Physical attacks on secure electronic devices

Brice Colombier

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Who am I?

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Teaching

GEII department

Research

Secure Embedded Systems and Hardware Architectures

What does the title mean?

Physical attacks on secure electronic devices

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Physical attacks on secure electronic devices

Electronic devices:

- light bulb
- camera
- electric bike
- smartphone
- headphones
- computer
- credit card
- blender

What does the title mean?

Physical attacks on secure electronic devices

Electronic devices:

- light bulb ✗
- camera ✗
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- smartphone ✓
- headphones ✗
- computer ✓
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- blender ✗

Only few of them handle **sensitive information**.
Only few of them must be **secure**.
However, their number is **increasing**...

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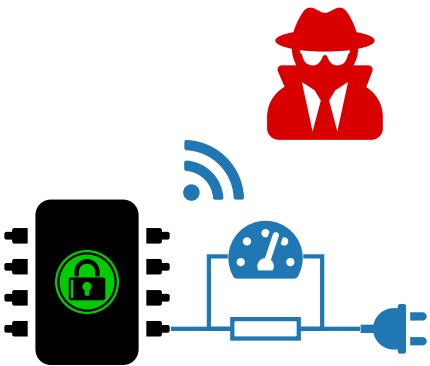

Side-channel attacks

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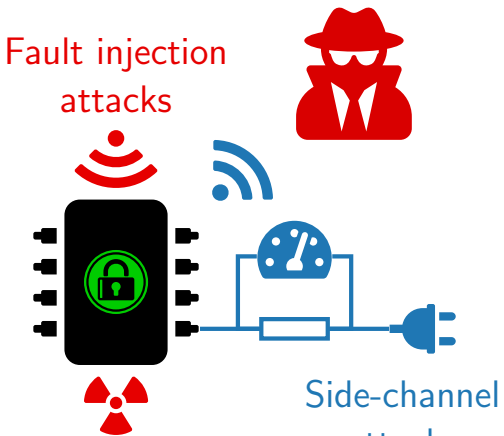

Side-channel attacks

Definition: measure a **physical quantity** while the device handles **secret information**.

- Power consumption
- Electromagnetic radiation
- Sound
- Photons

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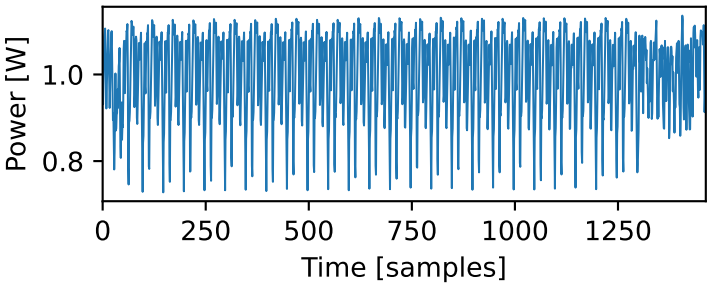
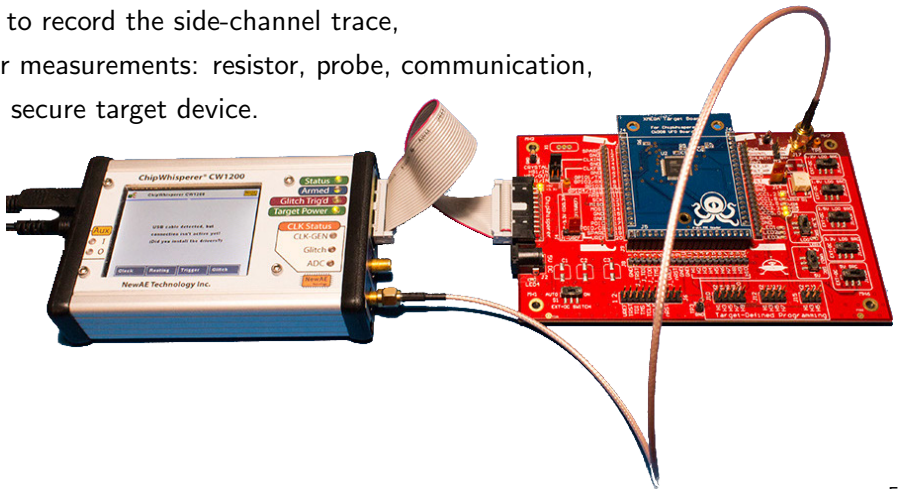
Side-channel trace:



Hardware platform

ChipWhisperer `https://www.newae.com/chipwhisperer`

- An "**oscilloscope**" to record the side-channel trace,
- A **motherboard** for measurements: resistor, probe, communication,
- A **daughterboard**: secure target device.



Target code

Credit card example: check if a 4-digit PIN entered by the user is correct.
If we want to **brute-force** it, how many trials will we need on average?

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```
1  def verifyPIN(user_PIN):
2      reference_PIN = "1234"
3      for i in [0, 1, 2, 3]:
4          if user_PIN[i] != reference_PIN[i]:
5              return False
6      return True
7
8  print("Enter your PIN:")
9  user_PIN = input()
10 if VerifyPIN(user_PIN):
11     print("CORRECT!")
12 else:
13     print("WRONG!")
```

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```
> python3 verifyPIN.py
Enter your PIN:
5874
WRONG!

> python3 verifyPIN.py
Enter your PIN:
1234
CORRECT!
```

Rewritten in C to run on the target micro-controller

Demo time

Target code with countermeasure

Countermeasure: **defense** against a **known** attack.

```
1  def verifyPIN_secure(user_PIN):
2      reference_PIN = "1234"
3      authenticated = True
4      for i in [0, 1, 2, 3]:
5          if user_PIN[i] != reference_PIN[i]:
6              authenticated = False
7      return authenticated
```

We want the implementation to be **constant-time**: the duration is the same for all input values.

Demo time again

Take-away messages

- An implementation might be **correct** but still not **secure**,
- Often, security is opposed to **optimisations**,
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Questions