Multimedia Content Traffic Distribution in Home Networking Database Architecture

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Abstract

Distribution of Multimedia content traffic in home is one of most challenging issues of Multimedia content service deployment. In this paper we focus on PLC and wireless LAN technologies as promising candidates for Multimedia content traffic distribution in home or small office environment. The paper presents a brief discussion of the respective PLC and wireless LAN technologies and evaluates the performance of each technology to support distribution of High Definition Multimedia content traffic throughout the home. This study can give a useful guide to design home network for supporting IPTV service.

Keywords: *Multimedia Contents, Home Networking, Database*

1. Introduction

Recently among the Multimedia contents, Internet Protocol Television (IPTV) has been gained high interest as an emerging service to provide digital television services over Internet protocol with advanced broadband Internet access technologies. IPTV is expected to be a key player of IP convergence networks and a promising business model of telecommunication service providers.

IPTV [1, 2] is an integrated service of broadcasting and telecommunication. IPTV service can provide data and voice on IP (VoIP) as well live digital TV and video on demand (VOD). Because two way interactive communications are supported by IPTV service between user and operator, user can select a program to watch and use video streaming control functions like forward and reward. However IPTV service has very stringent Quality of Service (QoS) requirements in terms of delays, jitter and packet loss probabilities. For example, High Definition (HD) TV is usually encoded in about 25Mbps and to stream one or more HDTV signal requires networks with sustained data rates of more than 30Mbps at the application layer. Therefore one of major challenges of IPTV service is design and development of network in home environment that users can enjoy IPTV services everywhere in home without cost and effort for rewiring.

In home the contents of IPTV from headend originate from home gateway to set top boxes through home network. It will then be the necessary to transport multimedia signal including HDTV traffic throughout the home for playing the video at multiple locations. Although traditional Ethernet networks with appropriate QoS may be one desirable choice for this purpose as it is a mature technology that supports very high bit rates, this may not be viable solution for deployment in existing buildings due to the inconvenience in laying the Ethernet cables around the house with the associated drilling through dry walls or even concrete walls. Thus wireless and the so-called ‘no

new wires' solutions become the top contenders for retrofitting a home network in existing buildings.

For some time there has been strong interest in the 802.11x wireless LAN technologies as key candidates for home networking because these wireless technologies provide the ultimate convenience and mobility to users. The widely used 802.11b is now considered to be less desirable for multimedia contents of IPTV service because of its low data rate. However, the IEEE 802.11g [3] provides raw data rates up to 54Mbps which may provide enough application level bandwidth to support streaming IPTV traffic. The IEEE Draft 802.11n standard [4] has also been proposed for higher throughput and QoS enhancements. It is expected to provide raw data rates up to 600Mbps and interoperability with IEEE 802.11a/b/g.

PLC uses the existing home power circuit to deliver digital data and is considered to be a potentially desirable candidate for home networks as there are plenty of outlets in a home and they are in convenient location.

The main contribution of this chapter is to conduct a real world performance assessment of the above recent wireless and PLC network technology for IPTV traffic distribution in home and small office environments.

2. IPTV

A general IPTV system is composed of four main parts which are video headend, core network, access network and home network as shown in Figure 1.

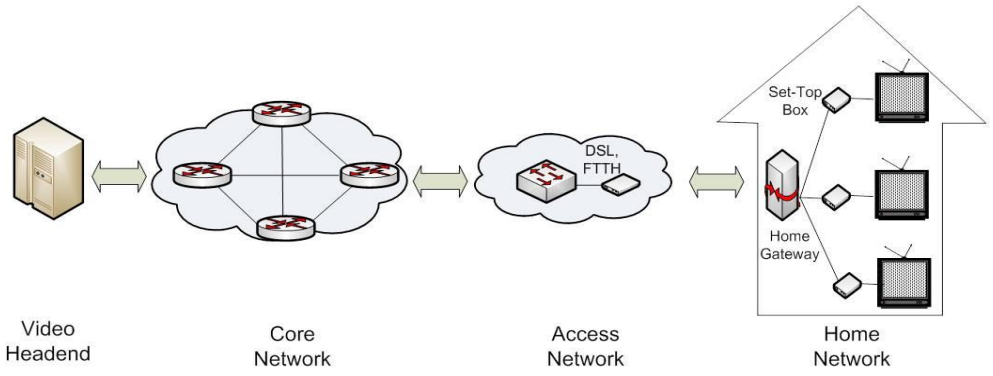

Figure 1. Architecture of IPTV

The video headend receives video and audio contents from contents provider and stores this content to serve. Also the video headend encodes analogue multimedia contents into digital format such as MPEG-2 or MPEG-4. Then multimedia contents are segmented and encapsulated into IP packets and these packets are delivered through core network to customer using IP multicast or IP unicast.

The core network which connects the video headend and access network is unique in accordance with IPTV provider. The IPTV traffic can be separated with other Internet data to guarantee stringent QoS requirement in the core network.

The Access network is used to reach each user in home through the set-top box. The Digital subscriber line (DSL) and fiber optic technique like fiber to the home (FTTH) are widely considered for IPTV service deployment.

The home network is for distributing IPTV traffic including data, voice and video to several user terminals in subscribing home. The set top box is a user side device that supports communication between IP network and terminals such as television and

computer and decodes MPEG-2 and MPEG-4 digital video data. The function of set top box can be integrated with home gateway or cable modem for an Internet access

3. Home Network Technology

In IEEE 802.11x technologies, there are two accessing methods. One is DCF (Distributed Coordination Function) and the other is PCF (Point Coordination Function). The infrastructure network works with DCF and PCF while ad hoc network uses DCF.

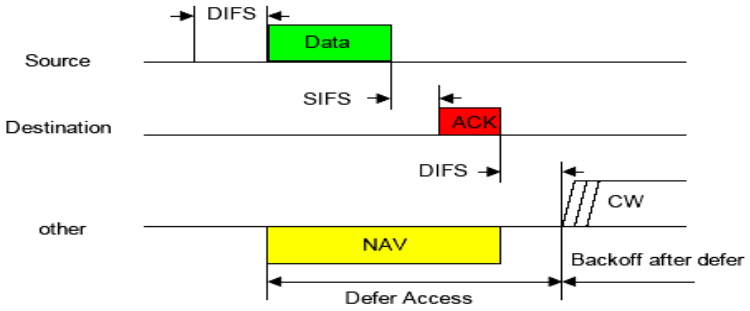

Figure 2. DCF Access Scheme

The principal approach of DCF is Carrier Sense Multiple Access with Collision Avoidance (CSMA/CA). The basic DCF Access scheme is shown in Figure 2. To avoid collision, physical carrier sense and virtual carrier sense are used and the physical layer uses these techniques to sense whether the medium is busy or idle. Whenever a machine decides to send a frame, a duration is specified in the duration field of the frame to indicate the ending time of the transmission. Other machines that receive the message update their local NAV (Network Allocation Vector) thus avoiding the possible collision resulting from more than one node sending frames at the same time.

The IEEE 802.11g uses 2.4 GHz band and provides raw data rate up to 54 Mbps. The latest standard of wireless LAN technology is IEEE 802.11n. The IEEE 802.11n significantly increases data rate using OFDM-MIMO in PHY layer and data aggregation in MAC layer.

The Power line communication uses wire but it has similar problems with wireless communication like as noise and hidden node problem. There are several groups providing Power line technology which has data rate up to 200Mbps. The Home plug AV[5] uses OFDM in PHY layer and both TDMA and CSMA in MAC layer. The UPA DHS[6] (Digital Home Specification) uses OFDM in PHY layer and TDMA with token scheme to assign the access right. The HD-PLC [7] (High Definition Power Line Communication) uses wavelet-OFDM in PHY layer and both TDMA and CSMA in MAC layer.

5. HDTV Streaming Test

To evaluate the feasibility of the distribution of a single HDTV stream in the home or small office environment, a 25Mbps HDTV stream was transmitted and received using Powerline and wireless LAN technologies. In this experiment we made a connection between the laptop and the desktop computer using PLC and IEEE 802.11g/n technologies.

For experiment of wireless LAN technologies, Linksys WUSB300N, wireless network adaptor was used. Also an Ad-Hoc mode and default setup of manufacture was used in this test.

The setup for the PLC tests is shown in Figure 3, while the PLC adaptors used in the test are described in Table 1.

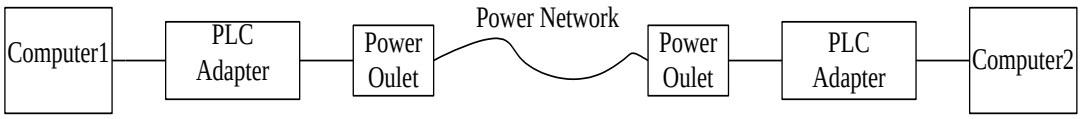

Figure 3. PLC Test Configuration

Table 1. PLC Adaptors

Model Name	Maker	Chipset	Technology
RD 6300	Intellon	Intellon	Home Plug AV
HDX101	Netgear	DS-2	UPA-DHS
BL-PA100	Panasonic	Panasonic	HD-PLC

The HDTV stream was played over the power line and wireless network using the PowerDVD multimedia player. A momentary video freeze phenomenon during playback occurred if the overall bit rate of the vide file was close to or exceeded the capacity the path for the selected technology. We conducted this evaluation on 5 paths in the same house. Table 2 shows the classifications used.

We evaluated the quality of video streaming in 4 categories of an informal Mean Opinion Score (MOS): “4=Very Good”, “3=Good”, “2=Poor” and “1-Very Poor. Table 3 shows the quality evolution for HDTV streaming.

Table 2. Classification of Video Streaming

Classification	Playback condition
4	Very Good: Video streaming is smooth and no packet drop is observed. Or it is hard to realize the packet drop
3	Good: video streaming has slight discontinuity or delay
2	Poor: Video streaming has evident discontinuity or delay but delay is not significant
1	Very Poor: video streaming has serious discontinuity and delay so quality of video is not tolerable.

In the experiment with MPEG-2 file with a bit rate of 25Mbps, we observed a serious video freeze and go (halting) phenomenon with IEEE 802.11g and n technology. The delay of IEEE 802.11g is more serious than that of IEEE802.11n. Panasonic’s BL-PA100 PLC adaptor

also shows bad video quality. Intellon's RD6300 and Netger's HDX101 PLC adaptor shows better performance than other technologies as we expected. But these could not support a 25 Mbps HD video signal perfectly at all paths

Table 3. Quality of 25Mbps, HD Video Streaming

Product	Path 1	Path2	Path3	Path4	Path5	Avg.
Intellon RD6300	3	4	2	2	3	2.8
Netgear HDX101	2	1	2	3	2	2
Panasonic BL-PA100	1	2	1	1	1	1.2
Linksys 802.11G	1	1	1	1	1	1
Linksys 802.11N	1	1	1	1	1	1

6. Conclusion

This paper evaluates wireless LAN and 200Mbps powerline communication technologies for supporting distribution of IPTV streaming in home. Our overall experimental results shows PLC adapter from Intellon outperforms other PLC products and the IEEE802.11n/g for HDTV streaming distribution. The homeplug AV technology can be a good choice for home network to distribute IPTV traffic however this also cannot support 25Mbps HDTV streaming perfectly. This study can give a useful guide to design a home network for supporting IPTV service traffic including HD multimedia content.

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