

Program Analysis of IoT Applications for Security and Privacy



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Penn State University - USENIX Security HoTSec 2018

The most amusing talk award



Smart homes—Healthcare— Energy—Farming...

IoT Apps...

Devices

```
input (p, presenceSensor, type:device)
input (s, switch, type:device)
input (d, door, type:device)
```

Events

```
subscribe(p, "present", h1)
```

Computation

```
h1(){
  s.on()
  d.unlock()
}
```



IoT enables the future (and a whole lot of problems)

IoT Devices Are Hacking Your Data & **Stealing Your Privacy** - Infographic

 Ken Savage | 01.11.17 | iot, Infographic

Alexa beware! New smart home tests reveal serious **privacy flaws**

By Sandra Vogel - February 28, 2018

"Issues such as the fear of oversharing of data by commercial services, insufficient protection of stored personal data, and the possibility of interception of digital traffic by cybercriminals [are] significant."

ANDY GREENBERG SECURITY 05.02.16 07:00 AM

FLAWS IN SAMSUNG'S 'SMART' HOME LET HACKERS **UNLOCK DOORS AND SET OFF FIRE ALARMS**

Program analysis helps...



Is user's presence leaked to the adversary?



Is front door unlocked when user is sleeping?

Why should we care about
program analysis of IoT
applications?

Make IoT
safe and secure

Make our lives
better

Why IoT apps cause safety and security issues?

How program analysis can help prevent those issues?





Devices





eclipse marketplace

Eclipse SmartHome > IoT (52)



Fire Alarm

This template checks all temperature sensors of a group for abnormal values and activates an alarm if some threshold is exceeded by one of them.

☆ 0 0

[Eclipse SmartHome](#)

Last Updated on Thursday, March 16, 2017 - 09:32 by [Kai Kreuzer](#)

 **Install**



Energy Meter

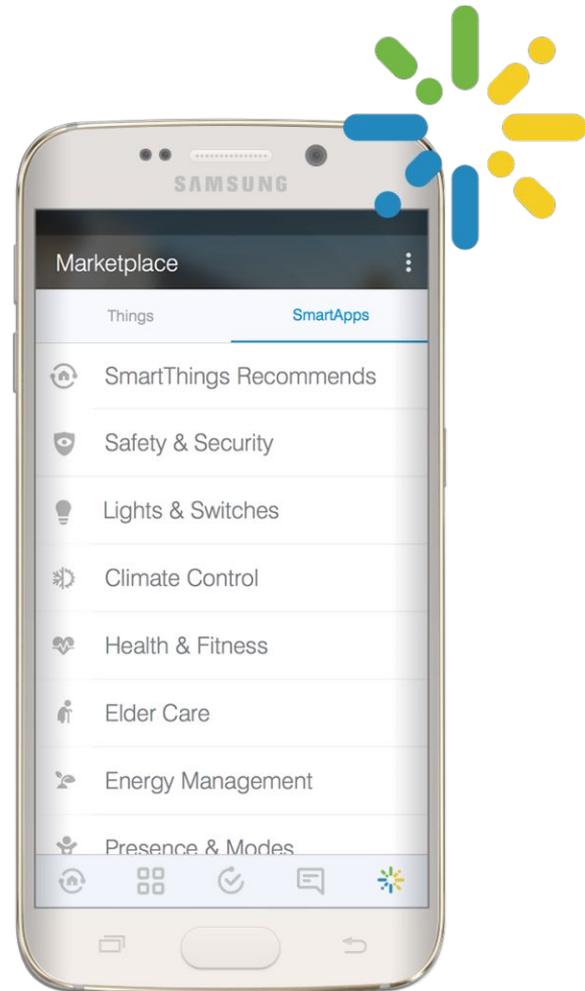
This rule template takes an energy consumption value as an input and controls a color light in the range from green to red for visualising the current consumption.

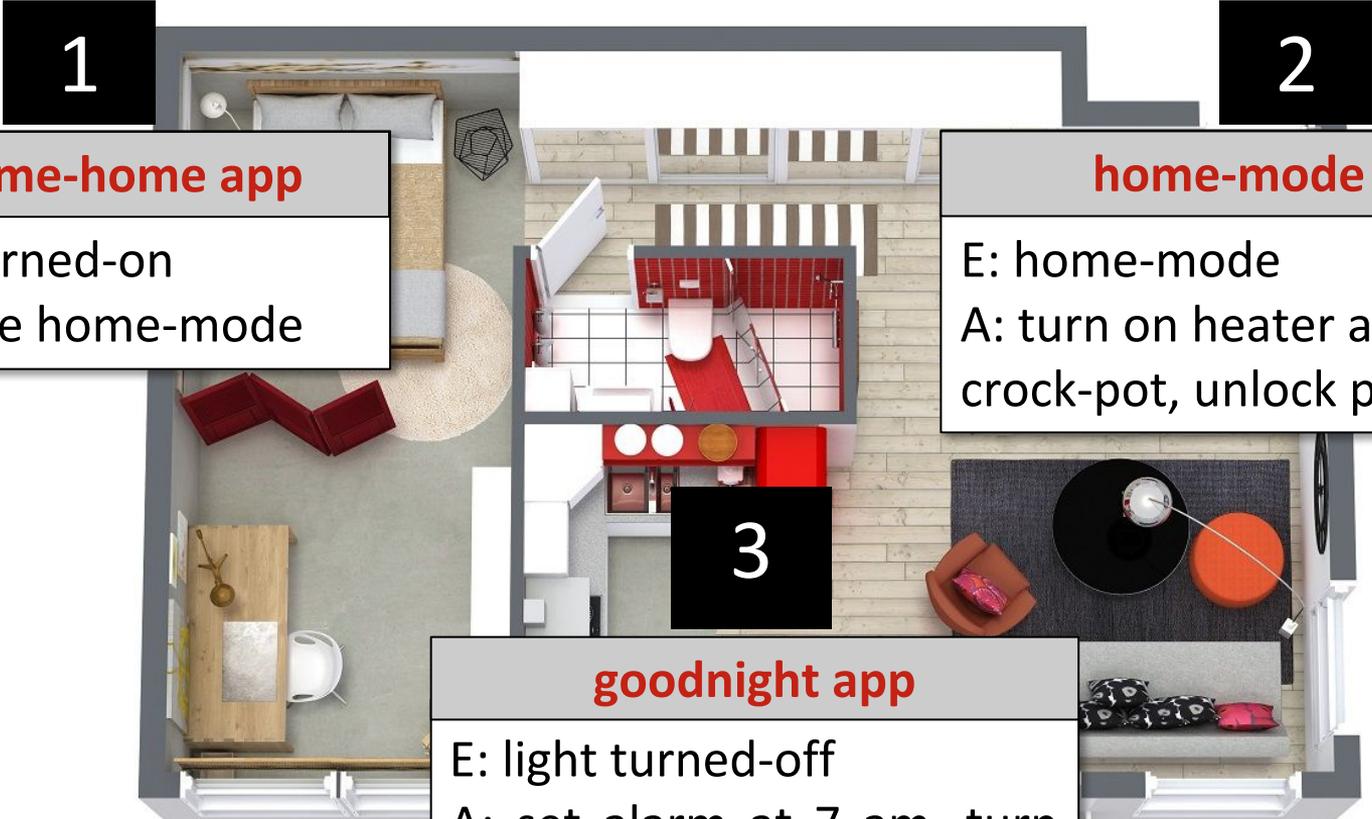
☆ 0 1

[Eclipse SmartHome](#)

Last Updated on Tuesday, March 14, 2017 - 08:25 by [Kai Kreuzer](#)

 **Install**





1

welcome-home app

E: light turned-on

A: activate home-mode

2

home-mode app

E: home-mode

A: turn on heater and
crock-pot, unlock patio-door

3

goodnight app

E: light turned-off

A: set alarm at 7 am, turn
on coffee machine at 7:15

E: Event
A: Action

App to turn Lights On/Off automatically while away (Simulate Presence)

Mobile App



Imosenko Community Journeyman

1  Dec '14

Looking for an app to turn lights On/Off while all are away from home to simulate presence. Just in case Mr./Mrs. Burglar want to drop by. Is there one out or can someone help with the code?

4

simulate-occupancy app

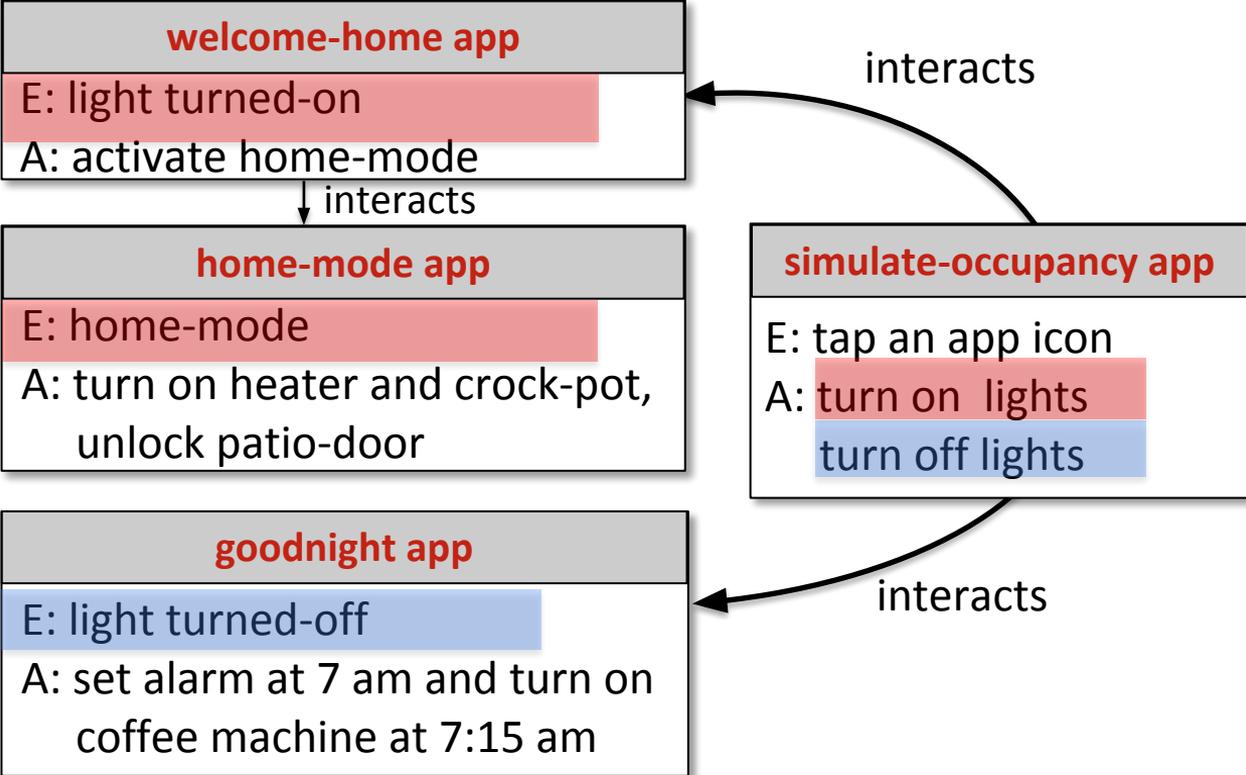
E: specific times

A: turn on lights
turn off lights



What went wrong?

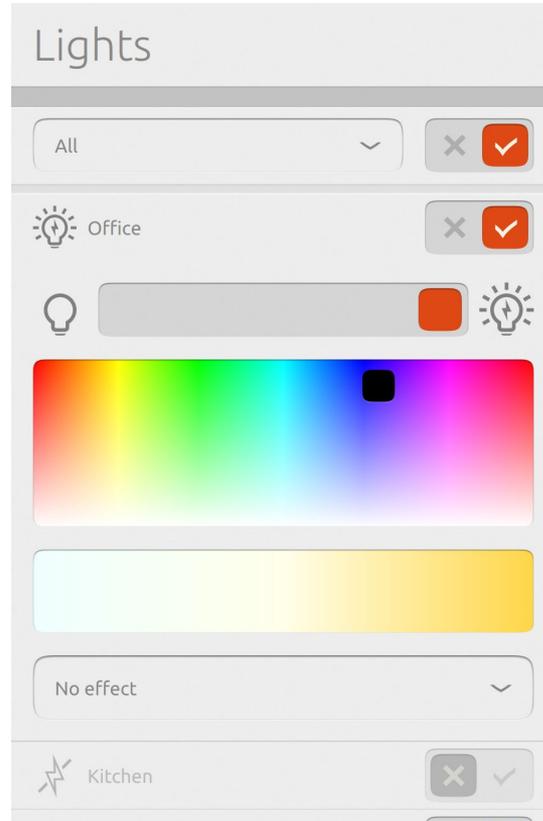
Interaction between IoT apps



When you are not at home

-  unlocked
-  turned on
-  turned on
-  turned on
-  alarm set

Physical channels...



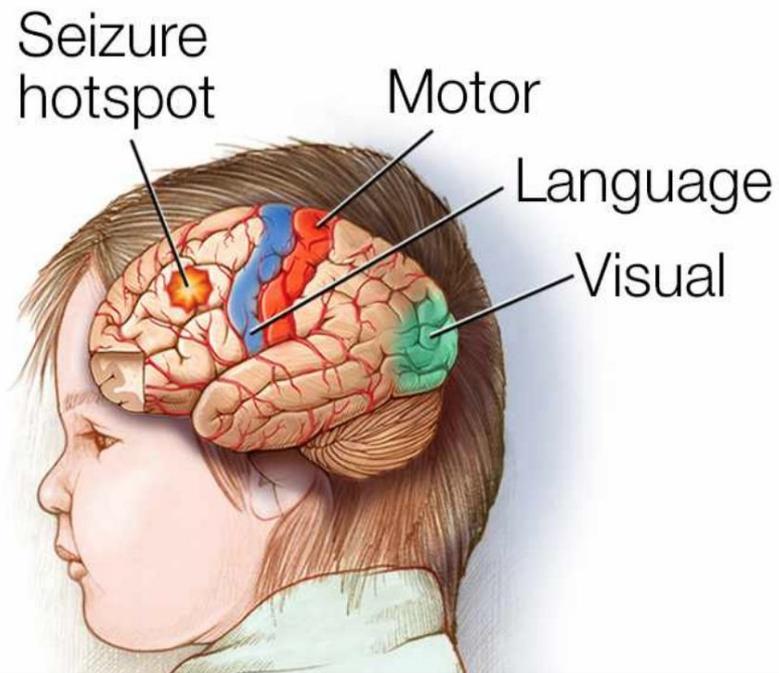
Light capabilities

- Intensity
- Brightness
- Color
 - hue
 - saturation

Physical channels...



What went wrong?



About one in 100 people in the U.S. have epilepsy. About 3% to 5% of those people have photosensitive epilepsy.

The purpose of program analysis is to
ENSURE that the **individual behavior** of an
app and **joint behavior** of apps **DOES NOT**
cause **SECURITY** and **SAFETY** issues



<https://beerkay.github.io>



@ZBerKayCelik



berkaycelik

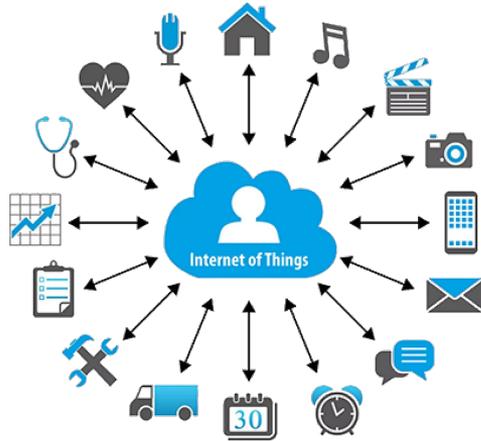


Thank you for listening!

Please come and ask your questions in the coffee break!

Extra Slides

IoT is not magic...

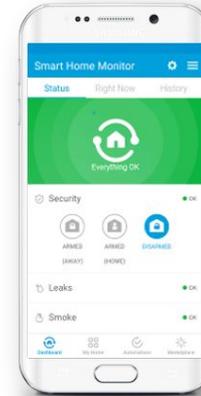


Connected devices

```
MQTT.sub(topicInLedA, function(conn, topic, msg) {
  print('Topic:', topic, 'message:', msg);
  if (msg == '0'){
    GPIO.write(pinLedA,0);
    isLedAO = 0;
  } else {
    GPIO.write(pinLedA,1);
    isLedAO = 1;
  }
}, null);

MQTT.sub(topicInLedB, function(conn, topic, msg) {
  print('Topic:', topic, 'message:', msg);
  if (msg == '0'){
    GPIO.write(pinLedB,0);
    isLedBO = 0;
  } else {
    GPIO.write(pinLedB,1);
    isLedBO = 1;
  }
}, null);
```

IoT program



Mobile app