Proposition de recherche doctorale

Evaluation des Performances des Reseaux Cellulaires avec Relais

Mots clés :

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Résumé du projet de recherche (Langue 1)

The growing demand for mobile broadband internet and wireless multimedia applications and the requirements for the future 4G mobile systems have pushed the search for means to improve wireless networks throughput and coverage. In particular, it is desired that the new networks provide very high data rate (up to hundreds of Mbit/s) in every location of the cell and to every User End (UE), even to the ones dealing with the most unfavourable conditions, i.e. experiencing a very high signal strength attenuation on the radio link with their service provider netowrk node, here referred to as enhanced Node B (eNB). The solution to this problem in a traditional network would consist in increasing the eNB density, in order to reduce the average distance between UEs and their respective eNB. In this way signal strength attenuation problems can be partly overcome. Nevertheless, this would imply a meaningful cost increase because of the growing number of deployed eNBs and other expenses related to eNB site rentals and backhaul links costs for connecting all the eNBs to the network backbone. Hence, new cost-e?cient strategies based on the introduction of Relay Nodes (RN) have been proposed. An RN is a wireless device communicating with both its controller eNB and its controlled UE. Its main task is to forward informations from the eNB to the UEs on the downlink, and from the UEs to the eNB on the uplink. RNs have less intelligence than an eNB, they use a lower transmission power and they are smaller (i.e in some cases they can be placed on lamp posts). In consequence, they appear to be the best solution for ubiquitous high data rate throughout the cell without an excessive increase in network costs. The use of RNs implies dealing with a multi-hop network scenario. Hence, complexity is greater and new strategies for communication and management have to be developed. According to the de?nition given by 3GPP, RNs do not only amplify the received signal before forwarding it to the recipient. Instead, they perform a decode-and-forward operation on the processed signal. This minimizes the e?ects of thermal noise and interference on the ?rst network hop a?ecting the forwarded signal on the second hop. RNs can operate in simultaneous mode of operation, sharing the same time-frequency resources with their controller eNB, or in division mode of operation, using non-overlapping time-frequency resources. In this way, in-sector interference between RNs and their respective eNB can be avoided. Division mode of operation can be achieved e.g. by mean of Time-Division Duplex (TDD) mode, in which eNB and RNs transmit in di?erent time instant, or Frequency-Division Duplex (FDD) mode, in which eNB and RNs transmit using multiple carrier frequencies. Orthogonal Frequency Division Multiple Access (OFDMA) is the proposed modulation scheme for relay-enhanced networks, because it optimally manages the frequency-selective fading and it is ?exible in resources allocation to UEs. In OFDMA, transmission of data is achieved by distributing the symbols to be transmitted on several adjacent narrow-band subcarriers, and regulating the data rate on each subcarrier according to the channel conditions at the subcarrier frequeny. Bad channel conditions force to transmit at a low data rate, while high data rates on a given subcarrier are possible if channel conditions are good. The narrow band implies long symbol duration, easing the problem of inter-symbol interference. Deployment of RNs in the network is expected to produce e?ects in terms of coverage, capacity and transmission power. The Signal to Interference plus Noise Ratio (SINR) decreases in the cell with the distance from the transmitting station, because the received power from the serving station diminishes, while the power from the interferers stations increases. The SINR gives us a measure of the quality of the communication link, and it is bonded with the achievable data rate per UE. If RNs are deployed the distance of the UE close to the cell border with respect to the serving station will sensibly decrease, with a positive e?ect on the coverage. If the SINR ratio is higher throughout the cell, then also the achievable data rate for users in every position of the cell will improve, leading to an increased overall cell capacity, and hence a greater throughput. Furthermore, as the serving station-UE distance is now smaller, the serving station transmitting power can be decreased keeping the throughput ?xed with respect to the single-hop network case. This will have a positive in?uence on the energy consumption, which is an important parameter in todays’ networks because it is related to networks costs and ecologic issues (’green networking’).