

# Web of Objects Platform for Service Composition using Devices Profile for Web Services

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**Abstract**— The Web of Objects (WoO) is realized by small objects which share data with each other and cooperate in groups to meet the composition goals. The WoO needs a centralized system for service composition and orchestration. This paper presents a WoO platform service composition with Devices Profile for Web Services (DPWS) environments. We adapt DPWSim which is a simulation toolkit for WoO applications using DPWS.

**Keywords**— *Web of Objects, Service Composition, Service Orchestration, DPWS, DPWSim.*

## I. INTRODUCTION

The Web of Objects (WoO) a concept inspired by Internet of Things (IoT) which is all objects is connected to the internet-like structure. The WoO expanded its concept and the main purpose is enabling smart distributed applications that means simplify objects and apply to IoT infrastructure. This WoO enables easy creation of cross-domain applications through service composition and orchestration. The service composition [1],[2] mainly desires combining multiple services for achieving the client request. On the other hand, service orchestration concerns execution of the result of service composition. The service orchestration coordinates the control and data flow. Thus, we need WoO platform which acting service composition and service orchestration.

On the other hand, the Device Profile for Web Service (DPWS) [3] is one of the new approaches for enabling secure Web service on small devices means resource-constrained. Using DPWS technology, we can make simulation toolkit called DPWSim for developing IoT environments. This toolkit also generates efficient synergy with WoO platform.

The rest of this paper is organized as follows. In the next chapter, we explain the architecture, functional flow, and service flow of WoO platform. In chapter 3, we concisely introduce DPWSim toolkit for WoO simulation. Finally, we conclude the paper in chapter 4.

## II. WO O PLATFORM

### A. Architecture

In this section, we propose WoO platform which is suitable for service composition and orchestration. The architecture of

WoO platform for supporting service composition is depicted in Fig. 1. There are two type of objects: general objects and converged objects which is like services. WoO platform consider all of things to objects means sensor, actuator, service enabler, user, and module can be objects. A sensor is a device that can measure simple physical quantity (e.g. temperature, pressure, light, and luminance). Actuator is devices that act independently or modify the behavior. For managing, pet care service, auto ventilation service, etc. sensor objects are cooler/heater, radiator, CCTV, humidifier, sprinkler, and ventilator. We put a number to all objects for converging it easily. Converged objects converges objects in the WoO platform and makes objects group. Then, the object group becomes application. The objects group #1 composed with cooler sensor, radiator, CCTV, humidifier, Pet care module, and user Park, all the objects are using for pet care application. The objects group #2 composed with cooler sensor, ventilator, auto ventilation module, and user Lee, all the objects are using for auto ventilation application. The objects group #3 composed with CCTV, sprinkler, plant water supply module, and user Kim, all the objects are using for plant water supply application. Finally, the objects group #4 composed with CCTV, home security module, and user Park, all the objects are using for home security application [4].

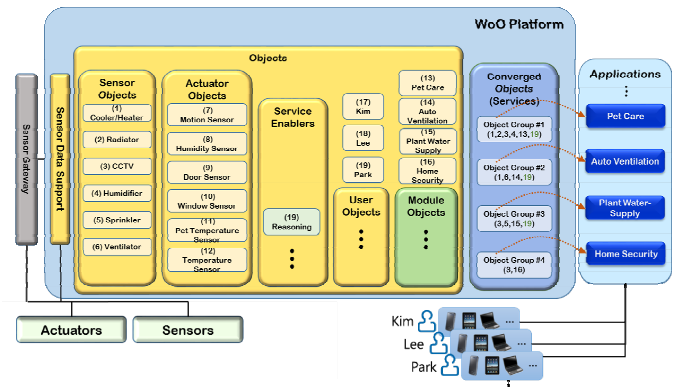


Fig. 1. Architecture of WoO platform

Fig. 2 shows functional view of WoO platform consisted of service orchestration, service composition, objects, sensor data support, and service support functions. Sensors and actuators are divided into web-supported and not web-supported objects

and sensor gateway is used for supporting not web-supported objects.

Service composition consists of following basic functions as illustrated in the Fig. 2.

- **Registry:** Registry function describes and publish the offered functionality of the services to potential consumers (clients). A service registry allows you to organize information about services and provide facilities to publish and discover services.
- **Discovery & Selection:** Service discovery & selection function is the process of locating and gaining access to provided services that satisfy a set of requirements (whether it is capabilities or non-functional aspects).
- **Deployment:** Service deployment function involves concretely associating services to devices in the real world system that is used as the infrastructure
- **Exposure:** Depending on whether the service provider or owner decides to exposes such information or not.
- **Security:** Providers have to guarantee the delivered service to respect a given security policy, in any interaction with the operational environment, and regardless who actually called the service.
- **Session Control:** Session control function deals with the network call control interactions.
- **Service Management:** Service management function comprises all the mechanisms that are required for capturing and processing several attributes of a service execution (related but not limited to quality aspects) to determine whether predefined agreements (such as Service-Level Agreements) are abided by and the execution goes as planned. [5]

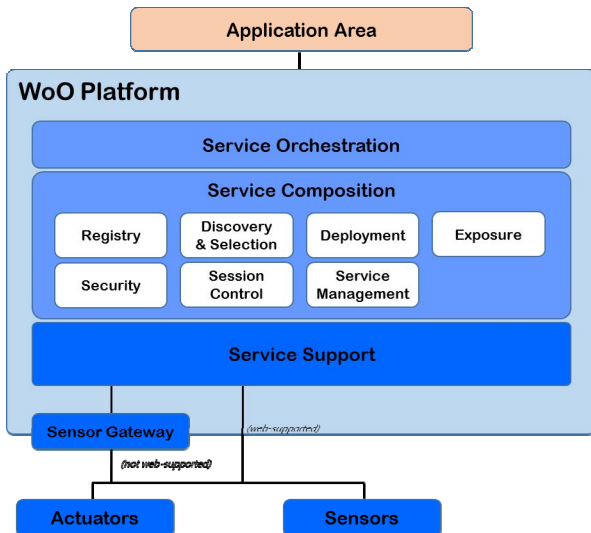


Fig. 2. Functional view of WoO platform

Service orchestration [6] define which message is sent when and by which participating service. Service orchestration

is about executing the result of composition synthesis by coordinating the control and data flow among the participating services and also about supervising and monitoring that execution.

### B. Concept of WoO platform service

WoO platform consider 4 planes, user, service, control, and physical plane described in Fig. 3.

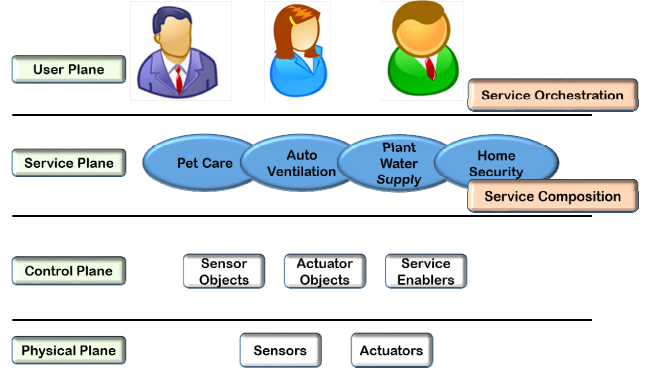


Fig. 3. Planes of WoO platform

- **User plane:** The user plane consider service orchestration. They describe the services that participate in a composition interact at the message level. They receive service request from the user and deliver service response to the user. They deliver service request and context information to the control plane. Also, they receive service allocation from the control plane.
- **Service plane:** They combine and coordinate a set of services with the purpose of achieving functionality that cannot be realized through existing services. In this scenario, we have pet care, auto ventilation, plant water supply, and home security service.
- **Control plane:** They control sensor object, actuator object, and service enabler. They deliver service response to the user plane.
- **Physical plane:** They manage physical sensors like CCTV, humidifier, sprinkler, ventilator, cooler, heater, and radiator. Also, they manage actuators like motion, temperature, pet temperature, window, door, and humidity sensor.

### III. DPWSIM TOOLKIT

The DPWS developed by a consortium led by Microsoft to transmit secure web service data between small devices. DPWS transmits secure messages through web services and also enables discovering web services. DPWS generates small device interactions using web services. DPWS is similar to Universal Plug and Play (UPnP), but it can be adapted general application scenarios through web service. The DPWS is composed of Web Service Description Language (WSDL) and Simple Object Access Protocol (SOAP) [7] to communicate device profiles. DPWS stack is appeared in Fig. 4. The upper layer of DPWS stack can be connected to WoO Platform for service composition.

DPWS provides several web service specifications.

- WS-Addressing: definition of message properties and endpoint references.
- WS-Policy: policy exchange
- WS-Security: message integrity and confidentiality
- WS-Discovery: notification of protocol specially SOAP-over-UDP
- WS-Transfer / WS- Metadata exchange: description of device and service
- WS-Eventing: managing subscriptions for event channels and extension of description.

Also, DPWS uses SOAP, WSDL, XML-Schema for sending messages.

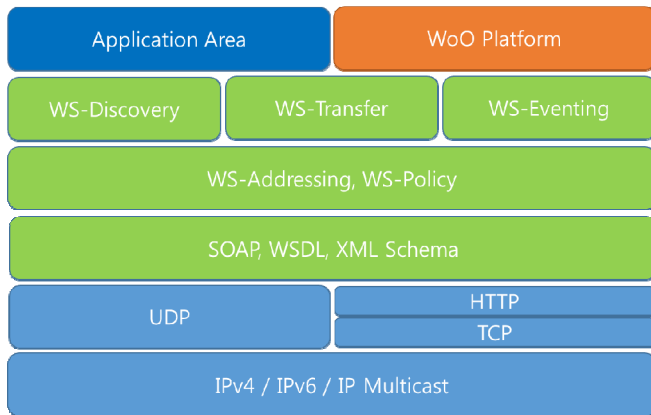


Fig. 4. DPWS Stack

Actually, DPWS provides only connection between objects, so if we converge WoO platform with DPWS, it is possible to simulate high level service composition and service orchestration. That convergence is realized by DPWSim [8][9]. The DPWSim is a simulation toolkit written in Java programming language which provide integrated environment allowing users to design virtual environments of DPWS devices using DPWS technology. It can be used to test collaboration and composition of objects in WoO. DPWSim consists of 4 basic components; space, device, operation, and event. The space provides location of devices and it can be house, office, etc... depicted in Fig. 5. The device is located in the space and it has operation and event. In Fig. 5, a light bulb, coffee machine, and unknown device is generated. Each device has their own operation and event. The operation is a functionality of devices and it can be Switch ON, OFF. The event is also the implementation of device functionality, but it has more time depended functionality. The operation and event can be monitored through DPWS Explorer [10].



Fig. 5. DPWSim space with devices

The DPWS Explorer is a GUI-based DPWS monitoring tool using the Web Services for Devices (WS4D) Java Multi Edition DPWS Stack (JMEDS). The DPWS Explorer provides visualization of message exchange of operations and events. Fig. 6 shows DPWS Explorer which synchronized with DPWSim devices in Fig. 5.

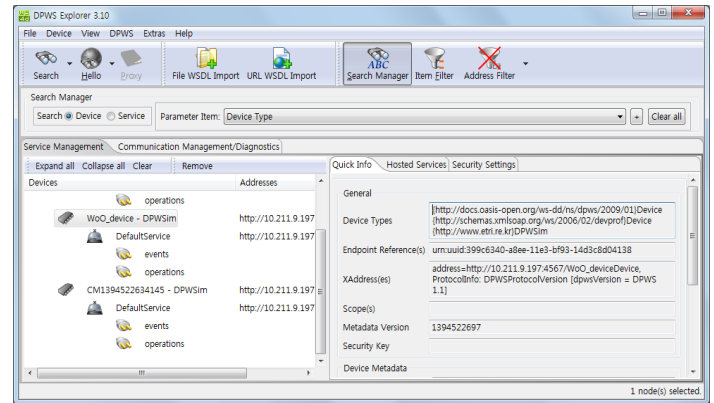


Fig. 6. DPWS Explorer

The DPWSim provides platform independence because it needs only Java Virtual Machine installed machine and flexibility of variety type of objects. In addition, it provides GUI through DPWS Explorer. Therefore, the WoO platform can be suitable platform through DPWSim toolkit.

#### IV. CONCLUSION

We proposed WoO platform which is an efficient platform for service composition and orchestration. We defined functions for service composition in WoO platform architecture. WoO platform is also suitable for home automation system and building automation system. DPWSim is a WoO simulation toolkit using DPWS technology. The simulation through DPWSim will give more experience of WoO applications.

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