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A Wired Extention Method for Bluetooth Networks

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Recently, with progress of network technologies, and advancement of intelligent appliances and information terminals, home networks, which connect computerized home appliances, have become practical.

Because of this background, various middleware for home networks such as Echonet and UPnP are proposed, and infrastructure technologies for home networks such as Bluetooth, IEEE802.11a/b/g and UWB (Ultra Wideband) are proposed now. In general, home networks demand the special systems that are not demanded in offices. Home networks requires, "no special rewiring", "no special operation when devices connect and disconnect to the networks", "low power consumption", and "high security".

Bluetooth, that can construct ad-hoc networks, and have low power consumption functions and high security functions, is one of the key technologies of infrastructure for the home networks. The problems of the home networks using Bluetooth networks are:1) Bluetooth is interfered with 802.11b/g and Microwave oven, because they operate in the 2.4GHz ISM band too, 2) Bluetooth networks must connect Bluetooth devices that installed outside of the Bluetooth's connection range or that installed between an obstacle like a wall. On such situations, Bluetooth networks must provide stable communication link quality to each Bluetooth devices on the home. In this research, a wired extension system for Bluetooth is proposed for improving reliability of Bluetooth communication channels and extending coverage of Bluetooth Networks.

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First we considered how to realize the wired extension methods on Physical layer / Data Link layer / adaptation profiles, and point out the advantages and disadvantages of each methods. From the result of considerations, we propose the wired extension system for Bluetooth networks that connect Bluetooth devices transparently by forwarding HCI events and HCI data packets over a wired medium. Proposed system can connect existing Bluetooth devices that did not have special Profiles by providing HCI level transparent connections.

Proposed system is constructed with two components, Bluetooth interface and Manager. Bluetooth interface is connection interface for Bluetooth devices, Manager manages Bluetooth interfaces that belong to the proposed system, and processes forwarding transaction, which sends and receives HCI data packets and HCI events from the wired medium.

Proposed system makes it possible to forward HCI event between local Bluetooth devices with remote Bluetooth devices by utilizing correspondence relation between HCI events with HCI commands, and realized to forward HCI data packet by switching connection handle on the HCI data packet's header. Because Bluetooth do not assume the wired connection on HCI, proposed system has some of problems for connecting Bluetooth devices transparently on HCI. We explain the Problems that is related to "pico-net synchronization", "acquisition of remote Bluetooth's information", "Bluetooth device address", and "corresponding of security", then propose the method to solve these problems.

We implemented proposed system, and evaluate the validity of proposed system by using it. The results of connection experiments using existing Bluetooth products succeeded, so we could prove that the wired extension which we proposed could connect Bluetooth devices transparently. We also measured delay of signaling times and transmission delays between the Bluetooth devices connected with proposed system. The delay of signaling times are about 4 sec at the maximum, and transmission delays are 10 msec to 15 msec. These measurement result means Bluetooth devices do not be influenced by proposed system, and proposed system can connect Bluetooth devices which have long distance. Moreover, the throughput of Bluetooth devices connected by proposed systems is equal to Bluetooth devices connected directly.

Finally we consider the management method for proposed system, and the protocols between the Managers connected by a wired medium. Design of these protocol and baseband layer for proposed system is our future work.