Compressing Music Files
by Gerald Fitton

My Musical Example

My intention in this article is to discuss, with a worked example, the way in which lossy compression affects the rendering of a piece of music. To do this I shall use a little tune which I composed a few years ago with the help of my Grandson, Sam.

I know it is not a masterpiece but it has the dubious merit that it can be used to demonstrate the four basic elements of a musical composition which are: melody, rhythm, harmony and counterpoint - and it is easy to play. We created it whilst I was teaching my grandson how to compose and play a tune on a modern musical keyboard. He had just got beyond a five finger rendering of "Twinkle Twinkle Little Star" and "Jingle Bells"!

MIDI Format

Modern musical keyboards play and store music in a file format known as MIDI.

My composition in MIDI format is 7.02KB (7225 Bytes) and it runs for 2:34 (m:ss), about two and a half minutes. Those of you into arithmetic will have no trouble discovering that the data rate is less than 50 Bytes per second! As an approximation 50 Bytes per second can be expressed as 500 bits per second; for comparison broadband speeds are generally measured in Mega bits per second, some thousands of times faster. You will have no problems downloading this 7KB MIDI file from the internet.

Windows computers can play MIDI files with a variety of programs in cluding the 'free' one, Windows Media Player. If you have a RISC OS computer then you can play MIDI files using RealMIDI.

As an alternative, it is possible that you have a musical keyboard which will take floppy discs containing MIDI files; all but the cheapest keyboards I've seen have such a slot. If you download the MIDI file, copy it to a floppy and put the floppy in your musical keyboard then it will play. Of course the MIDI file will be 'rendered' using whatever instruments you have on your musical keyboard. The MIDI file I have created uses five instruments from the basic MIDI set so you should be OK.

WAV Format

I transferred this MIDI file to my Windows computer and persuaded it to convert the MIDI file to WAV format. As far as I can tell this 26MB (27,264,044 Byte) file is an excellent reproduction of the MIDI file.

The streaming rate of this WAV file is 1411kbps (1,411,000 bits per second).

You may not be able to play it on your RISC OS machine and you can not copy this format to a CD (for playing on a CD player) without appropriate software. It will play with Windows Media Player and many other Windows programs.

You will find this file together with all the musical files on this CD.

Playing MP3 Format

Although Sam and I created this tune as a MIDI file, it is the 26MB WAV file which I have used to create the MP3 files. I shall use these MP3 files to demonstrate how compression reduces file sizes and how it affects the quality of reproduction.

If you download these MP3 files you will find that you (or your children?) can play them on lots of 'modern' machinery. MP3 players are available from as little as £20 in places like Argos and for not much more in specialist shops. All the modern mobile phones I've seen contain an MP3 player. Like Sam, your grandchildren will know how to do it!

I am suggesting that you shouldn't have too much trouble finding something by way of an MP3 player from someone such as my grandson, Sam. Sam has an MP3 player about the size of my thumb and my other grandson has transferred one of the MP3 files to his mobile phone. If you do something like this then please let me know what level of compression you find acceptable for your machinery, your hearing and your aesthetic tastes.

MPEG 3 and MP3

It was Richard Lambley who pointed out to me that previously I had made the mistake of confusing MP3 files with the MPEG 3 format.

As Richard pointed out to me, MPEG 3 is an abandoned HDTV standard. It was designed to handle HDTV video in the range 20Mbps to 40Mbps. The MP3 format is a standard called MPEG-1 Part 3 Layer 3 (or sometimes referred to as MPEG-1 Audio Layer 3).

As a by-the-way, MP2 audio is still the dominant format for digital audio broadcasting but it has been superseded by MP3, first for internet and computer use, but now for the dedicated MP3 players available so cheaply in the High Street shops.

Richard says:

"The mp2 format can, in theory, be played by any player which can play mp3 but, unfortunately, many hardware players don't recognise the mp2 file extension. Of course the files can be renamed and then they will play. The mp3 format gives better reproduction at lower bit rates but mp2 is more resistant to errors caused by a difficult radio path"

Degrees of Compression

Have a look at the table on the next page.

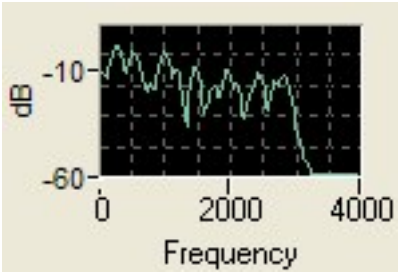
The WAV file, my starting point for different degrees of compression, is the file with the bit rate of 1411kbps. The file size is 26626KB. I have compressed this WAV file to MP3 files with sizes ranging from 152KB to 6039KB. I have done this by reducing the bitrate to values ranging from 8kbps to 320kbps.

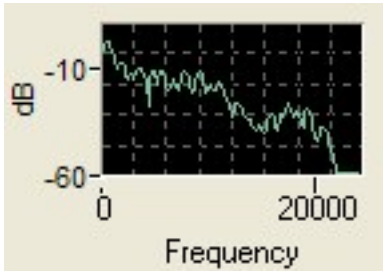
The 8kbps file is mono; all the other files are stereo.

Bit rate	File Size	Frequency
8	152	3400
20	378	4000
40	756	6000
80	1511	10000
160	3020	18000
320	6039	20000
1411	26626	20000

Audio Cut Off Frequency

Look at the next two screenshots. I had a great deal of trouble trying to get my proper audio spectrum analyser working. It does all sorts of clever things using Fourier Transforms but it doesn't seem to want to work today! Anyway, not to be beaten my mere technology I decided to resort to another program from my arsenal; unfortunately the pictures produced from this, my second string, are of very low resolution. Nevertheless, these two pictures do illustrate the point which I wish to make.





The biggest single effect of the method I have used to reduce the file size, is that the higher audio frequencies are lost. The picture on the left shows the audio spectrum of the smallest file, the one which streams at 8kbps. The picture on the right is for the original WAV file which streams at 1411kbps.

Now I have to reveal something to you. Like many of us who worked in a very noisy environment in our carefree youth, I am getting hard of hearing. The particular defect I suffer from is that audio frequencies above 4KHz, squeaks if you like, don't get as far as my brain. All the rumbling noises of a car engine and the dulcet tones of singers, even sopranos, come through loud and clear. What is missing in speech is all those bits and pieces, which generate frequencies above 4KHz, that differentiate between the sound of, for example, a P and a T, essential to understanding speech in a noisy environment.

Consequently I can't hear a lot of difference between the 8kbps file and the original WAV file unless I do something clever such as put the audio through a gadget called a graphic equaliser. I use the graphic equaliser to boost the higher audio frequencies and attenuate the lower humming sounds. When I do this I fancy that the WAV file has more 'presence' than what I shall describe as the 'muffled' 8kbps MP3 file.

If you look at the two screenshots you'll see that the picture on the left shows that the audio cut off frequency is a little above 3KHz. The picture on the right shows that the WAV file contains frequencies up to 20KHz.

For You to Experiment

On this AVLine CD you will find the six MP3 versions of the same tune. These are the files which I created from the original WAV file. I shall be most interested to know whether those of you with younger ears than I, can tell the difference between the different degrees of compression.