Practice of M2M Connecting Real-World Things with Cloud Computing

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Machine-to-Machine (M2M) means connecting many machines with a management center via wide-area mobile or satellite networks in order to monitor and control them. M2M has been used in various fields before. However, M2M is now undergoing a dramatic revolution. This is because we can more easily gather and analyze many pieces of information using recent improvements in telecommunication techniques and services and the appearance of cloud computing. Connecting real-world machines with the cloud and gathering much information will produce many new business opportunities through not only improving products and customer services, but also through selling that information. On the other hand, the requirements that M2M infrastructure needs to meet have also been changing with the appearance of the cloud. This paper will explain these new requirements and problems, introduce the solutions proposed by Fujitsu, and give some examples.

1. Introduction

Machine-to-Machine (M2M) is a concept of connecting many machines mainly via wide-area mobile or satellite networks to allow remote monitoring and control. The M2M concept itself is not recent, but has long been in practical application by means of analog telephone lines. As mobile phone networks grew in the 1990 s, the areas of its applications further expanded, spurred on by the convenience of wide-area wireless communications. Specifically, it is used in a wide range of fields including remote monitoring of elevators, crime prevention such as car and home security, mobile payments such as credit card authentication terminals, dynamic fleet management, and telematics for luxury cars.

The period from the end of the 2000s to 2010 s is a period of revolution for M2M, comparable to the expansion of mobile phone networks in the 1990s, and has been brought about by the advent of cloud computing. Cloud facilitates further expansion of the areas of M2M application. In addition, reduced prices and improved performance of communication devices and mobile communication help M2M to spread.

Meanwhile, on the premise of application in a cloud environment, additional requirements have been put forward for M2M. These include connectivity to a wider variety of machines than before and construction of an environment for information gathering by integrating networks. This paper will explain these new requirements and problems, introduce the solutions proposed by Fujitsu, and give some examples.

2. Revolution of M2M by appearance of cloud

As mentioned earlier, M2M is a concept and system for remote monitoring and control by connecting a number of machines. Its features include an ability to gather operation information from many machines in large quantities and for a long time. However, accumulating and

analyzing large quantities of information require massive amounts of computing power. For that reason, M2M applications have been confined to conventional ones up to now such as remote monitoring/control and dynamic fleet management, even among companies with advanced M2M capabilities. Accordingly, potential uses of the information gathered have not been fully explored.

On the other hand, cloud is capable of providing a system in which multiple users share a globally distributed computing environment. This allows relatively easy accumulation and analysis of large quantities of information and creates added value based on the results of the analysis. Furthermore, reduced prices and improved performance of communication devices and mobile communication make it possible to gather more information from more devices. Combining machines and cloud is significant for business since it is possible to gather operation information from many machines in large quantities and for a long time, leading to a multiplier effect. As a result, many companies that did not make use of M2M before have realized the potential of M2M business value and started to devise new businesses that take advantage of it (**Figure 1**).

Michi Kaifu discusses this in "Why 'M2M' is the Next Wireless Frontier."[1] He says "The development of an 'intelligent' cloud that processes vast amounts of data to lead to actions that have been automatically gathered, in addition to devices and connection lines, constitutes together with terminals the 'two wheels' of M2M. This is expected to become even more important in the future."

As a new model of M2M like this, Fujitsu has studied jointly with many customers how to connect machines with cloud so as to circulate information and increase value. Based on such past achievements, the way M2M has been applied can be classified into the following five phases.

- Phase 1

Improving efficiency by migrating the existing operations such as remote maintenance to ICT-based systems

- Phase 2

Conducting preventive maintenance by analyzing information and expanding service business that makes use of it

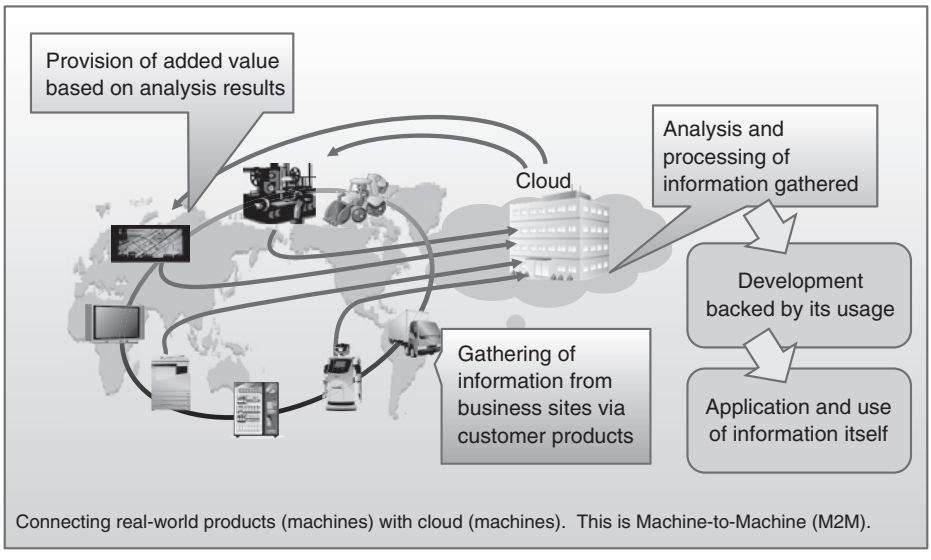

Figure 1
Next-generation M2M.

- Phase 3

Giving feedback to marketing and development by gaining an understanding of the way M2M is applied

- Phase 4

Providing useful support information, giving feedback and adding on-demand functions for users

- Phase 5

Providing information for or across industries based on the gathered or analyzed information itself as new value

Customers themselves can build business models that match their companies while referring to the five phases mentioned above. This allows the value of products or the companies to be further increased. As a result, they can make the best of the gathered information by taking advantage of cloud.

3. New requirements of M2M and problems

The appearance of cloud has not only brought about a revolution in M2M in terms of business but also new requirements and problems in terms of its implementation. To implement it, it is important to be able to integrate the information gathered via M2M into a large virtual information platform in a cloud. To that end, M2M needs a system for integrating various machines and network environments to gather information.

That is, M2M requires "integration" from a variety of perspectives more than ever. The types of integration have been classified from three perspectives: global integration; network integration; and vertical integration of applications, networks and terminals centered on cloud.

1) Global integration

Many companies in the manufacturing industry including machine manufacturers offer their products overseas as main markets as well as in Japan. Gathering information about globally dispersed machines to integrate it into a cloud as a virtual information platform requires individual ICT elemental technologies, including network connections, to be globally applicable.

2) Network integration

While fixed-line systems such as the Internet are relatively readily available, a connection environment cannot always be put in place. In addition, operating machines are located in end-user environments and often machine manufacturers are not allowed to freely use the existing networks for security and other reasons. Accordingly, mobile networks are frequently used as a means of M2M communication.

Future M2M that makes use of cloud requires mobile networks to be globally available. From a global perspective, individual mobile operators have slightly different methods of authentication and communication. For that reason, comprehensive support for a wide variety of methods is necessary to make use of mobile networks.

Another point of view is that mobile phones require relatively high costs and do not have perfect global coverage. Accordingly, efficient connection between a number of globally dispersed machines requires an ability to gather information in diverse ways including the Internet, satellite links and, recently, near-field communication technologies in addition to mobile phones.

3) Vertical integration of applications, networks and terminals centered on cloud

To realize M2M, not only communication links but also corresponding communication functions must be incorporated into machines. For that purpose, a basic system for efficiently managing many machines via communication functions is required. An example of this would be a system that can automatically construct associations between machine serial numbers and communication links. Furthermore, an ability to link with peripheral tools provided as SaaS, such as remote management tools, is

required as well.

On the part of cloud, it must be possible to integrate the information gathered via M2M with secondary information managed by companies such as customer, sales and maintenance information so that it can be analyzed.

Future M2M that makes use of cloud is expected to have a great variety of such vertical combinations, which means M2M is likely to see explosive growth. To deal with this issue, it will be more necessary than ever to give functional considerations to vertical integration and linking of communication devices, networks and cloud.

These three perspectives are key points in meeting requirements and solving problems in relation to M2M so as to make full use of cloud.

4. Provision of FENICS II M2M service

To meet the requirements and solve the problems involved with M2M in the cloud age, Fujitsu started offering the FENICS II M2M service in October 2010. This service provides an environment for connecting between Fujitsu cloud and on-site communication devices to gather information about on-site devices (**Figure 2**). Regarding the three perspectives of the requirements of M2M described earlier, the FENICS II M2M service has the following three specific features.

1) Global integration

Fujitsu has formed partnerships with multiple major mobile operators in Japan and overseas. This, in combination with international roaming, has made data communication services available via mobile networks in more than 200 countries and regions. However, different mobile operators have different countries and regions that can be covered at low prices and they place different levels of importance on M2M. For that reason, providing the most suitable communication environment for customers' businesses requires an ability to select and make use of the strengths of more than one mobile operator.

2) Network integration

As mentioned earlier, different mobile operators use slightly different methods. With thorough knowledge of the methods of the respective mobile operators, Fujitsu is able to absorb or consolidate the differences in some cases to re-provide them as common methods via the Web and application programming interfaces (APIs). Fujitsu also offers sample embedded scripts for customer devices. In this way, customers can use an integrated communication environment without having to be bothered by the mobile-operator-specific differences or learn

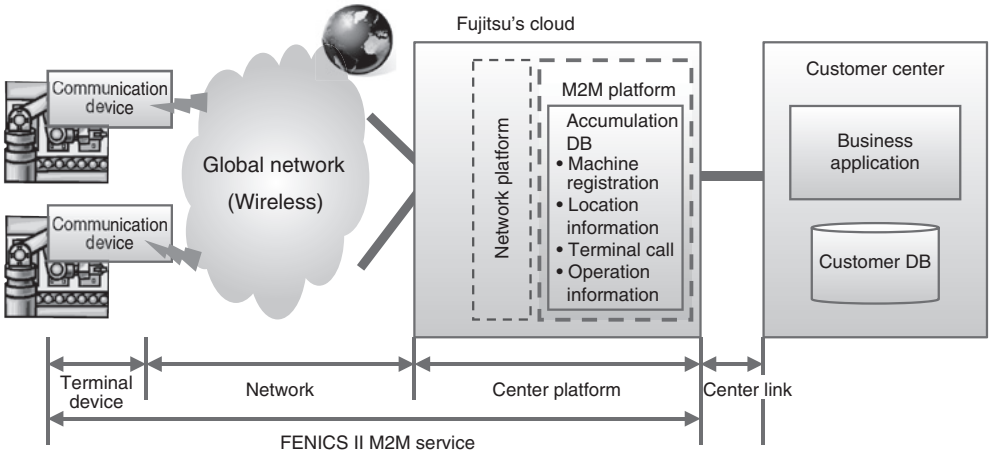

Figure 2
Outline of FENICS II M2M service.

from scratch about fine-tuning to support any specific mobile operator.

3) Vertical integration of applications, networks and terminals centered on cloud

Services including communication devices for equipping customer devices with wireless communication functions can be provided, not to mention the convenience of directly connecting with Fujitsu cloud. In addition, support functions required to allow customer devices or cloud applications to use M2M are provided via the Web or APIs. Such functions include automatic creation of associations between serial numbers of customer devices and communication links and accumulation of device operation logs on the cloud storage. Furthermore, a means of safely connecting from secure M2M networks to the Internet is offered. This allows peripheral tools, provided as SaaS such as remote management tools, to be used.

5. Examples of application

To better provide the FENICS II M2M service, Fujitsu has introduced it to more than 100 customers and studied its application. This section presents two examples of applying the FENICS II M2M service.

1) Example of remote maintenance of machine tools[2)]

In this example, "preventive maintenance" is realized, in which machine tool operation information is remotely gathered to detect any signs of failure, and maintenance personnel are dispatched before any failure occurs.

Operation information is sent to the center for analysis via a mobile network, thereby allowing users to identify any signs of failure. When they detect a sign of failure, they can establish a remote connection via the mobile network to a machine tool and acquire detailed information for taking emergency measures. In addition, they can give remote assistance when the field maintenance personnel arrive. Furthermore, the users can find out information such as how frequently the end-user actually uses which functions based on the operation information, and they can then use this in future product development.

Situations of application cover preventive maintenance in Phase 2 to feedback into development in Phase 3 explained earlier. Overseas sales account for a large proportion of the total sales of manufacturers of machines such as machine tools, and this means they must be able to use M2M globally (**Figure 3**).

2) Example of fleet management[3)]

This example is intended to visualize various types of operational information such as the delivery status and safe driving status by remotely gathering fleet service information.

An in-vehicle terminal acquires various types of fleet service information such as location information based on the global positioning system (GPS) and engine speed. The information is in turn sent to the center via a mobile network, which can be used to visualize operational information relating to fleet management.

Situations of application cover up to the provision of information to users in Phase 4. For such dynamic fleet management, M2M has been used for some time in the market. However, its purposes have been diversified recently to include analysis of the gathered information to use for ecological driving and use of information by regarding the vehicle itself as a kind of sensor. In this field, future M2M applications are expected to increase by taking advantage of cloud. In this example, the Fujitsu Group is a one-stop provider of the in-vehicle communication device, network and cloud services (**Figure 4**).

These are examples of application in two categories of business. Application of M2M leads to a reform of customer business models. It should be noted that it generally takes a long time after considering application before the application can be started.

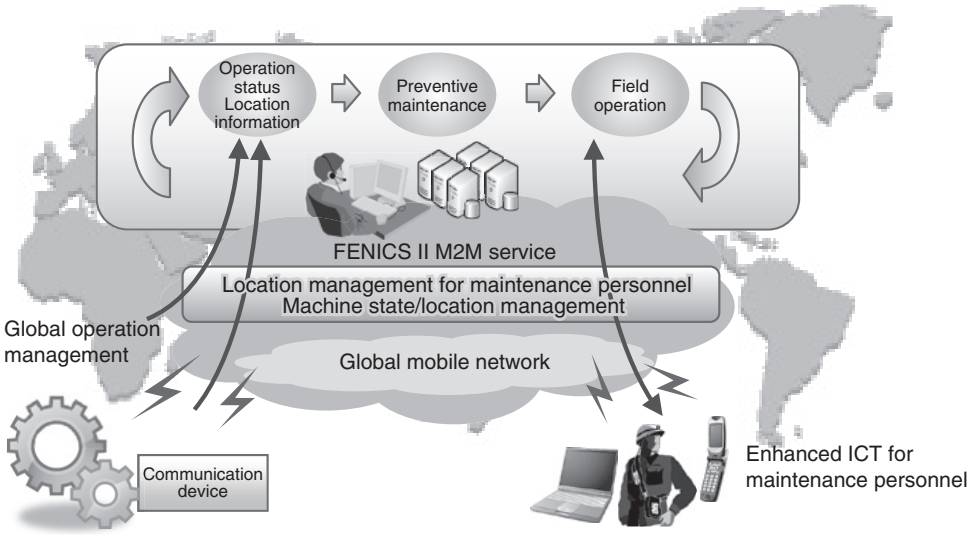

Figure 3
Example of remote machine maintenance.

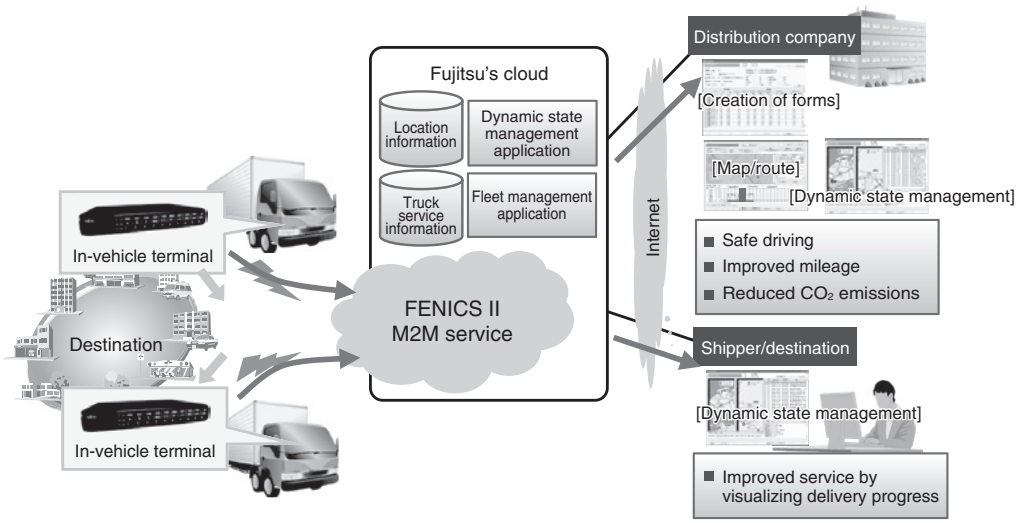

Figure 4
Example of fleet management service.

6. Conclusion

Fujitsu has just started providing the FENICS II M2M service. The requirements and problems in terms of M2M mentioned up to now have been solved only partially.

For example, global integration needs to be made available to customers who wish to use a cloud environment outside Japan. Regarding network integration, availability of the Internet and near-field communication as well as mobile networks will allow an explosive increase in the types of information that can be gathered at low costs. Recently in the field of sensor networks, a near-field communication technology called smart network technology has been attracting attention. With this, autonomous direct communication between wireless handsets allows their range to be extended. These new

technologies must be made more readily available in the future. For cloud vertical integration, we intend to strengthen the linkage with various terminals and cloud functions.

Fujitsu is committed to showing examples of advanced applications jointly with customers, which will hopefully help to increase the value offered by M2M.

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Mr. Osawa is currently engaged in planning for M2M network services.