Group Context-aware Service Discovery for Supporting Continuous Service Availability

Saehoon Kang, Woohyun Kim, Dongman Lee, and Younghee Lee

***Abstract*—This paper presents our research progress for group context-aware service discovery supporting continuous service availability by providing an alternative service. We believe that service discovery system need to have efficient method for representing the context of a service and a good algorithm for matching and evaluation. We adopt IOPE model from Semantic Web to represent service context and propose perception based effect ontology which is useful in ubiquitous home environment.**

***Index Terms*— Service Discovery, Alternative Service, Group Context, Resource Conflict, Service Ontology**

I. INTRODUCTION

The ubiquitous applications being aware of the situation of a user provide user with application services by forming service community consisting of various service entities. Service discovery systems discover a service entity, which satisfies required constraints, based on the specifications given by ubiquitous applications. Although a lot of researches [1-3, 8, 9] have tried to enable their service discovery systems to be aware of *context* [10] they have been considered the context only in terms of single user. However, their may be various situations where multiple users co-exist in the same environment. In those environments, there are different types of contexts from single user environments such as conflict between users, common interest of them. We call these kinds of context as *group context*. Especially, we call the situation as *service availability conflict*, where application requests a service entity which is not sharable simultaneously and unfortunately already has been preoccupied by another. To accommodate this conflicting request, service discovery should provide an alternative service which satisfies requirements of the originally requested service if it exists. For example, suppose that an application requests *alarm service* and the only alarm service entity in the environment which supports only one timer setting for alarming is preoccupied by another user. In real situation, *TVs* or *audio services* can be used instead of alarm service if they have timer setting functionality. By inferring that *alarm service* consists of two functionalities - time setting and making sound, it is replaced by a *TV* or *audio service* which has both time setting and making sound functionalities.

Although a number of service discovery techniques [1-5] have been already proposed in recent years, only few [4, 5] of them support an alternative service. However, they do not consider conflict situation caused by a service being preoccupied by another user.

To provide an alternative service, service discovery system need to have an efficient method for representing the context of a service, that is, functional semantics, and a good algorithm for matching and evaluation for selecting best one.

In [4, 5], they represent service context based on the ontological classification such as *Aura*'s *Supplier* or *Gaia*'s *Presentation. Gaia* evaluates candidates for an alternative service based on the distance in the service ontology hierarchy. However, it is very hard to build complete ontology to represent service functionality because ontology is built with heuristic criteria, and the discovery results may be different depending on that. Even if it is possible, service developers can not describe service's full functionality because they does not consider service's additional functionalities like alarming functionality in TV service not but its main ones.

We think the service context is realized in the form of a service action to the user by causing some effects. IOPE (inputs, outputs, preconditions, effects) model proposed by Semantic Web [6] is very popular because it represents service actions systematically. To apply this model to ubiquitous environments, it is very important how to represent effects for that because the semantics of services are realized in the form of effects human perceives in many cases such as light, sound, temperature.

In this paper, we present our research progress for group context-aware service discovery supporting continuous service availability by providing an alternative service. Especially, we focus on the ontology to describe service effects and how to evaluate the candidates for best alternative services.

II. PROPOSED APPROACH

A. Effect Ontology

To build ontology for effect description, we need to analysis a domain to which it is applied. Service effects can be categorized into information providing and state change of the world [7]. In ubiquitous home environments, as mentioned above, the semantics of services are realized in the form of changing state human perceives in many cases because the users of ubiquitous applications continuously interact with services in the space. For example, the user turn-on a ubiquitous light in a room, the semantic of the service is the brightness level of the room is increased and human perceives its effect by his/her eyes. Therefore, we decide to develop effect ontology based on the human perception. At present, we start from building effect ontology in terms of sight, sound and temperature. It will be extended gradually. Figure 1 depicts sample effect ontology.

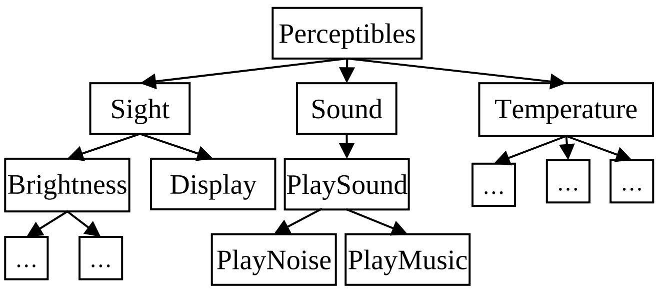

Figure 1. The Effect Ontology

B. *Service Description*

In IOPE model, service is described with inputs, outputs, preconditions, effects. In this paper, we does not consider preconditions for describing services because how to represent it is beyond of the scope of this paper. Each service action is described by its inputs, outputs, effects. Our service description consists of three parts - attributes-values based properties, service states, and IOPE based action. The values of service states are dynamically changed at run time and its changed state is registered with discovery server periodically. Accordingly, the availability of a service is easily known to service discovery. Figure 2 describes SAMSUNG_LCD_TV service. The notation of @ sign means that it describes service action.

```
; Property
Type := SAMSUNG_LCD_TV;
Size := 43 inch;
…
; State information
Service_available := true;
OnOffState := True;
Current_channel := 13;
Current_Volume := 20;
…
; Action representation
@TurnOnTV {
    Inputs :=  {TVSignal};
    Outputs : = null;
    Effects : = {PlaySound, BrightnesUp}
}
@SetTimeOn {
    Input : = {Time};
    Output := null;
    Effects := {PlaySound, BrightnessUp}
}
```

Figure 2. The example of service description

C. *Service Matching and Evaluation*

To find best alternative service efficient matching and evaluation algorithm should be developed. The subsumption relation is widely used to evaluate goodness of matching. Currently, we evaluate service based on both subsumption relation and the distance of ontology graph. However, we don't think our method is best. We need to develop more efficient and accurate method.

III. REMARKS

In this paper, we proposed group context-aware service discovery to accommodate service availability conflict in ubiquitous home environments. We have introduced perception based ontology to represent service effects. Even thought it is not sufficient to represent full service effects, we believe that it will be a good starting point for future research.

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