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Embedding ISRC Identifiers in Broadcast Wave Audio Files

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1. Abstract

A recent initiative by the UK Music Producers Guild and the European Broadcasting Union is to utilize the Broadcast Wave (BWF) file format for commercial music releases, allowing the International Standard Recording Code (ISRC) to be embedded within the file. At present, unlike with compact disc releases, it is not possible to embed the ISRC in a standard Wave or data compressed file. This paper gives a discussion of the opportunities brought by embedding the ISRC in digital audio files. Examples of BWF metadata are shown along with a discussion of the correct use of ISRCs in music production and audio mastering, as well as a look at relevant requirements of emerging music sales and delivery formats.

2. Introduction

In 1982, the compact disc (CD) brought the first commercially successful format of digital music delivery to the consumer, bringing a number of exciting new features and opportunities. In particular the digital format allowed not only the audio to be contained within the disc, but digital data describing the held audio could also be embedded within the disc. This brought the first widespread use of audio metadata and the opportunity for tracks to be uniquely identified on the disc by an International Standard Recording Code (ISRC). The ISRC is defined by International Standard ISO 3901:2001 and it is particularly useful for tracking artist and label copyright and repertoire, radio playback, and mechanical sales data, as detailed by the International Federation of the Phonographic Industry (IFPI) [1]. The CD itself therefore contains a number of digital tracks, represented by binary audio data streams, and a number of binary metadata information fields.

More recently music is sold and purchased as discrete digital audio tracks which due to the inability of ISRC data to be embedded uniformly during the production

process, tends to result in the MP3 file format to also not hold the IRSC codes despite the capability in metadata. So, at present, the metadata included within the CD specification is lost when the tracks are used in a software only format.

Although the WAV file holds a number of metadata fields in describing the audio data contained (such as information on sample rate, number of channels represented and resolution) there is no metadata field designated to hold the useful ISRC data. In 2012, however, the UK Music Producers Guild (MPG) identified the opportunity to utilize the already existing Broadcast Wave File (BWF) type for distributing digital audio data, given that the BWF format does have an identifier field (ID) which could feasibly hold the ISRC for an audio track. This initiative was implemented in 2012 by the European Broadcasting Union (EBU) to include the recommended practice of using the BWF format for audio data and holding the ISRC in the BWF metadata, as described by EBU Technical Document 3352 [2].

In the United States, it is anticipated that Apple iTunes are supportive of utilizing the BWF format, as it facilitates valuable improvements for database management and the ISRC can be passed through as part of the encoding process to the Advanced Audio Coding (AAC) file format. American radio has not historically had 'pay per play' mechanisms in place. This is gradually changing however, making reporting more critical for radio stations and copyright holders.

This paper gives an overview of the necessity and opportunities brought by embedding the ISRC in digital audio files and the use of the Broadcast Wave format for professional audio delivery. Examples of BWF metadata are shown along with a discussion of the correct use of ISRCs in music production and audio mastering. Additionally a look to the future is included which elaborates the relevance with respect to emerging music sales and delivery formats and with respect to the increasing need for audio data security, verification and management.

3. Wave and Broadcast Wave audio formats

There are many types of audio data file, of which the Microsoft Wave (WAV) type is one of the most widely used. Wave files contain a number of details about the audio data followed by the audio data itself. The WAV audio file uses the Resource Interchange File Format (RIFF), which holds consecutive stored data elements defined as chunks [3]. Each chunk of data is preceded by a 4-byte character code which describes the data chunk that follows.

Wave RIFF files generally contain uncompressed (i.e. raw) data, mostly in a format known as linear pulse code modulation (PCM) [4]. PCM specifically refers to the coding of amplitude signal data at a fixed sample rate, so each sample value is given to a specified resolution (for example 16-bit or 24-bit) on a linear scale. The data sample rate is known and fixed at a specific frequency, often 44.1 kHz or 96 kHz for audio files. Amongst other things, the wave header information includes details of the resolution and sample frequency of the audio, so by reading this header it is possible to accurately decode and process the contained audio data. Much of the

WAV metadata is stored using the American Standard Code for Information Interchange (ASCII) protocol [5], which allows the use of 8-bit hexadecimal values to represent alphanumeric characters. The full wave header file description is shown in Table 1.

Character Code	Offset (bytes)	Size (bytes)	Details
ChunkID	0	4	The characters "RIFF" in ASCII
ChunkSize	4	4	Details the size of the file from byte 8 onwards
Format	8	4	The characters "WAVE" in ASCII
Subchunk1ID	12	4	The characters "fmt " in ASCII
Subchunk1Size	16	4	16 for PCM.
AudioFormat	20	2	PCM=1. Any other value indicates data compressed format.
NumChannels	22	2	Mono=1 Stereo=2
SampleRate	24	4	Sample rate of the audio data in Hz
ByteRate	28	4	ByteRate = SampleRate*NumChannels*BitsPerSample/8
BlockAlign	32	2	BlockAlign = NumChannels*BitsPerSample/8 The number of bytes per sample block.
BitsPerSample	34	2	Resolution of audio data
SubChunk2ID	36	4	The characters "data" in ASCII
Subchunk2Size	40	4	Subchunk2Size = Number of samples*BlockAlign This is the total size of the audio data in bytes.
Data	44	-	This is the actual data of size given by Subchunk2Size

Table 1. WAV file information header structure.

It is possible to identify much of the wave header information simply by opening a .wav file with a text editor application, as shown in Figure 1. Here we see (the ASCII characters for ChunkID ("RIFF"), Format ("WAVE"), Subchunk1ID ("fmt") and Subchunk2ID ("data"). These are followed by the ASCII data which makes up the raw audio.

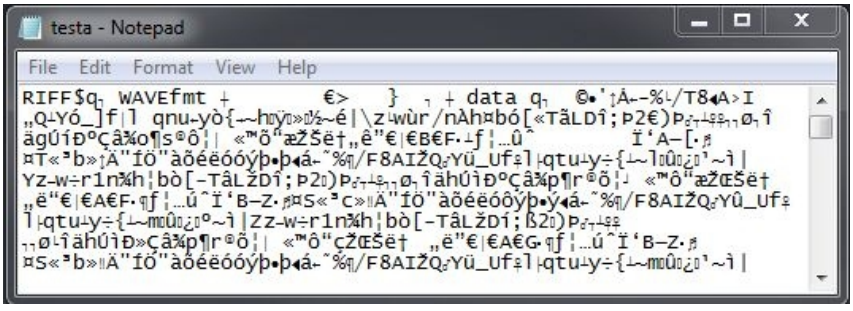

Figure 1. Wave file opened in text editor.

Looking more closely at the header information for this file in hexadecimal format, the specific values of the metadata can be identified, as shown in Figure 2. Note also that for each value made up of multiple bytes, the least significant byte is always given first and the most significant byte last. For example, the four bytes denoting the sample rate in this example is given as hexadecimal 0x80, 0x3E, 0x00 and 0x00, which describes a 32 bit value of 0x00003E80 = 16000 decimal.

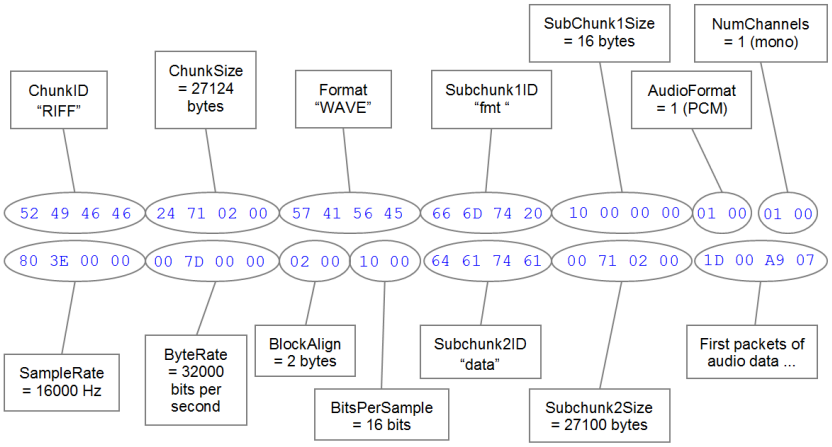

Figure 2. Structure of the WAV file header data.

The Broadcast Wave file format (BWF) was first published by the European Broadcasting Union in 1997 in order to define a WAV compatible file format which holds additional metadata of valuable use in broadcasting applications, as defined in the EBU Technical Document 3285 [6]. The BWF format is essentially identical to the WAV format but the EBU has also added a Broadcast Audio Extension (BAE) chunk to the metadata.

In addition to the metadata defined in the standard WAV file format (as shown in Table 1), the BWF format also includes, within the BAE chunk, metadata representing, for example, an ASCII field for the name of the originator or producer of the audio file and specific measured loudness parameters (including loudness value, loudness range and maximum peak level value) as defined by the EBU R128 recommendation [7]. Table 2 shows a number of example metadata parameters held by the BWF format. The BWF chunk data proceeds those of the standard WAV format, which are described in Table 1.

Character Code	Size (bytes)	Details
Originator	32	32 ASCII characters describing the originator or producer of the audio file
OriginationDate	10	10 ASCII characters describing the date the audio file was created
LoudnessValue	2	A 16-bit signed integer describing the Loudness Value of the audio data in Loudness Units (dBLU)
LoudnessRange	2	A 16-bit signed integer describing the Loudness Range of the audio data in Loudness Units (dBLU)
MaxTruePeakLevel	2	A 16-bit signed integer describing the Maximum True Peak Value of the audio data in decibels (dBTP)

Table 2. Example Broadcast Audio Extension chunk data contained in the BWF header.

Rather than add more and more data chunks for future incarnations of the BWF format, in 2003 the EBU decided to introduce a new chunk to the BWF file which could be used to hold as much varied metadata as desired, without the need for redefining the format each time. This is facilitated by the EBUCore chunk which carries Extensible Markup Language (XML) data, as described in EBU Technical Document 3293 [8]. The use of XML data means that the BWF file can carry any number of data fragments or identification fields, which can be accessed and utilized by software based broadcast and music playback systems.

4. Using the Broadcast Wav File format for holding ISRC information

4.1. The correct use of ISRC identifiers

The International Standard Recording Code (ISRC) has a number of unique identifying values within the full code and takes a total of twelve characters. In particular the ISRC identifies the year and country of release, the unique identifier of the record label implementing the release and the unique song catalogue number within that label's repertoire [1][9]. An example ISRC is in the form

AA-BBB-CC-DDDDD

where the elements A-D represent information as shown in Table 3.

Element	Description	Allowed Characters
AA	2 digit Country Code	A-Z
BBB	3 digit Registrant Code (unique to the publishing record label)	A-Z and 0-9
CC	2 digit Year of Reference date	0-9
DDDDD	5 digit Designation Code (the record label's incremental catalogue number for that song)	0-9

Table 3. ISRC elements and descriptions.

The correct use of the ISRC is to uniquely identify a song or audio release, regardless of the physical or software format in which it is distributed. So the same song released on multiple formats (CD and as various types of digital download for example) should always be referred to with the same ISRC. However, different mixes, or versions of the same song should be given a unique ISRC. For example, a song released as a single with the identical version included on the artist's album will have the same ISRCs. However, if the single release was an edited (shortened) version, then the single would have a unique ISRC, because it is now different to the album version. Remixes, some re-mastered versions and alternative recordings (such as a live or acoustic B-side version of a previously released song), should all be given unique ISRCs.

4.2. Embedding the ISRC in the Broadcast Wave File

The Broadcast Wave's Unique EBUCore data chunk gives an opportunity for the ISRC data to be stored within the audio file itself as metadata. This can bring numerous benefits for the music production industry and copyright owners of musical material; particularly given the movement towards music being sold ubiquitously as digital downloads. The recommended method for storing the ISRC as XML data in the EBUCore data chunk of a BWF file is described in EBU Technical Document 3352 [2].

```
<ebucore:identifier typeLabel="GUID" typeDefinition="Globally Unique Identifier"
formatLabel="ISRC" formatDefinition="International Standard Recording Code"
formatLink="http://www.ebu.ch/metadata/cs/ebu_IdentifierTypeCodeCS.xml#3.7">
     <dc:identifier>ISRC:NOX001212345</dc:identifier>
</ebucore:identifier>
```

Figure 3. Example XML code for embedding ISRC data in the BWF [2].

Technical Document 3352 gives examples of XML coding for embedding the ISRC in the BWF file. In particular the EBUCore definition and XML structure is given to describe an 'identifierType' data structure with the 'dc:identifier' element used to hold the actual ISRC value. Example XML code for the implementation of ISRC data within a BWF file is shown in Figure 3.

4.3. Mix stem identifiers

Mix stem identifiers are of less importance than ISRCs for sale and distribution of music through software channels. However, it can often be valuable during the music production process for mixing and mastering engineers to uniquely identify subtly different versions of the same track. A mix engineer might, for example, commonly generate instrumental and vocal only audio stems or mixes with three different vocal levels, to provide the mastering engineer a wider range of production options. In these instances it is equally useful for the metadata to hold information about the mix stems to ensure that the mastering engineer understands the subtle

differences between the audio files. Technical Document 3352 [2] also gives examples of using XML coding for embedding mix stems instead or in addition to the ISRC data, as shown in Figure 4. The use of mix stem identifiers is particularly valuable in the case where unpublished audio stems that were not used in the main release are subsequently used in a remix, allowing the correct contributors, artists and copyright holders to be credited.

```
<ebucore:identifier typeLabel="MIXID" typeDefinition="mix stem identifier"
formatLabel="URN" formatDefinition="A custom urn compliant identifier to
identifiy a mix stem" >
     <dc:identifier> MIXID:NOX001212345 </dc:identifier>
</ebucore:identifier>
```

Figure 4. Example XML code for embedding mix stem information in the BWF [2].

5. Royalty structures and production credits

The ISRC data is used commonly by radio broadcast stations to identify the playlists and airtime given to commercial music. This triggers a royalty payment system managed, in the UK for example, by PPL (formerly Phonographic Performance Limited), enabling record labels and artists to receive payments for the performance of their copyright music [9]. This is an equally important mechanism for music producers and outside investors who may have a royalty payment associated to particular music tracks.

An issue is observed in the fact that many radio stations nowadays accept music submissions in software only formats, uploaded to a radio station server through an online portal (the BBC Introducing system for example [10]). Where audio is delivered to a radio station in any format other than CD, it is therefore likely that the correct ISRC data is not provided alongside the audio material, so there is a significant likelihood that radio play statistics are not adequately recorded and hence artist royalties may be incorrectly calculated.

Similar issues arise with music streaming services such as Spotify and YouTube, given that the ISRC data is rarely associated or directly identified alongside internet based audio playback systems. To raise awareness and lobby for recommended practice, the UK Music Producers Guild have recently launched their ‘Credit Where Credit Is Due’ campaign with the aim of modernizing the methods for calculating and awarding royalty payments [11]. This is particularly timely given rapidly evolving technologies for music sales and streaming, which have emerged at a faster pace than legislation and copyright protection law can keep up.

6. Music information databases

A major benefit of embedding the ISRC data within a digital audio file is the ability for the ISRC to be a mechanism for accessing multiple layers of rich data and content relevant to a song being played or browsed by a consumer or listener. Given the emergence of audio playback systems which have constant online access, it is now

possible for the audio playback system to rapidly access additional data such as track names, song lyrics, relevant artwork, artist discographies, production details, performer credits, supporting video content and a host of other artistic materials which are associated with the song being played. The Gracenote music database, for example currently holds a large amount of song related information, which is accessed through many common audio playback software systems and usually recognizes songs by their unique order and duration, allowing the database to identify the album of audio which is being accessed by the listener [12]. This method however does not function well for individual song files, low volume releases or compilation albums, as it is more difficult for Gracenote to identify the song being accessed. Furthermore, Gracenote currently has a limited database of information (song names, duration, a single image of album art), which could be evolved to hold much richer and detailed information (including song lyrics, multiple album artifacts and direct links to online videos and artist interaction websites), i.e. enhancing the consumers' experience of music and the wider creative vision of the artist.

The movement away from physical media music has therefore lost the connection between the music and the wider creative vision of the artist, which may involve more than just sound alone; consider the album artwork for example. Beneficially, however, there is a unique opportunity for artists to deliver richer content through artwork, film, animation and interactive applications by utilizing the advanced digital systems that surround us. A bigger issue perhaps is that associated with the production details which would regularly be included in liner notes on vinyl and CD audio products, as highlighted also by the MPG's Credit Where Credit Is Due campaign [11]. The production credits are an essential part of the information defining an audio recording, and particularly describing the music producer (and other recording, mix and mastering engineers), the studios used during a production, as well as the guest and session musicians contributing on particular songs. This production information is regularly reported as being of major interest to the consumer who might for example seek other productions by a favorite music producer or through a particular recording studio. The production credits are not only of significance to the music consumer, but to the producers, engineers and session musicians too. A producer or session musician's portfolio and curriculum vitae is defined by the credits of the productions they have worked on, so it is essential that this information is captured and presented to enable the often unsung members of the music industry to develop their careers and showcase their successes. The move to embedding ISRC data within audio data files will help substantially with linking this connected and relevant information and equally enhancing the music listeners' experience as well as more completely representing the artist's creative vision.

7. The future for commercial music consumption

In the future it is proposed and encouraged that all Digital Audio Workstation (DAW) software developers will incorporate the BWF format as an option for data import and rendering of audio output files. For recording and mixing software systems, the BWF format can include data to denote and uniquely identify the mix version being

rendered. For audio mastering software packages the BWF EBUCore field can be used for encoding the unique ISRC file for the master audio. Indeed, in February 2013 Magix have announced their intention to support BWF formats in their next release of the Sequoia DAW package [13].

Furthermore, audio and music playback systems (such as Apple iTunes) and online databases (such as Gracenote) will be encouraged by the MPG's initiatives to incorporate advanced features based on the BWF format and ISRC song identifier. These databases and playback systems are expected to evolve to not only play audio alongside a single image of album cover art, but to provide rich content for both artists and music consumers to utilize in creating and exploring the diverse opportunities for creative output; in many ways bringing back the artistic vision and creativity that supported the physical vinyl format.

There are also a number of related issues to the ISRC initiative, particularly with the increasing focus towards software only music delivery and audio streaming services. In particular, the procedure for creating an audio CD master file, which can be duplicated at a manufacturing plant, provides a level of guaranteed authenticity for the artist, record label and manufacturing plant. The Disc Description Protocol (DDP) CD image format, along with a suitable MD5 checksum verification code [14], ensures that the manufacturer receives exactly the audio format provided by the mastering house, as it is very difficult for the DDP image to be tampered with following creation. However, with software only releases, and for upload to online distribution systems (such as Apple iTunes), there is little guarantee of security or validation. It is very possible that the mastering house might provide mastered and final audio files, which could be tampered with, edited or accidentally corrupted before they are uploaded to purchase websites. There may be future opportunities to enhance the BWF / ISRC approach outlined here to allow verification that the correct and final master file is the one being uploaded. In particular it is evident that a more secure and standard approach is required where master audio files are uploaded to music distribution websites.

One potential emerging format of software based music delivery is the 'application' format, similar to apps as seen on advanced mobile devices. Recently, for example, Bjork released her Biophilia album as an 'app' which can be purchased and downloaded to mobile devices such as iPhone, iPad and Andorid based devices. The 'album app' format is an interesting one as it allows unique artistic and interactive content to be distributed alongside the audio, again supporting the notion that an album is more than just a collection of songs, but equally a representation of artistic vision which may include artwork, photography, song lyrics, video, animation and even interaction and gaming features. The album app is also an attractive method for music delivery because it is relatively secure, i.e. once the app is created it cannot be tampered with, ensuring that the exact artifact created by the mastering house is exactly that purchased by the consumer. An interesting debate remains to be initiated should the album app format become more ubiquitous and commonplace. In particular it is essential that ISRC data is incorporated also into album app type releases, so that correct credits and royalties can be recorded and managed. In particular, should an artist decide to release music exclusively in the

album app format (i.e. not at all through iTunes, online stores or on CD or vinyl), then the question of how the ISRC data is encoded or recorded will become pertinent. Potentially, professional album app development software should be enhanced to support the BWF file format, so that music app releases can also contain the necessary metadata.

The move to incorporate ISRC data in the BWF file format, encouraged by the UK MPG and implemented by the EBU, is a clearly significant one for the international music industry. This motion sees a consolidated attempt to bring aspects of the music production and distribution industries in line with the technologies that are now common to the modern consumer. The move to embedding ISRC data in software files equally stands as a cornerstone motion towards improving the authenticity, piracy resistance and functionality of audio distribution whilst, perhaps more importantly, enhancing the opportunities for an artist to support their musical vision with rich creative content and ultimately providing a better experience for the music listener and audio consumer.

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