Integrated Service Platform for High Quality Interactive Multimedia Service, Digital Broadcasting, and Internet Services

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Abstract

Our platform introduced in this paper is based on DAVIC specifications which define high quality multimedia services with some extensions to provide user friendly and uniform interface to its users. We designed and implemented an integrated service platform for high quality interactive multimedia services, switched digital broadcasting, and Internet services. The integration in terms of a service provider system, a delivery system, and a service user system is taken into account. Our research results in the development of integrated high quality interactive and digital broadcasting multimedia services with web-based common user interface and its experience will be feedback to the field trial service which will be launched from next year.

1. Introduction

The world is being rapidly connected by global information networks. Especially, the Internet with explosive popularity keeps expanding its territory and citizen in enormous speed. It is expected that the number of the Internet users will be reached 300 million by the year 2001, according to the Internet related report of the ITU. Also many telecommunication providers believe that the Internet will soon play a very important role as much as the existing wireline and wireless telecommunication network. WWW was the killer application to boost to the current popularity of the Internet. Thanks to this, the surprising number of interesting applications to support various sectors such as business, government, education, broadcasting, and many more came alive and are marching towards its bright future. However, as lots of the Internet applications become ubiquitous, users who were ignorant with their quality start realizing its importance. Answers to this question is not easy to come by.

Many companies, researchers, industry consortia, and standard organizations are very actively carrying academic and practical research to provide solutions to this problem. IETF's integrated service architecture, ITU's multimedia services and their network capabilities, Internet2 activities by US universities and others, and DAVIC(Digital Audio Visual Council)'s activities to define high quality multimedia services are some of the important ones to consider in this area. Our platform introduced in this paper is based on DAVIC specifications with some extensions to provide user friendly and uniform interface to its users.

DAVIC (Digital Audio-Visual Council), by recognizing the importance, was established in 1994 to standardize application services that can be commonly used in broadcasting, telecommunication, and computer. DAVIC specifications, which include interfaces, protocols, and tools to interconnect service systems, not only cover currently well established multimedia services (movies on demand, distance learning, and home-shopping) but also provide the broadcasting-type services. Based on these specifications, we designed and implemented an interactive and broadcasting multimedia service platform. The service platform includes various service component systems such as movies on demand server, broadcasting server, ISAP (Internet Service Access Provider) server, service user terminal, and delivery system. Interactive multimedia services such as movies on demand and home-shopping, broadcasting service called switched video broadcasting service, and Internet access service have been developed over the service platform.

As mentioned above, the popularity of the Internet comes from the user-friendly and common user interface for a variety of different applications. One very important consideration for our platform development is to provide web-like common user interface to transparently hide service and technology details from service users. Some of the important advantages are service ubiquity, user-friendliness, platform independence, means of simultaneous access to the existing best-effort quality Internet and high quality multimedia services, and means of integrated network, system, and service management of our platform.

Our research results in the development of high quality interactive and broadcasting multimedia services with web-based common user interface and its experience will be feedback to the field trial service that will be launched from next year. In this paper, we will describe the overall architecture in the section 2. Section 3 provides each service and its system architecture. And in the last section, we will conclude our work with possible future extensions.

2. Architectural Overview of the Platform

Our development system, called IMPRESS (Interactive Multimedia exPRESS)[3], follows the reference model of DAVIC specifications 1.0/1.1/1.2[1,2,3] and, thus, consists of a service provider system, a delivery system, and a service user system. For the service provider system, there are four kinds of servers: Video on Demand/Teleshopping server, Switched Video

Broadcasting server, Internet server and Multimedia Conferencing server. For the delivery system, ATM switches are to be used as a core network and CANS (Centralized Access Node System) and/or ALAN with additional functionality of stream duplication and channel selection control are/is used as an access node. For the service user system, a PC based MPEG-2 set-top box and a PC based desktop videoconferencing terminal are being developed. Figure 1 illustrates the overall architecture of the IMPRESS. Among these services, we have implemented Video on Demand, Teleshopping, Switched Video Broadcasting, and Internet access services. Other services are under development.

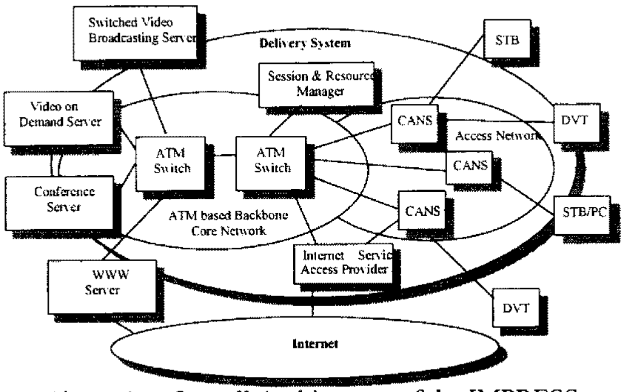

Figure 1. Overall Architecture of the IMPRESS

Besides three systems mentioned above, a number of reference points and five information flows(S1-S5) within and/or between them for these services are defined. MPEG-2[4] encoded content source flows over S1 and control commands for content source flows over S2. S3 and S4 are session- and network-related information flows. S5 is responsible for the transfer of network and system management information. IMPRESS implemented S1, S2, S3 and S4 flows. Detailed descriptions on each service and its system components and control flows among them are given in the next section.

3. Services and System Architectures

3.1 Interactive Multimedia Service: VoD & Teleshopping

Figure 2 shows an architecture for the interactive high quality multimedia services such as VoD and Teleshopping. To provide these services, Service Provider System, Set Top Box(STB) and Session and Resource Management System(SRM) are needed. These systems will be explained in details in terms of their functions and protocol stacks.

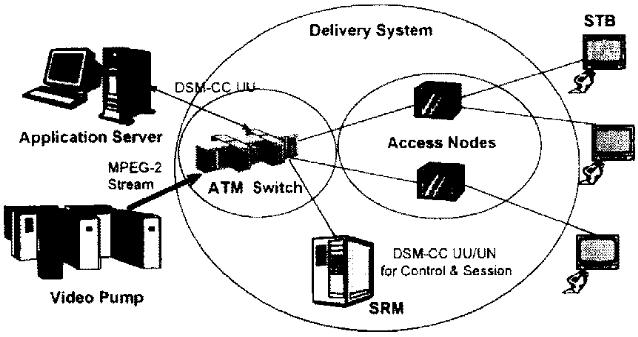

Figure 2. An Architecture for Interactive Multimedia Service of IMPRESS

3.1.1 Service Provider System (SPS)

The SPS consists of an application server and a video pump. An application server and a video pump together provide high quality video server's functionality. An application server provides service gateway, session control, stream control, and application control functionality. The video pump transfers a number of MPEG-2 encoded movies and audio/video clips to the STB in real-time. Figure 3 shows the system architecture of SPS. [5]

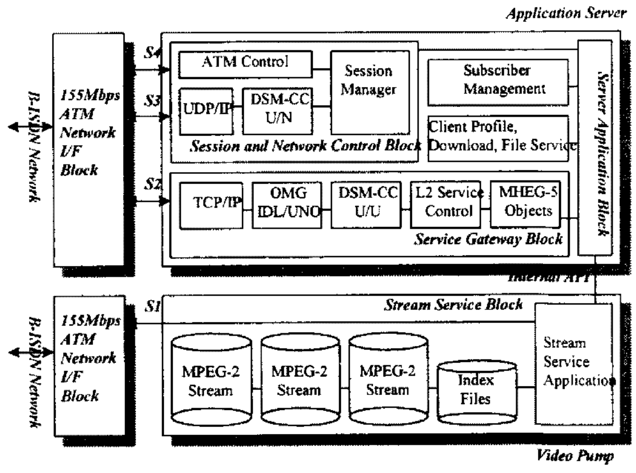

Figure 3. A System Architecture of the Interactive Multimedia Server

The application server consists of four blocks: Session and Network Control Block, Server Application Block, Subscriber Management and Supplementary Service Block, and Service Gateway Block. Session and Network Control Block performs the network connection control, user-network configuration, session establishment/release, resource allocation/deallocation, and status management for session and network connection. Server Application Block controls the other block in application server and video pump via internal API. Subscriber Management and Supplementary Service Block manages subscriber information and provides supplementary services such as client profile, download, and file service. Service Gateway Block is the core function block in application server. It provides user's navigation and application selection function.

3.1.2 Set Top Box

Figure 4 shows the system architecture of the STB [5]. MINIBA (Media and Network Interface Board Assembly) is the main unit that performs the MPEG-2 decoding and ATM network interface function. MINIBA is divided into two modules: ANIM (ATM Network Interface Module) and MPM (Media Processing Module). ANIM provides termination of physical signal, ATM and AAL processing, and Q.2931 UNI signalling function. MPM provides demultiplexing of MPEG-2 TS (Transport Stream), decoding of MPEG-2 AV (Video and Audio), and AV output function.

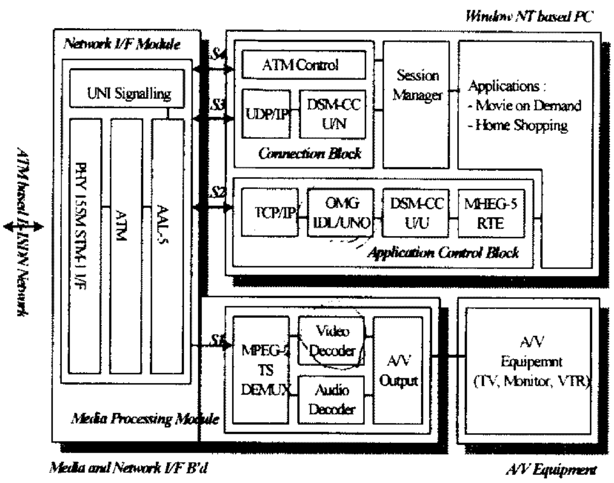

Figure 4. A System Architecture of the STB

3.1.3 Session and Resource Management System

SRM manages sessions and their resources. SRM consists of resource manager, session manager, and configuration module. The session manager sets up and releases the session according to the request from a client or a server. The resource manager manages various resources associated with outstanding sessions such as VPI/VCI and PID of MPEG stream. The configuration module provides clients and servers with configuration parameters that are required for devices to operate on the network.

3.2 Switched Video Broadcasting Service

Figure 5 shows an architecture for the switched video broadcasting service [7]. The service requires the following components: Broadcast Service Provider System(B-SPS), Replication Unit and Broadcast Control Unit(RU/BCU), Set Top Box(STB) and Session and Resource Management System(SRM). These system components will be explained in details in terms of their functions and protocol stacks.

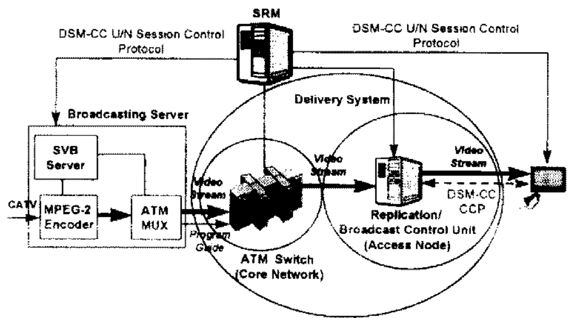

Figure 5. An Architecture for Switched Video Broadcasting Service of IMPRESS

3.2.1 Broadcast Service Provider System

Figure 6 illustrates the architecture of an Broadcast Service Provider System(B-SPS). B-SPS consists of an SVB Application Server and an MPEG-2 encoding system. The SVB Application Server provides CFS Session Control, which establishes program feeds from an MPEG-2 encoding system to RU/BCU. The SVB Application Server also provides SVB Session Control, which establishes SVB sessions requested by STB, and manages client service profile and electronic program guide to be transferred to RU/BCU and to STB respectively. The CFS Session Control and SVB Session Control are based on DSM-CC UN [6]. The MPEG-2 encoding system encodes real-time analog broadcast program sources from CATV Broadcasting Center into MPEG-2 streams and multiplexes multiple MPEG-2 encoded streams into one input for ATM network. Call Control is provided to support switched virtual circuit in ATM network and it is based on Q.2931 and SAAL.

B-SPS requests to establish a CFS session to SRM. The SRM allocates resources required for the session between B-SPS and RU/BCU. When B-SPS receives real-time analog broadcast program sources from CATV broadcasting center, all broadcast channels are encoded into MPEG-2 streams and delivered in separate ATM channels. When B-SPS receives SVB session establishment request, it requests to allocate resources required for the SVB service to SRM, and transfers entitlement information and electronic program guide to RU/BCU and to STB respectively.

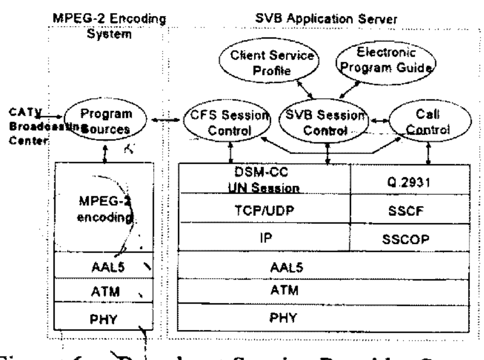

Figure 6. Broadcast Service Provider System Architecture

3.2.2 Replication Unit/Broadcast Control Unit

Figure 7 below shows the architecture of Replication

Unit and Broadcast Control Unit(RU/BCU). The RU/BCU are implemented based on an access node system which multiplexes and de-multiplexes ATM connections in access network. RU/BCU provides CFS Session Control to establish program feeds between B-SPS and RU/BCU. SVB Session Control controls SVB session and gets entitlement information of a user when an SVB session is established. The CFS Session Control and SVB Session Control are based on DSM-CC UN. RU/BCU provides Channel Control based on DSM-CC SDB-CCP to switch a channel stream to the requesting STB and checks the entitlement for the requested channel.

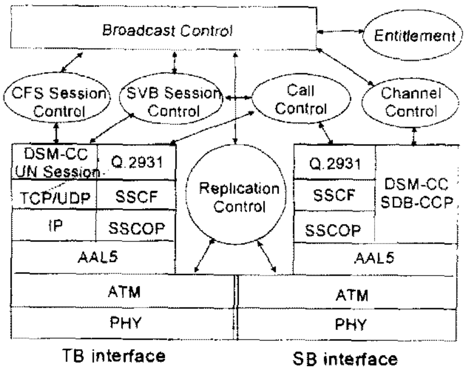

Figure 7. Replication Unit/Broadcast Control Unit Architecture

The Call Control function is provided to support switched virtual circuit in ATM network and it is based on Q.2931 and SAAL. When RU/BCU receives program feed establishment requests from B-SPS, it allocates resources required for the CFS session. When RU/BCU receives MPEG-2 streams from B-SPS via the CFS session, Replication Control copies and multicasts the streams to multiple STBs requesting the stream. When RU/BCU receives an SVB session establishment request, it allocates resources required for the SVB service and saves the entitlement information transferred from B-SPS.

3.2.3 Set-Top Box

Figure 8 provides architectural view of our Set Top Box. STB provides SVB Session Control to establish SVB session between B-SPS and STB. When an SVB session is established for an STB, two ATM connections are established between RU/BCU and the STB, one is used to receive MPEG-2 streams from RU/BCU and the other is used to control channel selection. The SVB Session Control is based on DSM-CC UN. And STB provides Channel Control to select a channel from several channels which is based on DSM-CC SDB-CCP protocol. The Call Control function is provided to support switched virtual circuit in ATM network and it is based on Q.2931 and SAAL.

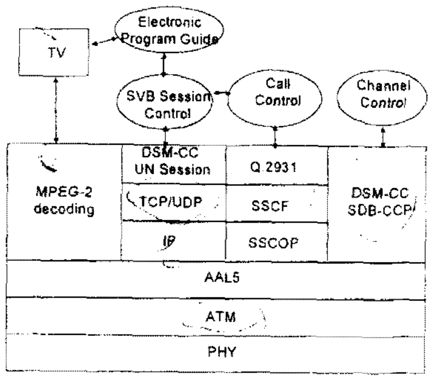

Figure 8. Set-Top Unit Architecture

When the STB receives a downstream MPEG-2 TV program stream from RU/BCU, it decodes the MPEG-2 stream and displays the stream on the TV which is attached to STB. The user of the STB selects a channel based on the electronic program guide which is transferred to the STB when an SVB session is established.

3.2.4 Session and Resource Management System

Figure 9 provides an architectural view of our Session and Resource Management System. SRM manages sessions and resources in the network. The Session Control manages CFS sessions for program feeds between B-SPS and RU/BCU and SVB sessions between B-SPS and STB. It allocates resources needed for CFS sessions and SVB sessions and manages the established sessions in the network. Configuration Control provides STBs and servers with configuration parameters that are required for devices to operate on the network. The Configuration Control is based on DSM-CC Config. For SVB service, the Configuration Control provides the B-SPS server Id and service information to STB.

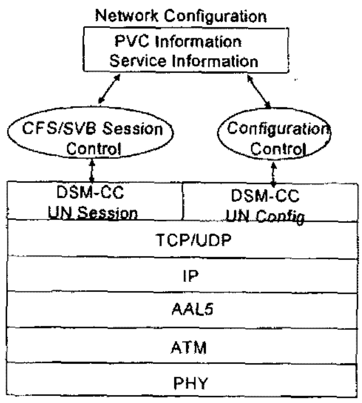

Figure 9. Session and Resource Management System Architecture

3.3 Internet Access Service

Clients in the above two service systems belong to a particular service provider domain. Although session control protocols depend on TCP/UDP/IP, it doesn't mean that the devices within this domain can be globally addressable in the Internet. In other words, clients of these services belong to a privately isolated domain from the global Internet. Thus, IP address for the device can be privately administered. However, if the service users want to have full Internet access while other multimedia services are being served, a mechanism should be provided. We have implemented a mechanism for this purpose and its architecture is shown in Figure 10. The service requires the following components: Service Provider System(SPS), Internet Service Access Provider (ISAP) [8], Set Top Box(STB) and Session and Resource Management System(SRM). These system components will be explained in details in terms of their functions and protocol stacks.

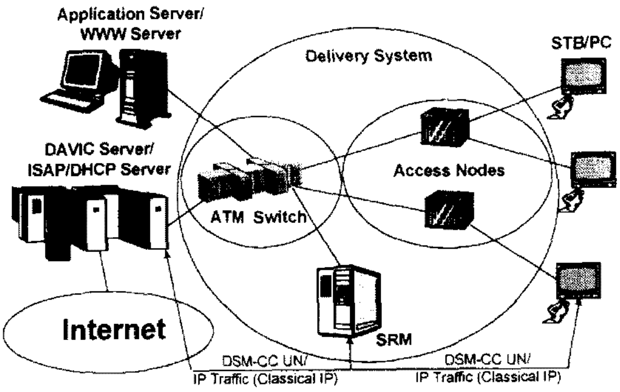

Figure 10. An Architecture for Interactive Access Service of IMPRESS

3.3.1 Service Provider System

The SPS for interactive multimedia services is used for Internet access service as well. The main function of the SPS to provide Internet access service is selection of an appropriate Internet Service Access Provider (ISAP). Once one is selected, STB sets up a session for Internet access with the ISAP selected. All IP traffic between Internet and STB flows over this connection. Besides the application server, web server is provided to maintain ISAP lists and its service promotion information. It also has very important roles in the integrated platform.

3.3.2 Internet Service Access Provider (ISAP)

For the direct Internet access, ISAP relays IP over ATM traffic from/to an STB. It is a typical router which has ATM and IP LAN interface. Any commercial routers of this category will fit for its purpose. An STB gains access to the Internet by connecting to a designated ISAP Router. The ISAP Router ports to which STB's can be connected use the inATMARP function of the classical IP on ATM (RFC 1577 and RFC 1293) [9] and the LLC/SNAP encapsulation option of RFC 1483. All ISAP Router ports which can be connected to the STB are ATM SVC's or PVC's. The connection is bound to the IP address through inATMARP from which the router can infer the IP address of the STB.

3.3.3 Set Top Box

The same STB for interactive multimedia services is used for Internet access service. STB provides Internet access session control to establish a session between ISAP and STB. For this session to be setup, STB first establish a session with the application server. STB selects an appropriate ISAP from the application server's ISAP menu. Given the detailed information from this selection, STB establishes a session with ISAP for Internet access. STB can have any Internet applications like a web browser. Our STB also supports ATM-forum's UNI 3.1 and Q.2931 signalling for switched virtual circuits.

3.3.4 Session and Resource Management System

SRM manages sessions and resources in the network. The Session Control manages Internet access sessions between ISAP and STB. It allocates resources needed for Internet access sessions and manages the established sessions in the network. Configuration Control provides STBs and servers with configuration parameters that are required for devices to operate on the network.

3.4 Integrated Platform

Based on the three system developed, we are currently in the stage of combining them to form an integrated platform. The web server which is a part of the service provider system plays a role of the service gateway to the end users. All user's service navigation requests and stream control requests are delivered to this server and conveyed them to the appropriate content servers via the internal APIs. All necessary session resource allocation and management such as Internet access session, VoD session, SVB session, CFS session, and SDB-CCP session are performed transparent to the end users. Users only see service objects and stream control objects in terms of graphical menus, buttons, remote controller icons, etc via their favorite web navigator. These session control modules are implemented as CGI programs or Java applets with access to STB's local environments for proper session related processing. Figure 11 shows IMPRESS's web-based user interface for the integrated service. The main page symbolize the virtual information village which can provide interesting high quality multimedia services. SRM will be combined to provide session and resource management with various user entities such as VoD application server, SVB application server, RU/BCU, and STB from the network point of view. Access node is now capable of providing all three services mentioned in the previous section.

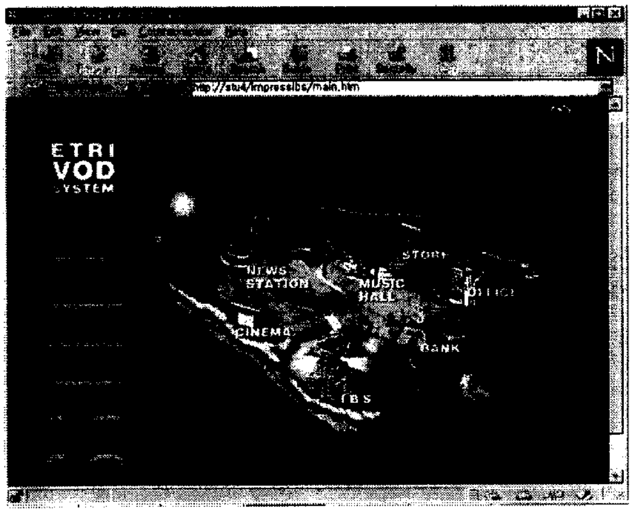

Figure 11. IMPRESS User Interface

4. Conclusion and Future Works

In this paper, our research effort to integrate high quality interactive multimedia services, broadcasting service, and Internet service is introduced. With this integrated platform, we try to build near future services which are high quality, scalable, easy-to-use, economically viable, and ready for future high speed networks. Having completed the platform development, our system will be deployed in the field trial from middle of 1998. Although the access network architecture of the field trial assumes Fiber to the Home(FTTH), we have a plan to expand the scope of the service to a practical access network architectures such as FTTC with ADSL, when the evaluation is finished with successful results. We hope this project will show the possibilities of the integrated information, telecommunication and broadcasting service and the integration will play much important role in future coming society, and will provide new working, shopping and leisure environment.

Acknowledgment

This work is supported by the Ministry of Information and Communication of Korea.

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