A Scenario of Machine-to-Machine (M2M) Health Care Service

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ABSTRACT

Machine to Machine provides a framework to develop services in different fields such as smart metering, car telematics (automotive), security, remote monitoring, health care and so on. The purpose of this paper is to show an architecture of the M2M health care service over IMS network. The functions of IMS are helpful to set up the communication between sensor device and doctor. The sensors get some information of patients’ heart rate, temperature and pulse rate. With the IMS technology all the information sends to the M2M application server. And then doctors using some software or web browser get the information and check the patients’ health whenever by smart phones, pads and computers. We will analyze M2M communication with IMS system and show some results of an experiment.

Keywords: M2M, IMS, Health care

1. Introduction

With the medical science, we can use Machine-to-Machine (M2M) technology to help the doctors by collecting patients’ information (such as temperature, HRR, pulse rates and so on). The sensors kept in the patients’ body automatically send the information to the application server via M2M network. By using some software or web browser, the doctors can get the information anytime they want. Health care could be used as a life-saver by monitoring the patient’s condition, where the real-time is very important. When the condition of patient becomes acuter, the messages from sensor must arrive to the hospital immediately. Follow the warning messages, the doctor does some emergency measures for patient. So the Quality of Service (QoS) of M2M becomes important. IP Multimedia Subsystem (IMS) network can be offered across different access networks (such as IP LAN, DSL/Cable, WiFi/802.11x, Cellular, and Local Loop access networks) [1]. More than that, it can provide an excellent QoS. We analyze M2M technology based on the IMS and try to improve the communication of health care.

2. Architecture

High-Level M2M System Architecture (HLSA) includes network and application domain and device and gateway domain. HLSA is based on existing standards regarding the network domain extended with M2M specificities [2].

Network and applications domain are based on existing standards 3GPP, TISPAN, IETF and so on. It includes M2M applications, M2M service capabilities, core network and access network as shown in Figure 1. The M2M applications run the service logic and use M2M service capabilities accessible via an open interface. M2M service capabilities provide M2M functions to be shared by different applications and expose functions through a set of open interfaces. M2M service capabilities interface at the service level with peer M2M service capabilities residing in the M2M devices or gateways. Core Network (CN) and access network act as a transport network in the M2M. M2M core is comprised of M2M service capabilities and core network; Usually core
networks contain 3GPP core network, ETSI core network, TISPAN core network etc. Different core networks offer different features sets and provide IP connectivity, service and network control functions, interconnection with other networks and roaming. Access network allows the M2M device and gateway domain to communicate with the core network [3].

M2M device and gateway domain is based on existing standards and technologies, for example, DLMS, CEN, CENELEC, PLT, Zigbee, M-BUS, KNX, etc. It is made of M2M gateways, M2M area network and M2M devices. M2M gateways act as proxies between network domain and M2M devices, they run M2M applications using M2M service capabilities. M2M area network provides connectivity between M2M devices and M2M gateways; M2M devices are devices that run M2M applications using M2M service capabilities.

The architecture of IMS defines one common protocol standard to be used. Session Initiation Protocol (SIP) as a protocol to establish and manage multimedia sessions over IP networks, it is chosen as the session control protocol for the IMS. Proxy-/ Interrogating-/Serving-Call Session Control Functions (P-/I-/S-CSCF) are the primary functions that bring session control back to the core where it can be managed and scaled [4].

3. A Scenario of M2M Health Care Service

A sensor is a device which receives and responds to a signal. A sensor's sensitivity indicates how much the sensor's output changes when the measured quantity changes [5]. Patients can get some benefit from continuous long-term monitoring as a part of a diagnostic procedure, can achieve optimal maintenance of a chronic condition, or can be supervised during recovery from an acute event or surgical procedure. Sensor network (small or large deployed for any purpose and by anyone) is represented by their gateways and treated as leaf nodes hanging off a mobile or fixed network that use these networks to interact with remote and local users. Each gateway exposes the capabilities of its sensor, actuators, and the sensor network as a whole [6]. Via sensor network, it is possible to connect the sensor to internet. With M2M technology, doctors can check the patients' condition much easier unmanned, such as temperature, pulse, etc.

In the M2M, doctors use smart phones, pads or computers to get patients' information and the messages flow is described in Figure 2. Doctor runs web browser or application software of watcher(e.g., smart phone, pad and computer) to check the patient's condition. The watcher sends a message to M2M Application Server (AS) in the form of a PUBLISH message. Here is a database named M2M management with major function to

Figure 1. The Architecture of M2M

Figure 2. The Messages Flow in M2M
authentication and authorization. Before the message is sent to the M2M system, the M2M AS should make sure the identity. So the M2M AS gets the message and sends it to M2M management with Location Information Request (LIR) and Location Information Answer (LIA). If the procedure is successful, the M2M AS accepts the command from the watcher, and sends a SUBSCRIBE message to M2M system.

In the IMS, Presence service (PS) offers the ability to inform the communication network on currently preferable methods of communication. It is also a real-time service that gives some information about the availability of your colleagues and their preferable ways to communicate. Resource List Server (RLS) functional entity that stores grouped lists of watched presentities and enables a watcher application to subscribe to the presence of multiple presentities using a single transaction. It stores resource information (e.g. presence, presentity, location and status of device) of users and entities. RLS also be extended to interact with the HSS for Authentication, Authorization, Accounting (AAA) and Quality of Service (QoS).

The sensor collects patient's information and via the gateway sends a SIP REGISTER request which includes the registration Uniform Resource Identifier (URI), public user identity, private user identity and contact address to the P-CSCF, the flow is shown in Figure 3. In order to subscribe the information of the sensor, watcher also sends REGISTER request to P-CSCF. The P-CSCF forwards the SIP REGISTER request message to I-CSCF in the home network. The I-CSCF don't keep a registration state, it is used for discover which S-CSCF would be allocated to the sensor, so the I-CSCF sends a Diameter User-Authentication-Request (UAR) message to the HSS. The HSS authorizes the sensor and answers with a Diameter User-Authentication-Answer (UAA) message to the I-CSCF. After that, the I-CSCF forwards the REGISTER request message to the S-CSCF with the HSS.

The S-CSCF gets the request message and creates a Diameter Multimedia-Auth-Request (MAR) message to the HSS, the HSS stores the S-CSCF URI in the user data and answers with a Diameter Multimedia-Auth-Answer (MAA) message to the S-CSCF. If the S-CSCF is not the one allocated to the sensor, the S-CSCF creates a SIP 401 Unauthorized response message to I-CSCF, P-CSCF and sensor, step by step. It is possible to happen at the first registration. The sensor receives the 401 Unauthorized response message, it will send the REGISTER request message to the P-CSCF again until registration is successful. The S-CSCF will send a Diameter Server Assignment Request (SAR) message to the HSS, later gets a Diameter Server Assignment Answer (SAA) message from the HSS. And the S-CSCF creates a 200 OK response message to I-CSCF and P-CSCF, at last to the sensor.

![Figure 2. The Procedure of Authenticating Watcher](image-url)
After registration, it can send the data for sensor and watcher to subscribe. The sensor and watcher subscribe to own registration state, also to P-CSCF. The sensor and watcher send a SUBSCRIBE request message to the P-CSCF, the P-CSCF forwards the SUBSCRIBE message to the S-CSCF directly [7]. To communicate with the M2M application server, the S-CSCF sends the SUBSCRIBE message to the presence server, and upload the information (such as the presence, location and the value of the sensor gets) to the presence server. The presence server collects and sorts the information, then creates NOTIFY messages and sends them to the sensor. And then, watcher can see the information of sensor using NOTIFY message.

M2M AS has received the command from the watcher and after verifying forwards the PUBLISH message to the presence server. Presence server can be considered as the central repository for the storing of the subscriber's presence information. And M2M AS sends a SUBSCRIBE request message to the presence server initiative and upload its presence.

In M2M communication, both watcher and sensor can send order to the M2M system. When the watcher wants to check the patient's condition, watcher commands to M2M AS with a PUBLISH message and gets the data from the sensor. And when the sensor has some problems or gets some abnormal value, the sensor alerts the watcher. The sensor creates a PUBLISH message and sends the PUBLISH and SUBSCRIBE message to the presence server and alert to the watcher. Following the case, they upload the information to the presence server and exchange the messages each other, and finally complete communication.

4. M2M Communication Simulation

Through the combination of the above theoretical knowledge about M2M, we have an experiment on our research with the IMS, the M2M demo elements overview and interconnection as shown in Figure 4.

In the first step, the patient takes the sensor stay at home, the sensor gets the value of the temperature, HRR and pulse rates automatically. When the value is out of the normal range, the sensor sends to the base station. The base station connects to a computer with USB, the computer as a M2M gateway connects to the Internet. In this experiment, the data of sensor and gateway replaced with the “Send Sensor Data” button shown
in Figure 6.

For the second step, we install the IMS core network. We use the Ubuntu 12.04 to install the openIMS which is constructed from P-CSCF, I-CSCF, S-CSCG and HSS.

In this paper, we make two programs using the Monster client based on Java which are shown in Figure 5. And Figure 6 shows the picture of presence service. The principal components of our paper are the sensor, base station and M2M gateway. The role of the sensor is to show its states to the watcher. At the bottom of the sensor, there is a button written as "Send Sensor Data". Push the button, the sensor sends the value to the watcher and we can get graphs at the watcher. In the Figure 7, sensor 1 shows the value of temperature and sensor 2 shows the value of pulse rates. The horizontal axis represents the time, and vertical axis represents the value. Following the sensor's health, we can improve the program.

The purpose is taking an experiment to make sure that this way can finish the whole procedure in real-time. The value shown in the picture is not get from the sensor, this test is a part of the M2M communication from M2M gateway to the watcher. Fortunately, after repeated experiments we did and set up the communication using the program. All the messages are set by SIP Diameter, and the transmission is finished in real-time.

![Figure 4. M2M Demo elements overview and interconnection](image)

![Figure 5. Programming of Sensor(left) and Watcher(right)](image)
5. Conclusion

Due the M2M system generally is unmanned system, so M2M technology cannot guarantee the QoS. In order to guarantee the QoS of M2M, we do some research effort on IMS which provides access to the network from different devices. Unmanned operating machines could be developed by Combining M2M and IMS technologies. M2M communication refers to real time data exchange via the transmission of information of network. M2M server with IMS communications technology could play especial role in the future communications system and the economic interest could grow up. It is just the beginning stage in the development of M2M communications, and a number of issues are still remained open for further investigation. The future works in our research are divided each component (M2M Gateway, Base Station and Sensor), in different machines to develop services capabilities in each of them.
References


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