A Device and Service Description Framework for Discovering and Reasoning in Autonomous P2P Environment

Noritada Shimizu[1], Kazuhiro Kitagawa[1], Haoyi Wan[2], Norihiro Ishikawa[2], Johan Hjelm[3]

Abstract

In this paper, we present a new service and device description framework in autonomous P2P environment. In couple of years, many ubiquitous oriented devices are coming into our life, which create peer-to-peer (P2P) network and work autonomously. When we do something inside such environment, we should discover the devices, and reason which one is most suitable for our objectives. We propose a new framework of describing device functionalities, which enables us to describe the device functionality and its capability in an abstracted form. In our framework, each device is described as a set of 'primitive service', which is abstraction of functionality. In ubiquitous environment, there are many APIs to use device functionalities (e.g. UPnP, IEEE1394, ECHONET, etc). By abstracting them, we can discover devices and use their functionalities without any care about their underlying APIs. API abstraction also ensures the atomicity in its execution. Independence of discovering and reasoning mechanism from APIs underlying ubiquitous environment and the atomicity assurance is key notions for activities in this environment. This framework should be a basement for ubiquitous network environment.

1 Introduction

In recent couple of years, we can see many ubiquitous oriented devices such as video recorders, refrigerators, and so on. They have wireless network connectivity and connect each other. They tend to up and down frequently, so they tends to create ad-hoc peer-to-peer network and work autonomously.

They also have the capabilities of providing their functionalities for other device use. That enables the devices to work cooperatively. There are many standards for the usage of device functionalities: e.g. Bluetooth, IEEE1394, UPnP, ECHONET, etc. They categorize the devices into some device types, and define some APIs to use the functionalities.

In such network environment, device discovery and reasoning are the most important for the devices' cooperative work in an autonomous way. In this paper, we propose a new device and service description framework. It supports the device discovering and reasoning to determine the most suitable devices to work with by describing the device characteristics.

This paper consists of four sections. In the second section, we discuss the issues and make clear the requirements for our framework. Then, we explain our framework in section 3. We explain it in three aspects: functionality abstraction, capability of functionalities, and device characteristics. After the explanation, we summarize our current and future works.

2 Issues

In our previous paper[5], we proposed some issues for the description framework to support reasoning. We think there are same issues for discovering devices, so now we summarize them as listed below.

- Functionality abstraction
- Atomicity assurance in functionality execution
- Dependency solution

There are many APIs to use the devices' functionalities, but the vendors tend to support only one API and the devices connected each other but they can not communicate. To use devices' functionalities effectively, these APIs should be abstracted.

These APIs does not ensure the atomicity of executing their functions. There are many devices and users on the P2P network, so the atomicity of each operation should be ensured. There are some abstracted APIs such as Parlay[3], but they does not take care about it.

[1]Graduate School of Media and Governance, Keio University
[2]NTT DoCoMo R& D Center
[3]Ericsson Research

When the devices use other device's functionality, they reason and determine the most suitable device which they use. The reasoning is done with the information of commitment dependency. The commitment dependency is solved by the device capability information, so our description framework is capable to describe the device capabilities.

3 Framework Design

In this section, we explain our description framework. This section consists of three parts. In the first part, we introduce the idea of "primitive service". It is an abstracted functionality. After that, we explain how to describe service and device capabilities. All information is noted in our XML syntax. We also explain it.

3.1 Primitive Service

We abstract the device functionality as "primitive service". It is defined as an atomic operation in our framework. When some primitive services are used by some device, its execution is not interrupted by others. If it fails, it will abort.

All primitive services have their own URI. It is used to specify the primitive service when the devices use it. We don't specify the name space which all primitive service should belong to. You can create new name space for your new primitive service, freely.

3.2 Service Description

A primitive service has its capability information, which is represented as an acceptable data type of its arguments and its output data type. This information is a basement of devices' reasoning. We can use three data types: string, integer, and base64encoded text. The last one is used to express the capability to handle some kinds of data file.

In our description framework, a primitive service is described with `PrimitiveService` element and its URI is written as a value of `type` attribute. Its capability is represented as a set of type information about arguments and its output. We can describe type of arguments type and output with `InputParameterList` and `OutputParameterList` elemnt. Both of them are the list of `Parameter` element, which describe the `name` and `type` of each arguments / output values. When base64binary is specified as its type, it should have `AcceptableFileType` elements as children to describe acceptable file type.

3.3 Device Description

A device description consists of primitive service list and specification information of the device. The former is described with `PrimitiveServiceList` element, which is a list of primitive services. The latter is described with `Specification` element.

4 Summary

In this paper, we explain our new device and service description framework. It supports for devices to work autonomously. With this framework and the descriptions, they discover others and reason the most suitable one to work with.

In future, we will attempt to formalize this framework, consider the semantic transparency for the descriptions, composite services dynamically and adaptively and introduce some trust model to this framework.

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