Karyl F. Stein

#### **Executive Summary**

This document outlines the experiences of building a home theater personal computer (HTPC). It is very specific in the hardware and software used, and has one major goal of being a road map for rebuilding the HTPC in the future if needed. However, several topics of concern that a person building an HTPC will face are also discussed. Therefore, this document may also be useful to those researching how to build their own personal HTPC even if different hardware and software choices are made. Finally, various configuration options for some common hardware and software packages are outlined, which makes this document possibly useful for those struggling to make certain components work together.

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#### 1. Introduction

This document covers a multi-year project to build a home theater PC (HTPC). After several revisions, the system is in a state that is considered finished. This means that no more additions or updates are planned for the HTPC except for perhaps critical security patches. It is therefore a good time to document the complete building of the HTPC in case a hardware failure or other major issue necessitates recreating it.

Another goal of this document is to outline some of the experience that was gained during the HTPC creation process. This may prove useful when building future systems. Various thought processes and resources used are noted, which may help people who want to build their own customized HTPC.

The HTPC covered in this document is tailored to a very specific environment and to meet certain needs. By its very nature, a do-it-yourself HTPC tends to be a very personal affair. Therefore, it is unlikely that someone will want to build an exact replica of the HTPC described in this document. Even if that is attempted, current hardware may be manufactured using different components and software may be updated. All of this can cause incompatibilities even if the same products listed in this document are used.

This means that some amount of base knowledge in PC building, software installation, and problem solving is to be expected if a custom HTPC implementation is attempted. Documents such as this, vendor web forums, and other enthusiast sites are great places to research some of the issues that may be faced when embarking on this journey. However, unforeseen circumstances are bound to arise.

As stated previously, this HTPC project has been ongoing for about two years. Although the state of HTCP technology and the resources available are much better now than when the project started, a doit-yourself project like this should probably only be attempted if it is considered a hobby. The enjoyment of tinkering with computers, and reading and discussing technology are requirements for anyone taking on such a project. The end result is the satisfaction of creating something from scratch that is uniquely customized to one's lifestyle. However, be warned that the road there may be bumpy.

## 2. HTPC Goals

The intended use of an HTPC should be given careful consideration before any purchases are made. It may also be prudent to research the current commercial offerings to see if they meet those specific needs. When the HTPC described in this article was first started, there were not many solutions available from vendors. As the HTPC market has become more popular, the well of available options has grown. This trend appears to be continuing. Quite a bit of time and money may be saved by opting to purchase a boxed system.

**Tip**: Be careful not to over engineer the system. It may be tempting to think about what the HTPC may be called upon to do down the road. However, looking too far into the future may cause a bloat of requirements and negatively impact getting something useful for the current time. Besides, technology in the home entertainment arena is moving fast right now and a planned upgrade may be obsolete or solved with better components in the future.

The main requirements for the HTPC covered in this document are given in Table 1. The requirements have grown from the original list as having a HTPC alters the way TV and other content is enjoyed. The original incarnation of this HTPC was only meant to replace a VCR to record football games as VCR tapes were not able to record at decent quality for the length of time a football game may be

showing. After that was accomplished, other desired features were discovered. It may make sense to build an inexpensive "starter HTPC" to get a better feel for the options available and those that are most important in a given environment.

Requirement	Comments	
Basic Digital Video Recorder (DVR) Functions	The HTPC should be able to record, pause, fast forward and rewind basic analog cable TV. It should also provide a self-updating program guide showing upcoming shows and allow specific shows or a series to be flagged for recording. There should also be a way to add recording time after a show is scheduled to end. This is beneficial for things like sporting events that may go into overtime. Finally, is should be possible to watch one program live while another program is recording, or start watching a recording even if it is not finished.	
Commercial Detection	n Commercials in TV programs should be detected and automatically skipped.	
Remote Access	The system should be accessible using a web browser over the Internet. This access should allow for programming shows to record.	
Other Media	DVDs and CDs should be playable with the system. Internet radio, music files, video clips, and digital images should also be playable or viewable.	
Remote Control	All the basic functionality of the system should be controllable using a hand- held remote control unit.	
Easy Use	The basic system, namely TV, recordings, and DVD playback should be easily usable by children and other family members.	
Surround Sound	The system should be able to play media in 5.1 Dolby Digital surround sound as found on DVDs.	

#### Table 1: HTPC Requirement List

Meeting the core requirements may also provide other benefits. However, the main goal when picking hardware and software should be to hit the core pieces. Only if multiple items provide a good solution for a core need should other things such as cost, additional features, and community support be incorporated in the purchasing decision.

#### 3. HTPC Environment

The environment in which the HTPC is placed also plays a role in its design and configuration. The home network and wiring, furniture, available TV services, (e.g. analog cable, digital cable, satellite, over-the-air, etc.), connectivity options for viewing display, and more all play a part in what hardware and software is used.

In this example HTPC, the main environment consists of the following key points:

- Analog cable TV,
- Over-the-air (OTA) reception of local HDTV channels,
- An LCD panel with DVI connectivity capable of running in 1080p HD format,
- Single wired Ethernet jack across the room,

- A single wired cable jack behind TV stand,
- Standard dual power outlet behind TV stand,
- A network attached storage (NAS) device holding all image, music, and archived video recordings,
- A cable modem for Internet access with a firewall router providing network address translation (NAT), DHCP, and network time services, and
- A generic TV stand with cupboards and shelves for holding components.

The environment has changed a little over time based on needs. For example, there are now three Ethernet drops behind the TV stand as well as two cable drops and a drop for the UHF antenna in the attic. A larger, custom cabinet is also being built in order to completely enclose the HTPC. Be sure that the HTPC target fits in the desired environment, or add the necessary changes to the overall plan.

#### 4. Target System

The current state of the hardware used in this system is listed in Table 2. Most of the core pieces are as first purchased. Therefore, some of these items may be considered obsolete or at least quickly aging. On the other hand, there is no need to pay a premium for equipment that surpasses the goals of the system. One might argue that it is good to have extra capacity to handle future needs. That may be true. However, it may turn out to be more cost effective to get something working for today and then overhaul the entire system when the future needs actually arrive.

The prices listed in Table 2 are just an estimate based on receipts, a price comparison web site, and other sources. It should only be considered a guideline as to what the example PC would cost if purchased at the time of writing. Some of these products are no longer being sold new, so the price used is for comparable equipment. Prices have also been rounded and may not reflect the vendor giving the absolute lowest price.

Component	Product	Comments	Price
Enclosure	Antec SLK3700-BQE	A standard PC case	\$100
Motherboard	AOpen AX4SPE Max II	Based on the Intel 865PE chipset	\$70
CPU	Intel 2.26GHz	2.26/512K/533 Northwood core	\$55
CPU Cooler	Zalman CNPS7000-AlCu	Slow speed setting	\$35
RAM	2x256MB PC2100 DDR Kingston Value	CL2.5	\$45
Video	Gigabyte GV-N66T128VP	AGP 8x, 128M DDR3	\$150
Display	Westinghouse LVM-37w1		\$1500
DVI Cable	RAM Electronics Dual Link DVI-D 12ft		\$50
DVD	Pioneer DVR-A08XLB	No longer available	\$40
Hard Drive	Samsung SP0812C 80G	80G SATA for OS	\$45
Hard Drive	Maxtor 6B250S0	250G SATA for video	\$110
Tuner Haupauge 500MCE Dual and		Dual analog cable tuners	\$130

Component	Product	Comments	Price
Tuner	AVerMedia AVerTVHD A180	HDTV tuner	\$70
Antenna	Antennas Direct DB2	UHF omni-directional	\$50
Remote	Niveus Media (X10)	IR and RF	\$50
Keyboard	Interlink Versapoint	RF with mouse	\$150
Audio	Creative Audigy 2 ZS Platinum	Hardware decoding	\$170
Speakers	Logitech Z-5500	Powered 5.1 system	\$280
OS	Windows XP Professional SP2		\$280
DVR Software	SageTV Media Center 5.0.4		\$80
Video Decoders	nVidia PureVideo Bronze		\$20
Commercial	ShowAnalyzer		\$10
Detection			
Approximate To	Approximate Total \$3		

Table 2: HTPC System Components

#### 4.1. Enclosure

A lot of strides have been made recently with HTPC enclosures. The enclosure used in this example HTPC is more of a temporary case until something better is found. The main things for which to look in an enclosure are:

- Does it fit the style of where it will be placed,
- Does it fit in the furniture, (be sure to measure before purchase),
- Does it fit all the desired components,
- How noisy is it,
- How cool does it keep the components, and
- Does it have all the desired connections for things like headphones, card readers, etc.

This HTPC is being used as a server meaning that it handles the recording of shows. Therefore, it needs space to handle capture cards, hard drives, and other items. It is also acting as a client meaning that it drives the TV and audio system, needs a DVD drive, and requires connectivity for items such as flash memory cards. A small case is just not big enough to handle all the pieces. Some people split server functions and client functions, but this increases the cost of the entire implementation.

The first enclosure purchased was the Antec Overture, which is a desktop style case. It looked like a good combination of space and looks. However, the case was larger than expected when it arrived and would not fit in the TV stand. The current case was quickly purchased as a stop-gap measure to build the system until more research could be done on cases. Since that time, several cases have been reviewed, but none offer the ultimate combination of looks, space, size, and connectivity options. Now, a new TV stand is being planned which fully encloses the HTPC, so looks are not as much of a factor.

# 4.2. Motherboard, CPU, Cooler, and RAM

All of these pieces are matched. The motherboard is probably the most important as it forms the base for what can be and needs to be installed in the system. The motherboard used in this HTPC holds a 478-pin Intel CPU, an AGP graphics card, Serial ATA hard drives, and contains several built-in components such as Ethernet, Firewire, and AC'97 audio.

The CPU provides enough performance to handle HDTV playback, although it is slated to be upgraded to a 3.4GHz model (still with the Northwood core as it is supposed to run cooler than the newer Prescott core). At that point, the RAM will also be upgraded so it is running at the same front side bus speed as the CPU. The CPU cooler does not need to be changed and runs very quiet.

# 4.3. Video

This may be the most important component of the system. The video card needs to be powerful enough to handle the desired resolution of the display and the video stream. It also needs to run quietly. The video card used in this HTPC is passively cooled meaning that it is quiet. It also can handle the 1920x1080 (1080p) resolution of the display and 1080i HDTV playback. It is unknown whether it can handle 1080p content or the HDCP protection required for new technologies like HD-DVD and BlueRay.

# 4.4. Display

The display was chosen because it looked good in the store, was inexpensive compared to other similar models available at the time, and natively ran at 1920x1080 screen resolution (1080p). The newer version of this display has an HDMI connector, which may be required for newer DVD formats like HD-DVD and Blu-ray. The DVI connection on the model purchased is supposed to support HDCP, but this has not been tested.

A display is really a matter of personal taste. If possible, the display should be viewed in person to get a better feel for how a moving picture looks. It needs to have all the connectivity required to link it to the HTPC and any other video equipment such as game machines. It should have a standard screw pattern for attaching to a wall mount bracket if this is desired. If newer DVD format support is required, it should be able to display 1080p resolution and have at least one HDMI connector with HDCP support.

# 4.5. Antenna

Finding the correct antenna, mounting location, and mounting direction is important for receiving a usable HDTV signal. A good start is the web site http://www.antennaweb.org/. For this installation, a DB2 model from Antennas Direct was mounted in the attic. Although a small multi-directional was suggested, the desk-mount version first attempted did not pull in a signal. The DB2 in the attic pulls in the local channels very well and even some channels from a nearby city—even though they are at a 90-degree difference in compass heading from the antenna.

# 4.6. Remote

The remote control chosen can transmit both infrared (IR) and radio frequency (RF) signals. This allows for the control of devices such as a VCR and TV that have IR receivers. The HTPC can be controlled using RF, which can travel through walls and other obstacles. This allows the HTPC to be

placed in a cabinet as long as it has proper ventilation.

#### 4.7. Audio

The motherboard used in this HTPC has built-in AC'97 audio capabilities that provide both analog and digital output. The Logitech speakers used have a receiver that accepts both analog and digital signals. The receiver also has hardware decoding for Dolby Digital and DTS audio streams.

Audio on a DVD or an HDTV signal needs to be decoded from its digital form to an analog signal that may be sent to the speakers. It is generally considered best to keep the audio in digital form as long as possible in order to preserve its integrity. The issue with this is that a digital stream has to be decoded in order to modify properties such as volume. This means that in order to keep the digital audio stream pure for as long as possible, it must be passed unmodified through the HTPC directly to the receiver. Unfortunately, this forces the volume for digital audio to be controlled by the receiver and not the HTPC.

Another problem is the fact that audio on a DVD or HDTV stream tends to have a higher dynamic range than what is captured from the analog cable line. The result of this is that regular TV sounds loud compared to watching a DVD. Therefore, if the volume is adjusted up to watch a DVD or HDTV channel, then it will be extremely loud when switching to regular TV. This can be a jolting experience.

There are basically two main options to address audio. One is to send everything over the digital link (S/PDIF) to the receiver and let the receiver handle all decoding and volume control. The Windows volume level settings can be adjusted to lower the volume on analog streams (e.g. Wave output), and to send analog audio over the S/PDIF link. This solves the problem of volume levels, but means that volume control has to be managed on the Logitech receiver, which has an IR receiver for remote control. The Niveus remote used in this example HTPC can be configured to send IR signals when the volume up, down, and mute buttons are pressed. However, this means that the remote must have an unobstructed path to the receiver in order to control the volume. This is not desired as the volume needs to be controllable from nearby rooms when, for example, it is being used to play music. To solve this, an IR blaster such as USB-UIRT and software such as Girder can be used.

An IR blaster sends IR signals. Girder can be configured to take input received from the remote control via the RF receiver and translate it to a command that is sent through the IR blaster. This adds additional complexity and cost to the system. It also creates more clutter as the IR blaster has to be located so it can send signals to the receiver as well as anything else it needs to control.

Another option is to decode the digital data on the HTPC and send it in analog format to the speakers. The decoding may be done by a hardware device or in software. SageTV comes with a software component called AC3Filter that provides decoding capabilities. Careful configuration of AC3Filter also allows the gain to be adjusted on decoded streams in order to make them louder. This solves both problems of volume changes between different audio streams and having the volume for everything controlled from the HTPC.

For this HTPC implementation, a hardware decoder was chosen. The only sound card offering such decoding capabilities was the Creative Audigy 2 ZS Platinum. A hardware decoder takes some workload off the CPU, but may not provide any noticeable performance gains.

**Lesson Learned**: If purchasing an Audigy 2 ZS Platinum card, be sure to avoid OEM versions, or make sure that the OEM version in question contains the hardware decoder chips. Some OEM cards do not have the ability to decode Dolby Digital and DTS data.

The retail version of this card costs more, but always has the decoding functionality.

#### 4.8. DVR Software

There is a wealth of software packages available that provide various DVR features. Some packages such as MythTV are free and run on Linux. In fact, MythTV was the first software installed on this example HTPC. Although it worked as advertised and the software cost was minimal, the state of the various hardware drivers on Linux were not stable at the time. Nevertheless, the MythTV software was used successfully for several months until the HDTV tuner card was added.

While researching Windows DVR software, SageTV seemed to be the most advanced and flexible at the time. Windows MCE was a strong contender, but the lack of a trial version removed it as an option. SageTV also had a strong user community actively developing customizations to the software. It already had some core features available as third-party additions such as commercial detection and skip, and a web server. It emerged as the only choice that met all the requirements with most of them addressed in the official package.

At this time, the various software options have matured and there are several good offerings. Most of the major names such as Windows MCE and BeyondTV meet the target goals of this example HTPC out of the box or through user-provided customizations. On the other hand, SageTV is not lacking in features, is still being developed, and has a strong user community. Therefore, SageTV remains as the software of choice for this HTPC.

#### 4.9. Video Decoders

Certain types of video data such as that found on a DVD need to be decoded before it can be sent to the video card and on to the display. Sometimes the DVR software or a software DVD player packaged with a DVD drive may provide decoders. If not, then an external decoder may have to be purchased. Because this example HTPC uses a video card with an nVidia processor, the nVidia decoders were chosen. Other decoders from Cyberlink and Sonic were tried, but no noticeable difference was detected between them. Those with a more trained eye or different hardware may find one decoder better than another. The major decoders all offer trial downloads, so may be "test driven" before purchase.

#### 5. Initial Build

The first step is to mount only the hardware that will be used for loading the operating system (OS). This is to minimize the number of variables that can cause problems. After the initial OS is loaded and configured, additional hardware may be added one piece at a time. Each piece can then be configured individually. It may be tempting to put everything in at once, however this approach makes it more difficult to identify what may be causing a problem. For example, if the system was running fine before adding a certain component, but is not operating correctly after the install of that piece, it provides a strong indicator that the new addition is the cause of the problem.

In this example, the motherboard, CPU, CPU fan, OS hard drive, video hard drive, DVD drive, and video card are all mounted in the case. The DVD drive is plugged in to the primary IDE connector on the motherboard, the OS hard drive is connected to the SATA1 connector, and the video hard drive is connected to the SATA2 connector. The receiver for the wireless keyboard is plugged in to a free USB port. The computer is then plugged in to a power outlet and turned on. The DEL key on the keyboard is pressed during the boot process in order to load the BIOS configuration menu.

## 5.1. BIOS

The rule of thumb used when configuring the BIOS is to only enable those things actually being used and to not push the hardware until a consistent level of stability is reached with the system. An HTPC should not need to be overclocked or otherwise tweaked to provide a smooth user experience. If it does, then more powerful hardware should be purchased. It may be desirable to underclock the system in order to have it run cooler. The HTPC described in this document is neither over nor underclocked.

To make sure that everything in the BIOS is operating on a clean slate, clear the BIOS and if necessary, flash it to the latest version. In this case, the version used is 1.06 dated 7/30/2004. Then, turn on the computer and press the **DEL** key to enter the BIOS configuration menu.

#### 5.1.1. Standard Settings

Any IDE channel not being used should be set to *None* instead of *Auto*. This will provide a slightly faster boot process. The currently installed DVD and hard drives should appear as IDE Channel 0 Master, IDE Channel 2 Master, and IDE Channel 3 Master respectively. The current date and time should be set on this page.

## 5.1.2. Advanced BIOS Features

Most settings on this screen may be left on the default settings. The main change is to set the **First Boot Device** as *CDROM* and the **Second Boot Device** to *Hard Drive*. The other "Boot Device" options should be set to *Disabled*. After the OS is loaded, the **First Boot Device** should be changed to *Hard Drive* and the other "Boot Device" settings should be set to *Disabled*. This will help speed up the boot process and avoid things like a CD left in the DVD drive causing problems when trying to reboot the system with no one around such as after a power outage. The **HDD S.M.A.R.T. Capability** option is *Enabled*.

## 5.1.3. Advanced Chipset Features

The DRAM timing should be set by the SPD on the memory. The System and Video BIOS Cacheable options should be set to "Disbaled" and AGP should be the option for Init Display First.

## 5.1.4. Integrated Peripherals

Any feature built-in to the motherboard should be disabled if not being used. This may provide some power savings and also lessens the complexity of the system. The drawback to this is if the feature is never needed in the future, one must remember to enable it in the BIOS.

In the case of this system, the "OnChip IDE" devices should have the **Primary PCI IDE** set to *Enabled* with the default settings and the **Secondary PCI IDE** disabled. The **Serial ATA** should be set to *Enhanced Mode* and the **Serial ATA Port 0 Mode** should be set to *SATA1 master*. This allows for the OS to load from the hard drive attached to a SATA port.

The **Onboard Device** options use the default settings except that the **Onboard Audio Codec**, **1394 control**, and **Dr.Voice Diagnostics** are all disabled. The latter is disabled because it can be rather loud and wake up sleeping children if the HTPC is being tinkered with during nap time. The 1394 (Firewire) ports are not needed in this example HTPC as the digital video (DV) camera is plugged in to the 1394 port on the audio card and there are no other Firewire devices currently in use.

All of the SuperIO options are disabled as they are not needed. The **AC PWR Auto Recovery** option is set to *Former Status* so that the HTPC will automatically boot following an event such as a power outage.

#### 5.1.5. Power Management Setup

There is no need to enable the power management settings in the BIOS. This may be different for systems where the CPU has more power management functionality. However, in the case if this system, Windows will control the power management. Therefore, the suspend and **HDD Power Down** options are set to *Disabled*.

## 5.1.6. PnP/PCI Configurations

It may be beneficial to set the **Assign IRQ for VGA** and **Assign IRQ for USB** options to *Enabled*. Otherwise, keep the other default settings.

## 5.1.7. Save and Close

At this point, the OS CD may be inserted in the DVD drive and the option to **Save and Close** the BIOS configuration menu may be selected. After the computer reboots, it may require that a key be pressed in order to boot from the CD.

## 5.2. OS Installation

There is nothing special that needs to occur during the OS install. The only caveat is that the computer name cannot be the same of an account name on the system. This HTPC will have two accounts defined on it called TV and SageTV. Therefore, the machine was given the name DVR. The TV and SageTV accounts may be created when the OS boots for the first time and asks for the names of people who will be using the computer. The TV account is used for all installation work and the SageTV account will never need to be logged in to.

At some point, the OS may warn that the computer may be at risk due to the lack of anti-virus software. This is optional software that may be installed and is usually recommended. However, it is a constant drain on system resources as it is continuously running and monitoring the system. Some people have found that anti-virus software affects their video performance. It is a personal choice whether or not to install anti-virus software based on how the HTPC will be used. If it is not used to browse the Internet other than to download patches from vendor web sites, it may not be as important to use anti-virus software. However, any computer connected to the Internet is a possible target. Therefore, it is recommended that some sort of anti-virus software be used. There are some free versions such as ClamAV that perform well. If anti-virus software is not to be used, it may make sense to open the **Security Center** in the **Control Panel** and turn off monitoring virus protection.

#### 5.3. Network

The Intel ProSet software and driver need to be installed in order to get the network adapter to work. Unfortunately, this cannot be retrieved from the network. One solution is to download the software to a USB flash drive and then plug that in to the HTPC.

Once the network driver is installed, the HTPC should be able to communicate over the network.

Verify its connectivity and fix any problems. After the network is enabled, the OS may be activated and all the OS updates may be downloaded and applied. Optional components such as the .Net Framework and Windows Media Player may also be installed. This process may take a while. At the time of writing, there are over 50 updates to download and install with three reboots required. Adding the optional software packages increases the count to over 70 updates and six reboots. Multiple visits to the Microsoft update site may be required as installing one update may open up the need to install additional updates previously ignored. Be sure to revisit the Microsoft update site until no more updates are listed.

## 6. Installation and Configuration

At this point, everything is ready to start adding hardware and software pieces. Each piece is installed one at a time with a reboot and functionality test following each installation.

#### 6.1. Video Drivers

The nVidia Forceware drivers are used to control the video card. The latest version of these drivers may be found on the nVidia web site. They should be downloaded and installed. At the time of writing, 91.31 is the current version and is what is being used. After the display control panel is installed, the resolution should be set to 1920x1080 (1080p) with a 32-bit color depth. The color quality settings may also be set to *Highest*.

In the Windows **Control Panel** under **Display**, the background image may be changed. This HTPC uses *Ripple*, which is stretched to fill the screen. To stop any annoying pop-up messages, the **Desktop Cleanup Wizard** may be disabled. The **Screen Saver** should be set to *None*. Under **Power**, all items to turn off should be set to *Never*. The option to prompt for a password when resuming from standby may be unchecked. Under the **Appearance** tab, the fonts may be set to extra large and, in the **Effects** screen, *Large Icons* may be selected. This makes it easier in some cases to read the screen when at a distance. Another option to assist in viewing is the **DPI** option under the **Advanced** tab. This may be set to *Large* or a custom value. One final display related setting is the mouse speed. Since the screen is so large, running the mouse at full speed may make it easier to get around.

The 91.31 version of the drivers installed in this example cause a warning balloon to appear after each boot saying that SLI has been disabled. Future versions of the driver are not supposed to display this message. To remove this message, a registry entry must be modified. Please see the following web site for more information:

#### http://nvidia.custhelp.com/cgi-

bin/nvidia.cfg/php/enduser/std\_adp.php?p\_faqid=1881&p\_created=1151105332&p\_sid=DHE4Bqci&p\_lva=&p\_sp=cF9zcmNoPTEmcF9zb3J0X2J5PSZwX2dyaWRzb3J0PSZwX3Jvd19jbnQ9MjImcF9wcm9kcz0yJnBfY2F0cz0wJnBfcHY9MS4yOzIudTAmcF9jdj0mcF9zZWFyY2hfdH1wZT1hbnN3ZXJzLnNIYXJjaF9mbmwmcF9wYWdlPTEmcF9zZWFyY2hfdGV4dD1TTEkgbXVsdGktZ3B1&p\_li=&p\_t opview=1

View the topic about the popup appearing and it has an attachment named *sliballoon.reg*. Download this attachment the the computer and double click on it to install the registry entry.

## 6.2. Audio

Shut down the computer and install the Creative Audigy 2 ZS card in a free PCI slot. Connect the three

analog audio cables to the sound card and turn the computer back on. Connect the other end of the cables to the Logitech decoder and make sure that its input is set to 6 channel direct. Be sure to turn the volume down to a low level to avoid any nasty surprises.

When the system starts, it will say that new hardware is detected. Press the **Cancel** button, go to the Creative web site, and download the latest drivers for the sound card. Run the downloaded file and it will install only the necessary software to use the audio card. At the time of writing, the current driver is in a file named *SBAX\_WEBUP\_LB\_2\_08\_0004.exe*.

After the system reboots, run the **Creative Audio Console**. Set the speaker configuration to 5.1. Go to the **Decoder** tab and press the **Settings** button for Dolby Digital. Select **Night (minimum)** for Dynamic Range. This will even out the volume between analog TV, HDTV, and DVD. All the other settings may remain at the default values. The system sound settings may also be changed if desired. For example, the **Exit Windows** and **Start Windows** sounds may be set to *None*.

#### 6.3. TV Tuner

Shut down the computer and install the Hauppauge 500MCE card in a free PCI slot. Connect the cable TV and FM antenna cables to the card. Then, start the computer.

When the system starts, it will say that new hardware is detected. Press the **Cancel** button, go to the Hauppauge web site, and download the latest drivers for the 500MCE card. This should be the executable driver installation file and not the MCD CD ZIP file. (They may be listed as drivers for the 150MCE.) Run the downloaded file and it will install only the necessary software to use the tuner card. At the time of writing, the current driver is in a file named *pvr150\_500\_basedriver\_2043\_24103.exe*.

## 6.4. HDTV Tuner

Go to the AverMedia web site and download the latest drivers for the A180. At the time of writing, the current driver is in a file named  $A180Dual_WHQL_Drv_V1.2.2.23.zip$ . Extract the zip file to a location easy to find such as C:A180.

Shut down the computer and install the AVerMedia card in a free PCI slot. Connect the antenna cable to the card. Then, start the computer.

When the system starts, it will say that new hardware is detected. Do not let it search Windows Update for drivers. Instead, opt to install the drivers from a specific location and provide the location where the drivers were extracted, (e.g. C: A180). They should be automatically detected and installed.

## 6.5. System Settings

At this point, two visible user accounts exist on the system. The TV account is the main account used to use and configure the system. The SageTV account is used for running SageTV as a service. The SageTV account needs to have a password assigned to it in order to work with the SageTV application. Also, the TV account should be configured to automatically log in at boot. This allows for the entire process from turning on the computer to having SageTV run be completely automated.

**Note**: Two accounts may not be needed. If a password is assigned to the TV account, it may be possible to use it to run SageTV as a service and still automatically log in to the account at boot. However, this has not been tested.

Use the **Control Panel** to set a password on the SageTV account. Then, follow these instructions taken from Microsoft (see http://support.microsoft.com/default.aspx?scid=kb;en-us;315231) to automatically log in as TV on boot:

- 1. Click **Start**, and then click **Run**.
- 2. In the Open box, type control userpasswords2, and then click OK.
- 3. Clear the "Users must enter a user name and password to use this computer" check box, and then click Apply.
- 4. In the <u>Automatically Log On</u> window, enter TV as the user and click **OK**.
- 5. Click **OK** to close the <u>User Accounts</u> window.

Test the automatic log in functionality by rebooting the computer.

#### 6.6. Remote

Download the Niveus remote software from the Niveus web site. Plug in the receiver for the remote in a free USB slot on the HTPC. Allow the new hardware wizard contact Microsoft Update to find drivers and select the automatic installation of drivers.

Once the new hardware is successfully installed, extract the Niveus remote software and execute the setup program. Select to launch it and set up your controls. In this example HTPC, the remote PC buttons are given the configuration as shown in Table 3.

Button	Command	Comment
Vol Up	Vol Up	
Vol Dn	Vol Down	
Mute	Mute	
Ch Up	Page Up	
Ch Down	Page Down	
Filled Hand	CTRL+X	Program guide
Number keys 0 – 9	Values 0 – 9	
Enter	Num Enter	
AB	Shift+Ctrl+F	Toggle full screen mode
Menu	Home	Go to home menu
Exit	Escape	
АКеу	Ctrl+V	Watch TV
В Кеу	Delete	Delete
СКеу	Ctrl+A	Rewind #2
D Key	Ctrl+F	Fast Forward #2
Up / Down / Left / Right	Up / Down / Left / Right	Menu navigation

Button	Command	Comment
Rewind	Prev Track	
Play	Play/Pause	
Fast Forward	Next Track	
Record	Ctrl+Y	
Stop	Stop	
Pause	Ctrl+S	

#### Table 3: Remote Button Configuration

Be sure to save the configuration with the name *default* in the folder automatically selected when the **Save** option is selected from the **File** menu. Reboot the computer then open the Niveus configuration application and verify that all the settings were automatically loaded correctly.

#### 6.7. SageTV

Format the video hard drive (D:) using a single partition with a 64K cluster size. Give it a descriptive label such as Video. After it is formatted, create a folder named SageTV on it. This is where all the live TV recordings will reside.

All data such as archived videos, music, and picture files reside on a NAS device. This device is named MYNAS and has shares named Video, Music, and Pictures. It also has a share named Backup that is used by computers on the network to store copies of important files.

**Tip**: Having a separate NAS device can reduce noise and heat generated by the main HTPC system. It may be possible to place the NAS in a closet or basement away from people. Another option is to put a main HTPC server in the basement and build small, quiet client systems that connect to the TV.

Download and run the installer for SageTV. At the time of writing, this is a file named  $SageTV_V5_0_4Setup.exe$ . The SageTV install process will also install a Java runtime environment (JRE). It is recommended that the JRE packaged with the SageTV installer be used instead of downloading and installing a JRE beforehand.

After SageTV and the JRE are installed, run the SageTV application. This will take you through an initial configuration process. In most cases, the default settings may be used. If necessary, they may be changed after the fact.

During the initial configuration process, select to have SageTV load at boot in full screen mode. Also, if may be desirable to enable the SageTV Service and Placeshifter Service. Set the video, music, and picture settings appropriately. In this example, the second hard drive (D:\) is used for videos while music and pictures are stored on an external NAS device. This means that the music folder is defined to be  $\MYNAS\Music$ , the pictures folder is defined to be  $\MYNAS\Pictures$ , and the video folder is defined to be  $D:\Next$ , the recording directory is defined to be  $D:\SageTV$  and all space on it may be used.

The video tuner configuration menu is then displayed. Set up the two Hauppauge TV tuner video sources being sure to select the correct location and channel line up. A composite source may also be

configured and set to Channel 1. This allows a composite device to be plugged in to the Hauppauge card and displayed by using SageTV to view channel 1. Next, set up the AverMedia tuner video source to tune over-the-air signals.

**Tip**: Be sure to have SageTV scan for available channels when configuring the analog and HD TV tuners to verify that the connection is good.

Once SageTV is configured, view some of the TV and HDTV channels to make sure that they work. Then, exit the SageTV application and run the **SageTVServiceControl** application. This will force the SageTV application to run whenever the computer is on and not just when the SageTV application is running. It also automatically detects if the service is not running for some reason and restarts it. This is useful if some problem causes the service to die.

First, change the user to .\SageTV. You will be asked to enter the password for the account. Next, check the **Enable Service Recovery** check box. Press the **Enable** buttons to enable the service and then press the **Start** button to start the service. The next time the SageTV application is executed, it will take you through the configuration process again. However, it will retain the settings from the initial run, so it will not take long to complete the reconfiguration.

## 6.8. SageTV Customizations

Although SageTV is a full-featured DVR software package, it requires the installation of some thirdparty modifications in order to meet all of the stated system goals. A good list of available customizations and instructions for their installation and use may be found on the SageTV Customizations forum. This may be found on the SageTV web site by going to the **Support** section and then selecting **Discussion Forums**. Only a handful of the available customizations are used for this example HTPC implementation.

## 6.8.1. Comskip Playback Support

This customization allows for the automatic skipping of commercials. It works based on a file created by the ShowAnalyzer application. Follow the installation instructions found on the SageTV forum topic about this customization (see http://forums.sagetv.com/forums/showthread.php?t=12194).

## 6.8.2. Default Record Padding

This customization may be retrieved from the following web site:

http://www.sage-community.org/index.cgi/wiki/NielmModuleDefaultPadding#null.zip

According to this site, "[t]his customisation [sic] allows you to specify a default padding to be added to all new manual records, or newly added favourites [sic]." Some shows show bloopers or other things at the very end while the credits are rolling. At times, SageTV may cut this part out as it encroaches on the next show's time slot. Adding one-minute padding to the end of shows by default is a good way to make sure nothing is missed. Follow the installation instructions found on the home web site for this customization.

#### 6.8.3. Exit Sage

All this customization does is allow an "Exit" option to be added to a SageTV menu. This option will close the SageTV application, but not stop the service. This may be useful if the HTPC is sometimes

used for other functions than just watching TV. The Dynamic Main Menu customization will also have to be installed and configured to make use of the Exit Sage customization. Follow the installation instructions found on the SageTV forum topic about this customization.

#### 6.8.4. SageTV Web Interface

This customization allows for the SageTV server to be controlled via a web page. If the HTPC is connected to the Internet, it may be possible to manage the HTPC from anywhere with Internet connectivity and a web browser.

SageTV now has a product called Placeshifter that provides this functionality and more. However, this product was not available while this HTPC was being built.

To install the SageTV Web Interface customization, go to the following web site:

http://www.sage-community.org/index.cgi/wiki/WebServer

Download and install the web server following the instructions found there. The result should be the ability to open a web browser on the HTPC and successfully load the following web page:

http://localhost:8080/sage/Home

Run the **Security Center** option in the Windows Control Panel and select **Windows Firewall Settings**. Go to the **Exceptions** tab and click on the **Add Port...** button. Enter the name *SageTV Web Server* with the TCP port *8080* and press the **OK** button. At this point, another computer on the same network as the HTPC should be able to load the web interface.

#### 6.8.4.1. SSL

The ultimate goal of the web interface is to be able to connect to it from a computer on the Internet and program the HTPC. This may be useful to set up the recording of a show while not at home. In order to provide some security so the login information is not sent over the Internet unprotected, SSL may be used.

To enable SSL, first open a command prompt on the HTPC and go to the following directory:

C:\Program Files\Java\jre1.4.2\_11\bin

Once there, execute the following command:

keytool.exe -genkey -keyalg RSA -keypass 123456 -storepass 123456 -validity 3650 -dname "cn=..."

Be sure to replace cn=... with the name that will be used to access the HTPC from the internet. For example, you may use cn=mytv.example.com if the URL https://mytv.example.com/ is used to connect to the HTPC. If this name is not known, then the *-dname* option may be removed.

Once the key file is created, it must be moved to the home directory of the account used to run the SageTV service. To do this, move the file  $C:\Documents$  and  $Settings\TV\.keystore$  to the folder  $C:\Documents$  and  $Settings\SageTV$ .

Next, stop the SageTV service. This may be done by clicking on **Start**, right clicking on **My Computer** and selecting **Manage**. Next, open the *Sage.properties* file, which may be found in the folder *C:\Program Files\SageTV\SageTV*. Edit the following lines:

nielm/webserver/port=443 nielm/webserver/use\_ssl=true

Now, start the SageTV service and use the Internet Explorer browser on the HTPC to go to the following web site:

https://localhost/sage/Home

This should display a security warning message about the certificate being from an untrusted source. Click on the **View Certificate** button and then **Install Certificate**. The defaults may be selected. This is required on the HTPC in order to have ShowAnalyzer to be able to successfully use the web server. This does not need to be done on other computers that are just accessing the web server. In those cases, when the security warning appears, the **OK** button may be pressed to accept the certificate for the session.

The final step is to go back to the **Security Settings** part of the Windows Control Panel and select to manage the **Windows Firewall**. Go to the **Exceptions** tab and edit the *SageTV Web Server* entry. Change the port from 8080 to 443 and press **OK**. The web server should now be accessible from other computers on the network.

Connecting to the HTPC over the Internet is beyond the scope of this article. In this case, the DynDNS service was used to create an Internet name. The perimeter firewall was then configured to pass certain traffic from the Internet to the web server on the HTPC.

## 6.8.5. FM Radio

The Hauppauge 500MCE video capture card used in this system also has an FM tuner. The FM Radio customization allows SageTV to tune and play FM radio stations. Currently, the import may be downloaded from http://forums.sagetv.com/forums/showthread.php?t=17715. Follow the installation instructions found on the SageTV forum topic about this customization.

## 6.8.6. Dynamic Main Menu

The Dynamic Main Menu is required in order to make use of some other customizations such as Exit Sage and FM Radio. By using Dynamic Main Menu, items may be added, removed, and relocated on most of the menu screens. It also allows for the launching of external programs from menu items. For example, if the Google Video Player is installed on the system, a menu item may be made in the Media Center menu of SageTV to load the player when selected.

To install the Dynamic Main Menu customization, go to the following web site:

http://www.sage-community.org/index.cgi/wiki/NielmModuleDynamicMenu

Download and install the customization following the instructions found there. If the menu icons are installed as described on that web site, then in order for them to appear, they will have to be moved after being extracted, or the default menu definition file will have to be edited. After extracting the icons, go to the folder C:\Program Files\SageTV\SageTV\SageTV\STVs\OriginalV2\MlbDude\Default and move all the files in there to C:\Program Files\SageTV\SageTV\SageTV\STVs\dynamic\_menu\_icons. The C:\Program Files\SageTV\STVs\OriginalV2\MlbDude folder may then be deleted.

# 6.8.7. Channel Logos

Adding channel logos is strictly a cosmetic addition and does not provide any real functionality. There are several logo packages available on the Internet and links to some of them may be found in the SageTV Customizations forum. Another good place to get logos is http://www.wikipedia.org/.

A fairly complete logo pack for the location in which this example HTPC is installed was found on the Internet. Therefore, adding the logos was as simple as downloading the zip file and extracting it to the folder *C:\Program Files\SageTV\ChannelLogos*. For the HDTV channels, some of the logo files had to be copied and given a different name. For example, a *wxyz.jpg* image file was copied and given the name *wxyzdt.jpg*.

## 6.9. Java

A Java runtime environment (JRE) is packaged and automatically installed with the SageTV application. It is recommended that the JRE packaged with SageTV be used. However, the JRE may display a warning that a new version is available. Although later versions of the JRE may work, they may also cause stability problems. Therefore, it is recommended that the automatic update feature of the JRE be disabled.

## 6.10. nVidia PureVideo Decoder

Download and install the nVidia Pure Video decoder according to the instructions received with the decoder, or from the nVidia web site. At the time of writing, the current driver is in a file named *NVIDIA\_PureVideo\_Decoder\_Retail\_1.02-196.exe*.

**Tip**: If multiple decoders are tried before purchase, it is a good idea to install the Microsoft DECCHECK utility. This may be downloaded for free by going to http://www.microsoft.com/ and searching for deccheck. After a new decoder is installed, run DECCHECK and verify that the proper decoder is set as the preferred decoder.

The audio decoding is currently handled by AC3Filter, which is installed by default with SageTV. The goal is to pass all decoding directly to the sound card and let the processing occur in the hardware. To do this, open up Windows Media Player. If this is the first time that the application is run, it may guide you through a configuration process. The defaults may be used. Once the Windows Media Player is running, go to the **Tools** menu and select **Options**. Press the **DVD** tab and then click on the **Advanced** button. This will bring up the AC3Filter configuration menu. Go to the **System** tab, select **Prefer other decoder**, and press **Apply**. Then press the **OK** button. Now, click on the **Advanced** button again and this time it should bring up an nVidia audio control panel. For the speaker configuration, select S/PDIF output to a receiver. Press the **OK** button and close Windows Media Player.

At this point, the default video decoding is done by the nVidia Pure Video decoder and the digital audio is sent directly to the sound card for decoding. SageTV needs to be configured to do this as well. To do this, launch SageTV, go to the **Setup Menu** and then **Detailed Setup**. Go to the **Video / Audio** and then **DVD** menus, and make sure that all the options are set to **Default**.

## 6.11. ShowAnalyzer

The ShowAnalyzer tool is one option for detecting commercials in TV shows. More information about it may be found on the web site http://www.dragonglobal.org/.

First, download and install ShowAnalyzer. At the time of writing, the current package is in a file named *ShowAnalyzerSetupBeta.0.7.7.exe*. Once installed, open up the configuration application. On the **Global** settings page, accept the defaults except say *Never* for **Mplayer** and set **Invisible Mode** to *Yes*. Also, enable the web server and set the **Version** to 2.8. Define all the web server connection details such as host name (localhost), port (443), SSL to yes, and the user name and password to use

when connecting. Then, select to test the connection and make sure it works.

## 6.12. DirMon2

The DirMon2 utility is only used on this system to run the ShowAnalyzer application. More information about DirMon2 may be found on the web site http://www.dragonglobal.org/.

First, download and install DirMon2. At the time of writing, the current package is in a file named DirMon2Setup.0.5.9.exe. Once installed, run the DirMon2 application. Create a new job called ShowAnalyzer. Set it to scan the video directory. In the case of this example HTPC, the directory is  $D:\SageTV$ . Set the executable to the *ShowAnalyzer.exe* program. This should be in the folder  $C:\Program Files\Dragon Global\ShowAnalyzer$ . Set the target file extension to *mpg* and define the "Must not exist" trigger to *txt*.

Under the **Global Settings** tab, add a new clean up rule that deletes any files ending in *txt* in the folder  $D:\SageTV$  if a matching file ending in *mpg* does not exist. Check the **Start automatically at boot up** check box. Then, click the **Install** button and then the **Start** button. Go to the **File** menu and select **Save**. Then, exit the DirMon2 GUI.

## 7. Other Utilities

Although the core HTPC is built and configured, there some additional utilities that may expand its use. The software installed on this example HTPC is listed below. Others may have different requirements such as the ability to play DivX files, or store DVD data in a file. Since the HTPC is a standard Windows-based computer, the available options are enormous. The Dynamic Main Menu customization for SageTV can make it easy to launch these applications from within SageTV.

## 7.1. Adobe Flash Player

This is the new name for the Macromedia Flash Player. If the HTPC is used for browsing the Internet, the ability to view Flash video may be desired.

## 7.2. Adobe Premier Elements

The purpose of this software is to take video from a DV camera, edit it and create a DVD with the video in a standard DVD player. A DV camera or DVD drive may come with similar software from Ulead, Pinnacle, or others. It is recommended to download trial versions of the various software offerings to determine the one that is easiest to use and provides the desired functionality.

## 7.3. Adobe Reader

This software allows the viewing of PDF files. User manuals such as for SageTV are sometimes released in PDF format. It is nice to be able to open and read those on a large screen.

## 7.4. Google Video Player

There are a number of video clips that may be downloaded from the Internet. The Google video service contains a good variety of clips. The player may be downloaded from http://video.google.com/ and installed. After installation, load the player, edit the preferences, and set the video directory to the shared network drive to which the videos may be saved. This way any computer in the house may easily access clips downloaded from any other computer.

#### 7.5. Interactual Player

Some DVD videos come with the Interactual player. When such a DVD is installed in the HTPC, a dialog appears asking if the player should be installed. This may be an annoyance in that the **Cancel** button must be pressed to bypass the install. It may also confuse those who do not understand why the dialog window is being displayed.

There are two ways found to stop this message from appearing. One is to go ahead and install the player and then configure it to not automatically play a DVD. Be sure to run DECCHECK after installation and verify that the nVidia decoders are still set as the primary decoders, (see *nVidia PureVideo Decoders* in the *Installation and Configuration* section for more information about DECCHECK).

The other option is to use software such as AnyDVD. This has an option to ignore any installation requirements. However, this software may not be legal to use in the US as it bypasses the protection on the data contained on the DVD.

## 7.6. TightVNC

At times it may be useful to access the HTPC remotely for support or other purposes. This was requested at one time by the SageTV support team in order to help solve an issue. There are various VNC packages available, but TightVNC was chosen.

The software may be downloaded from http://www.tightvnc.org. At the time of writing, 1.2.9 is the latest stable version. Once the installation package is downloaded, double click on it to install the software. Select to register TightVNC as a service and to start the service. Enter in a default password and check the **Poll in full screen** check box.

Next, run the **Security Center** option in the Windows Control Panel on the HTPC and select **Windows Firewall Settings**. Go to the **Exceptions** tab and click on the **Add Program...** button. Select **Launch TightVNC Server** and press **OK**. At this point, a VNC viewer on a remote computer should be able to connect to the HTPC server. Keep in mind that this is not Remote Desktop and any movement made through the TightVNC viewer will be visible on the TV.

## 7.7. Yahoo! Music Engine

Install the Yahoo! Music Engine. When first run, have it search the network share containing the music files. Log in and select to remember the log in details on the computer. Edit the preferences and set up the music directory. Set it to scan the directory every 30 minutes.

## 8. Open Issues

Although this example HTPC is considered complete, there are a handful of small open items that could still be addressed. These are:

- The mute button does not work for DVD and HDTV audio. The volume control works fine, so a mute can be simulated by turning down the volume.
- Occasionally a recording will contain invalid time settings. This may be seen as the playback timer increasing in 10 second blocks instead of one second at a time. The fast forward and rewind buttons also do not work correctly. This is due to a Hauppauge driver issue and may be fixed with a registry change. More information about the problem and fix may be found at

http://forums.sagetv.com/forums/showthread.php?p=158770&postcount=14.

- Some shows have small, white bars flickering along the top. This is closed captioning (CC) data. There is no way to remove these lines, but it is possible to adjust the screen offset to hide them. To do this, go to the **Setup Menu** and then to **Detailed Setup**. Go to the **Multimedia** menu and select **Aspect Ratio Settings**. Experiment with changing the **Vert. Offset** value. This example HTPC is using a value of *5*, although others on the SageTV forums report success with a value of *-3*.
- Taking regular backups of certain SageTV files such as *wiz.bin* and *menu.xml*, (for those who use the Dynamic Main Menu customization), is a good idea. This allows for the recovery of various preferences and show data if anything happens to the SageTV installation. A script for doing this may be found in the SageTV Customizations forum.
- It may be desirable to be able to take a snapshot or image of the OS hard drive. This may be useful in order to restore the system to a known working state after installing an upgrade that causes problems, or testing software that is no longer wanted. For example, if a new video decoder or version of SageTV is released, a snapshot may be taken of the existing, working system, and then the new software may be loaded and tested. If there are any issues with the upgrade, then the system may be restored from the snapshot to the exact state it was before the upgrade. The Acronis True Image 9.0 Home software is recommended on the SageTV forums for this and other backup tasks. Other software such as Ghost are also available.
- Depending on the location and antenna, it may be possible to receive HDTV signals from nearby cities. If these stations are not considered part of the local area when configuring the tuner, then programming guide information will not be retrieved for these channels. In order to address this, XMLTV may be used. It is also rumored that later versions of SageTV will provide a solution as well. For more information about using XMLTV, please see the following web page: http://forums.sagetv.com/forums/showthread.php?t=17363.

#### 9. Further Resources

Several resources were used during the process of building this HTPC. Some of the ones most visited are listed in Table 4.

URL	Comments
http://forums.sagetv.com/forums/index.php	SageTV forums
http://www.avsforum.com/	Wealth of information about A/V topics
http://www.tomshardware.com/	Helped in hardware and software selection
http://www.silentpcreview.com/	Provides some help in picking quiet components
http://www.sage-community.org/	Home for some customizations

Table 4: Useful Resources

#### 10. Revision History

Date	Author	Comment
2 August, 2006	Karyl F. Stein	Original document written.

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Date	Author	Comment
10 August, 2006	Karyl F. Stein	Added header, footer, and list of tables.

Table 5: Revision History