

A FRAMEWORK FOR DEVELOPING RDP APPLICATIONS FOR IPTV

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IŞIK UNIVERSITY
2008

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Submitted to the Graduate School of Science and Engineering
in partial fulfillment of the requirements for the degree of
Master of Science in
Computer Engineering

IŞIK UNIVERSITY
2008

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APPROVAL DATE: 21/04/2008

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Abstract

In this thesis a framework for RDP applications for IPTV is described. The goal is to develop applications easily by using the framework. Microsoft IPTV Edition Content Development Kit is used as a simulator of Microsoft IPTV, SQL Server 2000 as Database Management System and Internet Information Server as the web server. A total of eleven example applications have been developed with the framework to show how this framework can be used to develop applications easily. Firstly methods are distinguished; data types and classes of example web applications are designed. Then the architecture of the framework is determined. The “three tier architecture “ is used while developing this framework. In this design there is a Presentation Layer that includes user interface part and communicates with Business Layer only. The second layer is Business Layer which communicates both Presentation Layer and Data Layer and holds system logic. The third layer is Data Layer that communicates with Business Layer and sends data to the DLL to get the queries. The conclusion of the thesis is that using a layered architecture increases the reusability of the methods and it is easier to develop similar web services by using this framework.

IPTV UZAK MASAÜSTÜ UYGULAMALARI İÇİN BİR YAZILIM ÇERÇEVESİ

Özet

Bu tezde IPTV Uzak Masaüstü Uygulamaları için bir yazılım çerçevesi tasarlandı. Bu tasarımın amacı IPTV için uygulama geliştirmeyi kolaylaştırmaktır. Bu çerçeveyi geliştirmek için Microsoft IPTV Edition Content Development programı, Microsoft IPTV'nin benzetimi olarak kullanıldı. Veritabanı Yönetim Sistemi olarak SQL Server 2000 ve Web Sağlayıcısı olarak Internet Information Server kullanıldı. Tasarlanılan çerçeve ile onbir adet örnek uygulama geliştirildi. Böylece bu çerçeve ile kolayca uygulama geliştirebilecekleri gösterilmiş oldu. Bu çerçevenin tasarımı esnasında ilk olarak kullanılacak metodların veri türleri ve sınıfları belirlendi. Daha sonra altyapı tasarımı aşamasına geçildi. Geliştirme için üç katmanlı mimari kullanıldı. Bu katmanlardan "Arayüz Katmanı" kullanıcıya sunulan arayüz tasarımlarını içermektedir. Arayüz katmanı sadece "İş Katmanı" ile iletişim kurabilir. "İş Katmanı" ise hem "Veri Katmanı" ile hem de "Arayüz Katmanı" ile iletişim kurar ve sistemin işlerliğini düzenler. Son katman "Veri Katmanı" olmaktadır. Veri katmanı "İş Katmanı" ile iletişim kurar ve aldığı verilerle DLL dosyasındaki fonksiyonları çağırır. Sonuç olarak bu tezde üç katmanlı mimari kullanarak geliştirilmiş olan çerçevedeki metodların tekrar kullanılabilirliği artırılmış olup benzer uygulamalar geliştirilmesi kolay bir hale getirilmiştir.

Acknowledgments

I thank Prof. Dr. Selahattin Kuru, my major professor and dissertation supervisor. Having the opportunity to work with him over the years was intellectually rewarding and fulfilling. I also thank Mr. Mustafa Yıldız who contributed much to the development of this research starting from the early stages of my dissertation work. He provided valuable contributions to the development of the econometric model. I thank him for his insightful suggestions and expertise.

My special thanks go to Ahmet Soylu and Kadir Banıcar whose friendship I deeply value. I also want to thank to Kristin Benli for her help about how to prepare thesis document.

The last words of thanks go to my family. I thank my parents Ramazan Kırmızıbekmez and Elif Kırmızıbekmez and my brothers Hasan and Yılmaz for their patience and encouragement.

To my parents ...

Ramazan and Elif Kırmızıbekmez

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List of Abbreviations

DHCP	Dynamic Host Control Protocol
DLL	Dynamic Link Library
DNS	Domain Name Server
DSL	Digital Subscriber Line
DTV	Digital Television
DVS	Digital Video Server
FCC	Communications Committee
IIS	Internet Information Service
IPTV	Internet Protocol Television
NIC	Network Interface Card
NTSC	National Television Systems Committee
OSTN	Open Student Television Network
P2PTV	Peer to Peer Television
PAL	Phase Alternating Line
RAID	Randomly Array of Independent Disks
RDP	Remote Desktop Protocol
SECAM	Sequential Color with Memory
SP1	Service Pack 1
STB	Set-Top-Box
UDP	User Datagram Protocol
UHF	Ultra High Frequency
VHF	Very High Frequency
VoD	Video on Demand

Chapter 1

Introduction

IPTV (Internet Protocol TV) is a new technology that delivers television programming via broadband connection using internet protocols [1]. It requires a subscription and IPTV set-top box, and offers key advantages over existing TV cable and satellite technologies. IPTV is typically related with other services like Video on Demand (VoD), voice over IP (VoIP) or digital phone, and Web access. IPTV network provides transmission facility between user's Set-Top-Box and IPTV server.

Competitions from wireless cell phones and cable television Internet offerings have significantly reduced the use of dial-up Internet access. For some consumers, the ability to obtain telephone service via VoIP offerings from their cable television operator allows them to obtain their required communications services from a vendor other than their local telephone provider. There are several new technologies and market techniques that serve IPTV services. Below these parts are explained in detail.

Microsoft TV IPTV Edition is used in this thesis. This TV enables the delivery of high-quality live TV and video on demand (VoD) over diverse IP networks. It is a platform that also enables service providers to offer interactive TV services to subscribers, such as RDP applications, Electronic Program Guide (EPG), and digital video recording. This thesis focuses only on developing Remote Desktop Protocol applications for IPTV

IPTV Edition offers the following functionalities for developing web services [2]:

- Sending messages to individual subscribers or groups of subscribers
- Managing live channels
- Managing VoD titles
- Deploying RDP applications
- Managing channel lineups
- Managing subscriber account
- Integrating existing business and operational systems with IPTV Edition service and account databases

It is seen that there are lots of advantages of using IPTV Edition. IPTV Edition service providers can deploy applications that subscribers use through their set-top boxes. Remote Desktop Protocol (RDP) enables subscribers to interact with applications. For example user can play a game using her remote control. Applications can be in the form of Web applications or stand-alone Windows applications. These applications can interact with remote resources, such as Web servers and databases. For example the framework introduced in this thesis interacts with a database server. The Web content can be stored and delivered by a remote server and can also interact with other resources, such as Web services and ActiveX controls.

IPTV Edition supports Web applications; you can use familiar technologies to build your applications. Existing Web applications and services that are designed for use on a computer can be used as IPTV applications. You can use Internet standards, HTTP 1.1, HTML 4.0, CSS 2.0, JScript (based on ECMAScript), and your choice of backend technologies (application/Web server, database, server operating system, and so on), including Microsoft ASP.NET 1.1 which includes framework to develop Microsoft technologies [3].

Web applications can be hosted by:

- The IPTV Edition service provider
- An external party on a Web server

IPTV Edition also provides compatibility with Windows Media Center Edition. This Media Center Edition provides a platform for integrating audio and video into applications. You can easily use Media Center platforms with your applications. One can also develop a Windows application by using Microsoft Visual Basic, ActiveX/COM, ATL, MFC, Win32, DirectX, and other Windows technologies.

TV has a different form factor than a desktop computer, and application designs must be adapted to this platform. For example, TV screens offer lower resolution than most computer monitors, and they are most often viewed from a greater distance with only a remote control for input. Without using IPTV Edition servers and set-top box, you can simulate the runtime environment on your Windows development systems.

In this thesis a framework is designed for developing RDP applications for IPTV. It is first developed without using IPTV Edition servers and set-top-box. Then the applications are called from Microsoft TV IPTV Edition Content Development Kit to see how it works on TV platform.

The goal of developing this framework is making to develop new RDP applications easier. People can develop new web services easily by using this framework. It has some advantages in increasing reusability of methods, distinguishing code and layers that make results easy to understand the code.

In the first part of the report the state of the art of IPTV technology is discussed. The second part is more technical; where technical parts of IPTV servers and IPTV technology are described. In the third part problems with IPTV and ongoing research issues about IPTV are discussed. Then example applications are described with

methods, data types and classes in detail. Then the three tier architecture and its use in the thesis are described. Finally, a conclusion is given, together with future research directions.

Chapter 2

State of the Art in IPTV

2.1 Television Concepts

In this section some television concepts are summarized. These include analog television, digital television, lossy compression in the first part of this chapter. In the second part public IP-based network utilization will be described included Cinemanow [2] and Movielink [2] that are some best practice examples on Digital TV concept. After that private IP-based network utilization is described, SBC Communications and Verizon communication companies are studied. In the next part Internet Television concept is described by comparing free and subscription based models. Then a comparison is made between IPTV and Internet Television. At the end of this chapter Internet Television portals are described.

Analog Television

Analog Television encodes and transports information as analog signals [4]. All systems such as NTSC (National Television Systems Committee), PAL (Phase Alternating Line), SECAM (Sequential Color with Memory) are analog television systems.

Broadcasters use these Analog systems to encode their signals and modulate it for UHF (Ultra High Frequency) and VHF (Very High Frequency). Receivers translate the received signal and then the image is seen on the television screen. As seen in Figure 2.1 signal is created and it is transmitted to the TV. This figure shows signal creation.

Digital Television

Digital Television is a telecommunication system for broadcasting, receiving and displaying pictures and sounds by digital signals. DTV uses digital modulation data. This data is first compressed and then decoded by specially designed televisions.

In December 1996 the FCC (Federal Communications Committee) recommended the conversion of analog television into a digital TV standard. Broadcasters are supposed to implement these standards until February 2009 [5].

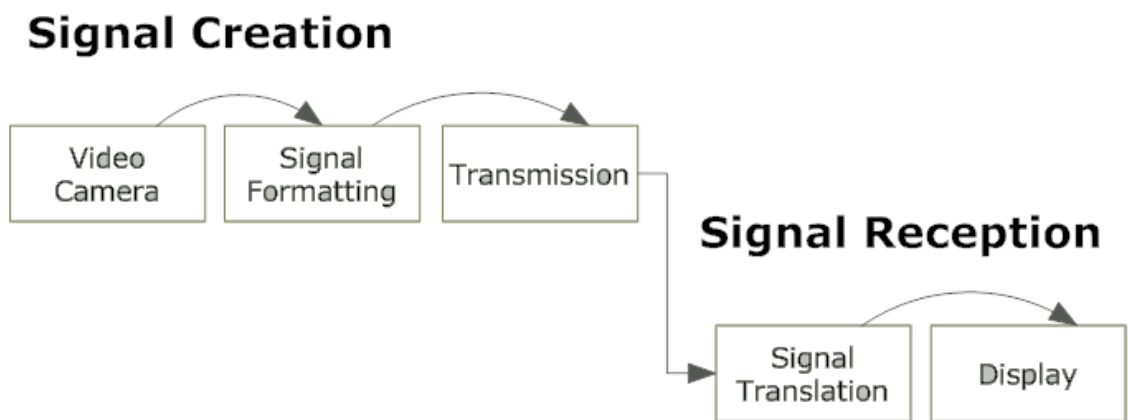


Figure 2.1 Components of Analog Television System

By comparing with the Analog Television Systems DTV have lots of advantages. For example in the Analog Television Systems someone has to adjust the aerial to receive good signal but in DTV there is not such a problem. Also there is no restriction for fixed bandwidth so there is no limitation of number of channels. DTV uses MPEG-2 compression systems and if an analog system wants to produce digital data the amount of data gets 60 to 1 as a compression result. Therefore more channels can be implemented in the limited frequency range.

Lossy Compression

Lossy compression method is one of the data comparison techniques is achieved by compressing and decompressing data. It retrieves data that may well be different from

the original, but is close enough to be useful in some way. Lossy compression is most commonly used to compress video, image or audio that can be defined as multimedia components. A problem with lossy compression is the loss of data, so for text files such as bank information or important information like that lossless compression is used.

The advantage of lossy methods over lossless methods is that in some cases a lossy method can produce a much smaller compressed file while still handling the requirements of the application. It is important to note all media storage methods are lossy when a live event has been recorded. Current recording methods only capture a small fraction of the total performance.

2.2 Public IP-Based Network Utilization

In this section we will elaborate the Network Utilization and delivering video content via internet. Some examples of video delivering over internet are downloading music videos, internet shows and full featured movies over internet. There are two good examples for delivering video content via internet:

- CinemaNow
- MovieLink.

CinemaNow

CinemaNow is a World Wide Web-based digital video distribution company. It is founded in 1999 and is one of the biggest digital video distribution services in the world. Web site is <http://www.cinemanow.com>.

The CinemaNow library contains approximately 10,000 feature-length films, shorts, music concerts and television programs from more than 250 licensors, including 20th Century Fox, ABC News, Disney, MGM, Miramax, NBC Universal, Sony, Warner Bros., Sundance Channel, Koch Entertainment, and Lions Gate Entertainment. Investors in the company include Microsoft, Blockbuster, Lion's Gate Entertainment, and Cisco Systems.

MovieLink

Movielink is a market in IPTV business, web-based video on demand (VoD) and electronic sell-through (EST) service that offers movies, TV shows and other videos. Web site is <http://www.movielink.com>. A subscriber can rent or purchase a Video content by her demand. It includes Paramount Pictures (owned by Viacom), Sony Pictures Entertainment (including Metro-Goldwyn-Mayer's share when SPE acquired MGM in 2005), Universal Studios (owned by NBC Universal/General Electric) and Warner Bros. Entertainment (owned by Time Warner).

It was the first company in the world to offer legal downloadable movies but it is only available for users in the United States. Downloading a movie lasts approximately 80 minutes. Movielink website allows users to search a movie by categorizing them by name, by type etc...

In general, movies obtained through Movielink can only be viewed on a computer or a TV connected to a computer. Also, Movielink has deals with certain set top box companies to offer its movies downloaded directly to TV's. Current business model allows people to purchase, download, and burn a DVD of a selected film.

Movielink uses digital rights management software from Microsoft and RealNetworks to protect their content. Consequently, compatibility is limited to Intel-based computers running Microsoft Windows 2000, XP, or Vista and Windows Media Player version 9 or later. Also, the service is currently available only people who resides in the United States.

2.3 Private IP-Based Network Utilization

This part will deal with the Private IP-Based Network Utilization that offers IPTV service to the customers. Two most known companies that provide this service are SBC Communications and Verizon.

SBC Communications

AT&T is the largest provider of both local and long distance telephone services, wireless service, and DSL Internet access in the United States. AT&T is based in San Antonio, Texas, United States.

Since the break-up of AT&T Corp. in 1984, most of the companies spun off from it (the "Baby Bells") have merged into three major US telecommunications groups: Verizon, Qwest, and AT&T Inc. Most of these companies are made up primarily of former components of AT&T Corp. For the new AT&T, these include many Bell Operating Companies and the long distance division.

SBC Communications offer IPTV service to the customers. Single SBC Communications customer connection will support VoIP and data services that will provide a 6-Mbps downstream and 1-Mbps upstream capability.

Verizon

Verizon is an American broadband and Telecommunication Company. It was formed in 2000 when Bell Atlantic, one of the Regional Bell Operating Companies, merged with GTE, formerly the largest independent local exchange telephone company in the United States. Prior to its transformation into Verizon, Bell Atlantic had merged with another Regional Bell Operating Company, NYNEX, in 1997. The name is a portmanteau of "veritas" and "horizon".

Verizon was founded in 1983 as Bell Atlantic Corporation. It inherited seven Bell Operating Companies from American Telephone & Telegraph Company (AT&T) following its breakup.

During 2005 Verizon started to sell IPTV and offered more than 180 channels 1800 video on demand titles by the end of 2005. Verizon offers three set-top-boxes. These boxes offer different services.

2.4 Internet Television

In the past years delivery of the TV is only delivered by cable or satellite systems. Primary Internet TV models are streaming the video content to the user's computer and selecting a video from a website to view it.

Nowadays as the connection speed increases and technology advances people needs changes. They need more quality services. We increasingly find traditional TV content accessible freely and legally over the Internet.

Internet television utilizes the connections of the Internet to deliver video from a source to a target device. There are some ways to delivering videos over the internet. Some of these methods are [6]:

- Watching on a regular TV, or on a computer, or on a portable device (such as a mobile phone)
- Live channel show (like regular TV), or allow the viewer to select a show to watch on demand (Video-on-Demand)
- Viewing anything from low budget, home camera recorder productions to expensive professional productions

Internet Television services have at least two different models:

Free

It is available from a Web site and accessible without set-top-box. It is easily viewed by connecting television set to the video output of the computer. You just need good Internet connection to get video easily.

In the free Internet Television Model like other publishing methods on the Web, people can access, use and build for, together with the development of open source software. Cyprus is the first country that owned their Internet TV model. It was created in March 2006 (Cyprusitv.com). Narrowstep telvOS operating system was used while creating this Internet TV.

People who create interesting video products have the opportunity to distribute them directly to a large scale of audience. Before it was impossible with the previous distribution models such as closed software, closed hardware and closed network. The free model used around the global televisions that aims to build collaborative environment for media production.

Subscription based

This type of Internet Televisions is supported by large telecom companies and it is spread over to a wide range of competition from even cable providers and broadcast networks. There is a subscription fee and you get some services depending on your fee. New features like video on demand and digital video recording is some services satisfied by the companies.

Europe and Asia have been the leaders in implementing these Internet Television services. In US providers have not shown much interest about this technology yet. Internet Television is a more interesting alternative to cable TV also in countries there is a more interesting alternative to cable TV. Also in India and China there is poor cable infrastructure.

In the United States one example of subscription based Internet Television under development is Zipityzap.com. As seen in Figure 2.2 Zipityzap.com homepage offer an entertainment platform to use TV. The text “Internet Television Cafeteria Style” is seen on the top right of the homepage. The aim is to bring a cafeteria style television as seen in the figure.

In this platform users can subscribe to channels individually. Video content will be streamed directly from the content provide to the end user with real-time subscription authorization provided by Zipityzap. The software platform chosen by network operators to provide the most recent Internet television services has been Microsoft TV IPTV Edition, which works together with a set-top box. These services are limited to the offer

supplied by the provider meaning that you can only get on your TV set the channels and services you are paying for. Some of the technological arguments to broad internet television acceptance are:

- Lack of set top boxes. Decoding chips are still new and expensive.
- Incompatible standards (different software and/or hardware are required to watch different providers)
- Low bandwidth to the home - a standard definition digital signal requires a 2 Mbit/s connection. High definition requires 8 Mbit/s
- Restricted bandwidth in the internet backbone (this will be a problem if many people decide to adopt internet TV via unicast.)
- Streaming technology - which can be of poor quality and high cost to the providers. Multicast and P2PTV are some of the suggested solutions
- Old media meeting new media - licensing regulations, existing deals, and uncertainty over payment, security, and advertising has led to only slow steps being taken by the companies which own the TV content

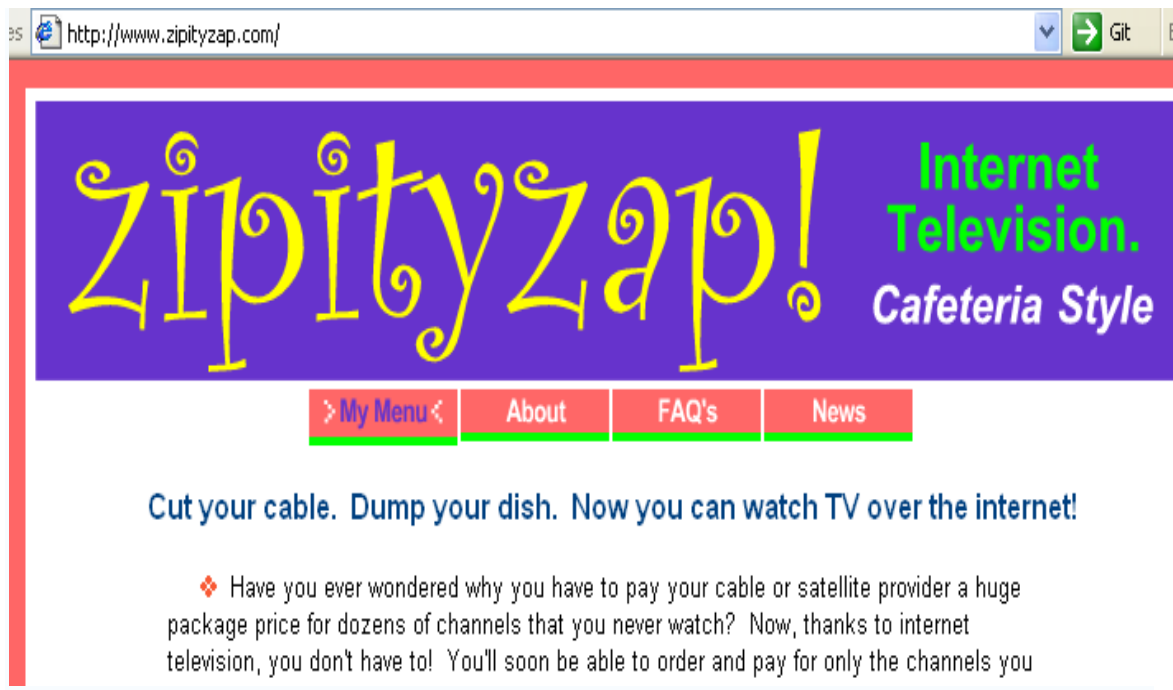


Figure 2.2 Zipityzap Web Site View

2.5 IPTV versus Internet Television

In this part IPTV and Internet Television is compared by means of net connections, storage space, MPEG4 and hardware and software production tools.

Both IPTV and Internet Television handlers want to bring good net connection to their audiences. The difference is one side delivers the video over the internet (Internet TV/ Video) and the other side delivers programming directly to audiences living room (IPTV). There are lots of differences between these two types of delivering methods.

The most basic difference is the how to deliver the content. Internet TV goes over open, public, global Internet; IPTV uses a private, managed network. We see that IPTV is more secure because carrying the video content over a private network allows more protection of content and control of video quality. You don't have to worry about the privacy and quality issues. Also Internet Video (Internet Television) is delayed due to the lower bandwidth, high traffic or poor connection, so IPTV delivery method is more reliable and higher quality.

In IPTV you are not responsible with the digital rights. Owners are both financially and ethically responsible for digital rights. Also they are responsible for collecting and paying bills and delivering high quality television service.

Users usually create short or long form video clips and share it over the internet. Internet Television captures some of these video and offers it to users for consumption. Both of these platform offer interactivity, but IPTV brings these capabilities to the TV screen. For example IPTV brings SMS service to the screen for consumers.

By looking at the formats IPTV will choose MPEG4 AVC format for video compression [7]. But MPEG4 content is not available today, but for next generations it will be available and you can see this format in the standardization of formatting. This format is expected to be available next year.

Both IPTV and Internet TV satisfy unique need in the market. Web based video will provide innovative ways to deliver video to the consumers and the amount of the content available will continue to grow. Also IPTV will continue to fill a huge demand for high-quality video content delivering to consumers. IPTV also has to find innovative opportunities to take more market place.

Internet video offered on IPTV has a good future due to the demand for long form content [8]. IPTV programming could attract viewers who mostly spend their time on the computer screen. Finally by looking at the IPTV although there are some limitations, the potential benefits are enormous. With the Internet's global distribution the choice may not be easy IPTV or Internet TV?

2.6 Internet Television Portals

Internet Television Portals are developed to provide users accessing Internet Television Stations. BeelineTV is one characteristic portal for this approach. (<http://www.beelinetv.com>)

Through the BeelineTV.com Web site you can view television stations located in more than 20 countries. For example you can see a lot of TV channels for 'English TV'. Among 'Turkish channels' you can see Bahane TV, TRT 1, TRT 2 and TRT Int. Your system should have Windows Media Player to watch TV. You must run the ActiveX control that BeelineTV ask for you to accept.

Chapter 3

A Technical Look at IPTV

3.1 IPTV System

IPTV system is a digital television service that is delivered via internet protocol. There are some requirements for IPTV system architecture to work. IPTV is a general term for internet delivering for TV signals. The system used in this thesis is Microsoft IPTV. IPTV personal server has the system parts below:

- Content Provider Windows Server 2003 with SP1 (Any windows server with any service pack packet to run Microsoft IPTV software)
- SQL Server 2005 (Or any database server)
- DHCP(Dynamic Host Control Protocol)/DNS(Domain Name Sever)/IIS (Internet Information Service)
- MS IPTV software

3.2 Business Model of IPTV

Nowadays, digital television that delivers its content via internet uses IP network. This network is commercially available for customers. It is expected that in the near future IPTV market will grove up with the telecom operators' new technologies and opportunities. With the appearance of IPTV technology the need for IPTV business becomes viable. A mature business model is not available currently for IPTV because there is no template that defines IPTV business model clearly. Telecom operators supply digital television service over IP to get profit. It is a chance for telecom

operators to combine multiple specialized networks into one cost efficient network. Telecom operators are the new entrants in the digital TV market and they are aiming to capture a big amount of market. IPTV's content goes to customers' home by way of four steps [9]:

- Content Provider
- Service Provider
- Network Provider
- Customer

By considering these ways business model of the IPTV can be delivered easily. In the Figure 3.1 IPTV Business Model is seen for Turkey. In the first part of the figure content providers supply content. This content can include TV channels such as ATV, SHOWTV, Video Contents such as a movie or a comedy show, and IPTV applications developed by IPTV content developers. TV channels, Video Content Providers and IPTV Application Holders can be listed as Content Provider part of IPTV business model [10].

There is a need to provide a service for customers to get the content. The second part of the IPTV business model is Service Providers. Türk Telekom is the service provider in Turkey. Alcatel has experience about IPTV technology so they sell needed software, hardware and help Türk Telekom for IPTV integration. Türk Telekom has the infrastructure and service providing responsibility. New IPTV organizations are expected to sell IPTV service and network provider but now Türk Telekom has the monopoly in the IPTV content delivering.

The third part is the Network Providers for IPTV business. Türk Telekom again has the main actor in this step. Alcatel provides necessary network equipments and implements network infrastructure for IPTV to the Türk Telekom. In this step it is controlled that which user demands which video shortly Video on Demand control is done in this step.

At the end content is gained by user. These users are TV watchers and application users. Users pay a subscription fee to get benefit from IPTV services. User can play videos, buy films, and watch TV channels, use applications [11]. Content is decoded with users Set-top-Box get ready to watch on Analog TV.

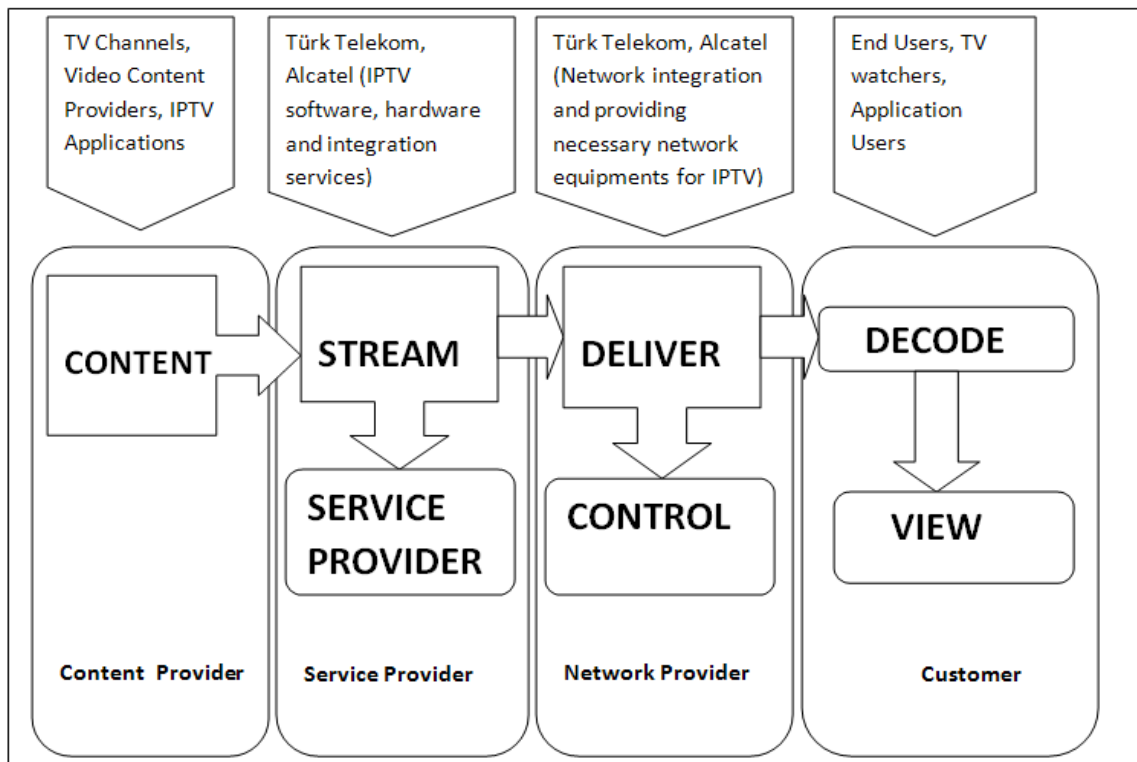


Figure 3.1 IPTV Business Model in Turkey

3.3 Infrastructure of IPTV

IPTV system usually works with many servers. Different servers are assigned to unique jobs. In our system there are three IPTV servers but one of the servers is assigned to do all kind of jobs. We call this server as IPTV Personal Server. IPTV Personal Server has two NICs (Network Interface Cards) as a result of this there are two different network connections for specific usage:

- MGMT Network (Management Network)
- STB Network (Set-Top-Box Network)

MGMT Network

MGMT Network is the connection for management. Administrators of the system connect to the server with Remote Desktop Connection and control and configure settings of the server by using Remote Desktop Protocol.

STB Network

The second network that Personal Server includes is Set-Top-Box Network. Set-top-box is a digital device that changes digital data to analog signals for end users television because normal televisions cannot process digital data. Personal Server sends signals to the client's set-top-box by UDP (User Datagram Protocol) network packets. Set-top-box changes this data to analog signals for TV.

3.4 IPTV Servers

In this section the operational characteristics of a series of servers of an IPTV infrastructure. These servers are [3]:

- Headend Server
- Broadcast Server
- Digital Video Server
- Video on Demand Server
- Archive Server
- Timeshift Broadcast Server
- Billing and Management Server

Headend Server

The headend server is the central server of the IPTV system. We can say that it is the basic server because this server captures video streams from satellite, terrestrial and cable. After capturing the video content it is converted to the multicast data streams for TV. MPEG-2 and MPEG-4 formats are used for conversion. MPEG-4 is better but it consumes much time to compress the video.

Broadcast Server

This server is like headend server but it has some additional functionality from the headend server. Broadcast server is designed to enabling broadcast live video, audio or different types of formats such as PPT to the selected IP addresses.

Digital Video Server

It is not as powerful as headend server and it is smaller. This type of servers can be located anywhere of the network. It supports storage, editing, capturing and transmission of digital video. It is used for schools, libraries, hotels, museums and also some corporations.

DVS can transmit data from different frames to different IP addresses. It is used in a closed IPTV system such as museums.

Video on Demand Server

VoD shows movies and other contents to the end users which user wants to watch with a fee. VoD server transmits such information directly to the requesting client. This server work with billing server in cooperates for billing service.

Archive Server

Storage for video contents is also a requirement for IPTV systems. Archive server does this job. It is designed to store large amount of video contents. It uses RAID (Randomly Array of Independent Disks). There are some RAID levels that depend on performance, fault tolerance or both together. Archive server can be connected to a LAN, where it can provide a backup storage capability to other servers connected to the local area network.

Timeshift Broadcast Server

Timesihft means scheduling the video at a time different than the original time. It is often for clients for using DVD or VCR recorder. High definition videos require more bandwidth than standard definition television. Timeshift Broadcast Server store premium channel standard definition and high definition.

Billing and Management Server

It has been previously mentioned VoD server. User selects a video to watch and usually a fee is required for that video, so Billing and Management Server is required to verify customer's account and billing info. Management and Billing can be in different servers with the system designer's desire. Billing and management are critical operations so it is implemented with dual core system connected to a RAID to decrease fault and risks of data loss.

3.5 Problems with IPTV

IPTV is a new technology so it has some disadvantages and problems with IPTV: The following problems are explained below:

- Packet Loss
- Currently No Support for HDTV
- Internet Connection Fault

Packet Loss

IPTV uses a different delivering technology from classical TV's. IPTV uses Internet Protocol for sending data [12]. While sending data from internet there will be a delay due to the internet connection speed and data comes as packages. While sending data sometimes data could be lost as a result of network problems, and if your internet connection is not good enough your packages comes with a delay time it differs from 5 to 10 seconds.

Currently No Support for HDTV

Currently IPTV does not support High Definition TV. This is also a problem with IPTV but in the near future there will be support for HDTV [7].

Internet Connection Fault

One problem with IPTV is if the internet connection is broken you cannot watch TV or you need also classical TV to watch TV.

3.6 Research Issues about IPTV

There are some research topics about IPTV technology and future of the IPTV. Below is a list of some important research issues about IPTV [13]:

- How Will The Internet Affect Public Broadcasting In The Future?
- IPTV Bandwidth Growth 60% of All Costumers IP Traffic in 2008
- Could Apple/YouTube Deal Encourage IPTV Growth
- Is Wireless IPTV Viable?

How Will The Internet Affect Public Broadcasting In The Future?

How internet changes for a looking at broadcasting side is our question. The increasing popularity of using online streaming will increase? What about the license and privacy issues? These questions are hold in this part.

IPTV Bandwidth Growth 60% of All Costumers IP Traffic in 2008

It has been suggested that all 60% of traffic in the internet is due to the commercial video delivered by internet via Internet Television or IPTV in the world. Researches show that consumers' IP traffic will exceed business traffic in 2008 [14]. Also it is mentioned that HDTV and high speed broadband doubles IP traffic every two years through 2011 in the world. Internet video downloading will be 30% of the internet traffic in 2011.

Could Apple/YouTube Deal Encourage IPTV Growth

iPhone could be a pioneer for mobile IPTV services? This part deals with this question. For example Apple iPhone has 63% of users view videos. If we compare it with normal cell phone users it is only 28%. Also these iPhone users watch at least one YouTube video. 46% watch music video and 34% watch music video.

Is Wireless IPTV Viable?

IPTV currently delivered to houses by wired Internet connection. In wireless technology you need no cable so you earn from infrastructure but you need high quality streaming media to deliver via internet and it is difficult to deliver it from wireless internet.

3.7 Research & Development Projects on IPTV

Below is a list of some major research & development projects on IPTV:

- IntelliOne Unveils TrafficAid IPTV Project
- OSTN Unite to Exchange IPTV Content over the Internet
- FastWeb: FASTWEB: first pilot project using the IPTV recommendation system ContentWise; Intuitive TV becomes a reality for Italian Viewers

IntelliOne Unveils TrafficAid IPTV Project

IntelliOne Technologies announcing TrafficAid R & D project in cooperation with Georgia Tech [15]. The aim is to create an IPTV interface for IntelliOne's TrafficAid personal traffic system.

It is supported by National Science and Foundation; IntelliOne developed its patented Roadway Speed Measurement System based on wireless devices.

OSTN Unite to Exchange IPTV Content over the Internet

OSTN is the acronym for Open Student Television Network (<http://www.ostn.tv/>) [16]. It is the leading for providing of educational, foreign language, news and entertainment IPTV content. OSTN is delivered nearly 60 million subscribers over 46 countries. It can be viewed by TV or computer as well.

OSTN uses Internet2 and National LambdaRail's advanced network for distribution content in North America.

FASTWEB

FASTWEB is Italy's second largest telecommunication provider and first company that offer IPTV to its customers [17]. It has selected Neptunus's ContentWise product for a

pilot project. This project will be based on previous viewing behavior and recommendations to television viewers. As a result of this FASTWEB TV occurs. In FASTWEB TV the system is based on an algorithm that supplies recommendations for individuals.

ContentWise offers unique features that increases the value of FASTWEB TV project, so customer enjoyment giving FASTWEB a competitive advantage. Adapting ContentWise to FASTWEB IPTV resulted innovative features for customers. (<http://www.company.fastweb.it>)

Also Neptun is a big company in Italy's IPTV sector. Neptun has four major products for IPTV: CAPLAN, CAPLAN IPTV, ContentWise, and ToughStream Server. CAPLAN enables organizations to collect, certificate and analyze system performances and qualities. CAPLAN IPTV Edition is a member of CAPLAN and helps for taking strategic decisions about reporting. ContentWise is a content recommendation system for IPTV. ToughStream Server is for error correction without asking packet transmissions.

3.8 Microsoft TV IPTV Edition and MiddleWare Architecture

Today, many telecommunication companies and service providers have begun to provide IPTV services that are based on Microsoft IPTV Edition. IPTV edition satisfies TV service providers all the services such as distribution, protection, digital video recorder programming quickly and economically.

Microsoft TV IPTV Edition reduces costs and complexity of integrating incompatible components. This platform is built on Windows Server software, and runs on standard, economical server hardware. IPTV Edition includes extensible Application Programming Interfaces (APIs) [18].

Finally, IPTV Edition can be expected to drive in a global, third-party IPTV ecosystem. In this system IPTV will benefit a wide range of businesses, from set-top-box manufacturers to content owners and producers.

3.9 Benefits of Microsoft TV IPTV Edition

IPTV Edition has some advantages for different layers of IPTV business that are listed below [18]:

- To Service Providers
- To a Large and Growing Ecosystem of Vendors
- To Consumers
- To Broadcasters and Content Providers

To Service Providers

Microsoft IPTV Edition represents a better way to attract personalized TV experiences a new “single play” converged video, video and data services. Customers that deploy Microsoft TV’s IPTV Edition platform include AT&T, Deutsche Telekom, T-Online, France and Swisscom.

To a Large and Growing Ecosystem of Vendors

Vendors has advantage for IPTV Edition platform, system integration and billing and back-office support companies, application and services developers, network access equipment makers. Partners are IPTV are Alcatel, Cisco, Harmonic, IBM, Intel, HP, Modulus, Motorola, Philips, STMicro, Tandberg, Tatum and Thomson doing vendor.

To Consumers

With Microsoft IPTV Edition, consumers benefit from a better TV experience, with greater selection of TV content and services, tailored to their individual tastes. In the future, consumers will enjoy exciting new cross-device, connected IPTV services [19].

To Broadcasters and Content Providers

IPTV Edition means compelling broadcast and on-demand programming, new and profitable business opportunities, and extended reach to consumers via devices beyond the TV.

3.10 IPTV Terminal Middleware Architecture

The middleware based interoperability between IPTV terminal and IPTV system provides flexible and expandable solution so that the application vendor [20]. This middleware can conveniently develop various new services and applications without paying attention to the detailed parameter and message format of the interface.

To shorten the new services development period, the software architecture of Microsoft IPTV terminal shall be able to reduce the difficulty level for new application development. There, the followings are the goals of defining IPTV terminal middleware:

- To adopt middleware based software architecture, the new IPTV applications and services could be able to run on different Operating System and hardware platform
- To achieve portability of the applications
- To meet requirement of new services and application development
- To support distributed computing and provide transparent application and interactive service across different networks, hardware and OS platform
- To achieve interoperability capability between IPTV system and IPTV terminal

The Software Architecture and Layers of IPTV Terminal

Usually the software can be developed based on a lot of program language, e.g. C language, C++ language, java language, etc. For different services, their service logic and implementation methods are different. When designing software architecture of terminal, it is necessary to define clear software layers. That means the software

architecture of IPTV terminal shall be based on the definition of abstract layers. The whole software architecture of IPTV terminal can be divided into three layers as below:

- Resource Layer
- System Software Layer
- Application Layer

From the perspective of application, the middleware API lies between the applications layer and the system software layer.

The resource layer could include a number of functions, hardware resource and software resources. This resource layers can have more than one hardware entity. From an abstract point of view it makes no difference if the logical resources are mapped into one or several hardware entities. The important thing is to provide an application through layers, sub-layer of system software layer. An application should be able to access all local resources as if they were are a single entity.

Applications will not directly address resources. The system software layer brings an abstract view of such resources. The System software layer shall include middleware API module and transplantable layer modules. The middleware layer isolates the application from the hardware, enabling portability of the application. The System Software realizes the API based on abstract model:

- Stream rendering and control by different sources
- Commands and events
- System resources, such as file system, timer, etc
- Hardware resources, such as hard disk, memory, interface, and etc
- Network and transport protocol management
- DRM/CA
- Startup and initialization
- Process for security and authentications
- Software download and upgrade

Middleware software and application run on different OS platform and hardware platform. The OS, for example, can be Linux, WinCE, VxWorks, and etc. The hardware platform can be Set Top Box, PC, or mobile phone, and etc.

The Middleware based Architecture for System Software Layer

Middleware is common services between the applications layer and the system resource layer. These services have an open standard program interface, and can be used on different OS and hardware platform. Middleware can be implemented based on various modes, but its basic function is to isolate applications from resource. Any application developed according to a specific middleware and its API can run on this middleware.

The system software layer of IPTV terminal shall be based on middleware architecture. The middleware core module layer is based on software module; they implement corresponding middleware function through transplantable layer to call OS resource and lower layer hardware resource. At the same time, the middleware core modules provide various services for upper application layer, it includes all services related protocols and service implementation at client, such as media play and control, media stream transmission control, user authentication, system resource management, download service, DRM, security management etc.

3.11 Microsoft Mediaroom

Microsoft Mediaroom is the latest update of the Microsoft TV IPTV Edition platform software for use in a set-top box to access on-demand as well as live television programming on an IPTV network. Microsoft Mediaroom has been adopted by AT&T (U.S.), BT (UK), SingTel (Singapore) and T-Home (Germany) as their IPTV delivery platform [21].

Microsoft Mediaroom includes all the features of Microsoft TV IPTV Edition such as support for on-demand and live video, video recording and time shifting, and interactive program guide with integrated search and scheduled recording. It has also lots of

features including media sharing and Multiview which allows multiple channel or camera angles watching simultaneously.

It is currently available only to Mediaroom content-providers. In Figure 3.2 Microsoft Mediaroom is seen. There are many options in this platform like TV, Music, Photos, and Movies etc...

Microsoft's IPTV platform is already being used by nine service providers worldwide, with AT&T's U-Verse using the platform in the United States. IPTV can be called as AppleTV killer. As IPTV services become more widely available and IPTV set-top boxes are provided to customers for free, the need for an AppleTV style system decreases.



Figure 3.2 Microsoft Mediaroom

Chapter 4

Design of the Framework

In this thesis a framework for developing RDP applications for IPTV is designed. These web services are Business Support System web services. Below there are ten example web services. For every web service Data Types of the web services, classes and methods are described. Some of the methods are common in some applications. This framework consists of these common methods as an upper level architecture. For example *AuthenticateUser* Method is called by *Questionnaire* Application, *Gifting* Application, *Video* Application and *Food* Web Service and so on. It is a generic and mostly used web service. By holding this web service as an upper level web service in my IPTV framework this enables developing other web services easier by calling previously written *AuthenticateUser* Method.

Also there are some methods which are private methods. These private methods are called by only one specific web service, so we cannot use that method as a generic web service and we put it as a low level web service. Customer can reach these web services by using their TV's remote control. For example when they open channel 345 *Gifting* Web Service will be opened and customer can send gifts to her friend by using this web service.

The application database developed in the thesis works together with IPTV database for some services. For example for Authentication method web application looks for UserID for IPTV database.

4.1 Class Definitions

In this framework there are classes for every application. These classes consist of attributes of the database tables and methods. There are some classes holding common methods which are used by more than one class. These classes are written in the ASP language. In this design there are ten example Remote Desktop Protocol applications. These are:

- Questionnaire Service
- Community Service
- Food Service
- Weather Forecast Service
- News Service
- Traffic Inform Service
- Identity Number Inquiry Service
- Entertainment Service
- Ticket Buying Service
- Gifting Service
- Video Service

Table 4.1 gives Data Types of the applications. Data types are Classes and Enumerations. All of the Applications have one class per each that is responsible to record and manage these applications' components that's name is combined with Application Name and "Record" string. Furthermore, Questionnaire Application has *ClientStatus* Enumeration that holds a specific user's status about a questionnaire; Food Application, Ticket Buying Application and Gifting Application have *BillingEventStatus* Enumeration for controlling billing status of users' billing records about transactions and *PrincipalType* Enumeration that is for identifying the rights can be granted and used to identify a subscriber.

Besides these there some applications have some enumerations that are not a class but just enumerations that hold the status of some key objects. Table 4.2 shows the enumerations and which enumeration is corresponded to which application.

Table 4.1 Data Types of Example Applications

Application Name	Data Type	Description
Questionnaire Application	ClientStatus Enumeration	Enumeration of clients' record status for a specific questionnaire
	QuestionnaireRecord Class	Represents an IPTV Edition questionnaire record and managing it
Community Application	CommunityRecord Class	Represents an IPTV Edition community records and managing it
Food Application	BillingEventStatus EnumerationFood	Enumeration of billing record status values
	FoodService Class	Exposes methods for managing IPTV Edition food service records and management
	PrincipalType Enumeration	Enumeration of principal types that is an identity in the IPTV system subscriber
Weather Forecast Application	WeatherForecastRecord	Represents an IPTV Edition weather forecasting records and management
News Application	NewsRecord	Represents an IPTV Edition news records and management
TrafficInform Application	TrafficRecord	Represents an IPTV Edition traffic information records and management
Identity Number Inquiry Application	IdNoInquiryRecord	Represents an IPTV Edition Id number information records and management
Entertainment Application	EnteratainmentRecord	Represents an IPTV Edition entertainment records and management
Ticket Buying Application	BillingEventStatus Enumeration	Enumeration of billing record status values
	TicketTransactionService	Represents an IPTV Edition ticket transaction records and management
	PrincipalType Enumeration	Enumeration of principal types that is an identity in the IPTV system subscriber
Gifting Application	BillingEventStatus Enumeration	Enumeration of billing record status values
	GiftSendingService	Represents an IPTV Edition gifting service records
	PrincipalType Enumeration	Enumeration of principal types that is an identity in the IPTV system subscriber
Video Application	VideoRecord	Represents an IPTV Edition video information records and management

Enumeration types that are described above are told which Enumeration corresponded to which application.

ClientStatus Enumeration members are *Participated*, *NotParticipated* and *NotAvailableForParticipation* and holds users' participating status for a questionnaire. It is corresponded to *Questionnaire* Application only. *BillingEventStatus* Enumeration holds users' billing information status for a transaction. Members are *Unread*, *Read*, *Recorded* and *Deletable* that are billing status. *PrincipalType* Enumeration holds users' account type information. Members are *Account*, *Device*, *Group* and *User* in the thesis only *User* status is handled. The other cases are potential member types.

Table 4.2 Enumeration Types for Applications

Enumeration Name	Corresponded Application	Member	Description
ClientStatus	Questionnaire Application	Participated	Customer already participated this questionnaire
		NotParticipated	Customer has not participated this questionnaire yet
		NotAvailableForParticipate	Customer is not available to participate this questionnaire
BillingEventStatus	Food Application, Ticket Buying Application, Gifting Application	UnRead	Billing record has not been read.
		Read	Billing record has not read
		Recorded	Billing record has not been recorded
		Deletable	Billing record can be deleted
PrincipalType	Food Application, Ticket Buying Application, Gifting Application	Account	Corresponds to an IPTV Edition subscriber used for billing purposes
		Device	Client device that user accesses to IPTV application services
		Group	Used to simplify the granting of rights for multiple subscribers
		User	Used to identify a specific person performing a billable action

Questionnaire Service

In this web service IPTV clients answers questions about a specific topic via TV commander or their personal PC. Answers will be collected. Users take more than one

questionnaire and cannot take the same questionnaire again. Table 4.3 shows the classes and explanation of these classes. In this application there are three methods these are *AuthanticonUser*, *GetQuestionnaire* and *Questionnaire* methods. These methods are described in the next section in detail.

Community Service

This service gives information to the IPTV subscribers about the important community places such as listing of nearest hospitals or open pharmacies at the midnight. Table 4.3 shows the classes and explanation of these classes. In this application there are three methods these are *SelectLocationDate*, *GetcommunityType* and *ViewAvailables* methods. These methods are described in the next section in detail.

Food Service

In this service IPTV subscriber enters her address and selects food from menu. Assuming that there are some restaurants registered for this application and they are providing food service to the homes, the registered restaurants and their menus are displayed in the IPTV screen. After the transaction, the user is informed about transactions' details with a message that prints the price and the dish bought. Table 4.3 shows the classes and explanation of these classes. In this application there are nine methods. These methods are *SelectLocationDate*, *DeleteBillingRecord*, *ReadBillingRecord*, *UpdateBillingRecordStatus*, *ShowRestaurants*, *ViewMenuAndSelection*, *AuthenticateUser*, *TakeUserConsent*, *DoTransaction* methods. These methods are described in the next section in detail.

Weather Forecast Service

This is a weather forecast service for a specific place within a specific time interval. In this service users can learn weather forecasts for the nearest place by using this application. Table 4.3 shows the classes and explanation of these classes. In this application there are two methods; *SelectLocationDate*, *ViewWeather*. Only one *WeatherForecastRecord* class is included in this application that manages the weather

forecast application. Methods that are included in this class will be mentioned in detail in the next section.

News Service

This is a news service for a specific place within a specific time interval. Most recent news can be easily learned by using this application. Table 4.3 shows the classes and explanation of these classes. In this application there are two methods these are *SelectLocationDate*, *ViewNews* methods. These methods are described in the next section in detail.

Traffic Inform Service

This service gives user information about the traffic for a specific place within a specific time interval. Table 4.3 shows the classes and explanation of these classes. In this application there are two methods these are *SelectLocationDate*, *ViewTraffic* methods. These methods are described in the next section in detail.

Identity Number Inquiry Service:

This service is for examining the user's identity number. To learn the Identity Number user must enter name, surname, father's name, birth date, birth place. After the inputs are taken then the identity number of the user is printed. Table 4.3 shows the classes and explanation of these classes. In this application there are three methods these are *AuthenticateUser*, *Search* and *View* methods. These methods are described in the next section in detail.

Entertainment Service

This service gives information to the IPTV subscribers about the entertainment services like cinema or theaters. This application is useful to find the nearest entertainment events. Table 4.3 shows the classes and explanation of these classes. In this application there are four methods these are *SelectLocationDate*, *GetEntertainmentType*, *GetEntertainmentName*, *ViewProgram* methods. These methods are described in the next section in detail.

Ticket Buying Service

By using this application, IPTV subscribers can buy tickets for a specific action like sport games, cinema, concert, etc. After the transaction is done the user is informed about transaction's details. Table 4.3 shows the classes and explanation of these classes. In this application there are eight methods these are *SelectLocationDate*, *DeleteBillingRecord*, *ReadBillingRecord*, *UpdateBillingRecordStatus*, *ViewTickets*, *AuthenticateUser*, *TakeUserConsent*, *DoTransaction* methods. These methods are described in the next section in detail.

Gifting Service

In this service IPTV subscriber enters her address and the destination address then she can send a gift to her friend. By using this application an IPTV subscriber can buy a gift by using her remote control. She has to give a destination address for the transmission of the gift to someone else. Table 4.3 shows the classes and explanation of these classes. In this application there are twelve methods these are *ViewGiftsMenu*, *InsertDestination*, *SelectLocationDate*, *DoTransaction*, *DeleteBillingRecord*, *ReadBillingRecord*, *UpdateBillingRecordStatus*, *ViewGiftsMenu*, *ViewMenuAndSelection*, *AuthenticateUser*, *TakeUserConsent*, *InsertDestination* methods. Methods of this application will be mentioned in the next section in detail.

Video Service

In this service IPTV subscriber chooses a video or package to buy or selects a previously bought video to watch. Users can subscribe to an advantage package to buy videos with a discount. Table 4.3 shows the classes and explanation of these classes. In this application there are eighteen methods these are *AuthenticateUser*, *Confirmation*, *ViewingOption*, *PlayVideo*, *ShowVideos*, *ShowPackages*, *ShowPackageVideos*, *SelectNewVideoorPackage*, *ShowBoughtVideo*, *ViewCurrentlyBoughtPackage*, *ShowCurrentlyBoughtVideo*, *ShowAllVideos*, *ShowAllPackages*, *InsertVideo*, *InsertPackage*, *SelectPreviouslyboughtVideo*, *GetVideoProperties*, *GetPakagePrice*, methods. Methods of this application will be mentioned in the next section in detail.

Table 4.3 Class Definitions of Applications

ClassName	Class Explanation	Attributes	Methods
Questionnaire Record	This class is responsible for questionnaire application.	EndDate, QuestionnaireId, QuestionId, UserId, Answer, StartDate, Status, Title, Question, UsersAnswer, Answer	AuthenticateUser, GetQuestionnaire, Questionnaire
Community Record	This class is responsible for community application.	Date, Location, CommunityType, IsAvailable, Name	SelectLocationDate, GetCommunityType, ViewAvailables
Food Service	This class is responsible for food application.	TransactionDate, Location, RestaurantType, IsAvailable, Id, Food, FoodId, Price, PrincipalExternalId, PrincipalType	SelectLocationDate, DeleteBillingRecord, ReadBillingRecord, UpdateBillingRecordStatus, ShowRestaurants, ViewMenuAndSelection, AuthenticateUser, TakeUserConsent, DoTransaction
Weather Forecast Record	This class is responsible for weather forecast application.	Date, Location, ForecastInfo	SelectLocationDate, ViewWeather
News Record	This class is responsible for news application.	Date, Location, News	SelectLocationDate, ViewNews
Traffic Record	This class is responsible for traffic inform application.	Date, Location, TrafficInformation	SelectLocationDate, ViewTraffic
IdNo Inquiry	This class is responsible for	UserName, UserSurName,	AuthenticateUser, Search, View

Record	identity number inquiry application.	FatherName, BirthdDate, IdNo	
Entertainment Record	This class is responsible for entertainment application.	Date, Location, EntertainmentType, Name, IsAvailable, Program	SelectLocationDate, GetEntertainmentType, GetEntertainmentName, ViewProgram
Ticket Transaction Service	This class is responsible for ticket buying application.	TransactionDate, Location, TicketType, IsAvailable, Id, Price, PrincipalExternalId, PrincipalType	SelectLocationDate, DeleteBillingRecord, ReadBillingRecord, UpdateBillingRecordStatus, ViewTickets, AuthenticateUser, TakeUserConsent, DoTransaction
Gift Sending Service	This class is responsible for gifting application.	TransactionDate, Location, DestinationAddress, GiftType, IsAvailable, Id, Price, PrincipalExternalId, PrincipalType	SelectLocationDate, DeleteBillingRecord, ReadBillingRecord, UpdateBillingRecordStatus, ViewGiftsMenu, AuthenticateUser, TakeUserConsent, DoTransaction, InsertDestination
Video Service	This class is responsible for buying a new video, package or watching a video for this application.	VideoID, PackageID, PackageName, VideoName, Discount, UserID, VideoHost, VideoExtention, Category	ViewingOption, PlayVideo, ShowVideos, ShowPackages, ShowPackageVideos, SelectNewVideoorPackage, ShowboughtVideo, ViewCurrentlyBoughtPackage, ShowCurrentlyBoughtVideo, ShowAllVideos, ShowAllPackages, InsertVideo, SelectPrevislyBoughtVideo, GetVideoProperties, InsertPackage, GetPackagePrice, AuthenticateUser,Confirmation

4.2 Class Methods

In this section class method definitions are given. The following methods are described:

- AuthenticationUser Method
- GetQuestionnaire Method
- Questionnaire Method
- SelectLocationDate Method
- GetCommunityType Method
- DeleteBillingRecord Method
- ReadBillingRecord Method
- UpdateBillingRecordStatus Method
- ViewMenuAndSelection Method
- TakeUserConsent Method
- DoTransaction Method
- ViewWeather Method
- ViewNews Method
- ViewTraffic Method
- Search Method
- View Method
- GetEntertainmentType Method
- GetEntertainmentName Method
- ViewProgram Method
- ViewTickets Method
- ViewGiftsMenu Method
- InsertDestination Method

- ViewingOption Method
- ShowVideos Method
- ShowPackages Method
- ShowPackageVideos Method
- SelectNewVideoorPackage Method
- ShowBoughtVideo Method
- ViewCurrentlyBoughtPackage Method
- PlayVideo Method
- ShowAllPackages Method
- ShowAllVideos MethodInsertVideo Method
- InsertPackage Method
- SelectPreviouslyBoughtVideo Method
- GetVideoProperties Method
- GetPackagePrice Method

AuthenticateUser Method

This method authenticates a user who has a specific user name and a password. It checks who is logging in. As you see in Table 4. 4 this method takes *UserID*, *Password*, *ApplicationName* as parameters. This method returns Bool(true, false). This method can have some exceptions such as:

- UserID does not exist.
- For a specific UserID password is incorrect.

GetQuestionnaire Method

By using this method user can select an available questionnaire. As you see in Table 4.4 this method takes *QuestionnaireID* as parameter. This method returns Bool(true, false). This method can have the following exception:

- Questionnaire that user tries to participate has been deleted before.

Questionnaire Method

By using this method user can participate for a specific questionnaire. As you see in Table 4.4 this method takes *QuestionnaireID,Answer* as parameters. This method returns void. This method can have some exceptions as:

- User does not answer all the questions.

SelectLocationDate Method

By using this method user can select a specific location and time interval. As you see in Table 4.4 this method takes *Location, StartDate, EndDate* as parameters. This method returns void. This method can have some exceptions as:

- Location that user wants does not have any community services
- Time interval that user enters is not sufficient
- Location that user wants to enter is not in the records

GetCommunityType Method

User select community types to view. User can enter more than one community type. As you see in Table 4.4 this method takes *CommunityType* as parameter. This method returns void. This method can have some exceptions as:

- There is no exception for this method

ViewAvailables Method

User view available community services matches with her criteria. This method returns void. This method can have some exceptions as:

- No matches has found with user criteria

DeleteBillingRecord Method

This method deletes a specific billing record within a specific timeframe. As you see in Table 4.4 this method takes *BillingRecord, StartDate, EndDate* as parameter. In the table it is explained that which parameter corresponds to. This method returns void. This method can have some exceptions as:

- User account does not exist
- Billing record does not exist

ReadBillingRecord Method

This method retrieves billing records within a specified timeframe. As you see in Table 4.4 this method takes *BillingRecord*, *StartDate*, *EndDate* as parameter. This method returns void. This method can have some exceptions as:

- User account does not exist
- Billing record does not exist

UpdateBillingRecordStatus Method

This method updates the status of a specific billing record within a specified timeframe. As you see in Table 4.4 this method takes *BillingRecord*, *StartDate*, *EndDate* as parameter. This method returns void. This method can have some exceptions as:

- User account does not exist
- Billing record does not exist

ShowRestaurants Method

This method brings user the registered restaurants which can be found in a specific location that user selected. This method returns void. This method can have some exceptions as:

- There is no available restaurant in the timeframe and location

ViewMenuAndSelection Method

This method brings user menu of registered restaurant with prices and allows user viewing menu, then user selects food. This method returns void. This method can have some exceptions as:

- Restaurant does not have a menu to view yet

TakeUserConsent Method

This method is a confirmation method before a transaction occurs. As seen in Table 4.4 this method takes *BillingRecord* as parameter. This method returns void. This method can have some exceptions as:

- Billing record does not exist

DoTransaction Method

After user consent is taken transaction is done and billing information is updated. As you see in Table 4.4 this method takes *BillingRecord* as parameter. This method returns void. This method can have some exceptions as:

- User account does not exist
- Billing record does not exist

ViewWeather Method

User views weather forecast with previously entered location and time criteria. This method returns void. This method can have some exceptions as:

- Forecast record does not exist that belongs to user criteria

ViewNews Method

User views news with previously entered location and time criteria. This method returns void. This method can have some exceptions as:

- News record does not exist that belongs to user criteria

ViewTraffic Method

User views traffic condition with previously entered location and time criteria. This method returns void. This method can have some exceptions as:

- Traffic condition record does not exist that belongs to user criteria

Search Method

User enters criteria to *IDNoInquiry*. As you see in Table 4.4 this method takes *Name*, *Surname*, *Father's Name*, *BirthDate* as parameter. This method returns void. This method can have some exceptions as:

- User Name or surname is incorrect
- Father Name or BirthDate does not belong to that user

View Method

User views the TC ID no of the person with previously entered criteria. This method returns void.

GetEntertainmentType Method

User selects entertainment types to view. User can enter more than one entertainment type. As you see in Table 4.4 this method takes *EntertainmentType* as parameter. This method returns void. This method can have some exceptions as:

- Type that user entered does not exist

GetEntertainmentName Method

User selects entertainment name belongs to the specified entertainment type. As you see in Table 4.4 this method takes *EntertainmentType*, *EntertainmentName* as parameter. This method returns void. This method can have some exceptions as:

- EntertainmentType that user entered does not exist
- EntertainmentName that user entered does not exist

ViewProgram Method

User views the program of the specified entertainment place. This method returns void. This method can have some exceptions as:

- Entertainment place doesn't have any program to view yet

ViewTickets Method

User views tickets and select ticket that she wants. This method returns void. This method can have some exceptions as:

- Tickets are sold out
- There are no tickets for that event

ViewGiftsMenu Method

This method enables users to view gifts and select gifts. This method returns void. This method can have some exceptions as:

- Gift that you want to buy are sold out
- Price of the gift has not been determined yet

InsertDestination Method

Destination address is taken from the user and inserted into the database. As you see in Table 4.4 this method takes *DestinationAddress,Id* as parameter. This method returns void. This method can have some exceptions as:

- User did not enter a destination address

ViewingOption Method

This method enables users to select viewing a previously bought video or buy a new video or package. This method returns void. This method can have no exceptions.

ShowVideos Method

This method shows user previously bought videos. As you see in Table 4.4 this method takes *UserID* as parameter. This method returns void. This method can have some exceptions as:

- User does not have a previously bought video.

ShowPackages Method

This method shows all packages available. This method returns void. This method can have some exceptions as:

- There is no package available or there is no package defined.

ShowPackageVideos Method

This method gets the *PackageID* as parameter as shown in Table 4.4 and shows user the videos of that package. This method returns void. This method can have some exceptions as:

- There is no video in the package yet.

SelectNewVideoorPackage Method

This method enables user to select new video or new package. This method has no exceptions and returns void.

ShowBoughtVideo Method

This method gets the *VideoID* as parameter as shown in Table 4.4 and shows user the currently bought video. This method returns void. This method has no exception.

ViewCurrentlyBoughtPackage Method

This method informs user after user buy a package. This method returns void and has no exception.

PlayVideo Method

This method gets the *VideoHost*, *VideoName* and *VideoExtension* as parameter as shown in Table 4.4 and shows user the currently bought video. User can stop or play a video while the video is playing. This method returns void. This method has the following exception:

- Video type is not supported by IPTV.
- Video has been removed.

ShowAllPackages Method

This method shows user all of the available packages so users can determine which package is preferred for registering. This method returns void. This method has the following exceptions:

- There is no package defined yet.

ShowAllVideos Method

This method shows user all of the available videos. This method returns void. This method has the following exceptions:

- There is no video defined yet.

InsertVideo Method

This method gets the *UserID* and *VideoID* as parameter as shown in Table 4.4 and inserts a transaction log for the bought video to the database. This method returns void. This method has no exceptions.

InsertPackage Method

This method gets the *UserID* and *PackageID* as parameter as shown in Table 4.4 and inserts a transaction log for the bought package to the database. This method returns void. This method has no exceptions.

SelectPreviouslyBoughtVideo Method

This method gets the *UserID* as parameter as shown in Table 4. 4 and selects previously bought videos and previously bought packages' videos of a user. This method returns void and has the following exceptions:

- There is no previously bought video or package.

GetVideoProperties Method

This method gets the *VideoID* as parameter as shown in Table 4.4 and gets a selected video's properties. This method returns *VideoID*, *VideoName*, *VideoHost*, *VideoExtension*, *VideoCategory* and *Price* and has the following exceptions:

- There is no property defined for the video.

GetPackagePrice Method

This method gets the *PackageID* as parameter as shown in Table 4.4 and gets selected package's price. This method returns *Price* and has the following exceptions:

- There is no video in the package

Table 4.4 Parameters of Applications' Methods

Method	Parameter	Explanation
AuthenticateUser	UserID	Contains UserID for a specific user. By looking at the customers user name this method checks the validation with the password
	Password	Gets password to check the consistency between username and password
GetQuestionnaire	QuestionnaireID	Contains UserID for a specific user. By looking at the customers user name this method checks the validation with the password
Questionnaire	QuestionnaireID	For every question that user answers takes the QuestionID to match with user answers
	Answer	This is the answer of the user for every question. Takes user answer for all questions and stores them
SelectLocationDate	Location	By taking the desired location this method looks for community services in that location.
	StartDate	Start date of for the criteria
	EndDate	End date of the criteria
GetCommunityType	CommunityType	By looking at the community type this method brings desired community types places.
ReadBillingRecord, DeleteBillingRecord, UpdatebillingRecord	BillingRecord	Billing record to be deleted.
	StartDate	Start date of the billing records.
	EndDate	End date of the billing records.
TakeUserConsent, DoTransaction	BillingRecord	Billing record for approval.
Search	Name	Name of a person
	Surname	Surname of the person
	Father's Name	Fathers Name of the person
	BirtdhDate	Birth Date of the person.
GetEntertainmentType	EntertainmentType	By looking at the entertainment type this method brings desired entertainment types places.

GetEntertainmentName	EntertainmentType	By looking at the entertainment type this method brings desired entertainment types places.
	EntertainmentName	Name of the available entertainment to view.
InsertDestination	DestinationAddress	User's destination address that is entered.
	Id	Id of the transaction record.
ShowVideos, SelectPreviouslyBoughtVideo	UserID	UserID is needed to look which user has which videos
ShowPackageVideos, GetPackagePrice	PackageID	PackageID is taken to get the Videos of the package
ShowBoughtVideo, GetVideoProperties	VideoID	Required to show which video user bought
PlayVideo	VideoHost	Host of the video
	VideoName	Name of the video
	VideoExtension	Extension of the video
InsertVideo	UserID	UserID of the customer
	VideoID	Currently bought video's ID
InsertPackage	UserID	UserID of the customer
	PackageID	Currently bought package's ID

Chapter 5

An Example

5.1 Framework Architecture

In this thesis the “three tier architecture” as client-server architecture is used. This “three-tier architecture” introduces a server between the client and the server. In this design there are 3 layers to distinguish code of this project. In this architecture it is easier to modify or replace any tier without affecting other tiers. This architecture also separates database and application functionalities so it is easier to write new functions that belong to database or application. Application Server provides the application logic layer in the “three-tier architecture”, enabling client components to interact with data resources and legacy applications. One other thing that easier is implementing security policies can be done easily. Using three layer architecture increases reusability of codes.

A common design practice is to limit client requests within a single unit of work (transactional session). This may affect how you design the presentation layer. For example, if a client requires multiple pages to collect information for a transaction, then the presentation layer must retain the information from page to page until the application collects the full set of changes or requests. At that point, the presentation layer calls the business layer to modify the database. Collectively, this architecture is programming models that enable the distribution of application functionality across three independent systems. Name of the layers used are:

- Presentation Layer (Client component)

- Business Layer (Logic Process of the Application)
- Data Layer (Discrete Collection of Database Queries)

Presentation Layer

In this layer interaction between end user and server is implemented. Forms are included in this layer. As you see in Figure 5.1 Presentation layer provides user interaction by using forms or other applications' components. Programmer uses this layer for designing purpose and to get or set the data back and forth.

For every web service a presentation layer is used in this thesis. In this layer all the web components that user interacts with is hold in this layer XHTML is used in this implementation to create the interface of the applications. Also, while designing the interface of the system you have to consider that you cannot use mouse as an input device. As a result check boxes, radio buttons, list boxes are not available while designing the user interface part. This restriction resulted in some difficulties. For example think about Questionnaire Web Service. If there was in radio button it was easier to select a questionnaire to take. Alternatively, simple html links are used to select questionnaire. When you use click on “key-up” and “key-down” keys you can select a questionnaire from a table which its row is designed as a link.

This layer only communicates with Business Layer; there is no option to call a function from Data Layer or DLL (Dynamic Link Library). Functions in this layer can be called by only Business Layer.

Business Layer

Mostly the term is applied to web application development where programs are separated into three-tier architecture with business logic referring to the middle tier. This layer is used to write the functions which work as a connection line to transfer the data from Application or Presentation layer to data layer. In the “three tier architecture” never let the data layer to interact with the presentation layer. If a customer attempts to buy a product such as gift or ticket for an item, the business logic layer must determine who

has the right for purchasing that item and authenticates user to learn if she can buy that item and also business layer looks for the availability of the product.

As you see in Figure 5.1 a Business Layer is implemented including one page per each web service. Pages that are in the business layer should be said that most intelligent pages. These pages first get user inputs for a specific RDP application and then calls the functions from the data layer by sending the arguments taken from the presentation layer. When results come from then this layer calls the presentation layer's functions again to output the desired results. This is just logic part of the application. Business Layer could be defined as a logical infrastructure of a system. All the communications passed through this layer. In the common three-tier architecture, the business logic in theory occupies the middle tier, the business-services tier or business layer. In practice, the business logic is often communicates with the other two layers (presentation and data layer).

This layer both calls functions from Data Layer and Presentation Layer. Simply it takes user inputs from Presentation Layer and sends necessary arguments to the Data Layer. After the results come to the Business Layer this layer calls functions from the Presentation Layer to print out user's desires.

Data Layer

This layer consists of Database Servers. Here information is stored and retrieved. This layer keeps data independent from Presentation Layer or Business Layer. Giving data its own tier also improves scalability and performance.

In the code this layer has just a page that keeps all functions called by Business Layer. As you see in Figure 5.1 this layer just reaches to the DLL that the code has used and calls the same functions. Functions inside the DLL connect to the Database and execute queries that are needed. Results are sent to the Data Layer.

In these applications generally some assumptions are done to write my code. This assumption is that there is initial data in the system. This system is for IPTV users it is

difficult to wait them to enter some inputs a web page because there is not an administrator in front of the TV.

For example by considering the Questionnaire Service, system initial simple questionnaires are put into the system and ask user to select a questionnaire. After user's selection user starts to answer the questions while the questionnaire finishes. Some tables has one-to-many and one-to-one relationships with foreign keys. Some tables don't have any relationship.

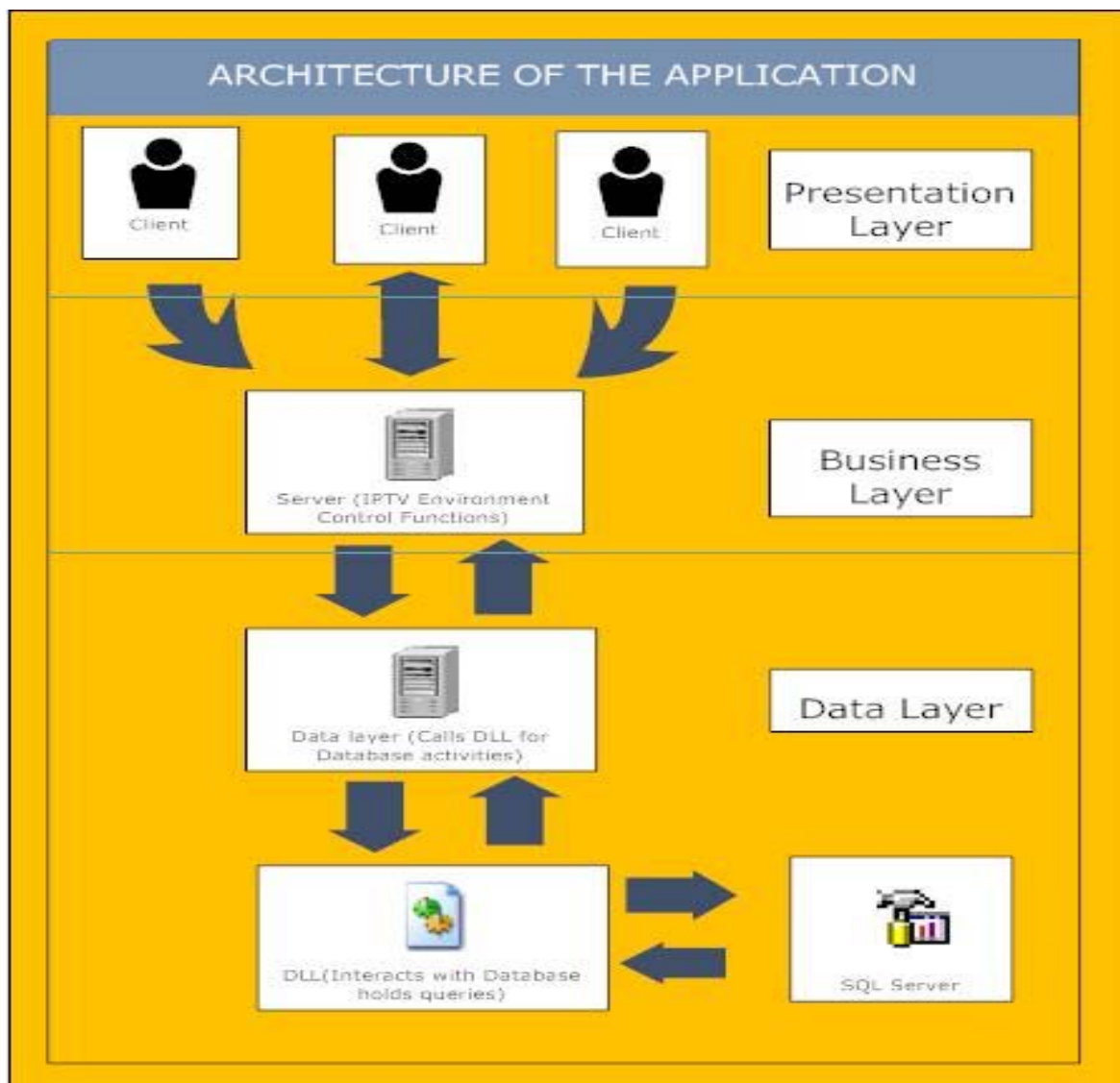


Figure 5.1 Architecture of the Framework

5.2 Database Schema

In the Figure 5.2 below you can see the database relations of *Food* Application. User table has one-to-one relation between *PrincipalType*. Assume that every user has one principal type. An account should be a *Group* account, a *Device* account or a *User* account. In this application an assumption is done for every user account is user type accounts. There is one-to-many relationship between *PrincipalType* and *Food* table; I assume that one user can buy more than one dish of food. And after transaction occurs a record is inserted into the *Food* table. *BillingEventStatusFood* table keeps the status of the bill so it there is one-to-one relationship between *Food* table and *BillingEventStatusFood* table. Menu table is related with the *AvailableRestaurants*, so menu of the available restaurants are kept. User selects available restaurants and views menu of the restaurant. After confirmation transaction occurs.

The database definition of the example application is given in Figure 5.2. As seen from the figure the database includes 5 tables, which are related to *Food* Application. These tables are:

- Food
- AvailableRestaurants
- Menu
- PrincipalType
- BillingEventStatus

Attributes of the tables are given in Table 5.2. Attributes that are related to these tables are listed in Table 5.2 for the example *Food* Application. *Food* Table's attributes are *Id*, *RestaurantId*, *TransactionDate*, *PrincipalType*; *AvailableRestaurants*' attributes are *Id*, *Location*, *Date*, *RestaurantType*; Menu Table's attributes are *RestaurantId*, *FoodId*, *Food*, *Prize*; *PrincipalType* Table's attributes are *PrincipalType*, *Device*, *User*, *Group* and *BillingEventStatus* Table's attributes are *BillingId*, *IsRead*, *Recorded* and *Deleted*. See Table 5.2 for more detailed explanation for the attributes.

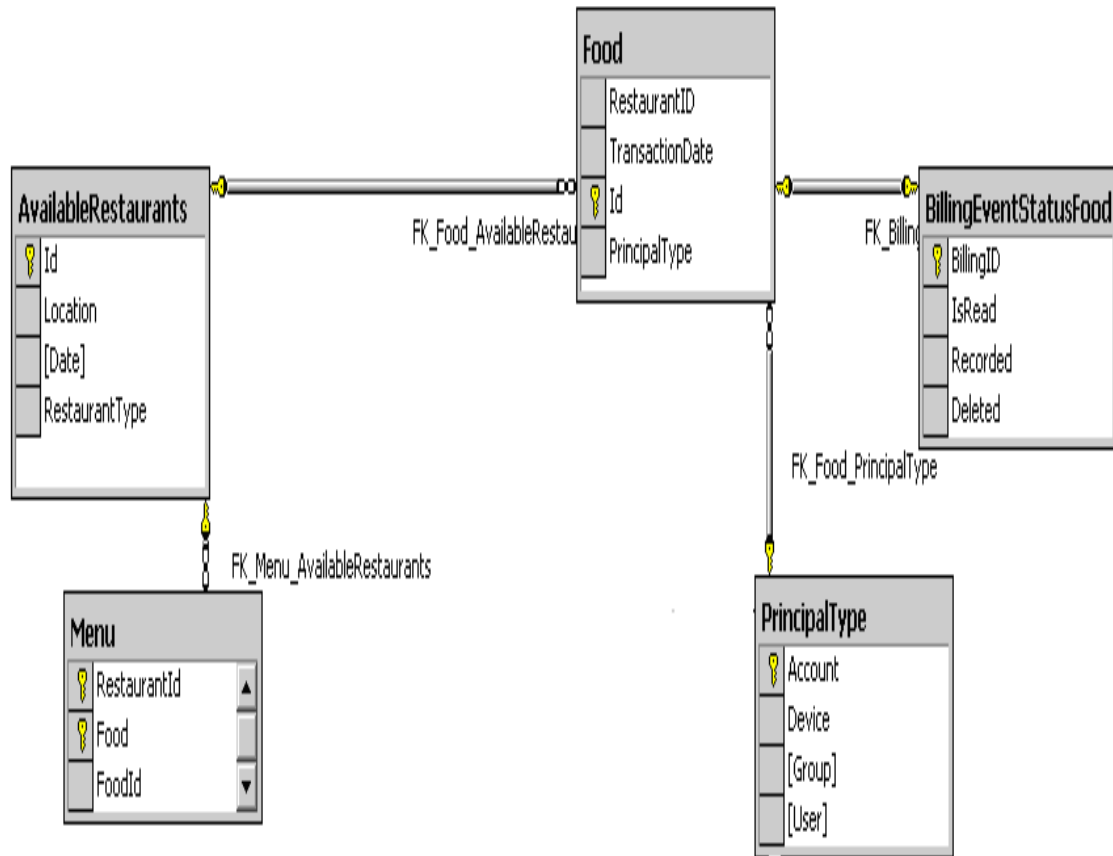


Figure 5.2 Database Schema of Food Application

5.3 Advantages of Using DLLs

DLL means Dynamic Link Library simply [22]. There are some advantages to use DLLs.

- Saves memory; many processes can use a DLL at the same time this is achieved by registered or unregistered DLLs
- Saves disk space; when a DLL is created many applications use its functions, so you just write and register a DLL then other applications can use it
- Multilanguage support; you can call a DLL from different languages. You write a DLL in Visual Basic but also Java, ASP, .Net can call DLL functions
- Privacy; it is not easy to read the DLL, so if you want to keep your key functions private you should use DLL

By considering the advantages above a DLL is used to keep the code private and increase reusability of the system.

Table 5.1 Attributes in example application database

Table	Attribute	Explanation
Food	Id	Id of the food
	RestaurantId	Restaurant's Id that is available
	TransactionDate	If transaction occurs current date is recorded in this field
	PrincipalType	Users account Type
AvailableRestaurants	Id	Id of the available restaurants
	Location	Location of a restaurant
	Date	Date of the availability record
	RestaurantType	Type of the restaurant
Menu	RestaurantId	Identifies which menu is related with which restaurant
	Food	Food of the menu
	FoodId	Id of a food in the menu
	Prize	Prize of the food
PrincipalType	PrincipalType	Is related to user name
	Device	These fields are Boolean data types that manage if the user is Device, Group or User type.
	Group	
	User	
BillingEventStatus	BillingId	Id of a billing record
	IsRead	These fields are Boolean data types that manage if a billing record is readable, deleted or recorded.
	Recorded	
	Deleted	

5.4 An Example Application

In this section an example application with screen shots will be shown. As seen in Figure 5.3 this application needs Microsoft TV IPTV Edition CDK Simulator. There is not enough documentation in public to understand the details of this tool. But there are some confidential Microsoft documents that are not public, so there is no chance to

mention this simulator. After starting ISS web server and MSSQL Server in your local server this application could work correctly.

“<http://localhost/tv/Thesis/PresentationLayer/Video/Video.asp>” is the URL as seen in Figure 5.3. This means that this application works on that directory. *PresentationLayer*” part you see in the URL means that this application is under the directory of *PresentationLayer*. There is a subdirectory called Video and Video.asp is called from that directory as the start page of this application. Before explained above methods used in this application’s Presentation Layer are *ViewingOption*, *ShowVideos*, *ShowPackages*, *ShowPackageVideos*, *SelectNewVideoorPackage*, *ShowboughtVideo*, *Confirmation*, *ViewCurrentlyBoughtPackage*, *ShowCurrentlyBoughtVideo* and *PlayVideo* methods. In the Data Layer *AuthenticateUser*, *ShowAllPackages*, *InsertVideo*, *SelectPreviouslyBoughtVideo*, *ShowAllVideos*, *GetVideoProperties*, *InsertPackage*, *GetPackagePrice* methods are used in this application. Figure 5.3 shows the labels *User Name* and *Password*. These are GUI part of this application so as seen in the URL. This page is in the Presentation Layer.

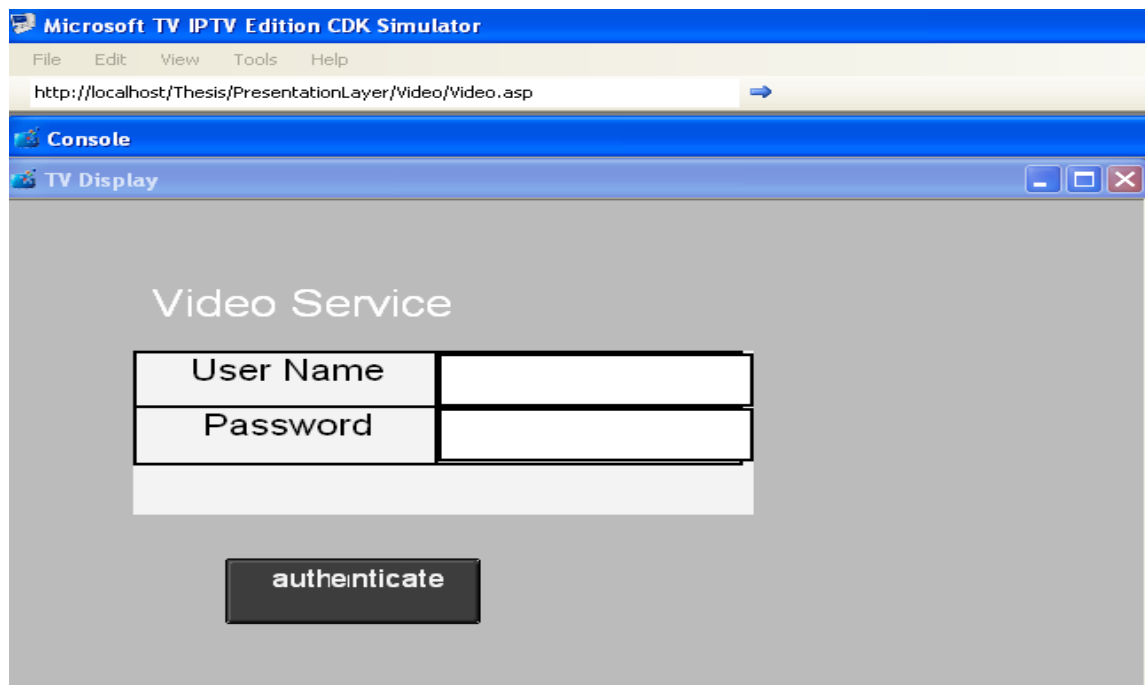


Figure 5.3 Start Page of Video Application

After calling the page from the simulator the next step is passing to the full screen mode, because this simulator works only in “full screen” mode. As seen in Figure 5.4 after user enters *User Name* and *Password* then presses the “*Authenticate button*”. User cannot use mouse but can pass through one form element to other form element by using “key-up” and “key-down” buttons. After user entered presses “*Authenticate*” button *AuthenticateUser* method is called by sending parameters *UserName* and *Password*.

AuthenticateUser method lies in Business Layer. Business Layer passes these parameters to the Data Layer and waits for the results. Data Layer sends these parameters to DLL and waits for result. After *AuthenticateUser* method procedure ends a new screen appears as seen in Figure 5.5.



Figure 5.4 Full Screen View of Video Application Start Page

If authentication returns true then user meets a new screen as seen in Figure 5.5 that enables user to select a previously bought video to watch or to select new video or package to buy. If user presses “Previous“ button than a new screen appears as seen in Figure 5.6 that show user previously bought videos by user. If a user bought a package before, videos that are in that package also listed.

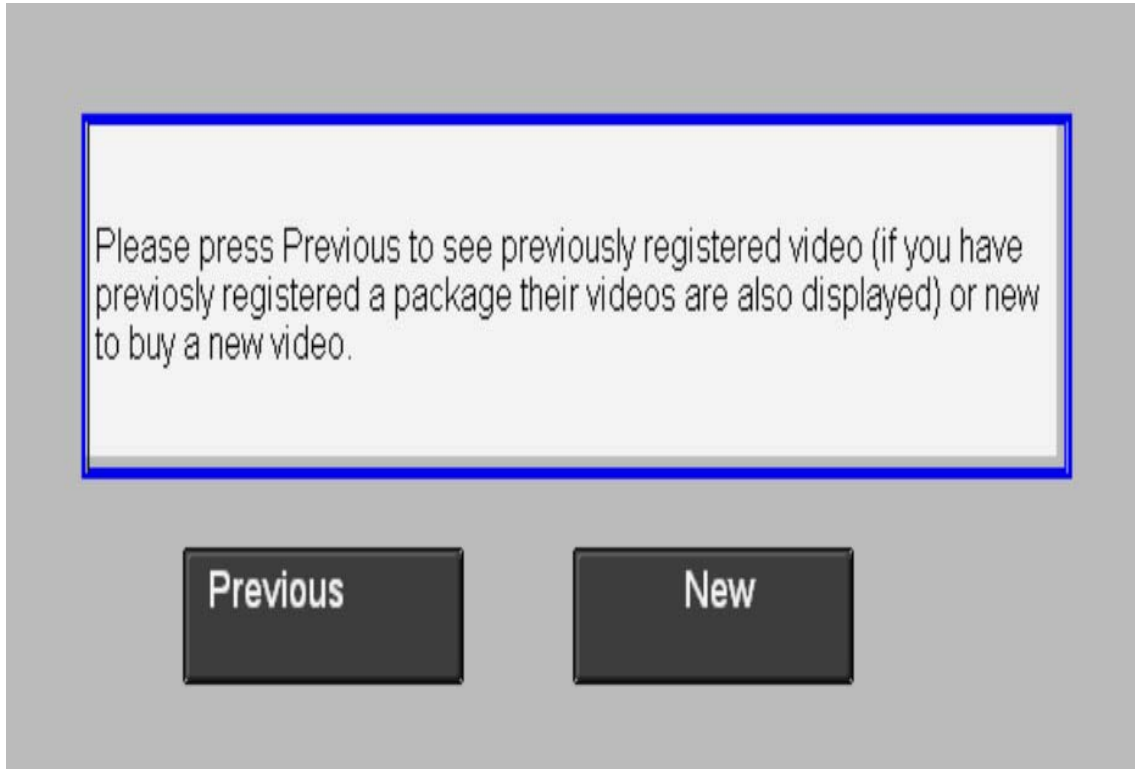


Figure 5.5 Show Options to Select After Authentication

VideoID	Video Name	Category	Price
2	Pip2	documentary	5 YTL
5	Pip5	documentary	10 YTL
6	Pip6	documentary	10 YTL
8	Video1	documentary	20 YTL

Figure 5.6 Display Properties of Previously Bought Videos

User can select a video to watch. We assume that user selects a video to watch and then as seen in Figure 5.7 video starts to display. This screen does not work in normal browsers such as IE 7.0 or Mozilla Firefox 2.0. This page can only be viewed by using Microsoft TV IPTV Edition Content Development Kit. As seen in Figure 5.7 user can pause the video by pressing “Pause” button. This is just a simple Jscript control. After pressing “Pause” button, the value of the “Pause” button changes from “Pause” to “Play” and user easily controls the video. There is the same control on the “Stop” button. If user presses “Stop” button value of the “Stop” button changes from “Stop” to “Play”.

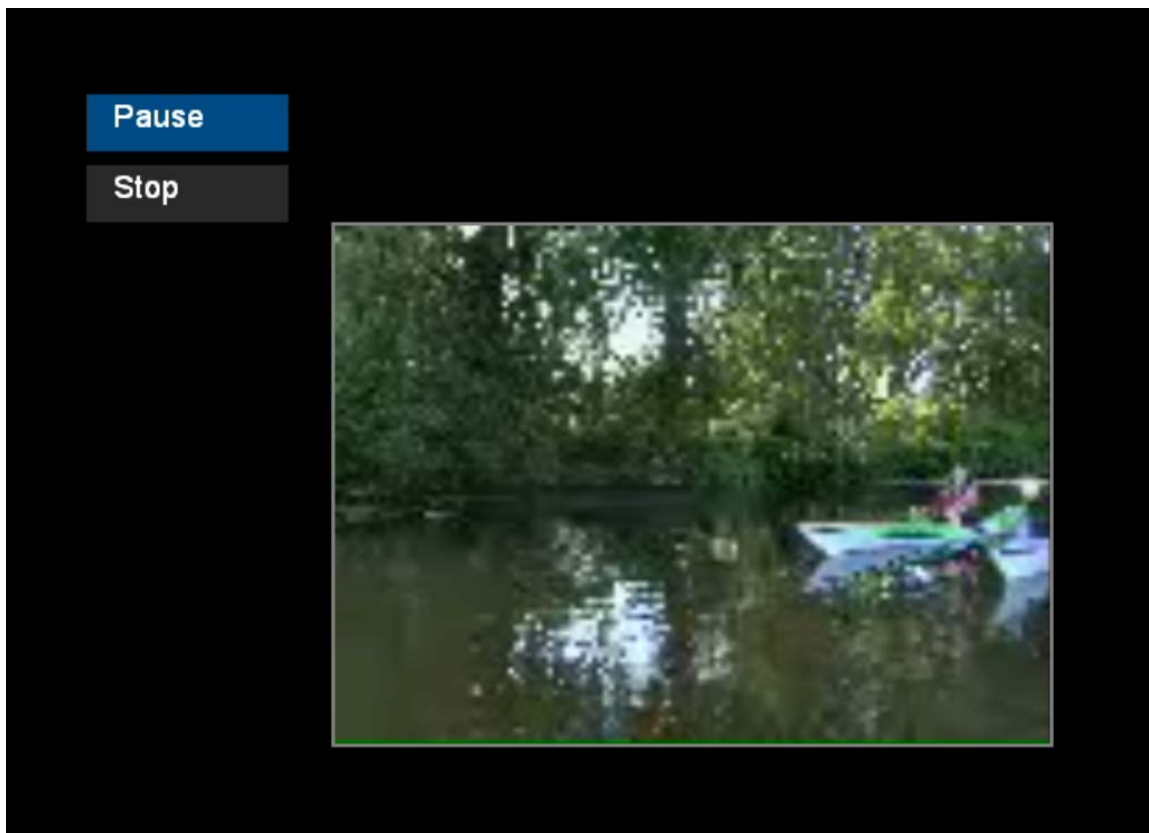


Figure 5.7 Watching Previously Bought Video

If user selects “New” option in spite of “Previous” then a screen shown in Figure 5.8 is displayed asking user to buy a new video or package. If user selects “Packages” option then as seen in Figure 5.9 package properties listed. User can select a package to buy and the discount rate of the package is listed.

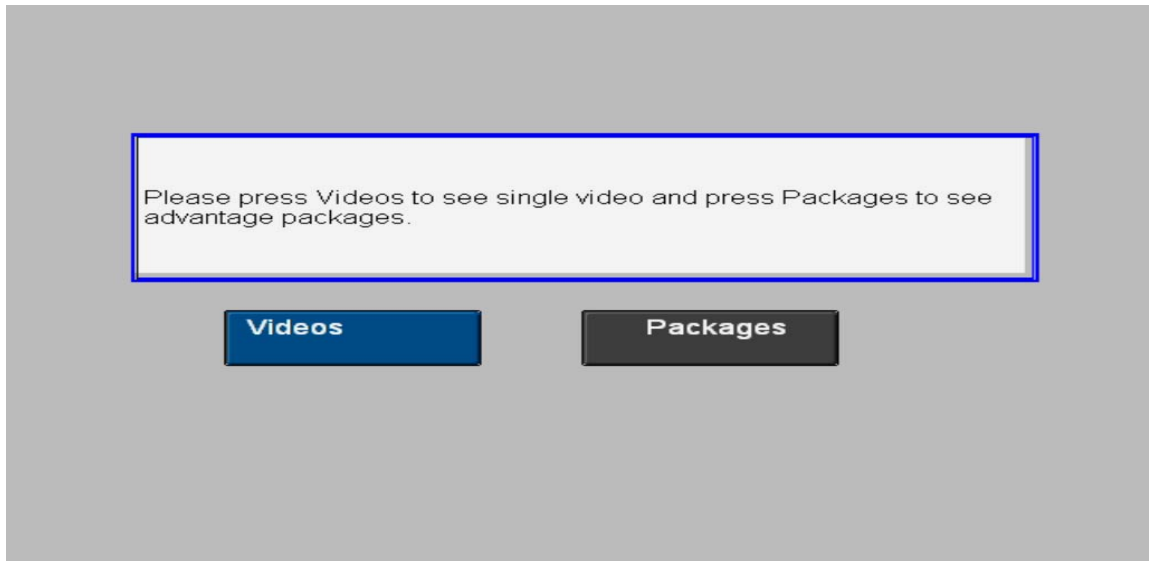


Figure 5.8 Selecting Videos or Packages?

Select a package to view

PackageID	Package Name	Discount Rate	Start Date	End Date
1	Documentary Package 1	%30	20.03.2008	30.04.2008
2	Documentary Package 2	%20	30.03.2008	30.04.2008

Figure 5.9 Displaying Package Properties

In Figure 5.10 after user select a package, videos that are in the package and “Buy” button displayed. If user wants to buy the package just clicks on the “Buy” button. If user presses “Buy” button than a confirmation screen seen in Figure 5.11 is displayed. In

the confirmation screen package price is also shown. Critical point is the price of the package has a discount rate of 30% that is the selected package's discount rate.

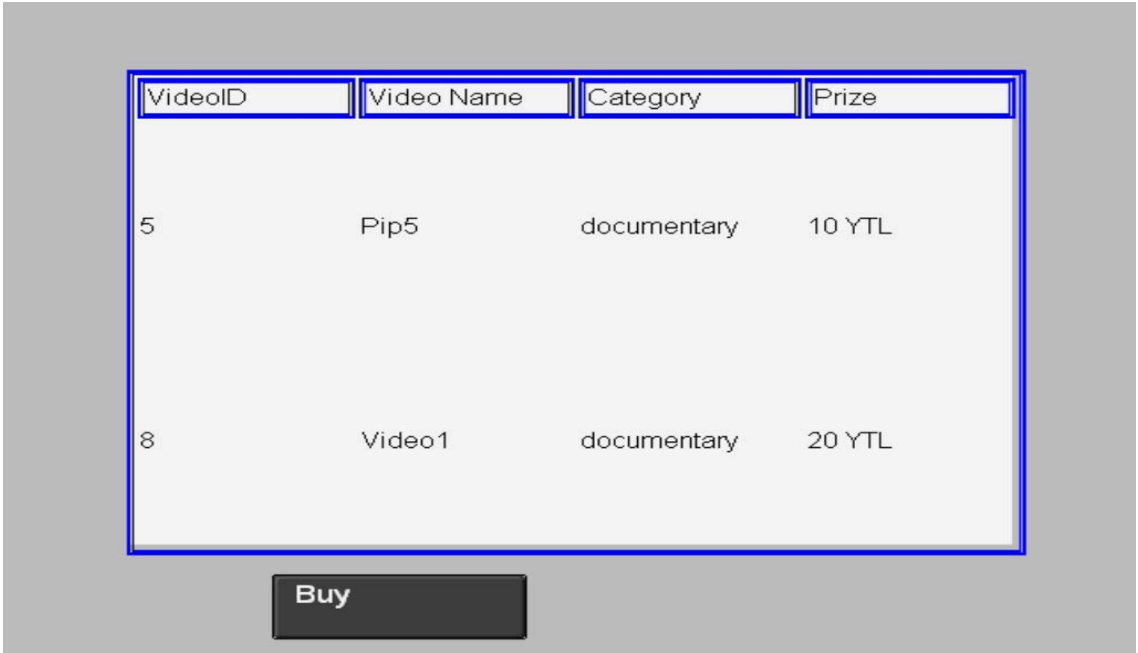


Figure 5.10 Displaying Selected Package's Video Properties

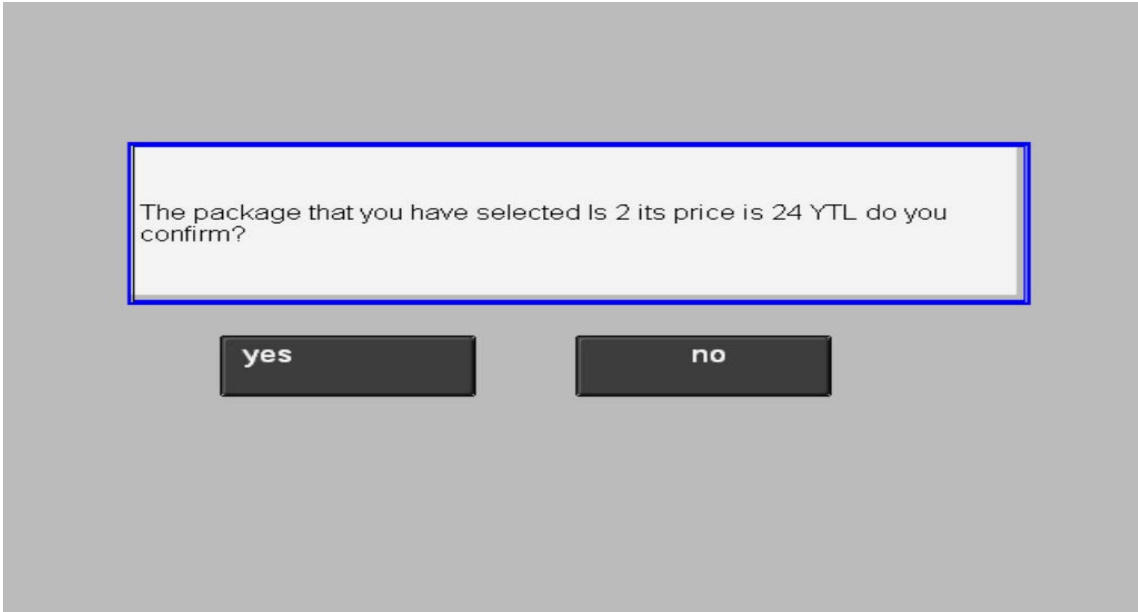


Figure 5.11 Confirmation Screen for Buying Package

After transaction completes an information screen is displayed as seen in Figure 5.12 and user presses the “Back” button to go the start page of the application. Transaction logs are inserted into the database. When user wants to watch previously bought videos the video of this package will also be displayed in the user’s video list.

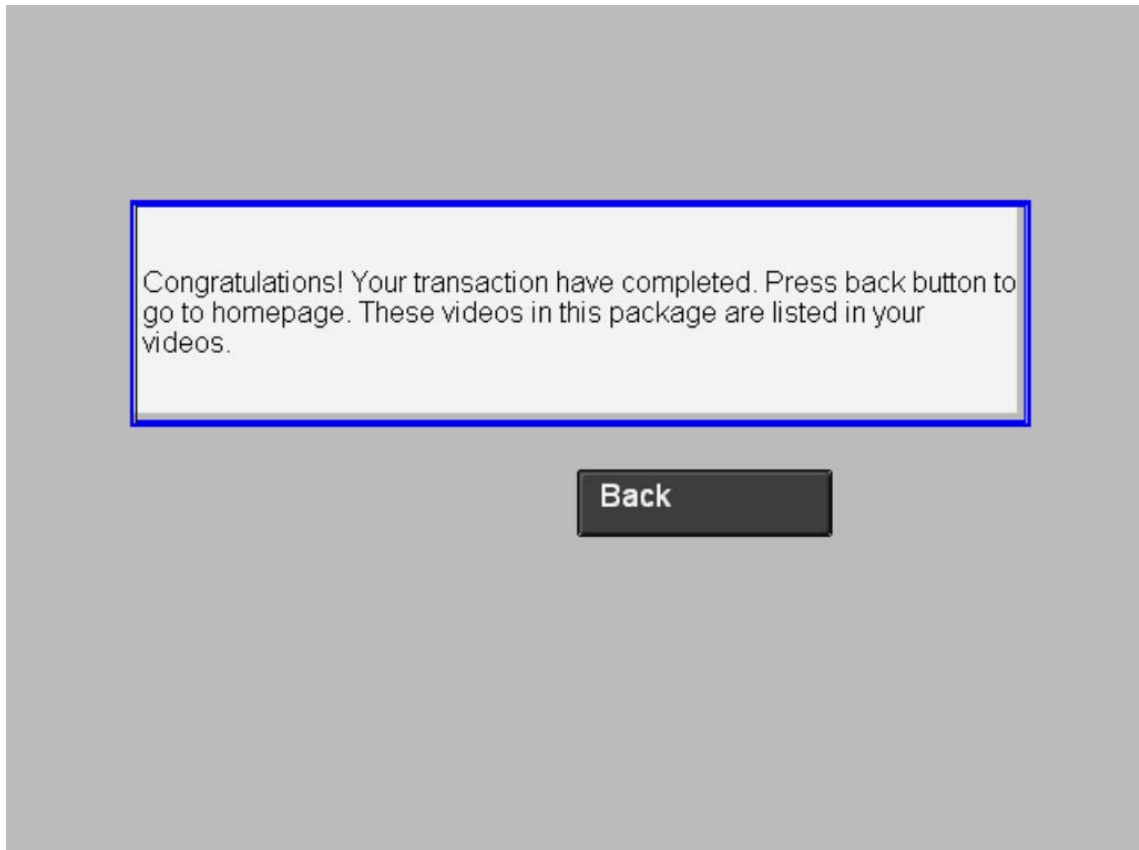


Figure 5.12 Information Message after Package Buying Process

If user selects “Videos” option all videos that are in the video pool are displayed as shown in Figure 5.13. If user clicks the link on a row than a confirmation screen is displayed with informing user the price of the video as shown in Figure 5.14. The difference between buying a video and a package is while buying a video there is no discount option so user just buys the video but package buying process includes a discount rate that makes a discount with an amount over total of video prices.

VideoID	Video Name	Category	Prize
1	Pip1	documentary	10 YTL
2	Pip2	documentary	5 YTL
3	Pip3	documentary	12 YTL
4	Pip4	documentary	15 YTL
5	Pip5	documentary	10 YTL
6	Pip6	documentary	10 YTL
8	Video1	documentary	20 YTL

Figure 5.13 Displaying All Videos

The video that you have selected is Pip3 its price is 12 YTL do you confirm?

yes **no**

Figure 5.14 Confirmation of Buying a Single Video

After user confirms transaction a new screen appears informing user about transaction as seen in Figure 5.15. User can view the video or return homepage. If user clicks “View” button than video starts displaying as shown in Figure 5.16

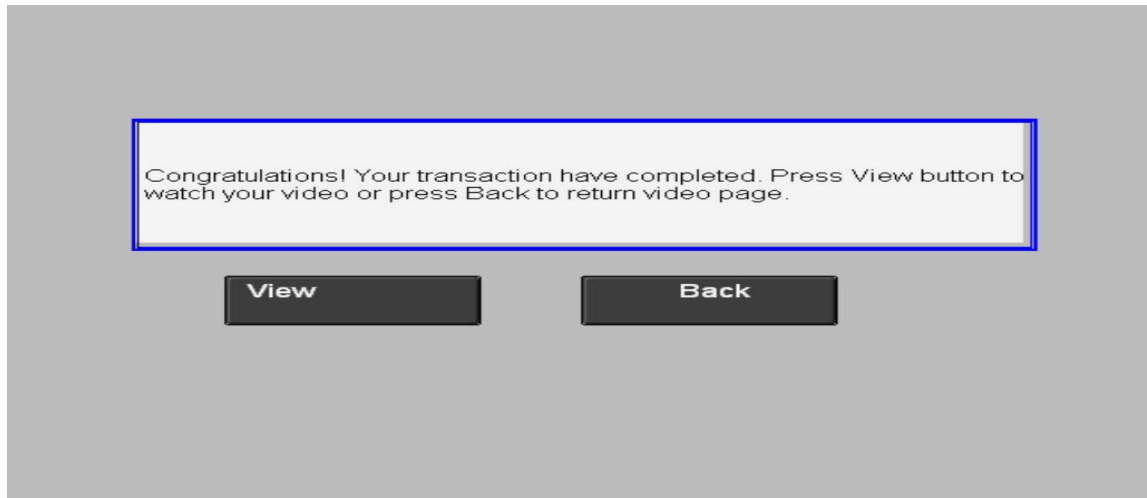


Figure 5.15 Informing User after Single Video Transaction

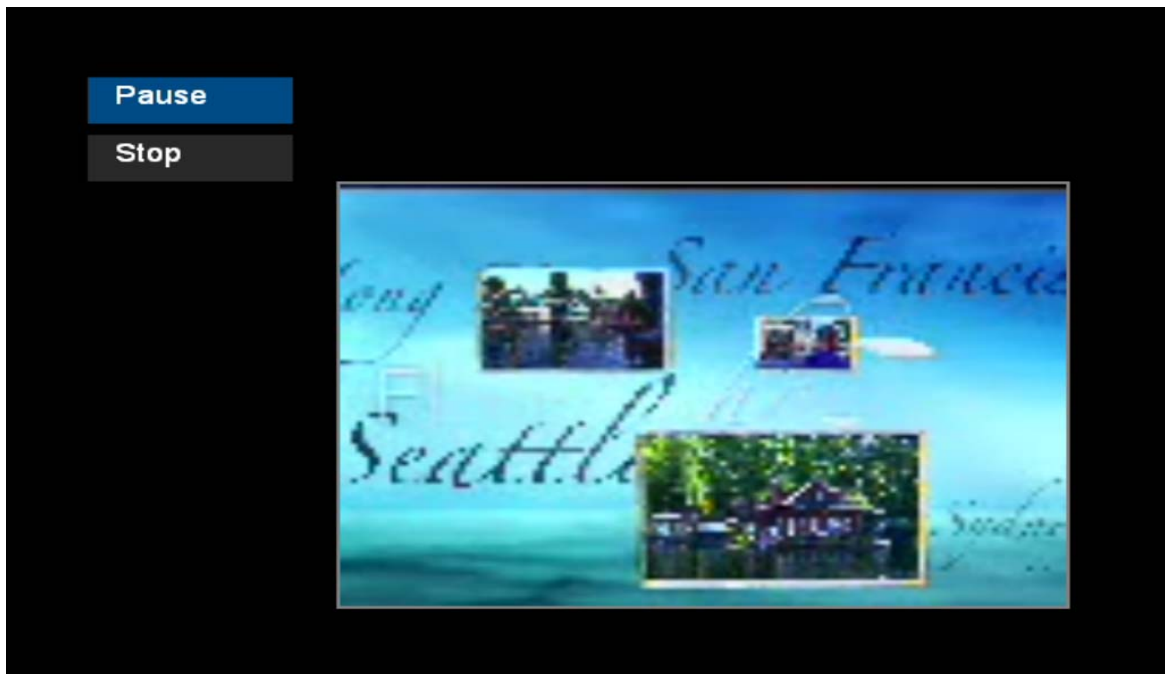


Figure 5.16 Watching Video after Transaction

Chapter 6

Conclusion and Recommendations for Future Work

The main goal of this thesis is to develop a framework for RDP applications for IPTV. The framework is developed to make developing RDP applications easier.

There will be some challenges while writing the thesis. Solutions were found to overcome these restrictions; IPTV topics are searched, papers describing IPTV are studied. At the same time some materials have been found to research about IPTV. IPTV main servers lie on the Alcatel-Lucent, so to see how it works with Set-Top-Boxes and Television, an arrangement is scheduled with engineers that work on IPTV in Alcatel-Lucent.

After searching topics and get information about IPTV, example RDP applications were developed. Eleven example applications were developed for this thesis, like *Questionnaire* application, *Video* application etc... After finding applications data types, methods and classes of these web services are determined. Some common methods between similar applications are determined. This methodology helps to determine the layers of the framework.

The next step is to designing the database of the system. It was easy because these were previously defined data types for methods, so only creating the logical relations between tables were enough to complete database diagram for the thesis.

While determining the architecture of the thesis focusing the existing architectures of software engineering and “three tier architecture” is chosen. The improvement of this architecture is best achieved by adding new methods by creating new applications. The more applications are developed, the increasing quality of the framework.

It was decided to use ASP.NET in the thesis, but due to the IPTV platform there were some restrictions to use ASP.NET properties. For example, when trying to put asp objects (button, form or textbox etc...) in spite of html objects, although this code works in internet explorer browser without an error, it gives a run time error when the simulator renders the code. As a solution to this problem ASP for writing standard methods code and Visual Basic for the Data Layer methods were chosen.

Layers that are Presentation Layer, Business Layer and Data Layer are developed for implementing previously chosen “three tier architecture” standards. Designing this architecture and describing and determining communication between them are done. While developing these layers, method flexibility and reusability is considered.

To complete data layer a DLL is created that contains basic functions that are directly related to the database. By using this DLL privacy of the code is increased and applications became faster. After registering the DLL to the system the security of the code is achieved, because database queries lie in the DLL. Another option could be writing stored procedures by using the Microsoft SQL Server, so the system is strengthened for SQL injection attacks.

The most difficult issue while developing this framework is to consider XHTML objects. If the coder forgets to close an HTML tag you cannot view the results in the IPTV Edition Content Development Kit. Internet explorer and Microsoft TV IPTV Edition CDK renders the code very different from each other, this will cause big problems for coder, because when the coder decides that the code is working fine in the internet explorer and than tries it in the simulator there will be unexpected behaviors. IPTV Content Development Kit do not accept check boxes, radio buttons and list boxes

while rendering the code, so alternative solutions must be created. To overcome this restriction links are given to the table rows to avoid user selecting a value.

In the future this framework should include more applications. More applications mean that there will be new different methods for public usage. This will increase the functionality of this framework. For example writing a game can be nice for this approach. Also there could be more control buttons on the video application. For example “mute”, “rewind”, “full screen” options can be added.

One more thing is to define the layers more accurately. For example ASP codes are used in the presentation layer. But if writing functions that generate html codes will be achieved this will satisfy to print HTML objects in the Business Layer without calling more complex functions. For example while printing a table a function that has HTML code of a table that is written could be called and when a table is needed it must be enough to call a function whose job is printing a table.

As a result this framework will be useful who wants to create IPTV applications for public usage. It is flexible for enlargement and easy to understand.

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Appendix A: CD Containing the Code for Framework and Application

Curriculum Vitae