Scalable and Personalised Broadcast Service

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Abstract

An aspect of the European IST SAVANT (Synchronised and Scalable Audio Visual content Across NeTworks) project is the personalisation of interactive TV systems combining broadcast programmes with additional content transmitted via the Internet. This paper describes scalability by selection of service components within the available services according to user preferences. This service adaptation is based on a developed metadata model. The personalisation techniques used in the first SAVANT prototype were demonstrated at IFA 2003 in Berlin, based on a news scenario. This demonstration showed content scalability by using a TV, a tablet PC and a PDA as display devices in addition to recommendations and personalisation by the selection of appropriate service components.

Keywords

Personalisation, Digital and Interactive TV, Recommendation, TV News, Scalable Media

Introduction

Interactive digital television (iTV) is becoming widely available and is being promoted by broadcasters in many countries as a means of attracting viewers to digital TV and as an additional revenue stream. iTV provides additional services to the viewer, which enrich the broadcast, and overcome some of the limitations of conventional TV. Examples of these additional services include time-shifted viewing; bidirectional feedback (e.g. voting); and additional content, from subtitles to interactive games; which all take the user's experience to a higher level than the linear, passive format of traditional TV. However, this comes at a cost.

Effective use of the enhancements offered by iTV requires careful presentation to the user as extra complexity discourages the service from being used. One approach to simplifying access to digital TV is personalisation. This is most commonly offered through a personalised Electronic Programme Guide (EPG), however new personalisation techniques need to be introduced to support interactive services at a lower, e.g. sub-programme, level, especially in information rich domains such as news shows.

Another challenge facing the broadcast world is the increasing diversity of user terminals and transmission networks. The number of people who possess portable media-capable devices, such as a Personal Digital Assistant (PDA) or a Tablet PC, is growing rapidly, as is the penetration of broadband networks to the home. These technologies are capable of enhancing the television viewing experience by allowing programme material to be viewed away from the conventional television and enabling additional material to be provided to supplement the conventional broadcast programme. As a result, different members of a viewing group may access different additional services both on the TV set and on personal portable devices.

SAVANT (Synchronised and Scalable Audio Visual content Across NeTworks) is a European research project that is developing integrated broadcast and Internet technologies, which allow end users to access and retrieve synchronised multimedia content in an intelligent and transparent manner on a range of devices (e.g. TV, PC and PDA) and under varying network conditions. These technologies are implemented within a studio production system, a delivery platform and a content access system consisting of different user terminals. One of the aims of the SAVANT project is to provide more interactivity with broadcast content as well as personalisation of the available services.

The scalability aspect of SAVANT refers to the adaptation of the content and service delivery to a variety of situations. The differences between situations can be due to differing transport mechanisms – e.g. DVB (Digital Video Broadcast) and IP (Internet Protocol); the variety of types of display devices or different users with their own preferences.

Content can be scaled in several ways. There may be several versions of content available scaled for different user terminals. For example, a PDA user would require scaled down content to be available, because of the limited available storage and screen size. This is not only true for the main video content, but for the user interface and any additional content. Alternatively the content may be re-scaled at some point in the delivery chain.

SAVANT also offers scaleable services. A service consists of a number of service components with a component consisting of either a segment of the main broadcast or an item of additional related multimedia content. Examples of the additional content include additional MPEG-4 audio-video clips, HTML pages, 3D graphics, additional languages, a signer or interactive games.

The aim of personalisation in SAVANT is to show service scalability according to user preferences (service personalisation), e.g. a service may be modified so that only those service components that are available to the user, or are of interest to the user are shown or recommended. For example, a news service can be scaled to the individual preferences of the user, i.e. someone, who is only interested in one topic, will receive a news selection that only includes the up-to-date news about that topic; possibly enhanced with extra content, e.g. web pages, images, and sound clips available on the TV or on a PC. A hard of hearing viewer might choose to receive an on-screen signer as an additional part of the service, or simply subtitles if a signer is not available.

This paper focuses on the personalisation aspects within the SAVANT project. Some of the personalisation features were demonstrated at the IFA (Internationale FunkAustellung) consumer electronics trade show in Berlin, Germany, in September 2003 and an extended set of features will be demonstrated at IBC2004 in Amsterdam in September 2004.

Related Work

The personalisation of iTV services may concern a number of different aspects. It may be applied to the presentation of broadcast programmes, allowing users to customise the look and feel of the user interface including colours and fonts [Correia & Peres, 2002]. More prominently, however, personalisation is used as a means to address the problem of information overload caused by the growing number of available TV channels offering thousands of programmes for the viewers to choose from. EPGs, offered by some broadcasters, provide a partial solution by allowing users to browse on-screen programme listings. In order to further minimise user effort, recent years have seen the development of intelligent and personalised EPGs [Cotter & Smyth, 2000, O'Sullivan et. al., 2004, Ardissono & Faihe, 2001, Ardissono & Buczak, 2002]. These systems typically provide viewers with recommendations of TV programmes of interest to them based on knowledge about the viewers' preferences, likes and dislikes. This knowledge may be manually supplied by the user or may be automatically gathered by the system. Manual approaches put the user in total control, but rely on explicitly provided information for setting up and maintaining user preferences. Automatic methods require no user intervention and learn user interests over time by monitoring the user's viewing behaviour. Combinations of the two methods, the hybrid approaches, aim to alleviate user effort while also allowing user control. Given a user profile, recommendations are typically produced as a result of information filtering techniques, such as content-based or collaborative filtering (or a combination of the two), where the profile is matched either against programme descriptions or other user profiles, respectively.

Personalised EPGs, however, provide only one application in personalising the iTV environment. They allow for the creation of a personalised channel, but do not support the creation of personalised TV programmes. The provision of personalised content at sub-programme granularity is considered especially valuable in information-rich domains, such as news, documentaries, sports and music, where the likelihood of finding relevant information among all the broadcast content is low. A personalised programme, such as a news show may then, for example, provide more detailed information regarding topics of interest to the viewer while ignoring or only including short summaries of other events.

So far, however, there has been little work on the personalisation of the broadcast service itself. The few exceptions include the delivery of personalised advertisements, interactive music video clip programming [Chorianopoulos et. al., 2003], and the creation of customised news programmes [Merialdo et. al., 1999, Dempski, 2002, Kazasis et. al., 2003, Dimitrova et. al., 2003, and Maybury et. al., 2004].

The work in [Merialdo et. al., 1999] combines video indexing techniques to parse TV news recordings into news stories and information filtering techniques to select from the annotated stories and construct a personalised programme

of predefined duration. [Maybury et. al., 2004] provide a system which indexes news programmes in a similar way, and then allows users to create complex queries supported by the metadata. User profiling is done within this interactive, query-rich environment, where the user's requests and then selection or rejection of news items is used as indications of his or her interests. [Dimitrova et. al., 2003, Zimmerman et. al., 2003] describe another system, which separates news programmes into segments using a variety of indexing techniques, including the analysis of closed captions. The personalisation is done by categorising each programme segment into one of six categories ("content zones"), and offering a prioritised list of news segments within each such category. The prototype PVR system described in [Dempski, 2002] delivers a single personalised programme, which includes only news stories that are of interest to the viewer. It does this by recording small segments of the programme based on the viewer's preferences and compiling these into one programme. Matching content to a user's profile is based on subject matter headings included by the content provider in the data segment of the broadcast. Finally, [Kazasis et. al., 2003] delivers personalised summaries of the broadcast content by exploiting the metadata that describes each segment.

The personalisation system described in this paper is similar to the above systems in that it allows the personalisation of TV programmes. Unlike the above systems, however, the personalisation in our system extends not only to the main broadcast content, but the additional content that is provided in realm of digital TV to enrich the service of an interactive TV programme (e.g. MPEG-4, HTML, 3D, etc.). Although the system described in [Dimitrova et. al, 2003] allows for additional content in the form of HTML pages, it provides this by searching the web for related content.

In SAVANT, we consider any type of additional content, together with segments of the main content, as service components within the complete service of the TV programme. We then exploit this structure in order to support the adaptation of a service to different user requirements by the sorting, filtering and adaptation of its individual components. For example, a relevant news story component in a news service may then be played out synchronized with the service component of an audio track of a given language and may be supplemented with information of interest contained in a host of HTML pages or MPEG-4 video. The adaptation, similarly to [Kazasis et. al., 2003], is based on metadata, which, in our case, is an extension of the TV-Anytime standard [TV-Anytime, 2002], also developed within SAVANT [Durand et. al., 2004]. In addition, while [Merialdo et. al., 1999, Dempski, 2002, and Kazasis et. al., 2003] deliver a personalised, but fixed programme or summary, in SAVANT users can access the individual service components (both main and additional content items), manipulate the service itself and compose their own TV programme from any components of the whole service or from service component recommendations. Furthermore, with the exception of [Kazasis et. al., 2003], all of the above systems only support personalisation on the TV set, while SAVANT provides access to the personalised service from a range of devices, including a Tablet PC and a PDA.

The use of different user devices is promoted by growing user mobility, which is seen by broadcasters as a new means of consuming iTV content. In line with this, [Kazasis et. al., 2003] supports the delivery of summaries to a variety of devices such as mobile phones, PDAs and PCs. [Chuah, 2002] describes a system that delivers additional interactive content synchronised with the stream of the main content to a range of devices, such as PCs, PDAs and cellular phones, through the use of the existing infrastructure of instant messaging. Similarly, although personalised EPGs typically reside on set-top boxes, the PTV system in [Cotter & Smyth, 2000] is designed to provide the personalised listings through a web site to a range of devices (PC, PDA, phone) rather than on the TV screen. Bringing the user interface onto separate user devices comes with the additional advantage of allowing users to access his or her chosen content without disrupting other viewers. This is of particular use in SAVANT, where the content of a scalable service can be accessed not only from a single device, but also from a combination of devices available to users. For example, while watching the live broadcast of a football match on the TV screen, up-to-date game statistics (goals, fouls, etc.) may be viewed in parallel on a PDA whenever requested by the viewer.

The Prototype System

Overview

A prototype version of the SAVANT system was demonstrated at the IFA (Internationale FunkAustellung) consumer electronics trade show in Berlin, Germany, in September 2003. One objective was to gauge public reaction to

such a system and to judge the potential for its use in the home. Implementing a functional prototype also enabled us to explore design issues and perform an initial evaluation of system performance.

The demonstrator concentrated on interactive, scalable personalised services over a broadcast network, which was accessible on three different devices: a TV set, a Tablet PC, and a PDA. A brief graphical overview of the demonstrator can be seen in Figure 1. The streaming server provided the DVB feed simulating the data that would be received by a DVB receiver. The DVB stream is received by an MHP compliant Set Top Box, which acts as the Home Media Server (HMS). The personalisation is done in the HMS. The TV set is plugged into the HMS, and the other user devices connect via a wireless network to receive the service. All three of the devices shown (TV, STB, PDA) were used to display scaled and personalised services to the viewer.

Figure 1: Overview of the prototype system's architecture

The scenario for the demonstration was a News service, consisting of four separate news programmes taken from a German news broadcast, which would normally be broadcast over the course of a day. Two national news programmes, *Tagesschau um 5* and *20 Uhr Tagesschau,* and two regional news programmes, *Abendschau 18.00* and *Brandenburg Aktuell 19:30* were chosen. In order to simulate all four news programmes in timely succession an animated clock was inserted between the "programmes", which were then played out in real time. Each news show contained a selection of news items (news stories) on various topics, each enriched with additional content including textual information, videos and sound clips.

The prototype made the following interactive features available:

- Time-shifted viewing of a complete news broadcast, where the programme need not necessarily have finished being broadcast before the time-shifted viewing is started.
- Direct access to single news items and their related material. This feature was supported by a module called the News Manager (see Figure 2), available on all three devices, which implemented a method of browsing both archived and recently received news items grouped according to the category, topic or programme that they belonged to. A user could choose individual news stories to view, and access extra material such as other video clips, sound, and text related to a news item or topic.
- An additional functionality, which allows viewers to compose their own news programme, was also provided. Users were able to select several individual news items and/or extra material to include in their own 'production', which they could then play out on the user devices of their choice.
- Personalisation and recommendations according to a viewer's personal interests were also implemented. The system could either recommend a list of news items and additional content likely to be of interest for the viewer, or present all the news items in an ordered list, with the most relevant items at the top. These are presented in detail in the next section.

Personalisation

In order to demonstrate personalisation at IFA'03, two fictional characters were developed in collaboration with our broadcast partner (Rundfunk Berlin-Brandenburg, RBB), taking into account the available broadcast content and based on RBB's expertise regarding user expectations. These were then offered to visitors as examples to experiment with while enabling them to explore for themselves how personalisation and recommendations would affect the user experience.

The following user profiles were designed to represent typical users of a SAVANT-like system. The descriptions were designed with thought given mainly to our news scenario, so these descriptions concentrate mainly on the viewer's interests in news stories.

User 1 was described as a single female, around twenty years old, who lives in Potsdam and works in the metal-processing industry. She is interested in issues concerning her own region, while keeping up-to-date with news about Iraq, as she is rather worried about the war and the destiny of the people in that region. Although she is a passive labour unionist, she is not interested in national politics at all. She spends her spare time mostly reading.

User 2, a married man with two children and a university education in his forties, who lives in Berlin and has a leading position in a bank, was characterised as being interested in the latest news, mostly in national issues in politics, culture and art. Since he has a family he follows all social issues in German politics, while his interest in Israel is decreasing. As he is usually rather busy, he has no time for reading background information and prefers watching news summaries.

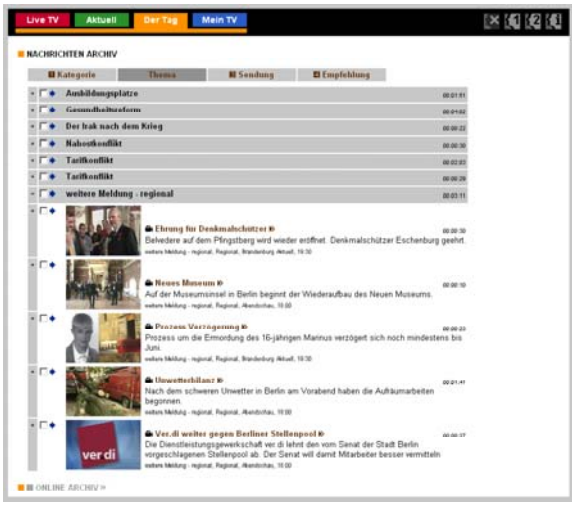

Figure 2: Topics contents page of the Archive tab in the News Manager

Figure 2 shows a screenshot of the News Manager's user interface on the Tablet PC. The interface was designed by IPSI, Fraunhofer Institute. As mentioned earlier, the News Manager acts as a service guide and provides a browsable list of service components both for the most recent ("Aktuell" (Current) tab) and archived news programmes ("Der Tag" (Today) tab). For IFA, personalisation was applied to the content pages of this service guide. Within the different pages, content was organized either by topics (e.g. "the war in Iraq" or "Health Reform"), categories (e.g. "Sports" or "Regional Politics") or programmes (e.g. *Tagesschau um 5*). The page shown in Figure 2 provides an alphabetical listing of content items from the daily archive, grouped under their respective topic headings (each grey bar represents a particular topic). The last topic, "Weitere Meldung" (further messages) has been expanded to show its contents – several news items. In fact, this topic (is a collection of all the news items, which are not associated with any specific topic.

This interface is displayed on the TV, or the Tablet PC, and allows the user to access the functions available in the prototype. A similar, down-scaled interface is available on the PDA. Selecting an individual News Item will play that particular story on the tablet PC, PDA or TV (the programme currently being broadcast will be muted and the selected news item will play in a window on top). This also provides the time-shifting functionality. Selecting individual news items, or whole topics, using the checkboxes to the left will add the items to a personalised play list, which can be seen when the user clicks on the "Mein TV" (My TV) tab.

Clicking on one of the user icons at the top right allows the personalisation of the content lists as if one of the predefined users had logged in.

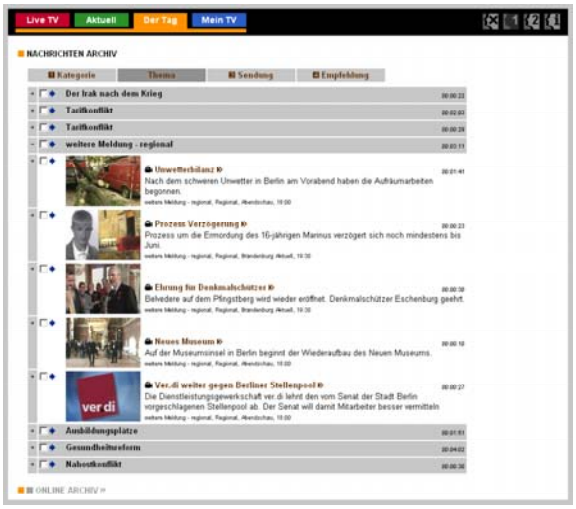

Figure 3: Applying personalisation in the News Manager for User 1.

Figure 3 shows the same content page as in Figure 2 after it has been personalised according to User 1's interests. Personalisation is applied to the topic listings as well as the individual main and additional content items of a news story within each topic. For example, it can be seen that the topic of "Iraq after the war", which is of special interest to User 1 has been placed topmost in the ranking. In addition, within the "weitere Meldung" (further messages) section, the list of news items has been re-ordered reflecting her interest in local weather and a local event (a murder investigation).

As well as prioritizing topics and individual news items, the personalisation system also builds recommendations according to user profiles. Figure 4 shows the "Empfehlung" (Recommendations) page for User 2. For example, the "Gesundheitsreform" (Health reform) article now appears at the top of the list. This is a national social politics issue, which User 2 is very likely to be interested in. The difference between personalisation and recommendation is that recommendations only include the ranked list of content items that the user is likely to be interested in, while personalised pages include all content items, but place the user's "favourites" at the top of the list. This helps to make the list more manageable and to reduce information overload. It would also be possible to implement a threshold value (i.e. minimum interest level or maximum number of items), which is used to limit the number of items displayed. This would benefit a user who has a large number of interests. For example, a user could choose to view only the top 5 matches on the recommendations page.

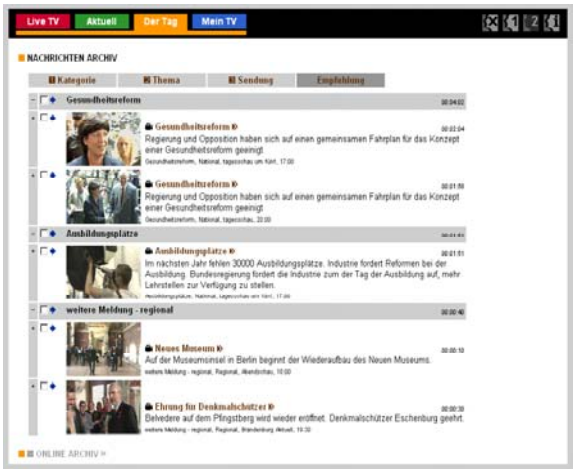

Figure 4: Recommendations for User 2

Scalability

In addition to personalisation, the prototype showed other forms of scalability, namely the ability to view the broadcast and all of the additional content on different types of devices, each with different capabilities.

Figure 5: News Manager as viewed on a PDA.

Figure 5 shows a PDA version of the News Manager. The user interface is kept as similar as possible to the main TV interface (for example the order and colours of the tabs on top of the screen are the same). However, access to the news items by category, topic or programme is obtained via the navigation screen shown in Figure 5. The introduction of a navigation screen overcomes the problem of reduced space availability on the small screen of a PDA.

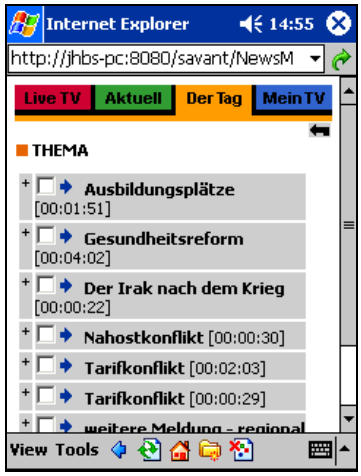

Figure 6: Topics contents page on a PDA

Figures 6 and 7 show the PDA version of the topics contents page within the News Manager's archive tab, the TV and Tablet PC version of which can be seen in Figure 2. All images have been removed to save screen space. Similarly, video and items to be played on the PDA are streamed to it in a reduced size MPEG-4 format. The streaming also means that the video and audio items do not have to be stored on the PDA itself. Currently these alternative video formats are sent as part of the broadcast, although future work on this project will provide a transcoding system within the HMS.

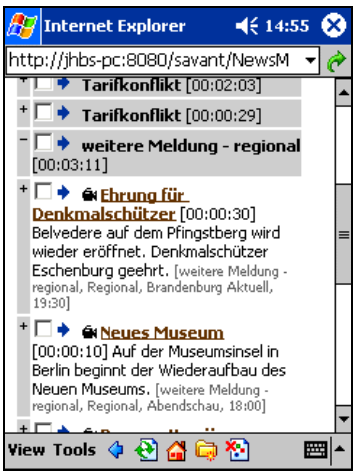

Figure 7: PDA topics page with expanded items

In its current status, SAVANT does not offer personalisation or recommendations on the PDA interface although in the future, the personalisation system will work on the PDA as well. The personalisation work (see section 4) is all done on the HMS so there are no processing or storage requirements on the PDA for content to be personalised. However, the interface for personalisation on the PDA is still under development, so this functionality was not incorporated into the IFA demonstrator.

Implementation of Personalisation

The implementation requires the annotation of content, the provision of user profiles, and the personalisation engine itself. All three are discussed in the next three sub-sections.

Content Annotation

A news item in the demonstrator was a multimedia–enriched news story and consisted of the news story as traditionally sent and additional multimedia information like audio, video or text. To ensure news item access and navigability, all stored television content and additional information was augmented with metadata by the content provider.

A novel metadata model was developed for this such that the traditional linear programme was segmented into sub-components, while separating device-independent and device-specific metadata. This enabled the HMS to "know" the details of what content was available, and to present that information to the user. Sent news items, including their metadata are archived on the HMS and can then be sorted and delivered according to different criteria on an end user's device. A realization of this model was built on the existing standards of TV-Anytime [TV-Anytime, 2002], MPEG-7 [MPEG-7, 2001] and MPEG-21 [MPEG-21, 2002] (details can be found in [Durand et. al., 2004]).

User Profile

As discussed in the Scalability section above, for the IFA demonstration two users, each with their own preferences in the types of news they wish to view, were simulated – namely User 1 and User 2. These fictional characters were each given an internal "profile", which is simply a set of values that indicates each user's preference for various topics and categories. These profiles were represented by a list of likes and dislikes with associated probability values reflecting the degree of interest. An extract of the internal representation of our two sample user profiles is shown below:

0.81 user_profile(arbeitskampf, user1)
0.11 user_profile(irak, user1)
0.10 user_profile(economics, user1)
0.09 user_profile(soldat, user1)
0.01 user_profile(irakkonflikt, user1)
0.69 user_profile(tarifverhandlung, user2)
0.17 user_profile(schaden, user2)
0.02 user_profile(wiederaufbau, user2)

Here the probabilities represent likes and dislikes (0 is dislike and 1 is like). For example User 1 has strong preference for "arbeitskampf" ("strike" in German) and lower interest for news about Iraq or the economy.

The user profile format is applicable to any scenario and any type of user, as it consists of topic (i.e. keyword) and associated probability values. In our next implementation of the personalisation process, user profiles will be built automatically by monitoring the actions of the user over a period of time. By examining the type of content that he or she chooses to view and by employing learning algorithms a user profile can be created and then continually maintained to reflect the changing interests of the user.

Personalisation Engine

The personalisation engine provides ranking of the news items for a given user, and is built using information retrieval technologies. The engine was implemented using HySpirit, an information retrieval platform that provides probability estimation, indexing, and retrieval functions [Rölleke et. al., 2001].

The personalisation engine exploits the metadata associated with the multimedia content to decide the ranking of the incoming news items. The metadata is indexed, i.e. keywords are extracted, and probability estimation is performed based on standard weighting schema [Baeza-Yates & Ribeiro-Neto,

1999]. High probability values are assigned to terms that are good at discriminating between relevant items and non-relevant items, and low probability values are assigned to terms that do not. The outcome of the indexing process consists of relation tuples, in a form similar to the internal representation of users profiles illustrated in the previous section.

This internal representation, obtained for each news item, is then matched against the internal representations of the user's profile. The matching process is based on a probabilistic framework, as provided by HySpirit, and results in the probability that the news item is relevant to the user profile. The higher the probability value, the higher the news item's interest to the user according to his or her profile. High probability values are obtained when there is a high number of matching keywords between the news internal representation and the user profile internal representation, and, a high number of these matching keywords have been deemed important in describing the content of the news item and the interest of the user. The following is a sample showing the output of the matching phase:

0.402404 (aci,aci_ts20030624_1700_1_1,user1)
0.278080 (aci,aci_ts20030624_1700_1_3,user1)
0.214276 (aci,aci_as20030624_1800_3_2,user1)
0.148853 (aci,aci_ba20030624_1930_1_3,user1)
0.024536 (aci,aci_ts20030624_2000_2_5,user1)
0.965359 (topic,tid_gesundheitsreform,user1)
0.783313 (topic,tid_weiteremeldung_regional,user1)
0.583820 (topic,tid_tarifkonflikt_regional,user2)
0.547741 (topic,tid_tarifkonflikt_national,user2)
0.502604 (ni,ts20030624_1700_1,user1)
0.235576 (ni,as20030624_1800_3,user1)
0.209376 (ni,ba20030624_1930_1,user1)

The information from left to right is: the calculated probability of relevance (e.g. degree of interest); the item type (e.g. category, topic, news item (ni), and additional content item (aci); the ID number which identifies a news item/topic (e.g. segmentID for news items, topicId for topics, etc.); and finally the user ID.

Conclusion

In this paper, we presented the first version of the SAVANT News Service prototype, as demonstrated at IFA 2003. The principal objective of the prototype was to offer users interactive and personalised access to news "anywhere", "anytime" and in any detail they wanted. This was achieved by personalising service components, which include main broadcast content as well as additional content, such as MPEG-4 video clips and HTML pages.

To demonstrate this objective, a news service was developed for IFA; however, news is only one generic example of an application for the SAVANT technology. Through this news implementation, visitors at the IFA exhibition were able to actively explore new ways of viewing broadcast programmes and learn about the SAVANT technology. Professional visitors (content and service providers) regarded the SAVANT demonstrator as a very positive example of a future interactive broadcasting service. In the face of the current call for attractive applications to prove the benefits of interactive television technologies, broadcasters commented very positively on the SAVANT approach as a truly innovative service that demonstrates an inventive usage of broadcast content. In particular, the possibilities of breaking up linear broadcast structures, as well as the manifold personalisation features demonstrated by SAVANT were among the points that were judged as beneficial for users.

The SAVANT scalability approach for making programmes and services available on many different devices proved to be of great interest. This was thought of as an opportunity for broadcasters to reach new, different and more diverse user groups. Other comments concerned the possibility in SAVANT of re-purposing content. According to the comments SAVANT very convincingly showed how content once produced for specific media types, such as TV, radio, Internet or video text, can be re-arranged for new services and how that re-purposed content can yield viable services in completely new contexts. Finally, the News Service was recognised as a generic service format, which can be employed by many content and service providers in different European countries and with different types of content.

The next version of the SAVANT system will be demonstrated in September 2004. The scenario adopted for this demonstrator will make use of sports broadcast content and additional sports related material. Additional features will include the automatic building of user profiles by monitoring users' actions over some definite period of time and personalisation will be extended to all user devices including the PDA.

Our hope is that people using the SAVANT technology will start viewing their television in a very different, more interactive and less passive way. As a result, the television can become a central information device in the home, incorporating more of the information-

seeking functionality of Internet-capable devices.

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