Interactive Multimedia System on Cable TV

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Abstract: Interactive CATV system is under development to provide multimedia applications such as movies on demand, home shopping, etc. in addition to the conventional analog cable TV services. This system applies international standard DAVIC, ATM forum, DSM-CC etc. The system adopts modular architecture design approach so that the system can be adaptive to the fast moving technology wavefront. In this article, interactive CATV system and essential elements such as video server, delivery network and Set-Top-Box(STB) and related international standardization are introduced.

1. Direction of interactive CATV system development

On CATV network using broadband cable medium, interactive multimedia services can be implemented at a low cost, at evolving digital communication technology. System development and related trial services are provided by TECOS as well as cable operators. Interactive CATV system is the system providing various video services such as movie, game, home shopping and home banking using broadband Hybrid Fiber and Coaxial(HFC) network. The system is configured in the figure 1.

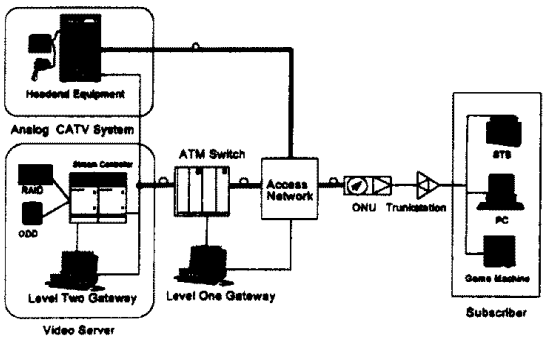

Fig. 1. Interactive CATV System

Also Interactive CATV system is compatible with analog CATV system.

Existing frequency bandwidth are used for analog services and extended bandwidth (450 ~750MHz) used for VOD, NOD and digital communication service. Subscriber terminal such as STB, PC, Network Computer(NC), game machine will be considered. In this system, STB is considered for subscriber terminal. STB will be developed as hybrid type providing analog and digital services.

The interactive CATV system consists of analog CATV headend including conditional access system and subscriber management system, video server, ATM switch, level one gateway, HFC access network, STB.

2. Video Server

The video server is to provide content access service. The server system consists of functional blocks like figure 2.
The following functional blocks are described.

1) System Management Service

This service provides the function to monitor the status of system, fault diagnosis and traffic management function. The function to monitor the status of system provides the overall system management, monitoring and report of the system status to system operator. All abnormalities are reported via audible and visible means. Informations regarding the system status is stored in the system monitor files and are able to be outputted through printer when the informa- tion content monitored is requested by the operator.

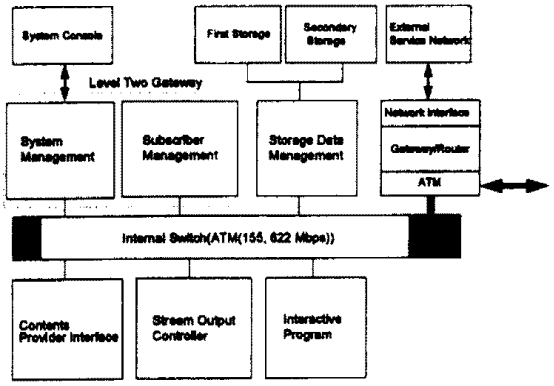

Fig. 2. Functional block diagram of video server

- System Maintenance Function

This function carries out a self diagnosis on a regular basis. When failure of connection is increased, the systems reliability is secured. Time of occurrence and time of recovery is recorded and downtime is managed.

- Traffic Management Function

This function measures traffic of the video stream and the control signal. For total system management, this function analyzes incomplete call, simultaneous viewers, program viewed, traffic distribution, etc. The following items are analyzed.

① Traffic analysis by the types of the subscribers
② Traffic analysis on overall system and system element
③ Analysis on incomplete service types
④ Traffic analysis on the peak time
⑤ Analysis of usage by the hour of the day

- Subscriber Management Function

This function manages subscriber menu, viewing content, statistic analysis of program, billing material. The billing management provides the ability to track subscriber billing information including regular, network connection and irregular basis. Subscriber usage pattern provides the ability to accumulate statistical information to provide a basis of billing and market information.

- Time-Out Function

This function has the capability to limit the amount of free time that a subscriber can watch the video previews and the capability to make announcements.

On completion of viewing of the video information, if no control signal such as ' fast rewind' is generated by the subscriber within 60 seconds, a 'time out' is established. The connection is be canceled during this 60 second period, an anouncement message 'End of Video' Information is displayed on the TV screen.

2) Title Storage Management Service

This service provides near-line storage for high volumes of archival data that require relatively low rates of access and can tolerate relatively longer access times. The storage device is a multi-layer structure that is to be organized to efficiently adjust the data requiring frequent usage and less frequent usage. According to frequent usage, storage configuration is described in figure 3.

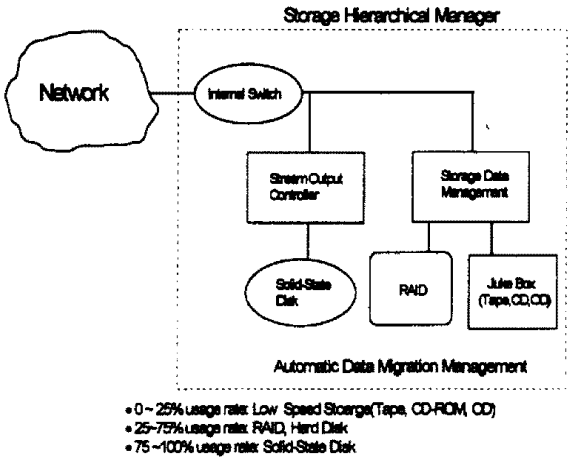

Fig. 3. Storage Hierarchical Configuration

Using high speed storage medium like RAID, first storage system stores data requiring frequent usage.

Secondary storage system storing data requiring less frequent usage consists of relatively inexpensive and high capacity devices such as digital tape, optical disk, compact disk, etc.

3) Stream Output Controller

This element uses DRAM to manage the look up of many simultaneous streams from the same movie. It exports the interface through which the STB controls the media stream. The interface provides functions to control the advance of a media stream, via pause and resume and to inquire about the state of the stream object.

3. Delivery Network

The delivery network subdivided into the core network and the access network. The core network provides switched connections from and to content providers, service providers(servers and brokers) and end-users. The core network can be as small as one switch or may extend to a worldwide network.

① Reliable transfer of information between entities like content providers, service providers and access network. The access network takes care of the delivery to the end-user.

② Switching functionality in order to set-up connections between entities. The multiplexing and switching technique in the core network is ATM. ATM allows to establish connections of virtually any bit rate to the maximum capacity of the transmission links. The access network is defined as a collection of equipment performing the following functions:

③ transmission, multiplexing, and possibly concentration of services and applications information flow between the end users of a given area and the rest of the system

④ Relevant control and management

⑤ Transport of other services (telephony, analogue TV, N-ISDN services, etc.)

The access network consists of the access node, the Network Termination(NT) and the distribution network in between them. The access network has no switching functionality.

1) Core network

For Core network, only public ATM UNI interfaces are considered. The allowable physical layer protocols for core network are SDH/SONET and PDH. The server is connected directly to the core network.

Level one gateway controls information flow from server using Permanent Virtual Channel(PVC) and Switched Virtual Channel (SVC) functions of ATM switch.

2) Level one gateway

The two levels of level one gateway are represented by two functional blocks: Service Related Control(SRC) and Network Related Control(NRC). Network related control provides control functions for network configuration, connection establishment and termination and information routing.

Service related control provides the following main functions.

① STU download: For basic gateway navigation, there is a need to download programs to the STB. This function controls this process and maintains any necessary service-related information.

② Directory: This functions controls the process and maintains the necessary information to generate menus for user navigation.

③ Address resolution: This function provides translation between a logical name and a network address.

④ Session control: This function is the processing required to set up, maintain and release sessions.

3) Access Network

The access network is connected with

subscriber. Access network can be classified according to the medium that is used or the topology of the access network.

This system is based on HFC access network. The fiber extends from the access node to Optical Network Unit(ONU). This ONU serves typically about 100 to 500 subscribers via coaxial cable. These subscribers share the same cable and thus the available capacity of this cable. Because several subscribers share the same downstream and upstream bandwidth, A Medium Access Control(MAC) scheme is required in the

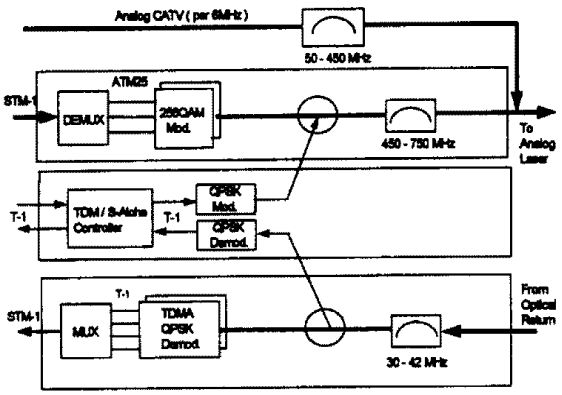

Fig. 4. Access Network

upstream direction to prevent collision of information from customer to the network. For interactive multimedia service, ATM25 access switch comverts STM-1 formatted data from a core ATM switch into several ATM25 formatted data (pure data rate: 25.6Mbps, coded data rate: 32Mbps).

This is an acceptable method for existing CATV delivery bandwidth(NTSC: 6MHz). High speed forward data part converts ATM25 formatted data into an equivalent RF signal and delivers RF signal over a broadband cable network. This bandwidth would require 6MHz using 256 QAM. Because useful bit rate of 256 QAM is 38.7Mbps, ATM25 bit rate is not suitable with 256 QAM method. A solution fitting different transmission rates is to assign frequency bandwidth matched to the ATM formal rate instead of the conventional frequency assignment i.e., constant bandwidth allocation.

For connection and session control, downstream transmission method is Time Division Multiplex(TDM). Upstream protocol mechanism is slotted-aloha protocol. For application control, upstream mechanism is Time Division Multiplex Access(TDMA). This bandwidth would require 1 MHz using QPSK and transmission rate is 1.544Mbps.

4. Set-Top-Box

Set-Top-Box provides with interactive service and analog/digital service and is divided with three parts. The first is Set Top Unit(STU) that exchanges MPEG-2 signal into NTSC signal, the second is Network Interface Unit(NIU) that acts a role of data transmitter/receiver, the third, OS and application software are needed to operate hardware. There are function and configuration of each part as follows.

1) STU

STU is configured as a figure 5. and has functions as follows.

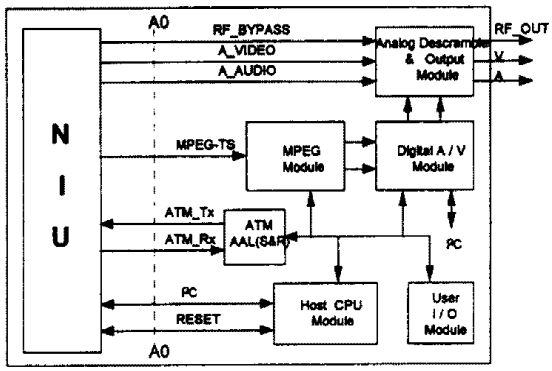

Fig. 5. STU Configuration Diagram

① analog CATV reception
② analog Pay-Per-View(PPV) channel descrambling
③ digital audio/video(MPEG-2) decompression and NTSC decoding

④ virtual VCR
⑤ NIU interface
⑥ decryption engine
⑦ ATM and TCP/IP protocol supporting
⑧ on-screen display
⑨ interface
- RS232C
- infrared remote controller

2) NIU

A figure 6. is a NIU configuration block diagram and the follows are characteristics of input signal.

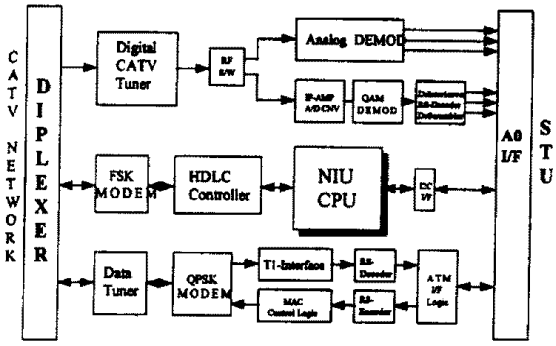

Fig. 6. NIU Configuration Diagram

① tuner frequency bandwidth ; 54~750 MHz
② channel bandwidth ; 6 MHz
③ digital channel
- modulation method ; 64/256 QAM
- FEC ; Reed Solomon T=8 (204, 188)
- transmission rate ; 30.336(64QAM)/ 40.448(256QAM) Mbps (6 MHz)

Modem for digital channel must have a high reliability as control channel in order to implement interactive CATV service. It uses different control channels from analog channels and selects standard protocols. The following are principal characteristics of signals.

① frequency bandwidth ;
receiver : 450~498 MHz
transmitter : 30~42 MHz
② modulation method ; QPSK
③ transmission bandwidth ; 1.0 MHz

Output signals consist of RF-bypass signal, audio/video signal and RF signal inputed from network output into TV or VCR through STU.

3) Software

Softwares in Set-Top-Box consist of communication software between network and server, software supporting it and application software. We have to consider facility of system development and portability of software. A figure 7. is a software configuration diagram for STB.

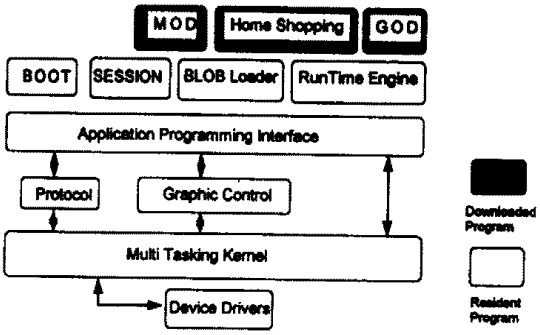

Fig. 7. Software Configuration Diagram

A server downloads such variable services as analog/digital broadcasting, MOD, GOD, Home shopping, etc. Boot is a program which initially operates system when power on. Session is a resident program in NVRAM that connects server and client through network. System softwares include multi-tasking kernel, graphics and peripheral device control program and execute application program on API.

5. Standard trends

To implement multimedia service, we must regulate service procedure and interactive communication procedure and interface between server and delivery system and STU. We consider interactive CATV service through HFC network and allocate communication bandwidth unused to analog CATV service for interactive service. Digital data transmission/reception has to be very fast to interact between subscriber and server. To examine standard and development trends of

delivery system on HFC network, upstream frequency bandwidth expands analog upstream frequency bandwidth 5~30 MHz into 5~42 MHz and downstream frequency bandwidth uses 450~750 MHz for digital transmission. But each network operator uses different frequency plan to some extent. Nations interested in interactive multimedia service, are researching about transmission method, control communication procedure, frequency plan. DAVIC has two proposals in transmission method. One is full ATM method and the other is merged ATM/MPEG method. The former uses ATM addressing at the client to select MPEG programs and other data streams. For this case, the client selects program information using ATM cell identifiers. It extends from the server to the client. For the latter case, the MPEG data stream is carried over ATM cells up to defined point in the access network. This method uses both ATM and MPEG multiplexing. Each method has different protocol stack. A figure 8. is a frequency plan.

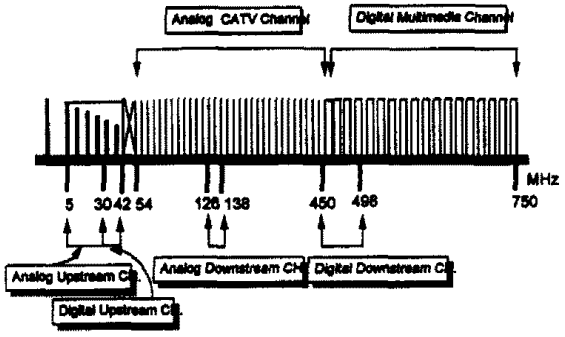

Fig. 8. Frequency Plan

Control/communication channel for digital service is also standardized in beginning of development. Analog CATV system allocated 17.9~29.6 MHz to upstream frequency bandwidth and 126.15~137.85 MHz to downstream frequency bandwidth to use as communication channels in subscriber converter management and network monitoring system. Interactive CATV system must use new frequency bandwidth for communication and control to be compatible with analog CATV system.

Including more than 200 companies worldwide, DAVIC makes its work about their interested parties to standardize digital audio/video service. DAVIC had standardized internationally agreed-upon specifications of open interfaces and protocols that maximize content creation and service interoperability for favoring success of emerging digital audio/visual application and services in December 1995.

A standard model of DAVIC has server, network, control/management and client object. They are closely connected each other to transfer audio/video data. DAVIC consists of Application Technical Committee(TC), System TC, Server TC, STU TC, Delivery system TC and Technology TC. Each TC organize subgroups within itself to discuss proposals from companies. Subgroups perform to arrange and modify a proposal to follow object of TC, a joint conference and a cooperation between TCs are performed to come to an agreement.

To develope interactive CATV system, we have adopted communication protocol standard that DAVIC proposes.

6. Conclusion

Many equipment manufactures and R&D organizations are actively international standard bodies and research domestic standard. Consortium of interactive CATV will develope prototype to the end of 1996 and construct test-bed system of laboratory scale. Members of consortium will develope core machine, associate parts and software using variable technologies(communication regulations, modulation/demodulation method, analog /digital system integration and interoperability)

To activate standard of communication protocol and drive of new service in company with I-CATV system development, we

propose a close cooperation or special committee with representatives from government organizations, R&D organizations, equipment manufactures and service providers.

Reference

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