

IEEE 1599: A NEW STANDARD FOR MUSIC EDUCATION

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Abstract

IEEE 1599 is a new multilayer music code whose international standardisation was recently achieved. Its development follows the guidelines of IEEE P1599, “Recommended Practice Dealing With Applications and Representations of Symbolic Music Information Using the XML Language”. This project proposes to represent music symbolically in a comprehensive way, opening up new ways to make both music and music-related information available to musicologists and performers on one hand, and to non-practitioners on the other. Its ultimate goal is to provide a highly integrated representation of music, where score, audio, video, and graphical contents can be enjoyed together.

In this paper, two different aspects of the matter are discussed: the key features of the standard that make it suitable for both music education and training, and some examples implemented to achieve such goals.

Keywords: IEEE 1599; XML; music; training; education.

1. Introduction

Current means and interfaces oriented to music presentation and diffusion can represent effective ways to enjoy music only according to traditional meaning. In this sense, a number of applications can be cited, from portable device interfaces to multimedia players. But these applications, often advanced from both a graphical and a semantic point of view, usually respond to a partial vision of the whole music context. On the contrary, music is made of many different but complementary facets, and describing music in all its aspects is a challenging matter.

For example, music pieces are usually distributed or enjoyed as audio contents (tracks), nevertheless they are based on symbolic contents (score), can also present text (lyrics), video contents (video clips), etc. Furthermore, for each multimedia category we have cited, a number of different descriptions is allowed; in the case of a pop song: the radio edit, the “unplugged” and live versions that regard audio, as well as the official video clip and the recordings of live concerts as regards video.

In order to describe a music piece in all its aspects, first we have to detect suitable encoding of its symbolic content. This implies choosing a format to describe the symbols which constitute the score. Furthermore, in order to add some form of multimedia description, many digital objects can be used. Consequently, heterogeneity is involved from two perspectives: i) different categories of descriptions (metadata, music symbols, text, still graphics, audio, and video), and ii) different objects belonging to each category. The former perspective catches the richness of facets music is made of, whereas the latter perspective allows comparisons or integrations among different instances of the same document type.

A format which is able to catch such different aspects and approaches could virtually take into account any kind of music description, thus becoming a good candidate for the comprehensive encoding of music. As illustrated in the following, this is the base for a number of advanced applications aimed for entertainment as well as music education.

2. A Brief Overview of the IEEE 1599 Standard

As a response to the goals previously mentioned, the IEEE Technical Committee on Computer Generated Music (IEEE CS TC on CGM), whose activities are described in [1], released the guidelines known as IEEE PAR1599 - *Recommended Practice Dealing With Applications and Representations of Symbolic Music Information Using the XML Language*. This project proposed to represent music symbolically in a comprehensive way, opening up new ways to make both music and music-related information available to musicologists and performers on one hand, and to non-practitioners on the other. The ultimate goal was to provide a highly integrated representation of music, where score, audio, video, and graphical contents can be appreciated together. The IEEE balloting, i.e. the final evaluation process, ended in September 2008 with the result of making IEEE 1599 an international standard sponsored by the Computer Society Standards Activity Board.

IEEE 1599 is the result of the research efforts of the IEEE Standards Association Working Group on “Music Application of XML”. The work has been endorsed by

the international research program *Intelligent Manufacturing Systems* and financially supported by the Commission for Technological Innovation of the Swiss Federal Government through the University for Applied Sciences of Southern Switzerland, SUPSI.

The key features of IEEE 1599 make it different from other languages oriented to music encoding (both binary and text-based), as music is described in all its aspects. In order to support heterogeneous materials, this standard employs six different layers to represent information:

- *General* – music-related metadata, i.e. catalogue information about the piece;
- *Logic* – the logical description of score symbols;
- *Structural* – identification of music objects and their mutual relationships;
- *Notational* – graphical representations of the score;
- *Performance* – computer-based descriptions and executions of music according to performance languages;
- *Audio* – digital or digitised recordings of the piece.

IEEE 1599 adopts XML as the language to encode symbolic contents and multimedia synchronization information. Thanks to the intrinsic capability of XML to provide strongly structured information, such representations can be organised in an effective and efficient way.

The main focus of an IEEE 1599 document is the description of a single music piece. The *Logic* layer contains a list and a definition of the music symbols that compose the score. Music events, intended as logic entities, can correspond to one or many instances in other layers. In detail, each music event (note, rest, etc.) can be described:

- in 1 to n layers; e.g., in the *Logic*, *Notational*, and *Audio* layers;
- in 1 to n instances within the same layer; e.g., in three different audio tracks referenced within the *Audio* layer;
- in 1 to n occurrences within the same instance, as usually happens with a song refrain performed m times (thus the same music events are mapped m times in the *Audio* layer, at different timings).

IEEE 1599 is not a simple container for heterogeneous descriptions related to a unique music piece. Different logic or multimedia descriptions of the same music events present references to a common logical structure, known as *spine*. In other words, for each music event (say for a given note), the logical description (e.g. G#5), an area in a graphical file (e.g. a given rectangle with vertex coordinates in pixels) and the timing in a number of different audio/video files (e.g. 1200 ms, 2.35 s, 712 frames) are put in relation to the same music event. This aspect creates synchronization among the instances within a layer (*intra-layer synchronization*), and also synchronization among the contents disposed in many layers (*inter-layer synchronization*).

The mentioned common data structure, namely the spine of the IEEE 1599 document, is a list of music events that are sorted and labelled in order to allow references from other layers. Against common sense, the score does not correspond necessarily to the list of events referred to by other layers. Because if it did, music works with no notation, such as pieces where the performance is improvised and a true score does not exist, or music for which the score is unknown, could not be supported by IEEE 1599, and the user would be forced to encode the reconstructed score entirely. In this way, a traditional notated score or a complete encoding of the piece is not required to produce a valid IEEE 1599 document. In our approach, on the contrary, the definition and granularity of events can be chosen by the author of the encoding.

The spine has a fundamental theoretical importance within the format, thanks to its “glue” function in the multilayer environment. However, it simply lists (and does not define) events in order to provide a unique label for them. Consequently, the mere presence of an event in the spine has no semantic meaning: what is listed in the spine structure must have a counterpart in some layer, otherwise the music event would not be defined and its presence in the list (and in the XML file) would be transparent.

For further details about the structure and the syntax of the format, please refer to the official IEEE documentation [2] or to scientific papers such as [3] and [4].

3. Characteristics of the Format

By analyzing the format from the user standpoint, it is worthwhile to cite a number of characteristics.

First, the standard and its applications present no constraint about music genres, cultural areas, historical periods, or different approaches to composition and musical analysis. Consequently, IEEE 1599 can be applied to baroque fugue as well as Indian raga, to operatic arias as well as jazz improvisation. Of course, the features to be investigated can change noticeably, but the overall approach – consisting in a unique framework for heterogeneous music descriptions – preserves its capability to convey information in an integrated, intuitive and immediate way. The case studies presented in the following sections will provide good examples of the heterogeneity of sources and materials supported by IEEE 1599.

Regarding multimedia, those contents are represented by adopting formats in use for digital objects. For instance, all the common graphical formats (e.g. BMP, GIF, JPEG, TIFF, etc.) are supported for score scans, as well as most well-known audio/video file types (AIFF, MP3, WAV, etc.). Inside the IEEE 1599 document,

multimedia contents are not described in the XML format, as existing formats are suitable for this goal. Rather, multimedia contents are synchronized with the other contents within the appropriate layer and linked to the aforementioned common data structure. Please note that this approach presents at least three advantages: i) existing collections and archives of digital objects in standard formats can be used; ii) the design and implementation efforts are limited to the logical descriptions of music events, and not to their multimedia counterparts; and iii) the verbosity typical of an XML-based language afflicts only a part of the heterogeneous descriptions provided for the music piece.

Finally, another important issue is the possibility of multimodal interaction with music contents. This feature is not properly a characteristic of the format; rather it is a consequence of the structure and potentialities of the IEEE 1599 standard. Only thanks to *ad hoc* implementations, multimodal interaction with music contents can emerge, with important consequences about the applicability of the standard to music training and education. These aspects will become clear in the section where case studies are shown.

All these features can be applied both to education and to entertainment. In fact, also people without a specific music background can be interested in evolved ways to enjoy music, but such an aspect goes beyond the goals of the present paper.

4. Applicability to Music Training

In the wide range of fields where IEEE 1599 is applicable, we can cite music education. In fact, the format supports a number of features that can be used in many different ways to create *ad hoc* implementations, both as a guide to listening in an entertainment context and as a tool for instrumental and ear training.

Regarding the former approach, the heterogeneity of descriptions and instances within each layer opens up new ways of enjoyment of a music piece. The logical score – encoded within the *Logic* layer – can be visually represented in the *Notational* layer not only through autographic and printed scores, but also through other forms of graphical descriptions. Furthermore, this feature can also support those scores that do not belong to Common Western Notation. The *Audio* layer can provide various performances of the same piece, i.e. many interpretations and a number of variations starting from the original score.

A basic application consists of implementing a score following software with advanced features. At a basic level students can concentrate on the synchronization features among audio and graphical contents to learn score following. A more

advanced use of IEEE 1599 music code consists in the possibility of switching the current media in real time in order to compare different performances of the same piece: such an application can be useful for instrument players, singers, and musicologists.

Besides the possibility of switching both audio and graphical contents in real time while maintaining the overall synchronization, a good degree of interaction with music contents could also be supported. In fact, thanks to the mappings encoded in the *Audio* and *Notational* layers, areas of graphic files can be sensible to mouse clicks and cause a prompt re-synchronization of music contents.

Moreover, let us couple two of the mentioned characteristics of the format, namely i) the possibility to see and listen to music together, in a context of advanced score following, and ii) the support of non traditional scores; a tool based on these features could be used to teach the reading and performance of contemporary music to students.

Also ear training and instrumental practice activities could be based on the adoption of IEEE 1599. By using audio source separation techniques or multi-track recordings, some parts and voices can be easily removed from (or differently mixed in) the audio output by an *ad hoc* software; then the mentioned score-following application can highlight the part the student has to perform.

Please note that some layers have been intentionally ignored till now, as they may open up many other applications. In particular, the *Structural* layer allows the identification of music objects and their relationships in a score. The meaning of the sentence and the possibilities of the format are wide enough to embrace both harmonic grid and segmentation, as well as the results of different kinds of musicological analysis. For instance, the final results and consequences of an analytical process could be only a text document that must be referred to a symbolic score to be understood, but they could be enjoyed within an integrated framework where the original score, its revised versions, its many audio descriptions, and much more are easily available.

Other interesting applications can be implemented, particularly for cultures and kinds of music far from Common Western Notation, such as those studied by ethnomusicology, where there has been little investigation and methodological research.

In general terms, the IEEE 1599 standard becomes interesting when rich files can be produced. In other words, all the applications we have cited are based on the contemporaneous presence of heterogeneous media descriptions. Please note that an IEEE 1599 document is valid even when only the *Logic* layer has been compiled, but in this case most of the advanced characteristics of the applications based on the standard would be lost. From this point of view, creating a rich IEEE 1599 document could present some problems related to heterogeneous media link-

ing and synchronization. Since a key concept of the format is the mutual synchronization of all associated media, the process of adding a certain kind of material cannot be viewed merely as linking a file, but it needs an automatic, semi-automatic, or manual synchronization procedure. A particularly promising research field consists in the automatic discovery of event instances inside digital objects, such as score scans and audio tracks. Luckily, all the materials have a direct relationship only with the common data structure (the spine), so that adding a new media has a linear cost and both intra-layer and inter-layer synchronization with the other objects are automatically achieved.

5. IEEE 1599-based Music Viewers

After the creation of an IEEE 1599 document, the goal becomes to play it appropriately. The characteristics of the format drive not only to the implementation of a mere viewer, but to the design of a tool to deeply interact with music contents. The guidelines of such an application have been described in [5].

First, heterogeneity in music contents should find a counterpart in the layout of controls and views. Players, panels, floating windows or other devices should be used to present multimedia contents in a unique framework.

A simple way to view and navigate complex contents consists in keeping different multimedia types separated by using different controls, and grouping a number of objects of the same type within the same control. In fact, homogeneous media types require similar controls and imply similar behaviour, so this approach proves to be both user-friendly and effective. For instance, the part of the interface dedicated to audio/video contents should contain the playlist of such media objects (dynamically loaded from the IEEE 1599 document) as well as the usual controls of a media player. On the contrary, the panel dedicated to score images should contain the list of score versions and the list of pages of each score (once again dynamically loaded from the IEEE 1599 document) as well as navigation controls.

Please note that the simultaneous presence of all the six layers listed in Section 2 is not strictly required for a generic music piece: a jazz piece could present no traditional score, a never performed music work could be described from a symbolic point of view only without any media attached, etc. Consequently, the corresponding controls of the interface should also be dynamically shown or hidden according to the characteristics of the encoding.

Furthermore, a general and comprehensive approach should assign the same relevance to all the forms of music description, thus the interface should present

no “privileged” media type. Nevertheless, from a user-oriented perspective, it is preferable to have a main window where a given media is shown with greater evidence. A solution to this dichotomy could be to allow any media to be played on the main window, as well as to be resized to a secondary view panel. As a matter of fact, in many real implementations of the viewer video files were initially loaded inside a small window, but full screen magnification was supported.

It is important to stress the presence of synchronizable and non-synchronizable objects within a single IEEE 1599 document. Audio, video and still graphics usually belong to the former family, whereas catalogue metadata fall into the latter. Where a number of homogeneous or heterogeneous synchronizable objects are available for a given music piece, IEEE 1599 implements mechanisms to provide full synchronization. In this way, it is possible to enjoy music in a highly integrated environment where a cursor highlights the current chord in the score and simultaneously the corresponding point in an audio track is playing. Similarly, it is possible to switch from a score version to another or from an audio performance to another in real-time, while the music is being played. Of course, this feature is not available for non-synchronizable objects such as metadata (track title, author, ...) or music-related material (on-stage photos, sketches, playbills, ...).

In a proposal for an interactive interface, full synchronization among synchronizable objects should be provided. Consequently, the interface should allow the simultaneous enjoyment of all the views involved in the representation of media objects. A problem could occur with objects belonging to the same media category: for instance, listening to many performances, each with its own absolute temporization of music events is confusing and difficult to implement. Finally, also non-synchronizable descriptions (such as catalogue metadata or iconographic contents) should be accessible, but in this case layout requirements are less problematic.

A number of applications following the mentioned guidelines were designed, implemented and presented during international conferences, symposiums and exhibitions in order to demonstrate the applicability of IEEE 1599 standard to different purposes, ranging from education to dissemination, from music information retrieval to entertainment, from advanced fruition of multimedia contents to music cultural heritage.

The first experiment in this sense was the application of IEEE 1599 to jazz music. The goal was not trivial, as jazz is often based on processes of variation and improvisation whose development can be poorly encoded by a traditional score. In this case, the logic description of the score can be either based on a transcription (one of the many possible instances) or simplified to a list of generic music events (e.g. a sequence of chords or a harmonic path). Let us point out the consequences for music education: the user is enabled to compare performances of the same jazz standard by different players from different periods, or even the solos performed

during a unique session on the same harmonic path, simply jumping from one media to another.

About music education in more general terms, a number of public multimedia installations based on IEEE 1599 standard have been realized. Among the most recent experiences, let us cite the opening of 2006/07 season at Teatro alla Scala (*Celeste Aida, Percorso storico e musicale tra passato e futuro*, Teatro alla Scala, Milan, Italy, December 2006 – January 2007) and 2007 Salzburg Festival (*Napoli, nel nobil core della musica*, ResidenzGalerie, Salzburg, Austria, May – June 2007).

6. Case Studies

The advanced interfaces proposed during the demo session and also here commented have mainly two goals: first, they are aimed at demonstrating the multi-modal synchronized description of music within a single XML-based file in IEEE 1599 format.. Furthermore, they provide examples of future ways to enjoy music at different degrees of comprehension and abstraction. These two aspects have a profound impact on the applicability in the music education field.

In this sense, at least three kinds of applications can be illustrated: i) tools aiming at involving more ways to listen to music, by providing a certain degree of interaction to the user together with the possibility to compare performances, ii) tools to support musicological analysis, and iii) applications oriented to music training in all its aspects and facets. These cases will be treated in detail in the following subsections, where an example of each application is shown.

Even if the goal is slightly different, we can notice some characteristics which are common to all the applications. The user is allowed to select one among many score versions, one among many audio/video tracks, and one or many leading instruments. A basic fruition model consists in following the evolution of the instrumental parts by listening and watching music in a synchronized fashion. But a second way to enjoy music through such a model of applications consists in switching from an aural/visual representation to another. In other words, it is possible to compare in real time different versions of the score (the hand-made and the printed one) or different performances. When the user decides to switch from a representation to another, the process continues from the point previously reached. Finally, the application provides a third way to enjoy music that consists in jumping – backward or forward – from one point to another point of the score, both in its visual and aural representations.

6.1. Navigating and Interacting with Music Notation and Audio

NINA, standing for Navigating and Interacting with Notation and Audio, is an application implemented at the Laboratory for Musical Informatics (LIM) of the State University of Milan, Italy, to illustrate how the IEEE 1599 standard works.

This application is the evolution of a number of earlier software demos and working applications developed by the LIM staff. NINA was designed and implemented for the exhibition “Napoli, nel nobil core della musica” held in May 2007 at the Residenz Galerie in Salzburg, Austria. One of the purposes of the exhibition was to make music tangible and visible, bringing together all five senses beyond hearing. The music piece chosen for this demonstration is the operatic aria “Il mio ben quando verrà”, from Giovanni Paisiello’s *Nina, o sia la pazza per amore*.

The core of the application is an XML encoding in IEEE 1599 format, which contains logical information about the piece, and synchronisation among the linked multimedia objects. Overall synchronisation is provided among graphic objects representing scores, audio and video clips containing human performances, and with the libretto.

In the context of that exhibition, a rich but simple user interface was designed, conceived for laymen, to let them listen to a track with various interpreted scores, and look at different score versions simultaneously.

The screenshot in Figure 1 illustrates the user interface of NINA. Music browsing is based on windows containing different representations of multimedia contents that operate in synchronism while the music is being played. In our approach, the layout is made of a number of floating panels which can be either opened or closed depending on the user’s needs. Each panel is dedicated to a specific kind of visualization. All the homogeneous objects, namely the material belonging to the same layer, are selectable in each panel designed to manage them.

The user is allowed to use a number of selection windows. In the lower window there are four choices among scores that can be loaded: autograph full score, historical hand-made copy, printed piano reduction, and libretto. In the left window, the user chooses either an audio track or a video clip to listen to. The movie is launched in a dedicated player. The upper window allows the selection of the instrumental part, to be followed in real time on the score previously chosen.

The main part of the interface contains key graphical contents, namely, the score of the aria in one of its versions. Upon that selection, several synchronised activities start and execute in real time. The music starts playing, while on the score the running cursor indicates what is being played, here the beginning of the 2nd bar. In addition, the interface make it possible to follow every instrument (as in the examples below), as well as to view a whole vertical line (as in common music notation software). The user can move the red cursor with the mouse and initiate playing from another point in the score, while the other real time windows

adjust synchronously, and of course the audio/video player cursor changes its current position accordingly. The user is allowed to follow the evolution of any single voice. Hence, another selection window is provided in the upper part of the interface, where instruments are listed.

During the performance, the user can change the instrument to be followed, as well as the audio being played and the score. This is achieved by clicking on any point of the current graphical score (the synchronization is driven by spatial coordinates), by dragging the slider of the audio/video player (the synchronization is driven by time coordinates), and even by selecting syllables from the libretto (navigation by text contents). Overall synchronization is immediately reconstructed. Figures 2.a (autograph full score & audio), 2.b (manuscript copy & audio) and 2.c (printed libretto & video) show some practical examples.

In conclusion, NINA is a browser that represents music with readable symbols that can be accessed and manipulated even by non-musicians. A significant result is that only one single XML file is needed for several – synchronised – renditions of the same piece, thus proving that the format used for audio and graphical contents is irrelevant.



Figure 1: The interface of NINA.

6.2. Musicological Analysis

Another set of tools based on the same standard and key features is devoted to the visual and aural representation of the results of musicological analyses.

Once again, the interface allows a number of different ways to enjoy music, similarly to what we have stated in the previous sections. However, new *ad hoc* navigational tools can be implemented in order to demonstrate a musicological thesis or to make it clearly tangible to the audience: e.g. the navigation by music themes or a graphic panel to highlight music fragments.

Recently, two applications have been designed at LIM with musicological purposes. The first tool is very similar from a logical point of view to the one shown in Figure 1, but a window with the current phrase has been added (see Figure 3). In this way, a new form of navigation has been implemented, aiming for the demonstration of a musicological analysis: all the piece – namely a duet from Puccini’s *Tosca* – is built on melodic arches of ascending/descending pitches, often split over the two characters’ parts. The interface provides an effective way to listen and watch the basic idea this piece is built on.

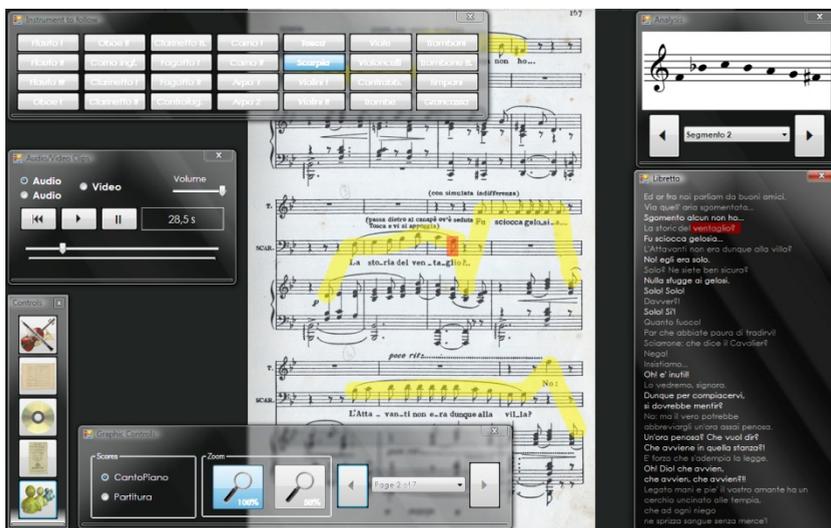


Figure 3: A tool to view the results of a musicological analysis.

The IEEE 1599 standard, and in particular its *Structural* layer, can be also used to put different pieces in relationship with common elements. This is the case of some compositions by Bruno Maderna where the same notational and audio fragments are used, even if mixed and interpolated in different ways. As a result of the musicological analysis conducted by Angela Ida De Benedictis, the pieces *Don Perlim-*

plin, *Honeyrêves*, *Serenata IV*, *Konzert für Oboe*, and *Musica su 2 dimensioni* result to have shared roots which can be highlighted thanks to IEEE 1599 technology. In Figure 4 some screenshots are shown. The upper part of the interface illustrates a synoptic table about the current piece and its relations with the other compositions. It provides a navigational tool to compare shared fragments in real-time.

The figure displays two screenshots of a software interface designed for comparing musical works by Bruno Maderna. The interface is divided into several sections:

- Schema sinottico (Synoptic Table):** Located at the top of each screenshot, it shows a horizontal timeline with 14 segments (pages). Colored bars indicate the presence of specific works: Don Perlimplin (green), Serenata IV (purple), Honeyrêves (blue), Konzert für Oboe (red), and Musica su 2 dimensioni (orange).
- Forma d'onda (Waveform):** A visualization of the audio signal, showing amplitude over time.
- Score View:** The central part of the interface displays the musical score for the selected work.
 - Honeyrêves:** The score is for flute and piano, by Bruno Maderna. It includes performance instructions like *molto espress.*, *Flauto solo*, *pp vibrato*, *pppp (come soffia)*, *p non vibr.*, *mp*, and *vibrato*. The tempo is marked *♩ = 50 ca.*
 - Don Perlimplin:** The score is for flute, titled "IL TRIONFO DELL'AMORE E DELL'IMMAGINAZIONE" (or "BALLATA AMOROSA DI FEDERICO GARCIA LORCA" and "AVVITAMENTO RADIOFONICO"). It is by Bruno Maderna, with music by Federico Garcia Lorca and a translation by Vittorio Bonini. The section shown is the "INTRODUZIONE". The tempo is marked *♩ = 50 ca.*
- Audio and Partitura (Score) Controls:** On the right side, there are controls for audio playback (play, stop, previous, next) and page navigation (Page 1 of 10 for Honeyrêves, Page 1 of 13 for Don Perlimplin).

Figure 4: A tool to compare some works by Bruno Maderna.

6.3. Music Instrument and Ear Training

Finally, it is possible to design software based on IEEE 1599 aiming at goals such as music instrument training and ear training. For these kinds of applications, a good integration between logic, structural, audio and video contents is fundamental.

Let us concentrate on music instrument learning. In a multimedia interactive environment, the student can see the score to perform, listen to a pre-recorded version of the music contents to reproduce, and even watch the performance of an expert musician. This latter aspect becomes particularly relevant for artists such as conductors or singers; nevertheless, video contents in the learning context are interesting also for instrument performers. For example, a clip can show the positions for guitar chords, or the hands of the pianist.

All these aspects are supported by IEEE 1599 standard, as extensively shown in the previous sections. However, let us recall that this format also allows comparisons among many performances, as well as synchronized multi-angle videos. These aspects of novelty are sufficient to justify IEEE 1599 adoption in order to create advanced interfaces for music training.

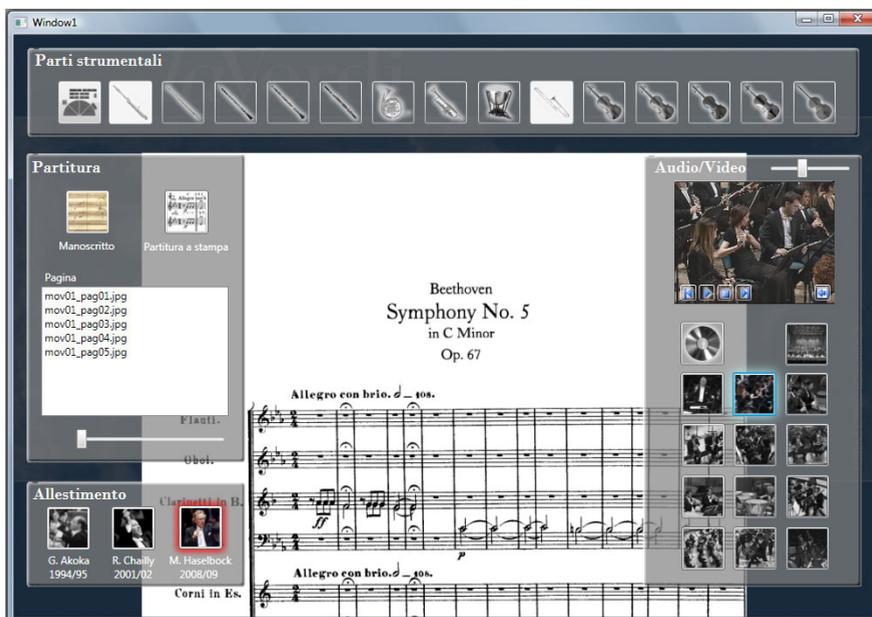


Figure 5: A tool oriented to music training.

Moreover, the support of multiple audio tracks is another key feature in this field. An *ad hoc* mixing or demixing of single instrument recordings allow the implementation of a software tool for both instrument and ear training. For instance, a

trumpet student and a double bass student could decide to play a jazz piece together by removing the audio tracks of their parts and using the other tracks of a historical instrumental performance. Regarding ear training, a student can try to follow a given part in an orchestral recording, and then validate understanding by listening to the isolated audio track.

An example of an application that supports part-by-part score and audio following, as well as multi-angle videos, is shown in Figure 5.

Thanks to the adoption of IEEE 1599 standard, computer-based methods prove to be particularly effective in the educational field.

7. Conclusions

This paper has illustrated the key features of the IEEE 1599 standard that are oriented to music training and education.

As demonstrated during the demo session, a software tool based on IEEE 1599 can follow a music piece in its many complementary aspects: symbolic score, graphical notations, audio, and even structure. The key feature is the ease of showing given characteristics of a music piece, highlighting music symbols or more complex aggregations over one of the possible graphical and audio renderings of a given score. Moreover, the deep integration among multimedia objects strengthens the comprehension of music characteristics, structures and interpretations.

The mentioned features both of the standard and of the software applications based on it are applicable not only to the educational field, but also to electronic publishing and entertainment. This standard opens new ways to enjoy music contents and to interact with them. Consequently, interesting applications can consist in integrating viewers within standard multimedia appliances (DVD players, entertainment-oriented consoles, etc.) and portable devices (last generation mobile phones, PDAs, music players, and other wearable devices).

In our opinion, the publishing of documents conforming to IEEE 1599 standard should be encouraged in order to offer rich descriptions of music contents to a wide audience.

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