PROJECT TITLE

Super Safe Smart Safe

STUDENT/TEAM INFORMATION

Team Name if any: **Team # on Canvas you have self-signed-up for:**	**Team Super Safe Smart Safe** Canvas Group **11**
Team member 1 (Team Lead)	*Norris, Reese; rnorris2528@sdsu.edu* 
Team member 2	*Billitti, Scott; sbillitti4263@sdsu.edu* 

ABSTRACT (15 points)

(Summarize your project (motivation, goals, system design and results). Max 300 words).

The "Super Safe Smart Safe" project aims to develop an internet-connected lock-box that enhances user convenience by eliminating the need for traditional keys, pins, or combination locks. The primary objectives include constructing an RFID-enabled safe that maximizes battery life, enforces time-constrained access via RFID keys, and logs all access events to a web portal for monitoring and management.

The system is designed with a three-layer IoT architecture: the Sensor Layer, comprising an RFID reader and a push-button for user interaction; the Edge Layer, centered around an ESP32-C3 microcontroller that processes inputs, controls the locking mechanism, and manages communication; and the Application Layer, featuring a web portal for remote access and data management.

Key hardware components include the ESP32-C3 microcontroller, RFID Peripheral IC, servo motor for locking, and a 3D-printed prototype case. The project successfully implemented RFID authentication, power-efficient operation using MOSFETs, and WiFi connectivity, with all access events logged to a cloud-based web portal.

Development challenges, such as poor internet connectivity and high power consumption in sleep mode, were resolved by integrating a larger WiFi antenna and MOSFET-based power switching, respectively. The resulting system offers a secure, user-friendly IoT solution for personal and shared safe access.

INTRODUCTION (15 pts)

Motivation/Background (3 pts)

(Describe the problem you want to solve and why it is important. Max 300 words).

The motivation for the "Super Safe Smart Safe" project stems from the need for a secure, user-friendly alternative to traditional lock-boxes that rely on keys, pins, or combination locks. By leveraging IoT technology, the project seeks to provide a smart safe that is accessible remotely and easy to manage, enhancing both security and convenience for users.

Project Goals (6 pts)

(Describe the project general goals. Max 200 words).

1. Build an RFID-enabled, internet-connected lockbox safe.
2. Maximize battery life and support alternative opening mechanisms (charging port, backup conventional key, etc.)
3. Enforce ephemeral (e.g. single-use) or time-constrained RFID key use.
4. Log all events to an internet-connected web portal.

Assumptions (3 pts)

(Describe the assumptions (if any) you are making to solve the problem. Max 180 words).

A primary user manages access via a web portal, with others using time-limited RFID keys.

RFID tags are unique and securely linked to users, read reliably by the device.

Stable WiFi ensures constant cloud communication, with reliable cloud services.

Power-saving features like MOSFETs extend battery life for typical use.

Encrypted communication and secure web portal authentication protect data.

Hardware, including ESP32-C3 and servo motor, performs reliably and durably.

Firmware and web portal manage authentication and logs accurately.

Users are skilled in using the system and web portal.

The safe operates in standard indoor conditions, free from interference.

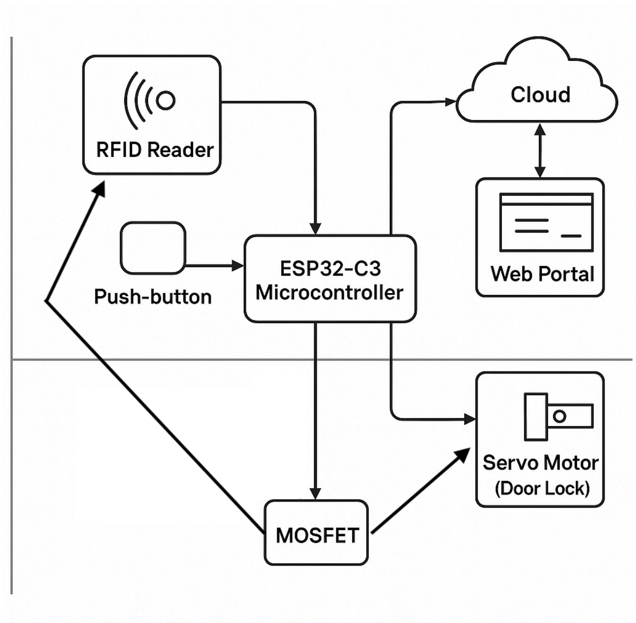
SYSTEM ARCHITECTURE (20 pts)

(Describe the final architecture you have implemented listing sensors, communication protocols (Wi-Fi, BLE, ...), cloud services and user interfaces. Include a block diagram of the system. Max 300 words).

Sensor Layer:
RFID Peripheral IC: Reads RFID tags presented by users to authenticate access requests. The reader communicates tag data to the microcontroller for verification.
Push-button: Provides a manual input mechanism, likely used for waking the device from sleep mode or enabling alternative access methods.

Edge Layer:
ESP32-C3 Microcontroller: Serves as the core processing unit, performing the following functions:
Processes RFID tag data and authenticates users against a stored list, either locally or via cloud verification.
Controls the servo motor to lock or unlock the safe based on authentication outcomes.
Manages power consumption using a MOSFET to switch power to peripherals during sleep modes, extending battery life.
Communicates with cloud services via WiFi to log events and receive configuration updates.
Servo Motor: Acts as the physical locking mechanism, receiving control signals from the microcontroller to secure or release the safe's door.
MOSFET: Enables power switching to minimize energy consumption, particularly when the device is idle.
WiFi Antenna: Enhances internet connectivity, ensuring reliable communication with the cloud, critical for real-time logging and remote management.

Application Layer:
Web Portal: A user-friendly interface that allows the primary user to:
View detailed logs of all access attempts and events, including timestamps and user details.
Manage authorized RFID tags, such as adding or revoking access permissions.
Cloud Services: Host the web portal and store data related to access logs and user permissions, ensuring accessibility from any internet-connected device.



FINAL LIST OF HARDWARE COMPONENTS (5 pts)

(Write the final list and quantity of the components you have included in your system)

Component/part	**Quantity**
ESP32-C3	*1x*
RFID Peripheral IC for Keycard I/O	*1x*
Door Lock (Servo Motor)	*1x*
3D-printed Prototype Lockbox Case	*1x*
MOSFET for low quiescent current power switching to peripherals	*1x*
Push-button for interrupting ESP32 out of deep sleep	*1x*
WiFi antenna	*1x*

PROJECT IMPLEMENTATION (30 PTS)

Tasks/Milestones Completed (15 pts)

(Describe the main tasks that you have completed in this project. Max 250 words).

Task Completed	**Team Member**
3D printed case	Norris, Reese Billitti, Scott
Front-end website UI	Norris, Reese Billitti, Scott
Keycard UUID generation	Norris, Reese Billitti, Scott
Ephemeral and/or permanent keycard validation	Norris, Reese Billitti, Scott
Power-saving MOSFET circuit	Norris, Reese Billitti, Scott

Challenges/Roadblocks (5 pts)

(Describe the challenges that you have faced and how you solved them if that is the case. Max 300 words).

Poor Internet Connection: Initial WiFi connectivity issues were resolved by incorporating a larger WiFi antenna, improving signal strength and reliability.

Power Draw in Sleep Mode: Excessive power consumption by peripherals during sleep mode was mitigated by adding MOSFETs for power switching, significantly extending battery life.

Tasks Not Completed (5 pts)

(Describe the tasks that you originally planned to complete but were not completed. If all tasks were completed, state so. Max 250 words).

Task	Reason
All tasks were completed.	

WEAK POINTS / FUTURE WORK (15 pts)

(Mention at least two points of your project that have room for improvement. These points can be additions to the existing project setup (components) or improvement of the current implementation. Max 200 words).

Locking Mechanism: Replacing the servo motor with a solenoid could enhance reliability and efficiency.

Power Source: Adding an independent power source, such as a rechargeable battery pack, could improve portability and resilience.

SOURCE CODE (25 pts)

Please include a link to the source code of your project. A link to a repository (like GitHub) is preferred.

https://github.com/renorris/cs496-final-project