D6.1 First Specification of the Personalized Content Recommender System

Project Ref. No.	**Integrated Project FP6 / IST 27312**
Deliverable/WP/Task	D6.1 / WP 6
Delivery Date	27 November 2006
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Filename	**LIVE-WP6-D6.1-RecommenderSystem-Final-20061113**
Publication Level	RE

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2 History

Version	Name	Date	Remark
V0.1	Janez Zaletelj	2006-09-01	First structure
V0.2	Janez Zaletelj	2006-09-20	UoL content added, usage scenarios, use cases updated.
V0.3	Janez Zaletelj	2006-09-27	Updated, sent to WP6 partners
V0.4	Janez Zaletelj	2006-10-13	Incorporated comments from WP6 partners
V0.5	UoL team	2006-10-25	Activity diagrams added
V0.6	Janez Zaletelj	2006-10-28	Draft final version
V1.0	Janez Zaletelj	2006-11-07	Final version
V1.1	Janez Zaletelj	2006-11-13	Final version

3 Executive Summary

This deliverable describes the first specification of the Recommender System, which is one of the five basic system components of the LIVE system. The specification is the result of the work carried out within the WP6, Personalization and Feedback. The specification is based on the user requirements described in the Deliverable 9.1, and the basic system architecture, defined in D9.2.

The document describes a general view of the Recommender System which should allow for different usage scenarios. It represents the WP6's current view of the final, fully functional Recommender System to be used in the production of LIVE TV programs. Implementation of the Recommender System will be carried out in phases. During the first 18 months, only part of the proposed functionalities will be realized and demonstrated within the first prototype.

This specification of the Recommender System covered within the document includes:

- User requirements. Users of the Recommender System services and the functionalities that they require are defined.
- Usage scenarios are proposed both for Video Conductor as well as for the Consumer.
- Functionalities. A list of functionalities provided by the Recommender system is defined.
- Based on the scenarios, six use cases of RS are defined in more detail.
- Internal system architecture of the RS is defined including components that comprise the Recommender System.
- Services and Interfaces. Services which are offered by the RS are described together with proposed interfaces.
- Activity diagrams. The activity diagrams define workflows that are performed inside the recommender system. The specification of workflows and activities will be detailed during the development of RS.

Further details on the Recommender System will be provided within the deliverables D6.2 "Report on user models", D6.3 "Report on content selection methods" and D6.4 "Specification of feedback mechanisms".

4 Introduction

This deliverable describes the first specification of the Recommender System, which is one of the five basic system components of the LIVE system. The specification is the result of the work carried within the WP6, Personalization and Feedback. The specification is based on the user requirements described in the Deliverable 9.1, and the basic system architecture, defined in D9.2. As stated in D9.1, the user requirements will be continuously adapted throughout the project duration by the requirement monitoring of WP9, Task T9.7 (Requirement monitoring). Thus a specification of the Recommender System will be revised and modified according to the experience resulting from the upcoming trials under live situations.

The document proposes general system architecture of the Recommender System which should allow for different usage scenarios, defined in the Use Case section. Thus it presents the WP6's current view of the final, fully functional Recommender System to be used in the production of LIVE TV programs, which would be available by the end of the project. During the first 18 months, only part of the proposed functionalities will be realized and demonstrated within the first prototype. Because the Recommender System is dependent on other system components and the availability of real content, the first prototype will demonstrate only partially integrated Recommender system. The level of integration and interfaces will be defined within the Deliverable D8.1.

4.1 Scope of the document

This section defines the areas and boundaries of the deliverable. The relation to the other deliverables and technical documents is defined.

Scope

The scope of the deliverable is to define the first specification of the Recommender system. This will include the following:

- User requirements. Users of the recommender system services and the functionalities that they require are defined.
- Usage scenarios. The scenarios are defined both for Video Conductor as well as for the Consumer.
- Use cases. A more explicit use cases are derived from the scenarios. Use cases are the basis for the definition of the specific services.
- Functionalities. A list of functionalities provided by the Recommender system is defined.
- System architecture. Recommender system components are defined and described.
- Services and Interfaces. Services of the RS are described together with proposed interfaces.
- Activity diagrams. The activity diagrams define the workflows that are performed inside the recommender system. The specification of workflows and activities will be detailed during the development.

The specification of the Recommender system will be revised during the project based on the updated user or system requirements. The definition of interfaces will be revised and updated if new requirements are specified by the clients (Video conducting system, Consumer system).

Because the RS uses services provided by other system components, the implementation of other components such as Intelligent Media Framework will also influence the specification and interfaces of the Recommender System.

Further details on the Recommender system will be defined in other documents. The topics that are not covered within this document include the following:

- user models of the Recommender system,
- content selection methods and algorithms, and
- feedback collection and analysis methods.

Relation to other deliverables and reports

- Personalization requirements were presented in the technical document LIVE_WP6_Personalisation requirements_UoL_apr06.ppt.
- First proposal on the Recommender system was defined in the WP6 technical document "Personalization and Feedback: Introduction, Scenarios and Functionalities" (LIVE-WP6-TED-Personalization_and_Feedback_Introduction-060529.doc).
- The scenarios and requirements for the personalized services and user feedback were defined in the D9.1 "Results from initial User Requirement Analysis".
- The first system architecture and components of the RS were defined in the D9.2 "Basic System Architecture".

The following documents will be related to the Recommender system:

- D8.1 "Description of the overall implementation and integration plan", will define the first prototype of the LIVE system, including the services and interfaces provided by the RS, and the implementation plan for the prototype.
- D6.2 "Report on user models" will describe the RS user models and data structures.
- D6.3 "Report on content selection methods" will describe the content selection and personalization methods.
- D6.4 "Specification of feedback mechanisms" will describe methods of feedback collection and analysis.
- D6.6 "Results of the evaluation". Describes the results of the RS evaluation.

5 Overview of the Recommender System

This chapter gives a high level overview on the function of the Recommender System within the LIVE system. This view should help to better understand the context of the following chapters giving more specific information about use cases, system architecture, and interfaces.

5.1 Roles of Recommender System within LIVE system

One of the main goals of the LIVE system is to support LIVE Video Conductor in the authoring of new type of live TV content, which is substantially influenced by the viewer (Consumer) preferences. The Video Conductor should be able to react in real-time to the live events by including related information and AV material into the program. At the same time, he should be able to review Consumer feedback on the program, which would influence his future decisions on the program content. These functionalities will be partly supported by the Recommender System.

The Recommender System is a subsystem of the overall LIVE system as shown in the diagram in the Figure 1.

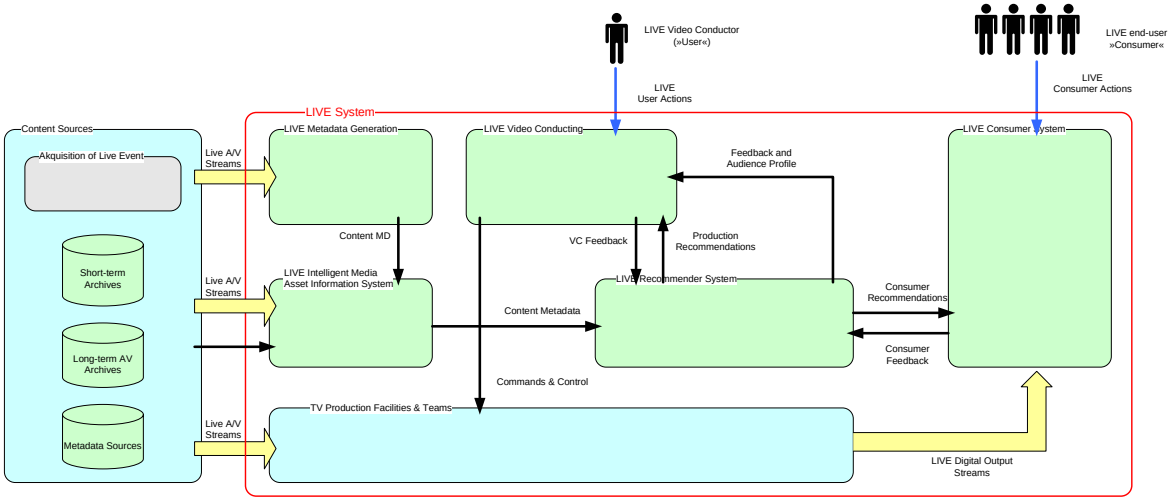

Figure 1: LIVE System Overview (from D9.2)

Main roles of the Recommender System within LIVE system are the following:

Support of the LIVE production by providing content recommendations to the Video conductor

The main role of the Recommender System is to support new conducting workflows of the LIVE Video conducting system by providing automatic recommendations of content suitable to be included in the program, as well as the information on Consumer feedback on the program. The Recommender System implements automatic methods to find and recommend archive content, which will be used to help Video Conductor in finding the related audio-visual

content from the archives, and will enable him to react to live events. Because of the huge amounts of AV material available in the TV archives, the content selection and finding functionalities of the Recommender System can be also successfully employed during program preparation phase, where the editor would get automatic recommendations of archive content for the given subject.

Collection, analysis and presentation of the Consumer feedback

The Recommender System is the system component through which the direct links to the Consumer systems are established. The Consumer System represents the application running on the consumer's set-top box or other end device, which is connected to Recommender system through suitable communication channel (also called the Feedback Channel).

The availability of consumer feedback information is one of the central requirements to the LIVE system. The collection of consumer feedback will be one of the roles of the Recommender System. The feedback from each Consumer will be collected, stored and analysed by the Recommender System services.

Analysis of the feedback will provide two kinds of information. First, the analysis of the feedback from the single consumer will be performed, which will result in a detailed user model of the Consumer. This information will enable personalized services for the consumer.

The second goal of the analysis is to calculate statistical information on the whole TV audience, which will be available to the Video conductor. Feedback from many (or all) of the TV consumers will be taken into account to derive statistical information on the audience.

Presentation services will be available to the VC application(s), so that the Video conductor will be able to review the aggregated statistical information on his audience. However, there will be no possibility to retrieve any information on the single Consumer.

Provision of personalized Consumer content recommendations

In the second phase of the project, the LIVE system might support personalized services also for the Consumer. These services will use the Feedback channel, which supports two-way communication, to provide additional personalized information to the single Consumer.

The Recommender System can provide personalized program recommendations to the Consumer. According to the Consumer's interests (profile), a personalized list of suitable program items can be compiled and sent to the Consumer STB. This service is called the personalized electronic program guide (EPG). The second variant of the content recommendations for the consumer are the personalized content alerts, which are displayed at the Consumer application.

5.2 User Requirements to the Recommender System

Users of the Recommender System

The Recommender System services support two groups of users of the LIVE system:

- Video conductor team members, including Video conductor or other members which deal with content preparation (Editor),
- Consumers of the LIVE programs (TV viewers), which are supported by personalized services of the Recommender system for the Consumer.

Requirements of the Video conductor

The main role of the Recommender System is to support new conducting workflows of the LIVE Video conducting system by providing automatic recommendations of content suitable to be included in the program, as well as the information on Consumer feedback on the program. The Recommender System implements automatic methods to find and recommend archive content, which will be used to help Video Conductor in finding the related audio-visual content from the archives, and will enable him to react to live events. Because of the huge amounts of AV material is available in the TV archives, the content selection and finding functionalities of the Recommender System can be also successfully employed during program preparation phase, where the editor would get automatic recommendations of archive content for the given subject.

The new conducting concepts will be also supported by Recommender System by providing real-time information on consumer's feedback on the program. The idea of LIVE is to enable the TV consumers to influence the TV authoring of live content. This requires that the Recommender System implements methods for feedback collection and analysis. Based on feedback analysis, the audience preferences can be produced and presented to the Video Conductor, so that he is informed in real-time on the preferences of his viewers.

Requirements of the Consumer

The problem of content selection is also present at the consumer side, where the individual consumer needs to make a selection among the available programs, channels etc. The third goal of the Recommender System is to support the Consumer by providing personalized information on the program content and schedule. This means that the individual viewer is supported in his decision on the selection of channels and viewing time to be able to make a more informed decision. Instead of browsing through the channels or manually checking the schedule, he is presented with channel and program recommendations based on his viewing preferences and habits. However this does not mean that he is able to request any additional personalized content, but rather he is helped in the selection of content (channel, program, time) which is scheduled for broadcast.

5.3 Usage scenarios of the Recommender System

In this section, the proposed usage of the Recommender System within the production workflows as well as by the Consumer is described in more detail. The scenarios and interfaces proposed within this section show the vision of the WP6 on how the Recommender System services might be used. However, the actual use and interfaces of the Recommender system for the Video conducting system will be defined within the WP4.

Similarly to most of the broadcast production processes, the LIVE production process consists of three phases:

- pre-production,
- (live) production and
- post-production phase.

This chapter describes the possible usage scenarios of the Recommender System within the pre-production and live production phases.

Scenario RS-Pre-1: Selection of Content in the Pre-production phase

The LIVE pre-production stage includes preparation activities for the production of the live program. This includes preparation of the staging concept, definition of the program content, and selection and preparation of related archive material, for example AV material showing former sport events or additional information about a certain athlete. The material needs to be edited in advance to fit into the live stream.

The Recommender System can be used in the pre-production by the editor who is preparing content for the show. Here we suppose that the Staging Concept including basic program information (title, genre, duration, etc.) has already been defined. The Recommender System can be effectively used in the process of planning of show content and preparation of audio-visual materials for the show. The Recommender System would provide automatic archive clip recommendations for each topic (subject), which is defined by the editor of the show. Then the editor will review the recommendations and select some of them to be included as candidate content for the show. These clips are then extracted from the archive and prepared for the production. The graphical representation of the proposed workflow is shown next.

Some of the advantages of the proposed workflow compared to usual pre-production practices are the following:

- The queries (topic definitions) to Recommender System are simple to enter and more structured because the proposed user interface of the Recommender System already presents predefined templates for entering queries based on the domain ontology. For example, for a given sport (football), all domain terms are predefined and selectable from the GUI, such as goal, player, coach, and their possible actions.
- The search through Recommender GUI results in content recommendation on the level of AV clips, which are part of larger AV materials. No browsing is necessary through large AV materials, only fine tuning of clip start and end times.
- LIVE System integrates information from different content databases such as Sport database, archive material database, sport event databases (containing team lists,

player names etc). This would increase the reliability and the hit rate of recommendations.

- Recommender System utilizes pre-existing information on the event, and the information on sport discipline (domain ontology) to build advanced search queries.

The details of the content selection workflow(s) and actual role of Recommender System within the pre-production will need to be defined within the WP4.

Scenario RS-Live-1: Video Conductor requests Archive Content Recommendation on new Subject (Topic)

This scenario is intended to help Video Conductor and members of his team to prepare background information (archive material) on the fly, during a live production phase. Suppose that during the live production an unplanned (unexpected) event occurs, for example an unknown athlete wins the race. This means that a new subject (topic) will appear in the show and the Video Conductor needs a background information and archive material on it.

VC (or other team member) would start a Recommender GUI (proposed interface is shown in Figure 2) and fill in information about new subject (Topic) of the show. Then he would request content recommendations on this topic. The Recommender System will return a list of matching clips. VC would review a list of suggested archive material and decide if some clip is to be included in the transmission.

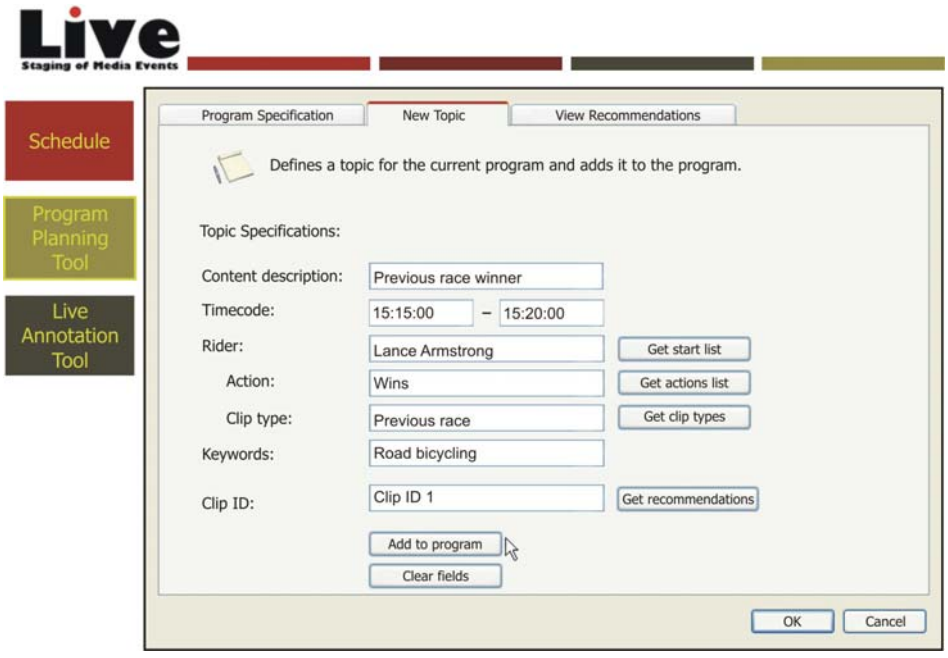

Figure 2: Proposed VC interface to define a new subject (topic) of the show and request content recommendations.

Scenario RS-Live-2: Video Conductor receives Related Archive Content Recommendations on live events

This scenario is intended to help Video Conductor and members of his team to prepare background information (archive material) on the fly, during a live production phase. In contrast with the previous scenario, information about the subject is coming from the Metadata generation system (either from automatic or manual annotation system).

A Recommender System receives a notification from the Metadata Generation System that the new subject (or action) was detected in the input stream. In an automatic scenario, this would already start the recommendation process on that issue. However, the feasibility of this scenario needs to be evaluated in terms of the available computation resources and real-time requirements.

The manual scenario requires that the VC reviews the list of detected events, select an event and then start a recommendation process. A Recommender System would then return a list of matching archive clips on the subject. In this scenario, no manual entering of subject information is necessary. Recommender System generates recommendations from retrieved clips metadata based on Video Conductor and Audience Models. Live Video Conductor then reviews the recommended clips and selects some of them for broadcast.

Example Scenario (from D9.2):

The automatic annotation process detects an athlete with number 38. In combination with the current program specification as well as with an athlete's database the number is assigned to the Norwegian bicycle racer Thor Hushovd. This information is given to the recommender system that sends queries to the intelligent media asset information system or more specific, to archive and event databases. There, queries are processed and linkages to other information like the athletes' place of birth or to a clip with an interview with the athlete are built. Based on the current profile of the video conductor (saying that he often shows interviews) and of the audience (saying that it likes Thor Hushovd) the recommender system suggests the interview as a content recommendation to the video conductor. The video conductor recognises the recommendation on his screen in the video conducting system. He decides to use the interview. On request he brings it directly into his current show by playing the A/V material in broadcast quality on one of his streams.

Scenario RS-Live-3: Video Conductor reviews Consumer Feedback and Audience Profile

The Recommender System provides analysis of the Consumer feedback. This information can be displayed by the VC application to the Video conductor, so that he is able to react on it.

By using the Consumer Feedback Interface (see Figure 3), the VC can see different aspects of audience feedback. There can be different feedback statistics for each output stream. The director can see implicit feedback, which can be of demographic nature, for example, nationality, gender or age. There is also an explicit feedback (thumbs up, thumbs down), as a result of an opinion poll, which could be started by the director. The content could also be personalized to the different audience profiles, such as preferences to specific TV program types or different sports. Because of that, the consumer feedback tool should offer also an insight into the number of consumers of different types, which are currently watching the selected content. The consumer feedback tool could also provide overall statistics and trends versus time for each output.

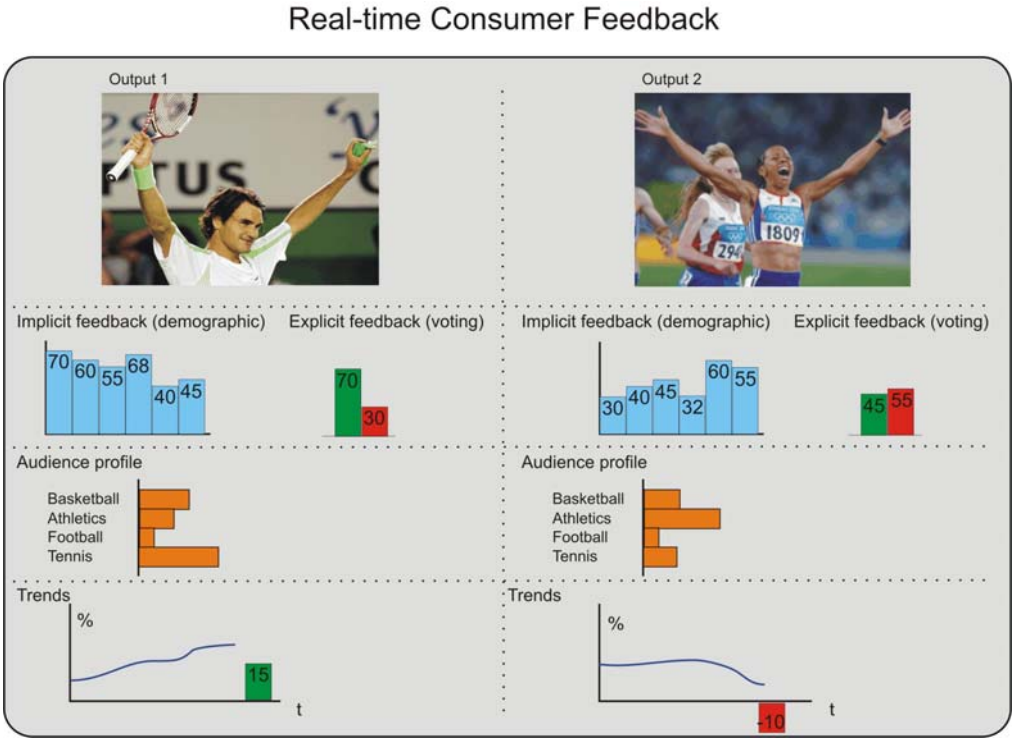

Figure 3: Proposed VC interface for reviewing the consumer feedback and audience information.

Scenario RS-Cons-1: Consumer requests personalized program recommendations

The Recommender System is capable of suggesting the user which content would be most appropriate for him to watch. Through the Consumer Application the Consumer is presented with an option to request personalized program guide(s).

Personalized EPG

The recommender engine must create a user profile for each new user and update this profile each time the user provides feedback. The user profile contains all the necessary information with which the recommender creates suggestion for the particular user. The recommender then scans the program and selects content that best matches the user's profile. These items are then considered to be recommendations for the user and can be presented as single clips (i.e. "I suggest you watch the football match at 13:00) or can be compiled into an electronic program guide that displays all the recommendations in an uniform presentation.

Automatic Program Alerts

The Recommender System is capable of detecting when new content is available (a special alert, something unpredicted has happened during an event....). When it detect such a situation it finds all consumers that would be interested in viewing this clip / content and send an alert to their terminals.

Consumers which use this scenario would receive personalized real-time automatic alerts on the program. Example: Consumer is watching a Subchannel 1 with live transmission of bas-

ketball from Olympic Games. But on the Subchannel 2, an interview with bicycling winner is taking place. Because the Consumer is also interested in bicycling, he receives an alert about this interview and he is given a suggestion to switch to Subchannel 2. These alerts can be in the form of scrolling text at the bottom of the screen.

5.4 Functionalities of the Recommender System

To be able to fulfil its goals, by the end of the project the Recommender System should provide at least the basic level of the following functionalities, to be used by the production teams as well as by the TV Consumers.

Personalized content recommendations in the production

The goal is that the recommender system selects (recommends) content from the set of all available (archive) content according to the given search query (topic description) and the personalization profile. The recommendations would be used by Video conductor or other members of the production team to compile the material to be used in the LIVE programs.

Selection of related archive clips for the program and its topics (subjects) can be done

a. in the pre-production during program preparation phase,

b. during live production, when new topic appears.

Input Data: Archive content descriptions (metadata), which describe archive AV material in terms of its content on the level of AV segments (clips).

Output Data: Ranked list of AV content (clips). This content fits to the given topic description or search query and is ranked according to the personalization profile.

Recommender Context: Pre-existing information on the domain, within which the current instance of the recommender engine is operating. It can be given in the form of the Program Specification, which defines the main theme of the target program, its genre, the domain (sport, basketball etc.), the domain ontology (list of terms, thesaurus, etc.). This information is provided in the initialization phase of the VCRecommender service. It is used during the computation of the recommendations to be able to interpret the search queries.

Topic definition: Definition of the search query terms or keywords, which are defining the search topic (subject). The definition of the topic should be interpreted within the given domain.

Personalization Profile: Profile of the target user of the recommendations. This profile is used to rank the available clips according to the preferences of the target user. This means that the recommendations are personalized to the user. Several personalization profiles are envisioned for the Recommender System: target audience profile (describing the preferences of the audience group, for example children, towards content), video conductor profile (personal preferences of the video conductor).

Personalized program recommendations for individual Consumers

The goal of this functionality is that it selects and recommends suitable content to the individual Consumer. The recommendations are selected from the list of program items (and/or segments) available on LIVE channel(s).

Input Data: Description of the available program items on the LIVE channel(s).

Output Data: Ranked list of recommended content (program items or specific program segments) for the individual Consumer. The list items are ranked according to the personalization

profile of the target Consumer. This list can be seen as a personalized electronic program guide (EPG).

Personalization Profile: Profile of the Consumer which specifies his preferences toward different types of content. This profile is used to select items from the set of available program items. This means that the recommendations are personalized to the individual Consumer.

Collection of user's feedback:

The feedback information from LIVE System users is collected. For the individual Consumers, the following information is collected:

- explicit feedback (voting on the program or rating of the content)
- implicit feedback (information, what channel the Consumer is watching)

The feedback from Video Conductor can also be collected if needed. The feedback data is stored for further analysis and user profiling.

Input Data: Information from the Consumer System.

Output Data: Feedback information is stored into the database.

Analysis of feedback

Analysis of (Consumer) feedback provides statistical information on the audience. This statistics might include demographic statistics, viewing statistics, results of voting, and audience preferences towards content. Results can be presented to the Video conductor.

Input Data: Consumer feedback data.

Output Data: Audience profile.

Profiling of LIVE users

Profiling functionality covers the process of analysis of user's feedback to generate or update his individual profile. The user profile in this context is mostly seen as personal preferences towards different types of content.

Input Data: Consumer feedback data.

Output Data: Consumer profile.

5.5 Use Cases of the Recommender System

This section describes the Use Cases of the Recommender System in UML 2.0 notation. The use cases are based on the proposed scenarios, describing how the Recommender System will be used in the pre-production and live production phases. The results are presented with use case diagrams in the next sections.

5.5.1 Overview of Use Cases of the Recommender System

Use cases of the Recommender System are grouped according to the user (actor) and according to the goal (Figure 4). The users of the RS are:

- Video Conductor (or members of his team), which means that he is presented with a Video conducting application (user interface) where he can issue commands to the RS and see the results of RS.
- Consumer Application, which is resident at the Set-top Box and through which the individual Consumer can issue requests and review the results of the RS (consumer recommendations of content).

Use cases are grouped by the Recommender System components:

- VCRecommender service, whose goal is to provide content recommendations in the LIVE production process,
- Consumer Recommender service, whose goal is to provide content recommendations for the Consumers
- Consumer Feedback service, whose goal is to collect feedback from the Consumers,
- Feedback Analysis service, whose goal is to analyse and present feedback to the Video Conductor.

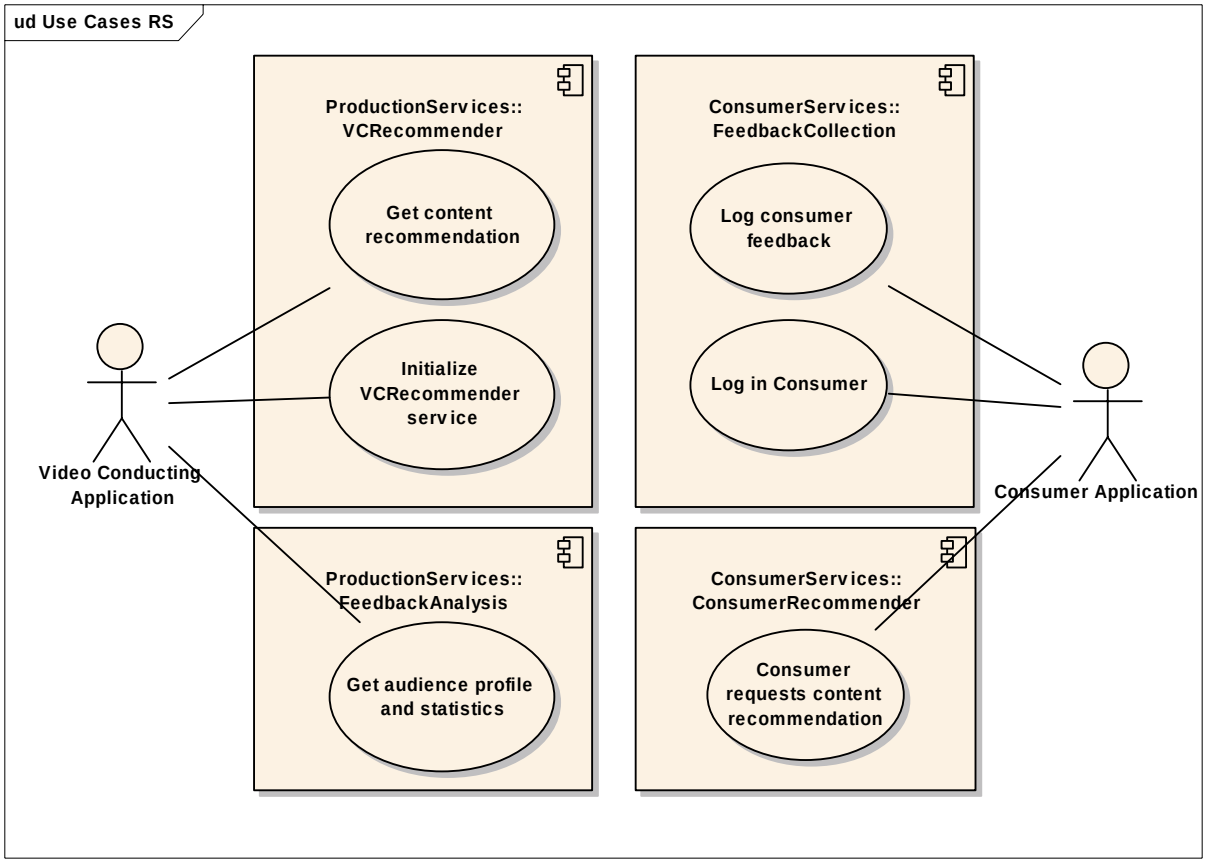

Figure 4: Use cases of the Recommender System in the UML notation.

5.5.2 Initialize VCRecommender Service

Description: VCRecommender Service needs to be initialized before it could recommend content. Profiles, such as audience or video conductor profile should be loaded. Program specifications and event specific information need to be provided. The VC starts the service through the Video conducting application.

Actors: Video conducting system

Requirements: Appropriate profiles have to be loaded before recommender system could recommend content.

Pre-Conditions: Recommender system is running.

Post-Conditions: VCRecommender is initialized and is ready to receive recommendation requests and messages.

Main Flow:

1. Start VCRecommender service,
2. Initialize VCRecommender program and event information.
3. Initialize VCRecommender personalization profiles (VC profile, audience profile).
4. Connect to content metadata generation services.

5.5.3 Get content recommendation

Description: The client application (Video conducting system) requests a content recommendation on the given topic (subject). For example, Video Conductor selects topics, players, athletes etc on the Video Conductor user interface in order to get related archive content clips for those objects. User interface generates queries for the recommender system. The VCRecommender then queries archive database to retrieve related archive content clip metadata. Recommender System generates recommendations from retrieved clips metadata based on Video Conductor and Audience Profiles.

Actors: Video conducting system

Pre-Conditions: The VCRecommender service is initialized with Program specification to understand the context of the topic, knowledge database (players', athletes', teams' information) can be queried to find additional information about a specific athlete and/or team which can then be used in the process of recommendation, archive material database with descriptions of previous events as the main database for related archive content clip information is available, VC Model (Video Conductor's preferences) and Audience Model for the personalized recommendation of related clips is available.

Post-Conditions: List of recommended clips is returned to the client application.

Main Flow:

1. Analyse the request.
2. Combine the request with given context.
3. Retrieve related information on the subject from the Knowledge database.
4. Search for suitable clips in the IMAIS system.
5. Compile the list of matching clips and rank clips according to the personalization profile.
6. Return the list of recommended clips.

5.5.4 Get audience profile and statistics

Description: The client application (Video conducting system) requests information on the audience statistics. The query parameters contain information on the target channel, time etc. which is used for the selection of feedback data. The Feedback Analysis service retrieves the feedback data and performs an analysis. The result can be a demographic statistics on the TV viewers, statistics on the channel, voting results etc. The results are displayed to the VC by the client application.

Actors: Video conducting system

Pre-Conditions: Feedback data is available.

Post-Conditions: Audience profile is returned to the client application.

Main Flow:

1. Analyse the request and extract the audience profile parameters.

2. Retrieve matching feedback data of the target audience (selected by channel, time etc.)
3. Perform analysis and compile the results into the audience profile.
4. Return the audience profile.

5.5.5 Log in Consumer

Description: Consumer identification is a basic requirement of the consumer personalized services such as content recommendations. A possible scenario is that each individual consumer of the LIVE channels will need to register (off-line) for the consumer personalized services. He/she will be provided with unique username and (optionally) password. The Consumer Application will require a username at start-up, and it will contact the Feedback Collection service to log in the individual Consumer to the system. This will enable the interpretation of the feedback, profiling of the consumer, and provision of personalized recommendations.

Actors: Consumer System application

Pre-Conditions: Consumer is registered with the LIVE system.

Post-Conditions: Consumer is logged in.

Main Flow:

1. Receive log-in request.
2. Check the username and password.
3. If successful, log in the consumer and provide the result to the Consumer Application.

5.5.6 Log Consumer feedback

Short Description: The Consumer application tracks consumer actions (switching of the channels) and report it to the Feedback Collection service. The Consumer application gives the Consumer an option to rate content (Like/dislike etc.) or to vote on an invitation. This feedback is also collected and reported to Feedback Collection service.

Actors: Consumer Application

Pre-Conditions: Consumer is logged in.

Post-Conditions: Consumer feedback is stored.

Main Flow:

1. Request from Consumer system is received.
2. Feedback data is stored into FeedbackData component.

5.5.7 Consumer requests content recommendation

Short Description: The system is capable of suggesting the Consumer which content would be most appropriate for him to watch. The recommender engine must create a user profile for each new user and update this profile each time the user provides feedback. The user profile

contains all the necessary information with which the recommender creates suggestion for the particular user. The recommender then scans the program and selects content that best matches the user's profile. These items are then considered to be recommendations for the user and can be presented as single clips (i.e. "I suggest you watch the football match at 13:00) or can be compiled into an electronic program guide that displays all the recommendations in an uniform presentation.

Actors: Consumer Application

Pre-Conditions: Metadata is available for each program item, a feedback collection mechanism is set up, database containing consumer profiles is available.

Post-Conditions: A list of recommended programs (segments) or a personalized EPG.

Main Flow:

1. Request from Consumer Application is received.
2. For a given consumerID, the list of program items is searched and the suitable items are selected.
3. The list of selected program items is compiled and sent to the Consumer Application.

6 Recommender System Architecture and Services

This section describes the first specification of the Recommender System architecture and its services. This specification is based on the work carried out within the WP6 as well as the work within other work-packages (WP8, WP5, WP7).

The specification is based on the current specification of the LIVE system architecture (D9.2) and might change if the system architecture will be updated. The specification of interfaces is seen as a proposal to other WPs and components who are the users of the recommender system services. The required interfaces depend on the actual definition and implementation that will be provided by other system components (IMIAS, Video Conducting system, Consumer System).

6.1 System architecture

Overview

The system architecture of the Recommender system is shown in the UML diagram in Figure 5. The Recommender System will be broken up into four main services:

- VCRecommender service,
- Feedback Analysis service,
- Feedback Collection service, and
- Consumer Recommender service.

Services will provide interfaces to other system components (Video conducting system, Consumer system).

Additional data storage components will be provided (AudienceProfile Data, Feedback Data, Recommendations Data, ConsumerProfile Data).

Requirements

Interfaces and services that will be required for the RS to operate are the following:

- ActionMessageQueue, as a central messaging system,
- Intelligent Media Asset Service, which will provide archive clip information,
- Knowledge Service to provide additional background information and event-specific information,
- Staging Service to provide staging related information and program information.

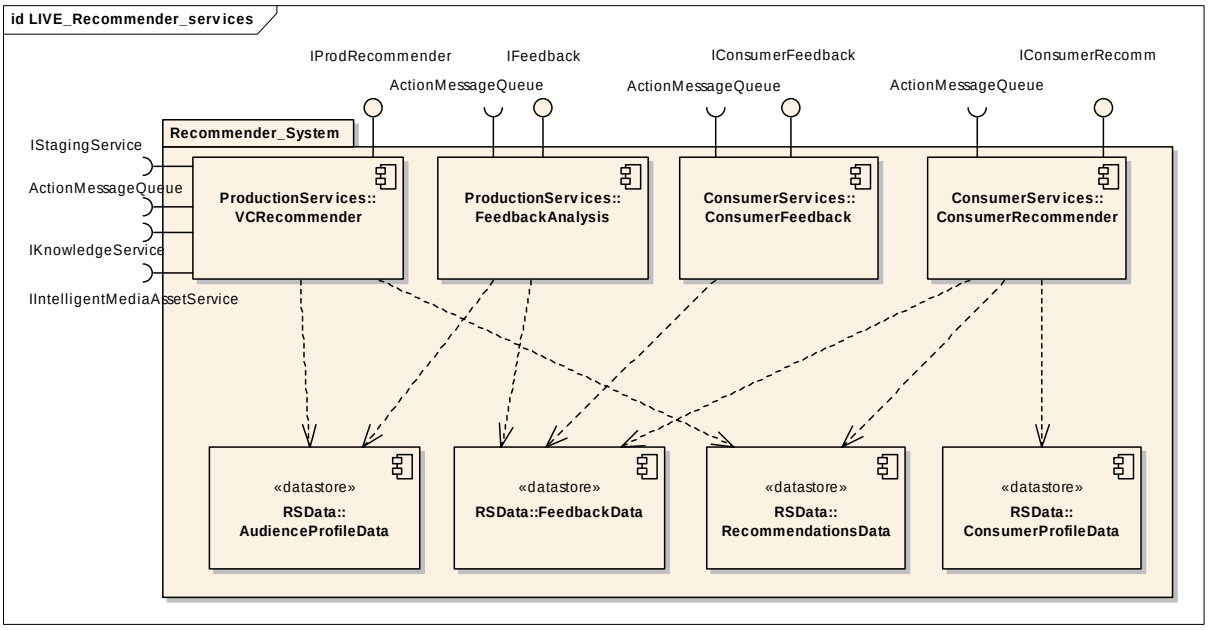

Figure 5: Recommender System architecture.

6.2 Recommender System components

6.2.1 VC Recommender Service

Description

VC Recommender Service provides content filtering and recommendations for the video conductor so that he/she is able to include content into the program. These are recommendations on the input clips which are available either in the archive or on-line. The recommender uses information on the program profile, video conductor preferences, and audience profile to rank input clips, obtained from the IMAIS system.

Interfaces

VC Recommender Service provides an interface (IProdRecommender) through which the VC application (Video conducting system) is using the service.

The VC Recommender requires the following interfaces to other system components:

- IStagingService, through which it retrieves staging-related information (program specification, VC profile etc.)
- IKnowledgeService, through which it can query the knowledge base with info on the specific domain and events.
- IIntelligentMediaAssetService, through which it searches for an AV material.
- ActionMessageQueue, through which the input and output messages are passed.

Messages

Name	Type	Description
NewActionDescriptionMsg	Input	Message is received when new statement is generated by MGS describing the content within live streams (for example recognition of person or action).
NewInputClipDescriptionMsg	Input	Message is received when new statement is generated by MGS describing the content within a specified time segment (clip) of the live streams.
NewRecommendationMsg	Output	Message is sent when content recommendation results are available.
RSInitializedMsg	Output	Message is sent when recommender service initialization is finished

6.2.2 Consumer Recommender Service

Description

Consumer Recommender Service provides personalized program recommendations to individual Consumers. It uses the consumer profile to filter available program items and generates the list of recommended ones. The recommendations can be in the form of Personalized EPG service or in the form of alerts for the consumer (Alert service). Besides that, the Consumer Recommender provides the Profiling Service: by analysing the consumer feedback data, the consumer profile is generated or updated.

Through the ActionMessageQueue, the Consumer Recommender is notified of the availability of new metadata describing (partly or in general) a new available program item or program segment. For example, when the VC includes new clip into the program, the Consumer Recommender is notified. Depending on the initialization, the Consumer Recommender might start a recommendation engine and calculate a suitability of the given item for the target set of Consumers.

Interfaces

Consumer Recommender Service uses the database queries to retrieve and write data from ConsumerProfileData, FeedbackData and RecommendationData components.

Consumer Recommender Service provides an interface (IConsumerRecomm) for the Consumer application (Consumer System) to retrieve the generated recommendations in a XML format.

Consumer Recommender Service requires the following interfaces:

- ActionMessageQueue, through which the input and output messages are passed.

Messages

Name	Type	Description
NewProgramSegmentMsg	Input	Message is received from VCS when new segment (clip) is included into the current LIVE program.
NewProgramDescriptionMsg	Input	Message is received from VCS when new Program Description is available (including general information about the program item which is planned for broadcasting) as a result of planning within the preparation phase.
NewChannelScheduleMsg	Input	Message is received from VCS when new Channel Schedule is available (electronic program guide for a channel) as a result of planning within the preparation phase.
NewProgramAlert	Output	Message is sent to the consumer application when a new clip is available that is deemed appropriate for the user by the system.

6.2.3 Feedback Collection Service

Description

Feedback Collection Service is responsible for communication with the Consumer System through the feedback channel. The functionalities are the following:

1. Collects and stores the explicit consumer's feedback (voting, rating of content items),
2. Collects and stores consumer's actions (channel switching).

Interfaces

Data interface to the FeedbackData component is provided. The IConsumerFeedback interface to the Consumer Application will use standard protocols such as HTTP.

Feedback Collection Service requires the following interfaces:

- ActionMessageQueue, through which the generated messages are sent to the Feedback Analysis and Consumer Recommender services.

Messages

Name	Type	Description
NewExplicitFeedbackMsg	Output	Message is sent when new voting info is received from a Consumer application.
NewSwitchingInfoMsg	Output	Message is sent when new info on consumer changing the channel is received from a Consumer application (Consumer enters or leaves the LIVE channel(s)).

6.2.4 Feedback Analysis Service

Description

This service provides aggregated data and statistics on the consumer feedback. It provides statistics on the current audience which is watching the target program (such as an average user) and the statistics on different specific audience subgroups. This statistics can be either collected and presented in real-time or updated regularly, for example on a daily basis.

Interfaces

The Feedback Analysis Service is using the data interfaces of the FeedbackData storage to retrieve the feedback data, and stores the results into the AudienceProfileData component.

The Feedback Analysis Service provides the interface to the Video conducting system (IFeedback), through which the VC application can retrieve and show the analysis results.

It uses the ActionMessageQueue to receive messages when new feedback is available and to notify the Video conducting system that the new analysis results are ready.

Messages

Name	Type	Description
NewExplicitFeedbackMsg	Input	Message is received from Consumer Feedback service when new voting data is available.
NewChannelInfoMsg	Input	Message is received from Consumer Feedback service when new info on consumer changing the channel is available (implicit feedback).
NewVotingStatsMsg	Output	Message is generated when new statistics is calculated for an explicit feedback (consumer voting).
NewViewingStatsMsg	Output	Message is generated when new channel viewing statistics is calculated from an implicit consumer feedback.
NewAudienceProfileMsg	Output	Message is generated when on-line audience statistics is calculated from an implicit consumer feedback (for example, demographic profile, content preferences etc.)
NewAudienceAlertMsg	Output	Message is generated if audience statistics is different from pre-defined threshold values: for example, if percentage of channel viewers drops below a predefined value.

6.2.5 AudienceProfileData component

Description

Storage of audience profiles. The database contains profiles for general audience as well as profiles of specific audience groups such as demographic or interest groups (children, women, etc, footbal fans, etc.).

Audience Profile is a general name for the statistics which is calculated from the consumer feedback data provided by the group of consumers. Some of the different types of the Audience profiles are the following:

1. Target audience group: a pre-defined profile which defines the criteria for inclusion of specific consumers. For example, demographic criteria (age) can be used to build a specific profile (Children profile). Target audience profile can be used in the content selection process to filter the content suitable for the specific audience group.
2. Online audience profile: A statistics is calculated for the current set of consumers which follow the channel.
3. Voting statistics: a subset of a general profile which contains only the results of voting.

Audience Profile instance can contain any of the following components

1. General audience profile MD (name of the profile, id),

2. Consumer membership: definition of the members (consumer-ids) which belong to the Audience
3. Demographic profile: statistics on the consumer demographic data
4. Voting statistics: statistics on the explicit consumer feedback (rating of the content or voting)
5. Channel statistics: statistics on the percentage of the viewers following the channel.
6. Timing profile: the time window of the statistics (such as current audience, long-term audience)
7. Content preferences: describes general preferences of the audience (consumer group) towards different content items or content types (genres, sports etc).

Interfaces

Audience profiles are searched, stored and retrieved through usual database data interface such as SQL queries.

6.2.6 FeedbackData component

Description

Storage of Consumer and Video Conductor feedback information. Feedback information is stored for each individual consumer over predefined time period. This enables the generation of individual consumer profiles.

Interfaces

Feedback data can be searched, stored and retrieved through usual database data interface such as SQL queries.

6.2.7 ConsumerProfileData Component

Description

Storage of consumer profiles. Consumer profile might include the following components:

- Demographic profile
- Content preferences: (content-based profile)
- Collaborative profile

Interfaces

Consumer profiles are searched, stored and retrieved through usual database data interface such as SQL queries.

6.2.8 RecommendationsData component

Description

Storage of recommendation requests and results.

Interfaces

Recommendation data are searched, stored and retrieved through usual database data interface such as SQL queries.

6.3 Recommender System Interfaces

6.3.1 VC Recommender Service

Provided Interfaces: IProdRecommender API

initializeRecommenderService	
Input:	String username: username of the video conductor currently using the system String password: password VCProfile vc_profile: VC profile (optional) AudienceProfile audience_profile: Audience profile ProgramSpecification program_specification: specification of the program
Returns:	Int userID: ID of the video conductor, if initialization is successful XML returnInfo: XML message if initialization is successful or error message describing the reason for initialization failure
Description (notes):	Initializes the recommender system, logs the Video Conductor into the recommender system.

setAudienceProfile	
Input:	AudienceProfile aud_profile: Contains data about the target audience.
Returns:	Boolean OK, failed.
Description (notes):	Sets the target audience profile for content-based generated recommendations.

setUserProfile	
Input:	VCProfile vc_profile: Contains data about video conductor
Returns:	Boolean OK, failed.
Description (notes):	Sets the video conductor profile for content-based generated recommendations.

setProgramSpecification	
Input:	ProgramSpecification progSpec: specification of the target program
Returns:	Boolean OK, failed.

Description (notes):	Sets the target audience profile for content-based generated recommendations.

startRecommendation	
Input:	RecommendQuery recQuery: query given by the video-conductor UserID userID: ID of the video conductor
Returns:	Int recommID: id of the recommendation query.
Description (notes):	Starts the VC recommendation process. Takes the query and combines it with the EventProfile. Based on that it compiles a list of suitable clips. Clips are ranked based on personalization profile. The results can be retrieved using getRecommendation method.

getRecommendation	
Input:	Int recommID: id of the recommendation [in]
Returns:	RecommendedItems: XMLDocument containing the list of recommended clips (clip-ids) and the relevance weights (to what extent the clip fits to the query).
Description (notes):	After receiving a message that the recommendation for his request have been calculated, VC sends request to the RS to retrieve those recommendations.

stopRecommenderService	
Input:	Int UserID: ID of the video conductor
Returns:	Boolean OK, failed.
Description (notes):	Stops the recommender service, log-out the video conductor .

6.3.2 Consumer Recommender Service

Provided Interfaces: IConsumerRecomm API

getProgramRecomendations	
Input:	Int consumerID: ID of the consumer who requires the recommendations
Returns:	RecommendedItems: XMLDocument containing the list of recommended content items, clips (clip-ids) and the relevance weights (to

	what extent the item fits to user profile).
Description (notes):	The Consumer Application asks for a personalized content recommendation for a specific consumer. The list of recommended program items (personalized EPG) is compiled by the service and returned to the Consumer Application.

getProgramAlert	
Input:	Int consumerID
Returns:	ProgrameAlert alert: A description of a program/clip that might be of special interest to the consumer.
Description (notes):	The second variant of the personalized content recommendations for the Consumer. Through this interface the Consumer Application can query and retrieve a list of alerts for the specific Consumer. This includes a description of a program that could be of interest to the consumer, taking into account his/her user profile (preferences).

6.3.3 Feedback Collection Service

Provided Interfaces: IFeedbackCollection API

loginConsumer	
Input:	String username: username of the consumer logging-in String password: password
Returns:	Int consumerID: ID of the consumer if login is succesfull. Error error: An error message describing the reason for login failure
Description (notes):	Logs the consumer into the recommender system.

logChannel	
Input:	Int consumerID: ID of the consumer who changes the channel Int channelID: ID of the channel to which the user has changed Time time: time of the channel change
Returns:	void
Description (notes):	Logs channel info when consumer changes channel.

logExplicitFeedback	
Input:	Int rating: rating value for the content item

	Int contentID: ID of the rated content item Int consumerID: ID of the consumer providing feedback
Returns:	void
Description (notes):	Provides the content rating functionality and stores the rating given by a user for a particular content item. This data is used later for updating the user profile.

6.3.4 Feedback Analysis Service

Provided Interfaces (APIs)

getViewingStats	
Input:	channelID: ID of the channel for which viewing statistics data is required StatsParameter: time frame or any other parameters
Returns:	ViewingStats object containing information about viewing statistics like number of viewers at the specified channel etc.
Description (notes):	Retrieves viewing statistics for a specified channel. The viewing statistics contain information such as percentage of viewers at the specified channel, trends etc.

getVotingStats	
Input:	channelID: ID of the channel for which the voting statistics are required StatsParameter: time frame or any other parameters
Returns:	VotingStats object containing statistical information about voting like voting percentages, average vote, etc.
Description (notes):	Checks and returns voting statistics for a specified channel.

getOnlineAudienceProfile	
Input:	channelID: ID of the channel for which AudienceProfile is required StatsParameter: time frame or any other parameters
Returns:	AudienceProfile object containing requested information parameters about current online audience at the specified channel.
Description (notes):	Based on the submitted parameters, the system extracts the information about online audience at the specified channel. The information may contain any subset of available audience profile information (demographic info, voting statistics etc.).

retrieveAudienceProfile	
Input:	Int profileID: ID of the profile, that needs to be retrieved from the recommender system
Returns:	AudienceProfile object containing requested information parameters about audience.
Description (notes):	Based on the profileID, the system returns the content of the specific audience profile from the AudienceProfileData database.

storeAudienceProfile	
Input:	AudienceProfile: new profile to be stored.
Returns:	profileID: ID of the profile
Description (notes):	Audience profile can be stored into the AudienceProfileData database.

7 Activity Diagrams

This section uses the UML Activity diagrams to define the activities (workflows) within the Recommender system. Activity diagrams are used for modelling the sequence and conditions of behaviours. For each of the Recommender system services, main activities are described and/or modelled using UML Activity diagrams.

7.1 VC Recommender Activity Diagrams

7.1.1 Recommender Service Initialization

Description:

Initialization activities are performed each time the VC starts the VC Recommender GUI and logs in. The VC Recommender GUI is a client application of the Recommender System. First, the recommender engine is started and then VC profile, Audience Profile and Program Specification are initialized.

Started by:

- request initializeVCRecommender (vc_profile, audience_profile, program_description)

Workflow:

1. Receive request for VC recommender initialization
2. Start recommender engine
3. Initialize VC profile
4. Initialize Audience Profile
5. Initialize Program Specification

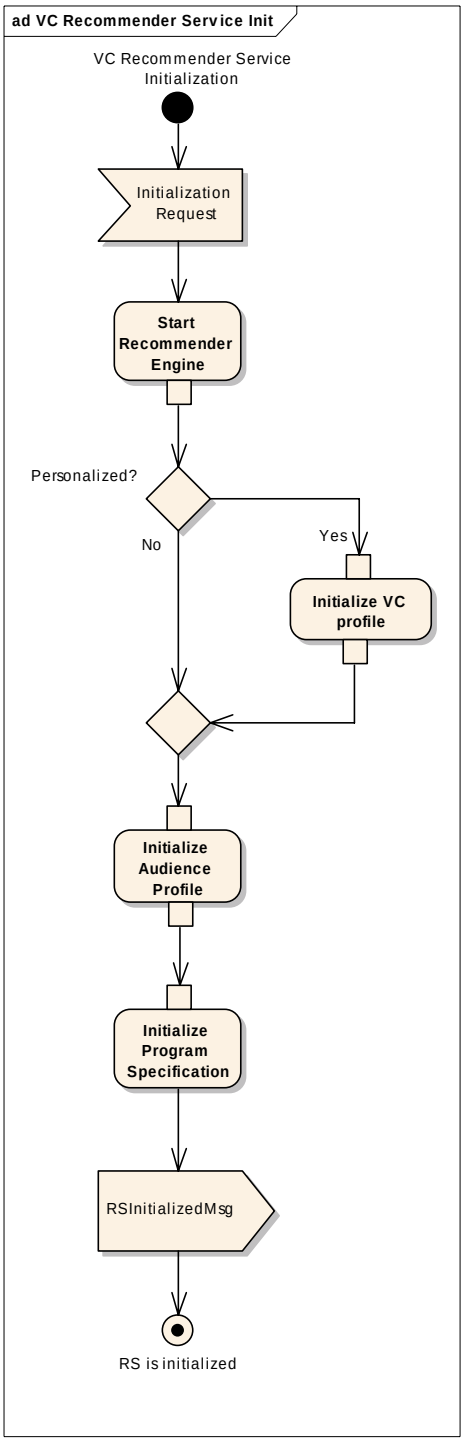

Figure 6: VC Recommender Service Initialization activity diagram

7.1.2 VC Recommendation Generation

Description:

Recommendations for the Video Conductor are generated on request (by the VC) or automatically (if this feature is enabled by the VC) when the message is received.

Started by:

- NewActionDescriptionMsg message: this message is received when new statement is generated by MGS describing the content within live streams (for example recognition of person or action) – this message starts VC recommendation generation activity if enabled by VC
- NewInputClipDescriptionMsg message: this message is received when new statement is generated by MGS describing the content within a specified time segment (clip) of the live streams
- VC recommendation request – VC requests recommendations by himself

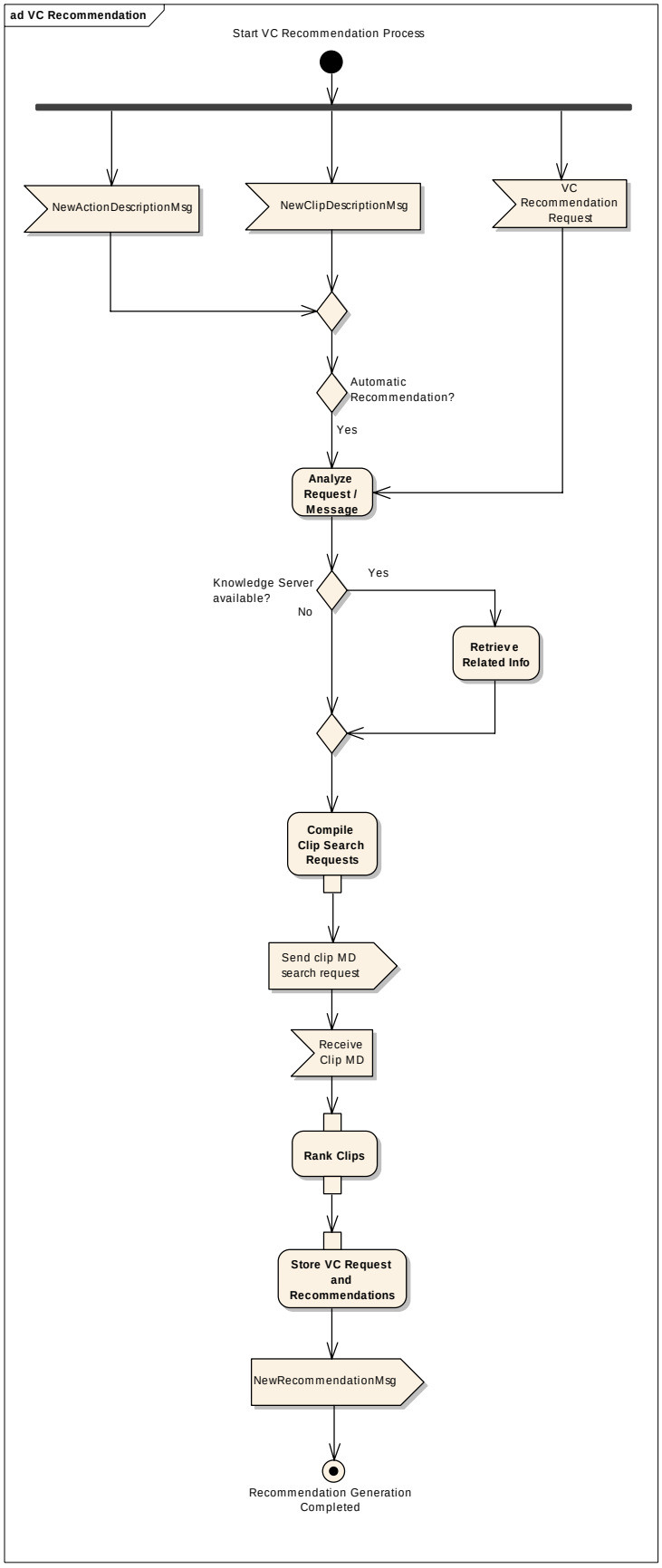

Figure 7: VC Recommendation Generation activity diagram

7.1.3 Recommendation Retrieval

Description:

Video Conductor System listens to the ActionMessageQueue and waits for the NewRecommendationMsg message, notifying him that the recommendations are available. After that VCS sends a request to the Recommender System to retrieve the recommendations from the DB.

Started by:

- request getRecommendation (recommID)

Workflow:

1. Receive recommendation retrieval request
2. Retrieve recommendations from the DB
3. Send recommendations to the VC System

7.1.4 Finalization

Description:

This activity is started when the request to stop the recommender service instance is received. It logs the video conductor out of the recommender system.

Started by:

- request stopRecommenderService (userID)

Workflow:

1. Receive request to stop the recommender service
2. Stop the recommender service instance

7.2 Consumer Recommendation Activity Diagrams

7.2.1 Consumer recommendation computation

Description:

Consumer recommendation computation activity calculates the recommendation value (score) for the given program segment or program item(s) for each of the Consumers.

Started by:

- message NewProgramSegmentMsg received: starts the alert calculation activity for Consumers who are subscribed to alerts
- message NewProgramDescriptionMsg received: starts calculation of recommended value for the program item (for each Consumer)
- message NewChannelScheduleMsg received: starts calculation of recommended value for all program items in the schedule

Workflow :

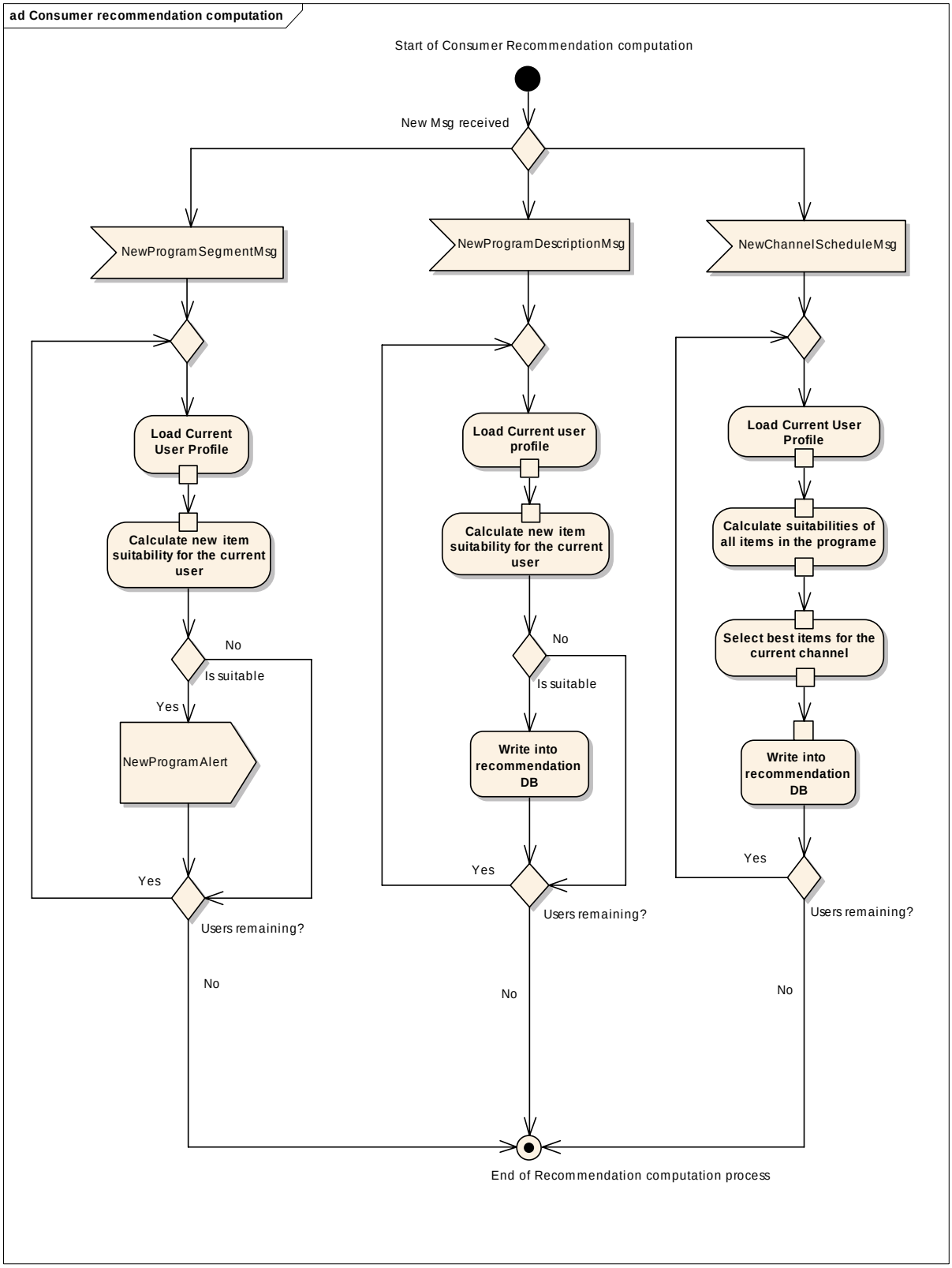

Figure 8: Consumer Recommendation Computation

7.2.2 Consumer recommendation request

Description:

Upon consumers request compiles the EPG and delivers it to the consumer application.

Started by:

- getProgramRecommendations(consumerID) request - personalized EPG request by consumer application

Workflow:

1. Checks all program items in the recommendation DB and get recommendation values for the ConsumerID
2. Sends the EPG to the consumer application.

7.3 Consumer Feedback Activity diagram

7.3.1 Receive explicit feedback

Description:

Feedback collection activity, which is started when Consumer application sends information on consumer voting. Collects explicit voting, which is either initiated on the VC's request or is generated when the Consumer rates the program.

Started by:

- logExplicitFeedback(rating, contentID, consumerID) request

Workflow:

1. Receive and collect ratings (rating, contentID, consumerID)
2. Store ratings into the database
3. Notify feedback analysis module that new ratings are available (send NewExplicit-FeedbackMsg message).

7.3.2 Receive implicit feedback

Description:

Receives and stores implicit feedback data. The Consumer application sends channel and consumer IDs when the Consumer leaves or enters the channel. This info is stored into the database for subsequent analysis.

Started by:

- request logChannel(consumerID, channelID, time)

Workflow:

1. Receive/collect channel statistics (consumerID, channelID, time)

2. Store info into the database
3. Notify feedback analysis module that new feedback is avaliable

7.4 Feedback Analysis Activity diagrams

7.4.1 Calculate voting statistics

Description:

Calculates voting statistics such as how many users rated each item, the rating propagation and prepares the results for the VC application.

Started by:

- NewExplicitFeedbackMsg message - if automatic calculation is set up
- getVotingStats request - if statistics are not calculated before

Workflow:

1. Retrieve voting info from the database
2. Calculate appropriate statistical information
3. Store information into the database
4. Send info to VC application.

7.4.2 Calculate viewing statistics

Description:

Calculates how many users viewed the channel / item and if they viewed the whole program or just parts of it and then displays this information in the VC application.

Started by:

- NewChannelInfoMsg (if automatic calculation is set up)
- getViewingStats request (if statistics not calculated before)

Workflow:

1. Retrieve viewing info from the database
2. Calculate appropriate statistical information
3. Store information in the database
4. Send info to VC application

7.4.3 Calculate audience profile

Description:

Calculation of audience profile is based on the collected feedback data. Based on the request parameters such as desired time frame of the statistics, the appropriate data set is retrieved and analysed. Audience profile is then used in VC recommendation generation process.

Started by:

- getOnlineAudienceProfile request

Workflow:

1. Retrieve data about online consumers
2. Calculation of demographic statistics.
3. Viewing statistics calculation.
4. Generation of audience profile.
5. Store profile in the database.

8 Glossary

Recommender engine	The core of the recommender system, includes recommendation algorithms, also controls communication with other systems
Consumer recommender	Service which produces recommendations for the consumer based on his preferences
VC (production) recommender	Service which produces recommendations for the video conductor (production) based on VC profile (optional), audience profile and program specification
Personalized content recommendation	The process of producing a list of content based on person's / group's preferences
Personalized EPG	Electronic program guide produced using person's / group's content preferences
Content based filtering	The process of filtering content based on content metadata.
Clip ranking	Ranking of available clips for recommendation based on some parameters (user profiles etc).
Profile	Relevant information about particular object (consumer, audience etc).
Audience profile	Profile of a group of people (for example current audience profile, long-term audience profile, target group profile)
VC profile	Profile of the video conductor (may include his personal profile and also role profile).
Consumer profile	Profile of the consumer (demographic information, content preference and collaborative profile).
Feedback	A response that is given by the users to the specific activity or content.
Consumer feedback	Feedback that a consumer gives to the system, by voting, switching the channel etc.
Explicit feedback	Feedback that is given explicitly - by giving a vote for the content (program)
Implicit feedback	Feedback that is given implicitly such as information on the consumer switching the channel (leaving, entering).
Voting	Giving a vote for a specific content

