universität innsbruck

IoT Light Bulb Covert Channel

Extended Functionality Attack on Smart Lights

Julia Wanker, Bennett Piater

Taxonomy of IoT Attacks [RS16]

1. Ignoring Functionality
2. Reducing Functionality
3. Misusing Functionality
4. Extending Functionality

Ignoring Functionality [Ang17, AAB+17, DDGS17]

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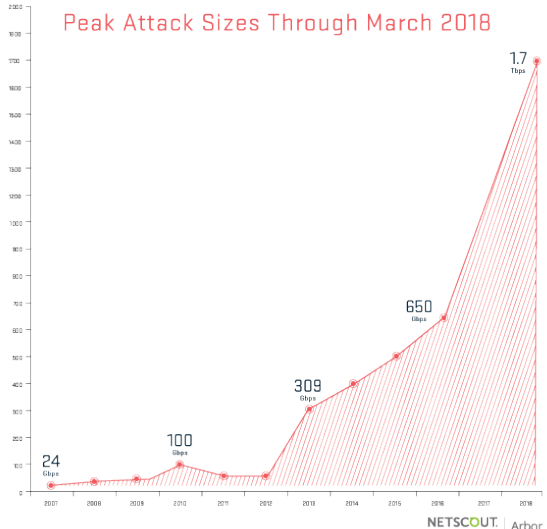


Reducing Functionality [Dha13, RSWO18, Bha17]

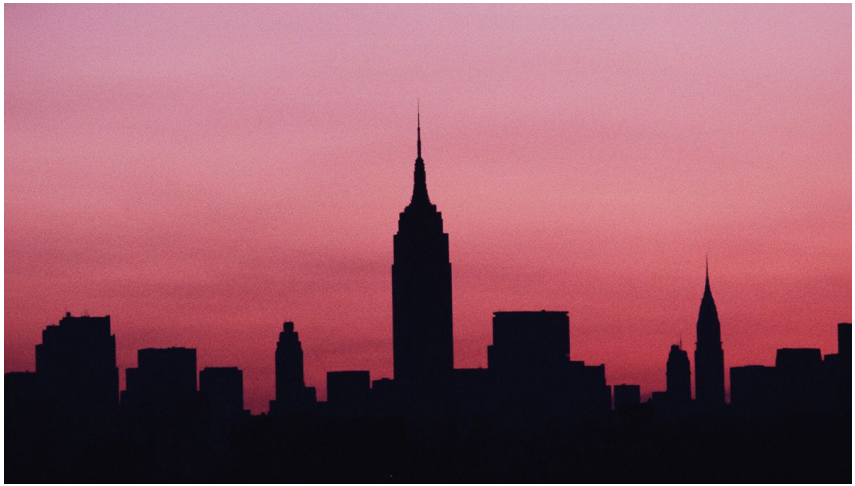


Figure: NYC Blackout of 1977 (Allan Tannenbaum/Getty Images)

Misusing Functionality

Create Discomfort

- Heat in summer, AC in winter
- Flash bedroom lights at night
- Turn on AC in bathroom in the morning

Generally be Annoying

- Turn on lights
- Open Faucets
- Run Washing Machine

Misusing Functionality

Create Discomfort

- Heat in summer, AC in winter
- Flash bedroom lights at night
- Turn on AC in bathroom in the morning

Generally be Annoying

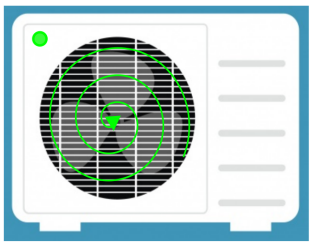
- Turn on lights
- Open Faucets
- Run Washing Machine

. . . when the owners leave for vacation.

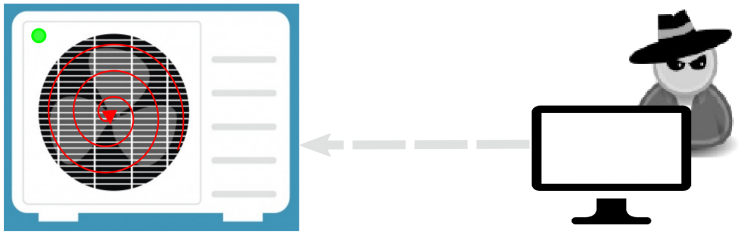
Extending Functionality [RS16]

Possible Extending Functionality Attacks

- Open front door with smart household robots
- Start a fire with an AC

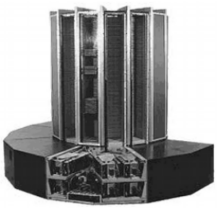


Extending Functionality [RS16]

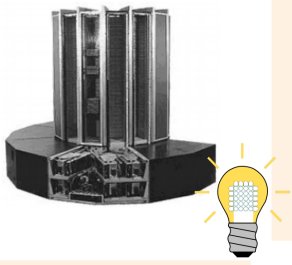


Extending Functionality [RS16]

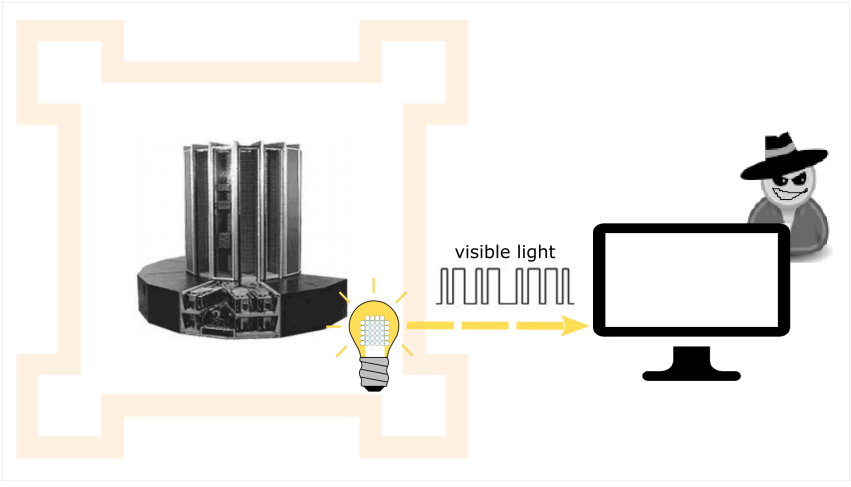
Extending Functionality — The Case of Smart Lights



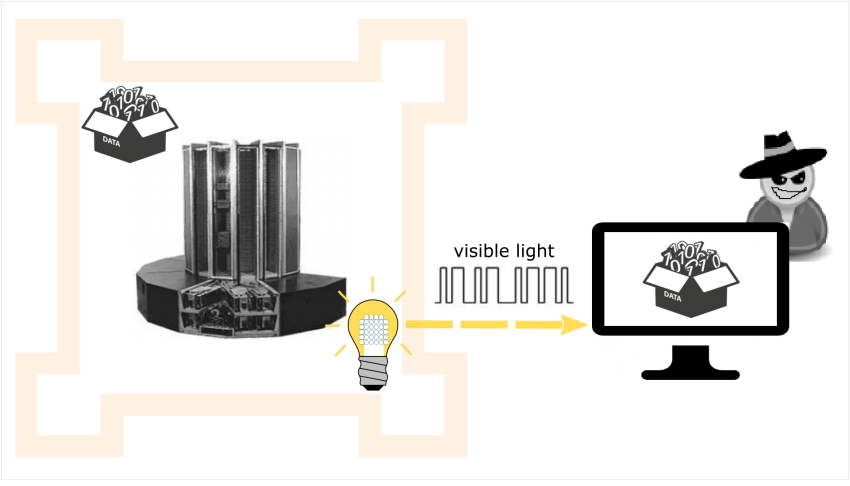
Extending Functionality — The Case of Smart Lights



Extending Functionality — The Case of Smart Lights



Extending Functionality — The Case of Smart Lights



E. Ronen and A. Shamir Paper

Extended Functionality Attacks on IoT Devices: The Case of Smart Lights

Julia Wanker, Bennett Piater

Requirements for Covert Channel

Correctness

Switch between 2 brightnesses that can be robustly distinguished by a sensor.

Covertness

Use brightnesses so similar or switch so fast that a human cannot distinguish them.

How (smart) LEDs Work

RF Receiver (and transmitter)

- For communication with controller
- Communicate with ZigBee Light Link (ZLL) [RSWO18]

How (smart) LEDs Work

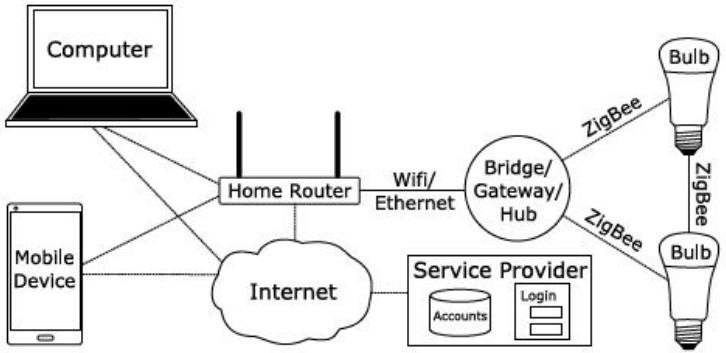


Figure: System architecture of a ZLL-based connected lighting system with two bulbs [1]

[1] Morgner et al. All Your Bulbs Are Belong to Us: Investigating the Current State of Security in Connected Lighting Systems

How (smart) LEDs Work

Processing Unit

- For processing commands received from controller
- LEDs are controlled using pulse width modulation (PWM) signals [YBZ14, EMHP07]

Drivers and LEDs

- Driver controls LED on and off states
- Determine brightness level of bulb

How (smart) LEDs Work

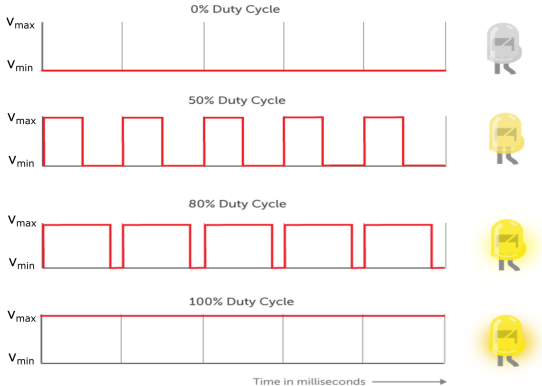
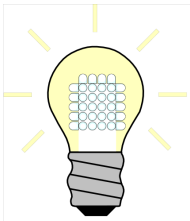


Figure: Brightness control on LEDs [1]

[1] PubNub - Building the Raspberry Pi Smart House: Controlling Lights with PWM

Encoding: Access Controller



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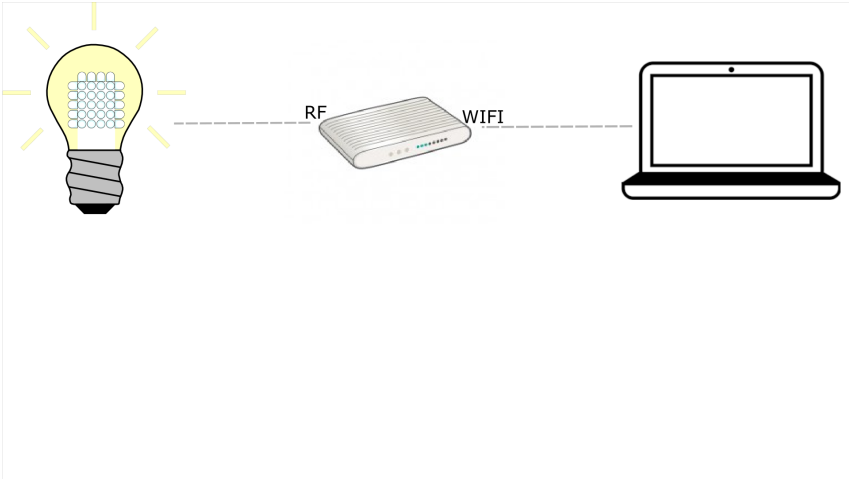

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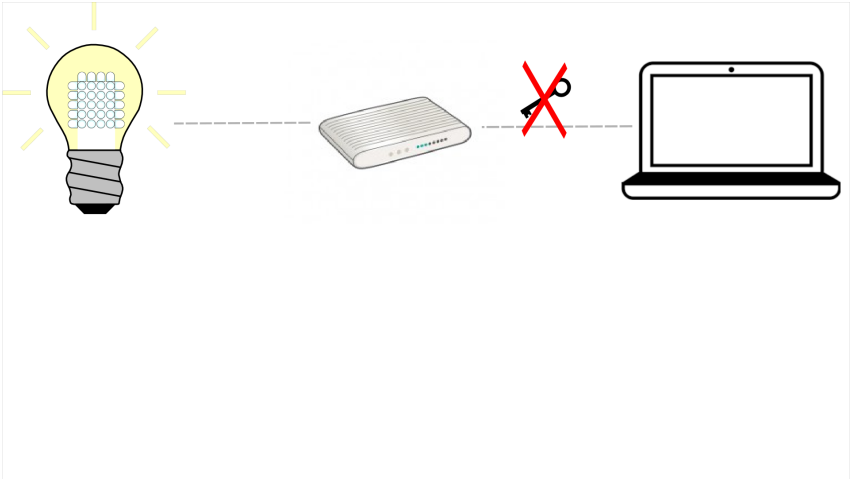

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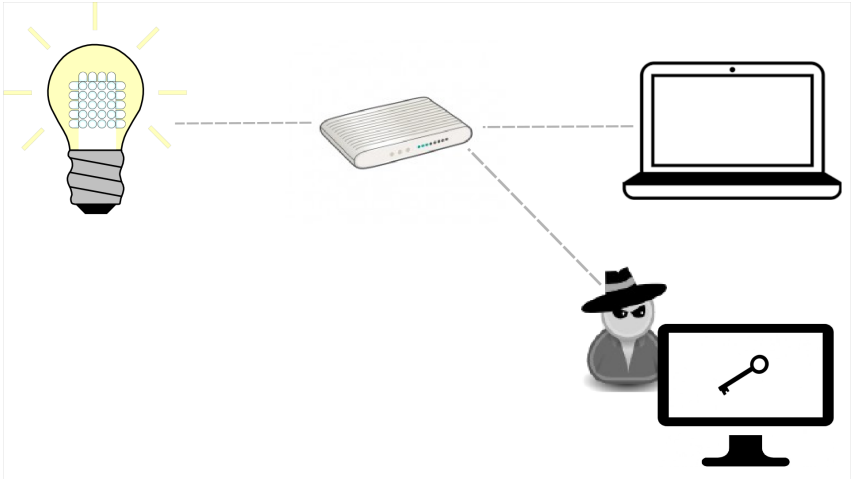

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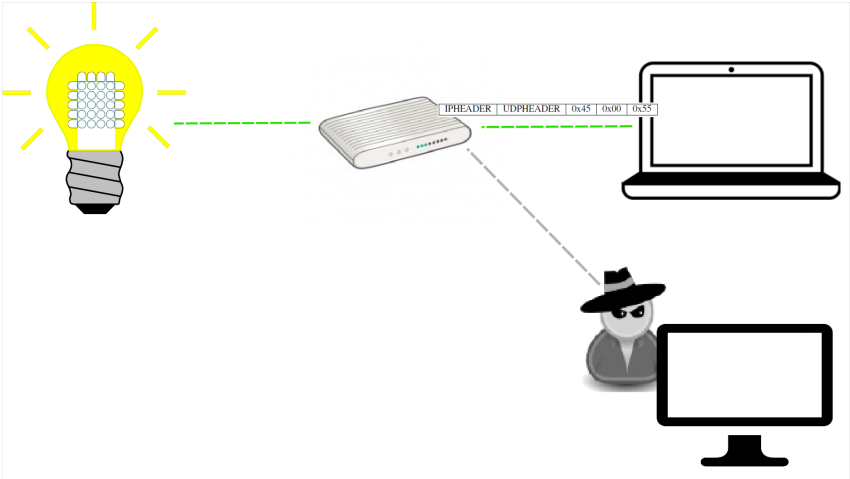

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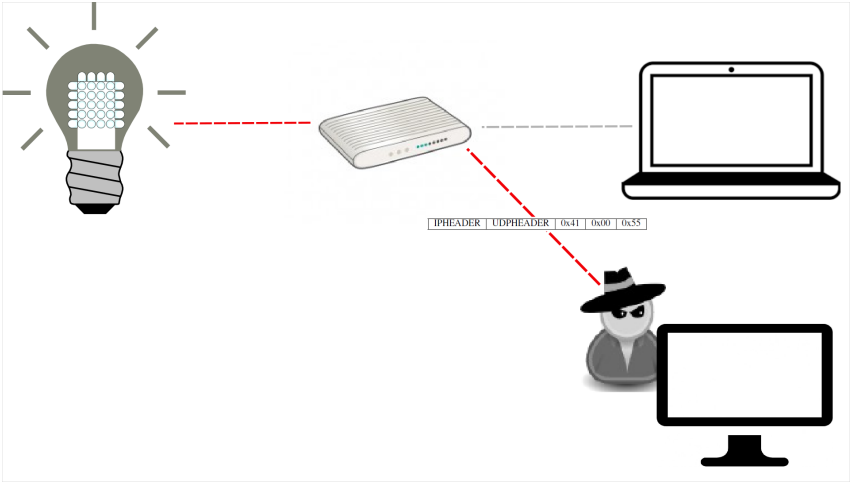


Encoding: Crafting of PWM Signals

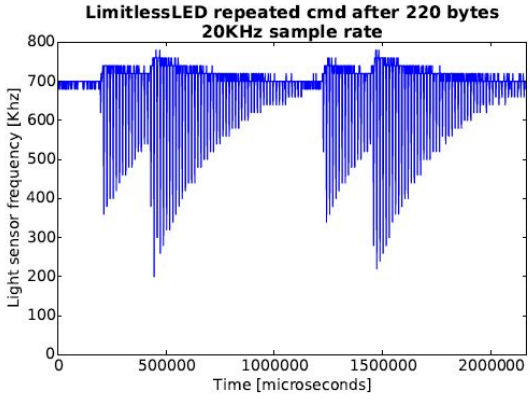
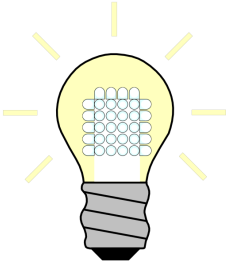


Figure: Smooth control of PWM duty cycle [2]

[2] Ronen and Shamir. Extended Functionality Attacks on IoT Devices: The Case of Smart Lights

Decoding: Light Sensor Signal Analysis



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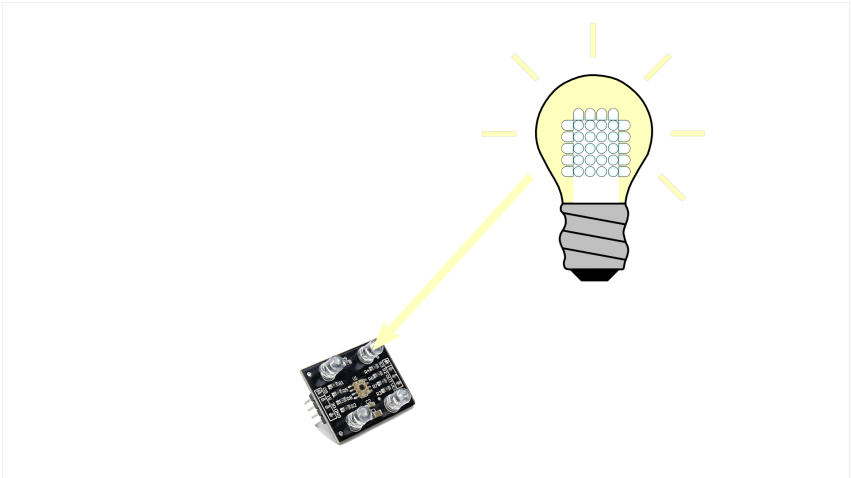

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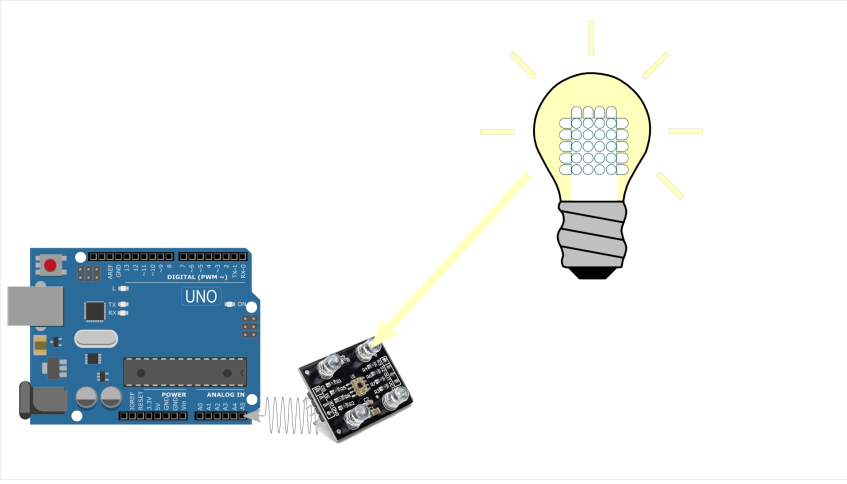

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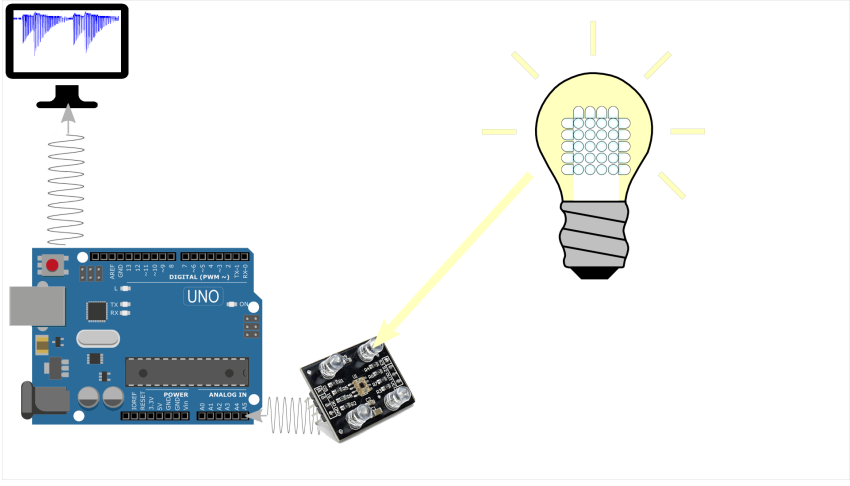

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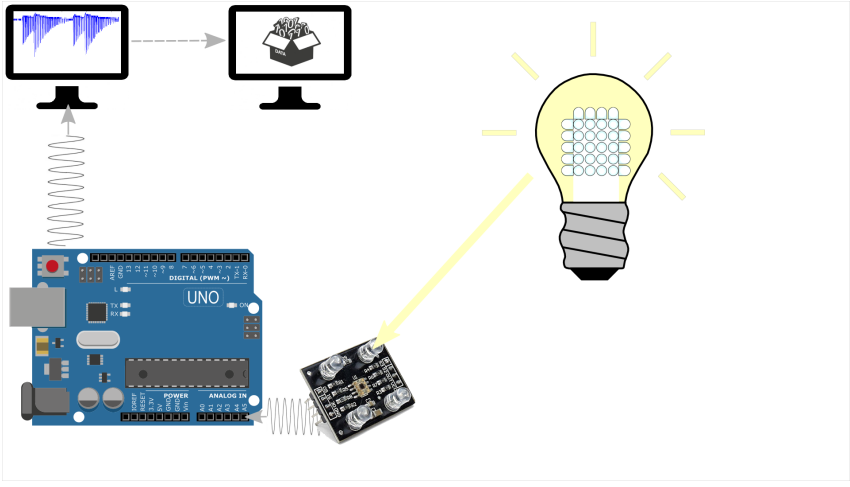

Why this Paper is Important for our Topic

The One and Only

- Cluster IoT attacks in presented fashion
- Functionality extension attack
- Covert Channel on IoT light bulb

Open Questions regarding our Project

LimitlessLED

- Faults in API
  - BUT have new API version now

Philips Lux

- Faults in flickering frequence
  - BUT have new verion of light bulb now

Questions?

Julia Wanker, Bennett Piater

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