DTV for Personalized Mobile Access and Unified Home Control

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Abstract: Today, all devices are trying to connect and communicate each other. There is an increasing trend for self-configuring networks that allow devices to easily and automatically join and leave networks and learn about other connected devices. Digital television (DTV) is one of the most significant developments in recent digital technologies. It will become a natural center of the digital home because of its rich functionality and simplicity of use. In this paper, we present a home networking system to show the newly developed technologies that allow DTV and mobile phone to deliver complete new experiences to the end users.

In order to achieve a total and seamless connectivity, a mobile DTV (MDTV)-centric home network architecture has been proposed and implemented. First, a MDTV link protocol is designed and implemented in the home network system to connect DTV and mobile phone. Once connected, the mobile phone provides the wireless connectivity to Internet and also acts as an identifier for the personal data access, DTV is used as a displayer. Then, Universal Plug and Play (UPnP) protocol and Simple Control Protocol (SCP) are implemented to guarantee a total connectivity of all home devices. The enhanced DTV provides features of service discovery and ubiquitous home devices control, and web browsing. In the proposed home network system, the DTV is the central control point situated at home, users can use remote control at home or mobile phone away from home to access or control home devices. Our experiments have showed that the proposed home network system provides a simple and unified home device control and access. The MDTV architecture alone accomplishes an instant personalized mobile access anytime, anywhere.

Key words: DTV, mobile phone, personalized mobile access, UPnP, SCP, home networking, unified home control.

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: 10.1007/978-0-387-35618-1_37

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1. INTRODUCTION

In today's homes, TV is only for watching. PC is used to access the Internet for email, Web browsing, and other applications. Users can't watch TV and access Internet simultaneously because TV and PC are usually in different rooms and TV can't access Internet. The role of the TV has been changing since the arrival of the DTV. TV has its advantages over PC for home networking. It is where people spend most of their time, and most importantly, it presents a simple interface to all users. It is natural to predict that TV will be the center of the networked home. The goal of this paper is to present new technologies that allow DTV and mobile phone to deliver new values to end users in their networked home by fully utilizing the advanced features of the DTV.

DTV brings to TV much more capabilities than ever before. One of the most attractive ones is the Internet. The high quality DTV display can be utilized to navigate Internet, view pictures, read messages, etc. However, the question is how to easily connect DTV to the Internet without any complicated wires and devices, and more importantly, how to get instant access wherever and whenever by the most convenient means at hand. Today's TV and mobile phone work independently. Can TV and mobile phone complement each other by using TV's large screen, high quality display capability and mobile phone's mobility? This paper presents the MDTV architecture (Fig.1) that allows DTV and mobile phone working together to provide an easy-to-use, anytime, anywhere instant Internet access solution with no new wires.

Connecting home devices together is hard to many families, especially devices in different categories, for example, electric devices such as television and audio/video devices, and power line devices, such as lighting and air conditioner. Many of home devices are connected today to form isolated "micronetworks" by using different technologies [1]. USB is used to connect printers, MP3 players, and digital cameras to PCs. IEEE 1394 is used to connect video cameras to PCs. Ethernet connects PCs to broadband modems. A bewildering variety of analog and digital interfaces are used to interconnect DVD players, DVRs, DTVs, and digital set-top boxes with other audio and video components. How to interconnect these isolated "micronetworks" raises challenge to home networking. It is believed that a combination of technologies will be used in many homes and UPnP is a technology to bring these isolated "micronetworks" together. In this paper, we present a MDTV-centric home networking system (Fig. 3) to deliver a total and seamless connectivity. This system achieves a simple and

ubiquitous home networking solution. DTV is the center of the proposed home networking system. The enhanced DTV provides features of service discovery, unified home device access and control, and web browsing. Users can use DTV remote control to access and control home devices, subscribe on-demand multimedia services such as movies and MPEG video, and access personalized information such as messages and pictures. The content provider can multicast the multimedia services to multiple homes, multiple home devices such as TV, PC, laptop, etc. When away from home, users can use their mobile phones to access and control their home devices. The MDTV-centric home networking system can easily be extended to include more devices that use different technologies.

2. A MOBILE DTV ARCHITECTURE FOR PERSONALIZED INSTANT INTERNET ACCESS

The MDTV architecture (Fig.1) consists of the MDTV server, the MDTV, and optionally Internet Service Provider (ISP). The MDTV is comprised of a wireless mobile device, a DTV, and a device adapter that connects the two. Both MDTV server and ISP are the content providers. The MDTV server, where user profiles are stored, is to provide user's personal information in a highly customized form according to user profile. The wireless mobile device communicates with the MDTV server via both a base station and the Internet. The adapter includes a MDTV Link protocol and an upstream protocol stack configured to generate IP data. The user uses DTV as user control interface as long as the DTV is connected to the wireless mobile device via the adapter. The MDTV architecture supports multiple upstream and downstream communications paths, not necessarily involving the same technology. User's personalized service requests are transmitted in the form of IP packets to the MDTV server over the already set-up wireless channel. In response to the IP data, the MDTV server unicasts the required service data to the DTV via the same wireless downstream or an alternate high-speed downstream communication path. For general services such as web browsing, the MDTV architecture automatically adapts to high-speed communication path if such path available.

In our implementation, the mobile phone is used as the wireless mobile device. A MDTV Link protocol is designed and implemented in DTV and the device adapter. The serial technology is used in current version of implementation and Bluetooth will be used in future version. In order to provide an easy-to-use solution, the physical interconnection between DTV

and mobile phone is as easy as plugging the mobile phone into a DTV docking station. The MDTV supports intelligent programming functionality. When user plugs his/her mobile phone into the docking station an IP connection is established between the DTV and the Internet through the cellular wireless network. Once connected, DTV turns into an Internet TV. With a web browser being integrated into DTV, users can watch TV program and navigate Internet or access personal information simultaneously. The mobile phone is charged while plugged-in. When un-plugged, the mobile phone and DTV can be operated independently. User's personal information is automatically deleted from DTV. The proposed MDTV architecture provide end user with a mechanism to access his/her personal content anytime, anywhere in the home or hotel wherever a MDTV available.

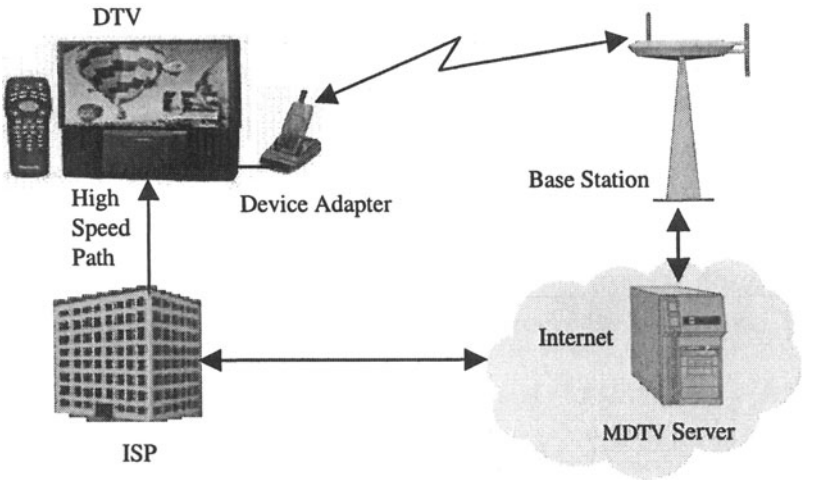

Figure1. MDTV Architecture Overview

To access personal information, content, or to activate other channels of services such as pay-per-view channels, the mobile phone is used as user identifier to conveniently enable user profile. The user then accesses personalized information and content through a customized interface. User can perform such access anytime, anywhere as long as a MDTV exists.

The user profile totally depends on user's preferences. For instance, some users might want to have personal pictures in their profiles and others might want to have personal messages in their profiles. The profile can be updated any time. When displayed on DTV, the MDTV content, such as messages and pictures, overlaps TV video. Users can choose either transparent or opaque background for the MDTV content. For example, user might choose opaque background for web browsing and transparent background for text

messages. When MDTV server receives an instant message such as email for connected user a notification is sent to DTV immediately. DTV then notifies user by displaying an icon on screen or playing a special sound. User may download message and read it or ignore the notification. Fig.2 shows a message being displayed on DTV.

Figure2. MDTV Snapshot

The MDTV architecture enables end user to access to personalized information anytime, anywhere. It provides end-to-end connectivity between DTV and Internet services. User personal information associated with the mobile phone. No explicit dialogue is required in order to connect to the desired services. No requirement to boot the device or for installation of software by the user. No new wires are needed.

3. A MOBILE DTV-CENTRIC HOME ETWORKING SYSTEM

Many of the forces that lead to the creation of business networks, such as distributed data availability, cooperation, and the optimized use of resources, are becoming the requirements for the home. The office products have been modified for the home networking market [3]. Unfortunately, the home presents some novel and unusual challenges that have not been primary concerns in networking deployments until now [2]. For example, low cost, easy of installation, and extensibility must be considered. Most importantly, home networks are for less knowledgeable users. Users want simple, personalized, and integrated experiences. To be successful, the home networking deployments must satisfy user's requirements and rely on consumer products [3].

The self-configuring networks that allow devices to easily and automatically join and leave networks and learn about other connected devices will greatly benefit end users. One of such technologies is UPnP. UPnP is an architecture for pervasive peer-to-peer network connectivity of intelligent devices. It is designed to bring zero-configuration, automatic device discovery, dynamic join or leave, standard-based connectivity to ad-hoc or unmanaged networks in the home or other spaces. UPnP is a distributed, open networking architecture that leverages TCP/IP and web technologies to enable seamless proximity networking in addition to control and data transfer among networked devices. SCP, architecturally an extension of UPnP, is a PHY-independent device control protocol that allows the manufacturers to make small and intelligent devices for limited bandwidth networks such as Power Line Carrier (PLC) networks. It is a lightweight protocol to provide peer-to-peer, event-based control of devices in the home. SCP aims at providing an inexpensive solution due to its simple architecture, small memory footprint, and using the existing infrastructure such as electric wiring.

TV is the center of home entertainment. It presents a simple and familiar interface to all users. TV-centric home networks have unique advantages and great potential in home networking market. Based on MDTV architecture, UPnP and SCP technologies, this paper has proposed and implemented a MDTV-centric home networking system (Fig.3) to provide a mechanism for the unified access to, and control of, home devices.

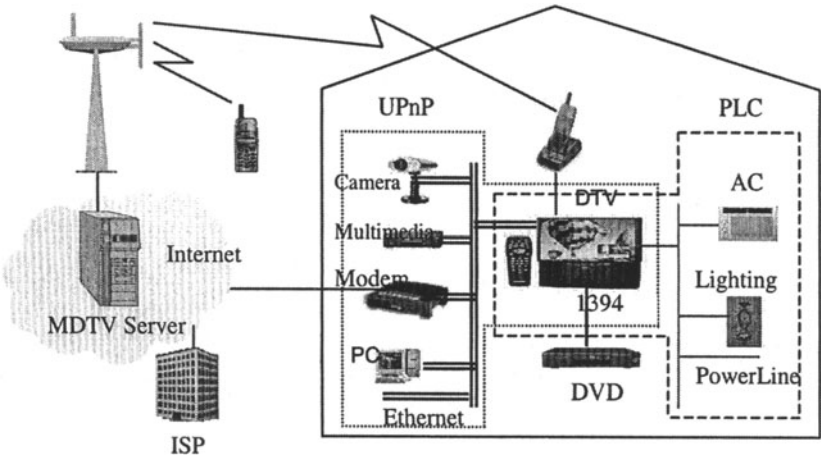

Figure3. MDTV-centric Home Networking System Overview

The proposed home networking system consists of UPnP domain, 1394 domain, PLC domain, and wireless domain. In the implementation, the

UPnP domain is comprised of a DTV, a security camera, a multimedia server and a PC. DTV is a UPnP device and a UPnP control point. PC can optionally serve as another control point. The SCP technology is used to network the power line devices that include a lighting and an air-conditioner. IEEE 1394 is used to connect DTV to a DVD player. DTV is a central control point of all devices. DTV bridges PLC domain and 1394 domain to UPnP domain. It initiates and runs a proxy device in the UPnP network for every device in the PLC network and 1394 network. The proxy device in the UPnP network represents its counterpart in PLC network or 1394 network. The proxy devices participate in UPnP activities. The bridge, that is DTV, translates UPnP commands and queries received by the proxy device into the corresponding messages in the PLC network or 1394 network, which are in turn passed to the target device via SCP or 1394. Thus, all devices in the PLC network and 1394 network are visible in the UPnP network, and can be controlled by DTV or other UPnP control point. The mobile phone is only device in wireless domain. The MDTV Link protocol is used to connect mobile phone to DTV. Once mobile phone joins system, it provides home network system with the wireless Internet connectivity. If there is already a high-speed connection, for example via a broadband modem, between home networking system and Internet this wireless link will only be used as an up stream link for personal data access and on-demand service. The high-speed connection will be used for the downstream path. User simply uses DTV remote control to access and control home devices, subscribe on-demand multimedia service, access personalized information and navigate Internet at home. User may also access or control home devices while away from home. Using mobile phone, user can send command to the MDTV server. The DTV (set-top box which is always live) pulls command from MDTV server periodically. If the command exists DTV then executes command and sends the result back to the mobile phone. In this case, home networking system needs a connection to the Internet or smart phone system. The proposed home networking system achieves a simple and ubiquitous home device control and access solution. Fig.4 shows devices that are currently connected to the home networking system.

The MDTV server stores user profile, customizes user's personal data, and provides on-demand multimedia services such as standard video, MPEG video, and HDTV video. The MDTV server supports multicast functionality. This allows multiple homes to share the resources without wasting network bandwidth. User may request multimedia services by using mobile phone as an identifier. The MDTV server may intelligently multicast multimedia content across Internet to multiple homes, multiple home devices such as

DTV, PC or laptop, etc. The rate adaptation capability and flexible multicast functionality have been integrated to handle network and user

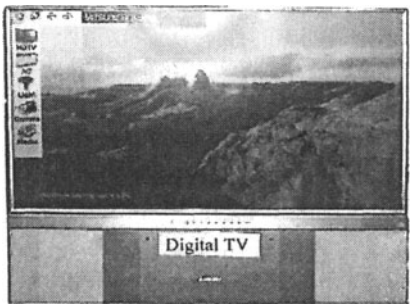

Figure4. MDTV-Centric Home Networking System Snapshot

4. CONCLUSION

The technologies have begun migrating to the homes from the offices. It presents tremendous opportunities for the home networking deployments. The MDTV-centric home networking system is designed to bring user a new mechanism to access and control home devices in the home, in the car, in the office, and virtually everywhere. It provides a total and seamless connectivity, and a unified access to, and control of, devices regardless of the technology used. It also presents a simple and familiar interface to all users. Our implementation demonstrates the effectiveness of a unified control over different types of technologies. The technologies presented in this paper will greatly increase the market opportunity for both home networking and DTV itself, will also provide more opportunities to service providers, and most importantly will benefit consumers. We will continue to improve our technologies by extending the device scope, enhancing security, and utilizing more advanced technologies to deliver high values to the consumers.

5. REFERENCES

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