Toward Interconnecting M2M/IoT Standards: Interworking Proxy for IEEE1888 Standard at ETSI M2M Platforms

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***Abstract*— Providing a common platform that can be used for Machine-2-Machine (M2M) communication though both wireless and wired networks supporting various kinds of devices is most required nowadays. Two M2M-related standards recently released are IEEE1888 standard and ETSI M2M standard. In this paper, we show the comparison of two standards based on supported features and capabilities and propose a model for interworking between two prototype platforms from both standards. The aim of this paper is to prove the interoperability of M2M standards.**

***Keywords*— Future Internet Architecture; M2M communication; Sensor Networks**

I. Introduction

Today the communication world inevitably aim to enable connecting different type of devices (e.g. smartphone, air-conditions, meters, cars, cameras) in the large-scale infrastructure. This allows the information exchange between heterogeneous content producers/consumers without human intervention through many access technologies available in the market today (i.e. Wifi, ZigBee, Bluetooth, 3G, LTE, FTTH and PLC). One of the main purposes is to improve efficiency, availability, maintainability and energy saving by using energy management systems. Standardization is essential to remove the technical barriers and ensure interoperable Machine-2-Machine (M2M) services. In this paper, we present two standards: the Institute of Electrical and Electronics Engineers (IEEE) 1888 standard for Ubiquitous Green Community Control Network Protocol [1], and the European Telecommunications Standards Institute (ETSI) M2M standard [2]. Both were developed for the same purpose, but by different organizations. Therefore, it is considered to be useful to enable the interworking of these two standards in a global Internet of Things (IoT).

The main contribution of this paper is to propose an interworking proxy of two major M2M standards; IEEE1888 and ETSI M2M; aiming to enable the creation of a global IoT paradigm. The proposed proxy is part of an Adaptable M2M Framework (AM2MF) that aims to make use of various transport protocols based on the application's requirements for a reliable end-to-end service.

The rest of the paper is organized as follows: Section II overviews both standards considered for the integration framework, Section III highline the main design aspects at both standards and provide a comparison of both. Section IV presents the proposed architecture for interworking proxy. Finally, the paper is concluded in Section V.

II. Related Work

This section briefly introduces background elements about IEEE1888 standard and ETSI M2M standard.

A. IEEE1888 Standrad

Released in March 2011, IEEE 1888 Standard [1] for Ubiquitous Green Community Control Network Protocol aims to provide suitable remote control and management solution for use and control facilities in building and social groups. Other objectives are to save energy, to reduce future scarcity of energy and to decrease rate of environment destruction though remotely monitor, management and maintenance.

The architecture of IEEE1888 standard is developed for TCP/IP based networks that compose of equipment such as gateways, storage, applications and registry. Generally, all components can communicate with each other by using protocol with basic commands such as FETCH, WRITE, TRAP protocol (data and query method) for fetching data from remote component and sending data to target component. Whereas, REGISTRATION and LOOKUP protocol (registration and lookup method) are used for registration all component and semantic of point that contain URI-based (Uniform Resource Identifier–based) globally unique identifier of dataflow (e.g. sensor readings, actuator commands). Transport data structure is defined by SOAP (Simple Object Access Protocol) and XML (eXtensible Markup Language) format and communicates by using HTTP (Hypertext Transfer Protocol). The standard is in use by a number of projects at the region of Asia for power data management [9] and Smart Grid [10].

B. ETSI M2M standard

The aim of ETSI M2M standard is to enable the interoperability of connected machines and allow data exchange without human interaction [2]. The ETSI M2M standardization work mainly focuses on the service middleware layer that facilitates the communication between connected devices and the network applications, and handles features such as device management, reachability, and generic communication mechanisms over communication networks [3]. The M2M system is dividing into two domains: the M2M Device domain (consists of Device and Gateway) and the Network and Application Domain (consist of network core). The standard defines a Service Capability Layer (SCL), which provides various functionality to M2M applications such as Application Enablement (xAE), Generic Communication (xGC), Interworking Proxy (xIP) and Remote Entity Management (xREM) [4]. The implemented functionality at the Gateway SCL (GSCL) can differ than those at the Network SCL (NSCL). All entities communicate over open standard interfaces (mIa, dIa, mId) [5]. ETSI standard define a RESTful architecture to manage resource structure in storage using multiply transport protocols such as HTTP or CoAP (Constrained Application Protocol), where RESTful-based services called “CRUD operation” (CREATE, RETRIEVE, UPDATE and DELETE) is paired with methods (POST, GET, PUT and DELETE) that are supported at client/server protocols. CoAP is used to support essential features required for constrained M2M devices, such as low overhead to maintain reliability of transmission [6]. The M2M SCL allows the connection of multiple applications addressing very heterogeneous use cases in different industries, such as energy, automotive, health, transportation etc.

Recently, ETSI M2M work is transferred to oneM2M consortium [11], which is aim to develop technical specifications addressing the needs for a common M2M service layer. A number of implementation already exists for ETSI M2M standards [3][12].

III. Comparison of IEEE1888 and ETSI M2M Standards

Both standards presented on previous section were defined to enable management of networked devices with limited human control. A brief comparison between IEEE1888 standard and ETSI M2M standard is shown in Table 1. Both standards have almost the same purpose and components, and are based on the IP communication protocol to enable IoT applications on a cloud computation platform. On the one hand, IEEE1888 has adapted the SOAP protocol; which is suitable for state-ful operations where conversational state management between client and server is required. On the other hand, ETSI M2M has adapted the stateless approach using REST that is argued to be more suitable for constrained bandwidth networks. A main challenge of interworking both systems is the mismatch data attributes and presentations as shown in Figure1 and Figure2, which requires a careful handling to enable data exchange between connected M2M applications and devices. Additionally, the uniform resource identifier (URI) addressing and specified resource tree at both standards need to be adapted by the interworking framework.

TABLE I. Comparison between IEEE1888 standard and ETSI M2M standard

Aspect	ETSI M2M	IEEE1888
Establishment date	Jan 2009	April 2011
Operations	RESTful method (CREATE, RETRIEVE, UPDATE, DELETE) Additionaly: NOTIFY, EXECUTE	FETCH, WRITE, TRAP, REGISTRATION, LOOKUP
Communication protocol	RESTful APIs with HTTP, COAP	SOAP, HTTP
Data presentation	XML, JSON, EXI, Fast Infoset	XML
Interfaces	Open IP based	Open IP based


```
{
  "contentInstance": {
    "content": {
         "$t":
"eyJkYXRhIjp7InRpbWVzdGFtcCI6MjA0NDUsImNvbnN1bWVkIjowLjg0Nn19",
         "contentType": "application/json"
    },
    "id": "contentInstance2478482",
    "creationTime": "2014-06-03T07:40:19.772Z",
    "lastModifiedTime": "2014-06-03T07:40:19.772Z",
    "contentTypes": {
      "contentType": [
        "application/json"
      ]
    },
    "contentSize": 45,
    "href":
"/m2m/applications/GameMeter/containers/1005/contentInstances/c
ontentInstance2478482"
  }
}
```


Fig. 1. Data representation of ETSI M2M platform


```
<?xml version="1.0" encoding="utf-8"?>
<soapenv:Envelope
xmlns:soapenv="http://schemas.xmlsoap.org/soap/envelope/">
 <soapenv:Body>
  <ns2:queryRQ xmlns:ns2="http://soap.fiap.org/">
   <transport xmlns="http://gutp.jp/fiap/2009/11/">
    <header>
     <query id="9eed9de4-1c48-4b08-a41d-dac067fc1c0d"
type="storage">
      <key
id="http://bems.ee.eng.chula.ac.th/ee/fl2/east/lectureroom_211/
z1/aircon1/control/max_temp"
      attrName="time" select="maximum" />
     </query>
    </header>
   </transport>?
  </ns2:queryRQ>
 </soapenv:Body>
</soapenv:Envelope>
```


Fig. 2. Data representation of IEEE1888 platform

IV. Adaptable M2M Framework

The connected world is extending exponentially including physical objects besides computers and smartphones. More than nine billion devices around the world are currently connected to the Internet, and the estimations show that by the end of 2020, there will be one trillion connected devices world-wide [7]. Interoperability between dissimilar M2M systems enables the creating of global IoT framework and overcoming the limitation of any. The main contribution of paper is the deployment of interworking proxy between IEEE1888 standard and ETSI M2M standard called "Proxy Gateway". Figure 3 shows the architecture of the Adaptable M2M Framework (AM2MF) that includes the interworking proxy of various platforms. The proposed proxy enables the exchange of data aggregated by both ETSI and IEEE1888 gateways as illustrated in Figure 4. The OpenMTC platform [8] is used as a prototype of the ETSI M2M standard. For IEEE1888 standard, the faculty of Engineering at Chulalongkorn University has implemented a Building Energy Management System (BEMS) by using IEEE1888 platform called "CUBEMS". The proposed framework aim to enable interworking of both implementations.

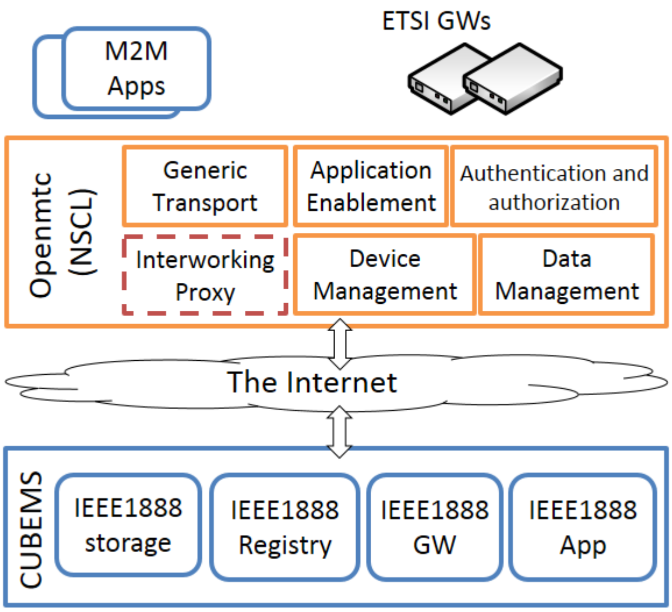

Fig. 3. Architecture of the Adaptable M2M Framework (AM2MF)

Data aggregation is one of the main functionalities of all M2M platforms. The scope of work presented in this paper is concentrating in this function to enable the exchange of data between IEEE1888 storage and ETSI M2M storage. The implementation is based on Node.js that uses JavaScript language [13]. As mentioned in the comparison section, the data representation and the URI addressing of resources stored at those two systems are the main challenges in the Proxy Gateway. Then in our work, we will use FETCH operation to fetch data from IEEE1888 storage and use WRITE operation to put data into IEEE1888 storage, using SOAP protocol. On the other hand, ETSI M2M have RETRIEVE operation to fetch data from ETSI M2M storage and CREATE operation to write data into ETSI M2M storage, and we also implement the translation of data representation and URI between IEEE1888 platform and ETSI M2M platform. Therefore, the process of Proxy Gateway is separated into two processes:

1. *Acquire data form IEEE1888*: the Proxy Gateway apply FETCH operation to get data from IEEE1888 storage and then translate the data representation and URI so that they are correspond to ETSI M2M platform, after that Proxy Gateway apply CREATE opration to put data into ETSI M2M storage. If the operation is successful, storage will send 200 OK back as shown in Figure 4. This process could take place in response to a request from an M2M application registered to the ETSI M2M platform.

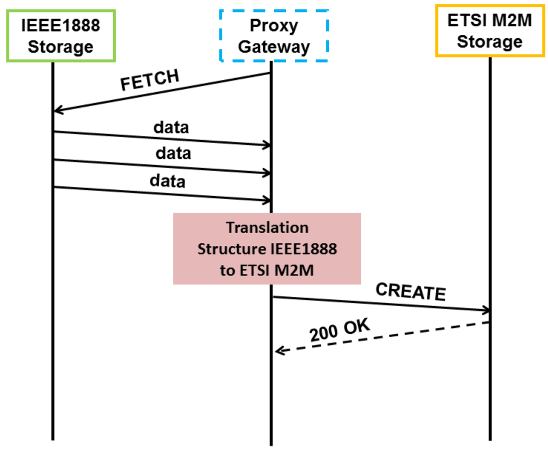

Fig. 4. Time digram of Proxy gateway in process 1

2. *Acquire data form ETSI M2M:* the Proxy Gatway apply RETRIEVE operation to fetch data from ETSI M2M storage and then translate the data representation and URI so that they are correspond to IEEE1888 platform, after that Proxy Gateway apply WRITE opration to put data into IEEE1888 storage. If the operation is successful, storage will send 200 OK back as shown in Figure 5. This process could take place in response to a request from an IEEE1888 applcation, retriving data measurement form sensors connected to ETSI M2M platform.

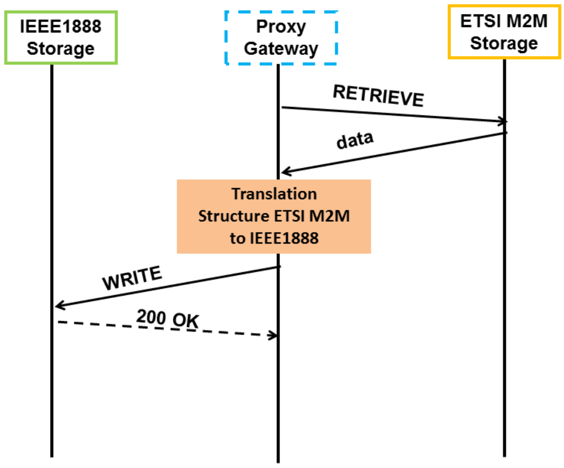

Fig. 5. Time digram of Proxy gateway in process 2

V. CONCLUSION AND FUTURE WORK

Both IEEE1888 and ETSI M2M standard aim to provide middleware platform for connecting heterogeneous devices and create smart environments. In this paper, we propose an interworking proxy to enable interoperating of both systems in a global Internet of Things framework. This shall improve the existing communication technologies in building smart and automated systems. The work presented in this paper is focusing on exchanging aggregated data between interworking systems. In future work, we will enhance the implement of the proxy gateway to include further interworking processes.

REFERENCES

[1] IEEE1888-2011: Standard for Ubiquitous Green Community Control Network,2011.

[2] ETSI Machine-2-Machine Communications [online] http://www.etsi.org/technologies-clusters/technologies/m2m

[3] M. Corici, H. Coskun, A. Elmangoush, A. Kurniawan, T. Mao, T. Magedanz, and S. Wahle, "OpenMTC : Prototyping Machine Type Communication in Carrier Grade Operator Networks," in 4th International IEEE Workshop on Open NGN and IMS Testbeds (ONIT 2012) @ GLOBECOM 2012, 2012, pp. 1735–1740.

[4] ETSI TS 102.690, "Machine-to-Machine communications (M2M); Functional architecture," December 2011.

[5] ETSI TS 102.921V2.1.1, "Machine- to- Machine communications (M2M); mIa, dIa and mId interfaces," December 2013

[6] C. Bormann, U. Bremen, and Z. S. Sensinode, "CoAP: An Application Protocol for Billions of Tiny Internet Nodes," IEEE Internet Computer, vol. 16, no. 2, pp. 62–67, 2012.

[7] J. Manyika, M. Chui, J. Bughin, R. Dobbs, P. Bisson, and A. Marrs, "Disruptive technologies: Advances that will transform life , business , and the global economy," McKinsey Global Institute, May 2013.

[8] "OpenMTC platform." [Online]. Available: http://www.open-mtc.org/index.html.

[9] H. Ochiai, "Power data management on the Internet space: Green ICT projects in Japan," in *2012 IEEE Colombian Communications Conference (COLCOM)*, 2012, pp. 1–2.

[10] C. Ninagawa, H. Yoshida, S. Kondo, and H. Otake, "Data transmission of IEEE1888 communication for wide-area real-time smart grid applications," *2013 Int. Renew. Sustain. Energy Conf.*, pp. 509–514, Mar. 2013.

[11] OneM2M. [Online]. Available: http://onem2m.org/.

[12] D. Seed, M. Starsinic, and P. Russell, "Enabling Smart Grid with ETSI M2M standards," in *2012 IEEE Wireless Communications and Networking Conference Workshops (WCNCW)*, 2012, pp. 148–153.

[13] S. Tilkov and S. Vinoski. "Node.js: Using JavaScript to Build High-Performance Network Programs." IEEE Internet Computing, 14:80–83,November 2010.