Technology Reports

Remote Maintenance and Management of FOMA Ubiquitous Module

We have increased the utility of the FOMA Ubiquitous Module, which is used as a solution in many types of scenario, by allowing various new features such as real-time status monitoring. Also included are functions for remote maintenance and management, responding to a demand for a highly-reliable, supported service with the FOMA Ubiquitous Module.

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1. Introduction

The FOMA Ubiquitous Module (hereinafter reffered to as "FOMA Module") is a communications device for embedded applications which integrates a mobile radio (FOMA data communications function) and a data communications adapter in a single device. Due to its light weight and small size, it can be embedded in various devices such as automobiles or vending machines.

To provide even better stability and radio quality to users of the FOMA packet service, and amid rising demand in the machine-communications business (providing data communications for equipment), we have improved quality by adding new functionality to the module and to the FOMA network, that allow remote maintenance of FOMA Modules.

In this article, we describe an overview of the remote maintenance and management services, the main technical issues addressed, and how the services are implemented.

2. Service Overview

FOMA Modules are used as an embedded device in equipment such as vending machines, and often in situations where it is not possible to have personnel readily available to perform maintenance work. In the past, when a user inquired about radio quality for a module, the request was time-consuming because it was necessary to dispatch someone to the site to check the FOMA Module and surrounding signal conditions. Also, software updates to improve product quality required on-site work and could result in long periods when the module was not usable. Further, factors such as changes in the surrounding traffic or construction can affect the communications environment, so on-site testing was required to check these conditions.

Because of these issues, several new functions were created to allow rapid, remote maintenance and management of FOMA Modules, including the "FOMA Module software update function," the "FOMA Module radio-quality-data remote retrieval function," and the "FOMA Module communicating-sector cell number (scrambling code) retrieval function." With these new functions, it is now possible to check the FOMA Module and communication conditions in the surrounding area remotely. The current software version can also be checked remotely, and if updates are required, the software

update can be carried out without user intervention by scheduling a date and time to download and install the update files.

Remote monitoring and maintenance of FOMA Modules is shown in **Figure 1**. If the FOMA Module maintenance center receives a request from a user regarding the radio quality for equipment containing the FOMA Module, the new functions can be used to perform required monitoring and maintenance work at the remote location. This allows requests to be handled quickly and reliably without having to dispatch staff to the equipment location.

Note that the "FOMA Module software update function" and the "FOMA Module radio-quality-data remote-retrieval function" are supported in FOMA Modules starting with "FOMA UM02-F" (**Photo 1**).

3. FOMA Module Software-update Function

3.1 Technical Issues and Implementation

We now describe issues surrounding implementation of the FOMA Module software-update function.

The feature was implemented in consideration of the following issues:

• A mechanism allowing software update, including safe overwriting of the software with no user operation is required, since the FOMA Module has no display or operating
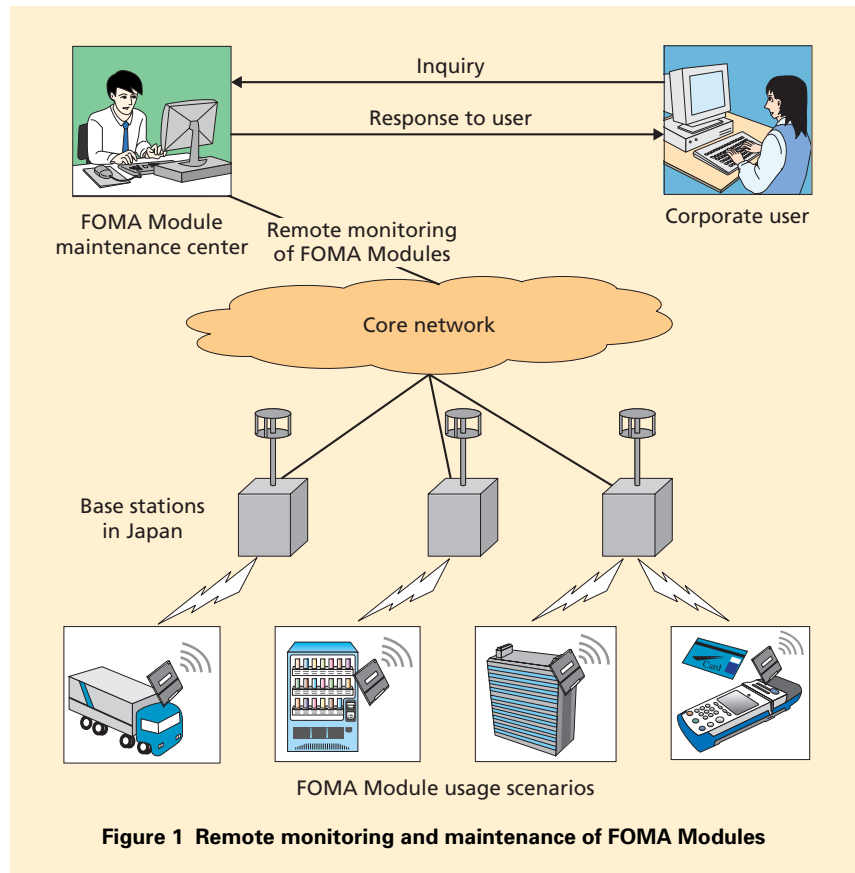

Figure 1 Remote monitoring and maintenance of FOMA Modules

component and is sometimes used in equipment installed in locations where maintenance staff is not available.

• It is desirable to be able to check the software version without interrupting a communication, even if the FOMA Module is currently engaged in packet communication.

• In order not to obstruct user communication, allow automatic download for update files to be scheduled at a time when the FOMA Module packet service will not be in use.

In order to reduce the development

Photo 1 FOMA UM02-F

time and costs for the FOMA Module software-update function, we based it on an established software-update function from an existing handset terminal (one with button operation and display

screen components). The terminal receives a software update Push notification from the network, and is able to begin the automatic update immediately. In order to perform the software update in a continuous sequence, we removed the need to initiate the update through operation from the user or an external device, and made changes to manage the state of the module internally. The user was also required to stop packet communication before initiating the software update, so this requirement was removed by allowing the FOMA Module to drop the connection autonomously if the software-update Push notification is received during packet communication and then begin the update. It is necessary to avoid unnecessary interruptions from external devices when downloading the software-update file and overwriting the current software. To ensure that the software update proceeds correctly, we used methods such as AT command[*1] responses and signalling-line control to notify external devices that a software update is in progress on the FOMA Module, or simply cancelled processing of interrupts from external devices. For cases where the software overwrite does not complete correctly, or cannot be confirmed to be correct after overwriting, we allow the FOMA Module to start up using the previous version of the software to avoid entering inoperable states.

We have implemented the remote software-update function so that it can be initiated from the network by linking it with the FOMA Module Management System (FMS)[*2], which allows the state of a FOMA packet communication session involving a FOMA Module to be monitored remotely from the FOMA Module maintenance center. Further, by linking to the Terminal Identification Service Control Point (TISCP), we have made it possible to identify a FOMA Module using only the telephone number. The TISCP is a database which holds pairs of telephone number and serial number for mobile terminals, including FOMA Modules, whose location is registered on the network. It is used to detect cases when a User Identity Module (UIM)[*3] is moved from one FOMA Module to another.

The software-update function must handle FOMA Modules with older software versions, so the existing version must be checked before attempting a software update. A FOMA Module can maintain an on-going Point-to-Point Protocol (PPP) session[*4], or can be used with an instant-connection service (which shortens connection times by only releasing the radio connection) to allow instantaneous communication. Accordingly, we developed a function for checking the software version using the Short Message Service (SMS), and without interrupting ongoing communication.

Because the FOMA Module cannot be used during the software update, it is necessary to perform the update when the module is not in use; but an appropriate time depends on how the module is being applied. On the other hand, it is necessary to distribute downloading of update files to reduce network load, so that they are not concentrated within a short time period. To handle these issues, we developed a function to control download start times from the network side, executing them within a time period requested by the user.

Using the FMS, it is possible to perform software updates and to check software versions using only the phone number, but it can also be done in batches by company name or APN unit[*5]. Also, since the FOMA packet service cannot be used during the software update, a time period which suits the user can be scheduled on the FMS. In addition to the time period, the device type, software version, whether it is scheduled, group name and other conditions can also be specified, and by combining these conditions, software updates can be accomplished according to users' wishes.

Note that the maintainance person can create groupings with group names in units of telephone-number according to users' particular requirements, summarizing the specified conditions into simply a group name and time period, or adding a group name for multiple conditions. This allows conditions that better suite users' needs to be specified. The maintainance person can also see

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*1 **AT command**: A command system which is used for controlling modems and terminal adapters.
*2 **FMS**: A system which recognizes the status of FOMA packet sessions and allows remote monitoring and maintenance.

*3 **UIM**: An IC card storing subscriber information such as the telephone number. It is inserted in the mobile terminal and used to identify the user.
*4 **PPP session**: The communications protocol used by the FOMA Module to connect to and

carry out data communications on the network.
*5 **APN unit**: An APN is a string containing the name of an access point conforming to 3GPP domain name format. Users may have multiple APNs that they can connect to, so they are managed in APN units on the FMS.

the status of reservations, the results of executing software updates or version checks, so that the user can be contacted for re-scheduling if the operation fails.

Through implementation of these features, remote, automatic and unattended software updates with no user intervention can be performed on FOMA Modules in environments with no display and no maintenance person available, allowing highly-reliable data communications services to be provided to users.

3.2 Operation Overview

Here we describe the operation of the FOMA Module software update function.

The system consists of the Mobile terminal Software Remote distributing system (MSR)[*6], the TISCP and the FMS. The MSR is a server which manages the terminal software and the FMS maintains the FOMA Modules based on the information held by the TISCP.

The software update sequence for a FOMA Module is shown in **Figure 2**. The MSR registers device-type information in the TISCP for FOMA Modules being monitored and maintained remotely (Fig. 2 (1)). The TISCP returns a list of applicable FOMA Module serial numbers and phone numbers through a fixed process that is run once per day (Fig. 2 (2)), and the list is forwarded to the FMS through the MSR (Fig. 2 (3)). After receiving this list, the
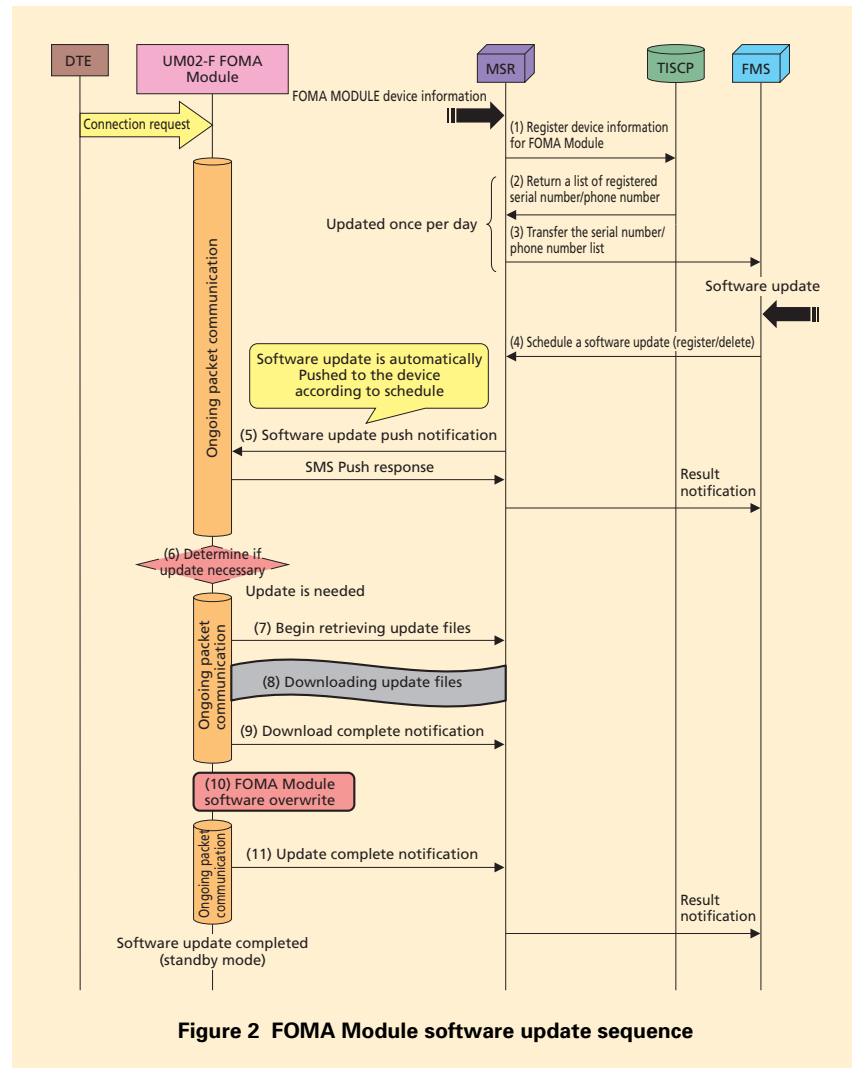

Figure 2 FOMA Module software update sequence

FMS updates the serial number/phone number pairs. When performing a software update, the time period desired by the user is sent from the FMS to the MSR (Fig. 2 (4)). The MSR manages the software update schedule, scheduling downloads and calculating the actual download times based on the requested times and the required download time. After scheduling an update, a software-update Push notification is sent automatically at the scheduled time

(Fig. 2 (5)). The FOMA Module receives the software update Push notification from the MSR, and from the notification data, decides whether the software update is necessary or not (Fig. 2 (6)). If the update is necessary, retrieval of the update file begins immediately (Fig. 2 (7)-(9)). After the update file has been received, the FOMA Module changes state to "out-of-range" and begins the software over-write (Fig. 2 (10)). After completing the over-write and

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*6 **MSR**: A system which uses radio communications (the FOMA data-communications function) for updating software and distributing security-scan pattern data in mobile terminals.

restarting, the FOMA Module sends an "update-completed" notification and returns to the stand-by state (Fig. 2 (11)). When the MSR receives the update-completed notification, it forwards this result to the FMS.

The sequence for checking the software version on a FOMA Module is shown in **Figure 3**. The sequence before sending the software-version request is the same as Fig. 2 steps (1) to (3). When a request for the software version in a FOMA Module is received, the time requested by the user is sent from the FMS to the MSR (Fig. 3 (4)). The MSR manages the software version check schedule, scheduling tasks according to the requests received. At the scheduled time, a software-version-check Push notification is automatically sent (Fig. 3 (5)). The FOMA Module receives the Push notification from the MSR, and without interrupting any packet communication (transmission, reception or communication state, returns an SMS Push response containing the software version to the network side (Fig. 3 (6)). The MSR forwards the software version to the FMS when it receives the SMS Push response.

4. FOMA Module Radio-quality-data Remote-retrieval Function

4.1 Technical Issues and Implementation

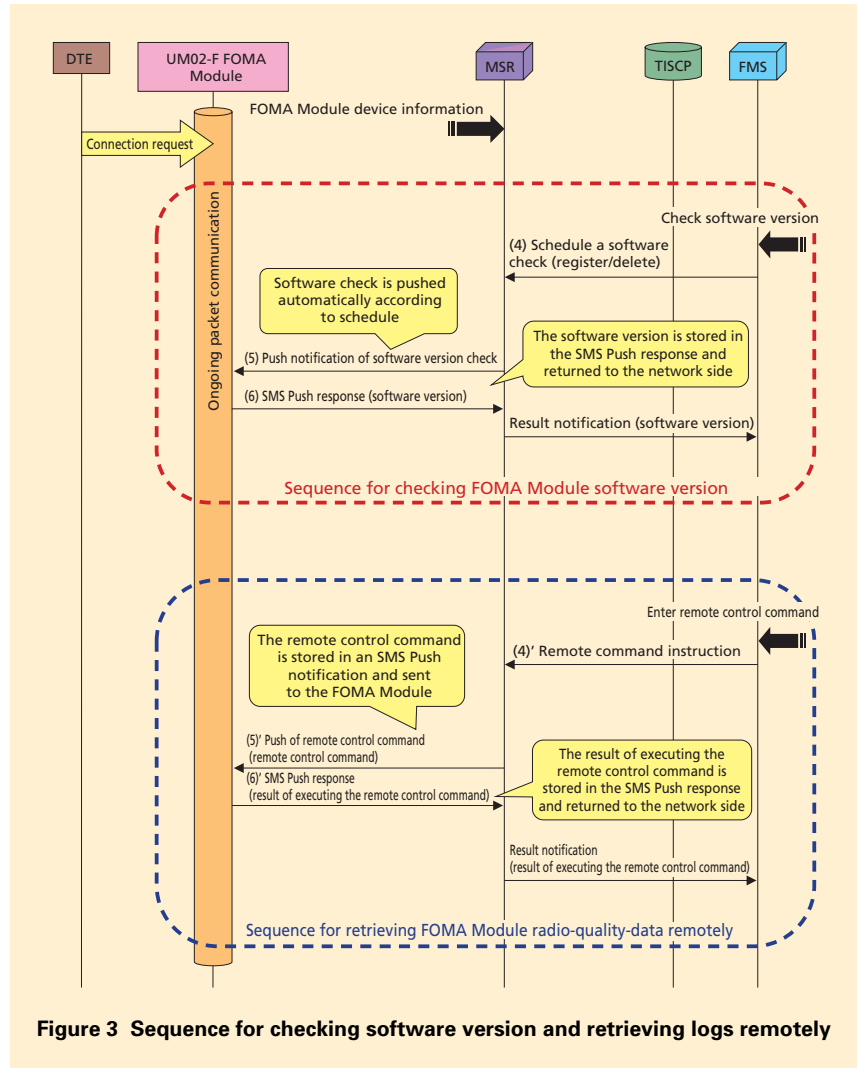We now describe issues surrounding implementation of the FOMA Module radio-quality-data remote-retrieval function.

The following issues where considered when implementing this feature:

- Real-time radio-quality information shall be stored so that the communication status can be checked when an inquiry is received.
- Operation should be possible remotely, without visiting the location of the equipment incorporating the FOMA Module.

The radio-quality-data remote-retrieval function was implemented by developing functionality for storing radio-quality-data, such as the state of radio signal reception and communication with the network (hereinafter referred to as "logs") in the FOMA Module itself, as well as for remotely starting and stopping log storage, or transmitting the stored logs over the network.

FOMA Modules include a function

Figure 3 Sequence for checking software version and retrieving logs remotely

for outputting such logs for test use. By connecting a log-retrieval tool to the FOMA Module through an external connector, logs can be output to the log retrieval tool by performing a specific log-output procedure. The log retrieval tool can monitor logs in real time, or store them for review later. This tool is used for testing during the mobile terminal development process and also for surveying the service quality at specific locations within the commercial service area.

To implement a function for retrieving this radio-quality-data remotely, functions equivalent to those of the log-retrieval tool were added to the FOMA Module, so that processing to receive and store the logs could be done internally. By enabling the module to collect logs equivalent to those produced with the log retrieval tool during FOMA Modules testing and area service-quality testing, maintenance staff can accurately evaluate the service quality remotely, thus achieving improved maintenance service for the users.

Starting and stopping accumulation of logs, and transmitting the stored logs over the network is initiated by remote-control commands[*7] received over the network. We added functionality to the FOMA Module to recognize remote commands within the text of an SMS Push message, and to perform the corresponding log-accumulation or transmission procedure. Logs are sent through the network in SMS Push message responses, but since the data size of single response is limited, logs are split into standardized, fixed time periods, and stored in block units of a size that can be sent in one response. This allows larger logs to be split into multiple messages in block units and sent over the network.

On the network side, we have developed features that allow the remote commands mentioned above to be sent through the network, using SMS Push, from the FMS to a FOMA Module at any time. The result of the commands can also be monitored with the FMS.

From the FMS, it is possible to check the call status (connected or disconnected) of a FOMA Module, whether it is in-range or not, and what its IP address is. This information is thus immediately available to a support maintenance person when responding to a user inquiry.

There are various other remote commands that can be executed at any time to obtain more detailed information regarding the state of the FOMA Module, as required.

When using remote commands to retrieve log files, they are retrieved in parts, but they are then reassembled, so that they can be reviewed according to time sequence whenever necessary.

These measures make it possible to perform remote maintenance tasks such as discovering configuration problems or analyzing logs in real time on FOMA Modules when users inquire about unreliable communications they may be experiencing with their FOMA Module.

4.2 Operation Overview

Here we overview the operation of the FOMA Module radio-quality-data remote-retrieval function.

This function utilizes the MSR, TISCP and FMS, and operates by sending remote-control commands through the network using SMS.

The sequence for remotely retrieving logs from a FOMA Module is shown in Fig. 3. The steps before entering the remote-control command are the same as steps (1) to (3) in Fig. 2. The particular FOMA Module is specified to the FMS by telephone number, and the FMS then sends the remote-control command to the MSR (Fig. 3 (4)'). Upon receiving the remote-control command line, the MSR formats it in an SMS message and pushes it to the module (Fig. 3 (5)'). Upon receiving the Push message from the MSR, the FOMA Module executes the command and returns the result through the network as an SMS Push result, without interfering with ongoing packet communications (Fig. 3 (6)'). The MSR then sends the result of executing the remote control command to the FMS.

5. FOMA Module Communicating-sector Cell Number Retrieval Function

5.1 Technical Issues and Implementation

We now describe issues surrounding the implementation of the FOMA Module communicating-sector cell number retrieval function.

- In order to get an accurate understanding of the conditions when the quality of communications coverage becomes unstable for a FOMA Module, such as at the edges of the service area, in the past it was necessary to do an on-site survey. In order to provide rapid maintenance support and to effectively expand the service area, allow these service area conditions to be retrieved remotely.

When the communication becomes unstable, as at the edges of the service area, the sector data can change frequently, or the data may become intermittent. However, the sector data can only be obtained when the FOMA Module is connected, and not when disconnected, retrieval of the sector data must be enabled when the module moves from a disconnected state back to a connected state. This functionality was implemented taking this into consideration.

The FMS registers the telephone number of the FOMA Module for which it needs to retrieve sector data with the core network. When the registered telephone number connects, the sector information is sent from the core network to the FMS. However, when the telephone number disconnects, the registration on the network side is discarded. This means that for FOMA Modules, which connect and disconnect often, continuous sector data cannot be obtained. To resolve this issue, functionality was added to the FMS so that after it receives information from the core network about a disconnection, it uses an existing FOMA Module call-state management function in the FMS to detect changes in the state of the applicable phone number. When a change from disconnected to connected states is detected, it re-registers the telephone number with the core network. The collected sector data is accumulated for a fixed period of time, and this information can be checked by the maintenance person at any time.

Through these measures, maintenance person obtain the state of the service area from a remote location, regardless of whether FOMA Module communications are stable or not.

5.2 Operation Overview

Here we describe the operation of the FOMA Module communicating-sector cell number retrieval function.

The FMS registers the telephone number of the FOMA Module, for which sector data is desired, with the core network. Whenever the sector data for the applicable FOMA Module changes or is updated, the core network notifies the FMS with the telephone number, a timestamp for the change and the new sector data (**Figure 4** (1)). As mentioned in the previous section, the sector data can only be obtained
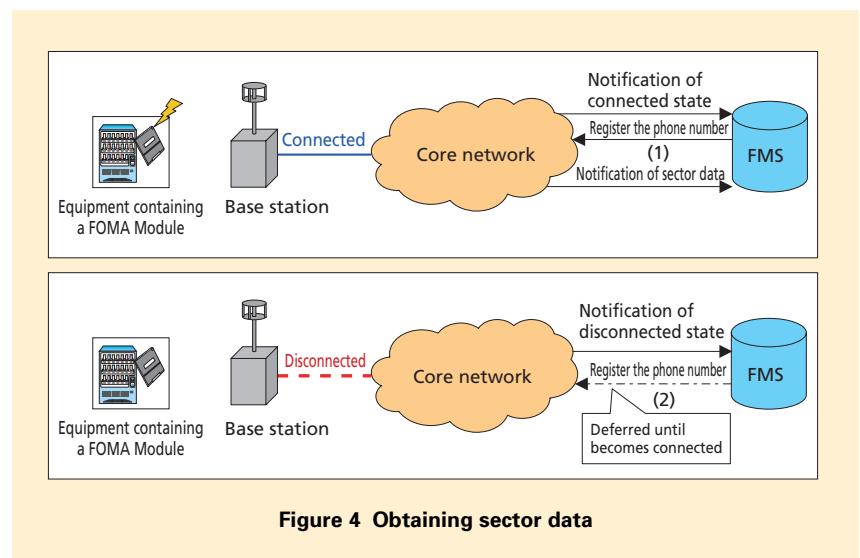

Figure 4 Obtaining sector data

when the FOMA Module is connected. Accordingly, when the module's call state, which is managed by the FMS, changes from disconnected to connected, the FMS automatically re-registers the module's phone number with the core network (Fig. 4 (2)).

6. Conclusion

We have described the technical issues and implementation method for a remote maintenance and management system developed for FOMA Modules. In the future, the machine communi-cations business, making use of FOMA Modules, is expected to expand even further, so we will contin-ue to extend FOMA Modules and the FOMA network to provide even more reliable communications through the FOMA packet service.