

INTERACTIVE MULTIMEDIA TECHNOLOGIES FOR MUSIC

URL: <http://www.interactivemusicnetwork.org>

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Abstract

The MUSICNETWORK is a Centre/Network of Excellence that is supported by the European Commission to help bringing the music content providers, cultural institutions, industry, and research institutions to work together. The key aim of the project is to reduce the barriers between the technology- and content-providers and to improve the exploitation of the new interactive multimedia technologies. The MUSICNETWORK helps research solutions to reach the marketplace by seeking agreements among different actors and formats. It brings together research institutions, industries, small and medium sized enterprises, and experts to build the required momentum in order to study and define multimedia music modelling and coding for the digital era. This paper presents the activities and outcomes and analyses, highlighting key achievements on the introduction of the Symbolic Music Representation to the ISO MPEG. Further information on MUSICNETWORK and the activities are available online via www.interactivemusicnetwork.org

INTRODUCTION

Time flies! The MUSICNETWORK project [2, 12] is now on its final year. This paper presents the results archived so far, together with a summary of the main activities carried out and the experiences in the last three years, reporting the key achievements of the network.

The MUSICNETWORK is a Centre/Network of Excellence that is supported by the European Commission to help bringing the music content providers, cultural institutions, industry, and research institutions to work together. The MUSICNETWORK draws on the assets and mutual interests of these actors to exploit the potentials of multimedia music content with the new technologies, tools, products, formats and models. There is currently a large gap between technology and content providers and many products in the marketplace fail to exploit the potential of new multimedia technologies. The MUSICNETWORK helps research solutions to reach the marketplace by seeking agreements among different actors and formats. This can be achieved by bringing together research institutions, industries, small and medium sized enterprises, and experts to build the required momentum to study and define multimedia music modelling and coding for the new age. The MUSICNETWORK is stimulating this activity with a set of actions and services mainly provided by its web portal: www.interactivemusicnetwork.org

At the time of writing, the MUSICNETWORK has over 930 subscribers participating in various activities of the Working Groups (WGs), and attracted a broad range of visiting to the project website, from about 8700 different institutions, with about 140000 copies of documents downloaded. It generates a high level of network traffic, with over 1 Million hits on the portal in the last three years. The MUSICNETWORK has successfully organised 5 major Open Workshops and a series of smaller workshops, both types of workshops are normally co-located with other related and important events, such as the WEDELMUSIC Conferences [6, 11, 16], MPEG meetings, and others.



Figure 1: Activities of the MUSICNETWORK © MUSICNETWORK

THE WORKING GROUPS OF THE MUSCINETWORK

The MUSICNETWORK addresses several aspects of music: music notation coding, protection, distribution, conversion, etc., by using a large group of participants of the network belonging to a large number of different states and having different cultures and technology skills. Most of the results produced by the project will have also a strong value for non-European countries and the inclusion of participants from non-EU states is also encouraged. To this end, several different working groups have been established and interested parties have been involved in the work.

- **Music Notation:** This group examines each and every aspect of coding music notation, including modern music notation, format conversion, lyric modelling (multilingual aspects), fonts, and defining standards for music symbols, standardisation into MPEG and other bodies.
- **Music Libraries:** This group has a cross-domain perspective including museums, archives, industry catalogues and other collections. It deals with metadata, information and content based retrieval, digital libraries, technological, legal and standardization developments, sharing documents and content.
- **Music Multimedia Standards:** This working group examines multimedia standards for music coding, including audio and video coding (mpeg7 [5], mpeg21, etc), portable internet formats, synchronization, media integration and other standardization aspects, with MPEG and other bodies.
- **Music Distribution:** This group examines the distribution of coded music including streaming, Internet, distribution models (B2B, B2C, P2P, etc.), mobile systems, WEB-TV, and transaction models (on-line, off-line, kiosks, virtual shops).
- **Music Protection:** This group is devoted to issues related with the protection of coded music, such as encryption, fingerprint, watermark, Digital Rights Management, profiling functionalities, active and passive protection, and other security issues.
- **Music Accessibility:** This working group examines music coding for print impaired people (visually impaired, dyslexic, etc), and studies accessibility issues, user interfaces, computer assisted software and devices and the provision of music in alternative formats.
- **Music Imaging:** This working group focuses on issues relating to imaging and processing of music sheets, printed music scores and handwritten manuscripts, including music image acquisition, acquisition of music with different types of page support, digitising ancient music, coding for images, optical restoration and preservation, and optical music recognition (OMR).
- **Music Audio:** This working group is focused on audio processing aspects such as: conversion from audio to music notation, query by content, beat tracking, audio shrinking and stretching, audio recognition and comparison for personalisation, etc.

- **Music Education:** This group analyses and works on educational aspects of music with the support of the information technology and pedagogical aspects. In particular it deals with the aspects of: cooperative work on music notation, performances, virtual conductor, virtual orchestra, playing instruments by using internet support, e-learning, distance teaching, courseware tools, assessing music performances, self learning, software tools for music education, etc.
- **Music Culture:** This working group addresses the cultural aspects of music and musicology. This permits to consider music in the related historical period, while considering also the interpretation aspects related to that musical context.

SYMBOLIC MUSIC REPRESENTATION (SMR)

Symbolic music representation/music notation [14] is one of the important aspects in multimedia music processing. It is a key requirement for a wide range of applications including music sheet production, music teaching, audio rendering, entertainment, music analysis, database query, performance, etc. Recently, with its integration of multimedia and interactivity aspects, music representation and associated applications are rapidly evolving. Many new applications are receiving market attention and are generally believed to become more diffused in a short time.

With the widespread of computer technology in the artistic fields, new requirements for computer-based applications of symbolic music representation have been identified:

- (i) cooperative music editing in orchestras and music schools, as illustrated by the MOODS project [9];
- (ii) music score distribution via the Internet;
- (iii) multimedia music for music tuition systems, such as the IMUTUS project, the MUSICALIS project, etc.;
- (iv) multimedia music for edutainment and infotainment, in archives such as in WEDELMUSIC or in theatres such as OPENDRAMA. A new concept of multimedia interactive music is growing.

Recently, several XML compliant mark-up languages for music modelling have been proposed, among them: MNML (Musical Notation Markup Language), MusicML, MML (Music Markup Language), MusicXML [7], WEDELMUSIC [1], CAPXML, etc.. Most of these representations are mainly focused on the modelling of the music elements to preserve and interchange with other applications. Past efforts in the standardisation of the music notation representation were partially achieved with SMDL [3, 15] and NIFF [13]. However, only a few of them are capable of supporting the needs of innovative multimedia music applications as mentioned above. They are mainly based on proprietary and incompatible technologies in which the music content is recreated for each product, for which the information exchange between products is difficult and limited to the notational part. Hence, *ad hoc* solutions are currently used.

MPEG SMR

The introduction and integration of Symbolic Music Representation (SMR) with the MPEG framework which offers technologies that encompass video, audio, interactivity, and digital rights management will enable the development of a huge number of completely new applications. Hence, the MUSICNETWORK has started the work which integrates Symbolic Music Representation into the MPEG standardisation process and format. The MPEG-4 permits the encoding of multimedia content, including many different kinds of object types and a scene description allowing precise synchronisation between objects and specifying object composition rules. MPEG-SMR is opening new possibilities and new applications in several domains of entertainment, edutainment, infotainment, etc., from education and distance learning, to rehearsal and musical practice at home, from consumer electronics; such as set top boxes for interactive-TV, to personal computers and mobiles systems. Many music-related software and hardware products are currently available in the market. Some of these products integrate symbolic representations of music with multimedia content. Examples include:

- Interactive music tutorials;
- Performance training, Play training;
- Ear training;
- Compositional and theory training;
- Multimedia music publication;
- Software for music management in libraries (music tools integrating multimedia for navigation and for synchronisation);
- Software for entertainment (mainly synchronization between sound, text and symbolic information);
- Piano keyboards with symbolic music representation and audio-visual capabilities;
- Mobile devices with music display and editing capabilities.

Current products generally utilise proprietary and incompatible technologies. Therefore content must be recreated for each product. Information and data exchange between products is difficult, if not impossible. The lack of standardised tools to offer the symbolic representation of music has resulted in many incompatible and proprietary technologies since each developer implements their own solutions. These solutions will inevitably vary in efficiency, scope, features, quality, and complexity. Recently the MPGE ISO has officially started the activities of standardising the Symbolic Music Representation and thus of including the music representation into MPEG-4 standard. To this end, the Reference Model 0 has been selected, see the MPEG web site http://www.chiariglione.org/mpeg/meetings/busan05/busan_press.htm in which is reported “*Symbolic Music Representation and Multimedia Middleware are two such projects now on a path toward standardization. The goal of the Symbolic Music Representation is to facilitate music education and content distribution by providing the ability to integrate music representation into other aspects of MPEG-4 standards. As the world is aware, MPEG-4 is the object-based media coding standard. The addition of symbolic music objects will be a powerful tool for specifying object composition rules when combined with the other media objects types in the MPEG-4 Standard.*”

For more details, please see <http://www.interactivemusicnetwork.org/mpeg-ahg/>

THE GROWTH OF THE MUSICNETWORK

Figure 2 presents the evolution of a simple set evaluation measurements monitored over the course of the MUSICNETWORK project. It provides an idea of the evolution of MUSICNETWORK since December 2002 when the first services of the project were activated.

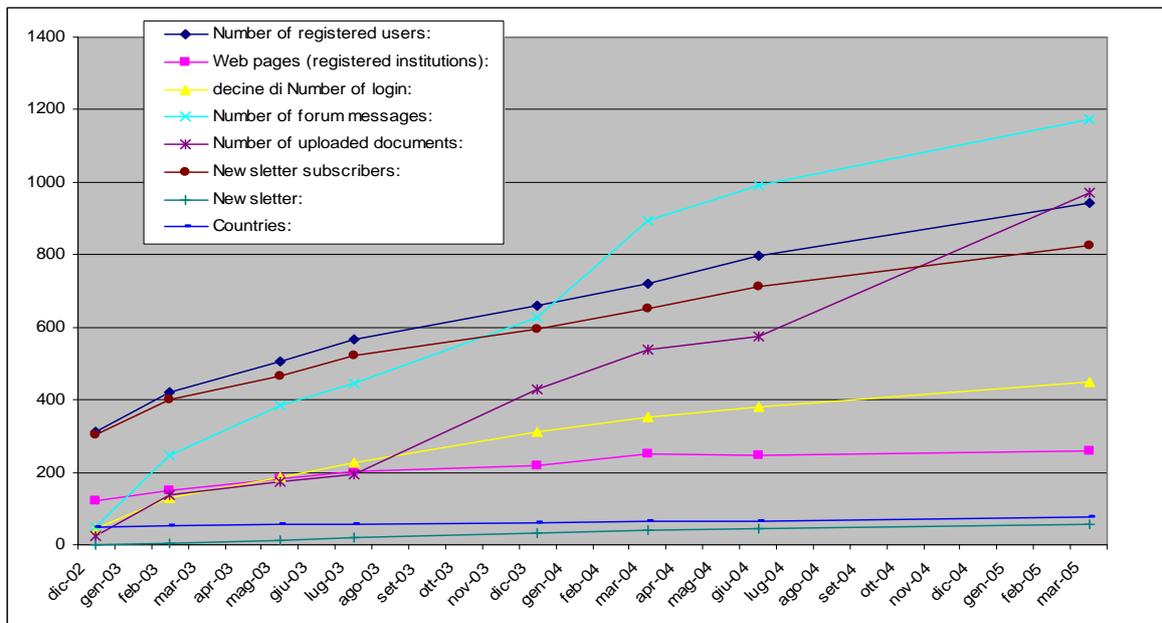


Figure 2: The growth trend of the MUSICNETWORK

The MUSICNETWORK project was officially established in August 2002. However the monitoring process of data begins from December 2002 onwards since the first version of the web-portal for the project was only available to public access during October 2002.

From the graph, it is evident that MUSICNETWORK is still growing steadily. Although the rate of growth is stabilising, it continues to expand nevertheless. From the analysis, it seems evident that the MUSICNETWORK statistics has gradually built up and reached a critical mass during December 2003 with the impact from the rapid increase of forums activities.

MUSICNETWORK PARTICIPATIONS

The latest analysis has been performed on a sample with approximately 940 participants; with about 230 qualified institutions, processing questionnaires participants filled during registration stage and whenever they modified their profile. Unfortunately, not all participants filled in the questionnaires and hence some of the data can only be analysed with a smaller sample.

Figure 3 presents the distribution of the MUSICNETWORK participants by countries, of which around 70% of the participants are from European countries and 12% of the participants are from US and Canada.

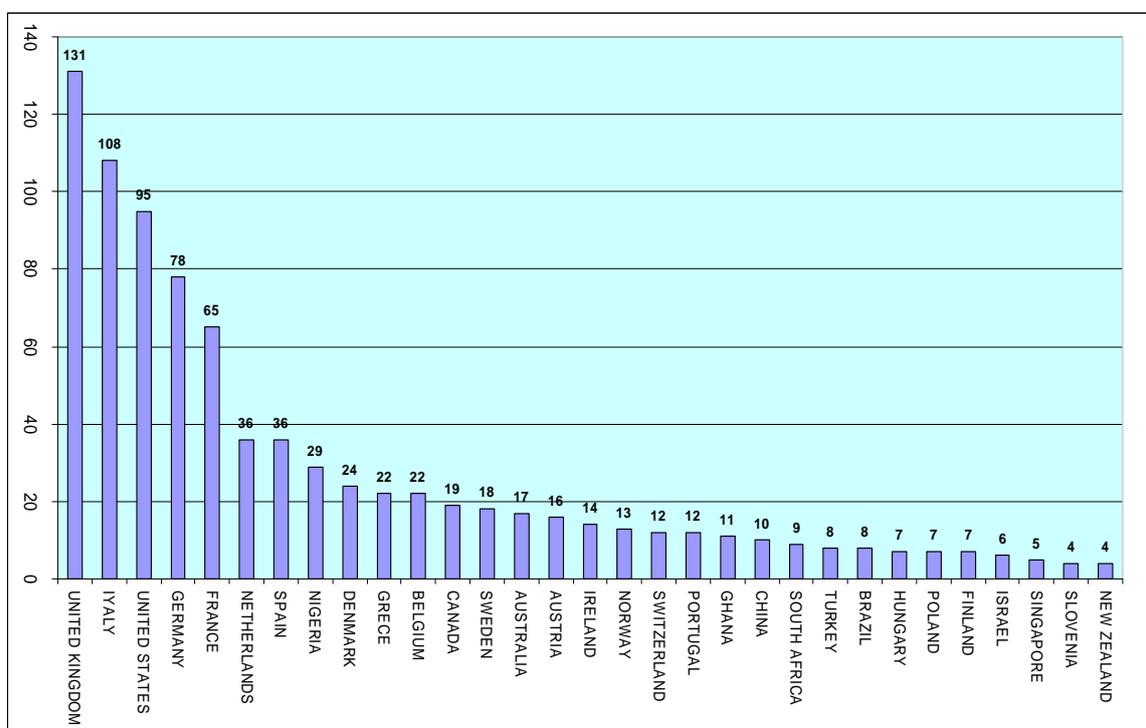


Figure 3: Distribution of MUSICNETWORK participants by country

We have also used the number of downloads (of documents from the MUSICNETWORK website) performed by participants as a measure of their areas of interests. It was found that participants have mainly been focusing on a number of specific areas as reported in the next table. The most popular downloads were those documents produced in the context of music notation and distribution (approximately 38000 downloads at the last survey).

TOPIC of INTEREST	Sub Areas	% of Downloads
Music Notation (symbolic and imaging)	Notation	52.87%
	Imaging	
	MPEG-AHG	
	Glossary	
Distribution and protection	Distribution	11.02%
	Protection	
Library	Library	6.54%
Standard	Standard	3.82%
Education and Culture	Educational	4.48%
	Culture	
Accessibility	Accessibility	2.45%
Audio	Audio	1.00%
Overview		1.41%
Events		16.40%
Total		100.00%

Table 1: Downloads distribution

The number of downloads related to the activities and documents produced by each individual Working Group have been also analysed and presented in Table 2. Note that the working groups for Notation, Imaging, Protection & Distribution, and Library are among the most attractive in terms of participants' interest. Protection & Distribution working-groups have been considered jointly since they are closely related. Sub-topics within the Notation working-group are also reported.

Topic	Number of downloads	Total number of downloads
Imaging		16031
Notation		22234
<i>AHG</i>	5945	
<i>WG</i>	19688	
<i>Glossary</i>	258	
Protection & Distribution		25633
<i>Distribution</i>	13660	
<i>Protection</i>	11973	
Library		15298
Education		5658
Standards		6454
Accessibility		3941

Table 2: Areas of interests of the MUSICNETWORK participants

CONCLUSIONS

With a brief introduction to the key aim and objectives of the MUSICNETWORK project, this paper analysed the outcomes and results collected so far. We believe that the MUSICNETWORK project has achieved its aim as a Centre/Network of Excellence to bring the music content providers, cultural institutions, industry, and research institutions to work together, providing a large number of services to SMEs in the area of Multimedia Music.

The MUSICNETWORK can help research solutions to reach the marketplace successfully, and it can assist in finding the appropriate matches between the community who have technical solutions to offer, and the community who could be benefited from these solutions. This has been achieved thanks to the help and contributions of research institutions, industries, SMEs, and all the experts in the domain of multimedia music modelling and coding. We hope the fast and continuous growth of the MUSICNETWORK activities will be sustained to continue supporting the development of the interactive multimedia music domain.

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