

Public Synopsis on Basic System Architecture

Project Ref. No.	Integrated Project FP6 / IST 27312
Deliverable/WP/Task	D9.3 / WP 9: Requirements and System Specification
Delivery Date	7 August 2006
Reporting Period	
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Filename	LIVE-9-D9.3- Public_Synopsis_Document_On_Basic_System_Architecture- 060810
Publication Level	PU

This deliverable is a synopsis on the first version of the basic architecture of the LIVE System. It aims to provide a high-level overview on the proposed functionality and the derived system architecture.

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Project Information:	Full project title:	Live Staging of Media Events
	Project Co-ordinator:	Joachim Koehler / FhG
	Project ID:	FP6-27312

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2 History

Version	Name	Date	Remark
V0.1	Oliver Lucht	2006-08-01	Very first version
V0.2	Heike Fischer & Oliver Lucht	2006-08-03	Version for circulation within WP9
V0.3	Tobias Bürger, Heike Fischer, Oliver Lucht,	2006-08-07	Consideration of comments for the Intelligent Media Asset Information System and some corrections

3 Abstract

The goal of this public deliverable is to provide a high-level overview of the idea of the LIVE project and its basic system architecture. The description goes to the level of detail that is needed to understand the basic architecture. For more detailed descriptions, particularly of the subsystems, the reader is referred to the respective subsystem deliverables.

The described first basic system architecture of this document was developed including the results of the first six months of research within the LIVE project. Derived from the basic idea of a system - whereby an interactive digital broadcaster should be able to create a non-linear multi-stream video show in real-time, which changes due the consumers' interests - first user tests were made and analyzed at the public Austrian broadcaster ORF (Österreichischer Rundfunk). These tests resulted in a set of initial requirements (compare deliverable D9.1 "Results from the initial requirement analysis"). Based on these requirements, actors of the LIVE System and their basic use cases were identified. This finally results in the basic system architecture which is briefly described in this deliverable.

The deliverable is written for the first 18 months and in sync with the first results on the search for user requirements within the project. The user requirements will be continuously adapted throughout the project duration by requirement monitoring. Thus a specific architecture designed throughout the first six months may be revised, modified or even changed completely by any experience resulting from the upcoming trials under live situations.

The target audience for this document is any person inside or outside of the LIVE project interested in learning about the proposed functionality and architecture of LIVE.

4 Introduction to the LIVE System

This chapter gives a high level overview on the system developed within the LIVE project. This view should help to understand the context of the following chapters giving more specific information about objectives, users and their roles.

The central idea of the LIVE Staging of Media Events (LIVE) project is to create

- Novel Intelligent Content Production Methods, and
- Tools for Interactive Digital Broadcasters

to stage LIVE Media Events such as the 2008 Olympic Games.

'Staging live media events' means for the professional user creating a non-linear multi-stream video show in real-time, which changes due to the interests of the consumer (end user). To allow for that an end-to-end system has to be set up; namely the LIVE System introduced in the following document.

The main idea of LIVE is the ability that the TV consumers can influence the TV authoring of live content. To enable this new way of live content authoring several technologies, tools and methods have to be developed and adapted for this purpose. The concept of intelligent media assets must be created and implemented. The media assets should be accessible for the TV consumers in a personalized way and the user profile should be matched with the metadata attached to the media assets. This requires methods for user profiling and to calculate consumer preferences in a fast and efficient way. Further, the incoming video streams must be annotated and processed in real-time to provide metadata for the live content. Here a combination of human annotation and automated real-time annotation is needed.

The following figure shows the LIVE System from a user's perspective. Within the LIVE project we distinguish between two kinds of users, the professional user (video conductor), who is staging the video show and the end user (consumer), who consumes the video show for example at home.

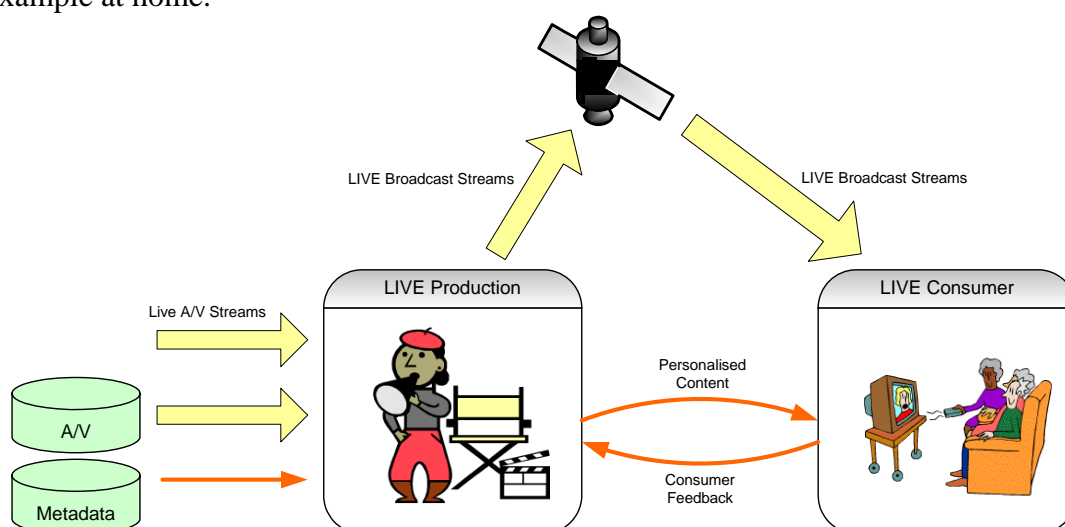


Figure 1: LIVE System from a User's Perspective

One of the main goals of the LIVE end-to-end system is to provide the consumer with an enhanced experience of the interactive TV viewing. To enable this, the LIVE System includes

- ◆ **the production side** (site) which produces TV programme and provides interactive TV services to the consumer, and provides the supporting services to the video conductor as the most important user of the system, and
- ◆ **the consumption side** (consumer equipment and software) which implements the functionalities for the TV consumer.

The production side includes the existing production and broadcast components which provide audio-visual inputs and basic metadata, and the TV production equipment.

It is important to note that the LIVE System will not produce live A/V streams by itself. Instead, it will be used as a helping tool in the production of digital TV content.

The LIVE System has to deal with several input streams and formats. First, there are the live A/V streams in broadcast quality (high resolution) produced at the event's location. But also archived A/V material (content) will be used. This content is not only available in broadcast quality but also in a lower resolution for previewing purposes. In addition, for most of the content, mainly the archived material, metadata is available, including production, rights and descriptive-content information. Main outputs of the LIVE System are several A/V streams, broadcasted in parallel to the consumption side. The consumer has to decide which stream to watch. The video conductor guides the consumer through the bouquet of streams by setting switching points between the different live streams. Again the consumer's feedback guides the video conductor through his staging process and helps him to choose on the currently most important content. In addition, special content recommendations given to the consumer based on his personal profile enlarge the personalized viewing experience.

The following section gives an overview of results of the initial requirement analysis.

5 Results of the initial requirement analysis

In deliverable D9.1 “Results from Initial Requirements Analysis” four different areas are defined having requirements on the basic system architecture of LIVE. Derived from the requirements actors and use cases as introduced in the next chapter were specified. To focus our development work of the system architecture, we concentrate on the most urgent requirements and will add more when their specific needs are well defined.

The main requirements are listed in the following.

- Team communication and collaboration support
- Access to digital archives to bring archived content into the video show
- Mixing tools for parallel processing of multiple output streams
- Modular, flexible and scalable system to integrate modules in existing broadcasting environment and to duplicate and install the system at more than one control rooms
- Support for visualisation of staging concept
- User interface to present consumer feedback to video conductor
- Tool for creation of iTV application
- Content recommender to handle the increasing number of A/V streams
- Support for content selection process during the pre-production process with the help of an archive content recommender
- Creation of consumer profile based on implicit and explicit feedback
- Consumer personalisation meaning content recommendations based on a consumer profile
- Creation of metadata during the live production phase to update the current context of the show; this is crucial for valuable content recommendations

5.1 LIVE Actors and Roles

This section deals with actors and roles introduced or changed by the currently envisioned LIVE production process. This document solely concentrates on the new or changed roles and actors, the so called LIVE actors. Nevertheless, some of the use cases may also be done by people, which are not LIVE actors but part of the present production process. Those additional actors will be listed specially.

In the following figure all roles within a broadcast environment and their relation to each other are shown. The novel LIVE actors are highlighted.

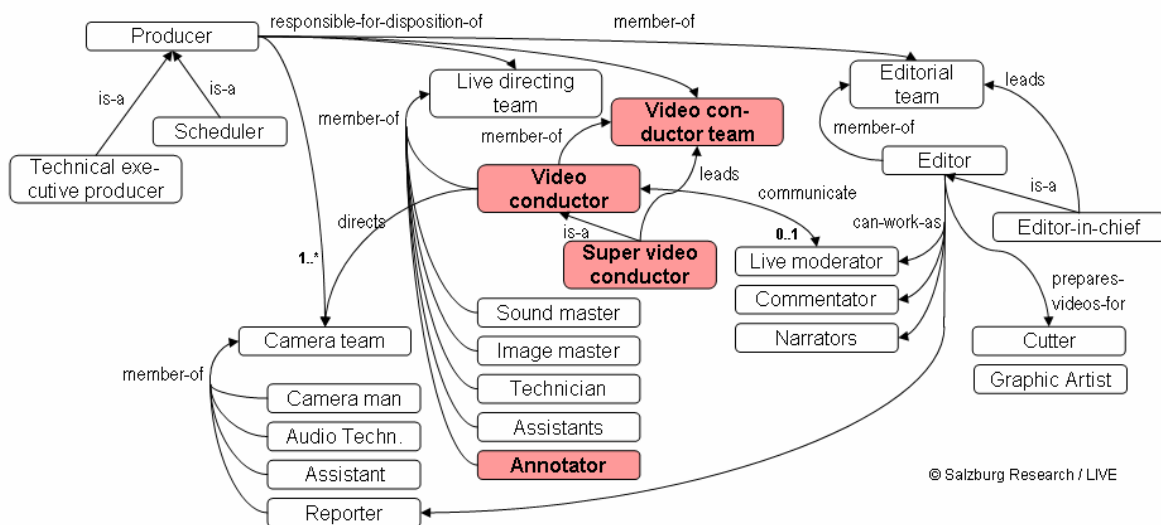


Figure 2: Newly introduced or changed roles within a broadcast environment

During the upcoming tests and experiments even more roles within the LIVE production process may be added or changed. This will lead to further LIVE actors. Currently only the following are envisioned:

Video Conductor Team

To produce several parallel and interlinked output streams it will be necessary to have more than one video conductor working within a team. Communication and collaboration between the members of that team is a critical factor. Because of that a team interrelation layer is envisaged to support this collaboration.

Video Conductor

The video conductor replaces the live director role in the LIVE context. Same as the live director, he leads the live directing team but he is also a member of the video conductor team.

Super Video Conductor

The super video Conductor is the leader of the video conductor team. Such a leading position is only present if a hierarchical work procedure is present between the different video conductors which are members of the team.

Annotator

The annotator enhances the incoming live video material by adding important semantic information about the current activities of the staged event.

Consumer

The consumer is one of the central users of the LIVE System. His viewing experience will change and therefore his current role in relation to live event productions. He will directly influence the course of the show for the whole audience and only for himself. Therefore he is one of the actors within the LIVE System.

In the following sections basic use cases of the LIVE System are introduced.

5.2 Use Cases Overview

Use cases are a means for specifying required usages of a system. Typically, they are used to capture the requirements of a system, that is, what a system is supposed to do. The key concepts associated with use cases are *actors*, *use cases*, and the *subject*. The subject is the system under consideration to which the use cases apply. The users and any other systems that may interact with the subject are represented as actors. Actors always model entities that are outside the system. The required behaviour of the subject is specified by one or more use cases, which are defined according to the needs of actors.

The following diagram illustrates the basic use cases within the LIVE System.

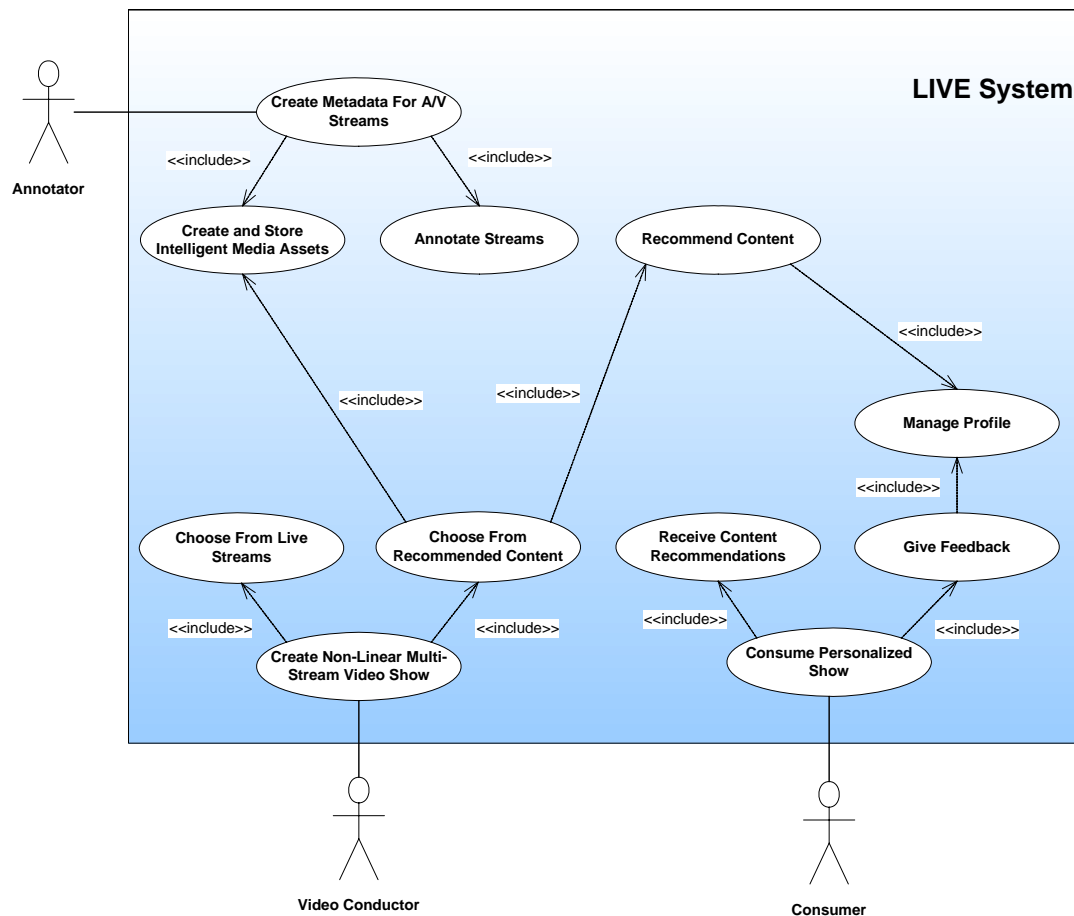


Figure 3: Basic Use Cases within the LIVE System

Every use case shown is described in some detail afterwards.

Create Metadata For A/V Streams

The objective of this use case is the creation of metadata by annotating A/V streams and importing additional information from external resources. The metadata could be created automatically, manually or by a combination of both. The process of metadata creation will be triggered automatically when a live event takes place. As result, metadata from different sources has to be combined into one common schema.

Create And Store Intelligent Media Assets

After the creation of an intelligent media asset (IMA) for a content asset, the intelligent media asset will be saved into a persistent storage (database, file system, archive system). Storage of the intelligent media asset includes storage of metadata and annotations as well as storage of A/V content in different resolutions (e.g. low resolution for preview and high resolution for broadcast purposes)

Annotate Streams

A/V streams can be annotated manually or automatically. To reach a certain level of semantics without losing too much time, automatic feature extraction and human annotation can be combined, be it the automatic extraction supporting the human annotator or vice versa.

Create Non-Linear, Multi-Stream Video Show

This use case describes the creation of an interlinked multi-stream video show around a live media event. This includes the choice of content for the streams and the creation of switching points between streams considering consumer feedback and recommendations. Furthermore the communication with internal and external teams and the control of the iTV application are included as well as the notification of the consumer about a new transition option (e.g. by a graphical overlay, the moderator or by the iTV application).

Choose From Live Streams

The conducting of the show can be done by setting switching points and templates for the multi-stream show. The content can be chosen from the stored media assets or - as described by this use case - from the live input streams.

Choose From Recommended Content

This use case describes the consideration of content recommendations offered by the system which can be considered by the video conductor. A recommended content asset can be previewed in a lower resolution. If an asset was chosen, the content has to be requested in high resolution for broadcast purposes.

Recommend Content

A use case that describes the recommendation (selection, ranking) of input content items from the set of all available content to support the production process. This might be either the selection of suitable content for a specific programme, or ranking of available content according to the given specifications (program profile). The recommendations can be influenced by e.g. audience and video conductor profiles. The recommendations will be displayed to the video conductor in a ranked order.

Manage Profile

The profiles of consumer and video conductor need to be managed (generated, updated). This includes the analysis of consumer feedback over a specified time period or the analysis of video conductor actions.

Consume Personalized Show

The general use of an iTV application is described with this main use case of the consumer. All other consumer actions are bundled under this use case. Each action (implicit or explicit) of the consumer (respecting privacy protection) will be transmitted as feedback to the LIVE System and can influence (personalise) the show. The iTV application offers the consumer information and transition options. Further the consumer can observe personalised recommendations.

Receive Content Recommendations

Recommendations for consumer (individually or grouped as audience) are transmitted to the consumer system. The consumer can then choose to use the recommended content.

Give Feedback

Information about the behaviour of consumers such as following a transition, staying on a channel or switching of the application will be collected and transmitted to the recommender system as implicit feedback. Furthermore it is possible that the consumer can give explicit feedback e.g. by voting or by creation of a short message to influence the show produced by the video conducting team.

6 Basic System Architecture

To reflect the research structure of the LIVE project and the first results from the initial requirement analysis including the derived use cases, the basic system architecture is divided into five subsystems. Four of them are directly related to one of the research areas; the additional fifth subsystem is closely related to the integration task of the LIVE project. The five subsystems are:

- Video Conducting System, dealing with the real-time staging of a live event
- Metadata Generation System, dealing with the detection, extraction and annotation of knowledge
- Intelligent Media Asset Information System, dealing with the creation and provision of intelligent media objects (assets) as introduced with the intelligent media framework
- Recommender System, giving content recommendations to the user based on personal profiles and feedback
- Consumer System, ensuring the consumption of the produced non-linear multi-stream video show including personalisation and feedback options

The next figure shows with which parts of the LIVE System the LIVE actors deal.

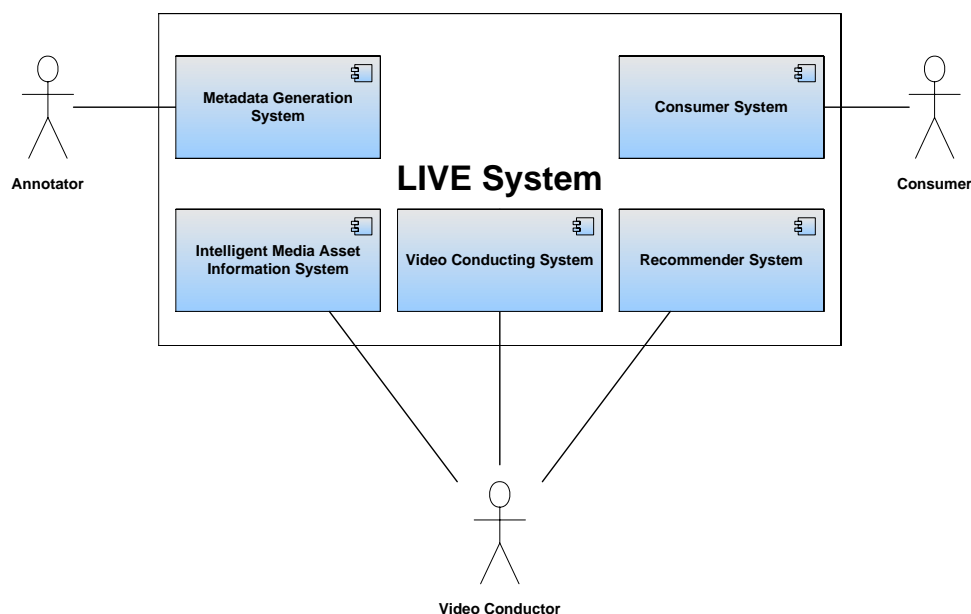


Figure 4: Subsystems within the LIVE System

In the following these subsystems are shortly described to give a first impression on their tasks and responsibilities.

Video Conducting System

The production of a live event is currently lead and controlled by a director and his team situated in the central directing facility. Here all live input A/V streams come in and the director decides which one of the input streams is used for the current output stream. This also applies to the creation of a non-linear multi-stream video show as planned in the LIVE project. The video conducting system enhances the current directing facility to support the novel idea of live media event staging. New interfaces for the professional user visualising additional information such as feedback from the consumer or A/V content recommendations are provided. This additional information allows for the direct response of the professional user to consumer reactions and to unforeseen events. A toolkit enlarging the current directing facility gives even more control options to the professional user.

Metadata Generation System

The LIVE System will combine several sources and sinks of metadata. Metadata will be used to identify, structure, search and move A/V essence throughout the system. Some of the metadata that is needed is already available but needs to be brought into a common format, some will implicitly be created during the live event and some needs to be created actively by the metadata generation system. Metadata generation will range from the extraction of rather low-level features from A/V signals to the creation of descriptive metadata on a semantically higher level. This leads to the development of a system that includes automatic metadata creation based on A/V analysis methodologies, human annotation and semi-automatic metadata creation that combines automatic and manual generation tools. The metadata generation system must also support the import of metadata from internal and external information systems like a long term archive of the broadcaster or an information system of the organizer of the event. All created metadata should be based on a common metadata model and structure and shall be stored in the Intelligent Media Asset Information System as described below.

Intelligent Media Asset Information System

The LIVE System requires a central storage for intelligent media objects. This subsystem extends typical functionality of a digital asset management with features needed to manage metadata specifically to the LIVE System. The Intelligent Media Asset (IMA) Information System is designed to act as a short and mid term archive and is mainly used during the live production phase. It must provide interfaces to allow integration of archived material, live material and other media assets produced during the preparation for and staging of an event (e.g. reportages, interviews...). In addition it must support an edit and search interface based on metadata for the staging and directing tools and the recommender system.

The focus of LIVE regarding this system is on functionality to satisfy the high demands on knowledge about media assets used in the live staging process. The central concept of the Intelligent Media Asset Information System are the Intelligent Media Assets which have so-called semantic facets that form modular entities to describe the properties of IMAs, including the 'raw' content object (essence) or media file, metadata and knowledge specific to the content object and about the topics of the content (its meaning). Capabilities related to the storage, coding, transformation, streaming and playout of A/V content are assumed as part of state of the art broadcasting equipment and not focus of the project.

Consumer System

To allow for the consumption of the produced non-linear multi-stream video show on consumers side, a consumer system has to be defined. This system comprises the minimal hardware and software capabilities needed for the consumption. It presents the received A/V streams to the consumer and provides him with direct feedback functionality and personalised content recommendations. The respected features are ensured by means of an iTV application guiding the consumer through the produced video show. The iTV application will be based on an appropriate middleware, interfacing the software iTV application and the underlying hardware. For future safety, the consumer system is designed to be as independent as possible from a precise distribution channel.

Recommender System

The selection of the most interesting and useful content to be included in the programme is often delicate and time consuming job because of the large amount of the available content (for example in the A/V archives) which is only partly annotated. The first goal of the recommender system is to assist in the production process by generating automatic recommendations of the content which is suitable to be included in the programme. These content recommendations are presented to the video conductor who makes a final decision on the content selection. The content recommendations are based on the programme specification and can be personalized to the preferences of the individual video conductor or the preferences of the TV audience.

The problem of content selection is also present at the consumer side, where the individual consumer need to make a selection among the available programmes, channels etc. The recommender system can help by generating personalized programme recommendations for the consumer which are based on his viewing preferences. The last goal of the Recommender System is to collect consumers' feedback and viewing statistics and to generate a general audience profile which is available to the video conductor in the production process.

The next figure shows the relations between the subsystems within LIVE. It gives a first overview of the system.

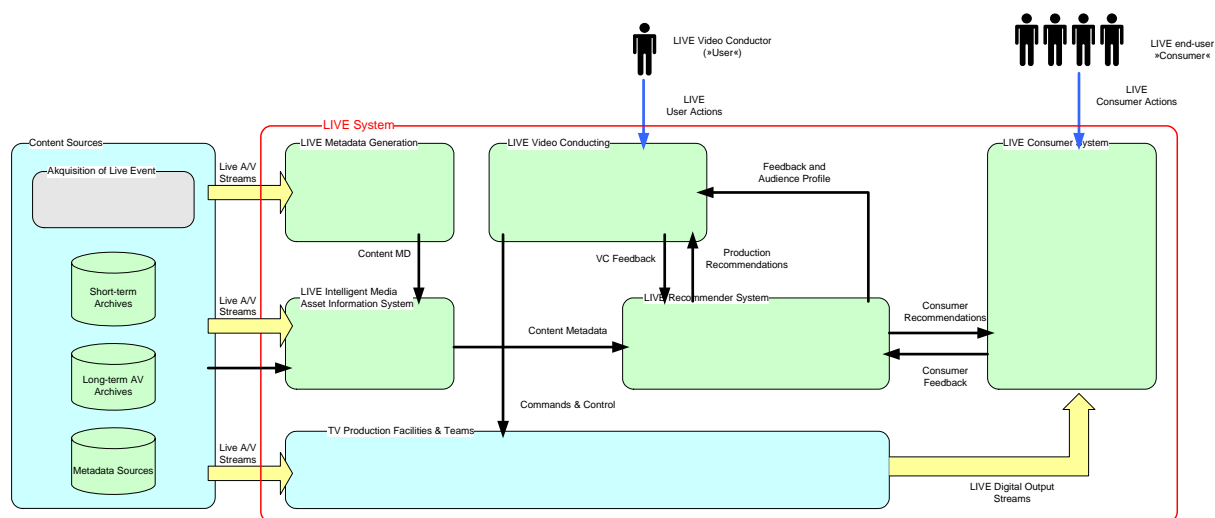


Figure 5: LIVE System Overview

A/V streams of the live event are the main input to the system. They are fed into the metadata generation and the intelligent media asset information system. In the first subsystem metadata to the live material is generated automatically or manually. In the second subsystem the metadata is stored in combination with the related A/V material. This system also imports metadata from further information sources. Besides the novel LIVE subsystems the live A/V streams are also given to the already existing production facilities. Those facilities (mainly the central directing room) are controlled by LIVE's video conducting system. In cooperation with the production team and other broadcast personnel the live video show is produced by the video conductor. This is done with the help of recommendations and consumer feedback provided by the recommender system. The recommender system itself receives content metadata from the intelligent media asset information system and consumer feedback from the consumer system.

The consumer system receives the produced video show by means of digital iTV signals and presents it to the consumer. In addition programme recommendations from the recommender system are included. The consumption behaviour of the consumer is returned as a feedback to the LIVE System.

6.1 The LIVE production process

Just like most of the broadcast production processes, the LIVE production process consists of three phases: pre-production, (live) production and post production phase. The first requirements analysis of the past six month was mainly concentrated on the live production phase. Therefore the derived basic system architecture focuses on this phase too. Since the necessary preparation of a production for example the provision of suitable content has to be done in the pre-production phase, this phase is also described in this deliverable but in lesser detail. Although the post-production phase is anticipated as an important part of the LIVE value chain, the consideration of this phase together with a more detailed view on the pre-production phase is left for a future revision of the system architecture based on the further requirements analysis.

The following illustration should give an overview about content lifecycle in the pre-production and the (live) production phase.

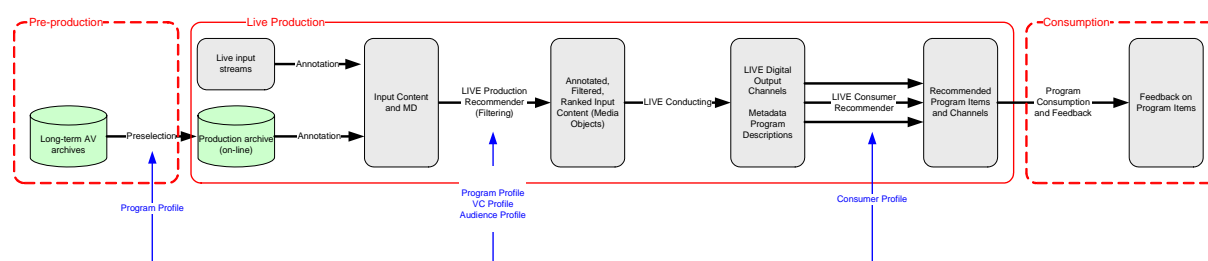


Figure 6: Content lifecycle within the LIVE System

The pre-production phase mainly comprises the selection and extraction of archived material that might be used during the live production phase, e.g. 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. For the LIVE System, the extracted material should be enhanced with additional descriptive metadata that makes it accessible in a faster way. As an example, the pre-selected material can be analysed by a speech recognition tool to create a keyword index, so that the recommender system will be able to find matches with the live stream immediately by comparing the keywords of the live annotator with those added to the archived material. The selection of archived material is based on a staging concept (program profile) created by the video conductor. It builds some kind of framework for the upcoming show. As illustrated on the left side of the image, A/V content will be stored in a production archive (the intelligent media asset information system) as result of this process.

During the live production phase, the live input streams have to be annotated just like the content already stored in the production archive. The metadata generation system annotates the incoming live A/V streams by human and automatic annotation processes. The generated metadata gets enhanced by external information systems. Afterwards the content can be filtered, ranked and recommended by the LIVE production recommender. Profiles can thereby influence these recommendations. The video conductor can create his non-linear multi-stream video show by conducting different A/V content from the production archive or from the incoming live streams. A LIVE consumer recommender can furthermore recommend personalised program items and channels to the consumers, appropriate to their individual profiles. Moreover, feedback of the consumers influences and personalises the broadcasted A/V streams.

On the consumption side the video show gets started and presented to the consumer. He can consume the show with the help of the iTV application, allowing for e.g. signalling of switching points between A/V stream, giving feedback or receiving content recommendations. The consumer feedback is returned to the recommender system, where it is analysed. Based on this feedback content recommendations for the consumer and the video conductor are given.

To explain the valuable support for the video conductor by the LIVE System a concrete example is given in the following paragraph:

The automatic annotation process detects an athlete with number 38. In combination with the current programme and competition schedule as well as with an athletes database the number is assigned to the Norwegian bicycle racer Thor Hushovd. This information is given to the intelligent media asset information system where it is further processed. Linkages to other information like the athletes' place of birth or to a media asset 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.

7 Glossary

Term	Definition
Annotator	The annotator enhances the incoming live video material by adding important semantic information about the sport event.
Archivist	An archivist is responsible for archiving newly shot material as well as already broadcasted shows and video contributions. In most cases he is also responsible for analysing the material and putting metadata into a database for reuse.
Assistant	Each of the other defined roles can have assistants. Very common are directing assistants and production assistants.
Camera Man	The camera man is the leading member of the camera team and responsible for taking the right shots. In Live-Productions he attends the orders of the director, for prepared shots he attends the order of editors or producers.
Camera Team	A group of people which are all working with one camera. This consists of a camera man, an audio technician and other assistants (holding cables, microphones....). Sometimes it also consists of a reporter.
Commentator	A commentator is not shown in picture, but talks to the consumer. In most cases he has no prepared text, but talks about a live event.
Content	Here: A/V content consisting of essence and related metadata
Consumer	End user of the LIVE System, consuming the created non-linear multi-stream video show
Cutter	A cutter copys video tapes or works with a non-linear editing system. In most cases he attends the order of an editor to produce a prepared video contribution.
Directing Team	A group of people which are all working on the directing of a television production. Their working place is a control room. If the broadcaster is the host broadcaster of the sport event, than the control room may likely be one at the location of the event. In that case mobile broadcasting vehicles or OBVAN – out door control room- are used. The live directing team consists of members playing different roles like the live director, sound master, image master, technicians and different assistants.
Director	The director is the leading member of the directing team and responsible for everything that is happening during a live-broadcast. A television director is usually responsible for directing the cameras, his assistants like Sound Master and Image Master, Moderators and other filmed/taped aspects of a television production. In contrast to a film director, the major creative control will likely reside with the producers and editors of the show.
DVB-C / -T / -S	Standards for digital broadcasting via terrestrial, satellite or cable networks
Editor	A single editor is responsible for a single shot or contribution.

	His ideas lead to the arrangement and composition of the parts of a video contribution. Editors can also work as moderators, commentators, narrators or reporters.
Editorial Team	The Editorial Team is responsible for the content of a television production. For example they decide which shots are taken, which interviews are made, and what should be the subject matter of a contribution.
Editor-in-chief	The editor-in-chief is responsible for the content of a whole show or television production. He has to check every single contribution by the editors and accept it or not.
Essence	A/V clip of varying length
Graphic Artist	Graphic artists are responsible for graphical elements of a video contribution, especially for all kinds of inserts
Image Master	The image master is a member of the live directing team. He is responsible for video aspects (selection of cameras, inserts,...) of a television production and attends the orders of the director.
Intelligent Media Asset	Media item of value consisting amongst others of A/V essence, metadata and rights information
IPTV Internet TV	Internet Protocol Television Distribution of TV signals using a broadband connection over internet protocols. The distribution can be done in a closed network with a guaranteed quality of service or over the open internet. The signal is received on consumer side by either a special set-top-box or by a multimedia PC
LIVE actor	User of the LIVE System with a novel or changed role (in contrast to the current production process) within the LIVE production process
LIVE System	End-to-end system, developed within the LIVE project allowing for the creation of a non-linear multi-stream video show in real time, which changes due to the interest of the consumer
Library Management System (LSM)	automatic change of tapes, developed by Sony
Metadata	Any kind of data about data, in this case information about A/V material used, created and needed in the LIVE production process
Moderator	The moderator of a live-show is shown in picture and talks to the consumer. In most cases he reads prepared text, but he can also interview guests in the studio. His moderation guides through the whole show.
Non-linear editing system (NLE)	video or audio editing system that involves being able to access any frame in a video clip with the same ease as any other
OBVAN	Outside / outdoor broadcast vehicle
Producer	The producers are responsible for all financial aspects of a television production. Together with the editorial team they decide which productions can be made within a given budget. They are responsible for booking all the equipment that is needed, as well as the disposition of the camera teams, directing teams and editorial teams.
SAST	automatic control system located in Broadcasting Operation Center which controls crossbars and playout-server in the

	production process and control systems for the distribution networks
Sound Master	The sound master is a member of the live directing team. He is responsible for audio aspects of a television production and attends the orders of the director.
Super Video Conductor	The Super Video Conductor is the leader of the video conductor team. Such a leading position is only present if a hierarchical work procedure is present between the different video conductors which are members of the team.
Technician	Technicians are responsible for very small technical details. They attend the orders of a director, editor or producer.
Video Conductor	The video conductor replaces the live director role in the LIVE context. Same as the live director, he leads the live directing team but he is also a member of the video conductor team.
Video Conductor Team	To produce several parallel and interlinked output streams it will be necessary to have more than one video conductor working within a team. Communication and collaboration between the members of that team is a critical factor. Because of that a team interrelation layer is envisaged to support this collaboration.