Rethinking Access Control and Authentication for the Home Internet of Things (IoT)

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From Single User to Multi User
Vendors Still Treat It The Old Way!

Smart Home

What level of access do you want to give “John”?  

- Guest  
  - Owner
Please Enter Your Password:
Home IoT Devices

“Play music!”
“Order me a puppy!”

Icon made by Those Icons, Smashicons, Vectors Market from www.flaticon.com
Research Goals

We conducted a user study to...

• Map desired access-control policies for home IoT devices
  • How policies vary by relationships and capabilities
  • Identify potential default policies
Method
Imagine you are the owner of a <smart device>. Using this device, some users can access the following feature: <capability>. When should <relationship> be able to use this feature?

- Always
- Sometimes
- Never
Imagine you are the owner of a **Smart Voice Assistant**. Using this device, some users can access the following feature: **Make online purchases (e.g., on Amazon) on a shared household account.**

When should **your spouse** be able to use this feature?

- Always
- Sometimes
- Never
Are Relationships and Capabilities Enough?

5 pm – 6 pm

12 am – 1 am

LG Smart TV – lg.com; Icons made by Freepik and Pixel Buddha - CC 3.0 BY
Research Goals

We conducted a user study to...

• Map desired access-control policies for Home IoT Devices
  • How policies vary by relationships and capabilities
  • Identify potential default policies

• What contextual factors affect the user's decision?
6 Relationships

24 Relationships

6 Relationships

- Your Spouse
- Your Teenage Child
- Your Child in Elementary School
- A Visiting Family Member
- The Babysitter
- Your Neighbor

Icons made by Vectors Market from www.flaticon.com
22 Capabilities

1) Order Online
2) Live Video
3) Answer Door

Mower Rule
Lights Rule
Results
425 Participants

- 54% Male
- 46% Female

Age
- 25-34: 47%

Home IoT Device
- 44%

CS
- 19%
Results

Given **one particular capability**, what **access-control policy** should be set up for whom?
Comparison Between Capabilities

- **Spouse**
  - Play Music: 30%
  - Order Online: 40%

- **Teenager**
  - Play Music: 70%
  - Order Online: 60%

- **Child**
  - Play Music: 80%
  - Order Online: 70%

- **Visiting Family**
  - Play Music: 50%
  - Order Online: 30%

- **Babysitter**
  - Play Music: 40%
  - Order Online: 50%

- **Neighbor**
  - Play Music: 30%
  - Order Online: 40%

**Icons:**
- Playing Music
- Ordering Online

Icon made by Alexander Madyankin, Roman Shamin, Echo Plus with built-in Hub – Black - www.amazon.com
Capabilities Within One Device

- Answer Door
- Delete Lock Log

Spouse: Always
Teenager: Sometimes
Child: Never
Visiting Family: Always
Babysitter: Sometimes
Neighbor: Never
Spouse Can Do Almost Everything

Access Control Preference for Different Relationships/Capabilities

- Spouse
  - Software Update
  - Play Music
  - Order Online
  - Temperature Log
  - Mower On/Off
  - Mower Rule
  - Lock Log
  - Lock State
  - Lock Rule
  - Answer Door
  - Delete Lock Log
  - Lights State
  - Lights On/Off
  - Lights Rule
  - Light Scheme
  - New Device
  - New User
  - Live Video
  - Facial Recognition
  - Delete Video
  - Camera On/Off
  - Camera Angle

- Teenager
- Child
- Visiting Family
- Babysitter
- Neighbor

Always

Sometimes

Never
Neighbor Can Do Nothing

Access Control Preference for Different Relationships/Capabilities

Spouse
- Software Update
- Play Music
- Order Online
- Temperature Log
- Mower On/Off
- Mower Rule
- Lock Log
- Lock State
- Lock Rule
- Answer Door
- Delete Lock Log
- Lights State
- Lights On/Off
- Lights Rule
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- New Device
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- Live Video
- Facial Recognition
- Delete Video
- Camera On/Off
- Camera Angle

Neighbor
- Software Update
- Play Music
- Order Online
- Temperature Log
- Mower On/Off
- Mower Rule
- Lock Log
- Lock State
- Lock Rule
- Answer Door
- Delete Lock Log
- Lights State
- Lights On/Off
- Lights Rule
- Light Scheme
- New Device
- New User
- Live Video
- Facial Recognition
- Delete Video
- Camera On/Off
- Camera Angle
Other Relationships Are More Complex

Access Control Preference for Different Relationships/Capabilities

- Teenager
  - Always
  - Sometimes
  - Never

- Child
  - Always
  - Sometimes
  - Never

- Visiting Family
  - Always
  - Sometimes
  - Never

- Babysitter
  - Always
  - Sometimes
  - Never

|-----------------|------------|--------------|-----------------|-------------|------------|---------|-----------|---------|-------------|----------------|--------------|---------------|------------|-------------|------------|----------|-----------|-------------------|------------|-------------|-------------|
Teenager vs. Child

<table>
<thead>
<tr>
<th>Task</th>
<th>Teenager</th>
<th>Child</th>
</tr>
</thead>
<tbody>
<tr>
<td>Order Online</td>
<td>Yellow</td>
<td>Red</td>
</tr>
<tr>
<td>Temperature Log</td>
<td>Blue</td>
<td>Green</td>
</tr>
<tr>
<td>Mower On/Off</td>
<td>Orange</td>
<td>Yellow</td>
</tr>
<tr>
<td>Mower Idle</td>
<td>Pink</td>
<td>Brown</td>
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<tr>
<td>Lock Log</td>
<td>Purple</td>
<td>Grey</td>
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<tr>
<td>Lock State</td>
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<td>Blue</td>
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<td>Answer Door</td>
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<tr>
<td>Delete Lock Log</td>
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<td>Lights Brightness</td>
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<td>Pink</td>
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<tr>
<td>Facial Recognition</td>
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<td>Grey</td>
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<tr>
<td>Delete Video</td>
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<td>Blue</td>
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<tr>
<td>Camera On/Off</td>
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<td>Camera Angle</td>
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“At 16 they would be able to pick their own things to buy but the final purchase should be ultimately my choice and need my authorization.”
Teenager vs. Child

“At 16 they would be able to pick their own things to buy but the final purchase should be ultimately my choice and need my authorization.”

“They are in no way responsible enough at this age.”
### Relationships Matter…But Are Not Enough

#### Access Control Preference for Different Relationships/Capabilities

<table>
<thead>
<tr>
<th></th>
<th>Spouse</th>
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<th>Child</th>
<th>Visiting Family</th>
<th>Babysitter</th>
<th>Neighbor</th>
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<td>Software Update</td>
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<td><img src="Sometimes" alt="Yellow" /></td>
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<td><img src="Never" alt="Red" /></td>
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<td>Delete Lock Log</td>
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<tr>
<td>Lights On/Off</td>
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<td>Light Scheme</td>
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<td>Delete Video</td>
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<td>Camera On/Off</td>
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*Always*, *Sometimes*, *Never*
Relationships Matter...But Are Not Enough

![Image of a table with relationships and activities]

**What does *sometimes* mean?**
Contextual Factors
Factor: Time of Day

“I would not want anyone trying to use the mower at night. The neighbors would most likely get mad.”
Factor: People Around

“They would be allowed to use it whenever I am home with them.”
Factor: Location of User

Why not play some music?

What is going on???

“Why do you need to use it if you aren’t close?”
Factor: Location of Device

“If it is used in the bedroom then it would matter who has access.”
Factor: Explicit Permission

“Can I...?"

“When they are authorized by the owner.”
Factor: Consequences
Factor: Responsible Usage

“They shouldn't use the lights if they are using them too frequently.”

Icon made by Freepik from www.flaticon.com
Factor: Understanding

“I would need to teach her how to first.”
Factor: Help

“If they want to come over to mow the lawn, then why not?”

Thank you!!!
Recap: Missing From Current Systems

Relationships

Capabilities

Contextual Factors
Design Implications
Current: Guest vs. Owner

What level of access do you want to give “John”?

- Guest
- Owner
Future: Designing for Relationships

Adding a new user:

- spouse
- teenage child
- young child
- visiting family member
- babysitter
- neighbor
Future: Designing for Relationships

Smart Home

Adding a new user:

is a young child

Next →
Future: Relationships and Capabilities

Smart Home

Default Settings for a Young Child

Voice Assistant

Lights

Thermostat
Future: Relationships and Capabilities

Smart Home

Default Settings for a Young Child

Voice Assistant

With permission, allowed to play music

Never allowed to order online
Current: Full Access or Temporary Access

Set Access Time

Start Date: Thu, 19 July 2018

Start Time: 06:00 PM

End Date: Thu, 19 July 2018

End Time: 06:00 PM

Access Time: Thu, 19 Jul 2018 02:00 PM to Sat, 21 Jul 2018 12:00 PM
Future: Contextual Factors

Smart Home

People Around

Your young child can have access when

I’m around
I’m not around
Future: Device Context

Is your camera an...

Indoor Camera  Outdoor Camera
Future: Device Location

Is your camera placed in...

Living Room

Bedroom
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