A way to the ubiquitous computing: Design and implementation of the PICKLES information kiosk

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abstract

The aim of PICKLES Project is to provide an environment for every person to have access to the Internet everywhere. In the project, people use Internet information kiosks and exchange information using the information kiosks. The authors also introduced very small portable computers. In PICKLES Project, we propose ubiquitous information provinding service using information kiosks and very small portable computers. We have developed information kiosk terminals named PICKLES Terminals. In this paper, we describe design and implementation of PICKLES Terminals and their management method. From some case studies, we show benefit of PICKLES Terminals.

Keywords: Information kiosk, Ubiquitous computing, Information infrastructure, Internet

1 Introduction

The Internet is a world wide communication medium, and many users exchange various kinds of information. Expanding the Internet as information infrastructure, it is necessary that every person can have access to the Internet and take information services everywhere. We should not only connectivity to the Internet but environment that every person can *use* the services easily and comfortably.

The aim of PICKLES Project is to provide an environment for every person to have access to the Internet everywhere. The authors propose the information system using information kiosk terminal and very small portable computers. We have discussed and designed hardware design, information providing services and user education with above concept, and have developed the information kiosks. Efficient management method is also necessary to manage the information kiosks installed to many places.

In this paper, we compare some terminals to connect to the Internet and management methods of them at first, and propose our network terminal architecture. Overview of PICKLES Project and management method of PICKLES information kiosk terminal are also described. Finally, the advantage of PICKLES Terminals is stated as a result of case study of utilize them as user terminals in our laboratory.

2 Management methods for Internet Terminals

As the growth of the Internet, number of its users has been increasing, and many users exchange large amount of and many kinds of information. The Internet is a widespread information infrastructure, and it should be available everywhere its user needs. Weiser discusses his concept of the "Ubiquitous Computing [1][2]."

The ubiquitous computing enhances computer use by making many computers available throughout the physical environment, making them effectively invisible to the user. In world of the ubiquitous computing, the user can also have access to the Internet everywhere he needs via physical environment around him.

Currently there are many cases that users connect to the Internet from home via commercial provider. Users can also connect to the Internet using wireless portable phones. Nevertheless, not all of people can use Internet information service nor use it anywhere. *Infrastructure* means not only environment that user can connect to networks everywhere, but also it that user can *use* the service everywhere. On a way to the ubiquitous computing, we should provide an environment that users can *use* the Internet everywhere. In this paper, we call this facility "using environment."

However when a user wished to use the Internet at home, he must introduce a computer, install an operating system (OS) and application programs, build a network and maintain them by himself. Though users can get access to the Internet using information kiosk or at Internet cafe left from home, they can not use in the same environment as that they usually use. Currently *using environment* is not provided as an infrastructure effectively.

We consider that usual terminals to get access to the Internet and method of its management is insufficient. To build the ubiquitous *using environment*, we should provide internet terminals and its management method at first. This terminal and its management method must satisfy following terms. In case of using the Internet from home, high-speed connection to outside can't be currently expected. Besides the network to which home network is connected might be changed. A terminal must be possible to carry.

Summary of above terms:

1. It can be used even with low bandwidth of connection to the outside network.
2. It can cope with the movement of the whole of, or a part of the home network.
3. The same environment must be provided in all terminals.
4. Updating terminal system must be done easily.

3 Comparison of system management

In this section, we compare some management methods of network terminals. First method is using complete stand-alone terminals. This method has been used generally with the personal computers. In this method, Users must install and periodically update the operating system (OS) and the application respectively. Since users build a really different environment, they can't use any terminals but *the terminal which they usually use.*

Oracle proposes the NC (Network Computer) [3], that retrieves OS and application programs via network, and has no hard disk drive. Thus, cost of NC is reduced. Using NCs, maintenance of many client terminals is integrated as maintenance of some servers. Though the costs of maintenance of servers become relatively large in small networks such as home networks. It isn't suitable in cases that a firewall divide the servers and clients, and that the network connected to outside is slow. Moreover, the migration of the terminal itself is difficult, because of its dependence on servers. Therefore hard disk drive is required to notebook type NC.

NetPC[4] that Intel, Microsoft and so on propose is based on usual hardware. OS and necessary applications are stored in the hard disk of the terminal, and a server updates these programs and manages the terminal. Since NetPC carries OS and application in its hard disk drives, users can use it separated from the network.

We introduce a terminal that carries OS and applications in its hard disk drives. Updating such programs are done by exchanging whole hard disk drives. Though we can use memory disks or high-speed CD-ROM drives instead, we suppose them hard disk drives for their price and speed. Using this method, we can update software such as OS without data transmission via network. Hence, maintenance work when a network isn't available can be done with the same means, too.

In this paper, we call such a terminal "an autonomous terminal." The comparison of management methods is shown in the figure 1. This table shows the degree of that each management method is sufficient to the above terms. A, B and C mean to fill a necessary condition in this order. The management method using autonomous terminals satisfies these necessary terms.

4 Autonomous terminals management

4.1 PICKLES project

We have produced PICKLES Project[5] since 1995. In the PICKLES Project, our goal is developing information kiosk terminals and to provide ubiquitous information service. The users can obtain information from the Internet using information kiosks everywhere.

Conceptual background of information kiosk can be compared to public telephones that are the same communication medium. Users can use public telephones that exist everywhere, and pay charges as they use. Users do not need to introduce public phones, maintain them and cope with troubles of them. Public telephones in every place make users possible to use telephone service everywhere. As like above example, if public Internet terminals exist in every place, its users can have access to the Internet everywhere.

	Term 1	**Term 2**	**Term 3**	**Term 4**
Stand-alone Terminal	**A**	**A**	**C**	**C**
Network Computer	**C**	**C**	**A**	**A**
NetPC	**B**	**A**	**A**	**A**
Autonomous Terminal	**A**	**A**	**A**	**A**

Figure 1: Comparison of management methods

We also introduced very small portable computers for PICKLES Project. The users can exchange information through the information kiosk only to carry the very small portable computer. This portable computer is as small as credit card in size and less than 100g, and has small LCD display and keypad. They are small and light enough to carry around for everyone. Users can browse information with its LCD, enter information into it using keypad, send and receive information through the information kiosk. They can also exchange messages such as e-mail. Authentication mechanism using entry from the keypad protects users' privacy. When users use the information kiosk they are authenticated by using this portable computer. In PICKLES Project, we propose ubiquitous information system using information kiosks and very small portable computers.

Information kiosks installed on the corner of street might be connected to the Internet by not so high speed line, and a management method using the autonomous terminals is suitable for this case[6]. We named the autonomous terminals developed in PICKLES Project, "PICKLES Terminals."

4.2 PICKLES Terminals management

The management method for PICKLES Terminals that are based on design of autonomous terminal and its advantage is described in this section.

Both OS and applications of the autonomous terminals are recorded in their hard disks. When an administrator updates OS and applications, he exchanges hard disk drives of the terminal.

Therefore it is necessary to record in separate information those OS and applications, and configuration information of the terminal. Otherwise exchanging hard drives changes configuration information of the terminal.

In this paper, we assume four groups of persons who use an information kiosk, who manage it, who own it and who sell it. We call each of them "*user*", "*owner*", "*administrator*" and "*seller.*" The responsibility of the three former persons can be divided clearly by information that they manage. These information are recorded in separated modules. The information that *users* manage is recorded in *users*' own very small portable computer. The information that an *administrator* manages it, and an *owner* manages it is recorded in the hard disk of the terminal. Each two information is recorded separately in two hard disk modules. The hard disk modules can easily exchange.

We named the hard disk module that the former information is recorded a "systemdisk," and that the latter is recorded a "userdisk." A typical PICKLES Terminal has one systemdisk and one userdisk. Though all the contents of the systemdisk are the same and it is never changed during the terminal being used, the information in userdisk is changed. Summary of information in a PICKLES Terminal is shown in figure 2.

The PICKLES Terminal is autonomous terminal, and replacing disk modules can install or update of OS and applications.

	module	**contents**
User	**Card Terminal**	**personal information** **authentication info.**
Owner	**User disk**	**host configurations** **working files**
Administrator	**System disk**	**OS** **applications**
Seller	**Hardware**	

Figure 2: Information in a PICKLES Terminal

These processes are followings.

Process of installation: At first, an *owner* purchases terminal hardware of PICKLES Terminal depending on specification[7] from its *seller*. At the same time, he submits the configuration information of the terminal for userdisk to the *administrator*. When a systemdisk and the userdisk is sent from *administrator*, the *owner* attaches them to the terminal, and turn it on. An *owner* doesn't need to install any operating system from CD-ROM or change configuration of operating system.

Process of updating system: *Administrator* sends the latest systemdisk to *owner*, and *owner* replaces old disk to the new one. He doesn't need to replace a userdisk.

Process to cope with the trouble: When the terminal hardware breaks down, *owner* removes two hard disk modules and attaches them to new terminal hard ware. There is no accident that the contents of the disk returned from the repair were erased. If only a systemdisk has broken, *owner* just exchanges the systemdisk to new one. *Owner*'s information is clearly divided into the userdisk, backup works can be easily done. Amount of data to backup is smaller than whole of the system.

4.3 PICKLES Terminal

PICKLES Terminal is built upon IBM-PC/AT. Exchangeable hard drive case is used for a hard disk module (figure 3). This module is easy to remove and install.

Figure 3: Removable disk module

Digest of specification of PICKLES Terminal of information kiosk type (figure 4) is following :

- Pentium90MHz CPU
- 32MB memory
- 21" CRT
- two 540MB hard disk drives in removable hard drive modules.
- rack for standing use
- PCMCIA Interface

The PICKLES Terminal of information kiosk type was built in 1995. Currently we have built PICKLES Terminals of desktop type and notebook type (figure 5).

4.4 PICKLES SYSTEM

PICKLES SYSTEM is an operating system for the PICKLES Terminal. PICKLES SYSTEM is based on BSD/OS. Revision of systemdisk is controlled with its whole contents that are operating system and applications. The same environment is ensured if the systemdisk of the same revision is used.

Information was separated into systemdisk and userdisk by following strategy. In UNIX operating system, information is classified in directories. Host settings such as host name, IP address and so on, are recorded in "/etc" directory. Variable information is recorded in "/var" directory. Most of the applications are recorded under "/usr" directory. A userdisk contains "/var" directory and a part of "/etc" directory as "/etc3."

Figure 4: PICKLES Terminal of Informatio kiosk type

Figure 5: PICKLES Terminal of Notebook type

It contains "/local" directory in which other information of terminal's owner is recorded. Files in "/etc3" are referred from files in

"/etc" by symbolic link. See also figure 6. Even if systemdisk is exchanged, host configuration is never changed using the same userdisk.

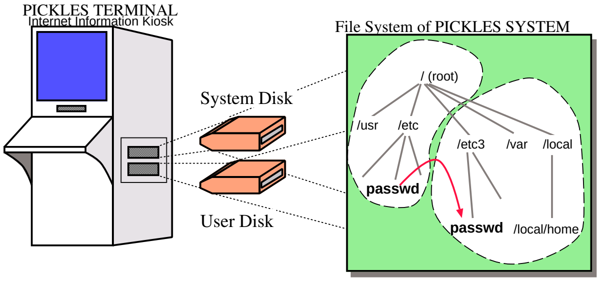

Figure 6: Directory composition of PICKLES SYSTEM

Standard PICKLES SYSTEM is composed of two hard disk modules. PICKLES SYSTEM can be also composed of one disk module, if the above composition of disk partitions is followed. This is useful for notebook type PICKLES Terminal. In this case, updating the systemdisk can be done easily by rewriting whole of systemdisk partitions. Compositions of disk partitions are shown in figure 7.

5 Case studies

5.1 Installation

In this section, we describe two cases of installing PICKLES Terminals. In these cases, installation was done by following installation model for PICKLES Terminals.

	Systemdisk
/ (root)	32MB
swap	96MB
/usr	left of systemdisk

	Userdisk
/etc3	8MB
/var	64MB
/local	left of userdisk

Figure 7: Composition of disk partitions

CASE 1: The PICKLES Terminal was installed to the office of graduate school of information science and engineering, Tokyo Institute of Technology, in March 1996. The aim is to provide an e-mail terminal to the staffs. This was the first case to introduce PICKLES Terminal, and its installation process was followings:

1. Owners purchase a PICKLES Terminal and send it administrator.
2. Administrator makes a systemdisk and a userdisk.
3. Administrator attaches disks to the terminal, and determine to work.
4. Administrator installs the terminal to where owner use it.

CASE 2: The PICKLES Terminals were installed to Tokyo Institute of Technology Library in 1996[8]. In this case, we cooperated with electronic library project in the library. The process of installation was followings:

1. Owner purchased PICKLES Terminals.

2. Seller installed the terminals.
3. Administrator only installed a systemdisk and a userdisk to the each terminal.

5.2 Designing networks

In this section, we describe about our networks design and implementation using PICKLES Terminals.

CASE 3: We have designed our laboratory networks in March 1997. In this case, our goal was to develop network terminals and network routers based on PICKLES Terminals, to design networks using these machines, and to evaluate the networks. The construction of the networks is shown in figure 8.

Fifteen researcher use the networks for daily works and their researches. The networks is consist of:

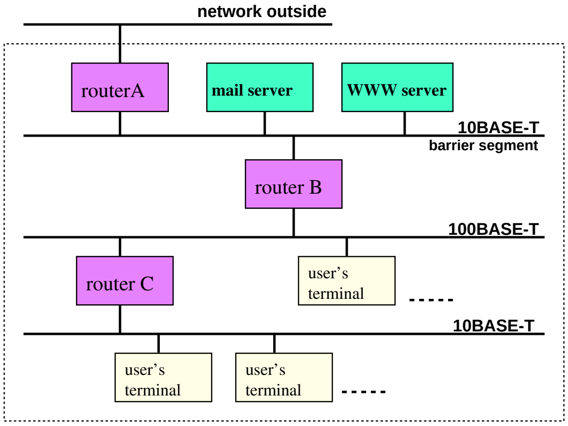

Figure 8: Construction of our networks

- Fifteen desktop terminals
- Three notebook terminals
- Three IP routers (figure 9)
- a mail server
- a web server

Figure 9: IP routers based on PICKLES Terminal

The router A in the figure acts as firewall routers. Both of desktop terminals and notebook terminals are kept in the same environment. Therefore, users can easily migrate their works from desktop terminal to notebook terminal. It is useful for demonstration and presentation outside.

6 Discussion

In this section, we discuss benefit of management model of PICKLES Terminals.

In cases of installation, responsibilities of administrator and seller are clearly separated. Owner purchases a PICKLES Terminal that satisfies the specification. And administrator set it up. This follows the administration model of PICKLES Terminals. We had some troubles on compatibilities, and this experience resulted in modification of specification.

In the second case, depending upon registration from owner, administrator made the userdisk and installed it to the terminal that the owner purchased. In this case, some lack of information was found in userdisk. This resulted in modification of registration form for userdisk.

From the experience we considered the necessary of experiment of network design using PICKLES Terminals.

Benefits of constructing our own network infrastructure using PICKLES Terminals in the third case are followings. At first, easy updating and utility of unified environment of terminals are proved. Sharing knowledge with members and problem gathering by cooperative works with many users are achieved. In a small organization such as an laboratory in a university, support of special assistants for examination of the system cannot be expected. All members of the organization using the system usually, the system must be enhanced. It is actually that the installation system for PICKLES SYSTEM was developed by cooperators in the third case.

Using PICKLES Terminals, administrators can recover the routers in trouble only by exchanging disk modules. We are also planing the 'network disaster drills' to evaluate the benefit of PICKLES Terminals and to train administrators.

Information kiosk terminals are installed into many places, and network agent system is useful to administrate these terminals. NMW[9] and magP[10] that we have developed are agent system aiming to support network management tasks. We are planing to utilize these agents to manage PICKLES Terminals.

In summary, we consider the benefit of network management using PICKLES Terminals. PICKLES Terminals are sufficient for our term of network terminal. PICKLES Terminals are appropriate to construct network infrastructure including *using environment*.

7 Conclusion

The environment to connect to the Internet is getting prepared as results of increase of internet service providers, popularization of personal computers and wireless communication methods and so on. Not every person can use information services on the Internet everywhere he need, though.

In this paper, the authors proposed the *using environment* of the Internet that everybody have access to it everywhere via information kiosk terminals. The design of PICKLES Terminal is based upon the concept that administrative tasks are separated from users. From the case of constructing *using environment* in our laboratory, benefit of the *using environment* and efficiency of administrative tasks using PICKLES Terminals are shown.

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