial Overview

The advent of more easy-to-use and powerful mobile user equipment such as smartphones and tablets has led to an exponential increase in the mobile data traffic in the recent years. This trend is expected to continue during the next decade. In this context, heterogeneous and small cell networks (HetSNets), which are characterized by a large number of network nodes with different transmit power levels and radio frequency coverage areas, including macrocells, remote radio heads, microcells, picocells, femtocells and relay nodes, have attracted much momentum in the wireless industry and research community. Despite the many accomplishments in HetSNets development and deployment in the last few years, many technical challenges to efficient rollouts of HetSNets remain. Moreover, if a 100x capacity increase is meant to be achieved to satisfy gigabit user experiences and ultra-low latency in the following years, there will be a need to go denser and denser with the cellular deployments. This leads to future ultra-dense small cell networks. Such ultra-dense network deployment will also make use of higher frequency bands where there is more available bandwidth and will contain a larger number of antennas to exploit pre-coding techniques. These challenges call for a thorough reappraisal of contemporary wireless network technologies. The goal of this tutorial is to provide a comprehensive review of key theoretical, standardization, and deployment aspects related to the present and the future HetSNets technologies. Besides, this tutorial will present a new theoretical tool, Deterministic Network Analysis (DNA), for network performance analysis.

A detailed breakdown of the tutorial is as follows:

Part I: Understanding capacity scaling in wireless cellular networks – Some noteworthy trends & their benefits and drawbacks

Part II: Ultra-dense small cell networks – A new paradigm in network deployment

Part III: Current and new theoretical tools to analyze ultra-dense small cell networks – Stochastic Geometry and Deterministic Network Analysis (DNA)

Presenter Biographies

David López-Pérez (M'12) is a Member of Technical Staff at Bell Laboratories, Alcatel-Lucent, and his main research interests are in HetNets, small cells, interference and mobility management as well as network optimization and simulation. Prior to this, David earned his PhD in Wireless Networking from the University of Bedfordshire, UK in Apr. '11. David was Research Associate at King's College London, UK from Aug. '10 to Dec. '11, carrying post-doctoral studies, and was with VODAFONE, Spain from Feb. '05 to Feb. '06, working in the area of network planning and optimization. David was also invited researcher at DOCOMO USA labs, CA in 2011, and CITI INSA, France in 2009. For his publications and

patent contributions, David is a recipient of both the Bell Labs Alcatel-Lucent Award of Excellence and Certificate of Outstanding Achievement. He was also finalist for the Scientist of the Year prize in The Irish Laboratory Awards (2013). David has also been awarded as PhD Marie-Curie Fellow in 2007 and Exemplary Reviewer for IEEE Communications Letters in 2011. David is editor of the book "Heterogeneous Cellular Networks: Theory, Simulation and Deployment" Cambridge University Press, 2012. Moreover, he has published more than 70 book chapters, journal and conference papers, all in recognized venues, and filed more than 30 patents applications. David is or has been guest editor of a number of journals, e.g., IEEE JSAC, IEEE Comm. Mag., TPC member of top tier conferences, e.g., IEEE Globecom and IEEE PIMRC, and co-chair of a number of workshops.

Ming Ding (M'12) received the B.S. and M.S. degrees (with first class Hons.) in electronics engineering from Shanghai Jiao Tong University (SJTU), Shanghai, China, and the Doctor of Philosophy (Ph.D.) degree in signal and information processing from SJTU, in 2004, 2007, and 2011, respectively. From September 2007 to September 2011, he pursued the Ph.D. degree at SJTU while at the same time working as a Researcher/Senior Researcher Sharp Laboratories of China (SLC). After achieving the Ph.D. degree, he continued working with SLC as a Senior Researcher/Principal Researcher until September 2014, when he joined National Information and Communications Technology Australia (NICTA). In September 2015, Commonwealth Scientific and Industrial Research Organization (CSIRO) and NICTA joined forces to create Data61, where he continued as a Researcher in this new R&D center located in Sydney, Australia. He has authored more than 30 papers in IEEE journals and conferences, all in recognized venues, and about 20 3GPP standardization contributions, as well as a Springer book Multi-point Cooperative Communication Systems: Theory and Applications. Also, as the first inventor, he holds fifteen CN, seven JP, three US, two KR patents and co-authored another 100+ patent applications on 4G/5G technologies. His research interests include 4G and 5G wireless communication networks, synchronization, MIMO technology, cooperative communications, heterogeneous networks, device-to-device communications, and modelling of wireless communication systems. He served as the Algorithm Design Director and Programming Director for a system-level simulator of future telecommunication networks in SLC for more than 7 years. He is or has been Guest Editor/Co-Chair/TPC member of several IEEE top-tier journals/conferences, e.g., the IEEE Journal on Selected Areas in Communications, the IEEE Communications Magazine, and the IEEE Globecom Workshops. For his inventions and publications, he was the recipient of the President's Award of SLC in 2012, and served as one of the key members in the 4G/5G standardization team when it was awarded in 2014 as Sharp Company Best Team: LTE 1014 Standardization Patent Portfolio.