DLNA-Based Multimedia Sharing System for OSGI Framework With Extension to P2P Network

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***Abstract*—Multimedia video sharing has been developed rapidly over the past years. P2P multimedia sharing mechanisms for P2P network such as PPLive, PPStream, Joost, have been used popularly. However, if Content Server and Client in home network have to transmit via P2P sharing, P2P network must be adopted, thus it is unable to increase the network transmission speed through this intranet connection. Although there are DLNA, HAVi, and Jini protocols in home network to share multimedia files, it cannot access P2P network due to the limitation of home network framework. Therefore, this paper proposes a DLNA-based Multimedia Sharing System for OSGI framework with Extension to P2P Network, which extends DLNA multimedia sharing mechanism to P2P network through OSGI platform, so that users can access multimedia resource on P2P Network via DLNA, and P2P network users can apply P2P network mechanism in OSGI bundle to access shared DLNA multimedia resource in home network.**

***Index Terms*—DLNA, multimedia sharing, P2P network.**

I. Introduction

With development of home multimedia service technology, more and more multimedia become available to every corner of home through home network sharing. For example, once built into DVD player, DVD multimedia content can be viewed from any computer at home through home network [1]–[9]. The technology has led to rapid development of multimedia, thus more devices can be added to home network to share files, and more multimedia file contents can be accessible by home network sharing. As sharable file types and devices increase, home network development will inevitably break the limitation of intranet. The traditional multimedia video sharing mechanisms can only share multimedia video in home network, which reduces the usage options. In order for all providers to join the sharing network more easily, while not being limited to home network, many studies attempted to extend Digital Living Network Alliance (DLNA) mechanism sharing from home network to P2P network [10]–[12]. However, P2P network has no related sharing mechanism to access these multimedia information converted from home network [13]–[19]. To improve the video sharing mechanism, this study proposed DLNA-based Multimedia Sharing System for OSGI framework with Extension to P2P Network. This framework consists of two main parts: 1) for P2P network, a multimedia sharing method is proposed based on Open Service Gateway Initiative (OSGi) framework [20], including registration, update, safety and dynamic video quality adjustment mechanisms, 2) for home network, based on the standard DLNA video sharing mechanism, multimedia sharing mechanisms of home network and P2P network are combined, and Home Content Server Adapter that includes P2P bundle and DLAN bundle is used to provide sharing mechanism to share the media content information between WLAN and DLNA [21]–[29], so that DLNA Content in home network can be obtained from P2P network. Thus, DLNA Player in home network can also acquire Content in P2P network.

The remainder of this paper is organized as follows. Section II discusses related works and results; Section III introduces the system framework and role of each server or converter in the whole network; Section IV presents the mechanism corresponding to the proposed system to help improving system performance and safety, Section V evaluates the system performance, tests the framework and gives conclusions.

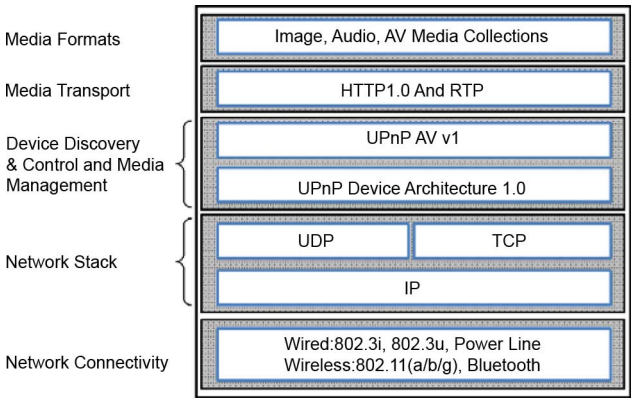

Fig. 1. DLNA transmission architecture.

II. Related Work

1) Digital Living Network Alliance: Digital Living Network Alliance (DLNA) aims to build an interoperable network that can manage personal computer (PC), consumer electronics (CE) and mobile electronic equipment throughout home in a centralized manner, and create a novel seamless environment of sharing and developing digital media and content service. Fig. 1 shows the DLNA transmission framework according to the DLNA guidelines.

Manuscript received March 15, 2009; revised February 25, 2010. Date of publication April 29, 2010; date of current version June 03, 2010. The work of C.-F. Lai was supported by the Sustainable Growth Project (S) (98WFA0900277) of the Department of Engineering and Application Science, National Science Council (NSC), Taiwan.

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Digital Object Identifier 10.1109/JSYST.2010.2047175

As stated in the guidelines, DLNA standard is the intermediate layer based on original network framework. Its main purpose is to facilitate communication among equipment that supports this definition, without the need to of other settings. Taking DLNA standard ver. 1.0, for example, it supports Ethernet (IEEE803.3u) and Wi-Fi (802.11 a/b/g), network support is essential for DLNA standard equipment. As for detection among equipment, UPnP standard is adopted. End-user player equipment employs the UPnP mechanism to search for the corresponding server devices that are interoperable in the network. After successful connection, it proceeds to play or transmission. This action is automatic, so users do not need to get involved. To find media content, the UPnP mechanism is adopted likewise. Transmission only supports HTTP standard protocol at present; only the later versions add RTP (Real-time Transport Protocol). Transmittable multimedia format can be divided to mandatory support and optional support. In mandatory support, the picture file format is JPG, audio format is LPCM, and video format is MPEG-2. While in optional format, the picture file is PNG, GIF, or TIFF, and audio compression format is AAC, AC-3, ATRAC3Plus, MP3, and WMA9. Video compression format includes MPEG-1, MPEG-4, AVC, and WMV9. As the current network transmission speed increases, most manufacturers tend to support high compression ratio compression format.

DLNA standard defines major product types as follows: Digital Media Server (DMS)—provide media file acquisition, recording, storage, and source abilities; Digital Media Player (DMP)—refers to capability of online searching and playing, or exporting any media file provided by DMS; Digital Media Render (DMR)—transmitting or receiving media file from server to the other equipment as universal multimedia format; Digital Media Controller (DMC)—used as remote control device, able to search playable media file in DMS, and play at designated terminal player that can play such content; Digital Media Printer (DMPr)—printer providing printing function in DLNA network framework, and photo printing or picture insertion function, DMPr also provides picture example function, let printed picture output as standard format.

Although current DLNA provides many solutions to home multimedia communication, there are some disadvantages in the standard and code. Code for the P2P network multimedia sharing mechanism is not yet formulated. To address this issue, this study proposed a DLNA-based Multimedia Sharing System for OSGI framework with Extension to P2P Network.

2) Peer-to-Peer Network: Peer-to-Peer (P2P) Network is a new direction in researches of Internet service approach, after the client-server framework. In conventional client-server framework, Client and Server have obvious distinction. Client often goes overcapacity and Server is under capacity or network congestion. In a P2P system, users can play multiple roles, such as Client or Server, simultaneously. The fundamental concept is that individual resources can be transformed into shared resource and vice versa at the same time. Any two users can make direct information sharing or content exchange without the server, so as to construct distributed Internet system with independent resource sharing, open resource exchange and search and highly extensible internet exchangeability. In the perspective of network topology, the current system developed from P2P technology has two modes: 1) typical client-server framework in the content distribution network (CDN), where server is the so-called Index Server, is responsible for maintaining all node information and multimedia information stored in the network, when the client wants to collect Content occupied by multiple nodes from P2P network, the client will check the server first for the nodes that contain data in the network, then connects these nodes to access data; 2) unstructured peer-to-peer network: all peer nodes in network are regarded equally without division of server and client. Each peer node can play roles of server and client simultaneously, the framework can distribute Server load to all peer nodes, alleviating the workload of Server effectively. Meanwhile, the number of Clients is not subjected to server and network; in other words, each peer node plays both the roles of Server and Client. This system is P2P multimedia sharing mechanism under the content distribution network framework.

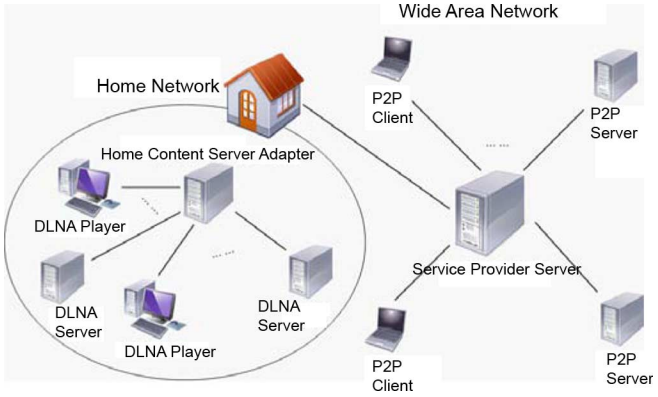

Fig. 2. System architecture.

III. System Architecture

The system architecture is consisted of six main components: 1) Service Provider Server (SPS); 2) Home Content Service Adapter (HCSA); 3) P2P Server (PS); 4) P2P Client (PC); 5) DLNA Player (DP); 6) DLNA Server (DS), as shown in Fig. 2. As seen in the architecture diagram, PS and PC can appear in any P2P network, so that any multimedia file can be shared throughout the network. To access DLNA multimedia resource in home network, the home network service relies on Home Content Server Adapter to deal with client request. Furthermore, there is a SPS in the network, containing several home networks, a few PSs and some PCs. Home network is composed of a Home Content Server Adapter, several DPs and DSs. Detail of system framework component will be introduced in following sections.

A. Architectural Components

1) Service Provider Server (SPS): SPS is the management core of the network framework, covering all HCSAs and PSs on the network, and maintaining all multimedia file information in all PSs and HCSAs. SPS faces all network servers, including client as well. However, its primary task is to keep database content updated in real-time, and provide the latest information to

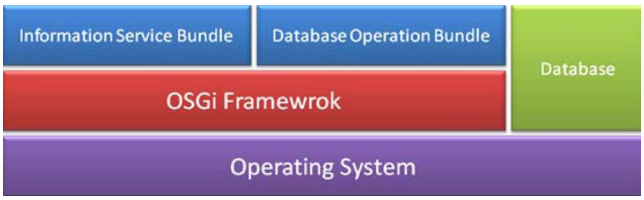

Fig. 3. Service provider server OSGi architecture.

Server List	Content List
Server ID	Server ID
Description	Content ID
IP	Title
Port	Register ID
Refresh Indicator	Class
Dynamic Quality Function	Metadata
Metadata	Mutiple Quality

Fig. 4. Service provider server database format.

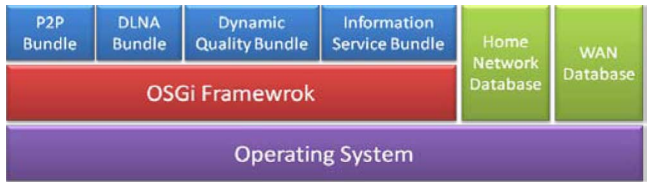

Fig. 5. Home content server adapter OSGi architecture.

Content Directory List	Content List
Directory ID	Content ID
Directory Location	Directory ID
	Content Title
	Content Class
	Content Resource Location
	Content Metadata
	Content Multiple Quality

Fig. 6. Home content server adapter database format.

users. As for PC, multimedia file list and information can be acquired from SPS database, and used to build multimedia video streaming. As for DP, HCSA acquires multimedia file information of other HCSA and PS from SPS regularly, and update multimedia file list in DP of its home network regularly by UPnP Event. Thus, when DP requests service, it can target at corresponding PS or DS directly. Its OSGi framework is shown in Fig. 3.

Information Service Bundle: it is the communication window for all servers with SPS, and carries out registration, update, and search in Extensible Markup Language (XML). These tasks are completed by accessing the database, thus, Database Operation Bundle is in charge of database access, and collaborates with Information Service Bundle.

Database Operation Bundle: SPS must be accompanied with a robust database system, so that all clients can have the complete and real-time multimedia file information, thus, the database system should record all multimedia files and corresponding HCSA addresses or PS addresses. Its format is shown in Fig. 4.

When PC or DP requests the multimedia file information of HCSA pr PS from SPS, the file locations in WLAN are constructed via the same Server ID between Server List table and Content List table. According to the file locations in WLAN, PC, and DP can access the multimedia content directly.

2) Home Content Server Adapter (HCSA): HCSA plays the role of communication window for the home network in multimedia file sharing. For home intranet, HCSA obtains survived DS's in home network by M-Search, and acquires shared multimedia file information in each DS by UPnP Browse, then converts these messages from internal IP to external IP, and registers information to SPS for P2P network equipment for use. When a multimedia file is located somewhere at some home network, video streaming of such multimedia file should be acquired through HCSA. As for the P2P network, HCSA regularly receives multimedia file information shared by the P2P network from SPS, and simulates HCSA into a virtual DS in a home network. This file information is provided in DLNA sharing format to DP in the home network. To receive a file, DP will skip HCSA and receive multimedia file directly from the Content Server. To build a home network sharing platform, HCSA should communicate with DS's and DPs in a home network and connect SPS's and PCs in a P2P network. The HCSA contains an OSGi framework as shown in Fig. 5.

P2P Bundle is the manner by which HCSA registers to SPS, while DLNA Bundle is provided for home network PS's to register HCSA. Information Service Bundle is used to access databases of home and P2P networks. Multimedia file information and paths of all DS's in home network are recorded in HCSA. As a result, when establishing streaming with client, HCSA can find corresponding DS quickly. From SPS perspective, when connection of each home network with external P2P network is started, it registers to SPS through HCSA. In other words, a HCSA represents the entire home network service for P2P network, when PC requests multimedia file of the home network, Client will connect HCSA directly. The advantage is that SPS can provide service to Client efficiently, and leave the remaining work to HCSA, reducing SPS-to-PC traffic and improving service quality. When playing a video stream, effort is made to let all clients enjoy good quality service. Moreover, devices in thee P2P network differ in network quality; thus, unlimited transmission mode in a home network is infeasible in a P2P network. Therefore, this study employed Dynamic Quality Bundle to execute dynamic quality algorithm for HCSA to evaluate video streaming output quality. Dynamic Quality Bundle will be introduced in detail later. In terms of database, HCSA is present in two database systems. One represents the entire P2P network, whose format and content are the same as the SPS database. The approach of distributing same data to all HCSAs is to reduce SPS loading. The other database represents the whole home network. Therefore, in the local network database, HCSA records all PS addresses in the home network; its content contained and format are shown in Fig. 6.