PRIMA: an Automated Tool for Android Releases Homologation Review

Heryck Michael Dos Santos Barbosa[1], **Pedro Ivo Pereira Lancellotta**[1], **João Gabriel C. Santos**[1], **Abda Myrria De Albuquerque**[1], **Janislley O De Sousa**[1]

[1]Sidia Institute of Science and Technology - SIDIA, AM - Brazil

{heryck.barbosa,pedro.lancellotta,joao.castro}@sidia.com

{abda.albuquerque,janislley.sousa}@sidia.com

Abstract. *Software testing is essential in maintaining the quality and integrity of technological products. This paper outlines the development of PRIMA, an automated tool based on a methodology that improves the Android Releases homologation review process. PRIMA reviews the test artifacts generated by Google tradefed tools using a set of predefined rules to validate the information contained in result artifacts. Real-world Security Maintenance Release (SMR) tests were conducted in our company, demonstrating the effectiveness of our tool in the Android release homologation process reducing almost 50 % of Android software release approval time.*

1. Introduction

Software testing plays an essential role in ensuring the integrity and quality of technology products [Zhao et al. 2021]. By identifying potential issues early in production, companies save time in later development phases. Google has strict rules and regulations for Original Equipment Manufacturers (OEMs) who want to incorporate the Android operating system into their mobile devices. Each model release by OEMs must comply with a series of automated and manual tests to meet Google's contract requirements [AOSP 2023a]. Moreover, the OEMs need to conduct additional tests according to their specific needs. After passing several compatibility tests, the results are sent to Google for approval and only the approved versions become available on the market.

Ensuring quality control over Android release validation rules is a major challenge due to the large number of artifacts that require analysis at the end of testing process [Lancellotta et al. 2022]. To improve the review stage of these validations, we proposed a methodology and developed an automated review tool called PRIMA (Primary Review In Mobile Android). By developing PRIMA, we expect to answer the main research question: *Does the development and application of the proposed methodology improves the Android releases homologation process?* By reviewing test artifacts before submitting to Google, we expect to reduce approval time and eliminate the extra fixes, thereby improving the validation process. To address our research question and test our hypothesis, we employed a quantitative approach by observing our methodology in real-world Android release tests. Our company's release testing process involves three distinct scopes. The first is the SMR tests, which focus on validating security issues by applying patches from the Google Security Bulletin. The NE (Normal Exception) test scope follows and

is responsible for validating the customization made by each carrier within OEMs. Finally, the Full Submission scope serves as a base release for the SMR and NE scopes and comprises a set of tests aimed at validating all components of the Android system [Alure and Puri 2021].

This paper compares data from SMR tests conducted before and after the implementation of PRIMA, between the first quarter of 2021 and the first quarter of 2023. The objective is to evaluate the impact of PRIMA on the SMR testing process. Our study offers valuable insights into how the proposed methodology and PRIMA tool can improve the Android release homologation process. Results will be presented in section 4, highlighting the contributions of this work.

2. Background

The paper [Balachandran 2013] discusses an automated source code review tool called Review Bot that can generate automatic reviews and recommend the best reviewers based on certain criteria, such as their familiarity with the project. [Lancellotta et al. 2022] proposed a methodology which we based to develop PRIMA. The authors discuss the concepts, in this paper we advanced in this work, developed the tool and introduced into our company daily work. Our findings will be presented in more details in the section 4.

2.1. Security Maintenance Release

The Android Security Bulletin [AOSP 2023b] offers patches that address Common Vulnerabilities and Exposures (CVE) issues, fixing security vulnerabilities including buffer overflows, use-after-free errors, and invalid pointer reference. The release of these patches and maintenance updates for significant mobile device models is the responsibility of OEMs, who follow a monthly SMR process provided by Google, as shown in Figure 1.

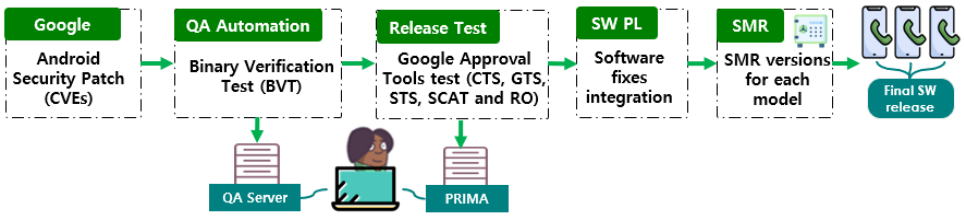

Figure 1. SMR process using PRIMA tool in Google Approval tests.

3. PRIMA Architecture

Our methodology was developed using REST API architecture, which offers flexibility, scalability and portability to the system [John and Siddique 2021]. This approach allows us to expand the usage of our automated review tool and communicate with other company tools that can benefit from the correct result input.

PRIMA is an API developed using the proposed methodology, designed to review test artifacts for Android release homologation. Figure 2 illustrates the resulting architecture of our approach. The process begins when a software tester enters the ID of the release request from the management system (I), which contains important information about the release being tested. The software tester then loads the test artifacts (III) into

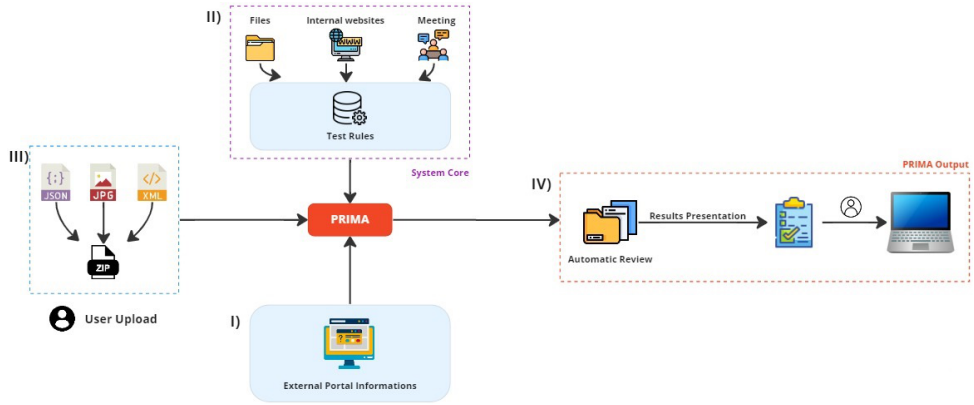

Figure 2. PRIMA tool architecture and software artifacts.

PRIMA. These artifacts consist of output files generated by tradefed tools, with various file types such as XML, JSON, TXT, and image extensions. Before proceeding (II), a set of rules for each tradefed tool was established as a prerequisite to verify each validation point pertaining to a specific topic and the anticipated value. Finally, PRIMA compares all information extracted from the request (I) and the artifacts (III) with the implemented predefined rules (II). The tool then displays an output to the user in the form of found and expected values (IV) for each incorrect value detected. With this information, the quality assurance tester can verify the proper files and take necessary actions to fix any issues.

4. Results

In our company environment, various tests are conducted to homologate Android releases. Our experiment focused on the SMR test type, which involves a high volume of releases with frequent changes and updates to security patches and software fixes, as shown in Table 1. Despite the volume of releases, SMR has a smaller number of test artifacts compared to other types of tests. On average, SMR involves reviewing 6 XML files, 3 TXT files, 62 JSON files, 20 PNG files and two other extension files. In our company's daily routine, each human test analyst typically concludes about five SMR tests per day, involving a review of nearly 500 files.

Release Period	Submissions	TTS (Days)	TTA (Days)
2021 1st quarter	605	5,40	6,60
2021 2nd quarter	723	2,85	4,18
2021 3rd quarter	380	1,98	3,32
2021 4th quarter	542	2,69	3,27
2022 1st quarter	396	2,26	3,34
2022 2nd quarter	514	2,69	3,27
2022 3rd quarter	269	1,55	3,00
2022 4th quarter	628	2,11	3,38
2023 1st quarter	**792**	**1,40**	**2,00**

Table 1. Submissions TTS and TTA.

Table 1 illustrates all SMR submissions made by our company between the years 2021 and 2023. We observed the time to submission (TTS) and time to approval (TTA), both are measured in days. TTS corresponds to the average time between release test creation and when quality assurance tester submits to Google, TTA corresponds to the time

between test creation and Google approval letter. We noticed a higher number of submission done after PRIMA implementation. Besides, the TTA and TTS were lower than other periods without our tool. Comparing 2023 1st quarter with 2021 2nd quarter, which are periods with similar number of submissions, we noticed approximately 50% time reduction from both TTS and TTA. In summary, we noticed a greater number of submissions and the shorter period to approve a release. We are aware that another factors like team head count, other tests demands can change this result number, these are possibilities for 2021 1st quarter disparity but analysing the whole scenario, the use of PRIMA tend to be a better efficiency into Android release homologation.

5. Conclusion and Future Work

Through our observation of real-world Android release tests from the SMR type we obtained promising results reducing almost 50 % time to approval the Android releases in the homologation process by Google. In the future, we plan to apply, observe PRIMA in other types of tests such as Full Submission and Normal Exception release types, which have a larger scope and are more susceptible to manual errors and more rigorous experimental for testing effectiveness of PRIMA in order to minimize external factors.

6. Acknowledgment

The authors are grateful for the support offered by SIDIA R&D Institute in Model/Mega project. This work was partially supported by Samsung, using resources of Informatics Law for Western Amazon (Federal Law No. 8.387/1991). Therefore, the present work disclosure is in accordance as foreseen in article No. 39 of number decree 10.521/2020.

References

Alure, S. and Puri, R. (2021). Firmware designing for android mobile. *INTERNATIONAL JOURNAL*, 5(12).

AOSP (2023a). Android open source project. Available at https://source.android.com/ (accessed: 2023/04/13).

AOSP (2023b). Android security bulletin. Available at https://source.android.com/security/bulletin (accessed: 2023/04/13).

Balachandran, V. (2013). Reducing human effort and improving quality in peer code reviews using automatic static analysis and reviewer recommendation. In *2013 35th International Conference on Software Engineering (ICSE)*, pages 931–940. IEEE.

John, E. and Siddique, M. (2021). Efficient semantic web services development approaches using rest and json. In *2021 International Conference on Decision Aid Sciences and Application (DASA)*, pages 231–235.

Lancellotta, P. I. P., Barbosa, H. M. D. S., Santos, J. G. C., Sahdo, K. M. I., and De Sousa, J. O. (2022). An industry case study: Methodology application to the reviewing process on android releases homologation. In *Anais Estendidos do XIII Congresso Brasileiro de Software: Teoria e Prática*, pages 13–16. SBC.

Zhao, Y., Hu, Y., and Gong, J. (2021). Research on international standardization of software quality and software testing. In *2021 IEEE/ACIS 20th International Fall Conference on Computer and Information Science (ICIS Fall)*, pages 56–62.