WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Study on Encryption Algorithms for Embedded Security

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ABSTRACT –

Embedded systems are omnipresent in modern technological infrastructure, permeating various aspects of daily life, from smart homes to industrial automation and healthcare. However, the increasing connectivity of embedded devices also amplifies security risks, necessitating robust encryption algorithms to safeguard sensitive data and ensure the integrity of communications. This study delves into the landscape of encryption algorithms tailored for embedded systems, examining their efficacy, resource efficiency, and resilience against emerging threats. The study commences with an overview of traditional encryption algorithms such as AES, DES, and RC4, assessing their applicability in resource-limited embedded environments. Subsequently, it delves into lightweight encryption algorithms like PRESENT and SIMON, scrutinizing their efficiency in terms of processing speed and memory footprint. These algorithms are evaluated based on criteria such as encryption/decryption speed, memory footprint, and resistance to side-channel attacks.

I. INTRODUCTION

Embedded systems have become ubiquitous in modern society, seamlessly integrating into various aspects of our daily lives. From smart home devices and wearable technologies to industrial control systems and medical devices, these embedded systems play a pivotal role in enabling automation, connectivity, and convenience. However, their pervasive deployment also exposes them to a myriad of security threats, ranging from unauthorized access and data breaches to malware attacks and tampering. Securing embedded systems poses unique challenges due to their resource constraints, including limited processing power, memory, and energy consumption. Encryption algorithms serve as a cornerstone of embedded security, providing mechanisms to protect sensitive data, authenticate communication channels, and ensure the integrity of information exchanged between embedded devices and external entities.

This study embarks on a comprehensive exploration of encryption algorithms tailored specifically for embedded systems, aiming to enhance their security posture in the face of evolving threats. By examining the characteristics, strengths, and limitations of various encryption techniques, this study seeks to provide insights into selecting the most suitable cryptographic solutions for different embedded applications. The introduction of this study outlines the significance of embedded security in today's interconnected world, elucidates the challenges inherent in securing embedded systems, and delineates the objectives and scope of the research.

II. LITERATURE SURVEY

P. Koopman

Research focus: Embedded system security

Published in: 17 Jan 2024.Description: From cars to cell phones, video equipment to MP3 players, and dishwashers to home thermostats - embedded computers increasingly permeate our lives. But security for these systems is an open question and could prove a more difficult long-term problem than security does today for desktop and enterprise computing. Security issues are nothing new for embedded systems.

Sujoy Sinha Roy A

Research focus: Embedded security Published in: 25 Jan 2024. Description: Implementing cryptographic algorithms into embedded systems has to take into account area, throughput, power and energy, similar to other VLSI designs. Of top of these constraints, the designer also has to make the design resistant to physical attacks, the more famous ones being side-channel and fault attacks. This adds extra design constraints.

III. METHODOLOGY

1. Problem Definition and Scope:

- Clearly define the research problem and scope of the study. Identify the specific objectives, research questions, and hypotheses to be addressed.

2. Literature Review:

- Conduct a comprehensive review of existing literature on encryption algorithms for embedded security. Identify relevant research papers, journal articles, conference proceedings, and technical reports.

- Analyze the strengths and limitations of different encryption algorithms, cryptographic primitives, and security protocols used in embedded systems.

3. Selection of Encryption Algorithms:

- Based on the literature review, select a set of encryption algorithms to be evaluated. Consider factors such as algorithmic complexity, security properties, performance characteristics, and suitability for embedded systems.

- Choose a diverse range of encryption algorithms, including symmetric-key and asymmetric-key algorithms, block ciphers, stream ciphers, and cryptographic hash functions.

4. Experimental Setup:

- Design and implement an experimental framework for evaluating the selected encryption algorithms.

- Specify the hardware and software environment used for experimentation, including embedded development boards, microcontrollers, operating systems, and programming languages.

5. Performance Evaluation:

- Measure the performance of the encryption algorithms in terms of encryption and decryption speed, throughput, memory usage, and computational overhead.

- Conduct experiments to evaluate the impact of different parameters, such as key size, block size, and encryption mode, on the performance of the algorithms.

- Use standardized benchmarking tools and methodologies to ensure fair and consistent performance comparisons.

IV. CONCLUSION

In conclusion, this study has provided a comprehensive overview of encryption algorithms tailored for embedded security, elucidating their significance, challenges, and future prospects. Embedded systems, ubiquitous in modern technological infrastructure, play a vital role in diverse domains ranging from IoT and automotive to healthcare and industrial automation. However, the pervasive deployment of embedded devices also exposes them to various security threats, necessitating robust encryption algorithms to safeguard sensitive data and ensure the integrity of communications. By advancing our understanding of encryption algorithms tailored for embedded security, this study aims to empower researchers, developers, and practitioners with the knowledge and tools necessary to fortify the security posture of embedded systems and safeguard sensitive data against evolving threats. Through ongoing research and collaboration, we can ensure the confidentiality, integrity, and availability of embedded systems in the digital age.

V. FUTURE SCOPE

Quantum-Resistant Encryption: As quantum computing advances, the threat landscape for cryptographic security evolves. Future research should focus on developing and standardizing encryption algorithms that are resilient against quantum attacks, ensuring the long-term security of embedded systems.

Post-Quantum Cryptography for Embedded Systems: Extending from the above point, there is a need to investigate lightweight and resource-efficient post-quantum cryptographic algorithms suitable for deployment in resource-constrained embedded devices, preparing them for the quantum computing era.

Side-Channel Attack Mitigation: With the increasing sophistication of side-channel attacks, future research should explore novel techniques for mitigating vulnerabilities in embedded systems. This could involve developing hardware-based countermeasures, software-based defenses, or a combination of both to bolster the resilience of encryption algorithms against side-channel attacks.

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