Developments in Embedded Module Implementation of M2M Devices

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Abstract

The creation of M2M type solutions via the linking of sensor networks and IT services are needed for systems utilizing the environmental energies as well as for various kinds of monitoring systems. Since the requirements for the devices used in these systems are often similar or shared, it is expected that the efficient construction of many such systems will be enabled by applying a standard device platform that satisfies these requirements. This paper introduces the potential benefits of an embedded M2M network module as a device platform for such systems.

Keywords

HEMS, BEMS, environmental energy, remote operation monitoring
sensor network, M2M, devices

1. Background

The current worldwide rise in environmental awareness has been promoting development of various systems and products capable of achieving reductions in CO_2 emissions and other environmental burdens as well as encouraging the use of new forms of energy. Specific examples of development and commercialization include the home energy management system (HEMS) and the building energy management system (BEMS) involving solar power generation and power storage batteries as well as electric vehicles and the electric vehicle recharging infrastructures.

In addition, vertical integration type services linking

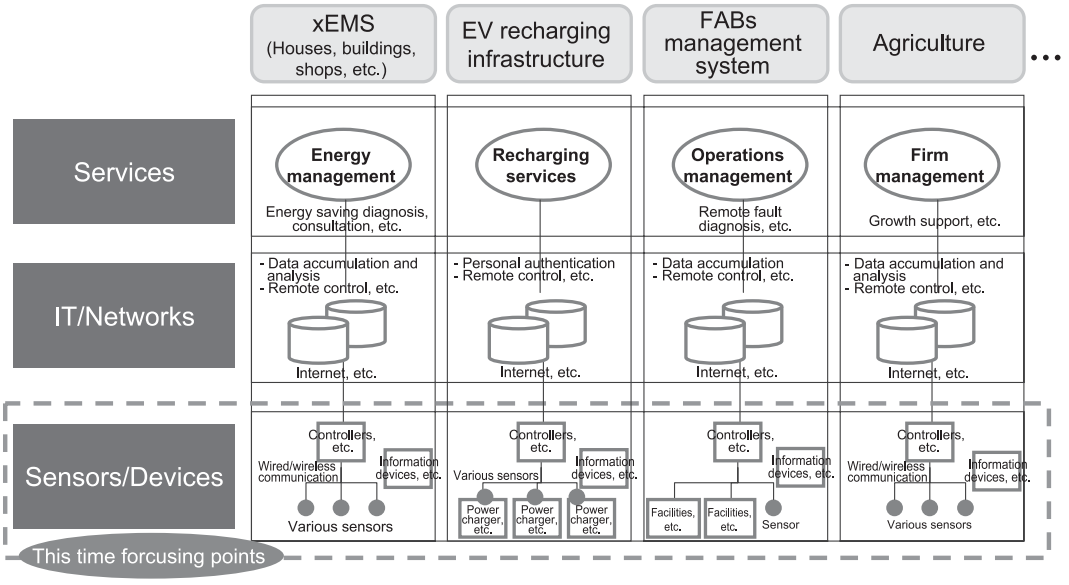

Fig. 1 M2M solutions and their key points.

sensor networks and IT services are expanding in various commercial scenarios and in the industrial sectors. Such services also include the sensing systems of environmental information for farms and rivers, monitoring systems of structures such as buildings, bridges and tunnels, remote monitoring of the operation of precision machines such as machine tools and composite machines, and crime-prevention/child-monitoring systems, which is of increasing importance in the declining birthrate and the aging population. These services belong mainly to the M2M type solutions.

A cross-sectional view of these systems shows that they are based on a common system model. However, in most cases such systems are built as individual systems and they are developed independently according to the appropriate industries, business types and applications.

We recognize that Japan needs to develop more efficient systems so that it can create industries and products that are globally competitive for the future. To make this possible, we believe that we should not be shortsightedly insisting on developing individual systems but that it is important to create and utilize a cross industrial, or horizontal platform. In this paper, we focus on the attempts related to these devices and introduce our efforts that are being applied in this sector (**Fig. 1**).

2. Requirements for M2M Device

We consider that the device platform for M2M type solutions is subject to the following requirements.

(1) Compatibility with various sensors

It is important that the platform can connect representative sensors including: current sensors for visualizing the electrical power, pulse counters for measuring water and gas usages, temperature/humidity sensors as the means of identifying environmental conditions and human sensors for recognizing the presence of humans and objects. It will thereby not be necessary to develop individual devices to support each sensing function.

(2) Possibility of using communication methods according to the usage environment

In housing, for example, we believe that the important issues include solutions related to obstacles such as wall surfaces and floors, radio interference with the wireless LAN used in Internet communications of home PCs and the selection of wireless communication systems that can ensure the ease of wiring work. On the other hand, in the communication of sensing data of machine tools, etc., what is important is to ensure the stability of communications and the compatibility with wired networks such as the RS485 networks in consideration of their connection with existing facilities.

(3) Possibility of executing the required output and control

Mechanisms capable of displaying graphs for visualizing the collected sensor data, sending mails according to the conditions, such as threshold value settings (for alarms, etc.) and executing output/control functions including the control of target devices (ON-OFF, etc.) make it possible to build systems that are versatile and valuable for the user.

(4) Flexibility and extendibility

The possibility of freely changing the sensing frequency (interval) and the rules of controls as described above (threshold settings, etc.) can secure the system flexibility and reduce issues connected to its introduction effects. In addition, a mechanism for enabling the extension of a local system that does not use a broad-area communication network to a larger system interconnected with cloud systems, etc., makes it possible to build optimum systems at the introduction stage or according to the levels required by users.

3. Development of an Embedded M2M Network Module

NEC is developing embedded M2M network modules by adopting background and device requirements as described above. We position these modules as device platforms that can be applied widely in M2M type systems, regardless of the business type or industrial sector. By deploying them extensively both in-house and outside, we are able to target cost reductions via the mass-production effect at the same time as contributing to improved efficiency and the added value of user enabled system building.

The module specifically consists of the “end device (slave machines)” that is connected to sensors and control devices, and the “controller block (master machine) that manages the collection of data from the end device, data storage and data processing as well as the linkages with server systems, etc. (**Fig. 2**).

The module can act as the basis for the user to combine the required component parts (sensors, communication module, etc.) and to customize the build function of an M2M system in order to rapidly match purpose and environment.

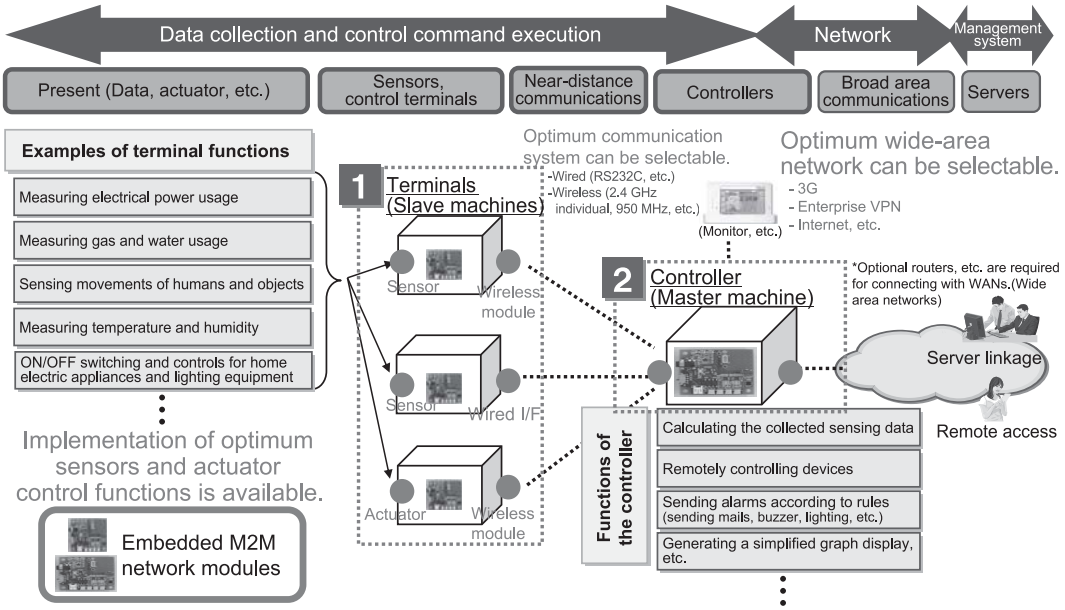

Fig. 2 Outline of the embedded M2M network module.

3.1 End Device (Slave Machines)

The end device has input interfaces for sensing by connecting to a current sensor, temperature/humidity sensor, pulse counter, etc. An interface for controlling home electrical appliances is also provided. This enables a mechanism for the remote control of home appliances such as air conditioners, lighting equipment and motorized shutters to be implemented when the user is out.

This block also has an interface for short-distance communications with the controller block so that the optimum component can be selected from various communication systems including wired (RS232C, etc.) and wireless (UHF band, etc.) communications. These communications can be secured by encryption.

3.2 Controller Block (Master Machine)

The controller block is equipped with an interface for short-distance communications with the end devices. This makes it possible to calculate the amount of sensing data collected by the end devices and to execute control commands sent from a server to the desired end devices.

The controller block also has basic functions for processing the collected data and performing controls by setting thresholds, etc. This allows the user to visualize data and control devices even for a system that is not connected to a server system (local operating system). On the other hand, the controller block also has communication interfaces with external networks, enabling implementation of a system linking a server system and the sensor network easily via a network such as Ethernet or 3G communication networks.

The web server function of the controller block allows it to be accessed by a Smartphone or tablet terminal in order to view data on a browser or to give control instructions. In addition, the controller block also enables linkage with NEC's M2M server (CONNEXIVE) as a standard function.

4. Specifications of the Embedded M2M Network Module

The embedded M2M network module is designed to offer the following specifications. In the future, we will implement them in the software by feeding back the needs defined by users and systems developers.

(1) Terminals

- **External connectors**

DC jack, power connector, CT connector, actuator connec-

tor, wireless module connector, stacking connectors for sub-board connections, etc.

- **Input interface**

CT input, analog input, pulse input, non-voltage contact input, reset SW.

- **Output interface**

Analog output, PWM output, non-voltage contact output, LEDs.

- **Other interfaces**

General-purpose input/output, serial interfaces (SPI, I2C, URAT).

(2) Controller

- **OS**

Linux OS.

- **External connectors**

mini PCI Express connector, USB connector (for extensions), LCD connector.

- **Network interfaces**

Serial (UART), wired LAN (RJ45: 10M/100M), wireless LAN (IEEE 802.11 b/g/n), 3G.

- **External interfaces**

D-sub 9-pin (RS232C), USB (2.0), SD card slot, LCD interface, general-purpose I/O.

- **Data processing functions**

Data reception, data storage, data analysis.

- **Event processing function**

Event processing.

- **Web interface (CGI)**

Graph display, web output, SD output, terminal control, authentication.

- **Command line interface**

Terminal management, log, firmware updating, system setting.

- **E-mail interface**

Mail notification.

- **HTTP interface**

Collected data sending, terminal control instruction reception.

- **Other**

Linkage with CONNEXIVE M2M service platform (Device Agent).

5. Examples of Application

This section introduces typical examples of applications of the embedded M2M network module.

5.1 Applications to Housings

The services that can be implemented for housings include power management, crime prevention and surveillance, and remote home appliance control (**Fig. 3**). Introduction of a

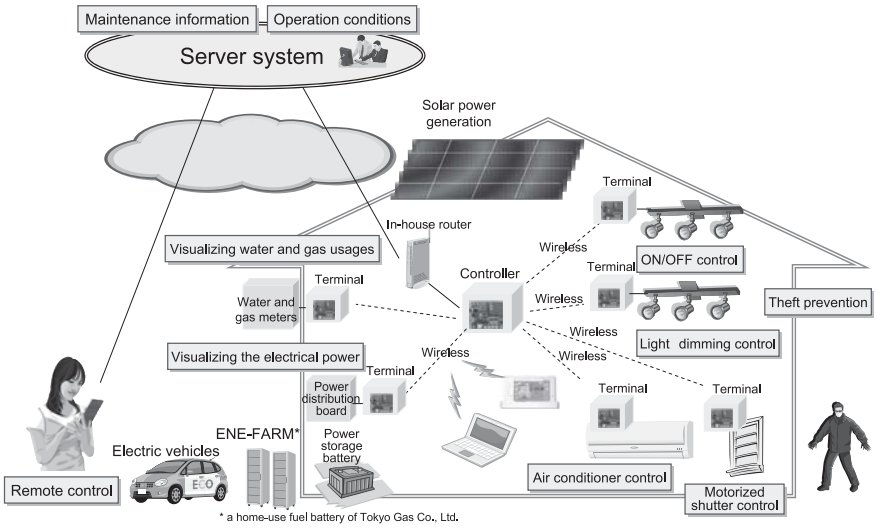

Fig. 3 Example of application to housing.

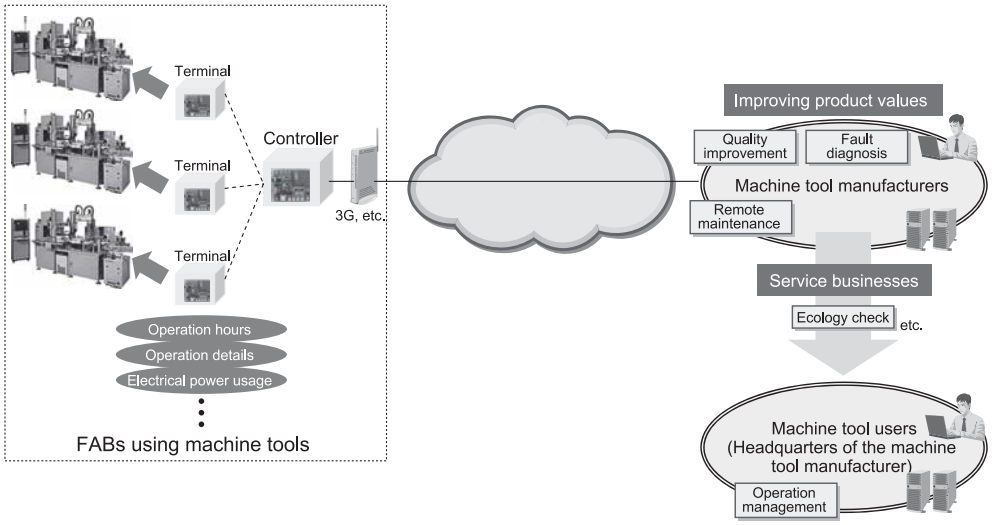

Fig. 4 Example of application to machine tools.

single controller is enough to implement a smart house by expanding services via the addition of a terminal for each of the required services.

5.2 Applications to Machine Tools

With regard to machines such as machine tools, remote identifications of the operating conditions and maintenance timing are possible by sending work-related data (operating time, power usage, temperature, etc.) (**Fig. 4**). This enables efficient identification of the operating conditions even of FABs in remote locations. A typical example for doing this is a machine tool manufacturer constructing a separate network from the FAB network of the user. In this case, the communication costs may be reduced by calculating the sensing data via the controller.

6. Future Plan

NEC has already completed development of the prototype of the module product and is planning to launch it in November 2011. Subsequently, we intend to sell the module to the assembled products manufacturers and to support their customized developments in order to advance provision of cloud-type services linked via our CONNEXIVE product.

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