# A Platform for Integrating Alexa Voice Service Into ECHONET-based Smart Homes

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*Abstract*—Voice is the most natural way of user interaction and there are many studies to utilize voice services for smart home environments. This paper introduces a solution which enables Alexa voice service for ECHONET-based smart homes.

*Index Terms*—Alexa, ECHONET, ECHONET Lite

## I. INTRODUCTION

Alexa voice service [1], also known as Alexa, is not only an intelligent service to enable users to voice control their smart homes, but also the brain of million devices including Amazon Echo - the smart home device recently introduced by Amazon. As voice is the most natural form of user interaction the integration of Alexa into the smart homes seems to be the most compromising approach to be able to simplify the modern lifestyle and gain user comfort.

ECHONET [2], which has become a de jure home network standard certified by ICE and ISO, stands for Energy Conservation and Homecare Network. ECHONET is an open communication protocol for reliable and low-cost home networks to enable mobile services, energy management services, remote equipment maintenance services, home health care services, home security services and services to support a comfortable living. ECHONET is being promoted by Japan Ministry of Economy, Trade and Industry to respond to calls from society for greater energy savings.

The integration of Alexa and ECHONET has not yet implemented because of their differentiations in term of network architectures. In this research, the network architectures behind Alexa and the ECHONET-based smart homes are describing as well as the platform which enables Alexa for ECHONET Lite home networks is proposed.

## II. BACKGROUND

The typical home network is following the 4-layer architecture which was recommended in ITU-T Y.2070 [3]. Devices on the home network are monitored and controlled by applications on the Internet via the home gateway(HGW) and the management platform (MP). The HGW bridges the Internet and the home network by converting various types of communication protocols used by devices and the MP. The MP manages home network resources and provides interfaces for applications. By making use of the HGW and the MP, application developers can develop applications without any
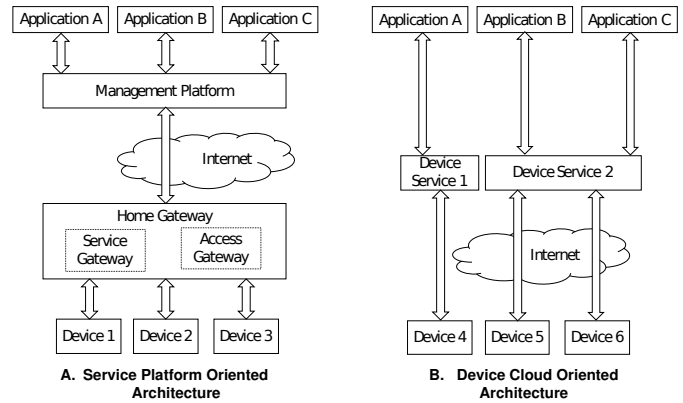


Fig. 1. Service Platform Oriented vs Device Cloud-Oriented Architectures

knowledge about device interfaces and communication protocols. In this paper, this kind of architecture is named Service Platform Oriented (SPO) architecture.

Currently, there is another trend initiated by big companies in America such as Amazon, Google or Belkin which devices now are directly controlled and monitored by their cloud services and application developers can only develop applications using provided APIs. This 2-layer model is called Device Cloud Oriented (DCO) architecture. The detail of these 2 models is shown in Fig. 1.

The ECHONET smart home environments are mainly followed the SPO architecture where ECHONET devices are connected to the HGW and home network resources are locally managed by the Service Gateway (SG). The Access Gateway (AG) provides communication infrastructure for the home network and the MP. The MP provides interfaces for application to access virtual device resources of the home. Meanwhile, AVS is following the DCO architecture where Alexa-enabled devices are directly connected to AVS and application developers can develop applications to allow user utilizing device features via interfaces provided by Alexa.

Because of these differentiations, ECHONET devices and Alexa-enabled devices cannot communicate with each other even though they are on the same home network.

## III. PROPOSED SOLUTION

The proposed architecture is shown in Fig. 2. ECHONET-based devices map their own resources into Device objects and these device objects are monitored by the Resource
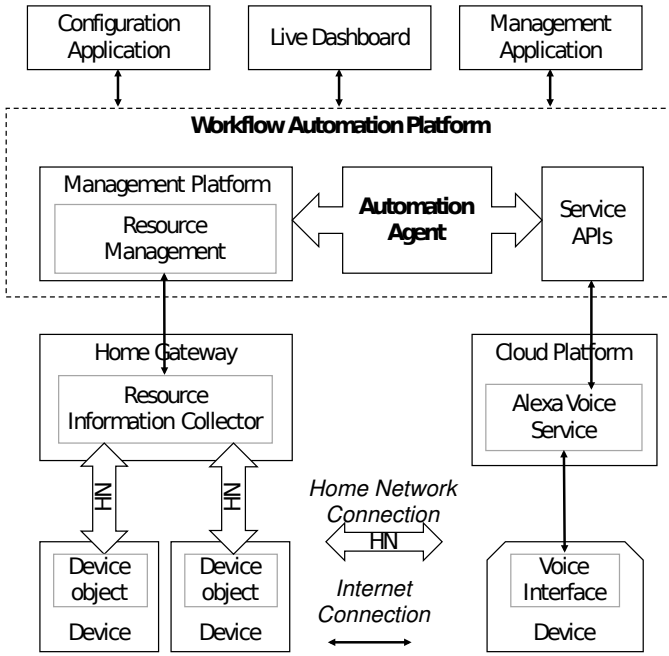
Fig. 2. Proposed Architecture



Fig. 3. Implementation Architecture



Fig. 4. Prototype State Diagram

Information Collector (RIC) module at the HGW. Then the Resource Management module at the MP manages resources of the home network. The Alexa-enabled device is responsible for interacting with users via the voice interfaces. User's intentions are processed at the Alexa cloud platform and provided via service APIs to allow third-party applications providing services accordingly to user requests. In order to integrate ECHONET-based network and Alexa, an automation agent is needed. This agent basically works as If-This-Then-That event trigger. By utilizing this module, the user's intentions extracted by Alexa will be applied to devices in the home network and gets user notified of any change in the home network via the Alexa-enabled device. Configuration Application is using to create and manage automation rules, Live Dashboard can be used to visualize the home network resources and Management Application allows users to manage the whole system.

## IV. IMPLEMENTATION

To prove the feasibility of the proposed architecture, the prototype showing in Fig. 3 is being implemented. The RIC module of the HGW provides a frame translator to translate from ECHONET frames into ECHONET objects and vice versa and on the top of the frame translator resource and service management module were implemented to enable the interaction between devices and system. Home network resources in the HGW is mapped to Thing Shadow [4] at the management PF by utilizing Amazon Web Service (AWS) IoT Software Development Kit (SDK) [5] provided by Amazon. The rule-based automation agent is implemented by AWS Lambda [6]. Smart Home Skill API is provided by Alexa to allow controlling Alexa-enable devices. The Skill Configuration Application is needed to configure the voice commands from users to events in AWS Lambda and Amazon
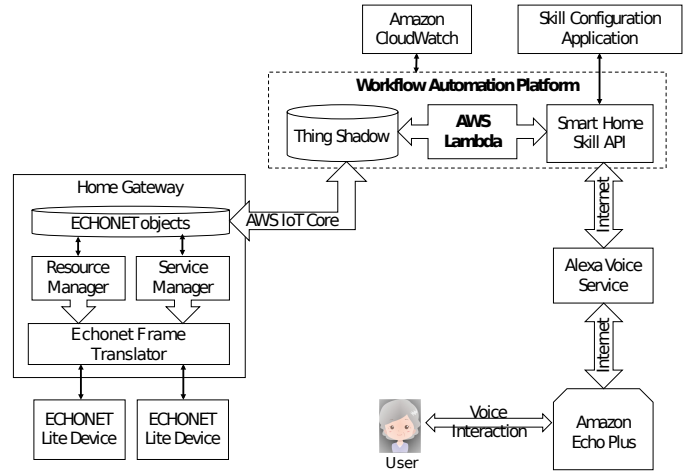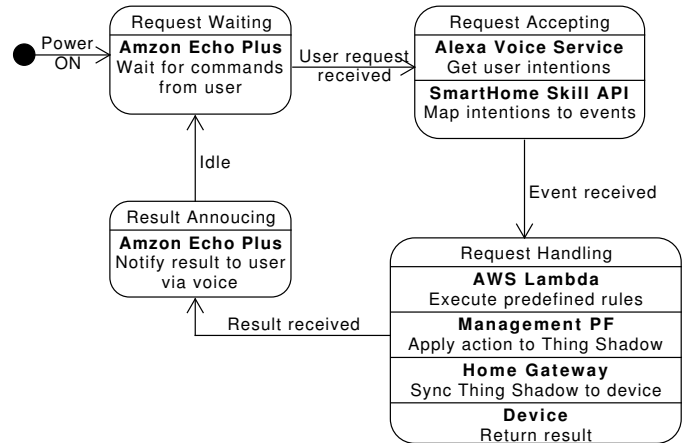
Cloudwatch is used as the visualization. The state diagram of the main program is depicted in Fig. 4.

## V. CONCLUDING REMARKS

This research proposed a solution to enable Alexa for the ECHONET-based smart home environment as well as the solution to support the combination of the common Service Platform Oriented architecture and the advanced Device Cloud Oriented architecture. Further works are required to verify the implementation, including more type of DCO-devices from different vendors (Nest thermostat, Philip Hue, and Belkin Wemo).

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