Device Collaboration System for Home Network Environment

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***Abstract*— This paper presents referential architecture of device collaboration system for home network environment. This architecture supports control and event message delivery, synchronization, and data conversion among devices that are connected on home network. With this architecture, users can implement multimedia presentation, video conferencing system, and multimodal application services with ease.**

***Keywords*— Embedded Software, Device Collaboration, Home Network, Middleware, Multimedia Presentation**

I. INTRODUCTION

Since explosive growth on the Internet, wireless networks and home networks have rapidly increased. In this situation, home servers are introduced to manage home appliances connected to the home network and to provide connection services from the outside networks. Home servers can include not only integrated network services but also a DTV set-top box function and a DVD player function.

Generally, most software programs for home servers are focused on control functions for the devices connected to the home servers. However, we added device collaboration functions in software form to the home servers so that the home servers can be main service centers for inter-home multimedia communication services such as video communication, video surveillance, etc.

In the environment if a user controls the devices separately, usability will be decreased. For this reason, if we provide consistent user interface to control the set of the devices for various multimodal or multimedia services based on systematic integration among them, usability will be increased. To do this, we introduced device collaboration system that is to control a set of computing devices that are connected with communication network as if the devices are connected in a single computer.

This paper presents referential architecture of the device collaboration system for home network environment. This architecture supports control and event message delivery, synchronization, and data conversion among devices that are connected on home network. With this architecture, users can implement multimedia presentation, video conferencing system, and multimodal application services with ease.

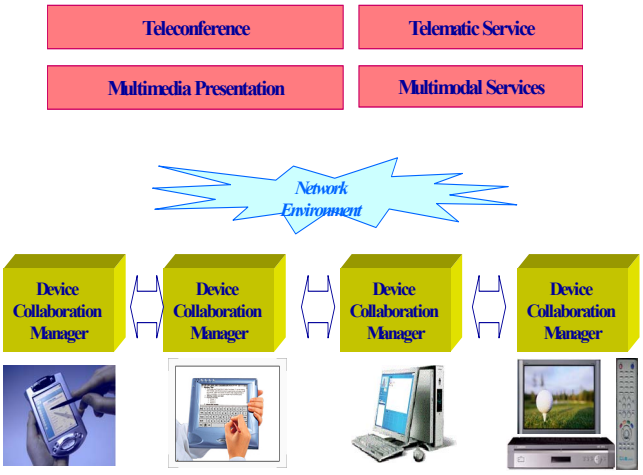

Figure 1. The Concept of Device Collaboration

II. OVERVIEW OF DEVICE COLLABORATION SERVICE

A. Device Collaboration Service

Device Collaboration is to control a set of computing devices that are connected with communication network as if the devices are connected in a single computer.

With fast growth of wired and wireless communication network, various devices that are connected to these networks are introduced. In the environment if a user controls the devices separately, usability will be decreased. For this reason, if we provide consistent user interface to control the set of the devices for various multimodal or multimedia services based on systematic integration among them, usability will be increased.

To provide device collaboration, we designed device collaboration manager.

B. Sample Scenario

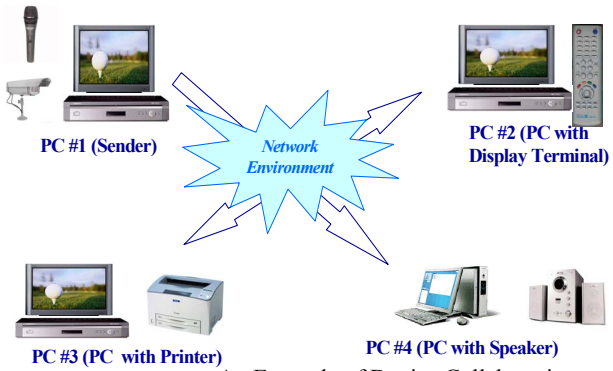

Figure 2. An Example of Device Collaboration

If we use the device manage, we can easily implement various multimedia services. As an example, if a person who has a small screen device, he can watch magnified video output screen on a big display terminal via device mangers. In addition, he can separately send audio stream and video stream from a multimedia file stored in his mobile device.

We also support multimodal interface for usability. We added data processing layer in the device manager so that we can support handwriting recognition, voice recognition, etc.

In Figure 2, there is a sample scenario of device collaboration. PC #1 receives audio and video input and it sends audio stream to PC #4 and PC #3, sends video stream to PC #2. PC #3 converts the delivered audio stream to text message and sends it to its printer.

III. Architecture for Device Collaboration

A. Service Sequence

If a person wants to perform a multimedia presentation service, he can use a service script in which time information, device information, event information, and multimedia stream information are described in text form.

To make the collaboration service possible, we define a service sequence as follows.

TABLE 1. Service Sequence

Item	Action
1) Device Discovery	Home Server sends device discovery packets to the devices with multicast protocol.
2) Service Discovery	Service Discovery: Home Server sends service discovery packets to them.
3) Script Parsing	Home Server parses script files for service.
4) Connection Building	Home Server makes connections to the devices.
5) Script Running	Home Server runs script for the service.

B. Device Collaboration Manager

For the above service sequence, we use device collaboration manger. Device collaboration manager make connection to other devices and to sends/receives control message, event message, and multimedia data streams.

The device collaboration manager has device input/output layer, device conversion layer, data integration layer, and presentation engine layer.

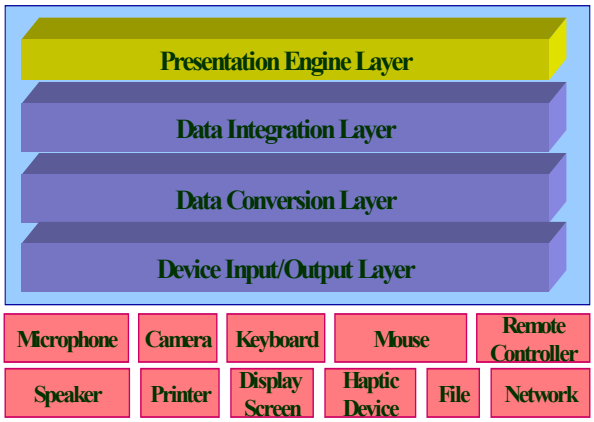

Figure 3. Device Collaboration Manager

Device input/output layer is composed of input/output module for peripheral devices such as microphone, speaker, keyboard, etc.

Data conversion layer has functional modules for converting data stream such as voice recognition that converts captured voice data to text stream.

Data integration layer supports stream manipulation functions such as stream copy, stream composition, and stream decomposition for multimedia data.

Presentation engine layer has main control functions for device collaboration. Presentation engine makes connections to devices and controls them.

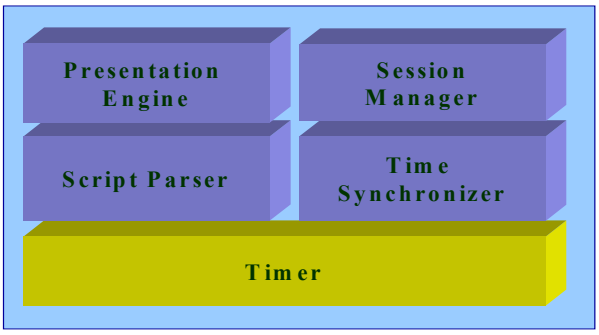

Figure 4. Components of Presentation Engine Layer

C. *Presentation Engine Layer*

Presentation Engine Layer is a key component of the Device Collaboration Manager. This layer is composed of Presentation Engine, Session Manager, Script Parser, Time Synchronizer and Timer.

Session Manager manages connection sessions and sends/receives messages among Home Server and devices. Session Manager finds devices that can be connected to the Home Server and monitors if the connection session is valid or not. The functions of Session Manager are described in Table2. For these functions, Home Server and the devices use UDP communication channels. The message structure that Session Manager uses is defined in Figure 5 and messaging protocol is defined in Figure 6.

TABLE 2. SESSION MANAGER

Function	Action
Device Discovery	· Home Server sends an UDP packet that notifies "Device Discovery". · The devices send the acknowledge packet to Home Server to join a session.
Service Discovery	· Home Server sends an UDP packet that notifies "Service Discovery". · The devices send the acknowledge packets that have service information it can support.
Connection Monitoring	· Home Server sends an UDP packet periodically. · If the connection is valid, devices send the acknowledge packets.
Action Request	· Home Server sends an UDP packet to request actions for collaboration services. · Devices send the acknowledge packet for these requests.
Event Notification	· Home Server sends an UDP packet to notify event signals for sessions. · Devices send the acknowledge packet for these requests.

Message ID	Sequence ID	Message Type	Message Body

Figure 5. Message Structure

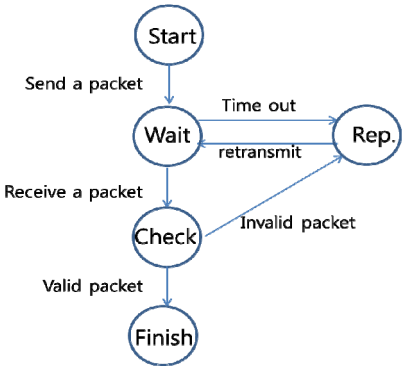

Figure 6. Message Transmission Diagram

Script Parser parses a script file delivered from its user and makes parse trees for presentation engine. Parse tree is a data structure that Presentation Engine uses to run the proper service.

Timer periodically sends time related events to its presentation engine. All the components of Presentation Engine Layer are synchronized with this timer event.

Time synchronizer is to synchronize time information of all devices in a set of collaboration environment. Home Server sends time stamps periodically. The connected device calculates time delay from Home Server and adjusts its timer.

Presentation Engine traverses parse trees and send request message to the proper devices. The Presentation Engine of Home Server makes proxy objects that represent the remote device. The Presentation Engine sends/receives messages with the proxies to run collaboration services.

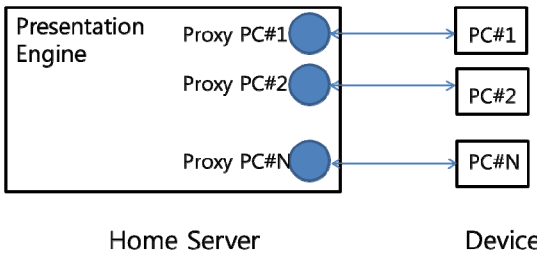

Figure 7. Connections of Presentation Engine among Home Server and Devices

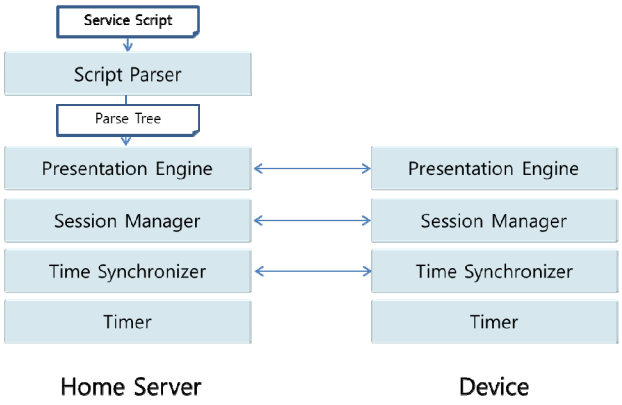

Figure 8. Presentation Engine Layer

Script file is a text that contains commands. Each command has time information, action, source and destination fields. The time information and destination fields are optional.

```
[2014/01/01 14:00] Play ₩PC#1₩Sample.mp4        PC#2
[2014/01/01 14:00] Play ₩HomeServer₩audio.mp3   pc#4
```

Figure 9. An Excample of Service Script File

D. Sample Application

With device collaboration manger, various application services can be implemented such as file transfer service, remote screen sharing service, remote audio/video play, etc. There is an example in Figure 10 that shows a remote screen sharing service between a home server and a mobile device.

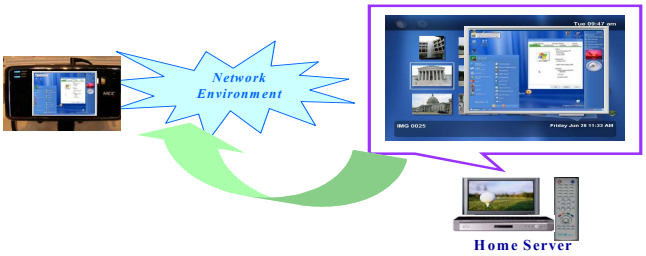

Figure 10. Remote Screen Sharing

IV. CONCLUSIONS

In this paper we presented the software architecture for device collaboration services based on home servers. To do this, the home servers will play an important role in home network environments and provide infrastructure for various applications.

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