Demo Abstract: PRINCE: Device Energy Estimation with a Single Photo

Farooq Dar
University of Tartu
farooq.dar@ut.ee

Mohan Liyanage
University of Tartu
mohan.liyanage@ut.ee

Mayowa Olapade
University of Tartu
mayowa.olapade@ut.ee

Zhigang Yin
University of Tartu
zhigang.yin@ut.ee

Abdul-Rasheed Ottun
University of Tartu
rasheed.ottun@ut.ee

Adeyinka Akintola
University of Tartu
adeyinka.akintola@ut.ee

Francisco Airton Silva
Federal University of Piauí
faps@ufpi.edu.br

Huber Flores*
University of Tartu
huber.flores@ut.ee

ABSTRACT

We contribute PRINCE, an innovative sensing solution capable of accurately estimating the energy consumption of applications executing on a wider range of smart and IoT devices, including smartwatches, wearables and autonomous drones, without the need for direct instrumentation of the device. Modern devices lack detachable batteries or are sealed, making it challenging to profile their energy consumption. In this demo, we showcase PRINCE, a proof-of-concept prototype that provides precise energy consumption measurements of applications running in devices with a single (thermal) photo. PRINCE harnesses the thermal radiation (heat) generated by the processing units of the device, which is released through the device casing. This allows PRINCE to derive accurate energy estimations of application execution. Extensive benchmarks that compare PRINCE with traditional solutions, such as Monsoon power monitor, demonstrate that PRINCE provide similar performance levels but does not require any instrumentation, facilitating the profiling of the energy consumption of devices.

KEYWORDS

Battery efficiency, Thermal Imaging, IoT, Temperature

ACM Reference Format:
Farooq Dar, Mohan Liyanage, Mayowa Olapade, Zhigang Yin, Abdul-Rasheed Ottun, Adeyinka Akintola, Francisco Airton Silva, and Huber Flores. 2024. Demo Abstract: PRINCE: Device Energy Estimation with a Single Photo. In *Proceedings of ACM Conference (Conference'17).* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 BACKGROUND

Modern devices come in a wide variety, from personal devices to autonomous ones like drones, wearables, and IoT devices. Many of these devices are sealed or do not have detachable batteries. This makes it possible to optimize their design and usability; and protect them from environmental factors once they are deployed. In turn, lack of access to batteries makes it difficult to estimate the energy consumption of applications running in these devices. Energy consumption estimation is critical to support development tasks, such as software optimizing, code troubleshooting and partitioning of functionality.

Existing solutions for measuring energy consumption are inadequate due to their reliance on specialized hardware or lack of generality. Hardware-based solutions, in particular, necessitate modifying the device by intercepting connections between the battery and other components. Likewise, software-based methods for estimating power consumption relies on various execution metrics, such as static code analysis or collecting performance metrics of applications during run-time. Moreover, these approaches are susceptible to errors due to differing execution environments, which can lead to significant variations caused by factors like input parameters, concurrent applications, and network connectivity issues. Besides this, external factors like ambient environment, resource availability (e.g., network connectivity), and battery capacity also influence energy drain.

In this demo, we showcase PRINCE as a proof-of-concept prototype that estimates energy consumption of a device just by taking a (thermal) picture. As shown in Figure 1, PRINCE harnesses the generated heat (aka thermal footprint [2]) resulting from application induced processing over the resources of the device. Indeed, released heat correlates with the processing effort required for executing an application [2].

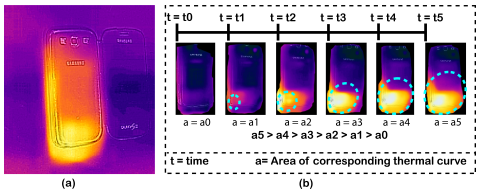

Figure 1: Heat released from the device casing as an application is executed, a) Single (thermal) photo taken from the back of the phone, b) Heat based on processing load.

2 PRINCE METHODOLOGY IN A NUTSHELL

PRINCE estimates energy consumption from thermal pictures using a three-stage pipeline. Figure 2b) presents a conceptual overview of the PRINCE. We next summarize each stage.

*Corresponding author

Conference'17, July 2017, Washington, DC, USA

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn