Jaime Ferragut holds a B.Sc. and an M.Sc. in Electrical Engineering from the Universitat de les Illes Balears and the Universitat Politècnica de Catalunya – BarcelonaTech, respectively. In 2005 he was a SICUE-Séneca Scholar at the Universidad Politécnica de Madrid.

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His research focuses on Self-Organising Networks (SONs), traffic and mobility management optimization in cellular systems, and new architectures for heterogeneous networks (HetNets).

Abstract

The growth in user demand for higher mobile data rates is driving Mobile Network Operators (MNOs) and network infrastructure vendors towards the adoption of innovative solutions in areas that span from physical layer techniques (e.g., carrier aggregation, massive MIMO, etc.) to the Radio Access Network and the Evolved Packet Core, amongst other. In terms of network capacity, out of a millionfold increase since 1957, the use of wider spectrum (25x increase), the division of spectrum into smaller resources (5x), and the introduction of advanced modulation and coding schemes (5x) have played a less significant role than the improvements in system capacity due to cell size reduction (1600x). This justifies the academic and industrial interest in short-range, low-power cellular base stations, such as small cells.

The shift from traditional macrocell-based deployments towards heterogeneous cellular networks raises the need for new architectural and procedural frameworks capable of providing a seamless integration of massive deployments of small cells into the existing cellular network infrastructure. This is particularly challenging for large-scale, all-wireless networks of small cells (NoS), where connectivity amongst base stations is provided via a wireless multi-hop backhaul. Networks of small cells are a cost-effective solution for improving network coverage and capacity in high user-density scenarios, such as transportation hubs, sports venues, convention centres, dense urban areas, shopping malls, corporate premises, university campuses, theme parks, etc.

This Ph.D. Thesis provides an answer to the following research question: What is the architectural and procedural framework needed to support efficient traffic and mobility management mechanisms in massive deployments of all-wireless 3GPP Long-Term Evolution networks of small cells? In order to do so, we address three key research challenges in NoS. First, we present a 3GPP network architecture capable of supporting large-scale, all-wireless NoS deployments in the Evolved Packet System. This involves delegating core network functions onto new functional entities in the network of small cells, as well as adapting Transport Network Layer functionalities to the characteristics of a NoS in order to support key cellular services. Secondly, we address the issue of local location management, i.e., determining the approximate location of a mobile terminal in the NoS upon arrival of an incoming connection from the core network. This entails the design, implementation, and evaluation of efficient paging and Tracking Area Update mechanisms that can keep track of mobile terminals in the complex scenario of an all-wireless NoS whilst mitigating the impact on signalling traffic throughout the local NoS domain and towards the core network. Finally, we deal with the issue of traffic management in large-scale networks of small cells. On the one hand, we propose new 3GPP network procedures to support direct unicast communication between LTE terminals camped on the same NoS with minimal involvement from functional entities in the Evolved Packet Core. On the other hand, we define a set of extensions to the standard 3GPP Multicast/Broadcast Multimedia Service (MBMS) in order to improve the quality of experience of multicast/broadcast traffic services in high user-density scenarios.

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