

## A Study on the Efficient Service Structure for Remote Meter Reading

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### Abstract

*The previous PDA based wireless meter reading system uses the method of transmitting the meter value of the gauge using the PDA meter reader when instructed by the PDA meter reader. Such meter reading methods requires a considerable amount of time when collecting the data from multiple collectors. This paper will propose the structuring of new meter reading system (Mobile OMR) and meter reading infra (Mobile Dongle) in order to overcome the limits and disadvantages of the previous PDA wireless meter reading system using the smart devices that can directly communicate with the remote meter reading system and the mobile dongle that can be linked to the smart devices. In addition, by utilizing the many features of smart devices and to solve the problems of timely/costly occurrence of installing wireless meter reading system, meter reading and maintenance, it was configured to enable the selection change of each devices and immediate meter reading operation test directly at the site according to the situation of the site where the remote meter reading system is installed. In addition, by using the smart devices, a user authentication technique to solve the security issues on the use of application was proposed, and through the GPS and map function, the location information of installation site of each devices were accurately mapped in order to allow the convenience in management of location information on the installation site of all devices, and by receiving the log data or status information stored in the remote meter reading system in high speed, it intends to provide the installation check, meter reading and maintenance methods of remote meter reading system using the smart devices and mobile dongle that can enable to recovery of data during the failure period and reducing the maintenance time.*

**Keywords:** Smart Device, Advanced meter reading, Mobile dongle, Remote meter reading service

### 1. Introduction

The recent development of embedded technology and wireless technology has led the creation of many applications for low-cost small wireless devices. The development of these technologies is enabling the creation of a variety of additional services for the wireless remote meter reading market that is connected with the smart water grid and home network. It has advantages such as easy installation of remote meter reading system using the wireless

system, reducing the equipment work and maintenance costs, and ease of expansion of various meter reading system [1-4].

Generally, for the meter reading targets such as sewerage, electricity and gas are read by the measuring agent by visiting each home or building and the results are manually recorded or entered using portable terminals such as PDA. [1, 2] Such method of meter reading not only requires many hours but inefficient and the cost will increase proportionally with the increase of meter reading targets and has a possibility of having omissions and errors of data collected by the measuring agents or having inspection error and invasion of privacy by the measuring agents. [3, 4] In addition, it has a difficulty of upgrading the software and a problem of connecting with a variety of services. For such problems, auto meter reading system that performs and reads the meter reading targets using the sensor connected to a network was proposed. [5, 6] It consists of the meter reading unit which includes the RF module obtains the meter value on the meter reading targets and display the above meter value, and wirelessly sends the meter value in response to the transmission request of portable terminals, and the repeater that wireless collects the meter value at the preset time, and the control server that creates either the billing information or statistical information by obtaining the meter value from the concentrator or each meter reading unit [7, 8].

However such technology has a problem of having to be installed on the pre-planned area after completing the creation of all setting information (periodic data transfer time, transfer order, device ID, *etc.*) of each installing equipments (collector, repeater, concentrator), and due to the functional limitation of mobile terminal, it has a difficulty of mapping the installation area information as a map or modifying the information of devices onsite. In addition, since it is not possible to check whether the remote meter reading system is operating normally on real-time basis during the installation process or immediately after the installation, after installing each devices and verifying whether the initial data (normally 4 or 6 hours of interval) of each device is sent by the remote meter reading server, check the error status of each device having problems or the connection of meter reading network, and if problems are found for the installation of devices, the installation personnel have to be sent back to the site having a problem to physically verify the meter reading network configuration and the status of each device and once again waiting for the initial data to be received from the server [6,7,9,10].

Therefore in this paper, in order to solve the above mentioned problems using the smart devices that can directly communicate with the remote meter reading system and the mobile dongle that can be linked to the smart devices, a variety of functions of smart devices were utilized to solve the timely/costly problems occurring during the system installation check, meter reading and maintenance, a remote meter reading method using the smart device was proposed which can enable the selection change of each devices and immediate meter reading operation test directly at the site according to the situation of the site. In addition, by accurately mapping the location information of installation site of each devices using the GPS and map function, and facilitating the management of location information on the installation site of each devices by managing the corresponding location information along with pictures of installed site, and receiving the log data or status information stored in the remote meter reading system in high speed, it intends to provide the installation check, meter reading and maintenance methods of remote meter reading system using the smart devices and mobile dongle that can enable to recovery of data during the failure period and reducing the maintenance time.

## 2. Remote Meter Reading Service Structure

Through the connection with dedicated mobile dongle, a two-way communication with the remote meter reading system is possible over the remote meter reading network from a mobile device. In the application of the smart device, efficient ID recognition and a variety of related information of each device can be checked, and through GPS, camera and map, it allows to manage more accurate location information of the installation site. Through the smart devices, a meter reading and status information of the remote meter reading system can be requested and obtained in real-time basis and it can effectively collect the big data stored in each device. The remote meter reading system being considered, as shown in Figure 1, performs the hierarchical data collection in the structure of collector, repeater and concentrator. Each device of the remote meter reading system, the collector, repeater and concentrator has a unique ID and each device can periodically wake to receive a command request and also transmit the meter reading data through the collector->repeater->concentrator at designated time intervals. Generally, the concentrator is equipped with the CDMA module and transmits the collected data each hour through the Internet using the CDMA network and the data is transmitted to the remote meter reading server connected to the Internet.

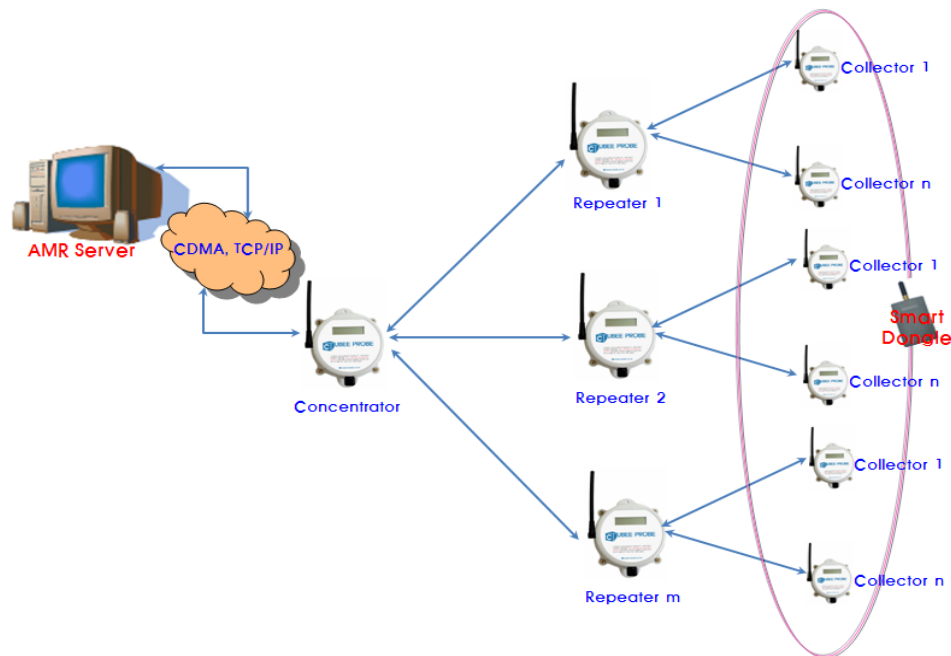


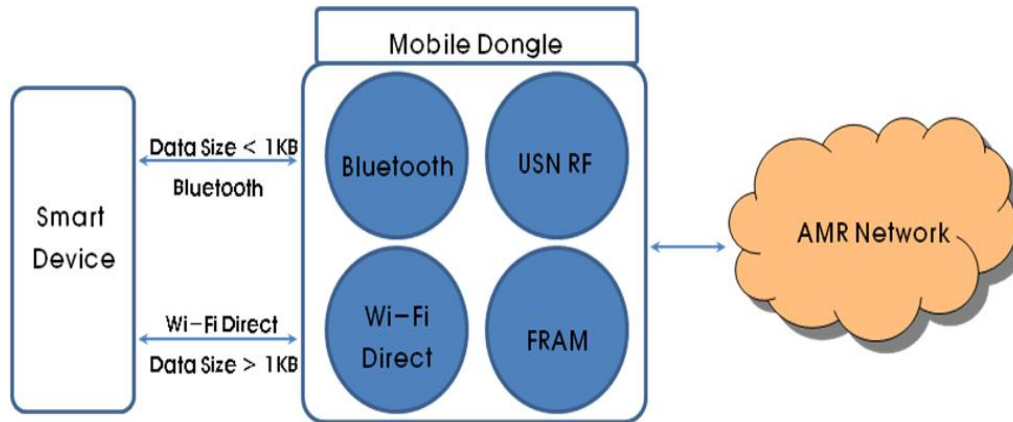
Figure 1. Configuration of Remote Meter Reading System

## 3. Mobile Dongle and AMR Network Access

### 3.1. AMR Network Connection of Mobile Dongle

The Figure 2 represents the structure of mobile dongle and the connection of AMR network. The mobile dongle as shown in Figure 2 has a built-in RF modem to communicate with each devices of remote meter reading network and the Bluetooth for connection with the smart device, and with the internal flash memory, it can store the 1st collected meter reading data, installation and setting information and the log information. In addition, when

transferring a large amount of data, the Bluetooth can be converted to Wi-Fi Direct to transfer the data to the smart device.

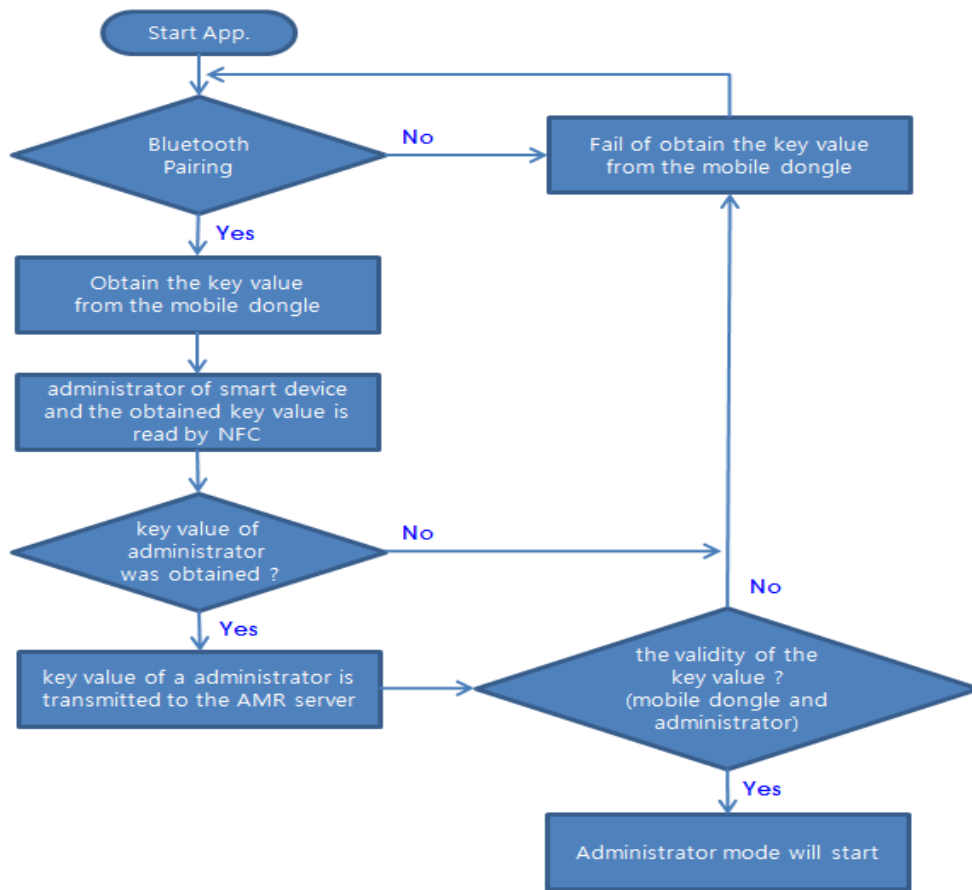


**Figure 2. The Structure of Mobile Dongle and AMR Network Connection**

### 3.2. User Authentication of Mobile (Installer) Dongle

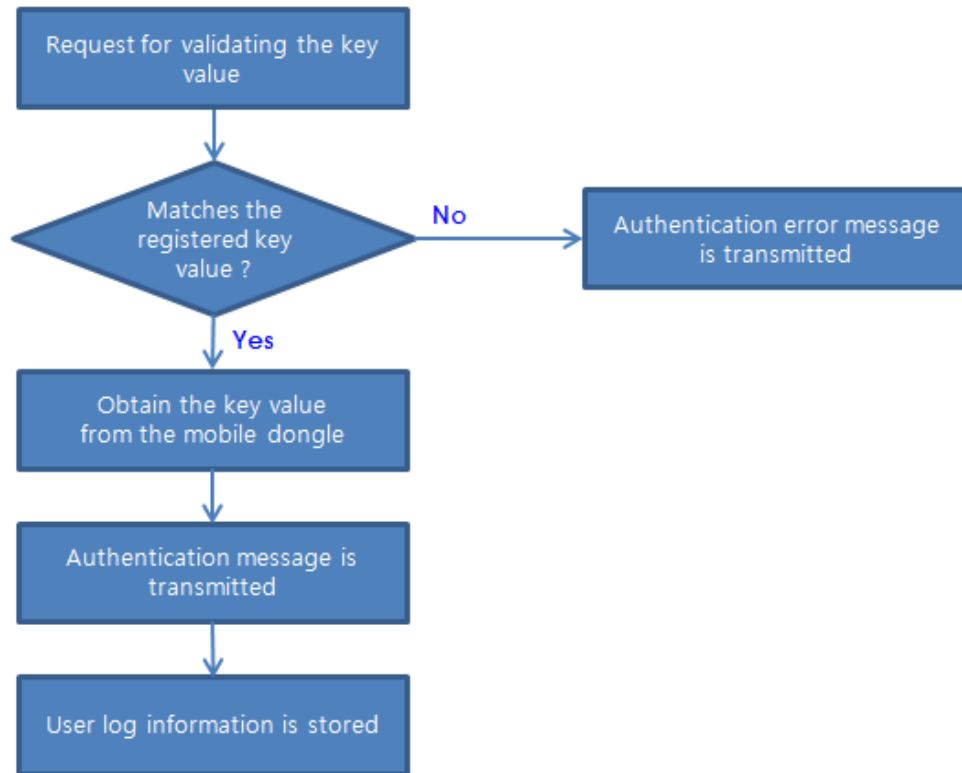
The Figure 3 represents the user authentication process of smart devices and Mobile dongle. First, the remote meter reading application is initiated at the smart device and after determining whether the Bluetooth has been paired between the smart device and Mobile dongle, if the Bluetooth was not paired, it cannot obtain the Key value from the Mobile dongle. If the Bluetooth has been paired, the key value is obtained from the Mobile dongle. After that, the RFID TAG which is given only to a specific administrator of smart device and the obtained key value is read by NFC. Since then, whether or not the key value of specific administrator was obtained will be determined. If the key value of a specific administrator was not obtained, it goes back to the initial state. And if the key value of a specific administrator was obtained, the key value obtained from the Mobile dongle and the key value of a specific administrator is transmitted to the remote meter reading server.

Afterwards, the validity of the key value obtained from Mobile dongle and the key value of a specific administrator is determined at the remote meter reading server. If the key value obtained from Mobile dongle and the key value of a specific administrator is invalid, it returns back to the initial state. If the key value obtained from Mobile dongle and the key value of a specific administrator is valid, the administrator mode will start and the user authentication process between the smart device and installer dongle will be completed. Here, the application will operate normally only when the key value obtained from Mobile dongle and the key value of a specific administrator is entirely received, and the validity of the key value obtained from the Mobile dongle and the key value of a specific administrator is then determined and the resulting authentication is transmitted after the corresponding values have been stored.



**Figure 3. User Authentication Process of Smart Devices and Mobile Dongle**

Figure 4 represents the user authentication process of remote meter reading server. First, the request for validating the key value obtained from Mobile dongle and the key value of a specific administrator is transmitted to the remote meter reading server. Afterwards, it validates whether the key value obtained from Mobile dongle and the key value of a specific administrator matches the registered key value. If the key value obtained from Mobile dongle and the key value of a specific administrator does not match the registered key value, then authentication error message is transmitted. If the key value obtained from Mobile dongle and the key value of a specific administrator matches the registered key value, then authentication message is transmitted. Afterwards, the user log information is stored in the remote meter reading server, the user authentication process of the remote meter reading server is completed. Here, using the key value obtained from Mobile dongle and the key value of a specific administrator, it identifies when and what site was accessed through a random installer dongle of a random specific administrator, and the user log information is stored.

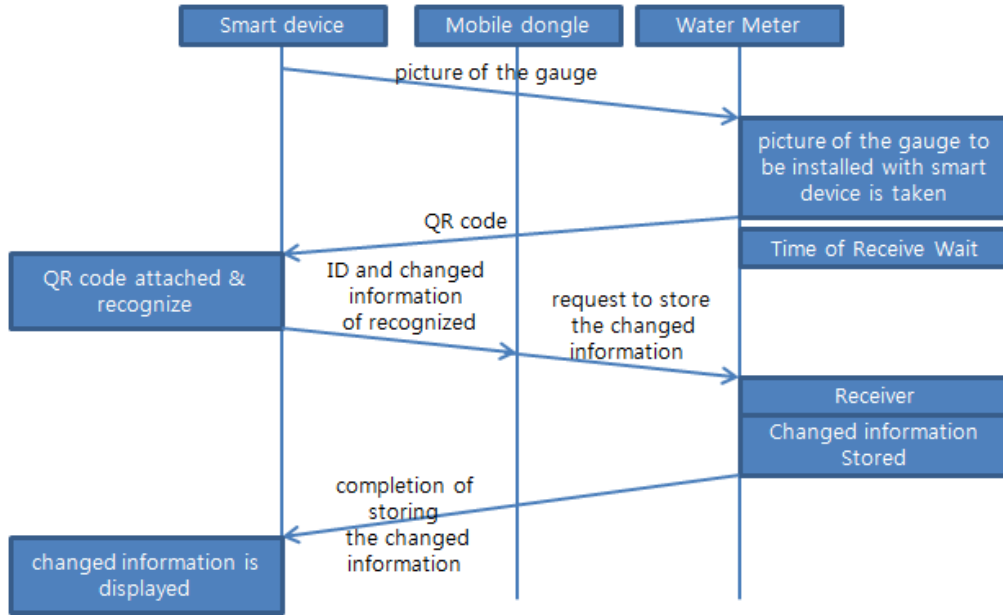


**Figure 4. The User Authentication Process of Remote Meter Reading Server**

### **3.3. Recognition /Diagnostics / Collection of AMR Device**

Each devices of remote meter reading system such as collector, repeater and concentrator will be given an ID value at the manufacturing phase and the value is printed as the QR code and attached to the front of each device. During the site installation phase, the QR code of each device is recognized by the application of smart devices and using the corresponding ID, the basic setting information of each device is requested and received using the Mobile dongle. In addition, when necessary, added or changed information of each device entered into the smart devices by the site installer can be stored in each device through the Mobile dongle. And using the recognized or already known ID, a specific device can be designated to store the setting information or read the stored information using the smart devices.

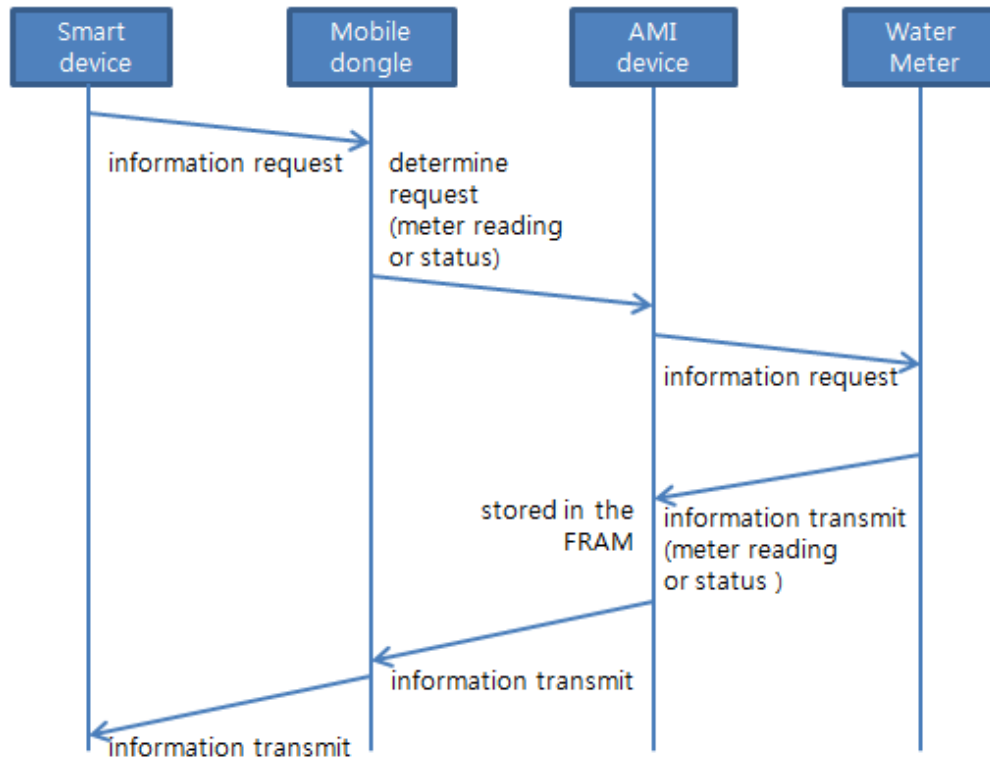
The Figure 5 represents the individual recognition between each devices and designation process. First, it is progressed assuming that each device (gauge, remote meter reader, remote collector, remote repeater, remote concentrator) are given an ID value at the manufacturing phase and the value is printed as the QR code and attached to the front of each device. First, the picture of the gauge to be installed with smart device is taken. Then, the QR code attached to the front of the gauge is recognized by the smart device. At such time, the smart device individually recognizes the gauge through the QR code. Afterwards, the ID and changed information of individually recognized smart device is transmitted to the Mobile dongle. Then, the request to store the changed information is transmitted to the gauge by the Mobile dongle. Thereafter, the gauge transmits the message indicating the completion of storing the changed information to the smart device and the individual recognition between each devices and designation process is completed. At such time, the message indicating the completion of changed information is displayed on the smart device.



**Figure 5. Individual Recognition between each Devices and Designation Process**

Before the request to store the changed information is transmitted by the Mobile dongle to the gauge, the preamble between the mobile dongle and the gauge will begin. In addition, due to such individual recognition and designation process, when necessary, the added or changed information of each device entered into the smart devices can be stored in each device through Mobile dongle. In addition, using the recognized or already known ID, specific devices can be designated to store the setting information or read the stored information using the smart device. Also, each device has a command receiving standby time for a periodic command receiving standby so each device transmits the information at the corresponding command receiving standby time.

The Figure 6 represents the meter reading and the status information request process. The smart device will request the meter reading or the status information to the Mobile dongle. Afterwards, the Mobile dongle will determine whether the information relates to the meter reading information or the status information, and the Mobile dongle then requests the corresponding information to the gauge. Then, the gauge transmits the meter reading or the status information. After transmitting, the gauge transmits the meter reading or the status information to the Mobile dongle. Lastly the meter reading or the status information is stored in the FRAM of Mobile dongle and by transmitting the meter reading and the status information to the smart device, the meter reading and the status information request process is completed. Also, each device has a command receiving standby time for a periodic command receiving standby so each device transmits the information at the corresponding command receiving standby time.

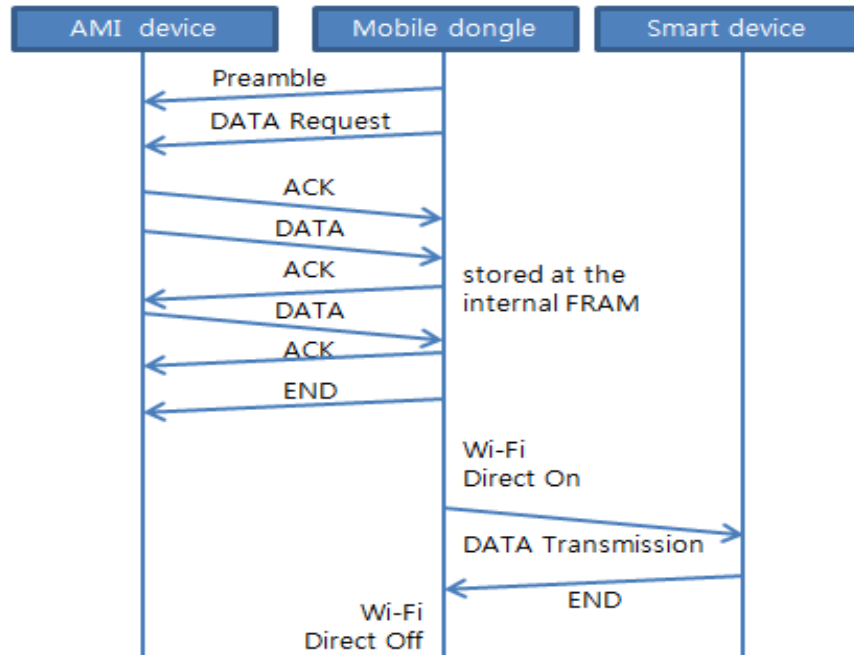


**Figure 6. Meter Reading and Status Information Request Process**

The Figure 7 represents the data collection process of each remote meter reading devices. The Mobile dongle will request the meter reading data to the remote collector, remote repeater and remote concentrator. Thereafter, the remote collector, remote repeater and remote concentrator will transmit the information requesting the meter reading data. Then, the meter reading data is transmitted between the remote collector, remote repeater, remote concentrator and the Mobile dongle and ACK confirming the receipt of such meter reading data is performed several times. Then the meter reading data is stored in the FRAM of Mobile dongle and the Mobile dongle informs the completion of the meter reading data collection of the remote collector, remote repeater and remote concentrator. Afterwards, the Wi-Fi Direct module of Mobile dongle is turned on. The Mobile dongle then transmits the collected meter reading data to the smart devices using the Wi-Fi Direct. Then the smart device confirms the completion of transmission of collected meter reading data to the Mobile dongle. After the receipt, the Mobile dongle turns off the Wi-Fi Direct module and the data collection from each device is now terminated.

Also, each device has a command receiving standby time for a periodic command receiving standby so each device transmits the information at the corresponding command receiving standby time. For the method of checking the installation of remote meter reading system, meter reading and maintenance using the smart devices and mobile dongle, even during the occurrence of a communication problem of the remote collector, if the reception is possible from the gauge it can periodically receive the current value of the gauge to be stored in the internal memory and through this, by reading the entire memory data of the corresponding remote collector in the future, the entire meter reading history and log can be checked.

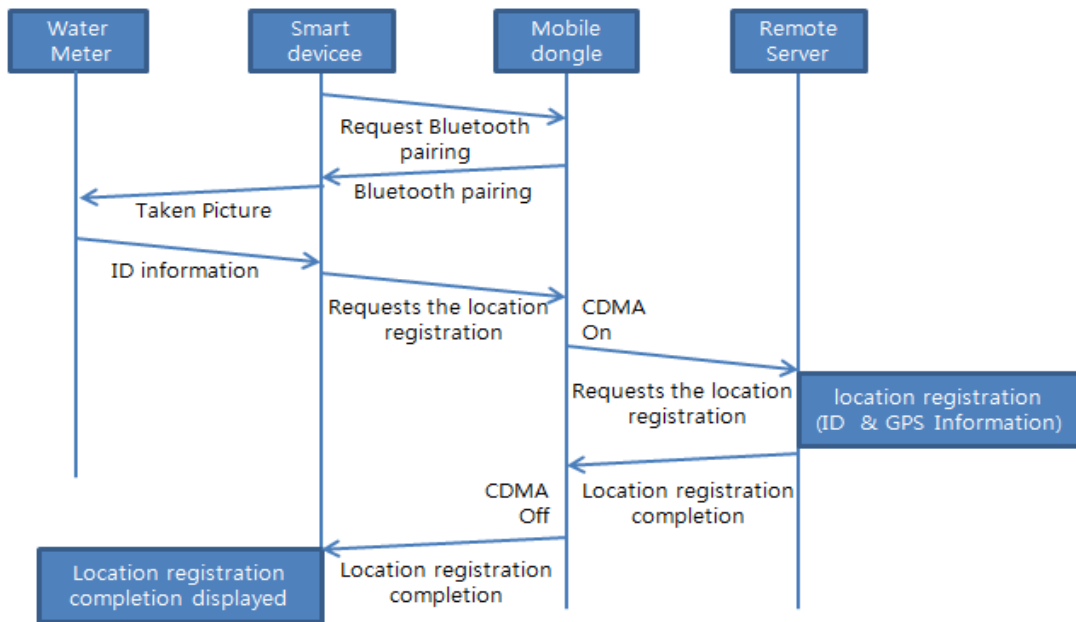




**Figure 7. Data Collection Process from each Remote Meter Reading Devices**

In addition, in order to solve the problem of transmitting a large amount of meter reading data, for the data having the size of more than 1KB, first using the RF, the data is stored at the internal FRAM of Installer dongle and such large data can be quickly transmitted to the smart devices using the Wi-Fi Direct and not the Bluetooth. The Wi-Fi Direct will remain in a power down mode to prevent the draining of the battery and only activated when transmitting a large amount of data to the smart devices and after the transmission, it converts back to the power down mode, and for transmitting a small amount of data, the status information can be checked with the Bluetooth.

The Figure 8 represents the location information of the remote meter reading installation site and verification process. First, the smart device requests the Bluetooth pairing with the Mobile dongle. Then, the Mobile dongle confirms to the smart device that the Bluetooth has been paired. Afterwards the smart device takes the site picture of the gauge to be installed. Then the ID information of installed gauge is transmitted to the smart device. Afterwards, the smart device requests the location registration (ID information of above installed gauge, current GPS information) to the Mobile dongle. Then, the Mobile dongle requests the location registration (ID information of above installed gauge, current GPS information) to the remote meter reading server and whether the ID of a specific gauge was registered on the remote meter reading server is confirmed. At such time, the current GPS information is stored on the remote meter reading server. Then, the remote meter reading server confirms the completion of location registration to the Mobile dongle. Then, the Mobile dongle confirms the completion of location registration to the smart device and the location information of installation site and verification process is completed. At such time, the smart device will display a message indicating the completion of the location registration. Here, the transmission between the smart device and Mobile dongle takes place using the Bluetooth. In addition, the CDMA of Mobile dongle and the remote meter reading server will turn on to allow the communication using the CDMA. Once the location registration is completed, the CDMA will turn off.



**Figure 8. Checking the Location Information of Installation Site and Verification Process**

#### 4. Conclusion

In this paper, using the Mobile dongle that can directly communicate with the remote meter reading system and utilizing various features of smart devices, the timely/costly problems which occurs during the system installation check, meter reading and maintenance was tried to be solved. According to the situation of the site, the function was configured to enable the selection change and immediate meter reading operation test of each device directly at the site. In addition, by using the generic smart device, a security problem on the use of application was solved and by accurately mapping the location information of installation site for each device using the GPS and map function, and managing the location information with the pictures of installed sites, it has facilitated the management of information on the installation site of all devices.

By being able to receive a long period of log data or status information stored on the remote meter reading system at high speed, and complexly utilizing the various functions(Bluetooth, Wi-Fi Direct, GPS, *etc.*) of smart devices that enables the recovery of data during the failure period and by reducing the maintenance time, a smart device and Mobile dongle that can resolve the timely/costly problems which occurs during the installation check of remote meter reading system, meter reading and maintenance was proposed, and it is expected to be effectively used for the installation check of remote meter reading system, meter reading and maintenance.

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