Smart Lock Network

lockNET

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Changes from the First Proposal

We have made the following changes to our design:

Hub

On further research, we realized that a LoRa Gateway had every part of the Intel Edison that we desired: web server capabilities, a cellular chip, and LoRa support.

Lock

Instead of using Arduinos to control the locks, we will be using the SmartFusion boards instead. Not only do the SmartFusion boards give us more computability power, they also allow us to add features otherwise impossible for the Arduino. Firstly, we can implement our secure communication via RSA fully in hardware. The change also allows more practical implementation of class material as opposed to prebuilt Arduino libraries.

The locks themselves, instead of being regular door locks, will be simulated as cabinet locks, with the servo turning a piece of metal that will prevent the door from opening.

1 Customer

Our target market is people in communal living spaces such as houses or shared apartments, and who are looking for greater control over the security of their own rooms by using a central system with credentials to allow access through doors as opposed to a simple key mechanism.

2 Value

The first benefit is the added security of the doors via two-factor authentication. Each door can only be unlocked either via something on you (i.e. NFC via a phone) or a part of you (i.e. fingerprint). This method surpasses using a physical key because it can not be as easily duplicated or lockpicked, and is also convenient as the odds of losing a key are much greater than losing a smartphone or your fingerprints. The state of the door can also be sent to the owner, so if they forgot to lock it they can just use their phone to do so (or set up autolock functionality).

The second benefit is that there is more freedom in terms of access. Each door can have both blacklists and whitelists to outright deny or accept people, and if someone's on neither, they can request access remotely instead, much quicker than waiting for them to come home.

3 Approach

The top level design is of a central hub (a LoRa Gateway) with a number of nodes connected. The hub is what allows users to communicate with the locks via a web interface. We only want the hub to store what is necessary, acting as a control station while each of the locks do most of the security part, making it much harder for someone to spoof access rights. Each SmartFusion will have a hardware RSA implementation in order to maintain secure communication (ensuring secure communication on the hub side should be trivial).

When a scan occurs, the SmartFusion connected to the lock will compare the credentials with its internal whitelist and blacklist. If it's on the whitelist, the door will unlock. If it's on the blacklist, not only will the door not unlock, but a record of the attempted access is saved. If the credentials are on neither list, the SmartFusion will inform the hub, which sends out a message to the lock's owner requesting approval. Upon answer, the lock will unlock if approved. The request will also be recorded. If the scan is via fingerprint, then only the prints already saved are allowed, and no requests will be made if access is denied.

A similar messaging method will be used to make changes to the locks. In order to allow equal ownership, if somebody wishes to change a common lock, they submit a request for the change, and the others must approve it first before it becomes implemented.

In case of power loss, the hub will have a backup power supply in order to make users aware of the situation. A power-based interrupt will occur upon loss of main power and the board will send out an SMS to all users.

NeoPixel LEDs would be used to provide visual feedback for the locks. There will be different states for idle, waiting for response, access granted, access denied, and an open door.

The diagrams at the end of this proposal will showcase the component networks as well as the control flow for the various operations that the system will perform.

4 Physical Components

4.1 Hub

Quantity: 1

- **LG01 LoRa OpenWrt IoT Gateway** (Tindie)
- Panasonic LC-R121R3P 12V 1.3AH Sealed Lead Acid battery (Battery Clerk PN: AJC-D1.2S-J-0-142493)

4.2 Lock

Quantity: 2

- **SmartFusion Board** (stock)

- Adafruit RFM95W LoRa Radio Transceiver Breakout - 868 or 915 MHz (Adafruit PID: 3072)
- Hitec HS-422 Servo (stock)
- Adafruit NeoPixel Digital RGB LED Strip (stock)
- KNACRO PN532 NFC Module 13.56MHz 3.3V Board (Amazon)
- Adafruit Industries LLC 375 Magnetic contact switch (Digi-Key PN: 1528-1907-ND)
- Portable USB Charger (stock)

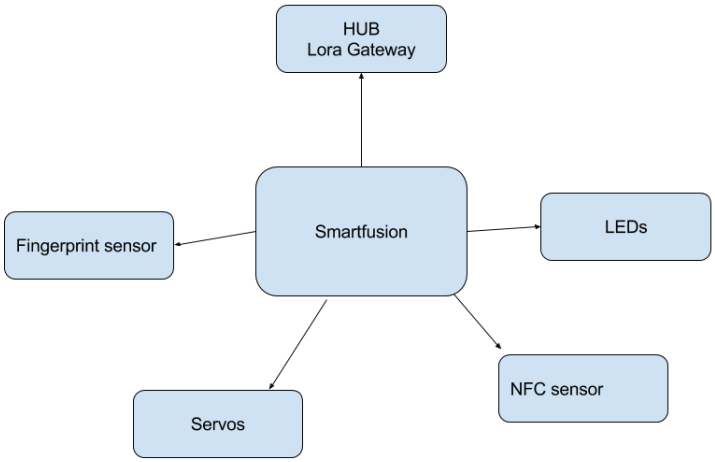
5 Potential Components

- Fingerprint Scanner - TTL (GT-511C1R) (Sparkfun PID: SEN-13007)

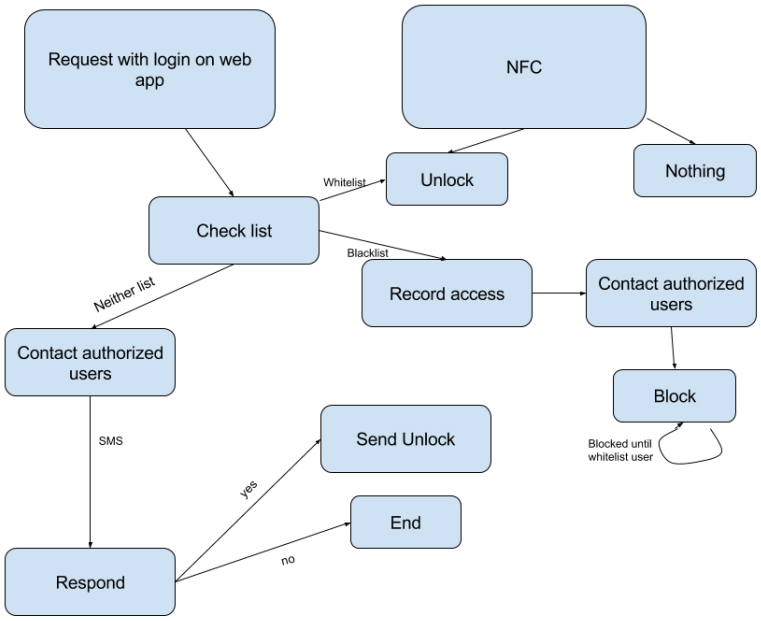
  The fingerprint scanner would be used as a failsafe in case the NFC reader was not viable (either an issue with the scanner or with the NFC tag/phone). The sensor itself communicates over UART and all of the heavy calculations are done onboard, so it would be something completely separate from the credential system that we have (which might be a positive, considering it's a failsafe).

6 Diagrams

Connections



Access



Administration