TV ANYTIME

Steve Draper1, Nigel Earnshaw1, Edwin Montie2, Simon Parnall1, Ronald Tol2, David Wilson3, Guy Winter1

[1]BBC R&D, United Kingdom [2]Philips Research Laboratories, The Netherlands [3]NDS, United Kingdom.

ABSTRACT

TV Anytime is the term used by DAVIC to describe the wealth of capability which results from the inclusion of random access and persistent local storage for audio-visual content within the home environment. *TV Anytime* creates new opportunities for both viewers and broadcasters, simplifying access to content, allowing the creation of 'on-demand' services, and providing the means by which broadcast and web services may be comprehensively interlinked. The paper describes the mechanisms, datastreams and referencing functions assumed within the *TV Anytime* concept, and looks at some of the aspects of human behaviour which lead to these assumptions.

INTRODUCTION

In late 1996 it became apparent to a number of members of DAVIC that the rapid increase in the amount of storage available on the ubiquitous hard-disc drive would mean that, in a few years, storage capacities and capabilities would be such that large amounts of audio-visual material could be stored on a low-cost device used in every PC. Coupled with advances in removable digital storage devices - such as tape and optical discs, the advent of home storage and content management systems could be seen as little as a few years away.

In order that such devices become usable it is important to consider the requirements for systems and data to facilitate the selection and acquisition processes, to enable viewers to use content in a non-linear fashion (as we expect with CDs and DVDs today), to allow the service provider to deliver hyperlinks between pieces of audio-visual content and hyperlinks to and from web-based content.

Today, we make decisions to acquire content as a result of reading newspapers, listings guides, accessing on-line and teletext information, as a result of seeing or hearing trailers on television or radio, or through recommendations from others. Some of these means are responsive, a reaction is provoked through seeing or hearing something. Others are more active, the user goes out to look at what might be on offer within the next few hours. *TV Anytime* seeks to provide uniform mechanisms and data structures which allow a variety of 'discovery' routes:

- The viewer will be able to push a single button on a remote control during a trailer to initiate acquisition of the programme, or the entire series or serial described;
- He or she will be able to browse and select forthcoming content using the same resident navigator that is used to look at the content already stored on the home storage system, and to instruct agent software to carry out simple repetitive selection operations to provide on-demand services; and
- The viewer will be able to select content using external references, from web sites - general or highly specific - which can employ sophisticated knowledge-based technologies to provide a very personalised and individual selection of forthcoming content.

Whatever the selection route, *TV Anytime* specifies requirements for the fulfilment process, which results in the acquisition of the content irrespective of changes in channel or time.

STORAGE TECHNOLOGIES

A proper implementation of *TV Anytime* functionality in consumer devices is enabled by the advent of affordable digital mass storage devices, such as hard disc, optical disc and digital tape.

As a minimum, consumers will expect a storage capacity equivalent to some 5 hours of video - typically a few programmes.

A capacity of 50 hours is equivalent to, say, a week's supply of TV watching, and a capacity of 500 hours or more enables the user to keep a large number of programmes in an audio-visual library.

Magnetic Hard Discs

A hard disc will typically serve as a non-removable storage device inside a digital television receiver.

The fact that it is non-removable can be an advantage when it comes to conditional access and/or copying restrictions; while on the hard disc the content can stay under the control of the service provider.

One may expect the rapid development that has characterised the hard disc industry over the past 15 years to continue. In fact, if we extrapolate the growth of hard disc capacity, as is shown in the table below, even a conservative estimate leads to an impressive amount of video on a relatively cheap hard disc in the foreseeable future.

Year	Video storage capacity
2000	4 hours
2005	40 hours
2010	400 hours

TABLE 1 - Video content stored on a hard disc for $100, assuming 5Mbit/s video data rate, and a disc capacity doubling every 18 months (a conservative estimate)

Two other key parameters of hard discs are sustainable data rate and access time. On both accounts, even present-day hard discs are more than adequate to enable simultaneous recording and playback - a technical requirement of *TV Anytime*.

Optical Disc

As with current trends in audio technology, optical discs are expected to replace tape in video recording systems. Rewritable DVD discs are now becoming available. Data rate, access time and storage capacity are all inferior to those of hard discs, but the fact that the discs are removable makes them particularly well suited for shelf storage.

Tape

The most important tape in the consumer electronics world today is VHS, which now has its successor in D-VHS, the digital version of the same cassette. The current system features a storage capacity of 7 hours, while growth to 25 and 50 hours is foreseen. Of course the tapes are removable, and form excellent media for shelf storage.

INTEGRATED NAVIGATION TECHNOLOGIES

A set of integrated navigation technologies is required to support the vision of *TV Anytime*.

These technologies are required to enable the home user to look both inside the home storage system at previously captured content and also to provide a consistent view of the world outside the box, that is, content available in the near future from the many broadcast sources.

Additionally, these technologies are required to allow content selection and subsequent storage of programmes to be based more upon programme attributes or 'attractors', rather than programme title or time of original broadcast.

The attractors are programme attributes that a viewer can use to judge the appeal of a programme (such as programme description, cast genre or format) and can be used to support 'machine assisted' programme selection by software agents within the resident navigator.

In addition to programme attractors, other information is required to provide the home appliance with a sufficient knowledge base to allow the automatic resolution and acquisition of specific programmes from only vague, intuitive user input.

In particular, the broadcaster must support at least the following concepts.

- Programme selection by response to an 'on screen' icon, incorporated into a broadcast trail.
- Programme selection by response to a web based TV listing, when viewed on the home system.
- Software assisted programme selection based on user defined 'values' requiring a comprehensive knowledge of forthcoming programme attractors by the home system.
- Programme based links to external web sites. Not necessarily 'on screen' but accessible by a single click to bookmark or view.
- Programme selection from downloadable software applications. Downloadable, 'off air' software applications may be an everyday part of the interactive DTV experience.
- Seamless integration with external (web based) alternative supplementary data such as parental guidance or film review web sites preferred by the viewer.

The supporting data can be sent over the same channels as the broadcast programme stream to ensure that the resident navigator has complete access to timely and comprehensive supplementary data.

In order for programmes to be identified to the resident navigator and cross referenced with supplementary information provided by the broadcaster, the programmes are assigned an identifying tag (Uniform Programme Identifier) or UPI. The UPI relates to a specific broadcast of a specific version of the programme. This provides the minimum necessary information to allow the resident navigator to locate the supporting information to operate in the manner outlined above.

The data to be communicated to the home appliance for each programme of interest falls into the following categories.

Content Description Data

This data provides the many programme descriptors and attributes relating to each programme contained within the programme schedules for the coming weeks.

The data stream should be machine readable and interpreted for humans by the home appliance.

It is this rich data set which allows user or machine selection of programmes to be based on general user preferences.

Programme Grouping and Decomposition Data

These tables provide the information to allow a particular programme series, or branded strand to be decomposed into its constituent programmes to be subsequently acquired by the home storage system. For example, a programme UPI relating to a series such as 'Black Adder' can be decomposed into the individual programmes making up the series.

Additionally the grouping tables can contain data on the recommended viewing order of the programmes and whether the next programme should replace a previous edition. In this way the broadcaster can define the relationship between individual programmes as a series or serial.

Segmentation Data

Segmentation tables will provide marker indices within individual programmes at natural breaks or points of interest. This information enables non linear programme viewing in a way suggested by the programme maker. These index markers can be transmitted and updated during a live TV broadcast, or prepared and sent before the associated programme.

Resolution Data

These tables contain the information mapping the time and channel of each programme to be broadcast with the specific programmes scheduled to be retrieved and recorded by the home appliance.

The programmes to be recorded will initially be referenced within the navigator by the respective Uniform Programme Identifier (UPI). It is this UPI that that provides the key to the resolution tables to obtain the time and location information in the form a Uniform Resource Locator (URL)

The resolution tables are updated regularly to allow the navigator system to base the recording acquisition on the latest broadcast schedules.

UNIFORM CONTENT REFERENCING

Proprietary content referencing schemas could always be implemented for an individual broadcaster in partnership with its chosen head-end and home appliance manufacturers. But such vertically integrated schemas, while sufficient for a broadcaster to offer a range of *TV Anytime* capture services for its own content, would prevent interoperability and more importantly, prevent the viewer from gaining access to content offered by other broadcasters and other content deliverers.

TV Anytime allows the creation of a new form of service provider – that of third-party service vendors such as 'virtual broadcasters' or 'trusted guides' who can offer a *TV Anytime* service by leading viewers to other broadcasters' content.

Without a uniform content referencing schema to provide the link between content selection and its subsequent automatic capture, this potentially whole new market cannot exist. Unified content referencing is therefore a fundamental requirement for *TV Anytime* in a horizontal market.

So what are the requirements for a uniform content referencing schema? First, there is a need for an invariant programme identifier that can be used to identify a programme on offer by a content deliverer independent of its actual location which may be subject to channel and schedule variations. Hence, the definition of the UPI and URL schemes as described above for identifying programmes, programme series or sets and segments within programmes.

The broadcaster or content deliverer defines and publishes the UPIs for each of the programme objects it wishes to make available for capture.

The UPI does not uniquely identify the content itself, which may be separately available from several content deliverers.

In contrast, unique content identifiers such as ISBN, ISAN, UMID etc. formats are used to identify source content and its versions as definitive, separate and unique 'works'. As such they remain inextricably linked with a piece of content – and indeed are usually embedded as part of the content – wherever it be distributed or broadcast.

These types of identifiers are useful for content searching and selection but do not represent a mechanism for location. Existing and proposed unique content identifiers are thus complementary to the UPI, which is used solely for the purposes of content location.

The broadcaster or a third-party service provider will provide a UPI as a handle to a home appliance as a result of a user or agent making a programme selection and request for capture. The process, from the point of acquisition of a UPI through to the capture of the content on to local storage is termed the fulfilment process. It comprises the following stages:

- Location of the Resolving Authority (RA);
- UPI to URL resolution and decomposition;
- URL updating;
- Content capture and verification;

Before commencing the UPI resolution process, the home appliance first needs to select the correct resolving authority (RA).

A registered identifier for the RA is contained within the syntax of the UPI format, which the home appliance may use to search/index its own RA resolution table. The resulting location of an RA may be defined in terms of a broadcast stream address or an Internet server-based URL. A broadcast stream-based RA will typically supply the resolution data using a carousel mechanism such that a home appliance can build and continually update its own resolution table, whereas a server-based URL may more typically use an interactive request and response resolution information exchange.

Having located a valid RA, the home appliance can begin to decompose and resolve the UPI into its constituent URLs.

A group UPI of a series or a set of related items, may at each stage of resolution decompose into further set of UPIs. Working through the resolution process, a home appliance may need to consult different RAs corresponding to different UPIs in a set.

The output of the decomposition process will be one or more of, what may be termed, 'Leaf' UPIs – UPIs which correspond to one content object to be captured and for which there must be eventually at least one corresponding URL. Note the word 'eventually'. It must be valid for a UPI, leaf or otherwise, to remain unresolved, as in the case of a programme that has yet to be allocated a schedule time, or unbounded, as in the case of a series (e.g. Eastenders) for which new UPIs may continually be added to the set.

A valid Leaf UPI will resolve into a URL. Where identical copies of a programme are available from a content deliverer (e.g. a repeat show), it may be appropriate to allow a Leaf UPI to resolve into multiple URLs allowing the option to capture the earliest version or perhaps to reschedule around a clash with another requested programme.

The syntax of a URL should indicate whether a content is broadcast or server-based such that for a broadcast URL, the URL syntax shall include a broadcast schedule time and channel.

Content held on-demand on a server may be downloaded as a video file transfer leading to the straightforward successful capture of the requested Leaf UPI.

Only when all content objects that make up a UPI are successfully captured onto local storage is the fulfilment process complete for any given UPI.

TV VIEWING BEHAVIOUR

TV viewing behaviour can historically be characterised as physically passive. The amount of behaviour required to watch TV is low, taking the form of channel changes and volume adjustments etc. There is limited interactivity with the traditional TV, though Teletext services offer an initial insight into more interactive TV use. This behaviour is often characterised as being 'lean back'. However, it is a fallacy to assume that 'lean back' models of behaviour imply no interactivity, as viewers do interact, but at a cognitive level. The mental engagement of the viewer with content is one of the great strengths of some programmes.

Viewers access a wide range of scheduling information sources to guide their viewing. Teletext provides an electronic means of accessing broadcast schedules, and can be considered a contemporary Electronic Program Guide (EPG). However, the range of programme references supplied in other media (such as trailers and magazine listings) suggests a preference over teletext. It seems clear that the interactive features of teletext may be less usable than those of the daily newspaper. The development of selection technologies must recognise this diversity.

Although the reduced cost of TV sets has led to an increase in the number of homes with more than

one TV, viewing often occurs in groups. Group viewing is negotiated to a large extent, with some group members' preferences being subservient to another at different times. With a limited choice of channels this may not cause difficulties but with several hundred channels this problem may be quite significant.

Another crucial aspect of social viewing is the importance placed upon the 'shared experience'. Scheduling of programmes such that all viewers see it at the same time creates the conditions for this 'sharing'. The sense of 'belonging' that develops from this is very robust, has significant social impact and in extreme circumstances can create psychological changes.

Future TV viewing behaviour

In the future, receiver functionality will require behaviour that is more characteristic of computer use.

Without suitable tools the viewer will be faced with a difficult information-seeking task. The amount of content available from storage, new channels and online sources will be huge.

TV Anytime will distort the relationship between time and content availability. Content can be selected from the past, the present and the future and the ability to pause 'live' TV will mean that 'present' content becomes 'past'.

Clearly in the development of suitable tools, an understanding of the human factors which govern our behaviour as viewers both as individuals and groups is required.

HUMAN FACTORS

Inevitably, home storage systems with the described capabilities will be used in a different way from current home recording systems. The integrated navigator technologies supporting the user interface to the new system must be able to handle all viewers' demands and requests and be relatively simple to use.

It is important to consider how people view television and will interact with a new system. Humans are essentially emotional creatures, and thus many psychological factors will come into play when examining their relationship with technology, particularly as television viewing may occur in the absence of any clear goals.

A list of the relevant human factors to be considered in the design of navigational tools is shown below. If viewers are unsure what they want to watch, then their viewing behaviour will be more greatly affected by these factors.

* Value
* Trust
* Personalisation
* Choice
* Cost
* Possession/ownership
* Security/privacy
* Control
* Emotion (anxiety)
* Knowledge
* Collectivity
* Genre/classification
* Branding
* Social effects

For the purpose of this paper, three important factors will be considered in more detail: value, trust and personalisation.

Value is considered to be the importance or significance that a viewer attributes to a piece of content. Viewers will ascribe different values to programmes at different times, and under different circumstances. Viewers must have mechanisms for specifying value and the system should have a number of mechanisms to select content including where appropriate, agent technologies.

Trust forms the basis of two key relationships: the first between the broadcaster and the viewer and the second between the system and the viewer.

Trust between the broadcaster and the viewer is characterised by transparency, neutrality and honesty. A public service that provides a list of future programmes should be accurate and unbiased. Trust between the system and the viewer is characterised by transparency of operation (i.e. knowing what the system does and why it does it), and by consistency of operation. These factors make a system both useful, and usable.

Personalisation refers to the ability to change the appearance and operation of the system. By creating a mechanism for specifying viewing preferences and values, an agent based system will be able to select and record content on the viewers' behalf.

A DEMONSTRATION PLATFORM

A *TV Anytime* demonstrator has been built in the STORit project, a project sponsored by the European Union under the ACTS programme

This system comprises a 50 GByte hard disc for storing up to 25 hours of video content plus accompanying meta data.

The system includes a database that handles the *TV Anytime* control data, and supports the main *TV Anytime* features, such as programme referencing from trailers, EPGs or websites, program grouping, segmentation, personalisation based on attractors, etc. Easy access to this functionality is provided through a resident navigator, which both allows the user to select content and to manage content on the storage device.

The STORit system will be demonstrated at the New Technology Campus of IBC'99, in Stand 6.311 (NTC-11).