

# Vision: Towards an Extensible App Ecosystem for Home Automation through Cloud-Offload

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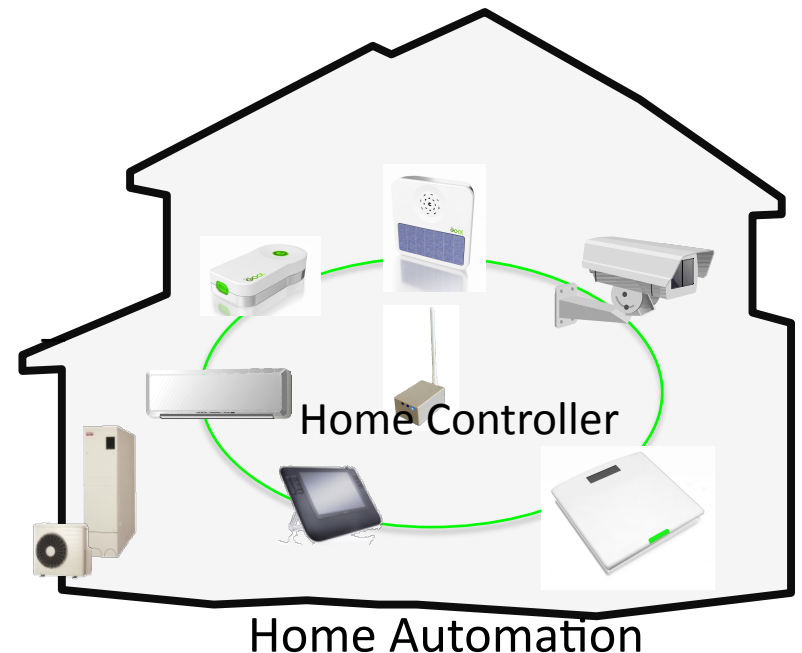
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June 15,2014@MCS'14

# Background: Home Automation

- Home Automation Systems
  - Sensors and actuators
  - Home controller(HC)
  - Resource constrained devices
- Many home applications
  - Energy management
  - Home Security
  - Health care
  - Remote monitoring



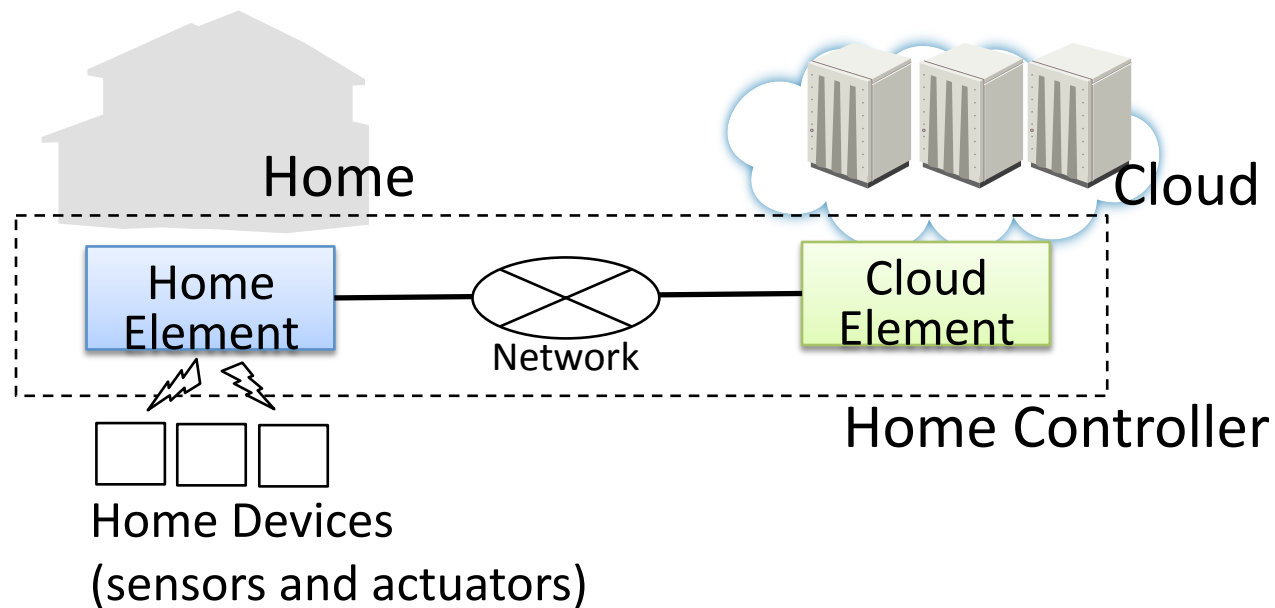
# An ecosystem for home applications

- **Vision**: users add new home applications as in smartphone ecosystem
- **Problem**: home controllers are inflexible and resource constrained
  - Some applications require a lot of HW resources.
  - E.g., one video stream consumes 20-40% of CPU resources.
  - HC is not easy to upgrade or replace due to cost reasons.

*We need a more flexible and powerful platform for home applications.*

# Cloud-offloading for the Home

Enhancing a home controller with a cloud backend:  
Programmable cloud Enabled Home controller  
system(PCEHC)



# Cloud Offloading for mobile

- Cloud Offload have been proposed for mobile applications
  - games, speech recognition, and navigation.
  - MAUI : dynamic energy-aware offloading.
  - CloneCloud :high speed execution and energy saving.

*Do mobile offloading techniques work for the home?*

# Characteristics of home applications

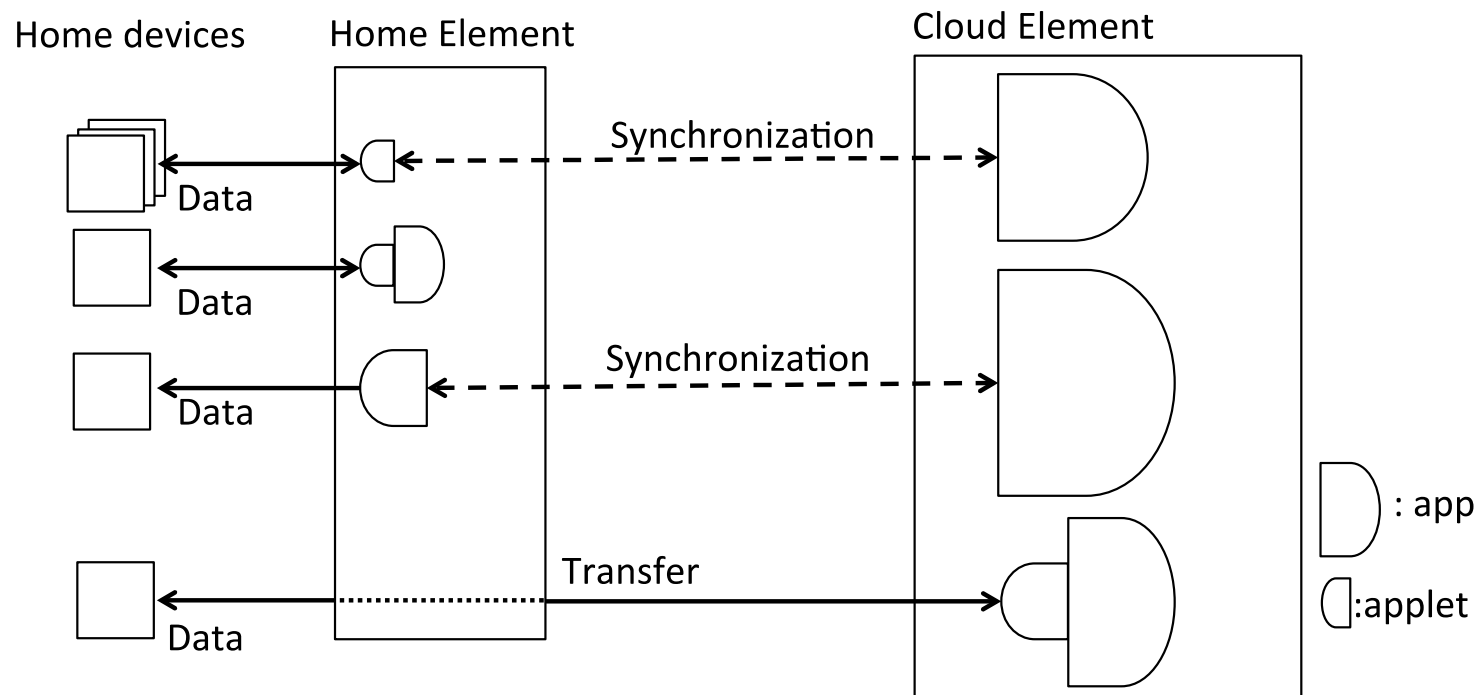
- Support wide range of devices
  - Zigbee/Z-wave sensors, USB cameras, door locks, switches, microphones, etc.
- Run multiple applications at the same time
  - Energy management, home security, healthcare, monitoring
- Applications run continuously even when user not home

# What is needed for Home Applications?

- Require **less human interaction** than mobile phone apps
  - Allow looser interactivity options, e.g., pure cloud based
- Support **safety applications** even if network disconnected
  - E.g., burglar alarms, healthcare
- Support **multiple continuously running** control applications
  - Need offload decision making with system-wide perspective

# Key Idea: application decomposition

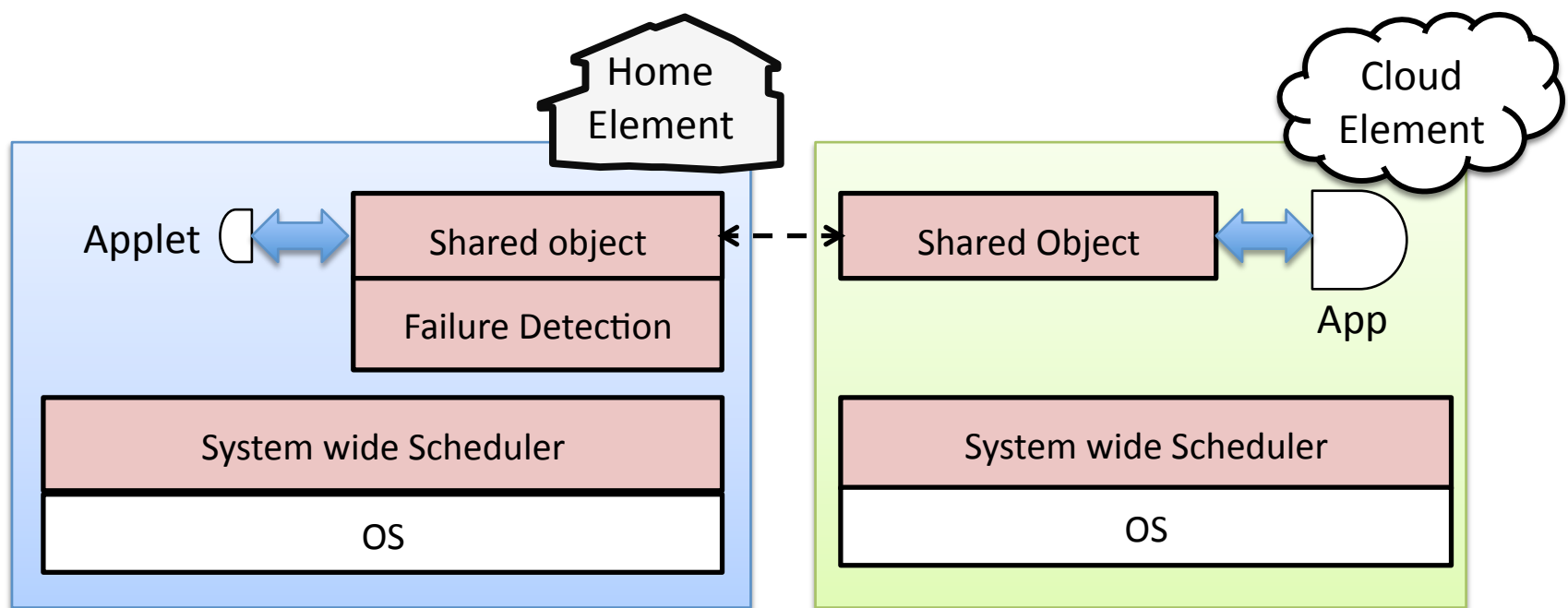
- A new application design paradigm
- Applications composed of **App** and **Applet**
  - App is full featured implementation
  - Applet is smaller and provides reduced functionality





# System-level functions of Home Controller

- System-wide scheduler for apps/applets
- State synchronization via shared objects
- Control transfer on network disconnection

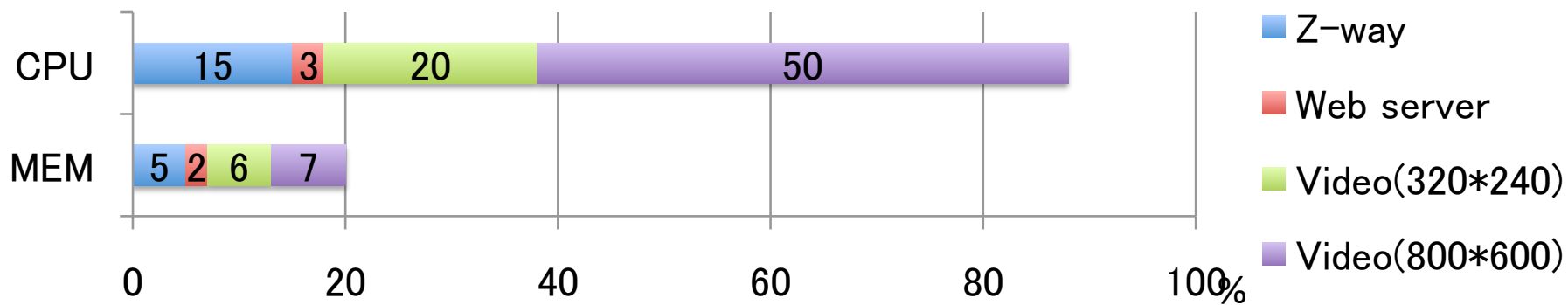
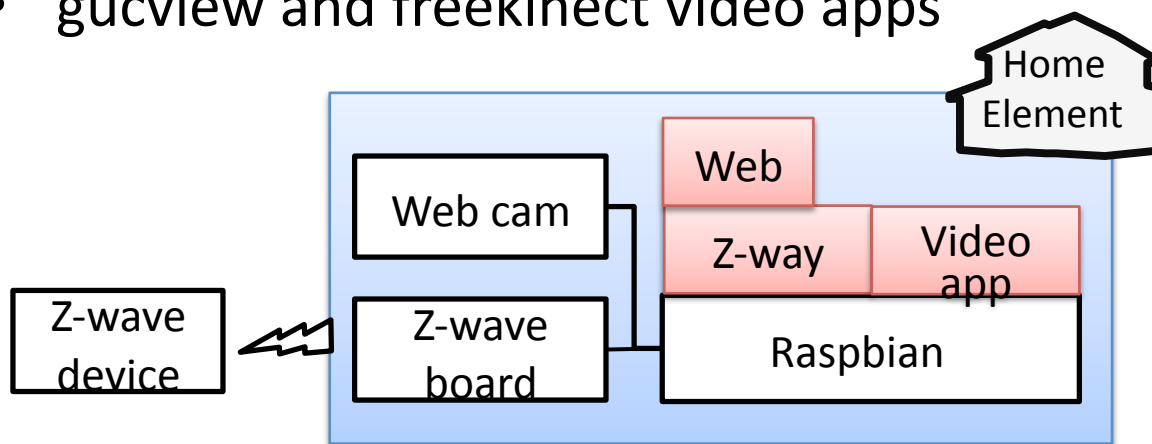


# Preliminary Experiments

- Home controller
  - Raspberry Pi with 700MHz ARM, 512MB of RAM, Raspbian OS
  - Multiple sensors: Z-wave controller, video camera
- Cloud server
  - x86 3.1GHz dual core with 4GB of RAM, Ubuntu 12.04
- Key Highlights
  - Multiple applications can easily overwhelm home controller
  - Remote control apps can be offloaded over 3G/LTE
  - Streaming media based applications always need applet

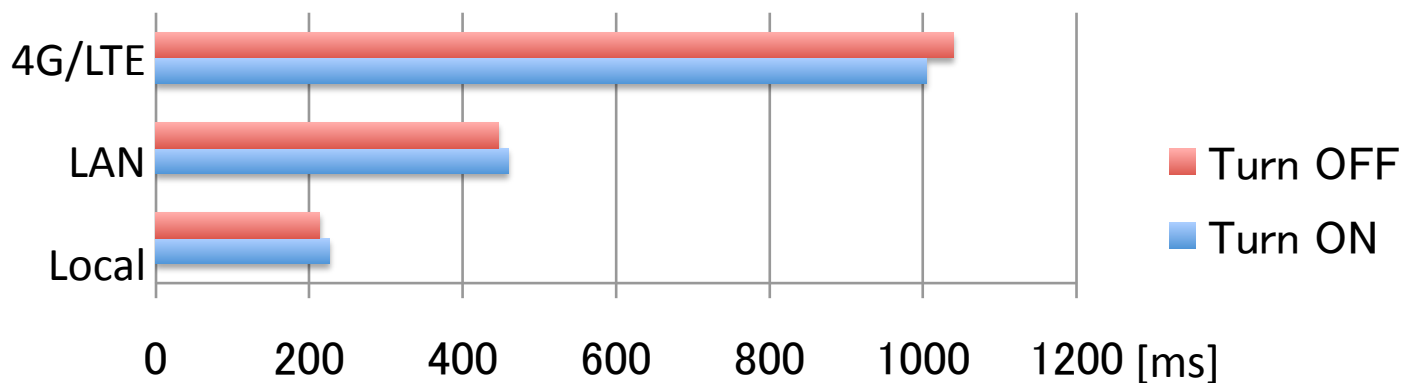
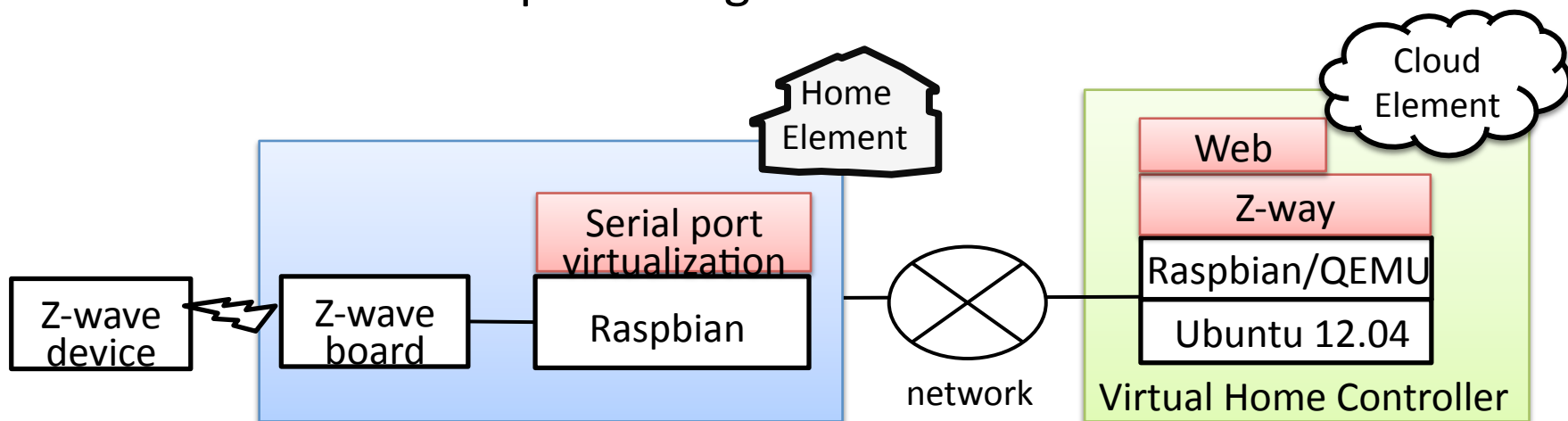
# Multiple apps can overwhelm local resources

- Home Element runs home automation and video analysis apps
  - Z-way and web server
  - gucview and freekinect video apps



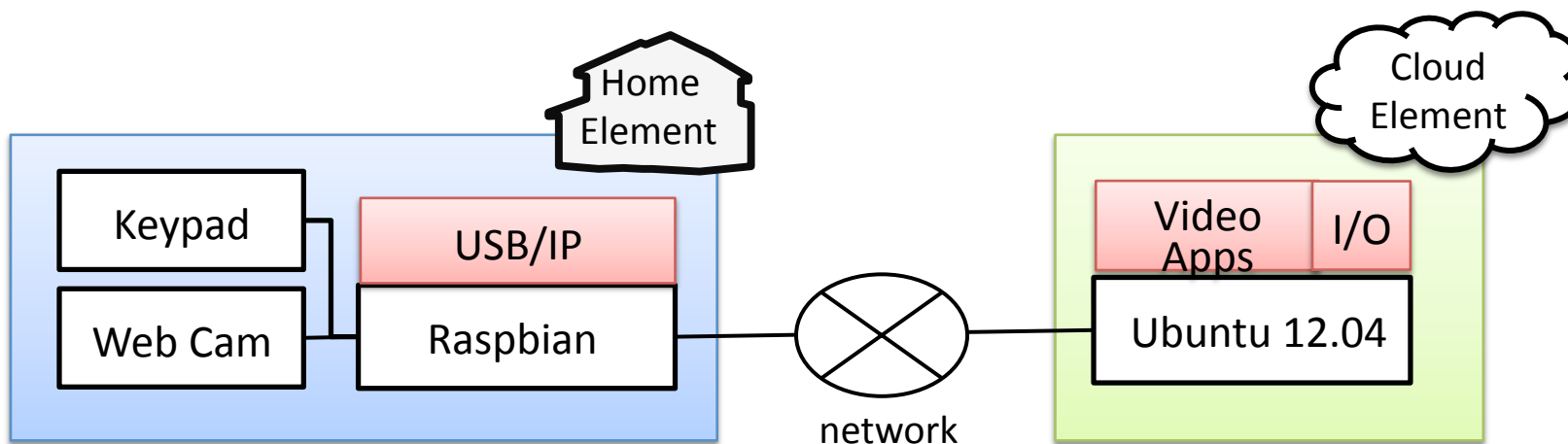
# Z-wave control from the cloud is feasible

- Z-way and web server apps in the cloud
- Virtualize serial port using Socat to offload GPIO



# Streaming media based applications need applet

- Video viewing application in the cloud.
- Attached virtually USB devices to the cloud using USB/IP



## **Result:** Cloud element

- can remotely control light weight USB devices
- can not capture video stream due to frame loss on a server

# Conclusion and future work

- Home automation has unique requirements
- Architecture for cloud-enabled home controllers
  - Application-level decomposition
  - System-wide offload decisions
  - Shared object between the home and the cloud
- Future work: implement our vision and evaluate

# Questions and Comments?