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Björn Dusza

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Context-Aware Power Consumption Modeling for Energy Efficient Mobile Communication Services

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Increasing the battery lifetime of power-hungry mobile devices has become a major research target for mobile operators. This is motivated by the fact that energy efficiency is progressively considered as important factor influencing the user satisfaction with portable communication equipment. Before novel, power efficient protocols and algorithms can be quantitatively evaluated in terms of their battery lifetime gain, it is however mandatory to have a significant power consumption model available that incorporates all the specific characteristics of a cellular communication system such as user mobility and time variant radio channel conditions.

Based on extensive measurement campaigns with the most recent Long Term Evolution (LTE) devices, in this thesis a new Markovian power consumption model is introduced, which takes into account the chosen system parameters (such as the number of physical resource blocks) as well as the context of a user in terms of radio channel conditions and service characteristics (non-real-time vs. real-time). One key advancement of this generic model is its stochastic nature, which allows for determining the average power consumption of a device based on usage profiles including location information and service statistics.

To validate the new model, comprehensive system simulations using realistic channel characteristics derived from ray tracing analyses are conducted. Beyond this, the validity of the model is proven by sophisticated battery lifetime measurements in the laboratory.

Exemplary case studies show that the expected battery lifetime is to a large extend depending on the actual system parameterization as well as the user context. Therefore, it is shown that the proposed context-aware power consumption model (CoPoMo) enables quantitative analyses of the trade-off between network resource allocation and enhanced battery lifetime.

Finally, the performed extension of the model towards LTE-Advanced illustrates that the fundamental ideas of CoPoMo can be applied to next generation wireless networks with only minor adaptations. The qualitative as well as quantitative impact of new or modified protocols and system properties can therefore be evaluated at the earliest possible time.

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