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Design and Implementation of WPAN Middle-ware for Combination between CDMA and Bluetooth

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ABSTRACT

The Wireless Internet services widely spread out with the developments of CDMA(Code Division Multiple Access) networks and wireless units. In contrast to the telecommunication network, WPAN (Wireless Personal Area Network) enables to transmit data and voice in personal area. Although WPAN technologies are commercially utilized, the combined services with CDMA network are not so poplar up to now. Various services can be provided using the combination between CDMA and WPAN. This paper presents the practical and united model between CDMA and WPAN. Specially, the main focus of this research lies on the design of the Middle-ware system of a handset which could be managing both CDMA and WPAN. This system used Bluethooth by WPAN. For the devices with the proposed WPAN Middle-ware, service areas of the CDMA network can be expanded to WPAN, various services can be realized by the transmission of data and voice, and consequently, the user computing environment could be improved.

Keywords: Ubiquitous Computing, WPAN Middle-ware, Combination of Different Network, Network Area Extension

1. INTRODUCTION

The wireless communication technology is rapidly developed with the standardization of GSM and CDMA. The voice and data are using those networks. On the other hand, ad-hoc network environments are settled applying Bluetooth[1] or IrDA[2], and so on. Using these technologies, data from the wireless keyboard is transferred to PC, the voice from handset is sent to wireless headset and mobile commerce services are provided. Also, ZigBee[3] and UWB[4] technologies are under standardization and being commercialized, soon.

The wireless short-distance networks as above are called WPAN (Wireless Personal Area Network) and the devices constructing WPAN are based on ad-hoc networking[5]. Although various ad-hoc networks are utilized, the combination of WPAN with CDMA network is not so poplar until now. The main reasons are that the wireless network technologies have been separately developed and it has different service targets. Since the handset is essential to the users, it is required to connect those networks.

In this paper, an infrastructure is proposed for the connection of CDMA network with WPAN. Applying the proposed structure, the service areas are expanded and various services can be provided to the customer side. A middle-ware to combine CDMA network and WPAN should be designed.

Especially, the structure is implemented for CDMA and Bluetooth and the handset with MS smart-phone is utilized for the implementation. The remainder of this paper is organized as followings. In Section 2, the CDMA and WPAN mobile computing environments are briefly sum-

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marized. In Section 3, the middle-ware structure for the connection of CDMA network and WPAN is proposed. In Section 4, implementation results of the proposed structure are presented and the conclusion followings in Section 5.

2. RELATED WORKS

2.1 Wireless Internet Service

CDMA(Code Division Multiple Access) is a digital spread-spectrum modulation technique and is proposed by Qualcomm. In 1997, the CDMA presents commercial services in Korea.

Fig. 1 shows the overall structures of CDMA network. The data and voice are transferred using CDMA network.

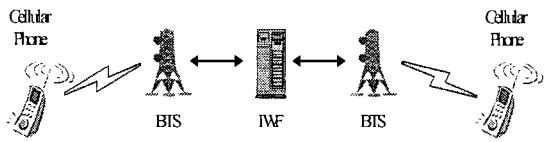

Fig. 1. Structure of CDMA Device.

Nowadays, the wireless Internet services are provided using CDMA network and handset. Fig. 2 illustrates the structures of wireless Internet service using WAP[6].

As shown in Fig. 2, the wireless Internet devices receive the data from the external contents provider server through CDMA network. The gateway is in charge of the connection of the Internet and CDMA network. As above, the WPAN is not connected to the services in the present[7].

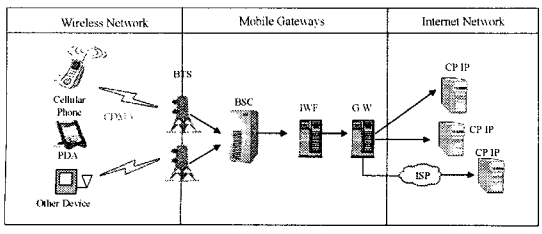

Fig. 2. Service Flow of Wireless Internet.

2.2 Bluetooth Technology

Bluetooth wireless technology is a short-range radio technology. Bluetooth is able to transmit signals over short distances between telephones, computers and other devices and communication and synchronization between devices are simply embodied. Recently, Bluetooth 2.0+EDR(Enhanced Data Rate) has been released by Bluetooth SIG[3]. In this specification, the data rate has been increased up to 3Mbps and power consumption is reduced. The Bluetooth technology is going to evolve to wireless sensor network and make efforts to compete with other PAN technologies such as ZigBee.

Nowadays, Bluetooth will be adopted in all GSM handsets. The followings are the examples of commercialized services using Bluetooth.

a. Inter-working of telephone and wireless handset using Bluetooth. Recently, a commercial inter-working service is possible for telephone and wireless handset in Korea.

When the user is at the indoor space, the wireless data service or call service are provided with PSTN using the Bluetooth. Until now, PSTN and CDMA network have been developed respectively. In a certain area, the call services are provided using PSTN network and the data services are provided with connection to VDSL or ADSL.

Both technologies are compensated applying Bluetooth. Though the main service is voice call, various services are expected.

b. Data transmission between devices

The main objective of Bluetooth is the connection of short-distance devices. A user can download data from PC or other user's handset by using Bluetooth.

c. Bluetooth Headset

The headset is most popular model in Bluetooth market. User can have a voice call using Bluetooth headset. Recently, MP3 players with the function of Bluetooth headset appear in a market.

Bluetooth falls short of the expectations at the beginning. However, the system adopting it widely appears in mobile devices. The Bluetooth-enabled handsets are made mainly for GSM market and are used primarily for the connection of devices. Since the operators have not designed the business model of the combination of wireless communication network and the Bluetooth network, the services are not so popular until now.

In this paper, a PAN platform is proposed for the connection of CDMA network and PAN in wireless handset, which enables various services to realize.

3. DESIGN OF THE SYSTEM

3.1 Introduction of the System

Fig. 3 shows the overall structure of the combination of CDMA and PAN.

Until now, each service of CDMA and ad-hoc networking is independent and there has been just a few services connecting each other. The proposed structure mainly focuses on the connection of those networks. CDMA network is linked to the ad-hoc networking the services area is expanded and the communication industry is extended to other industries[8].

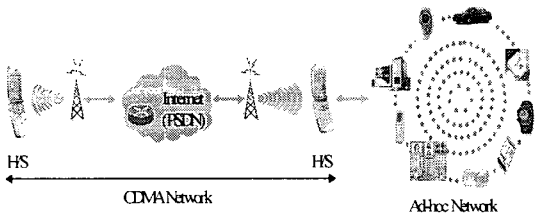

Fig. 3. Communication Of CDMA and Ad-hoc Network.

For the connection, a middle-ware is necessary to control the Bluetooth network and CDMA network. The services are mainly provided in wireless handset. Fig. 4 depicts the internal structure of wireless handset using the proposed middle-ware.

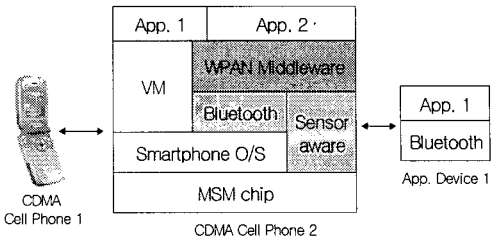

Fig. 4. The S/W structure of wireless handset using WPAN Middle-ware.

In Fig. 4, a WPAN middle-ware is simultaneously ported at the handset 1(App. Device) and handset 1(CDMA Cell Phone 1). It does function that handle user's context. context-awareness is as following here. Context-Awareness means awareness of requested phrases and contexts by processing and sharing information acquired from scattered sensors and other networks[9]. The WPAN Middle-ware sends the data and voice from the CDMA network or Bluetooth network to the corresponding handset application. In the WPAN Middle-ware, there are sensing module and identification module for the ubiquitous computing. The data from those modules are managed in the WPAN Middle-ware[10]. Also, there must be interfaces to the virtual machine in wireless handset for the programming of applications. Application device 1 has a Bluetooth module and Bluetooth middle-ware for application devices. The Bluetooth middle-ware in application device is similar to WPAN Middle-ware, but has a simple structure since there are no interfaces to CDMA network.

Application device 1 can communicate to not only handset 2 but also handset 1. Different from the conventional Bluetooth structures in handset, the proposed WPAN Middle-ware is linked to CDMA network and various services can be provided.

3.2 Design of WPAN Middle-ware

The detailed WPAN Middle-ware structure is as followings.

As shown in Fig. 5, the WPAN Middle-ware has 5 functional modules. The external I/F module deal

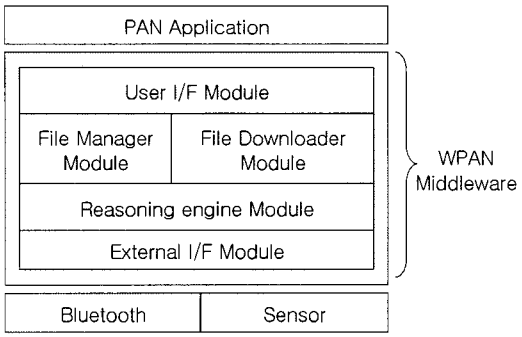

Fig. 5. WPAN Middle-ware internal structure.

with the Bluetooth communication and sensing interfaces. Reasoning Engine Module manages the external inputs and user contexts. File Downloader module downloads the applications connecting Bluetooth network and CDMA network, and the File Manager has the role of the management of files such as save and delete after the downloading and execution. The user can access the applications using User Interface module.

a. External Interface Module

The External Interface Module receives and deals with the command from the Bluetooth and sensors. Bluetooth and sensor of the API's are provided to WPAN application. Interface Module creates the task of the signal processing for the Bluetooth and memorizes the address of callback function.

b. Reasoning Engine Module

Reasoning Engine Module is a context-awareness module to deals with the user requirements corresponding to an application which is automatically executed. Generally, Context-Awareness schematically illustrates in Figs 8 and 9. Fig. 6 shows the internal structure of Reasoning Engine Module.

As depicted in Fig. 6, the Reasoning Engine Module consists of 3 components, i. e., description, condition and action. These can be presented by using XML. Let us consider the service which sends the real-time information of Starbucks Coffee shop. It can be represented as followings.

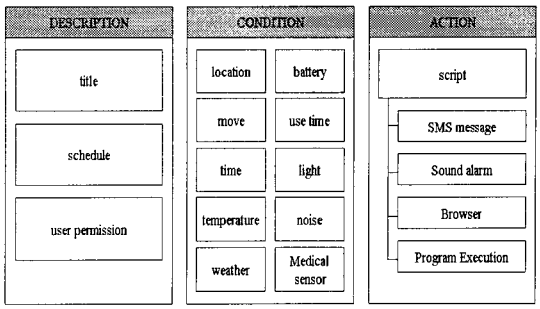

Fig. 6. Internal Structure of Reasoning Engine.

```
<wpanml>
  <descrption>
    <title>Notice of Starbucks Coffee shop</title>
    <schedule start="01/01/2005" expire="01/31/2005"
    week="sat, sun" time="12:00PM~13:00PM"
loop="5min">
  </description>
  <condition>
    <location area="In the Street" option="field"
      cond="1">
    <location area="Seoul" option="around" cond="1">
    <nomove duration=">1:00:00">
    <time range=">12:00PM,<13:00PM">
  </condition>
  <action>
<script>browser.url="http://wap.wpan.com/food/a.jsp?l
ocation=$location&favorite=$favorite"
    </script>
  </action>
</wpanml>
```

(code 1) XML Code Example

In <description>, there is <title> which displays on the screen and there is <schedule> which gives the scheduling information. In this example, the conditions have been checked for every 5 minutes from Jan. 1 2005 to Jan. 31 2005. The menu of <condition> implies the condition to be identified. The conditions can become plural and can have the structure of unification. If it is from 12:00 to 1:00, the condition was matched. In <action>, when the condition is matched, it will be connected to the browser using script. The current location ($location) and favorite Starbucks Coffee shop ($favorite) information are downloaded. After the context-awareness, Reasoning Engine Module manages the command using File Downloader Module

to download files.

c. File Downloader Module

File Downloader Module connects to URL server based on the Interface Module request. After connection, File Downloader Module downloads and installs automatically the corresponding application for the application devices. There is a remover which manages the memory resource. If the memory capacity is not enough, the remover maintains the memory resource. The detailed function of Downloader Module is as followings.

First, CAB File Download downloads the INF file including the install information and CAB file including the compressed installation files. Also, it connects to application server and makes it possible to have TCP/IP connection through CDMA modem. HTTP is used for the download and contents download is implemented using socket communication. Second, if there is an error during download or there is a user interrupt, the subsequent download module saves the subsequent download information. According to the download request, it displays the message box for the download. Third, Status Report sends the download status to the server. The billing and management of the status information is handled by the server.

d. File Manager Module

This module is in charge of the execution, installation and deletion of the application if there is a user request or the request of Interface Module (the request of application devices). If there is a request and there is no application in the handset, File Manager Module downloads the applications through Download Module. After that, it installs and executes the application. If the handset has the application already, the corresponding applications are executed. The components of Manage Module can be divided in detail as followings. First, there is an Installation which installs the CAB file of the application. CAB file is a compressed file of .inf file and program binary files. Program name, service ID, the information of installed binary and registry is saved for the execution and deletion. For example, the CAB file can be installed using API such as CreateProcess (wceload.exe, contents.cab, NULL, NULL, FALSE, 0, NULL, NULL, &si, &pi). Second, Check Space function manages the memory resource. If the memory size for CAB file download lacks, it request for the user to delete other programs. Third, Remove removes the application if the user wants to delete a certain application. According to the installation information, binary files and registry are deleted. Fourth, Execute runs the requested application. WPAN application can be executed using the API such as CreateProcess (0, "voiceterminal.exe", 0, 0).

e. User Interface Module

User Interface Module notifies the user of the result of download or error status through message box. Next, according to the user input, next command is processed. Since there is a CDMA module instead of WLAN in a smartphone, there must be a PPP connection for TCP/IP networking. To connect to the server using RasDial(), the struct RASDIALPARAMS is set to EntryName company name, PhoneNum, 1501, UserId speed011, UserPasswd, speed011. The implementation example can be explained as followings. The HTTP socket is opened using InternetOpen(), the contents location server is connected using InternetConnect(). Contents download is requested using HttpOpenRequest() and HttpSendRequest().

InternetQueryDataAvailable() checks the contents size for the save. If the memory size lacks, it request for the Manage Module to obtain the memory resource. InternetReadFile() download the CAB file, save to the file system and request the installation.

InternetCloseHandle() and RasHangUp() finish the HTTP connection and PPP connection, respectively. The functions of WPAN middeware have been explained as stated above.

4. IMPLEMENTATION AND TEST RESULTS

4.1 Development and Testing Environment

The development environment for WPAN Middle-ware is as followings. It consists of the CDMA handset and application device connected by Bluetooth.

- Mobile device : Smartphone
- OS : WinCE, PPC 2003
- CDMA Network : CDMA 1X EV-DO

4.2 Test Results

The Bluetooth-enabled application device is searched. Next, the data and voice are sent and received from the searched device. Fig. 7 shows the searching process of Bluetooth-enabled devices through WPAN Middle-ware. As shown in Fig. 7, the application device, voice terminal is identified.

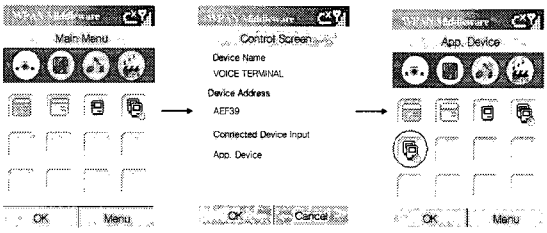

Fig. 7. Identification of Voice Terminal through WPAN Middle-ware.

Fig. 8 shows the sending and receiving between voice terminal and handset. The SMS message "Starbucks Coffee Shop is searched in Seoul" is transmitted and it is displayed.

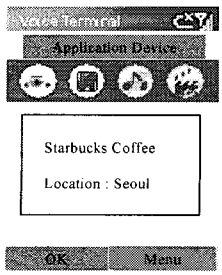

Fig. 8. Implementation Result.

In this system, H/S and Bluetooth is communication voice mutually. Environment for voice test is as following.

- BT RF Tester : TESCOM Bluetooth Tester TC-3000A
- BT Packet Analzer : Merlin2

When H/S and BT communicate voice in mutually, measured reception sensitivity is following. The test is Fig. 9.

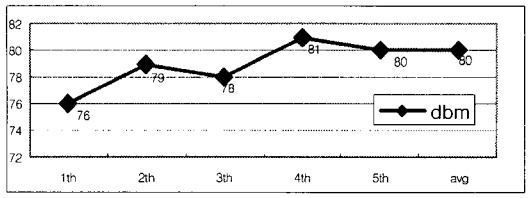

Fig. 9. Result of voice test.

The average of result is 80dbm. Usually, when see that adaptedness of communication data between BT is 80dbm, this system supply average data and is considered various service possible. The services which can be provided by the WPAN Middle-ware can be summarized as H/S to Access Point service, H/S to App. Device service and H/S to H/S service. Specific service expressed from figure 10 to 12.

First, the H/S to Access Point service is a service through access point. For example, when a user enter into a coffee shop, the menu information is searched and the order can be made by the handset. This is presented in Fig. 10.

Fig. 10. H/S to Access Point Service.

Second, the handset can communicate with the

application devices through H/S to App. Device service. The application devices such as watch. game machine, and other input terminal can be provided. This is Presented in Fig. 11.

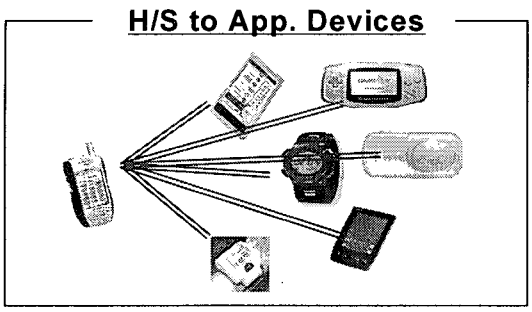

Fig. 11. H/S to App. Device.

Third, H/S to H/S service is a service through the communication between the handset with WPAN Middle-ware. Contents and data can be transferred. This is present in Fig. 12.

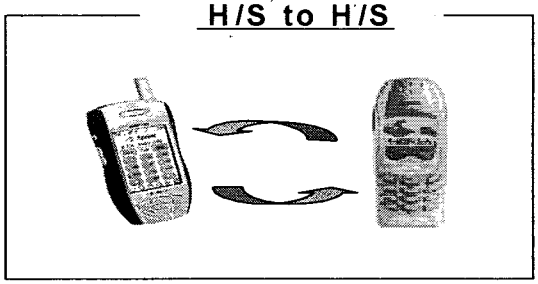

Fig. 12. H/S to H/S service.

5. CONCLUSION

In this paper, a WPAN Middle-ware to connect the CDMA network and WPAN is proposed. Though various WPAN technologies are utilized, the combination with 3G network is not so poplar until now. Various services can be provided using the combination of WPAN and 3G networks.

This paper presents the concrete model for the combination of CDMA network and WPAN. Especially, the main focus of this research is on the design of handset middle-ware system managing both CDMA network and WPAN. For the devices with the proposed WPAN Middle-ware, service areas of CDMA network can be expanded to WPAN, various services can be made through the transmission of data and voice, and the user computing environment can be improved.

Future research will be made towards other WPAN technologies such as ZigBee or UWB.

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