The Interactive-Music Network

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Abstract:
This document reports the description and motivation of the cases and related functionalities that are significant and should be coped to bring musing coding in the multimedia interactive age. For each aspects an analysis of the present technology is provided just to put in the context the discussions and to give the evidence of the relationships of what is missing with respect what is needed.

Keyword List:
Music, multimedia, infotainment, edutainment, music notation, standards, music libraries, optical music recognition, music distribution, protection, accessibility, music creation, education, music archives, music publishing, digital rights management, asset management.

Table of Content

1 Executive Summary and Report Scope

According to the Technical Annex of MUSICNETWORK project, this deliverable contains descriptions and motivation of the cases and related functionalities that are significant and should be coped to bring music coding in the multimedia interactive age. They can be examples taken from the market or from research centers or published on the web to show the problems in detail. Detailed state of the art will be produced as the next deliverable as planned in the technical annex.

This document and the enclosed analysis will be used as a starting and reference point to assess the effect of MUSICNETWORK in the European Environment and thus to measure id the activities performed will create some improvements in reducing the gap from content industries and technology providers to push them closer to the needs of the end users and thus to the market and to the content exploitation.

2 State of the art and its evolution

2.1 Music Notation Modeling and Standards (DSI, IRCAM)

The modelling of music notation is a complex problem. Music notation is a multi-layered piece of information, which may be used for several different purposes: from audio coding and entertainment to music sheet production, music teaching, content query, etc. In the current Multimedia and Communication age many new music-related applications are strongly attracting the market attention and most of them will become more and more widespread in a short time. In order to identify a unique notation format to satisfy all these application fields and to set the basis for the new forthcoming applications, several aspects have to be considered, ranging from information modelling and format to integration and synchronisation of the music notation information into other media and cross-media tools and formats.

The problem to be addressed are the integration of music and musical knowledge, in its visual, audio and logic formal domains - particularly scores – into multimedia applications. This integration permits the construction of a number of interesting new applications for musical activities, such as: multimedia music distribution, music education and music courseware construction, music searching in all domains, music annotation in all domains, music editing, music formatting of visual domain, music navigation in all domains, music formatting and presentation in other representations: Music Braille, Spoken Music, etc.

The present models for music notation are unsuitable to cope with innovative multimedia music applications. Also the MPEG standards have only a marginal capability of modelling that content and supporting the innovative features and requirements.
The adoption of MPEG-7 for modelling music notation leads in principle to the production of a music notation description, not to something that can be “executed” for creating a visual representation or for resyntesizing, producing and playing back audio, or for creating interactive multimedia music courseware. For all these purposes, the extension of MPEG-4 for modelling and integrating music notation seems to be a feasible and interesting possibility.
To summarize, on one hand there exists, among the requested functionalities, also the need to make composite queries. They are more related to the descriptors of MPEG-7. On the other hand, MPEG-4 seems to be more suitable for many aspects, since in the identified applications the music notation is mainly a content item that can be decoded for producing audio, representations (parts, main scores, etc.) and with which the user may interact to change these representations.

Several solutions have been analysed and the most promising are briefly described in this document.
To this purpose, we are asking for an extension to MPEG to include the music notation modelling. As MUSICNETWORK we have the capability and the duty (according to the contract with the European Commission) to work in that direction and thus of:

- Analyse the present technologies and highlight eventual problems and bet practices
- Find and review of innovative solution for multimedia music modelling to bring music industries in the interactive multimedia age.
- Launching calls for technologies and their corresponding evaluation and integration in a commonly agree format.
- Presenting and distributing the results of the above points to the whole contributors and market.

2.1.1 Detailed State of the Art

At the current state, there is a lack of unified models to represent in a uniform manner the four domains of music notation. Some of the available languages and models are capable only to represent the audio aspects with marginal coverage of logical (CSOUND), other represent very well the logical aspects (MUSICXML, WEDELMUSIC, FINALE, etc.) with marginal coverage of audio, etc. There is actually no solution to describe music in a comprehensive way. An attempt has being made to define a Standard Music Description Language in ISO/IEC JTC1 SC34 (editors Steve R. Newcomb, W. Eliot Kimber), but this attempt did not succeed [6] (now that project has been totally stopped and deleted), see also NIFF created as an interchange format, etc. These issues are discussed in deep in [8] in which a quite large comparison is reported considering several aspects for the innovation of music notation models. In addition, in all models the visual and graphical representations are mainly performed on the visualisation tools and is not formalised.

Some solutions also exist to encode musical performance, like MIDI, or to specify generation of audio, or sound synthesis, like MPEG SA. In these encoding schemes, there are no elements related to a number of musical concepts, like measure, beam, articulations…

The most comprehensive coded language in regular use for representing sound is the common musical notation (CMN) of the Western world. Western musical notation is a system of symbols that is relatively, but not completely, self-consistent and relatively stable but still, like music itself, evolving. It is an open-ended system that has survived over time partly because of its flexibility and extensibility [1]. Most alternative music notation representations aimed are also based on Western Music Notation, such as Braille Music and Talking Music [12].

2.1.2 MIDI

The establishment of the Musical Instrument Digital Interface (MIDI) gave easy access to tools for musical sound to home users, hobbyists, and millions of ordinary musicians. These users established a new constituency who could experiment with sound control in ways that previously had been possible only in research studios. MIDI is now the most prevalent representation of music, but what it represents is based on hardware control protocols for sound synthesis. Programs that support sound input for graphical and visual output necessarily must span a gamut of representational categories. Complex algorithms must be developed to generate a Common Music Notation score from MIDI representation, with complex issues [2]. The reverse process, generation of MIDI from Common Music Notation is generally considered as straightforward. MIDI is presently strongly used as an interchange format and for MIDI tools synchronization.

2.1.3 MPEG-4 Structured Audio and BIFS

In addition, the presence of music notation in many contexts is needed to state relationships among other media and to realise educational content. This is a very important aspect that presently is under represented in MPEG-4. MPEG-4 Structured Audio [5] specifies sound not as sampled data, but as a computer program that generates audio when it is executed. In MPEG-4 syntaxes for SASL (Structured Audio Score Language) and SAOL (Structured Audio Orchestra Language) have been defined to describe the logic and audio aspects. MPEG SASL is a more powerful language than MIDI for control of sounds and computer applications, but SA as a whole is suffering at present of a lack of applications.

Software tools capable to generate MIDI from a musical – and graphical – representation of a score, have contributed in the past to the great success of MIDI. In the same manner, a system which can be able to generate MPEG SASL from a graphical representation (acting as a MPEG SA sequencer) would be of interest for the success of MPEG SA.

Presently the SASL is capable to cover rather incompletely the logical aspects of music notation. It fails in representing: measures, clefs, change of clefs along the measure, dynamics, crescendo, decrescendo, expressions, etc. (some of these aspects are in fact possible, but require subtle matching between the SAOL instrument code and control statements in SASL). Some of these are represented in a way that makes their use for creating a visual representation impossible since multiple representations could be possible. The SAOL is functional to the description of the audio aspect of music and in this sense it covers, like its ancestor CSOUND, most of the needs.

The visual and semantic aspects of music notation according to the above reported terminology are not represented at all in MPEG-4. The graphical aspects are those that specify how the music notation elements are drawn according to the visual information and directives -- i.e., a synchronisation among different media is required. In this case, MPEG-4 could use XMT (and SVG) or BIFS for this purpose. Probably an integration with the management of custom music fonts is needed. This also applies for the generation of Braille Music scores. Braille Fonts are required but more importantly, the logic to come up with well-formed Braille Music syntax.

2.1.4 MPEG-7 MelodyDS

As stated in the MPEG-7 Applications requirements document [7], much of the musical industry is currently driven by people wishing to practice in their own homes. In addition to the applications listed in the MPEG-7 requirements, a number of home musical practices are to be considered in a complete multimedia framework. In MPEG-7 a

Melody Description Scheme associated to an audio content is defined. This description scheme allows the representation of a melody as a sequence of notes/rests or as a melodic contour. However this description scheme is focused on information retrieval and audio indexing and the music notation supported is poor, all the expression symbols (slur, staccato, tenuto, etc.) are missing and any visual information (stem direction, beams, note head, …) is missing. The melody description in MPEG-7 is less focused than the SASL in representing the logical aspects of the music notation. Limits are also present in describing in a uniform manner main score and parts, etc.

The adoption of MPEG-7 for modelling music notation leads in principle to the production of a music notation description, not to something that can be "executed" for creating a visual representation or for resyntesizing, producing and playing back audio, or for creating interactive multimedia music courseware.

2.1.5 XML-based Common Music Notation solutions

Some attempts have already been made to formalise Common Music Notation, CMN, in XML, like

- MusicXML (mainly designed as an interchange format) [3], or
- WEDELMUSIC (XML based format, mainly designed for educational and computer fruition with multimedia integration) [4].

In addition, other solutions have also been taken into account by the MUSICNETWORK: MEI, OPENMUSIC, expressiveMIDI, NIFFML, etc. These solutions have not reached a wide agreement since they are not integrated in a general framework, and thus are suffering of lack of interoperability. A comparison can be recovered in [8].
All the above models and formats are capable of modelling only the logical parts and partially the visual aspects. For the graphical aspects they use fonts or direct graphic primitives. Presently, in the MUSICNETWORK there is the aim of integrating WEDELMUSIC, SMDL, NIFF, MEI, and many other XML and not-XML music notation formats in a unique format for modelling logic and visual aspects by using SVG.

2.2 Music Libraries and archives (MICA)

2.2.1 State of the art

Libraries have important functions within the society: they accumulate and preserve knowledge, provide access to the society's cultural artifacts, and foster communication, education and scholarship. Music libraries, archives, documentation and information centers etc. play a crucial role in the field of music: They preserve manifestations of music, make them accessible, produce large amounts of metadata of high quality and thus make it possible to retrieve music and music-related information far beyond the typically rather short life-cycles within the music industry. Libraries have a long tradition of "producing metadata" (cataloguing etc.) and "making accessible" (bibliography, lending, inter-library loan, research etc.). In order to keep the large amount of metadata generated by music libraries worldwide interoperable, there are many rules, standards etc. being maintained and developed for a long time within regional, national and international networks, umbrella organizations and communities.

2.2.1.1 Characteristics of music libraries

- They use one of the biggest **varieties of media** within the library world
- They can use **connections between the different media**
- They produce a **great amount of metadata** within the music world
- They have specifical, highly complex **cataloging/indexing** rules
- They depend upon a developed **infrastructure for identification and classification**
- They are mostly **integrated**: Often part of a library, orchestra, TV/broadcasting agency, university, ...

2.2.1.2 Main types and use of music libraries

- Public libraries: Fast circulation of holdings
- Scientific libraries: Access to paid databases, manuscripts, ...
- Orchestra + Broadcasting archives: Enabling productions
- Libraries in educational institutions: Service providers for education
- Documentation/Information Centers: Promotion, publishing, ...
- Museums, ...

2.2.1.3 Main tasks of music libraries

The following identification of the main areas of activity of music libraries has been developed and iterated within the working group. It forms the basis for the monitoring and assessment of existing standards, rules and technologies.

A Acquisition

(1) Evaluation/selection/curating

(2) Acquisition
(3) Serials and service subscriptions

B Information management
(4) Identification
(5) Cataloging (metadata: extracting/generating catalog entries)
(6) Catalogue format requirements (metadata: structuring catalog entries)
(7) Classification (metadata extraction/generation: keywords, thesaurus, ontologies, ...)
(8) Search and retrieval
(9) Exchange of information (network catalogues, virtual catalogs etc.)

C Circulation ("Distribution", "Asset Management")
(10) Reserves
(11) Paging/placing
(12) Loan
(13) Interlibrary Loan

D Preservation (physical)
(14) Restoration
(15) Storage

E Digitization
(16) Coding
(17) OMR
(18) Digital preservation
(19) Storage

F Presentation and marketing
(20) Physical presentation
(21) Events (exhibitions, concerts, ...)
(22) Online services (directories, portals, "virtual libraries")
(23) On-demand services (score printing etc.)
(24) Reviews and introductions
(25) Services for patrons/consulting
(26) Information center services
(27) Publications

G Management
(28) Licensing/Copyright
(29) Workflow management
(30) Project management
(31) Staff development
(32) Finance, controlling and administration
(33) Patrons' management ("customers database", „CRM")

2.2.2 Overview of existing standards, rules and technologies (to be completed)

2.2.2.1 Acquisitions (A)

- BISAC
- ANSI X12
- EDIFACT
- EAN

2.2.2.2 Identifier (B4)

- ISBN International Standard Book Number
- ISSN International Standard Serial Number
- LCCN Library of Congress Control Number
- SICI Serials Item and Contribution Identifier
- ISMN International Standard Music Number
- ISWC International Standard Work Code
- ISRC International Standard Recording Code

- GRId Global Release Identifier
- DOI Digital Object Identifier
- SAN (Standard Address Number)
- OpenURL
- URN Uniform Resource Name
- Authority files (national)
- "Standalone identifier" (collection-specific)

2.2.2.3 Cataloguing (B5)

- AACR2 (Anglo-American Catalogue Rules)
- RAK (Regeln zur alphabetischen Katalogisierung)
- METS (Metadata Encoding and Transmission Standard)

2.2.2.4 Catalog format requirements (B6)

- MARC format for bibliographic data (MARC 21, USMARC, UNIMARC, ...)
- MARC formats for: authority data, holdings data, community resource data, ...
- MAB (Maschinelles Austauschformat für Bibliotheken)
- EAD (Encodced Archival Description)
- FRBR (Functional Requirements for Bibliographic Records)
- ISBD (International Standard bibliographic description)

2.2.2.5 Classification (B7)

- Library of Congress Classification System
- Dewey Decimal Classification
- SND (Schlagwortnormdatei)
- "Standalone classification" (collection-specific)

2.2.2.6 Search and retrieval / Exchange of information (B8/B9)

- TCP/IP
- XML
- Z39.50
- Bath profile
- US National Z39.50 profile
- Dublin Core
- MPEG-7
- EDI (Electronic Data Interchange)
- P/META
- ONIX (Online Information eXchange)

2.2.2.7 Circulation (C)

- 3M SIP
- 3M SIP2
- Z39.83 NICP (NISO Circulation Interchange Protocol)
- MPEG21 (?)
- SMEF (Standard Media Exchange Framework)

2.2.2.8 Interlibrary Loan (C12)

- NCIP
- ISO ILL

2.2.2.9 User authentication (G33)

- LDAP (Lightweight Directory Access Protocol)
- Social Insurance Numbers (national)
- Credit cards

Licensing / Copyright / Royalties

- cf. further standards etc. of broadcasters, producers, collecting societies

Trade / Retail / Publishers / Producers

- cf. ordering numbers, distributors (Phononet, VLB, Books in print)

2.2.3 Existing standards, rules and technologies

2.2.3.1 Cataloguing and catalogue format requirements (B5/B6)

AACR/AACR2
The AACR2 (Anglo-American Cataloguing Rules, 2nd ed., 1998 revision, with Amendments 1999 and 2001) are the cataloguing rules prevailing in Anglo-American countries. They are "designed for use in the construction of catalogues and other lists in general libraries of all sizes. […] The rules cover the description of, and the provision of access points for, all library materials commonly collected at the present time." [Rule 0.1].
http://www.nlc-bnc.ca/jsc/index.html

CIP (Cataloguing in Publication) is a voluntary cooperative venture between publishers and libraries which enables books to be catalogued before they are published. This pre-publication cataloguing information is then distributed widely to booksellers and libraries, giving them advance information so that they can select, buy and process new books. The distinguishing feature of Cataloguing in Publication is that the catalogue record is created and disseminated prior to publication and is printed in the book itself. The CIP program is coordinated by the National Library of Canada and is operated through a network of agent libraries across the country that provide CIP services to the publishers in their respective areas.

DC/DCMES
Dublin Core (DC) metadata is used to supplement existing methods for searching and indexing Web-based metadata, regardless of whether the corresponding resource is an electronic document or a "real" physical object. The Dublin Core Metadata Element Set (DCMES) was the first metadata standard deliverable out of the DCMI (IETF RFC 2413). DCMES provides a semantic vocabulary for describing the "core" information properties, such as "Description" and "Creator" and "Date". It is a set of 15 descriptive semantic definitions. It represents a core set of elements likely to be useful across a broad range of vertical industries and disciplines of study. The Dublin Core Metadata Element Set was created to provide a core set of elements that could be shared across disciplines or within any type of organization needing to organize and classify information.
http://dublincore.org

EAD
The EAD (Encoded Archival Description) DTD (Document Type Definition) is a standard for encoding archival finding aids using the Standard Generalized Markup Language (SGML). The standard is maintained in the Network Development and MARC Standards Office of the Library of Congress in partnership with the Society of American Archivists.
http://lcweb.loc.gov/ead/

ISBD
The ISBD (International Standard bibliographic description) developed by the International Federation of Library Associations and Institutions standardizes the descriptive portion of catalogue and bibliographical records produced in different countries; it prescribes the elements constituting the description, their order, and the punctuation between them.

MAB
MAB (Maschinelles Austauschformat für Bibliotheken) is a cataloguing format alternative to MARC, prevailing in German speaking libraries. MAB corresponds to the RAK – Regeln zur alphabetischen Katalogisierung cataloguing rules.

MARC
The MARC (Machine-Readable Cataloging) formats are standards for the representation and communication of bibliographic and related information in machine-readable form. It has several variations and subdivisions (e.g., USMARC, UNIMARC).

METS
The METS (Metadata Encoding and Transmission Standard) schema is a new standard (2002) for encoding descriptive, administrative, and structural metadata regarding objects within a digital library, expressed using the XML schema language of the W3C. The standard is maintained in the Network Development and MARC Standards Office of the Library of Congress, and is being developed as an initiative of the Digital Library Federation.
http://www.loc.gov/standards/mets

ONIX (Online Information eXchange) is a standard format that publishers can use to distribute electronic information about their books to wholesale, e-tail and retail booksellers, other publishers, and anyone else involved in the sale of books. It aims to standardize the transmitting of product information so that wholesalers, retailers and others in the supply chain will all be able to accept information that is transferred electronically in ONIX International format.
http://www.bisg.org/onix_faq.htm

RAK (Regeln zur alphabetischen Katalogisierung) are the cataloguing rules prevailing in German-speaking countries. There is a special subset of rules for the cataloguing of music (RAK-Musik), last revision 2003.

UNIMARC
The primary purpose of UNIMARC is to facilitate the international exchange of bibliographic data in machine-readable form between national bibliographic agencies. UNIMARC may also be used as a model for the development of new machine-readable bibliographic formats. The scope of UNIMARC is to specify the content designators (tags, indicators and subfield codes) to be assigned to bibliographic records in machine-readable form and to specify the logical and physical format of the records. It covers monographs, serials, cartographic materials, music, sound recordings, graphics, projected and video materials, rare books and electronic resources. (*UNIMARC Manual*: Bibliographic Format)

Z39.50
The standard specifies a client/server-based protocol for searching and retrieving information from remote databases. "Z39.50" refers to the International Standard, ISO 23950: "Information Retrieval (Z39.50): Application Service Definition and Protocol Specification", and to ANSI/NISO Z39.50. The Library of Congress is the Maintenance Agency and Registration Authority for both standards, which are technically identical (though with minor editorial differences). Z39.50 is supported by widespread library software applications such as ALEPH/ALEPH 500 and DABIS.
http://www.loc.gov/z3950/agency

2.2.3.2 Identifier (B4)

ISBN, called frequently BID
The ISBN (International Standard Book Number) is a machine-readable identification number, which marks any book unmistakably. In the past 30 years the ISBN has become a basic standard of the international book-trade. 159 countries and territories are officially ISBN members.
http://www.isbn.org
http://www.isbn.spk-berlin.de

ISMN
The ISMN (International Standard Music Number) is a unique number for the identification of all printed music publications from all over the world, whether available for sale, hire or gratis; whether a part, a score, or an element in a multi-media kit. The ISMN is designed to rationalize the processing and handling of printed music and the respective bibliographical data for publishing houses, the music trade and libraries. It is based on ISO 10975.
http://www.ismn.spk-berlin.de

ISRC
The ISRC (International Standard Recording Code, ISO 3901) is an international standard code for the unique identification of sound recordings and music video recordings. An ISRC identifies a recording throughout its life and is intended for use by producers of recordings as well as by copyright organizations, broadcasting organizations, media libraries and archives, etc. Each ISRC can be permanently encoded into a product as its digital fingerprint. Encoded ISRC provide the means to automatically identify recordings for royalty payments.
http://www.ifpi.org/isrc
http://www.riaa.org/Audio-Standards-3.cfm

ISSN
The ISSN (International Standard Serial Number) is a code used on catalogues, databases or commercial transactions each time serial publications are involved.
http://www.issn.org

ISWC
The ISWC (International Standard Work Code)

SAN (Standard Address Number) is a unique seven-digit identifier used to signify a specific address of an organization in (or served by) the publishing industry. It is an American National Standard, ANSI/NISO Z39.43-1993.
http://www.isbn.org/standards/home/isbn/us/san

2.2.3.3 Search and retrieval / Exchange of information (B8/B9)

EDI
EDI (Electronic Data Interchange) is a proprietary commercial standard providing a collection of standard message formats and element dictionary in a simple way for the exchange of business information via any electronic messaging service. It is relevant mainly for data exchange between producers/publishers and traders. Phononet and large parts of the book trading area are using EDI.

P/META
P/META is an 1999 EBU initiative for Metadata exchange standards, aiming to establish understanding between EBU members of the media-related data interchange requirements of media commissioner/publishers (broadcasters), suppliers (producers) and consumers, using the BBC Standard Media Exchange Framework (SMEF) as the core information architecture.
http://www.ebu.ch/pmc_meta.html

2.2.3.4 Circulation/Digital asset management

MPEG21
Multimedia Framework to enable transparent and augmented use of multimedia resources. The fifth standard by MPEG, commenced in 1999, creates a sort of general environment for users (including companies etc.) interacting with digital items. It makes use of the earlier MPEG resource standards (mainly MPEG2, MPEG4), the metadata standard MPEG7, and adds a number of new aspects like registration etc. It aims at an an open framework for multimedia delivery and consumption, with both the content creator and content consumer as focal points. It aims at applications for digital libraries, asset management, CIP, publishing, broadcasting, trade, music/video releases, etc.
http://mpeg.telecomitalialab.com/standards/mpeg-21/mpeg-21.htm

SMEF
The Standard Media Exchange Framework (SMEF, GB) has been designed by the BBC to support and enable media asset management ("MAM") as an end-to-end process across its business areas, from commissioning to delivery to the home. One aspect of this is the SMEF Data Model (SMEF-DM) consisting of a set of metadata definitions for the information required in production, distribution and management of media assets, currently expressed as a data dictionary and set of Entity Relationship Diagrams. SMEF is the subject of a patent application, but the SMEF Data Model is being made available to enquirers without charge, subject to a no-signature licence.
http://www.bbc.co.uk/guidelines/smef

WEDELMUSIC
See next section for a description. .

Other tools are: OntoPrise/OntoBroker, Verity Ultraseek, ALEPH/ALEPH 500, CLASSICAL, DABIS

2.2.3.5 Applications/Products/Services

FESAD
Fernseharchivdatenbank, proprietary TV archival database used by German TV stations within the ARD (HR, SWR). After the modernisation (2001/2002) it comprises multimedia files as well as rights management information. (Compliant to DC?)
http://www.irt.de/IRT/veranstaltungen/cms-pdfs/cms-Emmel.PDF

Phononet
Proprietary cataloguing software (PNStamm) connected to IFPI International Federation of the Phonographic Industry (programmed by DE-Parcon/Germany). Phononet is mainly a Business-to-business service (B2), providing order clearing, a search engine for recordings. It is connected to the end-user format MID (Music Info Disk) which is used to publish label catalogues on CD-Rom, etc. Phononet connects more than 100 record producers with more than 600 record traders (2000 outlets) in Germany alone, adding more in Austria and Switzerland.
http://phononet.de

http://phononet.at
http://www.phononet.ch
http://www.de-parcon.de

WEDELMUSIC
Complete tools for management of multimedia music archive supporting: Content Mangement system, distribution of content in B2B and B2C, protection, content sharing among archives, regis tration of clients and personalization of interface. The products has been built by using PHP and MySQL for the local distribution into the archive, thus it is fully customizable. www.wedelmusic.org. the Viewer is presently distributed for free.

Other tools are: OntoPrise/OntoBroker, Verity Ultraseek, ALEPH/ALEPH 500, CLASSICAL, DABIS

2.3 Music and accessibility problems (FNB, ARCA)

2.3.1 State of the art

Music consumption is about interaction with music notation. Most accessibility problems arise when consumers loose their capabilities or don't have the capablitites to interact with the content as it is currently provided. End users typically associated with accessible music are sighted or partially sighted users, but also people with dyslexia. Not only the consumption of music is affected by these special requirements, but also the production process has to be adapted. There is a need to enhance both parts of the accessible music problem domain.

Producing enhanced music notation is a laborious activity. The production of these enhancements requires expertise and resources retrieved from all the use-cases described above. Additional expertise is required to combine all the issues mentioned above in a workable and practical set of resources and operations, enabling the translation from the 'normal' domain to the 'accessibility' domain. Incorporation of these accessibility notions into a widely used multimedia representation format would enable:

- Enhanced browsing experience with specialised functionality for specialised assistive needs.
- Synchronising deliverance of new content available in such a format for vision impaired users and seeing users.
- The ability of customisation of the actual presentation of the musical content to the needs of the individual visually impaired user.
- Enhanced browsing and visualisation experience for users with problems in understanding complexity of musical information and the ability of it's customisation.
- Additional educational use through preserving this specific knowledge, expertise and resources in the format to cultivate the notion of accessibility of musical information.

The blind and visually impaired are the two main categories of users of music in conventional or coded IT form requiring a further transformation for access.
IT provides the visually impaired with systems for easier reading, i.e. via a PC monitor with simple controls, so that music can be written rather as in most other cases.

Alternative ways for representing music include the following formats:
1) Music coded to be used with 6-dot Braille
2) Enlargement
3) Spoken music

These three forms are used by the blind and visually impaired as follows:
.
1) Music in Braille format is able to represent all musical signs in a conventional musical score linear form. The signs which are conventionally in 2 dimensions (vertical and horizontal) are broken down and rebuilt in linear form.
2a) Enlarged music is a large print-out requiring a different lay-out and different page endings.
2b) Enlarged music may also be read on the computer monitor using an enlargement program (such as zoomtext or others on the market), or by exploiting the potential of MSWindows (or the more powerful XP version) broadening the image, or by exploiting musical editors which include enlargement features. Tools which read music directly from the computer must be studied in relation to the location of the monitor and the freedom to provide instructions. Recent programs (such as Wedelmusic) have been able to read musical scores directly, as they are deployed.
3) Spoken music is useful when:
   a. a blind musician is playing music, for example, the piano. The reproduction of the music properly recorded is a mnemonic device for the player, who generally knows the score already.

b. blind musicians do not know Braille for any reason. This may be because the person became blind as an adult and does not have sufficient tactile sensitivity to read Braille, or he/she may prefer voice synthesis to read texts or music. Spoken music is an alternative to written music.

2.3.1.1 Music management programs in Braille format

The IT industry has shown little interest in the Braille format of music. The few European and American products were created with public funding. The industry is well aware of the low market potential. The experience of those who have worked on publicly funded projects (as emerged from the Madrid conference) is that the final prices to consumers are extremely high and other producers and developers are needed to keep the prices down and make a compact market. The slow spread of the international Braille standard does not help the growth of the market.

The main products which exist are reported in the following.

2.3.1.2 **BMK**

The package includes two BME products and the Final plug-in

BME is an already marketed music editor and the only one in the world which allows blind musicians to write music in Braille according to the rules of the international manual of Braille music signs, to recognise written music, to listen to it, to manipulate texts by extrapolating voices and parts, to transport texts, page, print and convert them towards such commercial formats used by music editors for sighted musicians and, finally, to import music scores as written through graphical music editors used by sighted musicians. BME has proved to be a very effective tool for blind musicians, whether students and amateurs or professionals. It has been reporting successful results in terms of sales and usage in Europe and America as well. BME was so developed as to allow to adopt plug-ins of third parts to add further functions and program features. The package also includes a Final plug-in which is included in the final program for conversion from Final to Braille and vice versa.

2.3.1.3 Toccata

A programme created by Optek Systems, and consisting in a graphic music editor, that automatically converting the music text written in Braille format.

Unfortunately, this product is addressed to normally sighted people and not usable by blind people and, moreover, does not carry out any recognition work on the music text written in Braille. In so making, it converts the graphic format into Braille, but it doesn't recognise the Braille format, that is music elements of the Braille format. It costs US$795

2.3.1.4 OPOpusDots Lite

Opus Technologies from San Diego, California, has created the OPOpusDots Lite, a programme able to translate a single music line from black into Braille, for instance for single instruments, such as flute and clarinet. In this context we have conversion from black into Braille as well.

2.3.1.5 Goodfeel

Here we are with another American product that was originated by Dancing dots company.

It translates music from NIFF code into Braille format. Unfortunately, the NIFF code is no longer developed or updated. However, some commercial products exist, such as Sharp Eye and OMR (optical Music Recognition) saving the text in NIFF. The program is therefore useful in conjunction with Sharp Eye.

Unfortunately, not even Goodfeel can recognise Braille music texts. Therefore, it does not allow to manipulate, listen to or modify texts.

Vadim Bakhmetiev (ElecGeste, Moscow, RU) has created a prototype allowing musicians to insert musical signs from an editor via various menus. The product speeds up the input of complex signs. The editor is compatible with various existing screen readers and with voice synthesis and presents a valid Braille text representation on the screen which can be interpreted by a sighted musician, since an ingenious font is used to help interpret Braille characters.

2.3.1.6 BrailleMusic Producer and TalkingMusic Producer

FNB produced a production environment that is used to produce Braille Music translations of music scores. The Braille Music translation is compatible with the rules of the international manual of Braille music signs and has a extensible symbol and rule base. The environment is accessible from the Finale programme and is installed as a Plugin. The same environment can be used to translate scores into TalkingMusic (formally known as SpokenMusic). TalkingMusic can be produced in various audio structure formats, including DAISY, Text, AIFF, WAVE and can be

exported to CD-R/W, DVD or Harddisk locations. Using the accessible music production environment organisations (and eventually individuals) can produce music translations that can be consumed in all available DAISY talking book players. The production process and the logistics involved in this production process can be controlled. The accessible music production environment significantly enhances the accessible music production process.

2.3.1.7 Allegro Braille

ElecGeste (Moscow) have created a programme and a keyboard called Allegro which allows musicians to insert musical signs from an editor via various menus. The product speeds up the input of complex signs. The editor is compatible with various existing screen readers and with voice synthesis and presents a valid Braille text representation on the screen which can be interpreted by a sighted musician, since an ingenious font is used to help interpret Braille characters

2.3.1.8 Tocco Finale

A program developed by the Regina Margherita Library in Monza for the conversion of the ENIGMA code, i.e. the Final interchange code with Braille interpreted by ItalBRA. Sadly, development stopped at the Enigma version of Final 98. It is distributed free of charge.

2.3.1.9 Italbra

This program was created by CNR (the National Research Center) in Florence and is used by the Regina Margherita Library for processing and page lay-outs for musical scores, using a conventional editor. By using various markers it is possible to add line breaks for Braille printing. It is distributed free of charge.

2.4 Music Distribution and DRM (RIGEL)

Distribution of coded music and digital multimedia content in general addresses a wide set of topics, issues, problems and involves a large number of players with very different objectives and competencies. Distributing, selling or exchanging multimedia content involves aspects of different nature like content organization and management, content protection and delivering, licensing.
The work of the "Distribution" working group analyses ane focus on the following topics:

- **Business models:** main business models adopted, emerging and new business models for the market of distribution of multimedia content, from B2B to P2P.
- **Organization, management and retrieval of multimedia content**: formats and media that best suit the requirements and needs of this market, advantages and disadvantages in terms of
- **Legal framework**
- **Technologies for multimedia management and distribution systems:** there are currently several different multimedia management and distribution systems. These systems often are not compatible each other or easily interoperable. So content providers and distributors need support for selection of proper systems, according to their needs, dimension and business volume. Content management and distribution systems are considered in the framework of this Working Group also in relation to protection of multimedia content and digital right management.
- **Needs and requirements for the final users:** very important topic indeed is the quality of experience and fruition of end users, the customers, which will eventually validate the business model, the technology, the market.

Business-To-Business (B2B) models require complex systems and technologies. robust protection mechanisms to prevent unauthorised use and IPR violation , high level of security in online transactions. There is also a generalised lack of standards in data exchange protocols leading to reduced interoperability.
Business-To-Consumer (B2C) models require even more robust protection mechanisms and security in online transactions. Final users are generally reluctant to perform online payments and purchasing. From a financial point of view, there are two different, contrasting view on the possible approach and size of the B2C market for music, digital content and multimedia. The first one regards to B2C models as to scale-economy markets with low margin and requiring high capital and investments, where others see a bright future for smaller companies providing digital music content in high specialised niche markets.
Peer-to-Peer (P2P) models, finally, require attention as models becoming very rooted in the customers behaviour. They are simpler and less expensive to setup, even if they can show performance problems under heavy loads. P2P can involve a lot of protection issues because of the fact that it provides an easy and cheap tool for distributing content, often without proper rights clearing. However, this is also a great potential and in fact an opportunity for interesting and rewarding business models, when coupled with proper Digital Riths Management systems.

Organisational and content management issues concern basically the following aspects:

- digital archive creation: type of files to be included, audio and image formats to be preferred, technical limits, costs (system requirements, file dimensions), which kind of protection can be added
- selection of the proper set of metadata and management of identification and classification information
- legal aspects related to confidentiality and privacy of user data.
- market aspects related to the current and future customers demand
- information retrieval issues in coping with digital archives management, retrieval of digital media
- content accessibility: how both operators and final users can access to digital content. Operators must prepare multimedial objects to be distributed, final users must be able to enjoy these objects.

Organisational, management and distribution of multimedia content affects also the possibility of providing new services, like e-learning, infotainment, entertainment, tourism.

The current legal framework is at least confusing, even if evolving, with different national laws and lack of international laws on copyrights, and with different forces pushing in opposite directions. Form one hand, labels and publishers are asking for more support to protection technologies and more legal instruments to avoid and persecute unauthorised use and IPR infringement, while stressing continuous dropping in sales and pointing it to piracy. On the other hand, customers and final users are claiming for more flexibility concerning the usage of the digital content purchased while asking for lower prices.

End users' and customers' needs and requirements are the basis ofthe user centered approach followed by the Working Group, during the analysis, evaluation and organisational tasks. The impact on final user of usage restrictions, usage tracking and over-protection can enlarge the existing and growing gap between them and the content providers, publishers, the labels.

Nowadays, most of the problems related to the online distribution of coded music concern mainly security and IPR protection issues.
Protection issues concern both security of on-line transactions and content delivery and protection of intellectual property rights. In on-line market, the most common way of performing transactions is by mean of users' credit card number. Protection of the required data to carry out transactions is accomplished usually by encrypting them, for example with the 128 bit SSL protocol.
Transaction systems can require customs to insert their credit card number every time they want to perform a transaction, or only when they subscribes the service. In the latter case, there is no need for the credit card number to be sent via the Intenet for every transaction to be completed. However, the disadvantages is that this number is stored in the transaction system database.
Protection of intellectual property rights means protection of delivered content. This is the very delicate problem of the on-line market of coded music: how to ensure a correct (id est legal) use of musical content by the final users. This protection has to be accomplished both during the delivery of the content from the content owner system to the final user machine, both when it is stored in the purchaser computer. Therefore the system should fulfil at least the following guidelines:

- avoid intrusions into the server system through bugs and exploits of the server software;
- avoid intrusions into the server system through bugs and exploits of the Operating System and the Web Server;
- avoid intrusions into the network where the server system is located;
- provide a secure and protected way to perform transactions via the Internet;
- avoid illegal copies of the digital content;
- allow only authorized/selected operations on the music/multimedia object;
- keep control of the operations performed on the various objects downloaded.

The security matter must be faced even from the point of view of the hardware and software used to set-up the music distribution systems: in fact, it is useless to set up a secure music delivering system in a non-secure machine or environment. It could be worthwhile to define guidelines to establish when computer can be considered secure at a good level, specifying:

- which hardware components are suitable to work with music delivering applications;
- how to patch the operating systems (if there are known bugs which can threaten the security of the system) hosting the music delivering applications;
- how to patch the services (such as the web server) with known bugs which can threaten the security of the system.

The other important aspect to be considered is related to the perfomance of the system. The cost in terms of performance is formed by each step and operation involved in the content distributon, from the digitalisation to uploading in the server to downloading to remote clients. Generally, these step are:

- upload music files into the Server
- download music files to the final client machine

- open music files by the client

2.4.1 Detailed State of the Art

The market of digital music and multimedia content distribution can be structured according to the following categories of market players:

- Technology providers, software developers;
- Content owners, music publishers, music labels;
- Copyright collecting societies;
- Content providers and distributors;
- End users (musicians, musicologists, audiophiles, music amateurs…)

In general these categories can present overlapping, since, for instance, a technology provider can also play the role of music publisher. Examples are Liquid Music Network and Real Networks which provides both multimedia content distribution technologies (servers, systems and models) and music download services.

2.4.1.1 Technology providers, software developers

Technology providers are innovators, know-how and software developers providing technology transfers and/or tools for the management of multimedia content and related distribution and commercialisation in the net/digital world. Here is a list of the main technologies and the related provider entity (company, research centre, institution):

- **Adobe Content Server**: Adobe Content Server (http://www.adobe.com/products/contentserver/) from Adobe (www.adobe.com) is a system for publishers, libraries, enterprises, government agencies, retailers, and application service providers to produce, manage, distribute and protect eBooks and other digital content in Adobe Portable Document Format (PDF). It integrates preparation, procurement, distribution, fulfillment, and rights management of digital content.
- **Digital World Services ADo²RA System**: ADo²RA (http://www.dwsco.com/adora/index.html) from Digital World Services (www.dwsco.com) is a content independent digital distribution solution. It's a system that makes the creation, protection and distribution of digital content — text, music, software, games, and video — possible to access and enjoy from all mobile devices and methods.
- **DMDsecure DMDFusion**: DMDfusion (http://www.dmdsecure.com/products/dmdfusion/overview.php) from DMDsecure (www.dmdsecure.com) is a product consisting of flexible software components and applications including Digital Rights Management and Conditional Access technologies that manages the access, usage, protection and licensing of digital content. Central to DMDfusion is the concept of a separation of layers that each performs its own tasks.
- **element 5 e-sales**: e-sales (http://www.element5.com/index.html) is the element 5 (www.element5.com) solution to perform online sales of software through unique marketing campaigns to lower distribution costs, develop new international markets, increase customer loyalty and implement new licensing models. The element 5 Control Panel enables a complete overview of online activities and sales data, to adjust sales activities at any time to meet individual needs.
  element 5 e-sales offers order processing and all associated communications, in ten major languages. It supports local payment options for various countries, and all forms of payment commonly accepted across the globe including credit cards, checks, purchase orders, cash and bank transfers.
- **IBM Digital Media Factory**: IBM Digital Media Factory (DMF, http://www-1.ibm.com/industries/media/indseg/) is an open-technology framework comprised of e-business infrastructure that can help companies manage, store, protect and distribute digital video, audio and images.
- Digital media is unstructured content - video, audio and images not stored in traditional databases. The content can have intrinsic value, such as movies on demand, and business process value for managing large media files such as medical images and corporate media assets. Both uses require specially configured systems, including hardware, software and services to create the digital media, manage it efficiently and securely, distribute it and then process transactions.
  Digital media is being used in many ways across a range of industries - from retail kiosks, to government video surveillance, to wireless content distribution in the telecommunications industry.
  IBM products included in DMF are IntelliStation workstations, Electronic Media Management System, IBM Content Manager, DB2 Universal Database, WebSphere Commerce For Digital Media, IBM @.server, TotalStorage solutions and IBM Global Services.
- **InterTrust Rights|System**: Rights|System (http://www.intertrust.com/main/technology/index.html) technology from InterTrust (www.intertrust.com) provides tools to deliver digital content online. It supports any kind of content (music, videos, novels, articles, reports, images) and several business models (sales to subscriptions, membership clubs, pay-per-view, rentals, advertising). Rights|System technology also adapts to explore innovative new ways of generating revenue.
  InterTrust's Rights|System technology offers a large spectrum of distribution options, including downloading from the Internet or from a web site, streaming, CD or DVD burning, via wireless or cable links. Its DRM also

allows to forge new relationships with other members of the distribution chain, or DRM-enable the already existing relationships.

- **Liquid Audio Liquid Music Network**: The Liquid Music Network system (http://www.liquidaudio.com/services/distribution/lmn/index.asp) from Liquid Audio (www.liquidaudio.com) is based on two products for final users, the Player and the Secure Portable Player Platform (SP3), and a Server.
  Liquid Player for Windows enables streaming, downloading, purchasing, playback, ripping and CD burning of digital audio. Liquid Plug-Ins enable third party music players to access secure music in the Liquid Audio format.
  Liquid Audio's SP3 provides consumer electronics companies, chipset manufacturers and embedded operating systems developers with a digital music solution to get to market with digital audio devices. Combined with a custom-branded version of Liquid Player Plus software, SP3 enables the rapid development of secure digital audio devices that are compliant with the guidelines established using the Secure Digital Music Initiative (SDMI).
- **LockStream DRM Solution**: LockStream DRM Solution (http://www.lockstream.com/hi_band/index.htm) from LockStream (www.lockstream.com) includes a suite of products: Secure Package Creator Module, Secure Package Reader Module, License Generator Module, Media Manager and Deployer.
  The Secure Package Creator Module packages up digital media into Objects, encapsulating one or more pieces of digital content into LockStream's proprietary format. Then it creates a license template creating and registering DRM rules with the License Generator Module. Finally, it turns Objects into Protected Objects by associating DRM usage rules to them.
  The Secure Package Reader Module provides a set of component that developers can use to build LockStream DRM support into client applications on a multitude of client devices, platforms, and networks.
  The License Generator Module issues licenses based on the DRM rule set and to manage those licenses.
  The Media Manager is an executable file capable of interpreting LockStream's proprietary file formats, managing access to content encoded in the file formats, creating playlists for that content, rendering that content on computer desktops, and synchronizing the content on authorized mobile devices.
  The Deployer is an ActiveX control for browser integration that manages the download and installation of software for content playback, media files used within the Media Manager, licenses issued by the License Generator and other files.
- **Microsoft Windows Media 9**: Microsoft Windows Media 9, from Microsoft, (http://www.microsoft.com/windows/windowsmedia/9series/default.asp) is a suite of programs which form a complete platform for digital media distribution.
  The Windows Media Rights Manager includes both server and client software development kits (SDKs) that enable applications to protect and play back digital media files.
  Using the server SDK, developers can create applications that encrypt (package) digital media files and issue licenses for those digital media files. A packaged Windows Media file contains a version of the file that has been encrypted with a key so that only the person who has obtained a license for that file can play it. The license is separate from the packaged Windows Media file, which means that the content and license for that content can be acquired at different times. Encrypted files can be either streamed or downloaded to the consumer's computer.
  To enable digital media playback applications to play packaged Windows Media files, acquire licenses for them, back up and restore licenses, and issue security upgrades for its DRM component, developers should use the client SDK.
- **Microsoft Digital Asset Management**: Digital Asset Management (http://www.microsoft.com/windows/windowsmedia/mediaent/dam.asp) is the Microsoft (www.microsoft.com) technology to lower operating costs and increase productivity. The search and report system locates the assets, while Windows Media's DAM allows media companies to deliver encrypted Windows Media audio and video assets to any desktop.
  Windows DAM offers compression mechanism which enables asset owners to reduce bandwidth and storage costs. It allows digital distribution of video from low bit rate previews to full 720p high-definition resolutions.
- **NDS Synamedia**: Synamedia (http://www.nds.com/broadband/broadband.html) from NDS (www.nds.com) is the broadband operators' gateway to earning new video-based incremental revenues from broadband IP networks. It delivers a truly multi-service mix that lets distributors control, manage and personalize the way of providing content.
  NDS Synamedia allows broadband IP networks to offer interactive entertainment package and develop new business models around the following services: Secure digital broadcast TV, Video-On-Demand (VOD), Personal Video Recorder (PVR) functions, Pay-per-view and pay-per-use functions, Interactive applications.
- **RealNetworks Helix**: Helix (http://www.realnetworks.com/) from RealNetworks (www.realnetworks.com) is both a platform and community that enable creation of digital media products and applications for any format, operating system or device. The Helix platform combines extensive, proven digital software technology with a rich set of application interfaces. It empowers developers, information technology and consumer electronics companies to easily integrate digital media. The Helix community enables companies, institutions and

individual developers to license Helix DNA platform source code in order to build Helix-powered server and client products. RealNetworks has also released a family of products built on top of the Helix DNA platform, including the Helix Universal Server.

- **STARBAK Torrent Origin Streaming Appliance**: The Torrent Origin Streaming Appliance (OSA, http://www.starbak.com/products/origin_streaming_servers.html) from STARBAK (www.starbak.com) is a network appliance. A network appliance is a specialized device that is dedicated to performing one function very well. The Torrent OSA was specifically designed to stream media. Since it is not a normal multipurpose server, it is very easy to use.
  The Torrent OSA utilizes web-based administration. This means that it can be controlled from any computer that has a web browser. No special software needs to be installed. It can also be administered from any location on the network.
  The Torrent OSA streams all major streaming formats including Microsoft Windows Media, Apple QuickTime, MPEG-1 and MPEG-2. All formats can be streamed simultaneously from a single Torrent OSA.
- **WEDELMUSIC**: WEDELMUSIC (http://www.wedelmusic.org) is a complete system for distribution and sharing of interactive music via Internet totally respecting the publisher rights and protecting them from copyright violation. WEDELMUSIC allows publishers, archives and consumers (theatres, orchestras, music schools, libraries, music shops, musicians) to manage interactive music; that is, music that can be manipulated: arranged, transposed, modified, reformatted, printed, etc., respecting copyright. It is an innovative support for preparing performances, studying music, analysing music, learning instruments, distributing music at low cost, etc. The same music objects will be available for traditional media and Braille.
- **WebWare ActiveMedia**: ActiveMedia (http://www.webwarecorp.com/products_services_activemedia.html) software from WebWare (www.webwarecorp.com) provides a secure repository to manage, share, distribute, and publish rich media content, such as graphics, images, layouts, animation, video and documents. ActiveMedia is designed for wide-scale deployment and allows content sharing throughout global organizations among employees, partners, agencies, and distributors.
  WebWare ActiveMedia can be used as a stand-alone content management system or incorporated into an existing enterprise content management system (ECM) as the backend digital media repository. It can be implemented as installed software in-house or as an outsourced service.
- **KaZaA Media Desktop, WinMX, Morpheus**: KaZaA Media Desktop (www.kazaa.com), WinMX (www.winmx.com) and Morpheus (http://start.musiccity.com/m20/index.html) use peer-to-peer technology. This means that individual users connect to each other directly, without need for a central point of management. Users can choose which files he wants to share and how many files are allowed to be downloaded by other users at any one time. All these programs allows users to search and download the shared files. All items shared on the user network may be categorized by attributes such as category, author, description, language, etc.

2.4.1.2 Content owners, music publishers, music labels

In the present reports the generic term “content owners” refers to music and multimedia authors, music publishers and labels. Music authors are usually represented by their labels, major labels or independent one, or in some (rare) cases, they might directly distribute their own music. There is an unexplored space of the market, at this moment, however: new authors of multimedia content in various format.
In the following, there is a list of the major music publishers and labels:

- **Sony** (www.sony.com): The SonyMusic website contains a section, called Digital Dowloads, with three links to different websites (Bolt, MTV and VH1) selling Sony Music downloads (albums, tracks or multi-tracks) in ATRAC3, MP3, SAF or WMA format. Sony has developed ATRAC3 (Adaptive Transform Acoustic Coding), a sound compression technology. Sony states this technology can reduce the size of a Compact Disc audio track to 1/10 of its original size, with virtually no loss in audible quality. ATRAC3 files are protected with Windows Media DRM (digital rights management) technology.
- **Warner** (www.warnerbros.com): The Warner web site provides a music section with several services to the users. It is possible to browse a music catalogue by genres or authors to listen to or buy their music. The Warner web site offers free streamings of music and videos: music videos in the “Music Video Jukebox”, complete albums in the “Listening Party” section, live concerts in the section “Live Concert Series”.
- **Universal Music Group** (www.umusic.com): Universal Music Group intends to develop strategic marketing initiatives and opportunities in new technologies such as the Internet. It owns or administers more than 850,000 copyrights. Universal has got eLabs which serves as a strategic knowledge and research division dedicated to developing, and implementing global e-business and new technology distribution strategies for UMG. An equally held venture of Sony Music Entertainment and Universal Music Group created pressplay (www.pressplay.com), an online music service company which offers consumers on-demand access to music that can be streamed, downloaded, burned to a CD and transferred to portable devices, respecting and protecting artists’ rights. Music media company **GetMusic** (www.getmusic.com) is dedicated to creating a wide spectrum of online and offline music and lifestyle programming. It offers music contents to see, listen or buy.
- **BMG-Ricordi** (www.bmg.com): BMG has signed agreements for the development of its Internet digital commerce. BMG’s Buddha Records and Digital World Services has launched of a secure digital downloads

offering as part of the label's Black Anthology Web site (www.blackanthology.com). The Tracks was protected by Digital World Services' Promotional Products Solution.
BMG Music Publishing has launched BMG MusicSearch, a global online search engine for both popular and production music designed for the film, television, advertising and multimedia professional.
Liquid Audio has signed an agreement with BMG to provide the company with digital music services including encoding, hosting, digital rights management and clearinghouse functions.
BMG and FullAudio have entered into a licensing agreement that allows FullAudio to include BMG's extensive catalog of recordings in its digital music subscription service.

2.4.1.3 Copyright collecting societies

Copyright collecting societies are non-governmental organisations which administer the rights of copyright owners, ensuring that authors are rewarded for their creativity. These societies negotiate licences with users and receive payments which they pass onto their members. Each collecting society represents a different aspect of copyright.
Collecting societies have three common features. All societies:

- collect and distribute the income earned from the exploitation of copyrights;
- aim to advance the economic and creative interests of the owners that they represent;
- fulfil their functions by means of collective administration.

The status of collective administration bodies is recognised in European Union community law and national law. A Brussels-based umbrella body - **GESAC** (www.gesac.org) - was established in 1990 and encompasses 24 of the largest societies in the EU, Norway and Switzerland. GESAC represents around 480,000 authors and other rightsholders in the area of music, the visual arts, literary and dramatic works, audiovisual production and music publishers. The objects of the Grouping, in particular with regard to the institutions of the European Union, are the support and development of the legal, economic and cultural activities of its members.
Another association for music copyright is the **European Music Office** (www.musicineurope.org), an international not-for-profit association gathering professional organisations, associations and federations from the music sector in the European Union. It represents more than 600 000 people from all music genres and sectors (authors, composers, performers, publishers, producers, managers; those involved in live music, education and training…).

2.4.1.4 Content providers and distributors

The main content providers and distributors are converting their musical archives from papers to digital images and need to distribute music and multimedia content at a lower cost and to a wider audience with a strong control on the rights.
Music and multimedia authors themselves, which can be regarded also as content providers, are interested in making known their art and skill without companies financing costs for the distribution. They are interested in new methods of distributing their works. For example, ARTISTdirect Network (www.artistdirect.com) is a company which enables artists to control their own websites, online stores and downlable music.
Concerning music scores, big publishers (such as Casa Ricordi) prefer to delegate the distribution of music scores to third companies which are more focused on delivery a service for distribution of music and multimedia content. This is mainly due to the fact that current core business for major publishers is mainly on CD audio distribution rather than on music scores or multimedia objects, their name, the label, is mainly connected to those of the authors and not the product.

2.4.1.5 End users

Users of digital music distribution system can be divided in two categories: business users and end esers.
Business users are music distribution organisations and companies, music labels. Besides, there are a lot of smaller entities willing to enter the market of digital music, multimedia and on-line distribution/interaction. They are potentially interested in acquiring the a system for music and multimedia content distribution, even for small-scale distribution (for instance, distribution within their organisations). Such entities are mainly:

- Orchestras
- Theaters
- Conservatories and music schools
- Libraries and mediatheques

End users are users which are mainly interested in using and interacting with music and multimedia content, accessing the catalogue from the web, selecting and purchasing the content they need, downloading it in a protected way and finally using it by the proper music/multimedia players. They are the business users' customers.

2.5 Music Protection (FHGIGD)

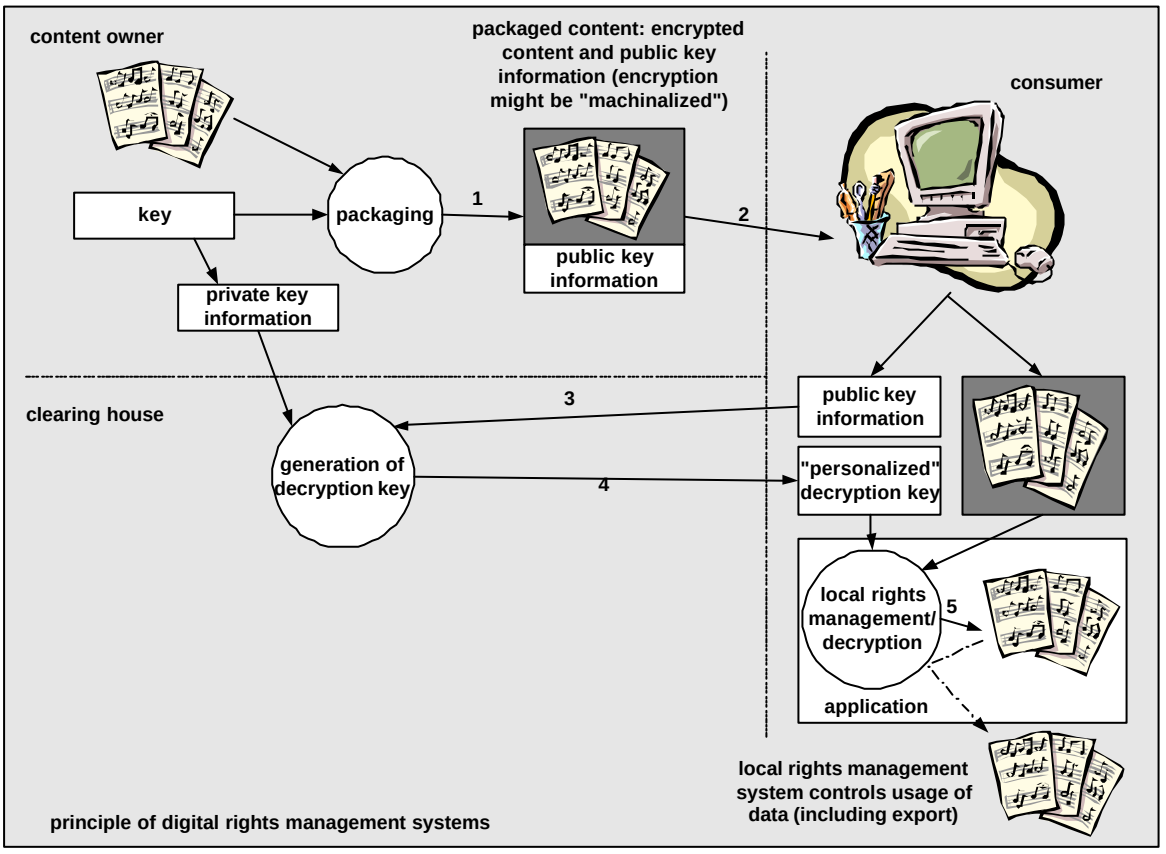
Content protection and distribution of content are closely related, as most content providers demand a certain level of security before they are willing to distribute any content. Some years ago content was protected by its analog presentation and the accompanying distortions when copying content or by the huge amount of data in its digital representation. Nowadays digital content can be copied without any quality degradations and be transmitted via the

Internet world wide almost without any time delay. Although this is a broadly recognized advantage for eCommerce pirates and illegal content providers also benefit from this development. Therefore content creators and providers are reluctant against digital content distribution as they will deliver digital data directly and no additional effort is needed, e.g. for acquisition of a digital file from an image or an audiotape.
Yet, protection aspects are not only limited to the restriction of content access. As protection is related to protection content against illegal access and distribution it is also related to rules and rights as rules and rights limit access and distribution[1]. Therefore advanced protection solutions take rules and rights into account and are much more enhanced than protection systems, which were developed a few years ago.[2]

2.5.1 Detailed State of the Art

Numerous technologies have been developed supporting content providers by securing digital content. Although general solutions can be considered as some content providers have developed ready-to-use platforms for content providers independent solutions. A detailed description of the state of the art is therefore impossible. Thus, we will outline here the principle of available protection platforms.

As the available products provide a solution to the the same problem the also share a common architecture as shown below: Content is packaged. This means that the content is encrypted and information necessary for creating the decryption key is added (step 1). Whenever a customer receives or downloads such a package (step 2) (s)he has to contact a clearing house with the information necessary to create the decryption key (step 3). The clearing house provides the customer with a license (ste p4). The license contains information about usage limitations (if any) and the decryption key. A local rights management systems decrypts the content and influences the functionality of the application. Access to content is only possible via the local rights management system.



Several commercial players are distribution solutions for digital rights management. Generally they can be used together with other services, e.g. for asset management. Among the known vendors are Microsoft (Windows Media Series), IBM (EMMS), RealNetworks (Helix DRM), InterTrust (Rights!System), Xerox (Content Guard), Sealed Media, Info2Clear, Reciprocal or LiquidAudio. Besides these mayor players several individual software solutions exist.

[1] These rules and rights are also called licenses.
[2] Besides content protection further issues are include in or can be combined with a DRM system. A typical example is a customer relationship management (CRM) component which is based on transaction information of the DRM system.

2.5.2 Possibilities and limitations

If protection technologies are accepted by content providers and by customers this will lead to the distribution of a huge amount of digital content via the Internet. However there are some limitations:

Some of the existing technologies have stronger some have weaker effects on the usage of content. On the one hand content protection is an important issue for content providers. On the other hand consumers strongly care about any usage limitation or interference. Even privacy is a very important issue. Other usage-related areas are addressed e.g. by accessibility or libraries. Certain people might not be able to access content or use content as they are used to when content is within a protection solution. For example blind people are legally allowed to create copies. However a protection environment cannot qualifiedly distinguish between a "good" and a "bad" copy. Therefore copies are generally forbidden in a content protection system. The same argument and additional ones holds for libraries.

These different requirements alienated content providers and consumers. Two extreme situations reflect this alienation: First, there are content providers offering content via the Internet legally. Second, consumers prefer illegal free download architectures. Although recently it seems that consumer will accept available online content distribution services one has to consider that these services are addressing a certain target group whose behavior cannot be extrapolated to different user groups.

Furthermore current DRM systems are not compatible. E.g. they are based on different right description language, use different encoders/decoders, apply different encryption algorithms, … This has a negative effect on the compatibility and the lifetime of content, an effect which is generally neglected but which has severe consequences especially for (digital) archives which store data for several decades. But also consumers take care about usage limitations e.g. incompatible DRM systems in consumer electronic from different vendors.

2.5.3 Rights Management and Rights Description

As the idea of DRM systems can be summarized as content protection by "usage control" one important aspect is the description and enforcement of rights and rules a customer has to meet. Two different scenarios can be identified:

- B2B (business-to-business): When rights are transferred to other commercial organization a complex management system is need as typically the content is processed. Therefore rights description language must be able to express a certain minimum complexity. Also systems are necessary for the management of rights and assets.

- B2C (business-to-consumer): The situation is different when dealing with consumers. Typically consumers want to "use" content that typically is the rendering of content.

- Archives[3] have an exceptional position, as they are content aggregators. Among their purposes is to preserve content. Furthermore they distribute content to further recipients that might render but even process the received content. As legal issues are more and more important digital archives have to consider this.

Digital content has to be described and identified. Several standards exist for identification (e.g. the Uniform Resource Identifier, the Digital Object Identifier or the ISO International Standard Textual Work Code) as well as for description (e.g. EDItEUR ONIX, IMS Learning Resource Metadata Information Model or <indecs>).

Concerning DRM systems different rights description languages exist and are used. Among the most famous ones are the eXtensible rights Markup Language (XRML) and the Open Digital Rights Language Initiative (ODRL).

2.5.4 Interoperability

Content identification and description: The establishment of one standard for content identification and description would positively influence content retrieval and distribution (even outside any DRM system). One important issue is the rights description language: The agreement on one unified rights description language will increase interoperability and therefore user acceptance as customers don't have to be afraid of "vanishing" content. Also content providers will benefit, as the overhead caused by moving to another DRM-system would be limited.

So far interoperability is limited which is addressed by several standardization activities including:

[3] There business model could be considered as B2B2C (business-to-business-to-consumer).

- Internet DRM group (IETF IDRM) was closed due to inactivity.
- Internet Streaming Media Alliance (ISMA, http://www.isma.tv/home) is also considering DRM issues but their main focus is on streaming data. They will release a content protection specification.
- The goal of the MPEG-21 activities is to describe an open framework, which addresses interoperability.
- Issues of DRM standardization is addressed by the CEN/ISSS's DRM group (European Committee for Standardization/Information Society Standardization issues, http://www.cenorm.be/isss/drm) which already published a draft version of their report.

One important aspect is the influence of legal issues on DRM standardization issues and vice versa.

2.6 Music education (ILABS, DSI)

2.6.1 State of t he Art

The major problem that a student or a teacher of music will have to face is usually the lack of resources. In many cases schools are not equipped to properly teach music (especially as far as primary and secondary schools are concerned. Moreover specialized **Authoring tools** are quite expensive and so often not affordable for non specialized schools. There is a need for new solutions enabling to achieve a twofold result: bring more young people close to music and make musing teaching more easily and effective (at least in primary and secondary schools). In the US back in 1996 was launched a program for bringing technology into education. Its primary goals were:

1 All students and teachers will have access to information technology in their classrooms, schools, communities & homes.
2 All teachers will use technology effectively to help students achieve high academic standards.
3 All students will have technology and information literacy skills.
4 Research and evaluation will improve the next generation of technology applications for teaching and learning.
5 Digital content and networked applications will transform teaching and learning

Presently this objectives have almost been fully met in the US[4], what about Europe? In most European countries these objectives are still far to come and this applies even mo re to certain field of education like music. Even if it is generally accepted that the driving force behind the 21st century economy has been knowledge, is also clear that this is still something to be fully exploited developing human capital. This second step is long to be achieved even if is the best way to ensure prosperity.
E-learning can be defined as instructional content or learning experiences delivered or enabled by electronic technology. E-learning has the potential to revolutionize the basic tenets of learning by making it individual - rather than institution-based, eliminating clock-hour measures in favour of performance and outcome measures, and emphasizing customized learning solutions over generic, one-size-fits-all instruction. Improvements in the quality of education and training are an important economic benefit of e-learning, which offers potentially universal access to best-in-class learning content, as well as a wide variety of content available anywhere in the world. E-learning also holds enormous potential as a tool for reducing the costs of education and training. Economic reasons, however, are not the only justification for aggressively supporting e-learning. At a time when many people express concern about growing economic disparities among different segments of the population, e-learning holds the potential to broaden access to high-quality education and training opportunities and, in turn, boost income growth at all levels. It is possible to foresee a future in which e-learning allows learning to become a continuous process of inquiry and improvement that keeps pace with the speed of change in business and society. With e-learning, the learner has convenient, just-in-time access to needed knowledge and information, with small content objects assembled and delivered according to the learner's specific needs.
The present situation of music related education software, according to Electronic Musician "*Computer Music Product Guide*" there are presently on the market 23 producers with 127 products. Reported prices range from 12 to almost 2000 USD according to complexity, features and platform of the involved system. In the following table data provided in the above mentioned report (available in PDF format at http://cmpg2003.emusician.com/) are summarised.

ID	Manufacturer	Products	Price (in USD)		
			Min	Max	Average
1	Charanga Ltd	3	40	50	43
2	ChordWizard Software Pty Ltd	1	45		

[4] Already in 1999 95% of schools in the US had Internet access and 63% instructional rooms with Internet access (Source: U.S. Department of Education, National Center for Education Statistics (2000). Internet Access in U.S. Public Schools and Classrooms: 1994-1999, NCES 2000-086, by Catrina Williams.Washington, D.C. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000086)

ID	Manufacturer	Products	Price (in USD)		
			Min	Max	Average
3	Cool Breeze Systems, Inc.	12	50	100	77
4	Datasonics	8	124	1.980	527
5	Electronic Courseware Systems, Inc.	69	20	595	61
6	FMJ-Software	1	20		
7	GenieSys Voice L.C.	1	30		
8	JustEnough Learning Co.	1	20		
9	Line 6	1	180		
10	MiBAC Music Software, Inc.	3	120	150	140
11	MIDIWorks Interactive	5	50	250	146
12	miniMusic	1	12		
13	MJ and Associates	2	200	200	200
14	PG Music Inc.	1	88		
15	Pianomouse.com	2	20	20	20
16	Play Music Inc.	3	50	50	50
17	Pygraphics	2	295	799	547
18	Rising Software	2	149	149	149
19	SDG Soft	1	289		
20	Sibelius Software	1	69		
21	Trail Creek Systems	2	60	60	60
22	Virtual Virtuoso	3	25	59	35
23	World Wide Woodshed	2	20	50	35
		127	**12**	**1.980**	**124**

This overview on market ready software for music related education software should be combined with data regarding the e-learning market in order to have a proper view of the overall market. According to the report *"A Vision of e-Learning for America's Workforce*" developed by the Commission on Technology and Adult Learning, the global e-learning industry comprises approximately 5.000 suppliers offering every imaginable method of e-learning. The vast majority of these suppliers are private; no single competitor in the e-training market accounts for 5% market share or more, a fact that is contributing to growing market consolidation. For a detailed view of this market is possible to examine also the *"E-Learning Market Guide 2001"* from Brandon-Hall. In such report the authors have provided a clear tabular view of the market available products listing along with contents providers, services and system integrators. In detail reported systems cover:

Technology / tool / service / content	Count
leaning management tools (LMS),	108
authoring tools,	65
synchronous e-learning tools,	39
content management tools (CMS),	10
collaboration tools,	13
simulation tools	6
digital video/audio tools	10
testing assessment tools.	21
custom course development	124
system integrators	13
learning portals (course aggregators)	13
on-line course publishers	331
on-line degree programs	17

According to Online Courseware Factory Ltd, what is driving the market in real time can be split among present and future trends as follows:

Today	Tomorrow
Technology training	Performance improvement
Classes for the masses	Personalised learning
Instructor centric	Learner centric
Training when scheduled	Learning on demand
Time to train	Time to perform
Teaching by telling	Learning by doing
Product-based learning	Project based learning
Know what	Know why
Skill and information (mastery basics = 3R's)	Inquiry, discovery and knowledge basics
Re-active	Pro-active

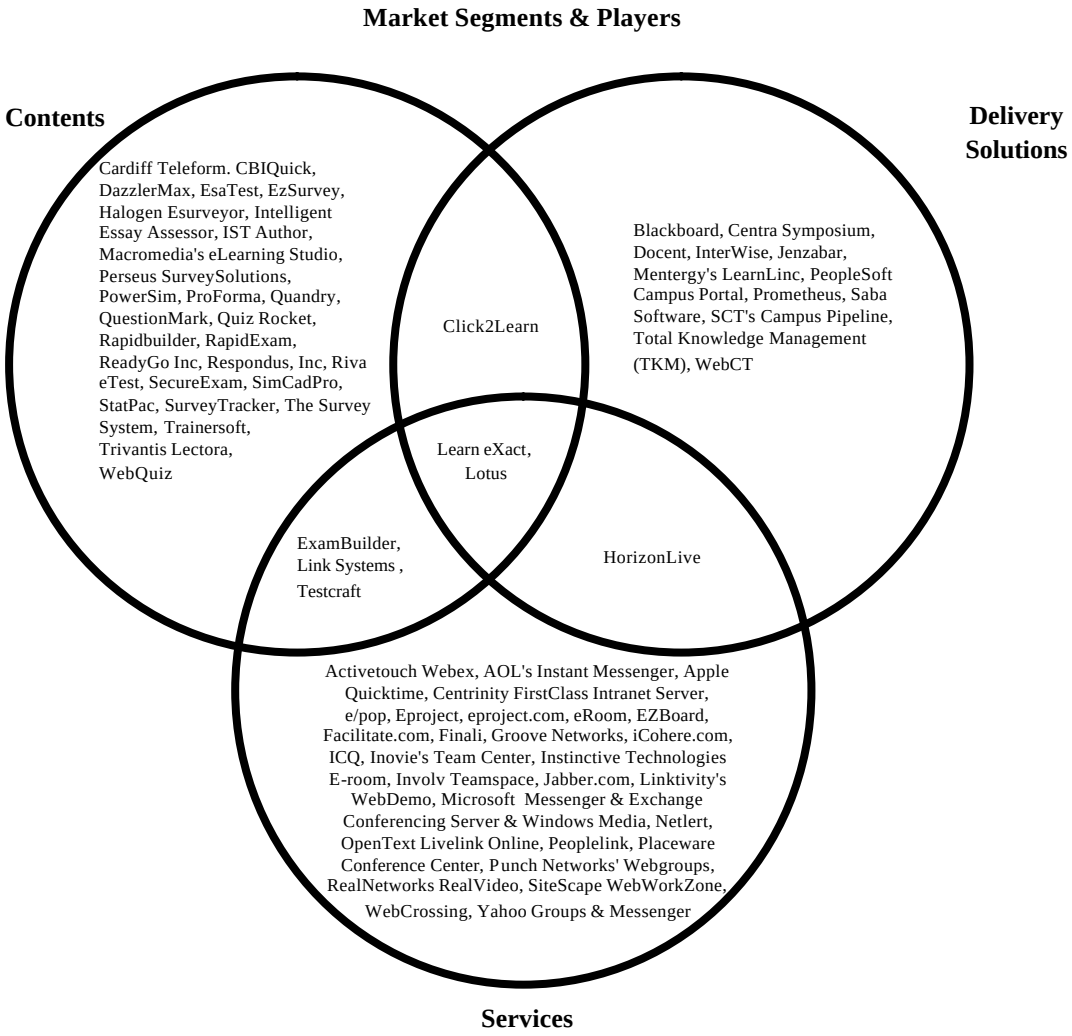
At present when examining the e-learning market we can identify a set of specific Drivers and Inhibitors which, according to Uwe Krueger of Realtech (www.realtech.de) can be identified in the following ones:

Drivers	**Inhibitors**
Lifelong learning	Technology Compatibility
Economic turbulence	Limitations
Need for continued education and staff training	Billing systems
Increased Internet/ eCommerce usage	Security concerns
	Price

All this has a direct consequences that: it is necessary to use technology to lower cost with re-use of content, increase of richness, adding value offering custom solutions and new approaches (performance support, customer education…). The present evolution of the overall education related market impose us to give a more in depth look to the e-learning market as this sector may cover aspects that are cross domain going from professional training to cultural heritage and edutainment. Maybe the most important issue regarding e-Learning systems is related to its effectiveness in transferring knowledge to the user. Learners' comprehension depends strongly on course structure. Therefore, particular attention must be paid in an effective navigation and look-and-feel. In addition, content should be designed, developed or adapted for multimodal delivery for effective content re-usability. Beside LMS available on the market, third generation communication opens new scenarios for e-Learning courses delivery. New mobile solutions integrated to the web can offer a large variety of learning solutions, despite the limitations due to small displays and reduced memorisation capacity. The winning factor is mainly the anytime / anywhere access to information guaranteed by the wireless technology. Wireless technology allows for integration of 'push' and scheduled delivery creating new services like personalised tutoring featured as "tips & tricks" which can reach learners via web-phones or PDAs. Cognitive modelling and ergonomics have been investigated since long time (for instance, [SUS], [UMA]) but now virtual reality, eye-tracking [VRE], map reading behaviour [MAP] and other technologies are seen as a possible frontier for e-learning applications. Studies on cognitive architecture have been carried out taking into account perception, cognition, action (motor) and memory (University of Oregon [ORE]); studies on Eye Movements and Visual Attention are more closely focused on the eye physical aspect (as explained at MIT [MIT]).

2.6.2 e-learning Market Segments

Current e-Learning market is segmented in three main areas [IDC – 1]: **Content**, **Delivery solutions** and **Services**. In more detail we have that *Content* providers offer courseware core material (like multimedia assets and course structure) and testing / assessments are included in their expertise. Companies that provide *Delivery solutions* offer products oriented to course preparation and organisation, such as training authoring tools and learning management systems (LMS), including collaborative software to help course fruition. *Services* include all additional features that can bring to better course preparation (Content design), and that are related to course maintenance (Management and hosting) and CRM (Online mentoring). Some products/platforms provide solutions in different areas covering partially or totally all the range of e-Learning offering. The following picture describes the current situation and introduces market players and their positions in the market:



2.6.3 e-Learning Products Offering

2.6.3.1 Asynchronous Web Based Software Suites

This category attempts to group software suites of tools that quickly allow an instructor to convert existing basic electronic documents to a hierarchical system with relative ease. Although most of these suites may require limited HTML knowledge to fully exploit, relatively little programming or other technical expertise should be needed to effectively use these software suites.

Key characteristics of major players in asynchronous suites typically include capability for secure student login via standard Java browser, centralized database-centred syllabus with links to internal or external web pages, on-line, time-monitored quizzes with randomized dynamically-generated testing, discussion groups, and integrated email. Systems also provide instructor development tools to ease transition from other media to these products. The academic user audience is dominated by two vendors: WebCT and Blackboard, with only a few additional competitors targeting academic audiences specifically. Separately, corporate/government learning organizations have a much larger number of competing systems.

2.6.3.2 Synchronous (real-time) Web Based Training solutions

This class of product is most appropriate facilitating relatively formal, instructor-led, hierarchical learning events, such as a seminar or interactive classroom. Some of these products incorporate "talking head video"; most video-enabled products suffer from poor video quality and tend to require 128KBPS (a.k.a. ISDN class) dial-in connections for acceptable performance; although a compelling sales feature tending to appeal to instructors familiar with videoconferencing, at present current "Talking head video quality" over dial-up Internet connections is not worth the effort; most students ignore such poor images very quickly into the course. Leading members of this class generally have also the following characteristics:

- browser-based (works with Netscape and Internet Explorer, though often PC-centric),

- on-line testing (designed for use over Internet dial-up connections or corporate intranets).
- live streaming audio (generally one-way, often two way)
- text chat, and occasionally private text chat, among students or between participants and presenter
- sequencing is controlled by a presenter-leader; a secondary/co presenter is available for the higher end products
- ability to show PowerPoint presentations
- ability to record sessions and make them available for on-demand viewing at any time
- shared whiteboard, with ability for students and faculty to import images that can be annotated on the whiteboard
- web-page sharing/co-browsing
- application sharing ability for presenters to share applications running on their desktop
- integrated polling/surveys
- virtual "hand/raising", to indicate when participants have questions
- firewall friendly

2.6.3.3 Application Service Provider (ASP)

ASP choose to make their products available as hosted solutions only; they do not sell the software for organizations to create and run their own servers under license. This license arrangement may better fit some needs, especially where institutions do not have the in-house capability to field tech support teams and servers. Vendors in this category generally offer the following feature set:

- Browser-based - All functionality is provided within a standard browser. Updates are added automatically.
- Presentation Sharing - allows any meeting participant to spontaneously share any presentation (generally PowerPoint).
- Document Sharing - allows meeting attendees to view content with multi-level zooming & annotation capabilities.
- Application Sharing - Run any software application for effective live demos and training.
- Desktop Sharing - Presenters can share anything on their PC system, including applications.
- Web Browser Sharing - Allows easy sharing of web-based information.
- Polling - Lets presenters solicit quantitative feedback from attendees online.
- Internationalization - ability to change the menus for selected languages.
- Text chat - generally available as group chat and a separate channel to interact during a session. A controversial feature in academics as it is perceived by faculty as the electronic equivalent of note-passing or whispering in class.

Many products in this category also offer:

- Record and Playback - Lets you record all interaction in a meeting for later reference, training or demos. Anyone can play back a recording.
- Application Share Control - The presenter can share control of any software application with others in a meeting, for unmatched interactive meetings on the web.
- Scalable - Supports multiple concurrent meetings with thousands of participants.
- File Transfer - Users can conveniently upload and download files as desired.
- Event Tech Support - ASP vendor's customer support personnel can take control of a user's PC system (with the user's approval) to instantly provide live assistance and resolve problems.

2.6.3.4 Learning Portals

This is an emerging variation of Personal Collaborative Environments and is an attempt to combine student services and community building through an integrated web-enabled system, much like the search engine portals Yahoo and Lycos.

The use of the term "Learning portal" could imply either the basic software product needed to develop a portal OR the actual use of such software to create a learning experience.

2.6.3.5 Collaborative Software

This emerging category of software allows individuals to interact one-to-one, peer-to-peer, or in small groups. The category may also be referred to as "Instant Messaging", or "Buddy Systems", although some products in this category also represent the older "listserve" email-broadcast technology. This type of tool will become integral in advanced web-based learning programs. Typically, tools in this category allow "awareness" of user-selected individuals and the ability to instant message (i.e. "chat" one-to-one) with individuals. Most programs provide for ad-hoc chatting in small groups. Some of these programs permit application sharing, voice-over-IP or other useful over-the-web features designed to allow individuals to interact. Currently, this category of software lacks interoperability. AOL, although officially in favour of interoperable information in and out of its dominant AOL Instant Messenger (AIM), has generally blocked competitors from interacting with its AIM product. This protectionist stance is

creating barriers to entry for AIM competitors. Some vendors are combining forces and contributing towards an industry standard for "instant messaging" (creating "Microsoft centric", "AOL Instant Messenger" and "Open Source" camps), but there is great animosity between these groups and little coordination. The Internet Engineering Task Force's Instant Message and Presence Protocol represents the current form of the proposed standard. If such a standard is successful, it may better validate this category of software, making functionality more ubiquitous and uniform than the current proprietary environment.

2.6.3.6 Team Groupware

A new subset of collaborative software aiming to create virtual project groups. For purposes of this discussion, "Team groupware" is distinguished from personal collaborative environments by these characteristics:

- ability to develop documents synchronously and review asynchronously
- one -to-one, one-to-many, and many-to-many capability
- centralized user management
- And real-time Internet communications by at least one of the following:
- Enterprise ready systems scalable to hundreds of users

Advanced software in this category includes group scheduling, ability to store and review older version of documents, and ability to route items. Systems should also require relatively little technical expertise to manage after installation as projects must be easy to create, edit or terminate.

2.6.3.7 Streaming Media

Real time and on-demand video/data playback was one of the earliest applications of the commodity Internet. Still unable to compete with the quality or ease of use of regular television, this media continues development anticipating broadband Internet access.

2.6.3.8 Web Based Education Development Tools (Authoring Tools)

This category attempts to collect basic and single purpose tools that meet specific needs but are not themselves intended to be a turnkey implementation system. They are generally visual authoring tools or programmers toolkits or meet a very specific web-based need. This category has undergone substantial consolidation since the high flying days prior to the dot.com crash in 2000/2001.

2.6.4 Market Figures and facts

What follows is a survey of current situation and foreseen trend in the near future for the e-Leaming Market [RWPC]. The eMarketer report cites research from the American Society for Training and Development (ASTD) supporting the corporate e-learning trend. ASTD finds that e-learning will comprise 25% of training time by 2004 - more than doubling from 10.5% in 2001 - and IDC predicts that corporations will be spending some $33.6 billion annually with employee training vendors, and a growing portion of that will be on Internet-based e-learning.
When taking into account the overall e-learning market is worth to give a look to the various products available and their classification as this will provide a real picture of the preset state of the art in the market. Due to marketing and / or development choice, some products cover more than a segment and will be therefore mentioned repeatedly throughout the various sections. According to eMarketer the global education and training market is worth roughly $2 trillion. The data, generated by Think Equity Partners and Eduventures, found that the United States already accounts for 37.5 percent of this market, or roughly $750 billion. On the other hand Brandon-Hall estimates the e-learning sector will grow from $10.3 billion in 2002 to $83.1 billion in 2006, and eventually swelling to over $212 billion by 2011. The trend is evidenced by an 80% growth increase from The University of Phoenix Online — whose virtual campuses boasted 72,230 students as of May 2003.
E-learning students are typically career-oriented professionals, as indicated by enrollment data from the University of Phoenix Online. The average age of the e-learning institution's students is 38 and nearly two-thirds have families.

E-Learning Students by Profession	**%**
Executives or business owners	20%
Middle managers	30%
Technical or licensed professionals	44%

A late 2002 study from Market Data Retrieval revealed that one-third of K-12 schools are already offering some distance learning programs for their students. High schools, in particular, have been attracted to the virtual classroom environment, with 53% offering such programs to students in rural states where students do not have access to specialized teachers. Furthermore, 36% of schools reported having distance learning progr ams for their teachers, allowing them to access professional development programs, which is similar to the applications corporations are finding for e-learning.

The overall European market of ITC training and education has been experiencing an almost constant growth and should reach a $13 billion by 2006. The rate of investment growth in e-Learning during the last years, and projections to the near future seem to keep the same trend [IDC - 2]. It is nevertheless essential to note that growth rates of e-Learning and of traditional training & education services display significant differences over the same observed period (1999 – 2004) [IDC - 2] as evident from the following tables. Especially impressive are forecasts on Compound Annual Growth Rate (CAGR) until 2004 [IDC – 1]

Sector	**1999 – 2004**
e-Learning	83 %
Traditional training & educational services	11 %

USD (millions)	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Content	80	186	409	737	1316	2134
Delivery Solutions	35	80	165	295	479	711
Services	20	54	143	308	598	1107
Total e-Learning market	**135**	**320**	**717**	**1340**	**2393**	**3952**

Segment	**CAGR**
Content	93%
Delivery Solutions	83%
Services	123%
Total e-Learning market	**96%**

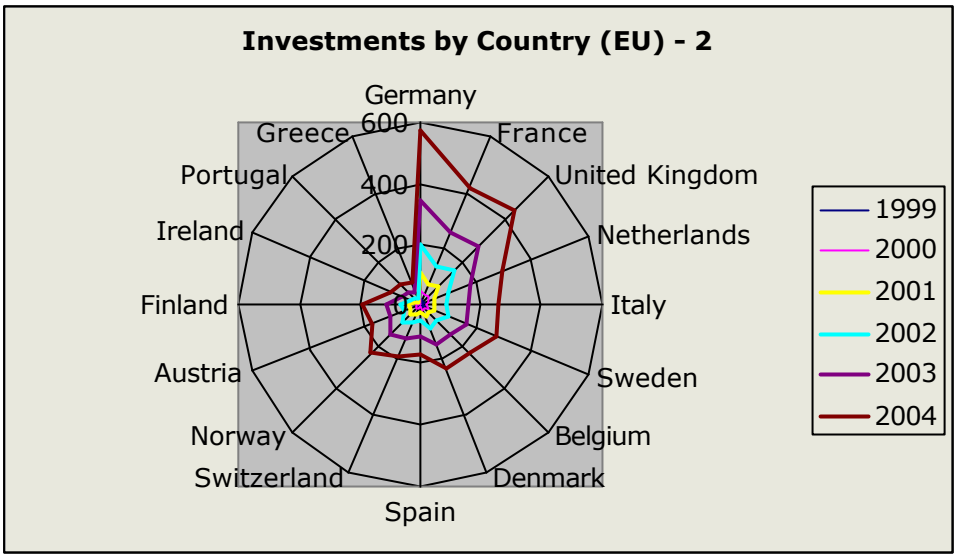
As far as market segmentation is concerned, *Content* will continue to hold the dominant position, while *Services*, experiencing the largest growth (123%). It will become the second largest segment overtaking *Delivery solutions* which are going to represent the third market leg despite a 'big' rate (83%). In the near and mid-term the market, maintaining a five-year CAGR of 96% increment, will reach $ 13 billions by 2006 [IDC – 1].

Early adoption markets of e-Learning solutions for training have been United Kingdom, the Netherlands and Sweden. After them, all western European countries (EU countries) have been and are being interested in e-Learning more and more. Last adopters in Europe which represent European new markets are Ireland, Spain, Portugal and Greece [IDC – 1]. Investments current situation and trend until 2004 are shown in the following table:

USD (millions)	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Germany	20	48	106	198	348	575
France	14	33	74	139	254	420
United Kingdom	16	38	84	156	270	446
Netherlands	11	26	54	101	179	296
Italy	8	19	45	84	157	259
Sweden	11	26	52	96	164	271
Belgium	9	20	42	78	139	229
Denmark	9	22	45	85	144	237
Spain	4	9	29	54	103	171
Switzerland	7	16	34	64	116	192
Norway	9	21	44	82	137	226
Austria	5	12	30	56	102	168
Finland	7	16	36	67	113	186
Ireland	2	6	18	33	64	105
Portugal	2	4	15	28	56	92
Greece	1	2	10	19	48	80
Total	**135**	**320**	**717**	**1340**	**2393**	**3952**

Countries investments can be better appreciate in terms of trends as reported in the following table and 'radar' chart. More mature markets are characterized by very high annual growth rates, while the others are trying to fill the initial gap.

USD (millions)	CAGR
Germany	95%
France	98%
United Kingdom	94%
Netherlands	94%
Italy	100%
Sweden	90%
Belgium	93%
Denmark	91%
Spain	113%
Switzerland	94%
Norway	90%
Austria	102%
Finland	93%
Ireland	113%
Portugal	228%
Greece	153%
Total	**96%**



A special case is the on eof Italy, where according to the ANAE *"e-learning report 2003"* it is apparent that the e-learning sector has been a driving force of the overall economical scenario accounting for an exceptional increase of 102,2% from 2001 to 2002. Moreover if compared with the overall ICT market it is possible to note that the relative weight has passed from 0,07% to a 0,14% doubling its relevance. Even when compared to the overall educational market the e-learning one accounts for a 3,8% and is expected to reach by the end of 2003 a 8,2%. Forecasts for 2004 foresee a 130% growth in terms of income. The strategic segments inside this market are in order of relevance content, services, technology and consultancy. The first is expected to have an overall growth of 123,7%.

2.6.5 e-learning product scenario

In the e-learning market a relevant role is covered by Learning Content Management Systems or LCMS. At the beginning of 2003 Brandon-Hall carried out a *"Comparative Analysis of Enterprise Learning Content Management Systems"*. In such analysis 24 systems are compared and their main characteristics are sketched. Characteristics taken into account to evaluate LCMS cover aspects like standardization, interoperability, easiness of use, test and assessment capabilities. In the mentioned study is also reported a very useful reference/master list of LCMS fatures divided into:

- Learning Object Model – Organizational Schema
- Database Support
- Levels of Reusability
- Support for Multiple Output Types
- Built-in Authoring (Rapid Content Creation)
- Test/Exam Delivery Features
- Support for Content Not Created in the System
- Adaptive Learning Model
- Collaborative, Team Development Tools
- Revision Controls, Archiving and File Management
- Advanced Search Engine and Metadata Tagging
- Use of XML (tagging, content, both)
- Adherence to Standards and Specifications (AICC, SCORM, etc.)
- Interoperability With Learning Management Systems
- Flexibility and Performance of Delivery Platform
- ASP (hosted) Solution vs. Internally Installed
- Product Support
- General - Other

According to the previously outlined master list some statistical analysis has been performed on data regarding the 24 assessed systems (which are not all the systems on the market but those that cover standards and are more representative). Main results are presented in the following tables:

Authoring type

Basic authoring tools	**42%**
Full authoring system	**58%**

Types of output

E-learning	**100%**
CD-ROM	**75%**
Offline courses	**54%**
Print-based	**67%**
Formatted student guide	**17%**
Formatted lesson plan	**17%**
PocketPC	**21%**
Palm	**13%**
Knowledge management system	**63%**
Word output	**29%**
PowerPoint output	**21%**
XML output	**71%**

Assessment/pre-testing

Built-in assessment tools for writing test questions	**100%**
Have built-in mechanisms for creating dynamic pretests (to drive adaptive learning)	**79%**

Built-in collaborative tools (built-into LCMS or turnkey platform – not part of separate LMS)

E-mail (learner-to-learner, learner-to-instructor)	**54%**
Threaded discussion	**63%**
Chat	**50%**
Full virtual classroom (as part of base platform -- either licensed or built internally)	**21%**

LMS functionality

Have built-in LMS functionality in the LCMS	**58%**
Offer full-featured LMS as a separate company offering (in addition to LCMS)	**63%**

It is also particularly interesting to examine the tools used to produce learning content as they can give a very interesting perspective on the variety of quality level that is possible to achieve.
A recent survey of e-learning professional indicated that standard document creation tools rank at the top in the list of utilities used to create e-learning content. Such tools are mainly used just for the wide diffusion and easiness of availability they have. Furthermore most of them do not require specific programming skills even if they may allow the user to achieve high quality results if used with all their extensions (including the programming facilities: macro, visual basic / C / C++ code …). In the following tables are presented in summary the result of the previously mentioned survey. Just for the sake of clarity we have split the survey results in two putting in evidence the clear distintion between specialized and general purpose tools.

Tool used to create e-learning courses content (standard)	**%**
PowerPoint	66%
Word	63%
Dreamweaver (can be used by specialized and novice users)	61%
Flash (can be used by specialized and novice users)	47%
Microsoft FrontPage	26%
Other	16%

Tool used to create e-learning courses content (specialized)	**%**
Dreamweaver (can be used by specialized and novice users)	61%
Flash (can be used by specialized and novice users)	47%
Code at the HTML tag level (NotePad or other text editor)	34%
Traditional authoring tools (Director, Authorware, ToolBook, etc.)	32%
Learning content management system (LCMS)	21%
Content authoring tools built-in to an LMS	18%
Rapid e-learning development tools (ReadyGo, Lectora Publisher, Trainersoft, etc.)	13%
Other	16%

Asynchronous Web Based Software Suites

Asynchronous Web-based Software Suites targeted toward academic adopters

- **Blackboard** http://www.blackboard.com/
- **Imc** www.im-c.de/

- **Learn eXact** http://www.learnexact.com/
- **Prometheus** http://www.prometheus.com/product/
- **WebCT** http://www.webct.com/

Corporate-focused Asynchronous web-based Software Suites
These tools differ from their academic-focused brethren above primarily in the area of flexibility. While Blackboard's template-driven implementation creates ease of use and short learning curves, corporations tend to opt for the tools below which emphasize assessment metrics, compatibility with enterprise-class corporate databases, industry standards-compliance, and ability to import sophisticated externally developed content from multiple authoring tools.

- **Click2learn** http://home.click2learn.com/
- **Docent** http://www.docent.com/
- **Integrity elearning** www.ielearning.com/
- **Learn eXact** http://www.learnexact.com/
- **Lotus LearningSpace** http://www.lotus.com/products/learnspace.nsf/wdocs/homepage?opendocument
- **Saba Software** http://www.saba.com/english/index.asp
- **Total Knowledge Management (TKM)** http://www.gen21.com/MainIE.htm
- **WBT Systems** www.wbtsystems.com/

Synchronous (real-time) Web Based Training solutions
- **Centra Symposium** http://www.centra.com/
- **EnglishTown** www.englishtown.com/
- **HorizonLive** http://www.horizonlive.com/
- **InterWise** http://www.interwise.com/
- **Lotus LearningSpace AnyTime** http://www.lotus.com/products/learnspace.nsf/wdocs/homepage?opendocument
- **Luvit** www.luvit.com/
- **Mentergy's LearnLinc** http://www.learnlinc.com/
- **S3R** www.s3r.com/

Application Service Provider (ASP)
- **Activetouch Webex** http://www.webex.com/
- **ExamBuilder** http://www.exambuilder.com/
- **HorizonLive** http://www.horizonlive.com/
- **GlobalEnglish** www.globalenglish.com/
- **Learn eXact** http://www.learnexact.com/
- **Lotus LearningSpace AnyTime** http://www.lotus.com/products/learnspace.nsf/wdocs/homepage?opendocument
- **Placeware Conference Center** http://main.placeware.com/index.cfm
- **Testcraft** http://www.testcraft.com/

Learning Portals
For the purposes of this listing, the listing below addresses the area of software to create gateways to learning opportunities.

- **Blackboard 5, Level 2 or higher** http://www.blackboard.com/
- **Jenzabar** http://www.jenzabar.net/products/jenzabars_internet_campus_solution.html
- **PeopleSoft Campus Portal** http://www.peoplesoft.com/
- **SCT's Campus Pipeline** http://www.campuspipeline.com/

Collaborative Software
- **AOL's Instant Messenger** http://aim.aol.com/
- **e/pop** http://www.wiredred.com/
- **Eproject** http://www.eproject.com/
- **eproject.com** http://www.eproject.com/
- **EZBoard** http://www.ezboard.com/
- **Finali** http://www.finali.com/
- **ICQ** http://www.icq.com/
- **Instinctive Technologies E-room** http://www.instinctive.com/
- **Jabber.com** http://www.jabber.com/index.php
- **Lotus Quickplace** http://www.lotus.com/
- **Microsoft Messenger** http://messenger.msn.com/
- **OpenText Livelink Online** http://www.opentext.com/
- **Netlert** http://www.netlert.com/
- **Peoplelink** http://www.peoplelink.com/next/
- **Punch Networks' Webgroups** http://www.punchnetworks.com/
- **Sitescape WebWorkzone** http://www.sitescape.com/
- **WebCrossing** http://www.webcrossing.com/

- **Yahoo groups** http://groups.yahoo.com/
- **Yahoo Messenger** http://messenger.yahoo.com/

Team Groupware

- **Centrinity FirstClass Intranet Server (previously SoftArc)** http://www.softarc.com/
- **eRoom Technology's eRoom** http://www.eroom.com/
- **Facilitate.com** http://www.facilitate.com/
- **Groove Networks** http://www.groovenetworks.com/
- **iCohere.com** http://www.icohere.com/
- **Inovie's Team Center** http://www.inovie.com/
- **Involv Teamspace** http://www.involv.com/
- **Linktivity's WebDemo** http://www.linktivity.com/
- **Link Systems** http://www.link-systems.com/r
- **Lotus Sametime** http://www.lotus.com/products/lotussametime.nsf/wdocs/homepage
- **Microsoft Exchange Conferencing Server** http://www.microsoft.com/exchange/default.asp
- **Microsoft SharePoint Portal** http://microsoft.com/sharepoint/
- **SiteScape WebWorkZone** http://www.sitescape.com/

Streaming Media

- **Apple Quicktime** http://www.apple.com/quicktime/
- **Microsoft Windows Media** http://www.microsoft.com/windows/windowsmedia/EN/default.asp
- **RealNetworks RealVideo** http://www.realnetworks.com

Web Based Education Development Tools (Authoring Tools)

General Content Development Tools

- **Click2Learn** http://www.click2learn.com/
- **DazzlerMax** http://www.maxit.com/daz_product_info.html
- **Element K** www.elementk.com
- **Imc** www.im-c.de/
- **Integral Coaching** www.integral-coaching.ch/
- **I progress** www.iprogress.com/
- **Learn eXact** http://www.learnexact.com/
- **Link Systems** http://www.link-systems.com/
- **Macromedia's eLearning Studio** http://www.macromedia.com/
- **ReadyGo Inc** http://www.readygo.com/
- **Thomson - NETg** www.netg.com/
- **Trainersoft** http://www.trainersoft.com/
- **Trivantis Lectora** http://www.lectora.com/

Simulation Development Tools

- **CBIQuick** http://www.amtcorp.com/
- **IST Author** http://www.edtlearning.com/
- **Quandry** http://www.halfbakedsoftware.com/
- **PowerSim** http://www.powersim.com/
- **ProForma** http://www.proformacorp.com/
- **Rapidbuilder** http://www.xstreamsoftware.com/
- **SimCadPro** http://www.visualprocessmodeling.com/
- **Thomson - NETg** www.netg.com/

Quiz and Assessment Creation Tools

- **EsaTest** http://www.esatest.com/
- **ExamBuilder** http://www.exambuilder.com/
- **Intelligent Essay Assessor** http://www.knowledge-technologies.com/
- **Learn eXact** http://www.learnexact.com/
- **QuestionMark** http://www.questionmark.com/
- **Quiz Rocket** http://www.learningware.com/
- **RapidExam** http://www.xstreamsoftware.com/products.htm#RapidExam
- **Respondus, Inc** http://www.respondus.com/bb/
- **Riva eTest** http://www.riva.com/etest/etest.asp
- **SecureExam** http://www.softwaresecure.com/
- **S3R** www.s3r.com/
- **Testcraft** http://www.testcraft.com/
- **WebQuiz** http://www.smartlite.it/

Software for Surveys and Polling
Distinctly different from Testing and assessment software (where there is one or a finite number of right answers), survey software has wide application in education, marketing research and public opinion polling, customer satisfaction and employee surveys, human resources, and program evaluation for healthcare and non-profit agencies. Though this industry started out selling individual software packages for consumer installation and use, the trend is toward providing a hosted solution (application service provider - ASP) where you use their software and web servers to create and mange your surveys. This trend has the advantage of reducing the cost of entry to this type of application but increasing the cost of long term operation for users who create a lot of surveys.

- **Cardiff Teleform** http://www.cardiff.com/
- **EzSurvey** http://www.ezsurvey.com/
- **Halogen Esurveyor** http://www.halogensoftware.com/
- **Perseus SurveySolutions** http://www.perseus.com/
- **StatPac** http://www.statpac.com/
- **SurveyTracker** http://www.surveytracker.com/, http://www.websurveysoftware.com/
- **The Survey System** http://www.surveysystem.com/

Standards, regulamentations, observatories and related bodies
In e-learning sector there are a number of Standardisations Bodies, User Organisations and Content Certification of Conformity Bodies. They produce reference material, reports, guidelines and even regulamentary documents. Since 1998 there has been rapid growth in the number of bodies working to develop specifications and standards for learning technology interoperability. Typically, the process starts with user needs and/or input from a research community active in a related area. This then leads to specification work, defining how interoperability can be achieved in the field under consideration. Next, these specifications are tested for their validity by user organisations (e.g. AICC, CETIS, JCIEL, JLCT). Finally, if a specification is deemed to be valid and widely accepted, it is submitted to a formal standards body. However, the real world is a bit messier. Several of these bodies have started to operate in more than one aspect of this process. [CET]
In the following section we report a brief description of each of them and of their activities directly quoting [MASIE] report and [CET] study. This will contribute to better understand why, in certain cases, despite the presence of such entities there are problems in interoperation.

ADL Initiative: (Advanced Distributed Learning)
An initiative by the U.S. Department of Defense and its partners in industry, academia, and the private and federal sectors to achieve interoperability across computer and Internet-based learning courseware through the development of a common technical framework, which contains content in the form of re-usable learning objects. This group is responsible for authoring the SCORM document. (http://www.adlnet.org) From the ADL Web site: The purpose of the ADL initiative is to ensure access to high-quality education and training materials that can be tailored to individual learner needs and made available whenever and wherever they are required. This initiative is designed to accelerate large-scale development of dynamic and cost-effective learning software and to stimulate an efficient market for these products to meet the education and training needs of the military and the nation's workforce of the future. It will do this through the development of a common technical framework for computer and net-based learning that will foster the creation of re-usable learning content as "instructional objects."
As part of this objective, ADL produce **SCORM (Sharable Content Object Reference Model)**, a specification for reusable learning content. Outside the defence sector, SCORM is being adopted by a number of training and education vendors as a useful standard for learning content. Version 1.2 of SCORM will also incorporate the IMS Metadata and Content Packaging specifications. [CET]

AICC (Aviation Industry Computer-Based Training Committee):
Maybe the most known User Organisation, the Aviation Industry CBT (Computer-Based Training) Committee (AICC) is an international association that develops guidelines for the aviation industry in the development, delivery, and evaluation of CBT and related training technologies (http://www.aicc.org). Online training materials have to be future-proofed, and have to work in learning environments not yet invented, since the life of an aircraft is longer than the typical life of an e-Learning system. Therefore, AICC's objectives are to assist airplane operators in development of guidelines which promote the economic and effective implementation of computer-based training (CBT), to develop guidelines to enable interoperability and to provide an open forum for the discussion of CBT (and other) training technologies. However, the scope of AICC specifications goes further than aviation, and the AICC work with IEEE, IMS and ADL. AICC produce "AGRs" (AICC Guidelines and Recommendations) in a number of areas, from hardware to interoperability. [CET]
From the AICC Web site: The AICC's mission is to provide and promote information, guidelines and standards that result in the cost-effective implementation of CBT and WBT.

ALIC (Advanced Learning Infrastructure Consortium) (Japan):
From the ALIC Web site: Our objective is to establish an active society by reasonably and effectively providing a learning environment, which enables anyone to learn anytime, anywhere, according to the goals, pace, interests and understanding of individuals and groups. Also, we attempt to foster experts who will be the origin of global competitiveness. (http://www.alic.gr.jp/eng/index.htm)

ARIADNE (Alliance of Remote Instructional Authoring and Distribution Networks for Europe):
ARIADNE (Association of Remote Instructional Authoring and Distribution Networks for Europe) is an association of mainly Higher Education Institutions in Europe sharing learning resources. Having begun life as a project funded under the EC's Framework 3 programme, its membership has grown out of the original project partners, and it aims to provide a mechanism for the sharing of learning resources. Its most significant contribution has been the development of a learning content metadata scheme, which was harmonised with the IMS metadata specification, and submitted jointly to IEEE, where it currently awaits ratification.
The ARIADNE Knowledge Pool System is a European-wide distributed repository for learning and teaching resources, and documents relating to learning and teaching. It is sometimes also referred to as the "European Knowledge Pool". [CET]
From the ARIADNE Web site: ARIADNE is a research and technology development project pertaining to the "Telematics for Education and Training" R&D program sponsored by the European Union. The project focuses on the development of tools and methodologies for producing, managing, and re-using computer-based pedagogical elements and telematics-supported training curricula. Validation of the project's concepts is currently taking place in various academic and corporate sites across Europe. (http://ariadne.unil.ch, http://www.ariadne-eu.org/)

CEN/ISSS (European Committee for Standardization/Information Society Standardization System):
In 1999, the European Commission gave a mandate to CEN/ISSS (the Comité Européen de Normalisation / the Information Society Standardisation System) to identify a work-plan for Europe in the area of learning technology interoperability. This it has done, publishing a report last year. CEN/ISSS continues with this work, seeking to ensure that any standards reflect European needs - i.e. can be internationalised and/or localised. This body claims to combine the rapid process of informal specification with the security offered by the formal open consensus of traditional standardisation. The CEN/ISSS Learning Technologies Workshop has contributed to work on the localisation of the IEEE LTSC Learning Object Metadata (LOM). The Workshop also has Project teams focussed around the following areas: Educational modelling languages, Repository of taxonomies/vocabularies for a European Learning Society, Educational Copyright Licence Conditions and a Quarterly Electronic Newsletter.
A business plan (http://www.cenorm.be/isss/Workshop/lt/BP/busplanwslt0402.pdf) contains a detailed description of the work of the CEN/ISSS Learning Technologies Workshop. [CET]
From the CEN/ISSS Web site: The mission of CEN/ISSS is to provide market players with a comprehensive and integrated range of standardization-oriented services and products, in order to contribute to the success of the Information Society in Europe. (http://www.cenorm.be/isss)

CETIS (Centre For Educational Technology Interoperability Standards):
CETIS is another typical User Organisation. It represents UK Higher and Further Education on international educational standards initiatives including: The IMS Global Learning Consortium, PROMETEUS, CEN/ISSS and ISO. CETIS advises Universities and Colleges on the strategic, technical and pedagogic implications of educational technology standards, including the Further Education Managed Learning Environment Programme. CETIS manages UK Implementation groups examining IMS specifications, including: metadata, content management, question and test, enterprise and learner information. CETIS disseminates information on learning technology standards via: workshops, conferences, publications and forums
CETIS is funded by JISC, the Joint Information Systems Committee, and is managed by Bolton Institute, in partnership with the Open University and the University of Wales, Bangor. [CET]

EdNA (Education Network Australia):
From the EdNA Web site: EdNA Online is a service that aims to support and promote the benefits of the Internet for learning, education, and training in Australia. It is organised around Australian curriculum, its tools are free to Australian educators, and it is funded by the bodies responsible for education provision in Australia - all Australian governments. (http://www.edna.edu.au/EdNA)

DCMI (Dublin Core Meta-data Initiative):
The DCMI is an open forum engaged in the development of interoperable online metadata standards that support a broad range of purposes and business models. The Dublin Core Metadata Element Set (DCMES) (http://dublincore.org/documents/dces/) contains 15 elements, which can be refined to add richness of description. The DCMES is used world-wide for the description of information resources. DCMI activities include consensus-driven working groups, global workshops, conferences, standards liaison and dissemination efforts. [CET] Dublin Core is now an ISO standard: ISO-15836.

From the DCMI Web site: The Dublin Core Meta-data Initiative is an open forum engaged in the development of interoperable meta-data standards that support a broad range of purposes and business models. DCMI is dedicated to promoting the widespread adoption of these standards and developing specialized meta-data vocabularies for describing resources that enable more intelligent information discovery systems. DCMI's activities include consensus-driven working groups, global workshops, conferences, standards liaison, and educational efforts to promote widespread acceptance of meta-data standards and practices.
Dublin Core Metadata Initiative http://dublincore.org/

elearningeuropa.info
At the beginning of February 2003 Mrs. Viviane Reding, the EC Commissioner to Education & Culture, presenting the Future of the eLearning initiative (2004-2006) at the Learntec 2003 conference in Karlsruhe has officially launched the e-Learning portal of the Commission: http://www.elearningeuropa.info/. The objectives of the European e-Learning programme are to promote and facilitate the effective use of ICT in European education and training systems. To achieve those goals, four main priority areas have been identified: the fight against the Digital Divide, the deployment of European virtual campuses, the development of schools etwinning and, finally, the promotion and monitoring of the implementation of the e-Learning Action Plan. The e-Learning Action Plan has four action lines: infrastructures and equipment, training at all levels, quality content and services, and, co-operation and dialogue. The e-Learning Portal elearningeuropa.info is part of the implementing initiatives of the e-Learning Action Plan. Among other EC initiatives for e-Learning there are the SOCRATES Programme (in particular the MINERVA action seeks to promote European co-operation in the field of Information and Communication Technology and Open and Distance Learning in education) and the LEONARDO DA VINCI Programme.

GEM (Gateway to Educational Materials):
From the GEM Web site: The Gateway to Educational MaterialsSM is a Consortium effort to provide educators with quick and easy access to thousands of educational resources found on various federal, state, university, non-profit, and commercial Internet sites. GEM is sponsored by the U.S. Department of Education and is a special project of the ERIC Clearinghouse on Information & Technology. Teachers, parents, administrators can search or browse The Gateway and find thousands of high quality educational materials, including lesson plans, activities, and projects from over 414 GEM Consortium member sites. (http://thegateway.org)

IEEE (Institute of Electrical and Electronics Engineers):
The IEEE's Learning Technology Standards Committee is working to develop technical standards, recommended practices, and guides for computer implementations of education and training systems. From the IEEE Web site: The mission of IEEE LTSC working groups is to develop technical Standards, Recommended Practices, and Guides for software components, tools, technologies, and design methods that facilitate the development, deployment, maintenance, and interoperation of computer implementations of education and training components and systems. (http://ltsc.ieee.org)
Many of the standards developed by LTSC will be advanced as international standards by ISO/IEC JTC1/SC36 - Information Technology for Learning, Education, and Training (http://jtc1sc36.org/). [CET]

IMS Global Learning Consortium (Instructional Management System):
IMS is a global consortium with members from educational, commercial, and government organizations dedicated to defining and distributing open architecture interoperability specifications for e-Learning products. From the IMS Web site: IMS Global Learning Consortium, Inc. (IMS) is developing and promoting open specifications for facilitating online distributed learning activities such as locating and using educational content, tracking learner progress, reporting learner performance, and exchanging student records between administrative systems. IMS has two key goals:

1. Defining the technical specifications for interoperability of applications and services in distributed learning, and
2. Supporting the incorporation of the IMS specifications into products and services worldwide. IMS endeavors to promote the widespread adoption of specifications that will allow distributed learning environments and content from multiple authors to work together (in technical parlance, "interoperate"). (http://www.imsproject.org)

Since its formation as an Educom project in 1997, it has developed a membership that includes almost all the leading technology system suppliers, publishers and many user organisations including leading US universities active in e-Learning. It has since then become an independent, subscription-based non-profit organisation, and has recently launched a subsidiary, IMS Europe.
While it aims to be technology and pedagogy neutral, it inevitably has to represent the interests of its subscribers. This is why the active participation of user organisations is crucial. [CET]
IMS: http://www.imsglobal.org/

ISO (International Organization for Standardization):
The International Standards Organisation is a network of national standards institutes from 140 countries and works in partnership with international organisations, governments, industry, business and consumer representatives. The ISO/IEC JTC1 SC36 (http://jtc1sc36.org/) develops international standards in the field of Learning, Education, and Training, with an aim to enable interoperability and reusability of resources and tools. The IEC (http://www.iec.ch/), also known as the International Electrotechnical Commission, is the international standards and conformity assessment body for electrotechnology and is working with the ISO on this sub committee. JTC1 stands for "Joint Technical Committee 1" (http://www.jtc1.org/) which has a scope of standardisation in the field of information technology as a whole. SC36 just means "sub committee 36". The focus of ISO/IEC JTC1 SC36 is on existing standards and technical reports. The sub committee consists of Working groups, Rapporteur groups and Ad Hoc committees which focus on different topics within the field of Learning, Education, and Training. ISO/IEC JTC1 SC36 liaises with other JTC1 sub committees, and with DCMI, IEEE LTSC and CEN/ISSS/LTWS. ISO standards will emerge from the work of these specification bodies, which are used and tested, then submitted to the standards bodies. There is a continuous feedback mechanism between research and development, specifications bodies, test-beds, and standards bodies to produce standards. [CET]
From the ISO Web site: The ISO is a worldwide federation of national standards bodies from some 140 countries, one from each country. ISO is a non-governmental organization established in 1947. The mission of ISO is to promote the development of standardization and related activities in the world with a view to facilitating the international exchange of goods and services, and to developing cooperation in the spheres of intellectual, scientific, technological and economic activity. ISO's work results in international agreements which are published as International Standards. (http://www.iso.org)

JCIEL (JISC Committee for Integrated Environments for Learners)
JCLT (JISC Committee for Learning and Teaching):
JCIEL's (JISC Committee for Integrated Environments for Learners) mission was to evaluate and pilot novel technologies of relevance to learning and teaching and encourage the integration of IT based applications to improve student support systems. This mission is achieved through funding development programmes and centres of advice and guidance. JCIEL has a particular interest in Managed Learning Environments.
From January 2002 its work has been taken forward by the JCLT (JISC Committee for Learning and Teaching) which is responsible for supporting the learning and teaching community by helping institutions to promote innovation in the use of ICT to benefit learning and teaching, research and the management of institutions.
Both committees has belonged to **JISC (Joint Information Systems Committee of the Higher and Further Education Funding Councils)** which promotes the innovative application and use of information systems and information technology in further and higher education across the UK. [JIS]

MENON
The MENON Network EEIG is an European organisation active in the field of ICT in Education and e-learning. MENON is developing e-Learning market intelligence, through research data, observation and analysis. The network aim at the support of policy makers, in order to better understand the ICT impact on education and training systems, at helping the education communities, in order to enhance the use of e-Learning and, finally, at advising the ICT industry, in order to develop multimedia and web-based learning materials of better quality. Among MENON services offered, the provision of 'best practices' can be found on the web-site as well as educational titles review. In addition, hand-outs addressed to European families for a better understanding of multimedia content and Internet potentialities as educational resources, and among them for selecting the 'right' e-Learning resources for their purposes, are available on the site: http://www.menon.org/

PROMETEUS (PROmoting Multimedia access to Education and Training in the EUropean Society):
From the PROMETEUS Web site: PROMETEUS is an open initiative launched in March 1999 under the sponsorship of the European Commission with the aim of building a Common Approach to the Production and Provision of e-Learning Technologies and Content in Europe. PROMETEUS is an expert opinion-making forum where actors from a wide range of professional, cultural, and linguistic backgrounds, come together to build critical mass in the field of educational technology and applications. The complementary expertise of the PROMETEUS Signatories is brought together in the aim to bridging the gap between research and actual use of learning technologies, content, and services. (http://www.prometeus.org.uk, http://www.prometeus.org/)

Scienter
SCIENTER is a research centre and service provider organisation, active in the field of education and training. Created by the initiative of a group of professionals, SCIENTER was established in January 1988, as non-profit organisation, of which the University of Bologna is one of the shareholders, and is represented in the Board of Directors. SCIENTER is interested in innovation of education and training systems, with main reference to the field of open and distance learning, organisational learning. It carries out activities of research, selection and assessment of learning materials, like the one performed for CERFAD (Regional Commission for the Certification of Educational Assets and Distance Learning Services) and promoted by Emilia-Romagna Region Councillorship for

School, Training, University, Work and Equal Opportunities. Furthermore, it develops research projects at regional, national, and European level in the following areas: training needs analysis; design and development of open and flexible learning systems; organisational learning design and implementation; training of trainers for the use of new methodologies and new technologies; research and selection of learning materials; market analysis in education and training, particularly concerning the use of new technologies and ODL.

2.7 Images of music scores (UNIVLEEDS)

2.7.1 Background

There are a vast amount of invaluable paper-based heritage, including printed music scores and handwritten manuscripts, that are deteriorating over time due to natural decaying of paper and chemical reaction (e.g. printing ink and paper), similar to many other paper-based items in library and museum archives. Digitisation has been commonly used as a possible tool for preservation. Although the digital copy may not conserve the original document, it can preserve the data in the document, with the advantage of easy duplications, distribution and digital processing.

Optical Music Recognition (OMR) has long been viewed as a possible automated input method for the vast amount of paper-base music documents. It was first attempted over thirty years ago by Pruslin (1966). It has received much attention over the last fifteen years (Bainbridge & Bell, 2001; Bellini et al., 2001; Bruno & Nesi, 2002, Ng & Boyle, 1992; Ng, 1995; Ng et al., 1999; Ng, 2001; Ng, 2002).

2.7.2 Commercial Systems

Currently there are a number of commercially available packages, including:

- PhotoScore, Neuratron
  - http://www.neuratron.com/photoscore.htm
- SmartScore, Musitek,
  - http://www.musitek.com/smartscre.html
- SharpEye, Visiv,
  - http://www.visiv.co.uk
- VivaldiScan, VivaldiStudio.com,
  - http://www.vivaldistudio.com/Eng/VivaldiScan.asp
- Optical Music easy Reader (OMeR), Myriad Software,
  - http://www.myriad-online.com/omer.htm
- capella-scan, WHC,
  - http://www.whc.de/capscan.htm
- MIDI-Connections Scan, CAS
  - http://www.midi-connections.com/Product_Scan.htm#englisch
- MP Scan
  - http://www.braeburn.co.uk/mp.htm#MP%20Scan
- SCORSCAN http://www.npcimaging.com/scscinfo/scscinfo.html (no longer available)

2.7.3 Survey and References

However there are still much room for improvements in many aspects. Currently there are no standard large ground truth dataset for OMR (as with other imaging domain such as Optical Character Recognition). Hence Imaging WG of MUSICNETWORK is taking up this challenge.

An online bibliography on OMR can be found at the Interactive MUSICNETWORK website. Besides common music notation, OMR related developments for other music notations include Greek Byzantine Music (Gezerlis & Theodoridis, 2000) and ancient music (Pinto et al., 2000).

2.7.4 Processings

Generally, the first process in a document analysis system is to threshold a given grey input image into a binary image. Some systems used binary input images produced by the digitiser. Typical scan resolution used is 300dpi (Selfridge-Field 1994). More recent literatures on archiving and preservation of music scores recommend higher resolution at 600dpi. Fujinaga & Riley (2002) reported that 600dpi is a sufficient resolution for all significant details. The paper suggested that further increase in resolution is not necessary for OMR.

2.7.5 Music Image Restoration

Besides recognition and translation into machine-readable symbolic representation, ICSRiM (UNIVLEEDS) is currently working on graphical representation of music scores and manuscripts. The idea is to digitize, extract and encode the music graphically, reusing the pre-processing modules as discussed earlier to extract the layout and other features of the scores, to preserve the look and feel of the original image from the paper-based input.

The advantage of optical music restoration is that the processes do not jeopardize the original layout of the scores, which have been optimized by the engravers, and normally represents the ideal visual configurations. Since the original spacing of the music is untouched, there are no large modifications and hence it does not require extensive proof reading. However, the process is only concerned with small and local modifications. Larger adjustments, for example insertions or deletions of a group of symbols cannot be fully automated without altering the original layout. No full recognition is necessary for this process and hence it does not provide multimedia functionalities such as playback or search. This process is robust and it can improve the visual qualities of the scores and manuscript for reprinting and archiving.

This is particularly important for handwritten music manuscripts, since this approach preserves the writing style and enables scalable reconstruction and visualization. Together with the intermediate results of an OMR system, the graphical representation and musical primitive recognition could provide useful synchronization links which is required to create integrated multimedia music systems (see MPEG-4 extension in section 4.1.4).

2.8 Multimedia Music Publishing (NOTISSIMO)

This is an over flight of the state of the art in multimedia music publishing.

2.8.1 Missions of the music publisher

* Discovery of new talent
* Production of the work
* Promotion of the work
* Exploitation of the work (a legal obligation):
    - In the past, printed music
    - In the recent years, production of CD
    - And now, developing schemes for new uses (music video, karaoke, music in interactive products, on-line services, and new forms of distribution).
* Administration of the work: licences, information to and from the performance organisations, mechanical rights, receiving and paying royalties,
* Protection of the work

Many of those topics are described in different sections of this document: Notation and Standards, Distribution, Protection, Imaging, Audio Processing.
In this paragraph, the promotion, the exploitation of the work will be examined throughout the market and, after, browsing the products and services.

Note: even if the publisher is not a professional publisher, those remarks, constraints … apply; an individual wanting to publish his own works has the same issues to solve.

2.8.2 The Market

2.8.2.1 Music on Internet in the world

	Billions US $
2000	1,2
2001	2,2
2002	3,6
2003	4,9
2004	6,6
2005	8,6

(Jupiter MMXI- 1st quarter 2001)

In 2004 the worldwide market for music subscriptions should be 0.47 Billions US $ and in 2007: 2.4 Billions US $ coming for 46% from the United States and for 33% from Europe. (Informa Media- march 2002)

2.8.2.2 Where are the consumers

The most active countries for downloading (Ipsos-Reid survey - 2001)

People having already downloaded music	between 18 and 24 years old customers	>24 years old customers
Taiwan	76 %	51 %
Canada	76 %	44 %
Hong Kong	75 %	58 %
Sweden	75 %	40 %
South Korea	74 %	50 %
Argentina	73 %	47 %
United States	73 %	40 %
Italy	70 %	46 %
South Africa	70 %	42 %
Singapore	69 %	38 %
Netherlands	67 %	40 %
China	65 %	44 %
Australia	61 %	37 %
India	57 %	57 %
France	57 %	34 %

2.8.2.3 European Market for online music

Millions €	2002	2005
On line CD Sales	411	1 600
Music download	3	152
Subscriptions	3,2	362

(Screen Digest - June 2002)

2.8.2.4 Online Music in Europe

Music downloaders	35 Millions
Titles downloaded (per month and per customer)	6
Percentage of customers burning CDs	37 %
Titles downloaded in Europe per year	2 Billions

(Forrester Research - 2002)

2.8.2.5 Number of unique visitors on music websites in Europe

	January 2002	February 2002	March 02
P to P sites	10 650	10 896	11 322
MP3	2 487	2 114	1 987
Artists sites	1 725	1 476	1 543

Applications	9 374	9 906	10 339
Radio	972	1 085	886
Music in Portals	2 137	2 137	2 350
CD producers	1 062	985	993

(Jupiter MMXI- 1st quarter 2002: survey in Germany, Spain, France, Italy, United Kingdom, Sweden, Switzerland)

2.8.2.6 Main legal platforms for online music

Platform	Services	Publishers	Titles	Format
Buymusic www.buymusic.com USA Created Jul. 03 Owned by Buy.com	Streaming Download Burning CD Pers. Audio device Multimedia store	Universal Warner Sony BMG, EMI Indep. labels	300 000	WMA
E-Compil www.ecompil.fr France Created Nov. 01 Owned by Universal	Streaming Download Burning CD Pers. Audio device	Universal Warner Sony	20 000	WMA
i-Tunes Music Store www.apple.com/music/store USA Created Apr.03 Owned by Apple	Streaming Download Burning CD Pers. Audio device (iPod) Email alerts	Universal Warner Sony BMG, EMI	200 000	AAC
Musicnet www.musicnet.com USA Created Dec. 01 Owned by AOL Time Warner, BMG, EMI, Real Networks	Streaming Download Burning CD	Universal Warner Sony BMG, EMI Indep. labels	350 000	WMA Real Audio
OD2 www.ondemanddistribution.com Europe Created May 00 Owned by OD2	Streaming Download Burning CD Pers. Audio device	Universal Warner Sony BMG, EMI Indep. labels	200 000	WMA
Pressplay www.pressplay.com USA Created Dec. 01 Owned by Roxio	Streaming Download Burning CD Pers. Audio device Radio	Universal Warner Sony BMG, EMI Indep. labels	300 000	WMA
Rhapsody www.listen.com USA Created Dec. 01 Owned by Real Networks	Streaming Burning CD Radio Playlists sharing	Universal Warner Sony BMG, EMI Indep. labels	330 000	WMA
VirginMega www.virginmega.fr France Created Apr. 02 Owned by Hachette	Streaming Download Burning CD Pers. Audio device	Universal Warner Indep. labels	15 000	WMA

(Journal du Net - Aug. 2003)

2.8.2.7 Short conclusion about the market

It is obvious that the part of the activities of the publishers dedicated to new uses (music video, karaoke, music in interactive products, on-line services, and new forms of distribution) is increasing dramatically.
Moreover, it is a vital stake for the future of the producers and publishers.

2.8.3 Services, Formats, Softwares

2.8.3.1 What can one do with multimedia products?

The birth of new formats allowed the explosion of the number of multi-media products and of the possibilities given to the customer to use them:
Not only the classical ones:

- Print sheet music at home
- Listen to thousands of on line radios
- Watch television
- See movies and video clips
- Download music
- Download movies
- Video game consoles
- Engrave CD, DVD on digital audio players, on home PC, on home cinema, on personal video recorders

But also new areas like:

- Softwares using multimedia products
- Web sites
- Emails services
- Chat rooms
- Sharing documents
- Files storage
- Education, teaching

2.8.3.2 Which formats and softwares?

2.8.3.2.1 Producing files

Finale 2003, Allegro, PrintMusic, SmartMusic, Notepad, Sibelius 2, Berlioz, Logic Audio, Logic Platinum, Cubasis VST 4.0, Cakewalk Sonar 3

2.8.3.2.2 Reading music files

- Windows Media Player 9. is able to read quite all the multimedia existing formats (ASF, AVI, WAV, MPG, MEG, MP3, MPE, MID, AIFF, AU).
- Foobar2000 0.62a
- Winamp 2.91
- Windows Media Encoder for uploading multimedia files on web sites.
- RealPlayer 8.0 watch TV on line (MP3 and AVI formats)
- RealJukebox transforms your audio CD in MP3 or Real Audio.
- FlashPlayer 5.0 and Shockwave Player 8.0

2.8.3.2.3 Converting audio CD into MP3

DBPowerAmp, Cdex 1.5, Easy CD-DA Extractor 5.1

2.8.3.2.4 Downloading music from Internet

KazaA Lite 2.1.0 K++, eMule 0.28b, WinMX 3.31, Bearshare, LimeWire, Gnotella, iMesh, Ohaha, FileFunnel, Napster, Rapigator, Newtella, Abe's MP3Finder

2.8.3.2.5 Repairing files

Steinberg Clean 4.0, MP3DirectCut 1.32, MP3Gain 1.0, Uncook 95

2.8.3.2.6 Organizing the files

MusicMatch Jukebox 7.5, Tag 2.1.7.4, K-MP3 3.9.62

2.8.3.2.7 Software for changing your PC into recording studio

Audacity, Protools, MixVibes Free, dbAmp Converter, MP3 Trim

2.8.3.2.8 Software for changing your PC into Hi Fi installation

Winanm, Sonique, eJay free player, Ultra Player, dbPowerAmp Player, Winamp3

2.8.3.3 Conclusion: problems

This market has exploded for a few years. The very great diversity of the formats, of the products, of the uses induced a lot of technical difficulties, whose are studied in the preceding chapters: notation, standardisation, distribution, storage, access to contents, imaging.
But the main problem seems to be problem of the rights. Since publishers have incomes from not only the direct sales, but also the performance rights and the licences rights, they have to be aware at any time of what happens with their content (either as representative of the author or composer, or as composer/author themselves).
Please refer to chapter 4.8

2.9 Music Audio Processing (CRL, ILSP)

2.9.1 MUSIC COMPRESSION - State of the Art

As far as the audio formats and the compression algorithms currently used for storing and transmitting music there are several which can be categorised into lossy and lossless compression methods.
Lossless algorithms do not change the content of a file. If you compress a file and then decompress it, it has not changed.
Lossy algorithms achieve better compression ratio's by selectively getting rid of some of the information in the file. Such algorithms can be used for images or sound files but not for text or program data. The following algorithms are lossy:

2.9.1.1 Lossless Compression

In contrast to image compression, lossless audio compression algorithms are not nearly as widely used. The primary users of lossless compression are audio engineers and those consumers who disdain the quality loss from lossy compression techniques such as Vorbis and MP3.
First, the vast majority of sound recordings are natural sounds, recorded from the real world, and such data doesn't compress well. In a similar manner, photos compress less efficiently with lossless methods than computer-generated images do. But worse, even computer generated sounds can contain very complicated waveforms that present a challenge to many compression algorithms. This is due to the nature of audio waveforms, which are generally difficult to simplify without a (necessarily lossy) conversion to frequency information, as performed by the human ear.
The second reason is that values of audio samples change very quickly, so generic data compression algorithms don't work well for audio, and strings of consecutive bytes don't generally appear very often. However, convolution with the filter [-1 1] (that is, taking the first difference) tends to whiten the spectrum a bit and allows traditional lossless compression to do its job; integration restores the original signal. More advanced codecs such as Shorten (SHN) and FLAC use linear prediction to come up with an optimal whitening filter.
Some examples of popular lossless audio codecs:

- Shorten
- FLAC
- LPAC
- OptimFROG
- Monkey's Audio
- LA (Lossless Audio)

Lossless audio codecs have no quality issues, so the usabilty can be estimated by

- Speed of compression and decompression
- Compression factor
- Software support

2.9.1.2 Lossy Compression

Note: Actually this is not a compression (i.e. redundancy reduction = reversible), but an irrelevance coding (i.e. an irrelevance reduction).
Most lossy audio compression algorithms are based on simple transforms like the modified discrete cosine transform (MDCT), that convert sampled waveforms into their component frequencies. Some modern algorithms use wavelets, but it is still not certain if such algorithms will work significantly better than those based on MDCT because of the inherent periodicity of audio signals, which wavelets seem not to handle well. Some algorithms try to merge the two approaches.
Most algorithms don't try to minimize mathematical error, but instead maximize subjective human feeling of fidelity. As the human ear cannot analyze all components of an incoming sound, a file can be considerably modified without changing the subjective experience of a listener. For example, a codec can drop some information about very low and very high frequencies, which are almost inaudible to humans. Similarly, frequencies which are "masked" by other frequencies due to the nature of the human cochlea, are represented with decreased accuracy. Such a model of the human ear is often called a psychoacoustic model or "psycho-model" for short.

Due to the nature of lossy algorithms, audio quality suffers when a file is decompressed and recompressed (generation losses). This makes lossily-compressed files less than ideal for audio engineering applications, such as sound editing and multitrack recording.
Some examples of popular audio codecs:

- MP2 Layer 2 audio codec (MPEG-1, MPEG-2 and non-ISO MPEG-2.5)
- MP3 Layer 3 audio codec (MPEG-1, MPEG-2 and non-ISO MPEG-2.5)
- MPC Musepack
- Vorbis Ogg Vorbis
- AAC Advanced Audio Coding (MPEG-2 and MPEG-4)
- WMA Windows Media Audio

2.9.1.2.1 MP3

MP3 (or, more precisely, *MPEG-1/2 Audio Layer 3*) is an audio compression algorithm (a.k.a. codec) capable of greatly reducing the amount of data required to reproduce audio, while sounding like a faithful reproduction of the original uncompressed audio to the listener.
History
The MPEG-1/2 Layer 2 encoding started as the Digital Audio Broadcast (DAB) project initiated by Fraunhofer IIS-A. This project was financed by the European Union as a part of the EUREKA research program where it was commonly known as EU-147.
Runtime of EU-147 was from 1987 to 1994. In 1991 there were two proposals available: Musicam (known as Layer II) and ASPEC (Adaptive Spectral Perceptual Entropy Coding) (with similarities to MP3). Musicam was choosen due to its simplicity and error resistance.
A working group around Karlheinz Brandenburg and Jürgen Herre took ideas from Musicam, from ASPEC and own ideas and created MP3, which was designed to achieve the same quality at 128 kbps as MP2 at 192 kbps
Both algorithms were finalized in 1992 as part of MPEG-1, the first phase of work by MPEG, which resulted in the international standard ISO/IEC 11172-3, published in 1993. Further work on MPEG Audio was finalized in 1994 as part of the second phase, MPEG-2, which resulted in the international standard ISO/IEC 13818-3, originally published in 1995.
Compression efficency of lossy encoders is typically defined by the bitrate, because compression rate depends on bit depth and sampling rate of the input signal. Nevertheless there are often published compression rates, which are using the CD parameters as reference (44.1 kHz, 2x16 bit). Sometimes also the DAT SP parameters are used (48 kHz, 2x16 bit). Compression ratio for this reference is higher, which demonstrates the problem of the term compression ratio for lossy encoders.
FhG official webpage publish the following compression ratios and data rates for MPEG-1 Layer 1, 2 and 3:

- Layer 1: 384 kbps, compression 4:1
- Layer 2: 192...256 kbps, compression 6:1...8:1
- Layer 3: 112...128 kbps, compression 10:1...12:1

These values are more or less public relation values, because

- the quality depends not only on the encoding file format, but also on the quality of the psycho acoustic of the encoder. Typical layer 1 encoders use a very simple psycho acoustic which result in a higher needed bitrate for transparent encoding.

- Layer 1 encoding at 384 kbps even with this simple psychoacoustic is better than Layer 2 at 192...256 kbps
- Layer 3 encoding at 112...128 kbps is worse than Layer 2 at 192...256 kbps.

More realistic bitrates are:

- Layer 1: excellent at 384 kbps
- Layer 2: excellent at 256...320 kbps, very good at 224...256 kbps, good at 192...224 kbps, should not be used below 160 kbps
- Layer 3: excellent at 224...256 kbps, very good at 192...224 kbps, good at 160...192 kbps, should not be used below 128 kbps
-

Comparing a new file format typically is done by comparing a medium quality encoder of the old format and a highly tuned encoder encoder of the new format.
The algorithm of the MP3 format uses, at its heart, a **hybrid transform** to transform a time domain signal into a frequency domain signal:

- 32 band polyphase quadrature filter
- 36 or 12 Tap MDCT, size can be selected independent for subband 0...1 and 2...31
- alias reduction postprocessing
-

In terms of the MPEG specifications, AAC from MPEG-2 is to be the successor of the MP3 format. In practice, however, due to numerous patenting and licensing issues with various parts of the MPEG specifications, Ogg Vorbis seems positioned to be the mostly likely successor to MP3 as the popular format for audio interchange.

MP2 and MP3 hit the Internet

In October 1993, **MP2** (*MPEG-1 Audio Layer 2*) files appeared on the Internet and were often played back using *Xing MPEG Audio Player*, and later in a program for UNIX by Tobias Bading called MAPlay initially released on Feb 22 1994. (MAPlay was also ported to Microsoft Windows.) Initially the only encoder available for MP2 production was the Xing Encoder, accompanied by the program CDDA2WAV, a CD ripper that copied CD audio to hard disks.

Beginning in the first half of 1995, **MP3** files, file representations of MPEG-1 Audio Layer III data, began flourishing on the Internet. Its popularity begat such companies and software packages as Nullsoft's Winamp, mpg123 and the now bankrupt Napster.

Quality of MP3 audio

Many listeners accept the MP3 bitrate of 128 kilobits per second (kbps) as near enough to CD quality; this provides a compression ratio of approximately 11:1, although listening tests show that with a bit of practice, most listeners can reliably distinguish 128 kbps MP3s from CD originals. To many other listeners, 128 kbps is unacceptably low quality, which is unfortunate since many commonly-available encoders set this as their default bitrate.

Possible encoders:

- ISO dist10 reference code: Worse quality, invalid MP3 files (all audio blocks are marked as corrupted)
- Xing: mainly based on ISO code, quality similar to ISO dist10
- Blade: quality similar to ISO dist10
- FhG: Some of them are good, some have really nasty bugs
- ACM Producer Pro: Some versions generate annoying artefacts
- Lame
    - r3mix: outdated for more than 2 years
    - alt-preset: Alternative presets by Dibrom (Nickname of a Lame programmer) with good quality at medium bitrates.
    -

Quality of MP3 depends on quality of encoder and the difficulty of the signal which must be encoded. Good encoders gave acceptable quality at 128...160 kbps, nearly transparence is achieved at 160...192 kbps. Low quality encoders never reach nearly transparence mode, even not at 320 kbps. So it is pointless to speak from 128 kbps or 192 kbps quality. A 128 kbps MP3 encoded with a good encoder typically sounds better than a 192 kbps MP3 encoed file with a bad encoder.

An important feature of MP3 is that it is lossy -- meaning that it removes information from the input in order to save space. As with most modern lossy encoders, MP3 algorithms work hard to ensure that the sounds it removes cannot be detected by human listeners, by modelling chacteristics of human hearing such as noise masking.

However, experienced listeners can tell the difference from the original at 192 kbps, and even at 256 kbps on some of the less powerful (and obsolete) encoders. If your aim is to archive sound files with no loss of quality, you may be more interested in lossless audio compression such as FLAC, SHN, or LPAC -- these will generally compress a 16-bit PCM audio stream to approximately 50-75% of the original size (depending upon the characteristics of the audio itself).

Bit Rate

The bit rates, i.e. number of binary digits streamed per second, is variable for MP3 files. The general rule is that the higher the bitrate, the more information is included from the original sound file, and thus the higher is the quality of played back audio. In the early days of MP3 encoding, a fixed bit rate was used for the entire file.

Bit rates available in MPEG-1 layer 3 are 32, 40, 48, 56, 64, 80, 96, 112, 128, 160, 192, 224, 256 and 320 Kbits (10^3 bits) per second, and the available sample frequencies are 32, 44.1 and 48 kHz. 44.1 kHz is almost always used as this is the audio CD frequency, and 128 Kbit is some sort of de facto "good enough" standard. MPEG-2 and (non-official) MPEG-2.5 adds more bitrates: 8, 16, 24, 32, 40, 48, 56, 64, 80, 96, 112, 128, 144, 160 kbps.

However, audio in MP3 files are divided into chunks called frames, which all have a bitrate marker, so it is possible to change the bitrate dynamically as the file is played. This technique makes it possible to use more bits for parts of the sound with high dynamics (much "sound movement") and less bits for parts with low dynamics. Some encoders utilize this possibility to greater or lesser extent.

Design bugs of MP3

There are several flaws in the MP3 file format, which can't be fixed by a good encoder. This flaws are inherent properties of the MP3 file format.

- it can't be encoded the exact play length of a piece of music (Vorbis)
- time resolution is too low for highly transient signals (AAC, Vorbis)
- encoder/decoder overall delay is not defined (Vorbis)
- so scaleband factor for frequencies above 15.5/15.8 kHz (AAC, Vorbis)
- joint stereo is done on a frame base (AAC, Vorbis)
- bitrate is limited to 320 kbps (AAC, Vorbis)

In parentheses are the file formats where this bug is fixed.
Encoding of MP3 audio
The MPEG-1 standard does not include a precise specification for an MP3 encoder. The decoding algorithm and file format, as a contrast, are well defined. Implementors of the standard were supposed to devise by themselves algorithms suitable for removing parts of the information in the raw audio (or rather its MDCT representation in the frequency domain). This process is typically based on psycho-acoustic coding, i.e., you remove things that a human listener will not notice anyway by modeling our audio perception system (both in our ears and in our brain).
As a result, there are many different MP3 encoders available, each producing files of differing quality; as of September 30, 2001, the best encoder at high bitrates (128 kbps and up) is LAME, and the best at low bitrates is Fraunhofer's own encoder. MP3 decoding, however, is carefully defined in the standard. Most decoders are "bitstream compliant", meaning that they will each produce exactly the same uncompressed output from a given MP3 file.
Many other lossy audio codecs exist, including:

- MPEG-1/2 Audio Layer 2 (MP2), MP3's predecessor;
- MP+, a derivative of MP2;
- MPEG-2 AAC, used by LiquidAudio, but not many others due in part to stiff patent royalties;
- ATRAC, used in Sony's Minidisc;
- AC-3, used in Dolby Digital and DVD;
- QDesign, used in QuickTime at high bitrates;
- Windows Media Audio (WMA) from Microsoft;
- RealAudio from RealNetworks;
- mp3PRO from Thomson Multimedia;
- Ogg Vorbis from the Xiph.org Foundation, a free software codec.
-

MP2, MP3, AAC, and mp3PRO are all members of the same technological family and depend on roughly similar psychoacoustic models. The Fraunhofer Gesellschaft owns many of the basic patents underlying these codecs, with Dolby Labs, Sony, Thomson Consumer Electronics, and AT&T holding other key patents.
Alternatives to MP3
There are also some non-lossy (lossless) audio compression methods used on the internet. While they are not similar to MP3, they are good examples of other compression schemes available. These include:

- SHN, FLAC, Monkey's Audio

MP3, which was designed and tuned for use alongside MPEG-1/2 Video, generally performs poorly on monaural data at less than 48 kbps or in stereo at less than 80 kbps.
Though proponents of newer codecs such as WMA and RealAudio have asserted that their respective algorithms can achieve CD quality at 64 kbps, listening tests have shown otherwise; however, the quality of these codecs at 64 kbps is definitely superior to MP3 at the same bandwidth.
Thomson claims that its mp3PRO codec achieves CD quality at 64 kbps, but listeners have reported that a 64 kbps mp3PRO file compares in quality to a 112 kbps MP3 file and does not come reasonably close to CD quality until about 80 kbps.
The Xiph.org Foundation, the developers of the Vorbis algorithm used in the new Ogg format, claims that Vorbis somewhat exceeds MP3 and WMA sound quality while infringing no patents, and provides a web page with listening tests to demonstrate this.
Licensing and patent issues
Thomson Consumer Electronics controls licensing of the MPEG-1/2 Layer 3 patents in countries such as the United States of America and Japan that recognize software patents. Thomson Consumer Electronics has, so far as yet, decided not to cash in on the patents, but this possibility looms like a shadow over the .mp3 file. In fact Microsoft, the makers of the Windows operating system, chose to move away from MP3 to their own proprietary Windows Media formats to avoid any patent implications.
In spite of these threats, the perpetuation of the MP3 format continues; the reasons for this appear to be the network effects caused by:

- people's familiarity with the format,
- the large quantity of music now available in the MP3 format,
- the wide variety of existing software and hardware that takes advantage of the file that revolutionized the music industry and copyright law.

2.9.1.2.2 **Ogg Vorbis**

Ogg Vorbis is a completely free and open audio compression (codec) project from the Xiph.org Foundation, and is part of their Ogg effort to create free and open multimedia and signal processing standards.

Like all developments of the Ogg project, Vorbis is believed by the developers to be completely free from the licensing or patent issues raised by other proprietary formats such as MP3. Outside parties have doubted the claim that Vorbis would be patent free, but without supporting any evidence on the contrary, it has been noted that this may be so-called FUD.
Compared to other audio formats Ogg Vorbis is relatively new, having been refined by developers until a stable version 1.0 of the codec was released on July 19, 2002.
Ogg Vorbis Popularity Growth
The Ogg Vorbis format has proved popular among open source communities, and they argue that due to it's higher fidelity, and completely free nature, it is a natural replacement for the entrenched MP3 format. However, MP3 has a popular history dating back to the mid-1990s and is still the primary lossy audio format. It may be some time before one sees more Ogg format files than MP3 files. In the commercial sector, Ogg Vorbis has already replaced MP3 as the *de facto* standard audio codec, with many newer video game titles employing Ogg Vorbis as opposed to MP3.
Technical Details
Given 44.1 kHz (standard CD audio sample frequency) stereo input, the current encoder will produce output from 45 to 500 kbps, depending upon the specified quality setting. While Vorbis 1.0 is tuned for bitrates of 16-128 kbps/channel, there's nothing saying you can't encode at 512 kbps or 8 kbps. These numbers are only approximate, however, as Vorbis is inherently variable bitrate (VBR). Vorbis currently produces better audio quality and smaller file sizes than other formats under comparable circumstances.
The specifications are placed in the public domain, the libraries are released under a BSD-style license, and the tools are released under the GPL (GNU General Public License).
Vorbis uses the modified discrete cosine transform (MDCT) for converting the sound data from time domain to frequency domain and back.
Hardware and Software Support
A fixed-point implementation of the Ogg Vorbis decoder, called **Tremor**, also under a BSD-style license, was released on September 2, 2002, in hopes that manufacturers of hardware audio players would support the format in upcoming versions and models of their devices. iRiver America, manufacturer of the popular iRiver MP3/WMA player, is reportedly in the testing stage of releasing a Vorbis-compatible firmware version.
RealNetworks has announced that they will support Ogg Vorbis in their products. See Helix project for more details.
Ogg Vorbis can be played using these (and other) players:
XMMS (for UNIX-style systems, GPL [formerly known as X11amp])
zinf (for Linux and Windows, GPL [formerly known as FreeAmp])
Winamp (for Windows, freeware but not free software)
JOrbis (pure Java, LGPL)
foobar2000 (for Windows, freeware, focused on high quality playback)
The BBC has recently experimented with putting out Vorbis-encoded audio streams. The technical experiments are now complete, and the BBC is considering whether to deploy the technology.
"Ogg" is *not* named after the witch Nanny Ogg in Terry Pratchett's Discworld books. However, "Vorbis" *is* named after another Discworld character, High Priest Vorbis in Small Gods.

2.9.1.2.3 Windows Media Audio

The Microsoft® Windows Media™ Audio codec is designed to handle all types of audio content, from speech-only audio recorded with a sampling rate of 8 kilohertz (kHz) to 48 kHz high-quality stereo music. This codec is very resistant to degradation due to packet loss because it does not use interframe memory. Its tolerance makes it excellent for use with streaming content. In addition, by using an improved encoding algorithm, this codec encodes and decodes much faster. The compression algorithm used creates audio files that need much less disk space for storage than the same content created with other codecs. Content created using the Windows Media Audio codec is easily distributed over the Internet because the files can be downloaded more quickly. Therefore, if you are creating audio files for download, the Windows Media Audio codec is a great choice because it provides near-CD, quality sound at half of the bandwidth required by most other codecs.

During tests against comparable codecs, the Windows Media Audio codec provided much clearer sound with greater tonal distinction than the others. The combination of superb clarity and tonal depth produces better-sounding music content across all supported bandwidths. The Windows Media Audio codec is highly scalable and provides high-quality mono and stereo audio content over a wide range of bandwidths. This allows you to choose the best combination of bandwidth and sampling rate for your content. Microsoft has chosen to make it the default audio codec for Microsoft Windows Media 9 encoding tools, and to include it in a Software Development Kit (SDK) for developers who want to use the Windows Media Audio codec to create high-quality audio files.

Comparison tests have shown that among all available formats the one with the best quality is hard to define, however if one keep in mind the outcome of these comparisons testings throughout time, can easily understand that this is a field of big and strong competition. Nowadays, the main actors in this field are the MP3, the WMA, the OGG VORBIS and the RealPlayer formats, as well as other proprietary formats that combine DRM. The field has been divided into two main conflicting interests though, the one for free and controless distribution of music (ie OGG, MP3) and the oposite side of distributing music of high quality with DRM management and control (ie WMA, hybrids of MP3, etc). This is probably one of the major issues concerning modern music indusrty, and main topic of protection workgroup in MUSICNETWORK.

2.9.2 MUSIC Audio Protection

This is one of the major issues concerning the modern music industry and although it is comprised in the general field of music audio encoding-compression, it consists by itself a whole new sector of research and study. In order not to be repetitive, this topic is more thoroughly and in detail discussed in the music protection section.

- Audio protection algorithms
- Media Copy-protection algorithms

2.9.3 MUSIC Audio Processing

- Signal Enhancement-Restoration
- Music Audio recognition

3 The Potential Users their needs

The project results will be useful to the different actors in the multimedia music scenario, which includes, multimedia music content providers (publishers, archives, distributors, music shops, etc.), music consumers (musicians, music lovers, music students, music schools, conservatories, multimedia libraries with their attendees) and multimedia software builders. In the following, the most important needs for each category are reported.

In the following a classification of potential participants is reported.

- content producers for music scores
  - music copyists, encoders, engravers, music typesetters, composers, music schools and conservatories, music owners,
- audio content producers
  - broadcasting agencies, music owners, music schools and conservatories,
- content publishers
  - publishers, labels, broadcasting agencies,
- contents distributors
  - broadcasting agencies, service providers, content distributors (score, audio, etc.),
- archives and collectors:
  - music libraries, multimedia distributors, documentation centers, audiovisual/multimedia archives, music-related museums
- content professionals for metadata
  - librarians, archivists, cataloguers (including providers of commercial/trade/retail catalogues)
- tool creators for content manipulation, distribution, etc.
  - experts on music imaging, multimedia software developers;
- research centers and technology providers
  - research & development institutions and organizations, music tools builders, computer music research institutes, ttechnology providers,
- contract and legal managers, legal support providers
  - economy and marketing, copyright collecting societies, phonic associations, publishers associations, experts in copyright,
- content users
  - musicologists, music schools and conservatories, musicians, players, performers, orchestras, chamber music groups, music teachers and students (educational sectors), visually impaired people, universities, broadcasting agencies, audiophiles, music amateurs…

They can be grouped in a smaller number of groups.

Multimedia and Music Publishers, Music and multimedia Distributors (about 450 medium and large distributors in Europe)

- *To exploit new content. This could be possible thanks to the integration in multimedia objects of different types of contents: audio, video, documents, etc;*

- *to protect music and thus to (i) distribute music in a safer manner, (ii) to be more convinced about the viability of the electronic market;*
- *to distribute music to a wider audience and to reduce the cost of promoting music and/or related events;*
- *To easily promote new music pieces (infotainment), composers, musicians, manifestations, products, via WWW, WEB-TV, UMTS devices;*
- *to distribute music with customised digital right management, DRM, mechanisms.*

They have understood that simple audio files or music sheets are not really interesting for the consumers. Music sheets can be easily photocopied, audio files can be cloned and freely distributed. The added value of the on-line distribution and on the distribution of digital objects is in the integration of different information;

Multimedia Libraries, and libraries of music schools, conservatories, etc. (about 2500 large libraries in Europe)

- *To find tools and solutions to offer new services for their users;*
- *To compare music pieces visually and/or analytically (for different executions and preparations);*
- *To execute music and at the same time to visualize the corresponding score generated by the symbolic music or to visualize the handwritten music sheet of the compositor;*
- *To easily promote new music composers and musicians and their manifestations;*
- *To share their digital content with other libraries and archives;*
- *To save in digital the cultural heritage contained in their historical archives.*

Music archives are significant sources of cultural heritage, be they independent mediatheques or archives associated with theatres, orchestras, music schools, conservatories, museum, foundations, universities, etc. Most of them present non-digital music objects such as audio (disks, cassettes, tapes, etc.), video tapes, documents and pictures. This material has a great cultural value for music lovers, students and experts. The publishers are not interested in digitizing this content since they do not see the possibility of a direct return of investment. The archives are interested in digitizing that content to (i) improve the service towards their attendees, (ii) add new functionalities at the service provided, (iii) save the material. The digitization of historical music archives can be a way to share via Internet the content among archives.

Music Shops, Messagerie (about 3500 medium and large in Europe)

- *They are transforming their market to be more digital and computer oriented;*
- *In the near future they will become a sort of multimedia kiosks, in which visitors can buy customised audio and video collection on CDs, DVDs or other media;*

Music Schools, Conservatories, Arts-music-theatre universities (about 2500 in Europe)

- *To produce specific multimedia music courseware for their pupils;*
- *To receive multimedia music content that will be used for preparing performances and lessons;*
- *To easily promote the young music composers and musicians and their manifestations;*
- *To exploit new methods for tuition;*
- *To acquire multimedia music content form publishers and distributors in real-time.*

Music Consumers (about 90 Million in Europe)

- *To receive multimedia music content that can be manipulated with the agreement of the publisher at reasonable price. They need to manipulate digital content in several ways;*
- *To have a huge amount of additional information that can be useful to understand and appreciate music;*
- *To reduce the cost and time to receive music;*
- *To have the possibility of enjoining the acquired music in several different devices and conditions.*

Multimedia Software Builders

- *To get real needs from their potential customers and corresponding end users;*
- *To stay updated about new technologies and solutions defined by research centres and institutions in the area of multimedia music fruition, distribution and modelling;*
- *To maintain updated about the market evolution in the field of multimedia music;*
- *To promote their solutions towards content providers and end users.*

4 The Innovative Applications in the above fields

4.1 Innovative Applications in Music Notation Modeling and Standards (DSI, IRCAM)

4.1.1 Identified Problems

The modelling of music notation is a rather complex and composite problem. Music notation is a multi-layered piece of information, which may be used for a wide range of different purposes: from audio coding and entertainment to music sheet production, music teaching, music analysis, content query, provision of enhanced or adapted music for consumers with specific needs, etc. In the current Multimedia and Communication age many new music-related applications are strongly attracting the market attention and most of them will become more and more widespread in a short time. In order to identify a unique notation format to satisfy all these application fields and to set the basis for the new forthcoming applications, several aspects have to be considered, ranging from information modelling and format to integration and synchronisation of the music notation information into other media and cross-media tools and formats.

The evolution of information technology has recently produced changes in the usage of music notation, transforming the visual language of music from a simple written "graphic alphabet" for creating music sheets to a tool for modelling music in computer programs, cooperative work on music and other multimedia integration tasks, associating actions to music notation features during playing, etc. More recently, millions of music users have discovered the multimedia experience, and thus, the traditional music notation model thus needs to be replaced with something much more suitable for multimedia representation of music. The improved capabilities of computer programs are going to solve many of the early music notation formatting problems encountered by the adoptionof powerful tools based on artificial intelligence technologies.

The present models for music notation are unsuitable to cope with many innovative applications [8]. A deep analysis suggested that the music notation mainly comprises of four domains of representation. Elsewhere, these domains may be referred by different terms, but here we categorise the domains thus:

- **Audio:** description of how a given note or chord has to be played in terms of parameters in the frequency domain, orchestration, sampling of audio signals to be used as wave tables to play notes, etc.
- **Logical:** description of the music notation structure in terms of sequence of notes, rests, chords, etc. organised into instruments, voices, measures, etc. This also includes the expression symbols that represents how a certain note or sequence should to be executed: markers (general terms used in some programs to identify accents, ornaments, etc.), accents, ornaments, accidentals, key signatures, clefs, dynamics, key signatures, crescendo and decrescendo, phrasings, bowings, instrument indications, metronomic indications, multilingual lyric, etc. M;any performance parameters (e.g., MIDI) can also be included in this domain. Also needed is the modelling of rules to generate alternative music notation for specialised consumer groups to be associated with the logic aspects. In this case, strong relationship with Audio Domain is needed. .
- **Visual:** parameters describing, the visual representation of the logical content as absolute and/or relative positions (spacing), colours, stem direction, beaming structure and slope, refrain/chorus, generic rests, slurs shape (knots based or other), 8va or 8ba or 15ma, repetition symbols, barlines, etc., and also the eventual image representation of the score, graphic representation of modern music notation symbols, formatting representation of the main score and individual parts in terms of justification parameters and page layout, ordering for symbols positioning around the figures, etc. (for example, which symbol has to be positioned closer to the notehead if a staccato, a slur, and a fingering are present on the same note) This domain implicitly also includes the formalisation of the relationships among music notation symbols. It also includes the description of the image sheet and its relationships with the music notation structures and elements (parts, measures, etc.)
- **Graphic** representation deals with the mechanisms to produce the music notation on an image sheet either as print output or screen canvas. This is performed by using graphic primitives and fonts, and associated parameters such as size, font and style together with mechanisms to avoid confusions (e.g., collisions, overlapping, etc) among graphic details. Details from the visual domain have to be considered as high level aspects/directives for the graphic representation. Separating graphic and visual aspects gives the possibility of generating alternative visualisations of music notations, for example for visually or print impaired users.

The above information need to be supported by the following aspects that may be represented using current standards:

- **Multimedia hyperlinks** from music notation elements to and from other media,
- **Synchronisation** with other media (audio, video, text, for karaoke), images of music sheets, documents, etc., but also at the logical level of the measure or note and not only based on time stamps.
- **Cataloguing and identification aspects:** bibliographical metadata, UNIMARC, Z39.50, ISMN, etc.
- **Protection, DRM, etc…**

The problems to be addressed are the integration of music and musical knowledge in its visual, audio and logic forms - particularly scores – in multimedia applications. The integration of these elements permits the construction of a number of interesting new application areas for musical activities, such as:

- Multimedia music distribution
- Music education and music courseware construction
- Music searching in all domains
- Music annotation in all domains
- Music editing in all domains
- Music formatting in the visual domain
- Music navigation in all domains
- Music formatting and presentation in other representations: Braille music, Spoken Music, etc.

4.1.2 Content and cases for Evidence and Validation

In this section, some use cases and related requirements in terms of music notation are reported to make evident the requirements in the area of music notation and multimedia at the moment. Currently, there exist a lot of applications that are only focussed on one or two functionalities in the above listed application areas, while all those functionalities are strongly related to each other and need unified models and formats.

4.1.2.1 Multimedia music distribution through physical devices and online

One of the biggest advantages of digital formats and their integration is the possibility to distribute content in a variety of forms in a completely integrated manner. The distribution of multimedia music content including music notation can be used for a large variety of applications of education, edutainment, entertainment, infotainment, etc.
At present with traditional distribution via CDs or sheet music these aspects are neglected, while the 12% of the European Population is capable of reading music and playing an instrument. In addition, the largest market for music notation is closely related to music education. About the 80% of young students in Europe is involved to study music, that implies that a large part of them is capable of music notation reading and music instrument playing in some measure.

For these reasons, in the same way that a text can be synchronised to images and sounds in commercial DVDs, it is strongly desirable to have the possibility of distributing content in different forms related to the same piece of music, including music notation for various (or separate) several instruments and voices. This would allow on the client side

- Generation of
  - transposition of the a provided music score provided from the server,
  - piano reduction,
  - specifically formatted music,
  - guitar tablatures,
- Visualization/playback of
  - music score synchronized with audio (MIDI or recorded from real performance) or video,
  - multilingual lyrics to the same music notation,
  - lyrics with music notation synchronized with video or audio (music karaoke, vocal and aural training),
  - animated hands (via virtual reality) for showing musical instruments being played,
- etc.

Most of these aspects have to be automatically performed on the basis of a music piece and not encoded for each specific music piece as in many software programs for music education and entertainment.

4.1.2.2 Music education and courseware construction

For music education and courseware construction music notation needs to be integrated with multimedia capabilities. Music courseware need to have music notation integrated with video, images, documents, animation, audio, video, etc. In addition, a music course may present some exercises which require special music notation symbols (e.g., given by the teacher for the student) and/or audio processing (e.g., play training assessment, theory training assessment, etc.). For these reasons, for music education and courseware production the users on the client (music content usage) and sever (content generation) sides have a visual representation of the musical score (with full access to audio and logical aspects), with full capabilities of music manipulation in all domains and a support for the synchronisation and establishing relationships with other media.. Therefore, system and model have to provide the possibility of:

- music editing, transposing, playing, formatting, etc.; this implies the dynamic alteration of aspects in the logical, audio and visual domains.

- Recognition of notes played by an instrument or voice, using pitch recognition or other technologies. This means that it needs to visualise the visual parts and compare the audio produced with what is expected, at the logical/symbolic level.
- synchronisation of notes played with the musical score, so as to show in a visual manner the correct point in the score being played. This requires the presentation of the visual aspects synchronised with the audio possibly allowing for changing the velocity of performance.
- assessment with respect to semantic annotations (how to execute a certain symbol, how to assess a certain execution of a music notation piece from the pupil, etc.) related to the above three domains: error recognition, evaluating a performance (scoring the execution for didactical purpose).
- playing along: automatic accompaniment of the user by having the computer play selected voices/parts. This can be performed by using real audio recorded, generating MIDI, or by a more sophisticated music notation rendering. The system mast be capable of automatically following the pupil performance and to product comments and corrections on-line or off-line.
- Cooperative work on music notation for classes, for orchestral work on music lecterns (e.g., Tablet PCs), for managing rehearsals, etc.
- Annotation, for adding teacher and pupil annotations that may be textual or in music notation; see also Section 1.1.3 on annotation. This also includes capabilities of versioning.
- Navigation among music notation features and multimedia aspects and content.

4.1.2.3 Music searching in all domains

On the client side, it is very important to be capable to specify a query in terms of audio, logical and visual aspects, rather than by relying on traditional cataloguing and identification aspects. A query to find music pieces could be expressed by:

- Humming (monophonic), playing a MIDI keyboard (polyphonic), playing an acoustic instrument (either);
- writing a sequence of notes with a music editor, and specifying for some of them the range of pitch, duration, markers, audio effects, etc.;
- giving a rhythm with a sequence of note durations;
- selecting (by mouse or other means) a segment of an onscreen music notation score (monophonic or polyphonic, query by example). It could be done even selecting two music pieces as a sort of range;
- requesting the presence of educational aspects, annotations and support.
- integrating cataloguing aspects with query by content: logical, audio and visual representation aspects.

Combination with logical operators of these queries.

4.1.2.4 Music annotation in all domains

The users from both server and client side need to be able to annotate music interactively by using

- personal or predefined music notation symbols (for example, to explain the semantic of music symbol or a possible comment on some music notation part), or
- simple textual or multimedia information (for example, the addition of an image or a video related to the music aspect).
- Audio details (for example, the example of the interpretation of a music notation symbol or music part as interpreted by different famous artists or by your teacher, etc.)
- visual details and representation constraints (for example, the user may decide to hide a given symbol or to change it position with respect to the others, etc.).

These annotations should be stored separately, and should be semantically linked to symbolic elements of the score, like measure, beat, note, voice and so on. They could appear differently in the main score and the parts, when the music is executed, printed or visualised, etc.

4.1.2.5 Music editing in all domains

Music editing is typically used from both the server and client sides. Users need to manipulate the logical, audio and visual aspects and the relationships of these with multimedia. This facility is typically focussed on the production of content for educational aspects or for producing music sheets. More recently the need of producing nice music scores to present them in multimedia applications has been realised.

4.1.2.6 Music formatting in the visual domain

The music formatting is very useful for creating the visual and graphical details from logical representations using rules such as performed in [13] and other languages. These can be loaded as defaults or defined by the user for customising and profiling his needs.

This feature is very important for music editing tools (used by copyists, composers or music lovers) that need to create music sheet from scratch. It is also very important for Music Recognition tools that must recreate the music

page from a logical description recognised from an image (e.g., via Optical Music Recognition, transforming paper-based music to symbolic machine representation) or from audio processing approach (e.g., pitch tracking, transforming wave source to symbolic machine representation, audio music recognition or transcription).

This feature also includes the possibility of defining different formatting styles.

4.1.2.7 Music navigation in all domains

Music notation navigation is a bi-directional feature. Users need to be capable to pass seamless from music notation items to other elements of the multimedia model and vice-versa:

- The user could browse a music score and follow hyperlinks associated to notes or measures, or other entities of the logic, audio and visual domains. The hyperlinked content could be external (a URL) or internal (an MPEG-4 component, element). The content associated with a note/measure could be a video/image/text explaining a difficult passage, for example.
- The navigation could be into the music notation structures and lower-level elements of the logical domain. From an MPEG4 elements it is useful to reach the music-notation content. For example, presenting the associated music notation with a video presenting the hand of a pianist, etc. This is a feature very useful feture for educational tools.

4.1.2.8 Music formatting and presentation in other representations

Producing enhanced music notation is a laborious activity. The production of these enhancements requires expertise and resources retrieved from all the use-cases described above. Additional expertise is required to combine all the issues mentioned above into a workable and practical set of resources and operations, enabling the translation from the 'normal' domain to the 'accessibility' domain. Incorporation of these accessibility notions into a widely used multimedia representation format would enable:

- Enhanced browsing experience with specialised functionality for specialised assistive needs (for example, when a non expert perform music editing it could be useful for him to have a verbal description of the context: measure 45, quarter chord of a D and C flat with arpeggio, etc.). This is very useful for impaired, young students, dyslexic people, etc.
- Synchronising delivery of new content available in such a format for print impaired and sighted (for example, to have a verbal description of music synchronised with its playing).
- customising the presentation of the musical content to the needs of the individual print impaired user (for example, selecting symbols to be verbally described or printed, selecting a simpler model for the visualisation, for example without beaming, etc.).
- preserving specific knowledge and resources to allow the accessibility of musical information for other impairments.

4.1.3 Benefits that can be obtained solving the problems

The benefits of solving the problems highlighted above are remarkable. A unified model for music notation integrated with an MPEG standard could provide the solutions for several classes of applications including:

- distribution of music content and courseware on media devices, i-TV and other devices such as PDAs,..
  - multimedia music distribution on multimedia devices, mainly visual and audio support;
  - fruition of composite music-related information, mainly audio and simple visual representation;
- creating innovative applications incorporating multimedia integration with:
  - music editing and formatting (an example might be WEDELMUSIC editor with MILLA engine)
  - cooperative work on music score (an example might be MOODS)
  - producing opera content with VR-3D, synchronisation of music notation, lyric and virtual modeling (an example can be OPENDRAMA)
  - synchronisation of symbolic music score and real audio (an example might be WEDELMUSIC)
  - 3D hand representation and synchronous score visualisation (an example might be MUSICALIS, EMEDIA, PLAYPRO, GUITAR Magic)
  - synchronisation of images of music score and real audio (an example might be WEDELMUSIC)
- creating content and courseware for music education
  - examples of multimedia music content can be MUSICALIS, SMARTSCORE, WEDELMUSIC
  - cases in which the pupil can do
    - play training (examples can be MUSICALIS, PIANO TUTOR),
    - compositional training,
    - play along (see Master Play along, MUSICALIS, PIANO TUTOR, VOYETRA),
    - sing training,
    - conduction training (see example of Vienna Philharmonic),
    - improvisation training, etc.

- production of music notation and synchronisation with other media
  - optical music recognition applications
  - music transcoding: from audio to music notation via audio processing
  - establishing relationships among images of music sheets and symbolic representation
- creating and managing content in music archives
  - examples can be WEDELMUSIC tools
- creating the support for the interoperability among the above mentioned different applications.
- creating musical information for consumers with different accessibility needs.

4.1.4 Possible Solutions and related issues

The extension of MPEG-4 for modelling and integrating music notation seems to be a feasible and interesting possibility. On one hand there exists, among the requested functionalities, also the need to make composite queries. They are more related to the descriptors of MPEG-7. On the other hand, MPEG-4 seems to be more suitable for many aspects, since in the identified applications the music notation is mainly a content item that can be decoded for producing audio, representations (parts, main scores, etc.) and with which the user may interact to change these representations.

Music notation has to be considered mainly as a visual formalism used to encode musical information in the same way as text is a visual formalism used to encode speech.

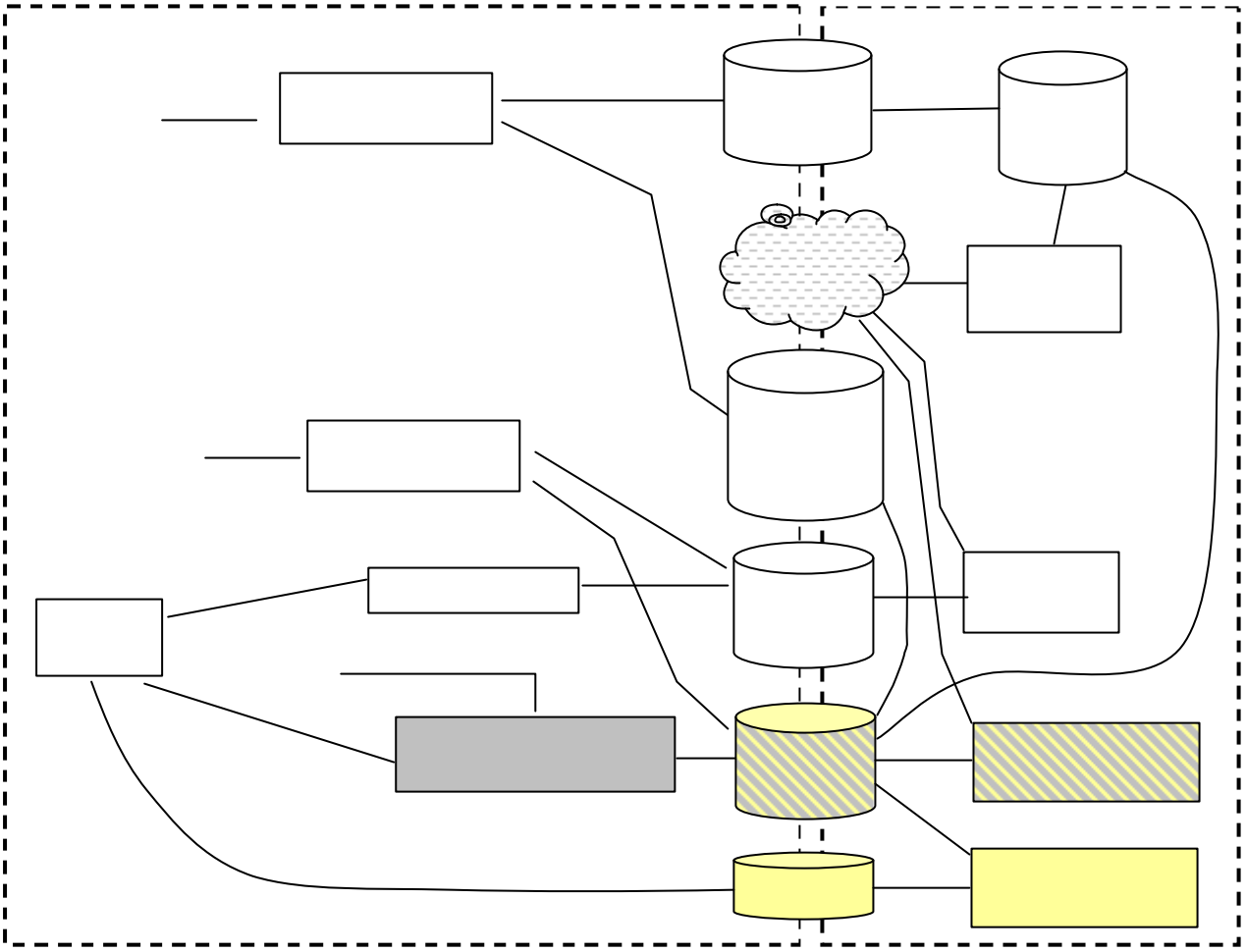
How music notation could be put in a multimedia object?

- The first simple solution might be as a raster image but it offers very low interactive capabilities (a note? Where is a note?) and printing will be at a low quality (at the resolution of the image and not like the case of vectors described in PostScript). Synchronisation with other media is also difficult (common picture formats are not spatially time-stamped).
- The second solution might be using vector graphics which results to have some interactivity (am I a note? No I'm a black ellipse) and a good printing quality.
- The third solution might be to associate to what it is shown a description of what it is. (I'm a black ellipse and I represent a C# quarter note). Since descriptions can be time-stamped, synchronisation with other media may be straightforward.

Unfortunately, what one can imagine to display is not all the information needed and/or available; the user sees the violin part score of Mozart's Trio and the computer plays also the other parts; but these other parts are not shown on the screen and thus where can they be stored ? What the user look at is a view (or projection) of a more complex data structure representing the whole music piece from which data is extracted (the violin part, the viola part, the main score) to produce a visual/graphic representation. The concept of view can be generalised also to an audio 'view' and thus data can be extracted to produce an audio representation (e.g. SASL). On the side of content production, in principle information can be extracted from the music piece data to produce melody descriptions to be used to index the music pieces and thus use the tools built for melody retrieval also for music notation search (query by humming). The same way, other kinds of symbolic structured information may be available through extraction or other authoring tool, creating a complete set of different data streams of different types all related to the same music piece; synchronisation among music notation information and all these object types is required.

The above Figure depicts only the data transformation aspects. It includes both the aspects of music notation description for query by content and the content modelling, coding and decoding.

How to integrate Music Notation in the current MPEG framework ? As mentioned above, music notation contains both content and descriptive information, so it is related to MPEG-4 but also to MPEG-7.



4.1.4.1 MPEG-4 related issues

In terms of MPEG-4, Music Notation may be integrated at least in two different ways.

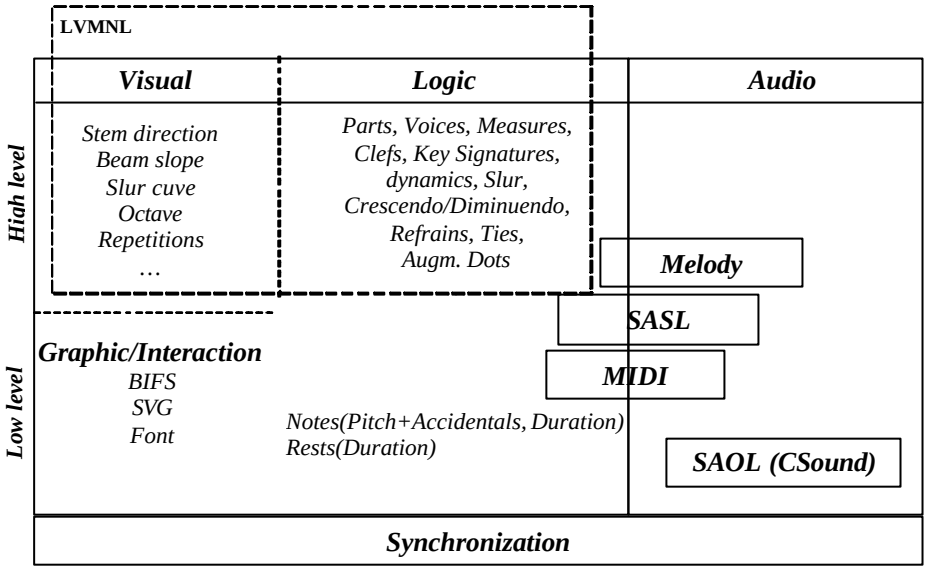
The first solution may be to deal with visualisation of notation as it happens with texts, by a specific (or a small set of specific) BIFS node(s) dedicated to the specification of the musical font, of the ad-hoc rules, etc. In this case the Music Notation content can be included in a field dedicated to code the musical information, or as well referenced by a field pointing to a specific stream carrying the musical information possibly in real-time. In this case, the content can be in form of plain text (like e.g. in the case of an XML-based notation format) or a form of binary-coded stream to reduce the bandwidth, like in the case of BIFS (vs. XMT). At the same time, the node should be able in any case to receive MIDI or SASL streams, that are already carried in MPEG-4 by the Structured Audio toolset and synchronised by time-stamping mechanisms with natural audio content.
In this first case, it is the BIFS Player itself that deals with the visualisation process, and the synchronisation with sounds must be assured by the visual node "execution". In some way this can simplify the process if the node can also receive sound composition buffers as input and dynamically deal with related sound. One possibility could be the realisation of at least the nodes modelling the part and the main score details of the music notation.
This solution is quite static and needs multiple coding to provide the music notation for the whole music piece. For instance, main score and parts are typically needed and present different formatting rules.
The synchronisation with music notation has to be done at level of measure or music notation symbol with audio samples or relative execution time. To this end, a specific node for modelling synchronisation is needed.

The second solution may be to define a specific new Object Type for Music Notation, able to "decode" the input stream and to generate the correct visualisation of the content. In this case, all the issues related to fonts, display etc. can be managed directly by a specific decoder, while the synchronisation issue may result someway more complicated; in fact, this should be solved in terms of BIFS scene authoring trying to deal with all the related ROUTEs that may help to implement an interactive user behavior. This new object type should be in tight relationship again with the SA stream, which is containing information that can be as well input for the notation decoder. This version has some advantages since all the complexity of music notation is confined into the new Object Type. Having the Music Notation decoder the MPEG4 Player based on BIFS get the specific information from the decoder according to its needs and to the visualization parameters.

Even in this case, the synchronization with music notation has to be done at level of measure or music notation symbol with audio samples or relative execution time. To this end, a specific node for modeling synchronization is needed. This node can load the synchronization file/stream stating the relationships between the music elements and the audio.

4.1.4.2 MPEG-7 related issues

In terms of MPEG-7, the Music Notation content, being it visualized by a BIFS node or by a specific decoder, contains a relevant amount of descriptions related to the associated sound content. While a direct interaction between the MPEG-4 and MPEG-7 layers is envisageable, it is at least clear that the support of music notation will introduce new extension possibilities for MPEG-7 description schemes directly connected to the content carried in MPEG-4, which is at its turn possibly synchronized with music clips and streams. A possible solution would be to have an XML-based object type (maybe also supporting a binary equivalent), whose schema can act as both SASL and MelodyDS extension and having the possibility to interact with both layers in two different ways. Like that, it could be possible to access through the DS e.g. already specific selection of the related sound in either SASL or MIDI, so that suitable applications may offer straightforward possibilities to refine queries by listening means.



The first step towards realisation of such systems passes from the definition of music notation representation. This task is related to both MPEG4 and MPEG7 standards. Other aspects related to music notation have to be integrated in this work by considering: synchronisation, protection and DRM, cataloguing, identification.

The mentioned music notation will have to model logic and visual domains. It could be called, LVMNL (Logical & Visual Music Notation Language) and should be XML. The name is just to highlight that the language can cover the logical and visual aspects of music notations integrating it capabilities of:

- Cataloguing: Z3950, UNIMARC (MPEG-7 harmonisation with these metadata is required, see the Convenor's document "Suggestions for future work by MPEG", n.5524, Pattaya)
- Identification: ISBN, ISMN, … other standards (Digital Item Identification, MPEG 21)
- Synchronisation: to be discussed (Digital Item Processing, DIBO and DIXO, MPEG 21)
- Hyperlinks: to be discussed
- DRM: MPEG21
- Graphic: BIFS
- Audio: MPEG SA

The two solutions are distinguished on the basis of the environment in which the LVMNL can be built:

- MPEG-7: integrated with the Melody Description Scheme, providing conversion in both direction and relationships. In this case, the LVMNL will be a description language and thus some limitations to the "execution" of the digital item for creating multimedia content and courseware will be present.
- MPEG-4: creating it on the audio models of SAOL, SASL, and defining with them strict relationships. In this case, the language will be oriented to the decoding and execution and thus some limitation to the query by content would be detected.

4.2 Innovative Applications in Music Libraries and archives (MICA)

4.2.1 Identified Problems

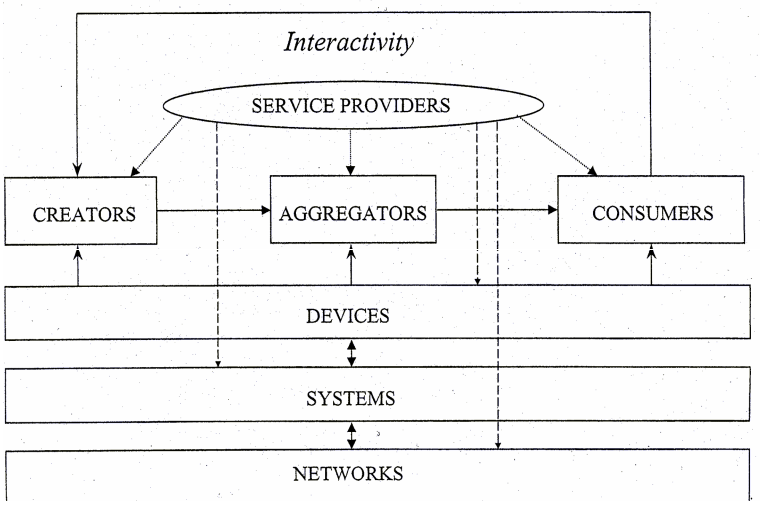
From a typical music library perspective, the most urgent problems do not appear to be originally technological but rather economical, legal or societal problems. As far as the general notion towards innovative technological applications within libraries is concerned, it will be more than expected if technology can help solving those problems instead of rising new ones. Due to the long and very successful tradition of music libraries as well as to the high level of training of library staff, a certain reluctance to adopt new means, rules and technologies can be found among music libraries more often than a longing for new multimedia functionalities. In times of decreasing economical resources especially for public and non-profit institutions, keeping up services will be prior to searching for new ones in many cases. At the same time, "simply" keeping up classical library services will hardly be enough: Corresponding to changes in the society, in the economy and in technology, "[public] libraries are changing fast: but they need to change even faster." (PULMAN Guidelines, 1st ed., June 2002, p.5)

Thus, to bring music libraries in the multimedia interactive age is an arguably more complex task as it will be e.g. with music notation: In order to help music libraries, librarians and library users to make the best possible use of interactive and multimedia technologies, the complex issues of one of Europe's most traditional forms of institution will have to be considered, including a wealth of societal, legal and economical aspects in addition to "pure" technological possibilities of innovative applications.

In order to meet these special requirements for the problem assessment as far as libraries are concerned, the Working Group Music Libraries is preparing a survey in close co-operation with several branches of IAML (the International Association of Music Libraries, Archives and Documentation Centers). The survey aims at locating the most relevant areas of library activities as far as the need for actual technological improvements are concerned.

General problems

The goal of MUSICNETWORK is to bring European music industries and content providers into the interactive multimedia area. But why are we not there yet?
Contradictions on every level of the content value chain have prevented so far that a market could take shape.



"The content value chain". Source: RITMO – Research for Integrated Trading Models for Online Music

- For the different categories of actors the balance of immediate need to interact with bodies outside their category vs. risk currently is negative. The barrier of high transaction cost results in the segmentation of communication and slows down the process of convergence and unifying the market.
- There's a lack of communication and exchange between technology, business, NPO and culture-related players as far as the development of standards and digital/interactive technologies is concerned.
- There's a lack of incentives for libraries and other NPOs to react to the societal and technological challenges by improving networking and cooperation.

General/Economical Problems

- "Trade-off" complexity vs. workflow, staff skills and cost
- Adoption of complex solutions for the future burdens today's budgets

Market/Structural Problems

- Market shaken up by disruptive technology (Clayton Christensen), "From product to service"
- Early risk takers have been pushed out of the market by established stakeholders: reluctant decision makers are encouraged
- Opposition of priorities of content holders and access providers is not overcome yet (telcos, hardware manufacturers, software manufacturers)
- Overheated competition of established stakeholders defending their position
- Competition of standard providers: standard bodies, industry networks, proprietary "de facto"-standards of individual stakeholders: everybody claims to have the solution and thus blocks the others
- Lack of new business models
- Missing consensus
- Conflict of non-profit status vs. exploitation-schemes, especially for libraries

Copyright/IPR Issues

- The legal situation regarding copyright is a complex task; it's hard to collect neutral/correct information not biased by interest groups (e.g., copyright-protected publications will generally state that copying is forbidden instead of stating at which time the respective publication will become part of the public domain)
- Licensing issues: Agreements with rights holders are difficult and time-consuming, at least if they cover more than what is provided by means of collective licensing (e.g. as is the copying of books in some countries)
- Slowly adapting legal framework, still based on paradigms of the old market: copyright issues, no European market (business models based on territorial licensing), international contracts, etc.
- No copyright harmonization yet, copyright law not "convergent" even within the EU member states (e.g., lending and copying especially of music recordings and music scores are very restricted in several countries)
- Border of copyright and constitutional rights not without conflicts (access/participation, privacy, fair use, etc.)
- The legal situation regarding copyright is partly an obstacle for the development of NPO and other structures enabling public access to cultural heritage and repertoire.

Technology-Related Problems

- Gap between R&D and practice – in other words: knowledge is outdated before it reaches the market
- Technologies not ready: standards, DRM, OMR, information retrieval, etc.
- Uncertainty concerning formats for digitization of sheet music
- Lack of commonly accessible and accepted technological solutions and standards
- Technology is a moving target (decision makers in the consultant trap)
    - The developments in the IST and library/metadata area are exploding
    - It's hard to decide for the right standard, technology or application.
    - It's increasingly hard to keep track of technological and standard changes and developments.
    - Most current technologies for the generation of metadata, for indexing and information retrieval, for asset management and lending demand additional training of the library staff and are very time-consuming.

4.2.2 Content for Evidence and Validation

In this section, both typical and emerging use cases within music libraries are listed in order to show the technological requirements in the area of music libraries.

Following Clifford Lynch (Lynch 2001), three main approaches can be differentiated as far as "finding information" in general is concerned:
• through **bibliographic surrogates** (intellectual description of aspects and attributes of a work)
• through computational, **content-based techniques** (compare queries to parts of the actual works themselves)
• through **social processes** that consider works in relationship to the user and his or her characteristics and history, to other works, and also to the behavior of other communities of users

While the library world is traditionally relying on the first approach, technological solutions are not only bringing the second (and, through "collaborative filtering" as used e.g. in Amazon.com etc., partially the third) approach

Currently, the standard library applications such as ALEPH are focused on the classical library functionalities, while new services and applications are emerging which make use of a wider spectrum of digital and interactive technologies. For example, streaming/download services are being developed both by libraries themselves (www.musikbibliotek.dk) or as a commercial proprietary resource that can be subscribed/used by libraries (www.classical.com). At the same time, first evaluations show that new standards and technologies(such as the MPEG group of standards) are mostly unknown/unused by music libraries / librarians so far.

Among the methods for evidence and validation chosen in this case is the mentioned survey in co-operation with IAML. The survey will cover as many of the following areas as practicable, while the main area of interest is (B) Information management (see below). The expected data from the survey should reveal which areas are considered currently the most problematic by music libraries themselves. At the same time it should reveal which areas are considered the most promising for technological improvements.

A Acquisition
(1) Evaluation/selection/curating
(2) Acquisition
(3) Serials and service subscriptions

B Information management
(4) Identification
(5) Cataloging (metadata: extracting/generating catalog entries)
(6) Catalogue format requirements (metadata: structuring catalog entries)
(7) Classification (metadata extraction/generation: keywords, thesaurus, ontologies, ...)
(8) Search and retrieval
(9) Exchange of information (network catalogues, virtual catalogs etc.)

C Circulation ("Distribution", "Asset Management")
(10) Reserves
(11) Paging/placing
(12) Loan
(13) Interlibrary Loan

D Preservation (physical)
(14) Restoration
(15) Storage

E Digitization
(16) Coding
(17) OMR
(18) Digital preservation
(19) Storage

F Presentation and marketing
(20) Physical presentation
(21) Events (exhibitions, concerts, ...)
(22) Online services (directories, portals, "virtual libraries")
(23) On-demand services (score printing etc.)
(24) Reviews and introductions
(25) Services for patrons/consulting
(26) Information center services
(27) Publications

G Management
(28) Licensing/Copyright
(29) Workflow management
(30) Project management
(31) Staff development
(32) Finance, controlling and administration
(33) Patrons' management ("customers database", „CRM")

4.2.3 Benefits that can be obtained solving the problems

- Development of New Library Services
- Music Streaming/Download Services
- Production and Distribution of Multimedia Content
- Mobile and Location-Based Services
- Services for Targeting Social Exclusion/Digital Exclusion (cf. PULMAN)
- Services for Digital Literacy/Lifelong Learning/E-learning (cf. PULMAN)

- Enhanced Interoperability and Resource Sharing
- Automatization of Processes (Cataloguing, Indexing, Information Retrieval)
-

4.2.4 Possible Solutions and related issues

As the mentioned survey is scheduled only after the publication of this version of this document, only a few basic assumptions are being stated here:

- Obviously, music librarians tend to be very skeptical about the technological potential as far as (automated) cataloguing/indexing is concerned. A careful comparison of "classical" cataloguing approaches versus emerging metadata/knowledge retrieval approaches (ontology-based search engines, semantic web etc.) has to be made.
- With regard to the arguably symbiotical co-existence of a) classical standard software solutions for (music) libraries and b) innovative applications for content-based classification and retrieval, plus new services such as streaming and download, it has to be carefully examined whether and to which extent integrated solutions (in comparison to modular/interoperable standards and solutions) might be practicable, including market acceptance, usability and training.
- New technology-enabled music library services can be observed in an increasing number of music libraries – from the Danish www.musikbibliotek.dk to the Norwegian www.phonofile.no and many others. Typically, these applications and services will extend classical functionalities of libraries into the digital and interactive domain, thus sometimes seemingly interfering with other actors. As libraries can hardly be expected to remain "offline" as the only player within the music area, new roles and synergies should be explored, while the original functions of libraries – to accumulate and to preserve knowledge, to provide access to the society's cultural artifacts, and to foster communication, education and scholarship – should be kept up even in the digital domain.
- In many cases music libraries – as other institutions – currently are suffering from decreasing economical resources. Best-practice examples of the use of technology within music libraries to cut costs, extend services and overcome limitations of resources should be carefully examined.

4.3 Innovative Applications in Music and accessibility problems (FNB, ARCA)

4.3.1 Identified Problems

Regarding accessible music provision there are several key issues.

- Efficiency in producing Braille Music according to current Braille Music translation protocols.
- Efficiency in producing alternative accessible music formats, like Talking Music
- Efficiency in integrating *potentially* accessible music formats
- Efficiency in logistics in delivering accessible music to the appropriate users
- Efficiency in logistics in administrating the production and delivery process when delivering accessible music to the appropriate users
- Solving the fragmented nature of development resources for producing accessible music production and consumption tools

Addressing these problems keeping unification of the solution of these problems as a main goal, would enable combination of the solutions. With these combinations of accessibility solutions new innovative ways of dealing with accessibility would present themselves.

4.3.1.1 Efficiency in producing Braille Music according to current Braille Music translation protocols.

Producing Braille Music is a huge endeavor. Various processing stages are involved and several people cooperate on one book. Capturing all the issues of accessible music production in a uniform production environment would not only speed up the production process. It would also provide means of explaining the production process and even create he possibility of incorporating the end-user in the production process.

4.3.1.2 Efficiency in producing alternative accessible music formats, like Talking Music

A lot of knowledge, code and applications regarding production of various kinds of accessible music is very similar. The production procedure and the initiatives undertaken to provide Braille Music production tools could be reused for the definition of production procedures for alternative accessible music formats.

4.3.1.3 Efficiency in integrating *potentially* accessible music formats

Just as music is a ‚living language', the accessible music is a living language. In due time new ways of understanding and creating accessible music will present themselves. Technology evaluates in a very high pace and if accessible music representation and provision is to keep up with this pace, the representation of accessible music should be as synchronised with ‚normal' music as possible.

4.3.1.4 Efficiency in logistics in delivering accessible music to the appropriate users

Integrating the production of accessible music into a digital environment, using a uniform format and with that uniform tools, would enable new ways of delivering accessible music.

4.3.1.5 Efficiency in logistics in administrating the production and delivery process when delivering accessible music to the appropriate users

Producing accessible music is one thing. Administrating the production process from music request to delivery is a huge task of it's own. A multitude of people is involved in the production process of accessible music, with a lot of dependencies between them. Building consumption and production tools on the same set of development resources and frameworks would open up efficient and elegant integration between the content provision processes and content provision administration processes.

4.3.1.6 Solving the fragmented nature of development resources for producing accessible music production and consumption tools

A lot of knowledge and experience in developing accessible music tools in both the consumptions and production domain can be categorized as *expert knowledge*. Often when addressing accessibility the company or institution undertaking this venture are more or less forced to reinvent the wheel. Because of the amount of research needed to collect the knowledge required to produce an accessible tool or format, development costs are heavily increased. Therefore the interest of the market for providing accessible tools is not encouraged.
If development knowledge and resources would be accessible

Studying a musical instrument as well as music theory has an educational and professional function which turns out to be quite significant and is focused on by visually impaired people who have been encouraged to approaching the world of music since they were children. Within integrated schools but more largely within special schools there exists a significant choice of topics concerning music.
There are many excellent schools in Europe, which offer their students a good number of Braille texts; teachers must be specially trained. Nevertheless, in countries where blind children are admitted to regular schools, especially in primary and secondary schools, music is less important because it is still difficult to find texts for them to follow regular classes. In addition, it is sometimes hard for teachers to get Braille music scores in a short time.
The more a blind musician improves his skills, the more he needs some more music texts, which are not always available in Braille. Furthermore, we have to consider that:

1. most available Braille texts are quite old and have a Braille music syntax which is partly different from today's;
2. raised dots of Braille texts get ruined as time goes by; therefore, many old and unique Braille music texts cannot be used and are lost;
3. Braille music texts follow local national rules, so blind musicians may have some difficulties in interpreting texts produced in other countries.

In August 1997 the World Union for the Blind published an International Handbook of Braille Music. The aim was to gather the various writing modes together in a single format; nevertheless, the handbook does accept and include some variations in syntax. Users are starting to adopt the rules of the handbook, whereas transcription centers and libraries are still meeting some difficulties in meeting the requirements of the new format.
As to accessing print alphanumeric texts, using hardware and software aids is essential for the blind today. Codified formats are a better means of exchanging data than printed paper, because of the greater number of alternative forms available. The latest techniques and the low cost of personal computers have enabled most data processing problems to be solved. A proper program capable of managing displays other than monitors, and of interfacing operating systems, displays, input and output peripherals allows the use of word-processors, databases, or any software that presents text-type information; only graphics are excluded.
Word processors are the most popular tools among the visually impaired. Once typed in (or acquired by an OCR) and saved on a PC, texts can either be read again through a voice synthesizer or a Braille display (bar), or interpreted by another program for converting characters into Braille and printing them out. Texts can be printed in either Braille or print.
If IT has helped improve the writing and reading abilities of the blind, then it can meet the needs of blind musicians, who have more complex requirements than the sighted. Such programs as sequencers, editors and printing programs are of a quite common use in the field of music. A MIDI card, a keyboard, a generator of sounds (or effects), more or less sophisticated expanders are usually needed in addition. This equipment has become quite popular thanks to the better quality of sounds achieved, easy usage and lower prices.
In addition to the regular needs of musicians using PCs to produce music, the blind (whose majority already use a PC for writing and reading) also generally need:

- to write musical texts in Braille format by using a special text editor (selection of the type of syntax and rules adopted in own country, corrections, and the most suitable aids to speed up writing and layout);
- to convert saved music from Braille text format into MIDI;

- to use musical electronic keyboards to speed up writing of music passages;
- to use sequencers, connected via MIDI through keyboards and/or expanders, enabling storage, processing, change, correction and re-listen function to the same passage as many times as required;
- to save and print Braille-formatted music passages, in compliance with the syntax and rules of the International Handbook, and in print through conventional notation symbols;
- to access MIDI, Finale, MusicXML, Wedelmusic (and similar codes) pieces available on the market, to listen to, process and print them either in Braille or in print;
- to make a personal collection of musical passages and related index to be consulted through Braille display or voice synthesizer;
- to be offered a proper tool (a recognition system for Braille pages) to gather all the Braille-formatted available scores and use them again by re-printing;
- to access music libraries for the blind and transcription centers, which should be provided with cheaper systems for transcribing and printing Braille texts.

These needs have been met through the positive results achieved by European and American projects.

Teaching and music for the blind

Music, as understood as a form of art and formalized language, is perhaps the only manifestation of the human soul which is completely accessible and usable by the blind, simply because it is not supported by visual channels. This does not mean, however, that you need a good natural ear to become either a musician or a good performer; education is important, as well as suitable knowledge of a code representing music (writing and reading), and skills in mastering an instrument. These are the fundamentals for educating music taste.

The equation blind = musician is now well accepted. This can influence expectations and even the perception of blind people. Both aspects are in fact generally based upon an approach to music of an informal, empirical, rather superficial kind, overlooking more formal aspects, related to what real acquisition of a musical alphabet involves.

There are factors that hinder or actually prevent the blind from accessing music studies, more or less consciously.

Some of these are evident. Others – less evident – instead of encouraging musical studies, do nothing but highlight further negative aspects.

Among the evident factors, there is the need to play music after memorizing it, since it is not possible for a blind to read and play at the same time, except in the case of solfeggio and singing. Good performers always play by heart, but, in this case, memorization is the result of a number of repetitions performed on the same piece, by reading the score. But blind students have to memorize music measure by measure, section by section, separately for the right and left hands.

Another obstacle is represented by the special notation used by the blind to represent music. Though it is now standardized, and therefore recognized more or less worldwide, and although Braille is the most effective solution to solve the problem of direct access to music scores, the notation is very complex, and far from visual representation, causing relatively long learning cycles. Above all, it creates problems in finding skilled teachers, because of the substantial difference between conventional and Braille notation.

If these factors hindering the approach of the blind to music studies are evident, another problem is the excessive coverage of high-level performance in the music field by the blind, underestimating the difficulties which need to be overcome, as though talent alone were enough.

Indeed, the equation blind = musicians ends up by molding several families' and young people's expectations towards learning music by ear, which is also strengthened by the above mentioned actual difficulties (complexity of Braille notation, lack of skilled teachers).

Finally, it must be stressed that, in spite of its obvious favorable aspects, Europe's tendency to school integration cannot give music education the room it should deserve. Therefore, in comparison with special institutes for the blind, the number of integrated classes where reading and writing music is taught is still too low.

If it is true that a high number of blind perform music, then it must be also pointed out that a strong decrease in the number of those who can actually read music has been reported in recent decades. The importance of the knowledge of written notation for those who make use of any common language cannot be overstated. Without depreciating oral culture from a historical and social viewpoint, we would like to point out that learning a written language means getting the opportunity of recognizing its structure, which helps clear up one's own thought and become an individual producing culture himself. Almost the same happens for amateurs, who are used to perform by ear, in comparison with whose who actually have a knowledge of any kind of music notation.

In addition, a high number of the blind work in the field of music world-wide: teachers, instrument players, arrangement specialists, composers etc. All of them have benefited from an outstanding inheritance of Braille music scores, which has enabled them to follow music schools and academy programs and to make their names as professionals.

Music in Braille format

At the end of the nineteenth century music in Braille format developed in different ways in different countries in order to meet the needs of libraries, transcription centers, music schools and uses connected with language. Different codes developed in various countries. The differences range from slight to substantial. The representation used in the UK for example is called "bar to bar", because it is written one bar at a time. Other systems prefer to represent a melodic line, continuing a number of bars. Another difference is intervals between chords are shown, but there are many.

In order to enable someone from a different country to read a musical score, and to explain the rules of the printers, it is common practice to include an initial guide with the main signs used which may not occur in other forms of syntax.

In short, for every book in a library or produced by a printer, a new Braille music syntax may need to be learnt.

Our investigations in 1997 and 2001 showed that users often have books from different printers, due to the general lack of books in Braille. One example will suffice: the Italian national library, one of the most heavily stocked in the world, contains no more than 4,000 music books. It is quite a large number, but not when compared to any city library. For example Mantova city library has 15,000 music books. Clearly the blind have access to far fewer music texts. Most of them are classical music texts, with very few Jazz or modern music scores.

For many years, the World Blind Union held conferences and finally appointed a commission to promote an international standard. Many countries resisted the idea, but after many compromises the final handbook saw the light of day in 1997.

Over the years, ARCA has monitored the spread of the handbook among blind musicians and in the Madrid Conference “Musica and Braille” on 20 June 2003, Bette Krolick – who drew up the handbook – said it was not translated into other languages and was still not used nearly enough. The Madrid Conference addressed this problem, identifying the following causes:

1. users see no benefit in learning a new syntax, since so few books are available in the new code;
2. few libraries promote the international code, although the RNIB is transcribing all its texts from English into the new code. Several English musicians know both codes but say they prefer to write in their local code.
3. During a heated discussion, transcribers at the Monza library said that the new code is very limited compared to the national code, and so will continue to use the local code.
4. DANCING DOTS, which produced the Goodfeel program i.e. the program for the transcription of books from hard copy (graphic format) to Braille, said in Madrid that to increase sales it needed to create modules for local codes and not only for conversion into the international code.

4.3.2 Content for Evidence and Validation

Libraries for the Blind have to deal with administrating, distributing and producing accessible music on a daily basis. Providing these libraries with tools that fit into the various processing stages of accessible music provision would enable monitoring the effects of assistive production tools. Situating these assistive production tools into a framework of assistive tools will provide an overview of the interdependencies of these tools. Using assistive production tools can be monitored from three perspectives:

- Production of accessible music : How does one create accessible music?
- Distribution of accessible music : How does one register the new production into an administrative system and proceed with delivering the music to the end-user
- Consumption of accessible music : How accessible *is* the music? How does the end-user appreciate the music?

Music teaching for the blind:

Integrate school or special school, tools for learning music and Braille

For professional musicians:

Composer, exchange information through codes, improve the numebrr of score in Braille

International Braille code

upgrade the Braille signs, more diffusion of the manual

Dialogue between conventional music product manufacturers and producers of special programs for the disabled.

4.3.3 Benefits that can be obtained solving the problems and Possible Solutions and related issues

The industries passive attitude does not help print impaired users to be able to participate in the everyday consumption process. The problems regarding the interest of commercial corporations in the accessibility market fixes the ‘workaround’ nature of traditional accessibility enhancements. Through formalizing fundamentally important ‘services’ that are required when considering accessibility transformations, this disinterest could be compensated. The huge threshold that makes investing in this area unattractive could be lowered. And with that the

asynchronicity between the accessible market and the 'normal' market could be replaced by a naturally available transformation and representation feature.

This would create new opportunities for multiple groups of users. The end-user clearly benefits from improvement of the developer and business opportunities, since the range of choice in content the end-user has will increase. The developers of accessible music tools, formats and fall back on integrated accessible music tuned 'services'. This enables them to skip parts of the huge research activities required to initiate an accessible music venture. The solution would also make the accessibility market more attractive for business. Because of the availability of expert knowledge in readily available development resources and logistical infrastructures costs can remain far lower then they are now.

Music teaching for the blind:
The problems differentiating countries are complex. Future prospects are related to the decisions in European countries about integrated schooling.
If the musical education of the blind is entrusted to sighted teachers, they will need to be trained and the students will need to be able to exchange information with other, sighted students. Music schools will need to have texts in Braille obtainable over the internet.
IT will be very useful for integration.
IT tools may help students in both integrated and special schools not to abandon music studies.

For professional musicians
The ability to use professional programs and to exchange information through codes for the blind is an important step in interaction between the blind and sighted in the musical field. One example is the immense satisfaction expressed by a professional choir master who used the BME program to transcribe the choir music into Braille and to print out final versions without eh need of a sighted transcriber.

International Braille code
As stated above, the existence of an international Braille standard is extremely useful for libraries, IT music for the blind and users. The standard was published in 1997, but it is important for it to be actually used.
Above, we saw why this is not so easy. But what are the ways out of these difficulties and what advantages do they bring?

- The spread of valid professional programs for blind musicians would encourage the full use of editors and the use of the new musical handbook. ARCA was asked by BME users where the international handbook can be bought.
- The spread of virtual libraries for Braille format would make up the current lack of musical scores and again help to overcome resistance to the new handbook.
- The ability to update the handbook continuously, for Jazz, symphonic and modern music, will make the international handbook more useful than national systems.
- The code may become more popular if more people are involved in its updates (the working group has lost members for various reasons, including simply the age of its members) involving delegates from blind associations and libraries in new countries, and producers of musical software. This working group generally meets once a year, which is not often enough. Meetings should be frequent and take place in various worldwide locations to encourage great participation and provide greater access.

Dialogue between conventional music product manufacturers and producers of special programs for the disabled.

This dialogue is sporadic and rare but needs to become systematic if the conversion from and into Braille is to become a reality, using a common format such as XML.

4.4 Innovative Applications in Music Distribution (RIGEL)

4.4.1 Identified Problems

The market of music and multimedia content distribution over the Internet currently presents different problems, related to the different market actors and sectors. Up to now, problems the major problems have been identified in the market structure, basically caused by the evolving technologies and digitization of contents. Other issues are related to systems, solutions and technologies currently available on the ICT market for securely distributing multimedia content technology providers need to guarantee the music content protection to copyrights owners, together with acceptable performances in content retrieval and delivery.. Moreover, end users must consider these new distribution systems convenient compared to the traditional ones.

The major problems affecting the structure and efficiency of the market can be summarized in:

- Lag in e-publishing at European Level, with respect to US market,
- Lack of efficient Business Models, which are and satisfactory for all the stakeholders,
- Uncertainty due to new untested business models,
- The Complexity of business models often generates confusion in customers,
- Lack of confidence in content providers and distributors, due to reduced barriers to entry (it's also an opportunity, indeed), piracy threats, fears of adopting of the "wrong" technology.
- Lack of content offer, in general, due to publishers' lack of confidence into protection of IPR. Lack of content specifically in high specialized niche markets, posing the need for valorization of cultural heritages (traditional music and representations, ancient music). Also the high cost and resources required to digitize existing content and prepare the multimedia objects with the proper quality level, is preventing the content offer to spread and grow.
- Political aspects, such as the high competition in the market, the presence of contradictions at any level of the digital value chain, the major changes to come in the traditional structure and the shifting in the role of traditional content distributors/retailers,
- Social aspects: the needs to provide wider accessibility for everyone to digital resources,
- Excess of investments in the past without support of sound business plan (euphoric financial markets of late 90),
- Out-of-date legal framework, applicable at national level and not world-wide, not considering the new needs of end-users/customers and those of content providers/distributors.

From a technological and infrastructure point of view, the major problems are identified in:

- Need for efficient, secure, non-intrusive content protection mechanisms,
- Lack for interoperability and compatibility among the different solutions and systems for multimedia content distribution, needs for standards.
- Infrastructure aspects like insufficient availability and limited geographic distribution of broadband connections, network of trusted content (re)distributors,
- Protection and security issues related to the extension of on-line distribution to mobile technology (UMTS, WiFi)
- Limited availability of secure micro-payments systems needed to enable mass purchasing of inexpensive items (e.g. like single music pieces, single "hits", special offer album)

Concerning music authors, one of the most important requirements is to improve their control on the music distribution chain and payments of right management as they are now usually represented at national and international level by a few, very large institutions for the collection of property rights. At the same time, artists are interested in increasing the knowledge and distribution of their works to end users, so to raise their profits.
Content providers and distributor, such as major labels or companies providing only distribution systems are mainly focused on the security aspects and on protection of copyrights in particular. The main issue here is to enhance their confidence and thrust in the new technology for on-line content distribution.
Protection of copyrights should preferably cover the spell of content providers' ownership of these rights. On the other hand, the cost of applying this protection must be acceptable, in terms of needed resources. In general, the application of protection systems to coded music is a time-consuming and space-consuming process. The more robust the protection algorithm is, the more time and space it requires to be applied.
Another important aspect in the distribution of coded music via Internet is related to the time needed to send the purchased ware to end users. This problem is related mainly to the size of the files to be delivered and to the type of connection purchasers are using. In turn, the size of the digitalized music depends on its quality. Usually the distribution system creates compressed files so to make the delivering of music files via Internet as a matter of minutes. But the algorithms which performs this compression cause a loss of quality, which can be more or less patent. In general, a compression algorithm can reduce this loss so to let it be detectable only to a professional musician. The cost is, a part an increasing of the time to create the compressed file, the growing of the size of these files.
From the point of view of end users, besides quality of downloaded files and time needed for the downloading process, there is a great interest in the functionality provided by the system and especially in the tools for downloading and using the multimedia content. Additionally, they want simple systems, user friendly and easy to customize for their own needs. The main issue related to end users is to give the most possible visibility to music distribution systems.
Another important aspect is the restrictions in the use of downloaded files. In fact, in the traditional music market, a purchased item, such as a CD, is regarded by the vendee as something that can be used without limitations. In the

online music market, content owners want to keep control of the delivered files, even if they have been legally bought, by applying restrictions in the use of these files.
These restrictions could keep away users from joining the online music market, all the more so as many people has been accustomed to free downloading and usage of music files, because of the success of peer-to-peer distribution systems without control of copyrights, such as Napster, KaZaA and WinMX. On the other hand, avoiding of illegal use of coded music appears to be a feature not to be set aside from the point of view of the content owners. Consequently, whatever online distribution system aims at conquering the major discography labels confidence, has to cope with the preventing of illegal use of downloaded files. Since it is accomplished by applying restrictions to the use of the downloaded files, it is important not to over restrict this use, not to run the risk of having a secure but boycotted system.
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4.4.2 Content for Evidence and Validation

Innovation at level of multimedia and music content management and online distribution can be introduced both at levels of technologies and at level of market structure and business models. From the technological side different solutions and system exist, still with some significant drawbacks, to partially solve some of the problems, and more attention is needed towards standardization of protocols, procedures, mechanisms as well as on interoperability and compatibility of systems. In such direction, the emerging of Web Services and the work on MPEG standardization is surely promising.
From the marketing side, new and efficient business models and licensing scheme still need to emerge to cope with the new, different nature of the multimedia products and the new needs and demands from customers.
To have a better idea of the structure and the complexity of the music distribution market, in the following there is a list of the main categories of actors involved:

- Technology providers, software developers
- Content owners, music publishers, music labels
- Copyright collecting societies
- Content providers and distributors
- End users (musicians, musicologists, audiophiles, music amateurs…)

Each one of these categories has different objectives, interests, points of view, competencies, organizations and size, bringing into the "distribution". From a strictly technical point of view, the several different aspects involved in multimedia content management and on-line distribution are mainly related to Intellectual Property Rights (IPR) clearing, content protection and Digital Right Management (DRM) systems, and can be summarized as:

- encryption of data
- managing of on-line transactions
- compression and storing of digital content files
- managing of delivering of digital content files
- prevention of illegal use of digital content

But as mentioned before, the large gap to cover is on the market side, where new business models and licensing scheme are most than needed, and where political aspects and competition are major the driving forces.

4.4.2.1 Encryption of data

Encryption of data includes both data for on-line transactions and music content files to be purchased via Internet. Online music market demands a secure way to hide personal data (such as credit card numbers) from unauthorized reading and to guarantee the delivered content not to be used illegally. By applying an encryption algorithm, information can be read and used only by decripting it by mean of the correct key. Hence, an encryption algorithm van be assessed using the following parameters:

- length of the encryption key
- time elapsed for the encryption process (performance)
- enlargement of the encrypted data compared to the original size
- esteemed time needed to break the encryption

4.4.2.2 Managing of on-line transactions

Managing of on-line transactions means mainly accomplishment of on-line payments.
On-line payments are usually performed with the credit card number of the purchaser. In general, there are two ways of managing on-line transactions:

- by requiring the credit card number every time the client want to buy digital content. This solution does not store the credit card number permanently.
- by requiring the credit card number only when the client subscribes the distribution service. This solution store the credit card number permanently and use it whenever an on-line payment is to be carry out.

Moreover, on-line transactions should concern several models of purchasing digital content:
- Pay-per-volume
- Pay-per-time
- Pay-per-track
- Pay-per-album

4.4.2.3 Compression and storing of digital content files

Compression of digital content makes possible the on-line distribution of digital content via Internet. In fact, the today's type of most of Internet connections makes troublesome the delivering of uncompressed musical files. The solution is then to compress these files, trying to minimize the loss of quality. In general, using a compression algorithm, the more the resulted file is a good quality one, the more its size comes out.
The assessment of a compression algorithm depends mainly on two considerations:
- time elapsed for the compression process (performance)
- ratio between quality and size of the compressed file

Storing of digital content is connected to the compression issue. In general, the archives of musical labels contains a huge quantity of titles, so it is to be expected that this storing requires adequately roomy devices. At the same time, access to stored content should be efficient. The storing system should then fulfill the following requirements:
- possibility of storing the whole digitalized content of a music label
- possibility of increasing its capacity by adding new devices
- efficiency in accessing the stored content
- possibility of performing queries to know the stored content

4.4.2.4 Managing of delivering of digital content files

The multimedia files/stream delivering system must cope with several aspects of the distribution process. In fact, its main tasks are to let the end users able to browse the content of its digital archive and to download what they buy.

The browsing of its content should be accomplished in different ways, according to the requirements of final user.
Searches can be performed by means of queries which allows users to specify the values of the interested fields (author, title, genre…). These queries can be:
- simple queries: these queries allow users to specify few parameters on which to perform the search. Moreover, this parameters must be the most used one, such as author and title. Alternatively, these queries can provide only the insertion of a single criterion; in this case, the system will perform the searches joining with the OR operator the most used fields.
- advanced queries: these queries allow users to specify more parameters on which to perform the search. This fields could be added or removed by the users and joined with logical operators.

Another way of browsing the stored content is by the catalog. The storing system should provide classification features to let the distributors able to publish on-line catalogues of their digital ware. The cataloguing of digital content should be accomplished in different ways, such as on the ground of authors, genres, periods and so on.
Finally, the system should provide the possibility of refining the search to reduce the final number of results.
The system should provide also good quality audio previews and additional information of the found objects, such as the list of performers, historical notes about the authors and so on.

The purchase and download of digital content should be accomplished in a simple way from the point if view of final users. At the same time, final users must trust the distribution system, concerning the security of on-line transactions.
For the purpose of usability, the system can be evaluated by means of several parameters:
- Percentage of times the user succeed in retrieving the desired multimedia content, given the content is present in the storing system
- Mean time from when the user start the search to the beginning of file download. Assume user finds the object.
- Average bandwidth available during download.
- Ability of the final users to recover an interrupted or failed download.
- Average number of failed downloads
- Average number of errors presented to user during a single complete operation (from entering the site to successful delivery)

Moreover, final users should be able to express their opinions about the distribution system, for example by means of questionnaires. Arguments of these questionnaires should be the overall quality of information available to users as a support to the service utilization (guide, user manual, contextual help) and of the service as a whole.

Another important feature of the system should be its customization. The service should collect information from customers and end users to personalize the offer and service itself. User's information can be manually inserted by users their selves using forms or automatically gathered from users' behaviors (previous purchases and searches). Then, the system could to propose to the users a personalized catalog on the basis of their preferences. Moreover, the system could send to users personalized offers and promotions through alternative channels (emails, newsletters, Instant Messaging, SMS).

4.4.2.5 Prevention of illegal use of digital content

This basic feature of a digital music on-line distribution system involves restrictions in the use of the purchased content. The system should reach an half-measure between the requirements of content owners to avoid copyrights breaking and the requirements of final users to fully enjoy what they have bought.
The distribution system should define a set of usage rules which make this system trusted by the content owner and convenient by the final users. The balance between these two requirements concurs to evaluate the system.
Here are some processes the system can or cannot allow:

- export to devices
- burning CD
- format conversion
- ID3 tag
- interchangeability of content with other devices (of different types and manufacturers), formats and services.

4.4.2.6 Innovative business models

More efficient and satisfactory business models need at least to have the following features:

- They address new ways of delivering and consuming music (digital revolution)
- They address the diversity of targeted market sectors and final customers,
- There are efficient, safe, performing and possibly standard protection mechanisms, enabling the operation of the business models ,
- They are Flexible, and their flexibility is supported by the underlying technologies
- They re developed and diffused by more dynamic and flexible companies with respect to the existing, often static, giants,
- They leverage the interactive and multimedia aspects of the digital content and music in particular,
- The revenue streams are mainly from added value services and features, focusing on what the customers really want and need,
- They leverage the reduction in distribution costs to make niche markets (vanity publishing, national and regional markets, cultural heritages) as new revenue streams,
- They are based on multiple revenue streams and on reuse of content for different markets and markets sectors (entertainment, advertising, multimedia content production, infotainment, education),

4.4.3 Benefits that can be obtained solving the problems

Solving the above addressed issues, or at least finding a path to improve the situation, would bring the on-line digital music market into a new era of expansion and development. In fact, an widely trusted environment, from the point of view of protection and security, would increase supply and demand of digital music via the Internet. Consequently, more people would be stimulated to provide themselves with high-speed Internet connections. This would increase the average availability of bandwidth, inducing other markets (such as movies or software ones) to increase investments on on-line market.

In particular, a list of possible benefits can be summarized in the following points:

- Reduction in distribution costs,
- Chances to reach a wider audience,
- Higher flexibility in the offer,
- Access to “niche” markets previously not economical to enter,
- Exploitation of new services (infotainment, edutainment, e-learning, …) and new media (3G mobile, Wi-fi, broadband internet),
- Valorization of existing archives, valorization of cultural heritage
- Creation of a standard in content protection: new distribution systems could refer to a proved and trusted way of protecting digital content. This could be the starting point to develop new on-line markets which distribute other kind of content, such as e-books, digital movies or software.
- Improvement in quality of digitalized content: the digitalized content quality could almost match the quality of the non-digitalized one. Customers could find more and more convenient buying digital content.

- Increasing in quantity of on-line distributed content: this could reduce the prices of digital content. Moreover, the traditional distribution system (shops) should improve their supply to try to regain positions in the market.
- Increasing of average availability of bandwidth: if Internet users had a better quality Internet connection, digital markets would increase the amount of sold digital content.
- Impulse in developing of on-line distribution to mobile technology (UMTS, Wi-fi): a robust on-line distribution market would naturally expand to alternative way of selling digital content.
- Creation of a standard in distribution systems: it would be easier to develop new distribution systems.
- Creation of a standard in exchange formats: the distribution systems could refer to a unique way of exchanging format, so to improve the interoperability among them.

4.4.4 Possible Solutions and related issues

4.4.4.1 Protection of digital content

The protection of digital content can be improved by improving encryption algorithms and by using longer encryption keys. This can be made possible even from the increasing performances of computers.
Given the robustness of the encryption algorithm, the problem becomes to protect the decryption key. If it is stored in the client's machine, it should be protected from unauthorized accesses, so to avoid breaking the protection of the digital content itself. If it is sent via Internet whenever the content must be read, this transmission should be protected in a similar way of on-line transactions.

4.4.4.2 Security of on-line transactions

Security of on-line transactions concerns mainly the protection of the customer's credit card number. This can be accomplished by encrypting the transmissions which carry this kind of data. Then the issue becomes to protect the decryption key.
Alternatively, the customer's credit card number could be stored on the distribution server side. In this case, there must be a secure way of identification of the client every time he/she access the system.

4.4.4.3 Protection of intellectual property rights

Protection of intellectual property rights can be accomplished by restricting the allowed operations on sold digital content (active way) and/or inserting hidden information (watermark) to be able to trace out possible illegal use of it (passive way).
The active protection involves the control on the operation attempted by the final user. This control can be performed on client side or on the content provider/distributor side. In the first case, the information to use the protected content is stored in the client machine, while in the second case this information is stored in the distributor machine. The second case is more secure, but the client has to be connected with the distributor to enjoy his content.

4.4.4.4 Performances in archive digitalization and protection

Performances in archive digitalization and protection is strongly connected with the compression algorithms and the performances of storing devices. These performances should improve with the increasing of the performances of the last computers. On the other side, it should be stimulated the research of better compression algorithms, from the point of view of the quality/size ratio.
It also should be stimulated the adoption of efficient storing devices, such as FireWire hard-disks.

4.4.4.5 Performances in code music distribution

Performances in code music distribution is related to the average availability of bandwidth and to the dimension of files to be delivered via the Internet. The research of better compression algorithms should be an improvement even in this sense.
On the other side, the adoption of high-speed Internet connection should be encouraged even from public institutions.

4.5 Innovative Applications in Music Protection (FHGIGD)

4.5.1 Identified Problems

So far several problems can be identified in available protection solutions and components. These problems include:

- Certification and privacy
- Multiple platforms and formats and interoperability
- License management
- Usage control

- Assumptions on hardware
- Legal framework

4.5.1.1 Certification and privacy

As content providers collect money from consumers they want to be sure that their business partner is authentic. Thus certification of consumer is important. Also consumers wants to be sure about the integrity of the digital goods which can be achieved by a certification of the content and of the content provider. Ideally public key infrastructures PKIs can be used for this task but currently there are no comparable schemes applied.

Concerning the future eCommerce scenario, e.g. including micro payment systems, privacy is an important issue which has to be guaranteed but which is contradictious to authentication of customers. Currently content providers are often not considering the privacy aspects of national laws and heavily store personalized information.

Privacy is not only an issue when dealing with user authentication. Modern customer relationship management tools collect customer information for personalized website. A typical example is the "other customer who bought X also bought Y" information available at several online stores. Again, privacy issues of customers have to be considered.

4.5.1.2 Certification with mobile devices

Mobile devices are limited in there computational performance. Therefore flexible schemes have to be developed limiting the computational overhead on mobile devices. E.g. PKIs structures are developed which transfer some tasks to clients.

4.5.1.3 Variety of platforms and media formats

Besides the fact that different operating systems and different platforms exist there are also a lot of competitive file formats for different media types. Of course a good protection system must be capable of handling all existing data types. Yet, this is not the case. Thus it seems that different protection technology vendors are trying to push their formats to proprietary standards.

4.5.1.4 Interoperability

Although the variety of platforms and media formats can be solved by a good architecture further problems occur when considering the interoperability between different and maybe competitive protection solutions. While exchange ability is a deserved criteria for customers technology and content providers haven't fully considered this need right now. Different standards exists or are emerging none of them has been fully adopted in real-world systems.
Another issue is the interoperability with existing solution. One interesting aspect is the effort to combine existing solutions with protection technology.

4.5.1.5 Flexible license management

Not only for mobile devices flexible license managing solutions are important as permanent online connections are not feasible. From a user's point of view protection systems should be capable of transferring licenses and content to mobile devices, which are able to render the protected content without access to any server.

4.5.1.6 Usage control

So far (and probably even in the future) protection solutions are not able to distinguish qualitatively between different intentions of customers. E.g. copy might be legal for a private copy while copying for friends might be illegal. But a protection system is not able to determine the intention of the customer.

4.5.1.7 Secure devices

Several assumptions are necessary for current protection systems. One of these assumptions are the so-called secure devices. PC-hardware components are considered as secure. However, the hardware components as well as the administration of a user's PC is so far under the control of the users. Therefore the user might be able to circumvent protection solutions.

4.5.1.8 Legal framework

As already described above legal issues are strongly interwoven with protection solutions as protection solutions somehow try to support law. However, this relationship has to be considered carefully especially with those issues that are contradictious.

4.5.2 Content for Evidence and Validation

Some use cases and requirements related to music proctection are reported to elaborate its current requirements. Due to the fact that various applications exists we restrict our description to:

- Online Distribution via the Internet

- Broadcasting Monitoring
- Specific content aggregators and providers
- Usage Control

4.5.2.1 Online Distribution via the Internet

Online distribution is the generalization of all kinds of distributions of digital content via the Internet. Different categories can be identified based on the participating organizations (e.g. business-to-business, business-to-consumer), on the download architecture (e.g. client-/server, peer-to-peer) or other features. As we are interested in use cases we identify our categories based on the participating organizations.

- business-to-business (B2B): In this scenario the participating organizations are commercial organizations.
- business-to-consumer (B2C): Private persons are the receivers of content.

The content distribution is not limited to up- or downloading. Content can be distributed via eMail, streaming or even (electronic) ordering of CDs.

4.5.2.2 Broadcast monitoring

Broadcasting is a concrete instance of online distribution. Its main characteristic is the fact that one organization is transmitting content and several organizations are receiving this content. The scenario can be either B2B (digital cinema) or B2C (radio broadcasting).

Typical applications are:

- atomic play list generations: Current technologies (e.g. watermarking and fingerprinting) can be used for the automatic generation of play lists. These play lists are useful for rights collecting societies and can be used for the redistribution of money.
- transmission monitoring: Similar to the automatic play list generation transmission channels can be monitored to verify and control that content is transmitted only by organizations having the necessary rights. Similar techniques can be applied in active nodes in the Internet to control the transmission of data.
- advertisement monitoring: This is important for companies when they want to ensure that fees for transmission correspond with the actual transmission time of commercial. This scenario is outside the scope of content protection.

4.5.2.3 Specific content aggregators and providers

Specific organizations can be identified which have additional requirements on protection solutions. Among them are:

- Libraries have an additional task in archiving content. This leads to very strong implications on protection solutions as content should be accessible even after some decades. This is already a problem even if only digital content without protection systems is considered: Storage medias, storage formats, and file formats change. Therefore regularly copies and format changes are necessary to sustain access to digital content. The usage of protection technologies on digital content severely affects this tasks. Copying might not be allowed or after some years not possible anymore due old-fashioned protection systems or rights description languages which supported anymore.
- Some content providers like music schools need also extended functionality of the protection system. E.g. processing of content should be possible for pupils or students. Furthermore it might happen that the processed content should be included in the archives. Besides requirements related to the processing operations (including modification and storage) additional requirements have to be considered by the licensing system.

4.5.2.4 Usage Control

The general idea of music protection is to control the users behavior. The main targets are copy control and access control. Different scenarios can be addressed:

- Limiting copying for mobile devices, computers, DVD players, …
- Limiting access to unauthorized content for mobile devices, computers, DVD players, …

Ideally content should not be allowed to enter any “untrusted” environment. But this has to be considered as very difficult as already explained in the publication about the DarkNet: Although it might be possible to prevent big P2P-distribution system small networks of users might exist in the future which are all well known too each others. As one person can and will be a member of several smaller network (communities) these small networks will be connected to each other and it won’t be possible to control the network of small networks.

4.5.3 Benefits that can be obtained solving the problems

Generally speaking solving the above addressed problems results in protection systems accepted by customers and content providers and aggregators. This leads to an increase of legal content distribution while a decrement of the illegal content distribution is a direct benefit.

- establishing certification and privacy:
  - Customers will be mentally associated with the customer as they know as they know that content providers are able to track individual users under certain circumstances.
  - The protection of privacy of user data reduces consumers negative attitude to distribute personalized information on the internet and also improves the usage of digital markets.
- addressing multiple platforms and formats:
  - Content providers do not need to spend any money for the conversion of data. As long as it is available in a digital format distribution can be done easily.
  - User are not forced to specific formats. This reduces software installation efforts as well as mental barriers don't have to be crossed.
- implementing interoperability
  - Consumers are reluctant because they are afraid of buying content which cannot be accessed somewhere in the future.
  - Content providers and aggregators are reluctant against new technologies as upcoming standards might not support "premature" formats.
  - If music protection technology can be smoothly integrated in existing distribution systems the usage of those systems will automatically increase.
- building a protection system with a flexible license management
  - Flexible license management is an important issue for customer. They want to have the same possibilities as with CDs.
  - Furthermore consumers are used to the advantages of illegal downloads. Therefore they won't accept any technology providing additional restrictions or limitations.
- establish improved usage control
  - If it would be possible to have a watermark system capable to distinguish between legal and illegal copying consumers were able to make legal copies. Thus the success of such as system is evident.
- building secure trusted devices and driver
  - The less the probability of any misuse (illegal copying) the more content providers are accepting the distribution of valuable content. Trusted devices strongly limit misuse. However other issues (e.g. privacy or controlling hardware/software) have to be considered when current developments are examined.
- establishing a legal framework
  - The development and usage of protection systems directly benefits from a straight legal framework. Any sponginess in a legal framework is a obstacle as protection systems might cross the border between legality and illegality and therefore will produce additional costs to content providers and technology developers.

4.5.4 Possible Solutions and related issues

The difficulty in finding solutions to the above solution varies. Some of them are already addressed by researchers or technology developers while for some problems a solutions is very difficult.

4.5.4.1 Certification and privacy:

Several standards are exist or are emerging to address the issues of PKIs as they are very valuable not only for content distribution and protections.

- Standard for the use of X.509 public key certificates as qualified certificates
- European profile based of current IETF PKIX draft as required by Annex I of the Directive
- Draft to be approved by ETSI SEC in 4Q2000

4.5.4.2 Multiple platforms and formats and interoperability

Supporting multiple platforms and formats is rather a problem of players as content can be encrypted independently of the content. Solutions are possible also for different platforms. However technology developers often support only one platform for financial or tactical reasons.

Interoperability is addressed in various standards like MPEG-21 or ISMA's new specification. However technology providers are afraid of increased competition due to exchangeable products. This is one reason why the standards are not broadly accepted.

4.5.4.3 License management

Flexible license managing is possible for example by using smart cards which store encrypted keys and which are accessible from different devices. Of course one can also think about storing keys directly in hardware chips (e.g. as suggested by TCG).

4.5.4.4 Assumptions on hardware

As already discussed above trusted hardware and also trusted software, e.g. device drivers, are the essential for effective content protection. If it would be possible to implement trust into clients, servers, network connections, and communication platforms content could be delivered to those trusted devices without being in danger of illegal access or copying.

This was first addressed by the Trusted Computing Platform Alliance (TCPA, http://www.trustedcomputing.org), whose mission was to "implement TCPA specifications for an enhanced HW[5] and OS[6] based trusted computing platform that implements trust into client, server, networking, and communication platforms". TCPA was formed by Compaq, HP, IBM, Intel and Microsoft with the aim to create a new computing platform for the next century that will provide for improved trust in the PC platform.

The Trusted Computing Group (TCG, http://www.trustedcomputinggroup.org) is the successor organization of TCPA. TCG has adopted TCPA specifications as initial TCG specifications. However, TCG has a broader scope as they are also addressing non-PC devices and software interfaces.

Although the idea of creating trusted devices and computers is appealing, critics cannot be neglected and is addressing the design of hardware as well as software components of the Trusted Platform Module (TPM) and of Microsoft Next Generation Secure Computing Base (NGSCB).

Among the issues which are addressed are:

- "hidden channels" can be integrated unnoticeably, which infringe the system's integrity.
- Microsoft plans to use symmetric keys. These keys endanger the security as either removal of the cryptographical coprocessors or loss of information due to inaccessibility would be possible.

Among the critics another issue is often addressed: The fear that computer and devices will be controlled in the future by hardware or software vendors and not by the owners or purchasers by themselves, which is even infringing European law. Furthermore hardware attacks against the TPM is possible even by hardware vendors. These attacks allow access to private keys and prevents trusted online transactions. Therefore the problem for the user is to prove that her/his was compromised.

Here we can see a general difficulty: Hardware and software companies are defining solutions which are neither considering law nor user requirements and objections. Smart cards might a better solutions for this problem.

4.5.4.5 Usage control

A solution to this problem is difficult and might infringe national laws. Even if systems might be able to fulfill the relevant requirements content protection is not guaranteed (cfg. the above description of the DarkNet).

4.5.4.6 Legal framework

A legal framework will support the usage of DRM. On the one hand it is important for technology developers and for technology users to ensure a legal usage of technology. On the other hand a legal framework must also determine possible consequence after a misuse was detected. So far the legal framework for the usage of protection technology leaves too much room for open questions

4.6 Innovative Applications in Music education (ILABS, ILSP, DSI)

4.6.1 Identified Problems

It is necessary to point out that we are facing the e-learning universe, covering distance learning, CD-ROMs, videoconferencing, computer-based instruction, satellite downlinks, interactive TV lectures, computerized diagnostic assessment & evaluation, competency certification, electronic portfolios, virtual educational networks,

[5] hardware
[6] operating system

corporate universities, communities of learners, group- and project-based learning technologies and much more (for a complete glossary of e-learning concepts and terms, see www.learningcircuits.org/glossary.html)
Authoring tools are generally desktop, single-user applications used to construct learning content by assembling and combining text, graphics, audio, video and animations into e-learning courses.
You can also consider general purpose Web development tools (visual HTML editors) as fitting into the authoring category. These tools are often used to create standard Web pages, but they can also be used for creating learning applications.
In addition, there are a growing number of authoring tools focused on rapid, template-based development of learning content, sometimes with a specific focus on a particular type of learning application, such as software simulations.
All of these are considered authoring tools even though they offer a rather broad range of solutions. Some people make unnatural comparisons between authoring tools and learning content management systems, mostly because both have content creation capabilities. Ninety percent of LCMS products in this report have some form of content authoring built-in to the system. On the other hand, some LCMS suppliers have chosen to focus their efforts on the assembly and management of content. These systems provide for flexible integration of content created with third-party tools, and in some cases come bundled with a popular authoring tool. According to Brandon and Hall used tools fall into one of the following category: general purpose, web specific and e-learning specific ones. In the following table are reported samples of each category.

General purpose	**Web specific**	**e-learning specific**
Authorware	FrontPage	TrainerSoft
Flash	Dreamweaver	Lectora Publisher (Trivantis)
Director		ReadyGo Web Course Builder
ToolBook		Tactic
Quest		DazzlerMax

e-learning / distance learning / life-long learning / operative training - computers are moving out of the laboratory and into the classroom in learning new languages, understanding complicated math formulas, and exploring other countries. Technology is changing basic notions of schools and education and creating classrooms without walls that offer students a valuable view of the world and enable them to experience and interact with other students and resources around the globe. With numerous forms of distance learning now available, public education is moving away from a need for students and teachers to assemble in school buildings for education to occur. This trend has far-reaching implications for the structure of state education budgets.
According to analysis performed by government and research institutions the rapid growth in such areas as distance learning, technology-enabled assessment, and the increasingly diversified and expanded public-private learning marketplace requires to develop new strategies for assuring quality and protecting consumers.
Important priorities for the public and private sectors include:

- providing reliable and universally accessible quality information for consumers;
- developing quality assurance mechanisms;
- ensuring that learners have the support they need to make the right decisions about their e-learning options;
- developing policies and practices to ensure privacy.

Traditional, institution-based approaches to assessment and certification are not well suited to an e-learning world in which the focus turns from a record of classes taken and degrees received, to measures of what an individual actually knows and is able to do. As a result, private and public sector leaders need to take steps to create new approaches such as: developing and promoting outcome-based assessments of learning results; and creating an electronic system for tracking those results.
In areas from supporting the development of common technical standards to promoting broader access in under-served communities, government and business must play a leadership role in making quality e-learning opportunities more widely available to all. The challenge and the opportunity are the same: to realize e-learning's potential for reducing the divide between the "haves" and "have not" today. Therefore it is necessary to:

- Create the highest-quality e-learning experiences possible.
- Implement new measures & methods for assessing & certifying what individuals know and are able to do.
- Ensure broad & equitable access to e-learning opportunities.

The potential return on investment for both the public and private sectors is enormous. The challenge for businesses is to realize the full potential of e-learning as a driver of productivity and performance gains by making it an integral part of organizational strategy and operations.
For government, the challenge is to create a nurturing policy environment for e-learning - first, by removing barriers that restrict access to e-learning's benefits and, second, by promoting industry self-regulation while balancing citizens' interests and needs.

Virtual reality – in nowadays world the usage of virtual reality is becoming more and more extensive. Usually the primary applications are either professional training or gaming. In the first case the simulation is devoted to enable

trainee to have access to equipments and situations that may be too risky to be faced otherwise and too costly too. At the same time only big organization can presently afford costs related to simulations. On the other hand, namely in gaming, customers are demanding more and more in terms of appearance and the huge numbers involved allow developers to achieve high levels of quality despite the production cost.
It is apparent that virtual reality could be easily exploited aim many other situations. For example (just to deal with performance related issues) imagine what will be if a music student could be presented a situation (all carried out in VR) where he is part of an orchestra and facing the director has to take part to a live performance.

Multisensorial – with today's technology is possible to achieve results just unforeseeable just a few years ago. In detail it's now possible to achieve multisensorial stimuli by combining visual, tactile and sound experiences into a unique new one the real challenge is to be able to generate similar situations (potentially involving even smell) for edutainment purposes. What is still lacking is a paradigm to convey all those rich stimuli into a single mainstream that may be used for both entertain and educate at the same time. Imagine what it would be if it was possible to make the end user perceive the sensation that must have been affecting Mendelssohn when composing "The Hebrides". If you do know those islands and listen to his music closing your eyes you are overwhelmed by memories… what a great thing would it be to be able to make someone who's never been there perceive only a fraction of this all.

Interoperability – by adopting e-learning standards like the one defined by IEEE, AICC … is possible to achieve full interoperability of e-learning platform and have real full portability of produced content. A learning object respecting all features described in those standards will be available in whatsoever platform and therefore full independence from a specific vendor is achieved. Moreover it's possible to package

4.6.2 Content for Evidence and Validation
Please refer to the section at the beginning of the document.

4.6.3 Benefits that can be obtained solving the problems
Please refer to the section at the beginning of the document.

4.6.4 Possible Solutions and related issues
To identify possible solutions for the previously mentioned issues could seam straightforward as part of the solution has been also pointed out while exposing the problem. Still this is only partially true as there is a further level to take into consideration: the institutional one. Education is a field where public institutions have a relevant role

4.7 Innovative Applications in Images of music scores (UNIVLEEDS)

4.7.1 Identified Problems
Current general issues identified in the domain of music imaging include:

- recognition
- comparative study
- input
- output formats
- standard features and supported range of musical features
- indexing and cataloguing
- multimedia synchronization

4.7.1.1 Recognition
For a system such as Optical Music Recognition (OMR), the recognized output is perhaps the most important aspect of the whole process. The main obstacles, putting off large application of this technology commercially/industrially is due to the recognition rate. Currently, there are some commercially available systems and also some research systems. However, if these systems cannot guarantee virtually near perfect recognition rate, it is not easy to apply the technology in large scale industrially.

The key attraction for using optical input method is to:

- save time and
- minimize manual operations, to allow their performing in short time.

If the system cannot be more effective than manual input using a keyboard or other interfaces, it will not be useful. If the output contains too many errors, the time required for correction and proof reading will also stop large scale industrial usage.

4.7.1.2 Comparative Study

Music notation is open ended and complex, and hence it is not easy to compare two OMR system. A single recognition rate percentage is not really useful without further details. It is necessary to have a good model to compare different OMR system which is informative and able to find out the basic capabilities of the system.

4.7.1.3 Input

Differences in the input requirement in various OMR system make the comparative study difficult and also not allow the ease of "scan once, use many" model for digitization. It would be good if all systems can have the same input interface, allowing direct on-line scanner input as well as off-line image file input. This will allow a set of image collection to be processed by a number of different OMR system (e.g. for results comparisons)

4.7.1.4 Output formats

Output format is the key issue investigates by the MUSICNETWORK. It is important to have a comprehensive machine representation so that no recognized musical information can be lost due to the *translation* process. At the moment, the most commonly used interchange format is MIDI, but it is more intended as a network protocol and it does not contain any expressive symbols and hence it is not a *lossful* format to use in this domain. Although it is sufficient for other usage. For the purposes of Music Imaging, it is vital that all symbols allowable on the paper-based music document can be represented on the output format.

4.7.1.5 Standard features and supported range of musical features

Due mainly to the complexity of the music notation, it is not easy to define the support musical features. Certain OMR system may perform better with certain set of musical symbols. Without knowing the standard musical features/symbols, it is difficult to determine which OMR system to use for a particular image collection.

4.7.1.6 Indexing and cataloguing

With the growth of digital database of music images, indexing and cataloguing requirement is increasing. Without effective content retrieval methods, large collection is difficult to manage. Related researches and practices can be study from digital image collection of other visual materials such as painting.

4.7.1.7 Multimedia Synchronization

An Optical Music Recognition system takes an input image and output a machine readable symbolic representation of the inputted image. The output generally does not include any synchronization information to allow interlinking the information in the two domains (visual and symbolic). Hence, it is not possible to know the location (on the image) for a particular note being sounded from, for example, a MIDI file outputted by the Optical Music Recognition System. Some synchronization can be done at level of measure such as performed in WEDELMUSIC Editor.

For various multimedia system, such as a sing along software that display the music scores with bouncing ball to indicate the current position of the music, this synchronization information is required.

Beside direct application of computer recognition of graphical symbols and translation to symbolic representation, imaging processing approaches can also be apply to restore decaying paper-based music scores and handwritten manuscripts.

4.7.2 Content for Evidence and Validation

Discussions from section 4.1.2 are applicable here. Particularly, in imaging aspects of audio visual synchronization. With the Optical Music Recognition intermediate recognition, links can be established to allow synchronization between graphical features of a music scores with its symbolic representations, at various level (e.g. note, bar or at graphical primitive level such as a notehead and a stem). This could also enable synchronization between handwritten music manuscripts with their symbolic representation, which provide visual preservation together with machine readable musical information.

4.7.3 Benefits that can be obtained solving the problems

With a robust and idealized Optical Music Recognition system, large scale industrial application is possible to enable more effective re-printing and/or re-editing of old typeset music scores. Large amount of paper-based music documents can be *enhanced* with multimedia technologies, allowing digital processing and distribution with ease. This could in turn benefit many other related domains such as educations, libraries, accessibilities and distributions in a vast amount of musical applications.

Pre-processing of Optical Music Recognition system also has their usage. For example, imaging requirements are generally required in many e-Learning related applications. Typical usage includes displaying images of music

manuscripts. This kind of usage is normally in low resolution. Direct application of images from a scanner is possible but not ideal since some of the musical features, particularly the stave lines, are broken due to the resolution used, and hence OMR pre-processing techniques could be apply to enhance the stave line and also to de-skew the image captured. Currently, various pre-processing processes of an OMR system are also being applied for music-image-restoration purposes, at the University of Leeds and Music Imaging Ltd.

An effective survey model for Optical Music Recognition system would push forward the development and progress of the technology, allowing comparison with different approaches and methods with standard test data. If all input requirement of the system as similar, digitization process can be very much simplified. Digitization for archiving can be "scan once, use many".

With an Output Format that can encapsulate all information that are in the paper-based music document, no information will be lost during the *translation*, due to the representation capabilities. Output format is a vital issue and one of the key issues of the MUSICNETWORK.

With a well specified features and supported range of musical features, it will be easy to determine which system to use to process certain music image collection.

With the synchronization capabilities, truly multimedia music content can be made available in many different domains to widen accessibility and to allow the creation of truly multimedia musical systems (see also section 4.1.3).

4.7.4 Possible Solutions and related issues

A possible solution to the synchronization issue is addressed in section 4.1 in the MPEG-4 extension discussions.

In order to advance the OMR technology, it is vital

- to understand the major obstacles of the technology
- to find out how to measure the performance of system
- to enable comparative study of different system

Possible solutions include continuing works by the Imaging WG of the MUSICNETWORK, which include

- a simple quick *tests* to establish capability of OMR systems, and
- large ground truth dataset (similar to dataset available in OCR domain)

Large ground truth dataset is difficult to create due partly to the copyright of the content, but increasing number of publishers and content providers are supporting MUSICNETWORK. The next main obstacle with respect to large ground truth dataset is the time and manual operations require:

- to count the musical features, and
- to count the resulted tests

Interfaces and efficient procedures for collecting and counting the tests are urgently required!

Related issues to establish the wider potential of music imaging technology include:

- to promote wider understanding of the imaging technology
- to attract wider application, to encourage industrial usage by music publishers, libraries and related bodies
- to explore new interface, making use of OMR technologies, such as
    - tablet-PC
        - to promote on-line OMR system as music input system
    - music visualization
        - electronic music stands (such as MOOD)
        - wearable computer and other portable devices

Nowadays, optical document scanners are widely available and used. One of the simply way of distributing a page of sheet music is to digitize it using a scanner and it can then be easily distributed via the internet. This brings the question about copyright. Works on watermarking of music images have been carried out to hide information using visual features of the music images which could sustain up to certain level of attack including printing and rescanning.

4.8 Innovative Applications in Multimedia and Music Publishing, Content Production and Integration (NOTISSIMO)

4.8.1 Identified Problems

4.8.1.1 Which standard of notation to use?

Since there is a wide range of products that have to be used, the standardization is a complex problem; but it is mandatory to reach a standard in the audio domain, as well as in the logical, the visual and the graphical domains, in order to:

- decrease the production costs
- reach a maximum of customers
- be able to integrate a maximum of contributors for aggregating products or construct rich products

This becomes particularly important regarding the multi channel distribution possibilities.

4.8.1.2 Problems of distribution

- What is the business model to adopt (B2c, B to B, peer to peer …)?
- Through which network (licenses, proprietary network …)?
- Which system (s) for payment, including micro payments?

4.8.1.3 Indexation

From the point of view of the publisher, the products have to be found easily by the customers. The product must be visible among a lot of others.

On the other hand, the customer doesn't want to consume time in browsing catalogues, websites, in order to find something.

So not only the composer, title, instruments, performers, labels, have to be significant, but also a sequence of notes or of rhythms or some part of the content.

4.8.1.4 Control- Tracing of royalties- Rights managements

How to control

- The number of copies sold?
- The dates and places of performances?
- The use of the product?

Those questions are fundamental in order to calculate exactly the royalties to be received and to be redistributed.

The tracing of royalties is probably one the most important issues for a content owner.

4.8.1.5 Digital assets managements

How to control

- The use of the licenses?
- The tracing of the contracts?
- The use of the product when some parameters can be modified by the distributor or the teacher, or the end-user (for example possibility of transposing, or adding annotations)?

4.8.1.6 Different laws in different countries

Since the distribution channels are universal, the product itself can be different from an area to another, due to the law in the country where applicable. The contracts as well as the licenses and royalties can be different.

In order to benefit from the universalization of the distribution, it is very important for the content owner to bring a solution to these problems.

4.8.2 Content for Evidence and Validation

All the cases described in the paragraphs 4.1.2 and 4.5.2 are valid here, particularly online distribution via the Internet, and usage control.

4.8.3 Benefits that can be obtained solving the problems

Considering what the future could be:

- Need to access to diversity, to discover unknown, foreign, or no more published works is increasing
- The digitized music will be more and more mobile (From a room to another, from a device to another…)
- The peer-to-peer technology is increasing dramatically

The content owners need absolutely progresses in those areas, and they can obtain following benefits, provided the related problems are solved:

- Easier worldwide distribution (speed of transmission, size of the contents, visibility of the products)
- More possibilities of giving licenses
- Many more possibilities of modifications of the content by the end-user (but respecting the rights given or not by the owner)
- Many more possibilities of using their products in the educational environment
- A better control with certification on the use of the rights
- A better control with certification on the royalties depending on the use of the content

4.8.4 Possible Solutions and related issues

They do not depend on the publishers or contents owners, because they are users of solutions; they are all described in the previous chapters: notation and standardization, libraries and archives, accessibility, distribution, protection, education, images, audio processing.

5 Conclusions

This document has been produced for giving the evidence of the technological state of the art and to the needed activities for solving the present problems in the different areas covered by MUSICNETWORK. The global view of the present status put in evidence that the computer music industry is very far to produce stable products that satisfy the needs of their consumers in the several fields:

- Music notation is not standardized at any level, neither for classical common music notation neither for visually and Braille formats. Any effort in this direction will be really of value and mandatory. Presently there area hundreds of products which are not scalable, interoperable, etc., and don't cover any needs. There are about 20 strong formats that presently the MUSICNETWORK is pushing to integrate providing organization support for meeting and coordination of research effort. Researcher belongs to the MUSICNETWORK are invited to discuss and produce voluntary documents. Covering all the needs in this are will be almost impossible but putting together a standard to guarantee a given integration with multimedia will be mandatory to avoid the companies to provide compatible solutions and tools. If this will not happen, the market evolution will govern these aspects and the winner will be probably a proprietary format. This is not acceptable for publishers, and for content providers in general that see their content not saved in a commonly accepted format.
- In the area of integration of music notation, audio and multimedia large standards are going and have been developed such as MPEG4, MPEG7 and MPEG21, while proprietary applications such as WEDELMUSIC, OPENDRAMA, etc., are more futuristic. Presently the status of the mentioned standard and in particular for MPEG21 is very coarse and thus not interesting. It is much more mature the MPEG4 and thus Music Notation could find a way to be included in that preparing the basis to be present also in MPEG21.
- In the area of music sheet digitization, restoring and optical music recognition is not standardized. In this line a real analysis of the tools provided in the market is needed to give the objective evidence of their value and of costs of their usage. This analysis is in progress. Publishers has presently the impression that for them is much more convenient to compose the music by hands directly rather than passing from an Optical Music Recognition tool. This probably is correct since these products are far to reach the 95% of recognition. On the other hand, music sheet production is presently more expensive than producing a text page. Text is produced at 280 character per minute and thus 10 pages per hour while the music is produced in about 1-2 pages per hours. This different should better motivate the publishers that need to convert music sheet in symbolic format. A non secondary problem is the market of music sheets in symbolic is not so strong presently to that of the music sheet. The usage of music is practically only on paper now, mainly reading, simple annotation with pencil and some transpositions. The investment for converting in symbolic has to be reasonably low.
- In the area of library there are several products but no one seems to satisfy the needs of the archive. Archives, music information centers, etc. have different needs and there are not capable of integrating these aspects in a unique model to cope with Music content management. In addition, the integration of music content management is only at level of metadata while the real digital content, indexing, query by content is far from their usage and from the state of the art in use in the libraries. Even in this area the lack of a common standard is creating confusion. There are several standard for cataloguing while the impression of the librarians is that the real difference is the content management. That is not standard in the commercial tools. They are mainly non open, non open source, non expandable and quite expensive. In most cases, they don't have money for getting large content management systems.
- Computer music for Music education is far to provide suitable tools to pupils and teachers. Typically simple tools for self study of music up to the 8 years are present on restricted markets limited by language and local distribution. Tools for teaching theory and training older kits and for life long education are totally missing. Distance learning is a completely non considered in the area of music education. Institutions such as conservatories and music schools are not capable to help the student with specific software for supporting its education over the 7-8 years. This provokes the abandon of innovative instrument when the student is capable

of manipulating a computer more in deep. Educational tools such as authoring instrument as Macromedia, etc. are far to be used for music education.

- Tools for visually impaired people are quite mature, it is not clear which kind of tool is really satisfying the needs of these particular group of people. The main problem is the user interface to access at the information and the difference from what they are used to read in terms of Braille music and in terms of computer visualization screen. Screen readers are used in some cases.
- Regarding protection and distribution the activity is strongly pushed from the technology providers industries regarding the innovative solutions. These solutions in most cases are not so "innovative" as they claim. In most cases the innovation is on the marketing of the product and of the service rather that on the technology used. The iTune model has demonstrated the problem. On this regard, the content provider should have leamt that the real business comes if the right content is used. The real business continues to produce significant revenue only if the technology and a good user requirements analysis have been performed. In this view, the most convincing solution is that provide a compromise in these aspects. A big technical problem is the Digital Right Management and the interoperability of the present solutions. A real competition is present now on MPEG21 to gain the right platform as soon as possible, but the process of requirements production for MPEG21 and its specification is consuming huge amount of resources without providing presently significant results. A more active and operative solution is needed in this field.

This document and the enclosed analysis will be used as a starting and reference point to assess the effect of MUSICNETWORK in the European Environment and thus to measure id the activities performed will create some improvements in reducing the gap from content industries and technology providers to push them closer to the needs of the end users and thus to the market and to the content exploitation.

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7 Glossary

B2B	**Business-To- Business** A transaction that occurs between a company and another company, as opposed to a transaction involving a consumer. The term may also describe a company that provides goods or services for another company. [INV]
B2C	**Business-To-Consumer** A transaction that occurs between a company and a consumer, as opposed to a transaction between companies (called B2B). The term may also describe a company that provides goods or services for consumers. [INV]
B2E	**Business-To-Employee** It can be considered the Corporate Portal, that is, a centralized starting point for everyone within a company or an organization. It concentrates via web a set of tools, services, applications, content that can be personalized by users (employees). Differently from an Intranet employees can make B2E be their usual work environment.
CAGR	**Compound Annual Growth Rate** The year over year growth rate applied to an investment or other part of a company's activities over a multiple-year period. The formula for calculating CAGR is (Current Value/Base Value)^(1/# of years) - 1. [INV]
CMI	**Computer Managed Instruction** The components of e-Learning that provide assessment, student tracking and personalized lesson plans
CMS	**Content Management System** Content Management Systems are used to store and subsequently find and retrieve large amounts of data. Content Management Systems work by indexing text, audio clips, images, etc., within a database. In addition, CMS often provide version control and check in/check out capabilities. Using robust built-in search capabilities, users can quickly find a piece of content from within a database by typing in keywords, the date the element was created, the name of the author, or other search criteria. Content Management Systems are often used to create information portals for organizations and can serve as the foundation for the practice of knowledge management. They can also be used to organize documents and media assets. For example, a newspaper agency may use a content management system to provide an archive of every story ever written for the paper. Likewise, they might use the CMS to provide an extensive library of photographs that are reusable for future stories.
CRM	**Customer Relationship Management** Those aspects of a business strategy which relate to techniques and methods for attracting and retaining customers. [INV]

Dot-com	**Dot-com** A company whose operations are entirely or primarily Internet-based, or more specifically a company whose business model would not be possible if the Internet did not exist. Dotcoms often deliver all their services over an Internet interface, but products might be delivered through traditional channels as well. Dotcoms are often divided into two categories: those that provide products and services for consumers (B2C) and those that provide products and services to other businesses (B2B). [INV]
EEIG	**European Economic Interest Group** A European Economic Interest Grouping aim is "to create a new legal entity based on Community law to facilitate and encourage cross-border cooperation". It must be formed in accordance with the following rules: "The purpose of the grouping is to facilitate or develop the economic activities of its members by a pooling of resources, activities or skills. This will produce better results than the members acting alone. It is not intended that the grouping should make profits for itself. If it does make any profits, they will be apportioned among the members and taxed accordingly. Its activities must be related to the economic activities of its members, but cannot replace them. An EEIG cannot employ more than 500 persons. An EEIG can be formed by companies, firms and other legal entities governed by public or private law which have been formed in accordance with the law of a Member State and which have their registered office in the Community. It can also be formed by individuals carrying on an industrial, commercial, craft or agricultural activity or providing professional or other services in the Community. An EEIG must have at least two members from different Member States." [LAW]. Other rules can be found at: http://europa.eu.int/scadplus/leg/en/lvb/l26015.htm
GPL	**General Public License** Short for General Public License, the license that accompanies some open source software that details how the software and its accompany source code can be freely copied, distributed and modified. The most widespread use of GPL is in reference to the GNU GPL, which is commonly abbreviated simply as GPL when it is understood that the term refers to the GNU GPL. One of the basic tenets of the GPL is that anyone who acquires the material must make it available to anyone else under the same licensing agreement. The GPL does not cover activities other than the copying, distributing and modifying of the source code. A GPL is also referred to as a copy left, in contrast to a copyright that identifies the proprietary rights of material. [WEB] GNU project web-site http://www.gnu.ai.mit.edu/ The GNU GPL http://www.opensource.org/licenses/gpl-license.php
GUI	**Graphic User Interface** A program interface that takes advantage of the computer's graphics capabilities to make the program easier to use. Well-designed graphical user interfaces can free the user from learning complex command languages. Graphical user interfaces,[…], feature the following basic components: pointer, pointing device, icons, desktop, windows and menus. [WEB]
HCI	**Human Computer Interaction** A discipline concerned with the study, design, construction and implementation of human-centric interactive computer systems. A user interface, such as a GUI, is how a human interacts with a computer, and HCI goes beyond designing screens and menus that are easier to use and studies the reasoning behind building specific functionality into computers and the long-term effects that systems will have on humans. [WEB]
HCI	**Human Computer Interface** Any software or hardware that allows a user to interact with a computer. Examples are graphical user interfaces (composed of Windows, Icons, Menus, Pointers, …), command-line interpreter, or virtual reality
HW	**HardWare** Refers to objects that you can actually touch, like disks, disk drives, display screens, keyboards, printers, boards, and chips. [WEB]
IBTV	**Internet Broadcast TeleVision** IBTV provides an innovative service of Web-based Streaming Video and Audio Media Solutions addressed mainly to business and special event organizations. It represents another useful tool for content delivery. One of most suitable applications is related to companies' internal training.
LCMS	**Learning Content Management System** A *Learning Content Management System* is an environment where developers can create, store, reuse, manage and deliver learning content from a central object repository, usually a database. LCMS generally work with content that is based on a learning object model. These systems usually have good search capabilities, allowing developers to find quickly the text or media needed to build training content. Learning Content Management Systems often strive to achieve a separation of content, which is often tagged in XML, from presentation. This allows many LCMS to publish to a wide range of formats, platforms, or devices such as print, Web, and even Wireless Information Devices (WID) such as Palm and windows CE handhelds, all from the same source material. [BRA]
LMS	**Learning Management System** A *Learning Management System* is software that automates the administration of training events. All Learning Management Systems manage the log-in of registers users, manage course catalogs, record data from learners, and provide reports to management. There used to be a distinction between Learning Management Systems and more powerful Integrated Learning Management Systems. That distinction has now disappeared. The term Learning Management System is now used to describe a wide range of applications that track student training and may or may not include functions such as: Authoring, Classroom management, Competency management, Knowledge

	management, Certification or compliance training, Personalization, Mentoring, Chat, Discussion boards. [BRA]
LO	**Learning Object** *Learning objects* refer to self-contained chunks of training content that can be assembled with other Learning Objects to create courses and curricula. Learning Objects are designed to be used in multiple training contexts, aim to increase the flexibility of training, and make updating courses much easier to manage. Update a part of a learning object and the change should appear in any course using that Learning Object. The size of a Learning Object differs based on the instructional designer, from as small as a single page of content to as large as is required to contain an objective, presentation material, a practice section, and an assessment. [BRA]
Metadata	Data about data. Metadata describes how and when and by whom a particular set of data was collected, and how the data is formatted. Metadata is essential for understanding information stored in data warehouses. [OPE]
ODL	**Open & Distance Learning** Open Learning means that a learner is offered a wide range of possibilities to learn. Within this range the learner can reach his/her individual goal of qualification. An Open Learning system supports the learner's individual learning process regarding the content and structure, that means it provides the learner with a framework. It is the learner's freedom to make up his/her own mind and decide about various aspects of the learning process. This freedom or openness can be more or less extensive. The widest range of freedom for the learner is the possibility to control place, time, speed, learning-methods and materials as well as contents and degree of difficulty. That means that the system is under the learner's control. Open Learning also realises a flexible interactivity between the learner and the 'mediator' (teacher or teaching material), and even among the learners themselves. Open Learning offers accessibility to the learning system as well as adaptability of the system to different objectives and groups of learners. The extension of openness can vary. There are open bounds to 'Not Open Learning systems' which above all depend on the learner's control of his work [OPE]
Open Source	**1)** Generically, *Open Source* refers to a program in which the source code is available to the general public for use and/or modification from its original design free of charge, i.e., open. Open source code is typically created as a collaborative effort in which programmers improve upon the code and share the changes within the community. Open source sprouted in the technological community as a response to proprietary software owned by corporations. **2)** A certification standard issued by the *Open Source Initiative (OSI)* that indicates that the source code of a computer program is made available free of charge to the general public. The rationale for this movement is that a larger group of programmers not concerned with proprietary ownership or financial gain will produce a more useful and bug -free product for everyone to use. The concept relies on peer review to find and eliminate bugs in the program code, a process which commercially developed and packaged programs do not utilize. Programmers on the Internet read, redistribute and modify the source code, forcing an expedient evolution of the product. The process of eliminating bugs and improving the software happens at a much quicker rate than through the traditional development channels of commercial software as the information is shared throughout the open source community and does not originate and channel through a corporation's research and development cogs. OSI dictates that in order to be considered "OSI Certified" a product must meet the following criteria: • The author or holder of the license of the source code cannot collect royalties on the distribution of the program • The distributed program must make the source code accessible to the user • The author must allow modifications and derivations of the work under the program's original name • No person, group or field of endeavor can be denied access to the program • The rights attached to the program must not depend on the program's being part of a particular software distribution • The licensed software cannot place restrictions on other software that is distributed with it. [WEB] The Open Source Initiative (OSI) http://www.opensource.org/ The Free Software Foundation (FSF) http://www.fsfeurope.org/index.en.html
ROI	**Return On Investment** A measure of a corporation's profitability, equal to a fiscal year's income divided by common stock and preferred stock equity plus long-term debt. ROI measures how effectively the firm uses its capital to generate profit; the higher the ROI, the better.[INV] Or, more generally, the income that an investment provides in a year. [INV]
Schengen Treaty (Schengen Agreement)	The Schengen Agreement was signed in 1985 in the village of Schengen, on the borders of Luxembourg, France and Germany. Member states are Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Italy, Greece, Luxembourg, Netherlands, Norway, Portugal, Spain and Sweden. Its purpose is to remove all controls at internal land, sea and airport frontiers. In order to maintain internal security, a variety of measures have been taken as e.g. coordination of visa controls at the external borders of the Member States through a common approach to visa policies and asylum procedures http://www.eurovisa.info/SchengenCountries.htm http://europa.eu.int/en/agenda/schengen.html

SW	**SoftWare** Computer instructions or data. Anything that can be stored electronically is software. Software is often divided into two categories: • systems software : Includes the operating system and all the utilities that enable the computer to function. • applications software : Includes programs that do real work for users. For example, word processors, spreadsheets, and database management systems fall under the category of applications software. [WEB]
XML	**eXtended Markup Language** It is an innovative Web technology deriving from the HTML language that allows to separate data structural description from their representation.
Wi-Fi	**Wireless-Fidelity** It is meant to be used generically when referring of any type of 802.11 network, whether 802.11b, 802.11a, dual-band, etc. The term is promulgated by the Wi-Fi Alliance. Any products tested and approved as "Wi-Fi Certified" (a registered trademark) by the Wi-Fi Alliance are certified as interoperable with each other, even if they are from different manufacturers. A user with a "Wi-Fi Certified" product can use any brand of access point with any other brand of client hardware that also is certified. Typically, however, any Wi-Fi product using the same radio frequency (for example, 2.5GHz for 802.11b or 11g, 5GHz for 802.11a) will work with any other, even if not "Wi-Fi Certified." Formerly, the term "Wi-Fi" was used only in place of the 2.4GHz 802.11b standard, in the same way that "Ethernet" is used in place of IEEE 802.3. The Alliance expanded the generic use of the term in an attempt to stop confusion about wireless LAN interoperability. [WEB] http://www.weca.net/OpenSection/index.asp http://www.weca.net/OpenSection/glossary.asp?TID=2

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