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IoT Light Bulb Covert Channel

Extended Functionality Attack on Smart Lights

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Topic Relevance

New Attack Vectors on IoT Devices

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IoT Security in General

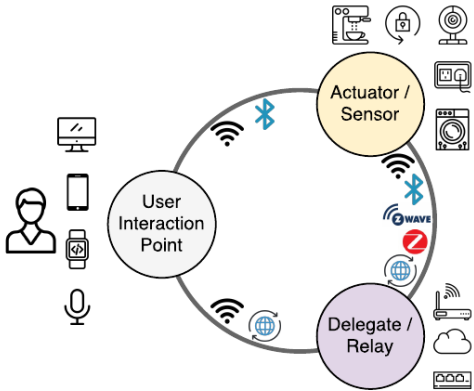


Figure: Infrastructure of IoT ecosystem [1]

[1] Zhan et. al. Understanding IoT Security Through the Data Crystal Ball: Where We Are Now and Where We Are Going to Be

IoT Security in General

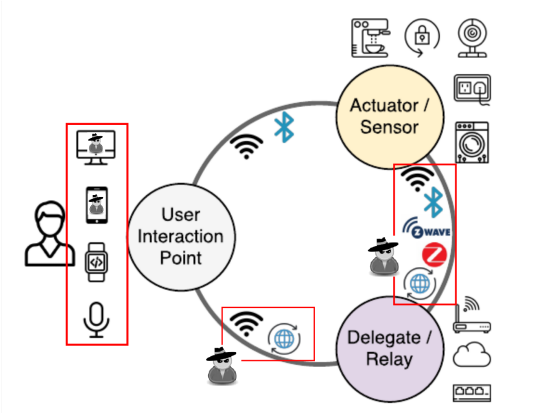


Figure: Attack Vectors in IoT ecosystem[2]

[2] Zhan et. al. Understanding IoT Security Through the Data Crystal Ball: Where We Are Now and Where We Are Going to Be / *edited*

Smart Light Security

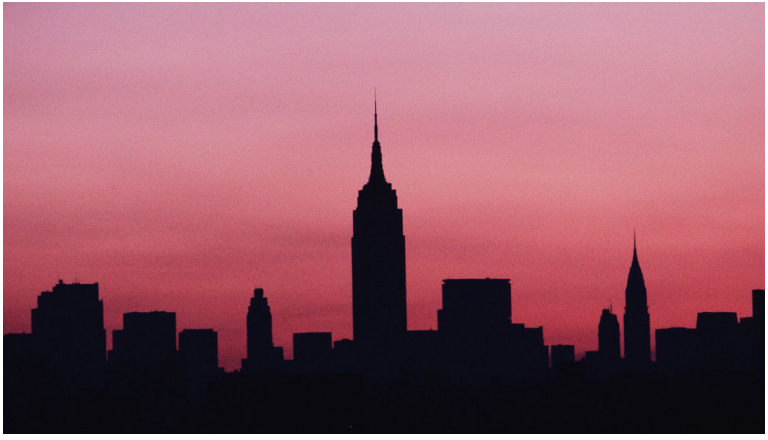
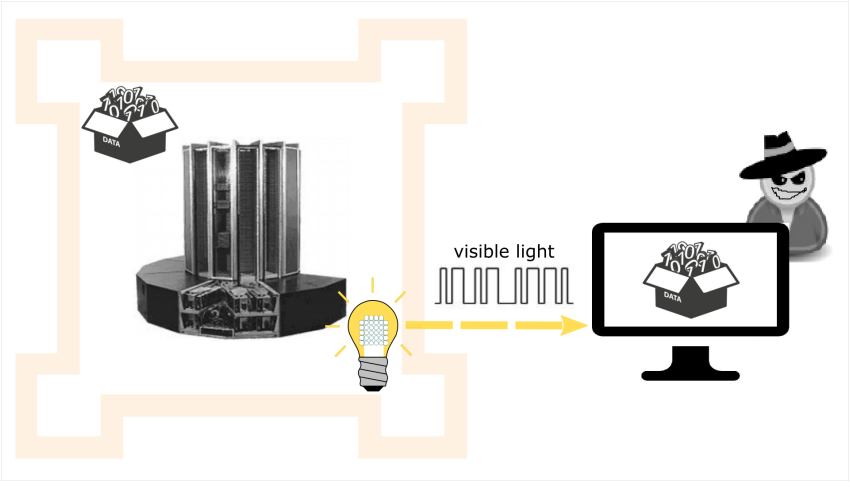


Figure: NYC Blackout of 1977[3]

[3] Allan Tannenbaum/Getty Images

Extending Functionality



Theoretical Background

Extended Functionality Attack on Smart Lights

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Communication With Lights

General Light Communication

- Change PWM signal
- **Off** period represents logical **0**
- **On** period represents logical **1**

Smart Light Communication

- Send close brightness change commands, distinguish using PWM
- **Lower level** represents logical **0**
- **Higher level** represents logical **1**

(Covert) Communication With Lights

Covertness

- Flicker at a rate above 60 Hz or use close brightness commands
- Detectable by sensor but not seen by human eye

Smart Light Systems

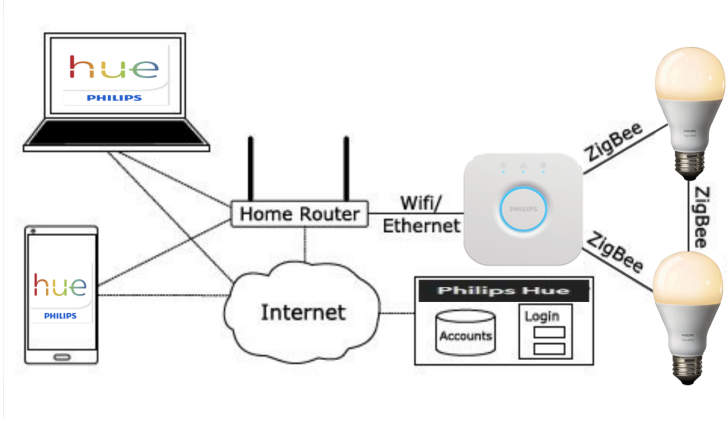

Figure: System architecture of a Philips Hue connected lighting system with two bulbs[4]

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

Experiment

Covert Communication Channel on Philips Hue White

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Controlling the Light

We use the Hue API for simplicity.

- Bridge controls light via ZLL
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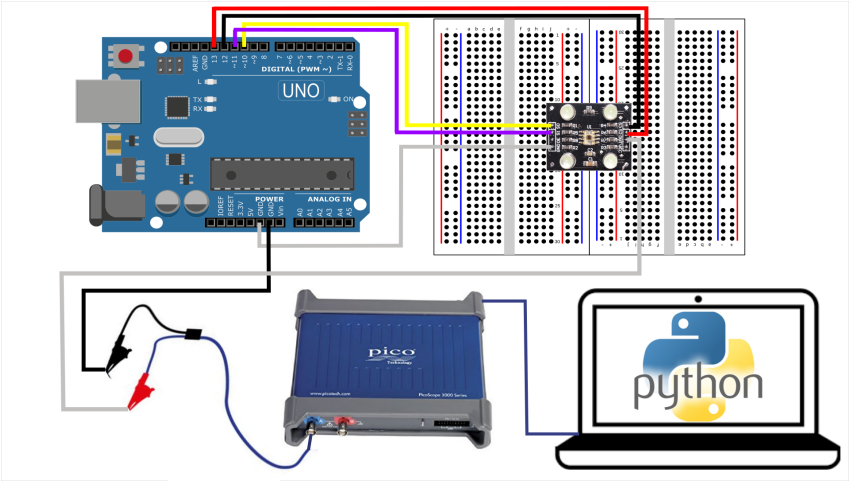
Limitations

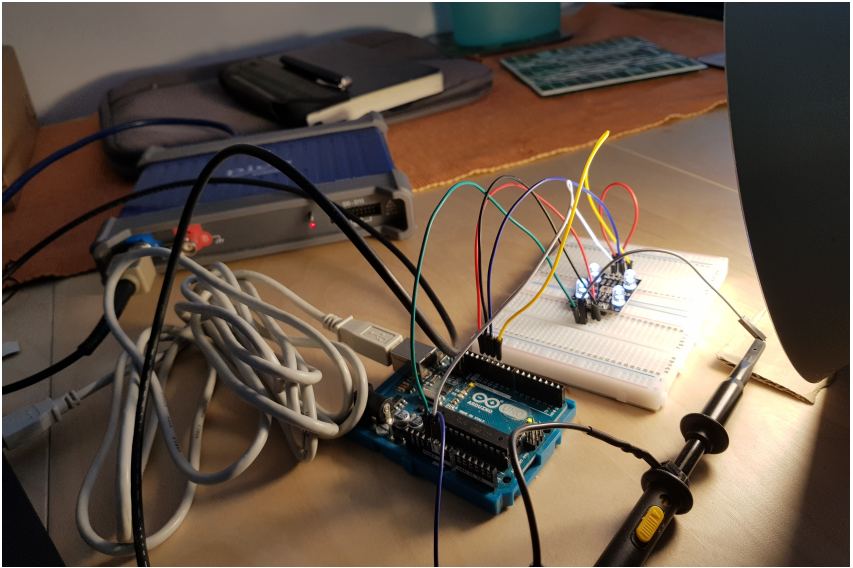
- Rate limit due to throttling by bridge?
- Automatic fading by the bridge or light (no phase shifts!)

May be worked around some by speaking ZLL directly?

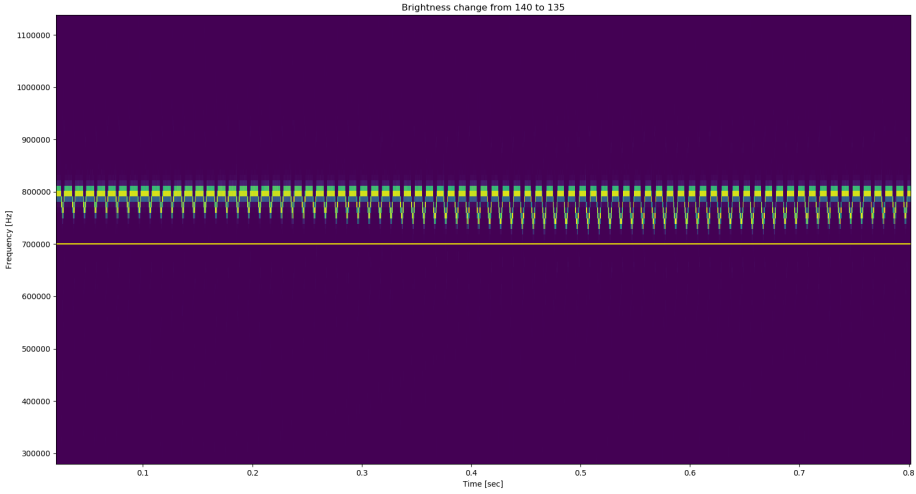
Overview



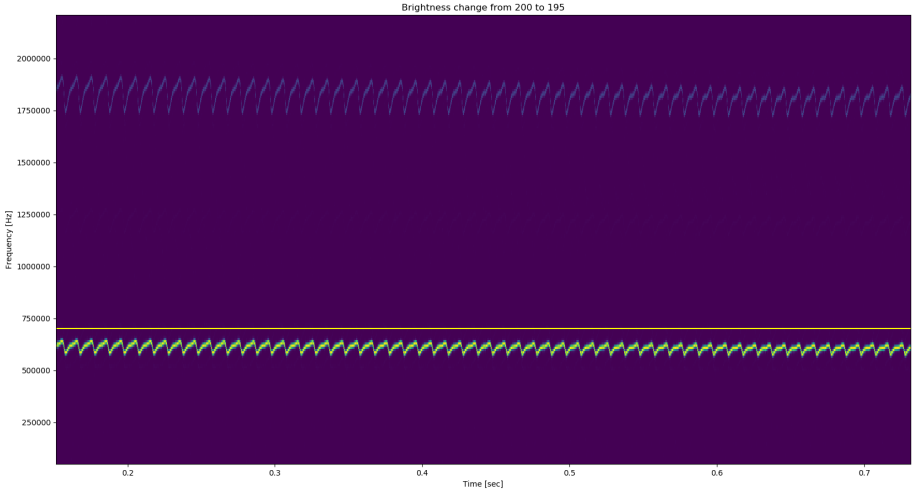
Experimental Setup



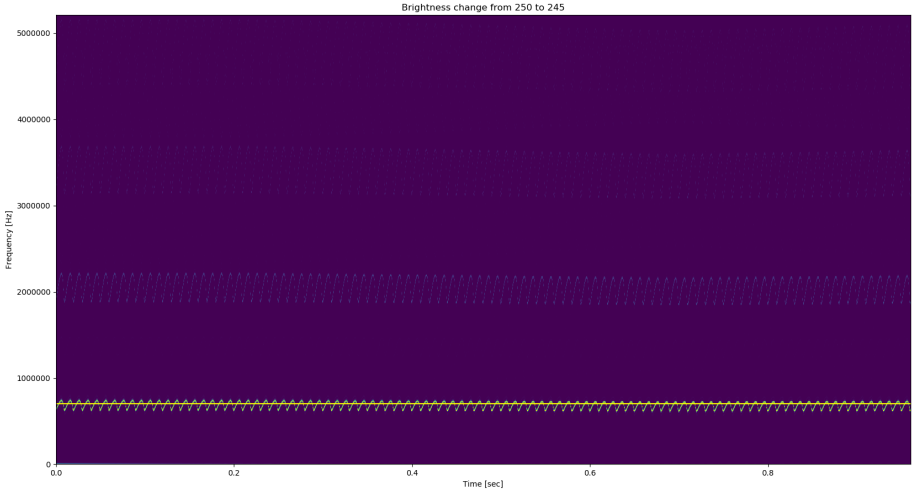
Some Results I



Some Results II



Some Results III



Demonstration

Covert Communication Channel on Philips Hue White

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Conclusion

Summary and Outlook

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Conclusion

Successes

- We can distinguish brightness differences invisible to the human eye
- We *think that we can* see the PWM, not just brightness

$\rightarrow$ Research from Ronen and Shamir [2016] reproduced in principle.

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Failures

Automating this is hard:

- Very high variance in our measurements
- Much trial and error to obtain a good picture
- Limited range and robustness to lighting conditions

Outlook

An automated covert channel could in principle be built using this technique.

Important Lessons

- Connected LEDs should not be trusted in secure areas
- Smart lights should not have this many brightness levels. Fading and throttling improve their security a little though.
- . . . combine this demo with the insecurity of IoT devices for maximum effect.
- Alternatively, if you must use smart lights, isolate and secure them as much as possible.

Questions?

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Bibliography I

E. Ronen and A. Shamir. Extended functionality attacks on iot devices: The case of smart lights. In *EuroS&P*, pages 3–12. IEEE, 2016. ISBN 978-1-5090-1752-2. URL http://dblp.uni-trier.de/db/conf/eurosp/eurosp2016.html#RonenS16;http://dx.doi.org/10.1109/EuroSP.2016.13;http://www.bibsonomy.org/bibtex/21ec9f74336617b4511304c4b35818c79/dblp.