GRAPHICAL USER INTERFACE FOR VIDEO ON DEMAND NAVIGATION FROM AN IPTV SET TOP BOX

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CHAPTER 1: INTRODUCTION

1.1 GENERAL INTRODUCTION

This thesis will describe the final project I did in the second semester of the academic year 2008-2009 at the UPC (Universitat Politècnica de Catalunya) campus Terrassa, school of industrial engineering (EUETIT). The project was supervised by Xavier Giró and was done mostly in the lab of the department of ‘Signal Theory and Communications’ (TSC).

The project is built on an existing project by David Vera, who made a video on demand server using a web browser as interface. Laurens De Vos, a fellow student of KaHo Sint-Lieven in Ghent (Belgium) where we study, also worked on this project. His goal was to improve the video on demand server implemented by David Vera to clean up the bugs and provide new capabilities but with better user interaction.

My work on the other hand, has focused on the graphical user interface (GUI) of this project. The requirements of this project focus on the remote access to the video content at the server from a TV set top box (STB). These type of devices have become popular in the latter years acting as a receiver of video signals which are later displayed on a screen, in our case, a HDTV panel.

The main goal of my part of this project is to create a GUI which is displayed and controlled by the set up box and that also manages the connections to a remote video database. The GUI is coded in web languages such as JavaScript, to manage the menu navigation, HTML represent the page, as well as PHP and JSON to connect to the database.

We split the video server part from the GUI’s because we want the uploaded video content to be able to watch from different types of GUI’s, a set top box and in the future maybe a web browser or even an Apple iPhone. If the video server is separated, we can create different services and connect them without having any trouble.

Below, a diagram showing all different blocks to make the service work.
1.2 WORD OF THANKS

I would like to thank everybody who helped me during this semester and reviewed this thesis. In the first place Xavier Giró; without his help this project would never have been achieved properly. Not only did he provide professional help, he was always there for us during the period of our Erasmus exchange. His persistence and hard work helped us achieving the necessary goals.

My fellow student Laurens De Vos also deserves a word of gratitude. I went with him on this Erasmus exchange and I must say that I don’t regret a single minute. He helped me a lot in all possible ways and we’ve become very close friends during this semester.

Erasmus is a very good way to meet people from all over the world. Thank you friends for your support and great friendship here in Catalunya.

A last word of thanks to our lab responsible Alberto Marquez, for his help in the lab with the soft- and hardware problems we faced during this period.
CHAPTER 2: REQUIREMENTS

The main goal for my project is creating interfaces for several applications, connecting to a video server. The video server already exists, and is used in the department, at this moment only for educational purposes. This whole project will generate a video on demand service containing material from the department theory of signals and communications (TSC) of the UPC campus Terrassa. The school wants to provide this service to share its content with the students and other researchers. It is also a good way to show the ‘world’ what the department offers and which projects are done or currently running. By creating this service, the department is also very well up to date with the technical improvement of our daily life; in the future, there will be more and more of these services.

2.1 INTERFACE

2.1.1 SET TOP BOX

This is the most important task for this project. Most of the time went to creating this interface. Basically this interface is made especially for use with the ADB set top box (HD3800/TW). The purpose of this interface is to be able to navigate into different categories and topics to select a certain video. After that the video needs to be played in High definition on a HDTV (1920 x 1050) connected to the ADB set top box. The navigation should be executed with a remote control, so basically the code will execute a function whenever a key of the remote is pressed, then look which key it was and go to the corresponding function. After selecting the right video from the chosen topic, the video should play in full screen after pressing play or enter with the remote control. All data is stored on a running server, including all names of categories, topics and videos. All this must be made keeping in mind that it has to run on the ADB set top box; as there are some differences between different types of set top boxes.

2.2 VIDEO SERVER

The interface will have to connect to the existing video server that Laurens improved. At this moment videos can be uploaded and watched or downloaded via a web browser interface. The server will be improved in order to correspond to the needs of the interface. The database of the video server needs to contain enough information to make it able to put all data in the right place. The videos need to contain extra info with the URL of the video and the thumbnail, the topic and the place of the video in the list displayed. The interface must then retrieve all necessary data from this database and show it on the screen.

The video server also needs to stream the video directly to the running interface. This will be done using VLC (VideoLAN Client) more specifically VLM (VideoLAN Manager).
CHAPTER 3: STATE OF THE ART

The following chapter will take a closer look at the existing video on demand services for educational use and interfaces designed for set top boxes. There are so many different designs already developed that it won’t be possible to discuss them all. The most interesting ones will be discussed.

3.1 VIDEO ON DEMAND SERVICES

Internet has become an important part of our lives. Nowadays people can search and do almost everything with it, from searching a nearby restaurant to watching a popular TV show. As education is a basic part of life, it is imaginable that it takes a piece from the internet world. One of these services will be discussed here.

A lot of Universities want to spread their material (recorded courses, interviews, projects) online, because then everyone around the world can access the content. Over the years several services saw the daylight and took their place on the World Wide Web. Before having a closer look at the different available services, a description of the service is necessary.

The sites are created to share contents with an educational background or purpose. They are all developed with the same objective: create an easy accessible video on demand service and share a number of videos or other content with internet users who have access to the internet. They all have several categories or topics through which the user can navigate. Most of the content can be watched directly – embedded in the interface – however, several services provide downloading the movie as well; this way the user can store the content on his device and watch it later. Also the problem of a bad or slow internet connection can be solved this way.

3.1.1 ACADEMIC EARTH

The first service to discuss is Academic Earth. It was launched not so long ago (March 2009) and contains mainly video material from different Universities in the world. Their main goal is to provide anyone with educational material, without the need of being an official student. People who think they have something interesting to tell or share, can join their community and add videos to the subject of their specialization. But they have to be from an institution with a professional purpose, most likely a University. The site is not so old, so they are still in their developing phase, but different reviewers believe that this site will grow and take a big piece of the online educational services. The videos can only be watched with adobe flash player, so in order to watch their movies this program needs to be firstly installed on the computer. But a good advantage is that the user can also download the video, so then the movie can be watched with quick time, VLC player or any media player which can handle the extension m4v.
3.1.2 DISCOVERY EDUCATION STREAMING

In January 2007 the company ‘Discovery Education’ – part of the company ‘Discovery Communications, LLC (who also have the famous ‘Discovery channel’ ) - launched their online educational service called ‘Discovery Education Streaming’. This service is aimed for use by schools, to use the material in the classroom. Schools can subscribe into the network and use it as much as they want. At this moment, more than half of the high schools in the US are already subscribed.

The service however is not free of charge, subscribers must pay around 2000 dollars a year before being able to download and share contents. This is a big difference between the other services, as they are free for everybody.

Not only do they provide videos, they also have a big audio library with speeches, sound effects and songs. Also a lot of images and clip art, and encyclopedia articles.
The site however has a lot more applications then the services mentioned before. Not only can you watch videos from the entire educational world, you can also make your own page – as a professor you can make a page for your students – create a quiz, make a calendar and even assignments can be made using Discovery Education.

They also work closely together with other companies such as BBC and Scholastic. A good thing to add is that they have scientific proof that using their service in the classroom helps students to learn faster and better. A very good advantage is that the user can install a language pack, which will allow him to watch the content in 30 different languages.

There are two options to watch the content: streaming and downloading. When streaming is selected, videos can be viewed using Adobe Flash Player. When downloading is selected, the video can be watched with Windows Media Player or Quick Time. There are several extensions of the video used, but mostly .wmv (Windows Media Video) or .mov (Apple).

The service has the following structure:

At the left top, a box with all subjects is placed. The user can choose a topic or a grade to explore the contents. Below that box, it is possible to search specifically for a grade from a school in the US. The terms are added to the service, so the professor will work following the right goals. At the right a box with ‘teacher’s center’ is placed, providing the material of choice from the professor logged in. Different applications can be opened here. At the right bottom there’s a last box with some ads from the company. The center box is the one used for navigation and playing video’s. You can also try the ‘trial’ or see the latest videos there.

The search engine provides the search of video content by curriculum standard, keyword, subject or grade. Also the new releases can be searched using their search engine.

### 3.1.3 ITUNES U

Apple created a service as well which is called iTunes U. It can only be accessed if iTunes is installed and running on the user’s computer. The service can be loaded via the iTunes store, an application embedded in the iTunes player to buy music and videos online. iTunes itself however is completely free of charge.
They provide a wide range of movies, but only from Universities in America, the UK, Canada, Ireland and Australia. It is a very professional service, accessible to any internet user. The use of the site is very easy. You can search the topic of your choice and then press 'download'. After that an extra folder will appear under iTunes store, containing the downloaded movie(s). The video format is MPEG-4. You can easily put the content on an iPod, to watch classes or other movies while sitting on a train or waiting for a bus.

Universities can make their own space on iTunes U, with the interface standards adjusted to the ones from their University. Note that only professional schools with a high amount of video content can share their content on iTunes U.

The structure of the page is different to a normal web page; there are several boxes with different categories in them. At the left top is the iTunes store box, to provide easy access to the other services of the iTunes store. Underneath there’s a box showing all categories iTunes U provides. Then there’s a box showing all participating Universities or the possibility to search for more institutions. At the right top there’s a box with quick links, where the user can search topics, watch your account, change settings. Underneath there’s a box showing the most downloaded movies or other content. In the middle you will find the newest movies, and some advertisements.

Figure 5: iTunes U

The structure of the page is different to a normal web page; there are several boxes with different categories in them. At the left top is the iTunes store box, to provide easy access to the other services of the iTunes store. Underneath there’s a box showing all categories iTunes U provides. Then there’s a box showing all participating Universities or the possibility to search for more institutions. At the right top there’s a box with quick links, where the user can search topics, watch your account, change settings. Underneath there’s a box showing the most downloaded movies or other content. In the middle you will find the newest movies, and some advertisements.

3.1.4 YOUTUBE EDU

As YouTube at this moment still provides 80 percent of the http traffic, it seems very logic that they also provide an educational service. The service is called YouTube EDU, and has a lot of info online. The site is created by Google (they bought YouTube a few years ago) and also uses Adobe Flash Player technology to display a wide variety of video content. Most of the content on YouTube has been uploaded by individuals, although media corporations including CBS and the BBC and other organizations offer some of their material via the site. The educational website is used to share academic talks, lectures and interviews.

The difference between YouTube Edu and iTunes U is that it’s not necessary to have a huge amount of content before being able to put it on. This gives the opportunity to smaller schools to share content as well. The site itself is built in three categories: Directory contains an alphabetic list of Universities sharing content. Most subscribed can be best compared with an RSS feed.
You can subscribe to several topics, whenever a new video is added you can see it there and lastly the well known category "most viewed", which contains the most viewed videos of the service.

Figure 6: YouTube EDU

The site is constructed in a very user-friendly way, and also has a search area. When a word is entered, the page will give all possible videos, in a list of twenty videos per page.

3.1.5 VIDEOLECTURE

Figure 7: Videolectures
Another video on demand service is Videolectures. It’s the first big Education online service created in Europe.

The difference between this service and the others is that this site contains material from all over the world, and not just from English speaking countries. The main language however is English, but that’s just to reach as much people as possible with only using one language.

It uses JW FLV media player, which supports all Adobe Flash Player formats (FLV, MP4, MP3, AAC, JPG, PNG and GIF) but also TRMP and HTTP streaming. Videolectures uses RTMP streaming, a service developed by Adobe to stream video (or audio) over IP. Windows Media Player can also be used if the user doesn’t want to install the plug-in for the JW player. Due to copyright laws it is not possible to download the movies.

There is a wide range of categories present: ‘most popular’ shows the best rated videos (if you subscribe to the site you can rate videos and add comments), ‘latest lectures’ shows the newest releases, listed with a thumbnail, title and author. ‘Categories’ gives the user the opportunity to search by the topic of their interest; there are about 25 different topics available at this moment.

A rather special category is ‘events’. It shows a list of educational events around the world, with of course video material.

Figure 8: Menu ‘Events’ in Videolectures’s service

Next in line is ‘people’, showing a list of all authors with material online, the number of videos the author has and the institution of the author. ‘Interviews’ is also a category, the layout is the same as ‘latest lectures’, only now all movies are interviews with interesting people. Finally there’s a category called ‘tutorials’, providing complete info on several topics. The layout is also the same as the one from ‘latest lectures’.

3.1.6 UPC TV

The University of Cataluña also has an educational web server. It is used to share content about the UPC with everybody. You can also log in as a student to watch specified material in which you’re enrolled. The videos are played with JW FLV media player. This player can handle the same formats as Adobe’s Flash Player, and also RTMP and HTTP streaming. The site uses RTMP to show videos.

The site is in Catalan and has no English translated version; we can assume that the service is only provided for students studying in Cataluña and with the knowledge of the Catalan language. Most content however can be viewed by everyone.
3.2 INTERFACES

The following part will handle different interfaces for video on demand services. Used with set top boxes. The interface can be from the company that provides the set top box or can be available online for use via an IP connection.

3.2.1 APPLE TV

Apple has its own set top box called Apple TV. In my opinion one of the most beautiful interfaces. Apple launched it a few years ago, to create the possibility to watch video content of any kind on a High Definition television. There are a lot of services available with Apple TV; the most important one is the connection between the Set top box and an iTunes player. You can connect to a Mac OS or Windows machine which has iTunes installed, and play whatever you want on your HDTV. All the services available on iTunes can be used with Apple TV. You can download (buy) TV - shows, podcasts and so much more. In this case you use Apple TV as a home cinema device, but you can also use it for other internet services, like YouTube, Flickr or Mobile Me. Not only can you play videos, you can also use it to play your favorite music or watch photo’s on your HDTV.
There is an internet connection, but also a connection for digital TV. To conclude we can say that you can watch almost every digital content with this device. It has a big internal hard disc, which enables you to store all your data on the set top box and watch it afterwards without the need of a connection to the internet or to your Mac or PC.

![Image of Apple TV interface]

*Figure 11: Interface Apple TV*

### 3.2.2 ADB

The set top box used in this project is one from ADB. They have a very regular interface where you can find and navigate through the services provided by ADB and digital channels. You can also open a web browser to surf on the net.

The only disadvantage is that when you open, for example, YouTube, you need a plug in for Adobe Flash Player, which you can’t install on the set top box. But if you open a page with the IGMP protocol you can watch videos online, if the requested services offer the correct content.

Streaming is also possible; it works also with the IGMP protocol. The user can subscribe him into a service, and the channel will be added in the list of services.
The main goal of this set top box is to provide the decoding of the digital signal, in Spain this set top box is sold by the company 'Telefonica' the biggest provider for digital television in Spain. The operating system is Linux. It is very easy to change the start page ‘file’ (the file loaded when you turn on the device. You can set up an internal network or even choose an open IP address, and load the set top box to this page. This is the reason why:

3.2.3 BBC IPLAYER ON WII

Not so long ago (28 march 2009) BBC announced a new service, together with Nintendo. They will add a video on demand service to the existing services from the Nintendo Wii game console.
The interface you can see above is the one for the web browser, the one for the set top box is not available yet. The goal of this service is to enable this service on the Nintendo Wii, so that with your game console, you can also watch a lot of BBC content. They will send all connected Wii consoles a message to ask if they want this service installed on their game console.

### 3.2.4 YOUTUBE XL

The third of June this year (2009) YouTube launched a new service called 'YouTube XL'. It offers the same content as the normal website, but is created especially for use with TVs, via set top boxes or other devices with a connection to a TV and the internet. It is based on the site Google created in January, to watch movies on game consoles such as PlayStation3 or Nintendo Wii. The interface has big letters and a quite easy navigation system. The scrolling function of the web browser is deleted, to make navigation easier. The goal is to navigate with a remote control. However when the service is loaded on the STB (HD-3800/TW) an arrow appears on the screen, so navigation needs to be done the same way as a mouse works. The letters are also too big which makes them not appear completely on the screen, and the video doesn't even play at all. Maybe it works with other set top boxes or it has to be loaded via a web browser.

This is what happens if the start page of the set top box is configured to the service:
First an image of YouTube XL is shown. After that the service loads the interface:

![YouTube XL Interface](image)

*Figure 17: YouTube XL Interface*

As mentioned before, the text is too big for the boxes, which makes the interface not very nice nor useful.

The interface has some categories on the left side, such as 'Spotlight', 'Top rated', 'Most viewed' and 'More'. There are also tabs for a search engine, to sign in with a YouTube account, or to change settings. The videos are shown on the right (more than half of the screen) with a tiny thumbnail and the rating displayed as well. The duration of the videos and number of views are also shown with each video.
When a video is selected, the screen changes into the one above. The video is played on the left side, and other corresponding videos are shown in a list of five on the right. Below there are five boxes with other functions, such as 'Favorite' (first the user has to log in) where the user can mark the video as one of his favorites, 'Flag' the video (report it) where he can choose the reason why (such as violent content, spam etc.), 'Share' the video with other people via the email account used to log in, show extra info about the video and show related videos.

In the video area, the user can pause the video, skip to then next or previous one, go full screen mode and/or put repeat mode on or off.

When a web browser is opened with the set top box, it also gives the same bad screen, and videos can still not be played. However on a normal web browser on a computer the video does play.

### 3.2.5 SEZMI

Sezmi is a special service (US – only). The company used to be named ‘Building B’ and the service is launched last year (2008). It provides all possible video contents and wants to be the first service with an all in one device. The service supports high definition digital broadcast signals, IPTV, vod (video on demand), As mentioned before, the service only works with the set top box form Sezmi (pronounced “SAYS-me”). The device is developed for DVR and on demand viewing, and has a hard disk of 1TB (Terra Byte) on board.

The big difference between the other interfaces is that this one will adjust to the preferences of the user. By pressing the remote control the user will log in to the service, and his favorite
shows, series or other content will be displayed on the screen. The user won’t have to scroll and search through 500 channels, but he will have his preferred channels or content available on his personalized interface. Every member of the 'house' can have its own user log in, so parents won’t be annoyed because they will not find the interface of their children, full of cartoons etc.

Figure 21: Sezmi’s remote control

They also created their own remote control, a very beautiful design. The color buttons are to choose the user, the other ones are roughly the same as the ones for the ADB set top box used in this project. The service is not free; it’s an all in one package with the set top box, an antenna to receive the signals and the remote control.

As mentioned before, the user can easily adjust his own ‘interface’. He can navigate and search content and then select it. After that it will be shown on the main page. A user can subscribe into a series and will see all available episodes.

3.2.6 TIVO

TiVo has a worldwide service for digital recording devices. The first TiVo device was sold in 1999, already ten years ago. The devices enables recording of television content, and many more. It also provides a set top box in order to execute the service.

The service can record a TV show simultaneously while the user is watching another program. Users can download (or buy) an episode or get a ‘season pass’ which allows them to watch an entire season of a series.

1 See paragraph 3.3.1.1
A small disadvantage is that it seems to be very slow in navigation. It does however provide a long list of network and IP features and has a search engine called ‘TiVo Search’, with millions of videos online.

The interface has a rather old fashioned look, but all the necessary services are where they should be. The user can also navigate and search other programs while the running program is still showed at the screen. A good advantage is that the user can also search for his favorite actor, director or genre.

There’s a comparison with other devices and services, in chapter 9.2 (Annex)
VUDU is a service with also a very nice interface. The service also needs to be executed from a set top box from the company, a 'VUDU box'. The service is specialized in providing movies; the user can 'rent' them or even buy them.

It has several different interfaces, the main page has five categories: ‘Find movies’, ‘New Releases’, ‘My Movies’, ‘My Wish List’ and ‘Info & Settings’. The only one that needs an explanation is ‘My Wish List’: if the user searches for movies or other content, but he doesn't want to watch it directly, he can add them in this category. A list will be made and the user can go back later to watch the movie.

VUDU also has a service called ‘VUDU labs’, a combination of all video on demand services VUDU supports. The user can choose a service and work on the platform of the service.
When ‘On Demand TV’ is chosen for example, this is the interface loaded. The user can choose now which topic he wants to see. On the right the possible videos are shown.

### 3.2.8 ZEEVEE

ZeeVee is created to run on a computer and send contents from this ‘server’ to different HDTV panels. The user can decide what he wants to show on which HDTV, which means that several panels can be used with this service.
The interface is very attractive, there are seven topics showed in the home page. ‘Launch’ let’s you watch you selected videos or other content, and tells you what you are currently watching or rented. Then there’s ‘video’, ‘music’ and ‘pictures’. Also ‘recent’ with new releases and ‘ZV presents’ with specialized content provided by ZeeVee. At last ‘menu’ with the settings and other configurations.

This is the ZeeVee viewer, executed using the category ‘ZV presents’. You can see the different topics the services provides, such as ‘Zv Presents with new services or things ZeeVee wants to share with the user, personal gathered content in ‘My Zv’, new released content, recently watched content, other applications, local content, a configuration part to send content to one or several HDTV panels, settings, help and back.
3.3 DEVICES

All video on demand services need a device in order to show the interface and navigate to the required video or other content. The three most important devices are a set top box, a web browser or a mobile phone.

3.3.1 SET TOP BOXES

A set top box is a device that converts an incoming signal into a useful signal for a television. Usually it’s used to convert the signal from a digital video broadcast (DVB) but can also be used to display analogue television or other video content from the internet.

3.3.1.1 ADB HD-3800/TW

The set top box used for this project is the HD-3800/TW from ADB. The company describes it as an advanced High Definition IPTV set top box with home networking capabilities. The product has an advanced, single chip microprocessor, providing performance enhancements such as fast channel change and swifter rendering of applications, including the Electronic Programming Guide. The unit is compatible with HD and SD television transmissions across all industry standard compressions, including MPEG-2, MPEG-4/H.264 and VC-1 Advanced Video Coding (AVC). ADB’s advanced and state-of-the-art HD technology, coupled with a High Definition Multimedia Interface™ (HDMI™), ensure crystal clear viewing. The operating system in the set top box is Linux. You can easily adjust the place of the start page loaded when you turn on the device, which makes it a very good device for developing. This is probably the reason why we will use this set top box in the lab to execute the interface.

Figure 32: ADB HD 3800/TW set top box

The device to control the set top box is a remote control. The one for this set top box is shown in figure 17. It has the possibility to change the input, from the TV to DVD and of course the set top box. The navigation through different interfaces can be handled using the arrows, and the colored buttons. The numbers can be used to go to a channel or change data in a settings menu. In the center there’s a button to open a keyboard on the screen. This way the user can write text to open, for example, an IGMP URL for a video streaming service.
There are also buttons to play, pause, rewind or fast forward and stop. For the rest there are some other buttons to go back, to open the menu or to change the screen mode. Also the volume and channel can be changed with their own buttons.
CHAPTER 4: DEVELOPMENT

4.1 INTERFACE FOR THE ADB SET TOP BOX

To create the interface for a set top box, these are the blocks needed:

The languages chosen for this interface are HTML, JavaScript and PHP. The set top box reads HTML and JavaScript, therefore these languages are used. PHP is needed to be able to retrieve data from a MySQL database. The code is executed in the set top box, but works on the video server, it retrieves data and does nothing after that. So it isn’t necessary for the navigation. Once the page is loaded, the retrieved data will not change anymore, the set top box will not use PHP anymore.

The PHP file with the source code is stored on an apache server. The data necessary for the menu, such as the categories, topic and names is stored on a MySQL database. The project is loaded on the set top box via an IP - network. Navigation trough the menu can be handled using the remote control, and finally, the interface is shown on a HDTV.

To build the interface, a lot of different programming languages are used. The figure below shows an overview of the languages:
The main file ‘index.php’ consists of PHP, HTML and JavaScript code. The PHP code is used to connect to the database, the HTML code to load the page (display the layout) and connects to the file ‘layout.css’ (will be explained later). The main part is the JavaScript code, with all functions for the navigation stored in .JS files.

4.1.1 CONTENT

The navigation consists of three levels:

- Level 0: Categories
  The main part of the interface. The categories can be selected via the remote control, pressing up/down and ok or pressing the colored buttons.
  - Courses (red)
    Shows the different courses the department (tsc) offers.
  - Thesis
    Explains the different projects running in the department
  - Campus
    Shows videos about the campus, the city (Terrassa) etc.
  - Most Viewed
    Shows the five most viewed videos
  - Top rated
    Shows the five best rated videos.

- Level 1: Topics
  Shows all the topics from the selected category or the five most viewed or top rated movies.
  - Courses:
    - Signals and Systems
    - Content Delivery and Management
    - Machine Learning
  - Thesis:
    - IPTV
    - Audio Processing
    - Image Processing
4.1.2 LAYOUT

The user should be able to choose the category by pressing the color, or move with the cursor. Then when he has chosen a category the available topics must be shown next to the categories. The categories should stay there all the time because it enables one to change from category anytime, by pressing a color on the remote control. When a topic is selected and confirmed the possible videos for the selected video should appear next to the topics. After that the box on the right has to show the thumbnail of the selected video. Above that the title should be shown in another predefined box and the metadata (extra info about the topic or video) in a box underneath the box with the thumbnail, which is by the way called ‘color’. When the user presses ‘OK’ the video must open full screen.

To do that, a lot of boxes need to be displayed on the screen, five for the categories, which are ‘Courses’, ‘Thesis’, ‘Campus’, ‘Most Viewed’ and ‘Top Rated’. Ten boxes for the topics, and ten boxes for the videos. And finally three boxes for the title, thumbnail and metadata. All these boxes are defined in a separate file, used specially for the layout. It’s a CSS file, and all boxes there are defined with some predefined data, like background-color, the place on the screen and much more. The place for the background image and the logo of the department are also defined in this file.

These are the boxes used in this project. We use 15 for the navigation, three for the video title, thumbnail and description and two for the background and the TSC logo.

Every box is defined with the same structure as in the following example:
All the boxes need to be ‘placed’ on the screen, some of them visible, others not visible. This done in the main file, in HTML code. A tag <div> is opened and then it loads the box. Note that at the end of each box the <div> tag needs to be closed again; otherwise the next box will place itself counting from the end of the previous one, this was in fact a problem that occurred while programming the code. This is the line used when the ‘color’ – box is shown.

<div id= "color"> </div>

The box can be loaded with some special preferences, for example: it could have a transparent border of 5px:

<div id="color" style="border: transparent 5px solid"> </div>

This is a very handy possibility, because the boxes containing the topics and videos should not be visible when the page is loaded the first time.

If changes need to be made to the boxes (which will happen all the time while navigating in the menu) it can be handled like this in the JavaScript code:

color = document.getElementById("color");
color.setAttribute ("style","background-image: url('Red.jpg') ");

The ‘box’ is loaded (officially called ‘Element’) and then attributes of the selected box can be changed. Note that the programmer can choose whatever name he wants to refer to the box (for example ‘color’), if thumb is chosen to call the element, the only thing necessary is that document.getElementById is “color”. So:

thumb = document.getElementById("color");
thumb.setAttribute ("style","background-image: url('Red.jpg') ");

Would work perfectly as well. If text needs to be displayed in the box, the function innerHTML is used, for example if the box ‘color’ should contain the text ‘Hello World’, this should be the code:

color = document.getElementById("color");
color.innerHTML ‘Hello World!’;

A JavaScript variable can also be displayed as text in the box. The code ‘Hello World’ needs to be changed into the name of the variable, for example title:

color = document.getElementById("color");
color.innerHTML title;

This last example will be used often, because all data will be loaded from a database with PHP code and stored it into JavaScript variables. After that these variables will be used to be displayed in their boxes.

In order to navigate, the program must execute a function when a key is pressed.
There is a routine in the HTML/JavaScript file, which is called whenever a key of the remote control is pressed. This routine starts with "switch event.keyCode". After that, there is a case structure, with one case for every button that needs to be assigned to a function. For example the OK button has the code "case rm.KEY_ENTER". Rm is a variable assigned in the beginning of the file, in this case "stb.remote", so the actual code for the case – structure is "case stb.remote.KEY_ENTER".

### 4.1.3.1 KEY UP / DOWN

When we press the buttons up or down on the remote control, the function KeyUp or KeyDown is loaded. The first thing that happens there is watch in which level the navigation is at the moment, with an if – then structure. ‘Level 0’ is the one with the categories, ‘level 1’ the topics and ‘level 2’ the videos. After that, the function needs to check which category, topic or video is selected. This is done with another if – then structure.

The last step is to change the selected box back to its normal layout, and change the layout of the next box (the one above in case of up and the one beneath in case of down). The attribute that changes is the border, it goes from the default color (the color from the category or gray for the topics and videos) to black, this way the selected box can be seen clearly. The image in the ‘color’ – box also needs to be changed, for the categories an image of the color, for the topics a thumbnail of the selected topic and for the videos a thumbnail from the video. The title and metadata change as well.

### 4.1.3.2 KEY ENTER

When the button ‘enter’ is pressed, two things can occur:

- The navigation is currently in ‘level 0’ or ‘level 1’.
  - ‘Level 0’: According to the category selected, ‘level 1’ is shown with all corresponding data. To do this, two functions are loaded. The function ShowLevel shows the boxes, changing the background – image of every box for the topics, and giving it a grey border to each of them. The function GetData uses PHP to query the database and stores all names into variables, showing them in the correct boxes. After that the box from ‘level 0’ that was selected turns into its default value again. At last ‘level 0’ is changed to ‘level 1’.
  - ‘Level 1’: According to the topic selected, ‘level 2’ is shown, also with the names of the videos displayed in the boxes. The function GetSecData queries the database.
- The navigation is currently in ‘level 2’.
  The function looks which video is selected and executes the function to play the video.

### 4.1.3.3 COLOR KEYS

The keys for every color on the remote control, being red, blue, green and yellow are also used. Whenever one of these colors are pressed, the corresponding function is called, clearing all levels that could be displayed - if a level wasn’t displayed at the moment it doesn’t make a difference when it is cleared again - and setting the border black of the box corresponding to the color of the pressed button. It also sets the level to ‘0’ and loads the thumbnail from the selected color. Also the variable ‘category’ is set to the number of the selected category.
Every function is stored in a separate file, all placed in a folder called ‘JS’. In the beginning of the code in the index.html file a few lines are added to connect all files to the main file:

```html
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyLeft.js"></SCRIPT>
<script language="JavaScript" type="text/javascript" src="/JS/KeyRight.js"></script>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyDown.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyUp.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyEnter.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyGreen.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyYellow.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/KeyBlue.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/ShowLevel.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/ShowLevelSec.js"></SCRIPT>
<SCRIPT language="JavaScript" type="text/javascript" src="/JS/ClearLevelSec.js"></SCRIPT>
```

This way the code in index.php is much smaller, and the separate functions can be found quite easily. It also keeps the different programming languages apart. Also the PHP files are split in several files. Some problems occurred trying to split these files. The functions for the keys are in a case structure, so when they were in the main project file ‘index.php’, after every key a ‘break’ tag was added; when the files are split, every case function is separated, so there’s no need for the ‘break’ tag anymore.

### 4.1.5 DISPLACING DATA

Now that the navigation is running, all data has to be shown in the right boxes. As mentioned before, PHP is used to connect to a MySQL database and get all the data.
For every level, the database is queried. The place on the screen (which data should appear in which box) is handled using a unique ID for every category, topic or video.

![Database Structure Diagram]

All data is loaded at the moment the set top box starts up, because the PHP code is running on the server-side, not on the set top box. So once the data is loaded it can’t be changed and sent back to the database. This is not a problem, the interface will not need to change any data. The only part where it might be necessary is when the video played and a counter is needed to be able to update the ‘most viewed’ part.

### 4.1.6 DATABASE CONNECTION

This part will explain in detail how the connection to the database works. The first task was checking if PHP runs on the computer with the current project. At first, a new file test.php was created, with only the following code (first the HTML tags, and in the ‘body’ of the page this code):

```php
<?php
phpinfo();
?>
```
If PHP is installed and this file is loaded with a web browser, the following should occur on the screen:

![PHP Version 5.2.9.2](image)

**Figure 40: PHP info**

Now that it’s sure that PHP is running, it’s ready to be used. PHP code is used to connect to the database, which is a MySQL database. The difference between PHP and JavaScript or HTML is that PHP works on the server side (where the project is running) and JavaScript or HTML works on the client side (in this case the set top box). The set top box loads all the code written in JavaScript or HTML into its RAM memory, and then stops connecting to the server. PHP however executes on the computer where the project is running, and all functions are executed when the page is loaded. This means that PHP can give variables to JavaScript and, but not the other way, because the page would have to be reloaded for that.

The extension of the project file needs to be changed to .php, so index.html → index.php. This way the set top box knows that he needs to watch out for possible PHP code first.

The files with PHP code are also divided in several files, the main reason to do this is to make sure that the login data (username, password) are not written in the index.php file, otherwise anybody could see it. And the file index.php needs to be as small as possible.

To add a file in PHP, the following line of code is used:
This code is written in the beginning of the file. Three files are included: ‘Connection.php’ for the connection to the database, ‘GetData.php’ to show the categories and topics, and ‘GetSecData.php’ to get the data from the videos.

If data from a database is required, a connection needs to be set up. Some info needs to be send to the database like the IP address, user, and password. An error report is included. If the connection failed it will return the code next to ‘die’. The right database from the selected IP address also needs to be selected. In this case it’s called ‘archivos’.

This is the code used to set up the connection:

```
<?php
    include("Connection.php");
    include("GetData.php");
    include("GetSecData.php");
?>
<html>
    <head>
        <title>Database</title>
    </head>
```

If it has to be sure that when an error occurs the user or programmer can see what went wrong, Error display has to be enabled in the file php.ini. In this file, several settings for PHP can be changed.

```
error_reporting = E_ALL
```

Now if the server isn't able to connect to the database, this error message will appear on the screen:

```
Warning: mysql_connect() [function.mysql-connect] Can't connect to MySQL server on '147.53.74.180' (10060) in C:\wamp\www\Connection_PHP on line 4
No database connection to 147.53.74.180: Can't connect to MySQL server on '147.53.74.180' (10060)
```

When connected, data can be asked or queried from the database. This is done by setting up a query (query means to get data from a place in the database). The database needs to know what data is necessary, and to which column it has to return.
The code used to query the database looks like this:

```php
<?php
function GetTopic($Topic,$Topic_Id)
{
    // 3. Perform database query
    $result = mysql_query("SELECT * FROM $Topic WHERE id=$Topic_Id");
    if (!$result) {
        die("Database query failed: ".mysql_error());
    }
    // 4. Use returned data
    while ($row = mysql_fetch_array($result)) {
        $course = $row[1];
        $thumb = $row[3];
        $data = $row[4];
    }
}
//store data into JavaScript variables
var course = "<?php echo($course); ?>";
var thumb = "<?php echo ($thumb); ?>";
var metadata = "<?php echo ($data); ?>";

?>
```

*Figure 44: Query to MySQL database*

After that, the variables returned are in JavaScript, and they can be used to display everything needed in the boxes. If the topics are required for example: the database queries once for every topic. Next, the names, url for the thumbnail, metadata (description of the topic) are stored in JavaScript arrays, the name of the first topic is stored in 'topic_title[1]'. Now these arrays can be used to show the data in the boxes. The following code explains how that is done:

```javascript
<SCRIPT LANGUAGE="JavaScript">
function ShowOption1(){
    // take the names of the courses from the database ans places them in the options
    ?><p>
    //query database for data first topic
    GetTopic('Topic',1,1);
    ?>
    //show metadata in box 'data'
    data = document.getElementById("data");
    data.innerHTML = metadata;
    //store data in array
    topic_data[1] = metadata
    //put topic name in box
    topic1 = document.getElementById("subopt1");
    subopt1.innerHTML = course;
    // show thumbnail
    color = document.getElementById("color");
    color.setAttribute ("style","background-image: url("+thumb+");/";)
    //store url thumbnail in array
    topic_thumb[1] = thumb;
    // show name of the topic in box 'title'
    title = document.getElementById("title");
    title.innerHTML = course;
    // store name of course in array
    topic_title[1] = course;
</SCRIPT>
```

*Figure 45: Showing and storing variables*
The reason why the data is stored in arrays is because the metadata, title and color box have to be changed when the user moves up or down in the navigation. By using these arrays, the data can be re-used easily.

The videos are queried differently. As the video doesn’t have a video_id (after a discussion with Laurens about the structure of the database it seemed not necessary to add it; besides it would have taken him a long time to generate a video id) the database needs to query the table videos and get all videos from the selected category and topic, and store them in the video – arrays. It took a long time to think about a solution, but finally this is the code:

```php
function GetVideo($Category_ID, $Topic_ID) {
    global $connection;
    $id = '';
    $video_name = '';
    $thumb = '';
    $data = 'no movie inside';
    $url = '';
    // 3. Perform database query
    // $Topic_ID = 1
    $result = mysql_query("SELECT * FROM videos WHERE
                          CategoryID=$Category_ID
                          AND TopicID=$Topic_ID", $connection);
    if (!$result) {
        die("Database query failed: " . mysql_error());
    }
    // 4. Use returned data
    var i = 1;
    <php
    while ($row = mysql_fetch_array($result)) {
        $id = $row[0];
        $video_name = $row[1];
        $thumb = $row[2];
        $data = $row[3];
        $url = $row[4];
        ?>
        video_title[i] = "<php echo $video_name; ?>";
        video_thumb[i] = "<php echo $thumb; ?>";
        video_data[i] = "<php echo $data; ?>";
        video_url[i] = "<php echo $url; ?>";
        i = i + 1;
    }<php
}
```

**Figure 46: Query database for videos**

Before the database is queried, a JavaScript variable ‘i’ is put on ‘1’. After that the PHP code executes the while loop until there are no more videos. Every time a video is queried, it is stored in the JavaScript array for the videos with the number of the variable ‘i’. At the end the variable is added with one, and the database is queried again. This way it doesn't matter how many videos a topic has, they can all be queried.

The problem now is that when the user goes back into the navigation, and goes to another topic, the videos of the previous topic will be shown if there are no videos in a certain topic. It occurs because the arrays still have the old data and are not rewritten. The solution for this problem is very easy. When then navigation executes the function ‘ShowLevelSec’ to show the boxes of ‘level 2’, all video arrays are cleared. This way if there are no videos in a certain topic, the screen will show nothing.
4.1.7 VIDEO STREAMING

After receiving and showing all data, the last step is to play the video. The video needs to be streamed directly from the video server to the set top box.

To do that, the info about where the movie is stored on the video server must be queried, apart from all the other data that was already queried. Another array is used for this. It’s called video_url[x]. If the video is requested to play, this value will be used to load the requested movie.

The selected video in the navigation is put in the vlm configuration file, and put ‘online’.

The IGMP protocol will be used to stream the videos. The service must be set up properly and the set top box must connect to the video server, using its IP address and the correct port.

The video on demand service is configured using VLM (VideoLAN Manager), this application has a rather easy interface, which is embedded in the VLC player.

![VLM configuration interface](image)

*Figure 47: VLM configuration*

The video is given a name, and then the input is selected (the location of the video). After that an output can be selected with the IP address and port of the host. This interface is one way to configure the videos, there are two more options to do that. A configuration file can be used, or the data can be inserted via a telnet session.

- Configuration file: this file contains all info needed to set up the vod (video on demand service) and is stored with the extension ‘.vlm’
The telnet session can be handled to manually insert the service.

The video can be played by opening the URL with the following data: IP address and the port. For example, if the IP is 147.83.74.115 and the port 1234, the URL will look like this:

Igmp://147.83.74.115:1234

At this moment, the video streaming still doesn't work. Due to a lack of time, it was not possible to solve this problem in time. A possible solution however would be to change the IP address to one with multicast possibilities. For example 239.0.0.1 would be a good one.
CHAPTER 5: INSTALLATION

This chapter contains all the installations needed in this project to create an user interface for navigation. The second part of this chapter will explain the changes the video server needed in order to pass the correct data to the interface.

5.1 SET TOP BOX SET UP

5.1.1 EXPLOITATION

The first thing that needs to be done is to access the set top box and to change the start page to the project file. This can be done by starting up a command prompt on any computer in the same IP-network as the set top box. The set top box must be connected to an IP-network, and the computer as well.

Start up the telnet session, accessing the root folder of the set top box. ADB provided the location of the link to the start page: etc → infosvc → tokens → config.startpage. To view the contents of the file the command ‘vi’ can be used. Then the destination can be changed from a file on the set top box to the file for this project, which is the IP address followed with index.php. After loading the file with the configuration of the start page, ‘i’ needs to be pressed on the keyboard. Then the text can be changed. To save and quit from the file ‘esc’, ‘w’, ‘q’ and ‘!’ need to be pressed.

![Figure 49: Telnet session to change start page](image)

After rebooting the set top box, it should load the project now, if it is at the right place.

The set top box must be connected to the HDTV, with a HDMI cable. The TV must be turned on and set to the channel of the set top box.
5.1.2 CONFIGURATION

The source code of the entire project should be in the 'X AMPP' or 'W AMPP' directory from the computer to which the set top box is connected. If the 'X AMPP' server for Linux is used the files need to be in root → opt → lampp → htdocs → 'your_folder'; if 'WAMPP' server for Windows is used in → program files → WAMPP → www. This folder should contain following files and folders:

- index.php
- layout.css
- A folder 'php' with the following files included:
  - connection.php
  - getdata.php
  - getsecdata.php
- A folder 'JS' with the following files included:
  - clearlevel.js
  - clearlevelsec.js
  - keyblue.js
  - keydown.js
  - keyenter.js
  - keygreen.js
  - keyhandler.js
  - keyleft.js
  - keyred.js
  - keyright.js
  - keyup.js
  - keyyellow.js
  - playpause.js
  - showlevel.js
  - showlevelsec.js
- A folder 'images' with the following images inside:
  - Background.jpg
  - BackOpt.jpg
  - Option1.jpg
  - Option2.jpg
  - Option3.jpg
- A folder 'thumbnails' with the following images:
  - Blue.jpg
  - Green.jpg
  - Grey.jpg
  - Red.jpg
  - Topic1.jpg
  - Topic2.jpg
  - Topic3.jpg
  - Topic4.jpg
  - Topic5.jpg
  - Topic6.jpg
  - Topic7.jpg
  - Topic8.jpg
  - Topic9.jpg
  - Topic10.jpg
  - Topic11.jpg
  - Topic12.jpg
  - Topic13.jpg
  - Topic14.jpg
  - Topic15.jpg
  - Yellow.jpg

If there are some topic – images missing, it means that they are not defined on the database and thus they are not used in the navigation.

All categories and topics must be on the database, in order to show them without problems. Go to the IP – address of the video server. In phpmyadmin, check if the categories and topics are there.
Turn on the set top box now. This should be the default screen:

![Start page](image)

*Figure 50: Start page*

The project is now installed properly. To check if the installation was successful, the programmer can execute several tests.

### 5.2 SERVER SET UP

Make sure that there are in fact videos stored on the video server. It is very important that the videos have all data necessary to display them on the screen (Category_Id, Topic_Id etc.).

If one of these is not present, the thesis from Laurens De Vos 'Usability Improvements on a Metadata Server for Video On-Demand based on Free Software' explains how to add topics and videos. The categories can be changed on the database from this video server.

The server needs to be accessible in order to be able to send the data to the project. The database is accessed using a user name and password, but the important thing to change is the 'Host' part. If it should be able to connect from no matter where in the IP network, the 'Host' should be changed to '%'. This way, the user can connect from anywhere.

![Server user rights](image)

*Figure 51: Server user rights*
CHAPTER 6: TEST

6.1 TESTING INSTALLATION

- The set top box needs to be in the IP network and turned on, with the start page configured to the project file. This can be tested by turning on the device. If the set top box doesn’t show anything, and the display of the devices shows an error code, it means that the start page was configured badly.
- When the page is loaded, the set top box should not show an arrow on the screen. If so, the program is not well executed due to an error in one of the files. It will probably be an error in the HTML or JavaScript part, because error displaying for PHP is normally turned on, which will show the error type in the screen.
- Navigation should work pressing the arrows on the remote control. If that doesn’t work, there probably will be something wrong with the ‘js’ files in the folder ‘JS’. Make sure that the files are connected properly and that all files are present.
- All data should appear in the right boxes every time a new level is called. If this is not the case, there is something wrong with either the database (data is not stored at the right place or data is wrong) or with the code to query the database.
- When ‘ok’ is pressed on a video, the set top box should start streaming the video in full screen mode. If this is not the case, there can be something wrong with the vlm configuration of the VLC on the video server. It is also possible that the video no longer exists or that is has been moved. Make sure that the required video is on the database, and configured with vlm.

6.2 INTERFACE FOR THE SET TOP BOX

First, the user needs to turn on the set top box. The start page should be configured to the project file on the server (see chapter five – installation). The following should appear on the screen:
Now the user is able to navigate using the remote control. The category can be selected using the up and down arrows as shown in figure x. When down is pressed for the first time, the border of category 1 (courses) will turn back to red and the border of category 2 (thesis) will turn black. The thumbnail will change to the image of the selected category.

When the user presses 'OK' or the right arrow, the topics from the selected category will appear next to the category boxes. The names of the topics are visible in the boxes and the thumbnail of the first topic is shown on the right. Also the title and some data are shown in their boxes.
The next step is to select a topic and show the containing videos. The way to do that is the same as selecting a category; after that this should be the screen:

To play the selected video, the user simply has to press ‘OK’ or the right button on it, and the video will start playing, full screen.

Note that the user can always go back to a certain category, by pressing the color of the desired category. In that case, all boxes will disappear and the selected category’s box
will get a black border – the thumbnail will appear – and the topics can be shown pressing ‘OK’ or the right button.

Figure 57: Color buttons remote control

When the user is in a certain level, he can always go back using the ‘back’ key or the left key. In this case the level in which the user is navigating disappears and the first box of the previous level is shown, with his corresponding data as well.

Figure 58: Back and left button remote control
CHAPTER 7: FUTURE WORK

This is what needs to or can be done in the future, to improve the service:

7.1 MAKE THE NUMBER OF VIDEOS VARIABLE

At this moment, the interface always shows five topics and five videos on the screen. Even if there are more or less topics or videos. The variable 'i' can be used after that to tell the navigation how many videos there are, and to adjust the number of boxes shown. However, the functions for going up and down in the navigation are fixed to five videos or topics. This should be changed to a variable number of videos or topics.

7.2 REDUCE THE AMOUNT OF CODE

There are still some parts of code that can be reduced. Functions that look the same but have a small amount of different code, can be made smaller using loops or other types of code.

7.3 GENERATE ERRORS DISPLAYS

At this moment, only the PHP errors are displayed. There should be other error displays as well, this way the user knows what when wrong when an error occurs.

7.4 CREATE A LOGIN WITH USER AND PASSWORD

There is not a login yet. The user should be able to log in with his existing username from the school.

7.5 MAKE A COMPLETE NEW INTERFACE FOR THE WEB BROWSER

At this moment, the interface for the web browser is the same as the one for the set top box. There should be a different one for the web browsers, adjusted to specific browser possibilities.

7.6 MAKE THE INTERFACE FOR THE IPHONE

Due to a lack of time, the interface for the iPhone was not created, this is an important work area for a future student.

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2 Explained in paragraph 4.1.6 ‘Database Connection’
CHAPTER 8: CONCLUSIONS

8.1 USER INTERFACE NAVIGATION

After creating and installing the user interface navigation, the result can be viewed. The installation was successful and the navigation works fine. Professors or other administrators can now start adding videos or topics, they will appear on the interface and can now be used by users who have the project installed and running.

The service can connect properly to the database and server from the other project of Laurens De Vos, and is able to retrieve the right information and put it in the right place. All problems that occurred during the development and installation - such as IP problems, connection failures due to rights on the database, video streaming etc. – are solved, which makes this project work successfully.

The layout looks very good as well, we can say that it has a nice and easy to use interface. The images are fine and the construction of the menu - the categories, levels etc. – are chosen well in order to have an easy accessibility and user-friendly navigation.

The video streaming doesn't work yet, but a future student or researcher won't have a lot of trouble making the streaming work.

The predefined goals were achieved, only the interface for the web browser needs to be upgraded and the interface for the iPhone needs to be made.

8.2 PERSONAL CONCLUSION

For me, this project was very interesting and I must say that I learned a lot during these four months. As I am a student Electronics in Belgium, creating an interface with programming languages such as HTML, JavaScript and PHP was very new for me. But I learned these languages rather quick, and I am happy that I will be able to use this knowledge in my future (professional) life.

It is great to be a part of the technical development of the services which will determine our future. The set top box for example will soon be a device present in almost every home and also the mobile phones will take a place in our daily life. The next person who will work on this project will definitely work further on the interface for the iPhone.
CHAPTER 9: ANNEX

9.1 BIBLIOGRAPHY

The following sites were used to create this thesis:

9.1.1 STATE OF THE ART:

ACADEMIC EARTH

http://www.foxbusiness.com/story/academic-earth-launches-website-offering-free-video-lectures-leading-1311788172/

DISCOVERY EDUCATION STREAMING

http://discoveryeducation.com/products/streaming/


ITUNES U

http://en.wikipedia.org/wiki/ITunes_U#iTunes_U

UPC TV

http://www.canalupc.tv/canal.php?canal=1

YOUTUBE EDU

http://en.wikipedia.org/wiki/Youtube

http://blog.historians.org/resources/773/youtube-edu

VIDEOLECTURES

http://videolectures.net/site/about/

APPLE TV

http://en.wikipedia.org/wiki/Apple_TV

SEZMI


http://www.pcmag.com/article2/0,2817,2289653,00.asp

http://www.multichannel.com/article/133067-Sezmi_Blends_Broadcast_TV_With_Broadband_Video.php

TIVO

http://www.tivo.com/whatistivo/tivois/index.html


http://www.mahalo.com/tivo
http://en.wikipedia.org/wiki/TiVo

**VUDU**

http://vudulabs.blogspot.com/2009/03/how-do-you-use-your-vudu.html

**ZEEVEE**

http://www.engadgethd.com/2008/05/01/zeevees-zvbox-streams-your-pc-to-your-hdtv/
http://www.zeevee.com/connected-home/comparezv

**DEVICES**

http://www.adbglobal.com/?q=node/189
http://en.wikipedia.org/wiki/Set_top_box

### 9.1.2 OTHER SOURCES

David Vera, "Servidor Web De Video Sota Demanda Basat En El VideoLAN":

Danny Goodman, "JavaScript & DHTML Cookbook". O'Reilly Media, Inc


Set top box supported JavaScript functions:

http://terrassatsc.upc.edu/file.php/34/moddata/forum/485/10443/ADBIPTVandDVBlavaScri
tptAPI_v3.8.1.pdf

http://bitsearch.blogspot.com/

Slides about digital television, Xavier Giró:

http://terrassatsc.upc.edu/course/view.php?id=10
### 9.2 COMPARISON SERVICES FOR SET TOP BOXES

This table shows the differences between different interfaces, discussed in chapter 3.2 (State of the art, Interfaces)

<table>
<thead>
<tr>
<th>DVR features</th>
<th>TiVo HD / HD XL</th>
<th>Basic DVR*</th>
<th>Apple TV</th>
<th>Roku</th>
<th>VUDU</th>
</tr>
</thead>
<tbody>
<tr>
<td>DVR included</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard drive capacity</td>
<td>160 GB / 1 TB</td>
<td>250 GB</td>
<td>40 G / 160 G</td>
<td>None</td>
<td>250 G / 1 TB</td>
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<tr>
<td>Expandable storage capacity</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Advanced multimedia search</td>
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<td>✗</td>
<td>✓</td>
<td>✗</td>
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</tr>
<tr>
<td>Schedule an entire TV series with your remote</td>
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<td>✓</td>
<td>✗</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Remote and online scheduling</td>
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<td>✗</td>
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<td>✗</td>
<td>✓</td>
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<td>Watch pre-recorded programs on portable devices</td>
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<td>✓</td>
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</tr>
<tr>
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<table>
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<tr>
<th>Internet entertainment</th>
<th>TiVo HD / HD XL</th>
<th>Basic DVR*</th>
<th>Apple TV</th>
<th>Roku</th>
<th>VUDU</th>
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</thead>
<tbody>
<tr>
<td>Movies &amp; broadcast TV on demand</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Netflix (subscription required)</td>
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<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
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<tr>
<td>Music streaming services</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Photos and slideshows</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Web video</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Even order pizza with your remote!</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Affordability</th>
<th>Hardware</th>
<th>Service cost**</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$299 / $599</td>
<td>Variable monthly</td>
<td>Free, rental, subscription and purchase options</td>
</tr>
<tr>
<td></td>
<td>Variable monthly</td>
<td>$229-$329</td>
<td>Free and purchase options</td>
</tr>
<tr>
<td></td>
<td>Averages to $8.31/month¹</td>
<td>N/A</td>
<td>Free, rental, and purchase options</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>Free, rental, subscription and purchase options</td>
</tr>
<tr>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>Free, rental, and purchase options</td>
</tr>
</tbody>
</table>

* Moto DCX Cable DVR w/ $39 activation fee
* *All set-top boxes may have additional subscription or down load fees that apply to certain premium media or content.

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