A Survey on Energy Consumption in Smartphones over Wi-Fi

Shivani Hiwarekar [*], A. R. Tayal[**], Ravindra Kale[***]

[*] Department of CS/IT, G.H. Raisoni Institute of Engineering Technology for Women
[**] Department of Computer Technology, Priyadarshini College of Engineering
[***] Department of CS/IT, G.H. Raisoni Institute of Engineering Technology for Women

Abstract- Wireless data transmission consumes a significant part of the overall energy consumption of smartphones, due to the popularity of Internet applications. The proposed method investigate the energy consumption characteristics of data transmission over Wi-Fi, focusing on user characteristics. The focus is on current and previous data usage profile of the user to optimize data usage of Wi-Fi by modeling energy consumption. Previous data usage profile will be tracked based on parameters such as time, battery usage etc. The background service will create a usage profile of a user to collect the data used by the user. This tracked information can be used to toggle the Wi-Fi on or off in order to reduce the battery consumption in smartphones. The proposed method enables effective battery usage by reducing useless battery consumption and detects abnormal battery usage by comparing operating times between normal and abnormal states.

Index Terms- Wi-Fi, Usage Profile, Smartphone

I. INTRODUCTION

Saving power of Android enabled devices have become a significant issue with 400,000 such devices being activated daily. Android smartphones and tablets offer several power hungry hardware components and the app developers are exploiting these components at disposal to provide revolutionary user experience. But the battery life has not increased at the same pace to support the power demand. Thus many researches have been carried out to investigate how to minimize the power consumption in smartphones. Today's smartphones are equipped with high quality graphics and processing power. They have 3G, Edge, WiFi and Bluetooth interfaces for data connectivity. As a result, smartphones have become very popular, and numerous applications are being developed for them. To name a few, surfing the web with browser, calling through VoIP client, checking emails, accessing weather forecast, stock market quotes, and navigating through GPS (Global Positioning System) based maps are some prominent applications. This increased availability of network applications in smartphones causes increased network traffic, and the volume is increasing rapidly, the growth rate is faster than broadband traffic.

In order to develop energy-efficient networked applications on smartphones, the developers need to know the factors that affect the energy efficiency in wireless data transmission and the joint effects of these factors (network throughput, traffic patterns) on battery life. Existing network management methods have focused on performance of network itself. However there is still need to address the requirements from the perspective of customers and personalized services.

This paper presents a usage pattern analysis of user's previous and current activity. The background service is developed which collects data from user's activity and then analyzes it in order to promote effective battery usage.

II. RELATED WORK

Energy consumption caused by wireless data transmission on smartphones is increasing rapidly with the growing popularity of internet applications that require network connectivity. This results in shrinking battery life, as the development of battery technology is not able to keep up with the energy demand of applications. While waiting for breakthroughs in battery technology, the networked applications can be made more energy efficient. In order to develop energy-efficient networked applications on smartphones, the developers need to know the factors that affect the energy efficiency in wireless data transmission and the joint effects of these factors (network throughput, traffic patterns) on battery life. Existing network management methods have focused on performance of network itself. However there is still need to address the requirements from the perspective of customers and personalized services[2]. To remedy the situation, Yu Xiao, Yong Cui et al. [1] have presented the power models that utilize traffic characteristics to estimate the energy consumption of WiFi data transmission. The models can be used for power analysis of network applications, as well as for runtime power estimation in energy-aware applications that utilize technologies such as as computational offloading. Existing network management methods have focused on performance of network itself. However there is still need to address the requirements from the perspective of customers and personalized services. In [2], Joon-Myung Kang and Sin-seok Seo, James Won-Ki Hong have presented the usage pattern analysis of smartphones. The authors present basic smartphone states based on their basic functions and they define time and battery spent in each operational states. Then the authors developed an application to log the data from smartpones and apply this to analyze the usage pattern. The data is analysed to show that the user has his/her own usage pattern.

In [4], Feng Qian, Zhaoguang Wang et.al. address the aforementioned challenge by developing a tool called ARO (mobile **A**pplication **R**esource **O**ptimizer). ARO is the first tool that exposes the cross-layer interaction for layers ranging from

higher layers such as user input and application behavior down to the lower protocol layers such as HTTP, transport, and very importantly radio resources. In particular, so far little focus has been placed on the interaction between applications and the radio access network (RAN) in the research community. Such cross-layer information encompassing device-specific and network-specific information helps capture the tradeoffs across important dimensions such as energy efficiency, performance, and functionality, making such tradeoffs explicit rather than arbitrary as it is often the case today. It therefore helps reveal inefficient resource usage (*e.g.*, high resource overhead of periodic audience measurements for Pandora) due to a lack of transparency in the lower-layer protocol behavior, leading to suggestions for improvement.

Researchers have studied the energy consumption in smartphones while running some network related applications (NRAs) but they have neither fully covered the wide pool of NRAs nor provided a methodology to measure the energy consumption in smartphones. In [4], Abdulhakim Abogharaf, Rajesh Palit, Kshirasagar Naik, Ajit Singh identified the most popular NRAs and configurable parameters which can impact the energy consumption while running these NRAs. They further propose a methodology to measure the energy consumption in smartphones while conducting a feasible set of experiments. They present a measurement bench for measuring the energy consumption in smartphones. They conducted selected experiments on latest smartphones to support the methodology. The methodology evaluates the impact of configurable parameters and NRAs on energy consumption and provide a base to compare the energy consumption across smartphones. In [5], authors present a detailed study of energy consumption of smartphones focusing on different communication interfaces (Bluetooth, 3G, Wi-Fi) in different scenarios such as standby, scanning, transferring.

III. OBJECTIVE

One of the main constraints of the mobile phones is the battery power. Because of their multi-purpose usage and multitasking characteristics, the battery life of smartphones is shorter than normal mobile phones these smart devices and mobile networks. However, research on mobile network management has focused on the performance of the network itself. Few research has focused on applying the usage patterns of smartphone users to power management. In proposed methodology, analysis of smartphone usage patterns will be presented. The real usage log data from real smartphone users will be recorded. This usage pattern information will be used for toggling the Wi-Fi connection.

The data collection module will be developed in Android. This module will collect the information about user's personalized activity. This module monitors the previously defined data and records it to a log file. The following data will be collected by this module

1) Number of bytes transmitted
2) Number of bytes received
3) Total Usage
4) Date and Time

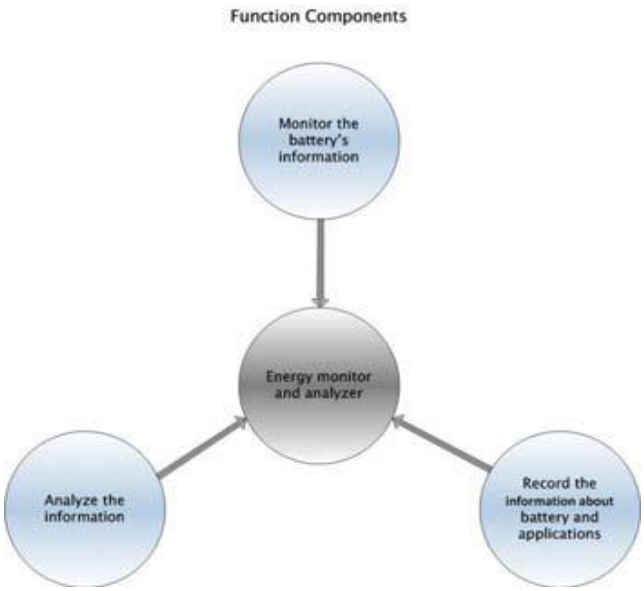

Figure 1

The smartphone users have their own usage pattern and the amount of time they spend and amount of battery power they use in different states varies. If we make the analytic model of usage pattern we can use it to optimize the energy efficiency of smartphones over Wi-Fi and that we can use to design smartphones that consumes less power.

IV. CONCLUSION

A mobile device's short battery lifetime can cause much inconvenience to the user's and can reduce the device usefulness. Thus mechanisms to provide long and stable battery life are required. One of the methods to guarantee long battery life is to minimize consumption by reducing unnecessary battery usage. In this paper we presented a survey of energy consumption caused by Wi-Fi data transmission. Further we aim to optimize the energy consumption by doing usage pattern analysis by creating usage profile of a user which will toggle the Wi-Fi connection of the smartphone to reduce the unnecessary battery power consumption. This analysis can help to optimize the energy and design the smartphones which consumes less power.

REFERENCES

[1] Yu Xiao, Yong Cui, Petri Savolainen, Matti Siekkinen, An Wang, Liu Yang, Antti Yl¨a-J¨a¨aski and Sasu Tarkoma, "Modelling Energy Consumption of Data Transmission over Wi-Fi" 2013 IEEE Transactions on Mobile Computing

[2] Joon-Myung Kang and Sin-seok Seo, James Won-Ki Hong, "Usage Pattern Analysis of Smartphones" Network Operations and Management Symposium (APNOMS), 2011 13th Asia-Pacific, 2011 IEEE

[3] Feng Qian, Zhaoguang Wang et. Al, "Profiling Resource Usage for Mobile Applications: A Cross-layer Approach" ACM 2011

[4] Abdulhakim Abogharaf, Rajesh Palit, Kshirasagar Naik, Ajit Singh, "A Methodology for Energy Performance Testing of Smartphone Applications" 2012 IEEE

[5] David Perez Abreu and Maria E. Villapol , "Measuring the Energy Consumption of Communication Interfaces on Smartphones", IEEE 2012 Conference Publications

[6] Renuka Arya, Rajesh Palit, Kshirasagar Naik, "A Methodology for Selecting Experiments to Measure Energy Costs in Smartphones", IEEE 2011 International Conference Wireless Communication & Mobile Computing

[7] Fangwei Ding, Feng Xia, Wei Zhang, Xuhai Zhao, Chengchuan Ma, "Monitoring Energy Consumption of Smartphones"

[8] Y. Xiao, P. Savolainen, A. Karppanen, M. Siekkinen, and A. Yl¨a- J¨a¨aski, "Practical power modeling of data transmission over 802.11g for wireless applications," in Proc. of e-Energy '10, April 2010

[9] E. Tan, L. Guo, S. Chen, and X. Zhang, "Psm-throttling: Minimizing energy consumption for bulk data communications in wlans," in Proc. of ICNP'07, October 2007

AUTHORS

First Author – Shivani Hiwarekar – B. E. (E&TC), Persuing M.E. (Wireless Communications & Computing), G.H. Raisoni Institute of Engineering & Technology for Women. E-mail Address- shivani.25h@gmail.com
Second Author – A R. Tayal – Asst. Professor, Deartment of Computer Technology, Priyadarshini College of Engineering, Nagpur, E-mail Address- annu09in@gmail.com
Third Author – Ravindra Kale- Asst.Professor, Department of CS/IT, G. H. Raisoni Institute of Engineering & Technology for Women, Nagpur, E-mail Address- ravi.ucoe@rediffmail.com