Research Project

LTE Uplink Energy Consumption Reduction Using Resources Allocation

Long Term Evolution (LTE) is popularly called a 4G technology. It is an all-IP technology based on orthogonal frequency-division multiplexing (OFDM), which is more spectrally efficient. LTE can be considered as the technology of choice for most existing Third Generation Partnership Project (3GPP) and 3GPP2 mobile operators since it will provide economy of scale and spectrum reuse. LTE, whose radio access is called Evolved UMTS Terrestrial Radio Access Network (E-UTRAN), is expected to substantially improve end-user throughput, sector capacity and reduce user plane latency, bringing significantly improved user experience with full mobility support. With the emergence of Internet Protocol (IP) as the protocol of choice for carrying all types of traffic, LTE is expected to provide support for IP-based traffic with end-to-end Quality of service (QoS).

As a technology of future, LTE is mobile broadband solution that offers a rich set of features with a lot of flexibility in terms of deployment options and potential services, as one of its salient features is the use of Orthogonal Frequency Division Multiple Access (OFDMA) for downlink and SC-FDMA (Single Carrier Frequency Division Multiple Access) for uplink, both schemes offer significant improvements in terms of throughput and spectral efficiency.

However, the gap between mobile phone complexity supported by LTE and battery capacity is increasing year by year, leading to limited and continually decreasing battery lifetime. The problem is evident for smartphones, where power and data demanding applications, such as video streaming, real-time services and social applications have emerged.

To cope with the requirements for higher data rates, lower latency, and higher spectral efficiency, the Third Generation Partnership Project (3GPP) is depending on LTE for offering such features. Even though, the new standard leads to more complex phones requiring more physical antennas and faster processors. Meanwhile less attention is paid to the amount of time the smartphone can run the aforementioned applications before the battery is discharged, leading to a problematic relationship between required and available energy.

The smartphone's or any device based LTE technology energy consumption can be minimized by optimizing the hardware and software. The hardware energy consumption can be reduced by choosing power efficient components and by performing power management e.g. by applying sleep modes to power down inactive hardware parts. In LTE Discontinuous Reception and Transmission (DTX) have been standardized to enable energy saving sleep modes. Furthermore the energy consumption can be reduced by adjusting the phone's resources, e.g. display brightness and processor speed, to the individual applications. By combining and/or reducing the transmitted data from each application via software control, energy savings are also possible. However, combining resource allocation with power consumption is an important issue which treated slightly in the literature especially, how to allocate resource while consuming less energy mainly in Uplink LTE systems. Besides, how to allocate resource and guaranteeing Quality of service for different service data flows in LTE is a matter of great issue, since power consumption should be taken into account while dealing with different kind of flows. This core problematic of this project proposal is how to ensure the quality of service parameters of different flow taking into account reduction of power consumption, all with the use of an efficient resource allocation scheme.

Main Focus

Our focus of this project proposal is on LTE Macro-cell uplink communication direction; this is due to the lack of work in this issue. In LTE uplink, and as stated earlier, SC-FDMA is used since it has good properties in terms of Peak-to-Average Ratio (PAR), which allows a lower power consumption at the User Equipment (UE). Among the different new functionalities, it is worth highlighting the support for advanced multi-antenna schemes, frequency domain scheduling, variable transmission bandwidth, and fast adaptation of modulation and coding.

Apart from a lower PAR, the orthogonality removes the intra-cell interference and the near-far problem typical of CDMA-based systems as HSPA. However, the system is still sensitive to inter-cell interference. As a result, the role of the Power Control (PC) becomes decisive to provide the required Signal to interference and noise ratio (SINR) while controlling at the same time the interference caused to neighboring cells.

The idea of classic PC schemes in uplink is that all users are received with the same SINR, which is known as full compensation. As an alternative, 3GPP has recently approved the use of Fractional Power Control (FPC). This new proposal makes users with a higher path-loss operate at a lower SINR requirement so that they will more likely generate less interference to neighboring cells.

Generally, the SINR is one of the factors that determine the user throughput. Therefore, a discussion of the impact of the FPC parameters on the per-UE experienced SINR would be very helpful for the operator. It is important to note that the throughput of UE is the main issue when dealing with real-time services. This is why, combining the FPC with a good resource allocation scheduler will have a good interest.

It is worthy to combine a scheme of resource allocation that combines the FPC and the assignment of physical resource blocs (PRB) since PRB is the principal unit of resource allocation in an OFDMA frame. Indeed, PRB allocation effects on LTE UE transmission power and energy consumption, as it is more energy efficient to allocate as many PRBs as possible to a single user instead of assigning several users less PRBs. LTE's Uplink Power Control entails that users with more PRBs will transmit with higher power, but the throughput increases concurrently and therefore energy can be saved and this will be the subject of our project proposal in order to find a trade-off between power consumption and PRB allocation in an optimal way. Besides, adding a new level of complexity which is the cross-layer level, which implicates QoS constraints in the power consumption for different type of real-time and non real-time service flows.

Related Information:

The post doctoral fellow candidate should have advanced knowledge on LTE system. The main place of research will be in LRI-Laboratoire de Recherche en Informatique, University Paris SUD 11 and the duration of the post doc fellowship will last one year starting from September 2013.

Contact

A recent PhD degree in communications and networking with strong publication record should send an email with her/his CV (including a complete list of publications and the contact information of three referees to the following contacts:

Steven Martin- Associate Professor: steven.martin@lri.fr
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