A Demonstration Experiment by PUCC of Controlling Information Appliances and Printers from Mobile Terminals

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This article describes an investigation of protocol specifications and the results of a demonstration conducted by the PUCC concerning the development of a service to link mobile terminals and information appliances, for example, for direct output to a printer and the control of white goods and AV devices from mobile terminals.

Technology Reports

1. Introduction

Mobile terminal services in the future will focus on linking mobile terminals with a variety of information appliances such as TVs, videos, and air conditioners, with the aim of developing new fields of application for mobile terminals. For example, there may be a service that automatically alerts a user leaving home via mobile terminal that air conditioners and lightening are not switched off, or when the topic of a program recorded on video a few days ago comes up in conversation while on a date, the recorded program can be viewed on-the-spot by accessing it from the mobile terminal. The cooperation of information appliances within the home network has progressed rapidly over the recent years, along with Audio Visual (AV) devices compatible with Institute of Electrical and Electronics Engineers (IEEE) 1394[*1] and Digital Living Network Alliance (DLNA)[*2], white goods compatible with ECHONET[*3], and printers compatible with PictBridge[*4] becoming increasingly popular. Within this context, DoCoMo is conducting R&D on technology to link mobile terminals and information appliances.

[*1] IEEE1394: A high-speed serial bus standard defined by IEEE. Adopted in many information appliances (e.g., video cameras, video decks, TVs), printers, and PCs for video streaming transfer between devices. A device control protocol is established in IEEE1394 AV/C.
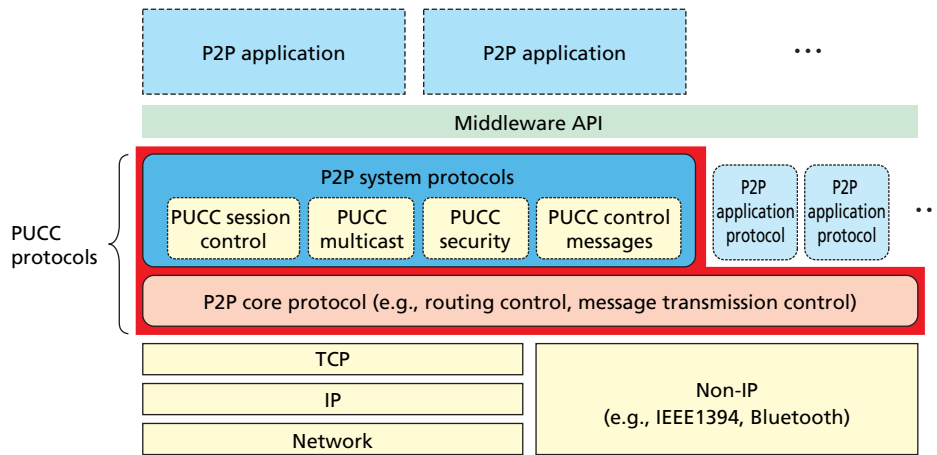
Figure 1 PUCC protocol stack

2. PUCC Protocol

Figure 1 shows the protocol stack proposed by PUCC. The PUCC protocol is an upper level protocol with regard to existing communications standards like Mobile Network, Bluetooth[®*5], IEEE1394, Ethernet, and as such, and is defined in the application layer. This enables the building of a Peer-to-peer (P2P)[*6] network across different networks, and makes interconnection between devices possible. The PUCC protocol is provided as general-purpose middleware independent of applications, called P2P networking platform, and permits the installation of a wide range of applications by using the Application Program Interface (API)[*7] available with the platform.

The PUCC protocol provides a function to detect devices on the network and execute services to permit the unified control of a variety of devices. **Figure 2** shows an example of a message sequence used in the detection of devices and execution of services. In the PUCC protocol, device and required service are dynamically searched based on metadata written in eXtensible Markup Language (XML)[*8] format that defines the name, type, and attributes of a device as well as the services it provides, and control is implemented. The metadata and protocol are of a general-purpose design, and by means of protocol conversion, interconnection with existing home information appliance standards is made possible. As shown in Fig. 2, when controlling a device that uses an existing standard, the PUCC protocol is converted to the existing protocol in the home gateway.

One aspect of this work is the R&D of a protocol for linking mobile terminals to white goods, AV devices and printers conforming to a common standard. Various standards currently exist for information appliances, and since the standards for the networks on which these appliances are used differ, the interconnection of mobile terminals and information appliances poses certain difficulties. There is currently no uniform means of remotely accessing home networks from mobile terminals that covers white goods, AV devices, and printers. The Peer-to-peer Universal Computing Consortium (PUCC) was therefore established in cooperation with vendors of such information appliances in December 2004 to develop a unified protocol for linking mobile terminals and a variety of equipment, and related research and development work is currently underway.

DLNA-compatible products are increasing in number, as is the size of organization and the number of participating major companies. The possibility of an expansion in the market is considerable, and work is therefore also progressing on technology to link mobile terminals using DLNA with equipment both inside and outside the home. For details see "Technology for Linking Mobile Terminals and Home Networks, and Prototype of Home Gateway Equipment".

This article describes an overview of the PUCC protocol, and explains the demonstration conducted by the PUCC in detail.

3. PUCC Demonstration Experiment

The PUCC has conducted a demonstration of the PUCC protocol installed on mobile terminals and home gateways in cooperation with the vendors of information appliances, printers, home gateways, and mobile terminal middleware. This

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*2 DLNA: An organization of manufacturers in the fields of information appliances, mobile phones, and PCs that promotes activities for standardization to ensure interconnection in the digital age and establish technical specifications. It also refers to the specification itself, which is called DLNA guidelines.

*3 ECHONET: A standard for networks using wiring for household lighting and wireless applications. Determined by the ECHONET Consortium to promote the

basic development of home networks to be used for the increasingly sophisticated energy savings, security, home healthcare, and the remote control and monitoring of devices. Primarily concerned with such white goods as air-conditioning and washing machines.

*4 PictBridge: A standard defined by the Camera and Imaging Products Association (CIPA) for printing by direct connection between digital cameras and printers.
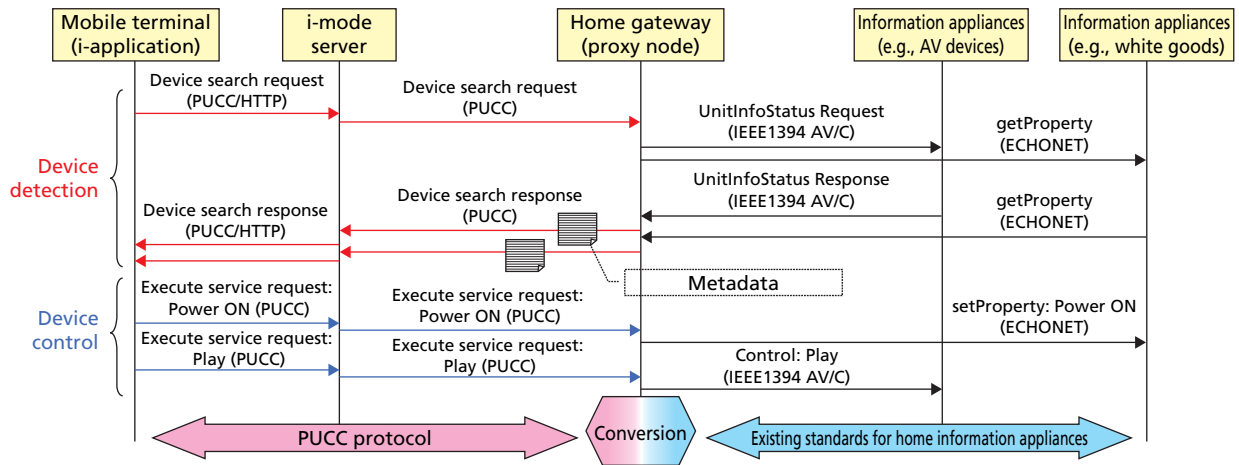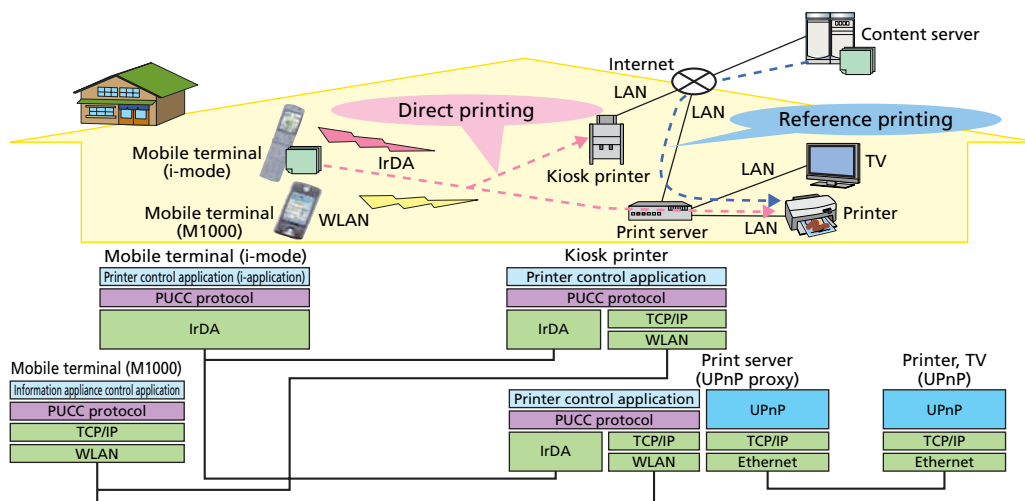
Figure 2 Example of message sequence

Figure 3 Overview of demonstration system (printer control from mobile terminal)

demonstration verified that it is possible to use the PUCC protocol to control information appliances that are compatible with existing standards. The prototypes used in this demonstration were exhibited at CEATEC JAPAN 2006 held in October 2006. Details of the demonstration system are given below.

3.1 Controlling a Printer From a Mobile Terminal

Figure 3 shows an overview of the demonstration system for controlling a printer from mobile terminals. In this demonstration, photos and PDF documents were printed directly on home printers and kiosk printers[*9] installed in shops from such mobile terminals as i-mode terminal and M1000. A home print-

er compatible with Universal Plug and Play (UPnP)[*10] was used. A print server was connected to the printer and the PUCC protocol converted to UPnP protocol. The PUCC protocol was used for communication with the kiosk printer and print server on Infrared Data Association (IrDA)[*11] for the i-mode terminal, and a Wireless LAN (WLAN) for the M1000. Two types of printing were used in the demonstration system: direct printing in which data stored in the mobile terminal memory is sent to the printer, and reference printing in which the printer is instructed from the mobile terminal to print content stored on an Internet server. The printer control procedure is described below.

The device first uses the device detection function to search

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*5 Bluetooth®: A short-range wireless communication standard for interconnecting mobile terminals such as cell phones, notebook computers, and PDAs. A registered trademark of Bluetooth SIG Inc. in the United States.

*6 P2P: A communication model in which computers exchange information on equal footing in contrast to the server-client model. In this article, mobile terminals and surrounding digital devices all exchange information on equal footing.

*7 API: An interface allowing upper-level software to use functions provided by the OS, middleware, etc.

*8 XML: A new markup language released in February 1998 for use in describing data handled on the Internet.
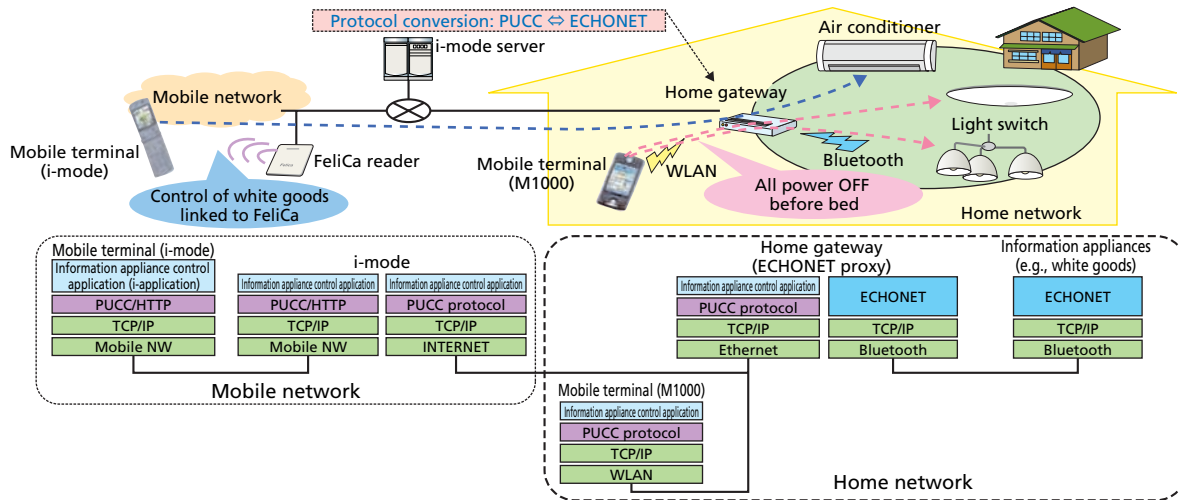
Figure 4 Overview of demonstration system (information appliance control from mobile terminal)

for a usable printer in the vicinity of the mobile terminal, and then selects an appropriate printer. For direct printing, contents are then sent to the printer and a print instruction is issued to print the sent content. For reference printing, the URL of the server on which the content is stored is included in the print instruction to the printer, and then the printer acquires the content from the server and prints it. This demonstration implemented printer control with the PUCC protocol, and verified the possibility of accommodating existing printing standards through protocol conversion.

3.2 Controlling Information Appliances From a Mobile Terminal

Figure 4 shows an overview of the demonstration system for controlling information appliances from mobile terminals. This system was used to control ECHONET-compatible white goods such as air conditioners and lightening via a home gateway from mobile terminals, such as i-mode terminal and M1000. The i-mode terminal was used for the remote control of information appliances via a mobile network. The M1000 was connected to a home gateway using a WLAN for controlling information appliances. The home gateway implements a function to convert PUCC protocol to ECHONET protocol, and the demonstration was thus able to verify the ability to control

ECHONET products with the PUCC protocol. As an example of a remote control application for white goods linked to FeliCa®*12, the exhibition at CEATEC JAPAN 2006 demonstrated such applications as the use of a FeliCa-enabled mobile terminal to automatically switch on air-conditioning and lightening in the home when the user passes through the ticket gate at the local railway station.

3.3 Controlling AV Devices From a Mobile Terminal

Figure 5 shows an overview of the demonstration system for controlling AV devices from mobile terminals. This system was to send video stored on an IEEE1394-compatible D-VHS video or DLNA-compatible HDD/DVD recorder on a home network to a mobile terminal via home gateway for viewing. An hTc Z mobile terminal installed with the PUCC protocol was used for acquiring lists of content and controlling the playback, fast-forward, and rewinding of content. The PUCC protocol was used to control the connection between the mobile terminal and home gateway. The protocol was then converted on the home gateway to IEEE1394 for the D-VHS video, and to UPnP, which is used with DLNA, for the HDD/DVD recorder. In this way, the AV devices were controlled and paths established with the PUCC protocol, while the streaming data was transmitted by using an existing streaming protocol. Since the output of con-
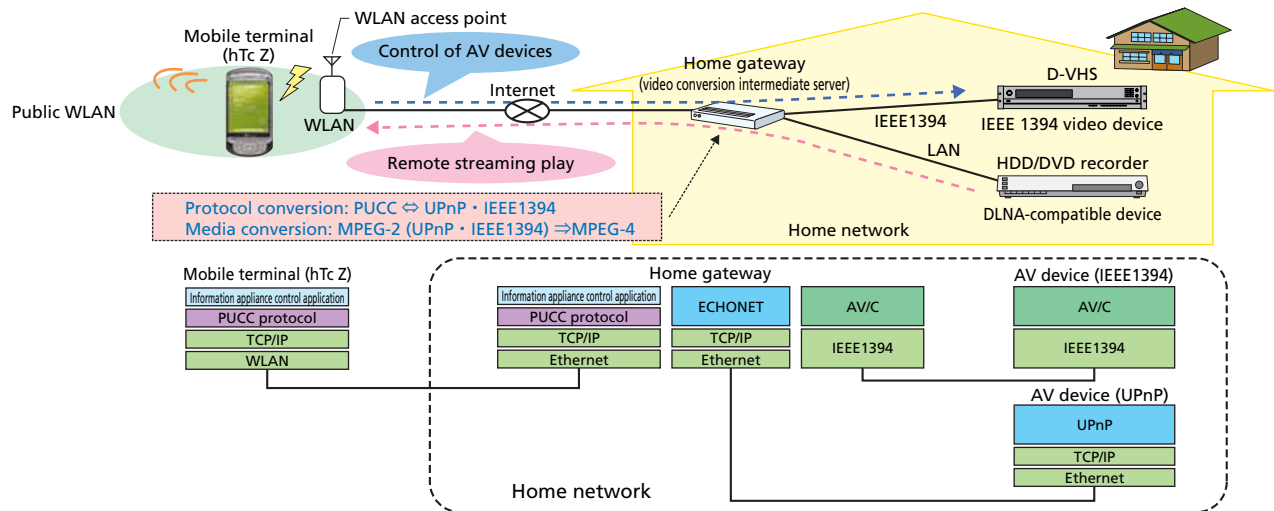

Figure 5 Overview of demonstration system (AV device control from mobile terminal)

tent from the AV devices was encoded in Moving Picture Experts Group phase 2 (MPEG-2)[*13], it was transcoded to MPEG-4[*14] in the home gateway, and then sent to the mobile terminal. This demonstration verified the ability to control IEEE1394 and DLNA-compatible AV devices with the PUCC protocol.

4. Conclusion

This article has described an overview of the PUCC protocol and details of the demonstration conducted by PUCC as part of work involved in the development of technology for implementing a service linking mobile terminals and information appliances. The demonstration linked mobile terminals with printers, white goods, and AV devices, and verified the ability to use uniformly a variety of information appliances from a mobile terminal through the use of the PUCC protocol. Further verification will be conducted for the development of a service aiming for practical use, activities designed to encourage its proliferation promoted, and sensors introduced to establish a more convenient control technology.

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*13 MPEG-2: A coding scheme for moving-picture data used for DVD and other storage media, as well as satellite broadcast.

*14 MPEG-4: A coding scheme for moving-picture data used for delivering video over relatively slow communication circuits as in mobile terminals.