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(54) Abstract Title: **Recording by preference profiling**

(57) An apparatus comprises a receiver (101) for receiving content item streams where each content item stream comprises a sequence of content items. For example, broadcast television channels with television programs may be received. A recording processor (103) records content items from the content item streams in response to a user content item preference profile for a user off the apparatus (100). A content item scheduler (107) generates a time list of content items by scheduling the first content items in response to a user access time preference profile. The time list may for example be used to generate a content stream of recorded content items. For example, a personalised pseudo television channel may be generated from recorded television programs. Additionally or alternatively, the time list may e.g. be used to plan recordings of content items.

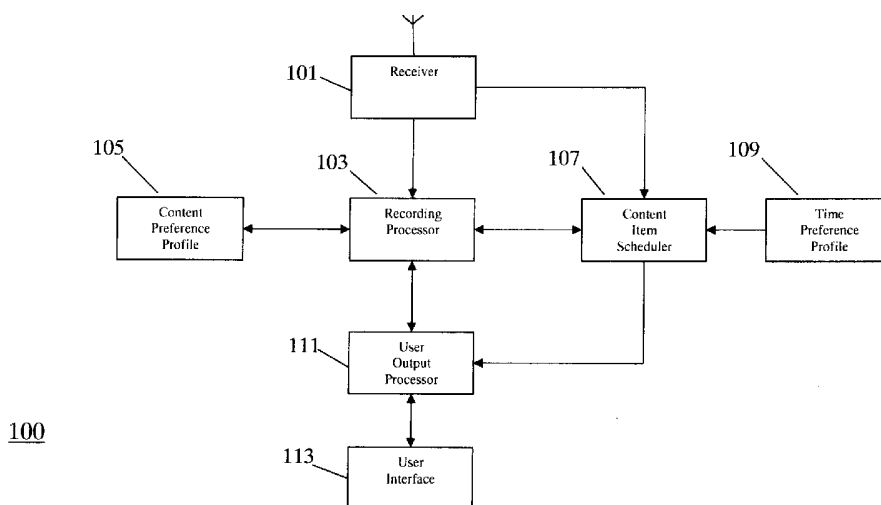


FIG. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

This print takes account of replacement documents submitted after the date of filing to enable the application to comply with the formal requirements of the Patents Rules 1995

Original Printed on Recycled Paper

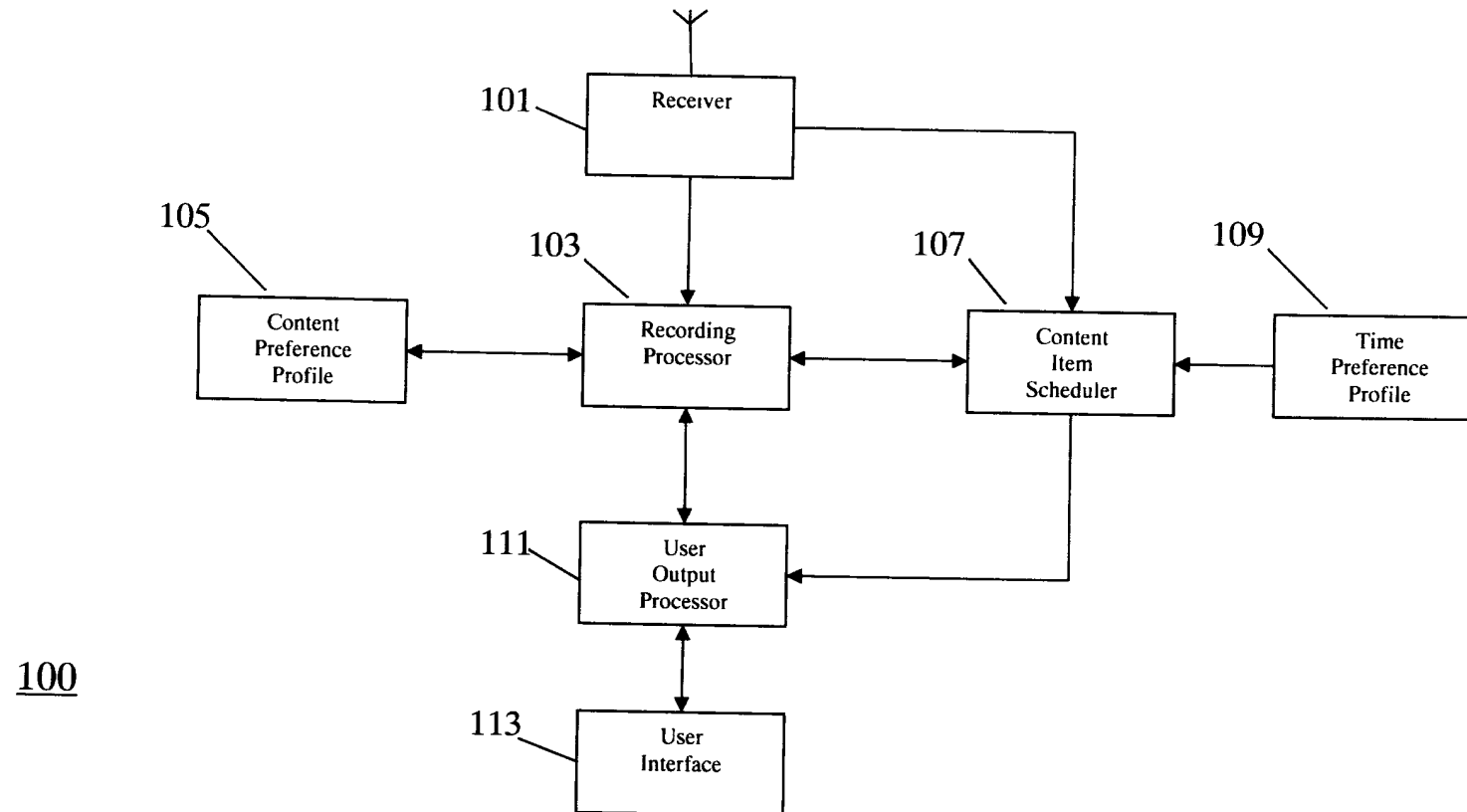


FIG. 1

Channel	Schedule period						
	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
NBC							
Fox							
ABC							
...							
Personal							

FIG. 2

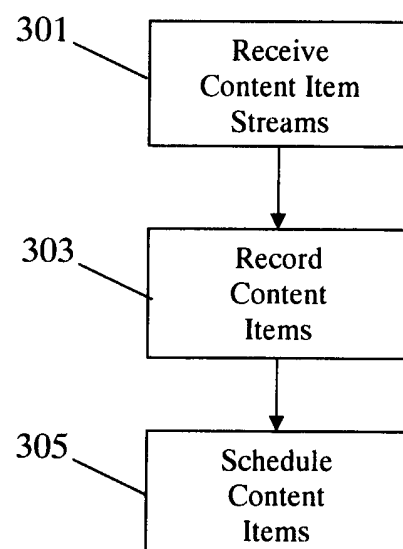


FIG.3

**RECORDING OF CONTENT ITEMS****Field of the invention**

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The invention relates to recording of content items and in particular, but not exclusively, to recording of content items from television broadcasts.

10

**Background of the Invention**

In recent years, the availability and provision of multimedia and entertainment content has increased substantially. For example, the number of available television and radio channels has grown considerably and the popularity of the Internet has provided new content distribution means. Consequently, users are increasingly provided with a plethora of different types of content from different sources. In order to identify and select the desired content, the user must typically process large amounts of information which can be very cumbersome and impractical.

25 Accordingly, significant resources have been invested in research into techniques and algorithms that may provide an improved user experience and assist a user in identifying and selecting content.

30 For example, Digital Video Recorders (DVRs) or Personal Video Recorders (PVRs) have become increasingly popular and are increasingly replacing conventional Video Cassette

Recorders (VCRs) as the preferred choice for recording television broadcasts. Such DVRs (in the following the term DVR is used to denote both DVRs and PVRs) are typically based on storing the recorded television programs in a digital format on a hard disk or optical disc. Furthermore, DVRs can be used both for analogue television transmissions (in which case a conversion to a digital format is performed as part of the recording process) as well as for digital TV transmissions (in which case the digital TV data can be stored directly).

In addition to an improved recording quality, DVRs also provide a number of additional functions and features which provide an improved user experience. For example, DVRs typically comprise functionality for providing recommendations of television programs to the user. More specifically, the DVRs typically comprise functionality for monitoring the viewing and recording preferences by the user of the DVR. These preferences are stored in a user preference profile and are used to autonomously select suitable television programs for recording. The automatically recorded programs are then recommended to the user, for example by inclusion of the automatically recorded programs in a listing of all the programs recorded by the DVR.

Such functionality may substantially improve the user experience. Indeed, with hundreds of broadcast channels diffusing thousands of TV programs per day, the user may quickly become overwhelmed by the offering and therefore may not fully benefit from the availability of content. Furthermore, the task of identifying and selecting suitable

content becomes increasingly difficult and time-consuming. The ability of DVRs to provide recommendations of television programs of potential interest to the user substantially facilitates this process.

5

However, although the conventional DVR functionality may provide an improved user experience, it still does not provide a fully optimised experience. For example, the personalisation of recommendations to the current needs and preferences of the user remains relatively limited. Also, current approaches still leave the user with the task of choosing which programs to watch at which particular instant as well as for managing the available storage space.

Behavioural research has indicated that users find the content selection and storage space management processes increasingly difficult and cumbersome and therefore a facilitated and/or increasingly automated approach would be advantageous.

Hence, an apparatus allowing an improved user experience, facilitated content selection, increased automatisisation, more efficient utilisation of storage space and/or improved content item recommendation would be advantageous.

25

### **Summary of the Invention**

Accordingly, the Invention seeks to preferably mitigate, alleviate or eliminate one or more of the above mentioned disadvantages singly or in any combination.

According to a first aspect of the invention there is provided an apparatus comprising: means for receiving content item streams; each content item stream comprising a sequence of content items; recording means for recording  
5 first content items from the content item streams in response to a user content item preference profile for a user of the apparatus; and scheduling means for generating a time list of content items by scheduling the first content items in response to a user access time preference profile.

10

The invention may allow an improved user experience and may in particular allow an improved adaptation of the operation to the user's preferences. In particular, the invention may allow the apparatus to modify the operation for different  
15 times reflecting the user behaviour at different times. The invention may for example allow recording, presenting or recommendation functionality to be adapted to current rather than average user preferences.

20 The scheduling and generation of the time list may be performed prior to receiving and recording of the content items. The time list may be an association of content items with real time such that one or more specific content items are associated with each time instant. For a given time  
25 instant, the time list may for example indicate a ranked list of a plurality of content items. The recording of the first content items may comprise storing the content items in a suitable content item storage such as a hard disk or optical disk. The user access time preference profile may  
30 specifically be a user content item access time preference profile indicating user preference(s) for accessing content items at various times. The user access time preference



profile and/or the user content item preference profile may relate to one or more users.

According to an optional feature of the invention, the  
5 scheduling means is arranged to schedule the first content items in response to meta-data associated with the first content items.

This may allow improved adaptation and may for example allow  
10 an efficient, accurate and/or reliable scheduling in advance of the content items being received and may e.g. allow a recording of content items to be adapted to the user's preferences. The meta-data may for example be data provided in an Electronic Program Guide (EPG) for the content item  
15 streams.

According to an optional feature of the invention, the  
apparatus further comprises means for generating user  
recommendations for content items in response to the time  
20 list.

The invention may allow an improved recommendation and/or may facilitate and assist the user in finding suitable content items. For example, the scheduling may be such that  
25 the recommendations provided to a user change for different times of the day or week.

According to an optional feature of the invention, the apparatus further comprises means for including the time  
30 list in an Electronic Program Guide.

This may provide a practical and user friendly way of providing improved and targeted information to a user and may in particular integrate well with other functionality and operation of the apparatus.

5

According to an optional feature of the invention, the apparatus further comprises means for generating a content item stream of content items in response to the time list.

10 This may provide an improved user experience and/or may provide additional features. The generated content item stream may for example be presented and controlled as a personalized television channel.

15 According to an optional feature of the invention, the apparatus further comprises means for downloading content items to an external device and means for determining the user access time preference profile in response to a timing characteristic for connections of the external device to the  
20 apparatus.

This may provide an improved and/or facilitated integration and/or interfacing with an external device. The external device may for example be a portable media player.

25

According to an optional feature of the invention, the scheduling means is arranged to generate the time list by modeling the allocation of content items of the first content items to a continuous content item stream as a  
30 constraint satisfaction problem.

This may provide an efficient scheduling that may accurately reflect the user's preference. In some embodiments the constraint satisfaction problem may be a combined model for a plurality of content item streams.

5

According to an optional feature of the invention, the scheduling means is arranged to divide the continuous content item stream and the first content items into time slots and to solve the constraint satisfaction problem by  
 10 allocating content item time slots to continuous content item stream time slots in accordance with a set of constraints.

This may allow an efficient and/or accurate scheduling of  
 15 content items. The constraint satisfaction problem may comprise at least one constraint from the group consisting of: a content item must be scheduled after it is available from the content item streams; no recording conflicts may exist between scheduled content items; a content item may  
 20 only occur once in the time list within a predetermined time interval; and a time difference between content items availability in the media streams and a scheduled time must be reduced.

25 According to an optional feature of the invention, the recording means is arranged to record content items in response to the time list.

This may allow improved operation and may for example reduce  
 30 the required storage space and/or allow an improved selection of content items for recording.

According to an optional feature of the invention, the recording means is arranged to select between recording corresponding content items in response to the time list.

5 This may allow improved operation and may for example reduce the required storage space and/or allow an improved selection of content items for recording. The recording means may specifically select recording of one program on one television channel over the same television program on  
10 another television channel depending on the transmission times of these.

According to an optional feature of the invention, the scheduling means is arranged to further schedule the first  
15 content items in response to a timing of the first content items in the content item streams.

This may allow improved operation and may for example reduce the required storage space or allow an improved selection of  
20 content items for recording.

According to an optional feature of the invention, the apparatus further comprises means for deleting recorded content items of the first content items in response to the  
25 time list and a current time.

The apparatus may specifically delete recorded content items when the time list indicates that the content item is no longer used.

30

According to an optional feature of the invention, the apparatus further comprises means for determining the user

access time preference profile in response to accesses of stored content items by the user.

For example the time of the user accessing different  
5 categories of content items may be monitored and used to create or modify the user access time preference profile. The feature may allow improved performance and may in particular facilitate an automatic adaptation to the user's preferences.

10

According to an optional feature of the invention, the scheduling means is arranged to schedule content items for the time list comprising both the first content items and content items manually selected by the user.

15

This may allow improved performance and may in particular provide an enhanced user experience.

According to an optional feature of the invention, the  
20 scheduling means is arranged to filter the first content items to generate a subset of content items for scheduling.

This may allow improved performance and may in particular provide an enhanced user experience. The filtering may be  
25 performed by removing a number of content items from the scheduling randomly or in accordance with a suitable selection criterion.

According to an optional feature of the invention, the  
30 apparatus further comprises means for time offsetting the time list in response to a detection of a user activity.

This may allow improved performance and may in particular provide an enhanced user experience. The user activity may for example be an access request and the time offsetting may for example be to align the start of a content item with the  
5 access request.

According to an optional feature of the invention, the content item streams comprise television broadcasts of television program content items.

10

The invention may allow an improved recording operation for recording of broadcast television.

According to an optional feature of the invention, the  
15 content items are audiovisual content items.

The invention may allow an improved recording operation for recording of audiovisual content items such as for example music, television programs or radio programs.

20

According to an optional feature of the invention, the apparatus is a Digital Video Recorder.

The invention may provide an improved Digital Video Recorder  
25 or Personal Video Recorder.

According to another aspect of the invention, there is provided a method of operation of a content item recording apparatus; the method comprising: receiving content item  
30 streams; each content item stream comprising a sequence of content items; recording first content items from the content item streams in response to a user content item

preference profile for a user of the apparatus; and  
generating a time list of content items by scheduling the  
first content items in response to a user access time  
preference profile.

5

These and other aspects, features and advantages of the  
invention will be apparent from and elucidated with reference  
to the embodiment(s) described hereinafter.

10

### **Brief Description of the Drawings**

Embodiments of the invention will be described, by way of  
example only, with reference to the drawings, in which

15

FIG. 1 illustrates an example of a content item recording  
apparatus in accordance with some embodiments of the  
invention;

20 FIG. 2 illustrates an example of a personalised television  
channel generated in accordance with some embodiments of the  
invention; and

FIG. 3 is an illustration of a method of operation of a  
25 content item recording apparatus in accordance with some  
embodiments of the invention.

### **Detailed Description of Some Embodiments of the Invention**

30

The following description focuses on embodiments of the  
invention applicable to a recorder for recording audiovisual

content items and in particular to a Digital or Personal Video Recorder for recording television programs from television broadcasts. However, it will be appreciated that the invention is not limited to this application but may be applied to many other systems and content items.

FIG. 1 illustrates an example of a DVR 100 in accordance with some embodiments of the invention.

10 The DVR 100 comprises functionality for scheduling content items in accordance with a user's time preference. In the specific example of FIG. 1, the DVR 100 comprises functionality for generating a personalized television channel for a user by combining recorded content items in  
15 accordance with a user's preferences.

The DVR comprises a receiver 101 which receives content item streams where each content item stream comprises sequences of content items. In the specific example, the receiver is a  
20 television receiver which is operable to receive a plurality of television channels each of which comprises sequentially scheduled television programs.

The receiver 101 is coupled to a recording processor 103  
25 which is operable to record different content items from the content streams. Specifically, the recording processor 103 can record different television programs received in the different television channels. The recording processor 103 may record specific television programs in response to a  
30 specific manual user request.



In addition, the recording processor 103 is coupled to a content preference profile store 105 which stores a content preference profile that contains information of the user's preference for different content items. For example, the content preference profile can indicate that a user likes to watch sports programs and in particular football programs. It will be appreciated that in some embodiments, a very simple content preference profile may be used, such as an indication of preferred genres.

10

In other embodiments, complex content preference profiles may be stored including preferences for specific actors, genres, languages etc. The recording processor 103 can retrieve the content preference profile and can select television programs to record in response to this and information for upcoming programs. For example, if the content preference profile indicates that the user has a preference for football matches and a football match is broadcast, the recording processor 103 can record this match. The recordings can be stored in a suitable data storage, such as a hard disk, comprised in the recording processor 103.

The DVR 100 of FIG. 1 further comprises a content item scheduler 107 which is arranged to generate a time list for some (or all) of the television programs which have been or are to be recorded by the recording processor 103. The content item scheduler 107 is coupled to a time preference profile store 109 which stores a user access time preference profile for the user. The time preference profile provides information of the user's time preference for accessing content items and in the specific example for watching

different television programs. The time preference profile reflects the user's preference for watching different television programs whether the television program is one that has been recorded by the DVR or whether it is watched  
 5 live.

The time list specifically indicates one or more scheduled television programs for a given real time instant. In some embodiments, the time list may indicate a single television  
 10 program for each time instant but in other embodiments a plurality of television program may be indicated and/or television programs may only be scheduled for part of the time.

15 The time preference profile may for example be determined in response to the user's behavior, e.g. the DVR 100 may comprise functionality for monitoring when a user selects different television programs for viewing. For example, anytime the user selects a recorded program, content  
 20 information is recorded as well as the time of the access. This information may then be used to determine when a user prefers to view different genres or categories of programs. As a specific example, a user time preference profile may indicate that a user prefers to watch the news at 8PM and to  
 25 watch a film at, say, 10PM on weekdays, to watch two films on a Saturday evening, and to watch sports Sunday afternoon. It will be appreciated that this is a simple example and that a practical time preference profile may comprise substantially more and more complex information.

30

In the example of FIG. 1, the content item scheduler 107 can specifically schedule recorded or to be recorded television


programs sequentially such that a new personalized television channel is generated locally by the DVR 100 and presented to the user. The television programs are scheduled such that they reflect the user's time preference for  
 5 television programs.

The content item scheduler 107 specifically schedules television programs such that a television program scheduled for a specific time reflects the preference of the user for  
 10 that time. E.g. in the above specific example, the content item scheduler 107 will schedule a news program for 8PM and a film for 10PM at weekdays, two films for Saturday evening and a sports program for Sunday afternoon. For time instants where the time preference profile does not indicate a  
 15 preference, the content item scheduler 107 may select a television program at random, and at time instants where the time preference profile indicates different possible preferences, the content item scheduler 107 may select randomly between the possible contenders (e.g. based on a  
 20 probability reflecting a degree of preference indicated by the time preference profile).

The scheduling of the television programs can include both television programs that have automatically been recorded by  
 25 the recording processor 103 as well as programs that have been specifically selected for recording by a user.

The content item scheduler 107 of FIG. 1 is arranged to compare content meta-data of the television programs with  
 30 the stored time preference profile to determine suitable television programs to schedule. Specifically, for a given time, the time preference profile may indicate a preference,

e.g. for watching sport and preferably football. The content item scheduler 107 can then search through meta-data for the stored television programs to identify if any football matches have been recorded. If so, the content item  
 5 scheduler 107 can schedule this for presentation at this time. If no football matches are found, the content item scheduler 107 can proceed to search for other sports events and schedule these instead. If no sports programs are recorded, the content item scheduler 107 may schedule a  
 10 television program selected at random.



The meta-data for the stored television programs can for example be extracted from the Electronic Program Guide (EPG) which is transmitted for many television broadcasts. As  
 15 another example, the meta-data can be extracted from teletext information or can be provided by other means or dedicated services. For example, the DVR 100 can comprise functionality for connecting to the Internet or a dedicated server dial-up line to retrieve meta-data for television  
 20 broadcasts.

The content item scheduler 107 can proceed to generate a new pseudo-television channel by scheduling a television program for all time instants. Thus, the user may be able to select  
 25 the pseudo channel and will then be provided with the television program that has currently been scheduled by the content item scheduler 107. This television program is likely to be a program which is of particular interest to the user at this specific time.

30

An example of a generation of a personalized television channel is illustrated in FIG. 2.

In the DVR 100 of FIG. 1, the content item scheduler 107 generates a time list which for each real time instant associates a single television program. The time list is fed  
 5 to a user output processor 111 which is coupled to the content item scheduler 107 and the recording processor 103. The user output processor 111 is coupled to a user interface 113 which is arranged to present the television programs to the user as well as to receive user inputs.

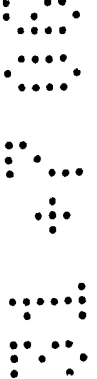
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Thus, when a user selects the pseudo television channel created by the DVR 100 the user output processor 111 proceeds to retrieve the television program currently indicated by the time list from the recording processor 103  
 15 and to provide this to the user interface 113 for presentation to the user. When the current television programs end, the user output processor 111 retrieves the following program indicated by the time list and presents this. This process continues as long as the pseudo channel  
 20 is selected.

Thus, the DVR 100 may provide an enhanced user experience by providing recommendation based not only on viewer preferences but also on usual or preferred viewing times,  
 25 enabling in some embodiments a truly personalized television channel based on all the programs available via broadcast. In contrast to a conventional list of automatically recorded television programs, the personalized channel also schedules which program shall be watched at which time. Based on user  
 30 preferences, the virtual channel will therefore be personalized both in terms of viewing tastes (proposing only programs of predicted interest to the user) and viewing

times (the system prepares appropriate programs to be ready when the user typically prefers to watch television).

The fact that user viewing times are considered allows  
 5 recommendations to take into account the day of the week and the time of day as context information for the recommendations. For example, each time the user switches on the television or requests a recommendation, the system can propose something relevant to watch, either live or  
 10 proactively recorded by the system for this purpose.

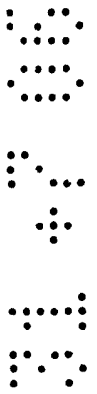


Specifically, research in the field has identified that within many households, a consistent routine exists to everyday activities including the normal times family  
 15 individuals tend to watch television. As an example, a study into family viewing habits within the United Kingdom identified a typical television watching routine in many households with school children. The main television in the home tended to be watched by, and to be under the control  
 20 of, the children from the time they returned from school until around 6:30 to 7pm. After this time, the adults in the family usually sat down to watch television and took control of the content.

25 The viewing preferences of e.g. children can be very different from their parents, and this creates a problem for existing TV recommender systems. These systems can only provide content based on past ratings from users and previously recorded material. If children happen to be the  
 30 most engaged users of such systems, this can often be a source of dissatisfaction for adults who when sitting down

to watch content of an evening are presented with recommendations based on their child's preferences.

Introduction of preferred viewing times context information  
 5 alleviates this problem as recommendations related to children's content would generally only be presented at the times when the children are usually watching. At other times, such as later in the evening, the suggestions will be biased towards the content usually viewed at these times,  
 10 typically related to the preferences of the adults.



The same would be the case in other use cases where users with differing viewing preferences are watching at specific times, such as a member of the family who regularly watches  
 15 live football a Sunday afternoon. Time context specific recommendations could cope with these events much more efficiently within the recommendations presented to the user than existing television recommendation mechanisms.

20 As described above, the DVR 100 may generate a personalized virtual television channel which can be selected by the user. If selected, the DVR 100 presents the television program currently identified by the time list. It will be appreciated that in different embodiments, this may be  
 25 enhanced or replaced by other means or ways of recommending television programs to a user.

For example, in some embodiments, the user may specifically request a recommendation. In response, the DVR 100 can  
 30 determine the current time and can identify the currently scheduled television program in accordance with the time list. A synopsis of this program can then be presented to

the user who may accept or reject the recommendation. In some embodiments, the time list may indicate a plurality of television programs for a given time instant and the DVR 100 can recommend a plurality of television programs to the user to select between.

In some embodiments, the recommendations may be presented via an EPG. Typically, a DVR can present an EPG which for each broadcast channel presents the television programs and when these are transmitted. In some embodiments, an additional entry can be made in the EPG indicating the current recommendation in accordance with the time list. Specifically, the EPG can be amended to include the personalized pseudo television channel generated by the DVR 100. The time list may be processed before being presented in the EPG, for example to ensure compatibility with the presentation of live broadcast television channels in the EPG.

The content item scheduler 107 may specifically generate the time list by modeling the allocation of television programs to the time list (and thus the personalized television channel) as a constraint satisfaction problem which is then solved by constraint reasoning. In some cases, the content item scheduler 107 may schedule television programs for a plurality of parallel television channels.

As a specific example, the DVR 100 may perform the following steps:

30

1. *Initialisation*: the system collects user preferences.

These preferences are twofold: content preferences and



viewing time-slot preferences. Content preferences can be manually provided by the user via a graphical interface, or can be automatically learnt by the system via user observation. Viewing time-slot preferences can also be manually specified, learnt from user's viewing habits or even retrieved via some other way, e.g. from a user's electronic calendar. This first step can be performed when the user first uses the system and is preferably continuously maintained such that the preference profiles are updated.

2. *Channel content selection*: The system periodically retrieves all the programs available for the time period being considered (e.g. a week). Such program description may for instance come from standard EPGs. The system then computes recommendations in order to select the programs of higher expected interest to the user. This list of recommendations can optionally be merged with other recordings scheduled by the user, or programs that have been previously stored on the recording device and are yet to be watched. If the size of the resulting list is far greater than the number of time-slots in the period, the system can filter out the recommendation list. This could firstly be done randomly, secondly by keeping only the recommendations from the user's preferred channels or thirdly by keeping the recommendations with the highest scores. This will be done whilst ensuring diversity in the genre of the programs remaining. Optionally the system may request the user's feedback for this filtering task.

30

3. *Scheduling*. The system finally generates the time list by scheduling the television programs identified in step 2.

Specifically, the personalised television channel can be divided into time slots. Filling several time slots with content from a list can be seen as a constraint satisfaction problem, which can be solved using well known techniques such as constraint programming ones (like Systematic Search algorithms, e.g. Generate and Test, Backtracking, etc.) or genetic algorithms. There are two types of constraints: "prohibitive constraints" and "fitness constraints". Prohibitive constraints ensure the validity of the schedule and can include e.g.:

- a. A program is never scheduled before its actual broadcast time;
- b. Program (or combination of program) duration shall match as much as possible the size of the time-slot and not exceed it;
- c. There must be no recording conflict between programs, if a recording is already scheduled at a particular time, the system shall find an alternative for either program and if it is not possible, one of the programs shall be removed from the schedule.

Fitness constraints improve the quality of the schedule though:

- d. The same program does not appear twice in the schedule;
- e. The number of shows that can be watched close to their live broadcast time shall be maximized;
- f. The storage duration of a show on the storage device shall be minimized;
- g. Two programs of similar genres shall not be in two consecutive time-slots.

Optionally, the user may also add specific additional constraints during the initialisation phase, such as particular program genres for particular time-slots.

5 The result of this process is the creation of a time list corresponding to a program timetable that can be used for a number of different purposes, such as e.g.

- It can be accessed by users on the standard EPG
- It can be used to propose a unique contextual (i.e. time-slot related) recommendation each time the user turns on the system.
- It can be used to provide the user with a ranked list of contextual recommendations each time the user requests.

10  
15

As a specific example, the time list and programs can be divided into sequences of 20 minutes. Therefore a program lasting for 1 hour occupies 3 time-slot units. A gene encapsulating a solution to the problem therefore consists of a population of the time slot units by programs.

An evaluation function can assign a value to each solution encoded in the gene (the smaller the value the better the solution). The value depends on the satisfaction of constraints expressed earlier as well as user constraints, such as "the program on Tuesday should be of genre A". An example of constraint weights is:

Constraint			Weight
<i>Prohibitive constraints</i>			
Scheduled	time	after	500000

broadcast time	
Recording conflict	100000
<i>Fitness constraints</i>	
No duplicates	10000
No empty time-slots	200
Close to live broadcast	-1000
Storage duration	1 per time unit
Genre similarities	100
Genre is A on Tuesday	-5000

Using an initial population of 1000 individuals and 20 recommendations, this approach has been simulated with a 5 convergence after about 30 cycles. A specific example of a result of this process is provided below:

Program	Genre	Broadcast	Duration
0	B	Wed. 8:00AM	40 min
1	A	Thu. 7:00 PM	40 min
2	C	Wed. 9:00 PM	2 h
3	C	Sun. 11:40 PM	1 h
4	A	Mon. 1:00 PM	2 h
5	A	Wed. 8:00PM	2 h
6	C	Sat. 9:20 AM	2 h
7	C	Sat. 7:00 PM	1h 20
8	D	Sat. 6:00 AM	1h 20
9	B	Sat. 1:20 AM	40 min
10	C	Fri. 3:40 PM	1h 20
11	E	Mon. 9:00 AM	1h 20
12	A	Sun. 9:40 AM	1h 40
13	E	Wed. 3:40 PM	1h 40
14	E	Sat. 2:00 AM	1h
15	E	Mon. 11:00 PM	1h 20
16	E	Wed. 9:20 AM	40 min
17	C	Tue. 11:00 PM	2 h
18	D	Mon. 11:00 AM	1h 40
19	C	Tue. 9:20 AM	20 min

**Solution** (value = -3838)

Timeslot	Programs
1 (Mon. 8:00-10:00 PM)	18
2 (Tue. 8:00-10:00 PM)	4
3 (Thu. 8:00-10:00 PM)	2
4 (Fri. 8:00-11:00 PM)	13, 10
5 (Sat. 6:00-7:00 PM)	14
6 (Sun. 12:00AM-4:00PM)	7, 12, 9
7 (Sun. 8:00-10:00 PM)	6

*Note: this solution has the correct genre for slot 2, but does not fully fill timeslots 1 and 6.*

The generation of the time list and specifically the personalised television channel can include both television programs which have been recorded automatically by the recording processor 103 as well as television programs recorded manually by the user. This may provide more flexibility and an enhanced user experience with a personalization providing both a high match to the user's preferences as well as a high degree of variation in the proposed content.

10

In some embodiments, the DVR 100 may further be capable of time offsetting the time list in response to a detection of a user activity. As a specific example, the DVR 100 may be able to align the time list, and thus the personalized television channel, to the user's activities. E.g., the DVR 100 may detect that a user selects the personalized television channel and may offset the timing of this channel such that it aligns the starting of a television program with the user's request. This may substantially enhance the user experience. For example, if the user sits down to watch television ten minutes later than normal, he will still automatically be provided with the beginning of the program selected for the user for this time.

Although the above described examples have focused on the generation of recommendations, e.g. in the form of a personalized television channel, it will be appreciated that the scheduling of content items in response to the user access time preference profile can be used for many other applications and can provide many other features.

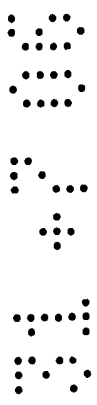
In some embodiments the DVR 100 may alternatively or additionally be arranged to record television programs in response to the time list generated by the content item scheduler 107.

5

For example, the scheduling of television programs for presentation in a personalized television channel provides an indication of when a specific television program is required for presentation. Accordingly, the recording of a  
 10 given specific television program will preferably be shortly before it is required. For example, in many cases, the same television program is retransmitted on different television channels. For example, a broadcaster often broadcasts on a number of different television channels and may transmit the  
 15 same program, e.g. film, on the different channels but at different times. In such cases, the recording processor 103/content item scheduler 107 can select which of the transmissions to record. Frequently, the transmission closest to the scheduled time will be used thereby  
 20 minimizing the storage requirements.

Similarly, the content item scheduler 107 can be arranged to further schedule the television programs in response to a timing of the transmission of the television programs. Thus,  
 25 the television programs in the time list may be scheduled such that it facilitates the recording of the television programs. For example, the content item scheduler 107 may seek to schedule a given television program shortly after it has been broadcast in order to reduce the time during which  
 30 it has to be stored on the hard disk.

Furthermore, the DVR 100 can be arranged to delete recorded television programs in response to the time list and a current time. As a simple example, whenever current time passes beyond the time at which a television program has  
 5 been scheduled in accordance with the time list, it is automatically deleted from the hard disk. Thus, the DVR 100 can comprise functionality for scheduling recommendations and recordings such that the television programs need only be stored on the hard disk for a short time period. This  
 10 frees up storage space for storing other programs and thus effectively increases the perceived capacity of the hard disk.



Thus, the specific described system is also responsible for  
 15 automatically managing the required set of program recordings to support the generated schedule. The system may additionally set reminders for the user (providing this is supported by the viewing device). Once a program has been watched by the user, the system may delete the file from the  
 20 storage device.

As users are free to not follow system recommendations, or decide to watch television at unpredicted times, the system may skip, shift or completely reschedule the planning for  
 25 the remaining of the period based on the new context.

In some cases, different users who are sharing the same device may get different schedules, providing they express their preferences separately. In this case, the system can  
 30 manage recording conflicts between different users (e.g. constraint f mentioned above can consider all recording requests for all users) and time-slots' conflicts (e.g.

time-slots that are common to several users shall contain programs that fit all users).

The system may thus solve recording conflicts. By planning  
 5 an entire set of recordings at once and ahead of time, the DVR 100 is able to deal with recording conflicts and to find workarounds (e.g. recording a given program earlier).

The system is thus able to plan program recommendations to  
 10 match a user's preferred viewing times. This allows a simplification of the user's tasks during the experience and also provides an improvement of the storage space and a reduction in the time a program is stored for.

15 One of the most critical issues for a DVR is the limited recording space. Whereas recording conflicts can be solved by increasing the number of receivers (tuners), user's tend to always end up recording more programs than they actually watch, and therefore the storage space tends to always be  
 20 perceived as a limitation. The DVR 100 of FIG. 1 may alleviate this problem by a number of approaches including:

- providing the user with a personalized channel so that the user has a reduced need for additional recordings; and
- 25 - reducing or minimizing the time difference between recording and deleting a recorded program.

In some embodiments, the DVR 100 comprises functionality for downloading content items to an external device. For  
 30 example, the DVR could be part of a media computer which allows a portable media player to be attached so that the stored content items can be downloaded to this. In this



case, the content item scheduler 107 may schedule the time list such that the preferred content items for the external device are ready when the media player is normally connected for download. Thus, the user access time preference profile  
 5 can comprise information indicating when an external device is normally attached. This can be determined from timing characteristic of previous connections of the external device to the apparatus. A time list of programs can then be generated and used to ensure that suitable television  
 10 programs are ready when the portable media player is typically connected. Thus, the preferences relating to television programs previously downloaded to the external device and usual synchronisation schedules can be used to select television programs and to plan recording times.

15

FIG. 3 is an illustration of a method of operation of a content item recording apparatus in accordance with some embodiments of the invention.

20 The method initiates in step 301 wherein the apparatus receives content item streams where each of the content item streams comprises a sequence of content items.

Step 301 is followed by step 303 wherein content items from  
 25 the content item streams is recorded in response to a user content item preference profile for a user of the apparatus.

Step 303 is followed by step 305 wherein a time list of content items is generated by scheduling the content items  
 30 in response to a user access time preference profile.

In some embodiments, step 303 may be performed before or at the same time as step 305.

It will be appreciated that the above description for  
5 clarity has described embodiments of the invention with  
reference to different functional units and processors.  
However, it will be apparent that any suitable distribution  
of functionality between different functional units or  
10 processors may be used without detracting from the  
invention. For example, functionality illustrated to be  
performed by separate processors or controllers may be  
performed by the same processor or controllers. Hence,  
references to specific functional units are only to be seen  
as references to suitable means for providing the described  
15 functionality rather than indicative of a strict logical or  
physical structure or organization.

The invention can be implemented in any suitable form  
including hardware, software, firmware or any combination of  
20 these. The invention may optionally be implemented at least  
partly as computer software running on one or more data  
processors and/or digital signal processors. The elements  
and components of an embodiment of the invention may be  
physically, functionally and logically implemented in any  
25 suitable way. Indeed the functionality may be implemented in  
a single unit, in a plurality of units or as part of other  
functional units. As such, the invention may be implemented  
in a single unit or may be physically and functionally  
distributed between different units and processors.

30

Although the present invention has been described in  
connection with some embodiments, it is not intended to be

limited to the specific form set forth herein. Rather, the scope of the present invention is limited only by the accompanying claims. Additionally, although a feature may appear to be described in connection with particular  
5 embodiments, one skilled in the art would recognize that various features of the described embodiments may be combined in accordance with the invention. In the claims, the term comprising does not exclude the presence of other elements or steps.

10

Furthermore, although individually listed, a plurality of means, elements or method steps may be implemented by e.g. a single unit or processor. Additionally, although individual features may be included in different claims, these may  
15 possibly be advantageously combined, and the inclusion in different claims does not imply that a combination of features is not feasible and/or advantageous. Also the inclusion of a feature in one category of claims does not imply a limitation to this category but rather indicates  
20 that the feature is equally applicable to other claim categories as appropriate. Furthermore, the order of features in the claims does not imply any specific order in which the features must be worked and in particular the order of individual steps in a method claim does not imply  
25 that the steps must be performed in this order. Rather, the steps may be performed in any suitable order.

**CLAIMS**

1. An apparatus comprising:
  - means for receiving content item streams; each content
  - 5 item stream comprising a sequence of content items;
  - recording means for recording first content items from
  - the content item streams in response to a user content item
  - preference profile for a user of the apparatus; and
  - scheduling means for generating a time list of content
  - 10 items by scheduling the first content items in response to a
  - user access time preference profile.
2. The apparatus of claim 1 wherein the scheduling means
  - is arranged to schedule the first content items in response
  - 15 to meta-data associated with the first content items.
3. The apparatus of any previous claim further comprising
  - means for generating user recommendations for content items
  - in response to the time list.
  - 20
4. The apparatus of any previous claim further comprising
  - means for including the time list in an Electronic Program
  - Guide.
- 25 5. The apparatus of any previous claim further comprising
  - means for generating a content item stream of content items
  - in response to the time list.
6. The apparatus of any previous claim further comprising
  - 30 means for downloading content items to an external device
  - and means for determining the user access time preference

profile in response to a timing characteristic for connections of the external device to the apparatus.

7. The apparatus of any previous claim wherein the  
5 scheduling means is arranged to generate the time list by modeling the allocation of content items of the first content items to a continuous content item stream as a constraint satisfaction problem.

10 8. The apparatus of claim 7 wherein the scheduling means is arranged to divide the continuous content item stream and the first content items into time slots and to solve the constraint satisfaction problem by allocating content item  
time slots to continuous content item stream time slots in  
15 accordance with a set of constraints.

9. The apparatus of any previous claim wherein the  
recording means is arranged to record content items in  
response to the time list.

20

10. The apparatus of claim 9 wherein the recording means is  
arranged to select between recording of corresponding  
content items in response to the time list.

25 11. The apparatus of any previous claim wherein the scheduling means is arranged to further schedule the first content items in response to a timing of the first content items in the content item streams.

30 12. The apparatus of any previous claim further comprising means for deleting recorded content items of the first

content items in response to the time list and a current time.

13. The apparatus of any previous claim wherein further  
5 comprising means for determining the user access time preference profile in response to accesses of stored content items by the user.

14. The apparatus of any previous claim wherein the  
10 scheduling means is arranged to schedule content items for the time list comprising both the first content items and content items manually selected by the user.

15. The apparatus of any previous claim wherein the  
15 scheduling means is arranged to filter the first content items to generate a subset of content items for scheduling.

16. The apparatus of any previous claim further comprising  
20 means for time offsetting the time list in response to a detection of a user activity.

17. The apparatus of any previous claim wherein the content  
item streams comprise TV broadcasts of TV program content  
items.

25

18. The apparatus of any previous claim wherein the content  
items are audiovisual content items.

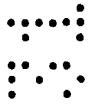
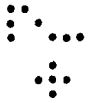
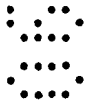
19. The apparatus of any previous claim wherein the  
30 apparatus is a Digital Video Recorder.

20. A method of operation of a content item recording apparatus; the method comprising:

receiving content item streams; each content item stream comprising a sequence of content items;

5 recording first content items from the content item streams in response to a user content item preference profile for a user of the apparatus; and

generating a time list of content items by scheduling the first content items in response to a user access time  
10 preference profile.





For Innovation

36

**Application No:** GB0607874.5

**Examiner:** Donal Grace

**Claims searched:** 1 to 20

**Date of search:** 17 August 2006

## Patents Act 1977: Search Report under Section 17

### Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	1 to 20	US 2003/0097657 A1 (ZHOU et al) see paragraphs [0107], [0131], [0134], [0135], [0139], and [0140]
X	1	US 2002/0199193 A1 (GOGOI et al) see figure 4 and related description

### Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

### Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC<sup>X</sup> :

Worldwide search of patent documents classified in the following areas of the IPC

H04N

The following online and other databases have been used in the preparation of this search report

EPODOC; WPI