



Technical Report	
Document Name	IoT mobile App develop project : monitoring presence of people in classroom
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Author	Team : Wanderer 15011091 박혜선 15011095 이유리 15011113 이다솔 15011117 장세영

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1. Intro

The present document provides a simple use case for the finding an empty classroom application of team 'Wanderer'. It is using functionalities provided by a oneM2M platform with the scope of as follows :

- objectives of the use case;
- the architecture of the use case mapped into an oneM2M service platform;
- the execution procedures for implementation of the user case;
- implementation details of the user case : Http and xml serialization;
- features that can be added later.

2. References

2.1. Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document applies.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] TR-0034_Developer Guide CoAP binding and long polling for temperature monitoring

[i.2] Thyme Developer Guide_v1.6.4_KR

[i.3] Installation Guide_Mobius_Yellow_Turtle_v2.3.4_KR

3. Motivation and Challenges

3.1. Motivation

Students have difficulty finding their places to study. Space in the library is limited, so it can not accommodate many students. However, there are many empty classrooms that are not used. So, our team decided to develop the application that show the empty classroom that are located in Sejong university to students.

3.2. Challenges

Before starting development, we search for case which is similar to our idea. There is an Gwangun university application 'Find an empty classroom', and it provides the information of existence of classroom based on their syllabus. It is not reliable in exceptional situations, such as change of the timetable and cancelation of class. In order to complement for such problems, we determined to use the Pi-cam and OpenCV source codes. That will provide real-time information to students by capturing the inside of classroom.

4. Use case

This clause briefly describes the use case from perspective of service being provided by oneM2M platform. The physical device components are introduced in the current clause.

The described use case enables the user to check the existence of persons in the classroom as well as the classroom congestion via a smart phone embeds an application that can send request to a Mobius server.

An overview of the use case is shown in figure 4-1. The main components include :

- The RaspberryPi and Pi-cams are deployed in any place as needed, and connected to a Mobius server by OpenCV.
- The server provides a set of services to enable the smart phone user to check the existence of persons in the classrooms by displaying red and green colors.
- The smart phone application should support some functions such as checking the existence of persons in the classroom, classroom congestion rate and showing a user where the buildings he or she choose are located on campus.

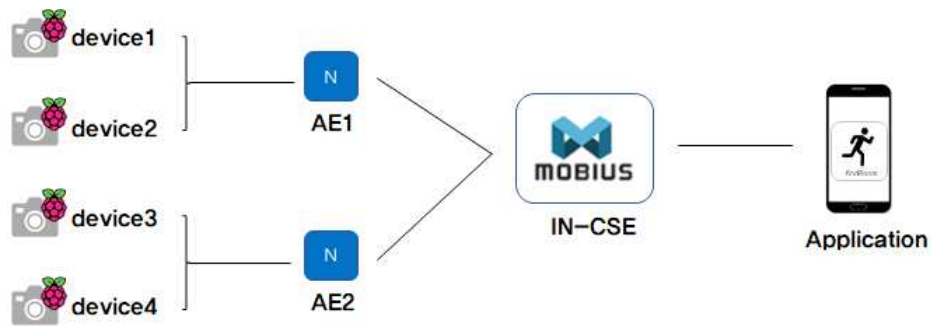


Figure 4-1 : Overview of detecting existence of persons in the classroom use case

Application UIs that show the use case is shown in figure 4-2. These explain :

- If the user select the building, the congestion rate appears as a pop-up. Then, user can choose the floor he or she wants to see.
- The server provides a set of services to enable the smart phone user to check the existence of persons in the classrooms by displaying red and green colors.

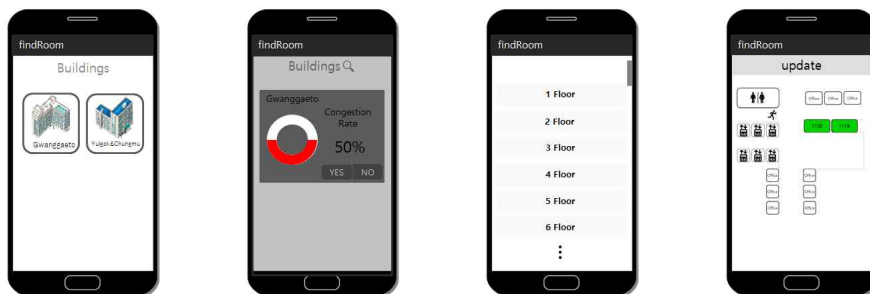


Figure 4-2 : Application UIs showing the steps for finding an empty classroom

Also, application UIs that handle error are shown in figure 4-3. These explain :

- When the server does not work, application display the server error message.
- When the Pi-cam breaks down, the color of classroom is displayed in yellow.

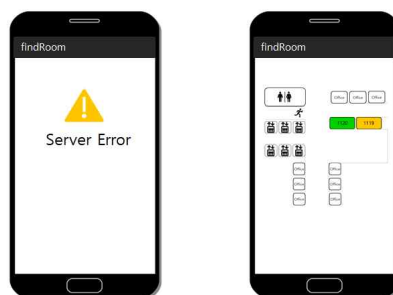


Figure 4-3 : Application UIs showing error cases

5. High Level Architecture and entities

This clause describes the high level architecture of Detecting the presence of People Project with components represented by the oneM2M entity roles.

In this project :

- The device RaspberryPi and Pi-cam are connected to Mobius server.
- The AE which resides in the &Cube Application Dedicated Node is called ADN-AE.
- An IN-CSE (short for Infrastructure Node CSE) is hosted in the server.

For instance, the architecture is show in figure 5-1 :

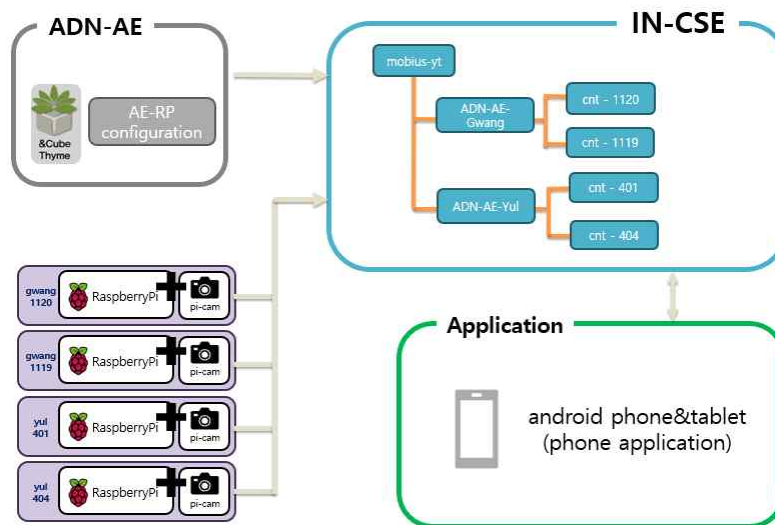


Figure 5-1 : High level architecture of Detecting the presence of persons

Applications used in the current project are classified as follows :

- 1) ADN-AE-Gwang : an application that deals with devices(RaspberryPi + Pi-cam) in Gwanggaeto through &Cube Thyme and interact with the IN-CSE.
- 2) ADN-AE-Yul : an application that deals with device(RaspberryPi + Pi-cam) in Yulgok through &Cube Thyme and interact with the IN-CSE.
- 3) Application : a smart phone application embedded in the smart phone device that can interact directly with IN-CSE and thereby monitor Pi-cam's result.

6. Resource tree structure

All of resource tree of this project is show in figure 6-1 :

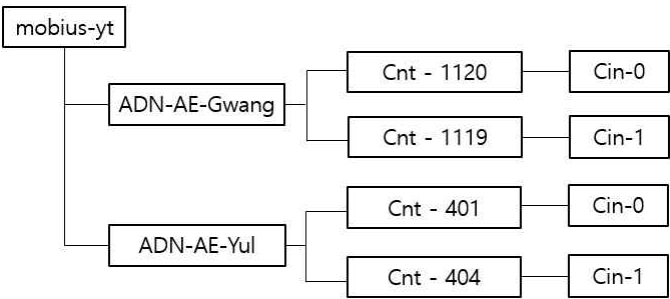


Figure 6-1 : Resource tree of this project

7. Procedures and call flows

7.1. Registration

The first step is device(RaspberryPi + Pi-cam) registration. Device(RaspberryPi + Pi-cam) will be registered by &Cube Thyme to Mobius server. The smart phone applications can connect to Mobius server anytime as needed.

Call flows regarding the registration phase depicted in figure 7.1-1 are ordered as follows :

- 1) &Cube Thyme is installed in RaspberryPi.
- 2) Device(ADN-AE-Gwang/ADN-AE-Yul) is registered to Mobius(IN-CSE) by &Cube Thyme.

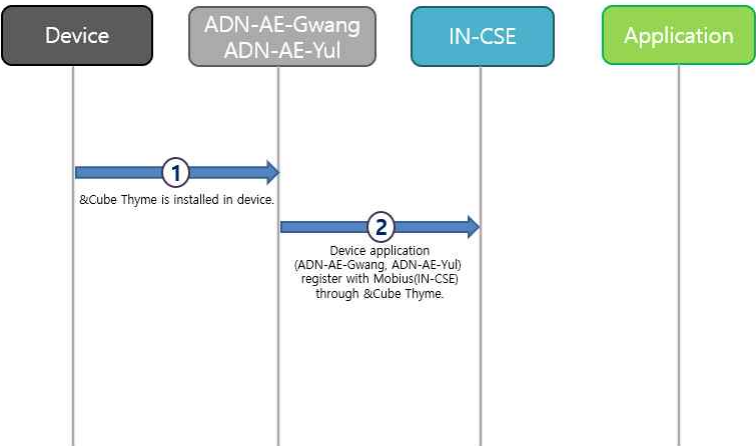


Figure 7.1-1 : Registration phase call flows

7.2. Initial resource creation

After registration, it is necessary to create container resources to store the data from device on the &Cube Thyme. Call flows regarding the initial resource creation phase depicted in figure 7.2-1 are ordered as follows :

Several container resources are created in the Mobius(IN-CSE) to store each of classroom's device data under the registered device(ADN-AE-Gwang/ADN-AE-Yul).

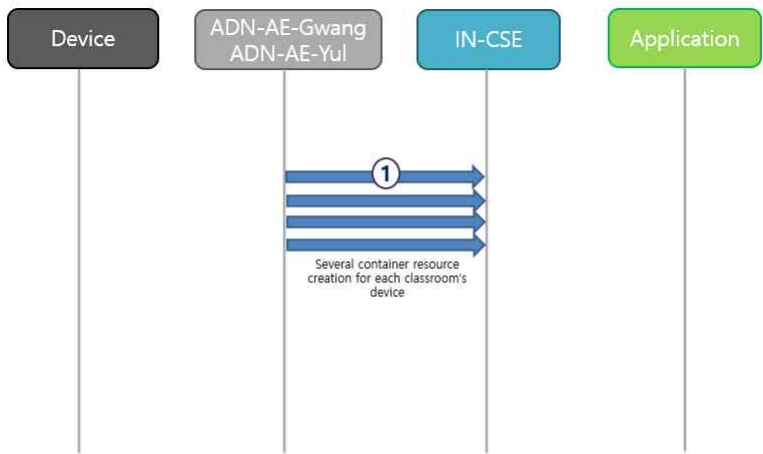


Figure 7.2-1 : Initial resource creation phase call flows

After the initial resource creation process, the resource tree of IN-CSE is depicted in figure 7.2-2.

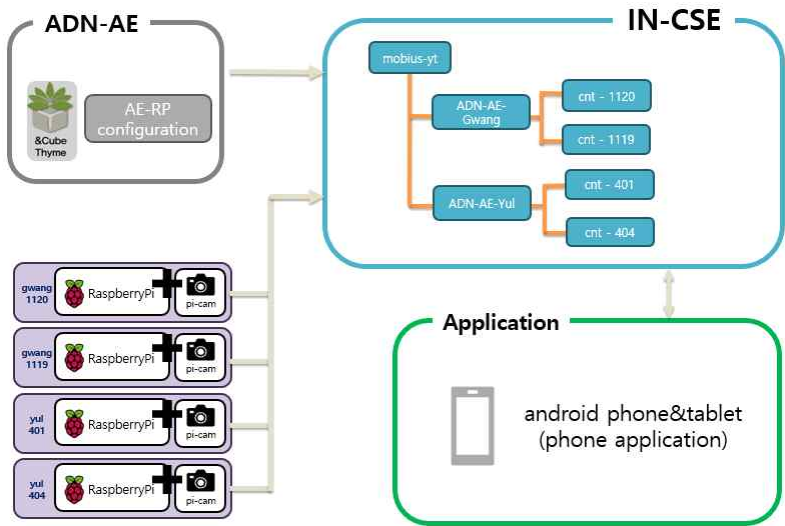


Figure 7.2-2 : State of after the initial creation process

7.3. Discovery and retrieval

Call flows regarding the discovery and retrieval of resources depicted in figure 7.3-1 are ordered as follows :

- 1) The smart phone application(Application) sends a RETRIEVE request including the parameter filterUsage and specific filter criteria condition(s) as a query string for discovery of resources stored under the ADN-AE-Gwang/ADN-AE-Yul.
- 2) The Mobius(IN-CSE) responds to the smart phone application(Application) with URIs of the discovered resources under ADN-AE-Gwang/ADN-AE-Yul.
- 3) The smart phone application(Application) sends RETRIEVE requests for retrieval of the latest data from discovered device resource(in the app, when user selects the update button), in this example, which is from the container-gwang1119 of ADN-AE-Gwang/ADN-AE-Yul(Figure 7.3-2).
- 4) The Mobius(IN-CSE) responds to the smart phone application(Application) with the latest data of device(contentInstance).

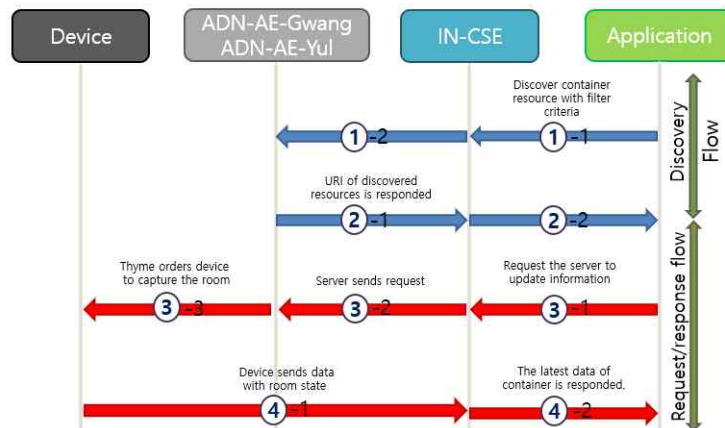


Figure 7.3-1 : Discovery and Retrieve phase call flows

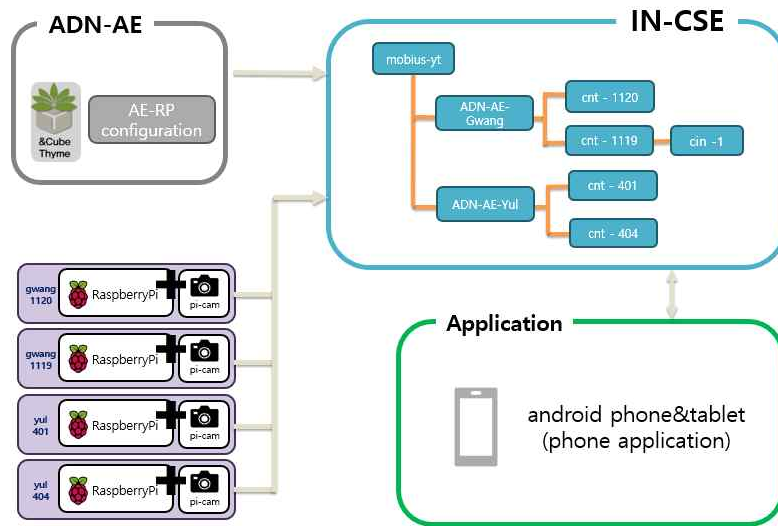


Figure 7.3-2 : Example of retrieve of latest data

8. Roles of entities

8.1. Mobius (IN-CSE)

The Mobius platform is modelled as an IN-CSE and is responsible for :

- handling requests from smart phone Application and &Cube(ADN-AE-Gwang/ADN-AE-Yul)

8.2. &Cube Thyme (ADN-AE-Gwang / ADN-AE-Yul)

Each of the device applications are modelled as an &Cube(ADN-AE-Gwang/ADN-AE-Yul) and are responsible for :

- registering devices with the IN-CSE
- creating container resources in the IN-CSE
- creating content resources under containers cin-1 or cin-0 according to data

8.3. Smart phone applications (Appication)

The smart phone application which directly communicates with the Mobius(IN-CSE) and is responsible for :

- discovering and displaying the data from IN-CSE

9. Procedures

9.1. Registration and resource creation

The following example shows an device ADN-AE-Gwang/ADN-AE-Yul registration request and response in clause 7.1 using Http with JSON serialization.

Http Request : (ADN-AE-Gwang)

```
Method : POST
Path : http://58.233.226.102:7579/mobius-yt?rcn=3
Headers
{
    Accept : application/xml
    X-M2M-RI : 4891
    X-M2M-Origin : S
    Content-Type : application/vnd.onem2m-res+xml; ty=2
}
Body
{
    <?xml version="1.0" encoding="UTF-8"?>
    <m2m:ae xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rn="adn-ae-Gwang">
        <api>4.2.801.916.0.130</api>
        <rr>true</rr>
    </m2m:ae>
}
```

Http Response :

```
{
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <m2m:ae xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
        <m2m:ae rn="adn-ae-Gwang">
            <ty>2</ty>
            <pi>rkR-qJGyf</pi>
            <ri>HkbCvxBExf</ri>
            <ct>20171123T123445</ct>
            <et>20191123T123445</et>
            <lt>20171123T123445</lt>
            <api>4.2.801.916.0.130</api>
        </m2m:ae>
    </m2m:ae>
}
```

```

        <aei>S20171123123445877p0AT</aei>
    </m2m:ae>
    <m2m:uri>/mobius-yt/adn-ae-Gwang</m2m:uri>
</m2m:rce>
}

```

Http Request : (ADN-AE-Yul)

Method : POST

Path : http://58.233.226.102:7579/mobius-yt?rcn=3

Headers

```

{
    Accept : application/xml
    X-M2M-RI : 4891
    X-M2M-Origin : S
    Content-Type : application/vnd.onem2m-res+xml; ty=2
}

```

Body

```

{
    <?xml version="1.0" encoding="UTF-8"?>
    <m2m:ae xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rn="adn-ae-Gwang">
        <api>4.2.801.916.0.130.2</api>
        <rr>true</rr>
    </m2m:ae>
}

```

Http Response :

```

{
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <m2m:ae xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance">
        <m2m:ae rn="adn-ae-Yul">
            <ty>2</ty>
            <pi>rkR-qJGyf</pi>
            <ri>BybLgeBVgz</ri>
            <ct>20171123T123245</ct>
            <et>20191123T123245</et>
            <lt>20171123T123245</lt>
            <api>4.2.801.916.0.130.2</api>
            <aei>S2017112312324556987Sz</aei>
        </m2m:ae>
    </m2m:ae>
}

```

```

        <m2m:uri>/mobius-yt/adn-ae-Yul</m2m:uri>
    </m2m:rce>
}

```

Then the following example shows a container(cnt-1119) create request and response in the procedure of clause 7.2 using Http with xml serialization.

Http Request :

Method : POST

Path : http://58.233.226.102:7579/mobius-yt/adn-ae-Gwang

Headers

```

{
    Accept : application/json
    X-M2M-RI : 4891
    X-M2M-Origin : SOrigin
    Content-Type : application/vnd.onem2m-res+xml; ty=3
}

```

Body

```

{
    <?xml version="1.0" encoding="UTF-8"?>
    <m2m:cnt xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rn="cnt-1119">
        <lbl>gwang1119</lbl>
    </m2m:cnt>
}

```

Http Response :

```

{
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <m2m:cnt xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rcn="cnt-1119">
        <pi>HkbCvxBExf</pi>
        <ty>3</ty>
        <ct>20171123T124347</ct>
        <ri>S1GitzSEIM</ri>
        <lt>20171123T124850</lt>
        <et>20191123T124347</et>
        <lbl>gwang1119</lbl>
        <st>2</st>
        <mni>3153600000</mni>
    </m2m:cnt>
}

```

```

        <cr>SOrigin</cr>
        <mbs>315360000</mbs>
        <mia>31536000</mia>
        <cni>2</cni>
        <cbs>2</cbs>
    </m2m:cnt>
}

```

Then the creation of a content instance resource under the container of ADN-AE-Gwang/ADN-AE-Yul with initial content is shown in the following procedure. The following example shows a contentInstance create request and response using Http with xml serialization :

Http Request :

Method : POST

Path : http://58.233.226.102:7579/mobius-yt/adn-ae-Gwang/cnt-1119

Headers

```

{
    Accept : application/xml
    X-M2M-RI : 4891
    X-M2M-Origin : SOrigin
    Content-Type : application/vnd.onem2m-res+xml; ty=4
}

```

Body

```

{
    <?xml version="1.0" encoding="UTF-8"?>
    <m2m:cin xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rn="gwang1119cam">
        <con>1</con>
    </m2m:cin>
}

```

Http Response :

```

{
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <m2m:cin xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rn="gwang1119cam">
        <ty>4</ty>
        <pi>S1GitzSElM</pi>
        <ri>B1Gs2QrEez</ri>
    </m2m:cin>
}

```

```

        <ct>20171123T124850</ct>
        <et>20191123T124850</et>
        <lt>20171123T124850</lt>
        <st>2</st>
        <cs>1</cs>
        <con>1</con>
        <cr>SOrigin</cr>
    </m2m:cin>
}

```

The smart phone applications can be connected to the Mobius server anytime as needed.

9.2. Discovery and Retrieve

As mentioned in clause 7.3, the smart phone application periodically sends a RETRIEVE request including the parameter filterUsage and specific filter criteria condition(s) as a query string for discovery of resources stored in the IN-CSE.

The discovery of containers for each devices registered with the ADN-AE-Gwang/ADN-AE-Yul by the smart phone AE is shown in the following procedure.

Http Request :

```

Method : GET
Path : http://58.233.226.102:7579/mobius-yt?fu=1&ty=3
Headers
{
    Accept : application/xml
    X-M2M-RI : 4891
    X-M2M-Origin : SOrigin
}

```

Http Response :

```

{
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <m2m:uril xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" >
    /mobius-yt/adn-ae-Gwang/cnt-1120 /mobius-yt/adn-ae-Yul/cnt-40
    1/mobius-yt/adn-ae-Yul/cnt-101 /mobius-yt/adn-ae-Gwang/cnt-
    1119</m2m:uril>
}

```

```
}
```

The smart phone application can retrieve the device data from ADN-AE-Gwang / ADN-AE-Yul. If the response is preferred to be returned with a xml representation, the following is a Http request message example :

Http Request :

Method : GET

Path : <http://58.233.226.102:7579/mobius-yt/adn-ae-Gwang/cnt-1119/latest>

Headers

```
{
    Accept : application/xml
    X-M2M-RI : 4891
    X-M2M-Origin : SOrigin
}
```

Http Response :

```
{
    <?xml version="1.0" encoding="UTF-8" standalone="yes"?>
    <m2m:dbg xmlns:m2m="http://www.onem2m.org/xml/protocols"
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    rn="gwang1119cam">
        <pi>S1GitzSEIM</pi>
        <ty>4</ty>
        <ct>20171123T124850</ct>
        <ri>B1Gs2QrEez</ri>
        <lt>20171123T124850</lt>
        <et>20191123T124850</et>
        <st>2</st>
        <cs>1</cs>
        <cr>SOrigin</cr>
        <con>1</con>
    </m2m:cin>
}
```

10. Future work

Later, functions of login, bookmark, and checking the number of persons can be added. With the addition of the login and bookmark feature, only authorized Sejong university students can use the app properly as well as registering a

classroom with a bookmark for the easier use. Also, adding a function of counting persons can provide reliable information rather than providing simple availability.

11. Conclusions

The current use case is realized by following the high level procedures such as registration of RaspberryPi and Pi-cam, container resource creation and content instance retrieval with the oneM2M service platform.