Computer Security and the Internet of Things

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Computer Science & Engineering
University of Washington

At USENIX Enigma, January 2016

The Internet of Things

Toys

Door Locks

Cars

Light Switches

Thermostats

Baby Monitors

Refrigerators

Furnaces

Fitness Tracker

IoT: Any consumer device with computation and connectivity

Many Benefits

Toys

Cars

Door

ht Switches

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Baby Monitors

Refrigerators

Fitness Tracker



IoT: A consumer device with computation and connectivity

Many Benefits, But Also Risks

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Cars

Door

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IoT: A consumer device with computation and connectivity

Many Benefits, But Also Risks

Toys

Cars

Refrigera





This Talk: Security and Privacy Risks with IoT

IoT: consumer device with computation and connectivity

IoT Security and Privacy Risks: A Broad Set of Issues

- Safety
- Privacy

IoT Security and Privacy Risks: A Broad Set of Issues

- Safety
- Privacy
- Inferred information
- Financial risks
- Stepping stones
- Zombies
- Uncertain future

IoT Security and Privacy Risks: A Broad Set of Issues

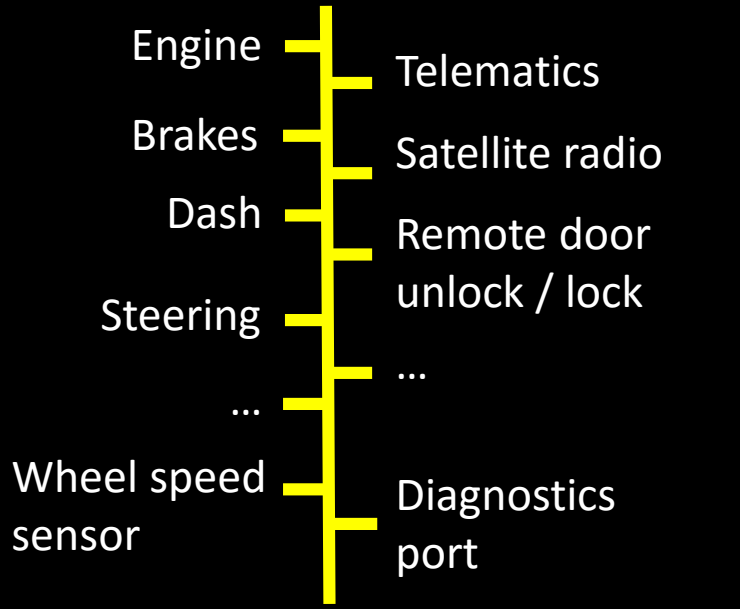
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- Uncertain future

This Talk: Examples

Goal: Encourage broad thinking about security and privacy risks (and possible defenses)

Thank You: UW students, UW faculty, other students, other faculty, NSF, Google, Intel, Microsoft

Example 1: Modern Cars

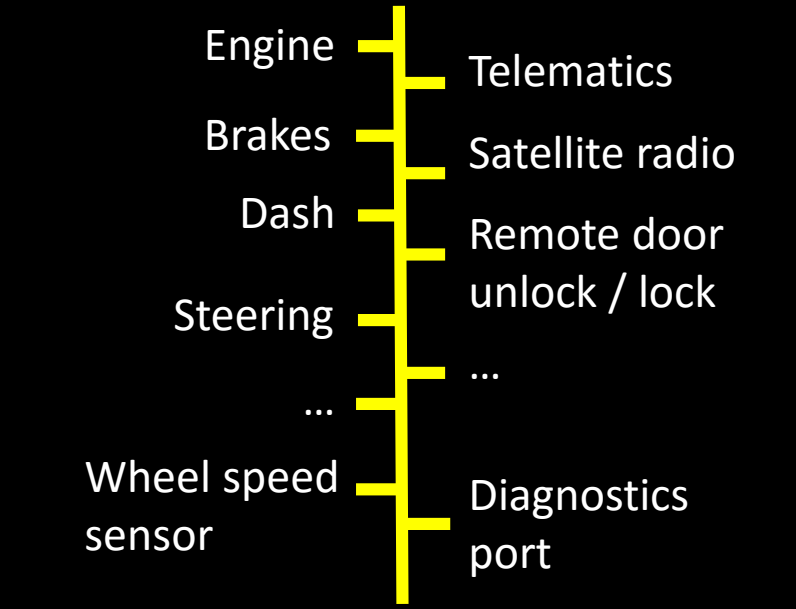


Example automotive computer network



K. Koscher, et al. “Experimental Security Analysis of a Modern Automobile.” IEEE S&P, 2010. S. Checkoway, et al. “Comprehensive Experimental Analyses of Automotive Attack Surfaces.” Usenix Security, 2011. (University of Washington, University of California San Diego.)

What About Security?



Example automotive computer network



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Approach

Bought two, 2009-edition modern sedans

- UW team bought one, kept in Seattle
- UC San Diego team bought one, kept in San Diego

Work published in 2010 and 2011

(Recently, new works published by others)

K. Koscher, et al. “Experimental Security Analysis of a Modern Automobile.” IEEE S&P, 2010. S. Checkoway, et al. “Comprehensive Experimental Analyses of Automotive Attack Surfaces.” Usenix Security, 2011. (University of Washington, University of California San Diego.)

Multiple Entry Points



Engi

Brak

Telematics

Satellite radio

555-555-5555

Telephone Network

Dash

Remote door unlock / lock

Steering

…

…

Wheel speed sensor

Diagnostics port



Internet

Telematics Service Provider

Example automotive computer network



Attacker

Attacker's Internet Servers

Road Test: Apply Brakes



K. Koscher, et al. “Experimental Security Analysis of a Modern Automobile.” IEEE S&P, 2010. S. Checkoway, et al. “Comprehensive Experimental Analyses of Automotive Attack Surfaces.” Usenix Security, 2011. (University of Washington, University of California San Diego.)

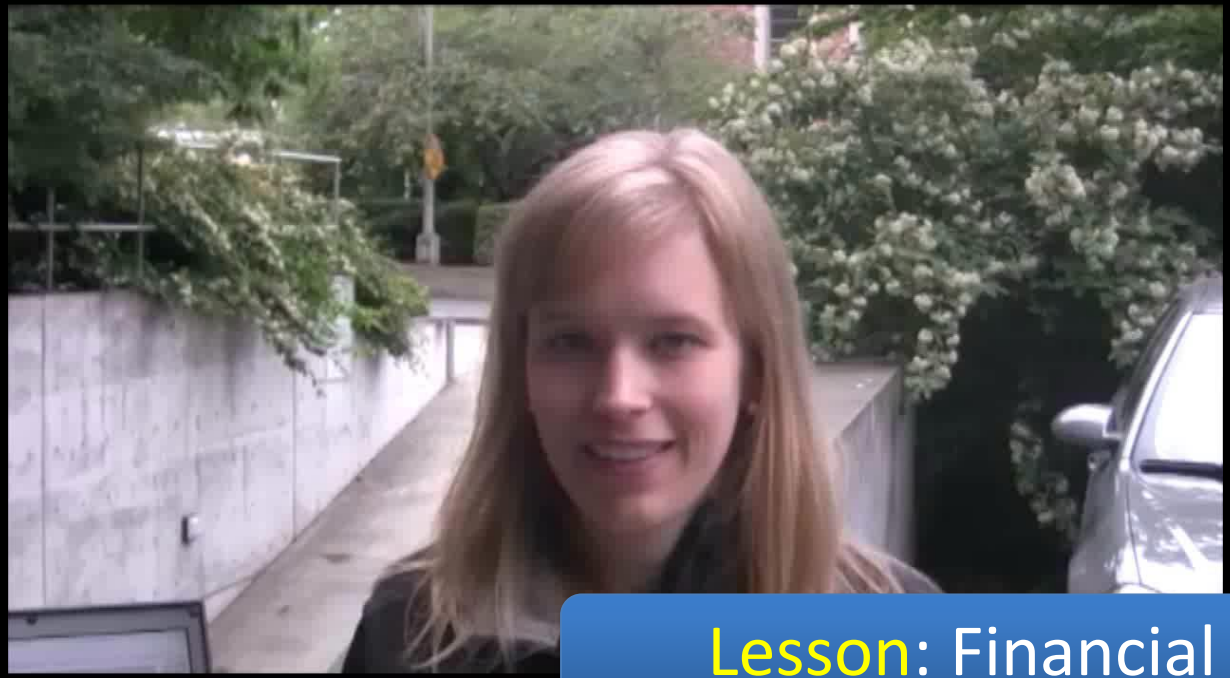
Road Test: Disengaging Brakes



Lesson: Safety Risks

K. Koscher, et al. “Experimental Security Analysis of a Modern Automobile.” IEEE S&P, 2010. S. Checkoway, et al. “Comprehensive Experimental Analyses of Automotive Attack Surfaces.” Usenix Security, 2011. (University of Washington, University of California San Diego.)

End-to-end Theft Example



Lesson: Financial Risks

Call car, exploit vulnerabilities to implant new software, car connects (over Internet) to UW server, then run theft program

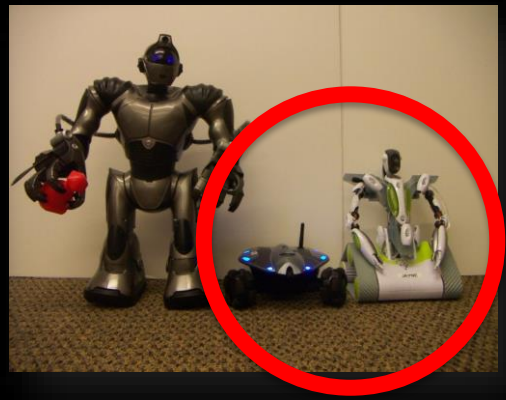
End-to-end Surveillance Example



Lesson: Privacy Risks

Call car, exploit vulnerabilities to implant new software, car connects (over Internet) to UW server, initiate surveillance

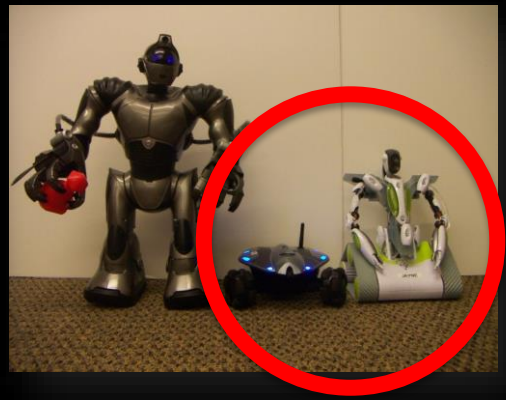
Example 2: Children's Toys





T. Denning, et al. "A Spotlight on Security and Privacy Risks with Future Household Robots: Attacks and Lessons." International Conference on Ubiquitous Computing, 2009. (University of Washington.)

Example 2: Children's Toys





WiFi + webcam children's toys are a thing

Unfortunately, webcams accessible to external adversaries

Lesson: Privacy Risks

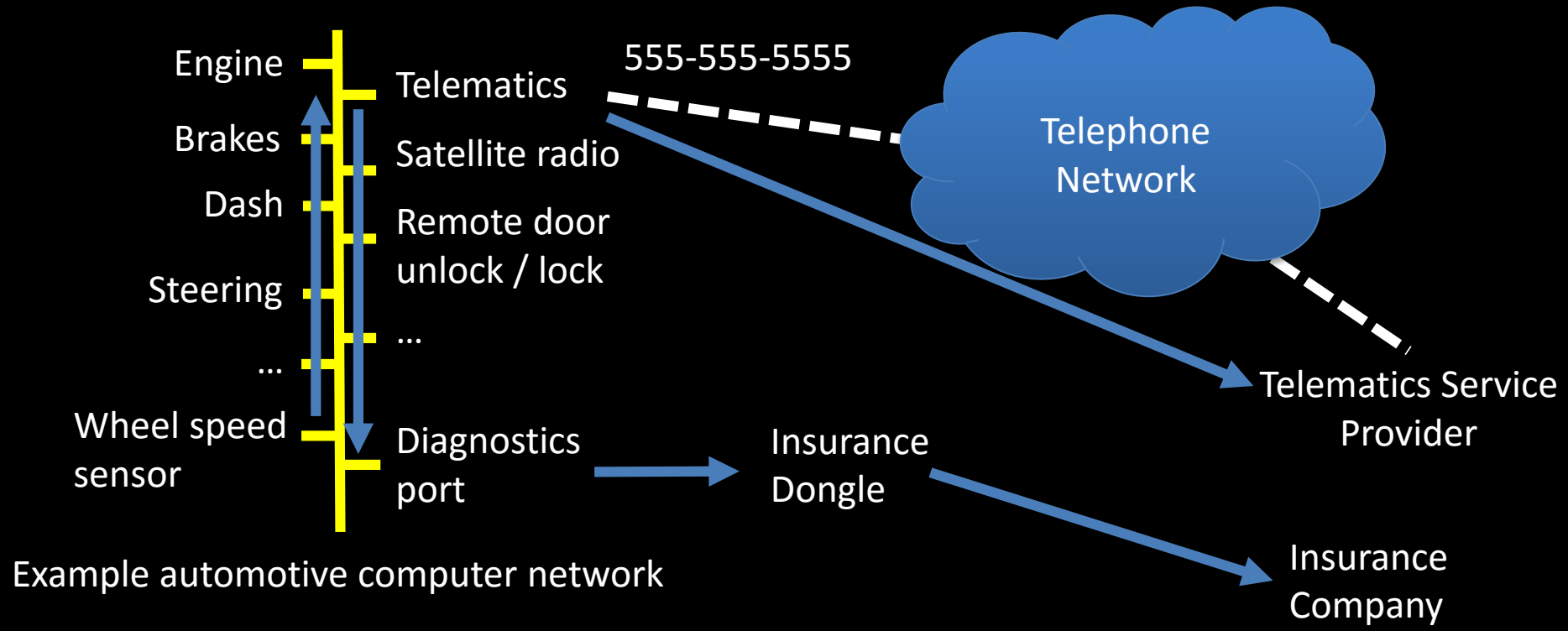
Lesson: Financial Risks

Lesson: Who Admins

Lesson: Who Affected

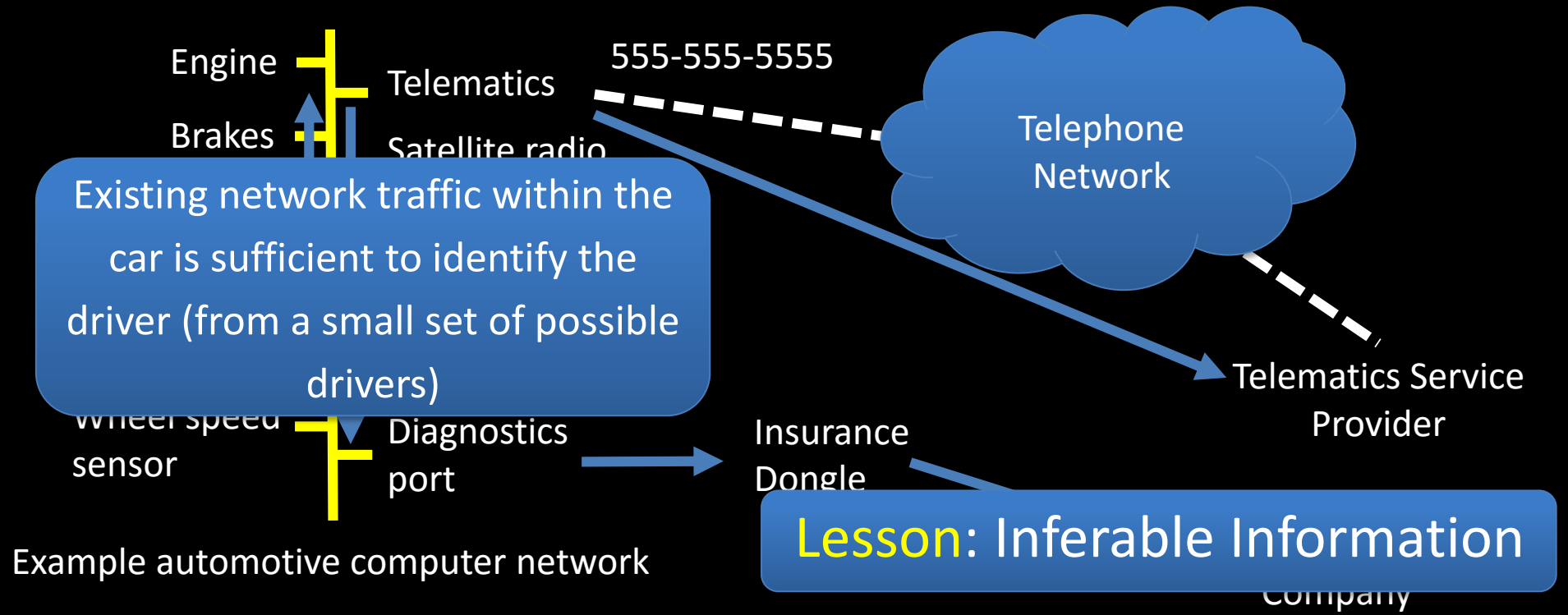
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Example 3: More On Cars



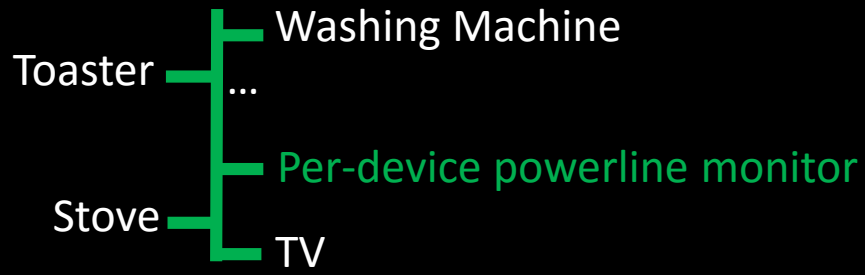
M. Enev, et al. “Automobile Driver Fingerprinting.” Privacy Enhancing Technology Symposium, 2016. (University of Washington.)

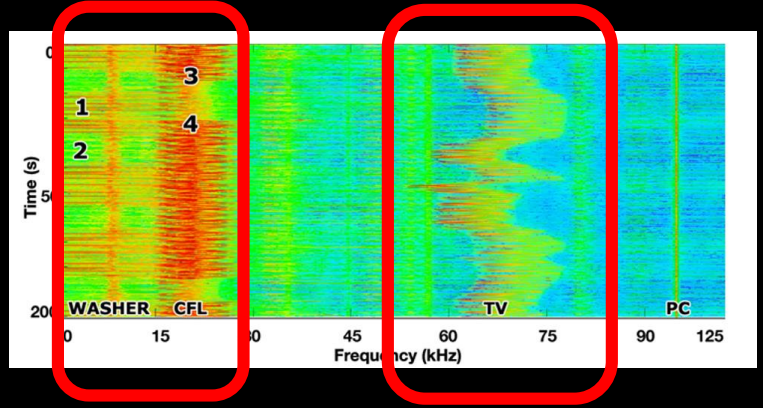
Example 3: More On Cars



M. Enev, et al. “Automobile Driver Fingerprinting.” Privacy Enhancing Technology Symposium, 2016. (University of Washington.)

Example 4: Powerline Monitoring





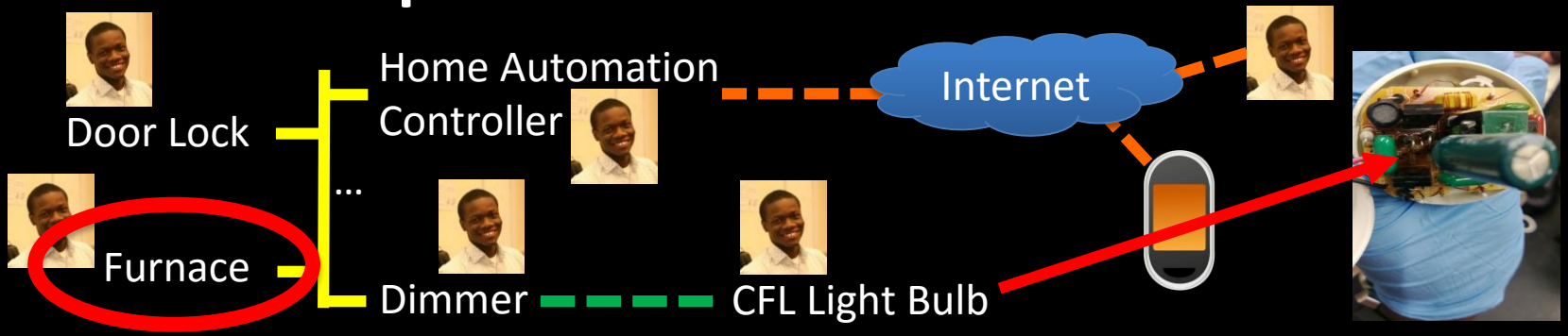
Powerline monitoring enables per-device energy consumption visibility

Our results: Infer TV show from from powerline measurements

Lesson: Inferable Information

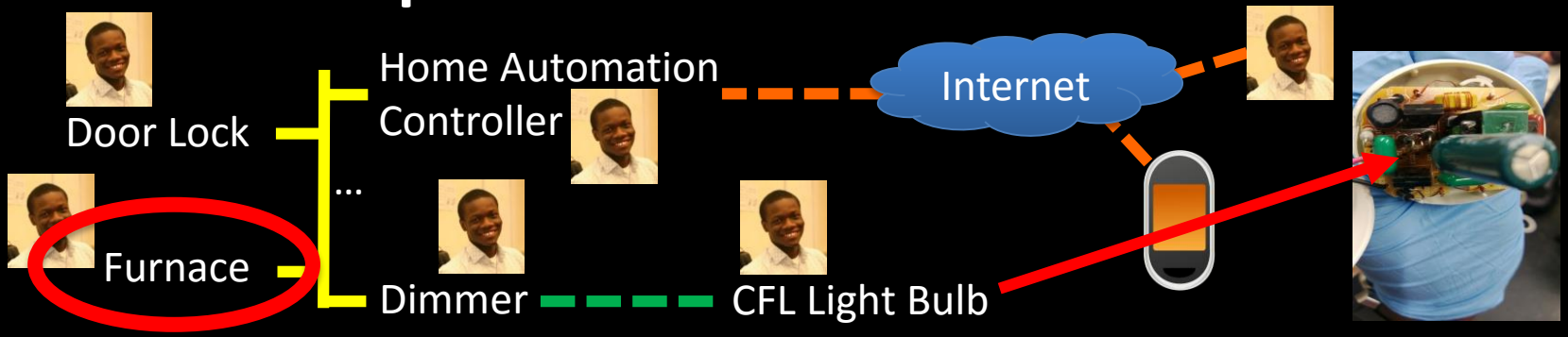
M. Enev, et al. “Televisions, Video Privacy, and Powerline Electromagnetic Interference.” ACM Conference on Computer and Communications Security, 2011. (University of Washington.)

Example 5: Home Automation



T. Oluwafemi, et al. “Experimental Security Analyses of Non-Networked Compact Fluorescent Lamps: A Case Study of Home Automation Security.” Learning from Authoritative Security Experiment Results (LASER), 2013. (University of Washington.)

Example 5: Home Automation



Well known: If can compromise home automation controller, can affect devices in home

But what about non-networked devices?

Lesson: Stepping Stones

Lesson: Non-IoT IoT Devices

Lesson: Zombies

Lesson: Uncertain Future

T. Oluwafemi, et al. "Experimental Security Analyses of Non-Networke
Security." Learning from Authoritative Security Experiment Results (LA

Thanks!

Automotive computer security (UW, UC San Diego)

- Karl Koscher, Alexei Czeskis, Franziska Roesner, Shwetak Patel, Stephen Checkoway, Damon McCoy, Brian Kantor, Danny Anderson, Hovav Shacham, Stefan Savage

Toy computer security (UW)

- Tamara Denning, Cynthia Matuszek, Karl Koscher, Joshua R. Smith

Automotive driver fingerprinting (UW)

- Miro Enev, Alex Takakuwa, Karl Koscher

Powerline monitoring (UW)

- Miro Enev, Sidhant Gupta, Shwetak Patel

Home automation security (UW)

- Temitope Oluwafemi, Sidhant Gupta, Shwetak Patel

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