



SEMEDIA
FP6-045032

Search Environments For Media



D6.2.1 Standards, Technology and Market Watch Report

Due date of deliverable: 31.12.2008

Actual submission date: 04.03.2009

Start date of project: 1st January, 2007

Duration: 30 months

Lead contractor for this deliverable: DVS

<Revision Final v1>

D6.2.1	Standards, Technology and Market Watch Report
Project Acronym :	SEMEDIA
Contract No :	FP6 - 045032
Due Date :	31.12.2008
Reply To:	Wolfgang Schmidt schmidt@dvs.de
Actual date of delivery:	04.03.2009

Deliverable Identification Sheet

Project ref. no.	FP6-045032
Project acronym	SEMEDIA
Project full title	Search Environments For Media
Security (distribution level)	Confidential (CO)
Contractual date of delivery	Month 24, 31.12.2008
Actual date of delivery	Month 27, 04.03.2009
Deliverable number	D6.2.1
Deliverable name	Standards, Technology and Market Watch Report
Type	Report
Status & version	V1.0
Number of pages	36
WP / Task responsible	WP6T2
Other contributors	
Author(s)	Wolfgang Schmidt, Anders Köpping (DVS), Xavier Vives Surroca (CCMA)
Internal Reviewer	
EC Project Officer	Antonio Puente Rodero
Abstract	This deliverable describes developments in the world of digital media content with respect to the three SEMEDIA contexts – Web, broadcast and postproduction – and with special emphasis on the SEMEDIA fields of work: media mining, navigation, search and retrieval. It explores the current trends concerning standards and technology in the Web based entertainment and professional media markets as well as relevant products on the market that can either be seen as potential deployment platforms for SEMEDIA tools or as competing developments.

Executive Summary

Introduction

The ever growing increase of digital media content by user driven multimedia content production as well as by commercial content providers necessitates intelligent mechanisms for efficient navigation, search and retrieval in the Web as well as in large distributed multimedia content repositories. This trend has been taken up by many organisations and companies that are creating standards and products for these markets.

This deliverable describes developments in the world of digital media content with respect to the three SEMEDIA contexts – Web, broadcast and postproduction – and with special emphasis on the SEMEDIA fields of work: media mining, navigation, search and retrieval. It explores the current trends concerning standards and technology in the Web based entertainment and professional media markets as well as relevant products on the market that can either be seen as potential deployment platforms for SEMEDIA tools or as competing developments.

Standards and Trends

An essential requirement for information exchange between different systems is a common representation of data. A range of metadata standards has been defined over time for the description of audiovisual material.

There are multiple simple, light-weight sets of metadata that gained some relevance like P/META, an exchange format for programme-related information in a business-to-business use case, or the Dublin Core, a small common subset of metadata that fits to many applications. Originally defined for broadcast- and archive-related developments it can also be used for the description of a wide range of networked resources.

On the other end appear all-embracing, complex standards that are intended to cover in depth all kind of possible applications. The most advanced one is part of the MPEG family of standards. Besides the well known multimedia standards (MPEG-1, MPEG-2 and MPEG-4), the MPEG consortium also established MPEG-7, a metadata standard for structured description of multimedia content, from low-level feature level up to semantics. The latest part also defines the format of queries.

Another result from the standardisation efforts of the MPEG consortium is MPEG-21, which defines a multimedia framework that covers the whole delivery chain for digital multimedia items with an emphasis on the transactions between content providers and content consumers.

A relatively new standardisation initiative is JPSearch. It can be seen as a development competitive to the MPEG family of standards, but there is also some collaboration on the query format.

Service Oriented Architectures based on Web services are the current trend in the development of Web based applications, an approach that aims to achieve flexible architectures for complex and challenging workflow tasks based on the concept of loosely coupled processes that together form the overall application. The general idea is not new as it is in parts covered by several former technologies like RPC (Remote Procedure Call), CORBA, DCOM (Distributed Component Object Model) or RMI (Remote Method Invocation). Standardized protocols for Web services are SOAP and REST.

The term RIA (Rich Internet Application), originally defined by Macromedia for their Flash applications, nowadays stands for internet applications that ideally look and behave like desktop programs. These applications make use of asynchronous calls to a server without blocking or a complete reloading of the user interface. Because of this

asynchronous approach some of the logic that was formerly covered by the server is now done on the client side.

To help the programmer in creating such an application, a set of libraries and many complete frameworks are available. Common RIA approaches are AJAX, Flash/Flex and Silverlight.

Another enabling technology is the material exchange format (MXF) that is now becoming the standard format in file-based broadcast productions. MXF offers a unique identification mechanism through the Unique Material Identifier (UMID), within an MXF file each package (a collection of tracks) can be identified by means of a UMID. Such an identifier can be used to synchronize metadata between the different systems, or to determine whether some essence is already present or still needs to be transferred between components.

Market Overview

Film post-production is a highly non-linear process that involves quite specialized tools, the equipment used is usually a very heterogeneous set of systems from different manufacturers using different storage technologies, operating systems and applications. This makes it difficult to manage all the content in the different storages with one comprehensive, universal tool that combines all the necessary information from the workflow planning, the essence files and the metadata.

Many companies offer storage solutions and workstations for the postproduction market, but only a few also provide the tools that are necessary to manage content, including search for content, on a studio level. Final Cut Server is an upcoming solution with many automation features and good content tracking, but it is only able to handle servers that run the Mac OS X operating system. The only solution that truly supports all main operating systems, file systems and storage architectures is still the DVS Spycer content management software.

The main technology platforms in the broadcast market are the media asset management systems that should support the online content as well as archives, manage the workflow of assets and allow the search for specific content. Today's media asset management systems for the broadcast market provide most of the basic features needed but must incorporate many more in the future to fully satisfy all user needs. Especially automation of the annotation process will be a key feature once it is technically achievable.

Improvements based on Web2.0 technologies are changing the face of the internet and bring the user an improved online experience. Simply showing a video or an image or some other kind of media is not enough to distinguish one product from another. Rather it is the efficiency, simplicity and speed in which the media can be searched, accessed and used that attracts users and makes business models successful. There are three main areas that create value for the user: using user generated content, content based information and tools for efficient navigation and search.

There is little doubt that Google is currently leading the general search engine market. With YouTube, Google also owns the clear number one platform for video sharing and search.

Yahoo's strategy to increase the search market share is to add features that can't be found at Google or somewhere else. The problem is that these features need to be distinctive and useful enough to attract the attention and make people switch to Yahoo or at least use it as a secondary search engine.

However, when it comes to image search combined with social networking elements then Yahoo's number one position with its Flickr platform is currently unchallenged. For some years Yahoo managed to be at least one step ahead. Steady progress will be

necessary to defend this top position. And by including videos in Flickr there is a possibility to extend the success of Flickr into the video search market.

Anything then, that enables the user to have more control over their image searching will be helpful. While pure search engines might provide comparable search results, media collections in social networks have an added value. Platforms that manage to offer interesting services will continue to lead the market.

Media mining technologies based on the analysis of essence like face detection or speech recognition start to appear in search engines. The added value will probably be limited as long as the semantic gap limits results to low-level features like colour and shapes, and on the other hand tagging by voluntary users is able to provide the high-level information actually needed.

Table of Content

1	Introduction.....	7
2	Metadata related Standards	8
2.1	Dublin Core	8
2.2	P/META	9
2.3	MPEG-7.....	9
2.4	MPEG-7 Query Format	10
2.5	MPEG-21.....	11
2.6	JPSearch.....	12
3	Web related Standards and Technologies	13
3.1	Web Services	13
3.1.1	SOAP	14
3.1.2	REST.....	14
3.1.3	SOAP & REST Frameworks	15
3.2	Web Programming Technologies and Frameworks	15
3.2.1	Ajax (Asynchronous Javascript and XML)	16
3.2.2	Flash	16
3.2.3	Flex	16
3.2.4	Silverlight.....	17
3.2.5	RIA approaches in comparison	17
3.2.6	AXAX Frameworks and IDEs	18
3.2.7	Other Frameworks and IDEs.....	19
4	Other enabling Technologies.....	20
4.1	MXF and the UMID.....	20
4.2	Video Codecs	21
5	Markets and Products.....	22
5.1	Postproduction Market	22
5.1.1	State of the Art	22
5.1.2	Relevant Products.....	23
5.2	Broadcast Market	26
5.2.1	State of the Art	26
5.2.2	Market Overview	27
5.3	The Social Web	31
5.3.1	State of the Art	31
5.3.2	Relevant Platforms.....	31
6	Conclusions	36

1 Introduction

Traditional media businesses are changing, the world of digital media is growing and the media user gains much more flexibility. All this happens at high speed.

During the last years, a vast variety of multimedia information has been brought to recipients due to the growing abilities of computer, telecommunications and electronic industry. Furthermore, a high amount of digital images, video and audio information has become publicly available over the years. The traditional TV broadcast business moves quickly into the digital area and the film postproduction is heading towards a full digital workflow from scene to screen.

The ever growing increase of digital media content by user driven multimedia content production as well as by commercial content providers necessitates intelligent mechanisms for efficient navigation, search and retrieval in the Web as well as in large distributed multimedia content repositories. This trend has been taken up by many organisations and companies that are creating standards and products for these markets.

This deliverable describes developments in the world of digital media content with respect to the three SEMEDIA contexts – Web, broadcast and postproduction – and with special emphasis on the SEMEDIA fields of work: media mining, navigation, search and retrieval. It explores the current trends concerning standards and technology in the Web based entertainment and professional media markets as well as relevant products on the market that can either be seen as potential deployment platforms for SEMEDIA tools or as competing developments.

The general goal of each standardization process is the achievement of interoperability. Looking into standardization efforts for media analysis, search and retrieval, either issued as formal standards by organizations like ISO or as de facto industry standards in the form of comprehensively used frameworks, we have to examine the whole process chain from description generation over description representation up to the description consumption. While there are no standardization efforts known for the generation of metadata descriptions via feature extraction, annotation, authoring tools or indexing some standards evolved for the representation of metadata and also for the consumption in search engines, filtering tools, retrieval and browsing processes. These standardization efforts are summarized.

The Web developments are driven by Web2.0 technologies. An overview is given on relevant trends like Web services, protocols, programming frameworks and integrated development platforms.

The markets for the three SEMEDIA domains are described with a state of the art summary, including current user needs, and the most interesting products are examined to what extent they match the user needs.

2 Metadata related Standards

In this section we present and discuss evolving and established standards that have relevance for the media analysis, mining, search and retrieval processes.

An essential requirement for information exchange between different systems is a common representation of data. A range of metadata standards has been defined over time for the description of audiovisual material. There exists now a large number of standards for the storage and exchange of multimedia metadata since new projects tended to rather 'invent' new standards than building upon or integrating existing ones. However, it seems in recent years this development has ended and a few of the existing metadata standards are beginning to evolve as the 'winners' in this evolutionary process.

There are multiple simple, light-weight sets of metadata that gained some relevance. In this document we take a closer look at Dublin Core as an example of a very simple metadata set and P/META, an exchange format for programme-related information in a business-to-business use case.

On the other end appear all-embracing, are complex standards that are intended to cover in depth all kind of possible applications. The most advanced one is part of the MPEG family of standards. Besides the well known multimedia standards (MPEG-1, MPEG-2 and MPEG-4), the MPEG consortium also established MPEG-7, a metadata standard for structured description of multimedia content, from low-level feature level up to semantics. The latest part also defines the format of queries.

Another result from the standardisation efforts of the MPEG consortium is MPEG-21, which defines a multimedia framework that covers the whole delivery chain for digital multimedia items with an emphasis on the transactions between content providers and content consumers.

A relatively new standardisation initiative is JPSearch. It can be seen as a development competitor to the MPEG family of standards, but there is also some collaboration on the query format.

2.1 Dublin Core

The Dublin Core¹ can be seen as a small common subset of metadata that fits many applications, originally defined for broadcast- and archive-related developments it can also be used for the description of a wide range of networked resources.

The semantics of Dublin Core have been established by an international, cross-disciplinary group of professionals from librarianship, computer science, text encoding, the museum community, and other related fields of scholarship and practice. The main goal of Dublin Core is not the expression of complex relationships or concepts, the main goal is to define a metadata set that is widely interchangeable and that can easily be 'grasped'.

The Dublin Core metadata standard was originally developed to describe electronic text documents but has later been extended to also cover audiovisual material. Focusing on simplicity its simple form contains fifteen attributes (title, creator, subject, description, publisher, contributor, date, type, format, identifier, source, language, relation, coverage and rights) belonging to three groups (content, version and intellectual property). Some of these elements can be refined using qualifiers to narrow

¹ Dublin Core metadata Initiative: <http://dublincore.org/>

down the meaning. This is called Qualified Dublin Core and also includes three additional attributes (Audience, Provenance and RightsHolder).

2.2 P/META

The EBU P/Meta² working group has designed this standard as a metadata vocabulary for programme exchange in the professional broadcast industry. It is not intended as an internal representation of a broadcaster's system but as an exchange format for programme-related information in a business-to-business use case.

The P/Meta definition uses a three-layer model. The standard specifies the definition layer (i.e. the semantic of the description). The technology layer defines the encoding used for exchange; currently KLV and XML representations are specified. The lowest layer, the data interchange layer, is out of scope of the specification.

P/Meta consists of a number of attributes (some of them with a controlled list of values), which are organized into sets.

The standard covers the following types of metadata:

- Identification
- Technical metadata
- Programme description and classification
- Creation and production information
- Rights and contract information
- Publication information

2.3 MPEG-7

MPEG-7³ on the other side is a very mighty set of multimedia metadata that allows its use in almost any kind of application. Its slow rate of adoption in the first years after its inception can probably be attributed to its mightiness, that could be disincentive to potential first-time adopters. But 7 years after its final definition it is now widely accepted and used in a growing number of projects.

MPEG-7 provides means for content-, object- and semantics-based description of visual and audio essence in various forms of media, such as pictures, 2D/3D models, audio, speech, and video. It has been formally standardized as ISO/IEC 15938 and is so far subdivided into 12 parts:

- Part 1 – Systems: specifies the tools (in the sense of description schemas) for preparing descriptions for efficient transport and storage, compressing descriptions, and allowing synchronization between content and descriptions. Part 1 just considers delivery of descriptions, not modifications or updates.
- Part 2 – Description Definition Language: specifies the language for defining the standard set of description tools (Description Schemes, Descriptors, and Data Types).
- Part 3 – Visual: specifies the description tools pertaining to visual content.

² http://www.ebu.ch/en/technical/trev/trev_290-hopper.pdf

³ <http://www.chiariglione.org/mpeg/standards/mpeg-7/mpeg-7.htm>

- Part 4 – Audio: specifies the description tools pertaining to audio content.
- Part 5 – Multimedia Description Schemes: specifies the generic description tools pertaining to multimedia including audio and visual content.
- Part 6 – Reference Software: provides a software implementation of the standard.
- Part 7 – Conformance: specifies the guidelines and procedures for testing conformance of implementations of the standard.
- Part 8 – Extraction and use of MPEG-7 descriptions: provides guidelines and examples of the extraction and use of descriptions.
- Part 9 – Profiles and Levels: definition of the adopted profiles and levels
- Part 10 – Schema definition: the XML Schema definition of parts 2, 3, 4, and 5
- Part 11 – MPEG-7 profile schemas: the XML Schema definitions of the adopted profiles
- Part 12 – the MPEG Query language: has just been finished. Due to its special impact it is described in the next chapter.

For its practical use it is essential to understand these main elements of MPEG-7:

- Descriptors (D): for the representation of features. Descriptors define the syntax and the semantics of each feature representation.
- Description Schemes (DS): to specify the structure and semantics of the relationships between their components, which may be both descriptors and description schemes.
- Description Definition Language (DDL): to allow the creation of new description schemes and the extension and modifications of existing description schemes.
- System tools: to support multiplexing of descriptions, synchronisation of descriptions with content, transmission mechanisms, file formats, etc.

Because of the richness and complexity of MPEG-7, it is necessary to agree on a subset for a certain application in order to simplify exchange of descriptions. Part 9 of MPEG-7 introduced the concept of Profiles, which are defined subsets for certain application domains.

Project partner JOANNEUM RESEARCH (JRS) provides an API for MPEG-7 Part 3 (audio), 4 (visual) and 5 (multimedia description schemes), which can be used free of charge⁴. With this library application developers are able to create multimedia content descriptions, manipulate them, serialize them to XML and de-serialize them – with validation – from XML. One major design goal was to simplify extending single classes to allow the developer to enrich interface functionality for certain descriptors. Furthermore documentation on concept and source code level improves the learning curve for the programmer.

2.4 MPEG-7 Query Format

Until recently, a common and standardized query format with defined communication between client and databases and with support for cross-modal and cross-medial

⁴ <http://mpeg7.joanneum.at/>

retrieval did not exist. Therefore the MPEG committee decided to contribute here as well, specified a set of requirements and instantiated a call for proposal for an MPEG-7 query format (MP7QF). In response to the call for proposals, six proposals were submitted. The strengths of each proposal were combined and further refined.

The MPEG-7 Query Format aims at standardizing query input format, query output format and query management tools for search and retrieval with MPEG-7 enabled databases. In November 2008 this work has been finished and the results have been published as part 12 of the MPEG-7 standard. Different to the earlier MPEG-7 parts its emphasis lays not in the description but in the consumption of metadata.

The MPEG query format provides a standardized interface for multimedia content information retrieval systems (e.g. MPEG-7 databases) in three aspects which are input query format, output query format, and query managements. The input query format specifies the interface through which the users can describe their search criteria with a set of precise input parameters in addition to a set of preferred output parameters to depict the return result sets. The output query format specifies the interface format for the result set. The query management provides means for selecting services (e.g. MPEG-7 database) or aggregated services (e.g. service provider that administers a set of different services) based on service properties (e.g. supported query format).

A rich set of Multimedia query types has been defined (e.g. QueryByMedia, QueryByDescription, QueryByFreeText, Spatial Query, TemporalQuery, Spatio-TemporalQuery, QueryByXQuery, etc.). Each query format tool is described in two normative sections:

- Syntax (normative specification of the query and management format);
- Semantic: (normative definition of the semantics of all the components of the corresponding query format specification).

The two main benefits of standardizing such kind of language are

- interoperability between parties (e.g. content providers, aggregators and user agents) and
- platform independence; developers can write their applications involving multimedia queries independently of the database used, which fosters software reusability and maintainability.

2.5 MPEG-21

The vision for MPEG-21⁵ is to define a multimedia framework for enabling transparent and augmented use of multimedia resources across a wide range of networks and devices used by different communities. MPEG-21 aims to describe how the various infrastructure elements for the delivery and consumption of multimedia content fit together. The result is an open framework for multimedia delivery and consumption for use by all the players in the delivery and consumption chain. This open framework thus provides content creators and service providers with equal opportunities in the MPEG-21 enabled open market.

In its current state, as ISO/IEC 21000 under the general title Information technology — Multimedia framework (MPEG-21), the standard is very complex and consists of 18 parts which can be clustered into six major categories each dealing with different aspect of the Digital Items: declaration (and identification), digital rights management,

⁵ <http://www.chiariglione.org/mpeg/standards/mpeg-21/mpeg-21.htm>

adaptation, processing, systems, and miscellaneous aspects (i.e., reference software, conformance, etc.). However, the underlying principle is simple.

MPEG-21 is based on two essential concepts: the definition of a fundamental unit of distribution and transaction (the **Digital Item**) and the concept of **Users**.

A Digital Item is a structured digital object with a standard representation, identification and metadata. It can be considered the “what” of the Multimedia Framework (e.g., a video collection, a music album). In practice, a Digital Item is a combination of resources, metadata, and structure. The resources are the individual assets or (distributed) resources. The metadata comprises informational data about or pertaining to the Digital Item as a whole or to the individual resources included in the Digital Item. Finally, the structure relates to the relationships among the parts of the Digital Item, both resources and metadata.

From a technical perspective, all parties that have a requirement within MPEG-21 to interact are categorised equally as Users. A User is any entity that interacts in the MPEG-21 environment or makes use of a Digital Item. Each User will assume specific rights and responsibilities according to their interaction with other users.

Users include for example individuals, organisations, corporations, communities, consortia, governments and other standards bodies and can assume roles like creators, consumers, rights holders, content providers, distributors, etc.

The **resource** is yet another important definition in MPEG-21; it is defined as an individually identifiable asset such as a video or audio clip, an image, or a textual asset.

At its most basic level, MPEG-21 can be seen as providing a framework in which one User interacts with another User and the object of that interaction is a Digital Item.

Some such interactions are creating resources, providing resources, modifying resources, archiving resources, rating resources, enhancing and delivering resources, aggregating resources, delivering resources, syndicating resources, retail selling of resources, consuming resources, subscribing to resources, regulating resources, facilitating transactions that occur from any of the above, and regulating transactions that occur from any of the above. Any of these are “uses” of MPEG-21, and the parties involved are Users.

2.6 JPSearch⁶

The JPEG committee, formally known as ISO/IEC JTC1 SC29 WG 1, is well known for the successful development and deployment of standards for data representation such as JPEG and JPEG 2000. Recognizing the need of a standard for interoperability for image search and retrieval systems, JPEG has recently launched a new activity, JPSearch, also known more formally as ISO/IEC 24800. The aim of this standard is to allow different image management systems to inter-operate in the process of image search and retrieval.

JPSearch is a relatively new and still ongoing standardization activity. Its goal is to provide a standard for interoperability for image search and retrieval systems. It is foreseen that JPSearch will enable more complete solutions and give consumers and businesses confidence in the longevity of their annotations and collection maintenance effort. More specifically, similar to the MPEG family of standards JPSearch aims at defining all the necessary interfaces and protocols for data exchange between devices

⁶ <http://dsmc.eap.gr/ppts/ebrahimipres.pdf>

and systems. For the part of the query format JPSearch collaborates with the MPEG consortium.

The JPSearch project is divided into five parts:

- Part 1 - Framework and System Components, is a Technical Report that introduces the JPSearch architecture and outlines the organization of the JPSearch specifications.
- Part 2 - Schema and Ontology Registration and Identification, standardizes a format for the import, export and exchange of ontology.
- Part 3 - JPSearch Query Format, which is developed jointly with MPEG, allows for the expression of search criteria, the aggregation of return results and the management of query process.
- Part 4 - Metadata Embedded in Image Data (JPEG and JPEG 2000) file format, standardizes image data exchange format with associated metadata.
- Part 5 - Data Interchange Format between Image Repositories, standardizes a format for the exchange of image collections and respective metadata between JPSearch compliant repositories.

The documents for most parts are currently on committee draft level.

The collaborative work of several European institutions for JPSearch is clustered in working group 7 of the research network COST292.

Recently the JPEG group announced that work has started on solutions for Social Tagging as part of the JPSearch metadata support. When the Social Tagging is supported, people can add their own metadata such as key words or text description to existing images and share them with the associated metadata. The candidate technologies for Social Tagging will be included in JPSearch Part 2.

3 Web related Standards and Technologies

3.1 Web Services

Web services are the main components of Service Oriented Architectures (SOA), an approach that aims to achieve flexible architectures for complex and challenging workflow tasks based on the concept of loosely coupled processes that together form the overall application.

A web service is defined by the W3C as “a software system designed to support interoperable machine-to-machine interaction over a network”. A remote system’s functionality is invoked through an API (Application Programming Interface) by a requesting client.

The general idea is not new as it is in parts covered by several former technologies like RPC (Remote Procedure Call), CORBA, DCOM (Distributed Component Object Model) or RMI (Remote Method Invocation).

The difference is that web services strongly focus on Internet standards, with HTTP as the transport protocol and XML as message format, and apart from that they are platform and programming language independent. A web service is usually stateless as long as there is no web service standard that defines how to keep a state in an interoperable manner.

There are two approaches that fall in the category of web services:

- Web services that rely on the SOAP standard

- RESTful Web services

SOAP uses XML messages and a service description that is found in a WSDL file that allows for strongly typed messages and automated client-side code generation using a SOAP framework where no further documentation is needed. SOAP is flexible and extensible with the use of WS-specifications and is suitable for “bigger” web services.

A **RESTful** web service does not require XML messages or a WSDL description, uses standard HTTP operations (GET, POST, PUT, DELETE,...) and focuses on interacting with stateful resources rather than messages or operations. A call can be initiated by a single global identifier (e.g. HTTP-URI). A separate documentation and manual parsing of results is needed in any case.

3.1.1 SOAP

SOAP, in its current Version 1.2, provides the definition of the XML-based information which can be used for exchanging structured and typed information between computers in a decentralized, distributed environment.

SOAP is fundamentally a stateless, one-way message exchange paradigm, but applications can create more complex interaction patterns (e.g., request/response, request/multiple responses, etc.) by combining such one-way exchanges with features provided by an underlying protocol and/or application-specific information. SOAP is silent on the semantics of any application-specific data it conveys, as it is on issues such as the routing of SOAP messages, reliable data transfer, firewall traversal, etc. However, SOAP provides the framework by which application-specific information may be conveyed in an extensible manner. Also, SOAP provides a full description of the required actions taken by a SOAP node on receiving a SOAP message.

Not only does the SOAP protocol handle data that can be represented by an XML-document like HTML, .pdf or order forms, “SOAP with Attachments”(SwA) and “SOAP MTOM” carry binary data like .png, .wav or .mpeg as a combination of SOAP and MIME.

Although HTTP - or the secure alternative HTTPS - would be the transport mechanism of choice for most SOAP communications, it is also possible to make asynchronous requests through SMTP for instance.

SOAP is an evolving standard. A variety of specifications are found in the WS-specifications (WS-Security, WS-Trust, WS-Addressing) that more or less find their way into the common SOAP Frameworks.

3.1.2 REST

Representational state transfer (REST) refers to a distributed resource exchange paradigm using standard HTTP operations. In contrast to SOAP there isn't any additional message layer on top. Shared methods and media types are used to indicate semantics and exchange information.

To request a resource, an application needs to know two things: the identifier of the resource and the action required. The information returned is typically an HTML, XML or JSON document but it may also be an image, plain text or any other content distinguished by its MIME type.

REST does not care for a session state and that means that different servers can handle different requests in a session. Less client side software and less vendor-specific mechanisms are needed as a single internet browser can access any application or any resource. Each resource, as it is an URL, may easily be cached, copied or book-marked.

Compared to RPC (Remote Procedure Call) operations are defined as the following:

RPC-style:**REST-style:**

getUser()	http://example.com/users/{userid}	as GET, PUT, DELETE or POST method
addUser()		
removeUser()		
updateUser()		
listUsers()	http://example.com/users/	
findUser()	http://example.com/findUserForm	

3.1.3 SOAP & REST Frameworks

The following table provides an overview on the most important frameworks for the development of Web services.

Name	Platform	Deployment	SOAP WS-specs support	SOAP	REST
Apache Axis 2	JAVA / C	stand-alone, Servlet Container (e.g. Apache Tomcat), J2EE app server (GlassFish, JBoss,...)	WS-ReliableMessaging, WS-Security, WS-Secure Conversation, WS-AtomicTransaction, WS-Addressing, WS-Policy, WS-MetadataExchange, WS-Business Activity, WS-Coordination, WS-Eventing, WS-Notification, WS-Transfer, WS-Trust	X	X
gSOAP	C/C++	stand-alone, cgi, Apache/IIS (via mod)	WS-Addressing, WS-Discovery, WS-Enumeration, WS-Security	X	
Windows Communication Foundation	.NET	IIS, WAS, Windows NT Services	WS-Addressing, WS-ReliableMessaging, WS-Security, WS-Trust, WS-SecureConversation	X	X
Web Services Interoperability Technologies (WSIT) (Metro, Glassfish)	JAVA	Servlet Container, J2EE app server	WS-Addressing, WS-Atomic Transaction, WS-ReliableMessaging, WS-Coordination, WS-AtomicTransaction, WS-Security, WS-SecureConversation, WS-Trust, WS-Policy, WS-MetadataExchange, WS-Coordination	X	X
Restlet	JAVA	Stand-alone, Servlet container			X
WSO2 WSF	C (PHP/Ruby/Pearl/Python)	stand-alone, Apache Module	WS-Addressing, WS-Policy, WS-Security, WS-SecurityPolicy, WS-ReliableMessaging, WS-Eventing, WS-Federation, WS-Transaction, WS-Enumeration, WS-Transfer	X	X
Apache CXF	JAVA	Stand-alone, Servlet Container, JBI, SCA, J2EE app server	WS-Addressing, WS-Policy, WS-ReliableMessaging, WS-Security	X	X

3.2 Web Programming Technologies and Frameworks

The term RIA (Rich Internet Application), originally defined by Macromedia for their Flash applications, nowadays stands for internet applications that ideally look and behave like desktop programs. These applications make use of asynchronous calls to a server without blocking or a complete reloading of the user interface. Because of this asynchronous approach some of the logic that was formerly covered by the server is now done on the client side.

To help the programmer in creating such an application, a set of libraries and ideally a complete framework or integrated IDE can help. The following explains the common RIA approaches, namely AJAX, Flash/Flex, Silverlight and also lists the frameworks

available at the moment. Other techniques like JavaApplets, JavaFX or SVG are left out.

3.2.1 Ajax (Asynchronous Javascript and XML)

Every modern Browser understands Javascript and is therefore AJAX compatible but especially in some company networks Javascript is sometimes deactivated. AJAX is strong because of its mixture of well-known technologies like HTML, CSS and Javascript with the XMLHttpRequest object for asynchronous calls. Although most browsers can handle Javascript, a big issue is the different interpretation of the standards, especially in combination with CSS, that leads to a longer development cycle. One major disadvantage is that an Ajax application consists of pixel graphics instead of vector graphics and animations therefore are sometimes slow and stuttering.

There exist a vast amount of libraries for AJAX. Although this may be seen positive, it is difficult to decide what is the best to choose and a decision also leads to a library dependency. Video and Audio can only be integrated via Plug-ins, e.g. via the widespread Flash. Another problem is to find the most suitable IDE for programming and debugging.

3.2.2 Flash

The Flash .swf file format is a binary format that can be created with Adobe Flash and is played back by the Flash Player. The Flash Player is currently available in the version 10 and runs on Windows, Mac OS X and Linux. Since version 9, Flash uses Actionscript 3, a Java-oriented programming language. The data exchange is asynchronous using the URLLoader class. The Flash development environment Adobe Flash CS4 is using a timeline and keyframe based approach and therefore is more suitable for graphic and animation-oriented tasks than for complex development projects. The new Flash Player 10 can also handle 3D animation tasks.

3.2.3 Flex

In the year 2004 Adobe started the Flex project to give the programmer a suitable development environment for building applications running in the Flash Player. The basis of Flex is MXML, an XML language for components, Actionscript 3 as the programming language and CSS that lead to a compiled swf file. The free Flex 3 SDK (also available as reduced open-source package) consists of several components that help the programmer in building strong applications right from the start.

Flex applications can also be built using an IDE called Flex Builder (not free) that is based on Eclipse with an integrated GUI designer. It fulfills most of the needs of a programmer and just lacks a Flash and easy vector graphics integration. Flash animations have to be created and compiled in Adobe Flash and the final result can then be imported into Flex as is. Adobe Flash and Adobe Flex have nothing more in common than the file format swf. The Flex Component Kit for Flash helps to import Adobe Flash generated content. The newer Flash Catalyst could eventually fulfill this exchange gap because it is able to store projects in .fxb format that can be opened by the upcoming Flex Builder 4 preserving design and code integrity. There are some things missing in the Flex Builder IDE that a programmer is used to, like automatic formatting of code, error report while coding and code completion for new user-written classes.

Flex 3 applications require the Flash Player version 9, the Flash Lite for mobile devices cannot handle these. Flex has several options for data exchange using web services and server backends for database access using ASP.NET, Java, ColdFusion or PHP. Flash/Flex supports the streaming via RTMP with Flash MediaServer or Red5 and the

binary protocol AMF that could be used for direct remote object invocation and data push using Adobe Data Services or AMFPHP.

3.2.4 Silverlight

With Windows Vista Microsoft introduced a framework for graphics output on a vector basis, the Windows Presentation Foundation (WPF). The graphical user interfaces of WPF applications are written in XAML, an XML-oriented language. A reduced version of this is used for Silverlight, a plug-in based approach for building rich browser applications.

Silverlight uses JavaScript as programming language but can also run managed code in C#, Visual Basic, Python and Ruby but not unmanaged code like C++. The IDE of choice is Visual Studio with an additional graphical editor called Expression Blend 2. With Silverlight one can build complete animations and integrate video. A major disadvantage is the restricted platform (Windows and Mac OSX) and browser (Internet Explorer, Firefox and Safari for MacOSX) support for Silverlight applications.

3.2.5 RIA approaches in comparison

The following table provides an overview on the different capabilities of the RIA approaches.

	Ajax/Javascript	Flash/Flex	Silverlight
technology	browser-integrated	plug-in-based technology from Adobe	plug-in-based technology by Microsoft
operating systems	all	all	Windows XP und Vista, Mac OS X, Linux (in beginning state)
Internet browser	modern browser (IE since 6, FF since 1.x, Opera 9, Safari/Konqueror)	all	modern browser
plug-in	none - but can be deactivated in the browser	Flash plug-in needed	Silverlight plug-in needed
graphics	pixel (vector with SVG possible)	vector	vector
scalability	bad	as wished	as wished
format	arbitrary height of website possible	fixed format, proportional scalable	fixed format, eventually proportional scalable
small icons visibility	blurred for curves or few pixels	also small icons are good looking	Also small icons are good looking
fonts	no own fonts	own fonts possible	own fonts possible but restricted
3D	no (only with other plug-ins)	since Flash 10	no
animations	stuttering (with libraries good quality possible)	possible	possible
animation technique	setInterval(), setTimeout() - second-based	frame-based, tween, via Actionscript	second-based, animation as XAML-element
drag & drop	possible, but complex (with libraries simple)	possible	possible
script language	Javascript	Actionscript (formerly Javascript-based, with AS3.0 C#/Java-oriented)	Javascript (1.0), .Net-languages (2)
element access	DOM	symbols controllable (movieclip architecture)	nearly every element controllable
preload functionality	loaded yes/no	at byte-level possible	at byte-level possible

Sound	playing sound difficult (only with external plug-in)	possible	possible
Video	playing video difficult (only with external plug-in)	possible - integrated codecs	possible – restricted codec support (but HD)
Streaming	Plug-in dependent	with FLV as progressive streaming - via MediaServer extended streaming	Possible - streaming service of Microsoft
CD/DVD/Offline	Ajax-connection not offline, JS offline restricted	offline as projector, as plug-in added to programs, with Adobe AIR as desktop application	planned
document integration	linkable in HTML	FlashPaper for pdf	Possible
server-side interaction	via Ajax library / XMLHttpRequest-Object	via Flash (with every technology)	via integrated technology (ASP.NET, but also others)
exchange formats	Text, JSON, XML	URL-variables, XML, AMF (binary), web service	Text, JSON, XML, .NET services planned
architecture / IDE	Ajax library, JS code output in front-end is interpreted in browser	SWF movie made with Flash or Flex (e.g. Flex Builder) is compiled	Silverlight movie made with Visual Studio and/or Microsoft Blend
generate graphics	as pixel graphic e.g. with Image Magick, eventually with library	dynamic generation of vector graphics of server-side data, forwarded data or generated in Flex (e.g. graph module)	Dynamic generation of vector graphics of server-side data

Many frameworks and Integrated Development Environments (IDE) exist for the development of RIA application. These can be clustered as follows.

3.2.6 AXAX Frameworks and IDEs

- **Pure Javascript Frameworks for AJAX:**
 Prototype: <http://www.prototypejs.org/>
 J-Query: <http://jquery.com/>
 Mootools: <http://mootools.net/>
 Ext: <http://extjs.com/>
 Script.aculo.us : <http://script.aculo.us/>
 Dojo: <http://www.dojotoolkit.org/>
 YUI: <http://developer.yahoo.com/yui/>
 Spry: <http://labs.adobe.com/technologies/spry/>
- **AJAX - Server-side Frameworks:**
 Sajax (PHP, Pearl, Python, Ruby, ColdFusion):
<http://www.modernmethod.com/sajax/>
 Xajax (PHP): <http://xajaxproject.org/>
 ASP.NET Ajax (.NET): <http://www.asp.net/ajax/>
 Direct Web Remoting DWR (JAVA): <http://directwebremoting.org/>
 Google Web Toolkit GWT (JAVA): <http://code.google.com/webtoolkit/>
 ZK (ZUML): <http://www.zkoss.org/>
- **AJAX – IDEs:**
 Aptana Studio: <http://www.aptana.com/>
 NetBeans: <http://www.netbeans.org/>
 Dreamweaver CS4: <http://www.adobe.com/products/dreamweaver/>
 Eclipse (via plug-in): <http://www.eclipse.org/atf/>
 Visual Web Developer: <http://www.microsoft.com/express/vwd/>

The following table provides a feature comparison of most important AJAX frameworks.

	Dojo	Ext	GWT	JQuery	YUI
Offline mode	✓	*1	*2	Not available	✓
Developer Tools	✓	✓	✓	✓	✓
Graceful degradation	✓	Not available	✓	✓	✓
Auto completion tools	✓	✓	*3	✓	✓
HTML generation tools	✓	✓	✓	✓	✓
Hierarchical tree	✓	✓	✓	✓	✓
Grid	✓	✓	✓	✓	✓
Input widgets + validation	✓	✓	✓	*4	Not available
History management	✓	✓	✓	✓	✓
Event handling	✓	Not available	✓	✓	✓
Drag&Drop	✓	✓	✓	✓	✓
Animation	✓	✓	✓	✓	✓
skinnable	✓	✓	✓	✓	✓
XMLHttpRequest	✓	✓	✓	✓	✓
JSON	✓	✓	✓	✓	✓

*1: via GoogleGears or Adobe AIR

*2: via GoogleGears

*3: via Plug-In

*4: via Plug-Ins

3.2.7 Other Frameworks and IDEs

- Flash – IDEs:**
 Flash CS4: <http://www.adobe.com/de/products/flash/>
 Flash Catalyst: <http://labs.adobe.com/technologies/flashcatalyst/views/>
 Flex - IDEs
 Flex Builder 3: http://www.adobe.com/devnet/flex/articles/flex_framework.html
 FDT: <http://fdt.powerflasher.com/>
- Silverlight – IDEs:**
 Expression Blend 2:
<http://www.microsoft.com/expression/products/Overview.aspx?key=blend>
- PHP – IDEs:**
 Zend Studio: <http://www.zend.com/en/products/studio/>
 Dreamweaver CS4: <http://www.adobe.com/products/dreamweaver/>
 Eclipse (via plug-in): <http://www.eclipse.org/pdt/>
 Visual Studio (via plug-in): <http://www.jcxsoftware.com/vs.php>
- PHP – Frameworks:**
 Symfony: <http://www.symfony-project.org/>

CakesPHP: <http://cakephp.org/>

- **Ruby – Framework:**
Ruby on Rails: <http://rubyonrails.org/>
- **CSS – Frameworks:**
YUI Grids CSS: <http://developer.yahoo.com/yui/grids/>
Blueprint CSS: <http://blueprintcss.org>
YAML: <http://yaml.de>

4 Other enabling Technologies

4.1 MXF and the UMID

The material exchange format (MXF) is now becoming a standard format in file-based production and should ideally enable a flawless exchange of essence and related metadata among different systems. However, interoperability problems can occur, and cooperation with vendors to overcome these can be necessary. MXF offers a unique identification mechanism through the Unique Material Identifier (UMID), within an MXF file each package (a collection of tracks) can be identified by means of a UMID; the basic UMID being a unique 32-byte number, as described in SMPTE 330M. The material package of an MXF file describes its output timeline as it is intended to be played; hence its UMID can be used to refer to what is played out.

A basic SMPTE UMID consists of:

- A 12-byte universal label to identify it as a SMPTE UMID. It also defines the type of material and the methods by which the material number and instance number are generated.
- A 1-byte length value, which defines the length of the remaining parts of the UMID. The length value is 13h for a basic UMID and 33h for an extended UMID.
- A 3-byte instance number, which should be used to differentiate between different representations of material with the same material number.
- A 16-byte material number, which is globally unique for every item of material. A given material number should have the same value for related instances of the same audiovisual material only where the instance number is used to uniquely identify these related instances.

As soon as a file-based camera creates an MXF file, a UMID is generated for the material package, as well as the other packages (the underlying source packages within the MXF file) that can be used to identify the material. When the file is transferred to other systems, such as the central storage environment, or an editing workstation, this UMID can be used as an external identifier (because these other devices will normally generate new UMIDs or proprietary identifiers) to indicate that the same material is being used. Consequently, store and search functionality for these external identifiers is required. Because the UMID is a property of the material itself, and not of a system containing it, it is a logical choice as a universal identifier. Such an identifier can be used to synchronize metadata between the different systems, or to determine whether some essence is already present or still needs to be transferred between components. Naturally, some remarks have to be made; for instance, what if only parts of the original MXF output timeline should be transferred or transcoding

occurs from one system to another. The MXF output timeline represents the material as it is intended to be played out from start to end; this is described by the material package, and can differ from the actual essence contained within the file. In these cases, the UMID is insufficient as a correlation method and one should add additional metadata, such as "timecode IN" and "timecode OUT" for partial-clip transfers. Then it becomes possible to determine whether a certain system contains the requested essence or not, but what about other metadata? Which metadata applies to the original material and which to the newly created one(s)? Although not hampering the development of an architecture, these are some questions to consider. Discussions are ongoing how to deal with such use cases.

4.2 Video Codecs

The MPEG-4 standard now includes an advanced video codec jointly developed between the Video Coding Experts Group (VCEG) of the International Telecommunications Union (ITU) and the MPEG committee of ISO/IEC. With its complex pedigree, the new codec acquired a number of transient names; MPEG refers to the codec as "Advanced Video Coding" or AVC. It is also known as MPEG-4 Part 10 and H.264. AVC can give broadcasters and Web applications 40-50% compression efficiency gains over today's optimised MPEG-2 bit rates.

There is no doubt that MPEG-4/AVC will be widely adopted in the next generation of software and systems for broadcast as well as for Web applications.

An upcoming trend in codec development is Scalable Video Coding. The idea of scalable media networking is to code once and then customize the stream to access the content in different resolutions and with different bandwidth restrictions. Of course in this approach lower resolution or bandwidth is as much associated with lower quality as with current solutions. But it will no longer be necessary to code and maintain multiple versions. One compression standard that already allows scalable video coding is JPEG2000.

5 Markets and Products

In this section we look into the markets for the three SEMEDIA domains. For each context we describe the state of the art and what is needed by users. Then we describe the most interesting products and examine to what extent they match the user needs.

5.1 *Postproduction Market*

5.1.1 State of the Art

Workflow design in postproduction has come a long way from the days of the standalone video production system. Within just a few years the workflows in the post-production facilities switched from film or videotape centric to data centric models. News outlets of all sizes and post-production facilities demand workflows that are fully integrated into the various levels of operation, making content simultaneously accessible to all stakeholders in a collaborative environment. This requires networked digital video systems and effectively managed content, which is not always easy when working with highly sensitive audio and video assets.

All these developments, that step by step decrease the share of traditional physical media and at the same time increase the share of IT-based production techniques, permanently force the post-production studios to expand their digital storage capacity. And in parallel the number of files to be handled increases at the same rate. Quite naturally this development also increases the need for a sophisticated management of the data files in these digital storages.

Already in facilities of medium size it is, due to bandwidth limitations, not possible to have a single scalable central storage for all the media files to be handled in the studio. Instead, the storage in a typical post house is scattered over multiple storage servers and workstations that form separated storage islands. Film post-production is a highly non-linear process that involves quite specialized tools, the equipment used is usually a very heterogeneous set of systems from different manufacturers using different storage technologies, operating systems and applications. This makes it difficult to manage all the content in the different storages with one comprehensive, universal tool that combines all the necessary information from the workflow planning, the essence files and the metadata.

Currently there are two distinctive approaches for this management. On the one hand there exist high-level tools that were already used in the time of film rolls and video tapes to manage the workflow aspect of a production on a project basis, for example what film rolls or video tapes came in, what output formats are needed, when will the different processing steps be performed. These tools lack the possibility to also manage online data files. On the other hand there are tools evolving for the management of media files in heterogeneous storage environments and its associated metadata.

It is not uncommon that the processing steps of a film project are spread over multiple facilities. One studio might do just the video editing, another one the audio editing and yet another one the special effects rendering. The exchange of the essence files between the studios is usually done via portable, disk-based storages and only in some cases via special high-speed networks like the SohoNet.

Producers of feature films or commercials virtually never reuse old content. Therefore, from the three SEMEDIA contexts, post-production is probably the one that so far has the slightest need for content based search, like for clips that show specific places, persons or actions. The files that are online in the post-production studio belong to specific projects that are well known to the people involved and the clips are usually addressed by metadata like reel names, take numbers, key codes or time codes.

However, so far there is no consistent handling of this technical metadata that is usually stored in the file headers of the essence files. It is still not uncommon for today's post-production tools to open all the files in whole storage volumes to find the specific files needed in a finishing process that, although running partly automatic, takes a lot of time and that often needs human browsing and interaction.

There is one stage in the early beginning of a new project where the search for specific content becomes quite reasonable. That is for figuring out how things have been done in older projects in the past. A good example is a customer that comes to a commercials company like Smoke & Mirrors to discuss a new campaign for a product. At that moment a content retrieval in the archive of older projects, based on all information that might help to detail the expected search results, would be extremely helpful to quickly get an overview on what has been done in similar projects in the past. Today this is only possible based on simple metadata like titles or annotations and only if a fast access to archived material is possible at all.

5.1.2 Relevant Products

Many companies offer storage solutions and workstations for the postproduction market, but only a few also provide the tools that are necessary to manage content, including search for content, on studio level. This section describes the most advanced solutions.

5.1.2.1 Apple Final Cut Server

Final Cut Server⁷ is a media asset management and workflow automation software from Apple that supplements the very successful editing software Final Cut Pro. The server process is only available for MAC OS X while clients are available for Macintosh and Windows operating systems. This limits the usability in a heterogeneous environment, but the software provides some very interesting features for the automation of several processes.

Final Cut Server continuously scans a network to identify and catalogue production assets. It generates "browse" proxies and thumbnails, and automatically keeps the catalogue up to date as work goes on.

Final Cut Server supports a wide range of file formats, file systems, and media storage devices. It supports Final Cut Studio project files as well shot lists, video and audio clips, images, graphics, and more.

As part of the cataloguing process, Final Cut Server extracts and captures most forms of industry-standard metadata, including QuickTime, IPTC, XMP, and XML data. This saves hours of potential data entry during cataloguing. A powerful mapping algorithm lets users translate metadata from different formats to provide consistent information across the catalogue. It is also possible to add metadata to each item after it is captured in the catalogue.

Final Cut Server works similarly to other client-server computer networks. A client computer sends a request to the server computers. Upon receiving the request, the server computer performs a job to process the request and then sends the result (or message of completion of the job) back to the client computer. Jobs can include uploading, copying, transcoding, cataloguing, and otherwise tracking media files. Media can be stored on the server computer's internal and external drives as well as on many

⁷ <http://www.apple.com/de/finalcutserver/>

supported network devices. Final Cut Server also supports the Apple Xsan storage area network (SAN) for asset and production storage.

The main operations and features that Final Cut Server provides are:

- *Search for Assets:* Final Cut Server provides multiple ways to search and organize the assets in the Final Cut Server catalogue.
- *Immediate access to media:* Final Cut Server provides immediate access to media from the Final Cut Server client software. For editing or using the media asset, it is possible to check out a Final Cut Server–managed copy of the file to the users local computer, edit it, and then check it back in to Final Cut Server. Because Final Cut Server is managing the checked out file, the new edits are tracked by Final Cut Server.
- *Track the status of media:* Final Cut Server provides metadata fields and saved searches to help users track assets as they move through the studio’s workflow. Administrators can further customize the metadata fields to increase the effectiveness of asset tracking.
- *Perform media conversions:* Final Cut Server uses Compressor, a transcoding application that is part of Final Cut Studio, to convert media from one video format to another when uploading, exporting, and copying media files.
- *Event based automation:* The basic building block of automation in Final Cut Server is a “watch and respond” sequence. The system watches for an event — a change in a specified metadata field, a new file in a watched folder, or a specified time — then responds with an action or series of actions. For example, if Final Cut Server is set up to watch a status metadata field for the value “Publish,” the system can immediately convert media to an output format and push the file to a broadcast server.
- *Work offline:* A user can check out Final Cut Server–managed project and media files and then edit them while not connected to the Final Cut Server network. When he later connects to the Final Cut Server network, he can check the edited files back in to Final Cut Server. When the files are checked in, the assets that track the files are updated with the new files.

To perform a simple search of the assets in Final Cut Server, the user chooses a search type, either ‘contains’ or ‘matches’, and enters a term. Final Cut Server searches for that term in every metadata field on every asset or production. Matches word searches are based on *stemming*, a process that identifies the root of the word, which gets modified by the grammatical requirements of the English language. For example, the stem of *work*, *works*, *worked*, and *working* is *work*. Therefore, if a user enters the search term *working*, Final Cut Server stems the term to *work* and then returns all assets with a stemmed term of *work* in any of the asset’s metadata fields.

Simple searches can be made more specific by using a search delimiter for multiple and for negative terms.

For performing advanced searches Final Cut Server provides filter functions for text (all, equals, contains, begins with, any of, etc.) and date (all, last 2 hours, before, after, etc.).

It is possible to create simple or advanced searches as Smart Searches which can be reused again.

Search results are displayed in thumbnail or list views and can be sorted.

5.1.2.2 AVID Interplay

Avid Interplay⁸ is a non linear workflow management system that is able to connect editors, producers, designers, or animators in a real-time non-linear production environment based on Avid products. The main storage system supported is the ISIS central storage server and although it is predominantly used to connect Avid workstations it also allows to connect non-Avid clients. However, those clients need to run the Mac OS operating system. Therefore it is also not a candidate to manage all content in a heterogeneous postproduction studio environment.

Similar to the Final Cut Server Interplay can be configured to automate routine tasks and to track any kind of media.

The Interplay search tool is quite basic. It allows a text based search with filters for project, file type and date.

In order to enable third parties to integrate their solutions with Avid Interplay a web services interface has been added recently. By exposing many of the functions that were previously only accessible through the Interplay Access application third parties can now integrate Interplay into their customised automated workflows.

5.1.2.3 DVS Spycer

DVS Spycer⁹ is a stand-alone content management application, which provides a solution for dealing with large amounts of video data and its accompanying metadata. It has been designed as an open platform that supports existing heterogeneous IT infrastructures and workflows in typical postproduction houses.

Thanks to its peer-to-peer approach Spycer does not require a centralized storage to carry out network-based browsing or efficient clip searching in a company network. Instead it makes this possible with a scalable content management network, the SpycerNet, on which several Spycer applications communicate with each other. The SpycerNet automatically builds up as a TCP/IP based content management network by simply installing Spycer applications on multiple workstations.

Via the SpycerNet several Spycer applications communicate with each other for browsing, data retrieval and file handling purposes. Metadata is automatically extracted from file headers or gained by content analysis. This metadata can be used for searching and the retrieval of data in the network. The distributed content management system grows with every additional Spycer application added to the network. Such a peer-to-peer architecture supports the dynamic nature of postproduction setups.

The SpycerAgent process runs all the time as a background server process. Once it has scanned all disk volumes and set up the local Spycer database its duties are:

- To track all changes in the file system
- To extract metadata from new or modified audio and video files as well as project files from DVS applications
- To keep the local database up-to-date
- To communicate with other tracking processes via a P2P protocol
- To answer query requests from high-level processes like the Spycer GUI

⁸ <http://www.avid.de/de/products/2145.htm>

⁹ http://www.dvs.de/Brochures/DVS_Spycer.pdf

The Spycer GUI is the main interface for the user for the administration of essence files and associated metadata on the local system as well as on any remote system in the SpycerNet. It allows the user to:

- Browse through all clips from all peers within the network
- Search for clips locally or remote that match specific metadata combinations
- Watch all metadata from selected clips
- Edit selected metadata items
- Perform file management actions like copy, rename, delete or defragment

Time consuming actions like the copy of big sequences or activities that might reduce real-time capabilities can be scheduled to run e.g. at night.

5.2 Broadcast Market

5.2.1 State of the Art

The migration to file-based production is one of the most fundamental, ongoing changes in the architecture of today's broadcasters and media companies. The underlying architecture is preferably based on open standards and interfaces and can include various components such as a central media asset management system (MAM), specialized editing systems, and program format-specific production systems (newsroom computer system, drama production system, etc.). All of these systems can provide some MAM functionality to a greater or lesser degree, to organize the various media assets. In this context, one of the most significant, outstanding challenges relates to facilitating effective integrations between these different MAM-based systems, which enable the seamless exchange of both essence and metadata.

The heart of digital media asset management systems is a very similar set of core content management functionalities (some native, some perhaps from 3rd parties):

- The repository: The core of any system builds a representation of the content utilizing a relational database or file system, or some combination. This includes basic repository services, such as version control, categorization, ingest, upload, and download.
- The metadata index: This includes descriptors, administrative data as well as versions, and other hierarchical, peer to peer, parent child or lineage relationships.
- The search engine: To perform searches against the above-defined index and repository.
- The access and rights subsystem: Privileges and permissions that define who can see and do what with which objects.
- The workflow or collaboration engine: Scheduling and definition of tasks in serial or parallel progression.

A MAM system must not necessarily be one consistent system from one manufacturer. In fact it is usually composed of many components from different suppliers that have been integrated either by the broadcaster itself or by a specialized service provider.

Another important part of each broadcaster, and usually integrated with the MAM, is the archive which is a copy of media data that is being retained for very long periods of time, usually for years and in some cases centuries. Archives are used throughout the entertainment industry for storing content that is not being used in ongoing projects, but could be re-purposed or referenced in the future. An archive may be active, online, where it can be accessed relatively quickly or cold, offline, where it can be stored safely

and economically, but may take a considerable amount of time to mount the digital storage medium and read the archived data.

Editing and some other content industry segments also keep working archives of content on storage networks during the course of their work. These working archives are raw content and edited content that are protected during active work on a project. They are often kept in storage area networks or network attached storage systems used in the working studio. After a project is completed, the content of a working archive may be retained in a long term archive depending on the value and time to create intermediaries, certain effects, and other content used to develop the final cut.

Archiving is currently driven by two factors: The need to cost-effectively retain content for re-use and the need to convert historical analog content to digital form to prevent degradation of content. Many sorts of facilities keep content for varying periods of time. Keeping completed content in long term archives is common practice by content owners, including movie and television production.

With respect to search and retrieval there are two main functionalities in the archive process where broadcast companies especially seek improvements:

- Currently the annotation of content, an absolutely necessary prerequisite for later reuse, is done in a completely manual way. The aim here is a transition to semi-automatic or automatic annotation. Related is the reuse and transformation of existing legacy databases for the legacy archives of analog film or video tape media. Again a semi-automatic to automatic process for the re-indexing into the new database with controlled conversion of vocabularies is required.
- On the reuse side there is a need for efficient and intelligent searching and surfing. Besides on better user interfaces this is of course heavily depending on the metadata created during the digitalization and archiving process.

5.2.2 Market Overview

The demand and need for MAM systems has created a big market and broadcasters can choose between many products as multiple software development companies started to offer solutions.

In this section we provide an overview on the most important commercial MAM systems and compare the current state of these solutions.

The following products are covered in this overview:

Application: Company: Program Description: Company Description: Usage:	Via2 Platform Visual Century http://www.visualcentury.com/products/via2platform.htm http://www.visualcentury.com/aboutus.htm http://www.visualcentury.com/downloads/index.htm#casestudies
Application: Company: Program Description: Company Description: Usage:	Media Archive enterprise Blue Order http://www.media-archive.de/products_media_archive_enterprise.html http://www.media-archive.de/company.html http://www.media-archive.de/customers.html
Application: Company: Program Description: Company Description: Usage:	VirageSmartEncode™featuring VideoLogger™ Virage http://www.virage.com/content/products/vs_smartencode/index.en.html http://www.virage.com/content/company/index.en.html http://www.virage.com/content/customers/index.en.html
Application: Company: Program Description: Company Description: Usage:	TD Tarsys MAM © Tedial http://www.tedial.com/restringido/doc.pdf?n=tarsysmam_e.pdf http://www.tedial.com/empresa_e.html http://www.tedial.com/instalaciones_e.html
Application: Company: Program Description: Company Description: Usage:	Digiton CCMA http://www.ccma.cat/inici/inici_eng.htm
Application: Company: Program Description: Company Description: Usage:	Spycer DVS http://www.dvs.de/Brochures/DVS_Spycer.pdf http://www.dvs.de/english/company/aboutdvs.html http://www.dvs.de/english/sales/europa.html
Application: Company: Program Description: Company Description: Usage:	Viz Ardome Vizrt http://www.vizrt.com/products/article138.ece http://www.vizrt.com/ http://www.vizrt.com/multimedia/archive/00000/Viz_Ardome_Solution_-_899a.pdf
Application: Company: Program Description: Company Description: Usage:	Cumulus Canto Software AG http://www.canto.com/en/products/product-editions/index.php http://www.canto.com/ http://www.canto.com/en/docs/datasheets/ds-cumulus76-for-users.pdf
Application: Company: Program Description: Company Description: Usage:	Mission Quantel http://www.quantel.com/site/es.nsf/html/mission_home?OpenDocument http://www.quantel.com/site/es.nsf/html/background?OpenDocument http://www.quantel.com/site/en.nsf/html/userlist?OpenDocument

The following table presents an overview on the features, similarities and differences of these products. The information in this table either derives from discussions with the manufacturers or from product brochures.

General MAM Characteristics	Characteristic	V. Century	Blue Order	Virage	Tarsys	Digiton	Spycer	Ardome	Cumulus	Mission
Technology / Data Base	Service oriented architecture (SOA)	✗	✓	✓	✓	✓	?	?	✓	✗
	Supports Windows	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Supports MAC OS	✗	✓	?	✓	✓	✗	?	?	✓
	Supports LINUX	✗	✗	?	✓	✓	✓	?	?	✗
	Editing and Conversion tools	?	✓	✓	✓	✓	?	✓	✓	✓
	Multiple storages and processing services	✓	✓	✓	✓	✓	✓	?	✓	✓
	Compatibility with multiple data bases (oracle, informix..)	✗	✗	✓	✗	✗	✗	?	?	?
	Based on standard hardware	✓	✓	?	✓	✓	✓	?	✗	✓
Ingest System	Multi-channel support for Web	✗	?	✓	✓	✓	✗	✗	✓	✗
	Detection of Cuts	✗	✓	✓	✓	✓	✓	✓	✓	✓
	Key-frame extraction	✗	✓	✓	✓	✓	?	✓	✓	✓
	Multi-channel support	?	✓	✓	✓	✓	?	?	?	✓
	Information on ingest duration	✗	✓	✓	✓	✓	✓	✓	✓	✓
	Ingest from different sources	?	✓	✓	✓	✓	✗	✓	?	✓
Metadata Indexes	Configurable data models	?	✓	✓	✓	✓	✓	✓	✓	✓
	Metadata for description of clip segments and events	✓	✓	✓	✓	✓	✓	?	✓	✓
	Annotation tool	✓	✓	✓	✓	✓	?	?	✓	✓
	Export in various formats	?	✓	✓	✓	✓	✓	✓	✓	✓
	Advanced metadata extraction from audio	?	✗	✓	✓	✗	✗	✗	✗	✗
	Advanced metadata extraction from video	✓	✗	✓	✓	✗	✗	✗	✗	✗
Search system	Support for multiple Web browsers	✗	✓	?	✓	✓	✗	?	?	✓
	Previsualisation of audiovisual content	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Multi-language support	✗	✗	✓	✓	✗	✗	✗	✗	✗
User and Rights Control	Common use of working tasks and results	✓	✓	✓	✓	✓	✓	✓	✓	✓
Collaboration on Workflow	Configurable workflow areas	✓	✓	✓	✓	✓	✓	✓	✓	?
	Project oriented	✓	✓	✓	✓	✓	✓	✓	?	✓
	Broadcast oriented	✗	✓	✓	✓	✓	✗	✓	✓	✓

As a summarize it can be said that at least some of the current systems already provide important features:

- Effective handling of large audiovisual volumes
- Uniformed management of hardware, service and backup
- Uniformed processing and formats
- Support of common workflows
- Search and retrieval based on textual information
- Reduced delivery times and better quality

However, there are still many desirable features that are not available with current systems. The following list provides the most important points on how the system should further develop:

- Metadata: A huge increase in metadata through automatic extraction (i.e., shot identification, logo identification, extraction of movement vectors, voice2text, automatic character identification, etc.) Metadata editing tools adaptable to the type of metadata. On-line tools for extracting metadata. In the near future, metadata may take up as much space as the audiovisual asset itself.
- Knowledge: Automatic exploitation of metadata. Automatic classification. Automatic links to web content. Generation of high-level metadata (i.e., through automatic classifiers).
- Semantics: Providing audiovisual assets with semantic capabilities through thesauri, taxonomies, ontologies.
- Search engines: Creation of advanced search engines (semantic, query-by-example, mixed searches). Content recommendations. Content ranking. Visual presentation of search results that allow for efficient navigation and quick consulting.
- Language: Making audiovisual content independent of language. Capacity to carry out searches independent of language.
- Users: Total adaptation of MAM functioning to the user profile, for example, automatic adaptation of the interface depending on use, context, customized searches, etc.

The limitations of these future challenges, with regard to software, involve managing an increasingly complex system such as MAM, that is so vast, multi-faceted and diverse (increasingly customized).

As for the hardware, there are also technological limitations with regard to storage capacity. MAM manages audiovisual content, that is, metadata and enormous files (with audio and video) that must be stored in databases and file systems. This is mainly an economic limitation, but one that is constantly improving since new technologies allow for increasingly greater storage capacity at lower cost.

5.3 The Social Web

5.3.1 State of the Art

From the three SEMEDIA domains the online media industry with its social Web applications is the most dynamic one with lots of recent technical and functional improvements that have become possible through Web2.0 technologies such as AJAX and Flex. These allow Web applications to execute some code directly on the user's computer contributing speed and dynamism to the access of data and services. These technical improvements are changing the face of the internet, bringing the user online experience closer to the immediacy and quality of the user desktop browsing experience.

Content that was traditionally controlled by professional editors is now in competition with open content created by the general public. This opens new roles and provides new management challenges.

Simply showing a video or an image or some other kind of media is not enough to distinguish one product from another. Rather it is the efficiency, simplicity and speed in which the media can be searched, accessed and used that attracts users and makes business models successful. There are three main areas that create value for the user:

- **Using user generated content (UGC).** The UGC associated with media objects such as photos and videos is essential to making rich media available to the larger public. Interest in such applications is not limited to professional publishers of content, but extends to every ordinary user of the Internet.
- **Content-based Information.** Technical improvements allow applications to take advantage of content-based information, thus using content features based on both visual and textual aspects of media, rather than simply relying on textual representations.
- **Tools for Navigating and Using Information.** Effective tools allow media to be displayed and searched in new ways, enabling users to access information more efficiently and effectively.

There are many online examples that use UGC in media applications. Rather than sites for pure consumption of media content users seem to prefer interactive online applications where they can participate and contribute, e.g. by uploading images or videos, and share, annotate, rate and discuss content within an active community.

5.3.2 Relevant Platforms

There is little doubt that Google is currently leading the general search engine market. With YouTube, Google also owns the clear number one platform for video sharing and search.

Yahoo's strategy to increase the search market share is to add features that can't be found at Google or somewhere else. The problem is that these features need to be distinctive and useful enough to attract the attention and make people switch to Yahoo or at least use it as a secondary search engine.

However, when it comes to image search combined with social networking elements then Yahoo's number one position with its Flickr platform is currently unchallenged. For some years Yahoo managed to be at least one step ahead. Steady progress will be necessary to defend this top position. And by including videos in Flickr there is a possibility to extend the success of Flickr into the video search market.

In this section we compare the search and retrieval features of the two leading applications with these of upcoming competing platforms. Most of these are 'just' search engines without a broader social aspect.

5.3.2.1 Flickr

Flickr¹⁰ aims to make photo storage, sharing and organization an easy, natural and collaborative process. Users may add comments, notes, and tags, post to any blog, search, share and much more.

Flickr is well designed and easy to use, but its popularity is probably because it permits a rich, sharing experience. The tools it gives users - in particular the ability to tag photos and then, via those tags, share images with others, have unleashed the social potential of digital photos.

Flickr didn't invent online picture sharing, of course, but it was the first such site to recognize itself as much more than a hosting service for personal photo albums. Tricked out with features inspired by the latest fashions in online-software design and social-networking tools, Flickr has also won a devoted following of users hungry to explore the possibilities its Web-centric toolset opens up. It's a place not just for self-display, but for an emergent visual conversation.

Flickr offers three different options for the upload of new images: by a specific desktop application uploadr (available for Windows and Mac PCs), via a dedicated Web site or by Email.

The search capabilities start with a simple text based search with space-separated words and a filter function to limit possible sources ("Everyone's upload", "from your friends", etc) and whether the search should look into all notes and comments or just into tags.

There are three ways of sorting the images found:

- 'Most relevant' is the default and sorts images by those that most closely match the search criteria (i.e. the term will appear in the title, description, tags, comments or notes)
- 'Most recent' sorts the images by those most recently uploaded.
- Sorting images by 'Most interesting' is often a good place to start. Flickr uses a complex algorithm to give each image an 'interestingness' score - the higher the score, the higher up it appears in search results.

A photo becomes more 'interesting' according to various factors such as how many times it has been viewed, how many people count it as a favourite, how many people have commented on it, how many pools it belongs to, and other assorted characteristics.

It's not just 'how many' but 'by who' and when - i.e. if a user with a high interestingness 'score' comments on a photo, that comment will count more towards the photo's interestingness than a comment from a new user. If x number of people mark it as a favourite within the space of a few hours, its score will be higher than if the same number do so over a longer period of time.

Flickr uses the top 500 interesting photos uploaded each day to populate its 'Explore' pages, giving users the option to browse through 'interesting' photos using a calendar.

Another way of searching Flickr is via groups. Any signed-in user can set up a group to pool photos from other users. There are thousands of public groups covering a broad range of subjects.

¹⁰ <http://www.flickr.com/>

With the Advanced Search, there are more text filters, the type of content and media may be specified and users can search for images taken between specific dates.

Users may also search by location - either by typing a location into the search box, or by exploring the world map. This can be useful for researching a particular area, or to see what a place 'really' looks like: i.e. from the public's point of view as an alternative to promotional photographs of an area or building.

There are a number of third party services that let users search Flickr in some interesting ways. Using Flickr's open API (Application Programming Interface), anyone with the technical know-how can write programs to present public Flickr data (like photos, tags, profiles or groups) in new and different ways. A good example is Retriever, a type of CBIR (Content Based Image Retrieval), allowing users to draw a rough sketch with their mouse with options to select from a colour palette and change brush size. The results are mixed, but it works especially well with large swathes of colour or basic shapes. Users can also upload an image or enter its URL to search for 'similar' images.

5.3.2.2 Google Advanced Image Search¹¹

Besides a simple tag based image search with very limited filtering of results for large, medium or small image sizes, Google also provides an advanced image query form, named Google Advanced Image Search.

The query form allows to select between four operators for the words in the text search entry (all, exact, any, without) and provides multiple optional filters for:

- rough image size
- exact image size
- file format
- color
- Web sites or domains

However, the most interesting filter is the one for the image type where a user may select between any content, news content, faces, photos, clipart and lineart.

The filtering for size and image type can alternatively also be applied on the result list.

The image files that can be found via Google are not stored on Google servers; the images are just indexed and stored somewhere in the internet. In fact many of them are actually stored on Flickr.

5.3.2.3 Other Image Search Platforms

Exalead¹²: Exalead offers a sophisticated image search filtering, including face recognition technology.

Exalead provides simple searching and some advanced options, which will apply Boolean operators, limit by Web site, and filter by size (including the ability to specify particular pixel dimensions). Once results are obtained, they can be filtered by size, colour and for "faces" (either tagged or by content-recognition software). Exalead offers

¹¹ http://www.google.com/advanced_image_search

¹² <http://www.exalead.com/search>

some “more choices”, which provide further search limiting (e.g. layout and file type) and gives an indication of what numbers or percentages of results relate to each image characteristic.

Picsearch¹³: Picsearch is a Swedish company and was an early provider of image searching, selling its search services to many of the general search engines.

Picsearch provides both simple and advanced search options, with the latter enabling users to limit searches by/to animations, by colour, or to one of 7 different gradations of size (usefully specified in pixels). Once a search is made there are suggestions for other searches (“Also try”) and, if the advanced search was used, it is possible to further refine the search.

5.3.2.4 YouTube

YouTube¹⁴ is likely the largest video archive on the Web. Thanks to its social network components it is also by far the most popular one.

The simplest way to find a video is to type one or multiple keywords into the search box. Results can then be filtered by relevance, upload time and type.

The advanced search feature on YouTube offers multiple options to refine and control search settings. Users can access these options by clicking the 'advanced' link next to the video search box on any YouTube page. The options include:

- Query Suggest: This feature provides suggestions for a given search term and is enabled by default.
- Safe Search: This feature allows you to filter videos in search that may be inappropriate for minors.
- Other Search Refinement Options: Users can also choose to refine the search by word phrases, location, duration of videos, language, relevance and upload time.

There are lots of ways to find videos to watch. Many ways are only possible thanks to the social aspect of YouTube as members rate videos that they like and YouTube reviews highly-rated and recent videos for consideration in the "Featured Videos" section of the home page and the featured videos on the "Categories" page. Examples are:

- Clicking on the Videos tab to browse the site: the links across the top give the user an idea of what other YouTube users find interesting and they can search further within each one using the time-related, category and honour-related links at the top and left to refine the list of videos. There is also the "Spotlight" feature to show users what YouTube thinks is interesting, based on access patterns.
- When a user finds other members whose videos he like, he can subscribe to them so that he will be notified whenever they upload new videos—the newest four will show up on the home page when he signs in.

¹³ <http://www.picsearch.com/>

¹⁴ <http://www.youtube.com/>

5.3.2.5 Other Video Search Platforms

AOL Video¹⁵: AOL provides access to 'millions of free, high quality videos including music videos, news clips, movie trailers, viral videos, and full-length TV shows'. The videos it is said are provided from a wide range of sources including AOL, Yahoo!, Google, YouTube, My Space, Veoh, ABC, CBS, NBC, CNN, ESPN, MSN, Crackle, iFilm, Stupid Videos, MTV, Comedy Central, VH1 and Walt Disney. The video search function is powered by Truveo which is a subsidiary of AOL. While users are only able to use a basic search they are able to browse content by categories which include 'most viewed' and 'highest rated'.

Blinkx¹⁶: Blinks uses speech recognition and video analysis software to search and qualify online video. Users can search for content, create video play lists and build resources for Web 2.0 applications. Blinkx hold over 18 million hours of video which is indexed and fully searchable. The video content is uploaded onto the Blinkx site by a wide range of providers including BBC, HBO and MTV.

Blinkx offers both basic and advanced search options. The basic search option is located on the home page. From there the user is also able to browse a number of selected videos from a number of genres. The user can browse video content from such areas as world news, entertainment, business and sport. The advanced search option offers searching using Boolean logic. The user is also able to choose between the results being returned on the basis of relevance or date. The type of media searched can also be selected and the range of content providers searched can be controlled. The site offers a safe search facility which can be turned on or off. Safe search helps to prevent unsuitable results being returned.

Ask.com¹⁷: Ask.com uses Web crawlers to collect data and information about a range of resources that it then indexes. Ask endeavours to provide a service that complies with service industry standards.

Video searching does not provide an advanced search option. The user is able to filter returns by clicking suggested search terms that are provided by Ask video. Further filtering can be done on duration of the video and its file type.

Google Video¹⁸: Google Video contains millions of indexed videos. The index is comprised of videos which have been added by people uploading content onto YouTube and Google Video. Videos can also be uploaded to the index from third party sites.

Both basic and advanced search options are available. A basic search can include all videos in the index or it can be limited to those videos that are hosted by Google. An advanced video search allows for Boolean logic. Searches can also be filtered on language, duration of videos and domain. The user can also choose how the returns are sorted (by relevance, rating, number of views, title or date) and set the amount of results per page (from 10 to 100). Users can also access a preference section and can set the language they wish to use during the session, limit the range of languages that are searched and place a filter on any searches that will exclude adult material.

¹⁵ <http://video.aol.com/>

¹⁶ <http://www.blinkx.com/>

¹⁷ <http://www.ask.com/>

¹⁸ <http://video.google.com/>

Live Search¹⁹: Formally MSN Search, Live Search is Microsoft's search engine and can be accessed via Microsoft's Live.com or MSN.com. While the search returns come from a wide variety of sources including BBC news, The Canadian Encyclopedia and Iowa Public Television, the majority of video clips included in the returns were provided by You Tube and My Space.

The engine provides an advanced search facility. Searchers are able to use Boolean logic to refine searches, to include or exclude particular sites or domains, to search within stated links and to search websites from particular countries using particular languages.

6 Conclusions

In this document we discussed relevant standards and technology trends for the main fields of work in SEMEDIA where standards provide the base for interoperability between applications and tools from different researchers, developers and manufacturers. Where applicable SEMEDIA partners made use of such standards. MPEG-7 has been used for the metadata representation in the SEMEDIA framework, Web services and the SOAP and REST protocols are used for the interfacing between server and client applications and multiple Web2.0 technologies like the FLEX framework have been used for the generation of client applications.

Spycer is still the only product in the postproduction market that supports all major operating systems, file systems and storage architectures. It provides all necessary functionality to manage assets on the file level basis. The new Web service interface will allow also the interfacing with higher-level asset and workflow management systems to form integrated management platforms.

Today's media asset management systems for the broadcast market provide most of the basic features needed but must incorporate many more in the future to fully satisfy all user needs. Especially automation of the annotation process will be a key feature once it is technically achievable.

The Internet is an entity which is subject to innovation and change. Change is happening rapidly. The desire to search for and use images and moving image content will no doubt increase in the coming years. It is probable therefore that the use of search engines to find suitable content will as a result also rise. Anything then, that enables the user to have more control over their image searching is helpful. While pure search engines might provide comparable results, media collections in social networks have an added value. Platforms that manage to offer interesting services will continue to lead the market.

Media mining technologies based on the analysis of essence like face detection or speech recognition start to appear in search engines. The added value will probably be limited as long as the semantic gap limits results to low-level features like colour and shapes, and on the other hand tagging by voluntary users is able to provide the high-level information actually needed.

¹⁹ <http://www.live.com/>