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(54) Title: DEVICE AND METHOD OF REGISTERING M2M DEVICES AND FOR ACQUIRING DATA THEREOF

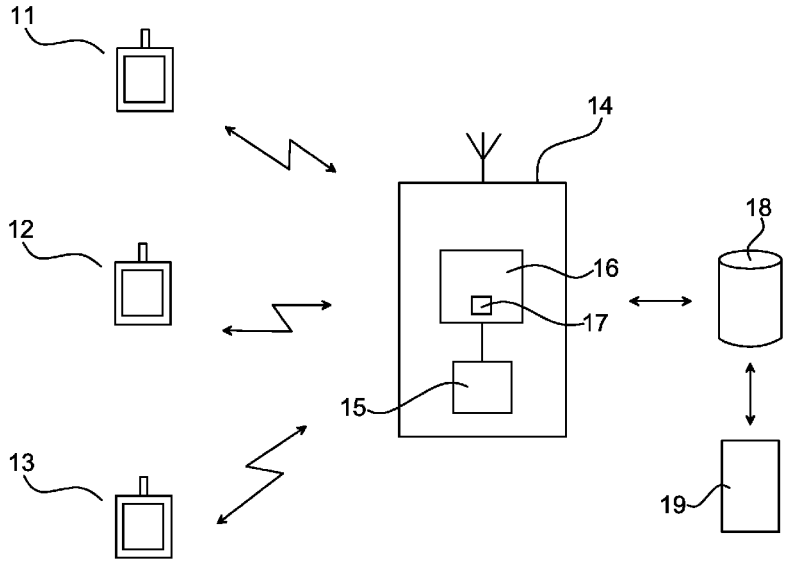


Fig. 1

(57) Abstract: The present invention relates to methods and devices (14) for registering M2M sensors (11, 12, 13) with a network node (18) and for acquiring data from the M2M sensors. The method of acquiring data from an M2M sensor comprises the steps of receiving a request from a network node to read data from an M2M sensor designated in the request and forwarding the request to the designated M2M sensor. Thereafter, in response to the forwarded request, requested data are read from the designated M2M sensor and sent to the network node according to a specified format included in the received request.

DEVICE AND METHOD OF REGISTERING M2M DEVICES AND FOR ACQUIRING DATA THEREOF

TECHNICAL FIELD

The invention relates to methods and devices for registering an M2M sensor at a network node and for acquiring data from an M2M sensor.

BACKGROUND

In machine-to-machine (M2M) applications, sensors are arranged at selected locations for registering an event or a physical property and reporting the event or registered property to a central unit, such as a server. The sensors are thus used to monitor and, in case the sensor can receive instructions and act on the received instructions, control a device or process with which the M2M sensor is associated. M2M sensors are generally physically small devices with wireless and/or wired communication capability having limited processing power and memory capacity running specialized protocols such as Constrained Application Protocol (COAP). In case the M2M sensor is used to control a device or process, the sensor is typically capable of communicating with an actuator associated with the device or process. Applications for M2M sensors include cars, machines, aerospace, medicine, manufacturing and robotics, etc. but also less industrial applications such as smart meters, home area networks, wireless tolling, logistics and fleet monitoring, wireless sensor networks and eHealth. As an example, an industrial robot may be equipped with one or more M2M sensors, and a physical property such as speed of operation of the robot is reported to a central monitoring server where operational decisions can be taken on the basis of the information reported by the M2M sensor. As previously mentioned, it can also be envisaged that the central server sends instructions to the M2M sensor, which communicates with an actuator for controlling the robot. In a further example, an owner of a holiday home may want to have indoor temperature reported to his/her mobile phone in order to subsequently turn on the central heater of the holiday home via SMS to have a warmed-up home at arrival.

Key requirements for M2M technology are for example:

- interoperability: devices use unlicensed/licensed bands for short/long range communications,

- real-time data acquisition and analysis: instrumentation of analog sensors, event ordering, time-stamping, synchronization and processing,

- reliability and robustness: sensors and other devices must operate reliably in harsh environments without manual intervention.

M2M deployments require millions of edge controllers to interface the M2M sensors to their respective central unit in e.g. factories, transportation hubs, hospitals and facilities to acquire, monitor and analyze data, automatically control functions, and transmit data and status to the central unit. The ubiquity of broadband and wireless networks enable a new generation of Internet edge controllers that allow operators and service providers to deliver, control, manage and update services on demand.

A number of wireless and industry specific technologies are routinely integrated in M2M applications. Examples include sensors and actuators, analog instrumentation, low power processing, energy harvesting and power management, low range wireless communication technologies (i.e. Bluetooth, Zigbee, WiFi), cellular radio, etc. In addition an ever expanding software protocol and application stack is used to facilitate custom software development.

Edge controllers used frequently in the design of custom M2M solutions are typically supplied with built-in embedded software that exposes a dash board for configuration and monitoring of the M2M sensors. Some controllers include a central processing unit (CPU) that is freely programmable, typically programmed as an embedded system without an operating system (OS). Generally, no commercial solution exists that will match the functionality and/or security needs of a specific use-case as is. This leads to extensive hardware and software development to ensure that integration between sensors/actuators, edge controllers, central servers and M2M applications utilizing M2M sensor data. The software integration is currently carried out over custom application programming interface (API) tailored to the needs of the specific combination of software and hardware. This is problematic since the high degree of customization prevents the mass production of such solutions and sustains the need for costly software development.

SUMMARY

An object of the present invention is to solve, or at least mitigate, the above described customization problem and provide a device being capable of communicating with M2M sensors.

This object is attained in a first aspect of the present invention by a method of registering an M2M sensor with a network node. The method comprises the steps of receiving a registration request from the M2M sensor via an interface, and identifying the M2M sensor and data communication format used by the sensor. Thereafter, the identity of the M2M sensor and information specifying the identified data communication format are sent to the network node for registering the M2M sensor.

Advantageously, the sensor initially registers, via an edge controller, with the network node which subsequently is to request data from the sensor, and/or send data to the sensor for actuation on the basis of the sent data. With this procedure, the specific format used by the M2M sensor is registered at the network node. Typically, even though a large variety of sensors exist on the market, the number of different data types used by the sensors is limited. Further, the sensors communicate according to a certain format with respect to parameters such as data size, data transmission/reception timing (e.g. at which rate and with which density is data communicated). Once this has been set up with the network node, data exchange between any type of M2M sensor having been registered and the network node can commence in a straightforward, specified manner.

The object is attained in a second aspect of the invention by a method of acquiring data from an M2M sensor. The method comprises the steps of receiving a request from a network node to read data from an M2M sensor designated in the request and forwarding the request to the designated M2M sensor. Thereafter, in response to the forwarded request, requested data are read from the designated M2M sensor and sent to the network node according to a specified format included in the received request.

Advantageously, once the sensor has registered with the network node, via the edge controller, the network node may request data from the M2M sensor by sending a request to the edge controller. The edge controller knows from the request which data format to use when communicating with the sensor and forwards the request to the

sensor. At reception of the request, the M2M sensor sends the requested data to edge controller in accordance with the specified data format initially registered at the network node. The data received at the edge controller is subsequently transmitted to the requesting network node. Once the requested data has been communicated to the network node, actuation of the entity with which the M2M sensor is associated can commence according to the specified format.

According to an embodiment of the present invention, the edge controller receives instructions for actuating an entity associated with the M2M sensor from the network node in accordance with the data sent from the M2M sensor via the edge controller. The edge controller sends the actuating instructions to the sensor in accordance with the specified format. In an example, the network node initially requested data from the M2M sensor being a thermometer measuring indoor temperature and being associated with an entity to be actuated in the form of a heater. When receiving the data, the network node - being e.g. server running an appropriate application - interprets the indoor temperature to be, say, 12 °C, whereby a decision is taken to increase the temperature. Accordingly, actuating data of the specified format is sent to the M2M sensor via the edge controller, instructing the heater to appropriately increase heat emission such that a target indoor temperature is reached.

The object is attained in a third aspect of the invention by a method of acquiring data from an M2M sensor. The method comprises the steps of receiving a request from a network node to read data from an M2M sensor designated in the request and forwarding the request to the designated M2M sensor along with an instruction to transmit the requested data to the network node according to a specified format included in the received request.

Advantageously, once the sensor has registered with the network node, via the edge controller, the network node may request data from the M2M sensor by sending a request to the edge controller. The edge controller knows from the request which data format to use when communicating with the sensor and forwards the request to the sensor. However, in this third aspect, the edge controller further submits an instruction to transmit the requested data to the network node according to a specified format included in the received request. The requested data is subsequently transmitted from

the M2M sensor directly to the network node, thereby bypassing the edge controller. Again, once the requested data has been communicated to the network node, actuation of the entity with which the M2M sensor is associated can commence according to the specified format.

The edge controller may be a stand-alone unit arranged remotely and separate from the network node being for instance a server. However, the edge controller may alternatively be integrated with the network node.

The present invention further provides devices for performing the methods according to the above mentioned three aspects.

It is noted that the invention relates to all possible combinations of features recited in the claims. Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following description. Those skilled in the art realize that different features of the present invention can be combined to create embodiments other than those described in the following.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 illustrates a plurality of M2M sensors communicating with a network node via an edge controller according to an embodiment of the present invention;

Figure 2 shows a flow chart illustrating a method of registering an M2M sensor with a network node via an edge controller according to an embodiment of the present invention;

Figure 3a shows a flow chart illustrating a method of acquiring data of an M2M sensor via an edge controller according to an embodiment of the present invention;

Figure 3b shows a flow chart illustrating a method of acquiring data of an M2M sensor via an edge controller according to a further embodiment of the present invention, which embodiment is an extension of that illustrated in Figure 3a; and

Figure 4 shows a flow chart illustrating a method of acquiring data of an M2M sensor via an edge controller according to an embodiment of the present invention, which embodiment is an alternative to that shown in Figure 3a.

DETAILED DESCRIPTION

The invention will now be described more fully herein after with reference to the accompanying drawings, in which certain embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided by way of example so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

Figure 1 illustrates a plurality of M2M sensors 11, 12, 13 communicating with a network node 18 via an edge controller 14 according to an embodiment of the present invention. As can be seen in Figure 1, the edge controller 14 is arranged to communicate wirelessly with the sensors 11, 12, 13 and the network node 18. However, communication could alternatively be performed via wire, for instance in case the edge controller would be implemented non-remote from the M2M sensors on the one hand or the network node 18 on the other. Typically, an application 19 in the form of a computer program interacts with the network node to communicate with the M2M sensors 11, 12, 13. As previously mentioned, an M2M sensor may be associated with an entity (not shown) to be actuated. The registration of the M2M sensors 11, 12, 13 and acquisition of data from the registered M2M sensors in different embodiments of the method of the present invention is managed by a processing unit 15 in the edge controller 14. In practice, the processing unit 15 is embodied in the form of one or more microprocessors arranged to execute a computer program 17 downloaded to a suitable storage medium 16 associated with the microprocessor, such as a RAM, a Flash memory or a hard disk. The microprocessor 15 is arranged to at least partly carry out the method according to embodiments of the present invention when the appropriate computer program 17 comprising computer-executable instructions is downloaded to the memory 16 and executed by the microprocessor 15. The storage medium 16 may be a computer program product comprising the computer program 17. Alternatively, the computer program 17 may be transferred to the storage medium 16 by means of a suitable computer program product, such as a floppy disk, a compact disc or a memory

stick. As a further alternative, the computer program 17 may be downloaded to the storage medium 16 over a network. The microprocessor 15 may alternatively be embodied in the form of an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), a complex programmable logic device (CPLD), etc. It should be understood that even though Figure 1 shows the edge controller 14 handling three M2M sensors 11, 12, 13, the edge controller will in practice handle tens, hundreds or even thousands of M2M sensors. The edge controller could be implemented in a number of different devices, such as a mobile phone, a laptop, a smart phone, a tablet computer or any other suitable mobile terminal or mobile module, or e.g. a custom-made controller implemented in a car for reporting automotive data to a central server, etc. A mobile module is a package of functional elements to enable communication over wireless network, such as a 3GPP or 3GPP2 network, as well as other networks, containing user credentials, trusted environment, security functions, radio and radio control part, and other necessary functions to establish such communication. It will also be appreciated that, although Figure 1 shows the edge controller 14 as a stand-alone unit separate from the network node 18, the edge controller 14 could in fact be integrated with the network node 18. Further, the M2M sensors 11, 12, 13 and the network node 18 are illustrated to communicate with each other exclusively via the edge controller 14. However, communication between the M2M sensors 11, 12, 13 and the network node 18 may occur in a direct manner, thereby bypassing the edge controller 14.

Figure 2 shows a flow chart illustrating a method of registering an M2M sensor 11, 12, 13 with a network node 18 via an edge controller 14 according to an embodiment of the present invention. In a first step, S101, the edge controller 14 receives a registration request from the M2M sensor 11. In step S102, the edge controller 14 identifies the M2M sensor 11 and data communication format used by the sensor; each M2M sensor may for instance have a unique ID. Further, in step S103, the edge controller 14 sends, to the network node 18, the identity of the M2M sensor and the data types used for registering the M2M sensor 11. Thus, by means of the method illustrated in Figure 2, an M2M sensor 11 is registered at the network node 18 via the edge controller 14 and is ready to start communication of data to the network node.

Figure 3a shows a flow chart illustrating a method of acquiring data of an M2M sensor 11, 12, 13 via an edge controller 14 according to an embodiment of the present invention. In a first step S201, the edge controller receives a request from a network node 18 to read data from the M2M sensor 11, which is designated in the request. The edge controller 14 forwards the request to the M2M sensor 11 in step S202. Thereafter, in step S203, in response to the forwarded request, the edge controller 14 receives the requested data from the M2M sensor 11. Further, the edge controller 14 sends in step S204 the received data to the network node 18 according to a specified format included in the received request. This format was previously decided on during registration. Thus, by means of the method illustrated in Figure 3, the edge controller 14 knows from the request which data format to use when communicating with a sensor and subsequently receives the requested data from the M2M sensor 11 and delivers it the network node 18 in accordance with the specified data format initially registered at the network node. Once the requested data has been communicated to the network node, actuation of the entity with which the M2M sensor is associated can commence according to the specified format.

In embodiments of the present invention, the specified format may stipulate e.g. data types to be used when sending the M2M sensor 11 data to the network node 18, size of the sent data, timing particulars of the sent data, etc. A number of different primitive data types can be envisaged, such as:

Data type	**Format**
byte	8-bit signed two's complement integer
short	16-bit signed two's complement integer
int	32-bit signed two's complement integer
long	64-bit signed two's complement integer
float	single-precision 32-bit IEEE 754 floating point
double	double-precision 64-bit IEEE 754 floating point
boolean	two possible values: true and false
char	single 16-bit Unicode character

Hence, the format for particular physical properties could in an example be defined as

Physical property	Unit	Format
Frequency	Hz	16-bit signed two's complement integer
Luminance	Lux	32-bit signed two's complement integer
Weight	kg	64-bit signed two's complement integer

Thus, a specified format of data may e.g. be {frequency, value of [frequency], size : 256 bits, rate : 100kb/s}. By having specified the format with which communication is to be undertaken with the M2M sensors 11, 12, 13 and the network node 18, the edge controller 14 acts as an interface via which any previously registered M2M sensor seamlessly can communicate with the network node 18, either by directly engaging in a communication with the network node 18 or by communicating via the edge controller 14.

The M2M sensors 11, 12, 13 and the edge controller 14 may communicate using a Constrained Application Protocol (CoAP).

As can be seen, the present invention eliminates the need for costly system integration since a network node is able to interoperate with a large number of sensors/actuators without any additional customization effort on the M2M sensor itself.

Figure 3b shows a flow chart illustrating a method of acquiring data of an M2M sensor 11, 12, 13 via an edge controller 14 according to a further embodiment of the present invention, which embodiment is an extension of that illustrated in Figure 3a. In step S205, the edge controller 14 receives instructions from the network node 18 for actuating an entity associated with the M2M sensor 11. Further, in step S206, the edge controller 14 sends the actuating instructions to the M2M sensor in accordance with the specified format. As previously exemplified, the network node may initially have requested data from the M2M sensor 11 being e.g. a thermometer measuring indoor temperature and being associated with an entity to be actuated in the form of a heater.

When receiving the data, the network node 18 - being e.g. server running an appropriate application 19 - interprets the indoor temperature to be, say, 12 °C, whereby a decision is taken to increase the temperature. Accordingly, actuating data of the specified format is sent to the M2M sensor 11 via the edge controller 14, instructing the heater to appropriately increase heat emission such that a target indoor temperature is reached. It should be noted that communication with the entity to be actuated not necessarily need to pass through the M2M sensor; the actuated entity could have communication capabilities and thus would be able to communicate directly with the edge controller 14 and/or the network node 18.

Figure 4 shows a flow chart illustrating a method of acquiring data of an M2M sensor 11, 12, 13 via an edge controller 14 according to an embodiment of the present invention. This embodiment is an alternative to that shown in Figure 3a. In a first step S301, the edge controller 14 receives a request from the network node 18 to read data from the M2M sensor 11, which is designated in the request. The edge controller 14 forwards the request to the M2M sensor 11 in step S302 along with an instruction to transmit the requested data to the network node according to a specified format included in the received request. Subsequently, the M2M sensor 11 sends the requested data to the network node 18 according to a specified format included in the received request.

Even though the invention has been described with reference to specific exemplifying embodiments thereof, many different alterations, modifications and the like will become apparent for those skilled in the art. The described embodiments are therefore not intended to limit the scope of the invention, as defined by the appended claims.

CLAIMS

1. A method of registering a machine-to-machine, M2M, sensor (11, 12, 13) with a network node (18), the method comprising the steps of:

receiving (S101) a registration request from the M2M sensor;

identifying (S102) the M2M sensor and data communication format used by the sensor; and

sending (S103), to the network node, the identity of the M2M sensor and information specifying the identified data communication format for registering the M2M sensor.

2. A method of acquiring data from a machine-to-machine, M2M, sensor (11, 12, 13), the method comprising the steps of:

receiving (S201) a request from a network node (18) to read data from an M2M sensor designated in the request;

forwarding (S202) the request to the designated M2M sensor;

receiving the requested data (S203) from the designated M2M sensor in response to the forwarded request;

sending (S204) the received data to the network node according to a specified format included in the received request.

3. The method according to claim 2, wherein said format specifies data types to be used when sending the M2M sensor data to the network node (18).

4. The method according to any one of claims 2 or 3, wherein said format specifies size of the M2M sensor data to be sent to the network node (18).

5. The method according to any one of claims 2-4, wherein said format specifies timing for sending the M2M sensor data to the network node (18).

6. The method according to any one of claims 2-5, further comprising the steps of:

receiving (S205) instructions from the network node (18) for actuating an entity associated with the M2M sensor (11, 12, 13); and

sending (S206) the actuating instructions to the M2M sensor in accordance with the specified format.

7. A method of acquiring data from a machine-to-machine, M2M, sensor (10, 11, 12, 13), the method comprising the steps of:

receiving (S301) a request from a network node (18) to read data from an M2M sensor designated in the request; and

forwarding (S302) the request to the designated M2M sensor along with an instruction to transmit the requested data to the network node according to a specified format included in the received request.

8. A device (14) for registering a machine-to-machine, M2M, sensor (11, 12, 13) with a network node (18), the device comprising a processing unit (15) being arranged to:

receive a registration request from the M2M sensor;

identify the M2M sensor and data communication format used by the sensor; and

send, to the network node, the identity of the M2M sensor and information specifying the identified data communication format for registering the M2M sensor.

9. A device (14) for acquiring data from a machine-to-machine, M2M, sensor (11, 12, 13), the device comprising a processing unit (15) being arranged to:

receive a request from a network node (18) to read data from an M2M sensor designated in the request;

forward the request to the designated M2M sensor;

receive the requested data from the designated M2M sensor in response to the forwarded request;

send the received data to the network node according to a specified format included in the received request.

10. The device (14) according to claim 9, wherein said format specifies data types to be used when sending the M2M sensor data to the network node (18).

11. The device (14) according to any one of claims 9 or 10, wherein said format specifies size of the M2M sensor data to be sent to the network node (18).

12. The device (14) according to any one of claims 9-11, wherein said format specifies timing for sending the M2M sensor data to the network node (18).

13. The device (14) according to any one of claims 9-12, the processing unit (15) further being arranged to:

receive instructions from the network node (18) for actuating an entity associated with the M2M sensor (11, 12, 13); and

send the actuating instructions to the M2M sensor in accordance with the specified format.

14. A device (14) for acquiring data from a machine-to-machine, M2M, sensor (10, 11, 12, 13), the device comprising a processing unit being arranged to:

receive a request from a network node (18) to read data from an M2M sensor designated in the request; and

forward the request to the designated M2M sensor along with an instruction to transmit the requested data to the network node according to a specified format included in the received request.

15. A mobile terminal comprising the device (14) according to any one of claims 8-14.

16. A mobile module comprising the device (14) according to any one of claims 8-14.

17. A computer program (17) comprising computer-executable instructions for causing a device (14) to perform at least parts of steps recited in any one of claims 1-7 when the computer-executable instructions are run on a processing unit (15) included in the device.

18. A computer program product (16) comprising a computer readable medium, the computer readable medium having the computer program (17) according to claim 17 embodied therein.

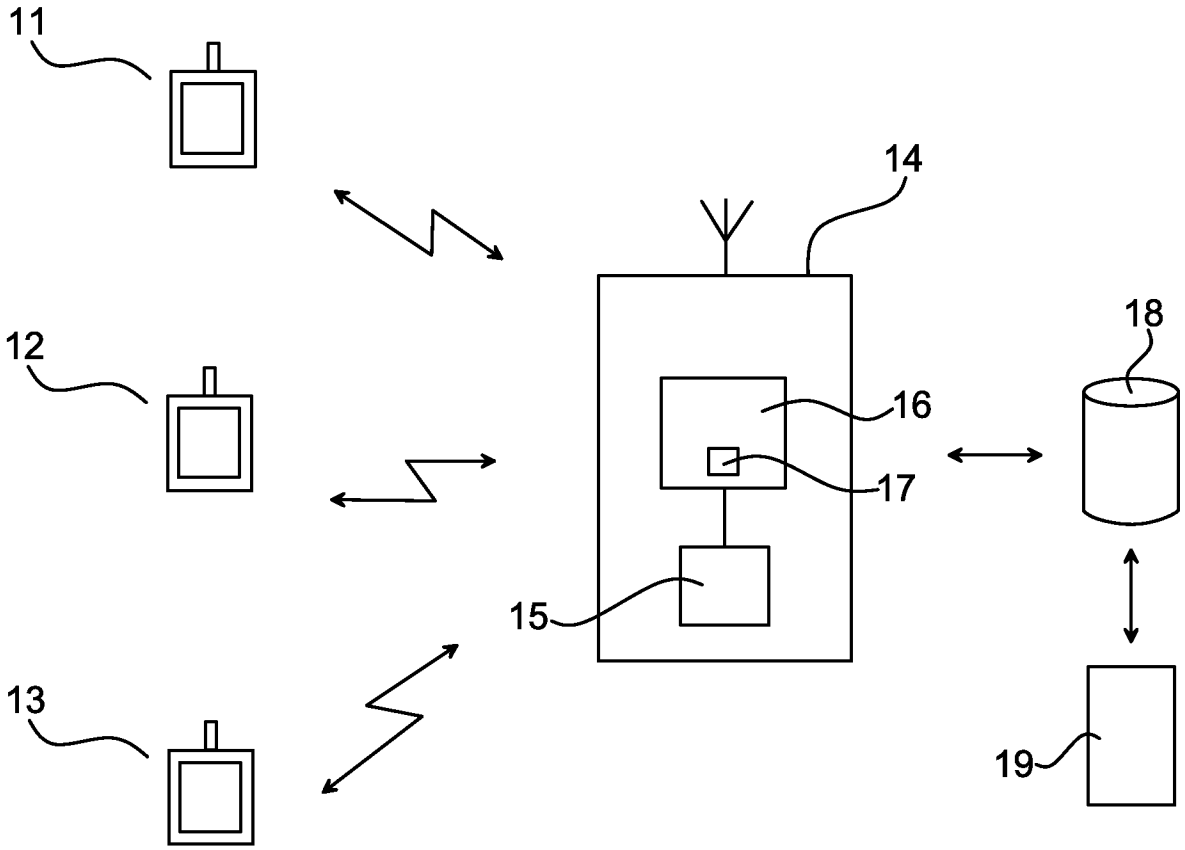

11
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18
19

Fig. 1

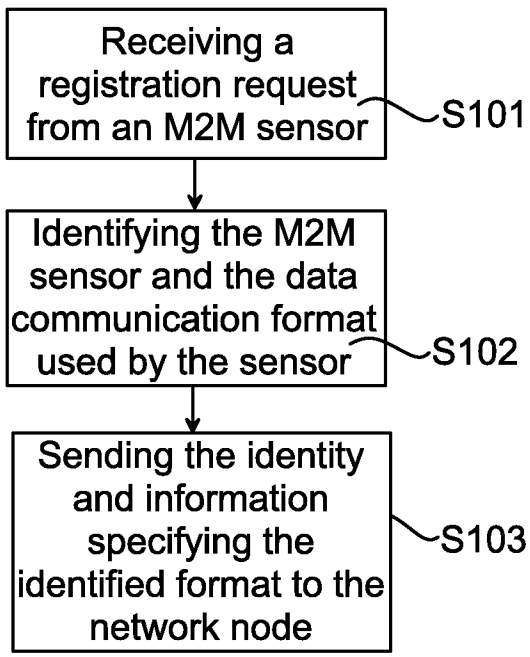

Receiving a registration request from an M2M sensor
S101
Identifying the M2M sensor and the data communication format used by the sensor
S102
Sending the identity and information specifying the identified format to the network node
S103

Fig. 2

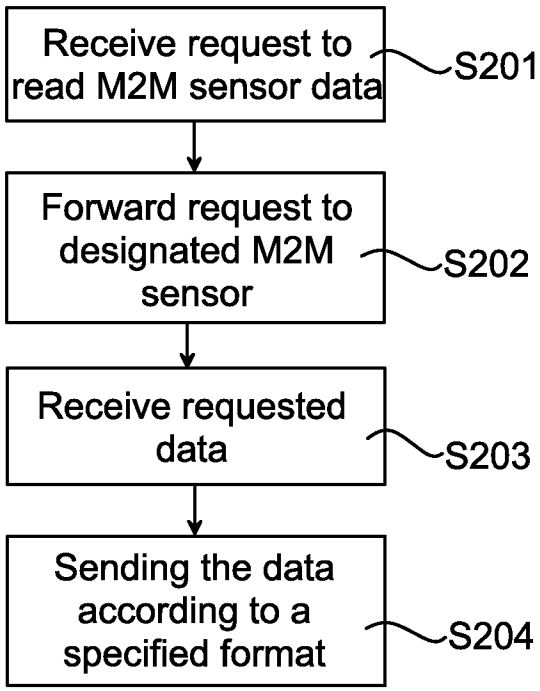

Receive request to read M2M sensor data
S201
Forward request to designated M2M sensor
S202
Receive requested data
S203
Sending the data according to a specified format
S204

Fig. 3a

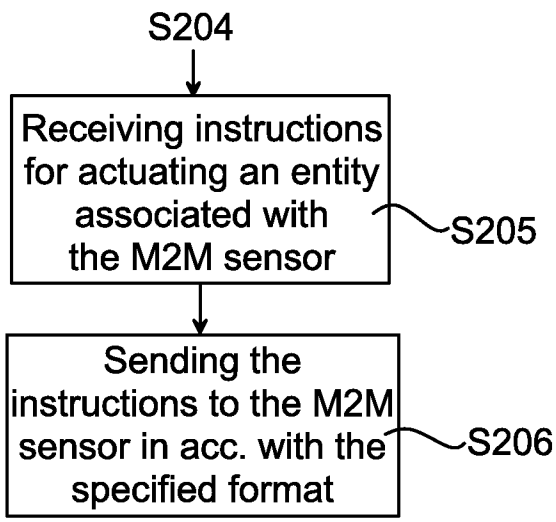

S204
Receiving instructions for actuating an entity associated with the M2M sensor
S205
Sending the instructions to the M2M sensor in acc. with the specified format
S206

Fig. 3b

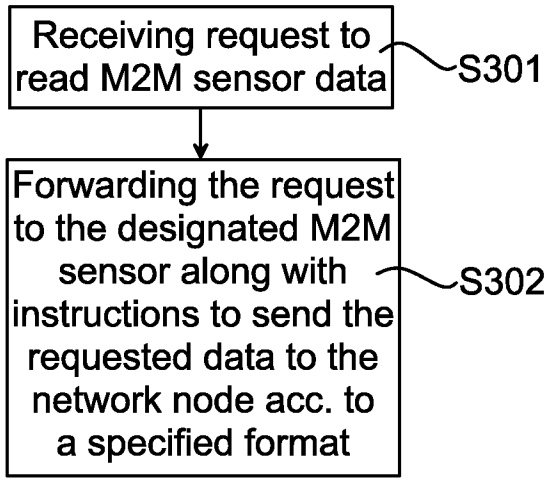

Receiving request to read M2M sensor data
S301
Forwarding the request to the designated M2M sensor along with instructions to send the requested data to the network node acc. to a specified format
S302

Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/053702

A. CLASSIFICATION OF SUBJECT MATTER
INV. H04L29/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	MUHAMMAD TAUFIQ N ET AL: "Shared sensor community for Navigation Information System in Indonesia", DISTRIBUTED FRAMEWORK AND APPLICATIONS (DFMA), 2010 INTERNATIONAL CONFERENCE ON, IEEE, 2 August 2010 (2010-08-02), pages 1-6, XP031893400, ISBN: 978-1-4244-9335-7 figure 1 tables 1,4 paragraph [III.A] ----- -/--	1-18

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
17 August 2012	27/08/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Tyszka, Krzysztof

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2012/053702

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Information on patent family members

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