

Programming a digitv system through the Internet

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Abstract

Digital television is gaining popularity as better picture quality and higher resolution become increasingly important to the consumer's eye. Digital television requires new technology for processing the digital signal, and numerous different set-top-boxes are sold for this purpose. Computer peripheral device and software manufacturers have seen the potential of this new market and new personal video recording hardware has been developed to create entire home entertainment systems from basic home computers.

PVR systems can also be controlled through the Internet and this paper reviews four software products directed for this purpose, namely MythTv, TitanTV, TVTV and VDR. TVTV and TitanTV are basically program guides on the Internet whereas MythTv and VDR are PVR software intended for operating the TV tuner card. These products also differ a lot in for example price and ease of installation. In addition to basic remote recording through the Internet, mobile recording control can be achieved as well. An improvement that may well be introduced in the future is the possibility to add recordings with an SMS message.

KEYWORDS: PVR, MythTv, TitanTV, TVTV, VDR, Remote programming

1 Introduction

Finland is moving to all digital television broadcasts in August 2007. This means that a person cannot watch television without a digital set-top-box or a television that can receive the digital signal. This is a major change since every user must invest in new technology to be able to continue watching television. There are numerous plug and play set-top-boxes that can be used to receive the digital signal but, in addition, there are also other options.

Many have already converted a normal computer into a digital TV receiver, and at the same time a Personal Video Recorder (PVR). The term PVR is used of a device, which records video data in digital format and stores it on a hard drive. A PVR is additionally often referred to as a digital video recorder (DVR) or a hard disk recorder (HDR). The implementation of a home made PVR is not difficult although the setup needs some configuration that may not be that easy to do if the field is new to the user. The hardware and software still have many flaws but the technology is developing rapidly and new hardware and software are introduced continuously. The use of a computer as a digital TV receiver also brings new possibilities that basic off-the-

shelf products are just beginning to implement, for example, the controlling of recordings through the Internet. Many of the products intended for controlling recordings of a digital receiver PC are commercial but, in addition, open source and free software exist.

This paper reviews methods for controlling a digital TV tuner card through the Internet and compares some of the most promising software intended for that purpose. Section 2 introduces the basic requirements for a digital receiver PC and also presents the software that is to be reviewed. Section 3 goes over some of the technologies that can be used to access a PVR through the Internet and in section 4, the different software is reviewed in detail. The products are compared in section 5, according to price, ease of installation, support, remote access methods and usage. The results are presented in a table at the end of the section. Section 6 takes a look at some common problems in remotely accessing a home system and section 7 includes a mobile aspect to the remote operation functionality. In section 8, future development is discussed and, finally, the review is summarized in section 9.

2 Setup

There are two basic types of digital TV tuner cards for PCs. Internal tuner cards are installed in the PCI slots of the motherboard. External tuners are usually connected through the USB port of the computer and can be as small as usual USB memory sticks. The physical installation is straight forward but the ease of driver and software installation depends mostly on the operating system. For most cards that have the proper operating system support, the installation can be as easy as setting the correct drivers and installing the needed software. Problems arise when there are no suitable drivers or the drivers are not up to date. In addition, the software must support the specified tuner card.

The basic components for a working environment are the TV tuner card itself, software for watching the TV channels and an MPEG2 decoder. The decoder is needed because the digital signal is encoded in MPEG2 format, which is a standard for digital compression of video and audio signals. The software varies from simple programs that can be used to watch different channels to whole operating systems that control all multimedia on a user's computer.

In addition to home made setups, there are products on the market that have these home media control centres ready installed. They are not sold widely in stores but can be purchased through the Internet. Examples of such products are the ones sold by Reel Multimedia [11] and also the prod-

ucts by D1 [1], which are built on the open source software MythTv.

2.1 Software

The PVR system needs software that controls the digital receiver device and searches for the frequencies which contain the television channels. When the channels are set, they can be viewed through the specified software either through the computer monitor or by connecting the tuner card to a normal TV. The Internet is full of different software, which can vary a lot in the features they implement and what they are meant for. In this paper we are going to look at a couple of them more closely, namely TVTV [15], TitanTV [14], MythTv [6] and VDR [20]. These are software that have one thing in common: they are all meant, or have the feature, for controlling the recordings through the Internet. The basic PVR environment is presented in Figure 1. It includes the PC that is equipped with a TV tuner card and an MPEG2 decoder. The PC can be connected to a monitor or TV in order to watch channels and recordings. The tuner card is connected to the TV broadcast cable and the PC is also connected to the Internet, where services such as TitanTV and TVTV are available. Control through mobile devices is possible via Internet as well.

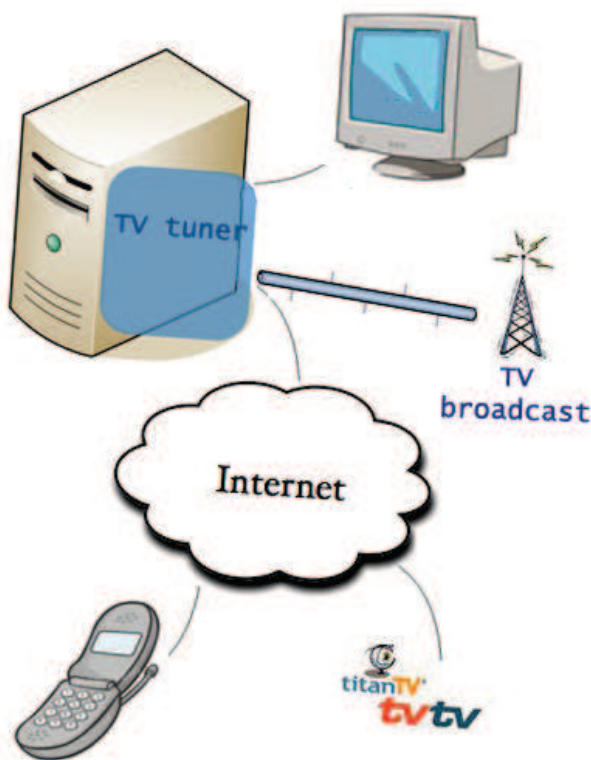


Figure 1: A basic PVR environment

3 Internet aspect

The basic digital television setup is controlled with a remote control while watching channels. A set-top-box that supports recording can be programmed to store television programs

on its internal hard drive. Often though, people are not at home when the time comes to set the recordings. Therefore, controlling the recordings away from home is the next major step in development. What different ways are there available to do this? We will take a look at that next.

The basic requirement for controlling any device on a home computer from another physical location is access to the computer from outside the home network. This connection can be achieved through many different techniques. Basic methods for remote access are to use telnet connections or web server interfaces. These access methods can therefore be used in this case as well. In addition to the connection, an interface is needed to provide functions to control the device itself, in this case the tuner card.

Commercial software seldom require installing a web server on a user's computer, and certainly do not require telnet usage skills. Thus, communication is handled in other ways. Internet access is however necessary in almost all cases.

4 Overview of products

The Internet is packed with PVR and other similar software and many of them could have been added to the ones being reviewed. This paper is intended to give a narrow overview of the existing products, and the chosen software should make a good reference group of what kind of products and technologies are available. The software introduced and compared are not primarily intended for the same purposes but the main feature reviewed, i.e. remote recording functionality, is implemented in one way or another. It should also be noted that a couple of the products, namely TVTV and TitanTV are not available in every country, meaning that they offer services to a distinct area only.

4.1 TitanTV

TitanTV is actually an online television program guide. It is a service provided by a company called Decisionmark and available only in the U.S. As a program guide, it allows users to view TV line-ups for the next two weeks and group channels into favourites. In addition, it offers a possibility to watch and record programs on a PC. Remote scheduling is an option for a limited number of PVR products.

Remote scheduling is achieved through cooperation with PVR software vendors. This means that the PVR software is updated so that it can use the information produced by TitanTV. This information is implemented in TitanTV's TVPI and TVVI file formats [13]. TVPI and TVVI files are XML files that provide information about television programs. An example of such a file is given in Appendix A. The TVPI and TVVI formats are identical; the only difference is that TitanTV generates a TVPI file for future programming and a TVVI file for in-progress programming.

A common file standard allows PVR programs to read the program information and set recordings with the given parameters. A local use of TitanTV's recording functionality is done by registering the PVR software as the default handler of TVPI documents. When a recording is set through the TitanTV web site, a TVPI document is created and sent back to

the browser. This will automatically launch the PVR application that will read the TVPI document and set the necessary recordings. The remote scheduling is achieved through a similar process. There, the TVPI document cannot be sent back to the browser, because the request has been sent from a different location. Therefore, a poll mechanism is used instead. The mechanism is activated from the user's home computer and it retrieves the recording information from the TitanTV server. When a user selects a recording remotely, the information is passed to the PVR in the next automatic update in the form of a TVPI document. The update is polled from the server's port number 80, i.e. the common port of http services, so no special firewall settings are required.

4.2 TVTV

TVTV is much like TitanTV and mainly functions as a program guide. It collects program information of over 350 international TV channels for up to three weeks. TVTV is owned by SONY UK Ltd. and available in Europe in countries such as Germany, Austria and Switzerland. In addition to a program guide service, TVTV also provides remote program recording.

TVTV has two different services for remote programming, namely TVTV for PC [16] and TVTV PLUS [19]. TVTV for PC has the same basic functionality as TitanTV; programming information is stored on a TVTV server and collected by the PVR software on the user's home computer. Information on how this data is transferred is not generally distributed, although a similar XML file is probably used as in TitanTV. TVTV also offers Linux users a binary that can be used to connect to the TVTV server. Examples of usage are given in Appendix B. TVTV PLUS is a bit different; it uses the standard TV signal to transfer the programming information to a user's digital receiver and therefore does not require an Internet connection. Because of this, integration of the TVTV servers and TV signal transmission systems is needed. Program information is sent regularly to the transmission systems, which in turn forwards it to users' set-top-boxes via TV cable. Recording tasks are identified with a specific TVTV ID so that home devices are able to set the required programming jobs. This functionality removes the need for an Internet connection in the PVR system. On the other hand, the cooperation with TV signal transmission systems makes the service hard to implement and therefore the service is only available in a few European countries at the moment.

4.3 MythTv

MythTv is a Linux based PVR software that is installed on the user's computer and it is licensed under GNU General Public Licence (GPL). As a product, it is quite different from TitanTV and TVTV, which were basically program guides. MythTv is a PVR software and it can be integrated to an external program guide. It controls the digital tuner card and can be used to record and watch programs. The Internet aspect is built into MythTv with a plug-in, MythWeb [9], that runs on a Jetty web server and can be accessed through a normal web browser. The service provides access to a vast

amount of content in MythTv and can be almost solely used to control the software. This means that recordings can be set through the web interface as well. [4]

A large number of other plug-ins can also be added to extend the functionalities of MythTv. In addition to the web server mode, the plug-ins include a telnet service [8] for the same remote recording purpose. A user can log in through a telnet session, and set recordings by giving simple commands to the software. This service has been complemented with other products, such as MythTvMobileRemote [7], which is a Java midlet for the Nokia N80 mobile phone, and can be used to connect to the MythTv front end and control it.

4.4 VDR

Another Linux based PVR is VDR, which is also released under GPL. It can be used to receive, record and playback digital TV, similarly as MythTv. VDR has a large community that continues to improve the software and creates plug-ins to extend the functionality. In addition, VDR has a comprehensive wiki site and support forums that help users to get started. In VDR, remote recording is accomplished in the same ways as in MythTv, through a web interface and with SVDRP [12], i.e. Simple VDR Protocol. SVDRP is used to send simple VDR commands over a plain TCP connection to the port 2001. Remote operability can easily be configured through a configuration file, where access privileges from distinct IP addresses can be defined. VDR can additionally be combined with, for example, TVTV by using a specific plug-in. This way, remote recording can be accomplished with a combination of the two products [18].

5 Product comparison

The nature of the products differs quite a lot and, in many aspects of the comparison, the products can be grouped as program guides and complete PVR software. Despite this fact, the criteria should give a good overview on what the products can be used for and what kind of users they are intended for. The comparison criteria are price, ease of installation, support for the product, access of remote programming and usage. The results are summarized in Table 1.

5.1 Price

Starting with price, the products vary quite a lot in the way they are offered to consumers. TitanTV is supported by commercial advertisements and offers the services free of charge. TVTV for PC on the other hand is a commercial products and a one year subscription is sold for 19.80 EUR. TVTV is sold on the Internet. MythTv and VDR are both free of charge as they are open source software distributed under the GNU General Public License.

5.2 Installation

Installation divides these products into very different categories. The installation of TVTV and TitanTV is fairly straight forward. The basic necessities are to register to

the service through the official websites and install the synchronizing application according to the TV tuner hardware. TVTV provides this through the registration procedure, but TitanTV users must get the application from the hardware manufacturer's site. It should also be noted that TVTV and TitanTV have only a limited amount of tuner cards that are supported, and one problem in general can be the interoperability of the device and service server in the synchronization process.

TVTV PLUS, on the other hand, requires a set-top-box that is equipped to handle the TVTV inserts in the television signal transmission. Information about TVTV plus was hard to find and instructions on configuring a home made PVR to understand these TVTV inserts were nowhere to be found.

MythTv and VDR support a larger amount of tuner cards and, with additional knowledge, they can be configured to support almost any card. Installation can, however, be difficult especially for a normal Windows user. The operating system is different and the installation of the device drivers can also be non-trivial to a novice user, let alone the installation of the software and required plug-ins. The installation of these two products is however being simplified and VDR is already offered through a Linux distribution, LinVDR [5], with VDR and necessary drivers ready installed. This package is especially suitable for normal users without prior Linux knowledge.

5.3 Support

When considering new technology and the installation procedure, the amount and quality of support available is very important and has an affect on how well users adopt the product. If the software is hard to install and hard to use, a brief introduction to the system is all that is needed in order for the customer to change to another product. When comparing the support available for each product, it became clear that the GPL licensed software have a much larger support community and information could easily be found on different forums and wiki pages. Information on TitanTV could also be found somewhat easily, and it has its own community forum as well. TVTV on the other hand is not that well supported. User experiences are hard to find and information on the used technologies is not available beyond the TVTV website, which does not offer a great deal of help.

5.4 Access methods

TitanTV offers XML based synchronizing, where the user's system retrieves the recording information from the TitanTV server on specified time intervals. This is a commonly used method in many web based services. TVTV for PC uses this same method as well, but TVTV PLUS uses the TV signal to route the recording information to the user's system. VDR and MythTv both rely on web interfaces that can be used to control many of the features in the systems. In addition, they both implement a simple TCP connection interface that can be used to give commands to the PVR.

5.5 Usage

Much like the ease of installation, the ease of usage and the features included in the service are important to the whole experience as a user. If the installation is difficult, it does not mean that the usability will be affected as well. This is the situation with MythTv and VDR, which are, in spite of the more complicated installation process, both easy to use through the front-end interfaces. TVTV and TitanTV are also very simple when it comes to usage. Reliability is another factor that is closely related to usage, but does not fit the scope of this paper.

When it comes to the overall products, it is obvious that if a user wants more features in one system, the Linux based PVRs are the way to go. There is no additional software that the system is dependent on and that makes it easier to control as a whole. Also, because the source code is freely available, any modifications to the software can be done if needed.

6 Access problems

Some common problems exist in the usage of services running on web servers. These are caused by dynamic IP addresses and network address translation routers and firewalls. We will take a brief look into these problems next and present simple solutions to overcome them.

6.1 Dynamic IP address

The use of web servers poses a problem for many users, since Internet access is often achieved through an Internet Service Provider (ISP) that uses DHCP. This means that the user has a dynamic IP address. This is a problem since the user has to know the IP address in order to connect with the service running on the web server. The solution is to use a dynamic DNS service, which stores up to date information of the IP address. Such services are available for example from no-ip.com [10], which is a free service. Through registering, a user is given a username specific domain name, which maps to the user's IP address. This way, when the IP address changes, it is updated to the DNS service, and the user can always access the web server using the specified domain name. [2]

6.2 NAT firewall or router

Another problem that can arise in a web server setup is running the service behind a network address translation (NAT) firewall or router. A NAT is normally used to enable multiple hosts in a private network to access the Internet using a single public IP address. This is achieved through re-writing the IP-addresses in IP packets. What this means for a web server setup is that a user doesn't have direct access to the server behind a NAT firewall or router. The solution for the problem is to use port forwarding, which means that connections to a specific port on the NAT router or firewall are redirected to a specific host and port in the private network behind the NAT. If the NAT firewall or router has a dynamic IP address then a DNS service can be used, as mentioned in the previous chapter. It must be noted that port forwarding is

Software	Main service	Price (EUR)	Ease of installation	Support	Remote access (synchronization)	Usage
TitanTV	program guide	free	easy	good	TVVI and TVPI (XML)	easy
TVTV	program guide	19.80	easy	minor	TVTV for PC and TVTV PLUS	easy
MythTv	PVR software	free (GPL)	fairly complex	excellent	web server and terminal connection (extendible)	easy
VDR	PVR software	free (GPL)	fairly complex (Linux-VDR easy)	excellent	web server and terminal connection (extendible)	easy

Table 1: Comparison of software

a solution that can only be used if access to the NAT configuration is available. If the ISP is in charge of the NAT then there is little that can be done. [3]

7 Mobile aspect

In the modern world, mobile communication is becoming more and more important. Therefore, it is quite clear that the control of a PVR system from another location must be extended to include control from a mobile device as well. Modern mobile phones can be used to access the Internet, and an easy way to set recordings is to use a mobile web browser, and use the web interfaces that the fore mentioned programs include. In addition, specific mobile interfaces are being built to suit the mobile environment, which lacks the proper screen size and usability that web browsing would require. Telnet services, such as in MythTv and VDR, also give more options in developing suitable software for mobile devices.

One improvement that could be added, and which is very likely to be the next step in development, would be the possibility to add recordings with an SMS message. In systems that can be freely configured, such as MythTv, this functionality could be easily added. The only restricting fact is that it would require an SMS server that would process the text messages and forward the commands to the user's PVR system.

8 Thoughts on future development

As mentioned in the previous section, it is obvious that mobile control will be the future trend. But what about the technologies that are used to transfer recording information to the PVR system? Another question is the evolution of the basic set-top-boxes. Many users will rather buy an off-the-shelf product than build a setup from a computer. Therefore, the evolution of the existing set-top-boxes will most likely follow the features in the PC based PVR systems. However, this will first require more stabilized protocols and software, or more flexible and updateable set-top-boxes.

Another question has to do with the supported controlling interfaces. Is the web interface model the best and easiest? When reviewing the software, the use of the TV signal as a

carrier for the recording information became as a surprise. As the technology advances, we think this could be an implementation of the future, although it requires a lot of cooperation with the TV broadcasters, the recording service providers and the PVR software and device manufacturers. Despite this fact, a basic of the shelf set-top-box supporting a TV signal based recording would be an attractive service in the eyes of a novice user. An important reason for this is that it does not require any configuration in, for example, firewalls and routers, because the information is passed via the TV cable network.

Another future prospect, which would replace the previous composition, is that basic set-top-boxes will include an Internet connection. This is maybe a bit more probable since the setup is easier to achieve and the needed software is already widely in use in the PC based PVR systems. This scenario would also enable the use of simple web servers in the set-top-boxes, which could then be controlled through web interfaces, as in for example MythTv.

9 Conclusions

This paper examined the components that a home personal video recorder (PVR) system requires and what kind of software can be used to control such a system through the Internet. Basic building blocks for a home PVR are the TV tuner card itself, software for watching the TV channels and an MPEG2 decoder for decoding the compressed digital video and audio signals. Ease of installation of the needed components can vary quite a lot, and is largely dependent on the user's operating system and up to date software and device drivers.

The connection methods used for remotely accessing the home system and setting recordings are, for now, limited to a few different alternatives. One way is to make use of web servers, through which PVR systems can be controlled using a web browser. Another way is to use a terminal connection such as telnet.

The features of the reviewed products vary quite a bit, but all implement remote programming in one way or another. TVTV could use both the TV transmission system as well as the Internet for transferring the programming information, while TitanTV, VDR and MythTv all required Internet

access. The program guides basically implemented remote recording through a poll mechanism whereas the PVR software provided a web server service and, in addition, a plain terminal based service that were directly connected to the PVR system. The PVR software could additionally be expanded to support other methods of access. Some of the software require more configuration work than others, and the products can clearly be grouped by installation difficulty. The Linux based VDR and MythTV need more configuration as opposed to TVTV and TitanTV, which are quite easy to take into use. It is of course clear that VDR and MythTV are also much more diverse when it comes to features.

The future trend in remote recording will certainly focus on mobility. An easy way to set recordings with a mobile phone is definitely something worth pursuing. Web interfaces can already be used with mobile phones and WAP interfaces exist as well. In addition, specific mobile programs are available to control PVR software such as MythTV. A probable future feature is a service that can set recordings with an SMS message. One thing is for sure; set-top-boxes will follow the footsteps of PC based PVR systems. A remote recording functionality would enable also novice users to take full advantage of their set-top-boxes. The way this will be implemented is still open. One possible alternative is adding Internet access to set-top-boxes so that they can be controlled through, for example, a web browser. Another interesting option is to use TV signalling, like with TVTV PLUS. Such a service, if reliable, would certainly interest at least novice users, because it would remove the need for configuration in firewalls and routers.

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Appendix A

Example of a TVPI file [TitanTVFile]:

```
<?xml version="1.0"
encoding="ISO-8859-1"?>
<tv-viewer-info version="1.0">
<program>
<station>WKPT-DT</station>
<rf-channel>43</rf-channel>
<stream-number>1</stream-number>
<tv-mode>digital</tv-mode>
<program-title>Friends</program-title>
<program-description>Description, if
any, goes here.</program-description>
<start-date>20010512</start-date>
<start-time>21:00</start-time>
<end-date>20010512</end-date>
<end-time>21:30</end-time>
<duration>00:30</duration>
<psip-major>5</psip-major>
<psip-minor>1</psip-minor>
</program>
</tv-viewer-info>
```

Appendix B

TVTV for Linux usage [TVTVForPCLinux]:

```
tvtvForPC <commands> <options>
```

commands:

```
-h, -? or -help: print this text
-i or -info: display
settings from your config
-s or -setup: creates a new config,
discarding your old one if any
-t or -gettargets: syncs
the target sites available
-c or -getchannels: syncs
your channel configuration
-j or -getjobs: syncs your joblist
```

options:

```
-login <your login@tvtv>:
used with the setup command
-passwd <your password@tvtv>:
used with the setup command
-target <tvtv site you login>:
used with the setup command
-useProxy: used with the setup command
-proxyHost <host>: used
with the setup command
-proxyPort <portnumber>:
used with the setup command
-path or -p <path to directory for tvtv
config and data
```