Your Smartcard is Dumb

A Brief History of Hacking Access Control Systems

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Outline

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- Access Control 101
- What is a “smartcard?”
- Ok, got it. How do we break it?
- Can we do better?



Access Control 101

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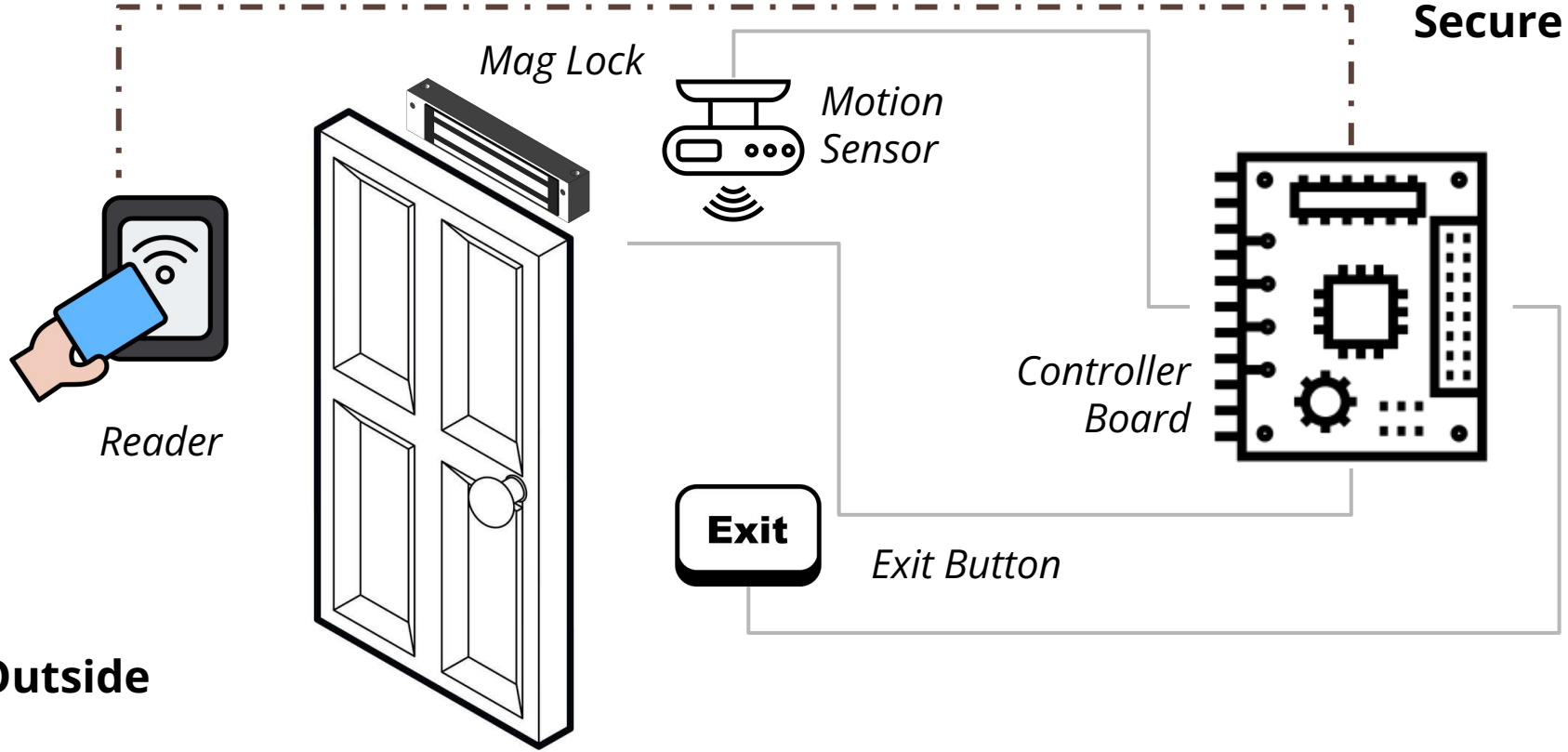
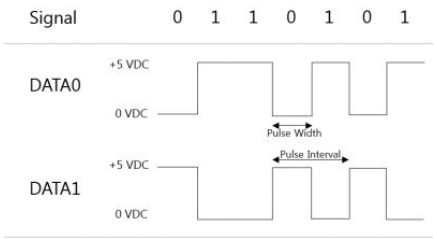


Access Control 101



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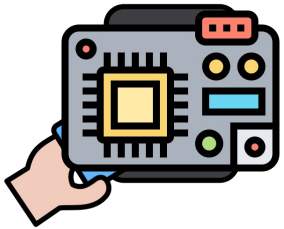
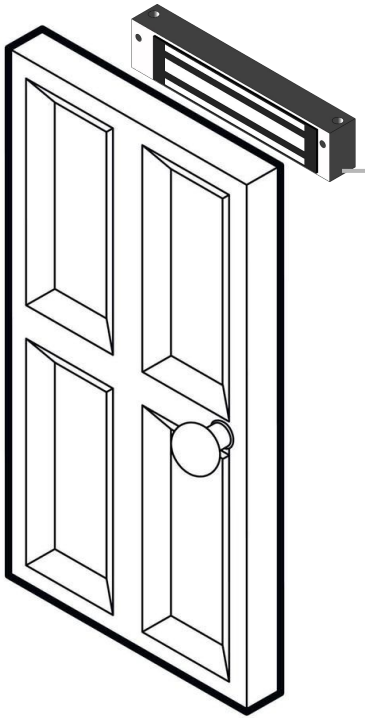
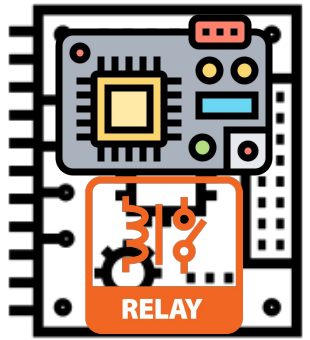
Secure Side

Wiegand (Unencrypted)











Outside

What is a smartcard?

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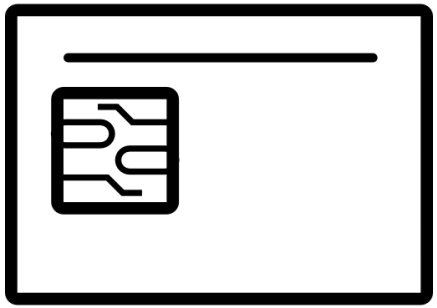
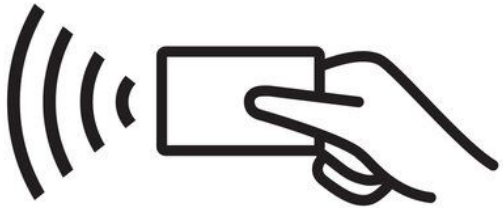
It looks something like this:



or



or



Not all smartcards are created equal

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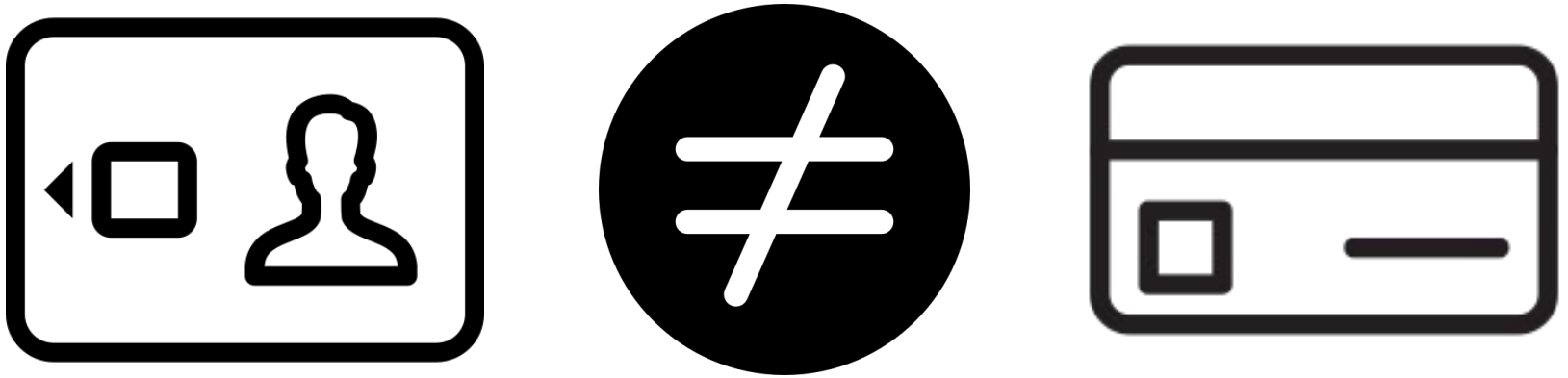

Credit Cards (magstripe)

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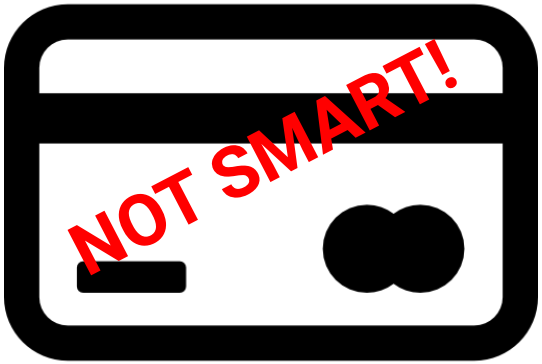
Simply store the information that is on the card



Simple Proximity Card (125 kHz)

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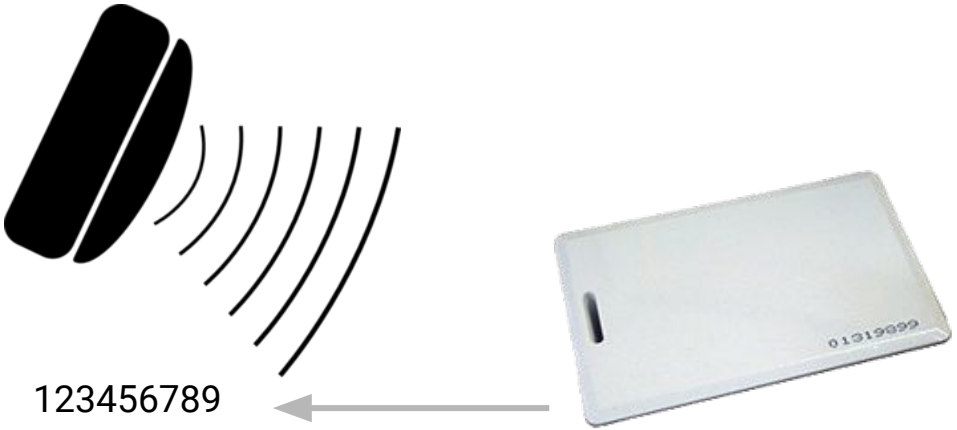
Anyone can read the data



Data has always been transferred in an **unencrypted** form with the prox card credentials. Card readers were designed to communicate small sets of data typically in **8-16 digit card numbers**.

https://willelectronics.com/why-125-khz-prox-cards-are-unsecured/

Proximity Cards (memory cards)

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Used to store a receive data, typically using **symmetric encryption**









Encrypted Proximity Card (13.56 MHz)

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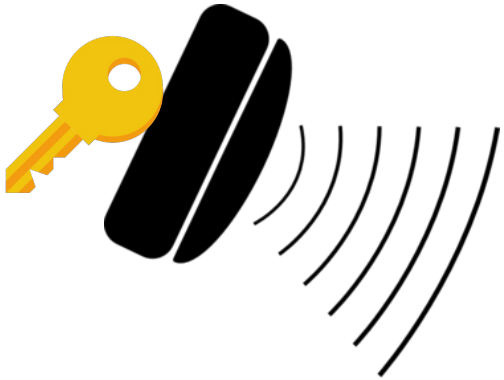
Shared key must be used to read data



123456789



Smartcards

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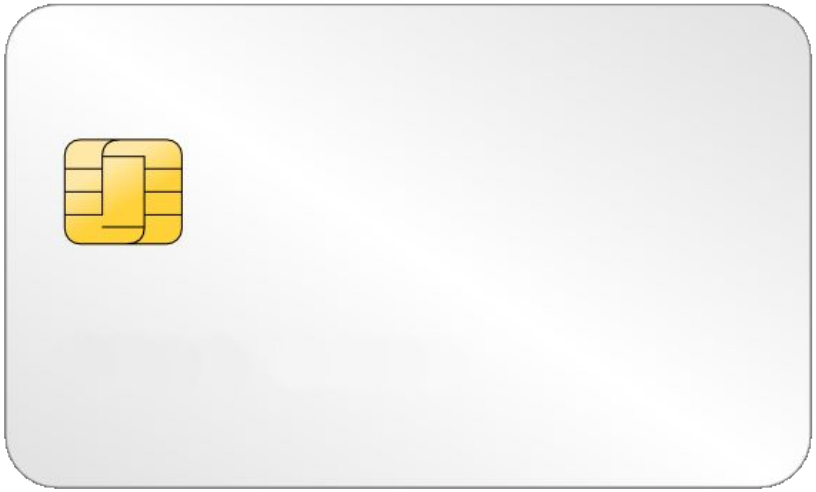
Contain a computer: *CPU, Memory, Operating System (Java)*



Smartcards (asymmetric encryption)

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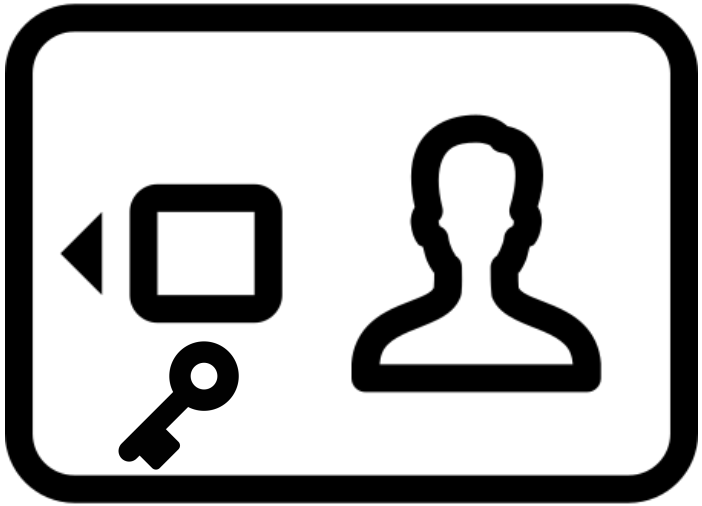
The private key never leaves the card and is used to *sign* messages







What's in a smartcard chip?

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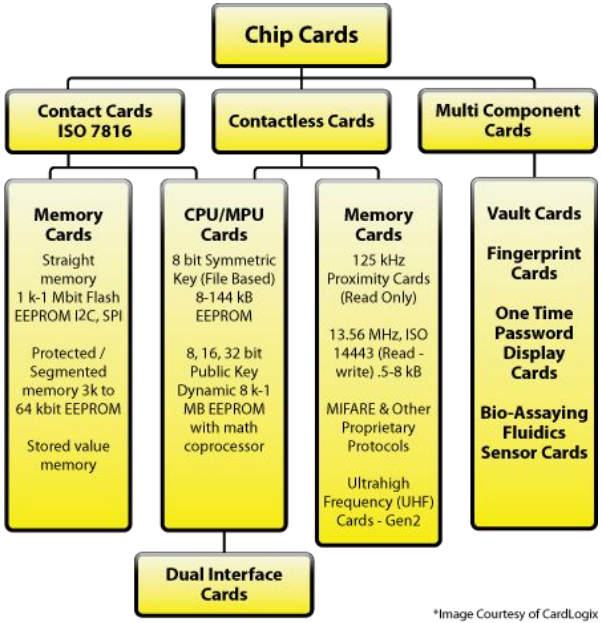
A little computer embedded in plastic



How do smartcards work?

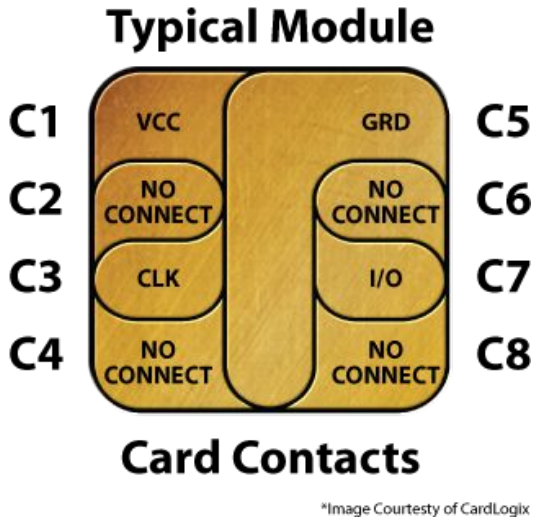
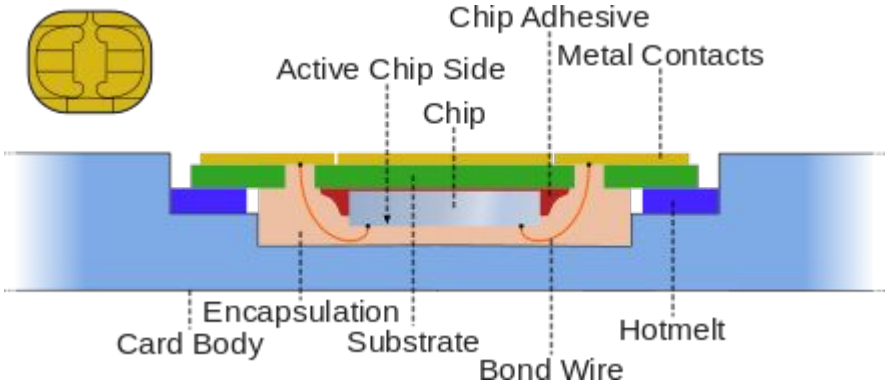


*Image Courtesty of CardLogix



Why do we have smartcards?

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Passwords aren’t great

Carrying a full computer is complicated (or used to be)

They can be “something you have”

> *Users can be authenticated by something they **have, are**, or **know***

Are they actually better?

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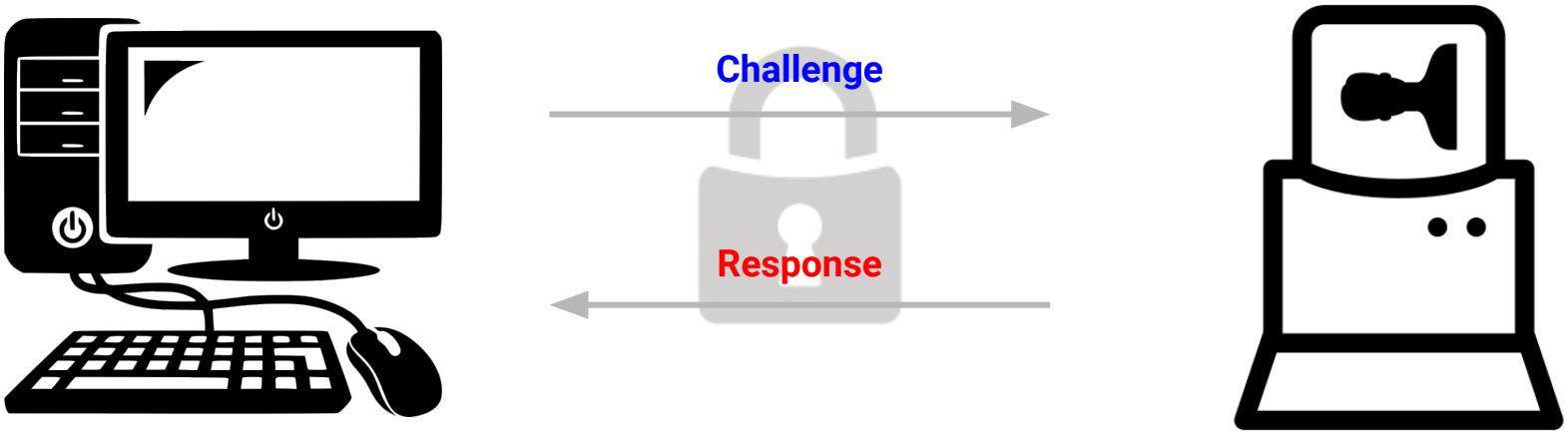

Are they actually better?

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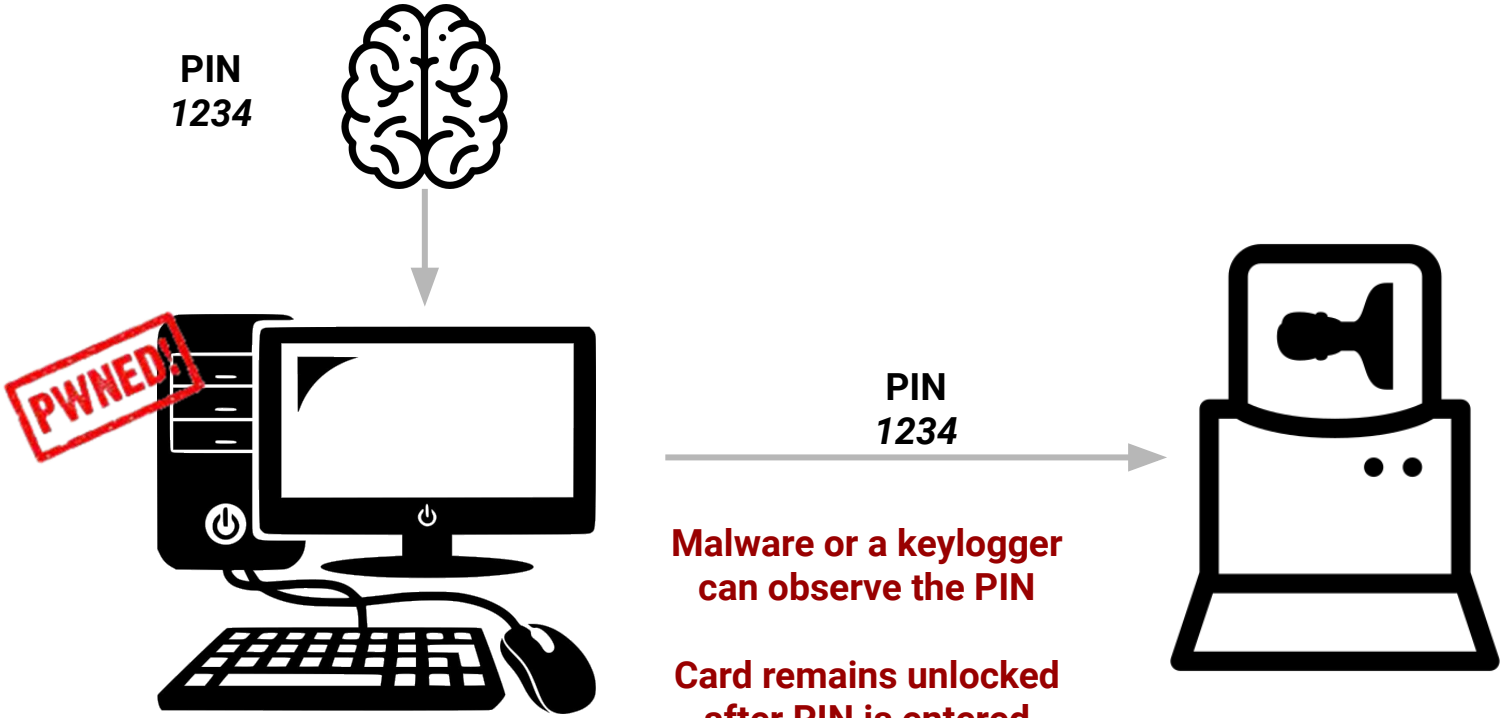

Physical tamper resistance

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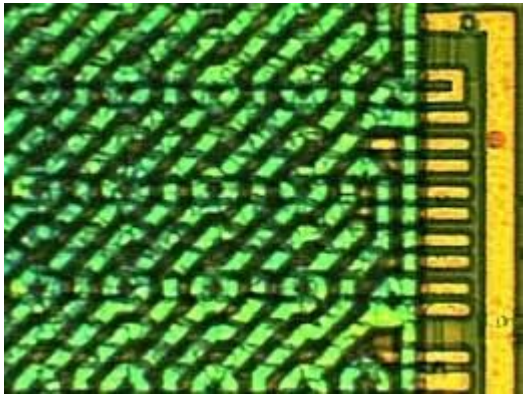
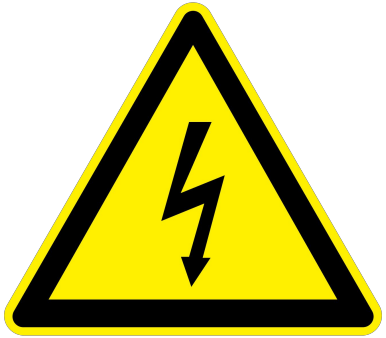


Mesh of contacts that will “destroy” the chip if breached



Brownout detection for voltage glitching

```
if PIN == STORED_PIN:
    unlock();
else:
    failed_attempts++;
```

NOT SMART!

```
pin_attempts++;
if PIN == STORED_PIN:
    unlock();
```

Fault-resistant software

Who uses smartcards?

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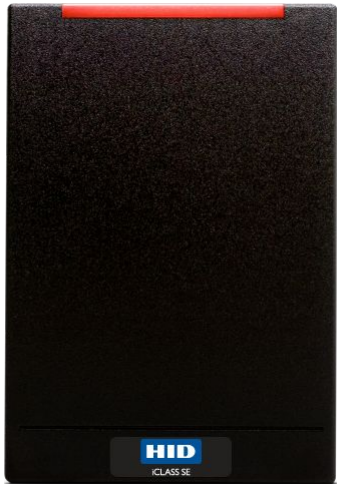

Physical Access Control



Digital Authentication



Device Identification

What’s the worse that can happen?

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Using the card without the user’s permission

Cloning the smartcard

Subverting the need for a card all together

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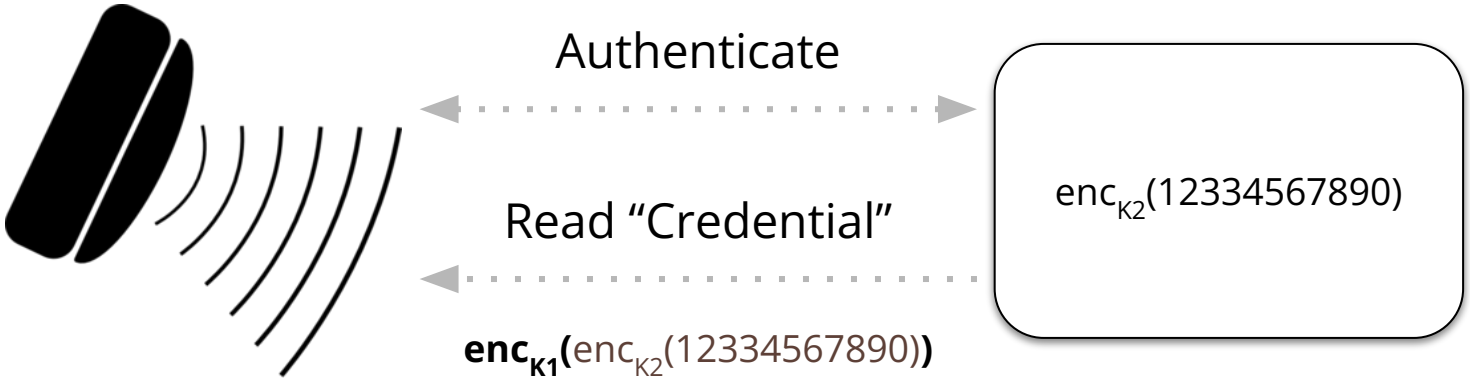
Ok, let's break it down

K1: In-transit Key

K2: At-rest Key



How do we break it?

Find that dang key!



Smartcard Attacks: Mifare

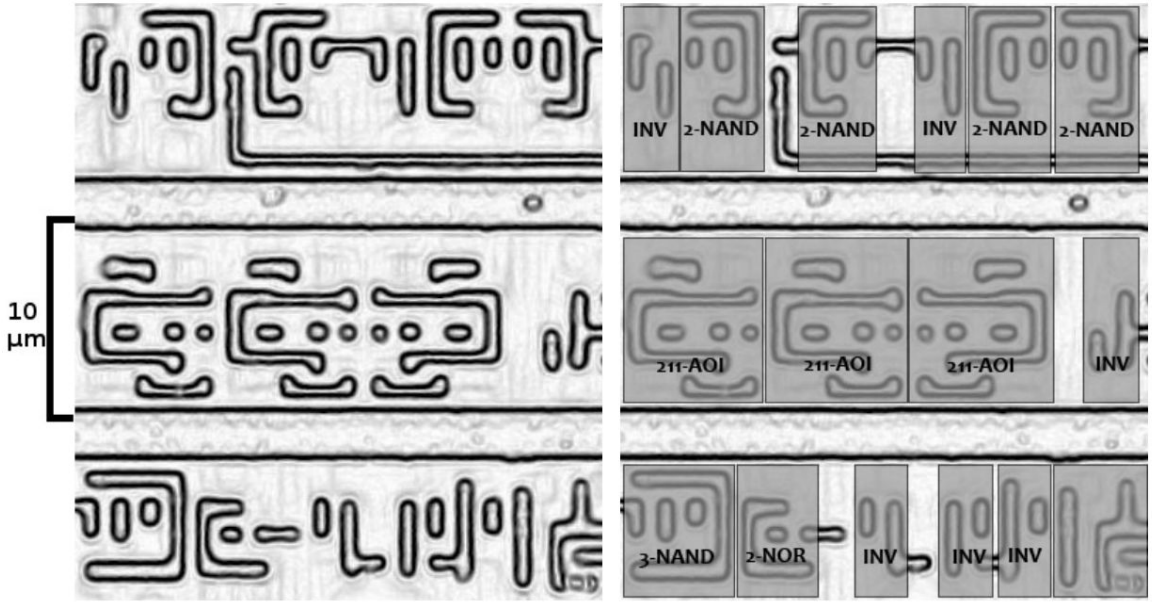


Figure 1: (a) Source image of layer 2 after edge detection; (b) after automated template detection.

Smartcard Attacks: Mifare

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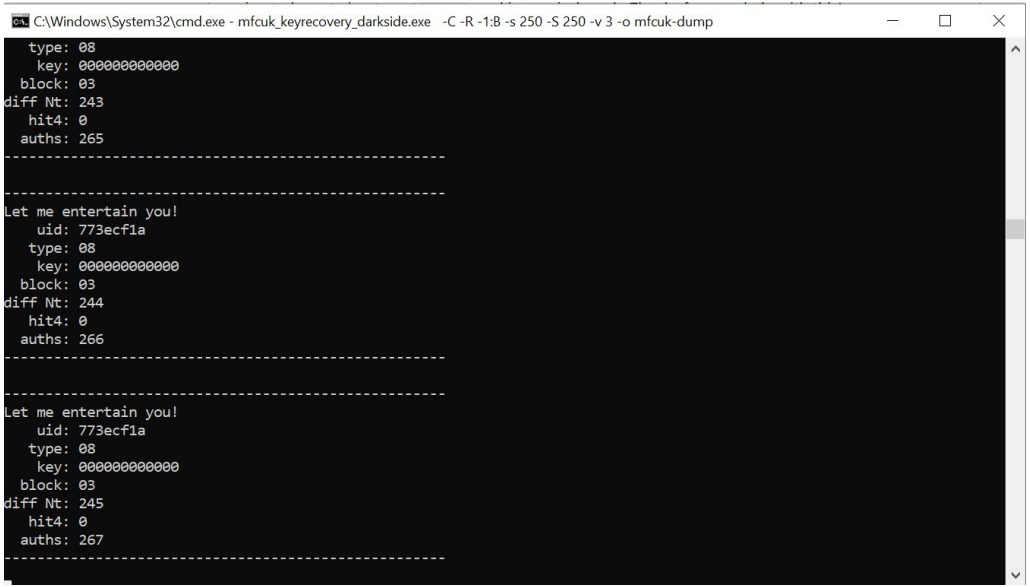
Result: Mifare cards can be trivially cloned with a tool: *mfcuk*



Smartcard Attacks: HID (Normal)



What if this key were leaked?



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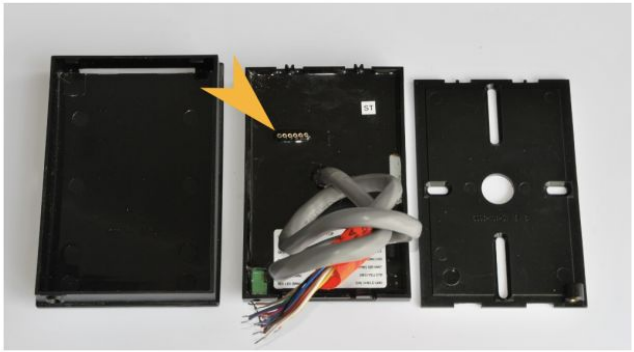
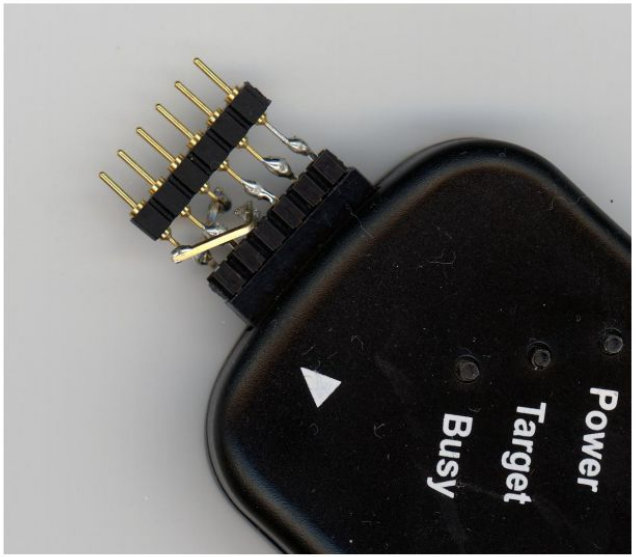
Smartcard Attacks: HID (Normal)

Heart of Darkness: exploring the uncharted backwaters of HID iCLASS





Smartcard Attacks: HID (Elite)

Elite mode enables *customer-specific* keys

See: *Dismantling iClass and iClass Elite*

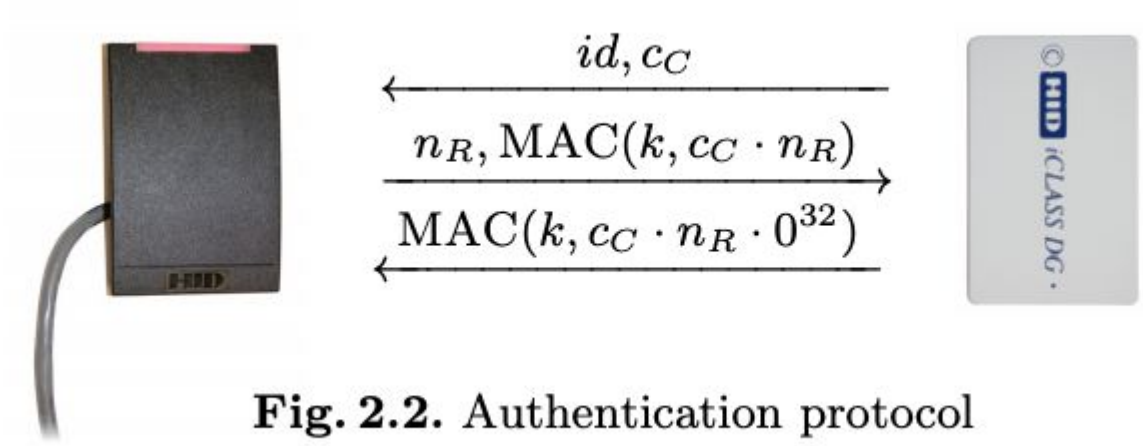


Fig. 2.2. Authentication protocol

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People are “Flipping” out



What do these attacks have in common?

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Bad implementation

Otherwise, smartcards have been one of the most secure mechanisms that we have



Why don’t we use smartcards more then?

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They do not scale well: one smartcard for every service

They require extra hardware: you need a smartcard reader

They lack a user interface: they can only be “something you have”

Can we do better?

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Imagine, a super smartcard

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Secure Elements

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Smartphones already have smartcards onboard



Trusted Execution Environment

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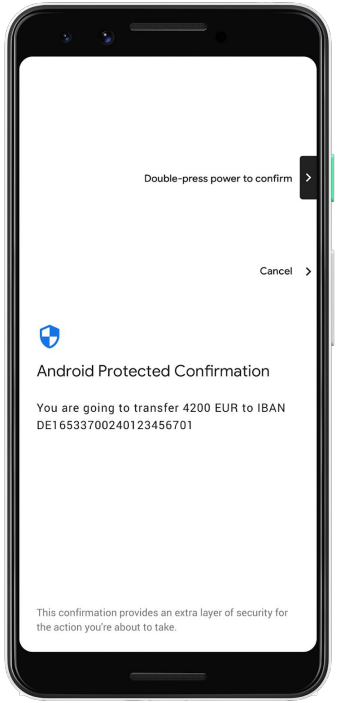
They can even provide a secure, trusted interface



The Future

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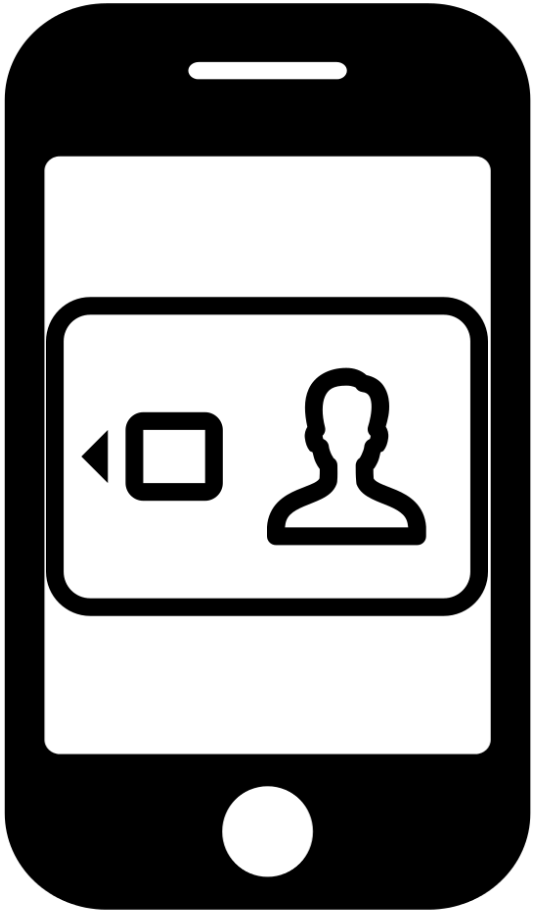
Trusted interaction with humans

Capable of interacting with anything

Can replace everything in your wallet



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