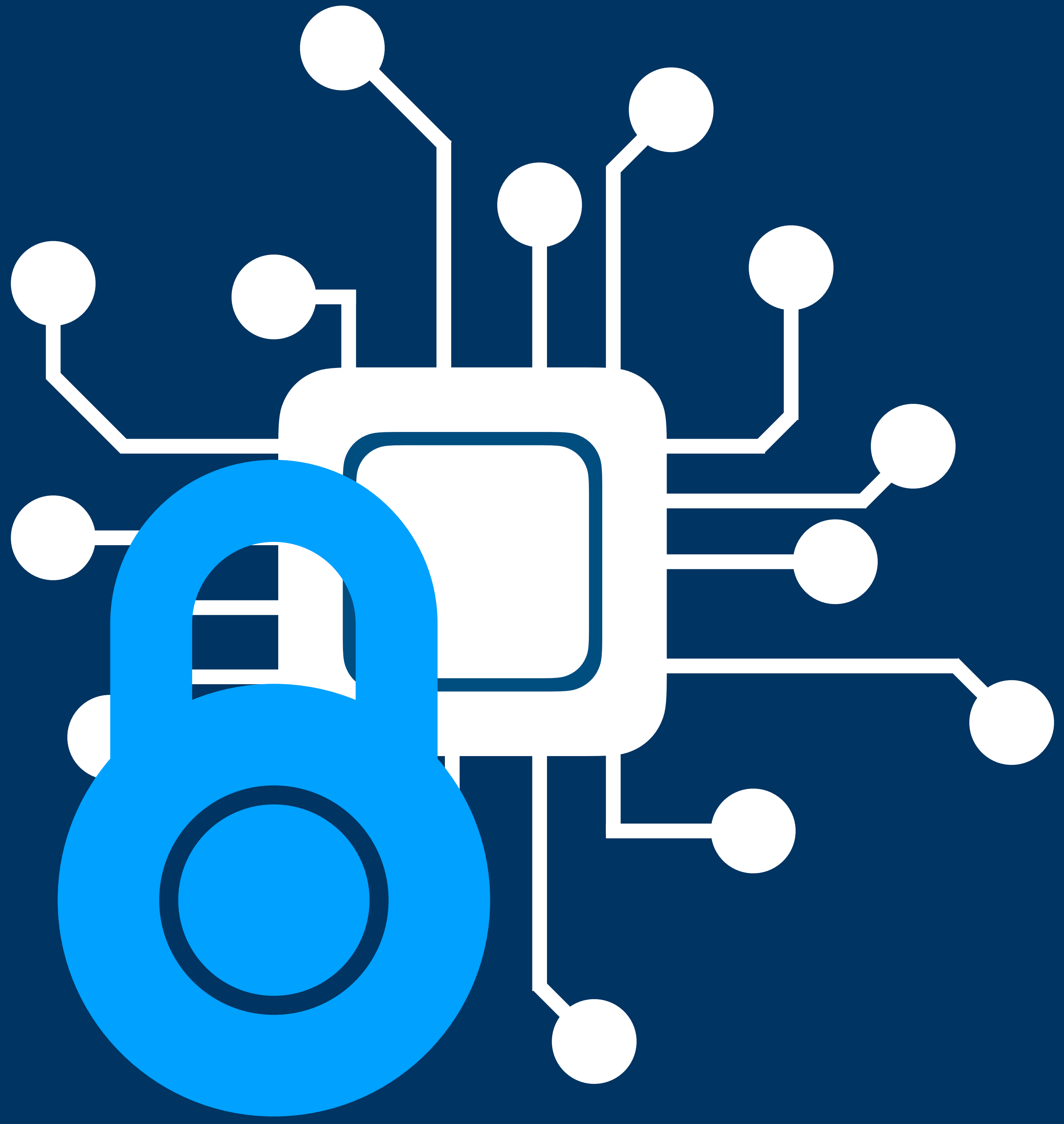
IoT Security

A Basic IoT Hardware Security Framework



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Agenda

1. Introduction
2. IoT Security Standards
3. Risk Identification
4. The Basic IoT Hardware Security Framework
5. Discussion
6. Conclusion

Motivation and Problem

- Due to the rapidly growing number of IoT devices, official security authorities have already integrated IoT security into their standards. ✓

- These standards focus on planning and usage of IoT devices, as well as software security and how to protect the data. ✓

- Most of them also consider hardware threats and security practices for IoT devices but there is no uniform process for IoT hardware security. ✗

Method and Goal

- The aim of our work is to develop a basic IoT hardware security framework that can be used to protect any IoT device on a basic level.
- We analyze three official IoT security standards to identify important hardware threats.
- The result of this comparison serves as a basis for a risk identification for four commonly used IoT devices.
- Based on the results, we derive a basic IoT hardware security framework that includes the identified risks.

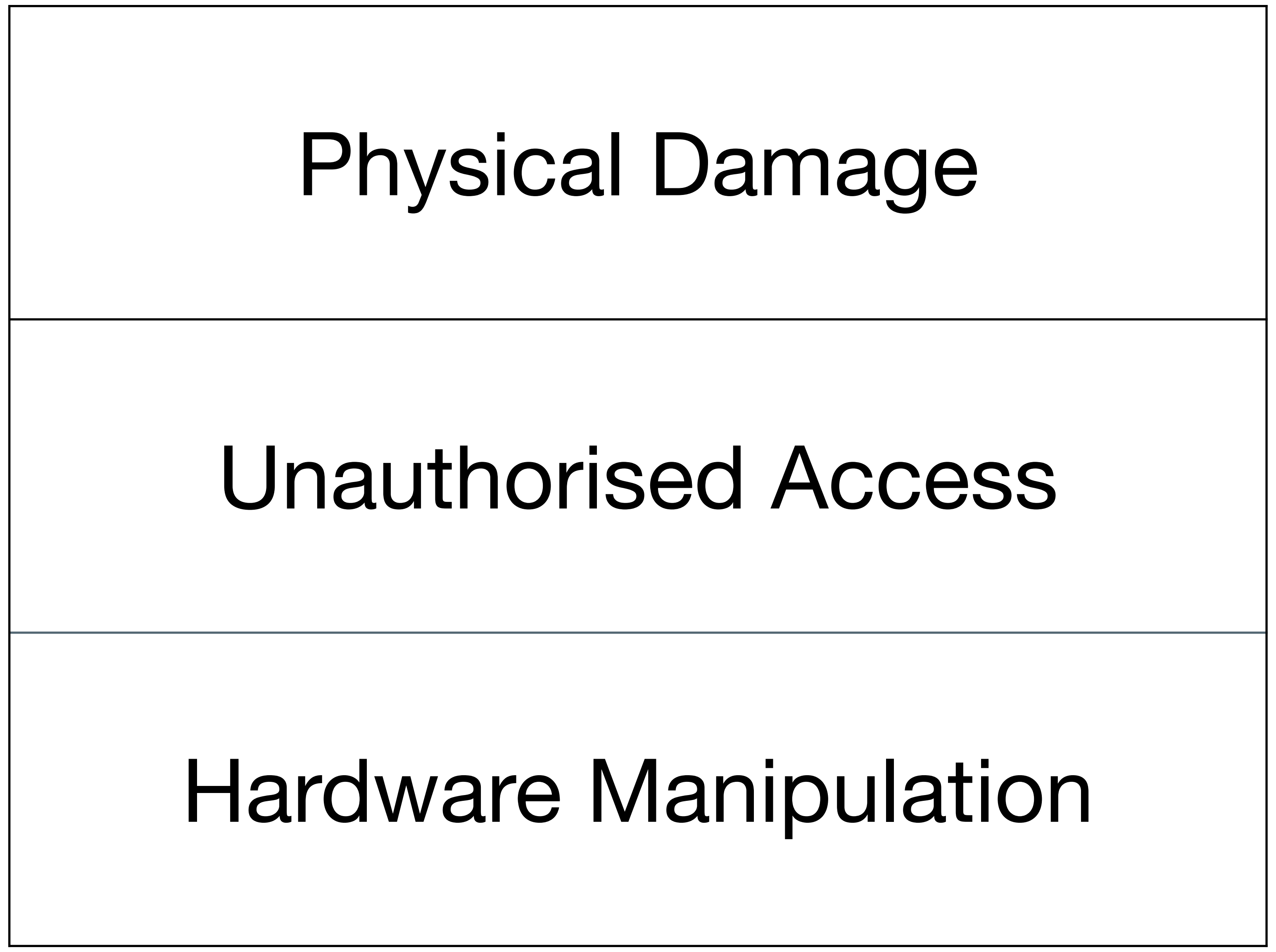
BSI Elementary Threats for IoT Devices

- The BSI describes 47 elementary threats for IoT devices in the BSI standard 200-3.
- 20 of them occur for IoT devices in the IT Grundschutz Compendium Module „SYS.4.4 General IoT Devices“.

G 0.2 Bad Environmental Conditions
G 0.4 Pollution, Dust, Corrosion
G 0.8 Disruption of Power Supply
G 0.9 Failure or Disruption of Communication…
G 0.14 Interception of Information / Espionage
G 0.16 Theft of Devices, Storage and Media…
G 0.18 Poor Planning or Lack of Adaption
G 0.19 Disclosure of Sensitive Information
G 0.20 Information or Products from a…
G 0.21 Manipulation with Hardware
G 0.23 Access to IT Systems
G 0.24 Destruction of Devices or Storage Media
G 0.25 Failure of Device or System
G 0.26 Malfuncrion of Device or Systems
G 0.28 Software Vulnerabilities or Errors
G 0.29 Violation of Laws or Regulations
G 0.30 Unauthorized Use or Administration of…
G 0.38 Misuse of Personal Information
G 0.39 Malware
G 0.40 Denial of Service

NIST Hardware Threats for IoT Devices

- The NIST published several drafts for IoT security.
- These drafts consider:
    - acquisition and implementation of IoT devices in companies
    - Important steps when planning to use IoT devices
    - how the data flow can be protected
- They also consider different threats.



Physical Damage

Unauthorised Access

Hardware Manipulation

ENISA Hardware Threats for IoT Devices

- The ENISA published the Baseline Security Recommendations for IoT.
- It contains a Hardware Security Section that addresses:
  - IoT Security Challenges
  - General Security Recommendations
  - Hardware Threats

Elemental Threats
Environmental Threats
Physical Damage
Hardware Manipulation
Power Loss
Data Interception

Selection of IoT Devices for the Risk Identification

- For our Investigation, we select 4 different IoT devices and list all their hardware components.
- The application scenarios are as different as possible.
- In this way, we are able to determine if the mentioned threats really apply to a wide range of different application scenarios.

Security Camera	**Smoke Detector**
Cables, Camera, Case, Infrared LED’s, Micro SD Socket, Microphone, Motherboard, Processor, Sensors	Battery, Case, LED, Motherboard, Processor, Reset Button, Sensors, Speakers

Soil Temp. Sensor	**Power Outlet**
Antenna, Battery, Case, Motherboard, Processor, Sensors	Case, Motherboard, Processor, Sensors, Socket Connector

Potential IoT Hardware Threats

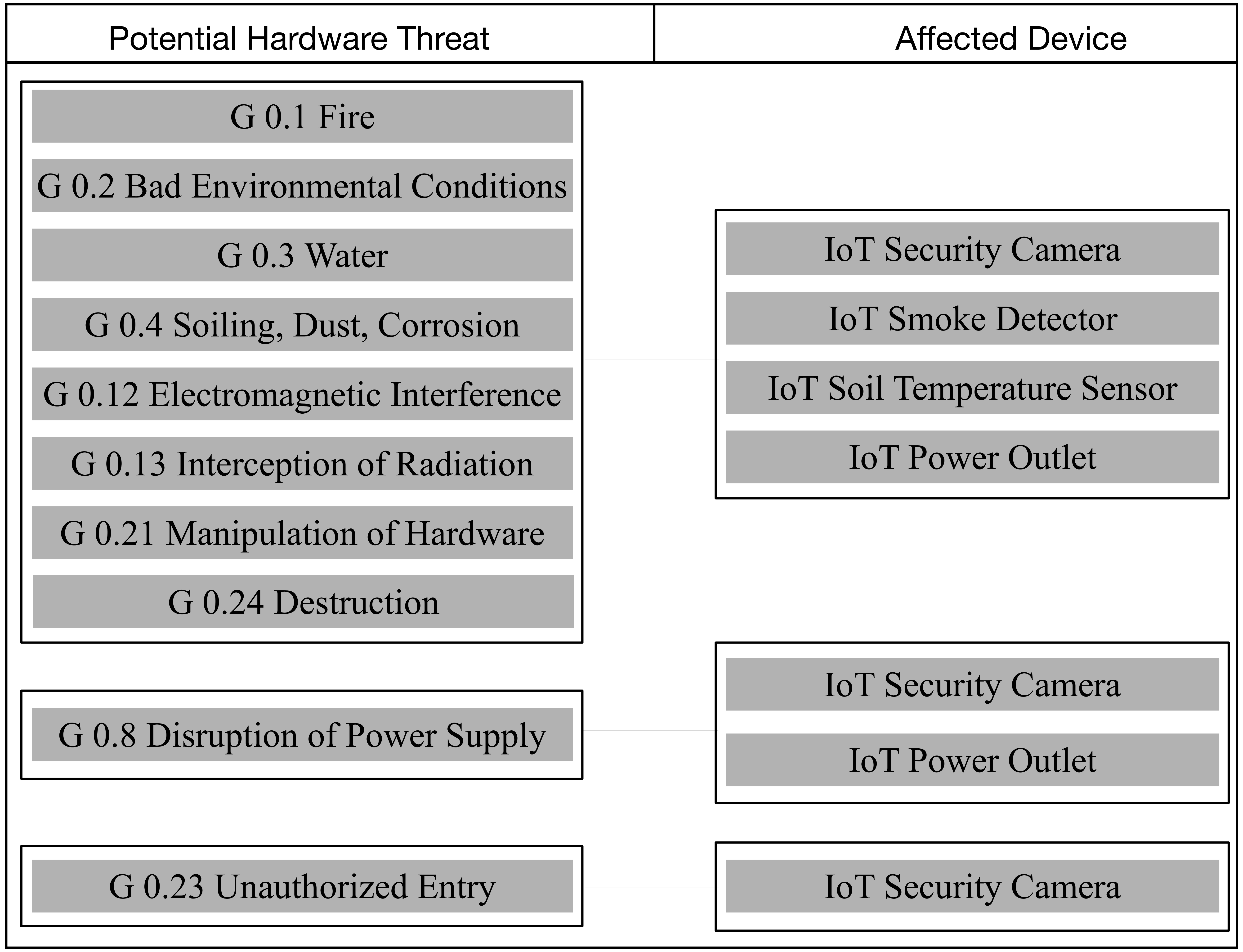
Potential IoT Hardware Threats

- The elementary threats from the BSI cover a wide range of threats for an entire company.
- They are not limited to the hardware.
- Because we focus on hardware security, we select those elementary threats addressing the hardware of IoT devices.

G 0.1 Fire
G 0.2 Bad Environmental Conditions
G 0.3 Water
G 0.4 Soiling, Dust, Corrosion
G 0.8 Disruption of Power Supply
G 0.12 Electromagnetic Interference
G 0.13 Interception of Radiation
G 0.21 Manipulation of Hardware
G 0.23 Unauthorized Entry
G 0.24 Destruction

Affected IoT Devices

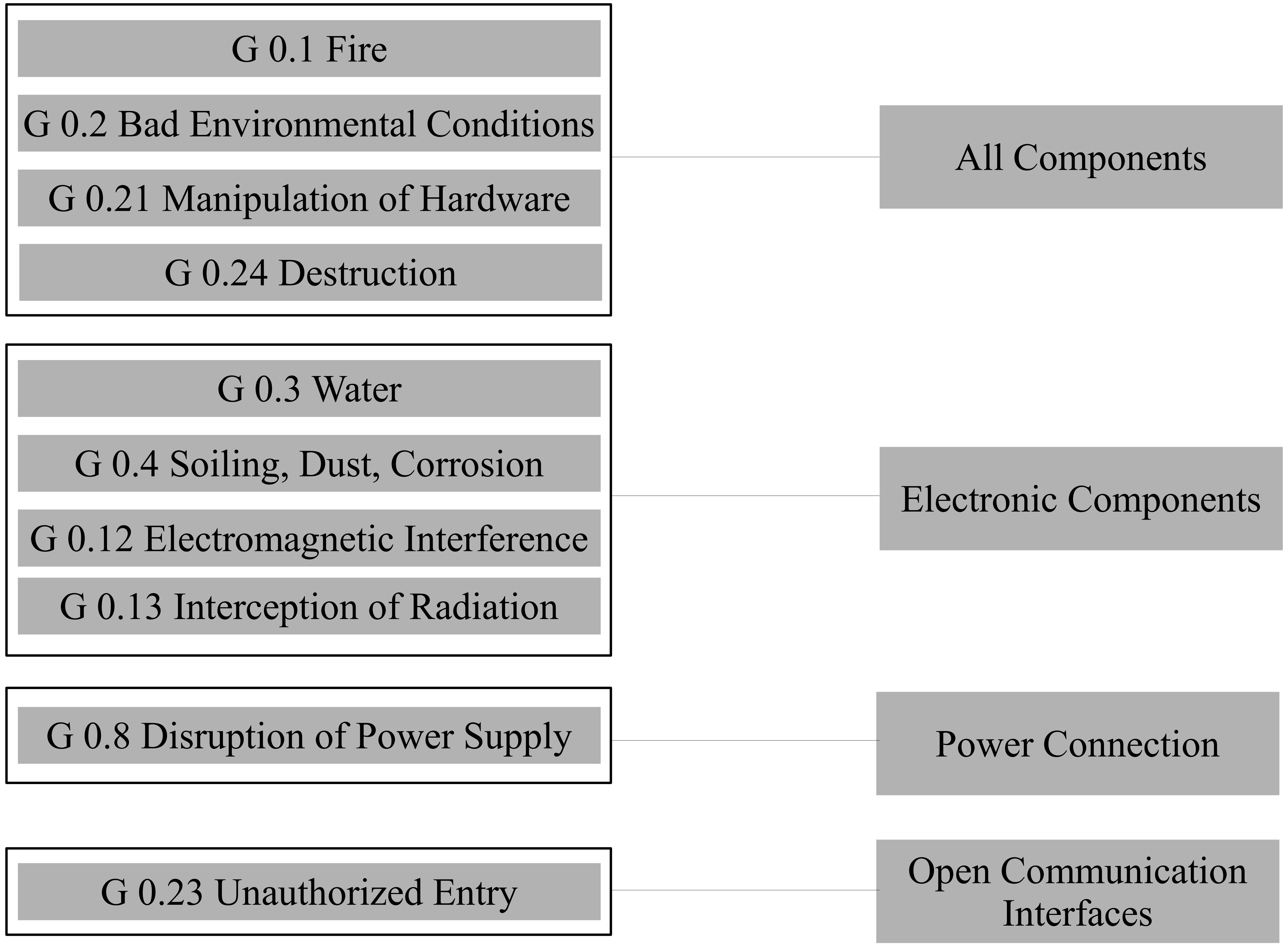
- In the next step, we implemented the risk identification.
- We checked if each device have the hardware component that a certain threat is addressing.
- If the device has the addressed hardware component, it is affected by the threat.



Potential Hardware Threat	Affected Device
G 0.1 Fire G 0.2 Bad Environmental Conditions G 0.3 Water G 0.4 Soiling, Dust, Corrosion G 0.12 Electromagnetic Interference G 0.13 Interception of Radiation G 0.21 Manipulation of Hardware G 0.24 Destruction	IoT Security Camera IoT Smoke Detector IoT Soil Temperature Sensor IoT Power Outlet
G 0.8 Disruption of Power Supply	IoT Security Camera IoT Power Outlet
G 0.23 Unauthorized Entry	IoT Security Camera

Generalization of the Results

- Hardware threats only arise for devices with addressed component.
- G 0.1, G 0.2, G 0.21 and G 0.24 are affecting all components.
- G 0.3, G 0.4, G 0.12 and G 0.13 are affecting all electronic components.
- G 0.8 is affecting devices with a power supply.
- G 0.23 is affecting devices with open communication interfaces.



G 0.1 Fire
G 0.2 Bad Environmental Conditions
G 0.21 Manipulation of Hardware
G 0.24 Destruction
All Components

G 0.3 Water
G 0.4 Soiling, Dust, Corrosion
G 0.12 Electromagnetic Interference
G 0.13 Interception of Radiation
Electronic Components

G 0.8 Disruption of Power Supply
Power Connection

G 0.23 Unauthorized Entry
Open Communication Interfaces

Definition of the Framework Basis

- Our risk identification confirms that the hardware threats mentioned in the three IoT security standards really apply to different IoT devices.
- These threats must be considered for all IoT devices or at least for a large number of different applications scenarios.
- For these threats, we define our basic IoT hardware security framework.

Definition of the Framework

- X is representing a certain IoT device which goes through the framework.
- SECURE indicates a function.
- If SECURE is ON, the hardware threat is affecting the device and a security practice has to be considered.
- Otherwise, the hardware threat is not affecting the device and no security practices has to be implemented.

```
For EACH IoT-Device x do
SECURE G 0.1, G 0.2, G 0.3, G 0.4, G 0.12,
G 0.13, G 0.21, G 0.24 ON x

    If x has power connection then
    SECURE G 0.8 ON x
    end if

    If x has open communication interface then
    SECURE G 0.23 ON x
    end if

end for
```

Discussion

- Our framework serves as a basic hardware protection for IoT devices but further security measures are necessary according to the security requirements and application scenarios of the devices.
- Our framework can be integrated into existing security concepts.
- Our framework does not consider appropriate security measures because the implemented threats are based on known threats that are described in the BSI.

Conclusion

- In this work, we developed a basic IoT hardware security framework that can be implemented into existing security concepts.
- We analyzed 3 official security standards and compared the mentioned threats.
- By performing a risk identification for 4 different IoT devices, we were able to confirm the importance of the mentioned threats.
- We used the results of the risk identification to develop our basic IoT hardware security framework that consists of 10 different hardware threats.

Thank You For Your Attention