Adaptive Integrated Unit to User’s Equipment for the Spectral and Energy Efficiency in Cognitive Networks

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ABSTRACT
The work proposes an adaptive integrated unit to user’s equipment for the spectral and energy efficiency, under severe channel fading condition like in 5Generation cellular network. The spectral and energy efficiency are formulated through an optimization problem under a coverage sensitivity criterion. This criterion is the ratio of the mobile user transmit power over its received power. The criterion is a typical awareness parameter that could help in effective counting of the number of active users within a cell coverage or in multi-transmitters coverage system. The criterion is meant to be embedded into the user equipment in such a way to provide much information about the device status (e.g. Idle, or active or off). The unit block diagram includes a downtilt switching tool that aims at decreasing the channel fading and inter-cell interference. The system transfer function is then evaluated. The obtained results show an enhanced spectral efficiency, and the energy consumption is also considerably reduced when the coverage area seems to be idle. Hence, the unit could be applied to a transmitter for power minimization as the objective in the absence of no-cell load.

KEYWORDS
Cognitive Networks, Energy Efficiency, Interference Awareness Tool, Power Minimization, Spectral Efficiency

INTRODUCTION
In future mobile communication systems, the cell-size will be very small. Many wireless backhaul solutions will be used for the scalability from the small scale to the large-scale networks. It may be admitted that, highly directional antennas will be used by the transmitting node, but these networks will be case sensitive to the cluttered environment. The mobile device-to-device communication may be used as relays, and further be equipped with the beam selectivity capability. However, their energy efficiency may greatly depend on the Medium Access Control (MAC) protocols (Zhuang & Zhou, 2013) despite the modulation schemes effect on the power amplifiers’ efficiency (Luis et al., 2010).

For instance, Long Term Evolution (LTE) system uses a hybrid of three modulation schemes (The IET, 2013) such as 64 Quadrature Amplitude Modulation (QAM), 16QAM and Quadrature Phase Shift Keying (QPSK) modulation. QPSK is used for users farther away from the Base Station; this is very robust to interference. The 64 QAM is used for users close to the Base Station, to provide very fast data speeds and very high capacity. In (Jain et al., 2011), a perspective layered network has been discussed in which the hierarchical layouts comprise the macro, micro, pico, and femto-cell with the aim of offering a diversity of services to meet high capacity demand whereby the macro-cell and the...
microcell overlaid each other. The enhanced layered layout in (Yang et al., 2012), is proposed with Orthogonal Frequency Division Multiplexing (OFDM) with multi-cell combination. Therefore, a dynamic multiplexing with the base station’s coordination capability has been evaluated to enhance the network load capacity. In (Ziaul et al., 2013), the emphasis was on the heterogeneous architecture of multi-cells in which macro-, micro-, pico- and femto-cell could overlap one another. This method has been proven efficient for energy savings. In (Guowang et al., 2013), the cross-layers’ optimization has been recommended. Similar approach has been shown to have efficient energy for the LTE power management system (Oliver, Dietrich, & Ulrich). The power efficient protocol relies on discontinuous reception (DRx) and discontinuous transmission (DTx) mode for the mobile handset. This has also been proved effective in minimization of the handset battery. In contrast, the study in (Andrews, 2005) has underestimated such techniques for improving energy efficiency. This was argued that the method would not necessarily be vital for one end to the other (transmitter to the receiver) since energy efficient requirement in both uplink and downlink is interference limited. Coverage ratio to the Base transceiver station’s optimal transmission has been investigated in (Zhou et al., 2013). In (Holtkamp et al., 2013), a radio resource management’s algorithm has been proposed that aimed at minimizing the base station supply power consumption for multi-user MIMO OFDM. Meanwhile, (Lopez-Perez et al., 2013), has introduced a self-organization rule, based on minimizing cell transmit power, in which a distributed cellular network could converge into an efficient resource reuse pattern. Two resource allocation algorithms, being autonomous and coordinated have been proposed.

The report in (Yan et al., 2013), has indicated that the Information Communication Technology (ICT) industries are consuming about 3% of the global energy and causing around 2% of the CO2 emissions globally. In this regard, the ICT industries are facing an increase in associated energy consumption of 16 - 20% per year. It is expected that this prediction may double in 2020. The reduction in energy consumption of the current wireless system is therefore necessary for the future ones as underlined in (Sunil, 2009). The proposed method in (Yong-Hoon et al., 2015) consisted to use cell-search zooming scheme. Cells with lower traffic are switched off. This method is in line with the traffic measurement. The authors further formulated the cell-search as a multi-objective problem by varying traffic patterns and interference, as well as the service availability of the whole area.

It is underlined in (Yan et al., 2013) that the power consumption for the core network (RAN) is approximately around 30%, the base band processing unit about 10-15% and the cooling system about 15%, this explains the reluctance of some operators to serve the remote areas and the lower rate implementation of the universal access service. In this scope the optimization of both the area spectral efficiency (SE) and the energy efficiency (EE) by considering a typical Orthogonal Frequency Division Multiplexing Access (OFDMA) downlink network was investigated in (Dotche & Ofosu, 2016). In order to reduce the power consumption while the downlink coverage seems idle, a coverage sensitivity was introduced into the multi-objective problem. A negligible power was obtained to keep the transmitters up during this status.

This work proposes an adaptive integrated unit to user’s equipment for the spectral and energy efficiency under severe channel fading condition like in 5Generation cellular network by considering the uplink transmission of mobile users. The rest of the paper is structured as follows. The next section depicts the system modelling, and addresses the problem formulation using some identified constraints. The subsequent section presents the simulation parameters and the software used. The obtained results are then discussed. The conclusion is given in the last section.

**THE SYSTEM MODEL**

Figure 1, illustrates the considered system model. It comprises two antennas that overlap at the far end, which may be assumed to the high interference area.
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