Experiment of Wireless Sensor Network to Monitor Field Data

Moo Wan Kim
Kwang Sik Kim
Tokyo University of Information Sciences
Chiba, Japan

ABSTRACT

Recently the mobile wireless network has been drastically enhanced and one of the most efficient ways to realize the ubiquitous network will be to develop the converged network by integrating the mobile wireless network with other IP fixed network like NGN (Next Generation Network). So in this paper the term of the wireless ubiquitous network is used to describe this approach.

In this paper, first, the wireless ubiquitous network architecture is described based on IMS which has been standardized by 3GPP (3rd Generation Partnership Program). Next, the field data collection system to match the satellite data using location information is proposed based on the concept of the wireless ubiquitous network architecture. The purpose of the proposed system is to provide more accurate analyzing method with the researchers in the remote sensing area.

Keywords: IMS, 3GPP, NGN, Sensor Network, WLAN, MODIS

1. INTRODUCTION

In the area of the mobile wireless network, 3G technologies continued evolution to 3.5G, 3.9G (LTE: Long Term Evolution) 4G to provide higher data speed. Fig.1 shows the 3.5G conceptual mobile network architecture based on IMS (IP Multimedia Subsystem) standardized by 3GPP . Fig.6 shows the configuration of IMS and as shown in Fig.6, main entities of IMS are P/S/-CSCF (Proxy/Serving Call Session Control Function), HSS (Home Subscriber Server) and ASs (Application Servers) to control various multimedia services. Basically the functions of these entities are also mostly necessary when the fixed network would be changed to IP based network like NGN (Next Generation Network).

So FMC (Fixed Mobile Convergence) will be expected to be realized by integrating both IMS (e.g. IMS in mobile network and core IMS in the fixed network). Furthermore various wireless technologies like W-LAN/W-MAN(e.g. WiMAX) /WPAN will be also able to be integrated into FMC as the access networks. In this paper the future wireless ubiquitous network is defined as the converged network based on this idea and Fig.2 shows an example of conceptual wireless ubiquitous network architecture.

Field data collection system to be proposed in this paper is an application example of the wireless sensor network which is one of the access networks of the wireless ubiquitous network. The purpose of the system is to provide more accurate analyzing method with the researchers in the remote sensing area by matching appropriate field data with the satellite data, which means to realize the ground truth in the area of remote sensing . Chapter 2 shows the outline of FS (Field Server) as a kind of wireless sensor node and Chapter 3 describes the field collection system. Chapter 4 describes the leaf phenology as the first trial of the system .

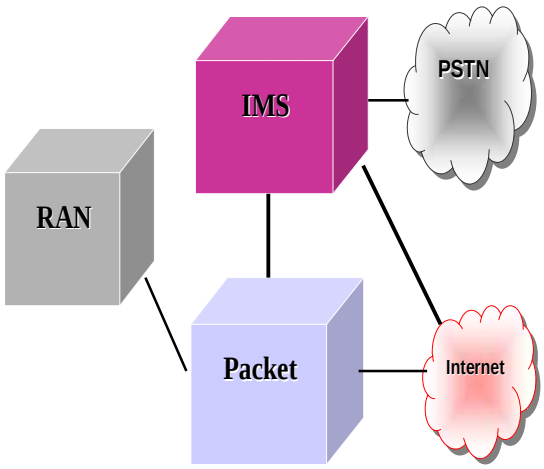

Fig. 1. 3.5G Mobile Network Architecture

2. FIELD SERVER

The wireless sensor network in the field data collection system consists of FS (Field Server) which is a kind of sensor node. FS has several capabilities to collect various field data and can make real-time monitoring in the farms or facilities. Fig. 3 shows the outline of FS.

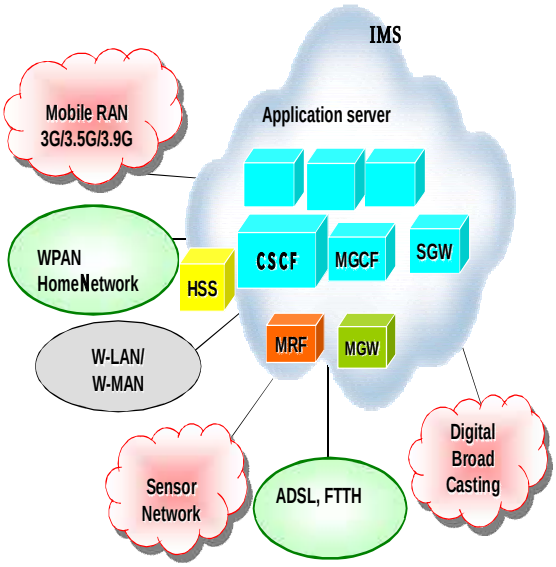

Fig. 2 Example of Wireless Ubiquitous Network

Table 1 shows the main specification of FS. The core chip of FS uses one chip microcomputer. FS has the network camera to take picture of the environment and sensors to collect the basic data in the field (i.e. temperature, humidity). If necessary, a number of sensors (i.e. CO2 concentration, soil moisture, leaf wetness) can be easily integrated into the FS.

Also FS has Wireless LAN capability to communicate with other FSs based on ad-hoc network and to connect with the core portion of the wireless ubiquitous network.

3. FIELD DATA COLLECTION SYSTEM

Fig. 7 shows the outline of the proposed system and how the field data can be processed via the ubiquitous network. The field data collected by FSs can be sent to the data monitor system, and then based on the location information of FS which can be obtained by the GPS equipment attached to the FS, operator can compare the field data with the satellite data. This scheme is the realization of ground truth from the viewpoint of remote sensing research based on satellite data .

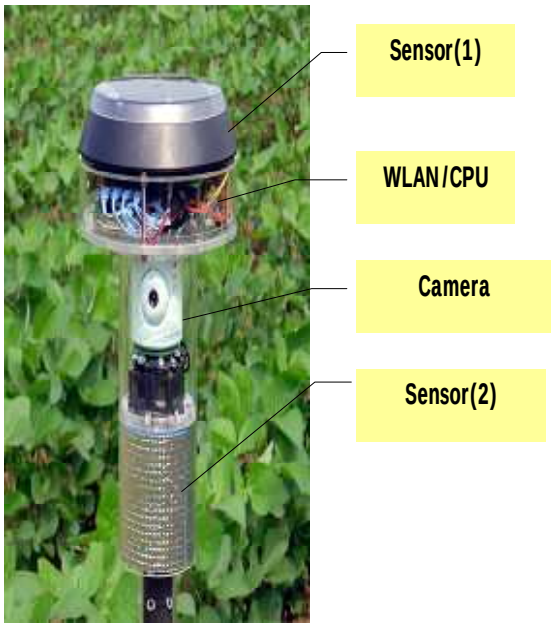

Fig. 3 Outline of FS

TABLE 1
SPECIFICATION OF FS

Sensor	Temperature	
	- Method	Transistor
	- Scope	0~100℃
	Humidity	
	- Scope	5~95%
	Sun Light	Value of PPFD
Comm.	Transport	DS-SS, OFDM
	Standard	IEEE802.11g:54/48/36/24/18/12/9/6[Mbps]
		IEEE802.11b:11/5.5/2/1[Mbps]
	Frequency	2412~2472MHz
	Speed	LAN port:100Mbps/10Mbps(AUTO-MDIX)×4
	Protocol	HTTP, FTP, TCP/IP, UDP, DHCP, SMTP

Tokyo University of Information Sciences has the facility to receive the satellite data periodically. The satellite data are the MODIS (MODerate-resolution Imaging Spectrora diometer) data in the Terra /AQUA satellite launched by NASA and various visible data can be obtained from the MODIS data processing system. Fig. 4 shows an example of MODIS data which include the area of the University, that is, city of Chiba in Japan.

Fig. 4 Example of MODIS Data

4. LEAF PHENOLOGY

Wireless sensor network that connect three FSs via W-LAN has been developed in the University to validate the feasibility of the proposed system. Fig.5 shows one of FSs installed on the roof of the building which has the firm foothold in order to protect against the strong wind like Typhoon .

Then the leaf phenology has been selected as a trial example of the monitoring target. Fig. 8 shows an example of picture that have been taken by the FS. Right side of the picture shows the evergreen tree and the left side shows the deciduous tree.

We have collected the field data (e.g. picture, temperature, humidity) for around six months . We had experienced the strong Typhoon three times during the period, but we had been able to collect the necessary data successfully thanks to the installed protection against the wind. Then we have selected the hue data as the basic validation data because the hue data can delete several noise. The hue data have been derived based on the following procedure.

<Procedure>

1. Selecting two areas (900-3000 pixels) in each picture for evergreen trees and deciduous trees.
2. Analyzing the basic color components (i.e. R:Red, G:Green, B:Blue) for those selected areas.
3. Calculating the hue data H by the following equation;

$$H=\tan\text{-}1(G-B)/(2R-G-B)$$

Fig.5 Example of Installed FS

5. CONCLUSION

This paper proposes the field data collection system which is based on the wireless sensor network and is also based on the concept of wireless ubiquitous network. Also the trial system to validate the feasibility of the proposed system which consists of three FSs has been described and some result has been shown. The main purpose of the proposed system is to provide more accurate analyzing method with the researchers in the remote sensing area by matching appropriate field data with the satellite data.

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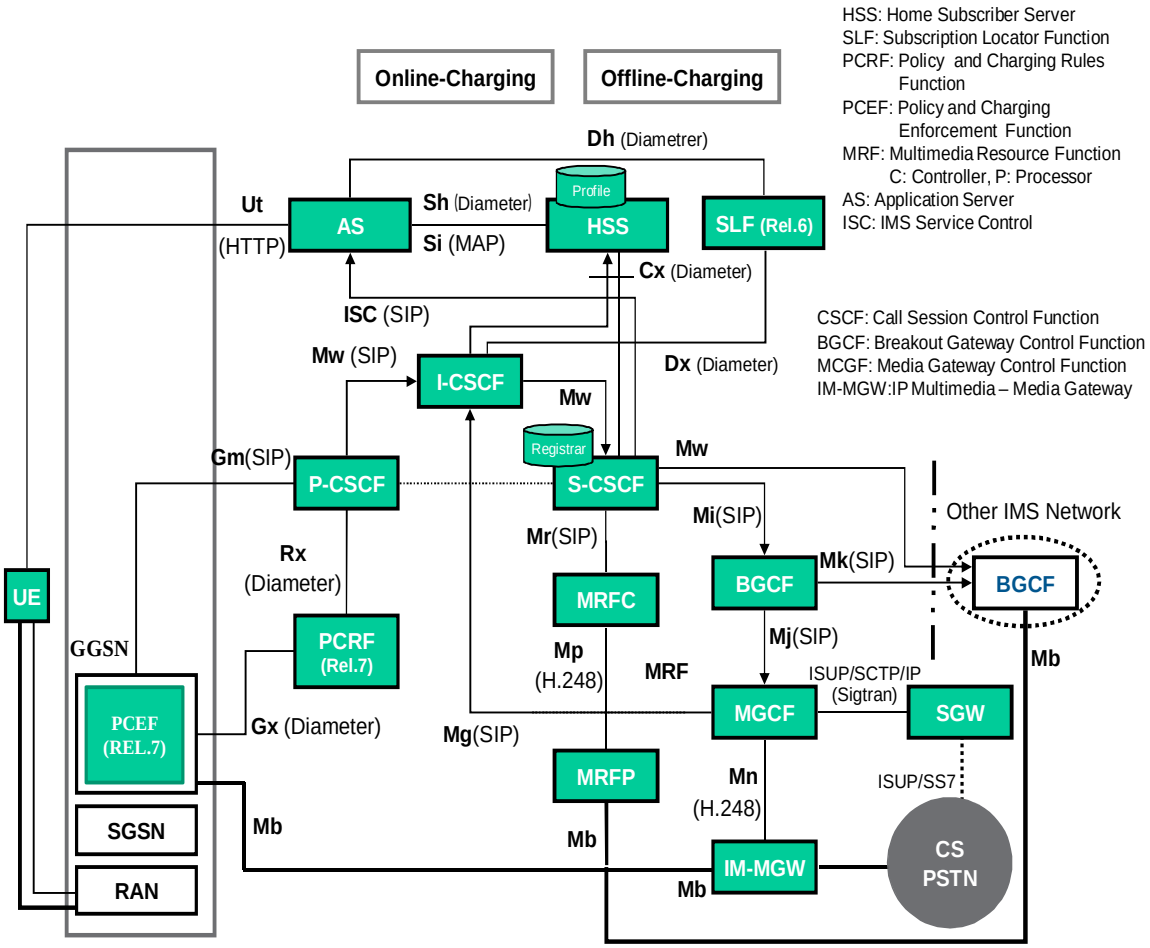

Fig. 6 Configuration of IMS (Release 7)

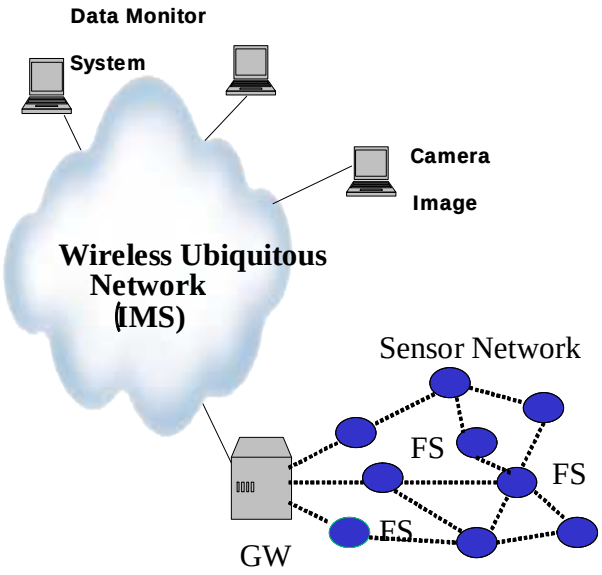

Fig. 7 Outline of Proposed System

<Deciduous Trees> **<Evergreen Trees>**

Fig. 8 Example of Picture taken by FS