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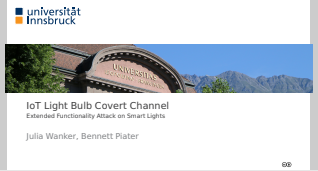
IoT Light Bulb Covert Channel

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

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1m

Briefly introduce the taxonomy to give viewers an overview.

Ignoring Functionality [Ang17, AAB+17, DDGS17]

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Analysis of Mirai by [Antonakakis] showed massive vulnerabilities, weak default passwords etc. as the cause.

Many IoT devices will cause more problems, esp. DDoS (see 1.2TB/s DynDNS) [Donno]

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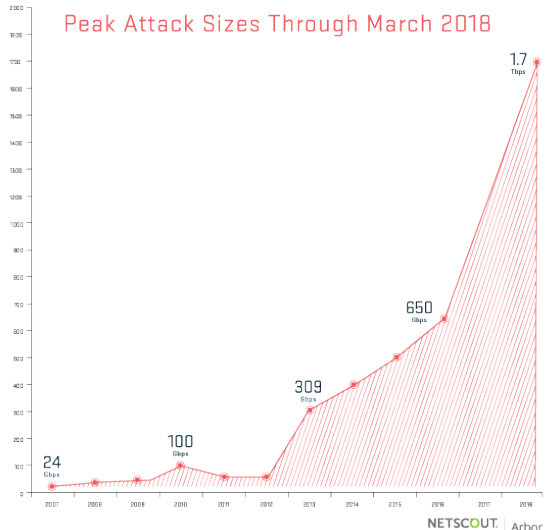

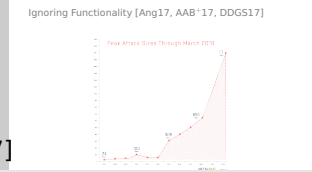

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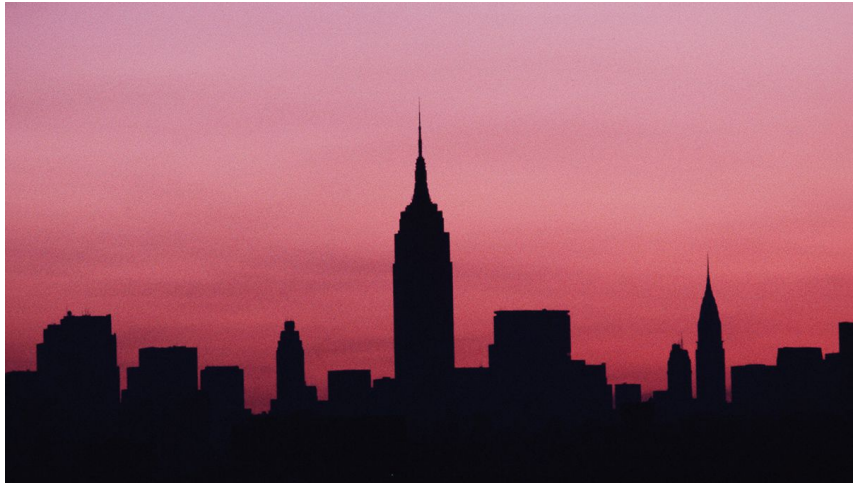


Figure: NYC Blackout of 1977 (Allan Tannenbaum/Getty Images)

Reducing Functionality [Dha13, RSWO18, Bha17]

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

1m

Disabling things can be very dangerous when more and more of them become connected.

e.g. blackout entire city with ZLL drive-by attack. (image was lightning strike)

Fridge murder story.

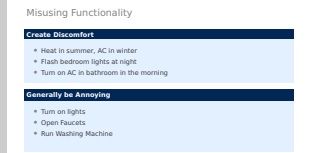
Misusing Functionality

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



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This is probably more annoying than dangerous.

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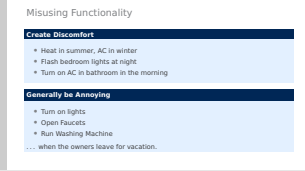
. . . when the owners leave for vacation.



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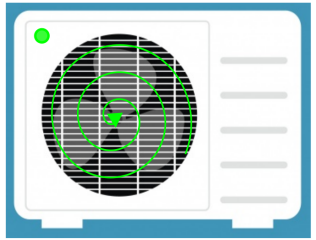
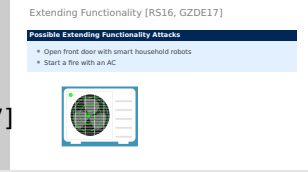
Extending Functionality [RS16, GZDE17]

Possible Extending Functionality Attacks

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





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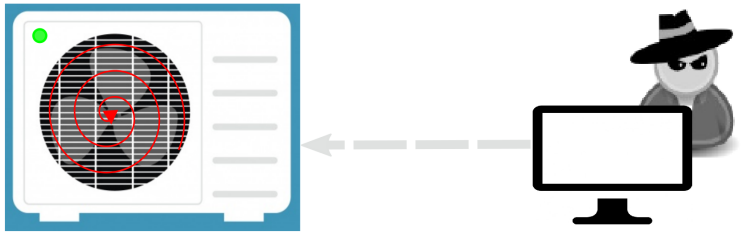
- Most interesting
- Almost no reseach (Ronen, Guri (Router LEDs))

Extending Functionality [RS16, GZDE17]



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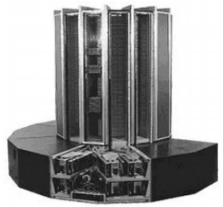
Extending Functionality — The Case of Smart Lights



Extending Functionality — The Case of Smart Lights

30s

Interesting because light is often the only part of the EM-spectrum that is allowed to leave air-gapped systems.

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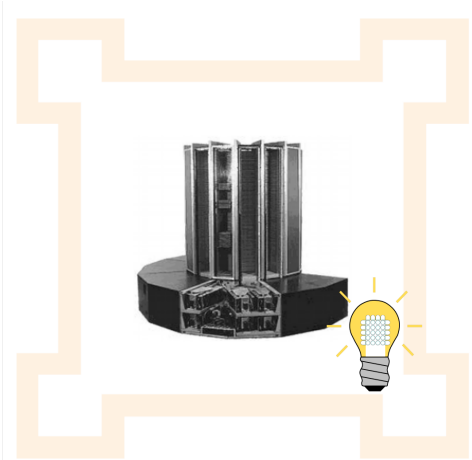

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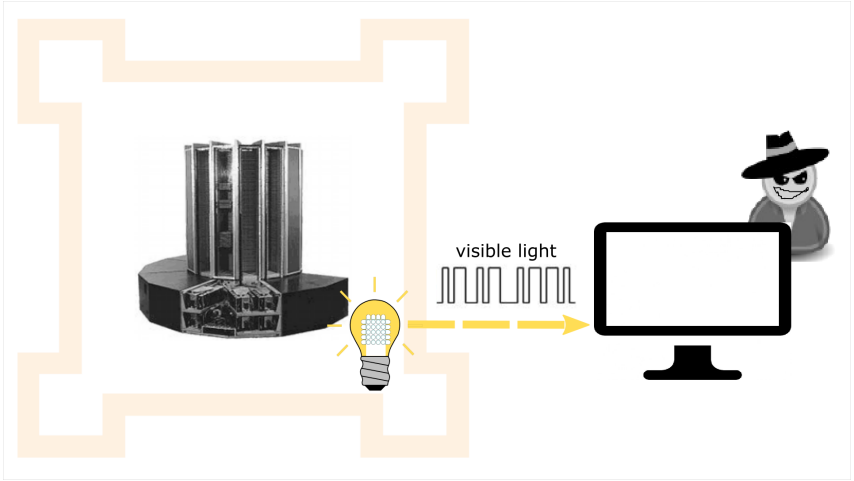

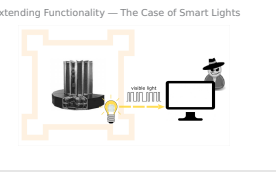

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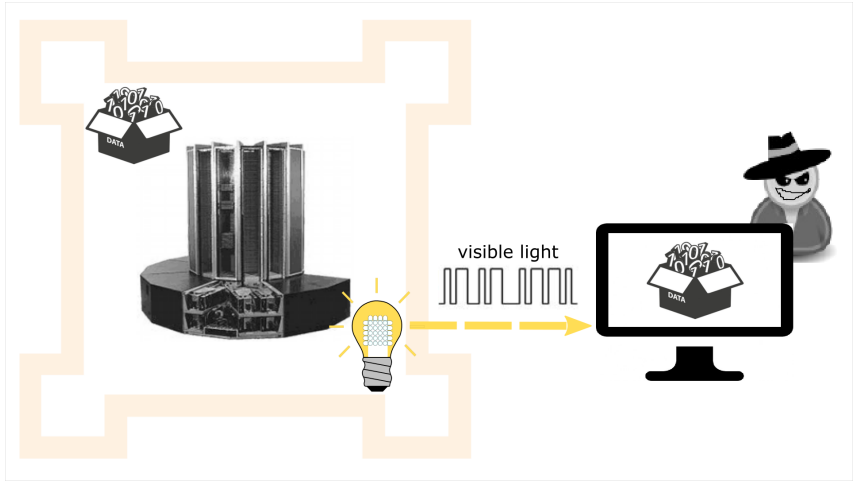

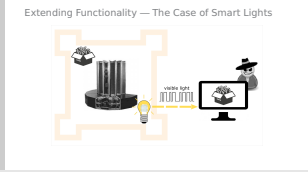

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E. Ronen and A. Shamir Paper

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

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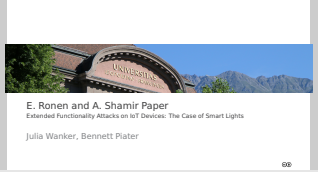


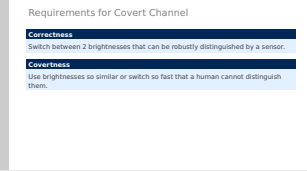
Requirements for Covert Channel

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

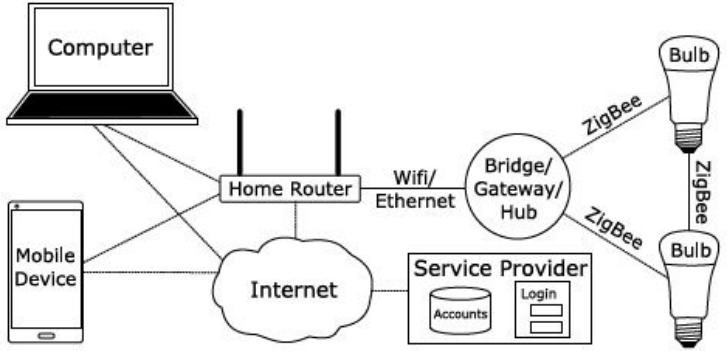


Figure: System architecture of a ZLL-based connected lighting system with two bulbs [1]

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

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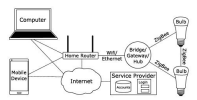

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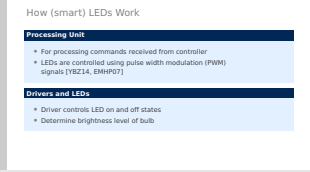
How (smart) LEDs Work

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



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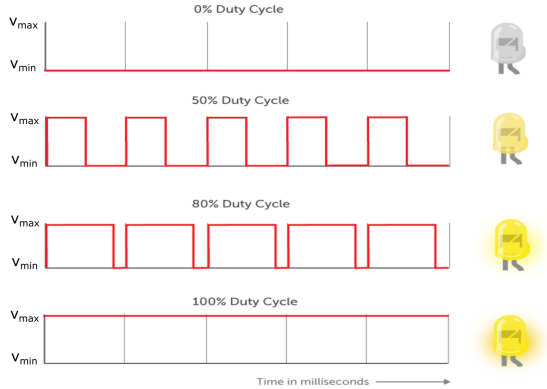
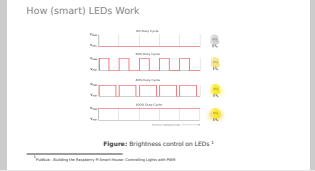
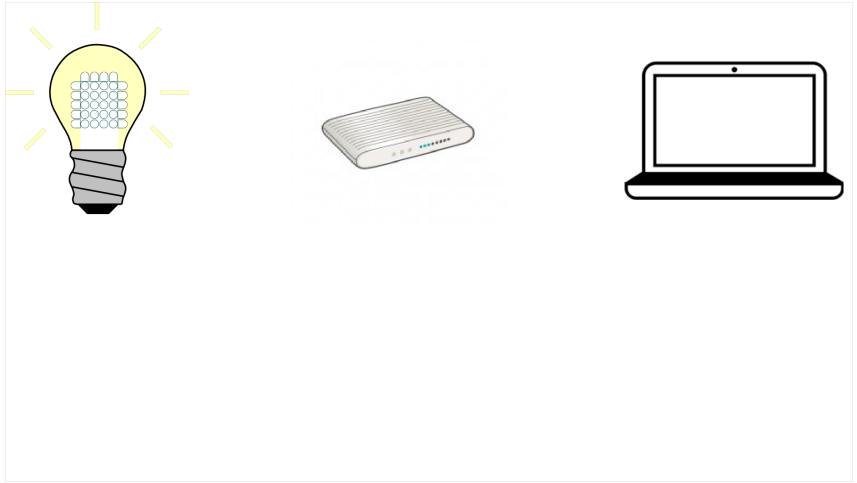


Figure: Brightness control on LEDs [1]

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



Encoding: Access Controller



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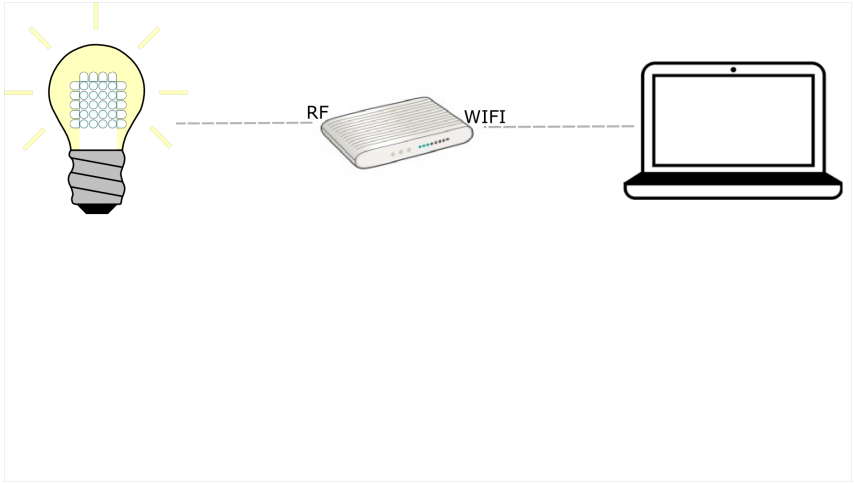

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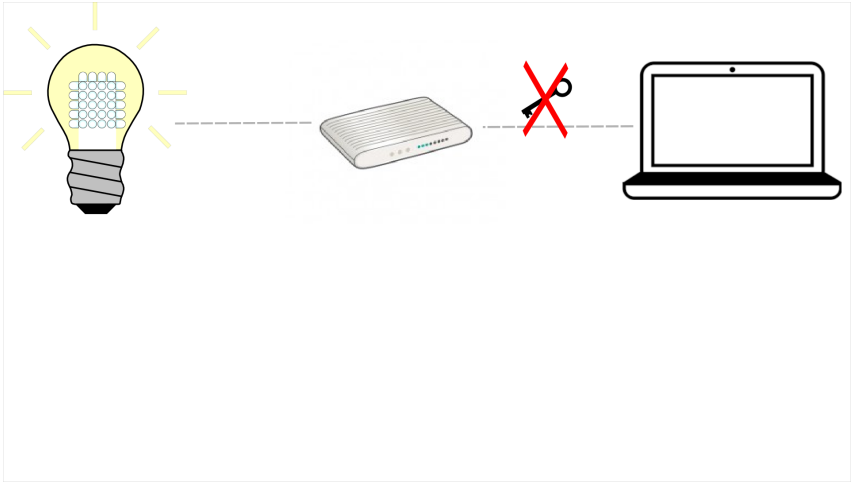

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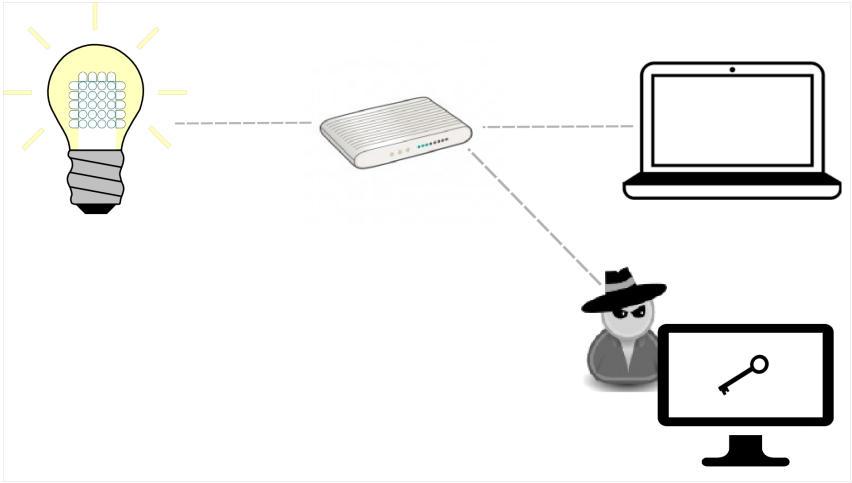

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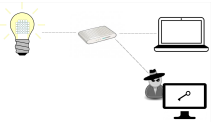

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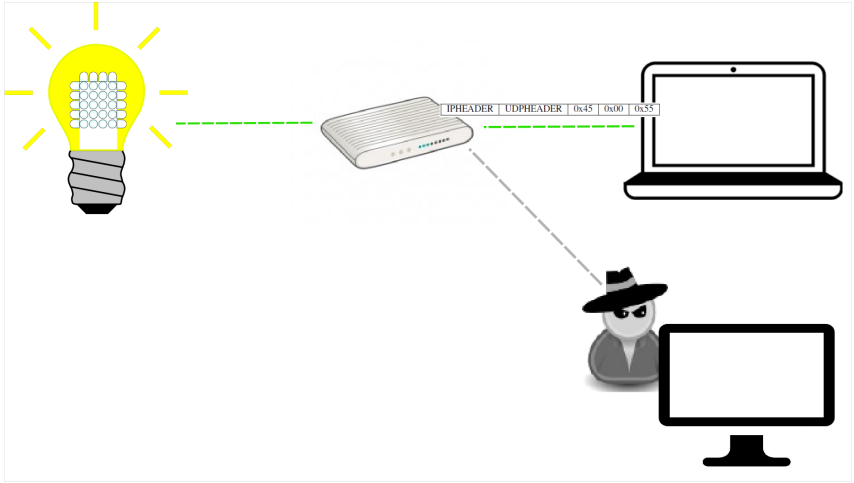

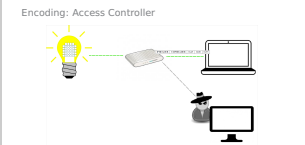

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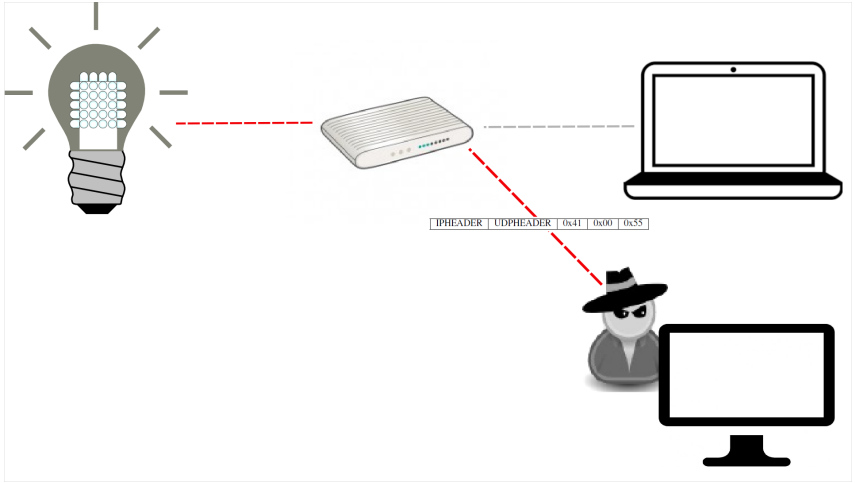
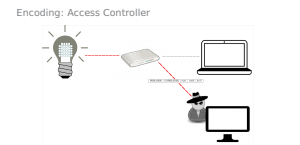




Encoding: Crafting of PWM Signals

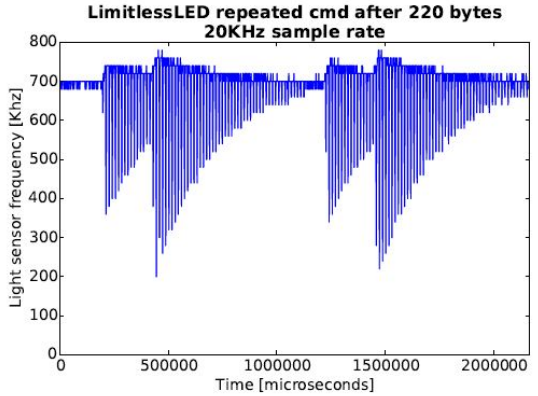
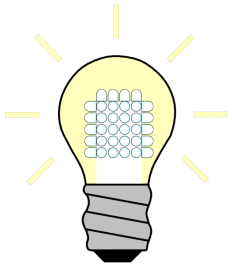


Figure: Smooth control of PWM duty cycle [2]

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

Encoding: Crafting of PWM Signals

Decoding: Light Sensor Signal Analysis



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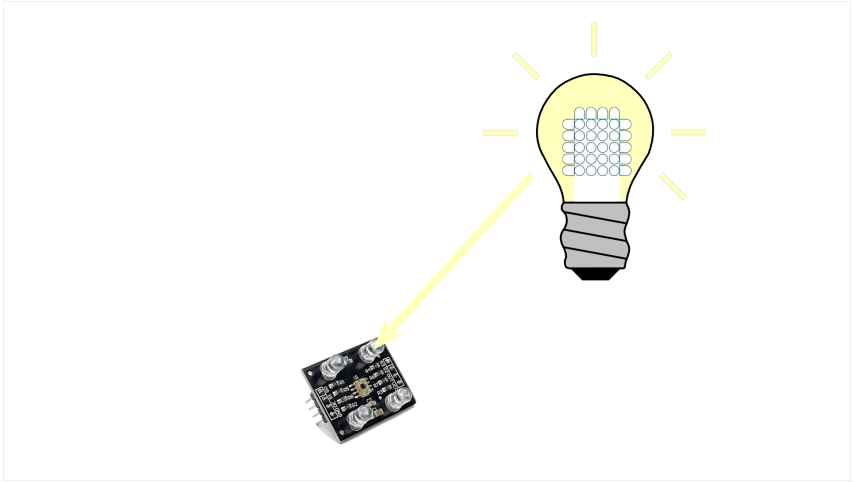

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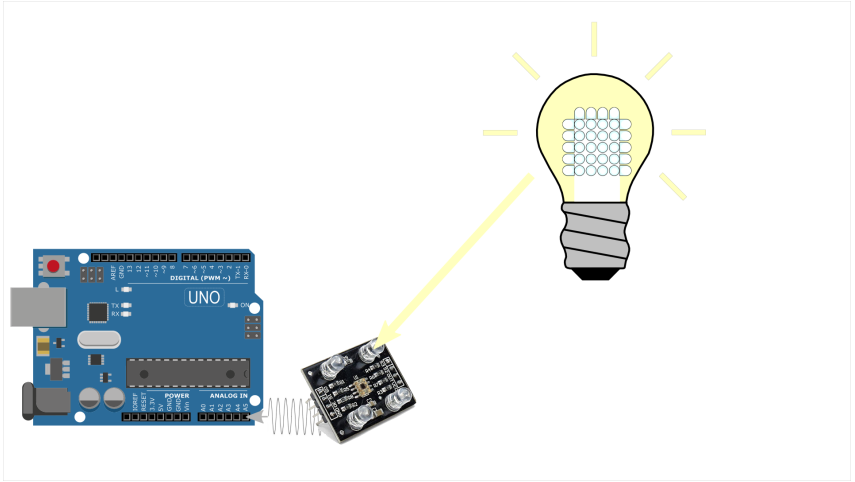

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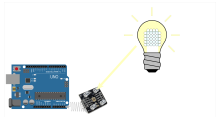

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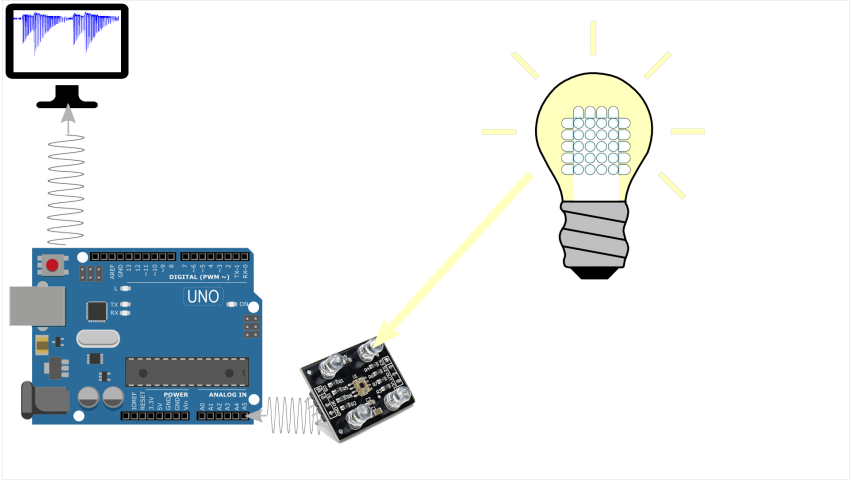
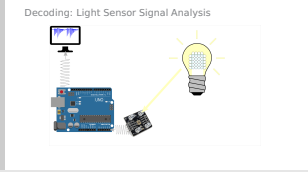
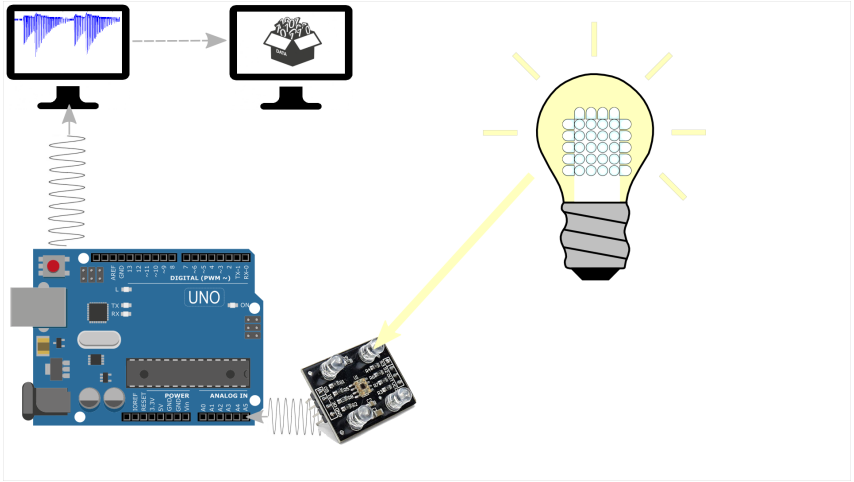
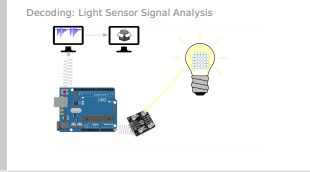




Decoding: Light Sensor Signal Analysis





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

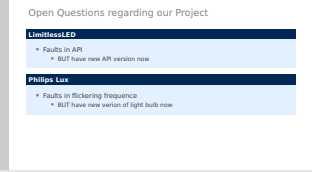
Open Questions regarding our Project

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?

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Bibliography I

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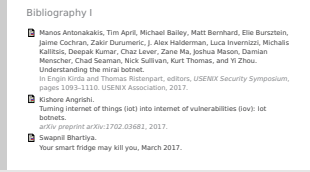
Your smart fridge may kill you, March 2017.



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