An Operating System for the Home

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Outline

- Introduction
- Motivation
- Challenges
- PC Abstraction
- Design and Implementation
- Evaluation
Question:
Imagine how to design a smart home?
Example

- Open the light when people come back.

**Question:**
How to create communication between light switch and door controller?
Problems

Communicate directly?

- There are so many lights.
- Some lights have different color.
- User can not manage.

Solution:
Use a central server.
Challenges

Management
- Make it easy.

Application Development
- Devices are interconnected in different ways
- Devices have different types
- Control based on time changing
- Cooperation between components

Incremental growth of devices
- Determine a component is compatible with current one
## PC Abstraction

<table>
<thead>
<tr>
<th>Application layer</th>
<th>Management layer</th>
<th>Device functionality layer</th>
<th>Device connectivity layer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Challenge</strong></td>
<td><strong>Heterogeneity</strong></td>
<td><strong>src. handled</strong></td>
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<tr>
<td>addressed</td>
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<tr>
<td>Incremental growth</td>
<td>User control</td>
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<tr>
<td></td>
<td>Management</td>
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<td>App development</td>
<td>Coordination</td>
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<tr>
<td>Incremental growth</td>
<td>Device</td>
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<tr>
<td>Incremental growth</td>
<td>Topology</td>
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DCL and DFL

DCL
- Encapsulate the details of discovering and maintaining connectivity devices
- Hidden the protocol-specific methods

DFL
- Provide API that developers can easily use
- Developer do not have to care about implementation of different devices contains methods for cooperation between devices
- It is easy to extend new component
Relationship between DCL and DFL
Management Layer

Requirement of Management Layer

- Time-based access control
- Applications as security principals
- Easy-to-understand, queryable settings

Solutions

- Datalog access control rules
- Time-based user accounts
- Hierarchical user and device groups
Application Layer

- This layer provides the ability to use and compose devices
- Determine whether an application is compatible or not
Design and Implementation

- Modules
- Services
- HomeStores
- Management tasks
Modules

- Modules are the basic unit of functionality in HomeOS
- Modules running on the DCL and DFL are drivers
- Modules running on the Application level are application
Services

- Provide basic way to communicate with each other
HomeStore and Management tasks

- Adding a new application
- Add a new device
- verify access rules
- Add new users
Evaluation

- Programming
- Managing
- System performance
## Evaluation

### Ease of Programming

<table>
<thead>
<tr>
<th></th>
<th>app</th>
<th>LoC</th>
<th>mins</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>CLU</td>
<td>183</td>
<td>84</td>
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<tr>
<td>2</td>
<td>CLU</td>
<td>193</td>
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<td>3</td>
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<td>172</td>
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<td>5</td>
<td>CLU</td>
<td>221</td>
<td>107</td>
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<tr>
<td>6</td>
<td>MFL</td>
<td>224</td>
<td>95</td>
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<tr>
<td>7</td>
<td>MFL</td>
<td>244</td>
<td>126</td>
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<td>8</td>
<td>MFL</td>
<td>239</td>
<td>102</td>
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<td>9</td>
<td>MFL</td>
<td>303</td>
<td>93*</td>
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<tr>
<td>10</td>
<td>MFL</td>
<td>130</td>
<td>100*</td>
</tr>
</tbody>
</table>

*(a) Programming study*
**Ease of Management**

<table>
<thead>
<tr>
<th>Task</th>
<th>Score</th>
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<tbody>
<tr>
<td>1. Configure your new EcoMonitor app. Let it access all but high-security devices for everyone.</td>
<td>11</td>
</tr>
<tr>
<td>2. Configure your new MusicFollowsMe app. Let it access all motion detectors and speakers but no high-security devices. All residents can use it but kids cannot not play music in the parents’ bedroom.</td>
<td>9</td>
</tr>
<tr>
<td>3. Configure your new kitchen security camera. Mark it high-security and let HomeMonitor access it.</td>
<td>11</td>
</tr>
<tr>
<td>4. Give guest access to Jane, who will be visiting until September 6th. Place her in the Guests group so that she can use appropriate apps during her visit.</td>
<td>12</td>
</tr>
<tr>
<td>5. Check the rules and tell the facilitator which apps can access high security devices.</td>
<td>1</td>
</tr>
<tr>
<td>6. Configure your new OpenFrontDoor app. Residents can use it any time. Sam (guest) cannot use it at all. Jane (guest) can use it only during the day (8 AM to 8 PM).</td>
<td>11</td>
</tr>
<tr>
<td>7. Check if only adults can access the camera in Rob’s room and only using HomeMonitor.</td>
<td>10</td>
</tr>
</tbody>
</table>

(b) Management study
Evaluation

System Performance
Summary

- It is easy to manage HomeOS.
- It is easy to develop for HomeOS.
- Detect whether an application is compatible.
Questions?
Thanks