zkTap: A Zero-Knowledge Trustless Authentication Protocol

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What Problems Do We Solve?

A readout of activity that took place on the hotel room's electronic door lock indicated that an attempt was made to reprogram al-Mabhouh's electronic door lock at this time. [citation needed] *The investigators believe that the electronic lock on al-Mabhouh's door may have been reprogrammed and that the killers gained entry to his room this way.*[41] *The locks in question, VingCard Locklink brand,*[42] *can be accessed and reprogrammed directly at the hotel room door.*

Assassination of Mahmoud al-Mabhouh

Location	*Dubai, United Arab Emirates*
Date	*19 January 2010*
Target	*Mahmoud al-Mabhouh*
Attack type	*Assassination*
Weapons	*Pillow, muscle relaxant*
Deaths	*1*
Perpetrators	*33 people, using forged and fraudulently obtained passports*

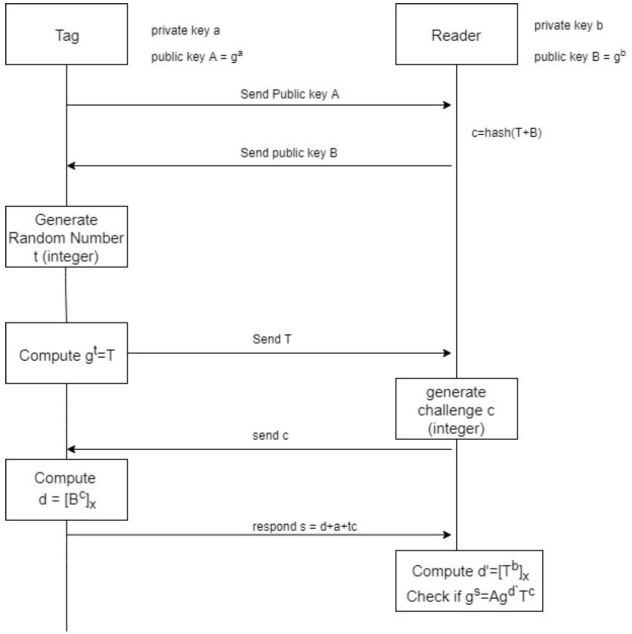
Our Solution

Security Protocol

- The tag and reader exchange public keys which is their claim of their identification
- The two systems communicate back and forth so the tag proves it is who it claims to be
- After the tag is verified, the reader grants or denies access depending if tag has privileges

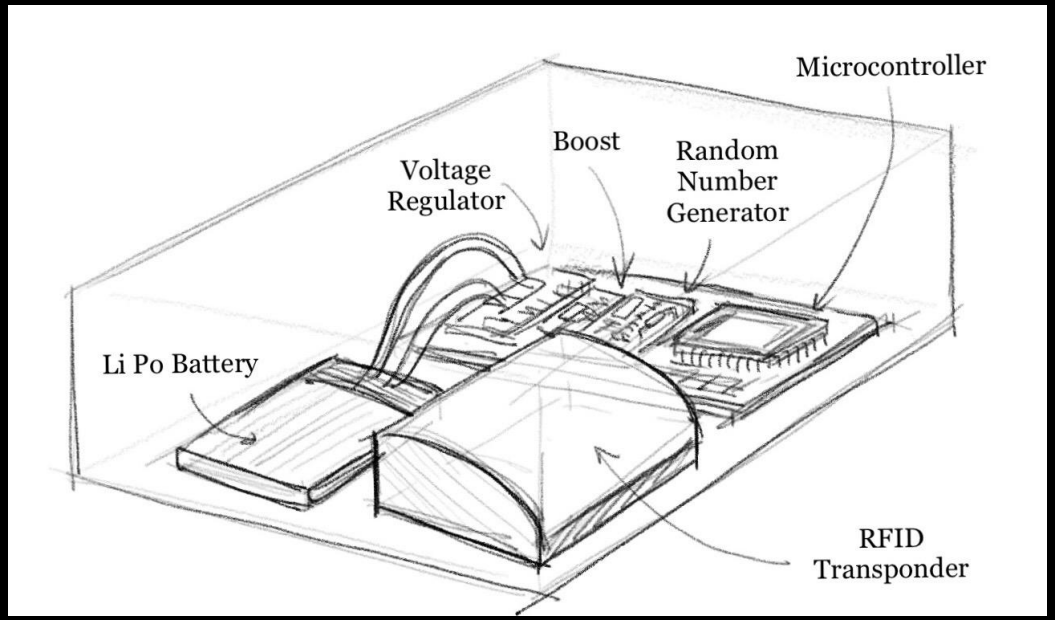
Schnorr-Peeters Protocol

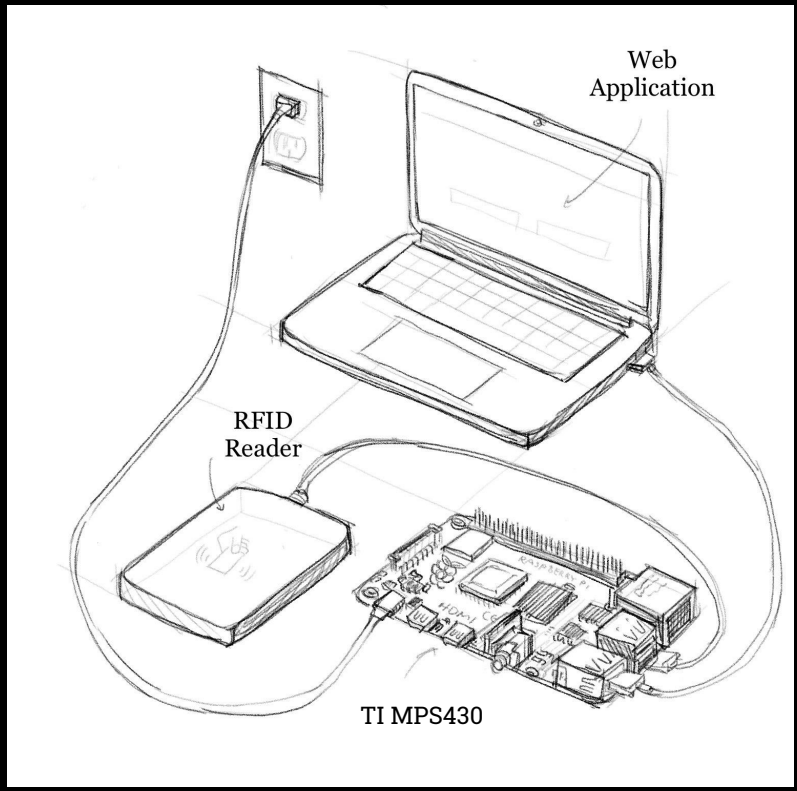
Schnorr-Peeters Protocol




```
Blinding Factor:  0x5f7e3a0347bd0
Commitment:  0x11bc0429e6efa
Tag's private key:  0xece445
Tag's public key:  0xeacf224b9d457


Reader's private key:  0xececafe
Reader's public key:  0x7532a02443798
Challenge:  0xa2e169b1c335f


Shared Secret:  0x8c864f1650952
Tag's Answer to the challenge:  0xd823281e72c11


Verification:  0xeacf224b9d457
```

Physical Diagram





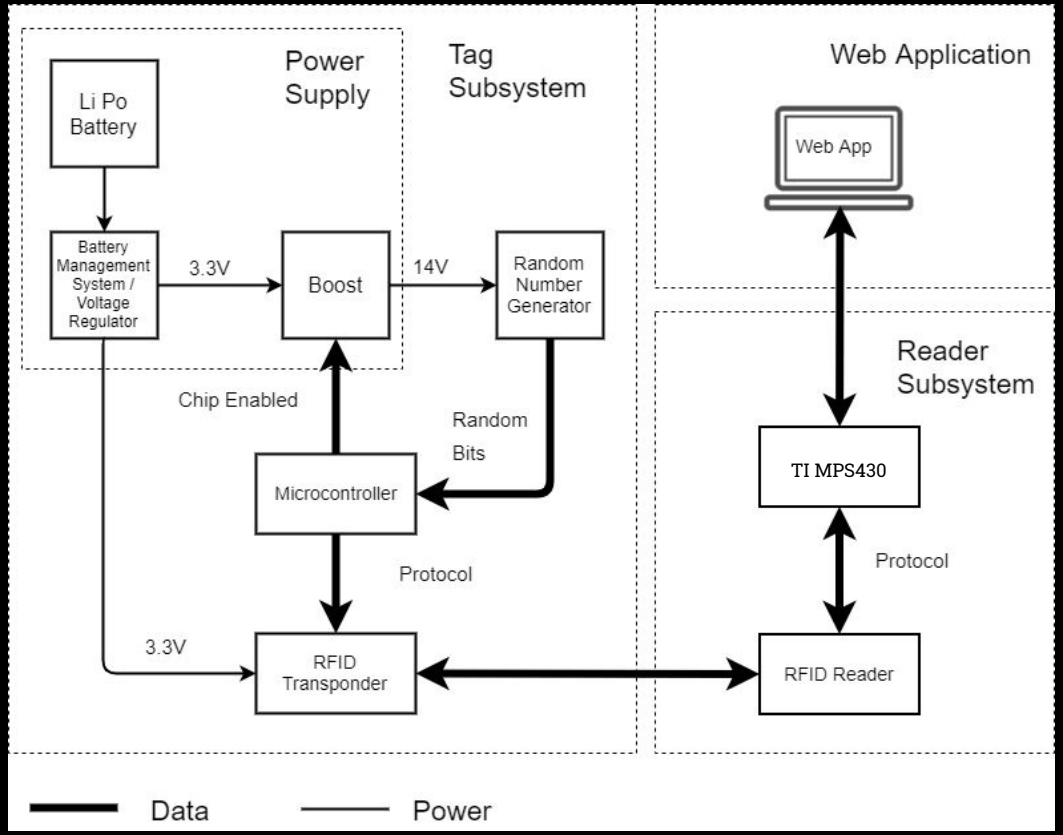
High-Level Requirements

01 The response given by the correct tag must be accepted by the reader with all but negligible probability (on the order of being rejected ~1\% of the time).

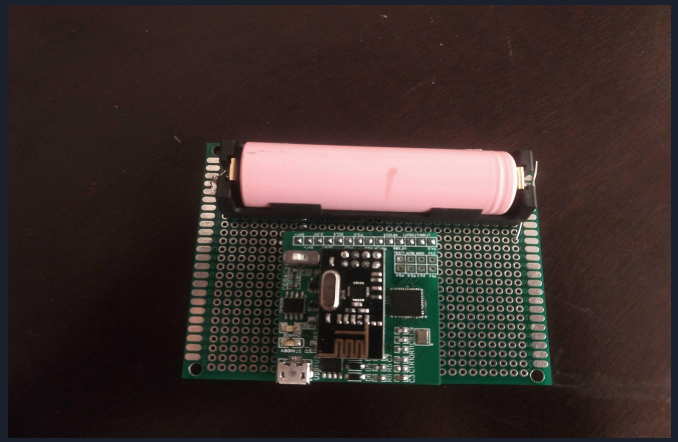
02 A user must be authenticated in under 10 seconds.

03 An eavesdropper must not be able to impersonate a user (except by guessing responses).

Block Diagram



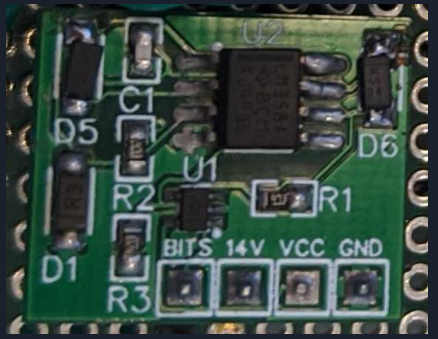
Tag Subsystem



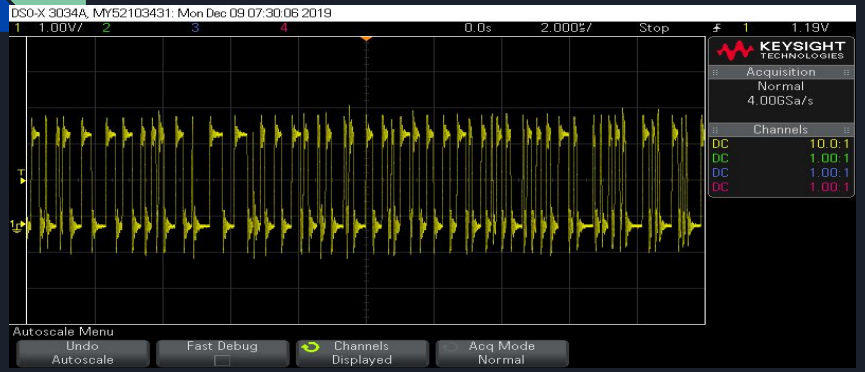
- The subsystem consists of:
  - power supply and management system
  - random number generator
  - a microcontroller with msp430 chip
  - NRF24l01 chip
- Power supply supplies power to the rest of the system and uses a battery so that it is portable
- Microcontroller manages the security protocol
- NRF24l01 enables communication via the air

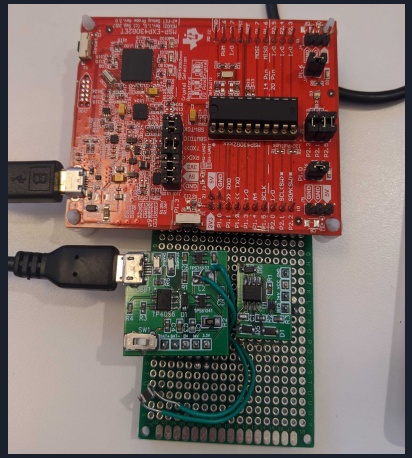
Random Number Generator

- Zener diode
- Avalanche Noise
- Discretize



RNG Results & Verification





```
[joseph@null cpp]$ ./ea_iid ../bin/rng2.bin
Calculating baseline statistics...
H_original: 7.868209
H_bitstring: 0.995580
min(H_original, 8 X H_bitstring): 7.868209

** Passed chi square tests

** Passed length of longest repeated substring test

Beginning initial tests...
Beginning permutation tests... these may take some t
** Passed IID permutation tests
```

```
[joseph@null cpp]$ ./ea_non_iid ../bin/rng2.bin

Running non-IID tests...

Running Most Common Value Estimate...

Running Entropic Statistic Estimates (bit strings only)...

Running Tuple Estimates...

Running Predictor Estimates...

H_original: 7.353758
H_bitstring: 0.885569

min(H_original, 8 X H_bitstring): 7.084548
```

Tag Transponder

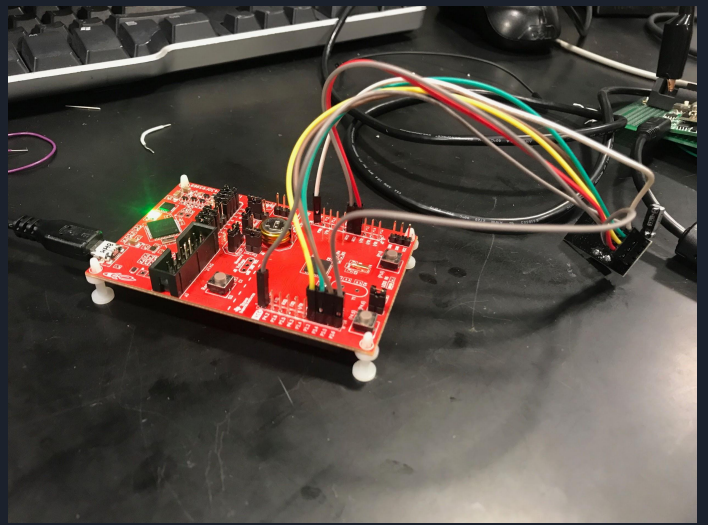
- The RFID transponder is responsible for transmitting data to the reader and receiving data from the reader
- The NRF24l01 chip allows for the tag to broadcast messages over the air
- The tag follows a security protocol implemented in msp430 and uses the random number generator to prove that the user is who it claims to be

Requirements: The data sent should resistant toward corruption

Verification: We collected 1000 messages and it was a success if 99% messages were uncorrupted

Reader Subsystem

- The reader subsystem consists of NRF24l01 chip and a msp430 board.
- The chip enables the reader to receive messages from the tag
- The msp430 verifies the tag's identification and transmits this information to the web application



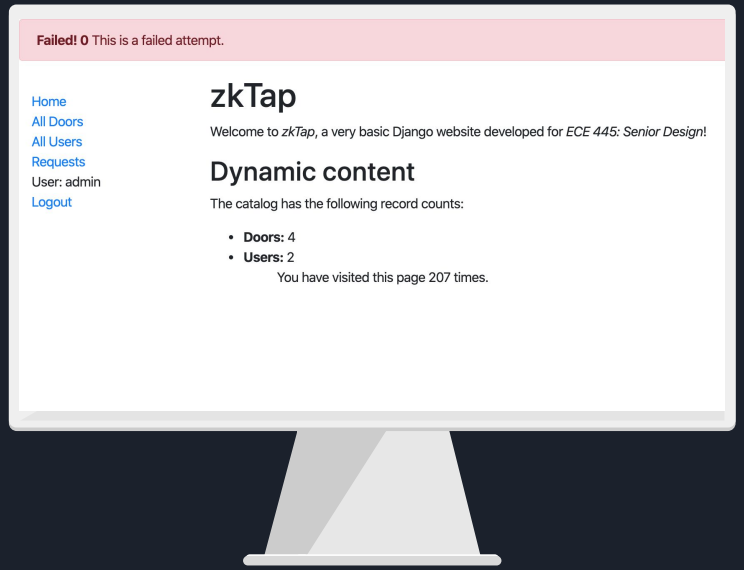
Requirements: It reads data from RFID transponder

Verification: reader authenticates tag and sends information to web app. If web app displays the information, then authentication is successful

Web Application

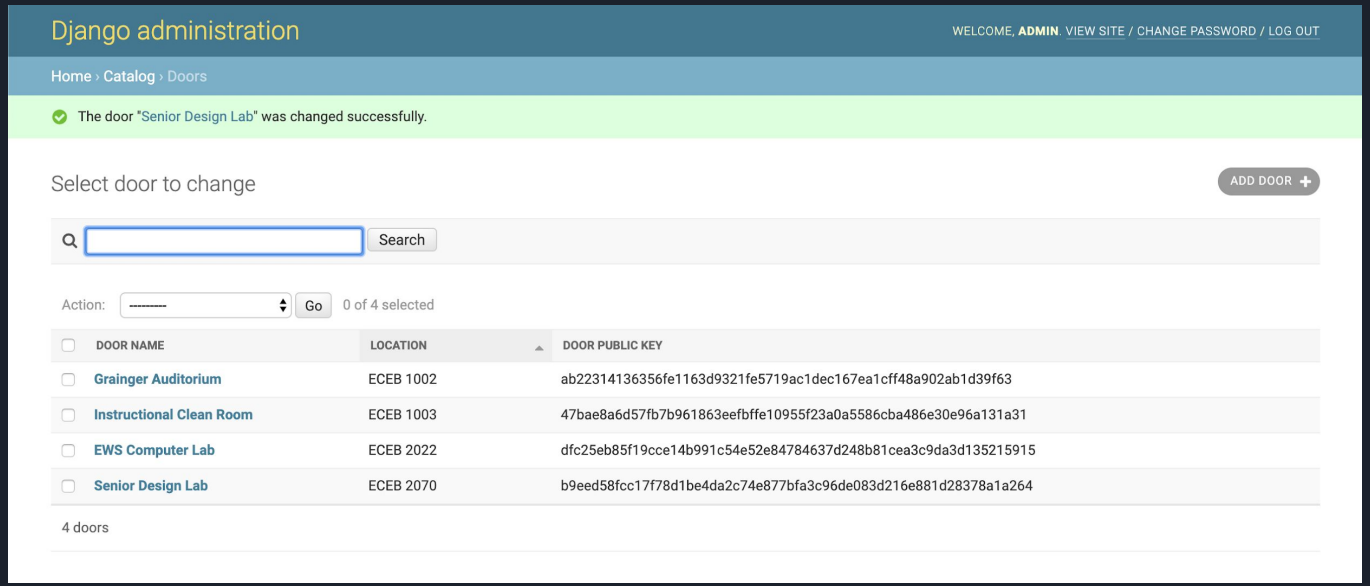
Function as visual aid

- View all doors and users
- User can request door access
- Admin can either revoke or accept door access requests
- Alert if there's successful or failed attempts



Database

SQLite



What’s Our Biggest Challenge?

What’s Next?


Thank you!