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An Architecture of IoT Information Gateway in the IMS*

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IMS 기반의 IoT 정보 게이트웨이 구조

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<Abstract>

With the rapid development of 5G technology, more and more network functions are interconnected and more popular. In order to effectively manage emerging network concepts, it allows any device object in the real world to be connected anywhere and at any time through the integration of device object recognition, interaction and raw data collection technologies. In addition, IP Multimedia Subsystem (IMS) is an architecture framework for transmitting IP-based information to the device object which can be represented as end user. Therefore, the Internet of Things and IP Multimedia Subsystem (IoT-IMS) communication platform can provide a convenient and fast way for user or device objects to deploy new application services effectively. In particular, in order to collect and manage the device information from IoT effectively in the IoT-IMS communication platform, an IoT Information Gateway (IIG) is proposed. Through the IoT Application Service (AS) scenario, the collected device information can be easily observed and managed in a unified way.

Key Words : IoT, IMS, SIP, IIG, AS

Ⅰ. 서론

With the rapid development of information and communication technology, the IoT are increasingly equipped with communication modules to connect various types of wireless, wired and mobile networks.

The IoT allows device objects in the real world to be connected at any place and at any time through the integration of device object recognition, interaction and raw data collection technologies. In order to provide convenient access to information, a novel and unified application service is needed. Application Services (AS) framework based on IP Multimedia Subsystem (IMS) can meet the design requirements. In our previous background [10], we

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have been designing and developing an IoT-based IMS AS, which can be considered to be integrated with identification and interaction between device objects [1, 3-5].

IoT Information Gateway (IIG) can collect raw data from devices such as IoT devices, generate meaningful IoT information at an abstract level from the original data of devices, and even make reasonable decisions in the collected raw data.

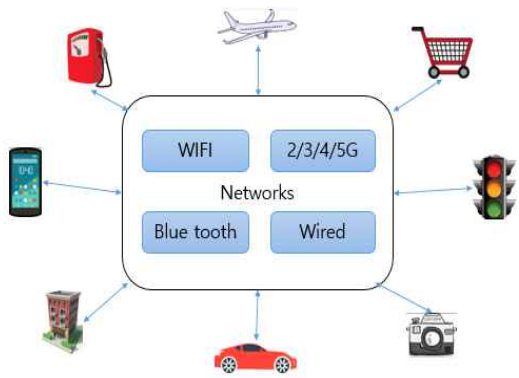
In the IoT-IMS communication platform, users can easily retrieve meaningful raw data from IIG through AS which supports to the device objects. And the IIG with the capabilities such as Event module with Subscribe/Notify, Information Aggregation and Information Abstraction has much more efficient than the gateway without similar any modules.

Ⅱ. Related Works

2.1 The IoT

The IoT is a computing concept that describes a feature where physical objects will be connected to the Internet and be able to identify themselves to other device objects. And the IoT is a network of device objects which communicates among itself using IP connectivity without human interference [11].

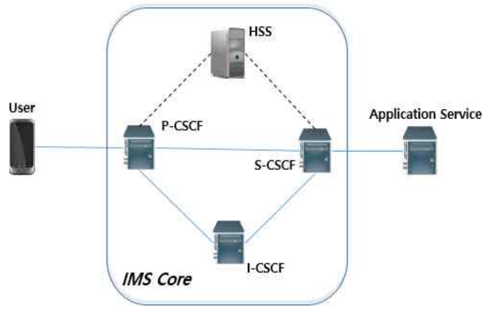
There is a lot of discussion happening around IoT these days. The IoT ecosystem consists of smart objects, intelligent devices etc. It will use a variety of network technologies to enable intercommunication among device objects.



<Fig. 1> Internet of Things (IoT)

2.2 The IMS

The IMS network which is the control layer of the Next Generation Network (NGN) and formulated by 3GPP, is used to access different network technologies and depends on SIP as the communications protocol to control SIP signals by the Call Session Control Function (CSCF).



<Fig. 2> Network Architecture of IMS

The architecture of IMS is shown in Fig 2.

• Proxy-CSCF (P-CSCF): As the first IMS network server faced by one user, P-CSCF forwards a user's SIP messages to I-CSCF for further processing, and any SIP signal response to a user.

- Interrogating-CSCF (I-CSCF): This is a query server which relies on a user's SIP requests or information brought by P-CSCF to find an appropriate S-CSCF for relevant services.
- Serving-CSCF (S-CSCF): This is a server which is particularly used in processing a user's service requests and depends on the requests to find a corresponding application server.
- Home Subscriber Server (HSS): HSS in IMS is particularly used in storing users' data.
- Application Server (AS): As a top-layer application server, it depends on S-CSCF to give a user services.

2.3 Resource Directory (RD)

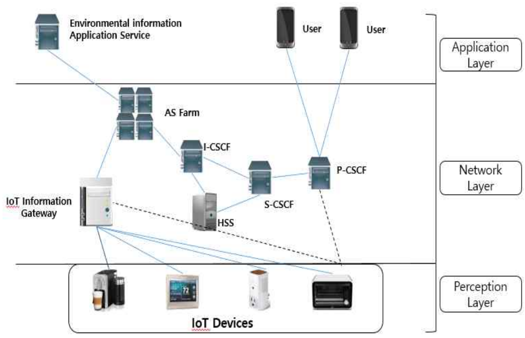
Regarding service discovery, constrained RESTful Environments (CoRE WG) defines a mechanism called Resource Directory (RD) for IoT applications. Resource registration in RD is performed by issuing HTTP/POST requests to RD, and discovery can be accomplished by issuing GET requests to well-known/core URIs. This discovery mechanism is fully contained in the Constrained Application Protocol (CoAP), because it only uses CoAP messages.

The adoption of SIP provides an alternative mechanism for registering resources on RD, which can also be called a constraint of the Session Initiation Protocol (CoSIP) registry service. The advantage of using CoSIP-based registration mechanism is that in addition to the resources available through the restricted application protocol (CoAP), other resources can also be registered, thus providing a scalable universal mechanism for service discovery in more expressive restricted applications, such as setting an expired registration time [9].

Ⅲ. The Framework of IIG Acting as an IoT-IMS AS

3.1 The Framework if IIG

Although the information obtained from IoT can be transmitted to related IoT applications through the network layer, the collected information can be transmitted separately in a simple IoT-IMS communication platform which is referenced in [8]. It will result in the transmission overhead of transmitting the collected information.



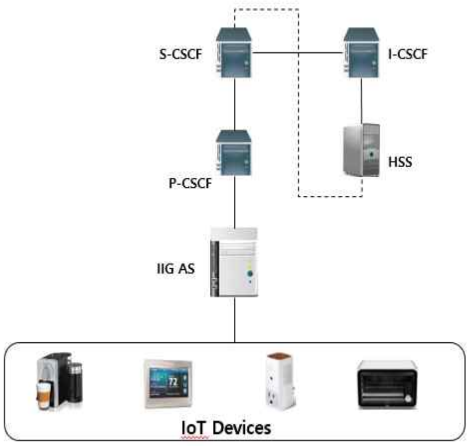
<Fig. 3> A Framework of IIG in the IMS

Fig. 3 shows that the IoT Information Gateway (IIG) can effectively collect and combine the information to throttle the flow of collected information between the IoT device and the corresponding application (i.e., Environmental information Application Service) [8]. The gateway is a key component for collecting, recording and forwarding the collected information and data from IoT devices.

The IIG also serves as a proxy perception layer and a network layer for IoT device objects connected to it. The common features of IIG should include multiple interfaces, protocol transformation and manageability [5]. Therefore, a well-designed IIG is programmable for effectively aggregating raw data disseminated from the perception layer to the network layer [2].

3.2 IoT Information Gateway (IIG)

The proposed IIG architecture is shown in Fig 4.

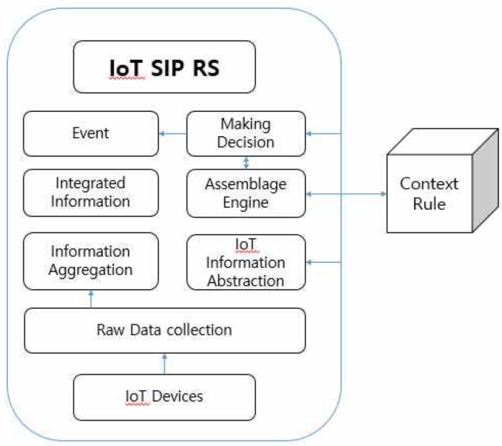


<Fig. 4> The Architecture of IIG Acting as an IoT-IMS AS

This section describes the IoT application service technology and designs the IIG which can collects and manage the data in the IoT in order to reduce the flow of sensing information transmission in the environment of IIG AS.

3.3 The modules of IoT-enabled AS of IIG

The proposed IIG IoT enabled functional modules are shown in Fig. 5. The IIG basically consists of four modules: SIP registration service, raw data collection, information aggregation and integrated information module. They are used to control message forwarding to IoT devices. The other modules of IIG are used for context-aware computing through object interaction to realize the intelligence of things in the IoT-IMS communication platform.



<Fig. 5> The Modules of IoT-enabled AS of IIG

The Raw Data Collection module is responsible for collecting the sensing raw data from the device objects in the perception layer. The Information Aggregation module aggregates various types of raw data into a compact mode. In order to encapsulate aggregated information in a readable fashion, the IoT Information Abstraction module is responsible for converting the IoT sensing information obtained from device objects. The raw data is used to the meaningful IoT information for conveniently examining and realizing the meaning of IoT raw data. The Assemblage Engine module analyzes the information to summarize the suggesting results based on context rules. The Making Decision module will refer the suggesting results to make some decision to trigger some event occurrences or due to some actions through the Event module [7]. The IoT SIP Registration Service module is through the SIP header and identification of IoT information, as shown in Fig. 5.

The IIG retains the feature of context-awareness [6]. It can easily integrate the ubiquitous and pervasive computing to realize the smart intelligence in IoT networks.

3.4 A Request by SIP MESSAGE

Fig. 6 shows a request of sensing information from the device object carried by a SIP MESSAGE.

To carry the aggregated sensing raw data between devices and IIG, it adopts the SIP "MESSAGE" and "200 OK" messages to encapsulate the requests and responses of sensing information respectively. A specific tag header, called "EVENT", is also embedded into the SIP "MESSAGE" and "200 OK" messages to identify and extract the sensing information from SIP messages based on the "EVENT" tag.

3.5 The IoT AS Scenario

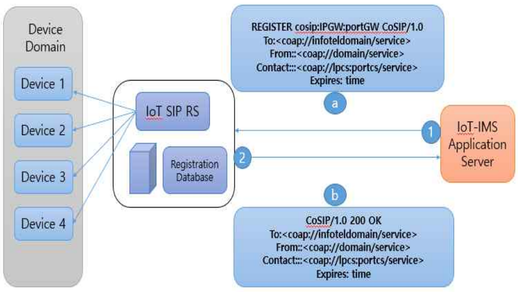
A network element, denoted as IIG, which includes also a HTTP/CoAP proxy, which can be used by nodes residing outside the constrained network to access CoAP services [12].

```
MESSAGE sip:iot-devices SIP/2.0
Via: SIP/2.0/UDP 220.68.65.162:5060;branch=z9h
From:<sip:devices@iot-ims.korearech>;tag=31415
To: <sip:iot-ims-as>
Call-ID: apb304a94sslfaser2le93aj22
Cseq: 3584 MESSAGE
...
Contact: iot-device id
Address of record: iot-device id<d1,d2,d3>
Route:<sip:orig@s-cscf.iot-ims.koreatech:5060;lr>
Event: iot-device
...
<?xml version="1.0"encoding="UTF-8"?>
<IoT_Information_Gateway type="request"id="1"time="4294967295">
<iot-device id="d1">
<iot-device id="d2">
<iot-device id="d3">
...
</IoT_Information_Gateway>
```

<Fig. 6> A SIP Request Message for Sensing Information

CoSIP allows device objects to register the services they provide to populate an IoT SIP Registration Service, which serves as a RD. The terms "IoT SIP Registration Service" and "Resource Directory" are here interchangeable.

Upon receiving the registration request, the Registration Serivce can store the Address of Record (AoR) to Contact Address mapping in a Location Database and then sends a 200 OK response.



<Fig. 7> An IoT Application Service Scenario

The depicted IoT Application Service scenarios consider several Subscribe/Notify interactions: the notifications can be also sent by an IoT-IMS Application Server and an IoT information Gateway. Let's assume that the notifiers have registered with their IoT CoSIP Registration Service. (This step is also denoted as the Publishing phase in a typical Subscribe/Notify scenario). The standard subscription/notification procedure is shown as following:

1. The subscriber sends a request to the device object, and specifying the service events.
2. The device object stores the subscriber's and event information and sends a 200 OK response to the subscriber.
3. Whenever the state of device object's changes, it sends a message to the subscriber.
4. The subscriber sends a 200 OK response back to the device object.

From the points of performance, although it has some minor processing overhead, the IIG with the capabilities such as Event module with Subscribe/Notify, Information Aggregation and Information Abstraction has much more efficient than the gateway without any modules intuitively.

Ⅳ. Conclusion

In order to collect and manage raw data effectively in the IoT-IMS communication platform, the IIG has been developing to collect changes in sensing raw data information and environmental conditions from IoT device objects. According to the change of perceived information in the IoT, trigger events are set to reflect the impact of environmental perception. Therefore, in IoT-IMS communication mode, it is easy to organize a scenario environment to serve the interaction of things and observe the effect of IIG AS.

IoT-IMS communication platform can provide device users with a convenient way to deploy new application services efficiently. Through IIG, mobile users can easily observe and manage the collected information in a unified way. In particular, in order to collect and manage the device information from IoT effectively in this platform, the IIG with the capabilities such as Event module with Subscribe/Notify, Information Aggregation and Information Abstraction has much more efficient than the gateway without these modules.

We believe that the next step in the field of the IoT is to implement a virtual computing platform that provides access to heterogeneous device resource groups that exist in our environment.

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