



# ThingPlug 활용 실습

## MQTT on Arduino

이상민/이호상/성지웅 Manager

SK텔레콤 | 플랫폼기술원 | IoT Tech Lab.



# Syllabus



- 1 ThingPlug 소개
- 2 ThingPlug – Device API
- 3 ThingPlug – Application API
- 4 Demo & 실습

- 회원가입: <https://thingplug.sktiot.com>



- 디바이스 연동 프로토콜: HTTP 선택 (oneM2M 국제표준 기반규격)

ThingPlug Portal

▶ 사용자 정보

사용자 ID \*

hellotp

이디는 영문 소문자, 숫자, 특수문자("@", ".", "-", "\_")만 가능합니다.

사용자 이름 \*

비밀번호 \*

.....

영문, 숫자, 특수문자 중 세 가지 조합: 9자 ~ 20자 사용 가능합니다.

비밀번호 확인 \*

.....

비밀번호를 다시 한번 입력하세요.

E-Mail \*

hellotp@skt.com

전화번호 \*

010 - 5431 - 9876

가입 승인 완료 SMS를 받아 보실 수 있습니다.

디바이스 연동 프로토콜 \*

HTTP ☒ oneM2M 프로토콜 기반

TCP ☐

개발자 구분

☐ 개발자  
 앱 또는 디바이스 개발자용 메뉴를 사용하고자 할 경우 체크 해 주십시오.

▶ 서비스 플랫폼

서비스 플랫폼 선택

☒ 사용
 ☐ 미 사용

sp1.sktiot.com

[나만의 IoT 서비스 만들기]를 이용하기 위해서는 '서비스 플랫폼 선택'에서 '사용'을 체크해야 합니다.

HTTP, MQTT, CoAP 지원

- 3 -

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# ThingPlug

- 디바이스 ID: **nodeID (0.2.481.1.101.01087654321)** 휴대폰 전화번호, MAC주소 등 고유번호
- 사용자 인증키: **uKey (시스템 생성)**
- 디바이스 인증키: **dKey (시스템 생성)**

developers ThingPlug®

openhwdemo 님 환영합니다. | 로그아웃 | 정보수정 | 마이페이지

검색어를 입력하세요.

☰

마이페이지

마이 IoT

마이 IoT

회원정보수정

나의 디바이스

나의 앱

나의 토픽

나의 매쉬업 API

장애 메시지 수신 설정

디바이스

등록 2건

펌웨어 업그레이드

신규 0건

디바이스 어플리케이션

신규 0건

앱

등록 0건  
구매 0건

토픽

등록 0건  
가입 0건

매쉬업 API

등록 0건

사용자 인증키

NmhHQmlMdEVpc0l6SWRqc3l iRUNQaUFYQkpkeA==

나의 디바이스

더보기 >

1.2.481.1.999.152.0003

홈모니터링, 개인개발자용 제조사...

Alive

2016-04-29

1.2.481.1.999.152.0001

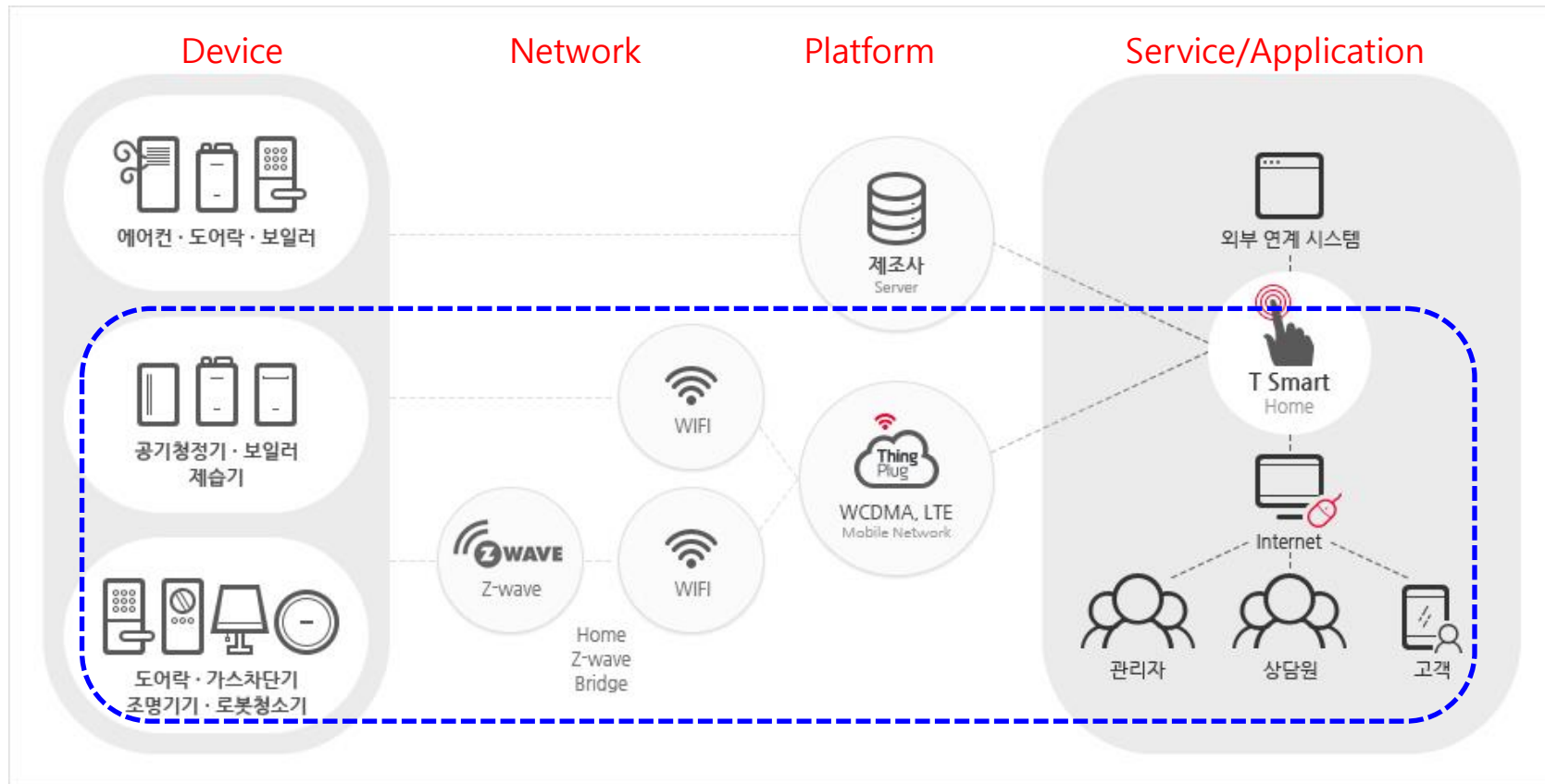
보안/안전, 개인개발자용 제조사...

Alive

2016-03-11

# ThingPlug

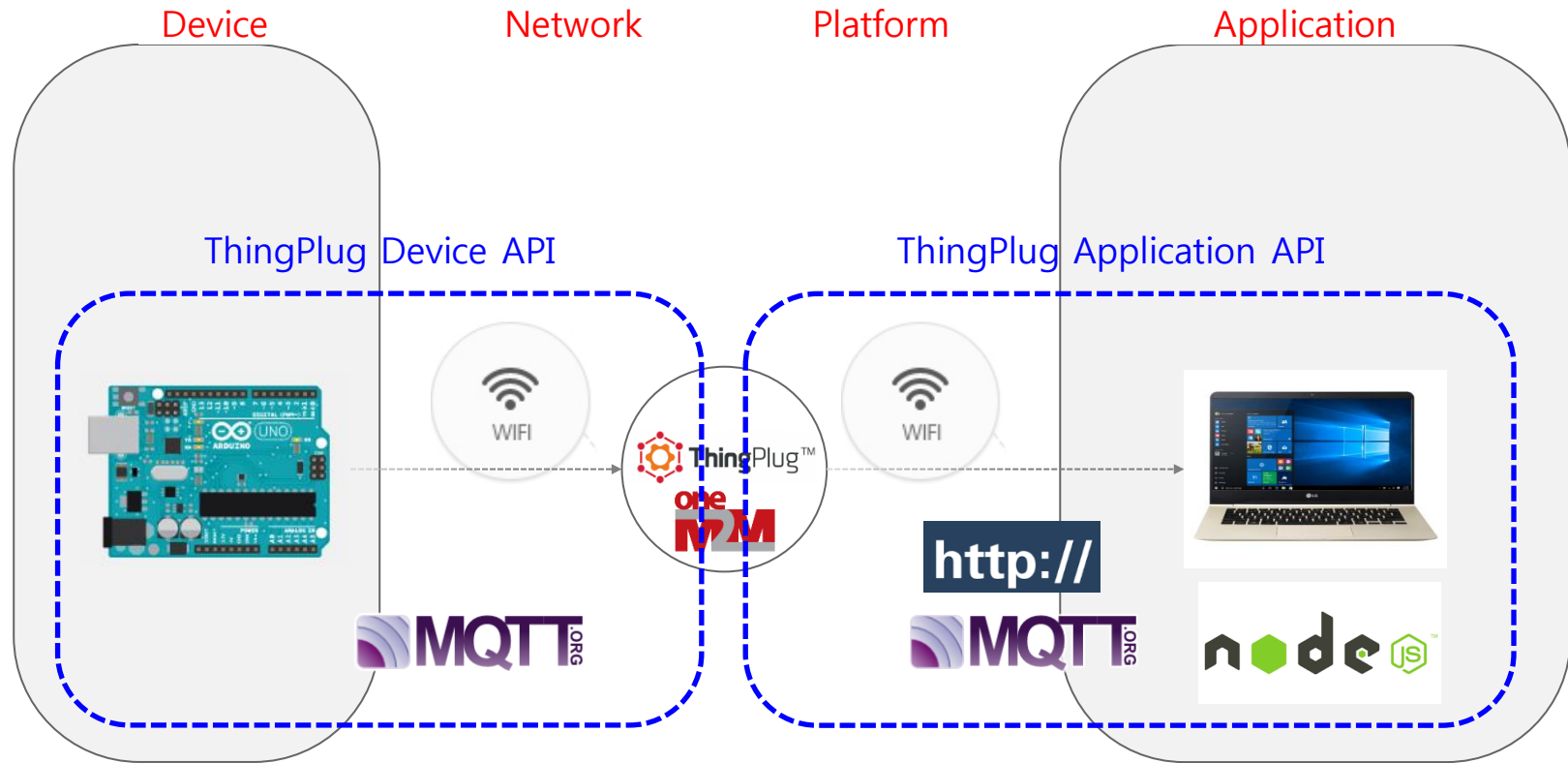
- IoT 서비스 구조: 스마트홈 사례





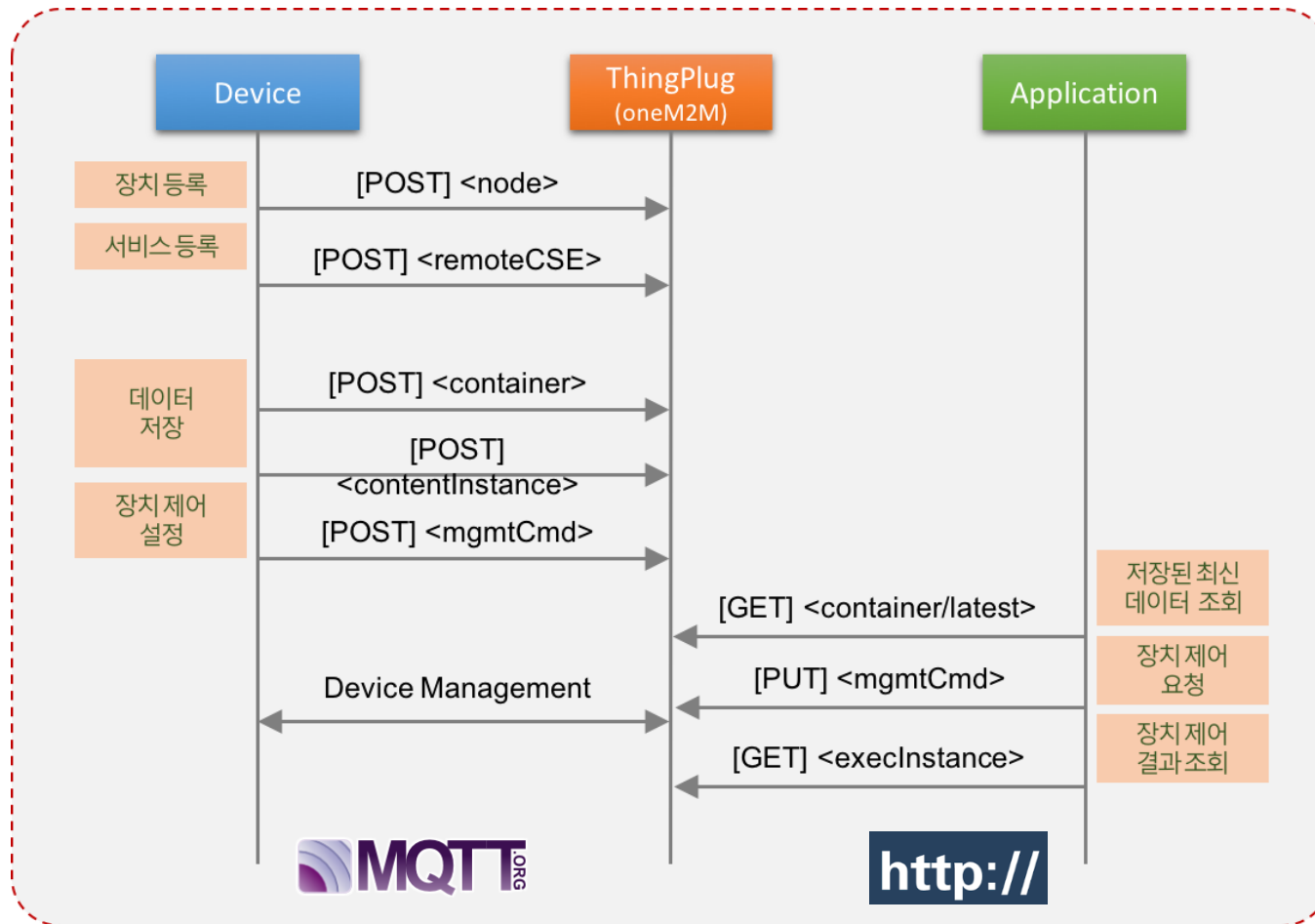
# ThingPlug

- IoT 서비스 구조: 실습 구조



# ThingPlug

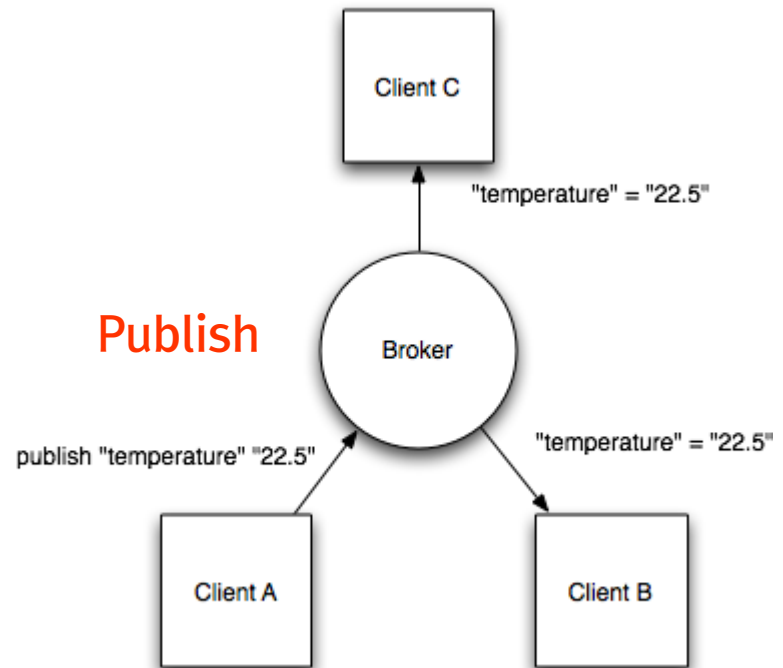
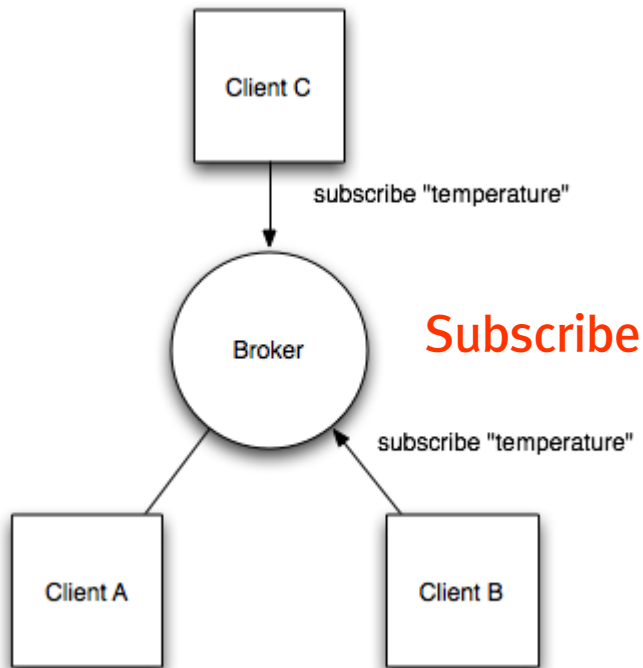
- oneM2M Protocol: <http://onem2m.org/technical/published-documents>





# MQTT

- MQTT (MQ Telemetry Transport) is an ISO standard (ISO/IEC PRF 20922) publish-subscribe based "light weight" messaging protocol for use on top of the TCP/IP protocol (from Wikipedia)
- MQTT의 개념



# MQTT

- MQTT client 설치

1. MQTTLens: chrome extension

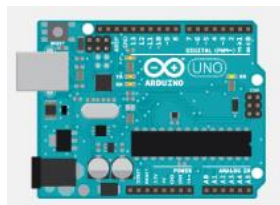
<https://chrome.google.com/webstore/detail/mqttlens/hemojaaeigabkbcokmlgmdigohjobjm>

2. MQTT.fx: Java application

<http://mqttfx.jfx4ee.org/>

3. MQTT client for Arduino

<https://github.com/knolleary/pubsubclient>



Subscribe  
Publish



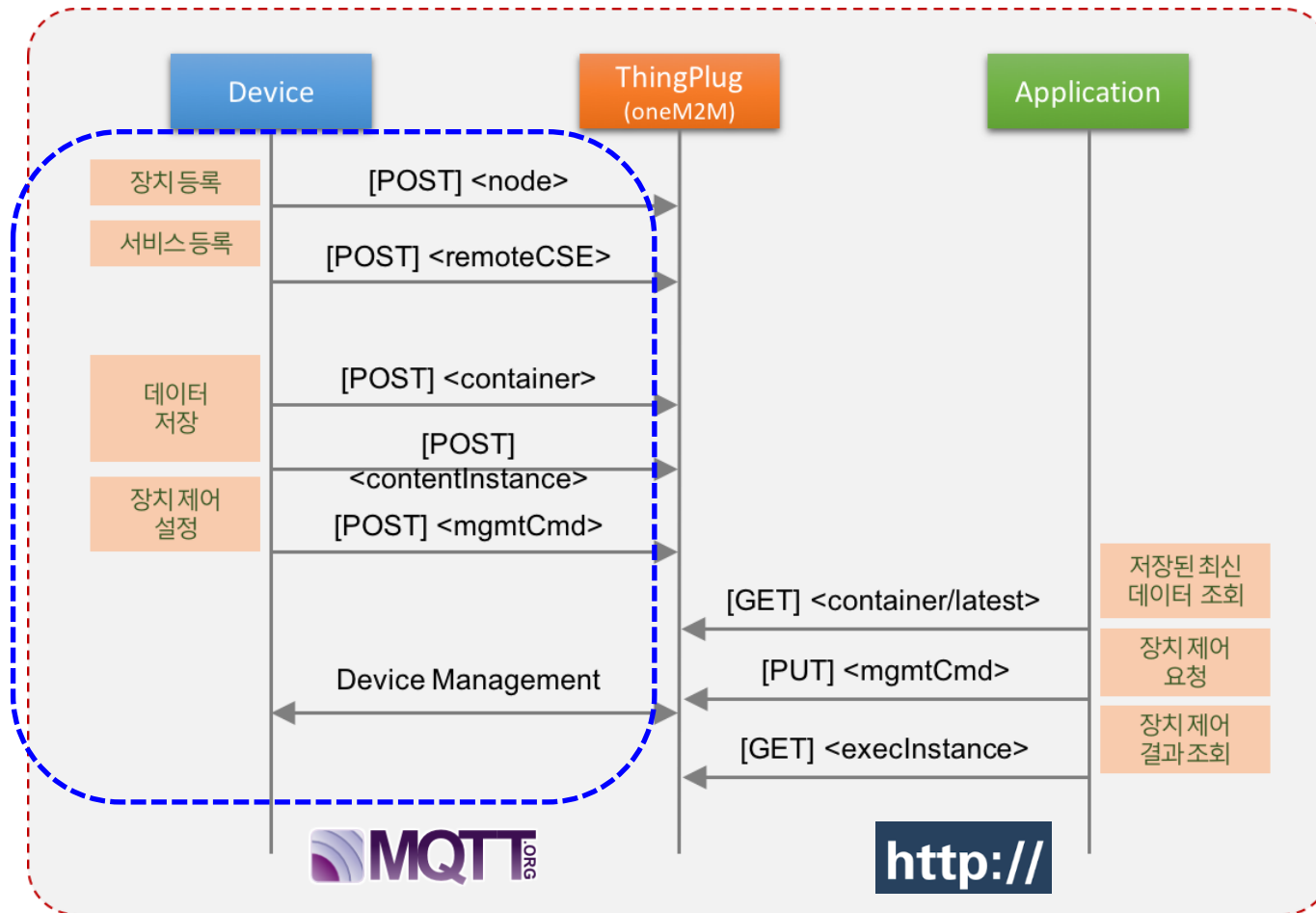
Hostname : **onem2m.sktiot.com**

Port : **1883**

Keep-alive: **120 sec**

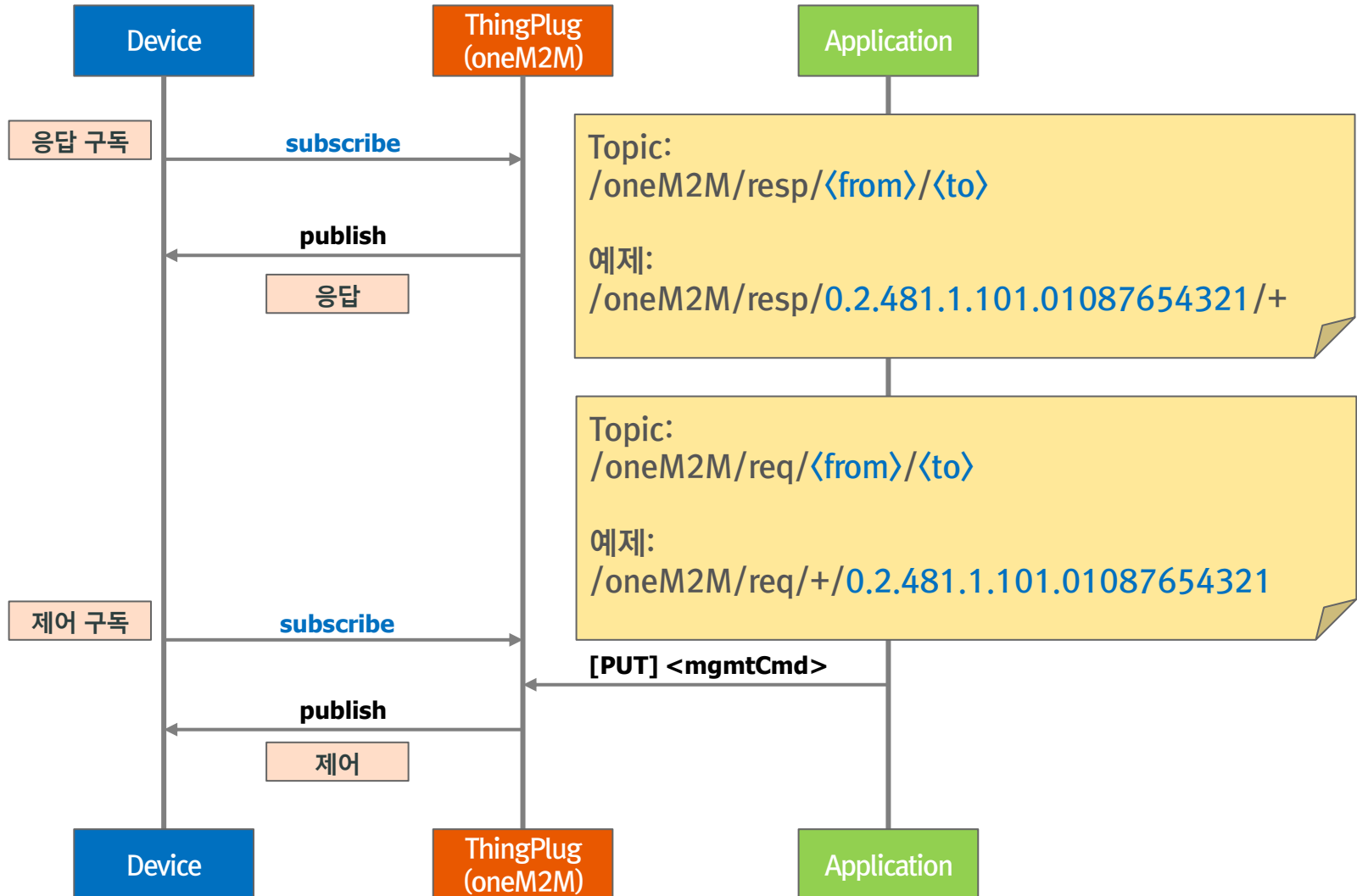
# ThingPlug – Device API

- Service Scenario



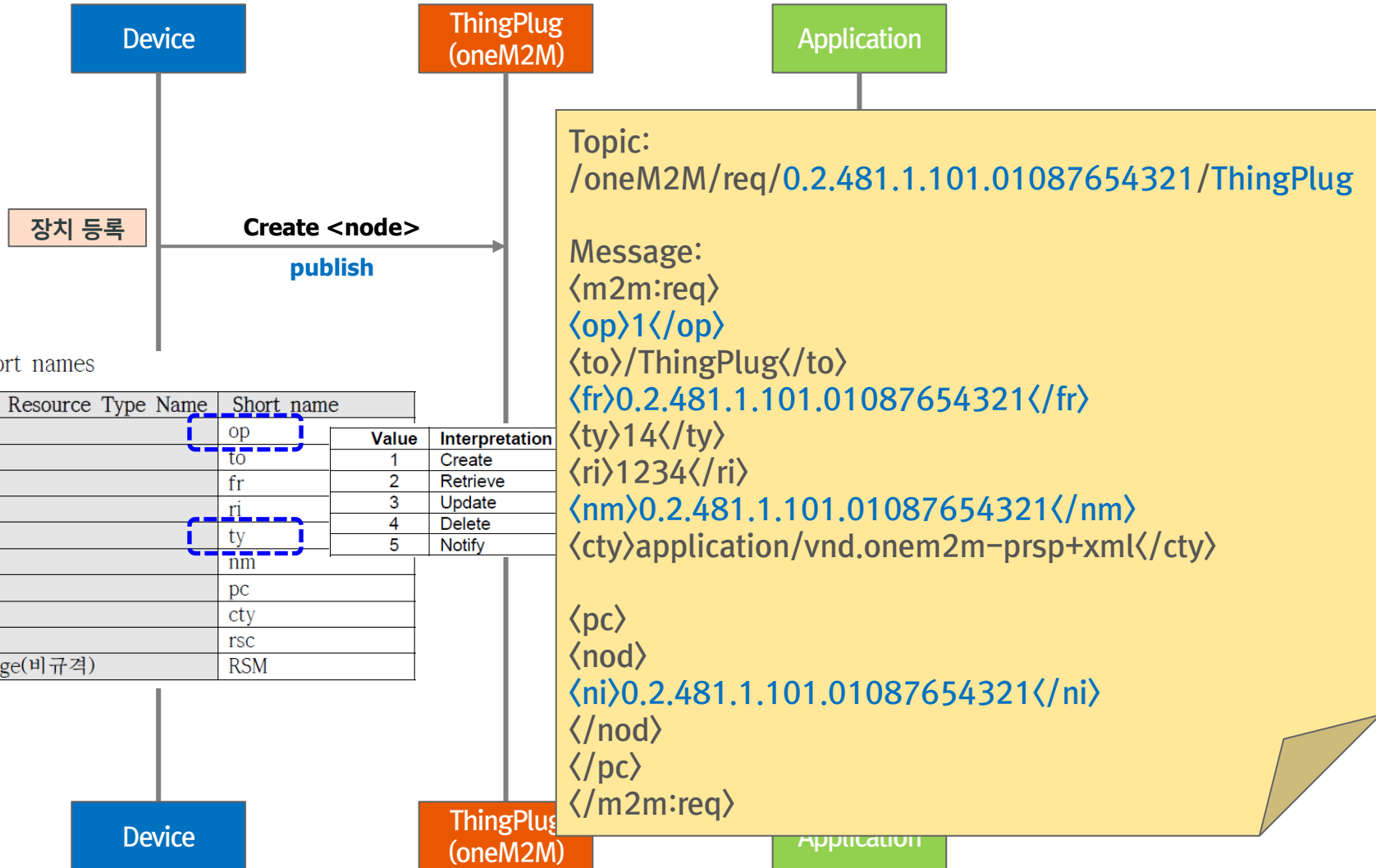
# ThingPlug – Device API

- MQTT



# ThingPlug – Device API

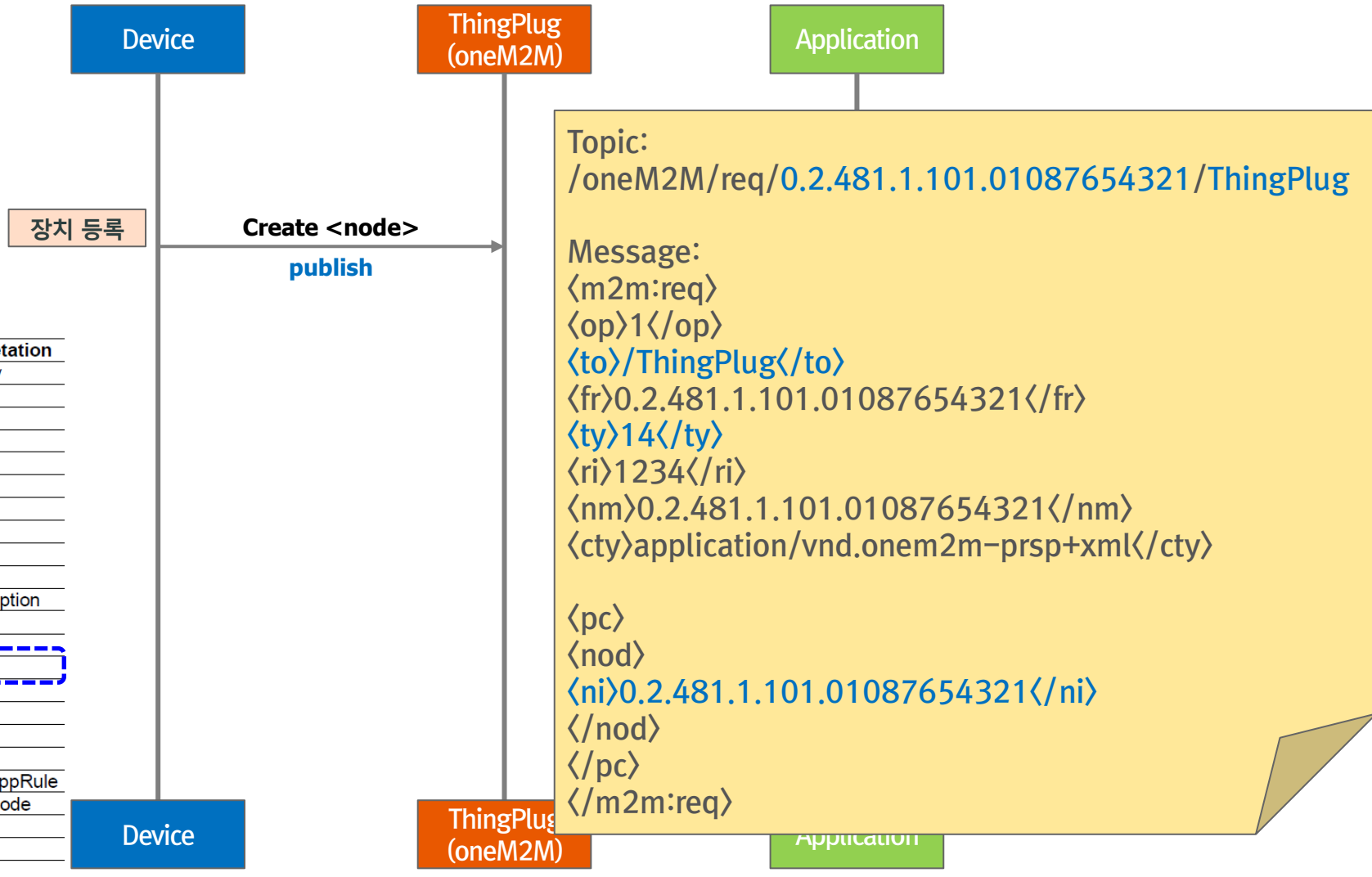
## • CSEBase



- 리소스 attribute short names

# ThingPlug – Device API

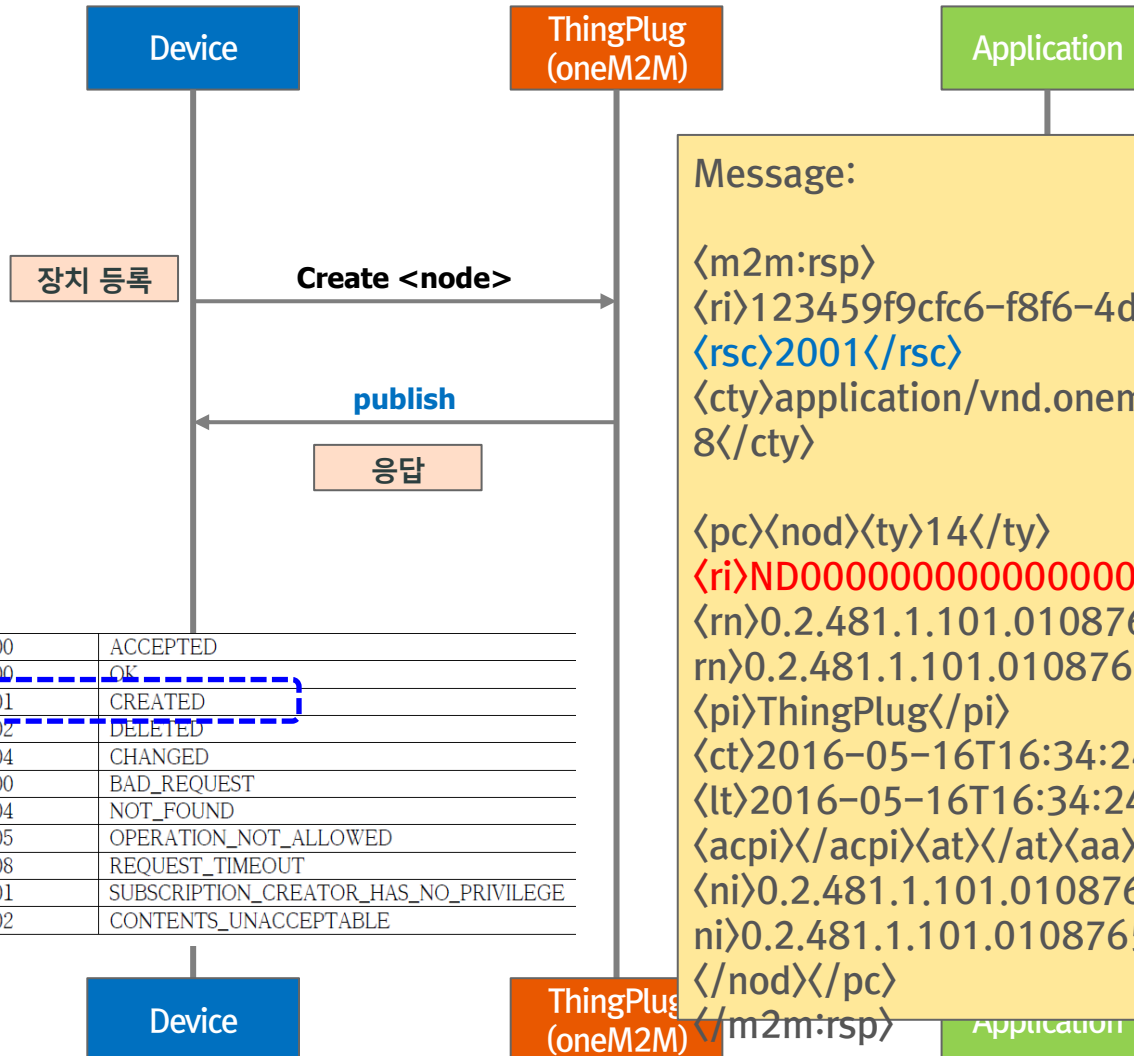
- node



Value	Interpretation
1	accessControlPolicy
2	AE
3	container
4	contentInstance
5	CSEBase
6	delivery
7	eventConfig
8	execInstance
9	group
10	locationPolicy
11	m2mServiceSubscription
12	mgmtCmd
13	mgmtObj
14	node
15	pollingChannel
16	remoteCSE
17	request
18	schedule
19	serviceSubscribedAppRule
20	serviceSubscribedNode
21	statsCollect
22	statsConfig
23	subscription

# ThingPlug – Device API

- node



Response Status Code (rsc)	1000	ACCEPTED
	2000	OK
	2001	CREATED
	2002	DELETED
	2004	CHANGED
	4000	BAD_REQUEST
	4004	NOT_FOUND
	4005	OPERATION_NOT_ALLOWED
	4008	REQUEST_TIMEOUT
	4101	SUBSCRIPTION_CREATOR_HAS_NO_PRIVILEGE
	4102	CONTENTS_UNACCEPTABLE

Message:

```

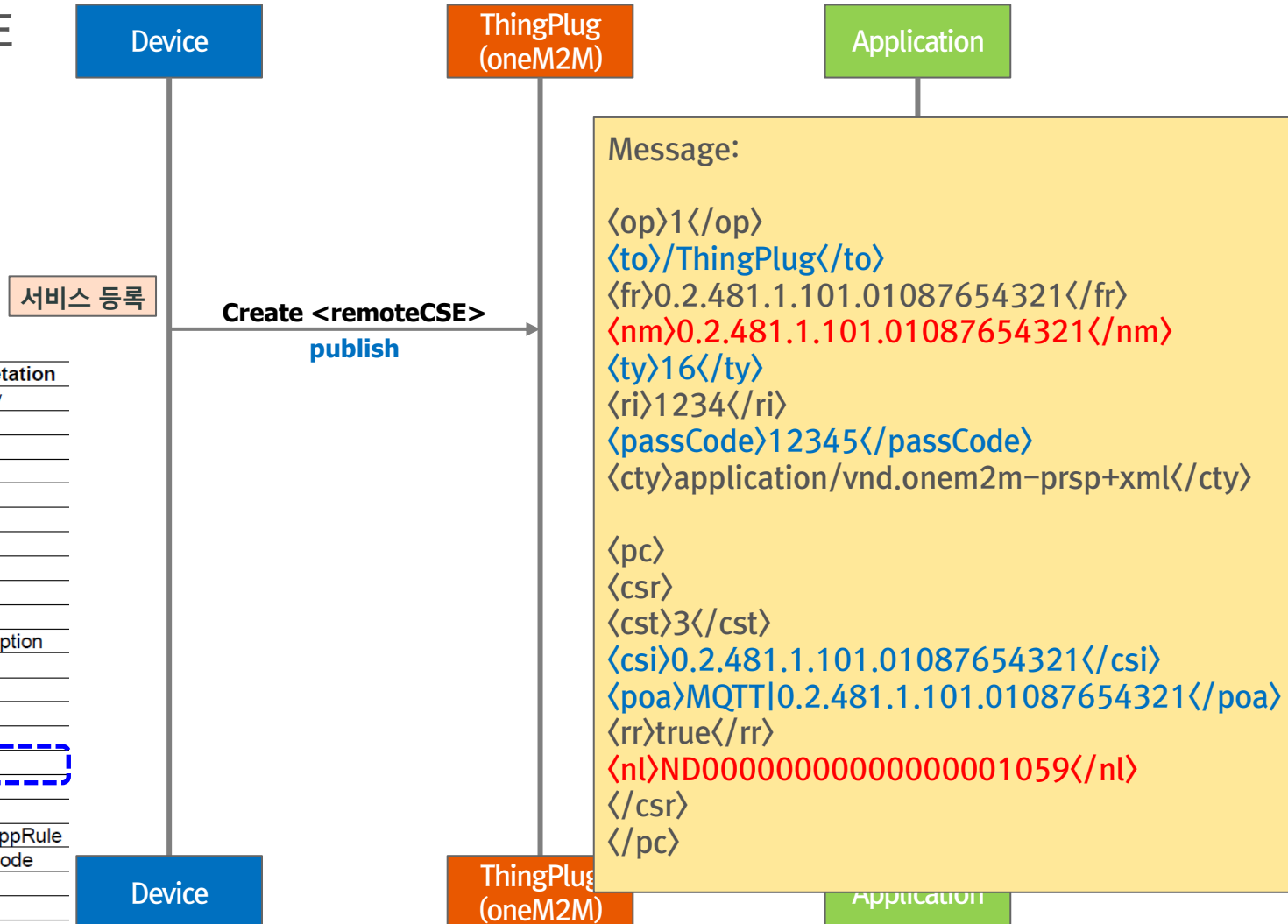
<m2m:rsp>
<ri>123459f9cfc6-f8f6-4d12-b813-d7ab6df769d5</ri>
<rsc>2001</rsc>
<cty>application/vnd.onem2m-res+xml;charset=UTF-8</cty>

<pc><nod><ty>14</ty>
<ri>ND000000000000000000001059</ri>
<rn>0.2.481.1.101.01087654321
rn>0.2.481.1.101.01087654321</rn>
<pi>ThingPlug</pi>
<ct>2016-05-16T16:34:24+09:00</ct>
<lt>2016-05-16T16:34:24+09:00</lt><lbl></lbl>
<acpi></acpi><at></at><aa></aa>
<ni>0.2.481.1.101.01087654321
ni>0.2.481.1.101.01087654321</ni>
</nod></pc>
</m2m:rsp>
    
```



## ThingPlug – Device API

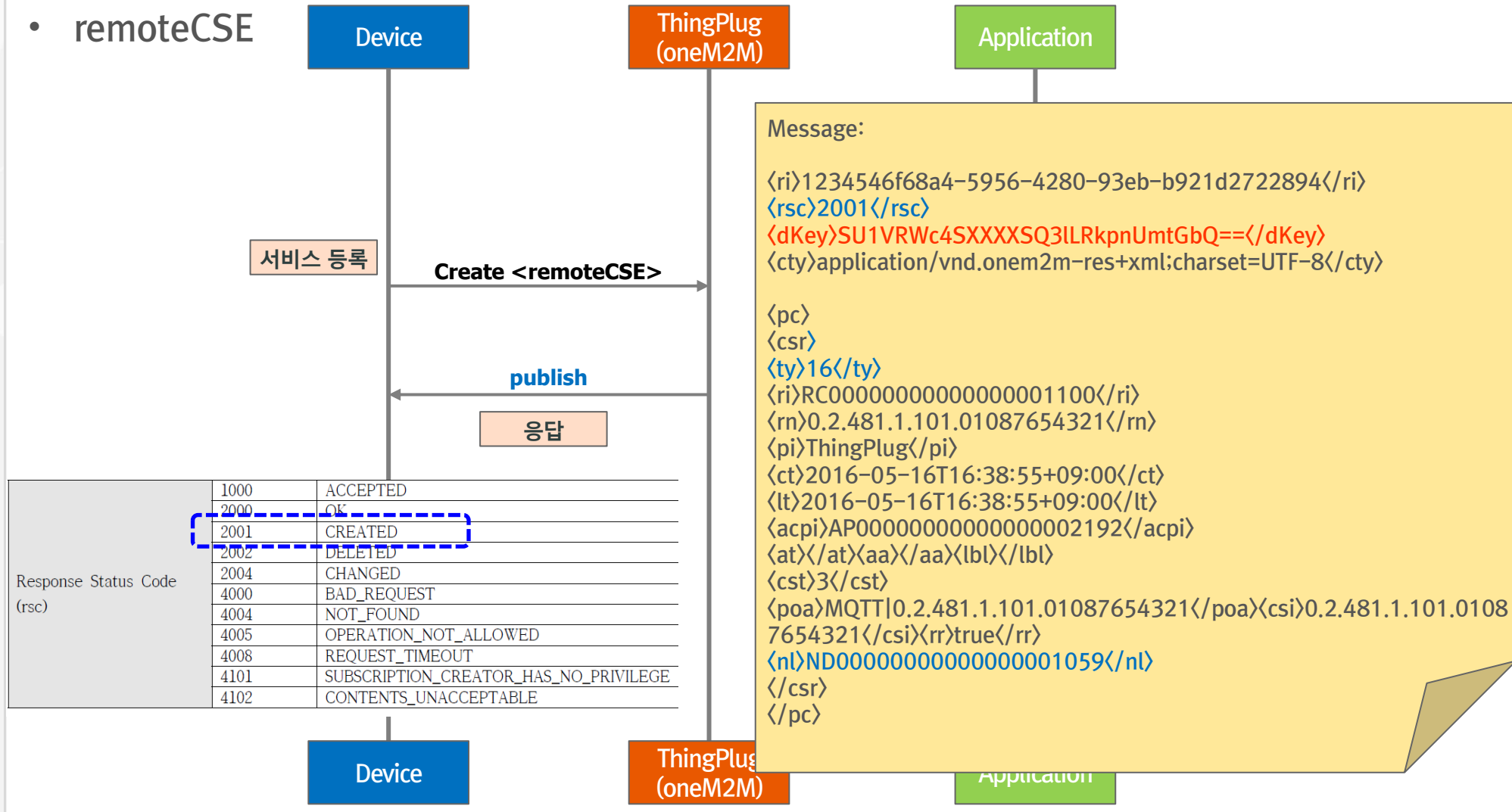
- remoteCSE



Value	Interpretation
1	accessControlPolicy
2	AE
3	container
4	contentInstance
5	CSEBase
6	delivery
7	eventConfig
8	execInstance
9	group
10	locationPolicy
11	m2mServiceSubscription
12	mgmtCmd
13	mgmtObj
14	node
15	pollingChannel
16	remoteCSE
17	request
18	schedule
19	serviceSubscribedAppRule
20	serviceSubscribedNode
21	statsCollect
22	statsConfig
23	subscription

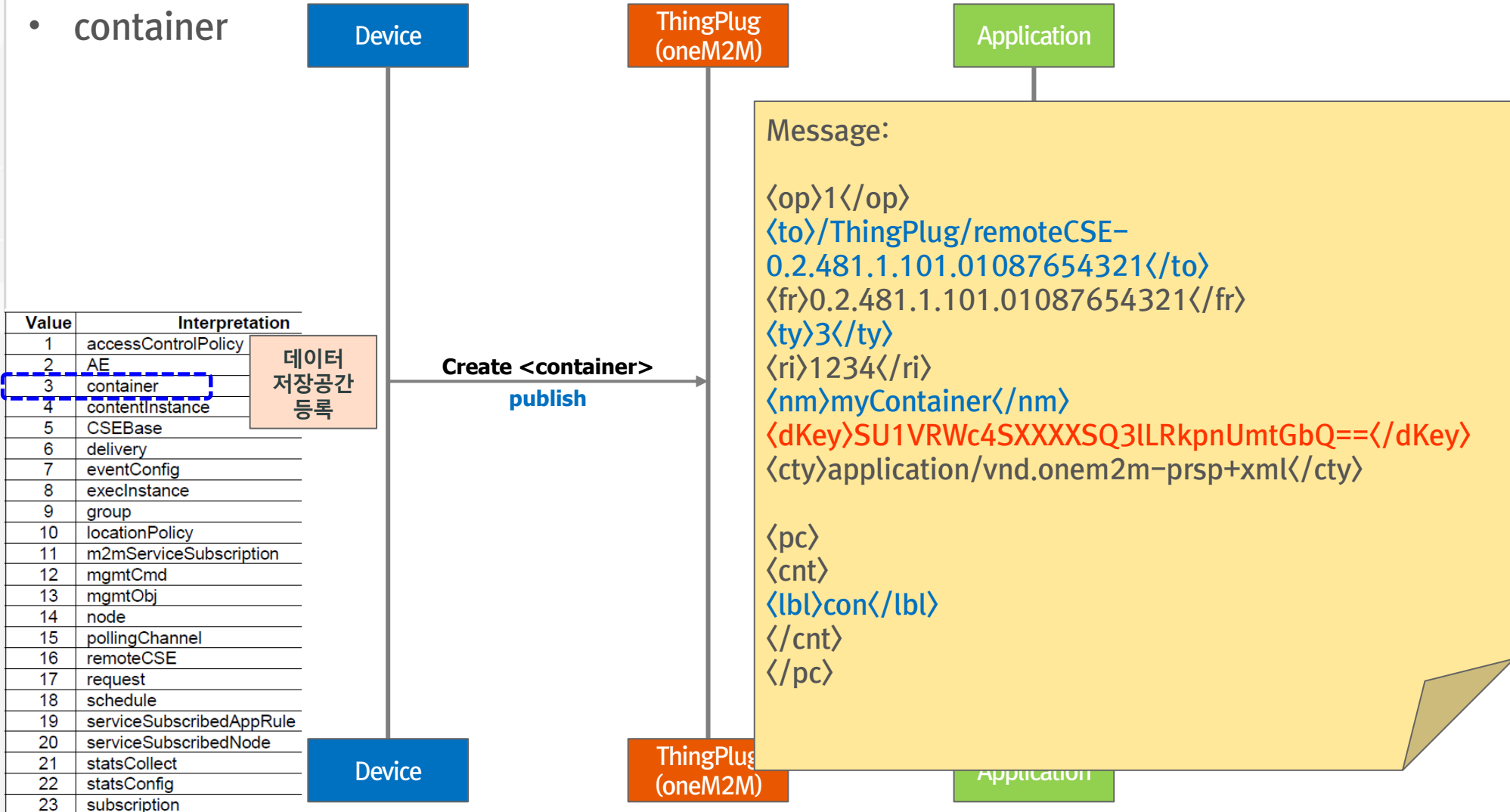
# ThingPlug – Device API

- remoteCSE



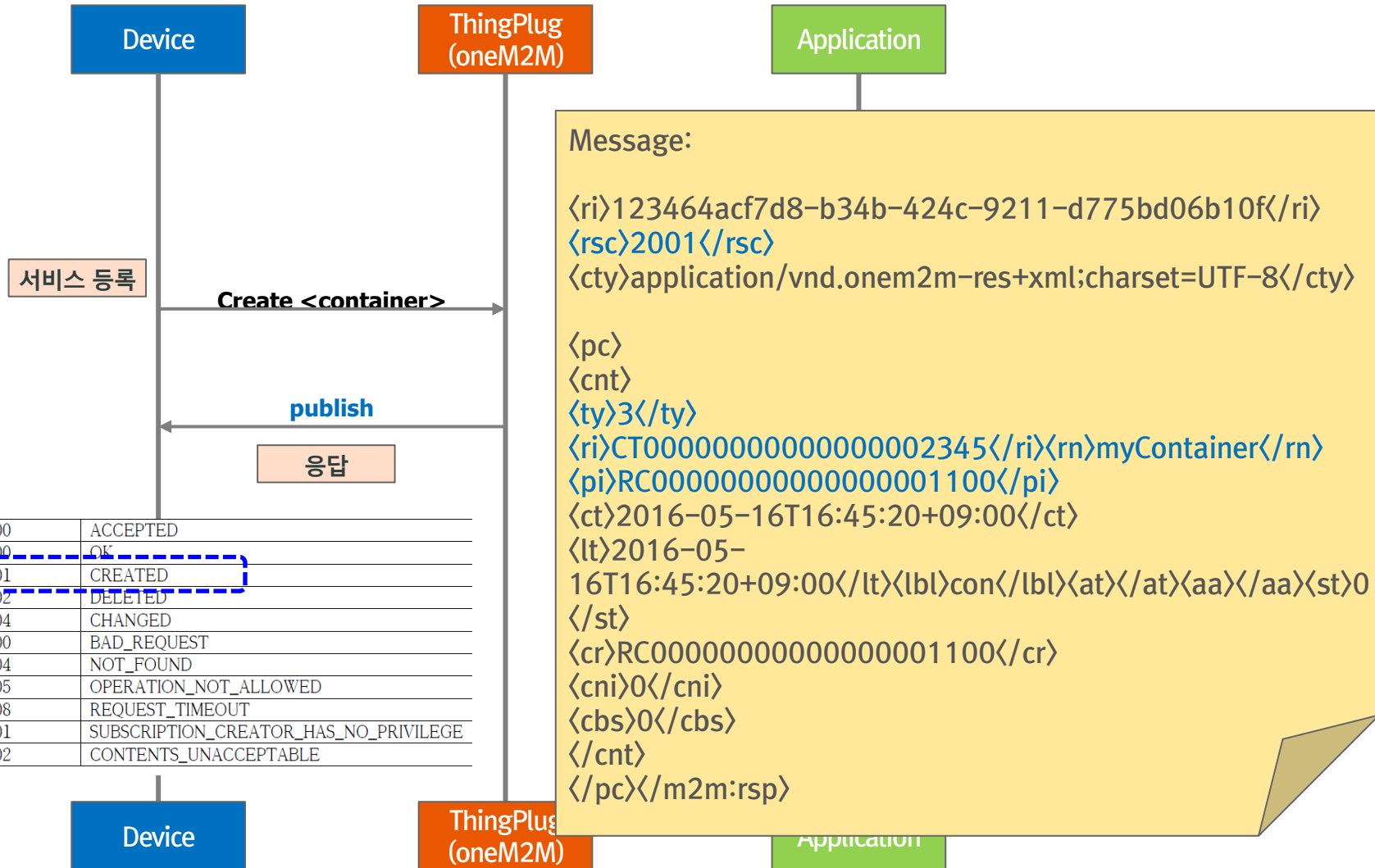
# ThingPlug – Device API

- container



# ThingPlug – Device API

- container



# ThingPlug – Device API

- contentInstance

Value	Interpretation
1	accessControlPolicy
2	AE
3	container
4	contentInstance
5	CSEBase
6	delivery
7	eventConfig
8	execInstance
9	group
10	locationPolicy
11	m2mServiceSubscription
12	mgmtCmd
13	mgmtObj
14	node
15	pollingChannel
16	remoteCSE
17	request
18	schedule
19	serviceSubscribedAppRule
20	serviceSubscribedNode
21	statsCollect
22	statsConfig
23	subscription

데이터 저장  
(주기 보고)

Create <contentInstance>  
publish

Text 형식의 '45' 값 저장



ThingPlug  
(oneM2M)

Application

Message:

```

<op>1</op>
<to>/ThingPlug/remoteCSE-
0.2.481.1.101.01087654321/container-
myContainer</to>
<fr>0.2.481.1.101.01087654321</fr>
<ty>4</ty>
<ri>1234</ri>
<cty>application/vnd.onem2m-prsp+xml</cty>
<dKey>SU1VRWc4SXXXXSQ3ILRkpnUmtGbQ==</dKey>

<pc>
<cin>
<cnf>text</cnf>
<con>45</con>
</cin>
</pc>
    
```

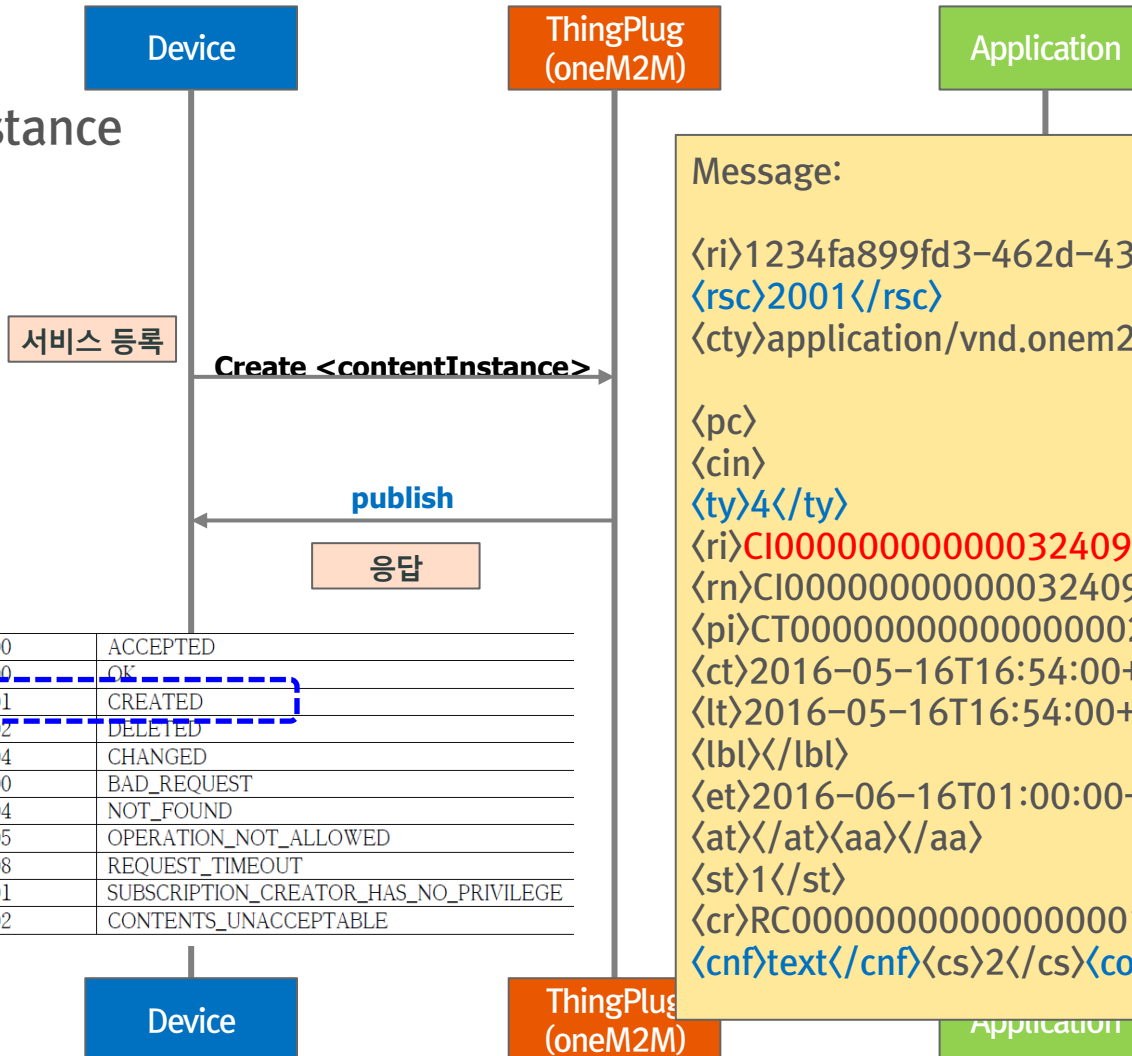
Device

ThingPlug  
(oneM2M)

Application

# ThingPlug – Device API

- contentInstance



Response Status Code (rsc)	1000	ACCEPTED
	2000	OK
	2001	CREATED
	2002	DELETED
	2004	CHANGED
	4000	BAD_REQUEST
	4004	NOT_FOUND
	4005	OPERATION_NOT_ALLOWED
	4008	REQUEST_TIMEOUT
	4101	SUBSCRIPTION_CREATOR_HAS_NO_PRIVILEGE
	4102	CONTENTS_UNACCEPTABLE

Message:

```

<ri>1234fa899fd3-462d-43a5-8755-392adb834bb2</ri>
<rsc>2001</rsc>
<cty>application/vnd.onem2m-res+xml;charset=UTF-8</cty>

<pc>
<cin>
<ty>4</ty>
<ri>CI0000000000000032409858</ri>
<rn>CI0000000000000032409858</rn>
<pi>CT000000000000000002345</pi>
<ct>2016-05-16T16:54:00+09:00</ct>
<lt>2016-05-16T16:54:00+09:00</lt>
<lbl></lbl>
<et>2016-06-16T01:00:00+09:00</et>
<at></at><aa></aa>
<st>1</st>
<cr>RC0000000000000000001100</cr>
<cnf>text</cnf><cs>2</cs><con>45</con></cin></pc></m2m:rsp>
  
```

# ThingPlug – Device API

- mgmtCmd

Value	Interpretation
1	accessControlPolicy
2	AE
3	container
4	contentInstance
5	CSEBase
6	delivery
7	eventConfig
8	execInstance
9	group
10	locationPolicy
11	m2mServiceSubscription
12	mgmtCmd
13	mgmtObj
14	node
15	pollingChannel
16	remoteCSE
17	request
18	schedule
19	serviceSubscribedAppRule
20	serviceSubscribedNode
21	statsCollect
22	statsConfig
23	subscription

장치제어  
설정

Create <mgmtCmd>

publish

Type은 'sensor\_1' 이고  
이름은  
'myMGMT0.2.481.1.101.0108  
7654321'인 제어명령 생성

ThingPlug  
(oneM2M)

Application

Message:

```

<op>1</op>
<to>/ThingPlug</to>
<fr>0.2.481.1.101.01087654321</fr>
<ty>12</ty>
<ri>1234</ri>
<nm>myMGMT0.2.481.1.101.01087654321</nm>
<dKey>SU1VRWc4SXXXXSQ3ILRkpnUmtGbQ==</dKey>
<cty>application/vnd.onem2m-prsp+xml</cty>

<pc>
  <mgc>
    <cmt>sensor_1</cmt>
    <exe>>false</exe>
    <ext>ND00000000000000000001059</ext>
  </mgc>
</pc>
  
```

Device

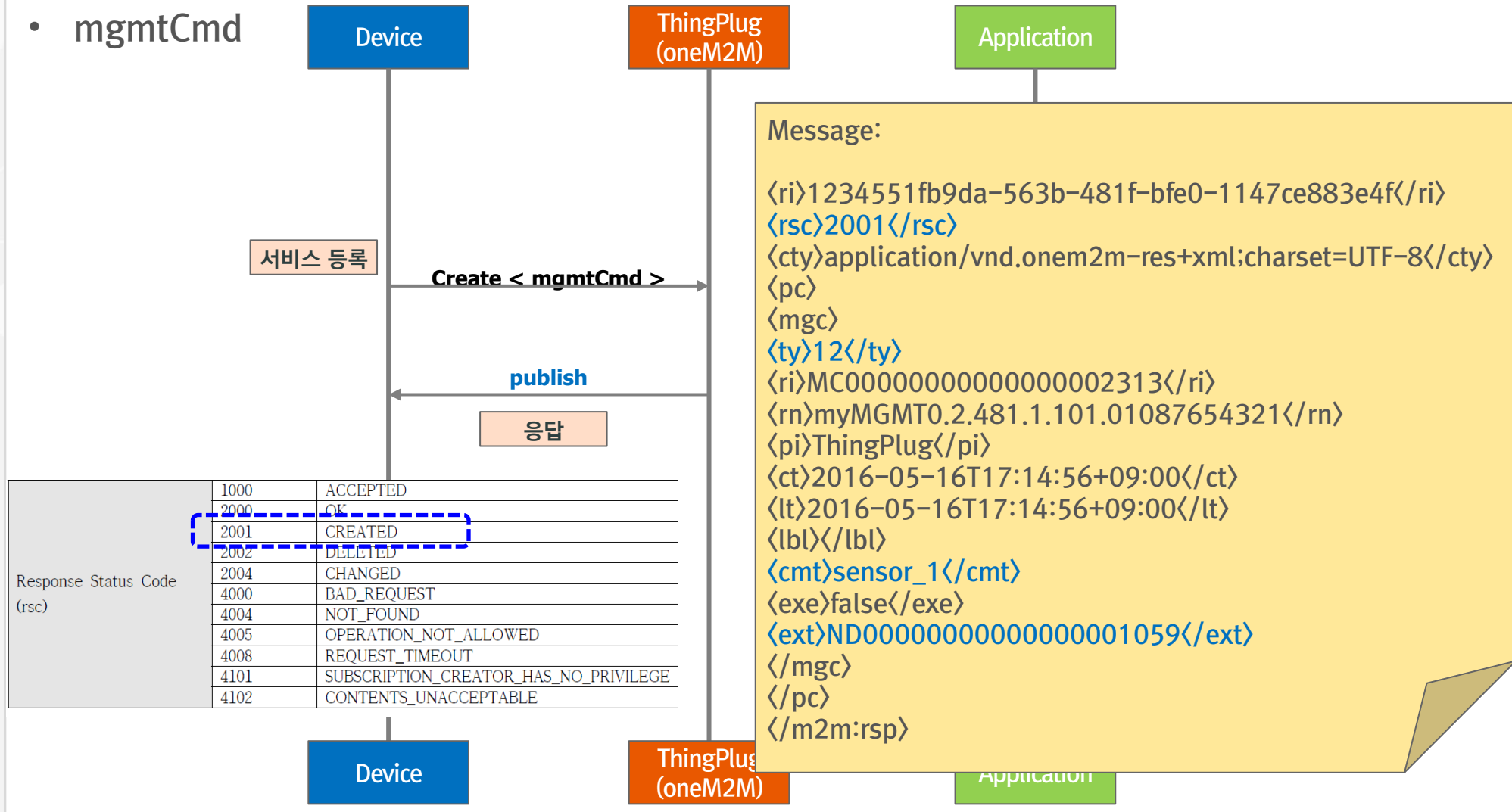
ThingPlug  
(oneM2M)

Application



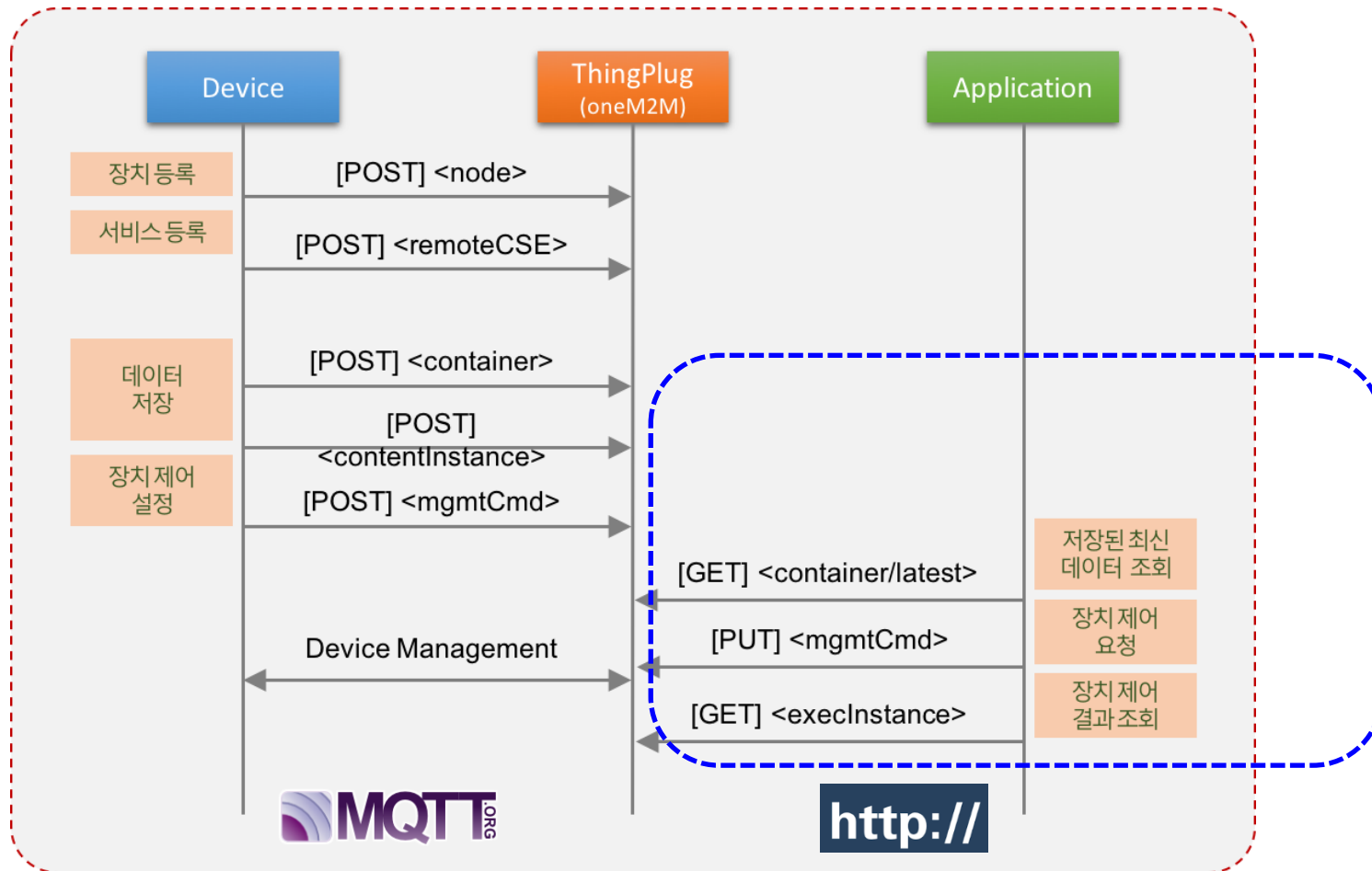
# ThingPlug – Device API

- mgmtCmd



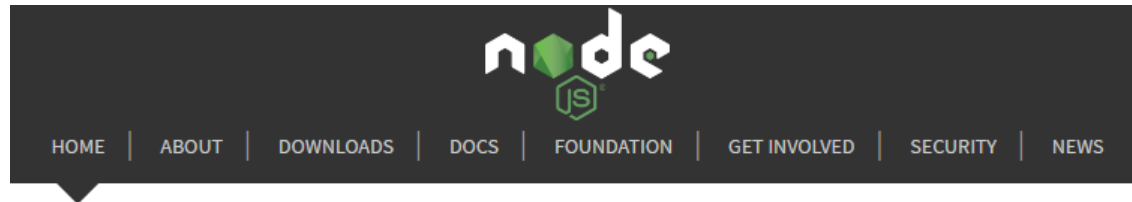
# ThingPlug – Application API

- Service Scenario



# ThingPlug – Application API

- Node.js 설치 <https://nodejs.org>



Node.js® is a JavaScript runtime built on [Chrome's V8 JavaScript engine](#). Node.js uses an event-driven, non-blocking I/O model that makes it lightweight and efficient. Node.js' package ecosystem, [npm](#), is the largest ecosystem of open source libraries in the world.

Important [security upgrades](#) for recent OpenSSL vulnerabilities

Download for Windows (x64)

**v4.4.4 LTS**  
Recommended For Most Users

**v6.1.0 Current**  
Latest Features

[Other Downloads](#) | [Changelog](#) | [API Docs](#)

[Other Downloads](#) | [Changelog](#) | [API Docs](#)

# ThingPlug – Application API

- Node.js 설치 확인

```
Microsoft Windows [Version 6.1.7601]  
Copyright (c) 2009 Microsoft Corporation. All rights reserved.
```

```
C:\Users\SKTelecom>node --version  
v4.4.4
```

```
C:\Users\SKTelecom>
```

# ThingPlug – Application API

- oneM2M Starter Kit 다운로드
- <https://github.com/SKT-ThingPlug/thingplug-starter-kit>

SKT-ThingPlug / thingplug-starter-kit

Watch 10 Star 10 Fork 8

Code Issues 0 Pull requests 0 Pulse Graphs

SKT ThingPlug의 oneM2M Starter Kit <http://thingplug.skoti.com>

70 commits 2 branches 2 releases 5 contributors

Branch: master New pull request

New file Find file HTTPS <https://github.com/SKT-ThingPlug/thingplug-starter-kit> Download ZIP

ThingPlug Merge pull request #14 from mihosang/master Latest commit 2d56fe2 13 days ago

example/edison	add missing config for edison	a month ago
images	a new flow image	6 months ago
lib	change url instead of ip address	13 days ago
public	add lib & static serving web dashboard files	a month ago
.gitignore	1st commit	8 months ago
README.md	Update README.md	a month ago
application.js	add dashboard support APIs and refactoring	a month ago
application_web.js	add dashboard support APIs and refactoring	a month ago
config.js_sample	add dashboard support APIs and refactoring	a month ago
device.js	add dashboard support APIs and refactoring	a month ago
package.json	add dashboard support APIs and refactoring	a month ago

# ThingPlug – Application API

- ThingPlug 홈페이지로 이동 → <https://thingplug.sktiot.com/>
- 로그인 → 마이페이지 → 마이 IoT 중 '사용자 인증키' == uKey
- Starter Kit 의 config.js\_sample 을 config.js 로 Rename
- config.js 의 항목 중 uKey를 ThingPlug 홈페이지 값으로 변경
- config.js 의 항목 중 nodeID 맨 뒷자리를 핸드폰 번호로 변경 (중복 방지)

```
module.exports = {  
  uKey: 'USER_KEY_FROM_SANDBOX.SKIOT.COM',  
  nodeID: '0.2.481.1.101.01000000000', // Device ID (핸드폰 번호 사용 권장)  
  passCode: '000101',  
  applD: 'myApplication', //Application ID  
  containerName: 'myContainer', // starter kit에서 생성하고 사용할 container 이름  
  mgmtCmdPrefix: 'myMGMT', // starter kit에서 생성하고 사용할 제어 접두사  
  cmdType: 'sensor_1' // starter kit에서 사용할 제어 타입 (임의지정)  
};
```

# ThingPlug – Application API

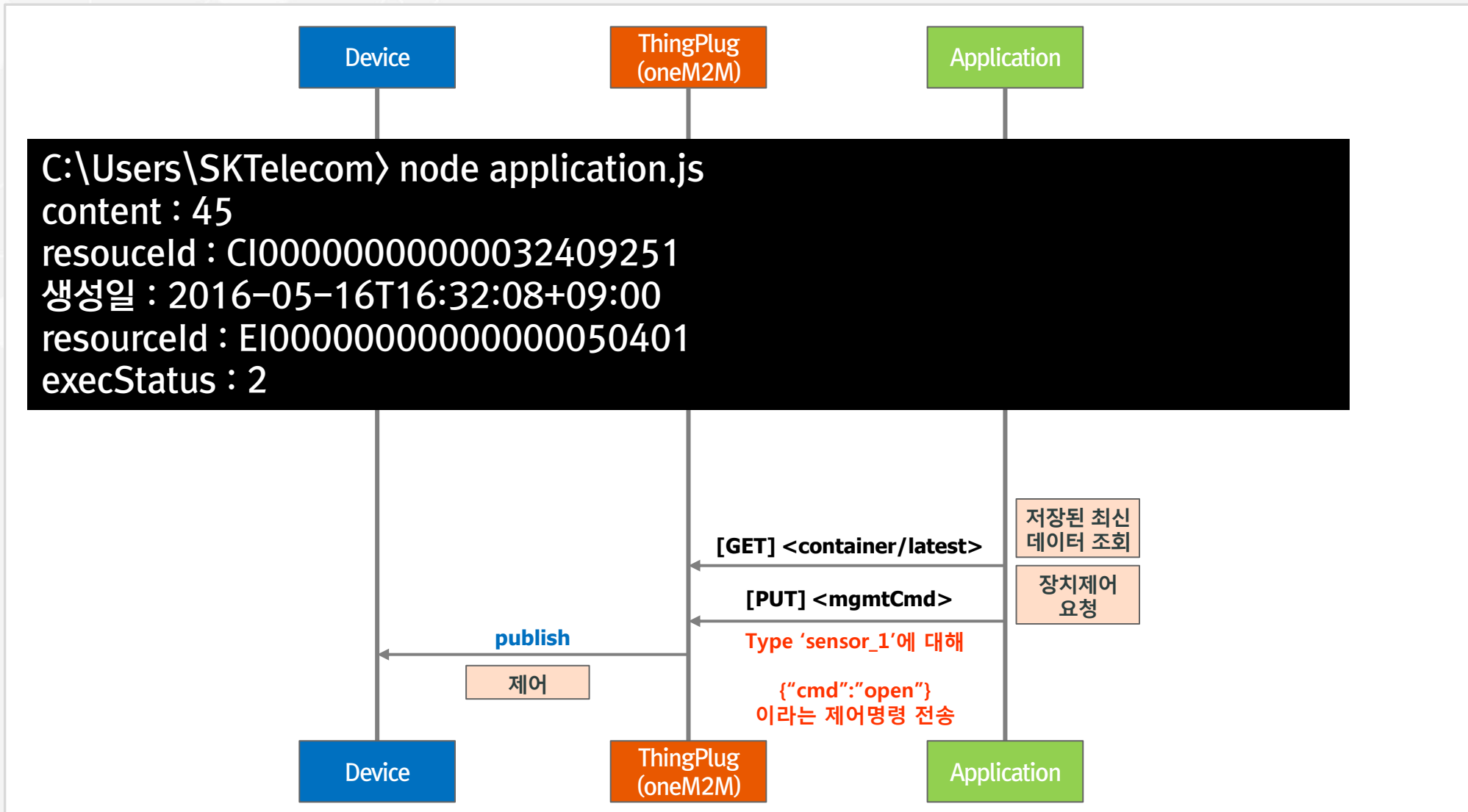
## 실행 방법

- npm install : 의존성 모듈 설치 (최초 1회)
- node application.js : 최신 주기보고 데이터 조회 및 device에 제어명령 전송

```
C:\Users\SKTelecom> node application.js
content : 45
resouceld : CI000000000000032409251
생성일 : 2016-05-16T16:32:08+09:00
resourceId : EI00000000000000050401
execStatus : 2
```

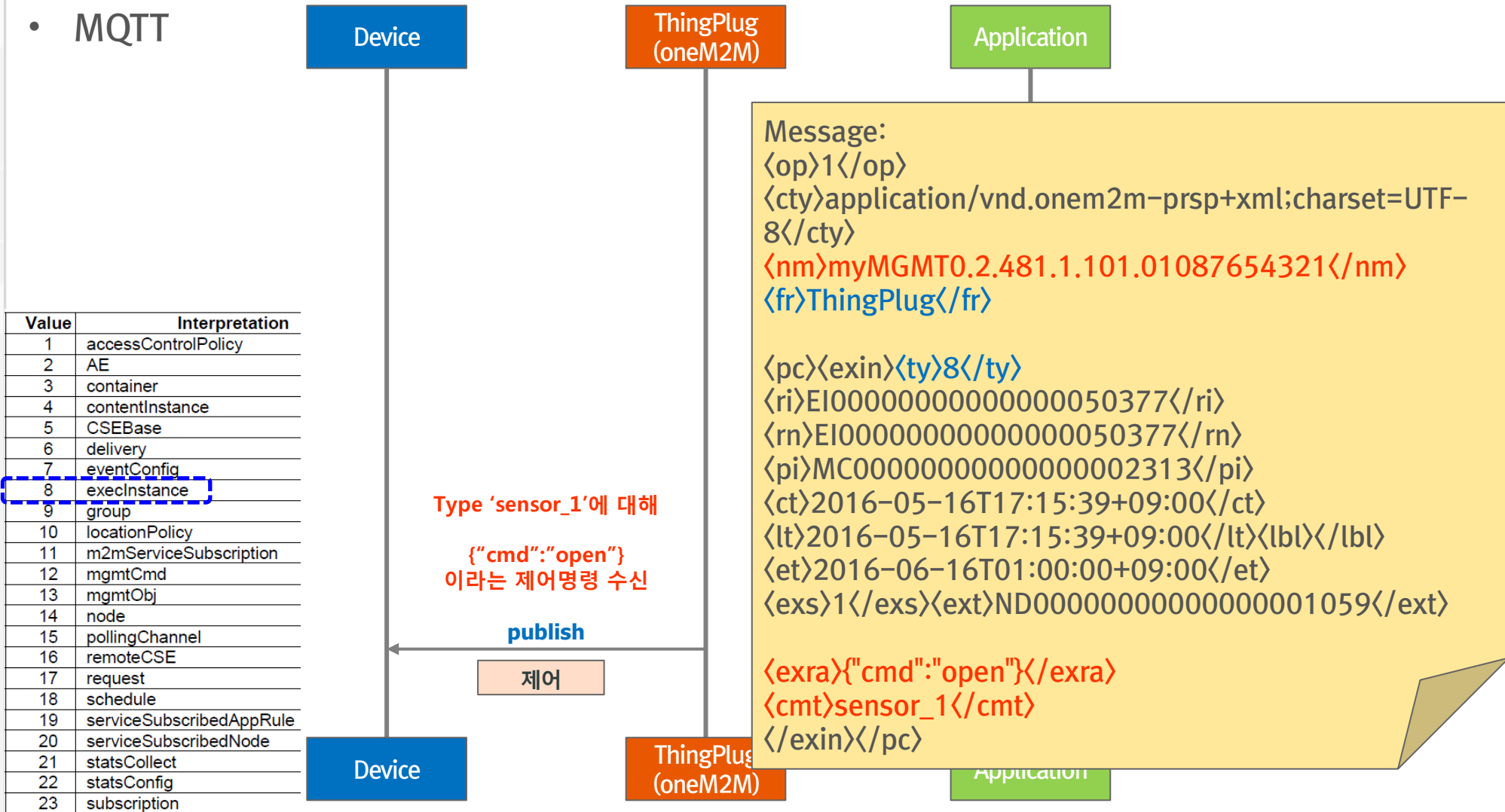


# ThingPlug – Application API



# ThingPlug – Device API

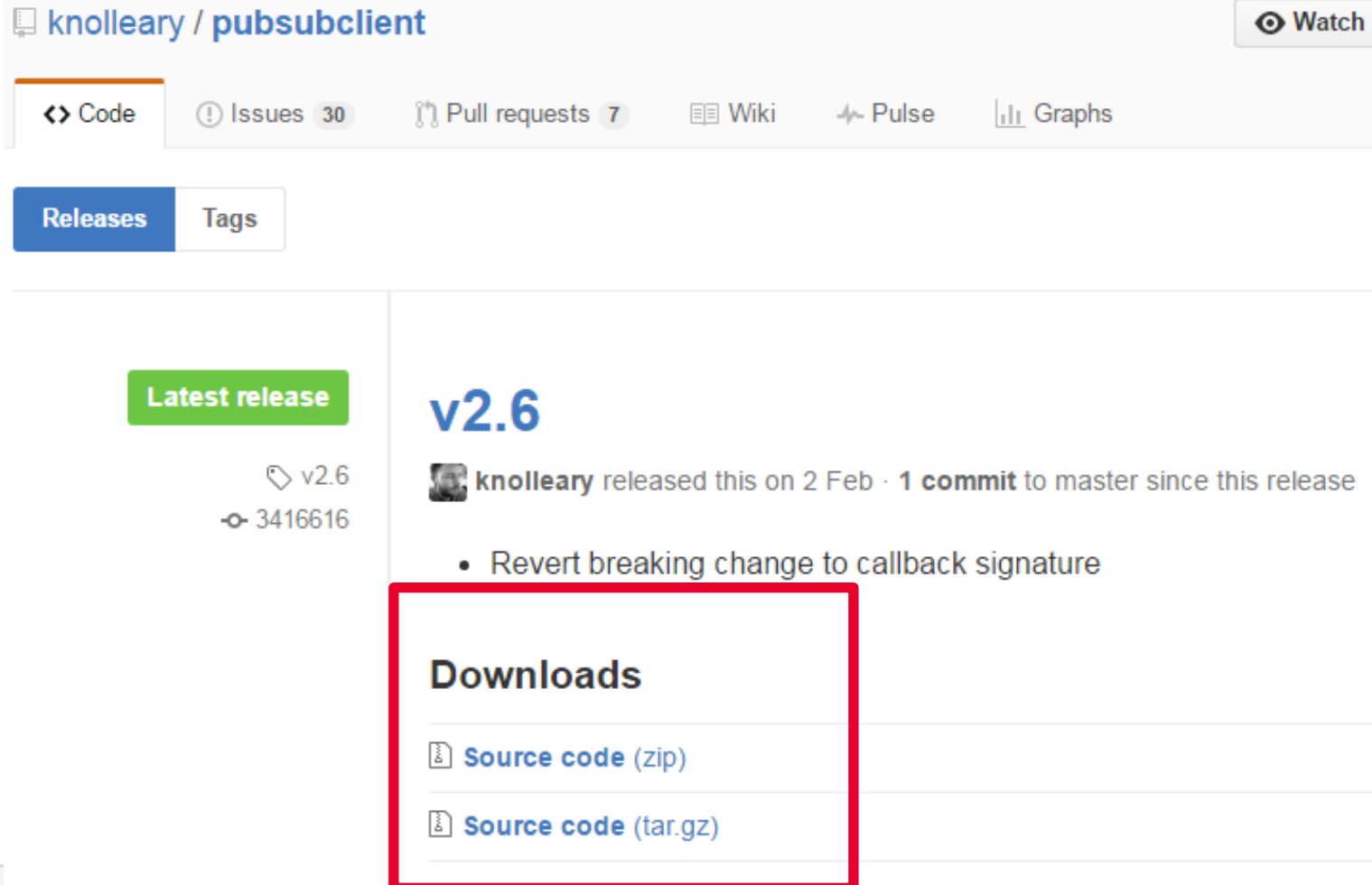
- MQTT



# PubSubClient 설치

<http://pubsubclient.knolleary.net/index.html>

<https://github.com/knolleary/pubsubclient/releases/latest>



The screenshot shows the GitHub repository page for `knolleary / pubsubclient`. The repository has 30 issues, 7 pull requests, a Wiki, Pulse, and Graphs. The `Releases` tab is selected, showing the latest release `v2.6`. The release was made on 2 Feb with 1 commit to master. The commit message is "Revert breaking change to callback signature". Below the release information, the `Downloads` section is highlighted with a red box, showing two download links: `Source code (zip)` and `Source code (tar.gz)`.

knolleary / pubsubclient Watch

<> Code ! Issues 30 🔑 Pull requests 7 📖 Wiki 📈 Pulse 📊 Graphs

Releases Tags

**Latest release**

v2.6

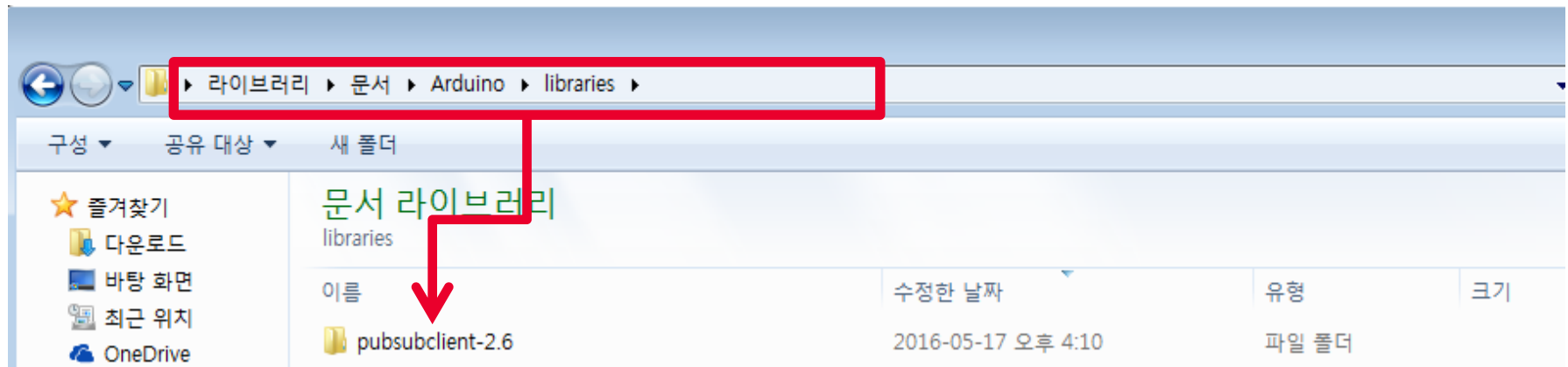
knolleary released this on 2 Feb · 1 commit to master since this release

- Revert breaking change to callback signature

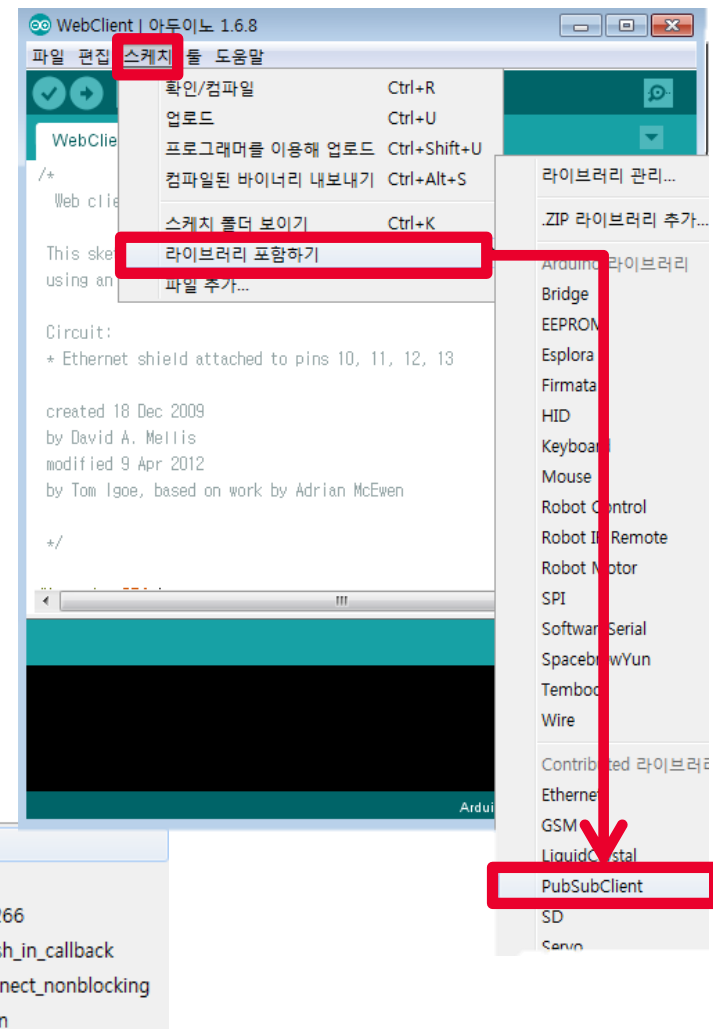
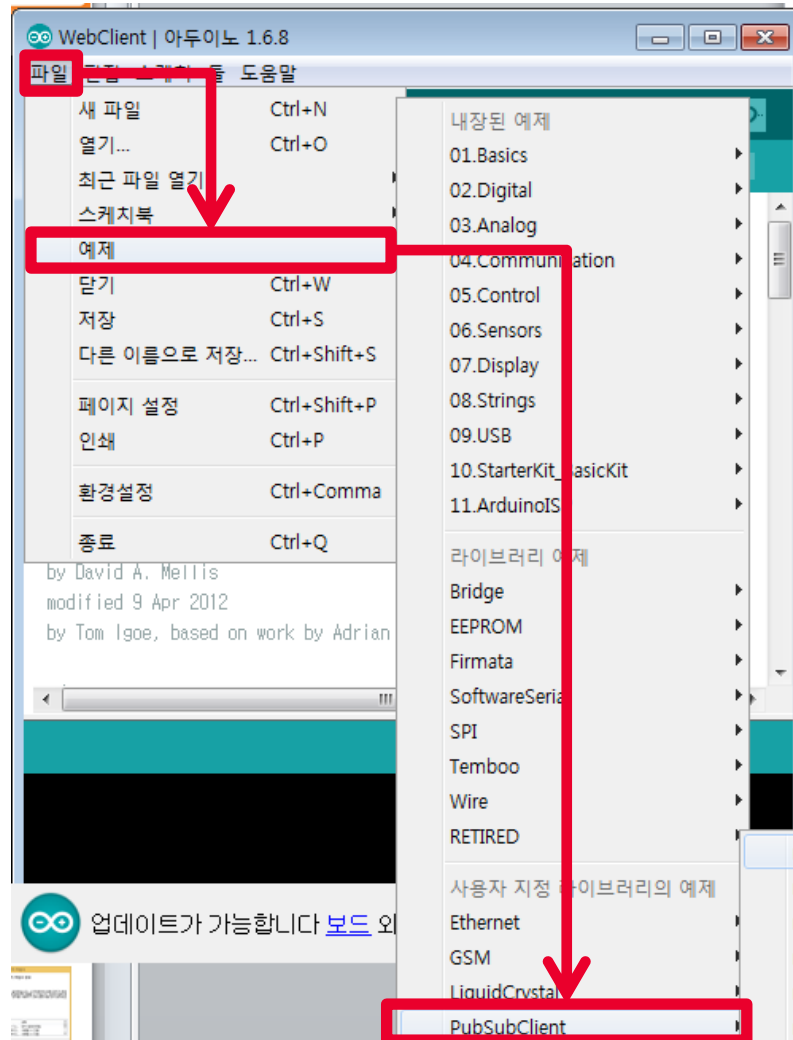
**Downloads**

- Source code (zip)
- Source code (tar.gz)

# PubSubClient 설치 - 압축해제



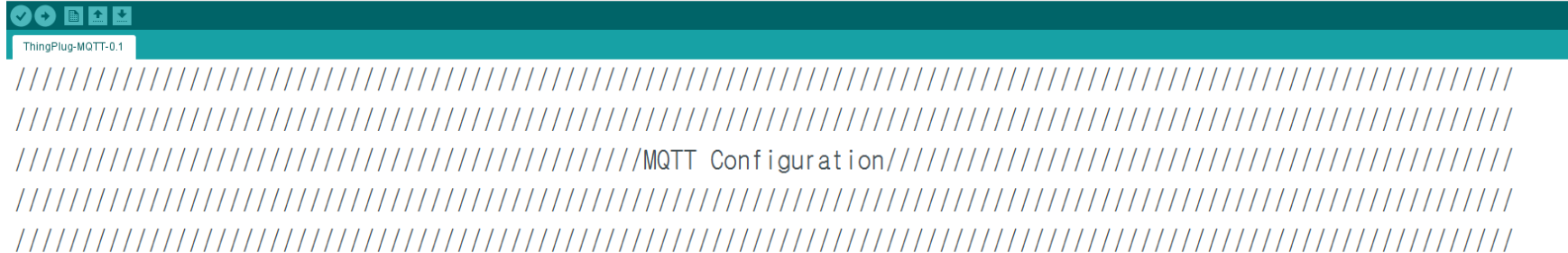
# 설치과정 – 아두이노 적용



# 샘플코드 – ThingPlug.ino

ThingPlug-MQTT-0.1 | 아두이노 1.6.8

파일 편집 스케치 툴 도움말



`char mqttBroker[] = "onem2m.sktiot.com";` MQTT Broker의 주소(ThingPlug서버 주소)

`int mqttBrokerPORT = 1883;` MQTT Broker의 Port 번호 ( 대부분의 MQTT의 Port번호는 1883)

`char mqttConnectID[] = "mqttYourID";` 사용할 ID(Not Required)

`char mqttPubTopic[] = "oneM2M/res/0.2.481.1.101.010phonenum/ThingPlug";` Publish할 Topic

`char mqttSubTopic[] = "oneM2M/res/0.2.481.1.101.010phonenum/+";` Subscribe할 Topic

`void mqttCallback(char* topic, byte* payload, unsigned int length);`

`void reconnect();`

`void CreateLoop();`

자원의 고유 ID ( ThingPlug의 OID)

`PubSubClient mqttClient(mqttBroker, mqttBrokerPORT, mqttCallback, ethClient);`

## 샘플코드 – ThingPlug.ino

## 파일 편집 스케치 툴 도움말

[illegible]

```
const unsigned char mqtttPubCreateRemoteCSE[] = {
    /* <passCode>12345</passCode> 값 사용자 정의 필요
    /* <fr><csi><poa>의 0.2.481.1.101.010phonenum 값 사용자 정의 필요(ThingPlug 01D)
    /* Node Create후 response의 <ri>ND000000000000000000001032</ri> 값을 <nl>값으로 설정필요
    /* <dKey>64bit based decoding value</dKey> 값 parsing 필요 -> 하위 Create들 실행시 필요
};
```

```
const unsigned char mqttPubCreateContainer[] = {  
    /* <nm>myContainer</nm> 값 사용자 정의 필요  
    /* <fr><ni>의 0.2.481.1.101.010phonenum 값 사용자 정의 필요(ThingPlug 01D)  
    /* RemoteCSE Create후 response의 <dKey>64bit based decoding value</dKey> 값 설정필요
```

```
const unsigned char mqtPubCreateMgmtCmd[] = {  
    /* <nm>myMGMT0.2.481.1.101.010phonenum</nm> 값 사용자 정의 필요  
    /* <cmt>sensor_1</cmt> 값 사용자 정의 필요  
    /* Node Create후 response의 <ri>ND00000000000000001032</ri> 값을 <ext>값으로 설정필요  
    /* RemoteCSE Create후 response의 <dKey>64bit based decoding value</dKey> 값 설정필요
```

```
const unsigned char mqttPubCreateContentInstance[] = {  
    /* <to>/ThingPlug/remoteCSE-0.2.481.1.101.010phoneidm/container-mycontainer</to>의 container 이름 값 설정필요  
    /* <cnf>text</cnf>, <con>45</con> 값들 사용자 정의 필요  
    /* RemoteCSE Create후 response의 <dKey>64bit based decoding value</dKey> 값 설정필요
```

```
void mqttCallback(char* topic, byte* payload, unsigned int length);
```





# 샘플코드 - 버퍼크기수정 / Documents/Arduino/libraries/pubsubclient-2.6/src/PubSubClient.h

```
PubSubClient.h - A simple client for MQTT.
Nick O'Leary
http://knolleary.net
*/

#ifndef PubSubClient_h
#define PubSubClient_h

#include <Arduino.h>
#include "IPAddress.h"
#include "Client.h"
#include "Stream.h"

#define MQTT_VERSION_3_1      3
#define MQTT_VERSION_3_1_1    4

// MQTT_VERSION : Pick the version
// #define MQTT_VERSION MQTT_VERSION_3_1
#ifndef MQTT_VERSION
#define MQTT_VERSION MQTT_VERSION_3_1_1
#endif

// MQTT_MAX_PACKET_SIZE : Maximum packet size
// #define MQTT_MAX_PACKET_SIZE
#define MQTT_MAX_PACKET_SIZE 700

// MQTT_KEEPA_LIVE : keepAlive interval in Seconds
// #define MQTT_KEEPA_LIVE
#define MQTT_KEEPA_LIVE 60

// MQTT_SOCKET_TIMEOUT: socket timeout interval in Seconds
// #define MQTT_SOCKET_TIMEOUT
#define MQTT_SOCKET_TIMEOUT 30

// MQTT_MAX_TRANSFER_SIZE : limit how much data is passed to the network client
// in each write call. Needed for the Arduino Wifi Shield. Leave undefined to
// pass the entire MQTT packet in each write call.
// #define MQTT_MAX_TRANSFER_SIZE 80
```

Packet Size 수정

Keep-Alive 수정

Time out 수정

# 샘플코드 - 실행결과

COM6

```
Ethernet Connected, My IP : 192.168.225.39
connecting MQTT...
mqttclient connected
subscribed
Create Node published
Create Node published
Message arrived [/oneM2M/resp/0.2.481.1.101.010phonenumber/ThingPlug] <m2m:rsp xmlns:m2m="http://www.onem2m.org/xml/protocols" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:
Create remoteCSE published
Message arrived [/oneM2M/resp/0.2.481.1.101.010phonenumber/ThingPlug] <m2m:rsp xmlns:m2m="http://www.onem2m.org/xml/protocols" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:
Create Container published
Message arrived [/oneM2M/resp/0.2.481.1.101.010phonenumber/ThingPlug] <m2m:rsp xmlns:m2m="http://www.onem2m.org/xml/protocols" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:
Create MgmtCmd published
Message arrived [/oneM2M/resp/0.2.481.1.101.010phonenumber/ThingPlug] <m2m:rsp xmlns:m2m="http://www.onem2m.org/xml/protocols" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:
Create ContentInstance published
Message arrived [/oneM2M/resp/0.2.481.1.101.010phonenumber/ThingPlug] <m2m:rsp xmlns:m2m="http://www.onem2m.org/xml/protocols" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:
Create ContentInstance published
Message arrived [/oneM2M/resp/0.2.481.1.101.010phonenumber/ThingPlug] <m2m:rsp xmlns:m2m="http://www.onem2m.org/xml/protocols" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:
```

# References

- **ThingPlug**

1. ThingPlug 개발자 포털: <https://thingplug.sktiot.com>
2. ThingPlug github: <https://github.com/SKT-ThingPlug>

- **oneM2M**

1. oneM2M 표준: <http://onem2m.org/technical/published-documents>
2. oneM2M TS-0004: "Service Layer Core Protocol Specification"
3. oneM2M TS-0010: "MQTT Protocol Binding"



감사합니다.