The TV-Trawler Project

Derek Rogers, Jane Hunter, Douglas Kosovic
DSTC Pty Ltd
University of Qld
St Lucia, Qld, Australia
+617 33654310
d.rogers, jane, douglask @dstc.edu.au

ABSTRACT
In this paper, we describe a system which enables the filtering, recording and delivery of digital video broadcasts over satellite, by matching incoming content descriptions to pre-defined sets of personal user preferences which have been defined using MPEG-7. The system enables the automatic analysis, selection and flexible, customized delivery of relevant content extracted from potentially hundreds of concurrent video channels.

Keywords
Digital Video, Filtering, MPEG-7, User Preferences

1. INTRODUCTION

With the advent of satellite, cable and Internet delivery huge volumes of multimedia content are now becoming available in digital form via broadcast data streams. Increases in bandwidth and improved wireless technologies mean that consumers are being bombarded with hundreds of audiovisual channels concurrently via interactive digital television and radio, personal computers and web browsers built into mobile devices or cell phones.

For consumers, the simple task of finding a program of interest to watch or listen to, is going to become a daunting challenge. The broadcasting environment hypothesizes that the TV experience will evolve into a highly personalized process and TV channels will no longer offer a traditional fixed schedule. This is already becoming a reality with the advent of services such as Video On Demand (VOD), Personal Video Recording (PVR), and WebTV. The latest and most exciting innovation in Personal TV™ services of which is *TiVo*, a product that allows consumers to control and manipulate various aspects of their cable or satellite TV service to create a highly personalized and convenient viewing experience.

The introduction of standardized multimedia content description is going to play a key role in this challenging situation. MPEG-7 [1] is an ISO/IEC standard developed by the Moving Pictures Expert Group. Referred to as the "Multimedia Content Description Interface" it aims to provide a rich set of standardized tools to describe multimedia. Adoption of MPEG-7 by content creators, broadcasters, publishers and consumers, will lead to value added services for the consumer and larger audiences, improved revenue and easier content management and greater content repurposing for the broadcasters.

Currently most applications that exploit MPEG-7 are manual search and retrieval of audiovisual archives or *'pull'* applications. This paper describes the application of MPEG-7 to a 'push' application. The *TV-Trawler* project investigates the viability of MPEG-7 to enable the automatic, user-/agent-driven, selection and filtering of broadcast content. The system filters and matches MPEG-7 content descriptions for incoming digital video streams against predefined MPEG-7 user preferences and also provides a flexible notification and delivery scheme for users. User preferences can be specified in terms of particular programs, times, channels, subjects, genres, directors, actors, other keywords etc. that are of interest to them. When incoming video matches their preferences the user is notified and the content will be recorded and delivered. Users may also set up their own video jukeboxes in which they can define preferred program playback times/dates.

The *TV-Trawler* is of particular relevance to defense and intelligence organizations, media monitoring and broadcasting organizations, government departments, state and federal parliament, archives and libraries, education and health related organizations - in essence, any organization which needs to monitor broadcast multimedia information services.

In Section 2, the project scope and objectives are described. The prototype's system architecture is outlined and discussed in Section 3. Section 4 provides details of the project implementation. Finally, conclusions and future work are described in Section 5.

2. PROJECT OVERVIEW, SCOPE AND OBJECTIVES

The computer-assisted monitoring and recording of TV broadcasts is not a new idea. For example, the Fischlar Digital Video System developed at Dublin City University [2] allows users to select and record TV programs from eight terrestrial TV stations, on the basis of either program name or pre-defined genres. However, as far as we are aware, neither the Fischlar system nor any other existing systems uses the MPEG-7 standard to support the filtering of satellite broadcasts - which can conceivably involve hundreds of concurrent channels.

A number of projects [3,4] have investigated the application of MPEG-7 UserPreferences to the search and retrieval of audiovisual archives, but not to the filtering of broadcast streams.

Hence the primary objective of this project was to assess the viability of MPEG-7 description tools for the filtering and retrieval of relevant audiovisual content from multiple synchronous broadcast data streams, according to users' preferences. The aim was to achieve this through the development of a prototype or testbed within DSTC which would include the functionality described below.

2.1 Capture of User Preferences

The system must be capable of capturing user's preferences in a format compatible with MPEG-7's User Preferences Description Scheme (DS) [5]. The preferences will also need to be stored and indexed so that the filter engine can quickly and efficiently check incoming content against the user preferences for multiple users to determine whether a match has been made or not. Using a simple web interface, users should be able to specify particular programs, times, channels, subjects, genres, directors, actors, keywords etc. which are of interest to them. They may also specify notification and delivery method actions for when incoming content is identified that matches their preferences. Users can then be notified via a java tickertape application or via email.

2.2 Extraction of Content Metadata

MPEG-7-conformant descriptions of incoming video satellite content will need to be generated in order to carry out the matching. Thus one of the project objectives is to analyze and investigate methods of extracting content metadata. This is currently possible through Electronic Program Guides (EPG's), closed-captions (teletext) or service information packets in the encoded digital stream. This metadata needs to be stored and indexed in such a way so that new content can be matched against user preferences and recorded content accurately and efficiently searched.

2.3 Recording and Streaming of Content

Matching content will be recorded in a personal archive, or immediately streamed to the user's workstation. The project will investigate the conversion of the incoming MPEG-2 DVB format to the MPEG-4 scalable object-based-encoding format [6]. MPEG-4 is more efficient in terms of bandwidth and storage whilst maintaining almost the same quality of service. Another advantage of MPEG-4 is that the metadata descriptions can not only be attached to the content itself, but can also be attached to actual elements within scenes of the content such as auditory or visual objects. This will allow fine-grained retrieval of specific segments of footage enabling enhanced consumer services.

2.4 Efficient Matching Algorithms

One of the most challenging aspects of the project is the accurate matching of the user preferences against the incoming content. Issues include:

- Implementing matching algorithms so as to maximize speed and efficiency;
- How to implement closed caption matching across multiple synchronous video streams;
- What represents a match? For example, if a user's preference containing twenty elements matches only one of those elements, say a genre description, to an incoming program of the same genre, is it a match?
- Interpreting semantic ambiguities correctly. For example, is a comedic animated movie, an animation genre or movie genre or both? A documentary about "eagles" is also a documentary about "birds". Incorporating a *thesaurus* would help resolve some of these semantic issues.

2.5 User Management Tools

Users must be able to enter, store, browse, search, and specify notification and delivery methods through an effective user-friendly web interface which allows users to:

- add/delete/modify their personal preferences anywhere and at any time across any type of platform. The preferences also need to be entered in a way that facilitates use of the MPEG-7 standard;
- browse their current matches and search the existing archive video content;
- specify flexible notification (via email or 'tickertape') and delivery e.g., immediate or deferred delivery;
- be assured of an acceptable quality of service (based on MPEG-4 streaming mechanisms and MPEG-4 players);
- set up their own video jukeboxes in which they define preferred program playback times/dates for matching content, thereby creating a "video-on-demand" environment;
- search the entire archive of video content trawled from the incoming satellite channels.

3. SYSTEM ARCHITECTURE

Figure 1 illustrates the three-tier system architecture which consists of:

- Client interface;
- Filter engine;
- Metadata store.

3.1 Client Interface

A web interface was developed using Microsoft's Active Server Pages (ASP) [7] scripting language to create, save and retrieve the user's information to and from the metadata store and transform it into HTML pages to be presented to the user. The interface allows the user to carry out the following tasks:

Figure1: System Architecture

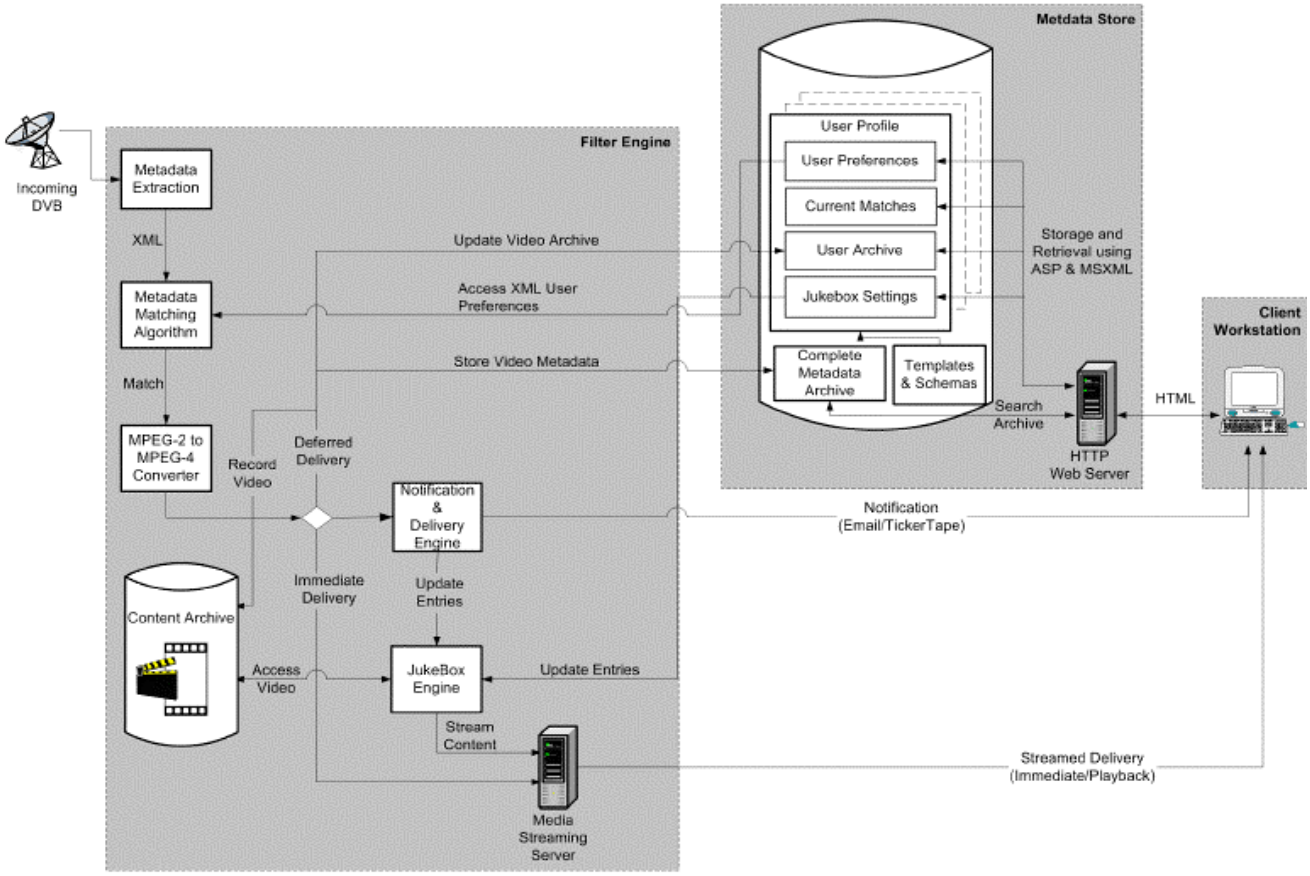
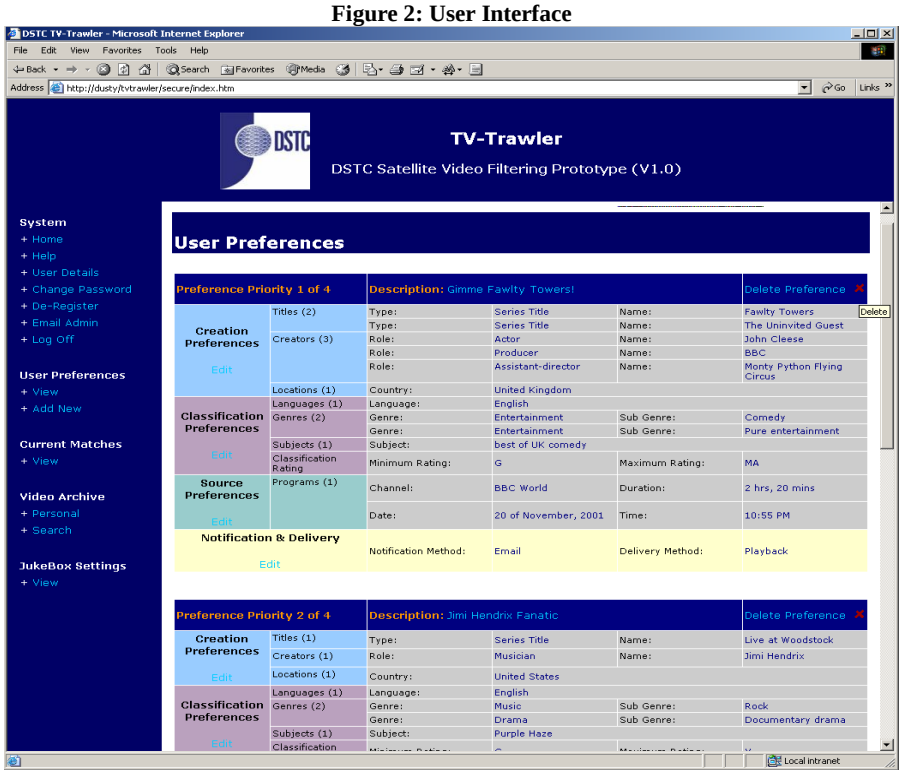


Figure 2: User Interface



- **Enter User Preferences.**
  The interface dynamically allows the user to view, add, delete, or modify their preferences whilst maintaining compliance with the MPEG-7 standard. Classification, Creation and Source preferences are specified via the FilteringAndSearchPreferences Description Scheme. The user also has to specify TV-Trawler specific information such as the notification and delivery preferences.
- **View Current Matches.**
  This shows the user how their preferences compare to the incoming content, for example, whether the preferences are "too loose" resulting in massive amounts of undesired content being matched and recorded. It also allows the user to see if any matches cannot be recorded due to conflicts with already existing scheduled recordings.
- **View Personal User Archive.**
  The user archive contains all the content recorded for the user by the TV-Trawler. This content will also be made accessible to users to search for in the complete archive.
- **Enter Jukebox Settings.**
  For the preferences that have the delivery method set to 'Playback', the playback time and date and location settings can be controlled in the Jukebox section of the interface.
- **Search the Complete Archive.**
  The complete existing archive can be searched by entering terms that are the same as the user preferences. Thus if a program cannot be recorded due to a conflict, the user may search the existing archive for matches later on.
- **View Content**
  The interface provides links to the content over the LAN so that the user can view the content at anytime or anywhere they please. The current format of the incoming content is in RealMedia format and can be played using the Real Player [8] application that is a standard application on most PC machines in the DSTC headquarters. Eventually, the use of automatic streaming will be enabled allowing players to open up on the users workstation for preferences that have an 'Immediate Stream' option set for the notification and delivery mechanism.

Figure 2 is a screenshot which illustrates the users view of their preferences. Each individual preference has a priority value and a description for ease of reference. The information for the creation, classification, and source preferences are colour-coded for ease of use, as well as the notification and delivery methods the user would like when a match for that particular preference occurs. Users may edit these preferences by clicking on the appropriate link.

3.2 Metadata Store

The Metadata Store houses three types of information:

- User Profiles;
- Complete Archive Metadata;
- XML Schema definitions.

3.2.1 User Profiles

Each user will automatically receive a new default profile when they register, which contains the following four metadata files, all of which are named using the user's identifier.

- *User Preferences* file - stores the multiple preferences for a user.
- *Current Matches* file - a dynamic file that lists all the incoming programs currently matching with their user preferences.
- *User Archive* file - contains links to the recorded programs that have previously matched with the user's preference descriptions.
- *JukeBox Settings* file - stores where and when content is to be played back to the user for all the preferences, (which have nominated a 'Playback' delivery method), matching with incoming content.

3.2.2 Complete Archive Metadata

Every program recorded by the prototype will have its content description added to the complete archive metadata file. This file is composed of the union of every user's archive file. Eventually this file will require indexing, as more and more content is recorded.

3.2.3 XML Schema Definitions

XML schema [9] definitions are stored for the various types of metadata files that are required throughout the prototype.

3.3 Filter Engine

The filter engine is the autonomous user agent that receives the incoming satellite video stream and continually carries out the following functions:

- Content metadata extraction;
- Metadata matching – compares incoming content metadata with users' preferences;
- Conversion of MPEG-2 DVB to MPEG-4 if a program matches with a preference description;
- Video Archival – matching video files are recorded and stored on the filter engine tier and linked to the personal users' and complete video archives;
- Notification and Delivery - when a match occurs and recording takes place, the filter engine is responsible for notifying the user (via email or tickertape) and delivering the content to the user (currently via their personal archive or jukebox settings), either immediately or at a specified date/time.

- Jukebox Engine - streams recorded content with a 'Playback' delivery method to a user at a nominated date/time.

4. THE SYSTEM IMPLEMENTATION

4.1 The User Preferences Schema

The MPEG-7 UserPreferences DS defines a user's preferences with regard to consumption of AV content, enabling effective personalization of the content. Figure 3 shows the hierarchical structure of the UserPreferences DS.

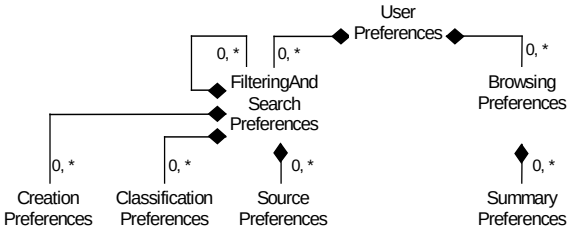


Figure 3: User Preferences DS

Our prototype only uses the UsagePreferences and FilteringAndSearchPreferences DS. BrowsingPreferences and SummaryPreferences DSs are not used. The user preferences are thus comprised of the CreationPreferences, ClassificationPreferences and SourcePreferences DS's and the entry process is subdivided accordingly. Within those three DS's, more simplifications have been made either because not all of the descriptors are able to be extracted or they are not relevant. Another aspect of the MPEG-7 FilteringAndSearchPreferences DS that hasn't been adopted, is the ability to specify recursive preferences within each other. This was not adopted because it would be extremely complex to implement within the matching algorithms and could lead to interpretative ambiguities.

Each user can have multiple preferences, (i.e. multiple FilterAndSearchPreference elements) and each preference has a "preference value" attribute which indicates the priority of the preference. In the situation where two preferences conflict when matching, the preference with the higher priority value is used.

In addition to the FilterAndSearchPreferences DS, a "TV-Trawler Information" element is provided. This stores the preferred notification and delivery methods as well a *description* attribute for each preference for ease of reference. The addition of a *description* attribute to each FilterAndSearchPreference DS will be recommended to the MPEG-7 Multimedia Description Scheme (MDS) group.

4.2 The Content Description Schema

Figure 4 shows the ContentManagement DS structure [5]. We use the CreationInformation, Classification Information and UsageInformation DS's, because they correlate to the CreationPreferences, Classification Preferences and SourcePreferences of the user preferences descriptions respectively.

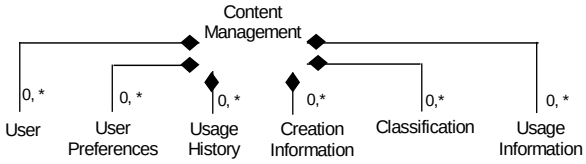


Figure 4: Content Management DS

The descriptors which we adopted from these three content DS's were dictated by the descriptors specified in the user preferences and the metadata which could feasibly be extracted. The table below shows the correlation between user preferences and content description elements.

User PreferencesDS	**ContentManagementDS**
<UserPreferences> <FilteringAndSearchPreferences> <CreationPreferences> <**Title**> <**Creator**> <**Location**> </CreationPreferences> <ClassificationPreferences> <**Language**> <**Genre**> <**Subject**> <**ParentalGuidance**> </ClassificationPreferences> <SourcePreferences> <**DisseminationSource**> <**DisseminationDate**> </SourcePreferences> </ FilteringAndSearchPreferences> </UserPreferences>	<ContentManagement> <CreationInformation> <Creation> <**Title**> <**Creator**> <CreationCoordinates> <**CreationLocation**> </CreationCoordinates> </Creation> <Classification> <**Language**> <**Genre**> <**Subject**> <**ParentalGuidance**> </Classification> </CreationInformation> <UsageInformation> <Availability> <Dissemination> <**DisseminationSource**> </Dissemination> <**AvailabilityPeriod**> </Availability> </UsageInformation> </ContentManagement>

4.3 Extracting Content Metadata

There are three approaches to extracting available metadata from the incoming content streams:

- Analyzing Service Information Packets;
- Extracting Closed Captions/Teletext;
- Parsing Available Electronic Program Guides.

4.3.1 Analyzing Service Information Packets

The incoming Digital Video Broadcasting (DVB) stream, which is an extension of MPEG-2, contains Service Information (SI) packets that specify information about each particular program in the digital stream. One of these SI packets, the Event Information Table (EIT) packet, contains data about each program's start time, duration, genre, parental rating and summary descriptions as well as other miscellaneous information. However there are problems with using the EIT packets to extract the content metadata:

- Only EIT packets for the current and the following broadcast programs are streamed. Thus there is no way

of building up daily or weekly content descriptions to use in the matching algorithms. The DVB specification is capable of providing weekly EPG's through the use of specific EIT packets, however the satellite services we are analyzing, either don't support this or encode it in a proprietary OpenTV interactive TV standard which cannot be easily extracted.

- The "content_descriptor" data that correlates to the MPEG-7 *genre* descriptor is not broadcast. This is a problem as the genre descriptor is heavily utilized by users as a filtering mechanism.

Hence analyzing the packets in the digital stream to access content metadata is currently not a viable approach due to under-utilization of the DVB specification by service providers.

4.3.2 Analysing Closed Captions/Teletext

Along with the Video and Audio streams, a DVB TV channel may include a teletext stream for subtitled programs. Each program broadcast is identified by an MPEG-2 Program Identifier (PID). In order to extract content metadata from the teletext stream for a particular program, the appropriate PID must be filtered and the closed-caption text parsed. However there are two problems associated with extracting metadata from the closed caption teletext streams.

- Only Optus Aurora has closed captions available. None of the other channels provide closed captions on a cable or satellite subscription.
- The process of capturing closed captions for matching consists of the following steps:
    - Capturing the closed captions;
    - Converting the teletext to MPEG-7 metadata;
    - Incorporating the teletext metadata within the program's existing metadata;
    - Matching the programs enhanced metadata with user preferences "on-the-fly";
    - If the content metadata matches any user preferences then start recording.

This process is difficult to carry out successfully over a large number of concurrent channels. It could be done by using multiple receivers/processors – but this would be very expensive. Alternatively, a single processor could cycle between channels, analyzing a small sample of teletext for each channel. This makes the matching step very complex and would expect to have a poor recall rate. For example, after capturing the closed captions for a slice of time, carrying out the above process, and initialising the recording, the program may have been broadcasted for a few minutes already, with the user missing out on the start of the desired content. Therefore, the viability of using closed-caption teletext streams for extracting content metadata is limited at this stage of development.

4.3.3 Parsing Available EPGs

The third possible source of content metadata is Electronic Program Guides (EPGs). A number of EPGs are available via the Internet. However the metadata that can be extracted from these sources varies considerably. An assessment of the available EPG's, indicated that Channel 7's '*i7*' EPG [10] would provide the most available, robust and accurate content metadata for the Austar/Foxtel and Optus Aurora television services which we are filtering. Within the EPG, each program has a number of descriptors that can be parsed from the HTML web pages. These include: the program title, genre, start time and duration, summary description and media rating. However not all descriptors are always present and since the EPG's are not standardized, complex manipulation of the data is required to convert it into MPEG-7 format. For example, the genre descriptor can be extracted by searching for the "Category:" string and if the program EPG includes an episode title, it will always be directly one line beneath the series title.

Because EIT packets (Sect 4.3.1) are currently unreliable and closed-caption decoding (Sect 4.3.2) prohibitively complex for large numbers of channels, we decided to use the 'i7' EPG as the main source of the content metadata. This involved analysing the structure and format of the '*i7*' EPG and generating an MPEG-7 content description. Metadata that cannot often be captured because it is not available included: the content creation details, creators and the language. This information may be captured from other sources using a software agent metadata retrieval tool to scour all available EPG's. However, for the initial development of the prototype, using the one EPG from '*i7*' was satisfactory.

The 'i7' EPG provides program details for a month in advance. However users want to see the matches of their preferences for the next week only and not have to manually check retrievals daily. Therefore, a perl script was developed which parses the EPG for a nominated period (currently one weeks duration), and creates one large XML content file, containing all the program descriptions for every channel, and ignoring duplicates. This process runs as a scheduled nightly task and takes roughly 10 – 15 minutes, producing a sizable XML file of around 5 MB.

4.4 Implementation of the Matching Algorithm

The matching algorithm takes each user preference description (combinations of *Creation*, *Classification* and *Source* descriptor values) and compares it to the program content descriptions extracted from the EPG. If a match occurs, then the program will be recorded.

Currently the content description metadata file contains descriptions of all of the programs for the next week. This results in an extremely large file. As a result, parsing the entire file, which involves comparing individual descriptors, takes around 2-3 minutes using Apache's Xerces XML parser [11]. This is because the parser first reads the entire Document Object Model (DOM) into main

memory, constructing a tree representation of all the nodes before processing occurs. This uses a lot of the main memory resources and is somewhat inefficient. In addition, the matching algorithm which uses the DOM is procedural based.

Researchers on the Kirrkirr dictionary browser project [12] have found that using a custom-designed index file to speed up access to the data source is very efficient. The index file is much smaller and hence can be stored in main memory without excessively consuming resources. If the index is unlikely to change it can also be stored in binary format on disk as a persistant DOM (PDOM). Since the content metadata file is only extracted from the EPG's once a day, the entire content file could be indexed and stored on disk as a PDOM each day. This would increase the matching algorithm processing speed substantially as the PDOM is accessible to DOM operations without the overhead of parsing the entire file for every invocation of the matching algorithm.

Further improvements are possible by also using XML Query Language (XQL) [13] for the querying component of the algorithm. When finalized, XQL will allow simple but powerful, complex queries on XML documents. If XQL is used to query the PDOM, looking for matches to descriptors in the user preference file then parsing of the large content metadata file will not need to occur repeatedly and access will be much faster as the document doesn't have to be read in each time. Results from the Kirrkirr dictionary browser project [12] have found that while XQL offers many advantages, the combination of custom indexing (i.e. using a PDOM) with XQL is the best way to achieve optimal performance.

4.4.1 Some Illustrative Examples

User preferences that contain only *Source* descriptors provide results with 100% recall and 100% precision. For example, if a user specifies all four source descriptors:

- Channel = "Lifestyle";
- Date = "21/10/2001";
- Time = "5:00 pm",
- Duration = 30 minutes.

then a single matching program is retrieved (recall = 100%, precision = 100%). This is analogous to setting a VCR to record a certain program.

With regard to *Classification* descriptors, the system currently provides sub-string matching rather than a thesaurus to improve recall. For example, if a user enters a subject description of "mad cow", then in the absence of a subject thesaurus, programs with subject "Creutzfeldt-Jacob disease" will not be retrieved. However if they enter "mad cow disease" and use sub-string matching, then the program will be retrieved.

The specification of Creation and Classification descriptors provides greater recall but lower precision (unwanted programs are often retrieved). To improve the precision and achieve best results, the most effective matching technique is to specify user preferences which contain descriptors of all three types: Creation, Classification and Source.

4.4.2 The Match DS

The various processes carried out by the TV-Trawler after a match occurs, require information about the match to be maintained. This information is recorded using a Match DS. The Match DS is essentially a container housing a user preference, a content description and the match status, match location, playback time and playback location. A Match element is created whenever a match occurs and it is assigned a unique identifier. Figure 5 illustrates how the Match element then flows through the system's various metadata stores.

Users are able to inspect the "Matches" at different stages, e.g., in their user archive or jukebox. Because the metadata is stored as XML files, XSLT [14] can be used to provide alternative views of the Match data. For example, if a user wants to view their personal archive in order of the date it was recorded, they simply click on the "Date" table header and an XSLT file transforms the metadata of the archive accordingly.

5. FUTURE WORK AND CONCLUSIONS

5.1 Future Work

While significant progress has been made on the TV-Trawler prototype, there remains considerable work to be completed and some complex problems to be solved.

XML Storage and Querying Mechanisms

Resolving the problem of how best to store, index and query the XML/MPEG-7 metadata files will increase the efficiency of the matching algorithms and resolve the concurrency and versioning problems of the existing file storage. XML databases such as Tamino [15], indexing based on PDOMs and further development of XQL will greatly improve future system efficiency.

Further Investigation and Analysis of the Matching Algorithms

The matching algorithm needs to be further refined in order to achieve a better balance between recall and precision of the results. Additionally more advanced matching techniques (AND, OR, NOT) need to be incorporated into the system. The integration of a thesaurus to allow term related matching is essential in order to produce more accurate matches.

Integration of Search and Retrieval

A search engine which permits searches upon recorded content using the descriptors specified in the users' preferences, needs to be built. This functionality will become more important as the number of users and conflicting recordings increases. Since the search engine

will use the same algorithm as the matching process, incorporating this functionality should be relatively simple.

Ease of Defining User Preferences

The success of applications similar to the TV-Trawler depends to a large extent on user interface issues and the ease of specifying preferences. This could be facilitated by:

- Providing an interface that allows users to browse EPG's and automatically select programs they wish to view. Selection of a program would automatically supply the necessary details to the descriptors for the source preferences.
- MPEG-7 provides a UsageHistory DS that describes the history of actions performed by a consumer over a specified period. User agent tools could automatically determine users' preferences by anlysing usage history descriptions.

Integration of Quality of Service

Users may want to specify personalized preferences pertaining to how they want to view and navigate the content they are receiving. For example, a user may want to specify a low frame rate to save on bandwidth or disk storage space. The BrowsingPreferences DS provided by MPEG-7 allows users to specify preferences relating to nonlinear navigation of content.

Enhanced Replay Functionality

Currently the option of immediately streaming content to a users workstation and invoking a multimedia player, is not implemented. This will provide further functionality for the user. As the content is being streamed to the workstation it will be recorded thereby allowing the user to stop or pause the content at their discretion and resume later on. This type of functionality is similar to the Personal TV™ services such as TiVo.

Assessing System Scalability

To date, the prototype has only been tested with three concurrent users. The following possible effects of increased numbers of users need to be considered:

- What happens when multiple users preferences match with programs that conflict in recording? As the number of users go up more conflicts are likely to occur and this will degrade the performance of the system.
- Whether concurrently matching user preferences to closed-caption teletext stream is effective. The rate of sampling the teletext stream may have to be adjusted as only one program can be trawled for closed-captions matching user preferences at a time.
- Whether the filter engine and file system storage technique can adequately handle the increased number of concurrent updates.
- Whether users are satisfied with the current user preference schema. Users may find that the schema doesn't adequately capture all of their preferences and require more descriptors with further levels of detail.
- The effects on bandwidth and storage as more users are recording and streaming video across LANS.

5.2 Conclusions

The work to date on this project has resulted in a prototype which enables the filtering, recording and delivery of digital video broadcasts over satellite, by matching incoming MPEG-7 content descriptions to pre-defined sets of MPEG-7 user preferences.

The viability of using MPEG-7 to match encoded user preferences against content descriptions has been evaluated and found to be quite effective. However, the extent to which we could apply MPEG-7 to the filtering of broadcasts, was seriously limited by the current lack of MPEG-7 descriptions provided by content creators, publishers and service providers. There needs to be a concerted industry move towards the support of metadata and in particular the support of MPEG-7 from content creators, content distributors and service providers. Without this, MPEG-7's full potential cannot be exploited and services to consumers will be limited. There is no point in trying to match complex user preferences to content descriptions if not enough accurate and meaningful metadata can be extracted for comparison. For the purposes of the TV-Trawler, of the three possible options for extracting metadata, only one can currently be utilised. The satellite services under-utilize the digital stream packets and teletext streams are only present for one television service. If more metadata was made available and able to be extracted, then the matching process would be much more effective.

It is expected that the release of the final MPEG-7 standard in March 2002 will be accompanied by the wider availability of tools capable of automatically generating MPEG-7 content descriptions. This will increase the availability of high-quality MPEG-7 metadata and should lead to a realization of the benefits of systems like the TV-Trawler.

ACKNOWLEDGMENTS

The work described in this paper has been funded by the Cooperative Research Centre for Enterprise Distributed Systems Technology (DSTC) through the Australian Federal Government's CRC Programme and the Defence Science and Technology Organisation (DSTO).

REFERENCES

1. Jose Martinez, Moving Pictures Experts Group, *Overview of the MPEG-7 Standard*, August 2001. *http://mpeg.telecomitalialab.com/standards/mpeg-7/mpeg-7.htm*
2. A.F.Smeaton et.al, *The Fischlar Digital Video System: A Digital Library of Broadcast TV Programmes*, JCDL 2001

3. M. van Setten et. al. *Personalized Video Search and Retrieval using MPEG-7 and Stylesheets*, Telematica Instituut, Netherlands, 2000.
4. O. Icoglu et. al. *User Preference Matching for Smart Browsing of Media Contents.* Multimedia Systems Group, Information Technologies Research Institute, Turkey, 2001.
5. Multimedia Description Schemes (MDS) Group, Text of 15398-5 FDIS Information Technology - Multimedia Content Description Interface - Part 5, December 2001 http://www.cselt.it.mpeg/working_documents.htm
6. Rob Koenen, Overview of the MPEG-4 Standard V.18, Singapore, March 2001 http://mpeg.telecomitalialab.com/standards/mpeg-4/mpeg-4.htm
7. M. Baartse et. al. *Professional ASP XML*, Wrox Press, Birmingham, United Kingdom, 2000.
8. RealPlayer http://www.real.com
9. W3C World Wide Web Consortium, *XML Schema*, http://www.w3.org/XML/Schema
10. I7 Satellite TV Guide http://tvguides.i7.com.au
11. Xerces Java Parser 1.4.4 http://xml.apache.org/xerces-j/index.html
12. K. Jansz et al. Using XSL and XQL for Efficient, Customised Access to Dictionary Information, Proceedings from the AusWeb2K, the Sixth Australian World Wide Web Converence, Southern Cross University,http://ausweb.scu.edu.au/aw2k/papers/jansz/paper.html, 2000.
13. W3C World Wide Web Consortium, *Xquery 1.0: An XML Query Lanugage*. http://www.w3.org/TR/xquery/, 2001. (current 7 Jun. 2001)
14. W3C World Wide Web Consortium, *XSL Transformations (XSLT) Version 1.0*. http://www.w3.org/TR/xslt, 2001. (current 16 Nov. 2001)
15. Tamino XML Server http://www.softwareag.com/tamino/

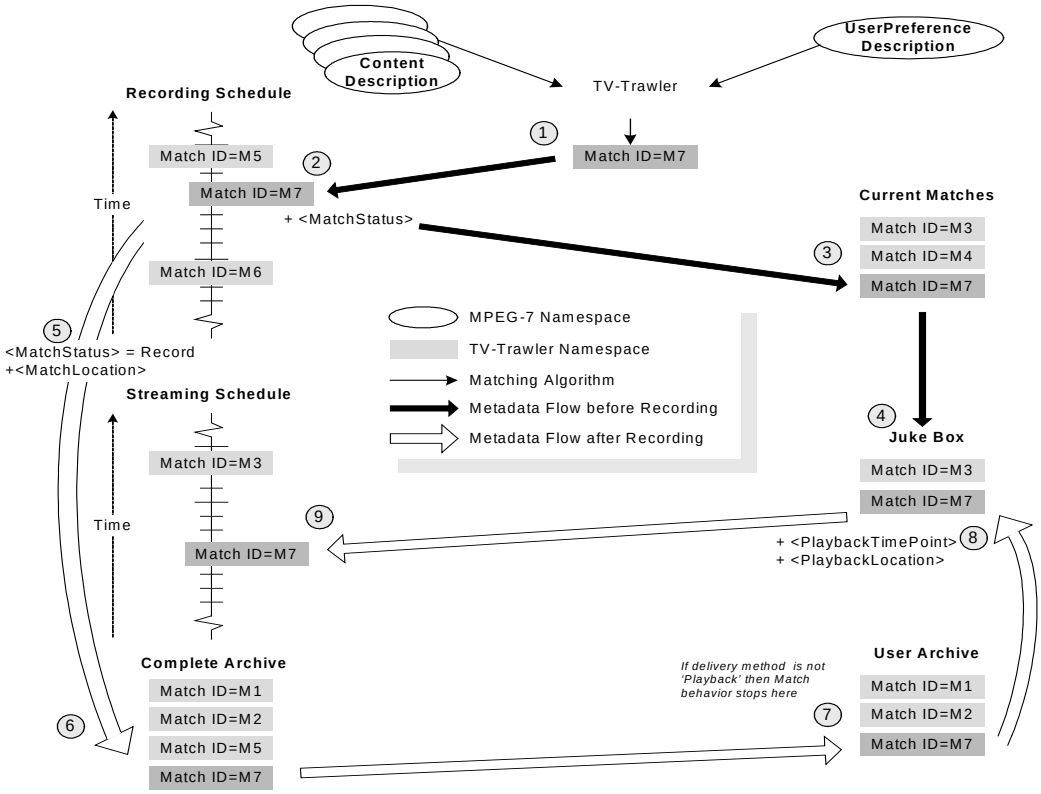


Figure 5: System Metadata Flow