Wired Smart Home: energy metering, security, and emergency issues

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Abstract—This paper discusses the specific area of M2M applications – Wired Smart Home. It contains the overview of requirements to Wired Smart Home in the scope of energy metering, security, and emergency communications. We consider ETSI activities on M2M standardization, Open Metering System specification, and Emergency Communications. In the field of software issues, we offer a newer web tool – Web In tents as a modern enhancement of M2M middleware. Also, the experience in Wired Smart Home implementation is given.

Keywords-m2m M2M; smart home; ETSI; Open Metering; web services.

I. INTRODUCTION

The M2M (Machine-to-Machine) communications industry has attracted increasing attention during the past several years. Analysys Mason forecasts [1] that the number of M2M device worldwide connections will grow from 62 million in 2010 to 2.1 billion devices in 2020, at a 36% year-on-year growth rate. According to the prognosis [1], over 90 percent of forecast connections will utilize wireless.

The M2M system consists of three main domains: M2M Device, Network, and Application Domain (Figure 2) and includes the following key elements:

M2M Device. A device capable of replying to requests for data contained within those devices or capable of transmitting data contained within those devices autonomously.

M2M Area Network. A network providing connectivity between M2M Devices and M2M Gateways. Examples of m2m Area Networks include: Personal Area Network technologies such as IEEE 802.15, ZigBee, Bluetooth; and local networks such as PLC, M-BUS, and Wireless M-BUS.

M2M Gateway. The use of M2M capabilities to ensure that M2M Devices interwork and interconnect to the communications networks.

M2M Communications Networks. These are the communications networks between m2m Gateways and m2m Applications (servers). They can be further broken down into Access, Transport and Core Networks. Examples include: xDSL, PLC, satellite, LTE, GERAN, UTRAN, W-LAN, and WiMAX.

M2M Application (Server). This is the middleware layer where data goes through the various application services and is used by the specific business processing engines.

The Cluster of European Research projects on the Internet of Things – CERP-IoT – comprises around 30 major research initiatives, platforms and networks working in the field of identification technologies such as Radio Frequency Identification and in what could become tomorrow an Internet-connected and inter-connected world of objects [2].

Figure 1. Commercial and consumer M2M device connections by industry sector, worldwide, 2020 (Source: Analysys Mason, 2011 [1]).
Building and home automation technologies have usually been deployed only in high-level offices and luxury apartments. As the technologies mature and cheap wireless communication becomes abundant, the range of applications is becoming much broader. For example, smart metering is becoming more popular for measuring energy consumption and transmitting this information to the energy provider electronically. In conjunction with modern home entertainment systems, which are based on general-purpose computing platforms, they could easily be combined with other sensors and actors within a building, thus forming a fully interconnected, smart environment. Sensors for temperature and humidity provide the necessary data to automatically adjust the comfort level and to optimize the use of energy for heating or cooling. Additional value is provided by monitoring and reacting to human activity, such that exceptional situations could be detected, and people can be assisted in everyday activities, thereby supporting the elderly in an aging society [2].

According to the European Internet-of-Things strategy [2], six priorities are named:

- Smart Metering,
- eHealth,
- Connected Consumer,
- City Automation,
- Automotive and Transport,
- Smart Grid.

Our goal is to analyze the state-of-the-art in the field of M2M communications for use in new multi-tenant building. We are considering the primary needs: energy metering, security, and emergency. Therefore, we offer wired version (not wireless) as it could be more secure for communication purposes in smart home. The rest of the paper is organized as follows. Section II contains an analysis of ETSI activities in M2M standardization. In Section III, we consider Open Metering System specification, which is based on M-bus protocol and suits well for Wired Smart Home. Section IV is devoted to Emergency Communications requirements. In Section V, we consider software issues and offer a newer web tool – Web Intents for enhancement of M2M middleware. Our experience in Wired Smart Home implementation is given in Section VI.

II. SMART METERING STANDARDIZATION MANDATE

Considering M2M communications as a central point of Future Internet, European commission creates standardization mandate M/441 [4]. The mandate M/441, issued on 12th March 2009 to CEN, CENELEC and ETSI, is a major development in shaping the future European standards for smart metering and Advanced Metering Infrastructures. The general objective of the mandate is to ensure European standards that will enable interoperability of utility meters (water, gas, electricity, heat), which can then improve the means by which customers’ awareness of actual consumption can be raised in order to allow timely adaptation to their demands. In this report cooling has been considered as well as heating. There are about 110 applicable technical standards available today which cover parts of a Smart Metering application. No standard covers the full application range.

In order to achieve full interoperability, as requested by Mandate M/441 [5], and with the OSI model as a reference, open interface standards must be defined for all layers of the communications protocol stack that reside on the meter, both upstream and downstream. Communications standardization does not mean to define meters, devices or software systems itself, but to make interfaces, messages and workflows interoperable (Figure 4). The mandate is centered on the interoperability of smart metering and communications architecture to support smart meters.
Electricity meter communications - E Interface - is between the “meter communications” function of the meter and the M2M gateway, providing connections to the LAN or WAN. This interface defines the access of external devices to internal data on the meter and is a local interface, typical a simple serial link without communication address management and authorization procedures. The gateway function may be implemented in a separate device, or it may be integrated in the meter together with the metrological protected part and the communications part.

Non-electricity meter communications M Interface defines the access of external devices to internal data on the meter. The functional specification of this interface is similar to the E interface.

Display and Home automation H interface connects an M2M gateway or data concentrator with a home automation or display functionality. The interface can be implemented in parallel to a G interface at the same system level. Display and home automation provides the following customer functionalities identified in the M/441 mandate: 1) provide accurate information on consumption in order to increase customer awareness, 2) provide additional functionalities enabling the customer to interact with the user’s environment

Interface G. Typical interface platforms for G interfaces are PSTN networks, public mobile networks (GPRS and UMTS), DSL or broadband TV communication lines. Interactors of M2M remote gateways are electricity meters, non-electricity meters (generally battery powered) or home automation and customer information systems.

ETSI’s standardization process started three years ago, and now there is an agreement on high-level system architecture as well as the requisite service capabilities [6]. What relates to interfaces E, M, and H, the scope of Mandate M/441 includes the interoperability of smart devices only; the search for the unique interface is not considered.

III. OPEN METERING SYSTEMS

Meanwhile, leading meter manufacturers and technology providers in Europe have joined the effort to create the new open standard for metering. The new Open Metering System (OMS) specification has been developed to meet a demand for interoperable solutions for meter reading, and a unified approach for the different media (electricity, gas, heat and water). In 2009, the three-part specification was released [7].

The specification defines a Multi Utility Communication (MUC) device, which acts like an intelligent data concentrator between the automated meter management (AMM) back office system (for billing or other purposes), and the metering and actuator devices. The MUC can be integrated into a meter (typically an electricity meter) or it can be a standalone unit (Figure 5). The primary communication is between meters and the MUC. A lot of effort has been put into unifying this part to support all media, as well as actuators and displays. The secondary communication is defined as an extension of the primary communication using simple repeaters or a multi-hop routing protocol. The tertiary communication is between the MUC and the back office AMM system.

The new specification is based on established norms and standards where it has been possible. The tertiary communication is solely based on TCP/IP, and the primary communication is based on the M-Bus standard (wired or wireless), EN 13757 (see also [8]). The specified data format is OBIS (Object Identification System) coded values [9]. The wired/Wireless M-Bus link to the meter supports both OBIS (not shown), as well as the M-Bus application data format (EN 13757-3). The MUC will translate the M-Bus application data format into OBIS before it is sent to the AMM on the operation data channel. A service data channel from the MUC to the AMM supports M-Bus formatted data as well. Figure 5 shows a simplified Open Metering System overview.

IV. EMERGENCY COMMUNICATIONS SERVICE: SERVICE 911

Emergency Telecommunications and Public Safety are areas requiring considerable standardization activity. Existing infrastructures and services have been shown to be inadequate when faced with widespread disruption due to natural disasters and other emergency situations. ETSI is heavily committed in
this area and is co-operating with other organizations around the globe [10]. ETSI pays now a great attention to the security aspects of emergency communications.

Today’s 911 system in the U.S. is built on an infrastructure of analog technology that does not support many of the features that most Americans expect are part of an emergency response. The general consensus is that new digital technologies, collectively referred to as Next Generation 911 or NG9-1-1, should incorporate Internet Protocol (IP) standards [11].

Only a digitized system with seamless IP-based connectivity can fully support the needs of groups that are currently poorly served by 911 systems, including those with disabilities, residents and travelers in rural areas, and workers and residents in high-rise buildings. Text messaging is ideal for people with certain types of disabilities and is a more viable means of communication than voice in times of high demand and widespread service outages, situations that often follow a disaster. Therefore, functional components that have been tested include

1) Ability to send and receive voice, video, text, and data,
2) Improvement to 911 access for deaf/hearing-impaired.

To fulfill Service 911 requirements, we need some device similar to the O2 Joggler (Figure 6). It is a computing appliance which was sold by company O2 in the United Kingdom. Using O2 Joggler, one can listen to the favorite radio station (the internet radio includes around 100 stations); send text messages to and from one’s O2 Joggler; watch videos, listen to music, and look at photos; keep up-to-date with news and sports headlines; get weather reports and traffic updates, and much more.

Programming is proprietary: The open protocol standards (e.g., BACnet or LonWorks) do not define a standard programming language or rules to program an application controller. The actual interpretation of the code written by the user is proprietary to each vendor.

Programs are not visible to end user: In the most cases, the manufacturer and/or the system integrator will not allow the facility manager to view the programs.

V. AUTOMATED BUILDING SOFTWARE ISSUE

Open standards, open protocols, open architecture and open web are some of the key concepts in the Building Automation System (BAS) industry, but there are some misunderstandings [12].

Interoperable, not interchangeable: Many people believe that open protocol implies that if a controller fails from one vendor, they can replace it with another vendor. It is not as simple as plug and play. There are overhead vendor dependent software tools that must be used to configure and program the controller before connecting to the network.

All software interfaces 1 to 5 must be open, as requested by Mandate M/441, but up to now ETSI efforts are restricted by Open M2M API only (i.e., Interface 1). The Open API for M2M applications developed in EURESCOM study P1957 [14] have been submitted as a contribution to ETSI TC M2M [15] for standardization.

 Actually, in this Open API we can see the big influence of Parlay specification. Parlay Group also specifies the Parlay Web services API, also known as Parlay X API, which is much simpler than Parlay/OSA API, to enable IT developers to use it without network expertise. Despite a lot of efforts, Parlay API’s actually increase the time for development. It is, by our opinion, the main reason for the Parlay’s failure.

In our opinion, Web Intents solves this problem [16]. Web Intents is a framework for client-side service discovery and
inter-application communication. Services register their intention to be able to handle an action on the user's behalf. Applications request to start an action of a certain verb (for example share, edit, view, pick etc.) and the system will find the appropriate services for the user to use based on the user's preference. It is the basic. Intents play the very important role in Android Architecture.

VI. ON WIRED SMART HOME IMPLEMENTATION

During 2008-2009, in Ventspils University College (Latvia) the research project oriented to market „Home gateway prototype for multi-tenant house” [17] was carried on. Figure 8 shows the network for demonstration (see Figure 3 also).

The Open Source PBX Asterisk plays a role of telephone exchange for connections between sensors, analog and soft-phones, and GSM modem. The main idea is to use the Asterisk as a platform for the development of telecommunication services. With its open source software and API, the Asterisk can bring the development of telecommunication services down to a simpler process of Web programming thus considerably lowering “the entrance barrier” for those involving in the programming of new services. A new component (proxy) was developed and integrated into the Asterisk platform [18]. The main functionality of the proxy is to translate telecommunication calls into HTTP requests to external web services. Telecommunication services are located separately from the PBX, while the information they receive from Asterisk is presented as a HTTP-request. Upon receiving necessary parameters, such as (calling/called number) a web service produces and forwards its instructions to the proxy. The latter receives and translates them into Asterisk instructions. The development of such services under the architecture described above is similar to a conventional CGI-script, for which there is a plenty of programming tools (Figure 9). As a result, a programmer doesn’t need to be familiar with the Asterisk API.

The software design was following the concept of Open Services Gateway initiative (OSGI). OSGI framework is a module system and service platform for the Java programming language that implements a complete and dynamic component model. Several new telecommunication services were developed in Java, namely: Voice SMS, PodCast, Listener, Traffic Jam, etc. [18]. These services are considered as building blocks for smart applications.

VII. ON FUTURE WORK

We are working now on pilot project for multi-tenant house oriented particularly to individual heat consumption measuring. The project relates to the international program “Partnership for modernization between Russian Federation and European Commission”. Our goals are:

- In hardware area - to enhance m-bus protocol use (in the framework of OMS) and bring it in production of home automation systems,
- In software area – to develop new tools for Open M2M APIs (particularly, Web intents based) and messaging platform (e.g., [19])
- In applications area – to implement the results (as Java products) for energy savings in multi-tenant houses.

VIII. CONCLUSION

This paper describes one area of M2M applications – Wired Smart Home. We consider ETSI activities on M2M standardization, Open Metering System specification, and Emergency Communications. In the field of automated software building, we suggest a newer web tool – Web Intents
as a modern enhancement of M2M middleware. Also this paper provides a brief description for our projects in Wired Smart Home. The key point for our project is integrated PBX that plays a role of telecom-enabled middleware.

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