

Energy Profiling of 5G Cellular Modems at the Software-Hardware Interface

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The advancement of computing systems has gone hand in hand with the development of increasingly sophisticated communication networks. The arrival of 5G cellular networks has dramatically enhanced mobility, flexibility, and data throughput—but at the cost of significantly higher energy consumption, particularly in mobile communication modules. While extensive research has been conducted on optimizing energy efficiency at the hardware and protocol levels, software-level energy optimization remains largely underexplored, especially within the 5G context.

In particular, existing studies rarely investigate how low-level software interactions with the cellular modem affect power consumption during atomic operations (e.g., connection setup, bearer establishment, paging responses). This constitutes a critical knowledge gap, since such operations are fundamental to all mobile applications and can occur frequently—even in background processes.

This study aims to address this gap by analyzing the current consumption profile of 5G cellular modems during these atomic transmission procedures. We focus on the behavior of the modem as controlled by various software layers, including the Radio Interface Layer (RIL), kernel drivers, and high-level telephony services. By profiling and characterizing the energy impact of atomic operations, we seek to provide actionable insights for optimizing software design in mobile systems. Our findings contribute to a more precise understanding of how software decisions affect energy usage at the modem level and open new directions for fine-grained energy-aware programming in 5G-enabled platforms.

Author: BANU-ȚĂRAN, Paul-Cristian (Universitatea Politehnica Timișoara)

Co-authors: Mr MARCU, Marius (Universitatea Politehnica Timișoara); Mr BOGDAN, Răzvan (Universitatea Politehnica Timișoara)

Presenter: BANU-ȚĂRAN, Paul-Cristian (Universitatea Politehnica Timișoara)

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