

Matter-Enabled Smart Plug for Cross-Platform Smart Home Interoperability

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Abstract

The rapid growth of Internet of Things (IoT) technologies has transformed conventional homes into intelligent and interconnected environments. However, interoperability among smart-home devices remains a major challenge due to fragmented ecosystems and proprietary communication standards. This paper presents the design and implementation of a Matter-enabled Smart Plug capable of operating seamlessly across multiple smart-home platforms including Amazon Alexa, Apple Home, Google Home, Samsung SmartThings, and ESP RainMaker. The proposed system utilizes an ESP-based microcontroller integrated with the Matter protocol stack to provide secure commissioning, reliable device control, and standardized communication. Experimental evaluation and simulation results demonstrate successful commissioning, low-latency switching performance, reliable interoperability, and robust operation under varying network conditions.

Keywords: Internet of Things, Matter Protocol, Smart Plug, Smart Home Automation, Interoperability, ESP32, Thread, Wi-Fi

I. Introduction

The Internet of Things (IoT) has emerged as one of the most influential technological developments of the modern era. Smart devices are increasingly being deployed in residential, commercial, and industrial environments to provide automation, remote monitoring, and enhanced energy efficiency. Matter introduces a unified application-layer standard designed to eliminate compatibility barriers across major ecosystems.

II. Literature Review

Early smart-home systems relied on Wi-Fi, Zigbee, BLE, and Z-Wave. While these technologies enabled communication, they failed to establish universal interoperability. Matter provides standardized communication, unified commissioning workflows, secure device attestation, local control capabilities, and multi-platform interoperability.

III. Problem Statement

Current smart-home environments face challenges including lack of interoperability, complex onboarding procedures, cloud dependency, inconsistent device behavior, and manufacturing difficulties.

IV. Proposed System Architecture

The proposed system consists of an ESP-based MCU, relay module, push button, LED indicator, power supply circuit, and Matter software stack integrated for secure smart-home control.

V. Methodology

The methodology includes requirement analysis, hardware integration, Matter firmware development, ecosystem integration, and validation/testing.

VI. Device Operation Algorithms

Algorithms include boot and state restoration, commissioning, relay control, and factory reset procedures.

VII. Results and Discussion

Testing demonstrated successful commissioning, low-latency relay control, reliable state retention, and stable operation across supported ecosystems.

VIII. Advantages of the Proposed System

Cross-platform interoperability, simplified commissioning, local operation, enhanced security, and scalability.

IX. Future Scope

Future enhancements include energy monitoring, OTA updates, Thread mesh networking, secure elements, AI-driven automation, and commercial certification.

X. Conclusion

The Matter-enabled Smart Plug successfully addresses interoperability challenges while providing secure onboarding, reliable communication, and seamless integration across major smart-home platforms.

References

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