Concept for and Implementation of a Root Data Domain Gateway to Provide Interoperability of IoT Data

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SUMMARY The use of Internet of Things (IoT) has become widespread, and therefore heterogeneous IoT services are being offered to meet various needs. The FED4IoT project aims to develop a smart-city application that realize interoperability of IoT system and IoT data among multiple IoT services on the cloud. Our activity is development of an IoT system for wildlife monitoring service in theHakusan area and development of a root data domain gateway that realize data analysis and format conversion for interoperation. FIWARE that is one of the API for IoT system was chosen for data management on the cloud for the system. In addition, data model was created for data analysis and format conversion at the gateway and finally the root data domain gateway applied to the wildlife monitoring system has been proposed.

key words: *IoT, Smart city, Gateway, Data Federation.*

1. Introduction

With the increasing use of Internet of Things (IoT), Heterogeneous IoT services are provided to meet various needs. In order to realize cost reduction and high efficiency, a platform that realize federate such heterogeneous IoT systems is needed. Fed4IoT project aims to develop an IoT virtualization technology to develop a smart-city application that realize data federation and interoperability of multiple IoT platforms.

2. Overview of FED4IoT

Smart-city application requires large-scale infrastructures including heterogeneous IoT devices and information systems. A schematic illustration of FED4IoT is shown in Fig.1. The Fed4IoT project is focusing on development of "VirIoT" platform which realizes interoperability between various IoT platforms using novel IoT virtualization technologies and edge/cloud computing resources in order to separate IoT system and IoT service [1].

Mechanism of the VirIoT is shown in Fig.2. MQTT (Message Queuing Telemetry Transport) networking that is one of publish-subscribe network protocols, was chosen in this platform. IoT data have to be handled in cloud networking for the interoperation, so the data from devices are transferred to cloud platform such as FIWARE and oneM2M. The transferred data is sent to the Fed4IoT cloud system and interoperated between other applications.

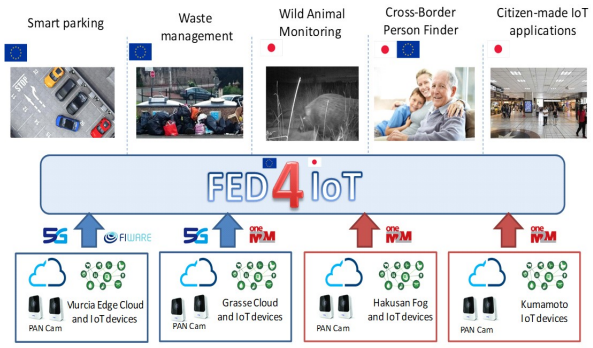

Fig.1 The schematic illustration of FED4IoT

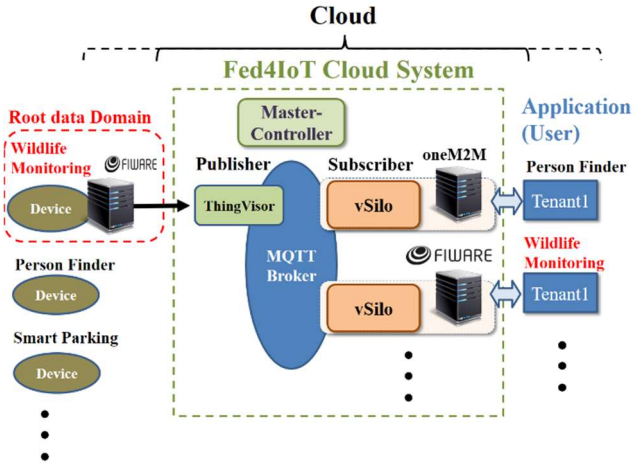

Fig.2 The schematic illustration of the VirIoT

3. The IoT Platform for Wildlife Monitoring

As a part of the project, KIT (Kanazawa Institute of Technology)'s activity is development of an IoT platform for wildlife monitoring in the Hakusan area in Japan. Fig.3 shows a schema for the IoT platform for wildlife monitoring. There are 3 types of end device that consist of sensor, camera and among other device. More details about the platform is written in the reference [2]. All data from end devices is collected at the root data domain gateway (RDG). At the RDG, the received data is analyzed and converted into the data format determined by FIWARE. The obtained data is transferred to the FED4IoT cloud system, distributed to each IoT service and interoperated.

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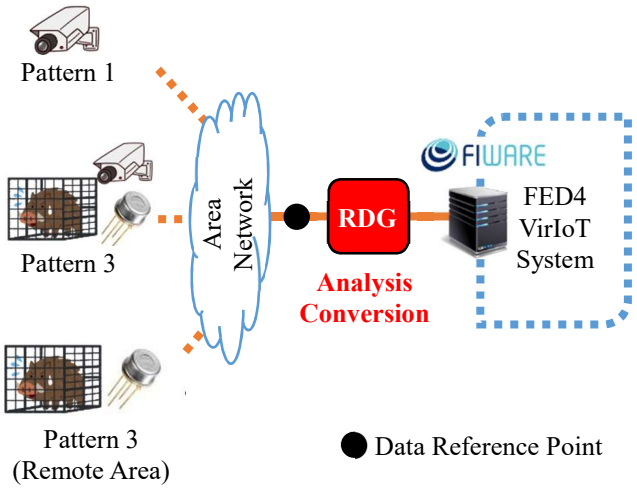

Fig.3 The Proposed IoT platform for wildlife monitoring

FIWARE is an open source platform enabling data economy on the cloud for IoT and big data usage using NGSI (Next Generation Service Interfaces) [3]. NGSI is a network application programming interface enabling data interoperability between different applications [4]. FIWARE was chosen for data management of the proposed system on the cloud.

4. Data Model and the Root Data Domain Gateway

Because it was needed to be known what type of data would be obtained at the RDG, data reference point was placed between area network and the RDG as shown in Fig.3. Data model for the wildlife monitoring system was created based on data model of the FIWARE. The data model is built based on entity-attributes relationship [5]. The entity-attributes relationship is shown in Fig.4. The entity is substance or box containing context data, so context data such as sensor data and location data is stored in the entity.

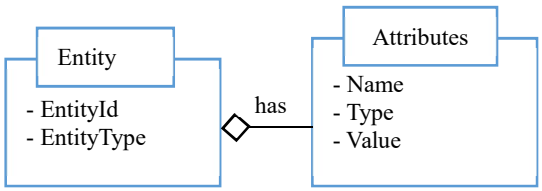

Fig.4 The entity-attributes relationship

Fig.5 shows an example of the data model. Common Data is basic information among the wildlife monitoring system and time, temperature, humidity, illuminance and raindrop data are included.

As a first step to realize the interoperability of IoT data, the RDG is required for data analysis and data conversion based on the data model. As shown in Fig.3, the RDG analyzes received IoT data, converts data format and transfers to the FIWARE server. Finally, the transferred data is interoperated between other FED4IoT applications such as Waste Management and Cross-Border Person Finder.

Table 1. The data model for the common data

Entity	Attributes
CommonData - EntityId - EntityType	- Name : dateissued - Type : date and time - Value
	- Name : temperature - Type : Temperature - Value - Unit : degree
	- Name : humidity - Type : Humidity - Value - Unit : degree
	- Name : illuminance - Type : illuminance - Value - Unit : lux
	- Name : raindrop - Type : Raindrop - Value - Unit : none

5. Conclusions

In this paper, the IoT system for wildlife monitoring service was introduced as one of use cases of the FED4IoT and then, data model for the system was created for development of the Root Data Domain Gateway. Finally, a concept for the RDG applied to the wildlife monitoring system has been proposed for the first step of interoperability of IoT data.

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References

[1] Hidenori Nakazato, "IoT Networks and Their Federation", JAC-ECC 2018, IEICE Invited session #2, 2018

[2] Yoshida, Eisei, et al. "Concept for and Implementation of Wildlife Monitoring to Contribute Sustainable Development Goals." 2019 International Conference on Innovation and Intelligence for Informatics, Computing, and Technologies (3ICT). IEEE, 2019.

[3] Fazio, Maria, et al. "Exploiting the FIWARE cloud platform to develop a remote patient monitoring system." 2015 IEEE Symposium on Computers and Communication (ISCC). IEEE, 2015.

[4] Bauer, Martin, et al. "The context API in the OMA next generation service interface." 2010 14th International Conference on Intelligence in Next Generation Networks. IEEE, 2010.

[5] How to – FIWARE – Data Models, accessed on August 8, 2020 [Online] Available https://fiware-datamodels.readthedocs.io/en/latest/howto/index.html