

Bringing “Intelligence” to iTV: The Intelligent Media Framework

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Abstract

This paper gives an overview of a software framework designed for the creation of interactive multi-channel television shows. The “Intelligent Media Framework” forms the middleware of an iTV production support system developed in the context of the European integrated project “LIVE”. The framework is designed according to service oriented architecture (SOA) principles for easy integration into existing iTV and TV production environments. Moreover, the Intelligent Media Framework is based on a knowledge model formalising the main aspects identified to make up the domain of real-time staging of media events: the content (media clips and media streams), the events, the staging and the users (professional users and consumers).

The framework offers services for the development of tools assisting the production team of multi-channel iTV shows in an intelligent way: The envisaged “intelligence” is based on formal, machine understandable descriptions of the content and the events: This document introduces the knowledge model and provides an overview of the architecture of a media framework designed to support the iTV production process in an intelligent way.

1. Introduction

1.1 Setting the scene: iTV production support

The European integrated project “LIVE Staging of Media Events” (LIVE, see www.live-ist.org) aims at the creation of novel intelligent content production methods and tools for broadcasters to stage live media events such as the Olympic Games 2008 in Beijing. In the terminology of the project, “staging live media events” is a notion for the real-time creation of non-linear multi-channel video shows, which change according to the interests of the consumers. While the development of the envisaged interactive content formats forms a research strand of its own in the project (Grünvogel, 2007), the concept also imposes several conceptual and technical challenges on the development of a system for the support of the preparation and the production

phase: On the architectural level the LIVE production support system consists of the metadata generation system (responsible for the automatic and semi-automatic detection, extraction and annotation of knowledge), the recommender system (providing content recommendations and handling consumer feedback), the consumer system (iTV application platform), the broadcast gateway service and a knowledge-based middleware called “Intelligent Media Framework” (IMF). On a very general level, the Intelligent Media Framework can be viewed as knowledge-based middleware supporting the aggregation, management and retrieval of information about content and events for the production of iTV shows. The framework is the core component of the LIVE production support system and provides the envisaged intelligence to the other LIVE sub-systems.

1.2 Structure of the document

In the remainder of the document we analyse the LIVE staging domain with a focus on the identification of the main semantic concepts. Subsequently we present a knowledge model for the LIVE staging domain and give an overview of the architecture of the Intelligent Media Framework. We conclude with a summary of experiences with the chosen approach.

2. The LIVE Staging Domain

As a consequence of the envisioned iTV formats, the LIVE production support system has to work in the environment of the LIVE staging domain which is depicted in Figure 1. The main aspects of the LIVE staging domain are as follows:

2.1 Events

Information about the event that is staged is crucial for planning of the show. During the event a production support system has to collect and analyse information in real-time to support the LIVE staging process. Typically event information is provided by external information systems.

2.2 Staging

Staging comprises all knowledge about how an event is presented to the consumer. This includes:

- Content formats, which consist of general stream types, different types of switching between streams as well as screen layouts like split screen or picture in picture.
- Stream profiles define hot topics for a specific stream and the target audience of each specific stream.
- The stream interrelation defines situations, in which linkages in-between two streams are possible.
- The audience profile models the target audience of the show.

2.4 Users

The LIVE staging process defines different user roles: (i) Automatic annotators which are software agents responsible to automatically detect features within live streams. (ii) Human annotators who manually annotate live streams. (iii) Editors searching and pre-selecting content for the video conductor. (iv) Video conductors who decide on how an event is staged.

3 The Knowledge Model

The LIVE staging domain is mapped to a knowledge structure that enables the utilisation of semantic technologies in the so called Intelligent Media Framework which is the core component of the

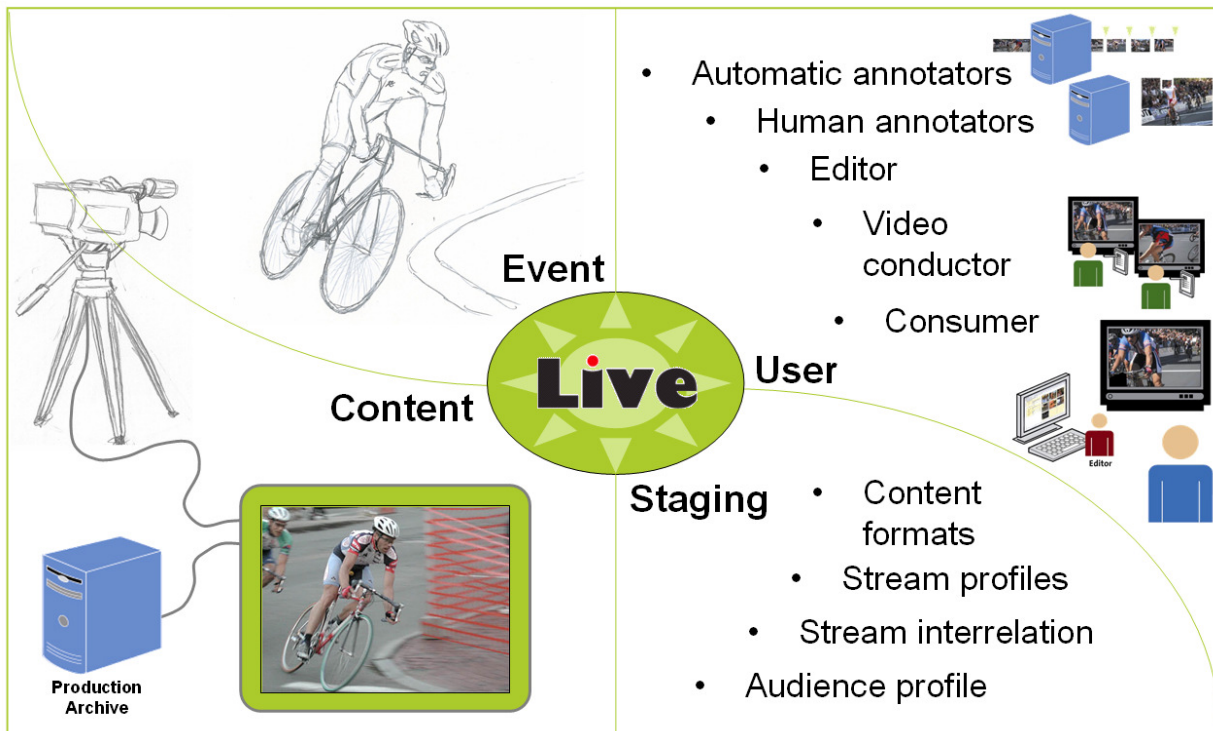


Figure 1 Modelling the LIVE staging domain

2.3 Content

The system has to handle essences as well as meta-data available for these essences. Live essences are created by filming the event and activities around the event (e.g. interviews, analysis of experts, etc.). Content may also come from production archives which contain prepared and previously annotated essences. To enable content based recommendations, essences have to be annotated and these annotations have to be combined with real-time and archived audio-visual objects.

LIVE production system. This knowledge structure divided in four sub-models: The Term Model, the Staging Model, the Event Model and the Intelligent Media Assets.

3.1 The Term Model

The Term Model defines the foundation of the knowledge structure. It is based on functionalities defined in the Simple Knowledge Organization System (SKOS) and supports the definition of vocabularies, terms, term metadata and semantic relations in between terms. In addition the Term Model defines a base typology for terms, the "Term Type

Hierarchy". This typology simplifies the structuring of the controlled vocabulary and provides additional semantics to the other knowledge models of the Intelligent media Framework. In addition the Term Model defines a base typology for terms – the Term Type Hierarchy – which on the one hand aims to ease the definition of controlled vocabularies for application domains by providing a simple hierarchy and on the other hand provides additional semantics exploited by the other knowledge models of the LIVE staging domain. All terms of the controlled vocabularies are aligned to the Term Type Hierarchy.

3.2 Staging and Event Model

Based on the Term Model the knowledge models for the two core domains of the LIVE staging environment – the Event Model and the Staging Model – are defined. The intention of these domain models is to provide an ontology supporting the definition of formal statements about the current state (annotating/ describing) or future state (planning) of the LIVE staging environment. Statements are instantiations of concepts defined in these ontologies and link to terms in the controlled vocabularies. Terms defined in the Term Model (e.g. in the controlled vocabularies) are used to parameterise such statements

3.3 Intelligent Media Assets

On the top level of the knowledge structure we defined the Intelligent Content Model. This model defines so-called Intelligent Media Assets (IMAs) managing the relation between the knowledge created based on the Event- and Staging Model and the content objects. In addition, IMAs provide the possibility to define simple classifications by directly assigning a set of terms of the controlled vocabulary to a content object.

To achieve this, an IMA consists of two main parts: Firstly, content annotations define knowledge about features of the essence such as storage location(s), encoding, access rights or publication rights. The dedicated parts of existing meta data standards like NewsML, TV-Anytime or MPEG-7 are supposed to be used creating such annotations. Secondly, subject matter annotations define information items expressing formal descriptions of what the essence is about. Subject matter descriptions cover a spatial- (location, GPS position), temporal (start/end, date, time as well as terms like morning, spring...), term-based as well as free text descriptions.

The strict separation of knowledge about the content item and knowledge about the subject matter was introduced, because the LIVE Staging Domain requires a possibility (i) to express different inter-

pretations of situations/occurrences of an event by different professional users and (ii) to support the attachment of different stories to a Content Item, based on the context of its usage in a stream. The first requirement was tackled by modelling different Professional Users creating different Propositional Descriptions expressed by the same Information Item. The second requirement is supported by Content Items realising different Information Items. This approach also solves a problem of typical domain standards like MPEG-7 or NewsML, which do not provide similar types of distinctions.

4 Architecture of the IMF

The role of the Intelligent Media Framework in the production process is to accept and handle partial information about media items, to add semantic information to the items and to infer and attach contextual knowledge to the items that is probably related to the event that is staged. It furthermore provides knowledge services that offer controlled vocabularies related to the current context of a stream to guarantee the unambiguousness of the terms used.

The Intelligent Media Framework provides the knowledge infrastructure for the LIVE production support system and is based on a multi-tier service-oriented architecture in which all interfaces to external components are modelled as Web services (see Figure 2).

4.1 Basic services

The Knowledge Service provides access to the vocabularies and terms of the controlled vocabulary. The service interface is based on the semantics defined by the Term Model.

The Event Information Service provides access to information specific to the staged event. This service provides knowledge about an event such as date, location and participants. Additionally, knowledge about agents and performed activities are accessible through this service during/after the event.

The Sports Information System is an example of the integration of an external information service providing support data and real-time data from the Olympic information system.

The IMA Service provides access to Intelligent Media Assets and therefore supports knowledge based queries for available content.

4.2 Messaging system

In addition to these pull-type services, the Intelligent Media Framework includes a messaging system to explicitly support the real-time aspect of the

staging process. Firstly, the Metadata Queue receives triggers from internal and external metadata generators. This mainly includes the metadata generation system (automatic annotators and the human annotator) as well as accessible external information systems (e.g. providing event and timing information of sport events). The Intelligent Media Framework has the responsibility to align all these

- 1) The Intelligent Media Asset Information System: providing access to services for the storage of media, knowledge models and metadata relevant for the live staging process and providing services for the creation and management and delivery of intelligent media assets.
- 2) The Metadata Generation System, dealing with automatic and real-time detection and extrac-

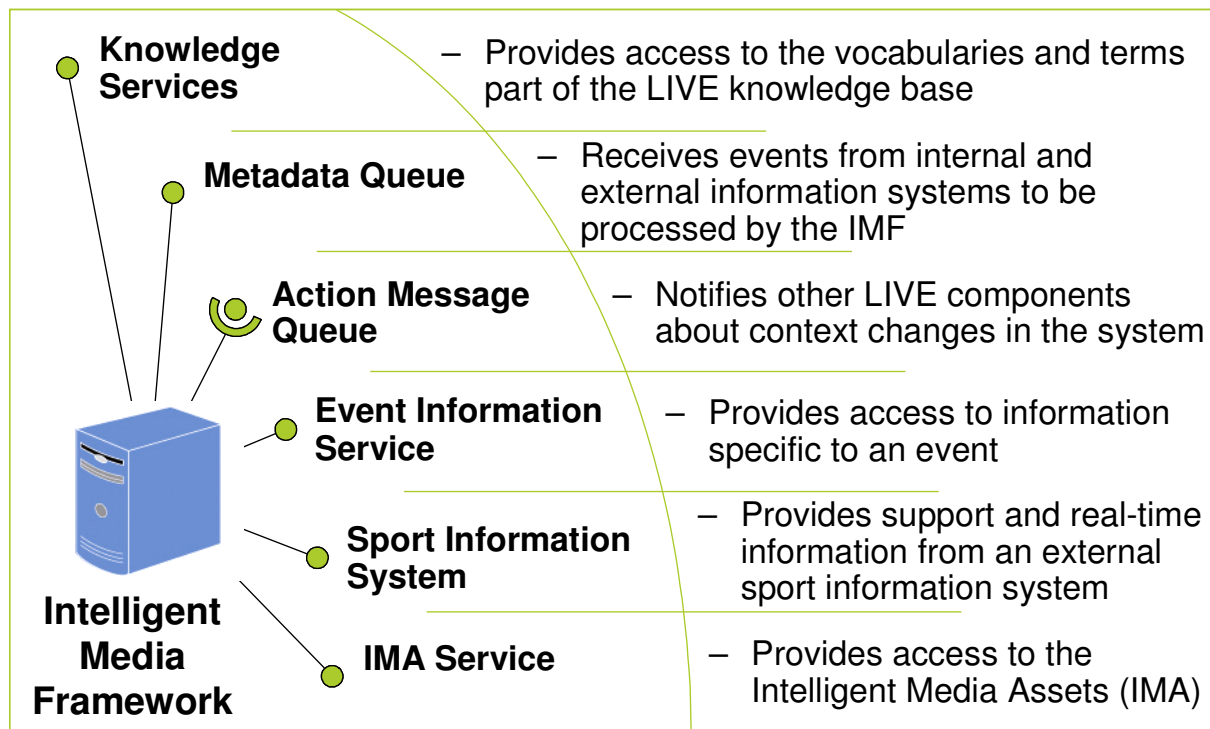


Figure 2 The services of the Intelligent Media Framework

triggers to the already available knowledge of the event and to propagate the resulting knowledge by publishing it. Subscribing components of the LIVE production support system receive this information in real-time.

5. Summary

In September 2007 a functional prototype of the LIVE production support system was shown at the International Broadcasting Conference. In December 2007 the implementation of the Intelligent Media Framework entered its second development cycle which will terminate in May 2008 with the delivery of a version of the framework to be used for the field trial during the Olympic Games 2008 in Beijing (August 2008).

In this trial, in which a multi-channel show will be distributed and feedback will be collected from approximately 500 consumers, the integrated LIVE production support system relies on the successful interaction of five sub-systems:

- tion of metadata
- 3) The Human Annotation Tool allowing manual annotation of the output of (2)
- 4) The Recommender System recommending content to the professional user based on the staging profile of the show, the personal profile of the video conductor and current and previous consumer feedback.
- 5) The Video Conducting System dealing with supporting the editor and the video conductor during the real-time staging of a live event.

The semantic enrichment process of content in the production chain is based on a semantic indexing pipeline consisting of the components (1) to (3). Based on the output of this pipeline, messages are sent to (4) and (5). (5) sends content requests to (4) which in turn sends recommendations based on incoming messages.

(Güntner, 2007) provides a synopsis of the specification of the Intelligent Media Framework.

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