AC-312
STORit

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Contents

1. Executive Summary

The STORit project (March 1998 - February 2000) has been the logical continuation of the preceding SMASH project (ACTS 018, 1995-1998), in which many of the project partners participated. The SMASH project focussed on technologies required for recording digital video broadcasts on hard disks and other digital storage media. Now that this technology had become available, and the storage capacity of affordable hard disks continued to increase rapidly, the STORit project focussed on getting the right content on the hard disk.

In a few years time, an affordable hard disk will be able to store tens -if not hundreds- of hours of television programmes, all instantly available to the consumer with great ease of use. This implies that this local storage space becomes a common interest between the consumer and the broadcaster. Both have an interest in getting the right programmes on the right hard disks! For the consumer it means a higher density of interesting programmes than the many available TV channels have to offer at any particular time. For the broadcaster it means an opportunity to get his programmes delivered precisely to those viewers interested in them, which is becoming more and more difficult with the ever increasing number of television channels viewers have access to.

This notion that local storage is really another delivery channel to the consumer, in addition to broadcasting, internet, publications etc., formed the basis of the STORit project. Our goal was to make local storage an integral part of the delivery chain, interoperable with internet and digital broadcasting, and with added value for the broadcaster and consumer alike. This has led to the concept of *TV Anytime,* initially developed within the STORit project, then taken up in DAVIC and later the TV Anytime Forum which currently has over sixty companies for members.

TV Anytime is a framework that enables broadcasters to offer programmes to consumers in a very low-threshold manner, and likewise enables consumers to easily acquire the programmes of their choice on their local hard disks. A few examples will illustrate the point:

- You watch a trailer advertising next season's new series of 'Robot Wars'. With one click of a button you are able to ensure that each episode of the new series will be captured on your local disk, for you to watch whenever it suits you.

- You visit the Open University web site, that lists all courses available in the upcoming winter. Deciding to learn French, you click on the link that tells your personal recorder to capture all episodes of the French language course starting next month.

- You personal recorder, having noticed you like programmes about antiques, starts automatically recording such programmes, in order to ensure it always contains new programmes matching your interests, ready for consumption.

In addition to the definition of these concepts and contribution to their standardisation, the STORit project has built demonstrators implementing the full TV Anytime functionality. This includes both the consumer device (the STORit Box), and the services provided by broadcasters and internet providers. The fully operational demo has been shown in the New Technology Campus of the IBC'99 in Amsterdam, and was received with great enthusiasm.

Much attention has been devoted to personalisation of the STORit Box. It now learns about the owner's preferences, and is able to record automatically with fairly high percentages for 'getting it right' - 70% to 80% on average. In the user interface, the automatic recording feature becomes visible through 'L-icons', little animated characters that share your tastes and give advice on which programmes to pick. There are several to choose from, but especially our Pingo has stolen many hearts at IBC.

In addition to the use of the STORit Box and TV Anytime, the project has also developed an application for home education purposes. Here TV Anytime is exploited to combine PC and internet-based training courses with educational television programmes. The directness of the TV programmes is a valuable addition to the course. For example, users are able to play back a particular fragment of an educational TV programme at exactly the right moment as they make their way through the material.

2. Project objectives

- from the original project proposal -

It is a major goal of the ACTS initiative to promote interoperability of different services delivered through different channels to the end user. Everyone aims at Interactive Multimedia Services and that is also our aim. There is however a **major basic issue** and that is that "bandwidth for interactive services" will always be (very) limited. The optimal realisation for interactive services is a combination of "pre-stored/downloaded information" at the users home and a low bandwidth interactive channel for feedback to the provider. This issue of Interoperability will become most manifest at the consumers home and especially when he will store the multimedia services.

It is our **main objective** to study and realise the complete chain from content provider to end-user for delivering all kinds of multimedia interactive services where the right balance is achieved between "on line" and "off line" communication with the service provider.

The **end goal** is to offer for the consumer a very cost effective solution for receiving and using multimedia services at home based on cheap local storage. The concept is based on the fact that in the near future 100 Gigabytes of storage will cost less than 50 dollars .

In the project we have partners covering the complete chain and we plan to achieve true interoperability with existing and new interesting services and guarantee end-to-end service interoperability.

We present here an example of what becomes possible when the complete chain is taken into account. Our concept is that in the future the consumers will receive much more information than they are able to consume and moreover they will find it difficult to find the right information. The following exemplifies on how this may be improved in the future.

A broadcaster is preparing a series of programs on home gardening where each program in the series is broadcast once a week and a total of say 20 programs are prepared. Those programs will cover a wide variety of issues such as flowers, vegetable growing, trees etc.. Each program may take 1 hour so a total of 20 hours is broadcast. The consumer records all programs at home. Later or even during the broadcast period he wants to "consult" what has been recorded but he does not have time to watch 20 hours of video and moreover he is interested only in vegetable growing. The broadcaster knows this and prepares each program with an index on topics and time codes where this appears in the broadcast. This example carries over to many other applications.

The **interoperability** aspects we want to study are manifold. First there are the different channels and different representations of information such as DVB/Internet channels and MPEG-2 and HTML information. Also we will address the interoperability of the equipment at the home and especially the interoperability of Set top boxes with several types of consumer storage both Tape and Disc based.

The **end result** of the project will be a prototype system compatible with the regular DVB broadcasts. However the broadcaster will simulcast special information with the regular broadcasts to aid and control the storage function at home. At home our prototype system will consist of a digital set top box and a home storage server. With this total system several new

services will be implemented. As part of the project several user trials are planned to verify the developed technologies with real users. The project will contribute its results to relevant standardisation bodies like DAVIC and MPEG-7.

3. Relation to ACTS programme objectives

- from the original project proposal -

The third call for ACTS has defined several tasks. Our project addresses mainly the tasks which are described in Task AC126 dealing with Interactive Multimedia Services Inter-operability. However our project has also some activities which fall under tasks AC92, AC706 and AC517.

Task AC126 addresses many items. Our project will focus on the following aspects as they appear in the call. With each aspect some explanation is given on the contribution from this project

- *protocols for interactive multimedia communication:*

  This project is based on the concept of interactive services where "information common to many users" is first broadcast and stored locally at the end user. We are interested in developing protocols for both the download communication as well as the interactive use by the user.

- *multimedia service platform with end-to-end service interoperability:*

  This is a very important goal of the project where from the broadcaster to the end user several services can be used on the same user storage platform.

- *new generation of intuitive usage terminals and customer premises networks:*

  We will contribute to this task because the project is focused on the usage at home. We would like that the storage function at home is regarded as a central function where both the service provider can "download his services" and "several users in the home can use those services independently". Our concept of a central home server coupled to other equipment via in an house network fits very well to this task.

- *tools and methodologies for multimedia program production:*

  This task will be addressed in a narrow focussed form by one work package on Personalised Remote Learning. Especially the task of the "teacher" to create multimedia based personalised learning programs will contribute to this task.

- *contribution to consensus on standards profiles to guarantee interoperability of multimedia applications across Europe:*

  As we work towards open interfaces in this project we plan to contribute wherever this is necessary and useful to standardisation bodies. Especially DAVIC and later the TV Anytime Forum have been important to our work, and much effort has been spent on contributions. Contribution to MPEG-7 has been more limited, because the relevant partners each already have other channels through which they participate in MPEG-7.

Also we have addressed AC92 (Broadening of participation) and actively sought for participation of new partners and SME's. We have included a partner from Central Europe and a SME from the EC. But we have also spent effort to include partners that cover the end-to-end service delivery chain.

Task AC706 (Guidelines Consolidation) is also important to us and we plan to contribute with the ongoing Guidelines Consolidation especially with the guidelines being drafted by the SII chain. This project will fit optimally in the SII chain and we will contribute to its activities.

Task AC517 (Open communication environment using agents technologies) will be addressed by one of the work packages but will focus more on the role of agents inside the users home.

4. Main achievements of the project

4.1. Introduction

The overall objective of the STORit project is to create and demonstrate end-to-end solutions for consumer-targeted services, making combined use of

- Digital Video Broadcasting (DVB),
- Internet,
- Local storage at the consumer's home.

Broadcasting, of course, has the advantage of being the cheapest way to reach all consumers simultaneously, with high bandwidth. Internet contributes its low-bandwidth interactivity, and local storage (e.g. a hard disk in a settop box) affords the possibility of caching material in order to have it available instantly, independent of broadcasting or network connections. Using the combination of these three media, consumer needs can be served much better than by either of the three separately. In order for the public to benefit from these advantages the creation and standardisation of new services is required.

Figure 1 presents this situation where content is being distributed to consumers in various ways, and Internet also provides a return channel. A provider, on the left hand side in the figure, has some or all of those distribution channels available. A television broadcaster typically has access to all of them. The BBC for example, the broadcaster in the STORit project, also runs internet services and publishes books, magazines, CDs etc. In such situations, it is worthwhile to combine these channels, in order to use them more effectively.

In addition to the interoperability, another important aspect of the project is personalisation: the tailoring of information and services to the needs of individuals. From the overwhelming amount of data available over DVB and Internet, consumers have difficulty to find and select the material of their interest. Personalised services will assist the consumer in this task, which is in the interest of the content provider as well: they profit from getting their material on the hard disks of their target audience and thus increasing the probability that the content is actually watched.

And finally, a major effort in the STORit project is the realisation and demonstration of a hardware and software platform that supports all this and allows us to demonstrate the achieved benefits.

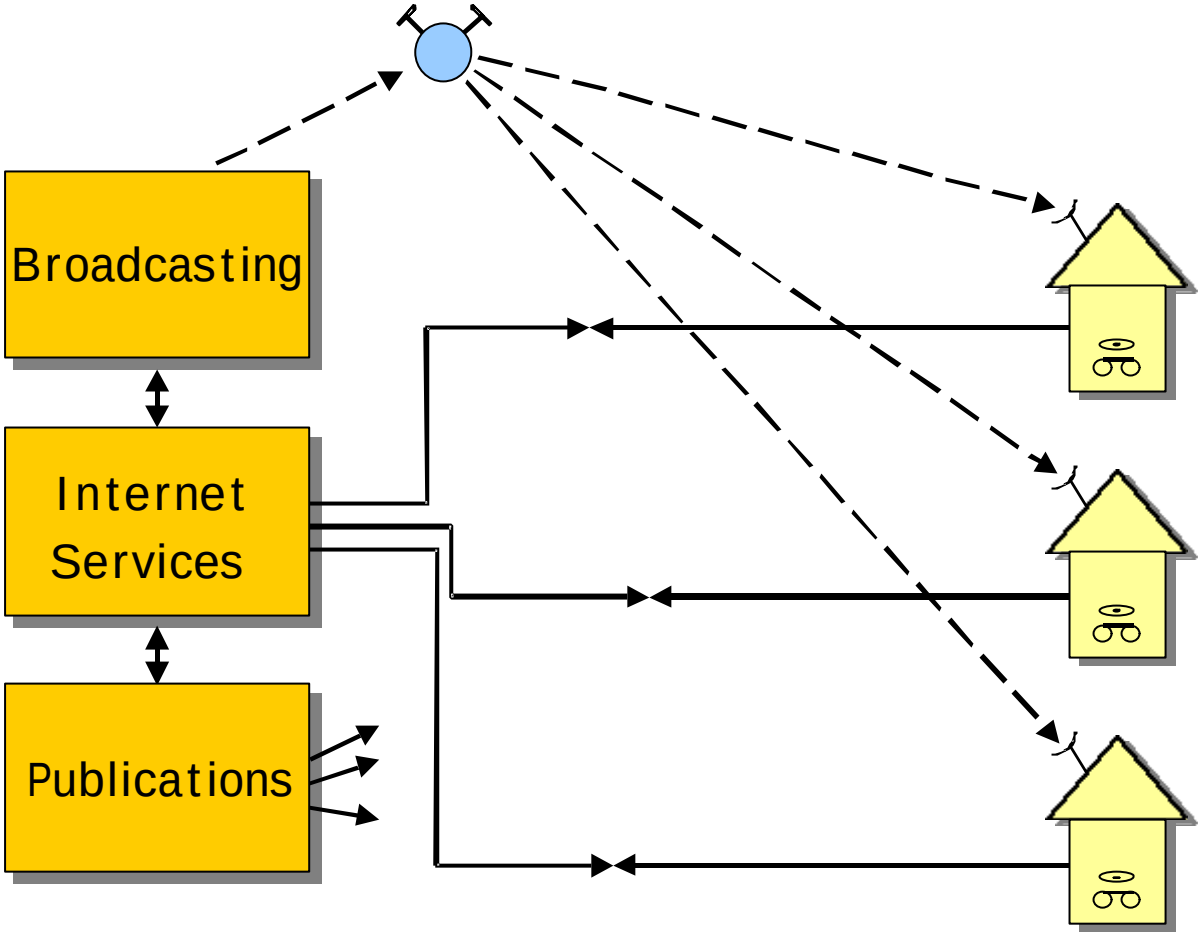

Figure 1 : DBV, internet and other means of publication reach the consumer's home, equipped with local storage.

In the STORit project, we have developed[1] *'TV Anytime'*, a framework that enables easy access to television content. It supports various low-threshold ways of selecting programmes to be captured on local storage. The selection can be made following up a link on a website or CD, or from another television programme. Or the metadata describing the programme can be used by a filter or agent in the consumer's device to reach a decision on automatic recording on the user's behalf.

The main application here is TV entertainment: helping the viewer to find those programmes he would have wanted to watch, and making them available at any convenient time on local storage. In addition to the use of TV Anytime for entertainment purposes, we have also built an application that illustrates how TV Anytime can be used for educational purposes, combining internet resources and Open University type of television programmes.

The following sections describe various aspects of the project results. This includes the system itself, some of the underlying technologies, user interface and applications, etc.

[1] Much of this work was done in DAVIC, together with the other participants.

4.2. The STORit system

TV Anytime primer

The STORit system implements 'TV Anytime', a framework conceived by the STORit partners in DAVIC, and now continued in its own separate international forum. For the benefit of the reader, the main characteristics of TV Anytime are summarised here, before we enter into the details of the STORit system.

1. Usage of local storage in the content delivery chain

Local storage, especially in the form of a hard disk in a consumer's receiver, can deliver TV content as good as, or in some respects even better than, live broadcasts. The users and the broadcasters have a common interest in getting the right programmes on the right hard disks: the users want programmes they like, and the broadcasters want to increase the probability that they reach their target audience.

2. Easy access

In order to fill the hard disk with TV content, it must be easy for the consumer to find interesting programmes and select them for capture, and it must be easy to subsequently 'consume' the content. TV Anytime provides several ways of doing this, including

- programme selection from trailer, web site, EPG
- capturing programme groups (series etc.)
- items
- links to related content

3. Attractors, metadata

In order for a user (or the device on his behalf) to make sensible selections from the large amount of content offered, data describing the programme must be provided. These attractors can include textual description, categorisation, rating, images, etc. TV Anytime and its set of attractors

- support both manual and automated selection based on personal interest
- allow personalisation

4. Programme referencing

An important underlying principle of TV Anytime is 'content referencing'. In short, it separates the identification of content from its physical location in time and/or space. A programme (or series of programmes) is referred to with a upi (unified programme identifier). An example is

upi:bbc:12345

which reveals that this identifier was assigned by BBC the identification code '12345', guaranteed to be unique within the BBC name space.

The main advantage of this construction is that it enables us to refer to programmes independent of scheduling, or even before they are scheduled. EPG tables and such will eventually reveal when the programme will be broadcast, or in a more distant future: from which server it can be downloaded.

The STORit demonstrator

The STORit system, demonstrated at IBC'99, features the full functionality of TV Anytime, illustrating how the use of local storage and the mechanisms of TV Anytime enable the viewers to easily get the programmes they like available at the moment they choose.

The IBC STORit demo system consists of home equipment (a television and a PC) connected to DVB and internet via a 'prototype' of the STORit box, a gateway to these external information channels equipped with extensive local storage in the form of a hard disk (see Figure 1).

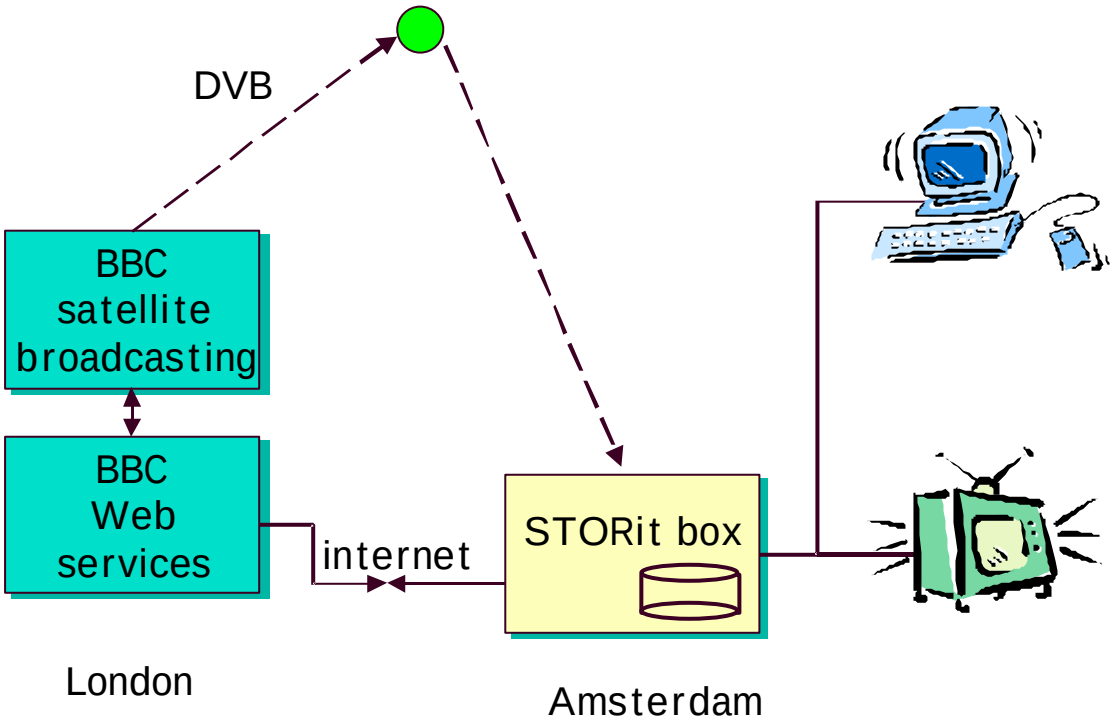

Figure 1: IBC demo set-up; BBC's DVB and Internet services live from the UK, being used in the IBC demo consisting of a STORit box, television and home PC.

The system works with live BBC digital television broadcasts received via satellite. The TV Anytime data for the broadcast programmes and dedicated web pages are supplied from London via an internet link and used in the demonstration set-up. This involves

- Fully automated generation of broadcast selection and resolution metadata in London related to live TV programme schedules from BBC the databases

- Encapsulation of the metadata stream in internet (delivery of the data via satellite to the IBC venue was not feasible yet).
- Reception of content, metadata stream and access to web site in the consumer system (RAI, Amsterdam)
- Usage of this data in the operation of the system, its advantages reflected in a dedicated user interface.

The TV Anytime features that are demonstrated, based on this data stream, are

- Easy programme selection from trailer, resident navigator using attractors, and web site,
- Fulfilment, i.e. subsequent time / channel independent capturing of these programmes on hard disk, and easy playback at any convenient moment
- Programme grouping (series, serial, season)
- Programme segmentation (Preloaded news bulletin, soccer match, educational material)
- Content management,
- Programme filtering and automatic recording based on meta data and personal profiles

More details can be found in the next sections. Another important feature shown at IBC is the interoperability between DVB and internet realised in TV Anytime. This creates great opportunities both for entertainment purposes (the BBC web site giving pointers to programs you don't want to miss, and that can be selected with one simple click) and for educational purposes (Open University type of programmes combined and integrated with web based course material).

Hardware set-up

We decided to use a PC-based approach to our STORit prototype. That is to say, we use commercially available equipment for receiving digital video (settop boxes), while using a PC for all dedicated processing. This allows us to re-use a lot of software and hardware developed in the SMASH project. A PC running the Linux operating system was selected as a flexible medium to route the data from the settop box to the system and vice versa.

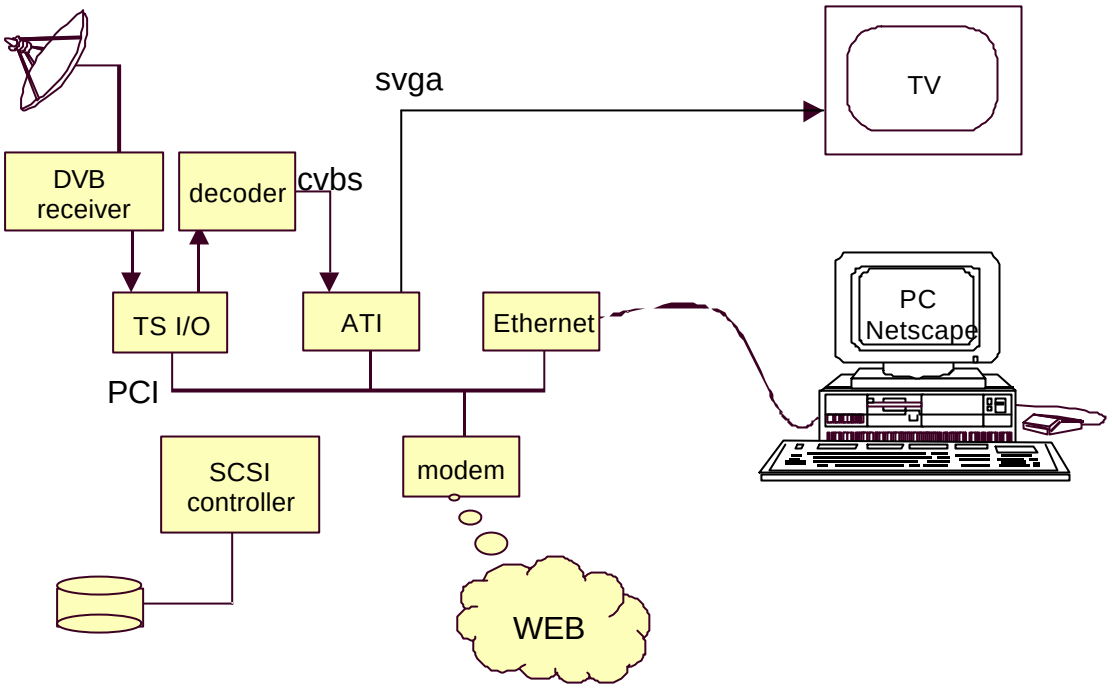

Figure 2: STORit demonstrator hardware set-up

The resulting set-up is depicted in Figure 2. The satellite signal is received by the settop box, and the resulting DVB compliant transport stream is passed to a custom-made PCI input card. On this card a program selection is made. A modem is used for accessing the Internet. To connect the PC to the Ethernet a network card is used. A Philips Tricord decodes the DVB transport stream during playback. The video output (CVBS) from this device is connected to the video-in from the graphics controller. This card is an All-in-wonder-pro from ATI. This card is used to realise the overlay function (display graphics on top of video). The VGA-out of this card is connected to the SVGA-in of the TV set. All video-data is stored on a SCSI-disk of 50GB. The disk is connected via a SCSI-controller to the PCI-bus.

Functional architecture

In Figure 3, the functional architecture of the STORit box is shown. The software architecture consists of different units. Each unit is a stand-alone program. The light grey units are programmed in C, because of the required bandwidth for the video. It is possible to have more than just one of the these units next to each other, e.g. there can be multiple receivers and displays. The language C is chosen so that future porting to an embedded system is easier. The darker ones are programmed in Java, also for portability reasons.

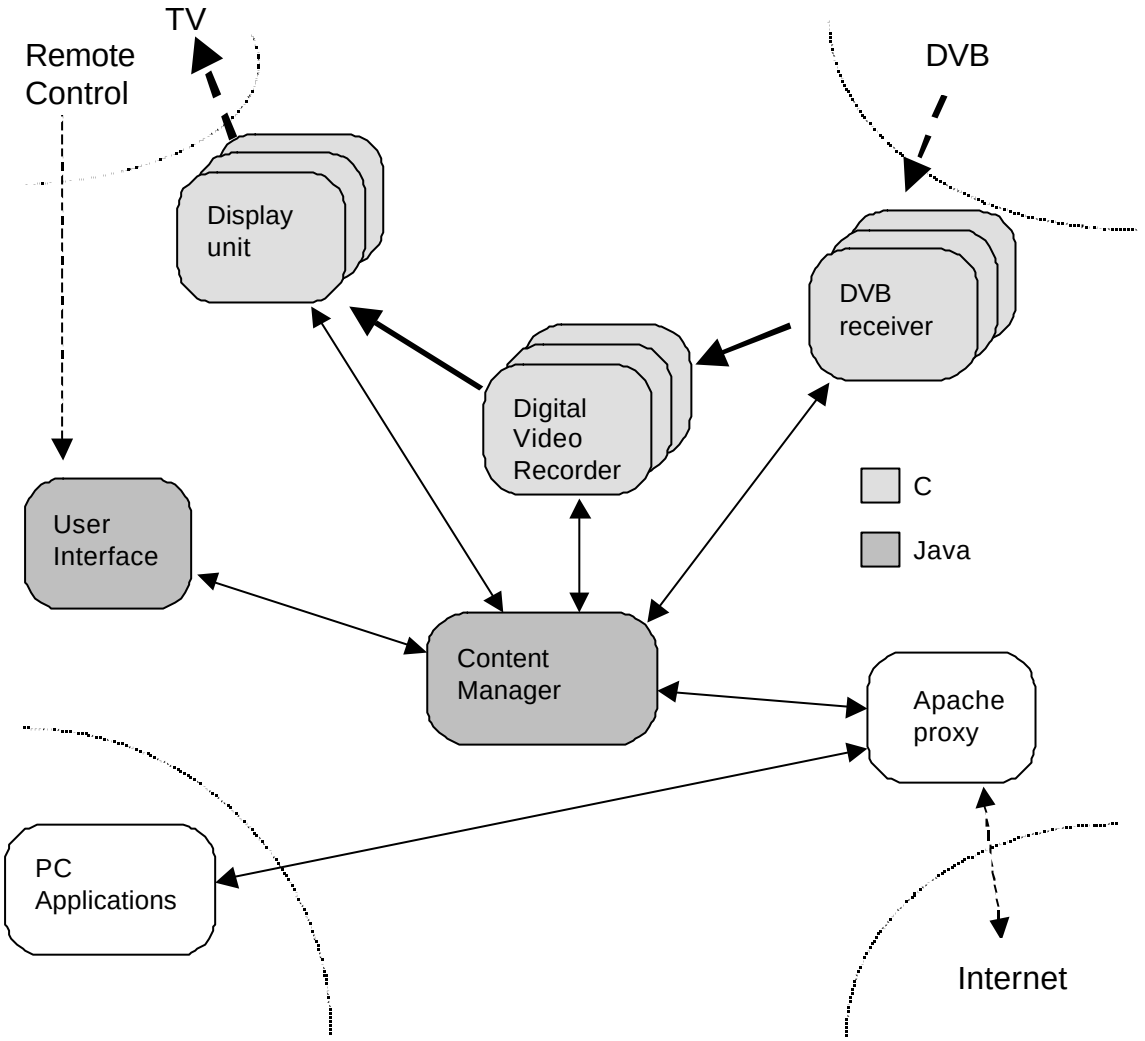

Figure 3: Functional architecture

DVB Receiver

This unit receives a DVB transport stream, a multiplex of several TV 'channels' from a DVB tuner. A custom-made PCI card enables the system to tune to a certain 'channel' in the DVB multiplex and to extract digital video and other data.

Display Unit

This unit displays the digital video data on the TV via the PCI card.

Digital Video Recorder

This unit implements real-time recording and playback to/from hard disk. For archiving purposes you can have more than just one unit, for example an optical disc or tape is also possible. A very simple filesystem is used for storing the video data. Each file consists of a number of large blocks, which are in the order of 50 Mbytes in size. The unit is connected to the DVB receiver and the display unit via FIFOs.

User Interface

The *STORit box UI* provides the user interface, on-screen graphics, and remote control handling. The UI is presented on the *display unit*. Graphics is overlaid on top of the video.

There's more about the user interface in the next section.

Content Manager

This is the core of the system. It keeps track of all the metadata, the recording list, the table of contents (TOC), and EPG. It also passes commands like *play* and *record* on to the appropriate units.

Internet Gateway

provides internet access for the STORit box and connected devices. It further provides a data cache on disk where data can be put for future use. The Apache proxy server is used for this functionality. Because all web traffic passes through the STORit box, it can intercept special links intended e.g. for the selection of television programmes, and treat them separately from ordinary links. After receiving an programme link the appropriate command is sent to the content manager via sockets. To do this a few rewrite rules were added to the config file of the Apache server. More details can be found further on.

PC Applications

These are programs running on a separate device, e.g a PC running a Web-browser, which have access to some functions of the STORit box: internet access, programming the video recorder and installing profiles for preference recording.

4.3. The STORit Box user interface

General aspects

In the near future a household will have access to about 500 channels through a satellite connection. This implies more than 12.000 programmes in one day, and 9 minutes of channel hopping to go through all channels[2]. Even at this moment, having only about 30 to 40 channels, most of us only regularly watch about 7 channels. Simply because it is too much trouble to find every programme of interest on all channels.

Since the chance of simultaneous broadcast of interesting programmes is getting bigger with the number of channels, the urge for recording programmes is growing. Another major reason to record programmes is the fact that people want to keep and own content (mostly series and movies).

[2] 500 channels with an average of 20 to 30 programmes a day equals more than 12.000 programmes a day. Going through all channels, while watching every channel for 1 second will take about 9 minutes non-stop zapping.

Thus, two related problems, from a user point of view, can be identified: finding the programmes one wants to watch, and finding the programmes one wants to keep.

On the other hand the broadcasters want *their* programmes to end up being viewed and recorded.

This implies that it is in the users interest as well as the broadcasters' interest to make an easy and fitting match between content (programme) and user. Therefore, the focus in developing the STORit system is to provide ways to help the user find programmes of interest to watch (view) and to record (keep).

At the user end of the broadcast delivery chain, in this case that would be the actual STORit box, three ways of helping the user to find the content of interest are implemented:

- Subsets
- Adaptation and user profile, resulting in a personal channel
- L-icons

At the broadcasters end of the broadcast delivery chain additional Metadata (data, broadcast along with the actual content, that contains descriptors of that content) and services are implemented, again to help the user to find the content of interest:

- Trailers with additional metadata
- Programme groups hierarchy information in the metadata
- Internet services.[3]

Subsets

Subsets actually are filters that are under full control of the user. When a subset is active, only the content (programmes), which fit the description of that subset, are presented to the user. One of the subsets is called 'all'; this subset can not be altered, since it simply encapsulates all content. Furthermore the system comes with a number of default subsets based on high level genre information conform the Metadata descriptors used:

- Movies
- Entertainment
- Sports
- News and documentaries
- Music and specialist

[3] These bullet points will not be discussed in this chapter, but of course these efforts are supported at the user end of the broadcast delivery chain, in the STORit box.

- Children

The user can alter, remove and add new subsets. Each subset has numerous entries that can be edited:

- The name of the subset (alphanumeric input required)
- Genres *and* sub-genres
- Languages *and* subtitle languages
- Countries of origin
- Programme names
- Channel names
- Keywords (alphanumeric input required)
- Days of the week
- Time span: starting time *and* ending time

Only the name of the subset is not used for filtering purposes, it is only used in order to allow the user to recognise and distinguish the subsets.

The description of a subset, on a system level, consist of AND/OR rules based in the content of the entries that can be edited. Basically AND rules are used for entries on different levels, whereas OR rules are used for entries on the same level.

The different bullet-points in the list above have a mutual AND relationship. The entries within an each bullet-point have a mutual OR relationship, except for genre and sub-genre. For the latter an AND rule must be used, because the sub-genre is on a different level: a sublevel to genre. Furthermore, each entry can consists of several items. For example multiple genres can appear in the description: movies, entertainment, etcetera. These items have a mutual OR relation.

Thus very simple subsets can be defined as well as very complicated subsets. For example a subsets can have a description such as *'genre: movies, sub-genre: western'*, which can be written as:

Genre: movies **AND** sub-genre: western

This subset will only show the western movies.

A subset can also can have a more complex description such as: ‘genre: movies, sub-genre: western, sci-fi and horror, genre: entertainment, sub-genre: factual, language: English, sub-title language: English, day of the week: Friday, Saturday’, which can be written as:

This subset will show all western movies, science fiction movies , horror movies and factual entertainment, either English spoken or with English subtitles, on Fridays and Saturdays.

((Genre: *movies* **AND** (sub-genre: *western* **OR** sub-genre: *sci-fi and horror*))

OR

AND

(Language: *English* **OR** Subtitle language: *English*)

AND

(Day of the week: *Friday* **OR** Day of the week: *Saturday*)

When a subset is activated, it could be possible that the Electronic Programme Guide (EPG) does not show any content in some at some points in time. A user then might get lost in the user interface. Therefore a zoomed out view is presented at the same time, providing help in navigating the EPG. When navigating within the EPG a highlight provides feedback on the current location in the EPG, a second highlight simultaneously provides feedback on the location in the zoomed out overview. In this way a direct link is established between the EPG, call it the *field of vision*, and the zoomed out overview, call it the *radar vision*.

L-icons

A problem in using user profiles is the so called ’cold start’ problem. At first time use the system has no knowledge on the user whatsoever. Of course the system could state all kinds of questions or present a list for the user to fill in, but this is not in line with the experience people have in the television domain. Even in the PC domain where questionnaires are more accepted, it would be a bothersome task. A solution to this problem are the Lifestyle icons (L-icons).

Furthermore (L-icons) are implemented to enhance the interaction and lighten up the user interface. A L-icon will present itself by telling its name and its personal interests (in programmes). The representation, behaviour, name and interests of a L-icon all are in line with a specific lifestyle. A user can select a personal L-icon, probably one that is the closest match: just as in making friends, similar interests form a base of familiarity and trust.

When asked, a L-icon can state its opinion on programmes and behave accordingly. Since the user has selected a personal L-icon based on similar interests, the user is likely to be more interested in programmes the L-icon likes and less interested in programmes the L-icon dislikes. Thus, the user can decide for himself what to do with the remarks made by the L-icon: ignore or use, but ideally the user does mind what the L-icon states, they are friends after all.

13 Different L-icons are implemented, based on lifestyles including kids and teenagers, both boys and girls.
Each L-icon is presented using 6 different animations, 1 introduction and 5 expressions:

- Introduction: each L-icon has to present itself
- Being Excited
- Having Fun
- Being Serious
- Being Neutral / Having no opinion
- Not being Interested / Disliking

The neutral state can also be used when no programme is selected to state an opinion on.

In the following table the relation between these different states and the Metadata is given:

Expression	Relation with DVB-SI metadata genre
Excited	General, but not *humour*, *comedy*, *news*, *current affairs*, *instruction* or *religion* Good match with profile
Happy / fun	***Humour*** and ***comedy***, but not *news*, *current affairs*, *instruction* or *religion* Good match with profile
Serious	***News***, ***current affairs***, ***instruction*** and ***religion***, but not *humour* or *comedy* Good match with profile
Neutral	General Not so good match with profile
Not interested / dislike / neutral	General Poor match with profile

The L-icons are 3D models and fully animated, adding an emotional dimension to their stated opinions. Not only to enlighten the user interface but also because emotional expressions are recognised in the blink of an eye and thus enhance the communication of their opinions towards the actual user.

For the IBC demonstrator, the L-icon profiles where entered by hand, partly based on existing market research, partly based on gut feeling.

The L-icons as implemented are a starting point; more precise descriptions for L-icons are needed depending on region if the STORit box would be an actual product for sale in the local shops.

User Interface screenshots

Figure 4 : The STORit EPG, with in the top part the zoomed out view, in the middle the actual EPG and at the bottom part some additional information on the programme currently selected.

Figure 5 : The STORit EPG, with an activated sub-set. Here it is clearly visible how the zoomed out view supports the use of the subsets.

Figure 6 : The STORit EPG, with an activated sub-set and a L-icon stating its opinion on the currently selected programme.

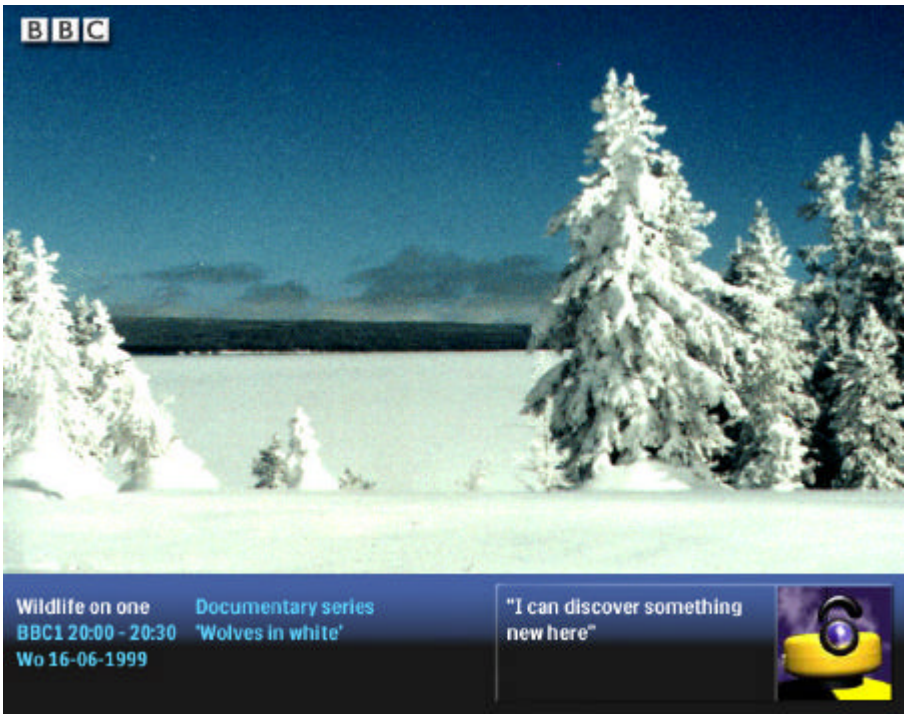

Figure 7 : During regular television viewing, the user still can display additional information on the programme being watched, and still ask the L-icon its opinion on that programme as well.

Figure 8 : A screenshot of the set-up menu where the user can select a (different) L-icon.

Automatic recording

The STORit system features automatic recording according to a user profile. The programmes listed in schedules are rated based on their title, genre, channel, etc. Details of how it works are beyond the scope of this report. Here we will illustrate how the automatic recording is reflected in the user interface.

In the user interface, the l-icon gives its opinion on programmes. Since the integration of the filtering engines into the user interface, this opinion is based on the evaluation according to the user profile. In other words, the L-icon takes decisions on automatic recording, on behalf of the user.

The L-icon's behaviour will change as the user profile changes. This is currently achieved by monitoring the user's behaviour. When the viewer manually marks a programme for recording, this is taken as positive feedback for that programme, and its attributes are fed to the jurors. When a user un-marks a programme, or deletes it without ever watching it, this is considered as a negative verdict, and again the feedback is used to adapt the profile.

The three screenshots below show illustrate how this works in practice. A penguin L-icon has been selected, intended for young boy profiles. The profile has on purpose been modified a bit.

1. The penguin L-icon has selected for recording (indicated by purple dots) some cartoons, exactly what the boy likes, but also a number of scientific programmes on the BBC IBC channel. It has failed to record the educational programmes which our boy, at home with flue, would like to see.

2. The boy manually selects two educational programmes (indicated by red dots), and removes (unmarks) two of the BBC IBC programmes.

3. The penguin's profile has been modified through the feedback these user actions have provided, and consequently the programmes in the schedule are evaluated again. The penguin now makes the correct decisions: cartoons and educational programmes, but no science.

This shows how the profile adapt to the users behaviour, even if this is not stable over time. For example, our boy can easily get rid of the educational programmes: if he deletes a few, the penguin will stop recording them.

First test results with this technology indicate that the percentage of correct decisions (to record or not record) can be quite high, depending on the kind of profile and the finesse of the programme meta data for that particular kind of programme. User tests indicate that too many wrong decision lead to annoyance, in which case the automatic is no longer an attractive feature. Our current scores are generally correct in over 70% of the cases, which is quite sufficient.

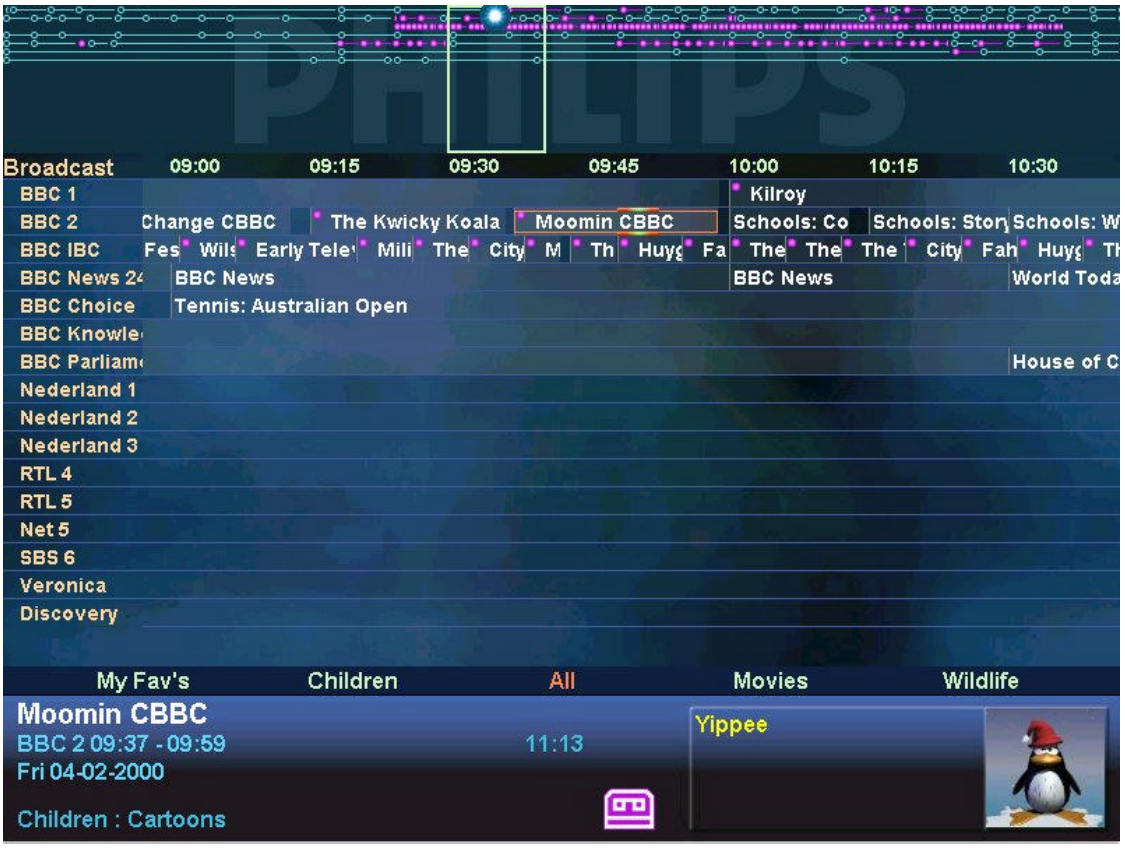

Figure 9: Programmes marked for automatic recording by the penguin L-icon, indicated by purple dots.

Figure 10: The user manually marks some educational programmes (red dots) and unmarks some of the BBC IBC programmes.

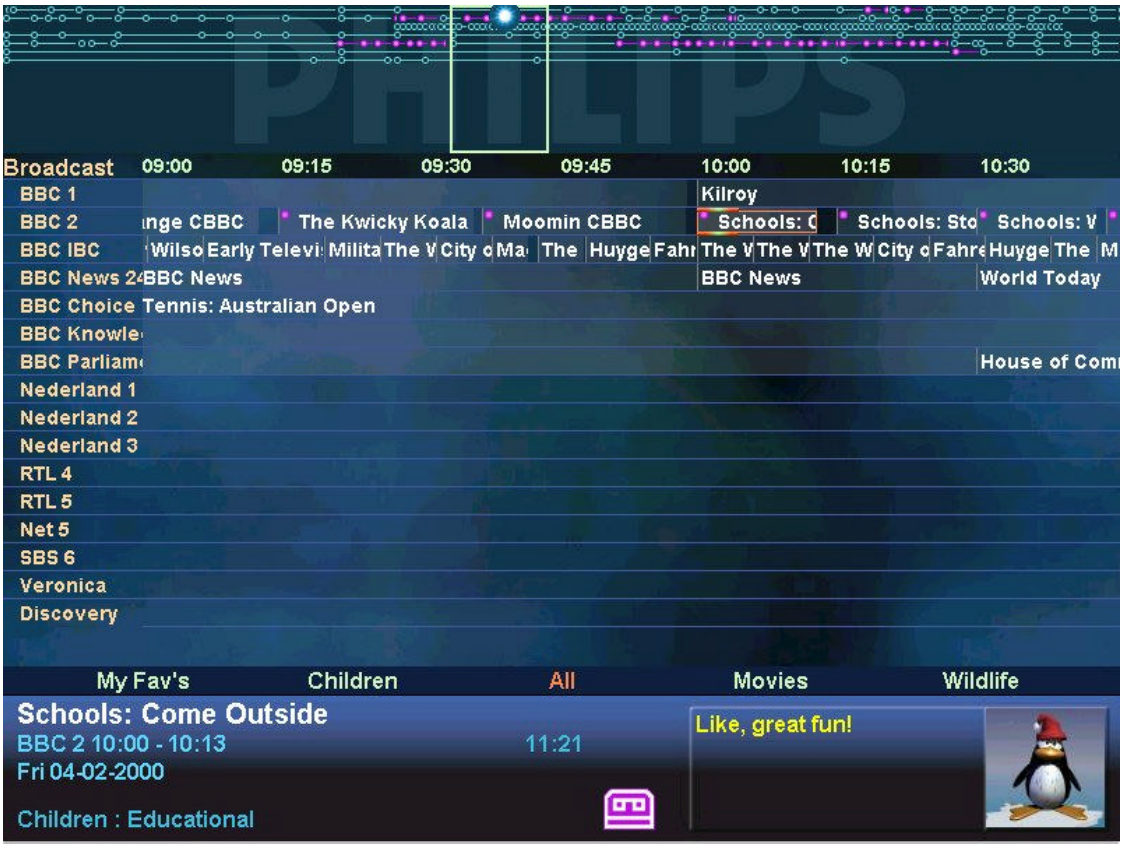

Figure 11: The user actions have resulted in a modified profile: the penguin now also records educational programmes, but no longer chooses programmes the from BBC IBC.

4.4. Programming the STORit Box from a website

It is clear that the information about TV programmes and schedules is finding its place on the Internet. Even though the user is able to find a lot of information about programmes on the Internet, until now the controlling of the video recorder while browsing, was not possible. Use of the STORit box as the Internet gateway for the personal computer at home, does offer this significant advantage. It enables sending of typical video recorder commands (Record, Play, Cancel…) to the digital video recorder, while browsing through the Internet. The result of a simple click on the programme's UPI link in the web page is an issued command for recording of this programme.

Figure 12 STORit Box ask confirmation following a click on chosen TV programme link.

Functional mechanism

An Apache server, which serves as the Internet gateway (proxy) for the user's PC, runs in the STORit box. Therefore all Internet traffic, including HTTP hyperlink requests, is filtered by the Apache server. To be able to issue an HTTP request, different from standard requests for web pages, we have defined alternative hyperlink structure for UPI links. These links are included in HTML documents as ordinary http links. In this way, the Apache server is able to distinguish between requests for web pages and requests for recording TV programmes or playing recorded programmes.

When a recording request is intercepted by the Apache server (it is a GET method of the HTTP protocol), the UPI hyperlink is processed by the Apache server *rewrite module*. The UPI hyperlink is parsed into several components (UPI identifier, programme's name, requested method (RECORD, PLAY…)). The rewrite module invokes execution of a CGI programme in the STORit box, which requests confirmation of the recording (or any other) command from the user (pop-up window, Figure 12). Upon confirmation, it sends the appropriate command to STORit box controller and returns the reply from the controller. In case the programme title is not included in the UPI hyperlink, the pop-up window refers to a programme through its UPI identifier.

UPI hyperlink structure

The special UPI link format (case insensitive), defined for the purpose of controlling a STORit box from a web browser has the following structure:

[http://<*hostname*>[:<*port*>]/][<*path*>/]STORit/<*upi identifier*>

[?[METHOD=<*method*>][+TITLE=<*title*>][+<*other parameters*>]]

The first part of the link is like a usual http link, which can be an absolute http link (with *http://hostname/*) or a relative one (without *http://hostname/*). The Apache server handles the absolute link as an http proxy request, while the relative link is handled as an http request to the STORit box. The key word *STORit* is mandatory to enable use of popular Web browsers, Netscape and Microsoft Internet Explorer. If the *hostname* and *path* were omitted, Microsoft Internet Explorer would not send the *upi* link to the proxy server on the STORit box. *Upi identifier* is a unique programme identifier, with a defined structure (ex. upi:bbc:1234). *Method* parameter defines the command we want the video recorder to execute (PLAY, RECORD...) and *title* is the programme title (e.g. Star Wars-Phantom Menace). If the method has additional parameters, they can be given as *other parameters.* The *Upi identifier* parameter is mandatory, others are optional. The default *method* is RECORD (in case of a missing *method* parameter). Some examples of valid upi links are:

- http://usr:pwd@bbc.co.uk/STORit/tvdata/schedules/STORit/upi:bbc:1317354015
- http://usr:pwd@bbc.co.uk/STORit/tvdata/schedules/STORit/upi:bbc:1317354018?title=City_Hospital
- STORit/upi:tvslo:340021?title= Football_Slovenia_ Ukraine
- tvprogrammes/STORit/upi:tvslo:340028?method=PLAY

4.5. TV Anytime pilot service

Whether or not TV Anytime devices and services will really make it in the market depends on a number of factors. Obviously the products and services need to be sufficiently interesting for the consumer to buy them. But also such services must be relatively easy for broadcasters or others to provide, and the market prospects must be sufficiently positive for CE manufacturers to commence product development and actual production. These issues are addressed in the next paragraphs.

BBC Pilot Service

A very important condition for the realisation of commercially sound TV Anytime services is that they must be easy to provide by a broadcaster, without substantial additional costs. To explore this issue, BBC R&D have set up a fully automated TV Anytime service, utilising existing programme schedules information in BBC databases - originally intended for TV guides etc.

Programme information

A requirement for the STORit content acquisition system is to have access to accurate data about when and where that content may be found. This data must be made available in a particular format which supports all features of the system. A system and specification for the data about programmes and how to acquire them has been developed within the STORit project. The specification is intended to be a first look at what data is needed for a "TV Anytime" system. The outcome is a series of tables which cover these requirements.

The STORit tables are defined in terms of the "eXtensible Markup Language" (XML). The tables use the idea of a Uniform Programme Identifier (UPI). Each programme (or group of programmes) is given an identity which can be used to link various pieces of information to the programme. Each table is therefore cross-referenced to the other by the UPI. The tables are:

Metadata:	information about the programme, such as synopsis and genre.
Location Resolution:	the broadcast time and duration
Group tables:	groups of programmes, e.g. a series
Segmentation tables:	identification of excerpts within a programme

Some of this information is invariant, such as the title and synopsis, and thus the Metadata tables are relatively fixed. But some of the tables change, e.g. in the Location Resolution table the time of broadcast may be updated to reflect delays.

BBC schedule information

The BBC supplies its channels to different service providers, and therefore must provide schedule information about these channels. This schedule information is compiled within the BBC and exported in different formats to services such as Digital Terrestrial and Digital Satellite.

Information about BBC programmes and schedules that is provided to Digital TV service providers is currently held within a "Schedule Information Database" (SID). This is held in a series of flat-file records in a private data format. The data is updated in real-time and

changes are signified by adding a new file to the list of flat-file records. A record is provided for each BBC channel in each of the National Regions (England, Scotland, Wales and Northern Ireland).

Data is available for BBC ONE, BBC TWO, BBC CHOICE, BBC NEWS 24, BBC KNOWLEDGE and BBC PARLIAMENT. The data we have extracted consists of the title, synopsis, a genre/sub-genre description, aspect ratio, audio format, the presence of subtitles, time of broadcast and duration of broadcast.

In addition to this data we require an identifier (the UPI) for each programme. This is so that we can show when repeats occur and link programmes to other programmes using "Group" tables.

Processing

The data for the Metadata and Location Resolution Tables is generated directly from the existing SID files. These files are located on a file server at BBC Television Centre. An hourly process polls the file server and downloads any files which have changed. These downloaded files are then processed using a Java program.

The Java program allocates a UPI to each of the programmes, and creates the Metadata and Location Resolution Tables. These tables are simply XML files with tags conforming to the specification developed within the project.

A further process is applied to generate Group tables. By knowing the programmes available via the BBC, one can start to group together programmes of a series. One can then group together series of programmes of a particular type, e.g. "Eastenders" is a popular "soap". All episodes should be grouped together such that the user can request that all Eastenders programmes should be recorded. Similarly "Neighbours" is a popular Australian soap, and this could be related to Eastenders by saying that they are both part of the group "Soaps on the BBC". This is shown diagrammatically below:

Soaps on the BBC

Eastenders
Tues 7.30pm (repeated Sun 2pm)

Neighbours
Mon 5.30pm (repeated Tues 12.30pm)

Many such groups could be created - we chose several that explored the richness of the grouping mechanism, and that were consistently named within the data that we received. A script was written which contained a static set of groups which we had devised, and some Metadata tables to describe the groups. The XML Metadata tables were then parsed using a text processing language to automatically produce entries in the group tables for actual programmes which belong to those groups.

The data created is then made available from a secure web-site so that our partners in the project can download the latest information.

We also constructed our own TV "channel" which is played back from the STORit box hard disk. This channel contains several short programmes interspersed with trailers (promotions) for the programmes to demonstrate trailer selection. The process of generating tables for this channel showed the usefulness of a linking mechanism such as the UPI. The static tables concerning individual programmes and trailers could be created by hand quite early on. When final editing was complete, the Location Resolution Tables could be updated separately with the final time of playback.

Output

The output XML Metadata table file is about 14 kB for a single channel and one day of programmes, e.g. for BBC ONE on Tuesday. The Location Resolution Table, with the channel, times of broadcast and duration for one day, is about 4 kB. The Group tables vary wildly in size depending on the number of related programmes but are generally only a few kilobytes long.

The opportunity was taken to produce Web pages from the same data - we are simply presenting the data in a different way. The pages provide a simple Electronic Programme Guide for the web. There is a page for each channel and day of the week. The pages a straightforward programme listing containing the time of broadcast, title, synopsis and other relevant information. To make the web page an active user interface, the title for each programme is also a link - the link contains the UPI of the programme. On clicking the title (the link), the UPI is requested and a server which has knowledge of UPIs interprets the UPI as a request to record that programme. The user is then asked to confirm the request to record the programme. Once the request is confirmed, the UPI is sent to the STORit box and added to the list of programmes to be recorded.

Conclusions

As described above, the process of generating the descriptive tables was automated as much as possible. The resulting tables were accurate and fairly complete. However, some of the more interesting processing (e.g. generating the Group tables) was based on text-based searches. Using text in this way is prone to error and can be time consuming when the text is not intended for automated processing.

The exercise of generating the tables shows the need for a system-wide use of programme identifiers which can be used link the programme itself to all useful data about that programme. Only with these programme identifiers can we fully exploit all the possible

4.6. Using TV Anytime for home education purposes

At home, a low-cost multimedia storage system with large capacity (the ‘STORit Box’) will allow the home consumer to record ‘any’ source of MM information, and use it later. This has shaped into 'TV Anytime', the DAVIC framework for the interoperable use of digital broadcasting, Internet and local storage. Although primarily focussed on entertainment at first, the TV Anytime concepts are perfectly suited for educational purposes as well. Educational programmes, like those of UK's Open University, can be combined with computer-based multimedia courses using TV Anytime features to improve self-education at home. Clever exploitation of interoperability between Internet, the computer-based training (CBT) courseware and TV Anytime features supported by the STORit box dramatically augments

the learning accessibility of the courseware as well as enrich the multimedia learning experience.

Based on the research made in the first year of the project and according to the initial design of the personalised remote learning application, a Web-based prototype of the system for self-education at home has been realised. The main features of the personalised remote learning application, also referred to as *personal learning assistant* (PLA), are:

- Usage of the STORit box to locally store a large collection of lessons and/or supporting video material, which could be broadcast over DVB streams, rather than accessed via Internet.
- On-line access to the Internet through the STORit box as a proxy server. Depending on the computer equipment at home, a videoconference with a learner's supervisor or a colleague is possible.
- Usage of dedicated internet-based courseware, incorporating said TV programmes into the course (by linking to relevant TV programmes and/or items at the appropriate stages in the course).
- Personalisation of the lesson based on the learner’s knowledge level and the selected learning objectives.
- Automatic retrieval of additional material from the courseware provider's site.
- Modularity supported by agents. This means that existing PLA can easily be extended by adding new modules - agents or by adding new equipment. For example, the PLA supports videoconferencing between the learner and tutor if the learner's computer has appropriate equipment.
- Graphical navigation based on mind maps. This concept, developed during the SMASH project, supports browsing of lessons in an intuitive manner.
- Creation of interactive lessons including video material in an easy way, making use of the large amounts of (educational) video material stored by the STORit box.

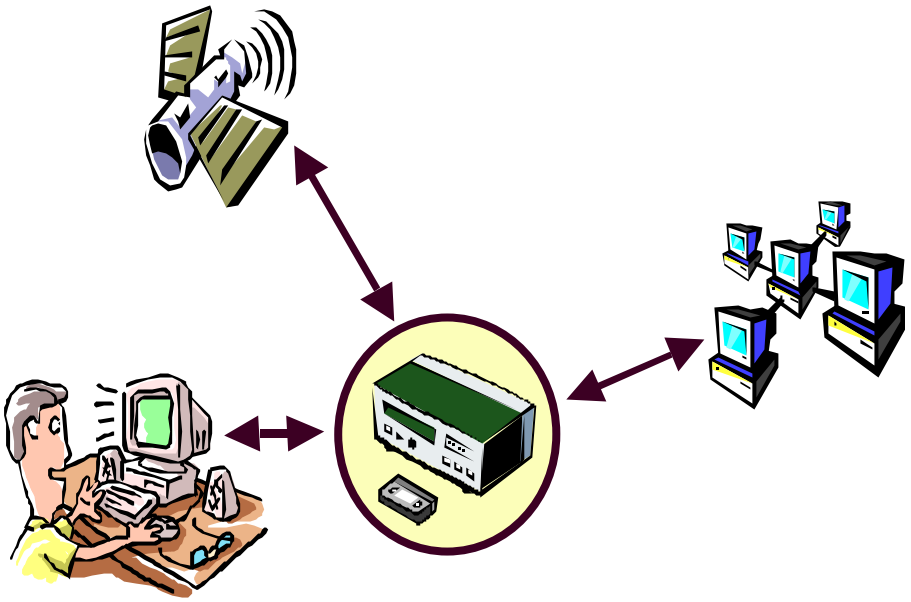

Figure 13: The PLA concept.

PLA concept

The PLA, shown in Figure 13, includes three main components:

- The PLA system, which is the PC based part of the application.
- The PLA service, which provides the Web-based courseware and identifies the DVB and Internet learning support material.
- The STORit box, which supports the PLA system by acquiring, storing and providing access to the appropriate TV programmes and Internet resources.

PLA user interface

The Personalised Learning Assistant (PLA) is a general educational application, designed to be used for learning on a remote location (i.e. at home). The PLA is not designed for learning a single course or a single type of material, but instead provides a framework for providing courses on different topics. The application itself is written in Java and JavaScript programming languages and runs in both popular WWW browsers.

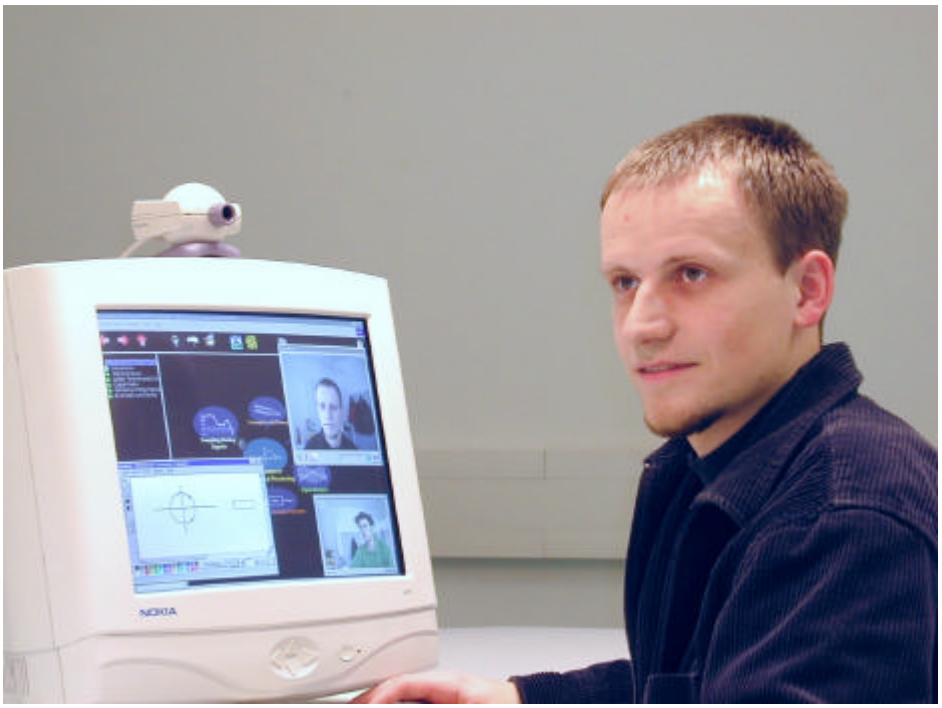

Figure 14: A student using the personalised remote learning application equipped with a videoconferencing system to communicate with a colleague.

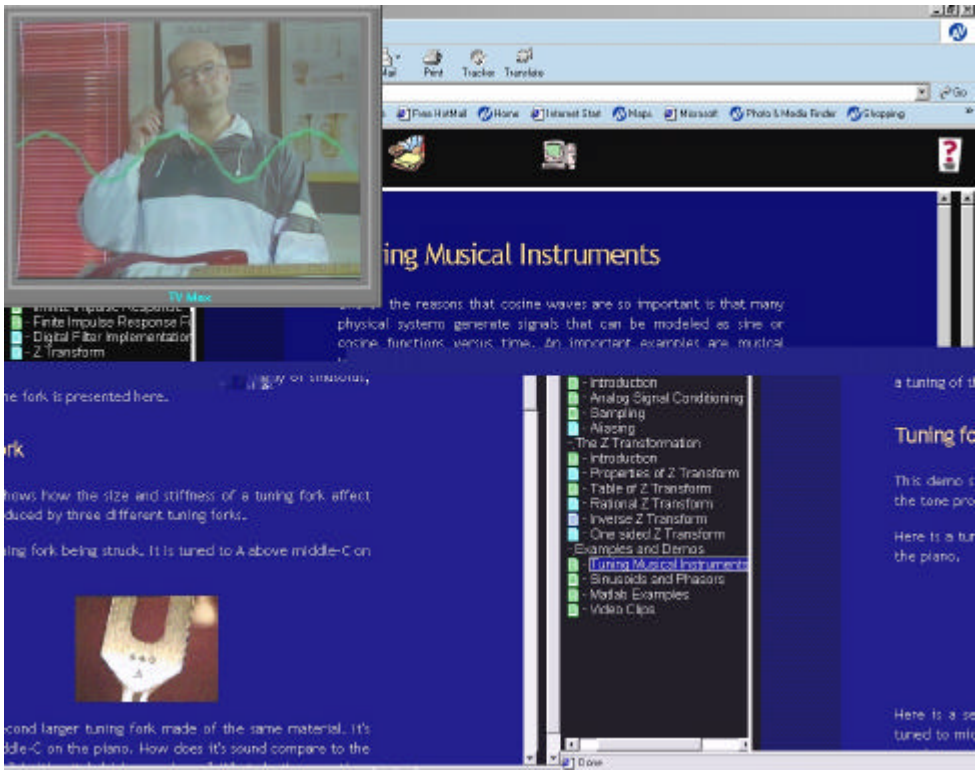

Figure 15: The personalised remote learning application playing a video segment from the STORit box.

The PLA provides the student with a twofold view on learning materials. Each course is organised in a linear manner, similar to the organisation of chapters, subchapters... in a book, and in a visually better representation of *mind maps*. The course path and the visibility of chapters can be adjusted according to the student's current knowledge level. More complex personalisation strategies can be developed by changing the working of the personalisation agent. The PLA also includes buttons for collaboration tools, such as videoconferencing and enables students to use a PLA search agent to search the WWW for relevant topics.

Agent proxy server

The agent proxy server (APS) is a software manager of the Web-based PLA prototype. The APS enables dynamic personalisation of the Web content by software agents. The APS is a general framework for developing Web solutions that need dynamic Web content filtering and transformation. In addition, it enables browser applications (i.e. Java applets) to interact with agents.

The agent proxy server is a special type of HTTP proxy server. It is an intermediary server that accepts HTTP requests from clients and forwards them to other proxy servers or the origin server. Similarly, it intermediates server responses back to the clients. It differs from generic proxies meant for regular HTTP access and cashing in three properties:

- It lacks any caching and logging because of its simple design.
- It acts actively on the response content.
- It handles a special subset of HTTP requests and produces the responses as an HTTP server to allow interaction between a WWW browser and software agents.

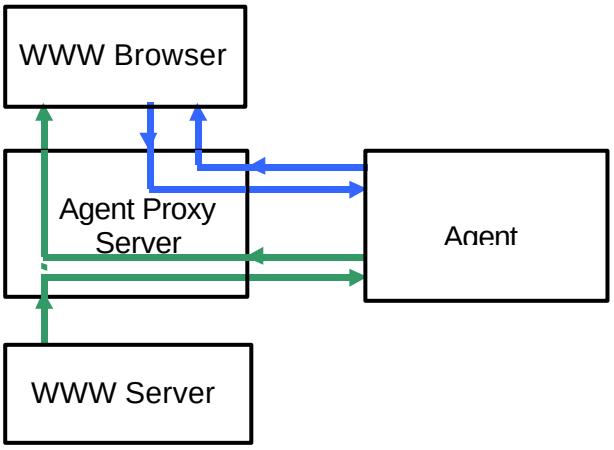

Figure 16: The agent proxy server serves as an entry point for software agents.

Courseware preparation

Learning materials for the Web-based PLA are standard HTML and multimedia files. Additionally to multimedia materials, segments of TV programmes recorded on the STORit

box are included into the courseware exploiting TV Anytime features of the STORit box. Standard Web content like HTML files, images, audio, and video clips can be prepared with any of existing multimedia tools on any kind of computer including PCs, while TV programmes, as additional video materials, are recorded on the STORit box together with the segmentation information. When all course materials are prepared, they are put into the mind-maps structure in an easy way by a special purpose mind-maps editor shown in Figure 17. Access to the segments of TV programmes stored on the STORit box as an integral part of the courseware is included simply by adding modified HTTP links, which are interpreted by a proxy server on the STORit box as TV Anytime API calls.

Besides descriptions of mind map and chapter-like organisation, materials also include XML metadata describing different aspects of materials; authors, creation dates, keywords, difficulty level,... These metadata, based on the Learning Object Metadata (LOM) Draft Document v2.5 issued by the IEEE Learning Object Standards Comitee, are used for displaying and personalising the student's view on the materials. Because the set of metadata is huge, only the most relevant metadata fields for the PLA have been selected. The metadata can be specified for each piece of the courseware or for a group of files. Organization of metadata is hierarchic. This means that the metadata field entered at one level of the hierarchy is a default value for all metadata fields of the same type bellow this level. However, the default values can be changed at any level. To simplify the adding of the metadata, the mind-maps editor has an integrated hierarchic metadata editor.

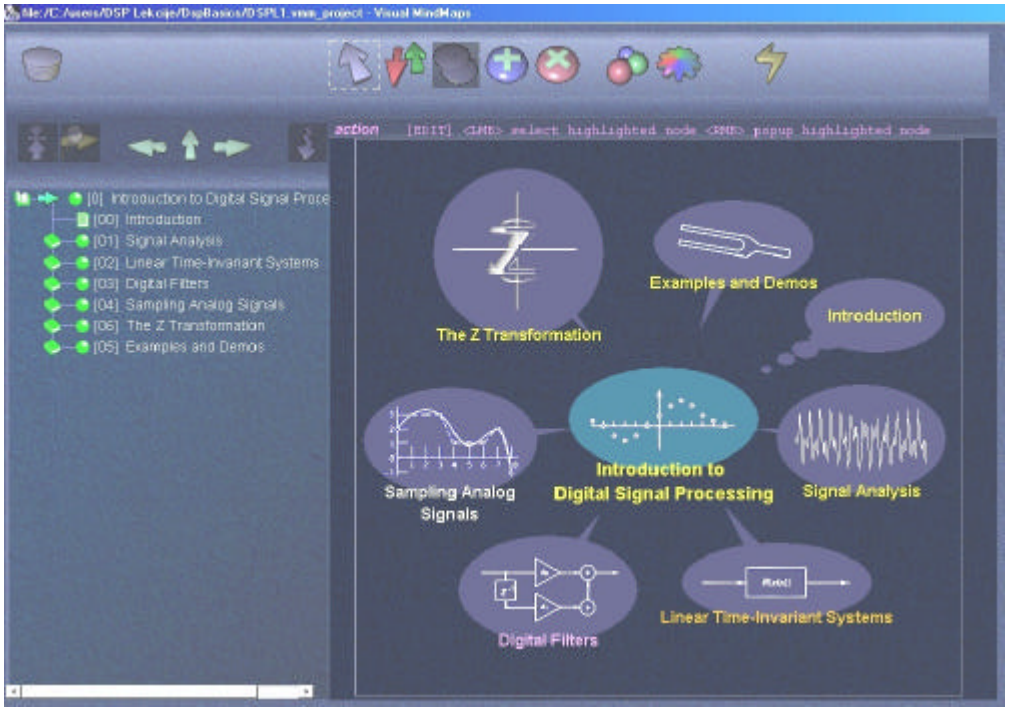

Figure 17: The mind-maps editor for arranging multimedia course materials into mind-maps structure.

5. Main conclusions reached

In this chapter, we will describe the main conclusions drawn from our experience achievements in STORit by looking at the main results of the project.

Result: IBC Demonstrator

Description

The STORit Box prototype that has been built served as a demonstrator at the 1999 IBC. It consists of a PC-based digital television receiver with extensive hard disk storage and internet access, connected to televisions and PCs throughout a household. The demonstrator features full TV Anytime functionality, i.e. supports various low-threshold ways of getting television programmes captured on the hard disk for later viewing at 'anytime'. This includes selection from EPG, following up a suggestion in a trailer by simply clicking a button, ordering whole series of programmes at the click of one button, and acquiring programmes via links on web pages.

Conclusions

The impact of the demonstration of the STORit system at IBC has been enormous. 'Seeing is believing' holds for TV Anytime too, and the professional public at IBC was very much convinced of the virtues of TV Anytime after seeing the demonstration. Consequently, the attendance of the newly created TV Anytime Forum has increased dramatically, making it a serious and important power, vital to the eventual introduction of TV Anytime in everyday life. 'Seeing is believing' also holds within companies: showing the STORit demonstrator to product managers and general management raises the level of interest for TV Anytime enabled products, promoting TV Anytime from a research activity to an industrial activity.

The building of the STORit Box prototype has lead to experience that can and will be used in the future. The right architecture of such boxes has become clear, which will be beneficial to products. Also the system approach used in STORit will lead to proposals for TV Anytime standards by the project partners. Due to the increased momentum of the TV Anytime Forum (IBC !) this is now much more likely to lead to actual results in terms of industrial acceptance and market penetration. In the end, this will lead to TV Anytime products and services on the market.

Result: Home Education Demonstrator

Description

Distant or remote learning was based only on books in the past. Later, audio and videotapes, especially for language learning, were introduced for self-learning at home to improve the educational process, which was still too passive. The appearance of the Internet and multimedia meant a new stage for developing of distant learning or self-learning at home. The educational process became interactive to enforce active participation of a learner in order to improve the achieved learning results. However, video clips included into multimedia courseware are short and low quality. Additional problem is a wide-bandwidth connection

required for transferring video material over the Internet, which is usually not available to the learner's home. Such problems are resolved using local storage offered by the STORit box to store all learning materials locally and the Internet is used only for online interaction with a tutor and colleagues as well as for downloading supporting materials related to the learning topic.

Although multimedia courses exploit up-to-date computer and Internet technology to enrich self-education at home by active involvement of the learner into educational process, they sometime miss the pedagogical opportunities offered by video lessons, especially for additional explanation or illustration of the learning topic. The main contribution of the PLA is a new teaching paradigm exploiting clever integration of the multimedia-based lessons with classical video lessons, which is enabled by interoperability between Internet, the computer-based training (CBT) courseware and TV Anytime features supported by the STORit box. Although primarily focussed on entertainment at first, the TV Anytime concepts are perfectly suited for educational purposes as well. Educational programmes, like those of UK's Open University, can be combined with computer-based multimedia courses using TV Anytime features to improve self-education at home. The learner can follow the multimedia course and where is available play a segment or entire TV programme recorded on the STORit box as additional explanation of the topic. She / he can also mark a relevant TV programme for recording directly from a Web page containing information about supporting materials, including TV programmes.

Conclusions

The PLA – STORit box system can serve as an example of successful interoperability of a (remote) education system and home storage system, since both can benefit from other's functionality. Incorporation of educational TV programmes into lessons is an example of a new teaching paradigm and we believe it can as such influence future learning trends.

University of Ljubljana is from East-Central Europe. Faculty of Electrical Engineering and Faculty of Computer and Information Science as members of the University are intensively devoted to research activities on broadband communications and multimedia systems as well as on personalised remote learning applications. By participating in this project the University benefited from the liaisons with the partners in STORit and the other actors in the ACTS programme. Since University is primarily a teaching institution, we expect graduate incorporation of PLA into some learning processes. Remote (home) learning is certainly an important future trend, and we expect the PLA to become part of this process when the required technologies are widely available. Some examples of current and future exploitation and dissemination are usage of the system in summer schools at the University and presentations of papers at different (European) conferences.

The indexing and metadata methodology used to describe the learning objectives and the learning support material can also be applied to many similar personal learning applications in support of history, science, technology and language learning domains.

Result: Impact on Standardisation

Description

The STORit partners have played a leading role in the standardisation efforts related to TV Anytime. Initially, this was part of DAVIC, where TV Anytime was conceived. When DAVIC ceased to exist in September 1999, Philips, BBC and NDS took the initiative to create a new

body in order to pursue the standardisation of this important part of the DAVIC heritage – the TV Anytime Forum. We were soon joined by others.

Conclusions

The efforts of the STORit partners towards TV Anytime standardisation have been crucial, both in DAVIC and the TV Anytime Forum. The promotional activities, including demonstrations, paper presentations and a panel session devoted to TV Anytime at IBC'99, have lead to much attention for TV Anytime, and a vastly increased number of companies participating in the forum. Their number is now approaching 60, some 50 of which have so far signed the memorandum of understanding required for full membership.

Clearly, the interest of the STORit partners in standardisation is to achieve an open standard. This will guarantee the all boxes work with all services, which is a condition for really opening up the market for television receivers equipped with local storage. Exploitation of the STORit results is therefore first in continuation of our efforts towards realisation of this open standard, and subsequently in the products and services building on it.

Result: Automatic TVAT data generation

Description

To exploit fully the potential of home-storage devices such as STORit requires that a rich set of metadata be supplied to the storage device for use with the stored content. This is needed to permit the selection of content against the profile of the user, adequately to describe the content in terms that are understandable to a user, to permit user agents to operate and to allow content management.

For the content provider, it is desirable that searches locate the highest possible number of matches from content that he has supplied as this maintains brand visibility and encourages the user to select that provider's content when it is offered in the future. Clearly there is a link between a users satisfaction with content that has been stored and their propensity to select content from the same source when it is broadcast. Thus, broadcasters, for example will have to ensure that adequate metadata accompanies their programmes if their content and their brand names are to remain highly visible.

This demands the creation of the metadata, which in turn can result in a high additional overhead if means are not found for much of the metadata to be created automatically.

Conclusions

The STORit project enabled a process to be implemented for automatically extracting essential metadata from an existing scheduling system and making this available to the STORit box. The demonstration of this process at IBC '99 gave many visitors the confidence that the support of a STORit-type system was a viable cost-effective proposition for broadcasters and other service providers. It has served to create a foundation for further development work.

The knowledge gained from the STORit project relating to the extraction of metadata, its coding and distribution, is being extended to allow additional features to be incorporated in STORit-type systems, such as selecting a programme for recording when a promotional trailer is shown, the segmentation of programmes to allow individual items of a magazine programme to be identified.

6. Input to standards and ACTS guidelines

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7. Overall impact, exploitation and dissemination

The main results of the STORit project include the concept of TV Anytime (utilising hard disk storage in digital television receivers, the design and construction of an end-to-end prototype system featuring all the appealing functionality of TV Anytime, and steps towards its standardisation. These results have had their impact both internally, on the companies and institutions participating in the project, and on the outside world.

For the companies in the project, the STORit demonstration has been an important step towards the realisation of actual TV Anytime products and services. The people actually working on the project have learnt new and better ways of using local storage in the broadcast chain to the consumers' advantage. 'Seeing is believing' holds on all management levels, from product managers to the captains of industry. Actually demonstrating TV Anytime in action inside our own companies has paved the way for further steps towards development and, eventually, market introduction of actual products and services. In such developments activities, the knowledge and experience gained in the STORit project is an important asset, that will lead to speedier progress as the major architectural issues have already been addressed.

For the universities in the project the results, in addition to new knowledge and experience, also include papers, conference presentations etc. All this helps in advancing their research program. The participation in such a joint project also makes it easier for universities to participate in a mostly industrial area of activity, both in terms of research work and standardisation. And of course an interesting research program with appealing demonstrable results and good international relations help in attracting new students.

For the world outside the project, the demonstration of the attractive features of TV Anytime have, again according to the principle of 'seeing is believing', convinced many in the television industry of the advantages - both to the viewer and the broadcaster - of local storage when used in the right way. This has lead to greatly increased interest in the efforts towards standardisation in the newly created TV Anytime Forum (the number of represented companies went up from a few to 40 immediately after the IBC, and is currently around 50).

The way in which the project's results will be exploited is different for the various partners. For the commercial companies the experience of building the STORit system and service can directly be used in further research and subsequent development of commercial products and services. In this light, standardisation of TV Anytime is crucial and an open standard in Europe is the only way to ever achieve market penetration in really high numbers. This is very important in a new market that is otherwise likely to be dominated within a few years by proprietary solutions. Open standards will lead to more competition and therefore better products and services for the end user.

The software service company which has a specialisation in personal learning support technologies will initially focus on a niche market for language learning applications. However the technology is more generally exploitable in technical and scientific domains.

For the universities participating in the project, exploitation is of course not in terms of product development. Rather, the results are published and shown at conferences and workshops,

and form the basis of further research and education programs. In the case of the home education application of TV Anytime, however, direct exploitation by one of the universities is being investigated as parts of the curriculum in the near future are expected to be offered via remote learning, in addition to or even in stead of more conventional ways of education.

The main results of the STORit project are the concept of TV Anytime, utilising hard disk storage in digital television receivers, the design and construction of an end-to-end prototype system.

8. List of deliverables

Deliv. Code	Main Work Package	Deliverable Title	Date	Deliv. Nature	Deliv. Type	Sec. Class
1	WP100	Report on interlinkages	y01/m02 Apr98	report	K	P
2	WP100	Report on first system concept and applications concept	y01/m07 Sep98	report	N	I
3	WP210	Report on specifications of the hardware devices	y01/m09 Nov98	spec	N	I
4	WP220	Report on file formats, attributes and file systems	y01/m10 Dec98	report	N	I
5	WP310/320 /330	Content description interface for home storage applications and relation to standards	y01/m12 Feb99	report	N	P
6	WP410/420	Validation of DVB/Internet interoperability concept including API and GUI	y01/m12 Feb99	report	N	I
7	WP700	Plans and goals for the IBC'99 demonstration	y02/m02 Apr99	report	N	I
8	WP700	Report on IBC'99 demonstration	y02/m08 Oct99	demo/ report	N	P
9	WP800	Report on advanced filtering & retrieval	y02/m12 Feb00	report	N	I
10	WP900	Report on STORit service and consumer system	y02/m12 Feb00	report	K	I

Legend:* ***Nature* *R= Report, S= Specification, P= Prototype, O= Other*

Type *N= intermediate, K= major*

Class *I= Internal usage of the project. No disclosure to any third party outside the project.*
L= Limited availability to certain ACTS projects having a 'need to know'.
P= Public. No restrictions on access.

9. List of published papers

Author	**Title of paper**	**Name of journal/ conference, etc**	**Vol / Page etc**	**Date**
Kosir et al	Sistem ucenja na daljavo s podporo vecpredstavnosti	INFOS 98, Slovenia	CD ROM	Oct 98
Leban et al	Using local storage in multimedia enriched education	Proc. COST 254, Slovenia	pp 153-156	Nov 98
Pogacnik et al	Metadata and user profiles as based for REA agents	Poc. COST 254, Slovenia	pp 91-94	Nov 98
Pogacnik et al	Inteligentni vs. mobilni agenti	INFOS 98, Slovenia	CD ROM	Oct 98
Leban	Computer / Intelligent Digital VCR Interoperability and New Possibilities in Multimedia Distant Learning (in Slovene)	INFOS 99, Slovenia	CD ROM	Oct 99
Tasic	Personalised remote education systems in Central and Eastern Europe	Invited lecture at Jornada Internacional sobre Teleeducation, UoCarlos III, Madrid, Spain		Sep 99
Leban et al	Realization of a HTTP server in Java	Proc. ERK'99, Slovenia	pp. 121-124	Sep 99
Pogacnik et al	Search and retrieval of video material for a remote education application	Proc. ERK'99, Slovenia	pp. 117-120	Sep 99
Marolt et al	Personalised Remote Learning	Proc. ISIMADE'99, Germany		1999
Privosnik et all	Personalised Learning Assistant	Proc. MIPRO'99, Croatia		1999
S.Draper et al	TV Anytime	IBC'99, Amsterdam		Sep 99

Hanjalic, A	Visual-content analysis for multimedia retrieval systems.	Thesis: Technische Universiteit Delft. Promotor(s): prof dr ir J Biemond, prof dr ir R L Lagendijk.	Uitgave: S.n., S.l., 1999, 151 p. ISBN: 90-9013189-2, cat. l, Projectcode: ET9906.	1999
Hanjalic, A., R.L. Lagendijk, and J. Biemond	Automated high-level movie segmentation for advanced video-retrieval systems		IEEE Transactions on Circuits and Systems for Video Technology, vol. 9, no. 4, pp. 580-588, 1999.	1999
Hanjalic A, HongJiang Zhang;	Optimal shot boundary detection based on robust statistical methods. In: D.C. Martin (eds.)	IEEE Multimedia Systems '99. International Conference on Multimedia Computing and Systems (Florence, June 1999), IEEE Computer Society, Los Alamitos, 1999	p. 710-714. ISBN: 0-7695-0253-9, cat. c, Projectcode: ET9906, ozschool TWI569530	June 99
Hanjalic A, R L Lagendijk, J Biemond;	Semi-automatic news analysis, indexing and classification system based on topics preselection. In: M.M. Yeung, B.L. Yeo, C.A. Bouman (eds.)	Storage and retrieval for image and video databases VII IS&T/SPIE Conference on Storage and Retrieval for Image and Video Databases VII (San Jose, Jan. 1999), International Society for Optical Engineering, Bellingham, 1999	Proceedings of SPIE 3656: p. 86-97. ISBN: 0-8194-3127-3, cat. c, Projectcode: ET9906, ozschool TWI569530	1999
Iacob S M, R L Lagendijk, M.E. Iacob;	Video abstraction based on asymmetric similarity values. In: S. Panchanathan, Shih-Fu Chang, C.C.J. Kuo (eds.); Multimedia storage and archiving systems IV	SPIE Conference on Multimedia Storage and Archiving Systems IV (Boston, Sept. 1999), International Society for Optical Engineering, Bellingham, 1999	Proceedings of SPIE 3846: p. 181-191. ISBN: 0-8194-3439-6, cat. c, Projectcode: ET9906, ozschool TWI569530	1999
Lagendijk R L;	A position statement for Panel 1: image retrieval.	In: Proceedings of the VLBV 99. (Kyoto, Oct. 1999), S.n., S.l., 1999	p. 14-15. cat. i, Projectcode: ET9906, ozschool TWI569530	1999

10. How to contact the STORit project

STORit maintains a public web site at the following url:

http://www.extra.research.philips.com/euprojects/storit/

This site contains further details on the project, an up-to-date list of contacts, all public STORit deliverables and many other public STORit publications.

For general information on STORit and its successor myTV, contact the myTV project leader:

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