

Client Energy Management System

MIR Lab

<http://mir.classlassanyang.ac.kr>

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2. System Architecture



Architecture

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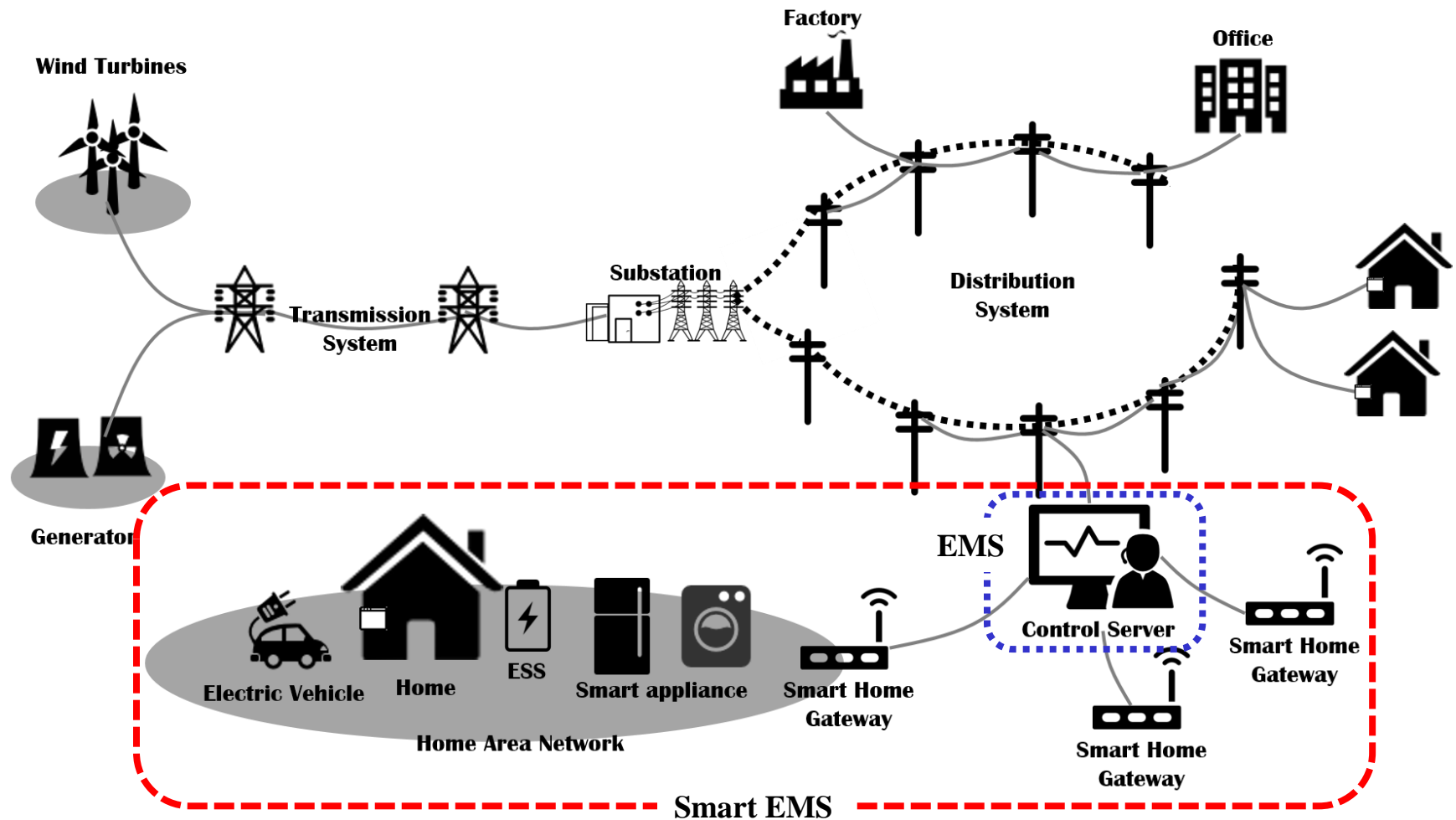
Practical Exercise

7. How to Execute MIR Program
(EMS, VTN, EMA)
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3. EMS Overview

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3-1. System Architecture



3-1. 스마트 에너지 홈 환경

스마트 에너지 홈 환경

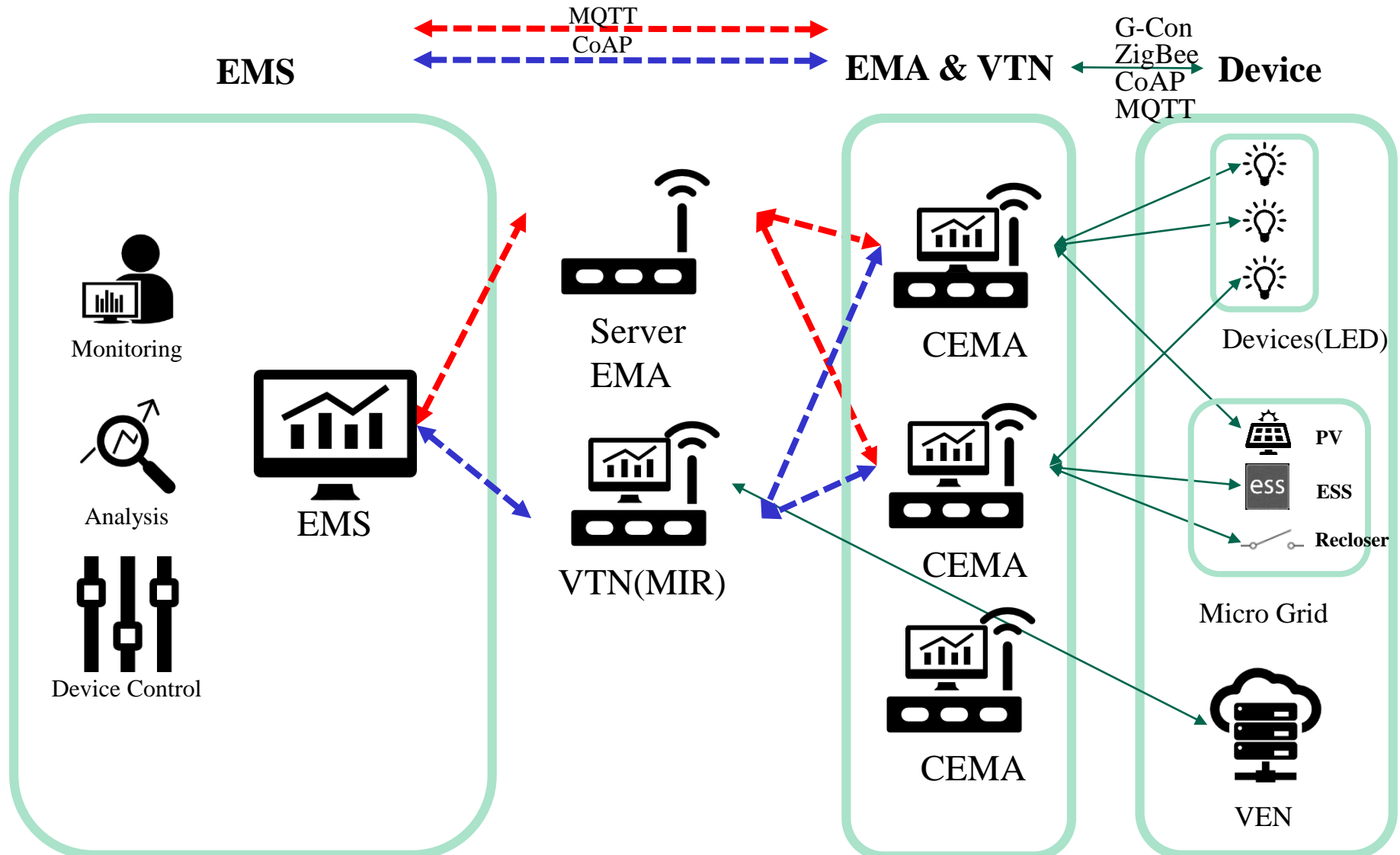
- 에너지 그리드 서비스를 제공하기 위한 **스마트 에너지 홈** 환경은 **EMA**가 관리하는 **디바이스의 그룹**과 상위의 서비스를 제공해주는 **서비스 제공자**로 구분된다.
- **EMA** 하위에는 **G-con, MQTT**(MQ Telemetry Transport), **CoAP**(Constrained Application Protocol)등과 같이 여러 가지 프로토콜로 구성된 디바이스의 그룹이 있고 이는 각각 **아두이노**와 **라즈베리파이** 등으로 구현되어 있다.
- 상위 서비스 제공자는 **VTN, EMS, Utility**등으로 구성되어 있으며 이들은 각각 에너지 소비에 대한 전략을 가지고 **EMA**에게 서비스를 제공해주는 역할을 한다.

3-1. 스마트 에너지 홈

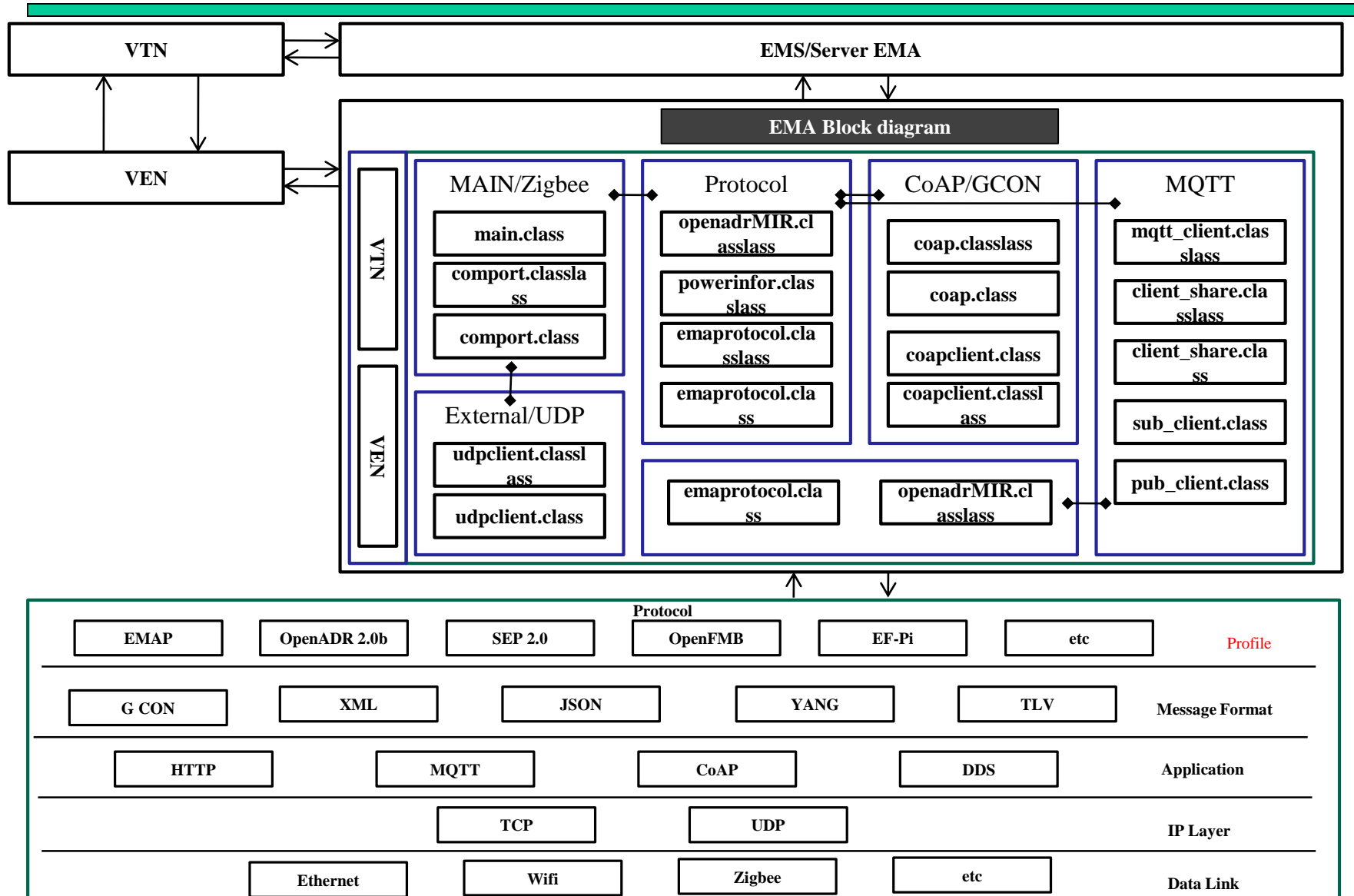
스마트 에너지 홈

- 스마트 에너지 홈란 일반적인 스마트 홈 환경에서 디바이스의 On/Off 제어 및 상태 보고 등과 같은 기능 외에도 자동적으로 지능화 된 수요반응 기능을 제공할 수 있는 환경을 의미한다.
- 앞서 이야기한 OpenADR 프로토콜을 통하여 전력 사업자와 사용자 간의 DR서비스 환경을 만들어서 지능적인 에너지 소모를 할 수 있도록 해야 한다.
- EMS는 EMA로부터 주기적으로 에너지 사용량을 보고 받아 모니터링 하게 되고, 디바이스를 직접 컨트롤 할 수 있도록 EMA에 명령을 전달 할 수 있도록 구성되어 있다.
- 다양한 모듈의 디바이스와 WiFi, Zigbee, IEEE 802.15.4통신을 위하여 해당 라이브러리에서 제공해주는 규격을 사용한다.

3-1. System Architecture with Protocol



3-2. Server EMA Overview



3-2. Client EMA Overview

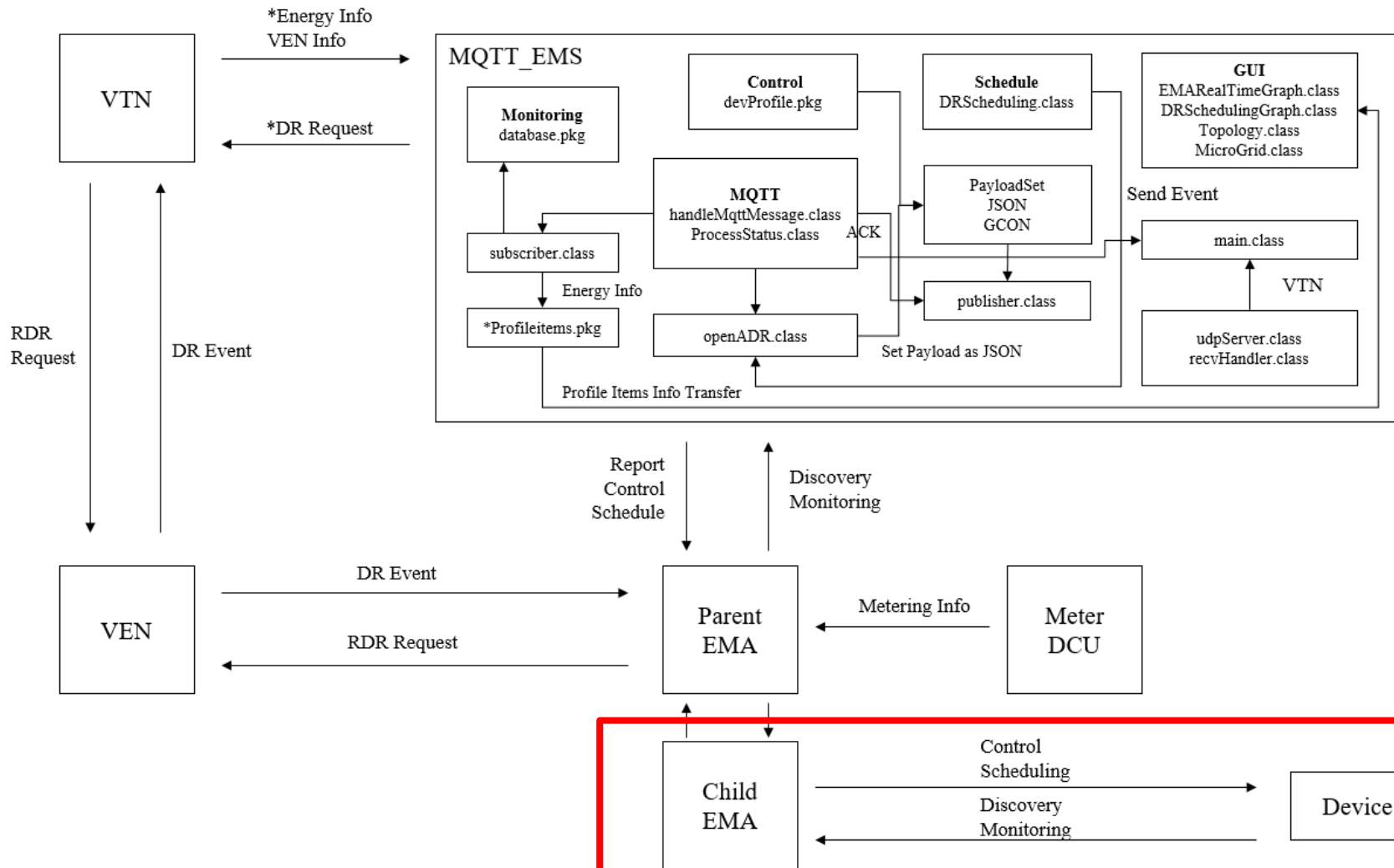
Application

- *GUI Subsystem* – To show the status and information.
- *Mobility Subsystem* – To be available for approaching anywhere.
- *Management Policy Subsystem* – Manage Policy

Energy Management System defines several primary services:

- *Scheduling Service* – Controls and manages EMA, Devices for optimization.
- *Report Subsystem* – Manage energy data to give processed report to energy customer.
- *Monitoring Subsystem* – Listen for EMA,VTN messages for manage and to make a topology and path
- *Profile Subsystem* - Manages inventory of sort of devices information and group
- *Control Subsystem* – To control child systems(EMA, OpenFMB and etc.) manually based on price policy(Incentive, Priced)

3-2. Client EMA Program Architecture

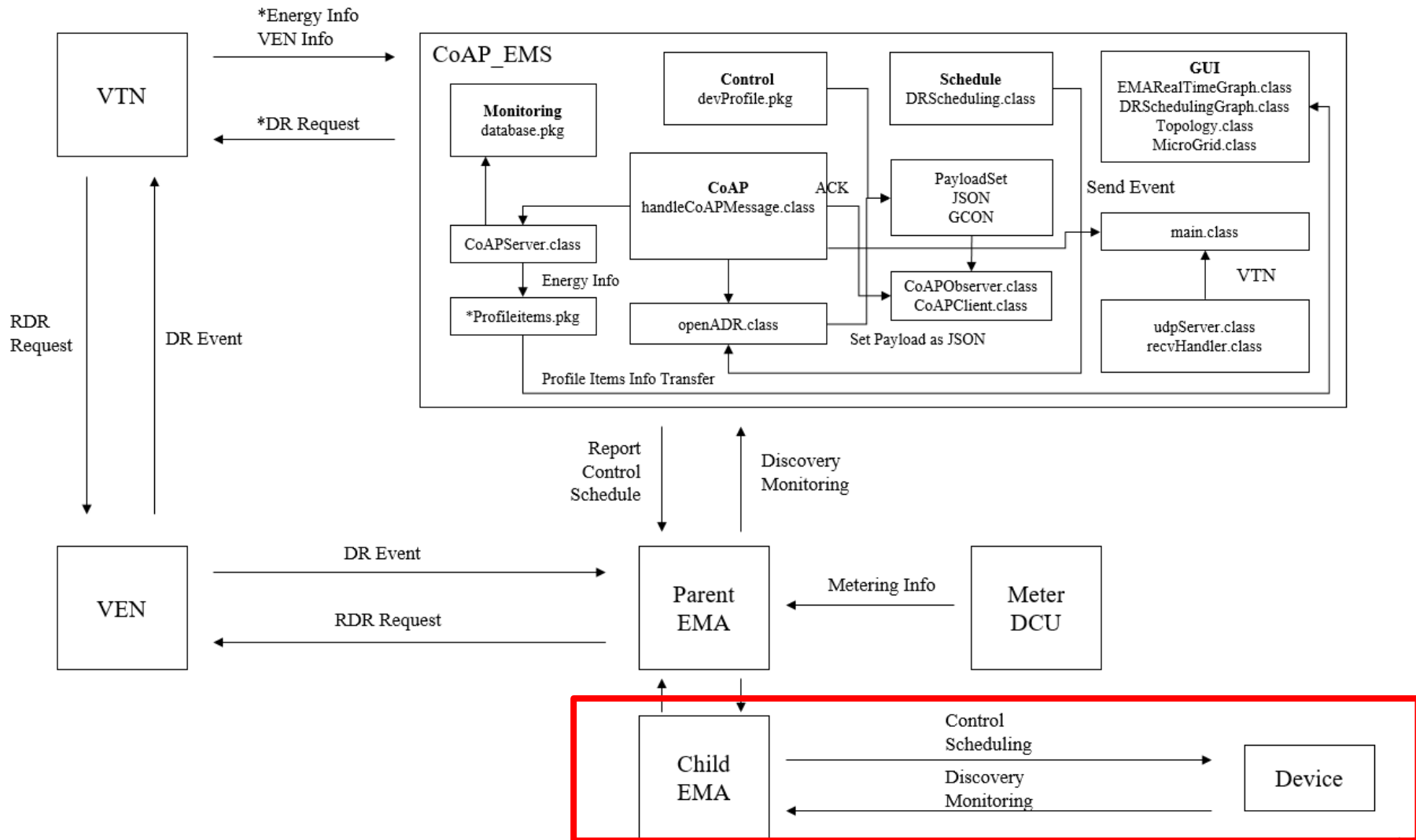


*DR Request: EMS가 VTN의 부하감축을 직접적으로 할 수는 없다. VTN Energy 정보를 바탕으로 최대 수요의 억제, 최대 부하의 이전, 고

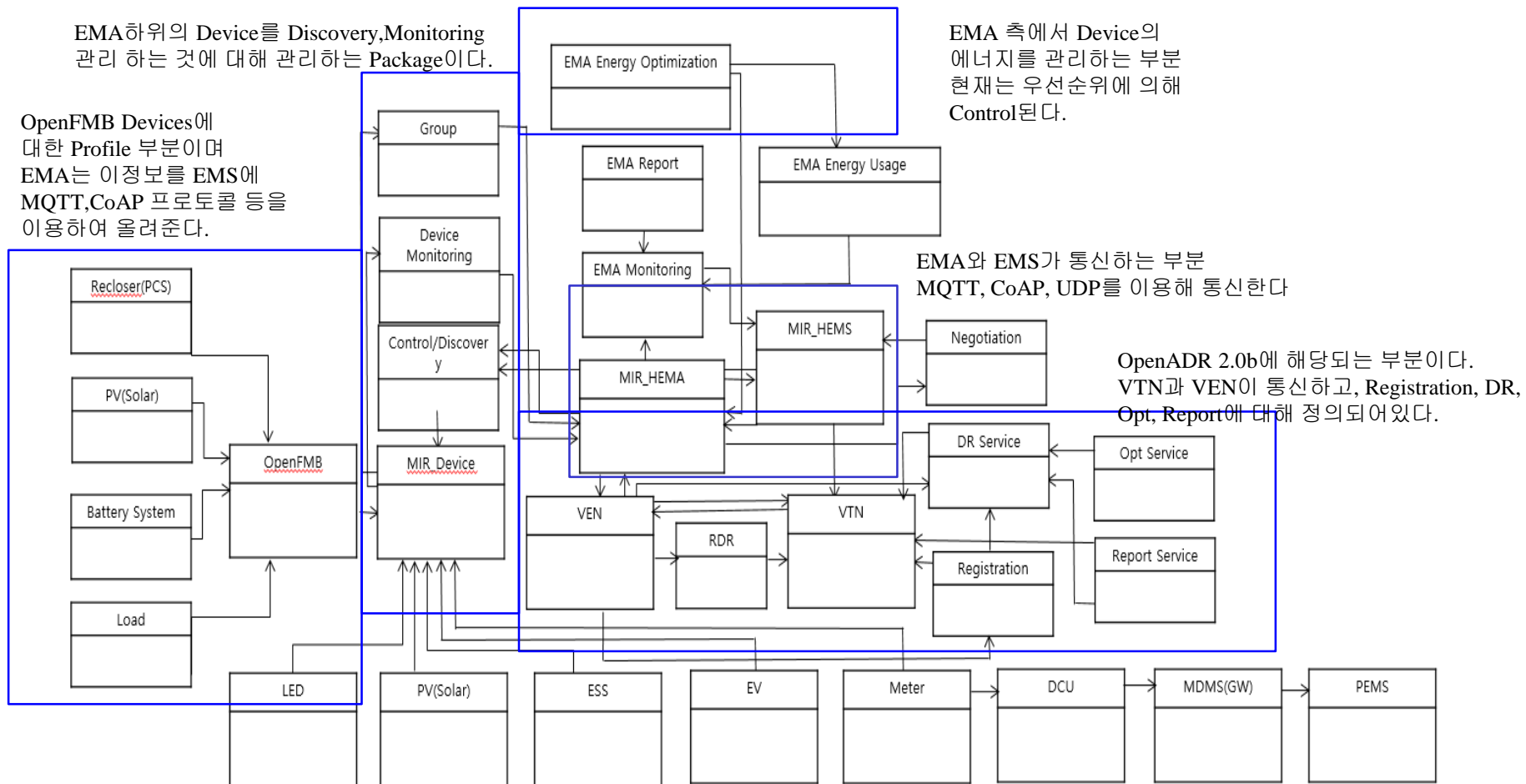
*Energy: 소비량, 저장량, 생산량, 사용량, Threshold, Load Flow

*D. C. 1960. VTN, EMA, D. 1960. EMPG. M. 1960.

3-2. Client EMA Program Architecture



Appendix. EMA Overview



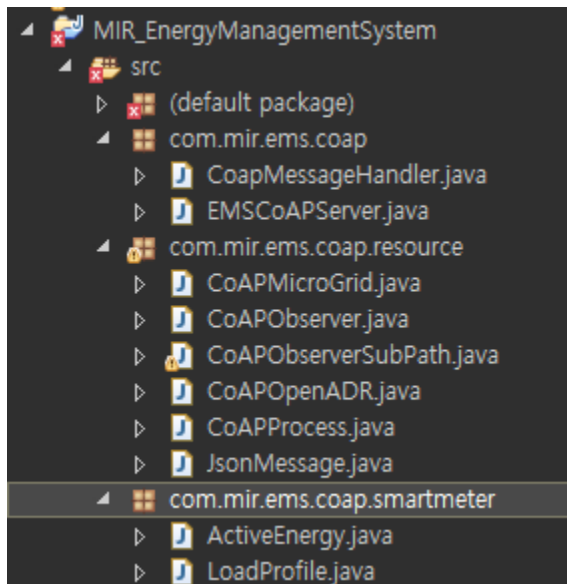
Smart Meter -> DCU
-> MDMS(Future) -> EMS

4. EMS : Package Explanation OpenADR

각과
무엇

In MIR Lab, We are using californium CoAP library

CoAP Package



com.mir.ems.classoap

- EMSCoAPServer :

CoAP Server

- CoAPMessageHanlder :

Handling the message that receive from CoAP Client

com.mir.ems.classoap.resource

-CoAPMicroGrid:

Restful API (Only use PUT Method)

-CoAPObserver:

It is super class of CoAPObserverSubPath

-CoAPObserver:

Send Push Message when Event occur

-CoAPOpenADR:

Process of OpenADR2.0b(e.g. queryRegistration)

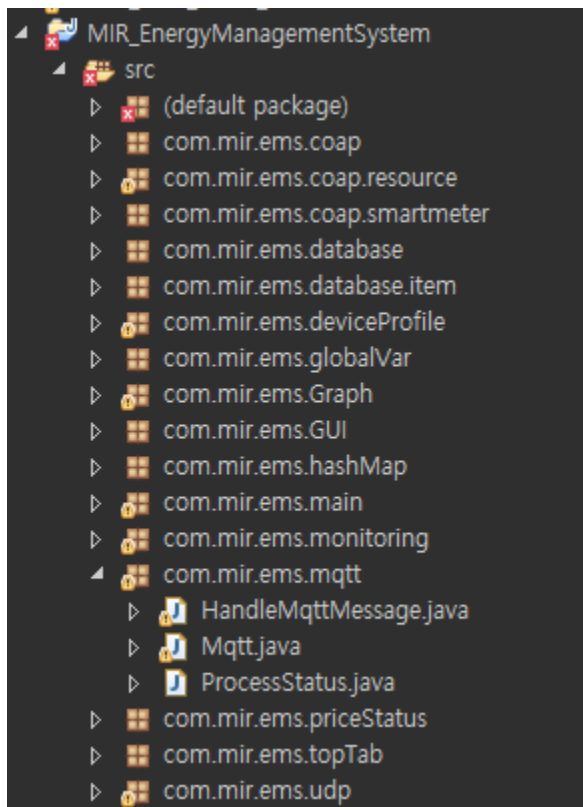
-JsonMessage:

Parsing JSON Type Message that receive from client

4. EMS : Package Explanation OpenADR

In MIR Lab, We are using paho MQTT library

MQTT Package



com.mir.ems.mqtt

-Mqtt:

Start Publish, Subscribe and MQTT Client

-HandleMqttMessage:

Handling the JSON and Text message
and publish Message to MQTT Broker

-ProcessStatus:

Save the Process value (Poll or Event)

4. EMS : Package Explanation OpenADR

Protocol

MQTT

```
com.mir.ems.mqtt
├── EventInitiator.java
├── EventResponder.java
├── HandleEnergyReport.java
├── HandleMqttMessage.java
├── Mqtt.java
├── NewHandleMqttMessage.java
├── ProcessStatus.java
├── Publishing.java
└── PushEventListener.java
```

COAP

```
com.mir.ems.coap
├── CoAPClient.java
├── CoAPDR.java
├── CoAPObserver.java
├── CoAPObserverSubPath.java
├── CoAPServer.java
└── HandleCoAPMessage.java
```

Service

프로토콜 서비스 참조

```
com.mir.ems.mqtt.emap
├── DemandResponseEvent.java
├── Opt.java
├── Report.java
├── Report1.java
└── SessionSetup.java
```

각 서비스에 맞는
모델링 참조

OpenADR Model Package

```
com.mir.ems.profile.emap.v2
├── Available.java
├── CanceledOpt.java
├── CancelOpt.java
├── ConnectedPartyRegistration.java
├── ConnectRegistration.java
├── CreatedEvent.java
├── CreatedOpt.java
├── CreatedPartyRegistration.java
├── CreateOpt.java
├── CreatePartyRegistration.java
├── DistributeEvent.java
├── Event.java
├── EventResponse.java
├── EventSignals.java
├── Intervals.java
├── Poll.java
├── PowerAttributes.java
├── Profile.java
├── RegisteredReport.java
├── RegisterReport.java
├── Report.java
├── ReportDescription.java
├── RequestEvent.java
├── Response.java
├── TestMain.java
├── Transports.java
├── UpdatedReport.java
└── UpdateReport.java
```

4. EMS : Package Explanation

EMAP – Client Side

CoAP Client Class : 수/발신 메시지 서비스에 따른 분류

... [Line 952]

```
server.add(new Emap("EMAP"));

server.add(new OpenADR("OpenADR"));
```

```
public class Emap extends CoapResource {

    public Emap(String name) {
        // TODO Auto-generated constructor stub
        super(name);

        add(new SystemID(global.SYSTEM_ID, name));
    }
}

....

// EMAP
add(new SessionSetup("SessionSetup"));
add(new Report("Report"));
add(new Opt("Opt"));
add(new DemandResponseEvent("Event"));
add(new DemandResponseEvent("Poll"));
```


4. EMS : Package Explanation

OpenADR - Client Side

MQTT Class : 수/발신 메시지에 따라 서비스 분류 (Session Setup/Report/Event/Opt)

... [Line 101]

```
if (topicParse[1].equals("OpenADR") && topicParse[2].equals(global.CHILD_ID)) {
```

```
    Services services = Services.valueOf(topicParse[4]);
```

```
    switch (services) {
```

```
        case SessionSetup:
```

```
            try {
```

```
                sessionSetup(procedure, profileVersion);
```

```
            } catch (JSONException e) {
```

```
                e.printStackTrace();
```

```
            }
```

```
            break;
```

```
        case Poll:
```

```
            try {
```

```
                poll(procedure, profileVersion);
```

```
            } catch (JSONException e) {
```

```
                e.printStackTrace();
```

```
            }
```

```
            break;
```

```
        case Report:
```

```
            report(procedure, profileVersion);
```

```
            break;
```

```
        case Opt:
```

```
            opt(procedure, profileVersion);
```

```
            break;
```

```
        case Event:
```

```
            poll(procedure, profileVersion);
```

```
            break;
```

```
        }
```

```
    }
```

4. EMS : Package Explanation

OpenADR – Client Side

Session Setup/Report/Event/Opt Class : 상세 서비스 분류 ConnectRegistration, Poll...

```
public void sessionSetup(String procedure, String profileVersion) throws JSONException, InterruptedException {
    String setPayload = "";
    SessionSetup sessionSetup = SessionSetup.valueOf(procedure);
    JSONObject jsonParse = new JSONObject(msgPayload);
    double generate = 0, storage = 0, power = 0;

    switch (sessionSetup) {
        case ConnectedRegistration:

            else if (profileVersion.equals("OpenADR2.0b_new")) {

                com.mir.ems.profile.openadr.recent.CreatePartyRegistration cp = new com.mir.ems.profile.openadr.recent.CreatePartyRegistration();

                cp.setHttpPullModel(this.connection.isPullModel());

                cp.setProfileName("OpenADR2.0b");
                cp.setReportOnly(false);
                cp.setRequestID("requestID");
                cp.setService("oadrCreatePartyRegistration");
                cp.setSrcEMA(this.connection.getEmailID());
                // cp.setTime(this.connection.getCurrentTime(System.currentTimeMillis()));
                cp.setTransportName("MQTT");
                cp.setXmlSignature(true);

                String topic = "/OpenADR/" + global.getParentNodeID() + "/2.0b/EiRegisterParty";
                setPayload = cp.toString();
                new Publishing().publishThread(this.client, topic, 0, setPayload.getBytes());

            }
    }
}
```

4. EMS : Package Explanation

OpenADR - Client Side

각 QueryRegistration Class : 상세 서비스 QueryRegistration
Message Build up

... [Line 50] JSON Message build up

```
public class QueryRegistration {

    int emaNum, requestID, version;
    String venID;

    public QueryRegistration(int emaNum, String venID, int requestID, int version){

        setEmaNum(emaNum);
        setRequestID(requestID);
        setVenID(venID);
        setVersion(version);

    }

    @Override
    public String toString() {
        return "{\"GW\":\"\" + getEmaNum() + "\",\"
        + \"VENID\":\"\" + getVenID() + "\",\"
        + \"RequestID\":\"\" + getRequestID() + "\",\"
        + \"Version\":\"\" + getVersion() + \"\"
        + \"}\";
    }
}
```

4. EMS : Package Explanation

EMAP

Protocol

MQTT

```

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├── EventInitiator.java
├── EventResponder.java
├── HandleEnergyReport.java
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├── Mqtt.java
├── NewHandleMqttMessage.java
├── ProcessStatus.java
├── Publishing.java
└── PushEventListener.java
    
```

COAP

```

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├── CoAPClient.java
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├── CoAPObserver.java
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└── HandleCoAPMessage.java
    
```

Service

프로토콜 서비스 참조

```

com.mir.ems.mqtt.emap
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├── Opt.java
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├── Report1.java
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```

각 서비스에 맞는
모델링 참조

EMAP Model Package

```

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├── CancelOpt.java
├── ConnectedPartyRegistration.java
├── ConnectRegistration.java
├── CreatedEvent.java
├── CreatedOpt.java
├── CreatedPartyRegistration.java
├── CreateOpt.java
├── CreatePartyRegistration.java
├── DistributeEvent.java
├── Event.java
├── EventResponse.java
├── EventSignals.java
├── Intervals.java
├── Poll.java
├── PowerAttributes.java
├── Profile.java
├── RegisteredReport.java
├── RegisterReport.java
├── Report.java
├── ReportDescription.java
├── RequestEvent.java
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├── TestMain.java
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├── UpdatedReport.java
└── UpdateReport.java
    
```

4. EMS : Package Explanation

EMAP – Client Side

CoAP Client Class : 수/발신 메시지 서비스에 따른 분류

... [Line 952]

```
server.add(new Emap("EMAP"));

server.add(new OpenADR("OpenADR"));
```

```
public class Emap extends CoapResource {

    public Emap(String name) {
        // TODO Auto-generated constructor stub
        super(name);

        add(new SystemID(global.SYSTEM_ID, name));
    }

    ....

    // EMAP
    add(new SessionSetup("SessionSetup"));
    add(new Report("Report"));
    add(new Opt("Opt"));
    add(new DemandResponseEvent("Event"));
    add(new DemandResponseEvent("Poll"));
```

4. EMS : Package Explanation

EMAP - Client Side

MQTT Class : 수/발신 메시지에 따라 서비스 분류 (Session Setup/Report/Event/Opt)

... [Line 101] JSON Message build up

```
if (topicParse[1].equals("EMAP") && topicParse[2].equals(global.CHILD_ID)) {  
    String profileVersion = "EMAP1.0b";  
    if (msg_json.getString("DestEMA").equals(global.CHILD_ID));  
    String procedure = msg_json.getString("service");  
    Services services = Services.valueOf(topicParse[4]);  
    switch (services) {  
        case SessionSetup:  
            try {  
                sessionSetup(procedure, profileVersion);  
            } catch (JSONException e) {  
                e.printStackTrace();  
            }  
            break;  
        case Poll:  
            try {  
                poll(procedure, profileVersion);  
            } catch (JSONException e) {  
                e.printStackTrace();  
            }  
            break;  
        case Report:  
            report(procedure, profileVersion);  
            break;  
        case Opt:  
            opt(procedure, profileVersion);  
            break;  
        case Event:  
            poll(procedure, profileVersion);  
            break;  
    }  
}
```

4. EMS : Package Explanation

EMAP – Client Side

Session Setup/Report/Event/Opt Class : 상세 서비스 분류 ConnectRegistration, Poll...

```
public void sessionSetup(String procedure, String profileVersion) throws JSONException, InterruptedException {
    String setPayload = "";
    SessionSetup sessionSetup = SessionSetup.valueOf(procedure);
    JSONObject jsonParse = new JSONObject(msgPayload);
    double generate = 0, storage = 0, power = 0;

    switch (sessionSetup) {
        case ConnectedRegistration:

            if (profileVersion.equals("EMAP1.0b")) {

                com.mir.ems.profile.emap.v2.CreatePartyRegistration cp = new com.mir.ems.profile.emap.v2.CreatePartyRegistration();

                cp.setDestEMA(global.getParentnNodeID());

                cp.setHttpPullModel(this.connection.isPullModel());

                cp.setProfileName("EMAP1.0b");
                cp.setReportOnly(false);
                cp.setRequestID("requestID");
                cp.setService("CreatePartyRegistration");
                cp.setSrcEMA(this.connection.getEmaID());
                cp.setTime(this.connection.getCurrentTime(System.currentTimeMillis()));
                cp.setTransportName("MQTT");
                cp.setXmlSignature(true);

                String topic = "/EMAP/" + global.getParentnNodeID() + "/1.0b/SessionSetup";
                setPayload = cp.toString();
                new Publishing().publishThread(this.client, topic, 0, setPayload.getBytes());
            }
        }
    }
```

4. EMS : Package Explanation

EMAP - Client Side

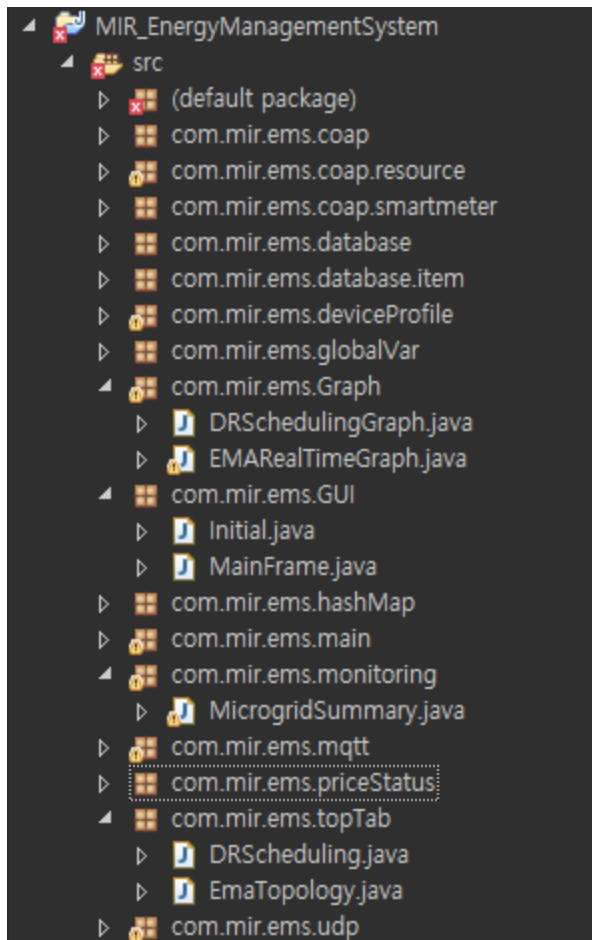
각 **ConnectRegistration** Class : 상세 서비스 **ConnectRegistration**
Message Build up

... [Line 101] JSON Message build up

```
public class ConnectRegistration {  
    // Mapping field  
    private String srcEMA;  
    private String destEMA;  
    private int requestID; private int version;  
    public ConnectRegistration(String srcEMA, String destEMA, int requestID, int version, int customerPriority,  
        String qoS, String service, String type, String time) {  
        super();  
        this.srcEMA = srcEMA;  
        this.destEMA = destEMA;  
        this.requestID = requestID;  
        this.version = version;  
        this.customerPriority = customerPriority;  
        this.qoS = qoS;  
        this.service = service;  
        this.type = type;  
        this.time = time;  
    }  
    @Override  
    public String toString() {  
        return "{" + "SrcEMA\\":\"" + srcEMA + "\"", "  
            + "\"DestEMA\\":\"" + destEMA + "\"", "  
            + "\"requestID\\":\" + requestID + "\", "  
            + "\"version\\":\" + version + "\", "  
            + "\"customerPriority\\":\" + customerPriority + "\", "  
            + "\"QoS\\":\"" + qoS + "\"", "  
            + "\"service\\":\"" + service + "\"", "  
            + "\"type\\":\"" + type + "\"", "  
            + "\"time\\":\"" + time + "\""  
            + "}";  
    }  
}
```


4. EMS : Package Explanation Monitoring

Monitoring



com.mir.ems.monitoring

-MicrogridSummary:

To show the microgrid status (ess, pv, resource)

com.mir.ems.Graph

- EMARealTimeGraph:

To show EMA'S Energy USE on Real Time Graph

- EnergyGraph:

To show total energy use on Real Time Graph-

-EMATopology:

To show EMA Topology

- DRSchedulingGraph:

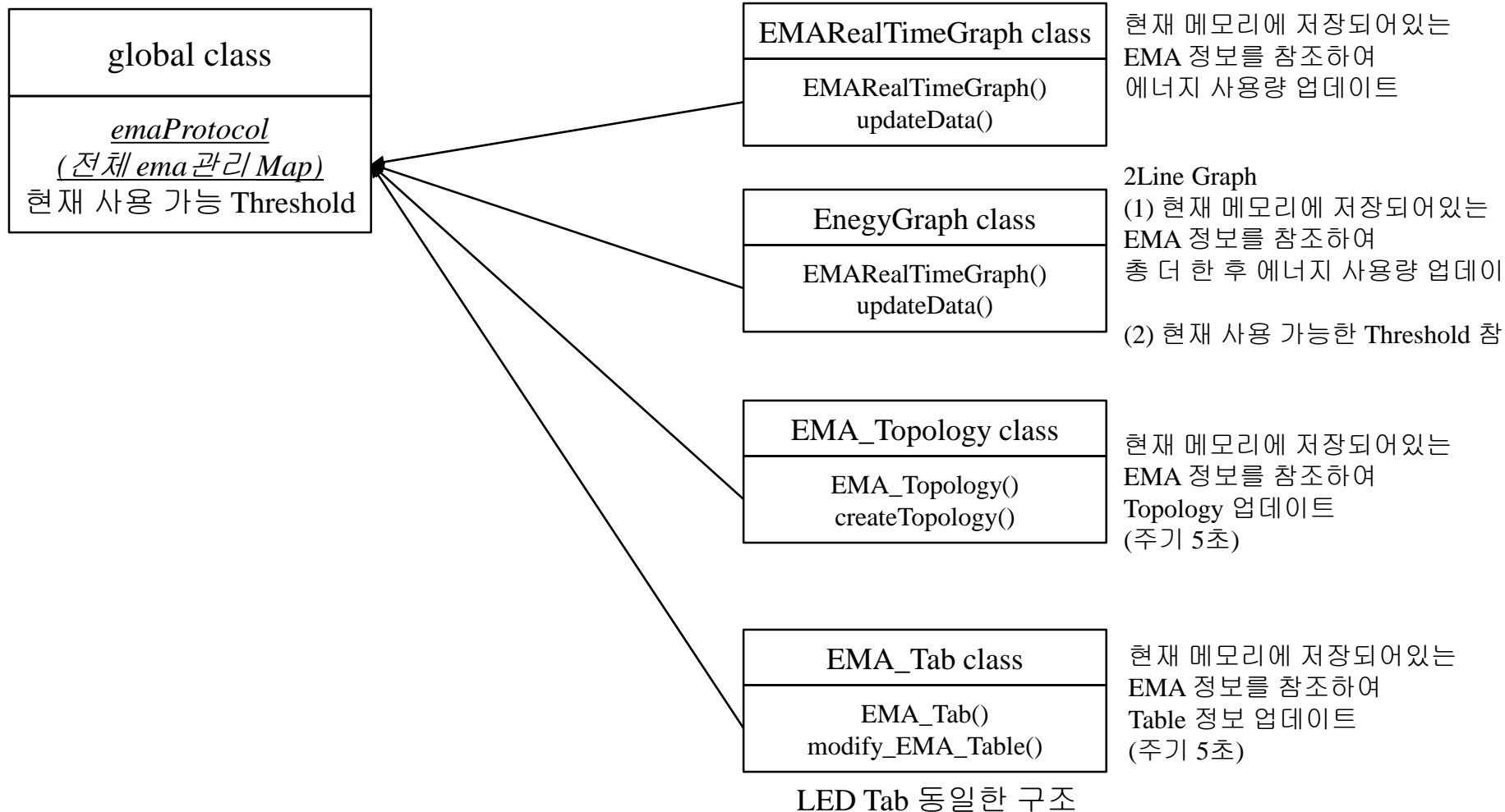
To show when you give a event to EMA

com.mir.ems.deviceProfile

: In order to store Devices profile in JVM

- EMA_TAB
- LED_TAB

4. EMS : Package Explanation Monitoring



4. EMS : Package Explanation

Monitoring : EMARealTimeGraph

EMARealTimeGraph Class : 각각의 EMA에 대한 실시간 그래프

... [Line 49] 그래프 생성 및 그래프 업데이트 주기 설정

```
public EMARealTimeGraph() {  
  
    setBounds(14, 60, 1467, 700);  
    final XYChart chart = getChart();  
    setLayout(null);  
    XChartPanel chartPanel = new XChartPanel(chart);  
    chartPanel.setBackground(Color.WHITE);  
    chartPanel.setBounds(0, 0, 1467, 700);  
    add(chartPanel);  
  
    TimerTask chartUpdaterTask = new TimerTask() {  
        @Override  
        public void run() {  
  
            updateData();  
  
            javax.swing.SwingUtilities.invokeLater(new Runnable() {  
                public void run() {  
                    repaint();  
                }  
            });  
        }  
    };  
  
    Timer timer = new Timer();  
    timer.scheduleAtFixedRate(chartUpdaterTask, 2000, 2000); (2초 주기로 그래프 업데이트)  
}
```

4. EMS : Package Explanation

Monitoring : EMARealTimeGraph

EMARealTimeGraph Class : 각각의 EMA에 대한 실시간 그래프

... [Line 109] 그래프 업데이트 함수, X축 Y축 업데이트

```
@SuppressWarnings("unchecked")
public void updateData() {
    List<Date> newXdata = getCurrentTime();
    xData.addAll(newXdata);
    int emaListSize;
    emaListSize = global.emaProtocolCoAP.size();

    for (int i = 0; i < emaListSize; i++) {
        arr[i][1] = getRandomData((List<Double>) arr[i][1], i);
    }

    for(int i=emaListSize;i<20;i++){
        arr[i][1] = getRandomData((List<Double>) arr[i][1], i);
    }

    for(int i=0; i<20; i++){
        xyChart.updateXYSeries((String)arr[i][0], xData, (List<Double>)arr[i][1], null);
    }
}
```

4. EMS : Package Explanation

Monitoring : EnergyGraph

EnergyGraph Class : 각각의 EMA에 대한 실시간 그래프

... [Line 52] 그래프 생성 및 그래프 업데이트 주기 설정

```
public EnergyGraph() {  
  
    final XYChart chart = getChart();  
  
    setBounds(14, 60, 1467, 700);  
    setLayout(null);  
  
    @SuppressWarnings({ "rawtypes", "unchecked" })  
    XChartPanel chartPanel = new XChartPanel(chart);  
    chartPanel.setBackground(Color.WHITE);  
    chartPanel.setBounds(0, 0, 1467, 700);  
    add(chartPanel);  
  
    TimerTask chartUpdaterTask = new TimerTask() {  
        Timer timer = new Timer();  
        timer.scheduleAtFixedRate(chartUpdaterTask, 2000, 2000); (2초 주기로 그래프 업데이트)  
    }  
}
```

4. EMS : Package Explanation

Monitoring : EnergyGraph

EnergyGraph Class : 각각의 EMA에 대한 실시간 그래프

... [Line 196] Y축 Sin Graph, X축 현재 시간 업데이트 함수

```
private List<Double> getYAXIS() {  
  
    double radians = phase + (2 * Math.PI / 100 * val);  
    val += 1;  
    phase += ((2 * Math.PI * 2) / 20.0) / PERIOD;  
  
    //Sin graph  
    global.THRESHOLD = (YAXIS_TRANSFERENCE * Math.sin(radians) + BASEWATT) * 1000;  
    global.AVAILABLE_THRESHOLD = (global.THRESHOLD - (global.THRESHOLD /  
global.RESERVE_THRESHOLD_PERCENTAGE));  
    global.RESERVE_THRESHOLD = global.THRESHOLD - global.AVAILABLE_THRESHOLD;  
  
    yData.add(YAXIS_TRANSFERENCE * Math.sin(radians) + BASEWATT);  
  
    return yData;  
}  
  
private List<Date> getEMAAXIS() {  
  
    //현재 시간  
    long now = System.currentTimeMillis();  
    Date date = new Date(now);  
    totalEMAxData.add(date);  
  
    return totalEMAxData;  
}
```

4. EMS : Package Explanation

Monitoring : EMATopology

EMATopology Class : 각각의 EMA에 대한 토폴로지 그래프

... [Line 34] 토폴로지 그래프 생성

```
public EmaTopology() {  
    java.net.URL emsUrl = EmaTopology.class.getResource("/IMAGE/dddd.png");  
    System.setProperty("gs.ui.renderer", "org.graphstream.ui.j2dviewer.J2DGraphRenderer");  
    Viewer viewer = new Viewer(graph, Viewer.ThreadingModel.GRAPH_IN_GUI_THREAD);  
    viewer.disableAutoLayout();  
  
    ViewPanel topologyPanel = (ViewPanel) viewer.addDefaultView(false);  
    topologyPanel.setSize(1467, 700);  
    add(topologyPanel);  
  
    setBounds(14, 60, 1467, 700);  
    setLayout(new BorderLayout(0, 0));  
    setVisible(true);  
  
    Node a = graph.addNode("EMS");  
    a.addAttribute("ui.label", a.getId());  
  
    int sum = 0;  
    for (int i = 0; i < 20; i++) {  
        sum += (i * 20);  
    }  
    a.setAttribute("x", (sum / 40));  
    a.setAttribute("y", 10);  
  
    a.addAttribute("ui.style", "text-alignment: above; size: 65px, 65px; shape: rounded-box; size-mode: fit; fill-  
mode: image-scaled; fill-image: url(\""+ emsUrl + "\");");  
    createTopology();  
}
```

4. EMS : Package Explanation

Monitoring : EMATopology

EMATopology Class : 각각의 EMA에 대한 토폴로지 정보

... [Line 34] 그래프 생성 및 그래프 업데이트 주기 설정

```
TimerTask chartUpdaterTask = new TimerTask() {
    Node emaGroup = null;
    Node deviceGroup = null;
    @Override
    public void run() {
        int cnt = 0;
        int devCnt = 0;
        for (int i = 0; i < emaList.length; i++) {
            String key = emaList[i];
            if (!strSet.classontains(key.toString())) {
                cnt += 1;

                try {
                    // NODE 추가
                    emaGroup = graph.addNode(key);
                    // NODE 생성 위치
                    emaGroup.setAttribute( " x " , (cnt * 10));
                    // NODE ID 설정
                    emaGroup.addAttribute("ui.label", emaGroup.getId());
                    emaGroup.setAttribute("y", 0);

                    //NODE 사이즈 설정
                    emaGroup.addAttribute( " ui.style " ,
                        " text-alignment: under; size: 65px, 65px; shape: rounded-box; size-mode: fit; fill-mode:
image-scaled; fill-image: url( ' " + gatewayUrl + " ' ); " );
                    // EDGE 설정
                    graph.addEdge(emsEdge + key, emsEdge, key);
                } catch (Exception e) {
                    e.printStackTrace();
                }
            }
        }
    }
}
```


4. EMS : Package Explanation

Monitoring : EMA_Tab

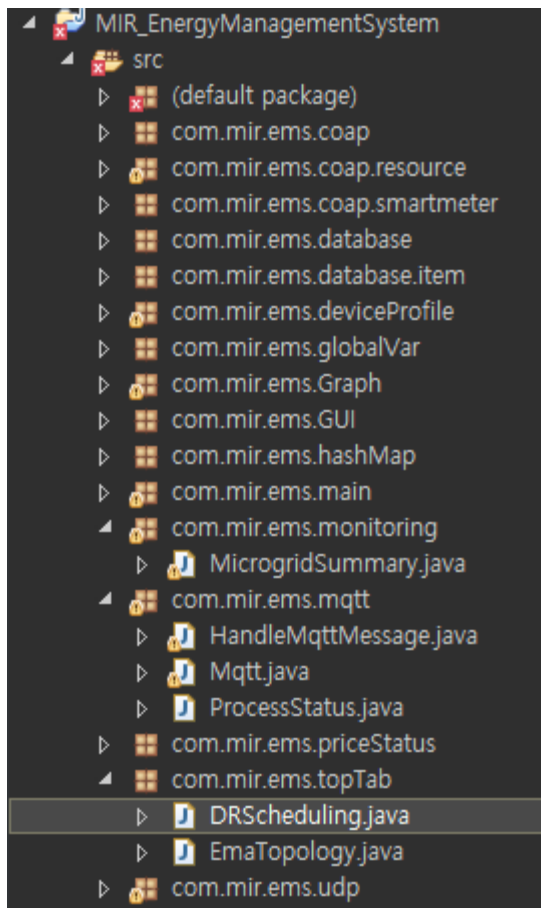
EMA_tab Class : 각각의 EMA에 대한 상세 정보 테이블

... [Line 23] 테이블 생성 및 테이블 업데이트 주기 설정

```
public void modify_EMA_table() {  
  
    int ema_rows_num = EMA_tab_temp.ema_table_model.getRowCount();  
    for (int i = ema_rows_num - 1; i >= 0; i--) {  
        EMA_tab_temp.ema_table_model.removeRow(i);  
    }  
  
    Iterator<String> keys = global.emaProtocolCoAP.keySet().iterator();  
  
    while (keys.hasNext()) {  
        String key = keys.next();  
  
        // 업데이트 항목을 global ema관리 Map에서 참조하여 업데이트  
        EMA_tab_temp.ema_table_model  
            .addRow(new Object[] { false, key,  
global.emaProtocolCoAP.get(key).getProtocol(),  
  
        global.emaProtocolCoAP.get(key).getqOs(), global.emaProtocolCoAP.get(key).getEmaCNT(),  
  
        global.emaProtocolCoAP.get(key).getPower(), global.emaProtocolCoAP.get(key).getMaxValue(),  
  
        global.emaProtocolCoAP.get(key).getMinValue(), global.emaProtocolCoAP.get(key).getMargin(),  
  
        global.emaProtocolCoAP.get(key).getCustomerPriority() });  
    }  
}
```

4. EMS : Package Explanation Control

Control



com.mir.ems.topTab

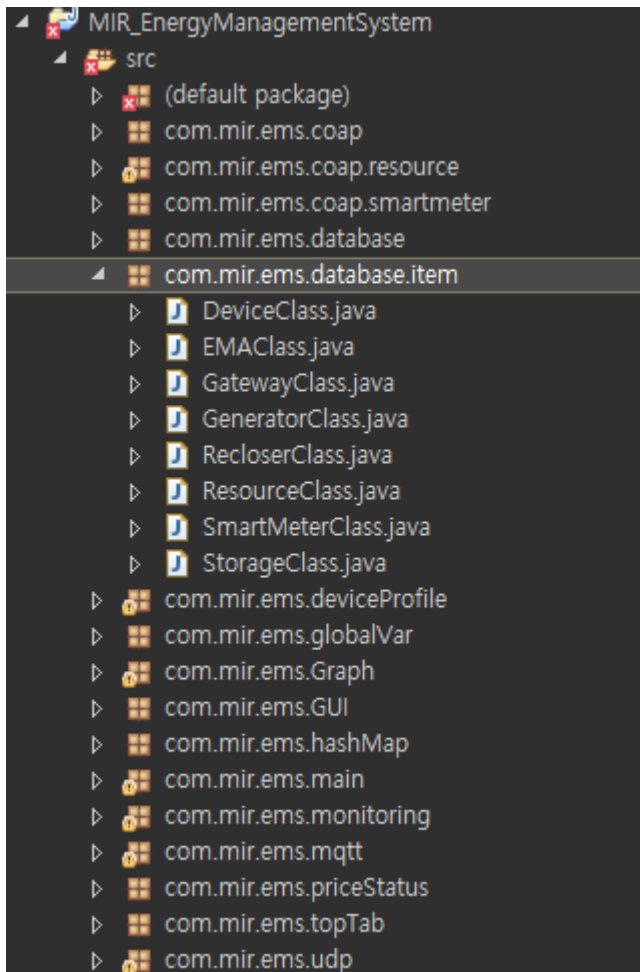
- DRScheduling:

Send DR Message to EMA

It is possible to send Push and Multicast Message here

4. EMS : Package Explanation Profile

Device Profile



com.mir.ems.database.item

Below all classes are Generic Class

:To make object type

DeviceClass

EMAClass

SmartMeterClass

...

com.mir.ems.classlassashMap

:Give key value each devices for easy to handle and search

ESS_values

PV_values

Recloser_values

Resource_values

VTN_values

4. EMS : Package Explanation

Monitoring : global

gloal Class : 각각의 EMA에 대한 정보를 저장하는 Map

... [Line 23] 테이블 생성 및 테이블 업데이트 주기 설정

```
public static ConcurrentHashMap<String, EMA> emaProtocol = new ConcurrentHashMap<String, EMA>();
```

// EMA 정보 저장

```
public static void putEmaProtocol (String emaID, EMA) {  
    try {  
        Thread.sleep(20);  
        emaProtocol.put(emaID, EMA);  
    } catch (InterruptedException e) {  
        // TODO Auto-generated catch block  
        e.printStackTrace();  
    }  
}
```

// Set EMA 정보

```
public static void setEmaProtocol (ConcurrentHashMap<String, EMA> emaProtocol) {  
    global.emaProtocol = emaProtocol;  
}
```

* **TIP:** **ConcurrentHashMap** 은 비 동기 방식의 **HashMap**으로 빠른 응답이 필요하거나 Map내에 **Sorting**이 필요하지 않은 경우 사용한다. 멀티 스레딩 방식에서 주로 사용하는 방식이다.

4. EMS : Package Explanation

Profile : EMA

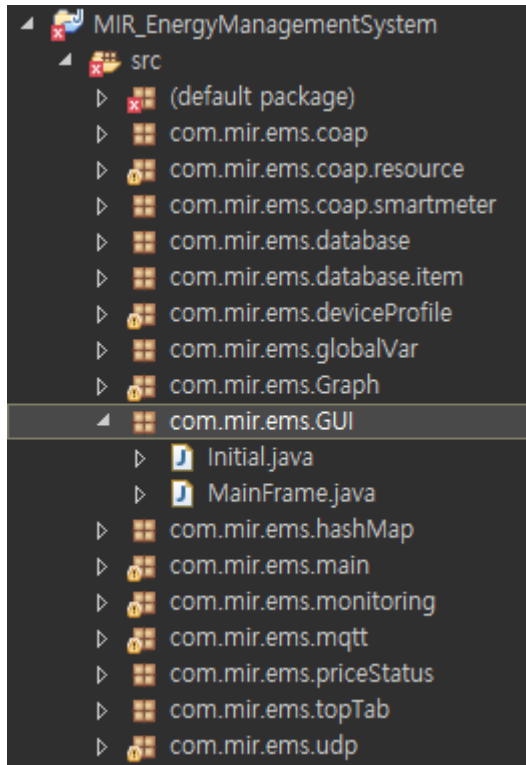
EMA Class : 각각의 EMA에 대한 상세 정보 테이블

... [Line 23] 테이블 생성 및 테이블 업데이트 주기 설정

```
public class EMA {  
  
    private String emaID, qOs, type, registrationID, transportName, transportAddress, reportName, reportType, state,  
                    profileName, requestID, version;  
    private String time, maxTime, minTime, connect, protocol;  
    private int customerPriority, reportOnly, httpPullModel, xmlSignature, emaCNT, priority, dimming;  
    private double margin, minValue, maxValue, avgValue, power, generate, storage;  
    private boolean pullModel, tableChanged, realTimetableChanged;  
    private JSONObject EMARegisteredInfo, EMARegisteredMgnInfo;  
  
    // EMA 정보를 저장하는 구조체  
    public Emap_Cema_Profile(String protocol, String emaID, String registrationID, String qos, String state, double power, int  
dimming, double margin, double generate, double storage, double maxValue, double minValue, double avgValue, String maxTime, String  
minTime, int priority, boolean pullModel, boolean tableChanged, boolean realTimetableChanged, String connect) {  
  
        setProtocol(protocol);  
        setRegistrationID(registrationID);  
        setEmailID(emaID);  
        setqOs(qos);  
        setState(state);  
        setPower(power);  
        .....  
    }  
}
```

4. EMS : Package Explanation GUI

GUI



com.mir.ems.GUI

**Initial
MainFrame**

- First Page
- Main Frame that will be shown after first

4. EMS : Package Explanation

GUI : Initial

Initial Class : IP 설정 및 프로토콜, 프로파일 설정 GUI

GUI 빌드 함수

```
public Initial() {  
    // setting  
    setTitle("MIREnergy Management System");  
    setSize(326, 614);  
    setResizable(false);  
    setLocation(800, 450);  
    setDefaultCloseOperation(EXIT_ON_CLOSE);  
    setLocationRelativeTo(null);  
    // panel  
    JPanel panel = new JPanel();  
    placeLoginPanel(panel);  
  
    // add  
    getContentPane().add(panel);  
  
    JPanel panel_1 = new JPanel();  
    panel_1.setBorder(new EtchedBorder(EtchedBorder.LOWERED, null, null));  
    panel_1.setBounds(12, 66, 298, 118);  
    panel.add(panel_1);  
    panel_1.setLayout(null);  
    ..  
}
```

4. EMS : Package Explanation

GUI : Initial

Initial Class : IP 설정 및 프로토콜 설정 GUI

GUI 빌드 함수

```
public Initial() {
```

```
    //IP 설정
```

```
    final JLabel lblNewLabel = new JLabel( " IP Address " );  
    lblNewLabel.setFont(new Font( " Arial " , Font.BOLD, 13));  
    lblNewLabel.setBounds(39, 75, 76, 25);  
    panel_2.add(lblNewLabel);
```

```
    //PORT 설정
```

```
    final JLabel lblNewLabel_1 = new JLabel("Port");  
    lblNewLabel_1.setFont(new Font("Arial", Font.BOLD, 13));  
    lblNewLabel_1.setBounds(39, 110, 76, 25);  
    panel_2.add(lblNewLabel_1);
```

```
    //Protocol 설정
```

```
    final JComboBox<String> comboBox = new JComboBox<String>();  
    ...  
    comboBox.addItem("MQTT");  
    comboBox.addItem("CoAP");  
    comboBox.addItem("UDP");  
    comboBox.addItem("BOTH");
```

```
    ..
```

```
}
```


4. EMS : Package Explanation

GUI : MainFrame

MainFrame Class : 가격 정보, 등록된 EMA 정보 CFG 파일을 가져오는 함수

```
public MainFrame() {  
  
    // 가격정보를 가져오는 함수  
    rdbtnmntmNewRadioItem_1.addActionListener(new ActionListener() {  
  
        @Override  
        public void actionPerformed(ActionEvent arg0) {  
            // TODO Auto-generated method stub  
            if (rdbtnmntmNewRadioItem_1.isSelected()) {  
                rdbtnmntmNewRadioItem.setSelected(false);  
  
                JFileChooser jfc = new  
JFileChooser(FileSystemView.getFileSystemView().getHomeDirectory());  
                jfc.setDialogTitle("Select an configuration file");  
                jfc.setAcceptAllFileFilterUsed(false);  
                FileNameExtensionFilter filter = new FileNameExtensionFilter(".classfg files", "cfg",  
"CFG");  
  
                jfc.addChoosableFileFilter(filter);  
  
                int returnValue = jfc.showOpenDialog(null);  
  
                if (returnValue == JFileChooser.APPROVE_OPTION)  
                    new RealTimePriceFileReader(jfc.getSelectedFile().getPath());  
  
            }  
        }  
    });  
}
```

4. EMS : Package Explanation

GUI : MainFrame

Initial Class : IP 설정 및 프로토콜, 프로파일 설정 GUI

GUI 빌드 함수

```
public Initial() {  
    // setting  
    setTitle("MIREnergy Management System");  
    setSize(326, 614);  
    setResizable(false);  
    setLocation(800, 450);  
    setDefaultCloseOperation(EXIT_ON_CLOSE);  
    setLocationRelativeTo(null);  
    // panel  
    JPanel panel = new JPanel();  
    placeLoginPanel(panel);  
  
    // add  
    getContentPane().add(panel);  
  
    JPanel panel_1 = new JPanel();  
    panel_1.setBorder(new EtchedBorder(EtchedBorder.LOWERED, null, null));  
    panel_1.setBounds(12, 66, 298, 118);  
    panel.add(panel_1);  
    panel_1.setLayout(null);  
    ..  
}
```

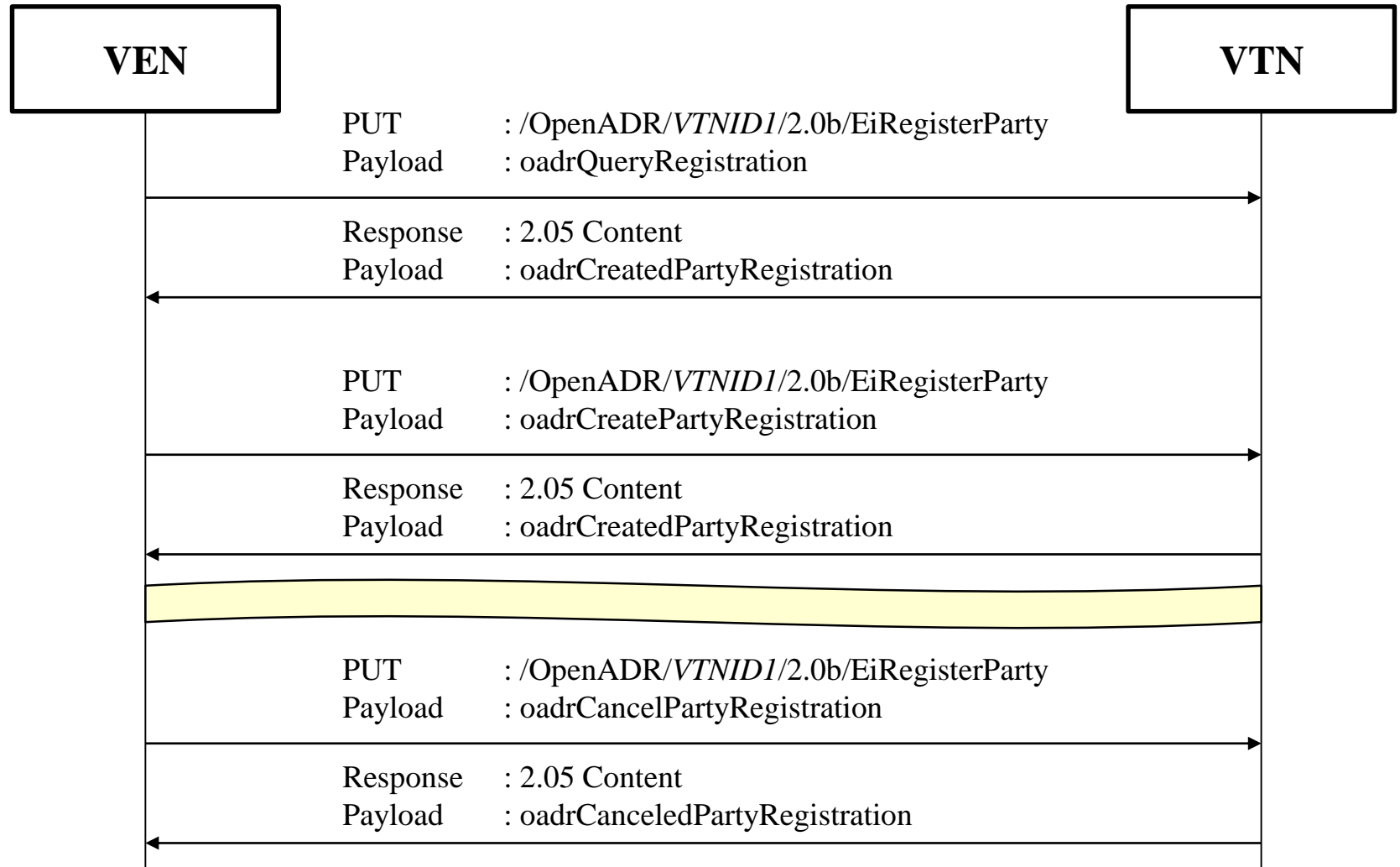
OpenADR 2.0b

(1) EiRegistrationParty

- HTTP / XML
- CoAP / JSON
- MQTT / JSON

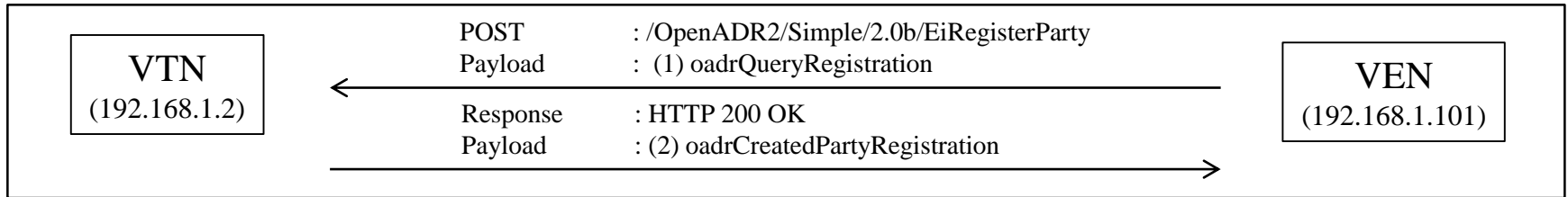
2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)



2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)



(1) oadrQueryRegistration

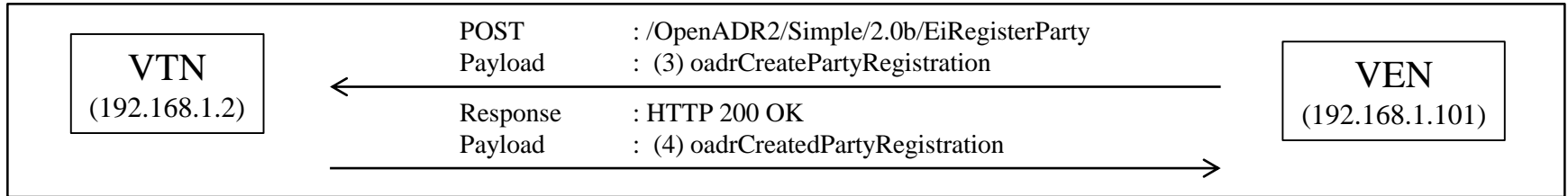
| Key name | Comments |
|-----------|--------------------|
| requestID | request identifier |
| service | message type |
| venID | requested VEN ID |

(2) oadrCreatedPartyRegistration

| Key name | | | Comments |
|---------------------|-----------------|-------------------|------------------------------|
| venID | | | requested VEN ID |
| vtnID | | | responded VTN ID |
| responseCode | | | response code |
| responseDescription | | | description of response code |
| requestID | | | request identifier |
| duration | | | requested polling frequency |
| registrationID | | | registration identifier |
| oadrProfile | oadrProfileName | | type of profile |
| | oadrTransports | oadrTransportName | type of transport protocol |
| service | | | message type |

2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)

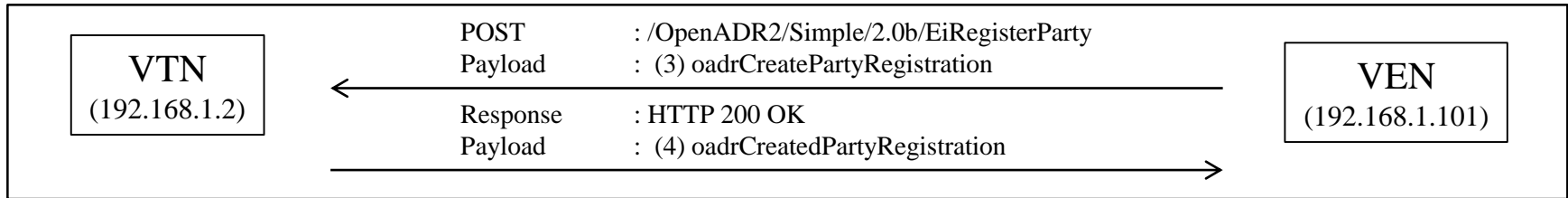


(3) oadrCreateRegistration

| Key name | Comments |
|-------------------|---|
| requestID | request identifier |
| oadrProfileName | profile name used by VEN |
| oadrTransportName | transport name used by VEN |
| oadrReportOnly | VEN type (report only or full functional) |
| oadrXmlSignature | xml 사용여부 true/false |
| oadrVenName | VEN name |
| oadrHttpPullMode | communication mode used by VEN (pull or push) |
| venID | requested VEN ID |
| service | message type |

2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)

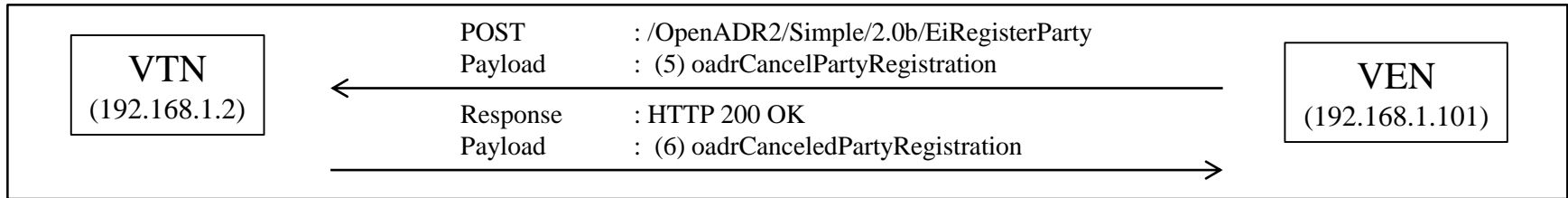


(4) oadrCreatedPartyRegistration

| Key name | | Comments |
|---------------------|-----------------|------------------------------|
| venID | | requested VEN ID |
| vtnID | | responded VTN ID |
| responseCode | | response code |
| responseDescription | | description of response code |
| requestID | | request identifier |
| duration | | requested polling frequency |
| registrationID | | registration identifier |
| oadrProfile | oadrProfileName | type of profile |
| | oadrTransports | oadrTransportName |
| service | | message type |

2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)



(5) oadrCancelRegistration

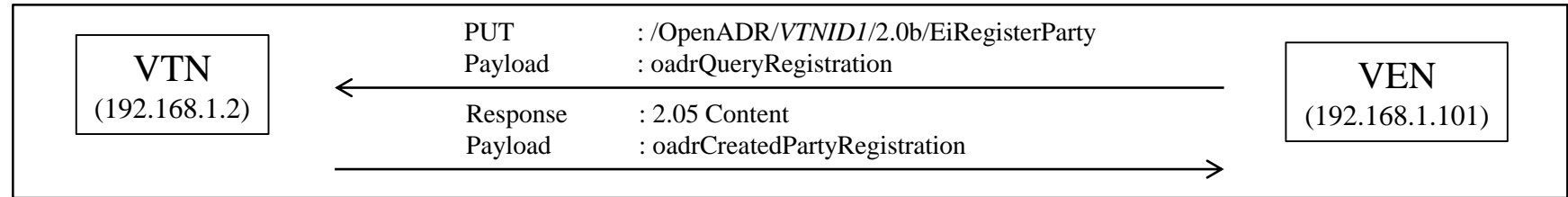
| Key name | Comments |
|----------------|-------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| registrationID | registration identifier |
| service | message type |

(6) oadrCanceledPartyRegistration

| Key name | Comments |
|---------------------|------------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| registrationID | registration identifier |
| service | message type |

2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)



| | | | | |
|------------------------------|------|---------------|---------------|---|
| (1) QueryRegistration | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:17505, PUT, /QueryRegistration |
| (2) CreatedPartyRegistration | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:17505, 2.05 Content (text/plain) |

oadrQueryRegistration JSON{

```

"requestID": String,
"service" : String,
"venID" : String
}

```

```

QueryRegistration{ "Service": " QueryRegistration", "GW": "gw\1 ",
"VENID": "VEN_MIR1", "Request ID": 1, "Version ": 2 }

```

oadrCreatedPartyRegistration JSON{

```

"venID": String,
"vtnID": String,
"requestID": String,
"duration" : Integer,
"responseCode" : Integer,
"responseDescription": String,
"registrationID" : String,
"oadrProfile" : Array,
"service" : String
}

```

```

oadrProfile Array{
  "oadrTransports": Array,
  "oadrProfileName": String
}

```

```

oadrTransports Array{
  "oadrTransportName": String,
}

```

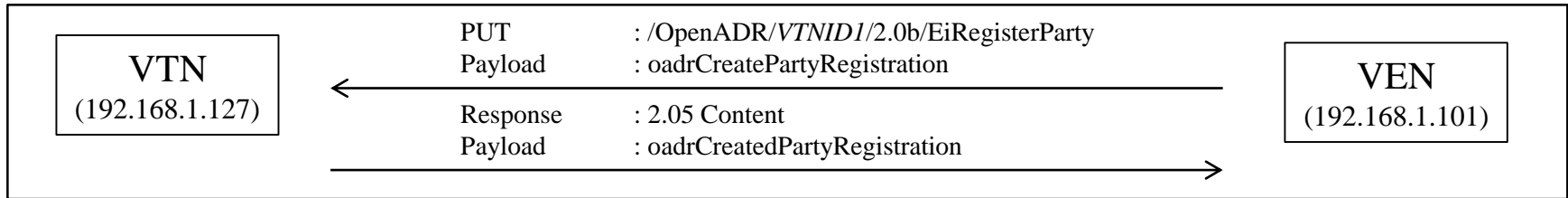
```

DR { "TransportName": "MIR_VTN", "RequestID": 1, "VENID": "VEN_MIR1", "RegistrationID": 1, "VTNID": "MIR_VTN", "Service": "CreatedPartyRegistration", "Duration": 2000 }

```

2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)



| | | | | |
|------------------------------|------|---------------|---------------|---|
| (3) CreateRegistration | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:17760, PUT, /CreatePartyRegistration |
| (4) CreatedPartyRegistration | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:17760, 2.05 Content (text/plain) |

oadrCreateRegistration JSON{

```

"requestID": String,
"oadrProfileName": String,
"oadrTransportName": String,
"oadrReportOnly": Boolean,
"oadrXmlSignature": String,
"oadrVenName": String,
"oadrHttpPullMode": Boolean,
"service": String,
"venID": String
}
  
```

```

CreatePartyRegistration{ "Service": "CreatePartyRegistrationRequest",
"GW": "gw \1", "RequestID": 1, "Version": 2, "TransportName": "CoAP", "ReportOnly": 0, "oadrVenName": "VEN_MIR1", "LastPollPushGet": 3, "oadrProfileName": 2, "oadrXmlSignature": 0, "oadrTransportAddress": "192.168.1.2" }
  
```

oadrCreatedPartyRegistration JSON{

```

"venID": String,
"vtnID": String,
"requestID": String,
"duration": String,
"responseCode": Integer,
"responseDescription": String,
"registrationID": String,
"oadrProfile": Array,
"service": String
}
  
```

```

oadrTransports Array{
  "oadrTransportName": String,
}
  
```

```

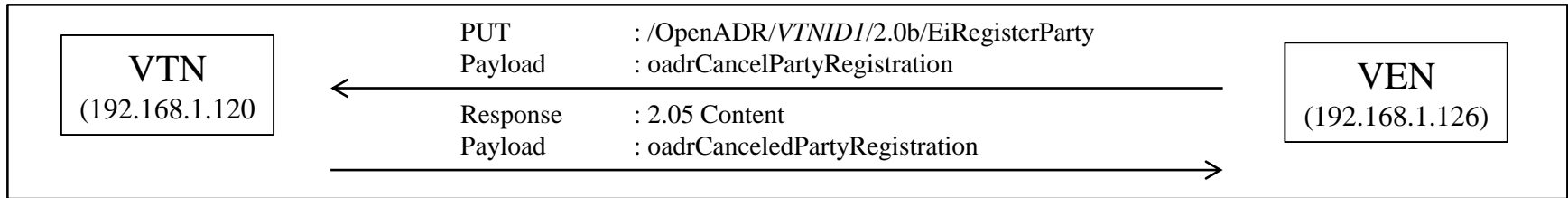
oadrProfile Array{
  "oadrTransports": Array,
  "oadrProfileName": String
}
  
```

```

DR { "Response": 200, "TransportName": "MIR_VTN", "RequestID": 1, "Version": 2, "VENID": "VEN_MIR1", "VTNID": "MIR_VTN", "Service": "CreatedPartyRegistration2", "Duration": 2000 }
  
```

2. Profile : OpenADR 2.0b

2.1 Services : EiRegistrationParty (CoAP / JSON)



- (5) CancelRegistration
- (6) CanceledPartyRegistration

```

CancelRegistration JSON{
  "requestID": String,
  "registrationID": String,
  "venID": String,
  "service" : String
}
  
```

```

CanceledPartyRegistration JSON{
  "venID": String,
  "requestID": String,
  "responseCode" : Integer,
  "responseDescription": String,
  "registrationID": String,
  "service" : String
}
  
```

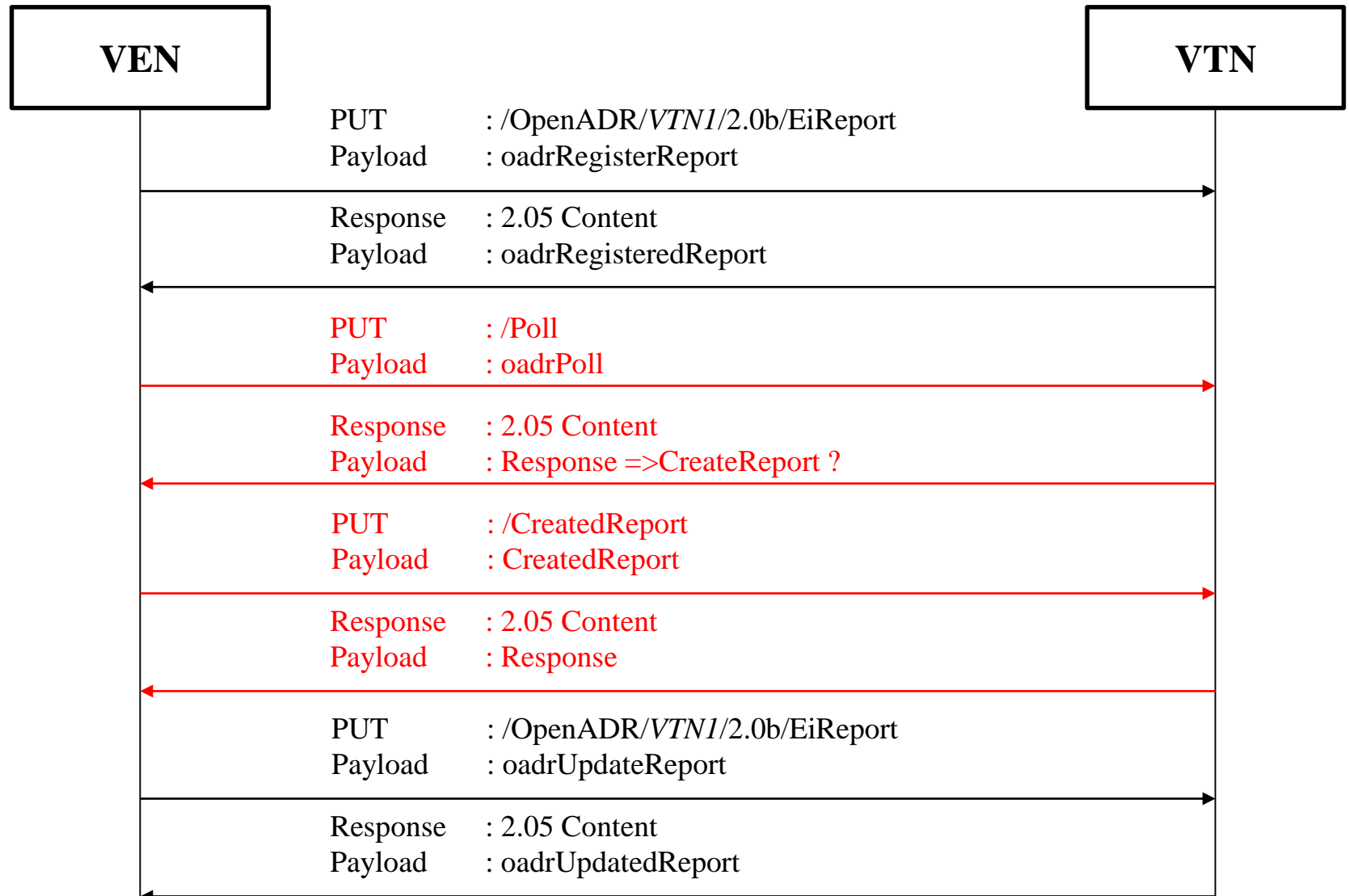
OpenADR 2.0b

(2)EiReport

- **HTTP / XML**
- **CoAP / JSON**
- **MQTT / JSON**

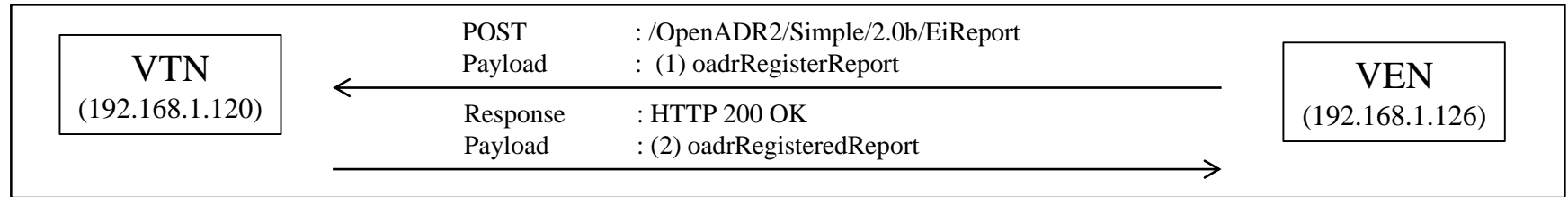
2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)



2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)

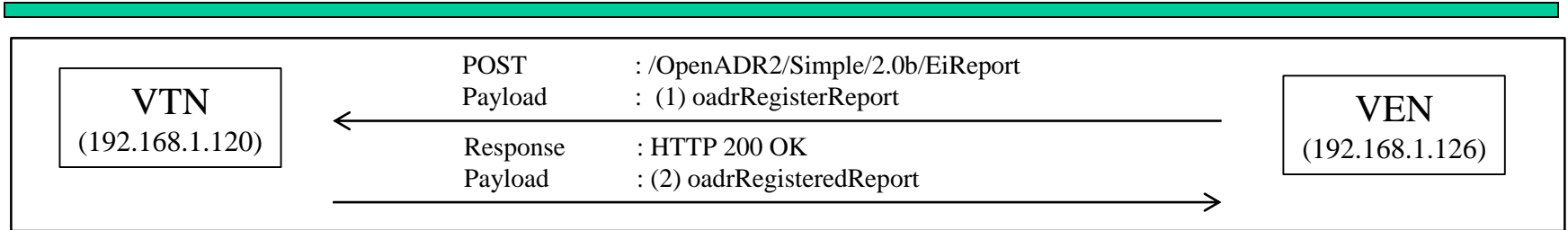


(1) oadrRegisterReport

| Key name | | | | Comments |
|-----------------|-------------------|--------------------------|----|---------------------------------------|
| venID | | | | requested VEN ID |
| requestID | | | | request identifier |
| oadrReport | duration | | | report duration |
| | reportRequestID | | | report request identifier |
| | reportSpecifierID | | | report specific id (created from ven) |
| | reportName | | | report name |
| | createdDateTime | | | created time of this report |
| | reportDescription | rID | | |
| | | resourceID | | resource identifier |
| | | reportType | | report type |
| | | itemUnits | | unit of item that report |
| | | siScaleCode | | |
| | | marketContext | | refer marketContext address |
| | | oadrMinPeriod | | Energy usage minimum period |
| | | oadrMaxPeriod | | Energy usage maximum period |
| | | oadrOnChange | | |
| | | itemDescription | | type of item that report |
| powerAttributes | hertz | pulse frequency of power | | |
| | voltage | voltage of power | | |
| | | | ac | Is this AC power? (True or False) |
| service | | | | message type |

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)

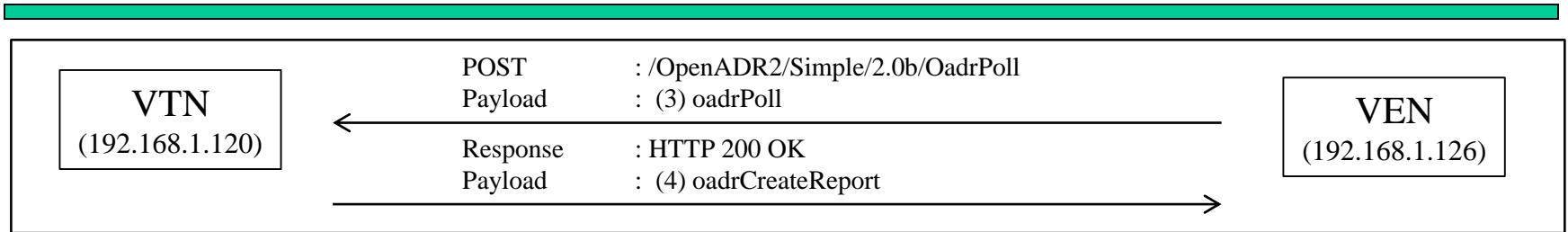


(2) oadrRegisteredReport

| Key name | Comments |
|---------------------|------------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | message type |

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)



(3) oadrPoll

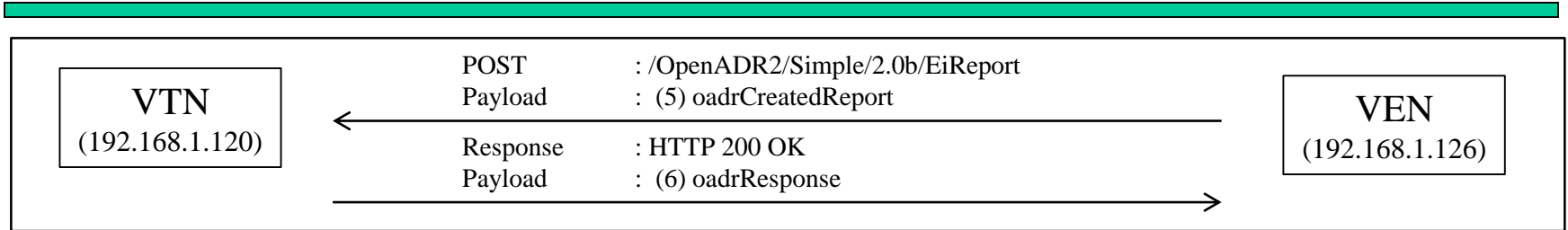
| Key name | Comments |
|----------|------------------|
| venID | requested VEN ID |
| service | message type |

(4) oadrCreateReport

| Key name | Comments |
|-------------------|-------------------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| reportRequestID | report request identifier |
| reportSpecifierID | report specific id(create from ven) |
| duration | report duration |
| dtstart | report start time |
| rID | |
| readingType | reading type xml or json |
| service | message type |

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)



(5) oadrCreatedReport

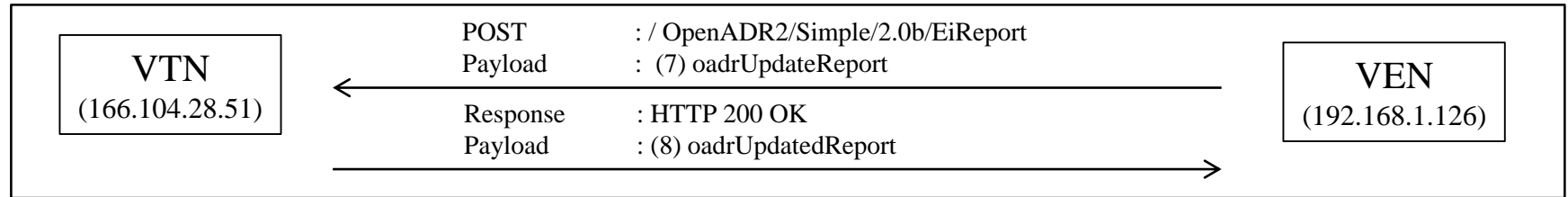
| Key name | Comments |
|-----------------|---------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| reportRequestID | report request identifier |
| service | message type |

(6) oadrResponse

| Key name | Comments |
|---------------------|------------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | message type |

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)

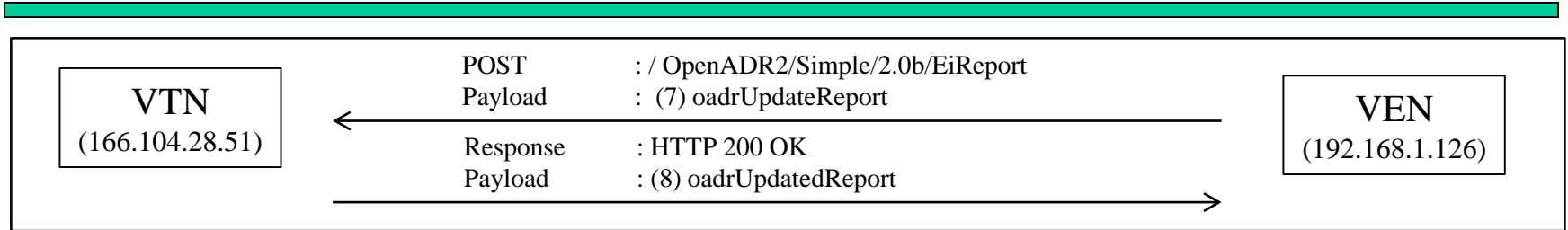


(7) oadrUpdateReport

| Key name | | | | Comments |
|------------|-----------------------------------|-----------------|-------|---------------------------------------|
| venID | | | | requested VEN ID |
| requestID | | | | request identifier |
| oadrReport | duration | | | report duration |
| | reportRequestID | | | report request identifier |
| | reportSpecifierID | | | report specific id (created from ven) |
| | reportName | | | report name |
| | createdDateTime | | | created time of this report |
| | reportDescription | rID | | |
| | | resourceID | | resource identifier |
| | | reportType | | report type |
| | | itemUnits | | unit of item that report |
| | | siScaleCode | | |
| | | marketContext | | refer marketContext address |
| | | oadrMinPeriod | | Energy usage minimum period |
| | | oadrMaxPeriod | | Energy usage maximum period |
| | | oadrOnChange | | |
| | | itemDescription | | type of item that report |
| | | powerAttributes | hertz | pulse frequency of power |
| voltage | voltage of power | | | |
| ac | Is this AC power? (True or False) | | | |
| service | | | | message type |

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)

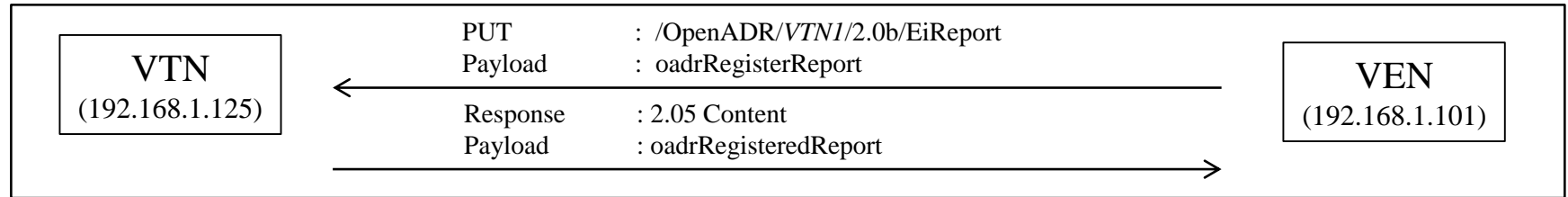


(8) oadrUpdatedReport

| Key name | Comments |
|---------------------|------------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | message type |

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)



| | | | | |
|----------------------|------|---------------|---------------|---|
| (1) RegisterReport | CoAP | 192.168.1.101 | 192.168.1.125 | CON, MID:46948, PUT, /RegisterReport |
| (2) RegisteredReport | CoAP | 192.168.1.125 | 192.168.1.101 | ACK, MID:46948, 2.05 Content (text/plain) |

```

oadrRegisterReport JSON{
  "requestID": String,
  "oadrReport" : Array,
  "venID" : String,
  "service" : String
}

```

```

powerAttributes Array{
  "hertz" : Integer,
  "voltage" : Integer,
  "ac" : Boolean
}

```

```

oadrReport Object{
  "duration" : String,
  "reportRequestID" : Integer,
  "reportSpecifierID" : String,
  "reportName" : String,
  "createdDateTime" : Date,
  "reportDescription" : Array,
}

```

```

oadrReportDescription Array{
  "rID" : String
  "resourceID" : String,
  "reportType" : String,
  "itemUnits" : String,
  "siScaleCode" : String,
  "marketContxt" : String,
  "oadrMinPeriod" : String,
  "oadrMaxPeriod" : String,
  "oadrOnChange" : Boolean,
  "itemDescription" : String,
  "powerAttributes" : Array
}

```

```

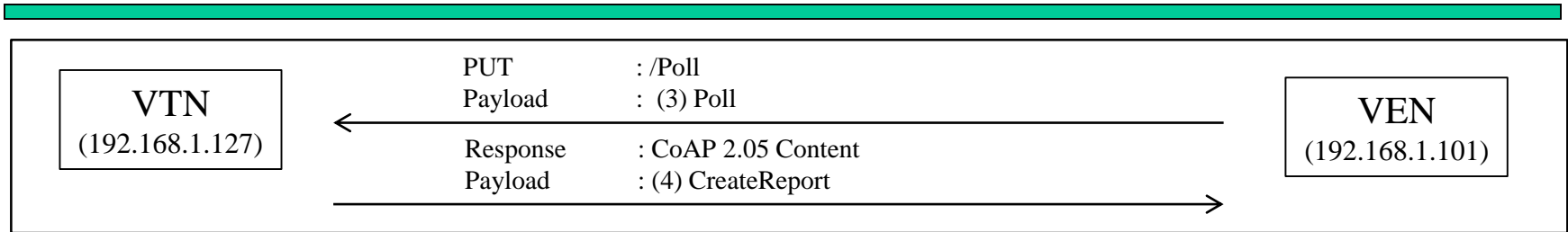
oadrRegisteredReport JSON{
  "responseCode": Integer,
  "responseDescription": String,
  "requestID": String,
  "service" : String
}

```

2. Profile : OpenADR 2.0b

Not implement yet

2.2 Services : EiReport (CoAP / JSON)



- (3) Poll
- (4) CreateReport

```
oadrPoll JSON{
  "venID": String,
  "service": String
}
```

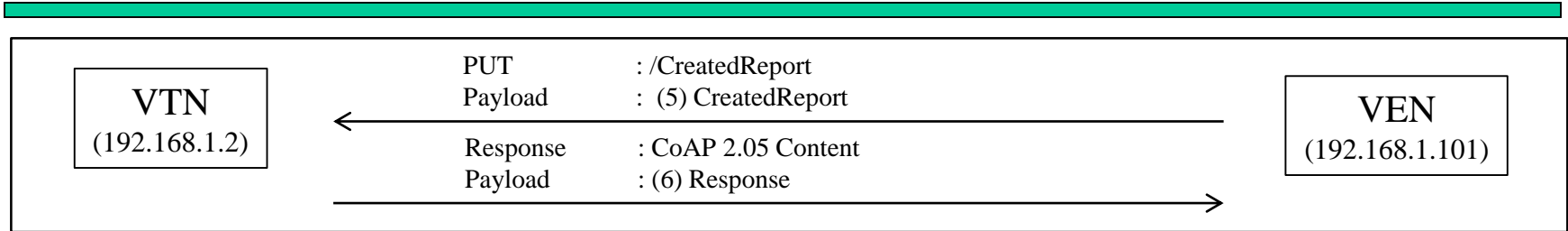
```
Poll{ "Service": "Poll", "GW": " gw\1", "VENID": "VEN MIR1", "Re questID":
1, "Ve rsion": 2 }
```

```
oadrCreateReport JSON{
  "requestID" : String,
  "reportRequestID" : String,
  "reportSpecifierID" : String,
  "duration" : String,
  "dtstart" : Date,
  "rID" : String,
  "readingType" : String,
  "service" : String
}
```

2. Profile : OpenADR 2.0b

Not implement yet

2.2 Services : EiReport (CoAP / JSON)



(5) CreatedReport

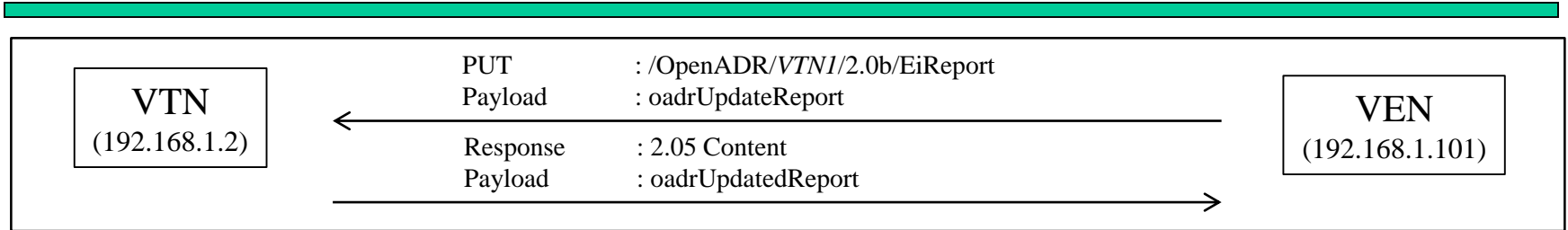
(6) Response

```
CreatedReport JSON{
  "responseCode" : Integer,
  "requestID" : String,
  "reportRequestID" : String,
  "venID" : String,
  "service" : String
}
```

```
Response JSON{
  "responseCode" : Integer,
  "responseDescription" : String,
  "requestID" : String,
  "venID" : String,
  "service" : String
}
```

2. Profile : OpenADR 2.0b

2.2 Services : EiReport (CoAP / JSON)



| | | | | |
|-------------------|------|---------------|---------------|--------------------------------------|
| (5) UpdateReport | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:25996, PUT, /UpdateReport |
| (6) UpdatedReport | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:25996, 2.05 Content (text/p |

```
oadrUpdateReport JSON{
  "requestID": String,
  "oadrReport" : Array,
  "venID" : String,
  "service" : String
}
```

```
oadrReportDescription Array{
  "rID" : String
  "resourceID" : String,
  "reportType" : String,
  "itemUnits" : String,
  "siScaleCode" : String,
  "marketContxt" : String,
  "oadrMinPeriod" : String,
  "oadrMaxPeriod" : String,
  "oadrOnChange" : Boolean,
  "itemDescription" : String.
  "powerAttributes" : Array
}
```

```
powerAttributes Array{
  "hertz" : Integer,
  "voltage" : Integer,
  "ac" : Boolean
}
```

```
oadrReport Object{
  "duration" : String,
  "reportRequestID" : Integer,
  "reportSpecifierID" : String,
  "reportName" : String,
  "createdDateTime" : Date,
  "reportDescription" : Array,
}
```

```
oadrUpdatedReport JSON{
  "reponseCode" : Integer,
  "responseDescription" : String,
  "requestID" : String,
  "venID" : String,
  "service" : String
}
```

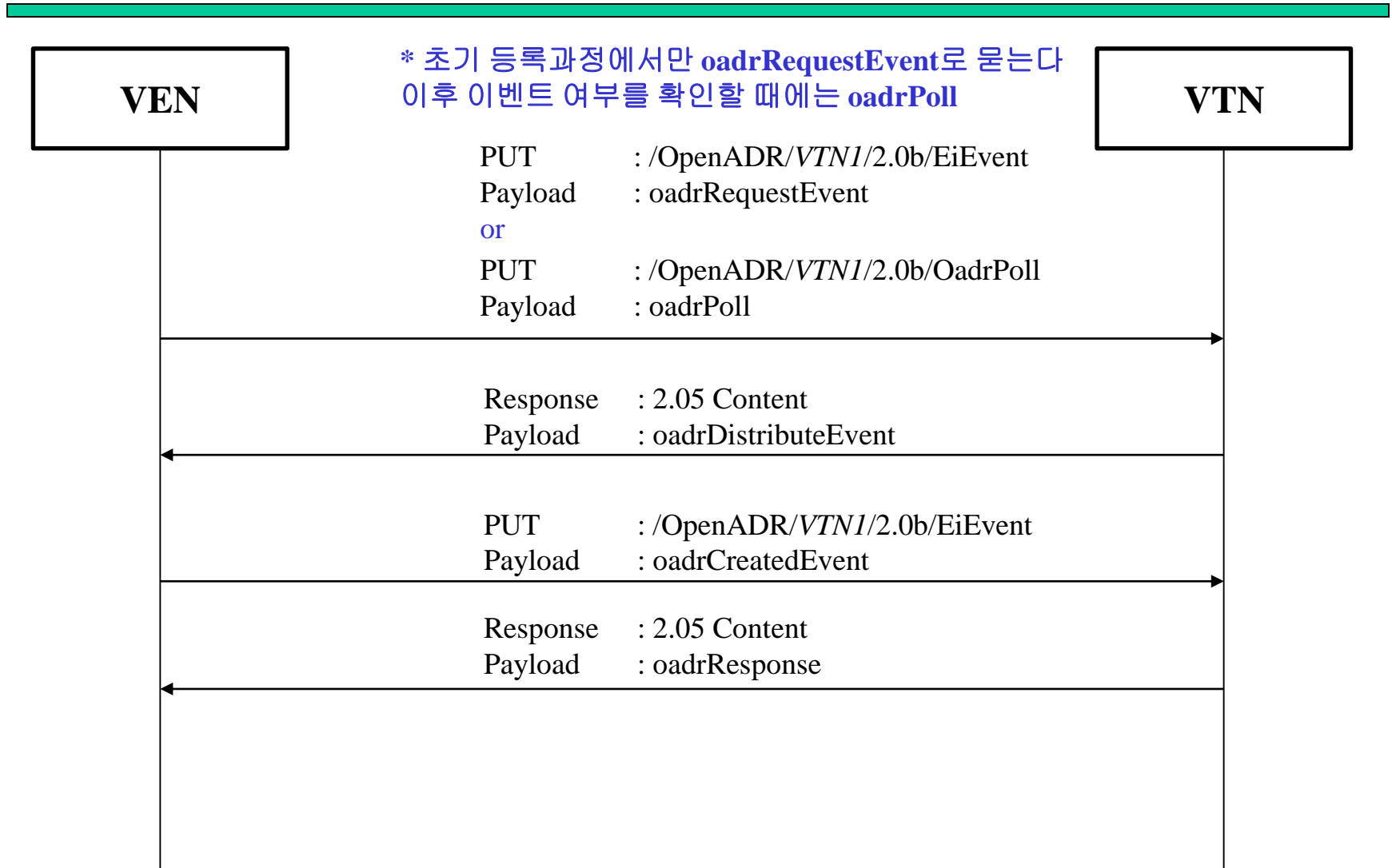
OpenADR 2.0b

(3) EiEvent

- HTTP / XML
- CoAP / JSON
- MQTT / JSON

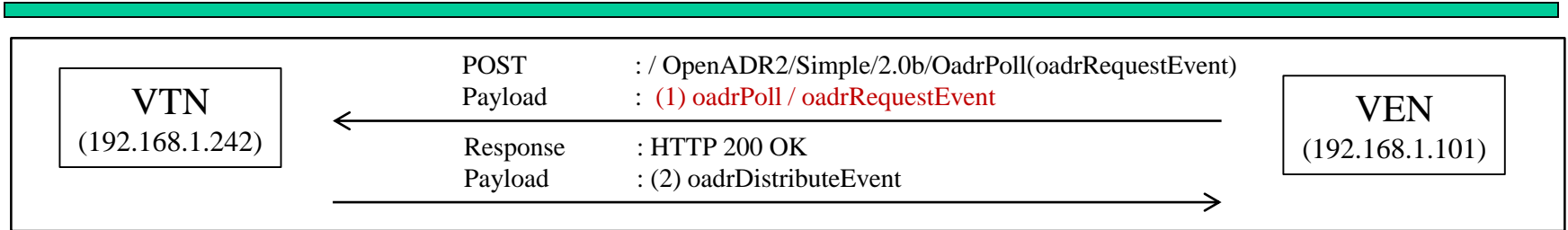
2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



(1) oadrPoll

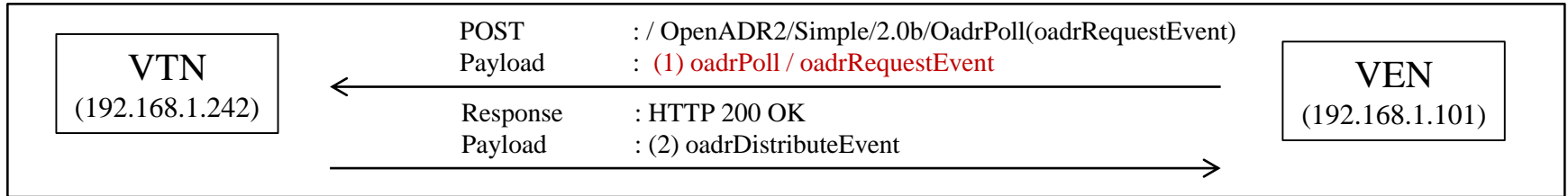
| Key name | Comments |
|----------|------------------|
| venID | requested VEN ID |
| service | message type |

oadrRequestEvent

| Key name | Comments |
|-----------|--------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| service | message type |

2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)

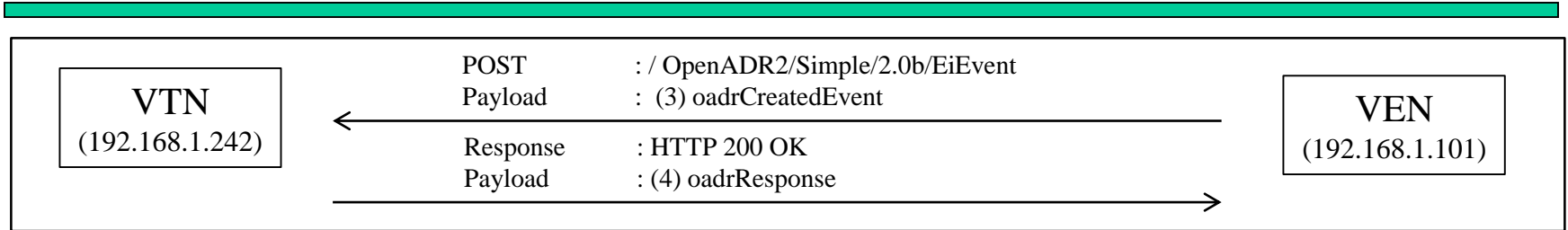


(2) oadrDistributeEvent

| Key name | | | | Comments |
|----------------------|---------------------|--------------|-----------------------|--------------------------------------|
| venID | | | | requested VEN ID |
| response | requestID | | | request identifier |
| | responseCode | | | response code |
| | responseDescription | | | description of response code |
| event | eventID | | | event identifier |
| | eventSiganls | intervals | duration | event signal interval duration |
| | | | uid | event user id |
| | | value | value | event value |
| | | | signalName | |
| | | signalType | | event signal type (bi direct, level) |
| | | signalID | | event signal ID |
| | | currentValue | | current usage value |
| | modificationNumber | | | modification Number(count) |
| | modificationReason | | | modification reason(event reason) |
| | priority | | | priority |
| | eiMarketContext | | | market address(market reference) |
| | createdDateTime | | | event create date & time |
| | eventStatus | | | event status |
| | testEvent | | | if event test or not |
| | vtnComment | | | |
| | dtstart | | | event start time |
| | duration | | | event duration |
| | properties | | | |
| | components | | | |
| venID | | | ven ID | |
| tolerance | | | tolerance duration | |
| notification | | | notification duration | |
| rampUp | | | ramp up duration | |
| recovery | | | | |
| oadrResponseRequired | | | | response mandatory or not |
| service | | | | message type |

2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



(3) oadrCreatedEvent

| Key name | Comments |
|---------------------|------------------------------|
| vtnID | responded VTN ID |
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| eventID | Event identifier |
| modificationNumber | modification number(count) |
| optType | if participate event or not |
| service | message type |

(4) oadrResponse

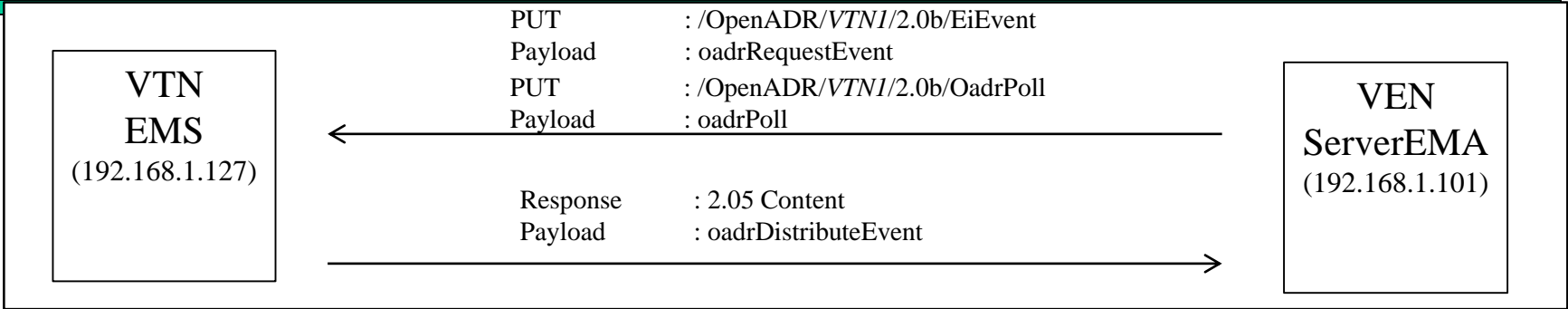
| Key name | Comments |
|---------------------|------------------------------|
| venID | requested VEN ID |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | message type |

Session Setup
Distribute Event (request Event)
vtnCommnet = "SessionSetup"

Poll & Push
Distribute Event
vtnComment = "Event"

2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



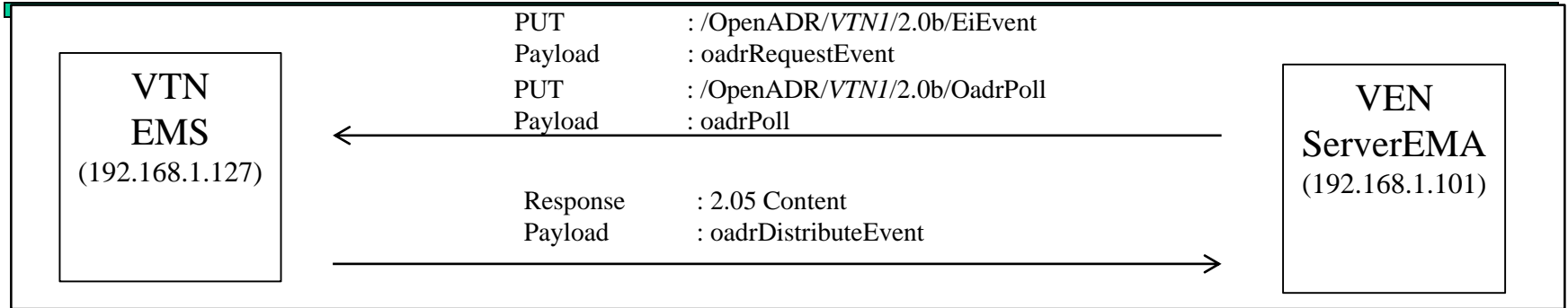
| | | | | |
|---------------------|------|---------------|---------------|---|
| (1) Poll | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:35224, PUT, /Poll |
| (2) DistributeEvent | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:35224, 2.05 Content (text/plain) |

```
oadrPoll JSON{
  "venID": String,
  "service" : String
}

Topic: EMS/oadrPoll/Poll/1
Message: { "GW": "gw\1", "VENID": "VEN_MIR1", "RequestID": 1, "Version": 2 }
```

2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



(1) Poll

(2) DistributeEvent

| | | | |
|------|---------------|---------------|---|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:35224, PUT, /Poll |
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:35224, 2.05 Content (text/plain) |

```

oadrDistributeEvent JSON{
  "requestID" : String,
  "vtnID" : String,
  "response" : Array,
  "event" : Array,
  "oadrResponseRequired" : String,
  "service" : String
}
  
```

```

{
  "Responded description": "MIR ",
  "EndTime": "194 1",
  "RequestID": 1,
  "StartTime": "19 40",
  "Service": "DistributeEvent",
  "EndYMD": "201702 09",
  "Response": 1,
  "Value": 1,
  "OptT ype": "optIn",
  "St artYMD": "2017020 9",
  "EventID": 1,
  "ModificationNumb er": 0,
  "TargetVEN ": "MIR_VEN1"
}
  
```

```

event Array{
  "eventID" : String,
  "eventSignals" : Array,
  "modificationNumber" : Integer,
  "modificationReason" : String,
  "priority" : Integer,
  "eiMarketContext" : String,
  "createdDataTime" : Date,
  "eventStatus" : String,
  "testEvent" : Boolean,
  "vtnComment" : String,
  "dtstart" : Date,
  "duration" : String,
  "properties" : String,
  "components" : String,
  "venID" : String,
  "tolerance" : String,
  "notification" : String,
  "rampUp" : String,
  "recovery" : String
}
  
```

```

eventSignals Array{
  "intervals" : Array,
  "signalName" : String,
  "signalType" : String,
  "signalID" : String,
  "currentValue" : Double
}
  
```

```

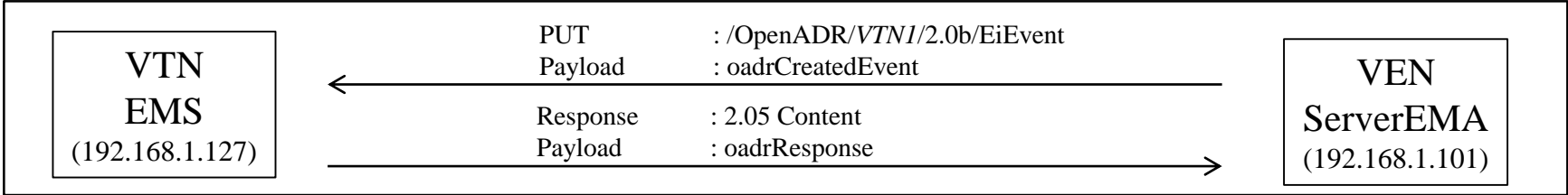
intervals Array{
  "duration" : String,
  "uid" : Integer,
  "value" : Double
}
  
```

```

response Array{
  "requestID" : String,
  "responseCode" : Integer,
  "responseDescription" : String
}
  
```

2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



(3) CreatedEvent

| | | | |
|------|---------------|---------------|----------------------------------|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:864, PUT, /createdEvent |
|------|---------------|---------------|----------------------------------|

(4) Response

| | | | |
|------|---------------|---------------|---|
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:864, 2.05 Content (text/plain) |
|------|---------------|---------------|---|

```
oadrCreatedEvent JSON{
  "responseCode" : Integer,
  "responseDescription" : String,
  "requestID" : String,
  "vtnID" : String,
  "eventID" : String,
  "modificationNumber" : Integer,
  "optType" : String,
  "venID" : String,
  "service" : String
}
```

```
createdEvent{ "Service": "Create dEvent", "VENID" : "VEN_MIR01", " Version": 1,
"Response": 1, "Req uestID": 1, "Value": 1 }
```

```
oadrResponse JSON{
  "venID": String,
  "requestID": Integer,
  "responseCode" : Integer,
  "responseDescription": String,
  "service" : String
}
```

```
{"Response":200,"RequestID":1,"VENID":"VEN_MIR01","Service":"Response"}
```

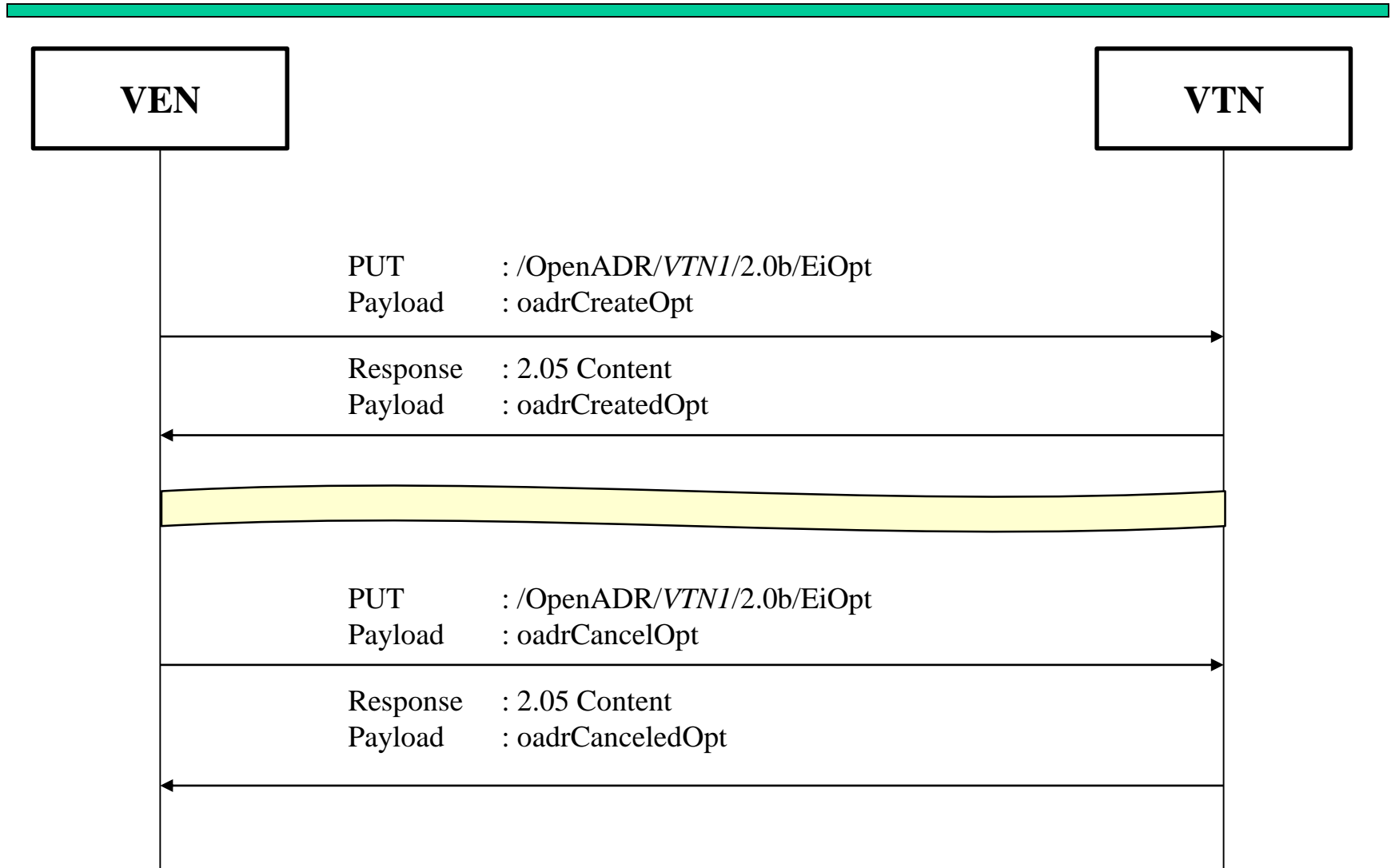
OpenADR 2.0b

(4) EiOpt

- HTTP / XML
- CoAP / JSON
- MQTT / JSON

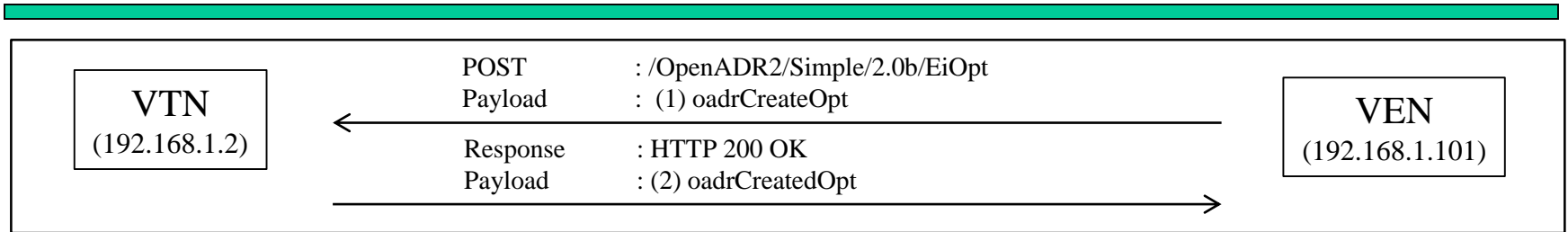
2. Profile : OpenADR 2.0b

2.3 Services : EiEvent (CoAP / JSON)



2. Profile : OpenADR 2.0b

2.4 Services : EiOpt (CoAP / JSON)



(1) oadrCreateOpt

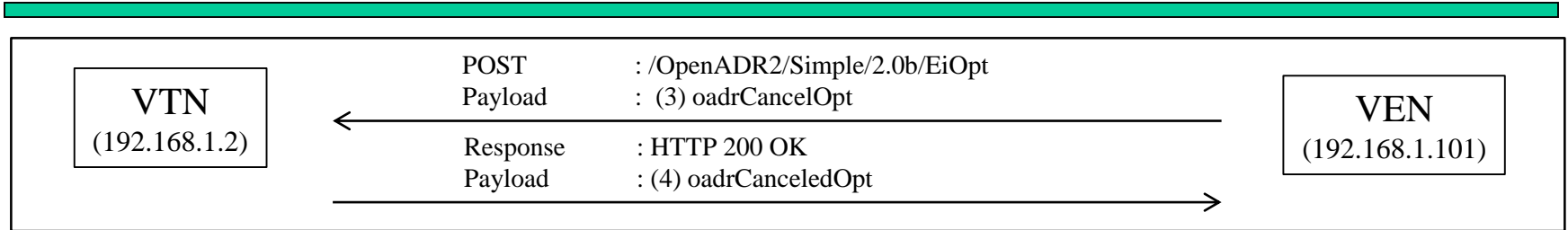
| Key name | | Comments |
|-----------------|----------|------------------------------|
| venID | | requested VEN ID |
| optID | | opt identifier |
| optType | | type of opt |
| optReason | | opt reason(e.g. emergency) |
| marketContext | | refer market address |
| available | dtstart | opt start time |
| | duration | opt duration |
| createdDateTime | | created time of this message |
| requestID | | request identifier |
| service | | message type |

(2) oadrCreatedOpt

| Key name | | Comments |
|---------------------|--|------------------------------|
| requestID | | request identifier |
| responseCode | | response code |
| responseDescription | | description of response code |
| optID | | opt identifier |
| service | | message type |

2. Profile : OpenADR 2.0b

2.4 Services : EiOpt (CoAP / JSON)



(3) oadrCancelOpt

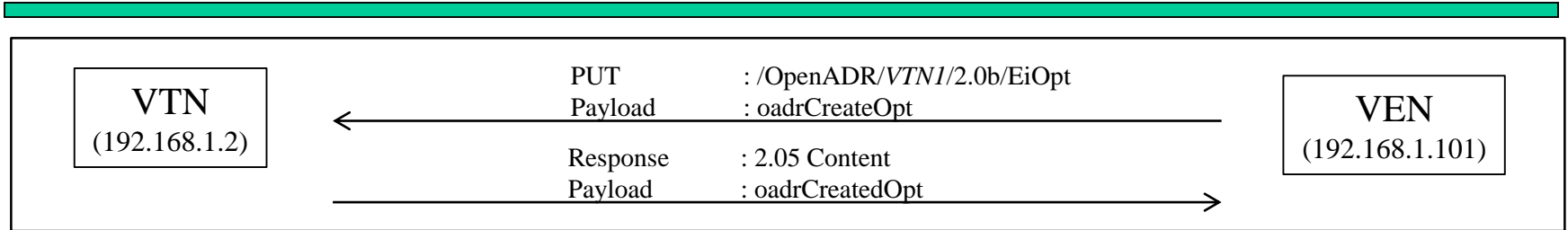
| Key name | Comments |
|-----------|--------------------|
| requestID | request identifier |
| optID | opt identifier |
| venID | requested VEN ID |
| service | message type |

(4) oadrCanceledOpt

| Key name | Comments |
|---------------------|------------------------------|
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| optID | opt identifier |
| service | message type |

2. Profile : OpenADR 2.0b

2.4 Services : EiOpt (CoAP / JSON)



- (1) CreateOpt
- (2) CreatedOpt

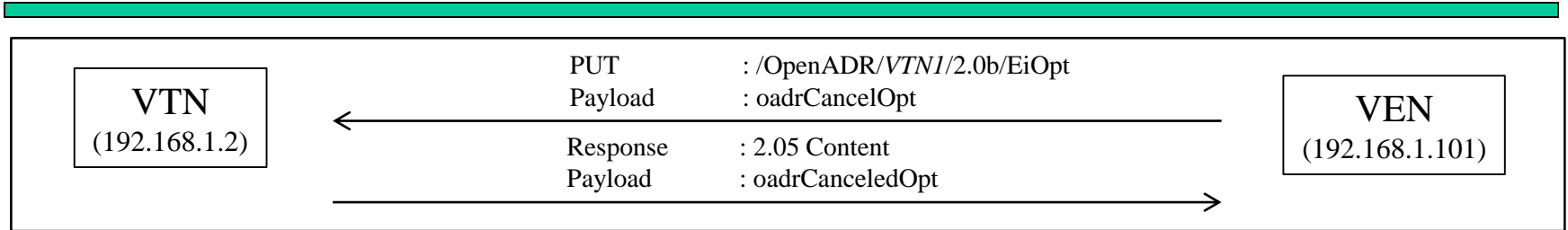
```
oadrCreateOpt JSON{
  "optID": String,
  "optType" : String,
  "optReason" : String,
  "venID" : String,
  "marketContext" : String,
  "available" : Array,
  "createdDateTime" : Date,
  "requestID" : String,
  "service" : String
}
```

```
available Array{
  "dtstart" : Date,
  "duration" : String,
}
```

```
oadrCreatedOpt JSON{
  "responseCode" : Integer,
  "responDescription" : String,
  "requestID" : String,
  "optID" : String,
  "service" : String
}
```

2. Profile : OpenADR 2.0b

2.4 Services : EiOpt (CoAP / JSON)



- (3) CancelOpt
- (4) CanceledOpt

```
oadrCancelOpt JSON{
  "requestID" : String,
  "optID" : String,
  "venID" : String,
  "service" : String
}
```

```
CanceledOpt JSON{
  "responseCode" : Integer,
  "responDescription" : String,
  "requestID" : String,
  "optID" : String,
  "service" : String
}
```

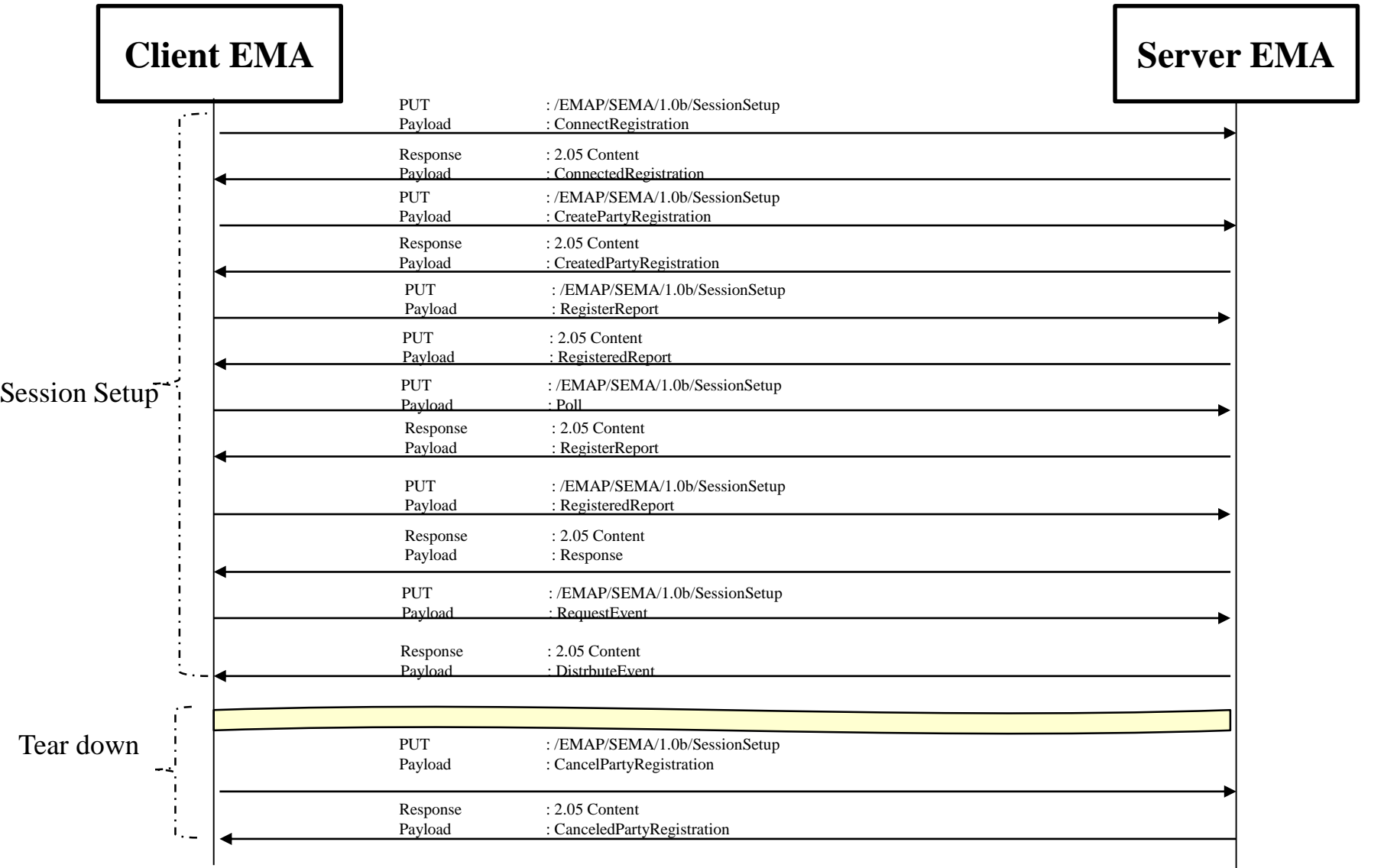
EMAP

(1) Session Setup (Registration)

- CoAP / JSON
- MQTT / JSON

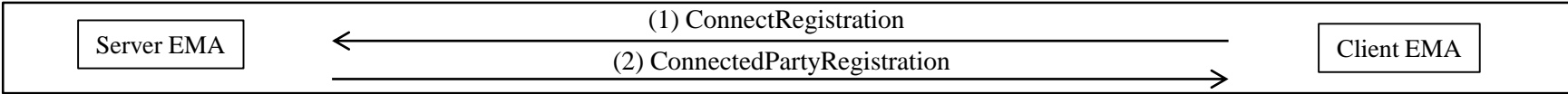
2.2 EMAP(CoAP/JSON)

Service : Session Setup



2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(1) ConnectRegistration

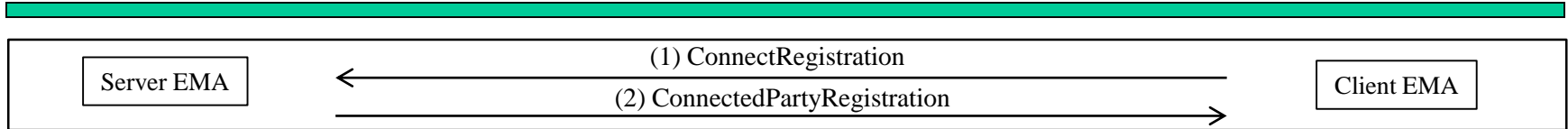
| Key Name | Reference | |
|-----------|----------------|---------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei: venID | |
| DestEMA | ei: vtnID | |
| requestID | pyld:requestID | |
| service | (Tag 이름으로 존재) | |
| version | | IdentifiedObject:version |
| time | | RandomizableEvent:creation Time |

(2) ConnectedRegistration

| Key Name | | Reference | | |
|----------------------------------|---------------|-------------------------------------|---------------------------|--------------------------------|
| | | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:vtnID | | |
| DestEMA | | ei:venID | | |
| responseCode | | ei:eiResponse | ei:responseCode | |
| responseDescription | | | ei:responseDescription | |
| requestID | | | Pyld:requestID | |
| profile | transports | Oadr:oadrProfile | oadrTransport: Array | |
| | profileName | Oadr:oadrProfile | oadrProfileName : String | |
| profile: profileName: transports | transportName | Oadr:oadrProfile:oadrTransportname | oadrTransportName: String | |
| duration | | RandomizableEvent:randomizeDuration | | |
| registrationID | | | | |
| service | | (Tag 이름으로 존재) | | |
| version | | | | IdentifiedObject:version |
| time | | | | RandomizableEvent:creationTime |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(1) ConnectRegistration

| Key name | Comments |
|-----------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| service | type of service |
| version | EMAP protocol version |
| time | service creation time |

(2) ConnectedRegistration

| Key name | | | Comments |
|---------------------|-------------|---------------|------------------------------|
| SrcEMA | | | source EMA identifier |
| DestEMA | | | destination EMA identifier |
| responseCode | | | response code |
| responseDescription | | | description of response code |
| requestID | | | request identifier |
| duration | | | requested polling frequency |
| registrationID | | | registration identifier |
| profile | profileName | | type of profile |
| | transports | transportName | type of transport protocol |
| version | | | EMAP protocol version |
| service | | | type of service |
| time | | | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



| | | | | |
|--------------------------------|---------------|---------------|------|--|
| (1) ConnectRegistration | 192.168.1.101 | 192.168.1.127 | CoAP | CON, MID:44318, PUT, /ConnectRegistration (application/json) |
| (2) ConnectedPartyRegistration | 192.168.1.127 | 192.168.1.101 | CoAP | ACK, MID:44318, 2.05 Content (application/json) |

ConnectRegistration Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID" : String,
 "service" : String,
 "version" : String,
 "time" : Date,
 "type" : String => RegisteredReport 로 변경
 "QoS" : String => RegisterReport 로 변경
}

- JavaScript Object Notation: application/json
- Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: requestID
 - Member Key: version
 - Member Key: customerPriority
 - Member Key: QoS
 - Member Key: type
 - Member Key: service
 - Member Key: time

ConnectedRegistration Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "responseCode" : Integer,
 "responseDescription" : String,
 "requestID" : String,
 "duration" : Integer,
 "profile" : Array,
 "profileName" : String,
 "TransportName" : String,
 "service" : String,
 "version" : String,
 "time" : Date,
 "type" : String => RegisteredReport 로 변경
 "QoS" : String => RegisterReport 로 변경,
 "registrationID" : String
}

oadrProfile Array{
 "oadrTransports" : Array,
 "oadrProfileName" : String
}

oadrTransports Array{
 "oadrTransportName" : String,
}

- JavaScript Object Notation: application/json
- Object
 - Member Key: profileName
 - Member Key: transportName
 - Member Key: SrcEMA
 - Member Key: type
 - Member Key: version
 - Member Key: responseCode
 - Member Key: customerPriority
 - Member Key: duration
 - Member Key: QoS
 - Member Key: responseDescription
 - Member Key: requestID
 - Member Key: service
 - Member Key: registrationID
 - Member Key: time
 - Member Key: DestEMA

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(3) CreatePartyRegistration

| Key Name | Reference | |
|---------------|------------------------|--------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:venID | |
| DestEMA | ei:vtnID | |
| requestID | pyld:requestID | |
| profileName | oadr:oadrProfileName | |
| transportName | oadr:oadrTransportName | |
| reportOnly | oadr:oadrReportOnly | |
| xmlSignature | oadr:oadrXMLSignature | |
| httpPullModel | oadr:oadrHttpPullModel | |
| service | (Tag 이름으로 존재) | |
| time | | RandomizableEvent:creationTime |

(4) CreatedPartyRegistration

| Key Name | | Reference | |
|----------------------------------|---------------|-------------------------------------|--------------------------------|
| | | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:vtnID | |
| DestEMA | | ei:venID | |
| responseCode | | ei:eiResponse | Ei:responseCode |
| responseDescription | | | ei:responseDescription |
| requestID | | | Pyld:requestID |
| registrationID | | ei:registrationID | |
| profile | transports | Oadr:oadrProfile | oadrTransport: Array |
| | profileName | Oadr:oadrProfile | oadrProfileName : String |
| profile: profileName: transports | transportName | Oadr:oadrProfile: oadrTransportname | oadrTransportName: String |
| duration | | RandomizableEvent:randomizeDuration | |
| service | | (Tag 이름으로 존재) | |
| time | | | RandomizableEvent:creationTime |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(3) CreatePartyRegistration

| Key name | Comments |
|---------------|---|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| profileName | profile name used by client EMA |
| transportName | transport name used by client EMA |
| reportOnly | EMA type (report only or full functional) |
| xmlSignature | xml 사용여부 true/false |
| httpPullMode | communication mode used by EMA (pull or push) |
| service | message type |
| time | service creation time |

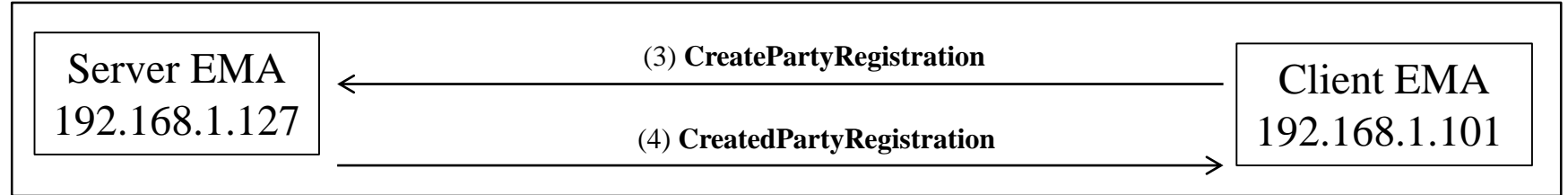
(4) CreatedPartyRegistration

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| responseCode | response code |
| responseDescription | description of response code |
| requestID | request identifier |
| duration | requested polling frequency |
| registrationID | registration identifier |
| profile | profileName |
| transports | transportName |
| version | EMAP protocol version |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



(3) CreatePartyRegistration
(4) CreatedPartyRegistration

| | | | |
|------|---------------|---------------|--|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:29975, PUT, /CreatePartyRegistration (application/json) |
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:29975, 2.05 Content (application/json) |

CreatePartyRegistration Object{

```
“SrcEMA” : String,  
“DestEMA” : String,  
“version” : Integer => 삭제,  
“requestID” : String,  
“transportName” : String,  
“reportOnly” : Integer,  
“httpPullModel” : Boolean,  
“profileName” : String,  
“xmlSignature” : String,  
“registrationID” : String 삭제  
“service” : String,  
“time” : Date  
}
```

JavaScript Object Notation: application/json

- Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: requestID
 - Member Key: version
 - Member Key: transportName
 - Member Key: transportAddress
 - Member Key: reportOnly
 - Member Key: httpPullModel
 - Member Key: profileName
 - Member Key: xmlSignature
 - Member Key: registrationID
 - Member Key: service
 - Member Key: time

CreatedPartyRegistration Object{

```
“SrcEMA” : String,  
“DestEMA” : String,  
“version” : Integer => 삭제,  
“requestID” : String,  
“oadrProfile” : Array,  
“registrationID” : String,  
“duration” : String,  
“responseCode” : Integer,  
“responseDescription” : String,  
“service” : String  
“time” : Date,  
}
```

oadrProfile Array{
“oadrTransports”: Array,
“oadrProfileName”: String
}

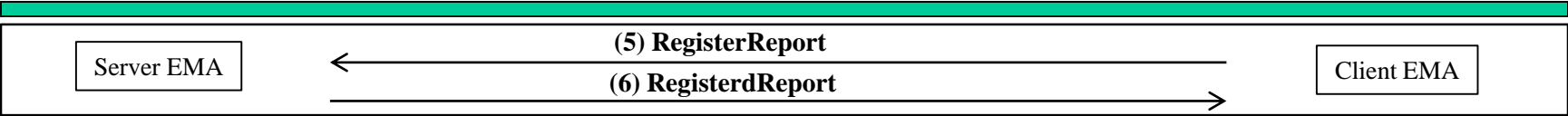
oadrTransports Array{
“oadrTransportName”: String,
}

JavaScript Object Notation: application/json

- Object
 - Member Key: duration
 - Member Key: profileName
 - Member Key: transportName
 - Member Key: SrcEMA
 - Member Key: responseDescription
 - Member Key: requestID
 - Member Key: service
 - Member Key: registrationID
 - Member Key: time
 - Member Key: DestEMA
 - Member Key: version
 - Member Key: responseCode

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup

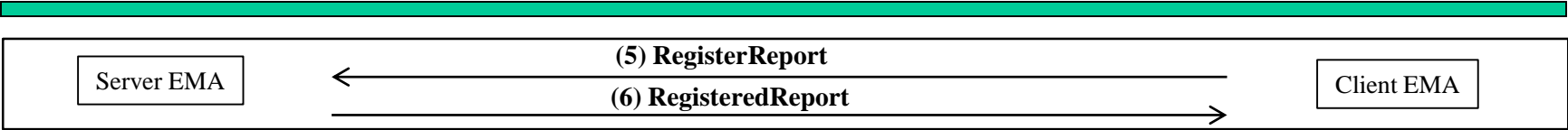


(5) RegisterReport

| Key Name | | Reference | | | |
|--------------------------|-------------------|----------------------------------|-----------------------|---|---|
| | | OpenADR 2.0b | | SEP 2.0(IEC 61968) | OpenFMB(IEC 61850) |
| SrcEMA | | ei:venID | | | |
| DestEMA | | ei:vtnID | | | |
| service | | (tag이름으로 존재) | | | |
| time | | | | RandomizableEvent:creation Time | |
| requestID | | requestID | | | |
| type(Implicit, Explicit) | | | | TariffProfile:serviceCategoryKind:ServiceKind | |
| report | duration | oadrReport | duration | | |
| | reportDescription | | oadrReportDescription | | |
| | reportRequestID | | reportRequestID | | |
| | reportSpecifierID | | reportSpecifierID | | |
| | reportName | | reportName | | |
| report:reportDescription | createdDateTime | oadrReport:oadrReportDescription | createdDateTime | | |
| | rID | | rID | | |
| | resourceID | | resourceID | | |
| | deviceType | | | | EndDeviceControlType:type |
| | reportType | | reportType | | |
| | itemUnits | | itemUnits | | |
| | siScaleCode | | siScaleCode | | |
| | marketContext | | marketContext | | |
| | MinPeriod | | oadrMinPeriod | | |
| | MaxPeriod | | oadrMaxPeriod | | |
| | OnChange | | oadrOnChange | | |
| | itemDescription | | itemDescription | | |
| | powerAttributes | | powerAttributes | | |
| | qos | | | EndDeviceControl:loadShiftForward | |
| | state | | | DeviceStatus:opState | |
| | power | | | | Readings: value |
| | dimming | | | Subscription:Level | |
| | margin | | | IdentifiedObject:DemandResponseProgram:availabilityUpdatePowerChnageThreshold | |
| | generate | | | | SolarEventProfile:SolarInvert errStatus:value |
| | storage | | | | BatteryEventProfile:BatteryStatus:value |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(6) RegisteredReport

| Key Name | Reference | | |
|---------------------|---------------|------------------------|---------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:venID | |
| DestEMA | | ei:vtnID | |
| responseCode | ei:eiResponse | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| requestID | | pyld:requestID | |
| service | (tag이름으로 존재) | | |
| time | | | RandomizableEvent:creation Time |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup

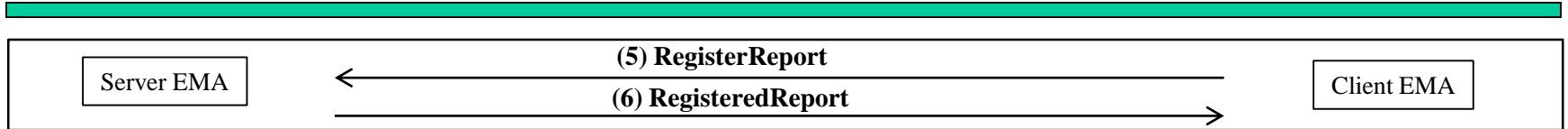


(5) RegisterReport

| Key name | | Comments |
|-----------|-------------------|--|
| SrcEMA | | source EMA identifier |
| DestEMA | | destination EMA identifier |
| requestID | | request identifier |
| report | duration | report duration |
| | reportRequestID | report request identifier |
| | reportSpecifierID | report specific id (created from EMA) |
| | reportName | report name |
| | createdDateTime | created time of this report |
| | reportDescription | rID |
| | | resourceID |
| | | reportType |
| | | deviceType |
| | | itemUnits |
| | | siScaleCode |
| | | marketContext |
| | | minPeriod |
| | | maxPeriod |
| | | onChange |
| | | itemDescription |
| | | qos |
| | | state |
| | | power |
| | | dimming |
| | | margin |
| | | generate |
| | | storage |
| | | maxValue |
| | | minValue |
| | | avgValue |
| | | maxTime |
| | | minTime |
| | | priority |
| | powerAttributes | hertz |
| | | voltage |
| | | ac |
| service | | type of service |
| time | | service creation time |
| type | | report message type (implicit or explicit) |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(6) RegisteredReport

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | message type |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



| | | | | |
|----------------------|---------------|---------------|------|---|
| (5) RegisterReport | 192.168.1.101 | 192.168.1.127 | CoAP | CON, MID:36645, PUT, /RegisterReport (application/json) |
| (6) RegisteredReport | 192.168.1.127 | 192.168.1.101 | CoAP | ACK, MID:36645, 2.05 Content (application/json) |

RegisterReport Object{
 “SrcEMA” : String,
 “DestEMA” : String,
 “requestID” : String,
 “reportType” : String,
 “EMAreRegisteredDRInformation” : Object => 변경
 “EMAreRegisteredMgnInformation” : Object => 변경,
 - “report” : Array,
 “time” : Date,
 “service” : String,
 “type” : String (Explicit, Implicit 인지 구분)
}

JavaScript Object Notation: application/json

- Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: requestID
 - Member Key: reportName
 - Member Key: reportType
 - Member Key: EMAreRegisteredDRInformation
 - Member Key: EMAreRegisteredMgnInformation
 - Member Key: service
 - Member Key: time

report Object{
 “duration” : String,
 “reportRequestID” : Integer,
 “reportSpecifierID” : String,
 “reportName” : String,
 “createdDateTime” : Date,
 “reportDescription” : Array,
}

reportDescription Object{
 “rID” : String,
 “resourceID” : String,
 “deviceType” : String,
 “reportType” : String,
 “itemUnits” : String,
 “siScaleCode” : String,
 “marketContext” : String,
 “oadrMinPeriod” : String,
 “oadrMaxPeriod” : String,
 “oadrOnChange” : String,
 “itemDescription” : String,
 “powerAttributes” : Array,
 “qos” : String
 “state” : String,
 “power” : Double,
 “dimming” : Integer,
 “margin” : double,
 “generate” : double,
 “storage” : String,
 “maxValue” : Double,
 “minValue” : Double,
 “avgValue” : Double,
 “maxTime” : Date,
 “minTime” : Date,
 “priority” : Integer
}

powerAttributes Object{
 “hertz” : Double,
 “voltage” : Double,
 “ac” : Boolean
}

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



| | | | | |
|----------------------|---------------|---------------|------|---|
| (5) RegisterReport | 192.168.1.101 | 192.168.1.127 | CoAP | CON, MID:36645, PUT, /RegisterReport (application/json) |
| (6) RegisteredReport | 192.168.1.127 | 192.168.1.101 | CoAP | ACK, MID:36645, 2.05 Content (application/json) |

RegisteredReport Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "responseCode" : Integer,
 ~~"responseDescription": String,~~
 ~~"transportName": String => 기존 OpenADR에 없는 내용,~~
 ~~"version": Integer => 삭제,~~
 ~~"threshold": Double => DistributeEvent로 이동,~~
 "service": String,
 "time" : Date,
}

JavaScript Object Notation: application/json

- Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: transportName
 - Member Key: requestID
 - Member Key: responseCode
 - Member Key: version
 - Member Key: responseDescription
 - Member Key: threshold
 - Member Key: service
 - Member Key: time

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(7) Poll

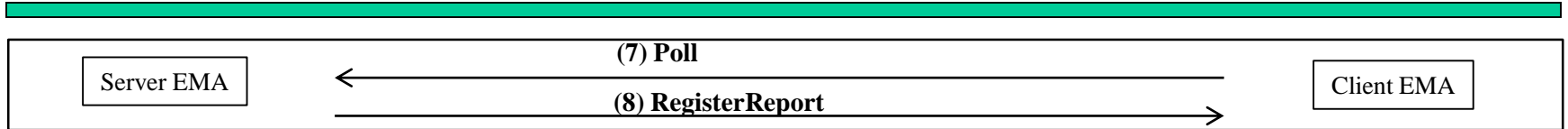
| Key Name | Reference | |
|----------|--------------|---------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:venID | |
| DestEMA | ei:vtnID | |
| service | (tag이름으로 존재) | |
| time | | RandomizableEvent:creation Time |

(8) RegisterReport

| Key Name | Reference | | |
|-----------|---------------|----------------|--------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | | |
| DestEMA | ei:venID | | |
| requestID | ei:eiResponse | Pyld:requestID | |
| service | (tag이름으로 존재) | | |
| time | | | RandomizableEvent:creationTime |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(7) Poll

| Key name | Comments |
|----------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| service | message type |
| time | service creation time |

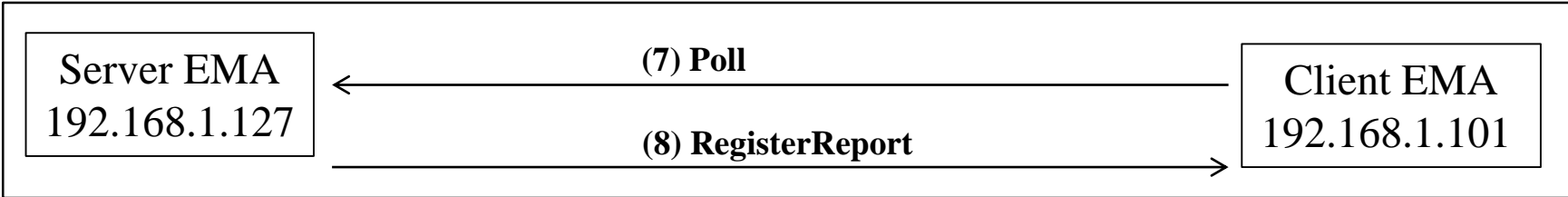
(8) RegisterReport

| Key name | Comments |
|-----------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



(7) Poll
(8) RegisterReport

| | | | |
|------|---------------|---------------|---|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:22170, PUT, /Poll (application/json) |
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:22170, 2.05 Content (application/json) |

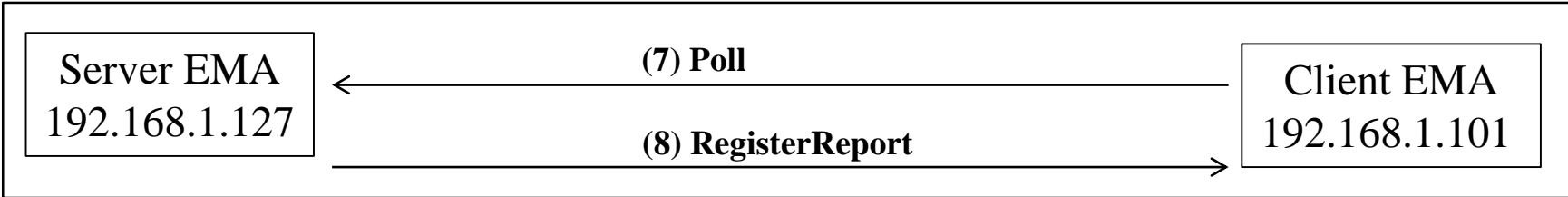
Poll JSON Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 ~~"requestID" : Integer => 삭제~~
 ~~"version" : Integer => 삭제~~
 ~~"type" : String => 삭제 (RegisteredReport로 변경)~~
 "service" : String,
 "time" : Date
}

- JavaScript Object Notation: application/json
 - Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: requestID
 - Member Key: version
 - Member Key: type
 - String value: Registration
 - Key: type
 - Member Key: service
 - Member Key: time

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



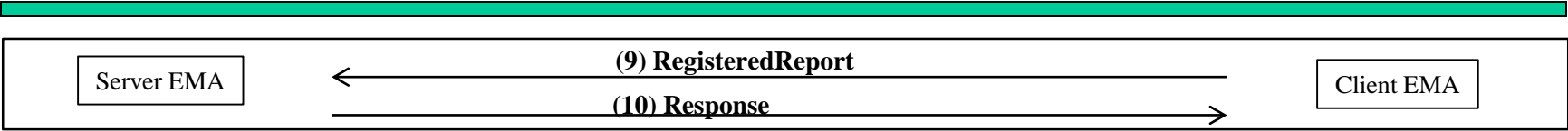
| | | | | |
|--------------------|------|---------------|---------------|---|
| (7) Poll | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:22170, PUT, /Poll (application/json) |
| (8) RegisterReport | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:22170, 2.05 Content (application/json) |

RegisterReport Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "time": Date,
 "service" : String
}

- JavaScript Object Notation: application/json
 - Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: requestID
 - Member Key: reportName
 - Member Key: reportType
 - Member Key: EMAregeredDRInformation
 - Member Key: EMAregeredMgnInformation
 - Member Key: service
 - Member Key: time

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(9) RegisteredReport

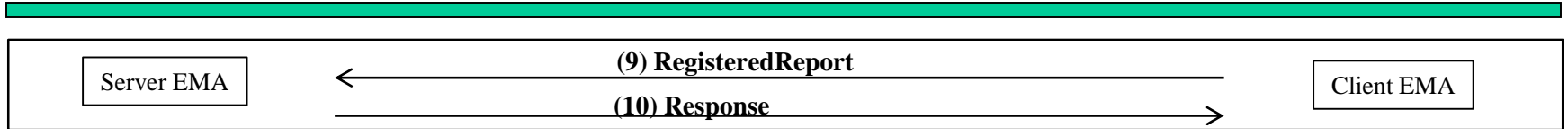
| Key Name | Reference | | |
|---------------------|---------------|------------------------|--------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtID | | |
| DestEMA | ei:venID | | |
| responseCode | ei:eiResponse | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| requestID | | Pyld:requestID | |
| service | (tag이름으로 존재) | | |
| time | | | RandomizableEvent:creationTime |

(10) Response

| Key Name | Reference | | |
|---------------------|---------------|------------------------|--------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtID | | |
| DestEMA | ei:venID | | |
| responseCode | ei:eiResponse | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| requestID | | Pyld:requestID | |
| service | (tag이름으로 존재) | | |
| time | | | RandomizableEvent:creationTime |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(9) RegisteredReport

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | message type |
| time | service creation time |

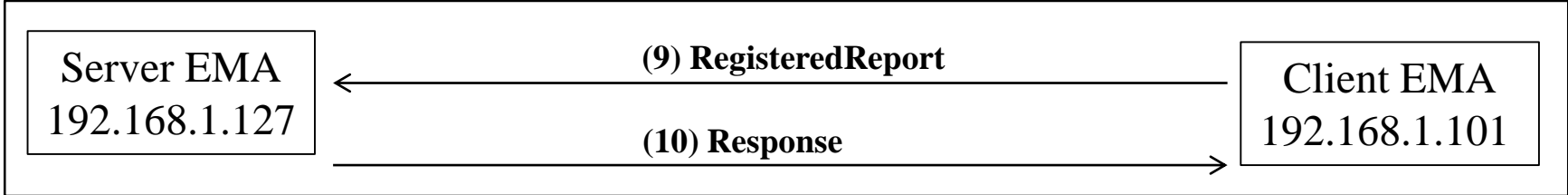
(10) Response

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



(9) RegisteredReport

(10) Response

| | | | |
|------|---------------|---------------|---|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:15201, PUT, /RegisteredReport (application/json) |
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:15201, 2.05 Content (application/json) |

RegisteredReport Object{

```
  "SrcEMA" : String,  
  "DestEMA" : String,  
  "requestID": String,  
  "responseCode" : Integer,  
  "responseDescription": String,  
  "transportName": String => 기존 OpenADR에 없는 내용,  
  "version": Integer => 삭제,  
  "threshold" : Double => DistributeEvent로 이동,  
  "service": String,  
  "type" : String,  
  "time" : Date,  
}
```

JavaScript Object Notation: application/json

- Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: transportName
 - Member Key: requestID
 - Member Key: responseCode
 - Member Key: version
 - Member Key: responseDescription
 - Member Key: threshold
 - Member Key: service
 - Member Key: time

Response Object{

```
  "SrcEMA" : String,  
  "DestEMA" : String,  
  "requestID": String,  
  "responseCode" : Integer,  
  "responseDescription": String,  
  "version": Integer => 삭제,  
  "service": String, JavaScript Object Notation: application/json  
  "time" : Date, Object  
}
```

- Object
 - Member Key: SrcEMA
 - Member Key: responseDescription
 - Member Key: requestID
 - Member Key: service
 - Member Key: time
 - Member Key: DestEMA
 - Member Key: version
 - Member Key: responseCode

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(11) RequestEvent

| Key Name | Reference | | |
|-----------|---------------------|----------------|---------------------------------|
| | | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:venID | | |
| DestEMA | ei:vtnID | | |
| requestID | pyld:eiRequestEvent | pyld:requestID | |
| service | (tag이름으로 존재) | | |
| time | | | RandomizableEvent:creation Time |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup

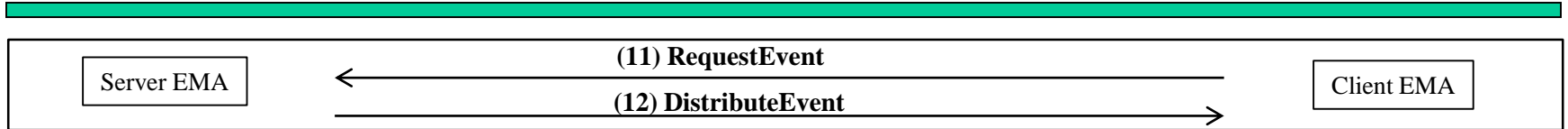


(12) DistributeEvent

| Key Name | | Reference | |
|--------------------|---------------------|--|------------------------|
| | | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:vtnID | |
| DestEMA | | ei:venID | |
| requestID | | ei:requestID | |
| responseRequired | | Ei:reponseRequired | |
| response | requestID | ei:Response | pyld:requestID |
| | responseCode | | ei:responseCode |
| | responseDescription | | ei:responseDescription |
| event | eventID | oadrEvent:eiActivePeriod:eventDescrip tor | eventID |
| | eventSignals | | eventSignals |
| | modificationNumber | | modificationNumber |
| | modificationReason | | modificationReason |
| | priority | | priority |
| | marketContext | | eiMarketContext |
| | createdDateTime | | createdDateTime |
| | eventStatus | | eventStatus |
| | testEvent | | testEvent |
| | vtnComment | | vtnComment |
| | properties | oadrEvent:eiActivePeriod | properties |
| | components | | components |
| | specificDestEMA | oadrEvent:eiTarget | venID |
| | dtStart | oadrEvent:eiActivePeriod:properties | dtstart |
| | Duration | | duration |
| | Tolerance | | tolerance |
| | notification | | x-eiNotification |
| | rampUp | | x-eiRampUp |
| event:eventSignals | Recovery | oadrEvent:eiEventSignals | x-eiRecovery |
| | eventSignal | | eiEventSignal |
| | Intervals | oadrEvent:eiEventSignals:eiEventSign al | intervals |
| | signalName | | signalName |
| | signalType | | signalType |
| | signalID | | signalID |
| | currentValue | | currentValue |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup

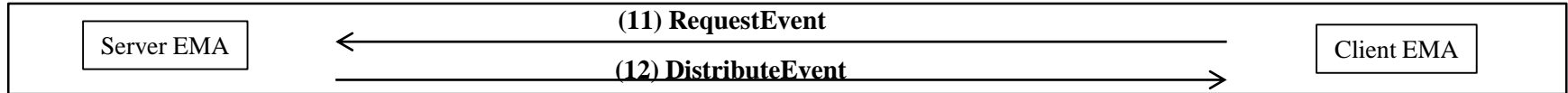


(11) RequestEvent

| Key name | Comments |
|-----------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| service | type of service |
| time | service creation time |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



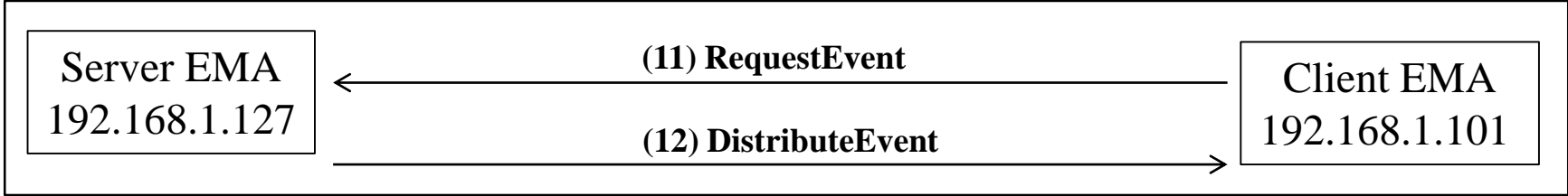
(12) DistributeEvent

| Key name | | | | Comments |
|------------------|---------------------|--------------|----------|--------------------------------------|
| SrcEMA | | | | source EMA identifier |
| DestEMA | | | | destination EMA identifier |
| response | requestID | | | request identifier |
| | responseCode | | | response code |
| | responseDescription | | | description of response code |
| event | eventID | | | event identifier |
| | eventSiganls | intervals | duration | event signal interval duration |
| | | | uid | event user id |
| | | | value | event value |
| | | signalName | | event signal name |
| | | signalType | | event signal type (bi direct, level) |
| | | signalID | | event signal ID |
| | | currentValue | | current usage value |
| | | threshold | | available amount of energy |
| | | capacity | | 사용 가능량 (threshold - power) |
| | | price | | price of energy |
| | | unit | | 단위 |
| | modificationNumber | | | modification Number(count) |
| | modificationReason | | | modification reason(event reason) |
| | priority | | | priority |
| | marketContext | | | market address(market reference) |
| | createdDateTime | | | event create date & time |
| | eventStatus | | | event status |
| | testEvent | | | if event test or not |
| | vtnComment | | | |
| | dtStart | | | event start time |
| | duration | | | event duration |
| | properties | | | |
| | components | | | |
| | specificDestEMA | | | specific target EMA |
| | tolerance | | | tolerance duration |
| | notification | | | notification duration |
| | rampUp | | | ramp up duration |
| | recovery | | | |
| responseRequired | | | | response mandatory or not |
| service | | | | type of service |
| time | | | | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



| | | | | |
|----------------------|------|---------------|---------------|---|
| (11) RequestEvent | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:44189, PUT, /RequestEvent (application/json) |
| (12) DistributeEvent | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:44189, 2.05 Content (application/json) |

RequestEvent Object{

“SrcEMA” : String,
“DestEMA” : String,
“requestID” : String,
~~“replyLimit” : Integer => 삭제,~~
“time” : Date,
“service” : String
}

JavaScript Object Notation: application/json

Object

- ▷ Member Key: SrcEMA
- ▷ Member Key: DestEMA
- ▷ Member Key: requestID
- ▷ Member Key: replyLimit

Member Key: service

String value:

Key: service

Member Key: time

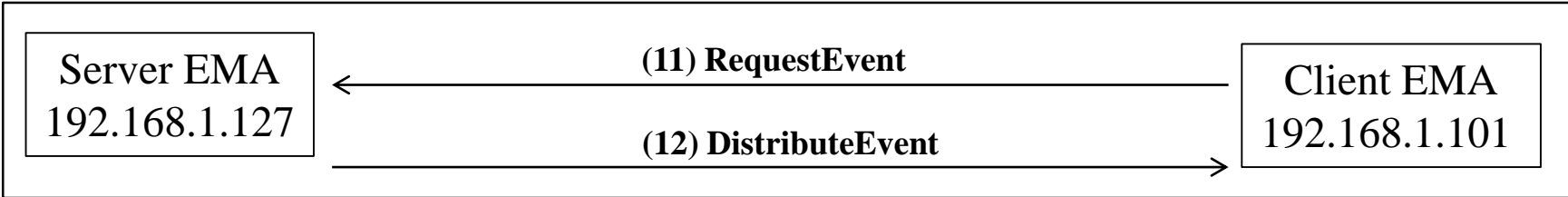
String value: 2018-04-18 07:18:39

Key: time

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



| | | | | |
|----------------------|------|---------------|---------------|---|
| (11) RequestEvent | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:44189, PUT, /RequestEvent (application/json) |
| (12) DistributeEvent | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:44189, 2.05 Content (application/json) |

DistributeEvent Object{
“SrcEMA” : String,
“DestEMA” : String,
“requestID” : String,
“response” : Array,
“event” : Array,
“responseRequired” : String,
“service” : String,
“time” : Date
}

response Array{
“requestID” : String,
“responseCode” : Integer,
“responseDescription” : String
}

JavaScript Object Notation: application/json
Object
Member Key: SrcEMA
Member Key: responseDescription
Member Key: requestID
Member Key: service
Member Key: EMADREventInformation
Member Key: time
Member Key: DestEMA
Member Key: type
Member Key: EMADREPriceInformation
Member Key: responseCode

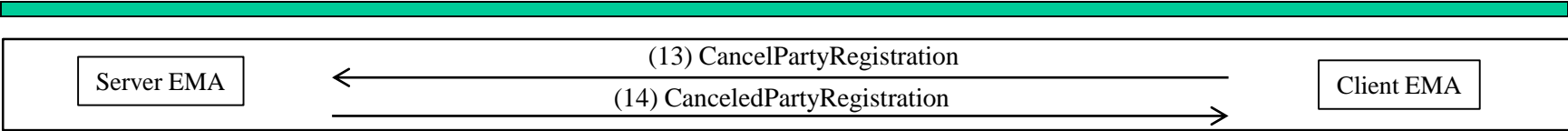
event Array{
“eventID” : String,
“eventSignals” : Array,
“modificationNumber” : Integer,
“modificationReason” : String,
“priority” : Integer,
“marketContext” : String,
“createdDataTime” : Date,
“eventStatus” : String,
“testEvent” : Boolean,
“vtnComment” : String,
“dtstart” : Date,
“duration” : String,
“properties” : String,
“components” : String,
“specificDestEMA” : String,
“tolerance” : String,
“notification” : String,
“rampUp” : String,
“recovery” : String
}

eventSignals Object{
“eventSignal” : String,
“intervals” : Array,
“signalName” : String,
“signalType” : String, (Price Event, Control Event, Reserve Mode, RealtimeDR인지 구분)
“signalID” : String,
“currentValue” : Double,
“threshold” : Double,
“capacity” : Double,
“price” : Integer,
“unit” : String,
}

intervals Array{
“duration” : String,
“uid” : Integer,
“value” : Double
}

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(13) CancelPartyRegistration

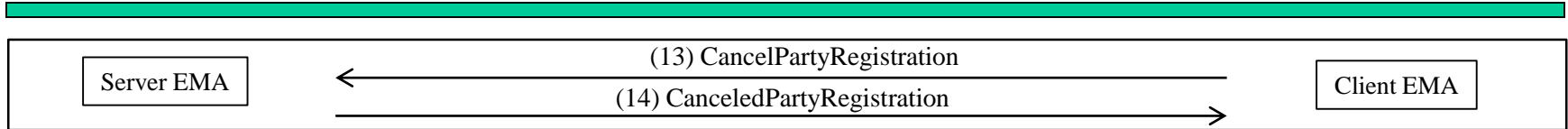
| Key Name | Reference | |
|----------------|----------------|---------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei: venID | |
| DestEMA | ei: vtID | |
| requestID | pyld:requestID | |
| regiatistronID | regiatistronID | |
| service | (Tag 이름으로 존재) | |
| time | | RandomizableEvent:creation Time |

(14) CanceledPartyRegistration

| Key Name | Reference | | |
|---------------------|---------------|------------------------|--------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtID | | |
| DestEMA | ei:venID | | |
| responseCode | ei:eiResponse | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| requestID | | Pyld:requestID | |
| service | (Tag 이름으로 존재) | | |
| regiatistronID | | | |
| time | | | RandomizableEvent:creationTime |

2.2 EMAP(MQTT, CoAP/JSON)

Service : Session Setup



(13) CancelPartyRegistration

(14) CanceledPartyRegistration

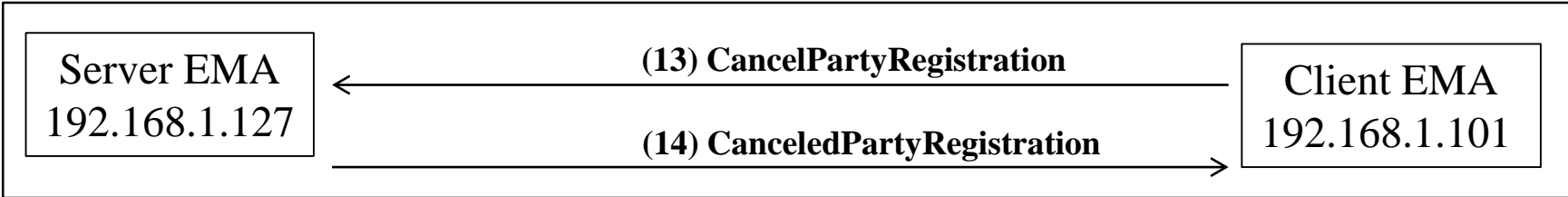
| Key name | Comments |
|----------------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| registrationID | registration identifier |
| service | type of service |
| time | service creation time |

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| registrationID | registration identifier |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Session Setup



(13) CancelPartyRegistration

(14) CanceledPartyRegistration

```
CancelPartyRegistration Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "requestID" : String,
  "registrationID" : String,
  "service" : String,
  "time" : Date
}
```

```
CanceledPartyRegistration Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "requestID" : String,
  "responseCode" : Integer,
  "responseDescription" : String,
  "registrationID" : String,
  "service" : String,
  "time" : Date
}
```

EMAP (CoAP & MQTT/JSON)

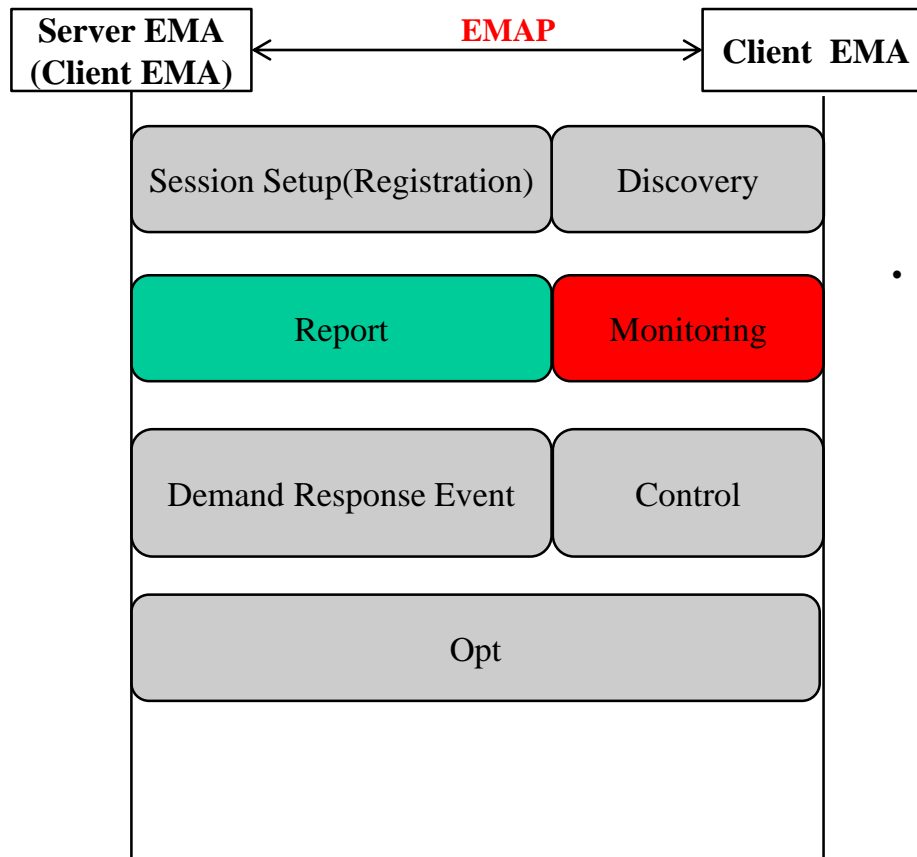
UpdateReport

2.2 EMAP(MQTT, CoAP/JSON)

Service : Update Report

EMAP

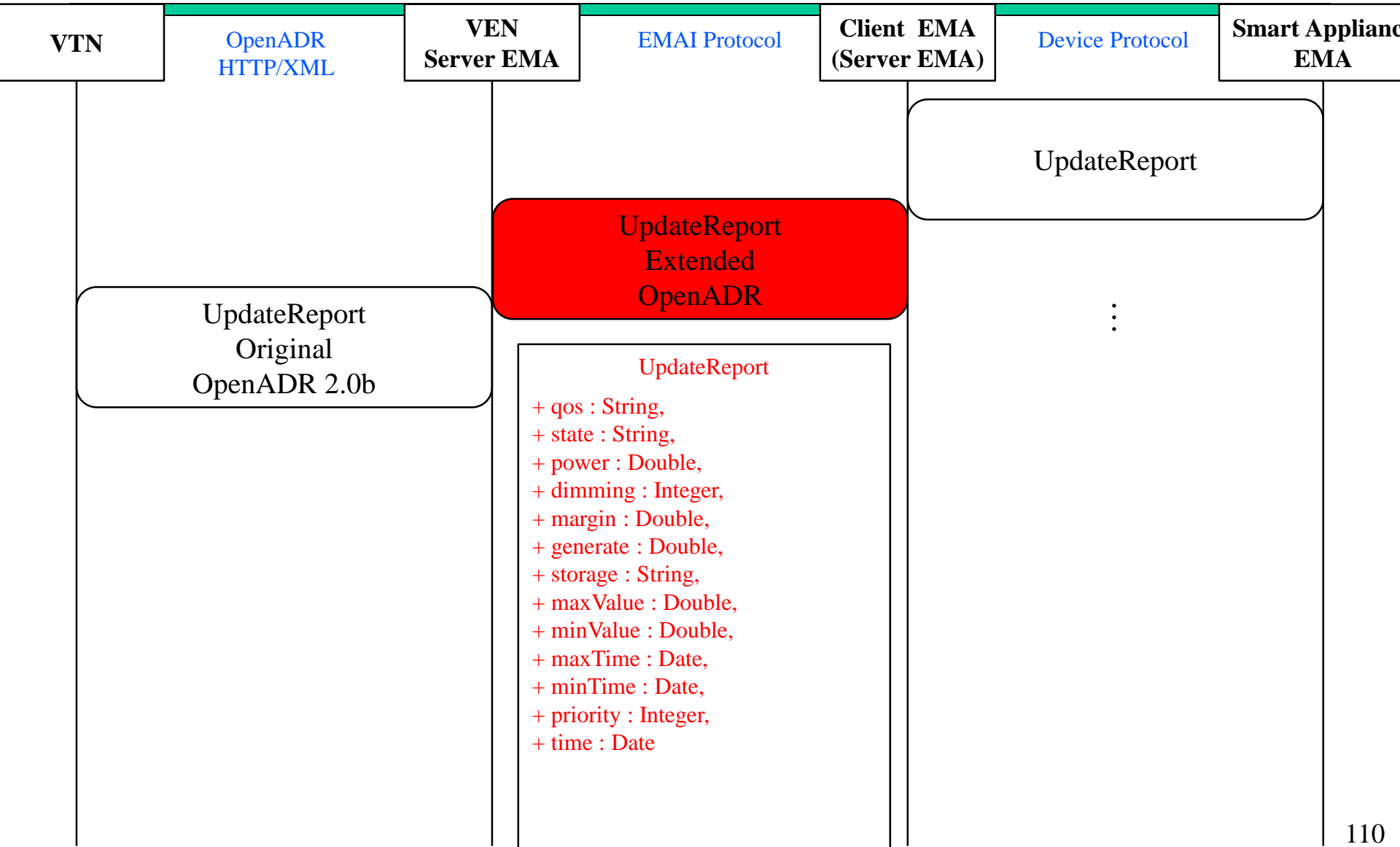
- EMA사이의 수요반응 통신 프로토콜이며 OpenADR 2.0b의 모델링을 따랐으며 일부 모델링을 확장했고 Discovery와 Monitoring, Control 부분의 통신 프로토콜이 확장.



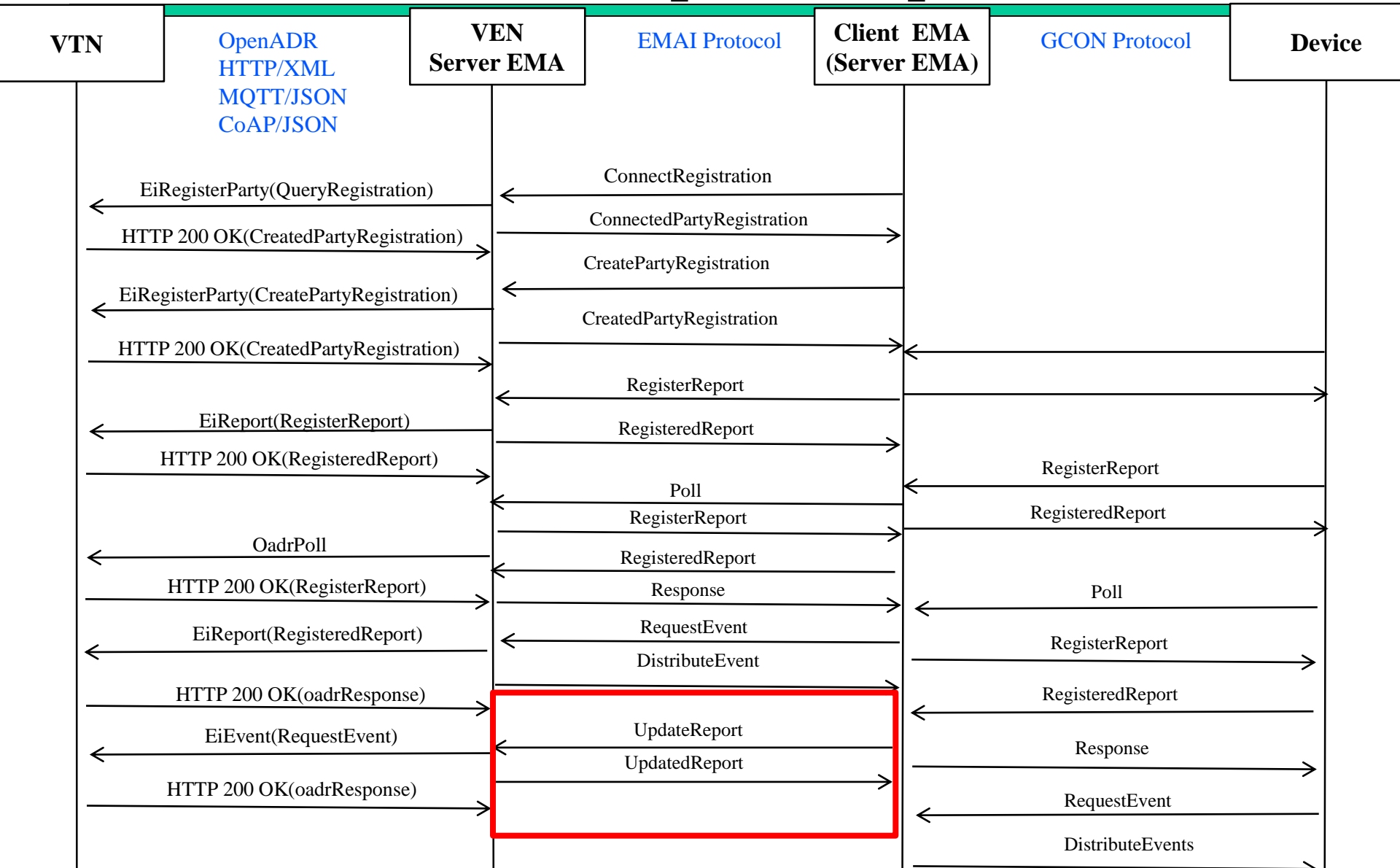
- **Report(updateReport)**
 - 에너지관리에이전트 간 서로 연결을 수립 할 때 **Report**을 교환할 때 실시간 에너지에 대한 가격 정보나 클라이언트 에너지관리에이전트의 디바이스 정보 등을 얻음.
 - 하위의 EMA의 정보를 모니터링 하는 단계, **Explicit/Abstract** 방식으로 **Monitoring**.
 - **Explicit**에는 **Device Type (LED, ESS, Recloser, Resource, PV)**에 대한 정보가 포함
 - **Implicit**에는 **Device Type**을 제외한 정보가 포함되어 있어 필요로 하는 정보에 따라 데이터 트래픽을 다르게 설정할 수 있음.

2.2 EMAP(MQTT, CoAP/JSON)

Service : Update Report



Service : Update Report



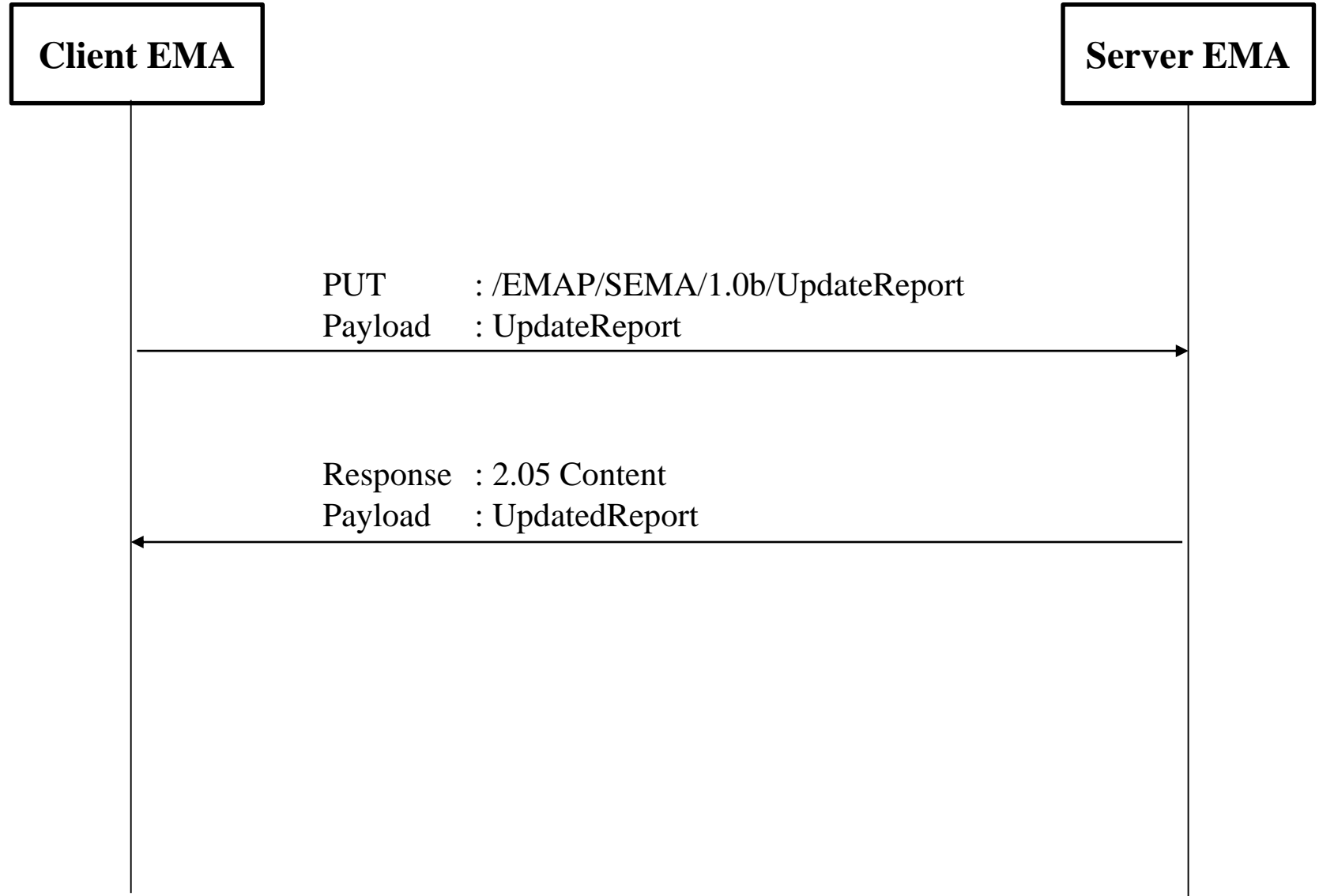
EMAP

(2) UpdateReport

- **CoAP / JSON**
- **MQTT / JSON**

2.2 EMAP(**CoAP/JSON**)

Service : Update Report



2. Smart Home Energy Framework :

2.2 EMAP(MQTT/JSON, CoAP/JSON) : UpdateReport

(1) UpdateReport

| Key Name | | Reference | | | |
|--------------------------|-------------------|---------------------------------------|-----------------------|---|--|
| | | OpenADR 2.0b | | SEP 2.0(IEC 61968) | OpenFMB(IEC 61850) |
| SrcEMA | | ei:venID | | | |
| DestEMA | | ei:vtnID | | | |
| service | | (Tag 이름으로 존재) | | | |
| time | | | | RandomizableEvent:creation Time | |
| requestID | | requestID | | | |
| type(Implicit, Explicit) | | | | | |
| report | duration | oadrReport | duration | | |
| | reportDescription | | oadrReportDescription | | |
| | reportRequestID | | reportRequestID | | |
| | reportSpecifierID | | reportSpecifierID | | |
| | reportName | | reportName | | |
| report:reportDescription | createdDateTime | oadrReport:oadrReportDescription n | createdDateTime | | |
| | rID | | rID | | |
| | resourceID | | resourceID | | EndDeviceControlType:type |
| | deviceType | | | | |
| | reportType | | reportType | | |
| | itemUnits | | itemUnits | | |
| | siScaleCode | | siScaleCode | | |
| | marketContext | | marketContext | | |
| | MinPeriod | | oadrMinPeriod | | |
| | MaxPeriod | | oadrMaxPeriod | | |
| | OnChange | | oadrOnChange | | |
| | itemDescription | | itemDescription | | |
| | powerAttributes | | powerAttributes | | |
| | qos | | | EndDeviceControl:loadShiftForward | |
| | state | | | DeviceStatus:opState | |
| | power | | | | Readings: value |
| | dimming | | | Subscription:Level | |
| | margin | | | IdentifiedObject:DemandResponseProgram:availabilityUpdatePowerChnage Threshold | |
| | generate | | | | SolarEventProfile:SolarInvert errStatus:value |
| | storage | | | | BatteryEventProfile:BatteryS tatus:value |
| | max Value | | | | solarModule:SolarCapability :MaxVal |
| | min Value | | | | solarModule:SolarCapability :MinVal |
| | | | | | ResourceReading:MMTP:A |

2. Smart Home Energy Framework :

2.2 EMAP(MQTT/JSON, CoAP/JSON) : UpdateReport

(2) UpdatedReport

| Key Name | Reference | | |
|---------------------|---------------|------------------------|--|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) | OpenFMB(IEC 61850) |
| SrcEMA | ei:venID | | |
| DestEMA | ei:vtnID | | |
| requestID | ei:eiResponse | pyld:requestID | |
| responseCode | | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| service | (Tag 이름으로 존재) | | |
| type | | | IdentifiedObject:TrafiiProfile:ServiceKind |
| time | | | RandomizableEvent:creation Time |

type: Explicit, Implicit

2. Smart Home Energy Framework :

2.2 **EMAP**(MQTT/JSON, CoAP/JSON) : **UpdateReport**

(1) UpdateReport

| Key name | | | | Comments |
|-----------|-------------------|-----------------|--|---|
| SrcEMA | | | | source EMA identifier |
| DestEMA | | | | destination EMA identifier |
| requestID | | | | request identifier |
| report | duration | | | report duration |
| | reportRequestID | | | report request identifier |
| | reportSpecifierID | | | report specific id (created from ven) |
| | reportName | | | report name |
| | createdDateTime | | | created time of this report |
| | reportDescription | rID | | |
| | | resourceID | | resource identifier |
| | | reportType | | report type |
| | | deviceType | | type of device |
| | | itemUnits | | unit of item that report |
| | | siScaleCode | | |
| | | marketContext | | refer marketContext address |
| | | minPeriod | | Energy usage minimum period |
| | | maxPeriod | | Energy usage maximum period |
| | | onChange | | |
| | | itemDescription | | type of item that report |
| | | gos | | device QoS |
| | | state | | device current state |
| | | power | | power usage |
| | | dimming | | dimming state |
| | | margin | | available amount of energy (Including generated, stored Energy) |
| | | generate | | generated energy |
| | | storage | | soraged energy |
| | | maxValue | | energy max usage value |
| | | minValue | | energy min usage vaalue |
| | | avgValue | | energy average usage value |
| | | maxTime | | energy max usage time |
| | | minTime | | energy min usage time |
| | | priority | | priority of this device |
| | powerAttributes | hertz | | pulse frequency of power |
| | | voltage | | voltage of power |
| | | ac | | Is this AC power? (True or False) |
| service | | | | type of service |
| time | | | | service creation time |
| type | | | | report message type (implicit or explicit) |

2. Smart Home Energy Framework :

2.2 **EMAP**(MQTT/JSON, CoAP/JSON) : **UpdateReport**

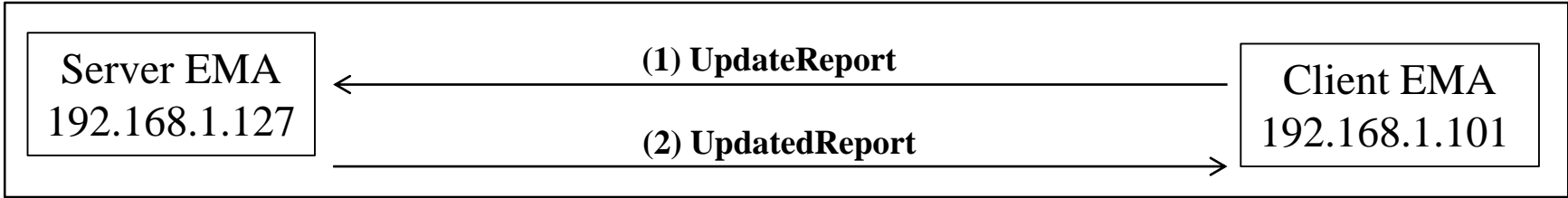
(2) UpdatedReport

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : UpdateReport (Implicit, Explicit)



| | | | | |
|------------------|---------------|---------------|------|---|
| (1) UpdateReport | 192.168.1.101 | 192.168.1.127 | CoAP | 1295 CON, MID:8526, PUT, /UpdateReport (application/json) |
| | 192.168.1.127 | 192.168.1.101 | CoAP | 802 ACK, MID:8526, 2.05 Content (application/json) |

UpdateReport Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID" : String,
 "reportType" : String,
 "EMAregisteredDRinformation" : Object => 변경
 "EMAregisteredMgnInformation" : Object => 변경,
 "report" : Array,
 "time" : Date,
 "service" : String,
 "type" : String (Explicit, Implicit 인지 구분)
}

report Object{
 "duration" : String,
 "reportRequestID" : Integer,
 "reportSpecifierID" : String,
 "reportName" : String,
 "createdDateTime" : Date,
 "reportDescription" : Array,
}

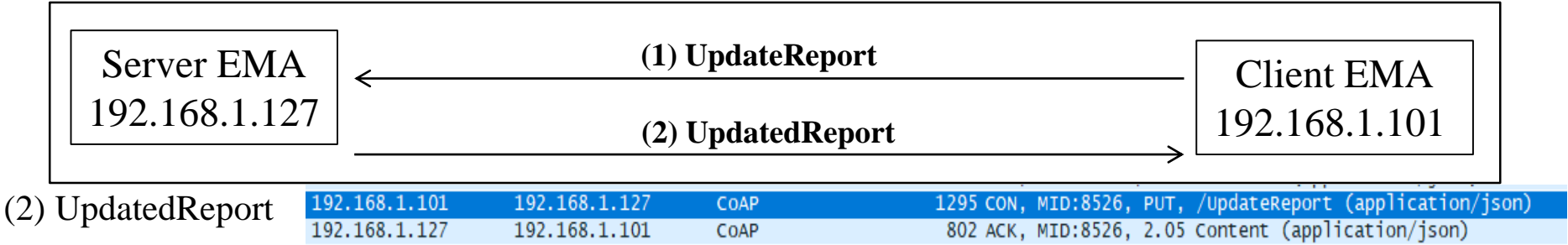
JavaScript Object Notation: application/json
Object
Member Key: "SrcEMA"
Member Key: "DestEMA"
Member Key: "requestID"
Member Key: "reportName"
Member Key: "reportType"
Member Key: "EMAupdatedDRInfo"
Member Key: "EMAupdatedMgnInfo"
Member Key: "service"
Member Key: "time"

reportDescription Object{
 "rID" : String,
 "resourceID" : String,
 "deviceType" : String,
 "reportType" : String,
 "itemUnits" : String,
 "siScaleCode" : String,
 "marketContext" : String,
 "oadrMinPeriod" : String,
 "oadrMaxPeriod" : String,
 "oadrOnChange" : String,
 "itemDescription" : String,
 "powerAttributes" : Array,
 "qos" : String
 "state" : String,
 "power" : Double,
 "dimming" : Integer,
 "margin" : double,
 "generate" : double,
 "storage" : String,
 "maxValue" : Double,
 "minValue" : Double,
 "avgValue" : Double,
 "maxTime" : Date,
 "minTime" : Date,
 "priority" : Integer
}

powerAttributes Object{
 "hertz" : Double,
 "voltage" : Double,
 "ac" : Boolean
}

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : UpdateReport (Implicit, Explicit)

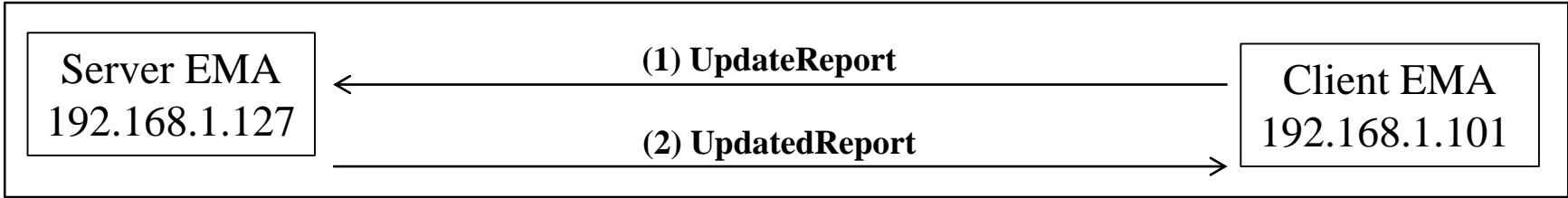


UpdatedReport Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "responseCode": Integer,
 "responseDescription" : String,
 ~~"EMAEnergyinfo" : Object => 삭제~~
 "service": String,
 "time": Date
}

▣ Payload: Payload Content-Format: application/json, Length: 753
 Payload Desc: application/json
▣ JavaScript Object Notation: application/json
 ▣ Object
 ⊕ Member Key: "EMAEnergyinfo"
 ⊕ Member Key: "SrcEMA"
 ⊕ Member Key: "responseDescription"
 ⊕ Member Key: "requestID"
 ⊕ Member Key: "service"
 ⊕ Member Key: "EMATopologyinfo"
 ⊕ Member Key: "time"
 ⊕ Member Key: "DestEMA"
 ⊕ Member Key: "responseCode"

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : UpdateReport (Implicit, Explicit)



| | | | | |
|------------------|---------------|---------------|------|---|
| (1) UpdateReport | 192.168.1.101 | 192.168.1.127 | CoAP | 1295 CON, MID:8526, PUT, /updateReport (application/json) |
| | 192.168.1.127 | 192.168.1.101 | CoAP | 802 ACK, MID:8526, 2.05 Content (application/json) |

UpdateReport Object{
 “SrcEMA” : String,
 “DestEMA” : String,
 “requestID” : String,
 “reportType” : String,
 “EMAreRegisteredDRInformation” : Object => 변경
 “EMAreRegisteredMgnInformation” : Object => 변경,
 - “report” : Array,
 “time” : Date,
 “service” : String,
 “type” : String (Explicit, Implicit 인지 구분)
}

report Object{
 “duration” : String,
 “reportRequestID” : Integer,
 “reportSpecifierID” : String,
 “reportName” : String,
 “createdDateTime” : Date,
 “reportDescription” : Array,
}

JavaScript Object Notation: application/json

```
{
  "SrcEMA": "192.168.1.101",
  "DestEMA": "192.168.1.127",
  "requestID": 1295,
  "reportType": "CON",
  "EMAreRegisteredDRInformation": {
    "MID": 8526,
    "PUT": true,
    "path": "/updateReport"
  },
  "EMAreRegisteredMgnInformation": {
    "MID": 8526,
    "ACK": true,
    "path": "/updateReport"
  },
  "report": [
    {
      "duration": "2.05",
      "reportRequestID": 802,
      "reportSpecifierID": 1295,
      "reportName": "Content",
      "createdDateTime": "2016-01-01T00:00:00",
      "reportDescription": [
        {
          "state": "on",
          "dimming": 0,
          "power": 0,
          "margin": 0,
          "generate": 0,
          "storage": 0,
          "maxValue": 0,
          "minValue": 0,
          "avgValue": 0,
          "maxTime": "2016-01-01T00:00:00",
          "minTime": "2016-01-01T00:00:00",
          "service": "on",
          "time": "2016-01-01T00:00:00"
        }
      ]
    }
  ],
  "time": "2016-01-01T00:00:00",
  "service": "on",
  "type": "Explicit"
}
```

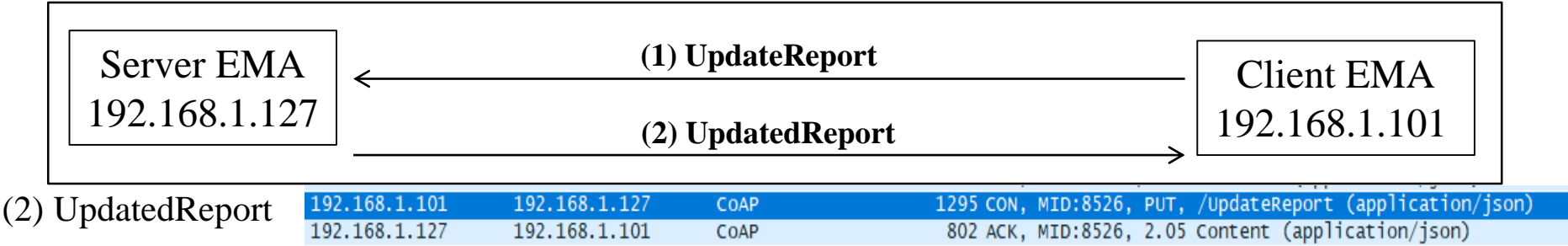
reportDescription Object{
 “rID” : String,
 “resourceID” : String,
 “deviceType” : String,
 “reportType” : String,
 “itemUnits” : String,
 “siScaleCode” : String,
 “marketContext” : String,
 “oadrMinPeriod” : String,
 “oadrMaxPeriod” : String,
 “oadrOnChange” : String,
 “itemDescription” : String,
 “powerAttributes” : Array,
 “qos” : String,
 “state” : String,
 “power” : Double,
 “dimming” : Integer,
 “margin” : double,
 “generate” : double,
 “storage” : String,
 “maxValue” : Double,
 “minValue” : Double,
 “avgValue” : Double,
 “maxTime” : Date,
 “minTime” : Date,
 “priority” : Integer
}

powerAttributes Object{
 “hertz” : Double,
 “voltage” : Double,
 “ac” : Boolean
}

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : UpdateReport (Implicit, Explicit)



```
UpdatedReport Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "requestID" : String,
  "responseCode" : Integer,
  "responseDescription" : String,
  "EMAEnergyinfo" : Object → 삭제
  "service" : String,
  "time" : Date
}
```

```
-----
Payload: Payload Content-Format: application/json, Length: 753
Payload Desc: application/json
JavaScript Object Notation: application/json
  object
    Member Key: "EMAEnergyinfo"
    Member Key: "SrcEMA"
    Member Key: "responseDescription"
    Member Key: "requestID"
    Member Key: "service"
    Member Key: "EMATopologyinfo"
      object
        Member Key: "emaCNT"
          Number value: 5
        Member Key: "topology"
          Array
            Member Key: "time"
            Member Key: "DestEMA"
            Member Key: "responsecode"
```

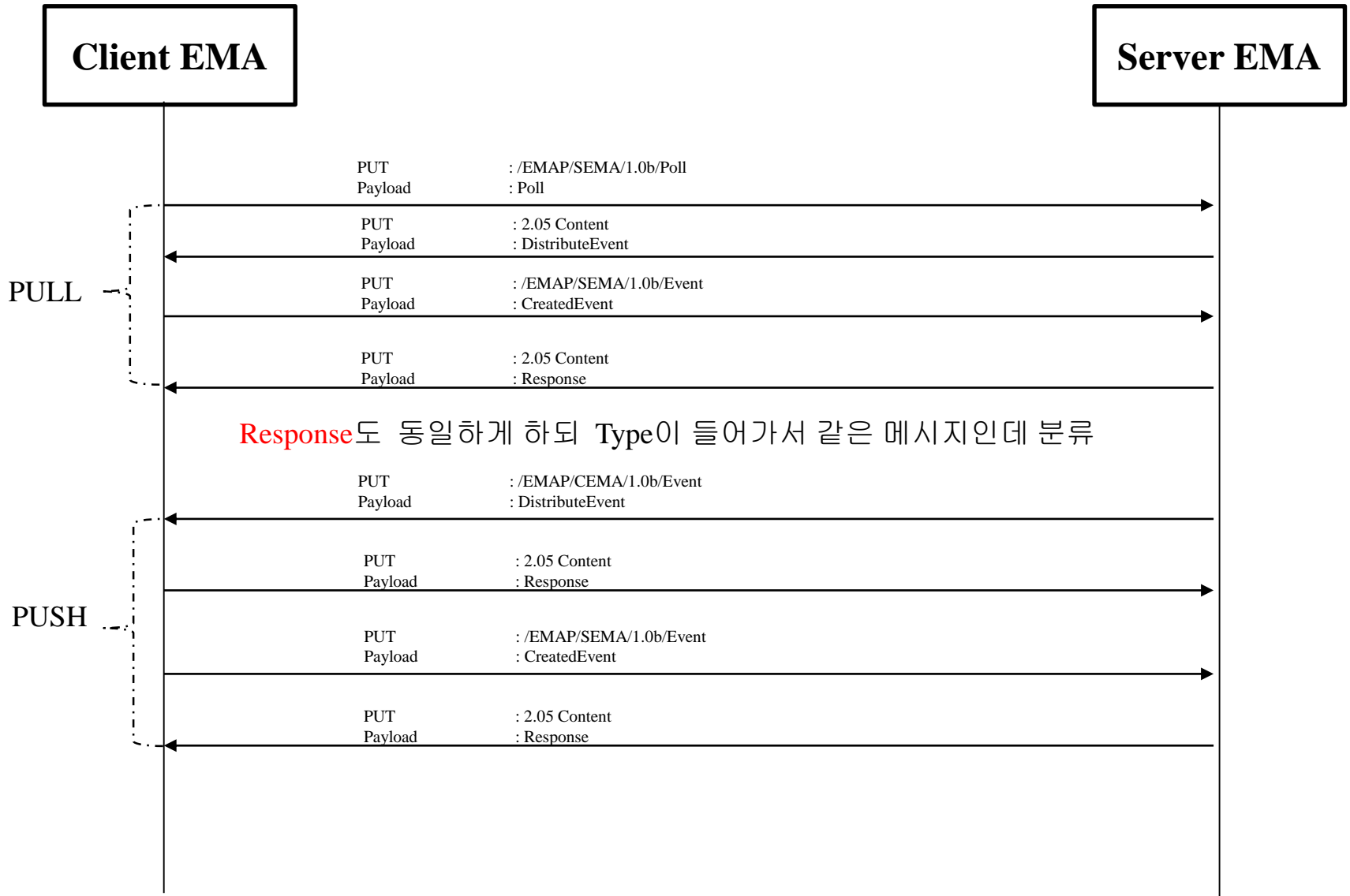
EMAP

(3) Event_PULL

- CoAP/JSON
- MQTT / JSON

2.2 EMAP(CoAP/JSON)

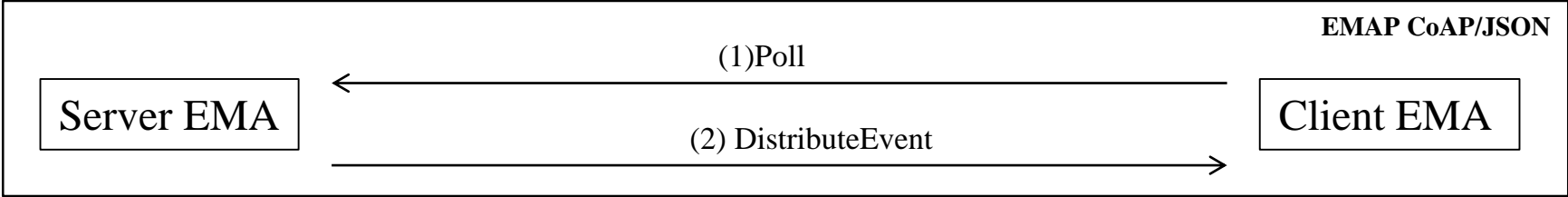
Service : Event



파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH



(1)Poll

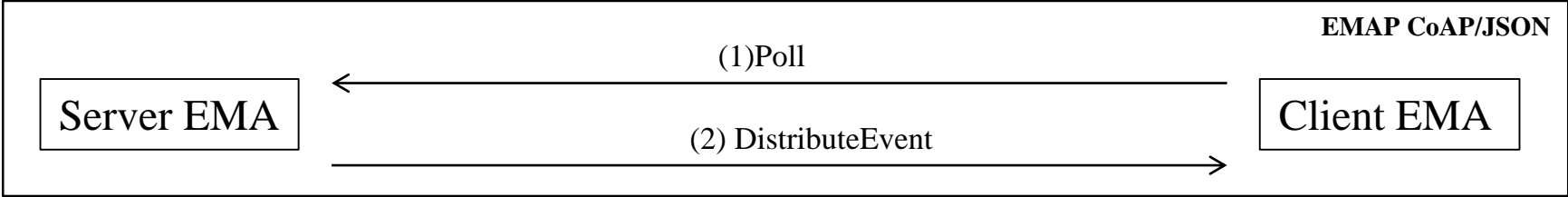
(2) DistributeEvent

| Key Name | Reference | |
|----------|---------------|---------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:venID | |
| DestEMA | ei:vtnID | |
| service | (Tag 이름으로 존재) | |
| time | | RandomizableEvent:creation Time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH

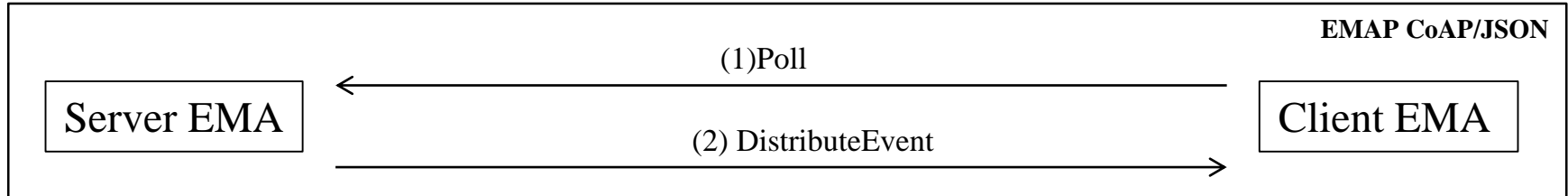


(2) DistributeEvent

| Key Name | | Reference | |
|--|---------------------|--|------------------------|
| | | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:vtnID | |
| DestEMA | | ei:venID | |
| requestID | | ei:requestID | |
| responseRequired | | Ei:responseRequired | |
| response | requestID | ei:Response | pyld:requestID |
| | responseCode | | ei:responseCode |
| | responseDescription | | ei:responseDescription |
| event | eventID | oadrEvent:eiActivePeriod:eventDescriptor | eventID |
| | eventSignals | | eventSignals |
| | modificationNumber | | modificationNumber |
| | modificationReason | | modificationReason |
| | priority | | priority |
| | marketContext | oadrEvent:eiActivePeriod:properties | eiMarketContext |
| | createdDateTime | | createdDateTime |
| | eventStatus | | eventStatus |
| | testEvent | | testEvent |
| | vtnComment | | vtnComment |
| | properties | oadrEvent:eiActivePeriod | properties |
| | components | | components |
| | specificDestEMA | oadrEvent:eiTarget | venID |
| | dtStart | oadrEvent:eiActivePeriod:properties | dtstart |
| | Duration | | duration |
| | Tolerance | | tolerance |
| signalType으로 Price Event인지 | notification | | x-eiNotification |
| | rampUp | | x-eiRampUp |
| | Recovery | | x-eiRecovery |
| | eventSignal | oadrEvent:eiEventSignals | eiEventSignal |
| | Intervals | oadrEvent:eiEventSignals:eiEventSignal | intervals |
| Control Event, Reserve Mode (Price Event, Control Event, Reserve Mode) | signalName | | signalName |
| | signalType | | signalType |

2. Smart Home Energy Framework :

2.2 EMAP(**CoAP/JSON**, MQTT/JSON) : Event-**PULL**,PUSH

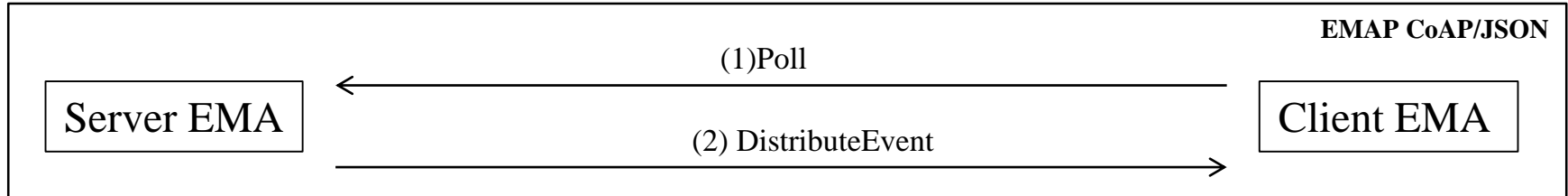


(1)Poll

| Key name | Comments |
|----------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| service | type of service |
| time | service creation time |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH



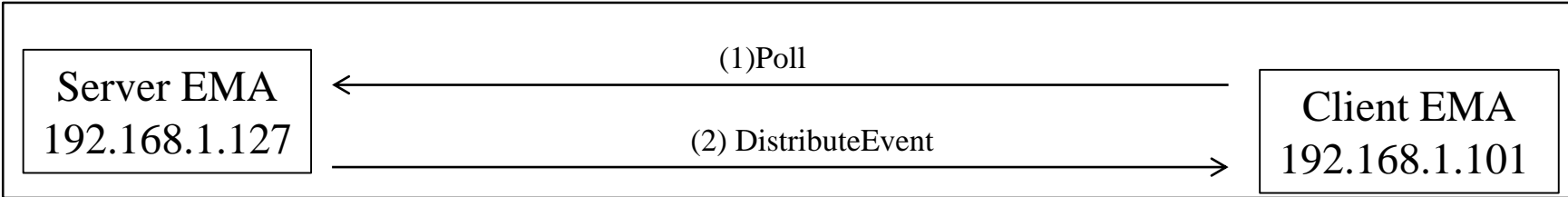
(2) DistributeEvent

| Key name | | | | Comments |
|------------------|---------------------|--------------|--------------------------------------|-----------------------------------|
| SrcEMA | | | | source EMA identifier |
| DestEMA | | | | destination EMA identifier |
| response | requestID | | | request identifier |
| | responseCode | | | response code |
| | responseDescription | | | description of response code |
| event | eventID | | | event identifier |
| | eventSigansls | intervals | duration | event signal interval duration |
| | | | uid | event user id |
| | | value | value | event value |
| | | | signalName | event signal name |
| | | signalType | event signal type (bi direct, level) | |
| | | signalID | event signal ID | |
| | | currentValue | current usage value | |
| | | threshold | available amount of energy | |
| | | capacity | 사용 가능량 (threshold - power) | |
| | | price | price of energy | |
| | | unit | 단위 | |
| | modificationNumber | | | modification Number(count) |
| | modificationReason | | | modification reason(event reason) |
| | priority | | | priority |
| | marketContext | | | market address(market reference) |
| | createdDateTime | | | event create date & time |
| | eventStatus | | | event status |
| | testEvent | | | if event test or not |
| | vtnComment | | | |
| | dtStart | | | event start time |
| | duration | | | event duration |
| | properties | | | |
| | components | | | |
| | specificDestEMA | | | specific target EMA |
| | tolerance | | | tolerance duration |
| | notification | | | notification duration |
| | rampUp | | | ramp up duration |
| | recovery | | | |
| responseRequired | | | | response mandatory or not |
| service | | | | type of service |
| time | | | | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH



| | | | | |
|---------------------|------|---------------|---------------|---|
| (1) Poll | MQTT | 192.168.1.101 | 192.168.1.201 | Publish Message [SEMA/SERVER_EMA1/Poll/Poll] |
| (2) DistributeEvent | MQTT | 192.168.1.201 | 192.168.1.101 | Publish Message [CEMA/1/Poll/DistributeEvent] |

Poll JSONObject{
 "SrcEMA" : String,
 "DestEMA" : String,
 ~~"version": Integer => 삭제,~~
 ~~"type" : String => 삭제(RegisteredReport로 변경)~~
 "service" : String,
 "time" : Date
}

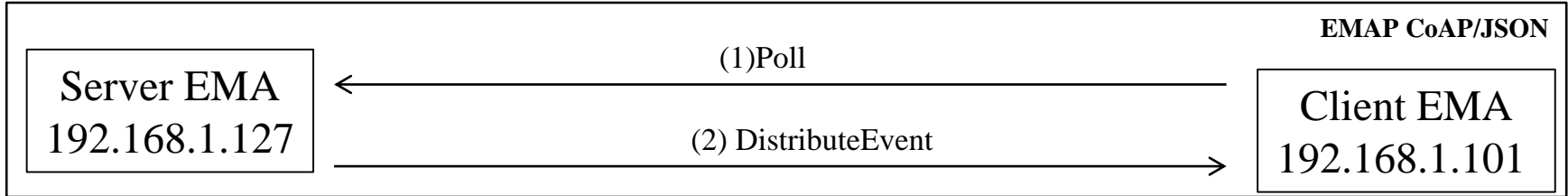
JavaScript Object Notation: application/json

- Object
 - Member Key: SrcEMA
 - Member Key: DestEMA
 - Member Key: requestID
 - Member Key: version
 - Member Key: type
 - String value: Registration
 - Key: type
 - Member Key: service
 - Member Key: time

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH



(1) Poll

| | | | |
|------|---------------|---------------|---|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:25500, PUT, /Poll (application/json) |
|------|---------------|---------------|---|

(2) DistributeEvent

| | | | |
|------|---------------|---------------|---|
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:25500, 2.05 Content (application/json) |
|------|---------------|---------------|---|

```
DistributeEvent Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "requestID" : String,
  "response" : Array,
  "event" : Array,
  "responseRequired" : String,
  "service" : String,
  "time" : Date
}

response Array{
  "requestID" : String,
  "responseCode" : Integer,
  "responseDescription" : String
}
```

```
event Array{
  "eventID" : String,
  "eventSignals" : Array,
  "modificationNumber" : Integer,
  "modificationReason" : String,
  "priority" : Integer,
  "marketContext" : String,
  "createdDataTime" : Date,
  "eventStatus" : String,
  "testEvent" : Boolean,
  "vtnComment" : String,
  "dtstart" : Date,
  "duration" : String,
  "properties" : String,
  "components" : String,
  "specificDestEMA" : String,
  "tolerance" : String,
  "notification" : String,
  "rampUp" : String,
  "recovery" : String
}
```

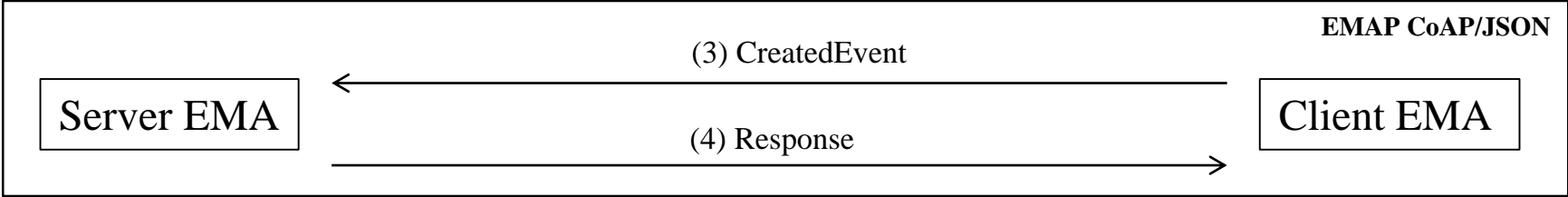
```
eventSignals Object{
  "eventSignal" : String,
  "intervals" : Array,
  "signalName" : String,
  "signalType" : String, (Price Event, Control Event, Reserve Mode, RealtimeDR인지 구분)
  "signalID" : String,
  "currentValue" : Double,
  "threshold" : Double,
  "capacity" : Double,
  "price" : Integer,
  "unit" : String,
}
```

```
intervals Array{
  "duration" : String,
  "uid" : Integer,
  "value" : Double
}
```

JavaScript Object Notation: application/json
Object
Member Key: SrcEMA
Member Key: responseDescription
Member Key: requestID
Member Key: service
Member Key: EMADREventInformation
Member Key: time
Member Key: DestEMA
Member Key: type
Member Key: EMADRPPriceInformation
Member Key: responseCode

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH

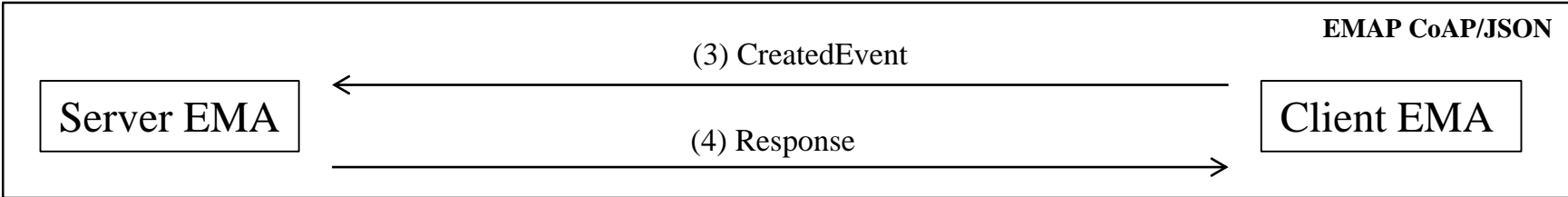


(3) CreatedEvent

| Key Name | Reference | | |
|---------------------|------------------|------------------------|---------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcMEA | ei:venID | | |
| DestEMA | ei:vtnID | | |
| responseCode | ei:eiResponse | Ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| optType | ei:eventResponse | ei:optType | |
| eventID | | ei:eventID | |
| modificationNumber | | ei:modificationNumber | |
| requestID | | pyld:requestID | |
| service | (Tag 이름으로 존재) | | |
| time | | | RandomizableEvent:creation Time |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH

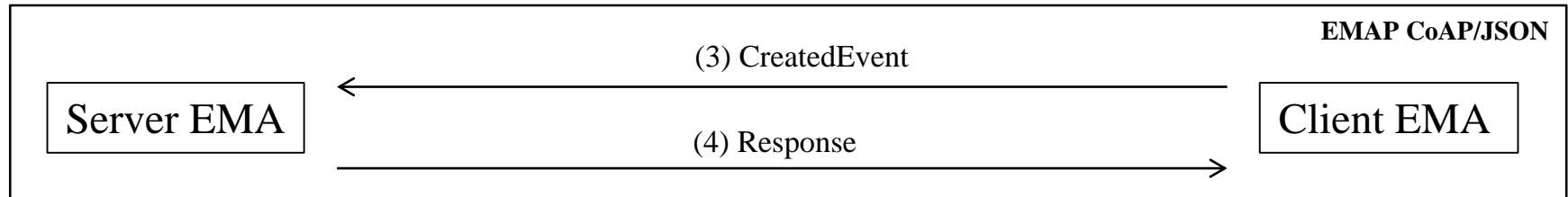


(4) Response

| Key Name | Reference | |
|---------------------|---------------|--------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | |
| DestEMA | ei:venID | |
| responseCode | ei:eiResponse | ei:responseCode |
| responseDescription | | ei:responseDescription |
| requestID | | Pyld:requestID |
| service | (Tag 이름으로 존재) | |
| time | | RandomizableEvent:creationTime |

2. Smart Home Energy Framework :

2.2 EMAP(**CoAP/JSON**, MQTT/JSON) : Event-**PULL**,**PUSH**



(3) CreatedEvent

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| eventID | Event identifier |
| modificationNumber | modification number(count) |
| optType | if participate event or not |
| service | type of service |
| time | service creation time |

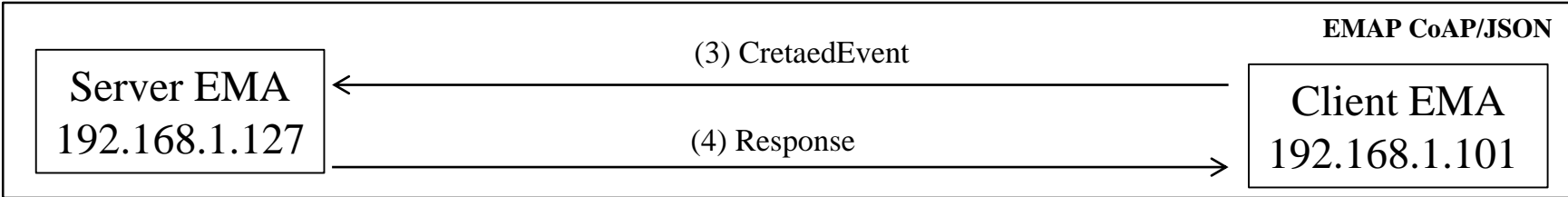
(4) Response

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH



(3) CreatedEvent
(4) Response

| | | | |
|------|---------------|---------------|--|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:8526, PUT, /CreatedEvent (application/json) |
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:8526, 2.05 Content (application/json) |

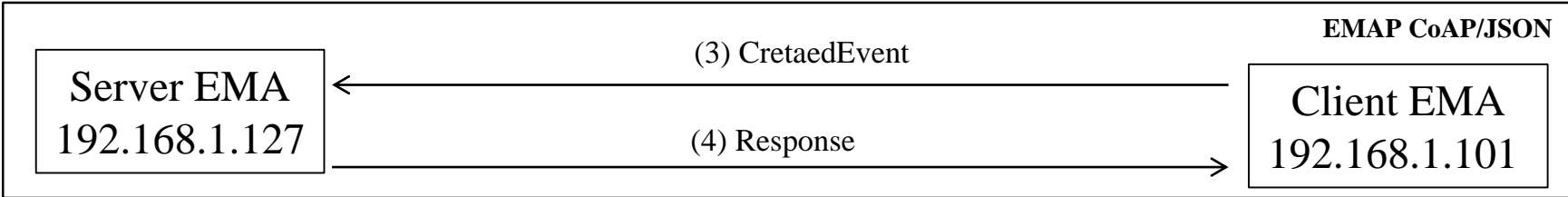
CreatedEvent Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "responseCode": Integer,
 "reponseDescription": String,
 "optType": String,
 "eventID" : String,
 "modificationNumber" : Integer,
 "service" : String,
 ~~"type" : String,~~
 "time" : Date
}

JavaScript Object Notation: application/json
Object
 Member Key: SrcEMA
 Member Key: DestEMA
 Member Key: requestID
 Member Key: responseCode
 Member Key: responseDescription
 Member Key: optType
 Member Key: eventID
 Member Key: modificationNumber
 Member Key: service
 Member Key: time
 String value: 2018-04-18 10:47:15
 Key: time

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL,PUSH



(3) CreatedEvent
(4) Response

| | | | |
|------|---------------|---------------|--|
| CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:8526, PUT, /CreatedEvent (application/json) |
| CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:8526, 2.05 Content (application/json) |

Response Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "responseCode" : Integer,
 "responseDescription": String,
 ~~"version": Integer => 삭제,~~
 "service": String,
 "time" : Date
}

- JavaScript Object Notation: application/json
 - Object
 - Member Key: SrcEMA
 - Member Key: responseDescription
 - Member Key: requestID
 - Member Key: service
 - Member Key: time
 - Member Key: DestEMA
 - Member Key: version
 - Member Key: responseCode

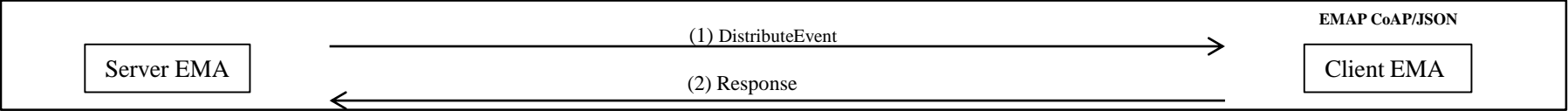
EMAP

(3) Event_PUSH

- CoAP/JSON
- MQTT / JSON

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**



(1) DistributeEvent

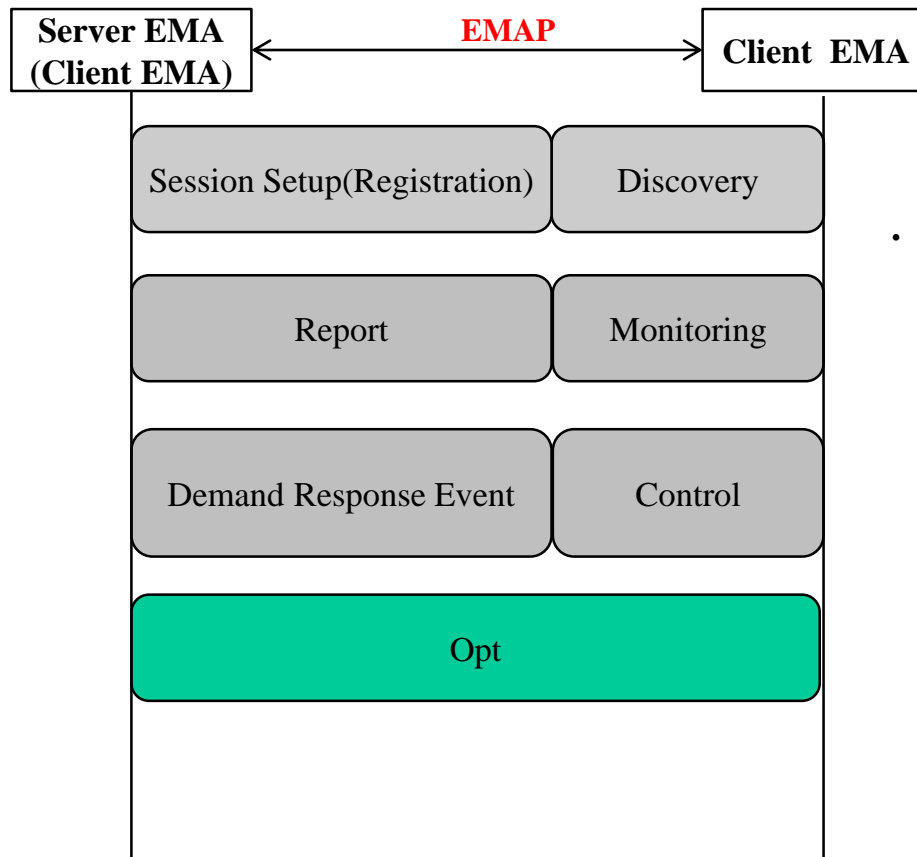
| Key Name | | Reference | | |
|--|---------------------|--|------------------------|---|
| | | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:vtmID | | |
| DestEMA | | ei:venID | | |
| requestID | | ei:requestID | | |
| responseRequired | | Ei:reponseRequired | | |
| response | requestID | ei:Response | pyId:requestID | |
| | responseCode | | ei:responseCode | |
| | responseDescription | | ei:responseDescription | |
| event | eventID | oadrEvent:eiActivePeriod:eventDescriptor | eventID | |
| | eventSignals | | eventSignals | |
| | modificationNumber | | modificationNumber | |
| | modificationReason | | modificationReason | |
| | priority | | priority | |
| | marketContext | | eiMarketContext | |
| | createdDateTime | oadrEvent:eiActivePeriod | createdDateTime | |
| | eventStatus | | eventStatus | |
| | testEvent | | testEvent | |
| | vtnComment | | vtnComment | |
| | properties | | properties | |
| | components | | components | |
| | specificDestEMA | oadrEvent:eiTarget | | venID |
| | dtStart | oadrEvent:eiActivePeriod:properties | dtstart | |
| | Duration | | duration | |
| | Tolerance | | tolerance | |
| | notification | | x-eiNotification | |
| | rampUp | | x-eiRampUp | |
| | Recovery | | x-eiRecovery | |
| signalType으로 Price Event인지 Control Event, Reserve Mode, RealtimeDR인지 구분한다 | eventSignal | oadrEvent:eiEventSignals | | eiEventSignal |
| | intervals | oadrEvent:eiEventSignals:eiEventSignal | intervals | |
| | signalName | | signalName | |
| | signalType | | signalType | |
| | signalID | | signalID | |
| | currentValue | | currentValue | |
| | threshold | | | IdentifiedObject:DemandResponseProgram:availabilityUpdatePowerChnageThreshold |
| event:eventSignals | capacity | | | AccountBalance:availableCredit |

2.2 EMAP(MQTT, CoAP/JSON)

Service : EiEvent

EMAP

- EMA사이의 수요반응 통신 프로토콜이며 OpenADR 2.0b의 모델링을 따랐으며 일부 모델링을 확장했고 Discovery와 Monitoring, Control 부분의 통신 프로토콜이 확장.

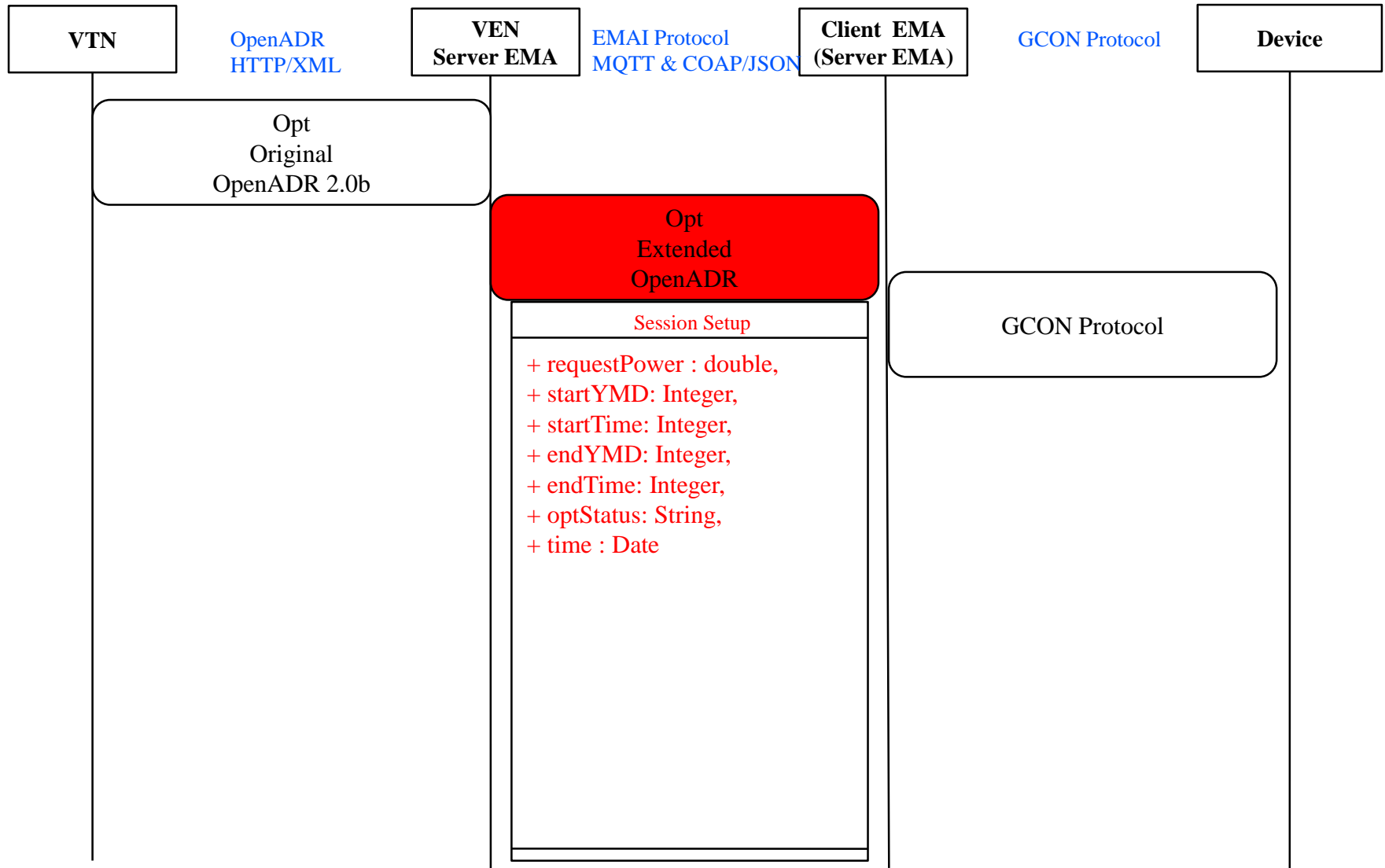


- Opt

- 에너지관리에이전트 프로토콜의 Opt는 클라이언트 에너지관리에이전트가 상위 서버 에너지관리에이전트에게 수요반응 이벤트의 가용상태 또는 수요반응 이벤트 프로그램 변경, 수요반응 스케줄링을 요청을 알려주는 서비스.

2.2 EMAP(MQTT, CoAP/JSON)

Service : Opt



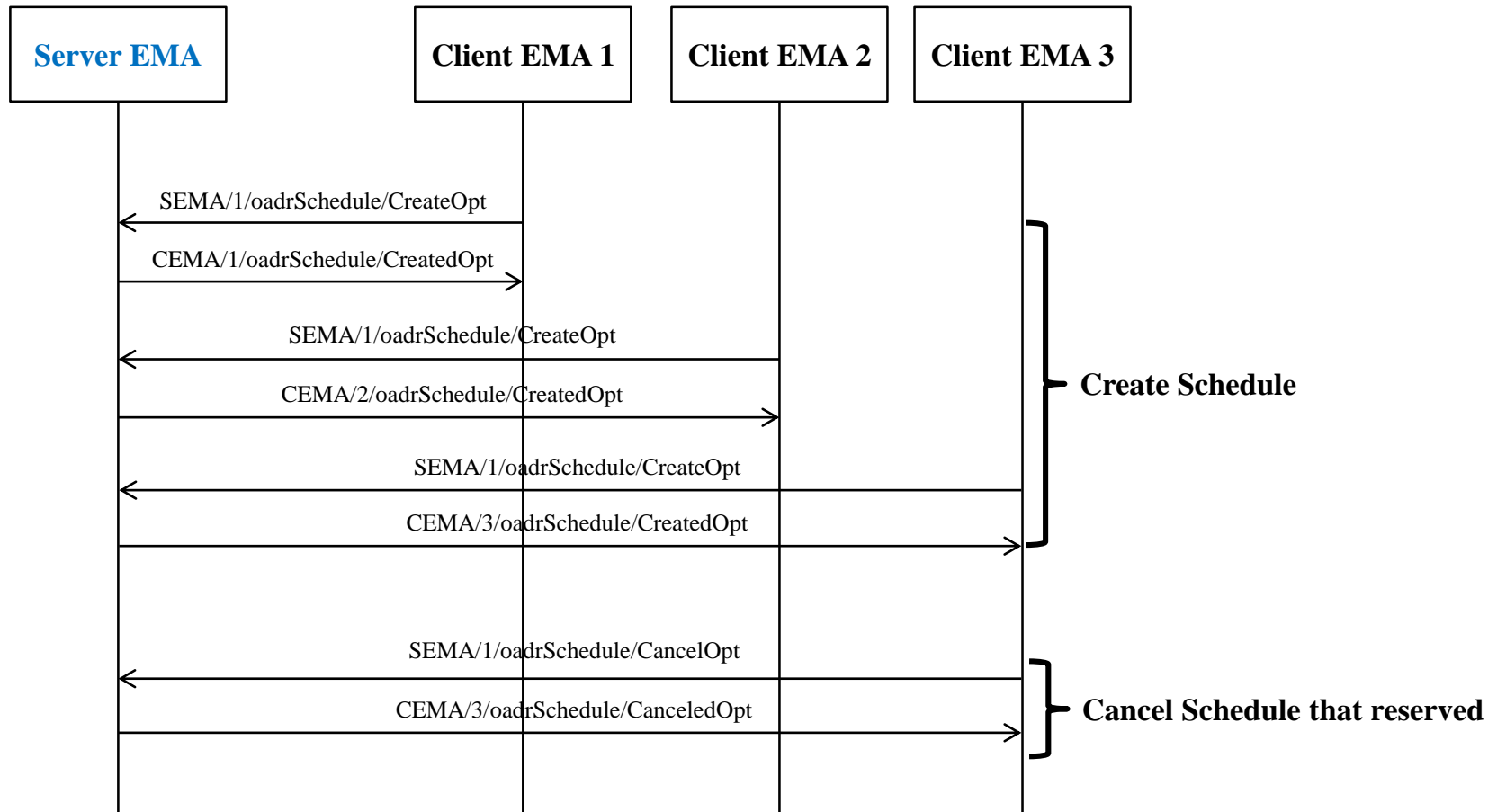
EMAP

(4) Opt

- **CoAP/JSON**
- **MQTT / JSON**

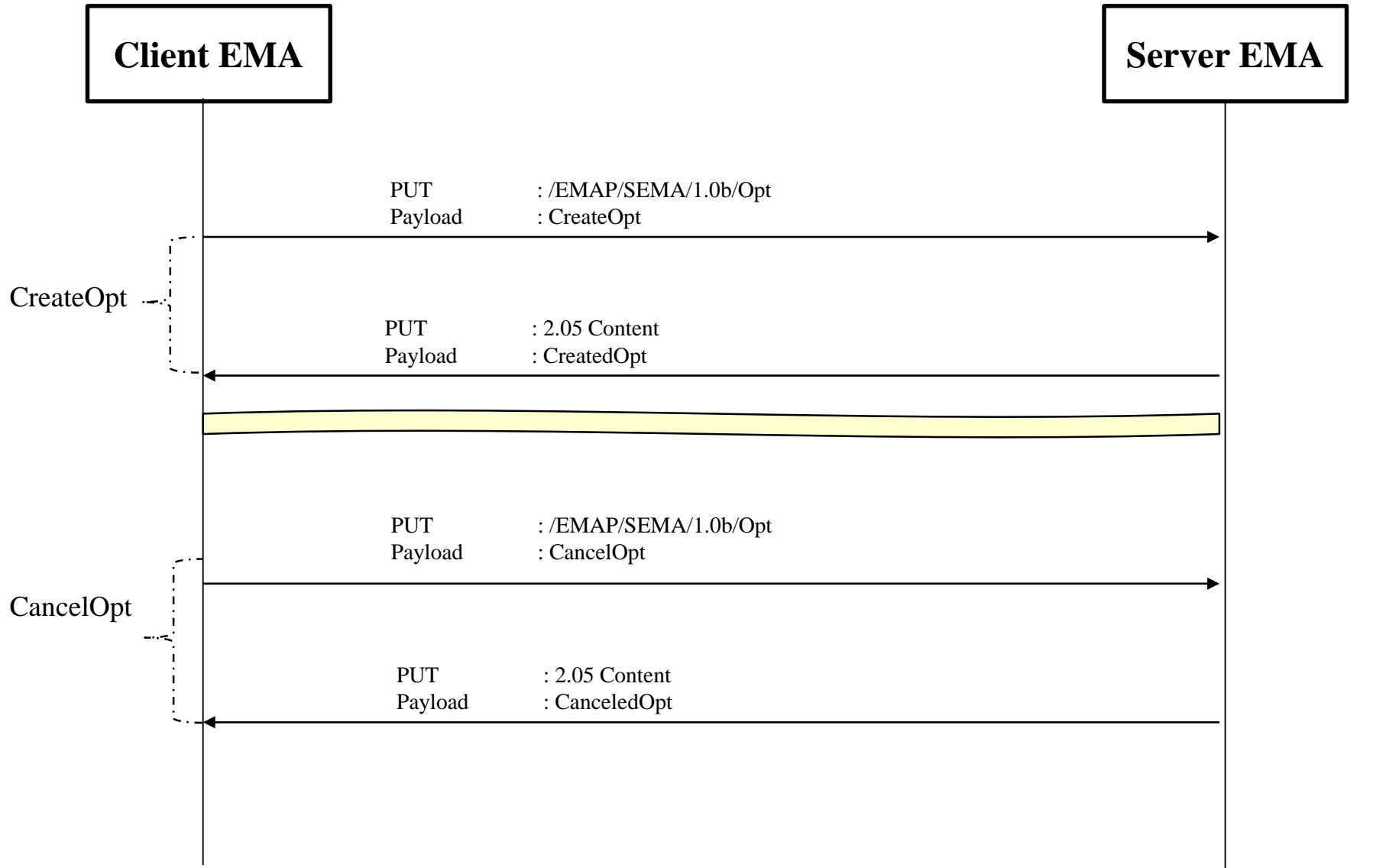
2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule by using Opt



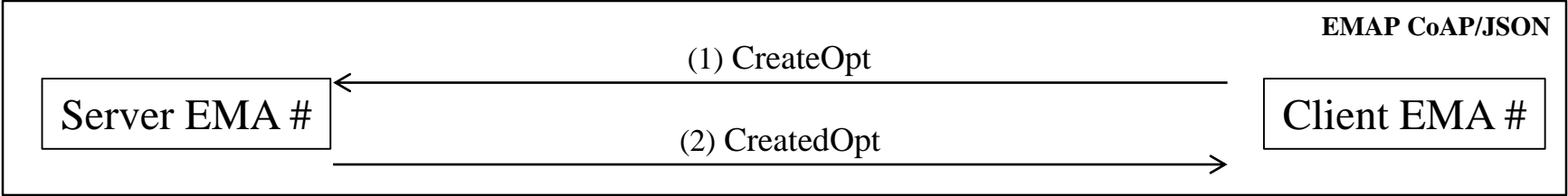
2.2 EMAP(CoAP/JSON)

Service : Opt



2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule (Opt)

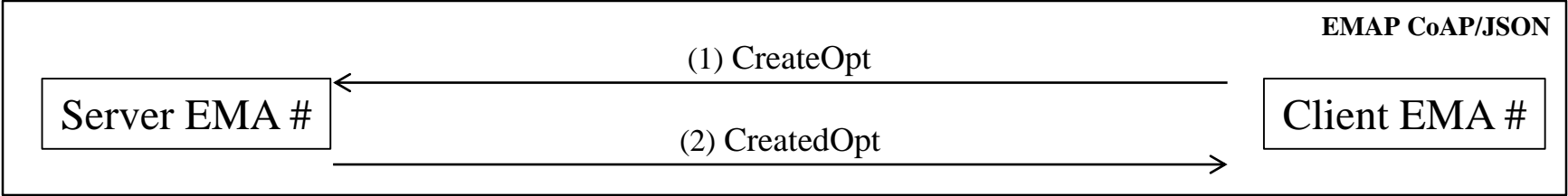


(1) CreateOpt

| Key Name | | Reference | |
|-----------------|--------------|---------------------|-------------------------------------|
| | | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | | ei:vtnID | |
| DestEMA | | ei:venID | |
| optID | | ei:qualifiedEventID | |
| optType | | ei:optType | |
| optReason | | ei:optReason | |
| requestID | | pyld:requestID | |
| marketContext | | ei:marketContext | |
| createdDateTime | | ei:createdDateTime | |
| service | | (Tag 이름으로 존재) | |
| available | dtstart | | |
| | duration | | RandomizableEvent:randomizeDuration |
| | requestPower | xcal :availability | |
| | startYMD | | TimeObject:dstStartTime |
| | startTime | | TimeObject:dstStartTime |
| | endYMD | | TimeObject:dstEndTime |
| | endTime | | TimeObject:dstEndTime |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule (Opt)

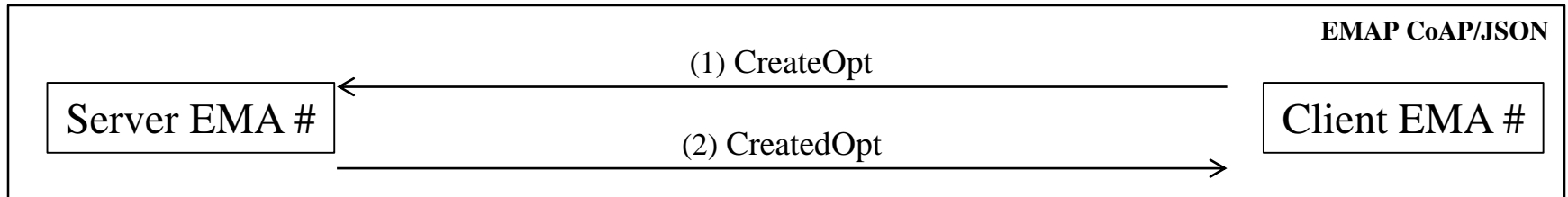


(2) CreatedOpt

| Key Name | Reference | |
|---------------------|------------------------|--|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | |
| DestEMA | ei:venID | |
| responseCode | ei:responseCode | |
| responseDescription | ei:responseDescription | |
| requestID | pyld:requestID | |
| optID | ei:optID | |
| optStatus | | IdentifiedObject:TrafiiProfile:ServiceKind |
| service | (Tag 이름으로 존재) | |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule (Opt)



(1) CreateOpt

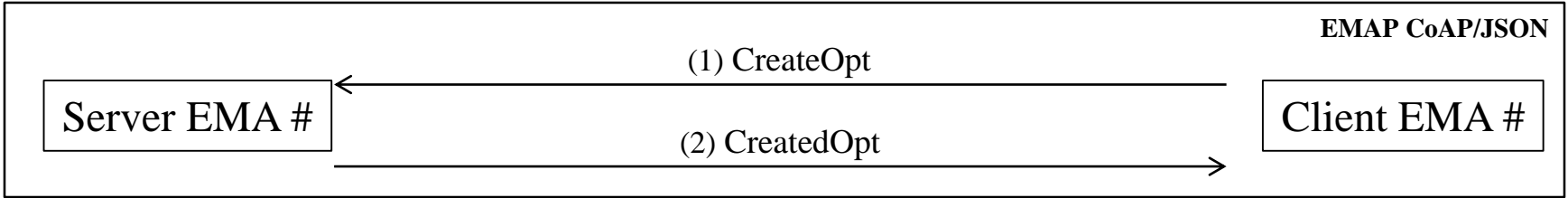
| Key name | | Comments |
|---------------|--------------|----------------------------|
| SrcEMA | | source EMA identifier |
| DestEMA | | destination EMA identifier |
| optID | | opt identifier |
| optType | | type of opt |
| optReason | | opt reason(e.g. emergency) |
| marketContext | | refer market address |
| available | dtstart | opt start time |
| | duration | opt duration |
| | requestPower | opt 요청 전력량 |
| | startYMD | opt start date |
| | startTime | opt start time |
| | endYMD | opt end date |
| | endTime | opt end time |
| requestID | | request identifier |
| service | | type of service |

(2) CreatedOpt

| Key name | | Comments |
|---------------------|--|------------------------------|
| SrcEMA | | source EMA identifier |
| DestEMA | | destination EMA identifier |
| requestID | | request identifier |
| responseCode | | response code |
| responseDescription | | description of response code |
| optID | | opt identifier |
| service | | type of service |
| optStatus | | |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule (Opt)



(1) CreateOpt

(2) CreatedOpt

| | | | | | | |
|-----|-----------|-----|---------------|---------------|------|--|
| 444 | 60.023690 | 322 | 192.168.1.102 | 192.168.1.127 | CoAP | CON, MID:39442, PUT, /CreateOpt (application/json) |
| 445 | 60.024630 | 202 | 192.168.1.127 | 192.168.1.102 | CoAP | ACK, MID:39442, 2.05 Content (application/json) |

```
CreateOpt Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "optID": String,
  "optType": String,
  "optReason": String,
  "requestID" : String,
  "marketContext" : String,
  "createdDateTime": Date,
  "service" : String,
  "available" : Array,
}
```

```
available Array{
  "dtstart" : Date,
  "duration" : String,
  "requestPower" : double,
  "startYMD": Integer,
  "startTime": Integer,
  "endYMD": Integer,
  "endTime": Integer,
}
```

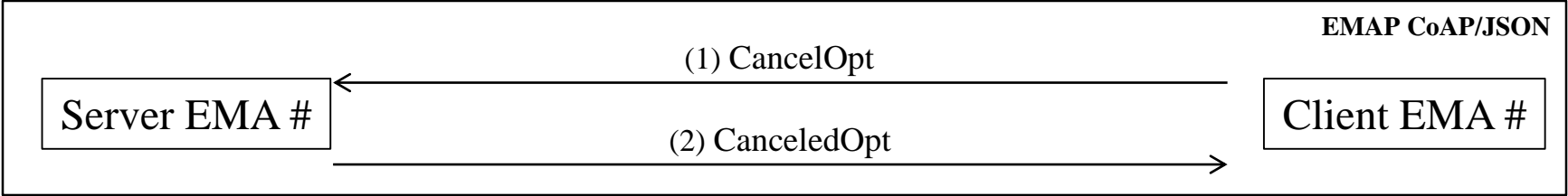
```
..00 .... = Type: Confirmable (0)
.... 0000 = Token Length: 0
Code: PUT (3)
Message ID: 39442
> Opt Name: #1: Uri-Path: CreateOpt
> Opt Name: #2: Content-Format: application/json
End of options marker: 255
[Response In: 589]
Payload: Payload Content-Format: application/json, Length: 263
Payload Desc: application/json
JavaScript Object Notation: application/json
Object
  Member Key: SrcEMA
  Member Key: DestEMA
  Member Key: optID
  Member Key: optType
  Member Key: optReason
  Member Key: requestID
  Member Key: requestPower
  Member Key: startYMD
  Member Key: startTime
  Member Key: endYMD
  Member Key: endTime
  Member Key: duration
  Member Key: service
  Member Key: createdDateTime
```

```
CreatedOpt Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "optID": String,
  "requestID": String,
  "responseCode": Integer,
  "responseDescription" : String,
  "service" : String,
  "optStatus": String
}
```

```
Payload Desc: application/json
JavaScript Object Notation: application/json
Object
  Member Key: optStatus
  Member Key: SrcEMA
  Member Key: responseDescription
  Member Key: requestID
  Member Key: service
  Member Key: DestEMA
  Member Key: optID
  Member Key: responseCode
```

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule _CancelOpt



(1) CancelOpt

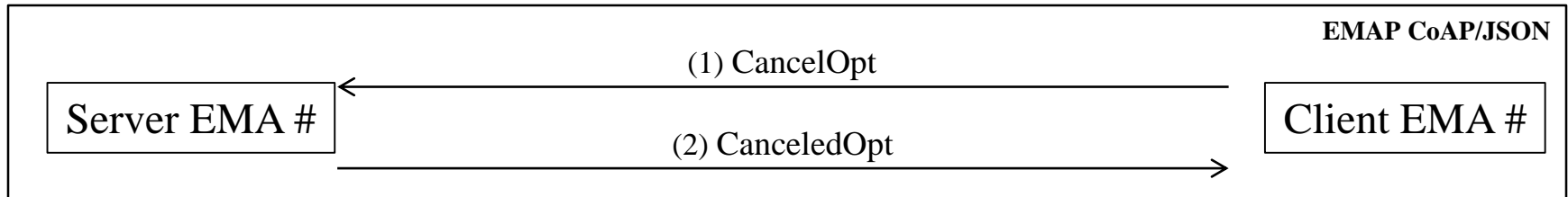
| Key Name | Reference | |
|-----------|----------------|---------------------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | |
| DestEMA | ei:venID | |
| requestID | pyld:requestID | |
| optID | ei:OptID | |
| time | | RandomizableEvent:creation Time |
| service | (Tag 이름으로 존재) | |

(2) CanceledOpt

| Key Name | Reference | |
|---------------------|------------------------|--------------------|
| | OpenADR 2.0b | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | |
| DestEMA | ei:venID | |
| responseCode | Ei:responseCode | |
| responseDescription | ei:responseDescription | |
| requestID | Pyld:requestID | |
| optID | ei:optID | |
| service | (Tag 이름으로 존재) | |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : **Schedule _CancelOpt**



(1) CancelOpt

| Key name | Comments |
|-----------|----------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| optID | opt identifier |
| service | type of service |
| time | service creation time |

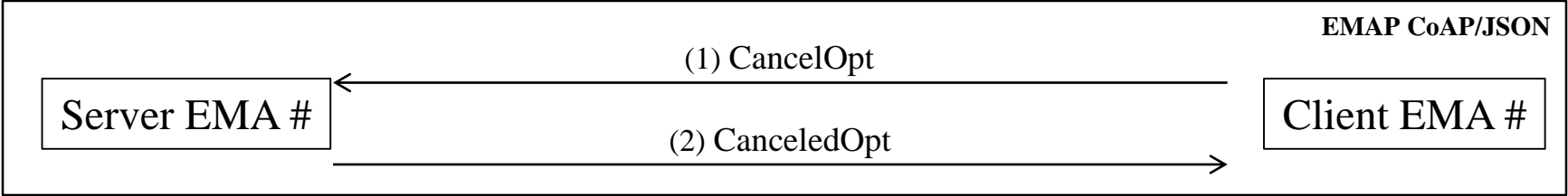
(2) CanceledOpt

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| optID | opt identifier |
| service | type of service |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Schedule _CancelOpt



| | | | | | | | |
|-----------------|-----|-----------|-----|---------------|---------------|------|--|
| (1) CancelOpt | 484 | 64.751022 | 179 | 192.168.1.102 | 192.168.1.127 | CoAP | CON, MID:42798, PUT, /CancelOpt (application/json) |
| (2) CanceledOpt | 486 | 64.751910 | 224 | 192.168.1.127 | 192.168.1.102 | CoAP | ACK, MID:42798, 2.05 Content (application/json) |

CancelOpt JSONObject{
"optID": String,
"SrcEMA" : String,
"DestEMA" : String,
"requestID": String,
"service" : String
"time": Date
}

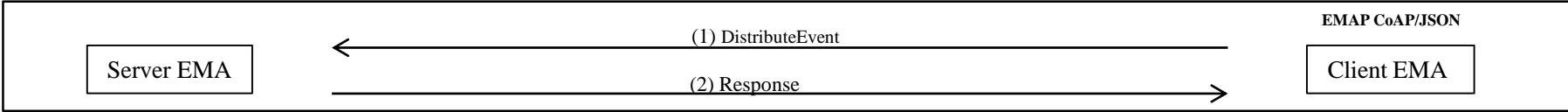
Payload Desc: application/json
JavaScript Object Notation: application/json
Object
Member Key: optID
Member Key: SrcEMA
Member Key: DestEMA
Member Key: requestID
Member Key: service
Member Key: time

CanceledOpt Object{
"optID": String,
"SrcEMA" : String,
"DestEMA" : String,
"requestID": String,
"responseCode": Integer,
"responseDescription" : String
"service": String
}

JavaScript Object Notation: application/json
Object
Member Key: SrcEMA
Member Key: responseDescription
Member Key: requestID
Member Key: service
Member Key: time
Member Key: DestEMA
Member Key: optID
Member Key: responseCode

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**

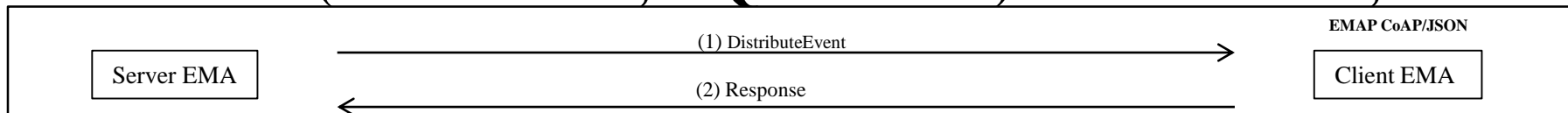


(2) Response

| Key Name | Reference | | |
|---------------------|---------------|------------------------|---|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | | |
| DestEMA | ei:venID | | |
| responseCode | ei:eiResponse | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| requestID | | Pyld:requestID | |
| service | (Tag 이름으로 존재) | | |
| type | | | TariffProfile:serviceCategoryKind:ServiceKind |
| time | | | RandomizableEvent:creationTime |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**

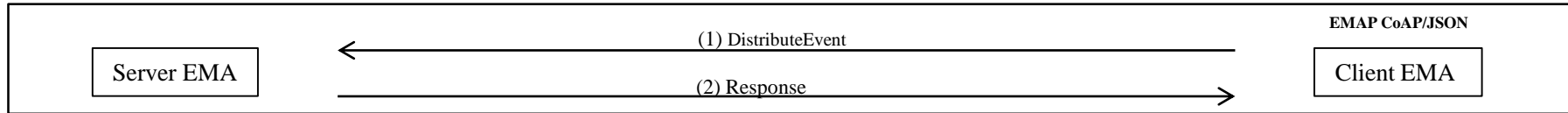


(1) DistributeEvent

| Key name | | | | Comments |
|------------------|---------------------|--------------|----------|--------------------------------------|
| SrcEMA | | | | source EMA identifier |
| DestEMA | | | | destination EMA identifier |
| response | requestID | | | request identifier |
| | responseCode | | | response code |
| | responseDescription | | | description of response code |
| event | eventID | | | event identifier |
| | eventSiganls | intervals | duration | event signal interval duration |
| | | | uid | event user id |
| | | | value | event value |
| | | signalName | | event signal name |
| | | signalType | | event signal type (bi direct, level) |
| | | signalID | | event signal ID |
| | | currentValue | | current usage value |
| | | threshold | | available amount of energy |
| | | capacity | | 사용 가능량 (threshold - power) |
| | | price | | price of energy |
| | | unit | | 단위 |
| | modificationNumber | | | modification Number(count) |
| | modificationReason | | | modification reason(event reason) |
| | priority | | | priority |
| | marketContext | | | market address(market reference) |
| | createdDateTime | | | event create date & time |
| | eventStatus | | | event status |
| | testEvent | | | if event test or not |
| | vtnComment | | | |
| | dtStart | | | event start time |
| | duration | | | event duration |
| | properties | | | |
| | components | | | |
| | specificDestEMA | | | specific target EMA |
| | tolerance | | | tolerance duration |
| | notification | | | notification duration |
| | rampUp | | | ramp up duration |
| | recovery | | | |
| responseRequired | | | | response mandatory or not |
| service | | | | type of service |
| time | | | | service creation time |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**



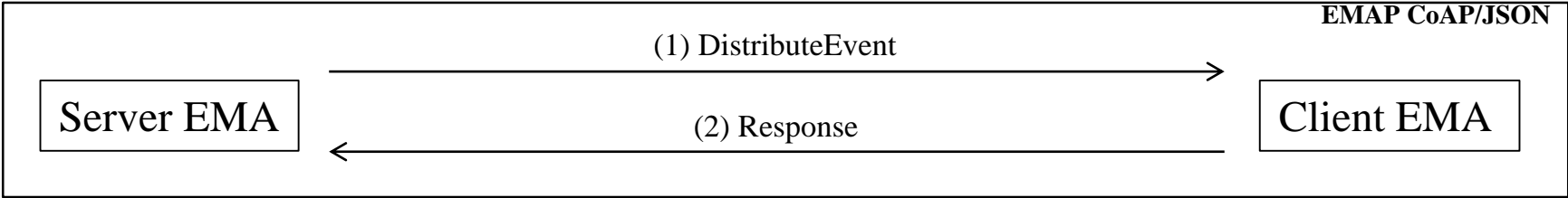
(2) Response

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, PUSH



(1) DistributeEvent

DistributeEvent Object{

```
"SrcEMA" : String,
"DestEMA" : String,
"requestID" : String,
"response" : Array,
"event" : Array,
"responseRequired" : String,
"service" : String,
"time" : Date
}
```

response Array{

```
"requestID" : String,
"responseCode" : Integer,
"responseDescription" : String
}
```

JavaScript Object Notation: application/json

Object

- Member Key: SrcEMA
- Member Key: responseDescription
- Member Key: requestID
- Member Key: service
- Member Key: EMADREventInformation
- Member Key: time
- Member Key: DestEMA
- Member Key: type
- Member Key: EMADRPriceInformation
- Member Key: responseCode

event Array{

```
"eventID" : String,
"eventSignals" : Array,
"modificationNumber" : Integer,
"modificationReason" : String,
"priority" : Integer,
"marketContext" : String,
"createdDateTime" : Date,
"eventStatus" : String,
"testEvent" : Boolean,
"vtnComment" : String,
"dtstart" : Date,
"duration" : String,
"properties" : String,
"components" : String,
"specificDestEMA" : String,
"tolerance" : String,
"notification" : String,
"rampUp" : String,
"recovery" : String
}
```

eventSignals Object{

```
"eventSignal" : String,
"intervals" : Array,
"signalName" : String,
"signalType" : String, (Price Event, Control Event, Reserve Mode, RealtimeDR인지 구분)
"signalID" : String,
"currentValue" : Double,
"threshold" : Double,
"capacity" : Double,
"price" : Integer,
"unit" : String,
}
```

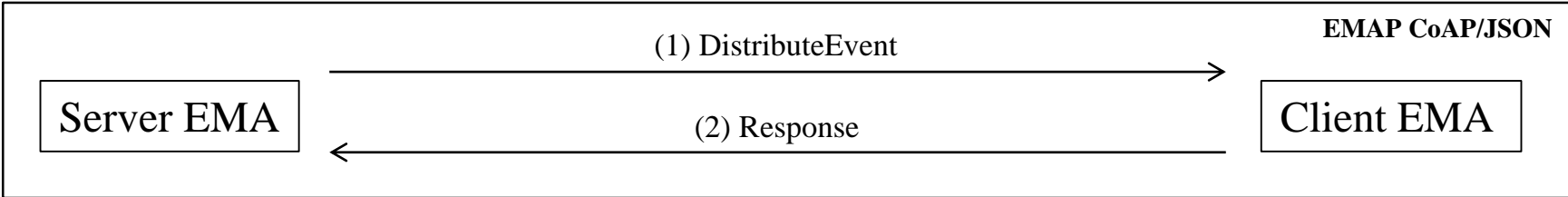
intervals Array{

```
"duration" : String,
"uid" : Integer,
"value" : Double
}
```


파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, PUSH



(2) Response

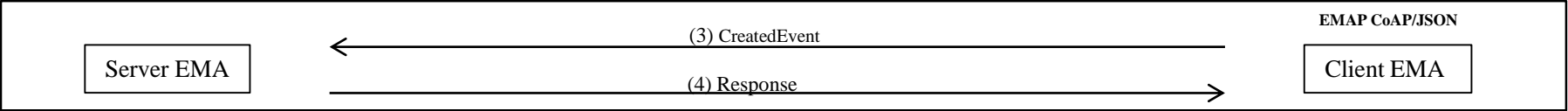
Response Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "responseCode" : Integer,
 "responseDescription": String,
 "service" : String,
 "type": String,
 "time" : Date
}

Object
 Member Key: SrcEMA
 Member Key: DestEMA
 Member Key: requestID
 Member Key: version
 Member Key: responseCode
 Member Key: responseDescription
 Member Key: type
 Member Key: service
 Member Key: time
 String value: 2018-05-01 03:35:46
 Key: time

type : Registration ,Periodic , report, Event, Price인지 구분

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**

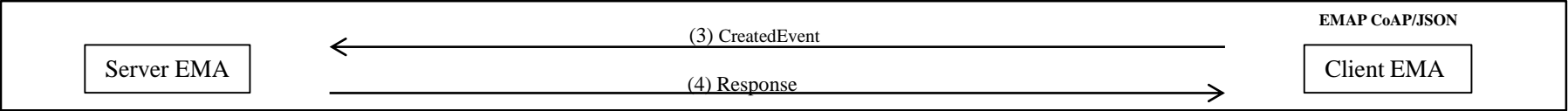


(3) CreatedEvent

| Key Name | Reference | | |
|---------------------|------------------|------------------------|---------------------------------|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcMEA | ei:venID | | |
| DestEMA | ei:vtnID | | |
| responseCode | ei:eiResponse | Ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| optType | ei:eventResponse | ei:optType | |
| eventID | | ei:eventID | |
| modificationNumber | | ei:modificationNumber | |
| requestID | | pyld:requestID | |
| service | (Tag 이름으로 존재) | | |
| time | | | RandomizableEvent:creation Time |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**

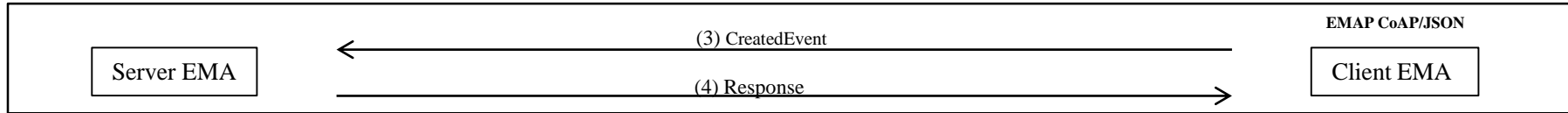


(4)Response

| Key Name | Reference | | |
|---------------------|---------------|------------------------|---|
| | OpenADR 2.0b | | SEP 2.0(IEC 61968) |
| SrcEMA | ei:vtnID | | |
| DestEMA | ei:venID | | |
| responseCode | ei:eiResponse | ei:responseCode | |
| responseDescription | | ei:responseDescription | |
| requestID | | Pyld:requestID | |
| service | (Tag 이름으로 존재) | | |
| type | | | TariffProfile:serviceCategoryKind:ServiceKind |
| time | | | RandomizableEvent:creationTime |

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, **PUSH**



(3) CreatedEvent

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| eventID | Event identifier |
| modificationNumber | modification number(count) |
| optType | if participate event or not |
| service | type of service |
| time | service creation time |

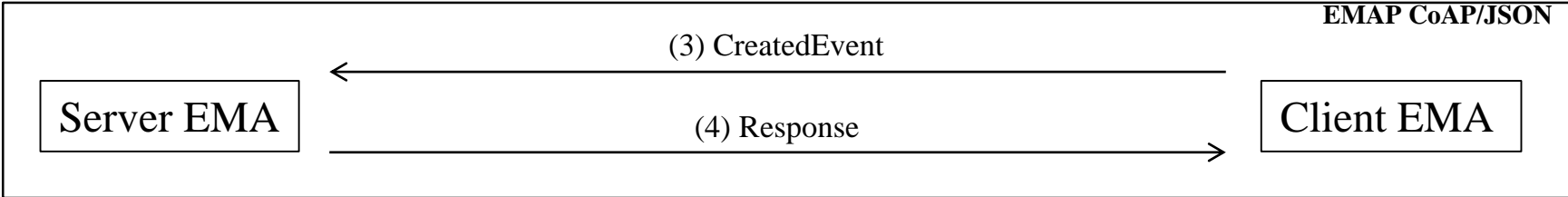
(4)Response

| Key name | Comments |
|---------------------|------------------------------|
| SrcEMA | source EMA identifier |
| DestEMA | destination EMA identifier |
| requestID | request identifier |
| responseCode | response code |
| responseDescription | description of response code |
| service | type of service |
| time | service creation time |

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, PUSH



| | | | | |
|------------------|------|---------------|---------------|---|
| (3) CreatedEvent | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:17396, PUT, /CreatedEvent (application/json) |
| (4) Response | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:17396, 2.05 Content (application/json) |

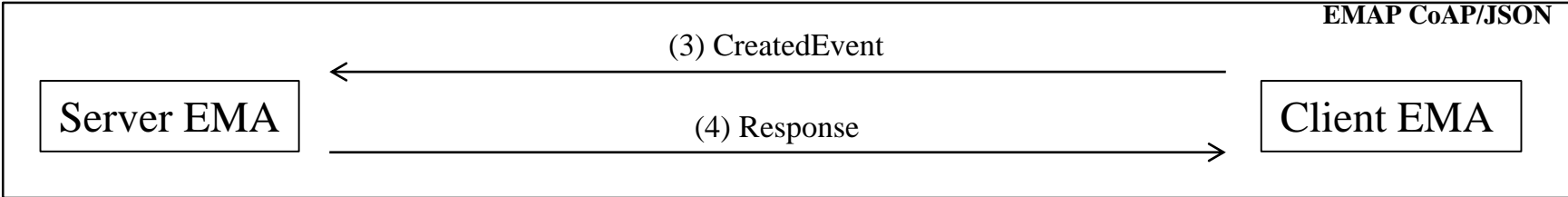
CreatedEvent Object{
 "SrcEMA" : String,
 "DestEMA" : String,
 "requestID": String,
 "responseCode": Integer,
 "responseDescription": String,
 "optType": String,
 "eventID" : String,
 "modificationNumber" : Integer,
 "service" : String,
 "time" : Date
}

```
JavaScript Object Notation: application/json
Object
  Member Key: SrcEMA
    String value: 1
    Key: SrcEMA
  Member Key: DestEMA
  Member Key: requestID
  Member Key: responseCode
  Member Key: responseDescription
  Member Key: optType
  Member Key: eventID
  Member Key: modificationNumber
    Number value: 1
    Key: modificationNumber
  Member Key: service
  Member Key: time
    String value: 2018-05-01 03:35:46
    Key: time
```

파란색 : 기존 OpenADR Tag 부분
빨간색 : OpenADR 확장된 Profile
초록색 : 삭제 또는 변경

2. Smart Home Energy Framework :

2.2 EMAP(CoAP/JSON, MQTT/JSON) : Event-PULL, PUSH



| | | | | |
|------------------|------|---------------|---------------|---|
| (3) CreatedEvent | CoAP | 192.168.1.101 | 192.168.1.127 | CON, MID:17396, PUT, /CreatedEvent (application/json) |
| (4) Response | CoAP | 192.168.1.127 | 192.168.1.101 | ACK, MID:17396, 2.05 Content (application/json) |

```
Response Object{
  "SrcEMA" : String,
  "DestEMA" : String,
  "requestID": String,
  "responseCode" : Integer,
  "responseDescription": String,
  "service": String,
  "type": String,
  "time" : Date
}
```

```
Object
  Member Key: SrcEMA
  Member Key: responseDescription
  Member Key: requestID
  Member Key: service
    String value: Response
    Key: service
  Member Key: time
    String value: Tue May 01 12:35:29 KST 2018
    Key: time
  Member Key: DestEMA
  Member Key: version
  Member Key: responseCode
    Number value: 200
    Key: responseCode
```

Appendix

- Java Thread Management
 - Smart Meter : Periodical On Demand Request

Java Thread Management

```
JButton btnNewButton = new JButton("SET");  
btnNewButton.setBounds(556, 242, 62, 23);  
add(btnNewButton);
```

```
btnNewButton.addActionListener(new ActionListener() {  
    @Override  
    public void actionPerformed(ActionEvent e) {  
        if (global.onDemandCNT > 0) {  
            Thread[] ee = new Thread[10000];  
            Thread.enumerate(ee);  
  
            for (int i = 0; i < ee.length; i++) {  
                if (ee[i].getName().equals("onDemand")) {  
                    ee[i].interrupt();  
                    break;  
                } else {  
                }  
            }  
            int sec = Integer.parseInt(textField.getText()) * 1000;  
            RunnableJob onDemandInterval = new RunnableJob(sec);  
            Thread onDemandRequest = new Thread(onDemandInterval);  
            onDemandRequest.setName("onDemand");  
            onDemandRequest.start();  
            global.onDemandCNT += 1;  
        }  
    }  
});
```

현재 실행되고 있는 Thread List를 Thread 배열에 저장한다

Thread 배열에 'onDemand' 라는 이름인 Thread를 검색한다.
해당 Thread가 있을 경우 Interrupt 명령어를 통해 종료한다.
검색 시간을 줄이기 위해 break;
Stop 이라는 명령어를 쓰는 것 보다 수행하는 Thread Class에
Interrupt Option 을 걸어 주는 것이 효율 적인 Thread 관리 방법

Java Thread management

```

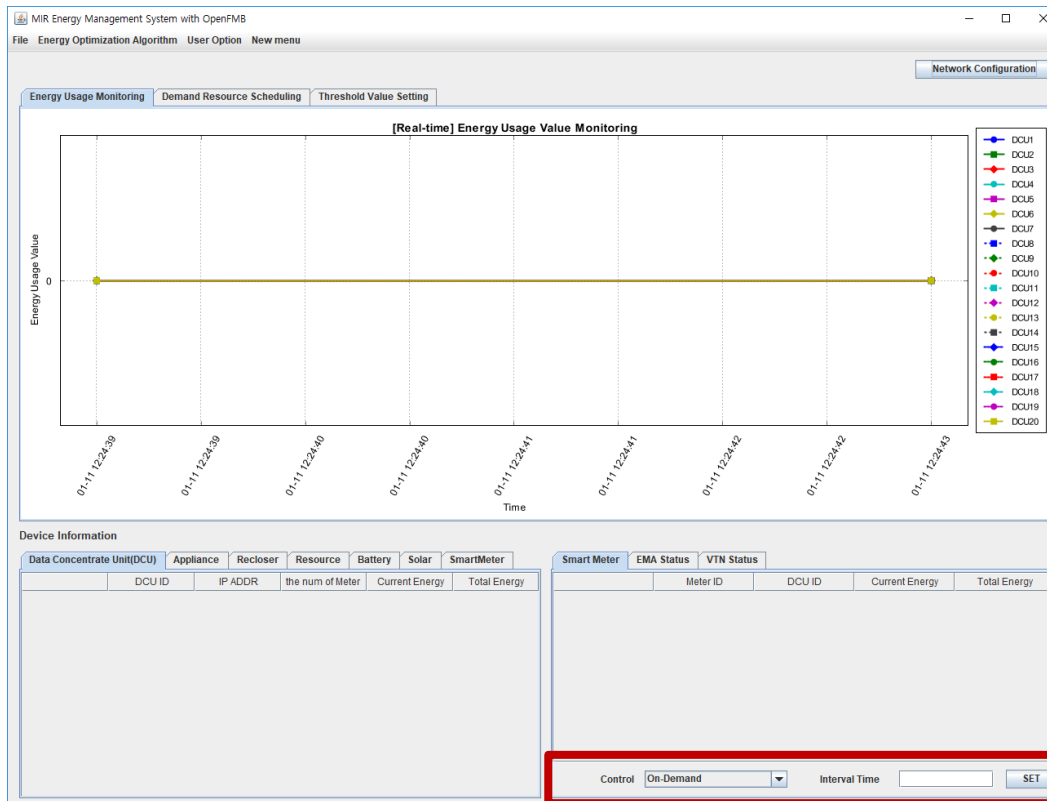
public class RunnableJob implements Runnable {
    public int intervalTime = 1000;
    public RunnableJob(int interval) {
        this.intervalTime = interval;
    }
    @Override
    public void run() {
        try {
            while (!Thread.currentThread().isInterrupted()) {
                long sTime = System.currentTimeMillis();
                Thread.sleep(intervalTime);
                long cTime = System.currentTimeMillis();
                long rTime = cTime - sTime;
                System.out.println(rTime / 1000 + " 초");
                Object[] dcuList = global.dcuHashMap.keySet().toArray();
                for (int i = 0; i < dcuList.length; i++) {
                    System.out.println(global.dcuHashMap.get(dcuList[i]).toString());
                    String[] parseRemoteIp = global.dcuHashMap.get(dcuList[i].toString()).toString().split("/");
                    String remoteIp = parseRemoteIp[0];
                    String dcuId = parseRemoteIp[1];
                    String meterId = parseRemoteIp[4];
                    JSONArray meterList = global.dcuHashMap.get(dcuList[i]).getMeterInfo();

                    for (int j = 0; j < meterList.size(); j++) {
                        JSONArray meterIDarr = new JSONArray();
                        meterIDarr.add(meterList.get(j));
                        TcpClient tcpClient = new TcpClient(remoteIp, dcuId, meterIDarr, "ondemand");
                        tcpClient.start();
                    }
                }
            }
        } catch (InterruptedException e) {
            e.printStackTrace();
        } finally {
            System.out.println("OnDemand Thread is Dead");
        }
    }
}

```

Thread.isInterrupt() 이 아니라 현재 수행 중인 Thread 를 종료하는 코드

수정 된 사항



목적:

Data Traffic & Event Response 실험을 위해 On-Demand Interval Time을 설정 할 수 있다.

기존 문제점:

기존에는 'SET' 버튼을 누를 때 마다 Thread가 추가적으로 생성된다.

해결방법:

Thread Interrupt 함수를 이용하여 보다 효과적으로 Thread를 관리한다.