Poster: Application-Layer Optimization of Performance vs Energy in Mobile Network I/O

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Extended Abstract

The number of smartphone users globally has already exceeded 2 Billion, and this number is expected to reach 3 Billion by 2020 [2]. It is also estimated that smartphone mobile data traffic (cellular + WiFi) will reach 370 Exabytes per year by that time, exceeding PC Internet traffic the first time in the history [4]. An average smartphone consumes between 300 – 1200 milliwatts power [1] depending on the type of applications it is running, and most of the energy in smartphone applications is spent for networked I/O. During an active data transfer, the cellular (i.e., GSM) and WiFi components of a smartphone consume more power than its CPU, RAM, and even LCD+graphics card at the highest brightness level [3, 1]. Although the mobile data traffic and the amount of energy spent for it increase at a very fast pace, the battery capacities of smartphones do not increase at the same rate. In this work, we analyze the effects of different application layer data transfer protocol parameters (such as the number of parallel data streams per file, the level of concurrent file transfers, and the I/O request size) on mobile data transfer throughput and energy consumption.

Figure 1 shows the achieved end-to-end throughput, total energy consumption, and the change in instantaneous power consumption during a wide-area data transfer with increased concurrency level. This figure presents the break point for the throughput versus energy consumption trade-off very well. As long as the energy gain due to the decreased transfer time is more than the loss due to the increased instantaneous power consumption, then we save energy at this device while increasing the throughput. But this is not always the case. We observe that although the throughput continues to increase up to a certain concurrency level, the total energy consumption does not continue to decrease, instead comes to a balance and starts increasing again. The main reason for this is the server and network components are typically not energy proportional. When used wisely, these parameters have a potential to improve the end-to-end data transfer performance and decrease total energy consumption at a great extent, but improper use of these parameters can also hurt the performance of the data transfers due to increased load at the end-systems and congested links in the network. For this reason, it is crucial to find the best combination for these parameters with the least intrusion and overhead to the system resource utilization and power consumption.

Our contributions within this work are the following: (1) To the best of our knowledge, we are first to provide an in depth analysis of the effects of application layer data transfer protocol parameters on the energy consumption of mobile phones. (2) We show that significant energy savings can be achieved with application-layer solutions at the mobile systems during data transfer with no or minimal performance penalty. (3) We also show that, in many cases, performance increase and energy savings can be achieved simultaneously.

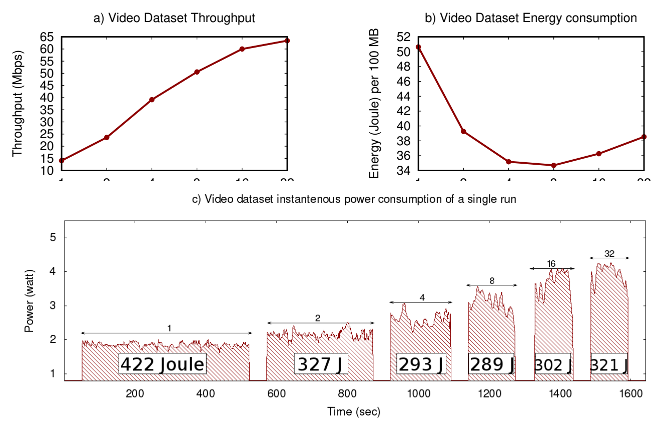

Figure 1: (a) Throughput; (b) Energy Consumption; and (c) Instantaneous Power Consumption of a data transfer with increased level of concurrency.

1. REFERENCES

[1] A. Carroll and G. Heiser. An analysis of power consumption in a smartphone. In *USENIX annual technical conference*, volume 14. Boston, MA, 2010.

[2] E. A. Edwards, J. Lumsden, C. Rivas, L. Steed, L. Edwards, A. Thiyagarajan, R. Sohanpal, H. Caton, C. Griffiths, M. Munafò, et al. Gamification for health promotion: systematic review of behaviour change techniques in smartphone apps. *BMJ open*, 6(10):e012447, 2016.

[3] A. Pathak, Y. C. Hu, and M. Zhang. Where is the energy spent inside my app?: fine grained energy accounting on smartphones with eprof. In *Proceedings of the 7th ACM european conference on Computer Systems*, pages 29–42. ACM, 2012.

[4] C. Systems. Visual networking index: Forecast and methodology, 2015–2020, June 2016.

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