Design Scheme for Power Consumption Optimization of Mobile Applications

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Abstract. This paper conducts an in-depth analysis and optimization of the high power consumption issue in mobile office applications. By long-term tracking and analysis of the power consumption logs and CPU processes of a certain office work APP, it was found that there are abnormal threads when the application calls the security access component [①], leading to high CPU load and high power consumption. Further validation using the Android Studio tool revealed the issue of infinite loops[②] in the security access component when handling network requests. In response to this issue, the paper proposes an optimization plan: changing the infinite loop monitoring of the security component to a one-time security check only when the APP initiates a request to the backend, thus avoiding continuous high CPU load. Comparative test results show that the power consumption of the improved application is significantly reduced on different phones, verifying the effectiveness of the optimization plan. The research in this paper provides a practical solution for power consumption optimization of mobile office applications and has important reference value.

Keywords: energy consumption, safety, mobile officing

1 Introduction

With the rapid development of mobile Internet technology, mobile phones are playing an increasingly important role in our work and life. Once upon a time, mobile phones were just a tool for making phone calls and sending text messages, but now it has become an integral part of our daily lives. Especially in the field of work, the functions of mobile phones are constantly expanding and improving, making the mobile office become an irreversible trend.

With the continuous progress of mobile Internet technology, mobile office has become an irreplaceable way of office. It not only changes the way we work, improves the work efficiency and flexibility, but also provides new impetus and opportunities for

[①] security access component: Ensuring the APP runs in a secure environment module.
[②] infinite loops: An infinite loop that keeps executing without an end condition.

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the development of enterprises. In this rapidly changing era, we should actively embrace mobile office, make full use of the convenience brought by mobile technology, and constantly improve the quality of work and living standards.

But the limited battery capacity of the phone is particularly evident in outdoor scenarios. The use of office and operation applications will significantly increase the power consumption, but in the outdoor and other inconvenient charging environment, this consumption cannot be timely supplemented. This will not only affect the outdoor work time, but also negatively affect the user experience. How to reduce the power consumption of office and operation applications has become a research direction[1].

2 Power Consumption Analysis Scheme

The author conducted a tracking analysis of the office work APP of a million user for three years. When the APP was initially promoted, a large number of Android users complained that the mobile phone was very hot and the mobile phone battery life was greatly reduced. The technician opens the ADB (debugging bridge) on the user's mobile phone to record the power consumption log and analyze the power consumption log[2]. Power consumption hardware is analyzed by log analysis, and abnormal power consumption is analyzed by hardware operation monitoring (Fig 1).

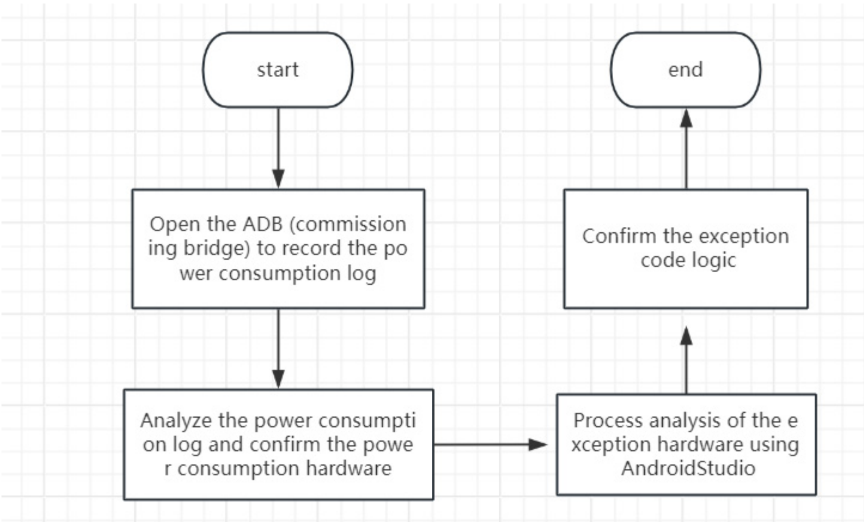

Fig. 1. Power consumption test scheme

2.1 CPU Exception of Power Consumption

First of all, the power consumption log of the mobile phone is analyzed, and the log time is 1 hour, which shows the overall power consumption and application power consumption during this time Table 1.

Table 1. Overall energy consumption meter

module	System power consumption (mAh)	Application power consumption (mAh)	Power consumption ratio
CPU	671	595	88.67%
mobile data	96.4	77.8	80.71%
Screen (screen)	43.9	37.6	85.65%
Camera (camera)			
Location-related (GNSS)	9.25	9.25	
WIFI	1.35		
system_services	8.96	4.51	
idle	2.52		
Sensor (sensors)	0.578	0.103	
wakelock (Wake-up lock)	0.00342		
amount to	833.96	724.263	86.85%

According to the power consumption log analysis, the system consumes 833mAh in 60 minutes, with CPU power consumption 671, radio module (mobile data) power consumption 96.4 and screen power consumption 43.9; other modules consume less power and are negligible. The front ground consumes 652mAh and 72mAh. The CPU consumes 595mAh; screen consumes 37.6mAh; mobile data power consumption 77.8mAh, GNSS positioning related module consumes 9.25mAh other modules less WIFI, sensors, negligible.

The power consumption of the application is 724.26mAh, accounting for 86% of the power consumption of the system. Among them, the application of CPU consumes 595mAh, accounting for 82% of the application and 88.6% of the CPU power consumption of the system. The abnormal CPU usage leads to abnormal power consumption.

2.2 Mobile Phone CPU Process Analysis

The tester repeated the user operation several times and coordinated the mobile phone manufacturer to analyze the mobile phone system log. The manufacturer reported that there were abnormal threads and abnormal points in the CPU during the operation. As shown in Figure Fig 2 and Fig 3.

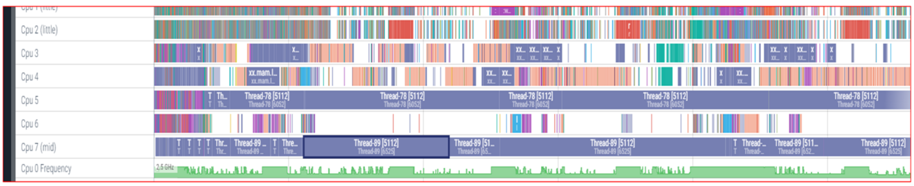

Fig. 2. CPU exception process

Fig. 3. Exception thread

As can be seen in the figure above, users, in the process of using APP, there are two threads with abnormal, Thread-78, Thread-89 have been running, causing CPU kernel CPU 5, CPU 7 has been occupied, on the contrary, other CPU cores are running and sleeping alternately. According to the mobile phone manufacturers provide computing logic, used to test the mobile phone a total of eight CPU (four small core, two nuclear, two big core), system scheduling priority using small nuclear calculation, if small nuclear calculation cannot meet the requirements for the nuclear operation, the calculation task in the nuclear or large nuclear calculation, after the nuclear phone power consumption will increase dramatically. The application always occupies the medium nucleus and the macronucleus for calculation. So determine that there may be endless ops in the code.

2.3 Confirm the Application Problems

Analysis of the application using the Android Studio performance analysis tool found that as long as it entered the application, an abnormal thread was kept running as shown in Fig 4 and Fig 5. According to some information in Figure 3 and Figure 4, the developers preliminarily judge that the safe access component is caused. In order to further verify the guess, the test module is used for verification[3]. There is no abnormal thread when entering the test module, and abnormal threads will appear when the component is called to establish a link. This confirms the specific abnormal components.

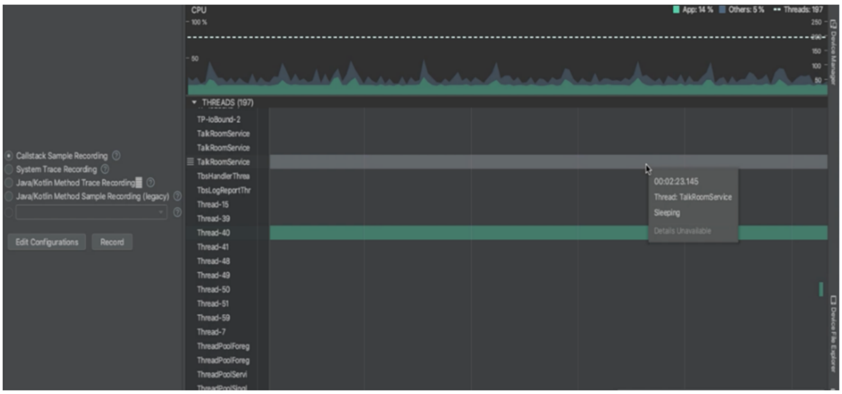

Fig. 4. Security process

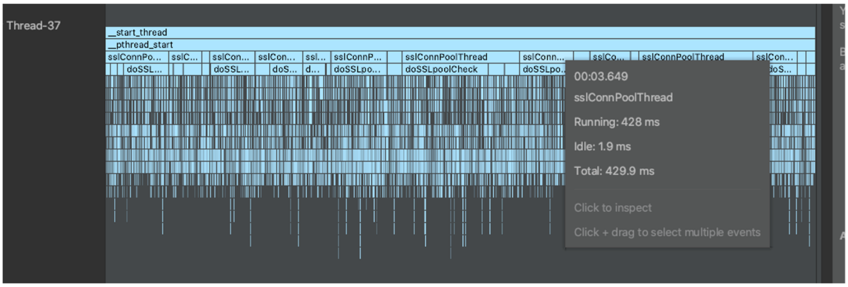

Fig. 5. Process resource occupancy

3 Improvement and Comparison of Power Consumption Technology

Improvement scheme: change the dead loop monitoring of security components to call security components for security inspection only when the APP initiates a request to the backend[4]. This way avoids the safety components' continuous dead loop check safety-related configuration, reduces the time of CPU high load operation, and reduces the power consumption. (shows Fig 6 Fig 7)

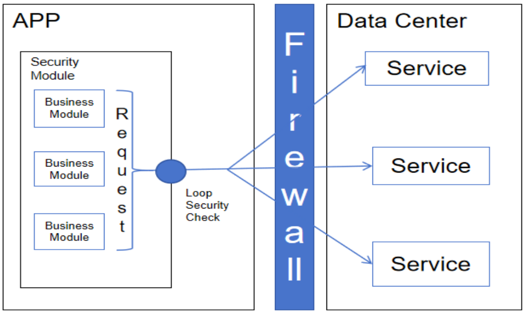

Fig. 6. Before optimization

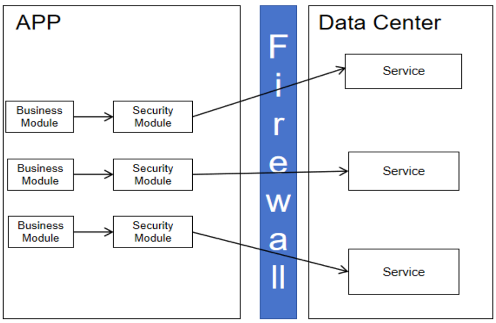

Fig. 7. Optimize the results

Using the same power consumption test scheme as the first chapter, the comparative test of multiple mobile phones. In them, the test data of Honor X40 (Table 1-2) showed that the power consumption was reduced by 52.6% in the standing state (without established safety link), and the power consumption was reduced by 61.4% in the Magic5 Pro, the power consumption was reduced by 74.91%, and the established safe connection was reduced by 65.87%.

Table 2. Honor X40 after optimized power consumption data

Unit: mAh / min

policy	Test scenario	The first time	The second time	The third time	Mean power consumption
Before optimization	Workbench static	7.95	7.33	7.02	7.43
postoptimality		3.42	3.46	3.68	3.52
Before optimization	Establish secure interaction links	9.72	9.77	9.75	9.75
postoptimality		3.86	3.55	3.86	3.76

Table 3. Glory Magic5 Pro is optimized for power consumption data

Unit: mAh / min

policy	Test scenario	The first time	The second time	The third time	Mean power consumption
Before optimization	Workbench static	14.14	15.01	14.75	14.63
postoptimality		3.53	3.67	3.80	3.67
Before optimization	Establish secure interaction links	18.36	18.56	18.72	18.55
postoptimality		6.30	6.27	6.41	6.33

4 Conclusions

This study analyzed the power consumption of mobile office applications and found that the safe access components cause high power consumption through dead loop monitoring during application startup. The proposed optimization scheme changes the monitoring to only the one-time security check when the APP requests to the back end, which significantly reduces the power consumption and mobile phone heating, and improves the user experience[5]. Compared with the mobile APP of the whole industry, this study details the high power consumption problem brought by the infinite cycle, and puts forward the solution of "time loading". Although the test environment is limited and for a single application scenario, future research should be carried out in more devices and application scenarios, combined with intelligent power management, application ecosystem optimization, hardware collaborative optimization and standardization, to comprehensively improve the energy efficiency of mobile office applications and contribute to green and sustainable development.

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