

# **Video Streaming Service Trial over ADSL-Based Telephone Networks**

Kou-Sou Kan\*, Cheng-Dow Hwang, Chi-Shi Liu, Bing-Shan Crien,

Yin-Hwa Huang, Her-Hsiung Chang, Ta-kang Ju

\*email:can@chttl.com.tw

ChungHwa Telecommunication Laboratories, 12, Lane 551, Min-Tsu Road Sec.5

Yang-Mei, Taoyuan, Taiwan 326, R.O.C

## **Abstract**

This paper presents the Multimedia-On-Demand (MOD) trial which is expected to create a diversity of high speed entertainment video streaming services and applications into the most widespread twisted-pair local loops in Taiwan. MOD trial is a massive system integration work since there is no sufficient reference information can be referred. The major system of MOD includes proprietary ATM switch as well as DSLAM, internal LAN, service management system, video streaming server and STB. Except high speed Internet access, all the streaming services are presented by STB. The MOD subscriber number is over 400. These subscribers are equally distributed within 7 End-Office service areas. The major object of the trial is to verify the transmission reliability and stability of ADSL network under high speed streaming environment, in addition to seek out the potential multimedia entertainment system architecture solutions for commercial services across the 21 Century.

## **1. Introduction**

With the advances in high speed access network technology, streaming video is feasible for remotely demanding and playing programs. Traditional twisted-pair copper loops was designed for voice service[1][2][3][4][5]. The transmission bandwidth of this loop is intrinsically insufficient when compared with CATV network. Evidently, it is difficult to provide high speed multi-media service before technical improvement. In the past decades, CATV carriers have widely deployed coaxial cable to cities and communities. With the development of Cable Modem, coaxial cable network can transmit data at the speed more than 10 Mbps. Various types of high speed multimedia services can be realized on CATV network such as high speed internet access, Voice over IP and digital TV. However, in Taiwan, CATV carrier will not become a competitor to the traditional telecommunication carrier until new cabling work is completed. Besides, the intrinsically shared medium constrains of cable network will cause security issue in commercial service.

Generally speaking, direct improvement of the transmission capability on existing twisted-pair loop should be the most economic and reliable solution for traditional Telecom company to provide the service which requires wide bandwidth. The ADSL can transmit at least 1.5 ~ 6 Mbps

to subscriber and 64 Kbps ~ 1 Mbps in return path. With this new technology, the telephone company is truly able to provide high speed data service which is never been possible before. Since there is no new cabling in using ADSL, telecommunication carrier can deploy such environment in reasonable time. Before Fiber To The Home(FTTH) becomes reality, Chunghwa Telecom believes ADSL be the best solution to provide high quality and high speed multi-media service. ADSL will dominate the public transmission requirement over the next decade in Taiwan due to the Chunghwa Telecom's aggressive deployment plan. Home and business can connect to more exciting interactive multimedia broadband services. The MOD trial is planned and established for the purpose of non-voice multimedia commercial deployment across to 21 Century.

In this paper, the video streaming system architecture and function is presented.

## **2. MOD system Architecture**

The system architecture of the ADSL-based MOD trial system is shown in Fig 1, which can serve 400 users. A 5 Gbps Virtual Path ATM Switch BEX-VPX (abbreviated as VPX) is the core switch which is a 32 x 32 (OC-3c per port) ATM switch. A proprietary multicast function is employed in the VPX to achieve the point-to-multipoint requirement. The ATM Multiplexer (AMX) in Fig. 1 provides the STM-1 (STS-3c) to 10 BASE-T termination between the VPX and the ADSL ATU-C. An AMX has 16 lines of 10 BASE-T ports, in which each line can connect to one ATU-C. Each ATU-C can support 4 lines of twisted-pair user or service provider. Thus, a VPX OC-3c port with an AMX can support 64 lines of POTS user/service provider. There are 7 AMXs are deployed to provide at most 448 users whereas 6 AMXs are setup for connecting at most 384 lines of the video or data service servers. The Common Control of VPX (VPX-CC) manages the PVC connections setup including multicast and unicast connections of the VPX and the AMX. The required message of setup PVC connections is received from the MOD service management system(SMS), which is the service and network management of the trial system. All of the communication among the VPX, the Video/Data Servers and the SMS is via a private LAN connected by Ethernet. In addition, the VPX also reserves a trunking port for system capacity expansion as well as additional network connections.

MOD trial streaming service is based on residential ADSL loops, in central Taipei city since 1996. In this pilot phase, 28 customers subscribe the service for free. Since 1998, the subscribe number is increased to 400 and uniformly distributed within 7 End Office (EO) coverage area. Each EO serves subscriber number around 48 to 64. The video services are decoded by STB and presented on TV. End user employs PC to connect to the internet and enjoy the fun of high speed accessing. The ADSL downstream is 1.5 Mbps and upstream is 74 Kbps. The service type in MOD trial is listed as follows.

- a. High speed internet access with downstream 1.5 Mbps and upstream 72Kbps

- b. Near-Video-On-Demand (NVOD) with 1.5 Mbps MPEG-1
- c. Karaoke-On-Demand (KOD) with 1.5 Mbps MPEG-1
- d. Live TV with 1.5 Mbps MPEG-1

As illustrated in Fig 1, a high speed ATM-based multimedia network, which supports IP multicasting function, is used to transmit control message and MPEG streams among the service management, ATM switch and STB. This ATM-based network can setup a QoS connection between customer and video server. Multicast server delivers all the stream with only one copy into the network. Client side send IGMP request message to the network device for join . In order to support massive user requesting on single program, both NVOD and Live TV are multicast services. With multicasting mechanism, the server complexity can be heavily reduced. Since the popular program such as news and hot movies can be duplicated by network element. This type of service can heavily reduce the backbone network traffic. Since the loading is distributed to the nearest local network device. On the other hand, KOD is unicast service to suit personal favorite, such as MTV. Unicast server transmits the program to every client as long as client sends legal request message. Unicast service usually causes damage to the network due to the intensive network traffic.

### **3. Major components of streaming services**

The major streaming components are described in the following section.

#### **3.1 Service management system (SMS)**

SMS acts as the portal site which receives every user request message and responds to relay to the appropriate system for following service. After complete the boot procedure, STB sends request message to the SMS. SMS returns the information of video services including the NVOD as well as LiveTV multicast channel information and available KOD unicast channel information.

If user requests to join multicast service, STB sends the demanding multicast channel information which is packed in IGMP format to SMS. SMS examines the message and notifies ATM switch to duplicate the specified multicast video stream to the STB via the pre-established PVC channel.

In KOD service, SMS notifies ATM switch to build PVC between STB and KOD server. User can choose program title and send control message such as VCR functionalities to the KOD server via return channel. The program video is received in down stream channel decoded by STB and presented on TV. SMS maintains the video server related system operating status including the multicast channel number as well as program schedule, present channel status, content program title and the present user number of the KOD server. All the system information is maintained in ordinary database system.

### **3.2 Near-Video-On-Demand system (NVOD)**

NVOD is a modulo CD-ROM broadcasting system with network streaming capability. It consists of 90 sets video transporter, control module, and 180 read-only CD-ROM. Each Video transporter transmits digital video to broadband switch via Ethernet. Control module manages and monitors the operation of video transporter. Each control module can command 96 video transporters to streaming digital video and monitor the streaming process. In addition, network management message can be transmitted to the management system via 10BT network.

NVOD server can deliver 240 channels of digital video to customer simultaneously. The channel number can be increased as long as the module is increased. The maximum channel rate is 1.544 Mbps each channel. This rate can be used to transmit MPEG-1 stream. The content source of NVOD server is VCD. All the content which is in VCD or MPEG-1 system format applies league usage license from the content publisher.

### **3.3 KOD system (KOD)**

KOD is the only system designed to provide the On-Demand service. KOD real time transmits the requested stream to the remote client via network. The client real time decodes and plays the stream on STB. KOD system consists of KOD master and KOD slave. KOD master is a system integrated with Intel Pentium 133MHz PC, 10BT Ethernet and gateway service software. KOD master acts as a gateway between client and streaming server. KOD slave is a streaming server which is a system integrated with Intel Pentium 133 MHz PC, mass storage units, multiple 10BT Ethernet interfaces and streaming kernel software. KOD slave can simultaneously stream out 32 streams. KOD master can manage multiple KOD slaves.

The remote requesting message is transmitted to KOD master via the ADSL upstream channel. The request message includes program title, destination network address and other necessary information. KOD master analyses the client request information then directs the KOD slave to real time transmit the requested streaming to the client.

All the content which is in VCD or MPEG-1 system format applies league usage license from the content publisher.

### **3.4 Live TV system (LiveTV)**

In general, LiveTV is designed to simulate the traditional CATV service. It encodes the CATV analog audio and video channel signal into MPEG format in real time respectively, then multicasts the stream to the client. LiveTV system consists of PC based streaming server installed with a MPEG real time encoder and dual 10BT Ethernet interfaces. The CATV demodulator is used to extract the selected CATV channel analog channel signal. The traditional CATV headend office provides CATV signal via optical fiber. Therefore, in telecommunication central office, an

optical receiver converts the signal into multiple channels of electronic TV signal. Then the TV demodulator filters the selected TV channel into separated audio and video signal. Each TV channel is the input source of LiveTV server. The MPEG-1 encoder kernel is been modified to buffer, shape and pack the bit stream into multicast packet format. The buffer control and shaping mechanism can achieve constant bit rate requirement by smoothing out the bit stream variation generated by the encoder. In ADSL transmission, CBR is more suitable than VBR due to its limited capacity. MOD trial provides 30 channels of LiveTV service. With multiple LiveTV servers, a specific management system is required to monitor the system operating status. The second 10BT network interface of LiveTV is used to return the polling acknowledge signal to the management system.

### **3.5 Set-Top-Box(STB)**

STB is designed to decode and present MPEG audio and video and display on traditional analog TV set. The set-top box is a system integrated with Intel 486 microprocessors based PC, VGA, flash ROM, 10BT Ethernet, MPEG decoder, PS2 mouse, keyboard and kernel software module. Basically, the STB is a simplified PC without hard disk. All the software is stored on flash ROM including booting system, MPEG decoding driver, networking kernel, service module. A STB examining mechanism is designed to on-line download the STB driver when new version is available.

The STB is responsible for all the streaming service including NVOD, LiveTV, KOD. Therefore, STB supports multicast and unicast type of services. In multicast service, STB sends IGMP request message to SMS to join the specified NVOD or LiveTV multicast channel. In unicast service, STB sends client IP address, request stream title to KOD to subscribe service. User can use STB to send pause, stop, resume, and skip in KOD. In addition, STB sends acknowledge signal periodically to KOD for polling. Once the connection between KOD and STB is not existant, KOD master can release the occupied channel resources between STB. In normal program end case, STB transmits end-of-program protocol to the KOD server to declare formal playback stop. In order to solve unstable transmission situation, the MPEG decoding kernel is further modified. The timing mechanism for decoding audio and video is altered dynamically to guarantee certain degree of smooth playback. An IR remote sensor device is built in to simulate traditional TV and VCR function.

## **4. Conclusion**

The ADSL-based MOD trial system is a new service trial initiated by Northern Taiwan Business Group of Chunghwa Telecom Co., Ltd. The trial system can provide 400 users to subscribe the services. The subscribers of the trial are equally distributed within 7 telecommunication

End-Office service area. The services provided by this system are high speed Internet service, KOD, LiveTV program and NVOD (pay per view). The system can afford 240 NVOD program channels, 32 KOD channels and 30 LiveTV channels. In order to create multicast type of service, we use BEX-VPX which is an ATM switch developed by Chunghwa telecom Labs to be the core switch of our MOD system. According to the experiences accumulated from MOD trial, a commercial scale MOD system which is based on revolutionary Gigabit Ethernet Switch Router(GSR) technology is under established and will be in service in the middle of 2002. The architecture is easy to be extended when designed network traffic loading is reached. The necessary network configuration effort is much less than ATM. In addition, TCP/IP network communication protocol is widely used in most of the multimedia equipments and services. Therefore no protocol translation effort is required in router. The multimedia streaming service is expected to play a major role in the 21 Century.

## **References**

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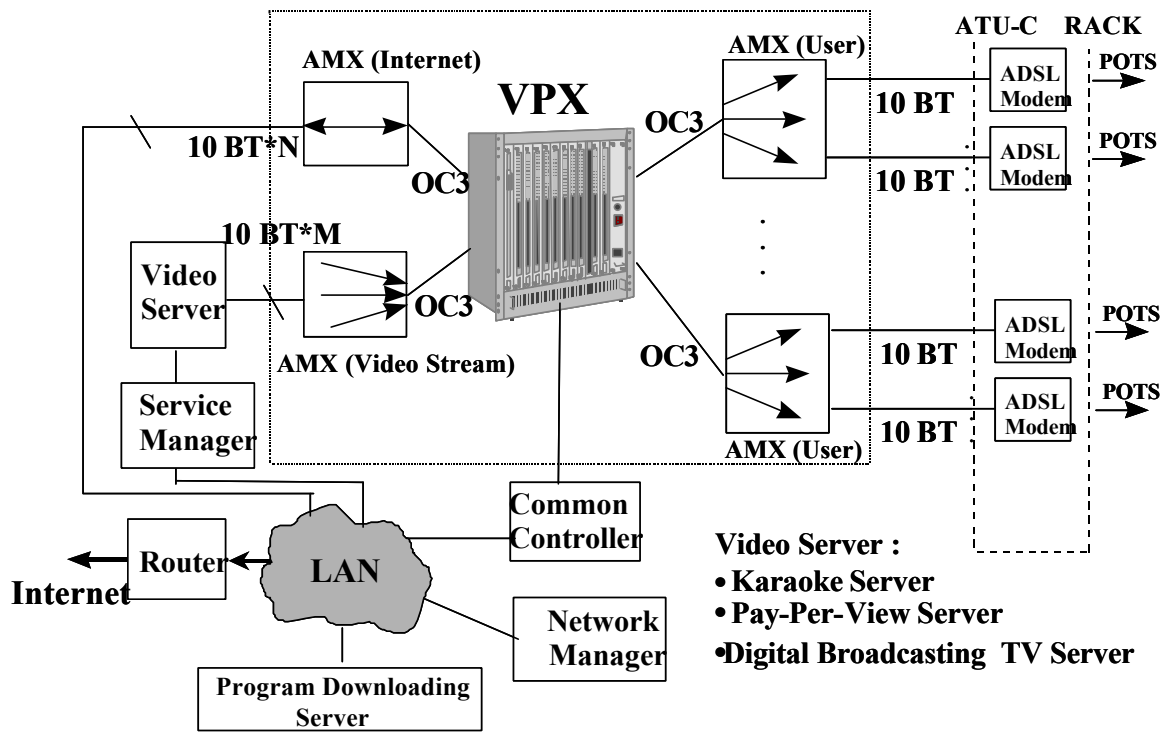


Fig. 1 MOD trial system architecture.