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**

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

**Events**

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

**Computation**

```java
h1()
{
    s.on()
    d.unlock()
}
```
IoT enables the future (and a whole lot of problems)

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."

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
**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.

*Eclipse SmartHome*
Last Updated on Thursday, March 16, 2017 - 09:32 by Kai Kreuzer

**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.

*Eclipse SmartHome*
Last Updated on Tuesday, March 14, 2017 - 08:25 by Kai Kreuzer
1. **Welcome Home App**
   - **Event (E):** light turned-on
   - **Action (A):** activate home-mode

2. **Home Mode App**
   - **Event (E):** home-mode
   - **Action (A):** turn on heater and crock-pot, unlock patio-door

3. **Goodnight App**
   - **Event (E):** light turned-off
   - **Action (A):** set alarm at 7 am, turn on coffee machine at 7:15
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?

simulate-occupancy app

E: specific times
A: turn on lights
turn off lights
What went wrong?
Interaction between IoT apps

**Welcome-home app**
- **E:** light turned-on
- **A:** activate home-mode

**Home-mode app**
- **E:** home-mode
- **A:** turn on heater and crock-pot, unlock patio-door

**Simulate-occupancy app**
- **E:** tap an app icon
- **A:** turn on lights
- **A:** turn off lights

**Goodnight app**
- **E:** light turned-off
- **A:** set alarm at 7 am and turn on coffee machine at 7:15 am

When you are not at home
- unlocked
- turned on
- turned on
- alarm set

When you are not at home
- unlocked
- 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.
Thank you for listening!

Please come and ask your questions in the coffee break!
Extra Slides
IoT is not magic...

Connected devices

Mobile app

IoT program