Dissertation Title: Semi-Dynamic Scheduling of Model Driven Protocols for Multi-Core Mobile Terminals

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Dissertation Summary

Emerging wireless communication standards like Long Term Evolution (LTE), which is the enhancement of the Universal Mobile Telecommunications System (UMTS), promise to bring a drastic increase in data rate for the end user. To reach this challenging target, sophisticated technology for the mobile equipment is required. The computational capabilities provided by single-core processors in today's mobile phones are insufficient for the LTE protocol stack processing demands at reasonable power consumption. Multi-core processors are promising solutions for providing high performance at low power consumption, while increasing the dimensions for resource allocation and scalability. Although, the majority of research focuses on the signal processing in the physical layer, this work targets at the computational capabilities for protocol processing, that is getting more critical. This thesis describes a novel system architecture for the LTE mobile terminals that allows parallel execution on a multi-core processor. Thus, it allows for exploiting the multi-core advantages like higher performance through parallelism at low power consumption.

The LTE protocol stack is a layered protocol and its layers should be processed sequentially. Targeting execution on more than one core, such a layered protocol is developed using a model driven development approach with the Specification and Description Language (SDL). In addition, the LTE protocol stack is parallelized and executed on a multi-core processor, by employing the Extended Finite State Machine (EFSM) concurrency. The modeled LTE system is scheduled on multi-core by customizing the SDL scheduler to implement a pipelined scheduler. Furthermore, a new load balancer scheme is proposed by moving it to the modem subsystem's layer and using the SDL process migration concept to replace the classical thread migration scheme at the operating system's level. We introduce a new software architecture to achieve the LTE Parallelized Protocol Stack (LTE-PPS) with semi-dynamic scheduling on multi-core hardware platforms.

The performance of the LTE-PPS using the new load balancing scheme, developed in this thesis, beats the classic thread migration scheme by more than 50% on single as well as multi-core platforms. Compared to single core, the LTE-PPS performance on two, three, or four cores increases to around 1.95, 2.9, and 3.6 times, respectively. The developed software solution on multi-core saves more than 35% of the energy compared to the classical load balancing using thread migration. When executing the LTE-PPS at a data rate of 300 Mbit/s (i.e. the maximum data rate for LTE), the energy consumption of the multi-core platform with four cores is about 25% less than the energy consumed by the single core running at high clock frequency to accomplish the same task. In this thesis, the investigations show that the optimum solution, with respect to performance and energy consumption, for LTE-PPS processing is achieved with the quad-core processor. This solution is therefore the most suitable for future LTE mobile terminals.