PC-based Home Multimedia Centers

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Abstract

Multimedia content is these days created, stored, delivered and consumed in digital format. This has opened entirely new possibilities, but has also caused some consumer centered problems that can be solved using PC-based home multimedia centers. This paper builds a conceptual model of a typical home multimedia system, extracts its components, and describes the hardware devices and software modules needed to implement such a system. Available software suites are surveyed, and three Windows and two Linux-based candidates are chosen for detailed comparison. Of these, MediaPortal and MythTV are considered the most appropriate solutions for home multimedia entertainment. An example design using the selected components is also given.

1. Introduction

Figure 1 shows a typical home multimedia setup, which consists of standalone devices that are connected together with cabling that carries only analog audio and video signals. The system is robust, scalable, has fast response rates and is relatively inexpensive, but has several problems attached as well. First, there is no central control point of operation, which results multiple man-machine interfaces and input devices (a total of 6 remote controls are needed to operate the systems of Figure 1!). Second, the only way to transfer audio and video material between rooms is by using storage media such as discs or tapes, and managing a large collection of discs and tapes can become so time consuming, that one rather takes the risk of loosing a title into the archives. The computer is well suited for archival tasks, but a third problem arises because it can be accessed only from single room. Finally, a port to the internet can be opened only from that computer, making real-time multimedia streaming and information retrieval somewhat artificial.

There have been more or less successful efforts to solve these problems. For example, recent HDD-DVD-VCR combo devices [1] that can even play compressed audio streams and interface digital still and video cameras, wireless media streamers that work across the rooms, and thin internet clients such as connected stereo equipment provide partial remedy. However, the most flexible multimedia system should be built around an appropriately equipped personal computer, often tagged with marketing terms ‘media center’ or ‘digital entertainment center’. It differs from a basic multimedia PC (practically all modern PCs, including laptops, can be considered as multimedia PCs) by providing similar audio-visual connections that are found in standalone set top boxes, DVD players, VCRs, TV sets and stereos, and by providing recording functionality of VCRs in digital domain (referred as Personal/Digital Video Recorders, or as PVRs/DVRs). They also contain a media player component that is capable of rendering audio, video and still pictures, and naturally have internet connectivity integrated as well. Their user interfaces can be operated from a distance using a remote control input device, using TV screen as the output device.

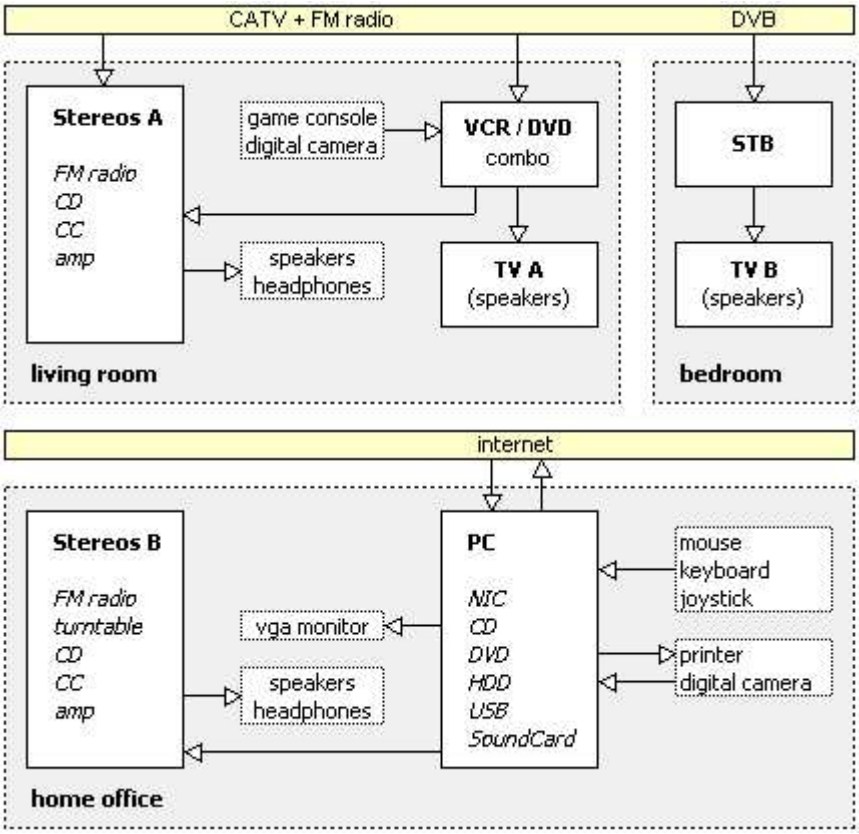

Figure 1. A typical home multimedia setup. The yellow boxes denote broadcasts and web content.

This document investigates how the problems evident in Figure 1 can be overcome using such a media center approach. Chapter 2 defines conceptual requirements of the system, by drawing common usage scenarios associated with live and recorded multimedia content and extracts the basic components and interfaces from the use cases. Chapter 3 lists the hardware components, while Chapter 4 concentrates on the core software and plugins that are needed to fulfill the conceptual requirements. The leading software suites are surveyed in Chapter 5 for Windows, Linux and Macintosh platforms, and a feature-by-feature comparison of most potential systems for Windows and Linux is carried out. Chapter 6 re-designs the initial setup of Figure 1 using the pre-built hardware and software components discussed in preceding chapters, and calculates a rough price tag for the design. Finally, Chapter 7 concludes the discussion by checking the design against the conceptual requirements, and pointing some further work topics.

2. Conceptual Model and Requirements

Standalone consumer media devices can be divided into audio group that use speakers and headphones as output terminals (stereo combos containing FM radio receiver, CD player, compact cassette deck, turntable, amplifier), and into visual group (TV, STBs, DVD player/recorder, VCR, hard disk recorders and game consoles) that use additionally displays or projectors for output. There are also portable devices such as digital cameras, MP3 players, PDAs and iPOD -like gadgets. However, most of the tasks performed by the standalone devices are conceptually similar, and can be combined into a framework like the one shown in Figure 2.

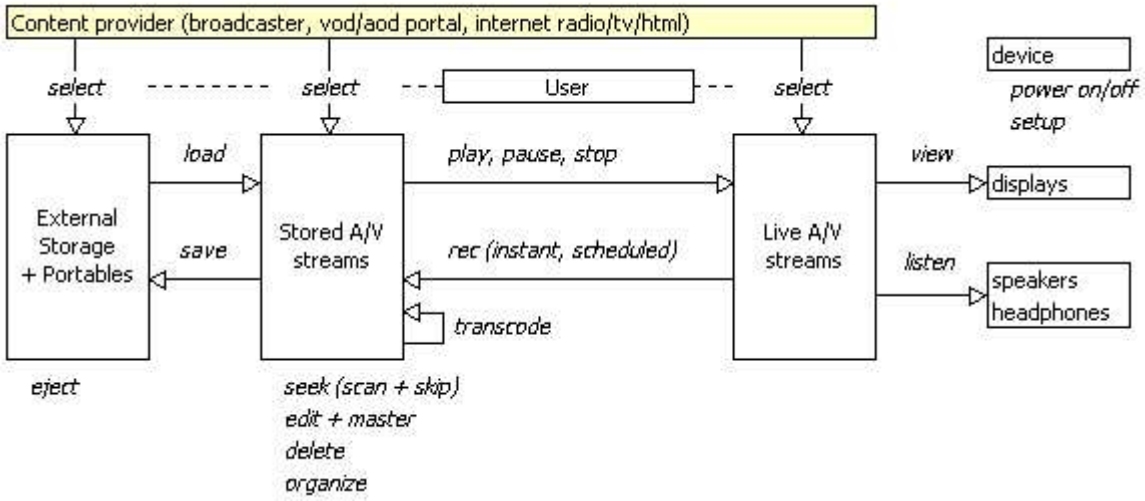

Figure 2. Most common usage scenarios.

Here the system is modelled as operations on audio/visual streams of different states. A live stream is the one that is currently playing, coming either from the internal storage, or from an external source as analog or digital TV/radio broadcast or real-time internet media stream. A stored stream is previously recorded material persisting in internal (HDD) or external storage media (DVDs, CDs or VHS tapes). It is important to realize, that the solid arrow lines of Figure 2 represent simultaneous streams, so that more than one stream can be rendered at a single time, or that one stream can be viewed while another one is being recorded or saved.

Most of the operations are targeted towards the stored content, although live broadcast can be paused or scanned backwards as well, if proper buffering is provided. Seeking can be performed inside current playback stream on single frame basis, or on higher hierarchy levels between scenes, chapters, titles and movies / shows (corresponding levels in music streams would be samples, indices, tracks and albums). Simple editing functions such as commercial cutting and DVD mastering should be available before material is backed up into external storage. Finite space properties of the internal storage require also a form of cleaning policy, and compression techniques to transcode recorded material in offline mode. Organizing a large collection is essential, and automatic metadata generation should be utilized as much as possible. The obvious device power on/off operation is included in the model because it is important to keep the initial boot-up time in minimum.

Permanent internet connection adds functionality of the system far beyond real-time vod/aod service utilization. Automatic metadata fetching was already mentioned, but news, other RSS feeds, weather forecasts, timetables, information searching and plain internet browsing provide more content to select from. An important application area is communication, as email, instant messaging, VOIP and even video calls are available. Their user interfaces differ from the standard Wimp paradigms when operated from a multimedia-oriented device.

The conceptual components of the system are live and stored streams, substreams, schedules (EPGs, recording task lists, playlists), live sources (channel frequencies, URLs), stored libraries (metadata) and stream handlers (player, recorder, editor, ripper, burner). The interfaces include physical input and output terminals, analog signalling, protocols, storage and transfer formats, and codecs.

3. Hardware

A media center PC should be equipped with at least 2 GHz processor and 1 GB of RAM, which can be found inside any standard desktop PC these days. In addition to the supporting hardware (casing, quiet fans, power supply, motherboard etc.), tuner, video and audio cards, permanent storage, interaction and network IO devices should be included.

3.1 TUNER CARDS

TV and radio broadcasts are received using a PCI or USB compatible tuner/capture hardware. Analog tuner cards often contain additional input for video signals from VCR and similar sources, while digital cards employ only one DVB input source (there are different models targeted for terrestial, cable and satellite reception). Dual-tuner cards allow simultaneous reception of two channels, and some recent cards offer one analog and one digital channel simultaneously. Analog cards may support FM radio reception as well; digital reception is automatically available if radio channels are included in the DVB bundles. Furthermore, analog teletext is commonly supported, but many DVB cards cannot handle digital teletext, subtitles or EPGs properly.

DVB transport streams are MPEG-2 encoded, so recording is just a simple disk write operation that does not require much processing power of the main CPU. On the other hand, analog signals must be compressed in real-time, which is a computationally demanding task, and for this reason the analog tuner cards are often equipped with MPEG-1/2 encoding chips (later models offer even MPEG-4).

3.2 VIDEO CARDS AND DISPLAYS

Video output is eventually routed to display terminals, which comprise computer monitors accepting VGA signals, analog TV displays with RGB or composite video input, and LCD or plasma panels and projectors using digital streams. Conventional TV displays have low resolution and a low refresh rate when compared to other display types. They also use interlacing that should be compensated when playing back progressive content.

The display terminal is interfaced with a PCI or AGP bus video card, which is equipped with VGA, TV or DVI/HDMI output. Some dual-head video cards have the ability to connect multiple displays into one unit, and with some cards it is possible to send a separate video signal into TV out while viewing the desktop from a monitor connected into VGA output of the card. Video cards may also employ MPEG-1/2/4 hardware acceleration for decoding, thus taking the processing load off from the main CPU. The quality of the TV out signal can be increased using a VGA-to-PAL converter, which is an external unit connected into VGA output of the graphics card, but that is more expensive solution.

If the TV display is not located near the computer, an external wireless video sender/receiver device can be used to transmit the signal even between different rooms of the house. There are also networked digital streamers available for the task.

3.3 AUDIO CARDS

Most motherboards contain integrated audio hardware, with line/mic level stereo and mono inputs, and multichannel analog and digital outputs. The sound quality of these integrated chips is usually quite noisy because of interference, and a separate PCI or USB compatible device is often more adequate choice. Some cards offer DSP effects processing algorithms in hardware, e.g. for virtual 3D space modelling.

3.4 STORAGE DEVICES AND DISCS

Audio and video content consume large amounts of storage space, as one hour of DVD quality MPEG-2 compressed stream equals roughly to 2 GB of storage. One minute of uncompressed CD quality audio takes about 10 MB of space, but it can be easily compressed into 2 MB without noticeable loss in quality using for example MPEG-1 Layer-3 compression. More advanced compression techniques like MPEG-4 can reduce both video and audio material storage requirements further.

Even with compression, a large capacity hard disk drive is needed to hold even a reasonably sized media library. 200 GB drives with 7200 rpm speed are acceptable, and with USB2 or Firewire ports external hard disks with terabyte capacities are also at disposal. They provide naturally more portability, but more common distribution method is to use DVD and CD media.

Single layer DVD discs have 4.7 or 9.4 GB capacity for single- or double sided discs, respectively. Double layer discs increase the storage to 8.5 or 17 GB. CD discs are capable of holding 700 MB worth

of data. Both disc types have read-only, write-once and rewritable formats, while DVD discs have further two competing formatting standards that have to be supported by the DVD drive of the computer. Forthcoming Blu-ray and HD-DVD formats increase capacities to 25 and 15 GB per layer. Digital cameras use solid stage storage such as flash memory, which can be interfaced by a computer using an internal or USB-connected universal card reader.

Figure 3 shows comparison of the storage cost per gigabyte using the media formats discussed above ([2] sampled 22-Jan-2006). CDs should only be used as transfer format to provide compatibility with existing players, and dual layer DVDs might be more appropriate for mass archiving, because they take less physical space than corresponding single layer discs. External hard disks are more expensive than internal ones, but they provide larger capacity. In order to increase response times, multimedia content and application code should be stored in different physical disks, especially if PC is used in other tasks while recording in background.

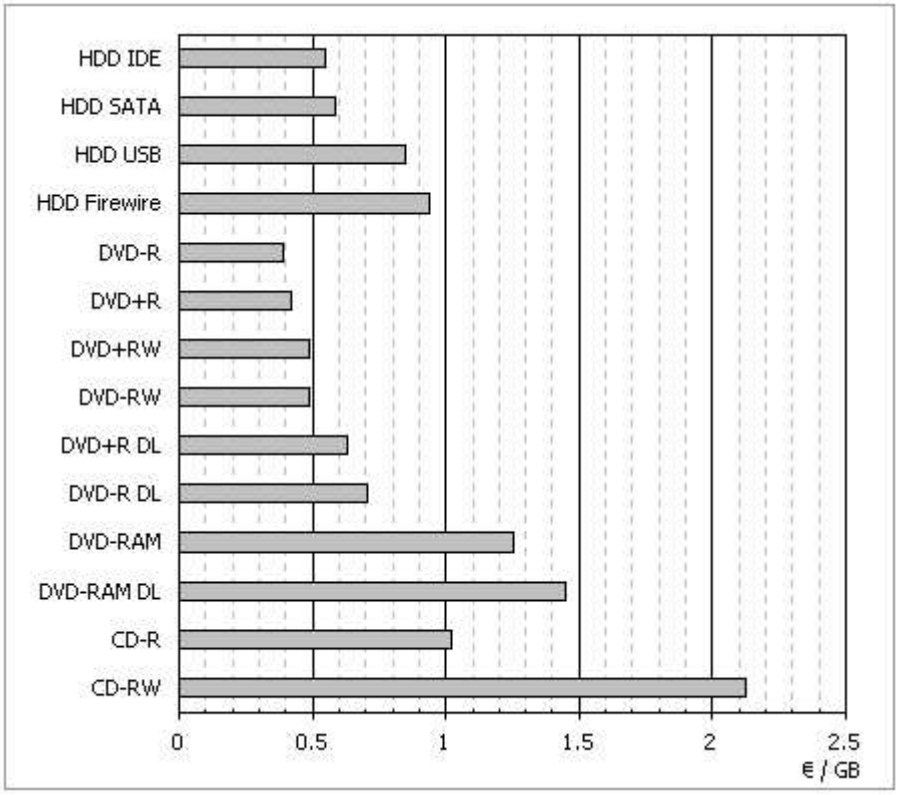

Figure 3. Storage cost using various media formats (euros per Gigabyte).

3.5 INTERACTION DEVICES

The user can interface media center PC using mouse, keyboard and remote control devices. Mouse and keyboard are traditionally wired into the computer, but for the purpose, wireless solutions are more appropriate. Infrared connection is cheaper, but it requires direct line of sight between the transmitter and the receiver, while devices using radio frequency connection are usable even if there are physical obstacles between the recipients. Receivers plug in into computer's USB port, and the same interface might contain also IR transmitters that are used to control STBs and other peripheral standalone units. Remote controls are likewise available in IR/RF formats, and can be interfaced with the same receiver that is used for keyboard and mouse devices.

3.6 NETWORKING

Internet connection is usually established using a cable or xDSL modem plugged into PCI/USB bus or Ethernet port of a computer. Multiple subscribers can also connect into a shared high-speed modem via standard telephone cabling, and use a HomePNA NIC or an Ethernet converter to interface the network.

This type of connection provides speeds from 1 Mbps upwards, which is lower than VCD MPEG-1 at 1.5 Mbps. More advanced compression techniques do produce acceptable quality even with this speed, however.

Inhouse LAN can be wired (Ethernet, HomePNA, HomePlug) or wireless (IEEE 802.11a/b/g, Bluetooth) [3]. Theoretical maximum data rates and ranges for each technique are given in Table 1 below, but in practice at least bandwidths are considerably lower due to physical obstacles, interference, collisions, encryption and the like. For reference, Table 1 contains maximum speeds also for USB and IEEE 1394 ports and some multimedia stream sources.

Wired	*speed (Mbps)*	*range (m)*
Ethernet 10BASE-T	10	100
Ethernet 100BASE-T	100	100
Ethernet 1000BASE-T	1000	100
HomePNA 1.0	1	150
HomePNA 2.0	10	300
HomePNA 3.0	128	300
HomePlug 1.0	14	n/a
HomePlug AV	100	n/a
Wireless	*speed (Mbps)*	*range (m)*
IEEE 802.11a	54	15
IEEE 802.11b	11	46
IEEE 802.11g	54	46
Bluetooth	1	10
Ports	*speed (Mbps)*	*range (m)*
USB 1.1	12	5
USB 2.0	480	5
IEEE 1394a (Firewire)	400	4.5
IEEE 1394b (Firewire)	800	100
Multimedia Streams	*max (Mbps)*	*ave (Mbps)*
DVB (sdtv, per channel)	5	-
VCD (mpeg-1)	1.856	1.15
SVCD (mpeg-2)	2.6	2
DVD (mpeg-2)	9.8	4
DivX (mpeg-4, home theater profile)	4	1
CD-A (uncompressed)	1.4	1.4
mp3 (medium quality)	0.128	0.128
mp3 (high quality)	0.256	0.256

Table 1. Theoretical data rates and distances.

Inhouse LANs are connected to the internet (or WAN) using a gateway computer that has two NICs to interface both networks, or through a central residential gateway / router which contains one NIC to the WAN, and one port or wireless access point for each LAN node.

4. Software

This chapter introduces various software components of a media center, organizing them into core, communication and plugin applications. MMI, networking and driver issues are briefly discussed at the end of this chapter.

4.1 CORE COMPONENTS

A media player component is capable of rendering audio and video streams and still pictures of various transfer formats, either from live or stored source. Recognized formats are sometimes hardcoded into the player, but more flexible solutions perform transformations via separately installable codecs. Audio material can be processed with effects (e.g. equalization or delay) before it is directed to the sound card for stereophonic or multichannel output. Digital photos can be shown one-by-one, or played back as a slideshow, with background music and transition effects. Wide selection of video formats is usually available, but an external decoder is often required for DVD playback. It is common to use predefined playlists for audio playback.

A special player is used for real-time streams originating from TV and radio broadcasts. It is capable of switching the input channel according to user inputs and providing subtitling from DVB stream or from teletext. Timeshifting can be used to pause the live material, while the component keeps storing real-time content into a buffer, and then later resumed where left off. It is also possible to rewind live shows for instant replay using the same buffering technique. It is however surprising, that not all media centers allow storing of the buffered material, although the buffer is actually already in HDD.

Recorder component is responsible for storing the received stream into hard disk for later viewing or listening. Video material is usually stored in MPEG-2 format, because transcoding might be computationally too demanding operation to perform in real-time without hardware support. Software encoding is possible with current CPUs, but the machine may then be unavailable for any other task. Transcoding raw recording into more economical format can be done in background, using a lower priority process. Recording can be done instantly or triggered by a predefined schedule.

Electronic Program Guide (EPG) is an interactive on-screen display of broadcasting channels and their programs. It is usually displayed as a 2D grid with channels on vertical axis, and programs on the horizontal axis, tied to time. The grid displays program title, but more information is often available by selecting a single program from the grid. EPG may also provide searching based on keywords or genre. Sources of EPG can be internet, analog or digital teletext, or standardized DVB service information format. A related utility is channel list manager, which allows tuning, channel name and order editing, and management of personalized favourite lists to ease channel surfing.

Managing a large media collection can be a challenge, so media centers often store metadata of stored streams into a database to ease searching and source selection. Some metadata can be automatically gathered via EPG, from internet databases such as IMDB or CDDB, and there are modules specifically written for automatic album cover fetching.

Most of the parameters of the system are defined at installation phase, usually within the desktop environment. Some parameters might need adjusting later, so there must be a setup component that can be run using the media center interface. There are also basic housekeeping tasks like storage space management that are handled using the setup component.

4.2 PLUGINS AND COMMUNICATION FACILITIES

Plugins or add-ins do not necessarily perform multimedia-related tasks, but are nevertheless well suited for situations where a media center would be used. They are either available from main application provider, or from 3rd party sources, and are glued to the main application via dedicated API, or are just simple standalone applications reachable from media center's menu structure.

Ripping audio and video material directly from disc is a recording related process, for backup purposes. Dedicated applications for the task exist, so they are often grouped into the plugin category. Rippers usually work using separately installed codec base, so they can perform various compression tasks. The opposite task is Dvd authoring, which involves also simple stream editing (like commercial detection and stripping).

Games are perhaps closest to the multimedia components, as they can benefit from large display screens and multichannel audio. Games do not necessarily have to be single player versions, as LAN and internet multiplaying is possible. They might be controlled by a simple remote, although a joystick or a dedicated game control pad is more common interaction device.

Internet browser is particularly useful if display has decent resolution. For example, when listening to a music track, the browser can be used to get background information on composer, artist or song. The browser can be naturally used for any surfing, although the navigation might be too demanding for a standard remote control.

RSS and Atom services are XML-based feeds that can be used to quickly browse through new content in selected web sites. They can be read using a dedicated application, a news reader / email client or even the browser. For example, local weather forecasts and news can be shown on-screen interfacing these kinds of feeds.

A particularly attractive application for media center is the interactive 3D world map from Google. Also smaller applications (i.e. desktop widgets in Apple jargon) like calculators, on-line timetables, reminders and sleep timers are well suited for media center experience.

Media center can also be used to check/read/answer emails, for instant messaging, for callerID display, VoIP and even for video calls or video conferencing. These facilities are often provided as plugins.

4.3 Related Issues

A challenging problem for usability is the 10-foot experience, where a low-resolution output device is used for display, and a remote control works as the principal interaction device. Interaction mechanism is familiar from DVD menus, where focus point is moved using remote's navigation buttons inside a coarse grid of elements. There are also direct shortcut buttons in the remote. In practice, new frontends must be written to existing applications, so media center applications often provide a higher level XML or HTML interface to the main MMI, and a lower level API using some conventional programming language.

Some systems provide distributed architecture, where several client applications can access the server remotely via network. Clients run in proprietary standalone extender units or PCs, employ a simple playback engine with MMI and are able to stream the server content into TV sets and stereo equipment. Some systems have even distributed servers across the network.

The most important software components influencing usability, stability and quality properties of a system are the low-level drivers that are provided by hardware manufacturers. Drivers are interfaced through a higher abstraction level API, which is determined by the media center system. In Windows platform, this usually spells DirectX, while in Linux there is a collection of APIs separately defined for each hardware device type.

5. Software Survey

5.1 Overview

There are a growing number of media center software suites available for all major platforms. Suites from Microsoft and Apple are practically integrated into the underlying operating system, while those bundled with some third party hardware are simple standalone applications. In between there are commercial and open source solutions that integrate multiple standalone applications into one central media center suite. Extensibility and customization is available (in varying depth) in form of plugin APIs / open source modules, codec selection and skinnable user interfaces.

Windows

In Windows platform, the native media center is built around *XP Media Center Edition 2005* (MCE), which is a cutdown version of XP Professional operating system enhanced with media related functionality [4]. The forthcoming Windows Vista is going to contain at least some functionality of MCE built into its retail distribution. MCE 2005 is an OEM component, and cannot be purchased separately without buying the hardware required to run it. It is also a frustratingly closed system, but reportedly quite stable.

MediaPortal (MP) is an open source alternative [5]. The project started in 2004, but having its roots in XBox Media Centre project, the software had already gone through several revisions before it was re-used in MP. Current registered user base is over 10000, and development status is quite active. Its open nature and scalability makes it an attractive choice over MCE. It is implemented in C# and uses .NET framework and DirectX 9.

SageTV, SnapStream's Beyond Media and CyberLink's *PowerCinema* are commercial media center suites all in their 4th major release versions. The latter comes bundled with a tuner card, and can even be found pre-installed on some OEM PCs. *SageTV* has a Java-based plugin API, which is documented on their web site, and does support custom skinning using an optional authoring tool. Another

commercial application *Meedio* Pro has an exceptionally large add-in collection (SDK, sample code and tutorials are available online), while still providing most of the core functionality described in Chapter 4 [6]. It reports to hold over 18000 registered users, and it is based on an earlier open source myHTPC project.

There are many other applications available for Windows platform besides the ones discussed above. For example*, J.River Media Center* and *ShowShifter* are low-cost but extensive all-in-one applications, and most tuner cards come with 'free' PVR applications, like those from Hauppauge, Pinnacle, or LogiTech.

LINUX

A large number of small media related applications are available free of charge when working in Linux platform, but many of these are designed to run in a desktop environment rather than with a remote control and TV. Furthermore, they are actually core modules or plugins of a media center application, and do not provide a centralized solution to the control problem discussed in Chapter 1.

However, there are two high-level front ends designed especially for 10-foot experience, which tie the functionality of standalone tools together to form a real media center application. *Freevo* was started on 2002, and is currently in release version 1.5.4 of November 2005 [7]. *MythTV* dates also from 2002, and has matured since into release version 0.18 of May 2005 [8]. Both of these are naturally open source, implemented in Phyton and C++, respectively. Dedicated Linux distributions are available for MythTV for easier setup, and there is a Windows port (WinMyth) available as well.

MACINTOSH

Macintosh based media centers are not evaluated in detail, but the following list describes briefly what is available. FrontRow is freeware application from Apple, collecting company's iLife application suite into an iMac media center package. MediaCentral is another 3rd party freeware application providing most of the core functionality described in Chapter 4. CenterStage is an open source project written in Objective-C, which is quite active, but still far from being complete. EyeHome is a commercial media center application that is bundled with a hardware digital streamer device.

5.2 COMPARISON

Five media center applications were chosen for head-to-head comparison: Media Center Edition 2005, Meedio Pro and MediaPortal run in Windows platform, while MythTV and Freevo run in Linux. Latter three can be downloaded free of charge, MCE costs 125 €, and Meedio 45 € (as of 23-Jan-2006). Their features are compared against supported hardware, core components and additional functionality. MMI issues and architectural solutions are also discussed briefly.

5.2.1 HARDWARE

All compared applications are able to interface *tuner cards* with analog TV and video input, and even external tuners are available using IR blasters or serial ports. Analog FM radio is missing from Meedio and Freevo, though. In digital domain, MythTV and Meedio have support for DVB, MCE supports only up to two terrestial digital tuners, while MP works even with hybrid analog/digital models. Overall, MediaPortal offers the most when considering tuner cards, as multiple cards (seven or more!) having different sources are at disposal at one single time (for example, it is impossible to mix digital and analog cards in MCE or Meedio). Its only shortcoming is that it supports only digital teletext (and might thus have difficulties with subtitles), whereas MCE, MythTV and Freevo have analog teletext capabilities.

The amount of supported *video and audio cards* depend on driver API and hardware requirements of the particular media center system. Windows suites demand DirectX 9 compatible drivers in general, and MCE has an additional list of hardware requirements as well. Linux cards should support XVideo extensions and ALSA drivers. TV output is naturally a must.

Large capacity *hard drives* are required, and for large file size support MythTV suggests XFS or JFS file systems. FAT formatted systems may be problematic, and this will make cross platform file sharing difficult. CD and DVD drives do not have specific requirements, and card readers are unsupported in general. All suites are designed to work with IR/RF *remote controls* and keyboards. Mice are not supported by Freevo and MythTV. MediaPortal can utilize universal USBUIRT and StreamZap remotes, and IR or serial line control of peripherals is available in all applications.

5.2.2 CORE COMPONENTS

LIVE TV AND RADIO

Live TV and FM radio support is largely based on the choice of the tuner card(s), although timeshifting is possible in all applications, excluding Freevo. Even if the card has a tuner for radio and media center knows how to tune it (Meedio and Freevo do not), the support is rather varied. MediaPortal contains full support, whereas MCE can timeshift but cannot record the audio. All suites support Internet radio streams.

MCE records in a proprietary dvr-ms format, which is actually MPEG-2 housed within a proprietary ASF container (there are 3rd party editors and transcoders available, but these are naturally unsupported by Microsoft). Recorded files can be saved to DVD/CD, but played back only in another MCE equipped computer, and if the source is copyright-marked, only with the machine that recorded it. Otherwise recording is well interfaced, as it can be started immediately or using EPG/manual scheduling, can be prioritized for conflict management and as it can have 4 different qualities. Background recording is also available.Other suites can record transport streams directly or compress analog signals into MPEG-2 format, and transcode the recording later automatically in background with better compression ratios.

MEDIA PLAYER

Excluding Freevo, all suites employ an internal player for video and audio, which can be substituted with external players if desired. Video clip playback capabilities depend on installed codec base. MCE can play any format that is recognized by Windows Media Player 10, but cannot utilize custom video filtering. MediaPortal supports DirectX filters, so it can use ffdshow for postprocessing. All Windows suites require DirectX 9, and use the improved VMR9 for rendering as default. Separate DVD decoder software is needed for DVD playback, although external playback application is not a necessity. Freevo uses MPlayer or Xine for rendering.

Video output is available in full screen and in windowed mode (MythTV supports even picture-in-picture), and different aspect ratios and zooming is well supported. MythTV runs always under X, whereas Freevo supports also Linux frame buffers. For multi-head video cards, full screen output is available only on first monitor. All common audio formats are supported internally (cda, mp3, wma, ogg, wav), while CD ripping is usually handled using a plugin. Playlists are supported by all applications. They are also capable of displaying still pictures as a slideshow, but the pictures must be copied into hard disk manually before that feature is available (i.e. smartmedia and twain are not supported).

EPG

All suites excluding MCE use xmltv [9] for EPG data grabbing from the internet. MCE has a proprietary format (although a tool for xmltv - guide conversion exists). MediaPortal and MythTV can also utilize streamed DVB EPG for program listings. The number of days that the EPG holds ahead depends on content provider, typically it is between 1 and 2 weeks. MythTV and 3rd party MCE plugin support record scheduling via internet, although that might be a potential security risk.

Visually, 5 to 8 rows of channels are shown per screen with 1.5 to 2 hour timespan horizontally, and a short summary information for selected item is displayed at the top or bottom of the EPG screen. MCE, MediaPortal and MythTV show a thumbnail preview of currently selected show if it is being broadcasted (see Figure 4). MediaPortal contains also horizontal and vertical scrollbars for quick navigation.

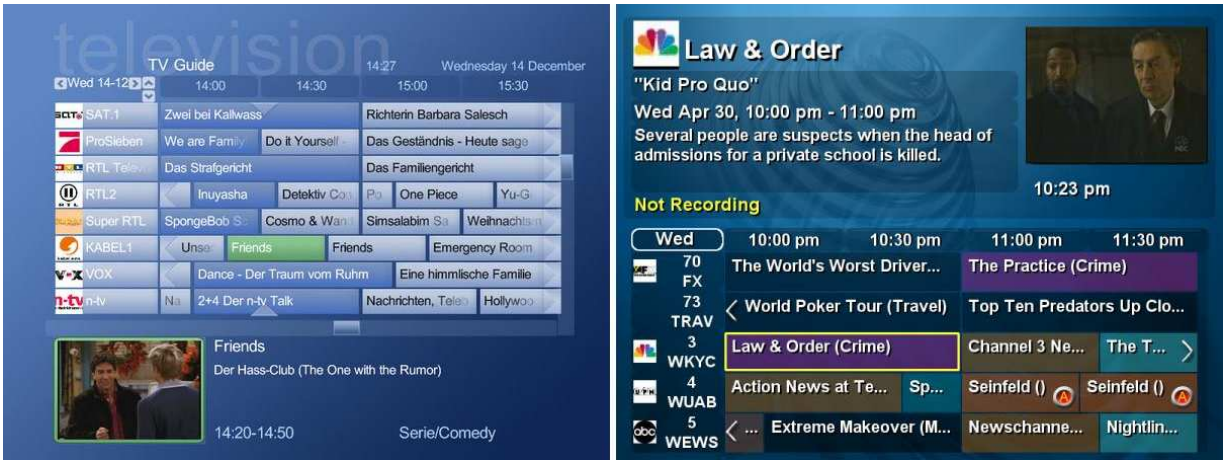

Figure 4. EPGs of MediaPortal (left) and MythTV (right).

METADATA

All suites excluding Freevo store metadata inside a database which can be built by scanning current hard disk contents, whereas Freevo uses an (inefficient) text file and directory based approach instead. MCE shares the database with Windows Media Player and gets movie information (cover art, cast, reviews etc.) from All Movie Guide, while the others rely on IMDB. Music album information is fetched from cddb or freedb, and id3 tags are supported by all applications.

Suites using a database are able to search and sort media items by name, date, type, genre, artist, actor or keyword, although there are also plugins that are specialized for metadata handling. For example, MCE has an online/offline DVD collection manager, while MediaPortal has similar extensions for all video and audio metadata management. MCE maintains also an additional recording history for trouble-shooting purposes.

INSTALLATION AND MAINTENANCE

Windows-based suites have simple wizard-driven installation packages, while Linux suites have to be built from scratch and installed manually. Luckily, documented installation procedures exist for both MythTV and Freevo, even for different Linux (mini)distributions, and these can be easily found from the internet. MediaPortal and Meedio come with conventional desktop installation packages, while MCE manages most of the installation tasks using just the remote control and tv display (there are some specific settings that have to be made within XP's desktop, though). Maintenance actions can be done with the remote control, excluding Freevo, which requires manual scripting.

CONTENT EDITING AND TRANSCODING

MythTV includes a commercial detection mechanism that produces cue markers for later delete/move editing actions, and automatic skipping while in playback. Other applications do not employ such a mechanism, and the general method is to use dedicated external tools for the task. MCE native format dvr-ms files can be edited and converted to MPEG/WMV format using free tools from [10]. MediaPortal and MCE have configurable background transcoding, Freevo has some transcoders in plugin format, while Meedio relies entirely on external software. MythTV can transcode internally or externally using a perl script. DVD authoring is handled exclusively using external tools.

5.2.3 PLUGINS AND COMMUNICATION WIDGETS

At the time of this writing, 97 add-ins were listed for MCE [11] (provided both by Microsoft and 3rd party developers), including games, RSS/Atom readers, transcoders, weather and google maps. SDK is available from the internet [12], and it can be used to write MCE-hosted HTML applications, managed-code extensions and device drivers for the environment. MediaPortal treats the entire application as a collection of plugins, as most useful and popular ones get eventually integrated into the core. Plugins can be written in any .NET language, and an excellent C# tutorial is available at [13]. It is also possible

to launch any external program from the MMI. Meedio's site has a dedicated add-in directory containing links to more than 200 plugins and tools. API documentation, plugin templates and source code examples written in C++, C#, Delphi and VisualBasic using .NET are readily available [14].

MythTV plugins are dynamically loaded libraries, interfaced with three C entry points. SDK, plugin source code and documentation is available from their primary website [8]. Freevo can also be thought as a mere frontend to plugins, but the variety available is not as large as that with other suites. Plugins are interfaced by python scripts, and can either be implemented as such or as external applications. Documentation and core plugin distribution can be downloaded from [7].

Most communication related functionality is provided as plugins. For example, all suites provide email checking and reading capabilities, and VoIP/video calls using Skype or SIP are available in all systems except Freevo. MCE even integrates callerID display from POTS and MSN Instant Messenger support into the application itself.

5.2.4 MMI

All suites can be operated using a remote and a keyboard, and excluding MCE, all support button/key configuration and scripting either internally or via a Girder-like plugin [15]. They use LIRC for infrared signal decoding [16]. MythTV and Freevo do not officially support mouse interface, but can be patched to do so. MCE, MediaPortal and Meedio have an on-screen keyboard for text entry. Freevo and Meedio have a Bluetooth plugin, which allows remote control operations using a cellphone.

MCE cannot be skinned without dirty binary file modifications, but its 3D user interface looks so nice out-of-the-box that other packages try to emulate it with their themes. Themes consist of XML files defining layout, menus, colors, fonts etc., and of image files defining icons, logos and backgrounds. They can be downloaded as a package, or created from scratch using separate tools of MediaPortal, Meedio and MythTV. In Freevo, the theme can be created by editing XML and image files directly.

5.2.5 ARCHITECTURES

MCE master machine can be accessed from up to five client extenders, which are standalone devices connected to the LAN (one of the extenders can have wireless connection, others must be wired) and to the TV terminal for output. Most of the functionality of the master is available on extenders, but there are performance constraints that limit the number of simultaneous sessions. There can also be multiple remote desktop sessions, so it is for example possible to watch TV while surfing with another PC.

MythTV has the most advanced distributed architecture, allowing multiple recording machines and multiple playback machines on the same network. The internal structure is transparent to the user, so for example recording can be started from any frontend computer, while MythTV takes care of the physical resource allocation in backends. MediaPortal, Meedio and Freevo do not currently support client/server architecture, so a general digital media streamer [17] is the only option.

6. Design

Figure 5 shows a re-designed version of multimedia setup of Figure 1, addressing the problems that were discussed in chapter 1. PC A hosts a media center application offering single MMI to operate the entire setup with a single remote control unit. Multimedia content is distributed over several hard disks, and it can be accessed from any room of the house via ethernet LAN. Metadata is collected into central database that can be browsed, searched and sorted by PC, Laptop or Streamer. Internet is also available from any computer or any room of the house, because of wired and wireless access points.

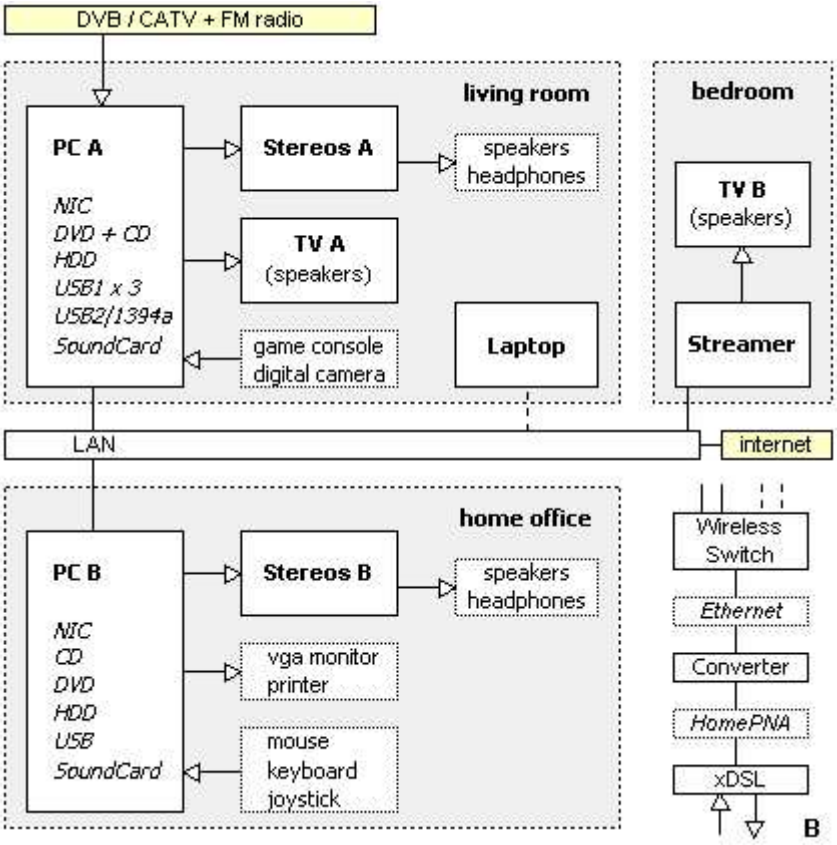

Figure 5. Re-designed multimedia setup. B) Network stack.

So, problems solved, but at what cost ? For this particular setup, the web is interfaced with a shared HomePNA connection, so it must be converted into 100 Mbps Ethernet, with wireless (802.11g) access point in the switch. Laptop and Streamer use wireless connection, while desktop computers are wired for faster speed. PC A does not have a monitor, mouse or keyboard, but can be accessed using a remote desktop client running either in Laptop or PC B instead. PC A houses a large capacity hard disk that is used for recordings and frequently used media content, while PC B provides additional storage capacity. Storage space can be increased further into the Terabyte dimension using an external USB2 / Firewire hard disk.

PC A contains two tuner cards (for analog and digital cable), a decent TV-out equipped video card (DVI as an option), RF remote control and receiver, 2 IR transmitters (for TV and stereo equipment control) and two sound cards (PCI + integrated) for 2 x stereo line level inputs, microphone input and 2-channel analog and SP/DIF multichannel output. Tuner card has also FM radio and S-video inputs for VCR, game console and digital camera. In addition to the Firewire port, at least 3 USB1 ports are needed (one spare for HUB, webcam or memory card reader).

PC A is configured as a multiboot device with Windows XP Home running MediaPortal, and Linux hosting MythTv. Naturally, one media center application would suffice, but as half the fun is tweaking, more parameters equals better. The Linux distribution has yet to be decided.

Table 2 lists configuration for PC A and network peripherals, and calculates a price tag for the entire system ([2] sampled 29-Jan-2006). The initial investment is rather high, but the price tag is later brought down because there is no need purchase STBs when analog broadcast services are shut down, and there is no need to buy standalone hard disk / DVD recorders either.

PC A

General		
cpu	AMD Athlon 64 3200+	190
ram	Transcend 1 GB DDR 333	96
motherboard	EPoX 9NDA3+	110
case	Thermaltake Tenor	110
power + fans		120
AV cards		
tuner #1	TechnoTrend DVB-C Budget 1500	80
tuner #2	Hauppauge PVR-350	158
video	(in tuner #2)	0
audio #1	(in motherboard)	0
audio #2	(in tuner #2)	0
Storage		
hdd #1	Samsung SpinPoint P120	100
hdd #2	Samsung SpinPoint P80	83
dvd	LG GSA-4167RB	47
cd	LG GCC-4521B	33
Network		
ethernet	(in motherboard)	0
usb2	(in motherboard 8x)	0
1394a	(in motherboard 2x)	0
MMI		
remote	MCE Remote USB	35
ir receiver	(with mce remote)	0
ir blaster 2x	(with mce remote)	0
Software		
os	Windows XP Home	93
dvd player	(comes with dvd drive)	0
		1255

Peripherals

Network		
ethernet <-> hpna	A-LINK COH-E	46
ethernet switch	A-LINK WL54AP2 /w 802.11g	58
ethernet -> tv	Hauppauge MediaMVP	100
		204

Table 2. Hardware components and expenses.

7. Conclusion

A media center software suite running in a hardware configuration given in Table 2 is able to solve the problems that were discussed in Chapter 1, while fulfilling the conceptual requirements of Chapter 2.

MediaPortal is the preferred application on Windows platform, because it is open, supports a large set of hardware devices (including DVB-C), and because of its ability to work with multiple tuner cards. On Linux platform, MythTV is clearly a much more advanced suite than Freevo.

The lack of digital subtitling support is definitely a big shortcoming that should be addressed later. There are also other items that need further investigation: requirements for quiet operation, boot time, support for portable devices and stability issues remain still open, and should be examined more closely.

References

[1] *JVC DR-MX1*, JVC Consumer Electronics, 2005. Referenced 30.1.2006. http://www.jvc.fi/tuote?kategoria=10200.3000&id=1158770 (in Finnish).

[2] *Verkkokauppa.com*. Referenced 30.1.2006. http://www.verkkokauppa.com/ (in Finnish).

[3] Thurrott, Paul. "*Windows XP Home Networking*", Wiley Publishing, 2002.

[4] *Windows XP Media Center Edition 2005 Homepage*, Microsoft, 2006. Referenced 30.1.2006. http://www.microsoft.com/windowsxp/mediacenter/default.mspx

[5] *MediaPortal Homepage*. Referenced 30.1.2006. http://www.team-mediaportal.com/

[6] *Meedio Homepage*. Referenced 30.1.2006. http://www.meedio.com/

[7] *Freevo Homepage*. Referenced 30.1.2006. http://freevo.sourceforge.net/

[8] *MythTV Homepage*. Referenced 30.1.2006. www.mythtv.org

[9] *XMLTV Homepage*. Referenced 30.1.2006. http://membled.com/work/apps/xmltv/

[10] *the green button Homepage*. Referenced 30.1.2006. http://www.thegreenbutton.com

[11] *MCE Plugin List*. Referenced 30.1.2006. http://moremce.com

[12] *Microsoft Windows XP Media Center Edition 2005 Software Development Kit*. Referenced 30.1.2006. http://www.microsoft.com/downloads/details.aspx?FamilyId=33839D15-FD6E-46BE-A3B3-EEB7A62D1B20&displaylang=en

[13] *How To Write a Plugin For Media Portal*. Referenced 30.1.2006. http://www.team-mediaportal.com/PluginTutorial/PluginTutorial.htm

[14] *Meedio Developers Network*. Referenced 30.1.2006. http://www.meedio.com/mdn

[15] *Girder*, Proximis LLC, 2004. Referenced 30.1.2006. http://www.promixis.com/products.php?section=girder

[16] *LIRC Homepage*. Referenced 30.1.2006. http://www.lirc.org/

[17] *Hauppauge MediaMVP*, Hauppauge Computer Works, 2006. Referenced 30.1.2006. http://www.hauppauge.com/pages/products/data_mediamvp.html