Action Plan Background: AIFF / AIFF-C

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Preface:

The AIFF format conforms to the EA IFF 85 Standard for Interchange Format Files (also called the IFF format). The IFF format was written by Electronic Arts and published on January 14, 1985. All IFF files consist of groups of data, called 'chunks'. An IFF file is a single chunk that may contain other chunks. A chunk has a specific format that makes parsing of chunks relatively straightforward for IFF readers, even if the type of chunk is unknown to the reader. Some types of chunks can be nested within other chunks and the 'inner' chunks inherit the properties of the 'outer' chunks. See [Morrison 1985] for more details on IFF files.

The AIFF-C format is a variant of the AIFF format. The primary difference between them is that the AIFF-C format can contain compressed sound data (but doesn't have to). Because the two formats are so similar they are addressed here in the same report.

1 General Description

1.1 Format Name: Audio Interchange File Format (can be shortened to Audio IFF, or AIFF) The full name of the AIFF-C format is also Audio Interchange File Format.

1.2 Version:
AIFF: 1.3
AIFF-C: 1.0

1.3 MIME media type name: audio (see *section 1.4*)

1.4 MIME subtype: There is not an IANA-registered MIME type for AIFF files. Some applications use audio/x-aiff, some use audio/aiff, and some use both. Obeying the MIME rules, an “x-” prefix for the MIME subtype should be used for formats without registered MIME types, therefore audio/x-aiff should be used for AIFF files and AIFF-C files.

1.5 Short Description: a general-purpose audio format

1.6 Common Extensions:
For AIFF: aiff, aif (recommended by the AIFF specification), snd
For AIFF-C: aifc, afc (less common but recommended by the AIFF-C specification), aiff, aif

1.7 Color depth: N/A

1.8 Color Space: N/A

1.9 Compression: AIFF files store their sound data in PCM format (equivalent to no compression for digital audio); AIFF-C files store their sound data in PCM or any one of a number of compressed formats.

1.10 Progressive Display: N/A

1.11 Animation: N/A

1.12 Magic number(s): IFF files, and therefore AIFF files, are big-endian. Starts like most IFF files: "FORM" (0x46, 0x4F, 0x52, 0x4D), followed by four bytes that tell how many more bytes follow in the file. For AIFF files this four byte number is followed by "AIFF" (0x41, 0x49, 0x46, 0x46). For AIFF-C files instead of "AIFF" in this file location they have "AIFC" (0x41, 0x49, 0x46, 0x43).

1.13 Specification Requirements

- File Header is the start of the Form Chunk which contains all other chunks in any order
    - Bytes 0-3 equal "FORM" (0x46, 0x4F, 0x52, 0x4D)
    - The chunk size (bytes 4-7 in the file) value must equal (the number of bytes in the file minus eight bytes)
    - Bytes 8-11 equal "AIFF" (0x41, 0x49, 0x46, 0x46) (AIFF-C files will have "AIFC" here)
- Exactly one Common chunk is required with the following field requirements:
    - ckID equals "COMM"
    - ckSize equals 18 (this is > 22 for AIFF-C files)
    - numChannels >= 1 and numChannels <= 32
- A Sound chunk is required if the waveform data has a length greater than 0
- Every marker in a Marker chunk must have a markerId field > 0 and no two markers can have the same markerId
- All chunk fields must be of the correct data type - see [Apple 1989].
- Every chunk must contain an even number of bytes
- All chunkId fields are composed of ASCII characters in the range 0x20 - 0x7E
- Can have 0 or 1 of the following chunks: Instrument, Audio Recording, Comments, Name, Author, Copyright
- Can have 0 or more of the following chunks: MIDI, Application Specific, Annotation
- If it has an Audio Recording chunk, its cksize value must be 24.
- If it has an Instrument Chunk, the following are required:
    - ckSize = 20
    - baseNote >= 0 and baseNote <= 127
    - detune >= -50 and detune <= 50
    - lowNote >= 0 and lowVelocity <= 127
    - highNote >= 0 and highVelocity <= 127
    - lowVelocity >= 1 and lowVelocity <= 127
    - highVelocity >= 1 and highVelocity <= 127

Additional Requirements for AIFF-C files:
- Must have exactly one 'Format Version Chunk '

2 Essential and Distinguishing Characteristics

AIFF files are very simple and flexible containers for PCM (pulse code modulation) audio data. The data can technically have from 1 to 32,767 audio channels, although the specification defines the speaker position conventions for only 1 to 6 channels. They can have up to approximately 4.3 billion sample frames, from 1 to 32 bits per sample, and for all practical purposes, an unlimited sampling rate. *Table 1* shows the technical metadata that can be extracted from an AIFF file.

AIFF files can optionally include a 'Marker Chunk' that effectively labels positions (sample frames) in the sound data. These markers can be used to mark positions where sound data can be looped (repeated) or to otherwise label positions in the sound data. An optional 'Comment Chunk' can be used to store textual information about particular markers.

AIFF-C files can use any of a variety of compression types, including PCM (which is equivalent to no compression). AIFF-C files can achieve compression rates up to 6:1 over AIFF files.

Technical metadata Element	***Obligation (R = required by spec., S = information given by spec., O = optional but described in spec., X = described in publication external to spec.)***
Number of channels	R
Number of sample frames[1] (this number multiplied by number of channels equals the total number of sample points for the noncompressed data)	R
Sample size (bits per sample point prior to any compression)	R
Sample rate (Number of sample frames that should be played back per second)	R
Compression Type (for AIFF-C files only)	X [Apple 1991]
Channel mapping (1-6 channels)	S

Table 1: Technical metadata that can be found in an AIFF file. Note that additional metadata can be derived from these metadata. For example, the WAVE format includes Average Bytes/Second, but AIFF does not. This can be derived from AIFF metadata by: (Sample rate * (sample size/8) * Number of channels). Similarly, WAVE's Bytes/Sample (aka block align) can be derived for AIFF files by rounding up to the nearest whole number: ((sample size/8) * Number of channels).

1 AIFF defines sample frames as a set of interleaved sample points, where each sample point is destined for a particular channel. This definition is different from how other audio formats define sample frames.

3 Usefulness

3.1 Version Duration:
AIFF: 15 years, 3 months - the specification for AIFF 1.3 was published on January 4, 1989.
AIFF-C: 12 years, 7 months - the specification for AIFF-C 1.3 was published on August 26, 1991.

3.2 History of Prior Versions Duration: The AIFF 1.3 specification mentions AIFF version 1.1 (January 21, 1988) and AIFF version 1.2 (June 17, 1988) but I was not able to find these earlier specifications.

3.3 Expected Newer Versions: none expected

3.4 Existence of Publicly Available Complete Specifications: The AIFF specification and general AIFF information is available for free from many Internet sites. Although the specification itself does not seem to be available from the Apple website, AIFF information ([Apple 1998], [Apple 1999]) is available on the Apple website 'Apple Developer Connection' (http://developer.apple.com/index.html).

3.5 Specifications-controlling Body: Apple Computer, Inc.

3.6 Related Legal Issues: AIFF files can contain a 'Copyright Chunk'.
Although the AIFF is a proprietary format, there are no known legal issues specific to the AIFF format.

3.7 Application and Platform Support: The AIFF format is more commonly associated with Macintosh and SGI audio applications but is now supported by most Windows' audio applications. For example, the popular Windows' applications Winamp and Windows Media Player both support AIFF files.

3.8 Limitations:

AIFF files tend to be much larger than other audio formats, except for PCM WAVE files which are equivalent in size. They are not well-suited for exchange over the Internet where their larger file sizes lead to longer transfer times.

AIFF files can not be streamed. Unlike the WMA or MP3 format, all of the file has to be downloaded to be able to play it.

AIFF files are required to store very little metadata. They do not have any inherent DRM (digital rights management) capabilities, which may make them better for archives but less popular with music companies.

3.9 Perceived Popularity:

The AIFF format does not seem to be as popular as it once was, in relation to the functionally-equivalent WAVE format from Microsoft. The WAVE format is more commonly supported than the AIFF format in Windows' applications, and Windows is more widely used than any of Apple's operating systems. Figure 1 shows the results of using Google to search on various audio file formats. It should be noted that the search results could be skewed by the search terms used, that all of the results returned do not necessarily refer to the file formats intended for the search, and that the popularity of a file format does not directly correspond to the number of hits Google returns. These results can be used, however, in conjunction with other findings to determine how popular or unpopular a particular audio format is. The relative popularity of a format has implications on future application support and therefore obsolescence.

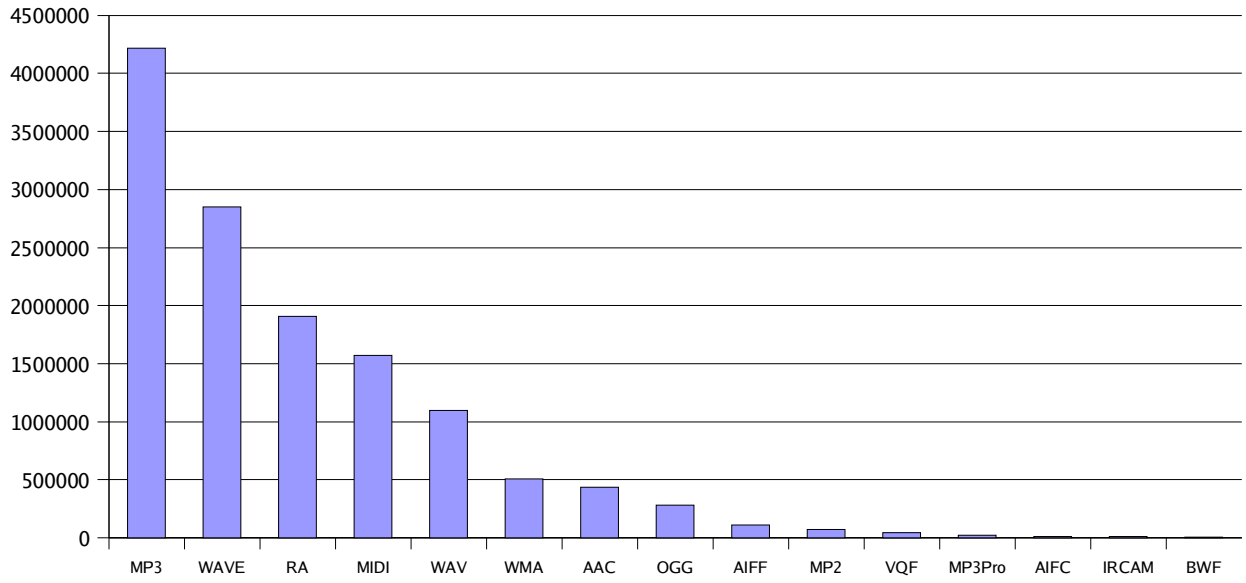

Figure 1: Number of search hits returned by Google. Each term on the X axis of this graph along with the word 'Format' was searched for using the Google search engine (www.google.com) on March 23, 2004. The terms 'AIFF Format' produced 111,000 hits; 'WAVE Format' produced 2,850,000 hits; 'MP3 Format' produced 4,220,000 hits. In all cases the search was performed only on websites that had been updated in the last year.

New audio compression algorithms like the MPEG audio family were designed to seem lossless to the human ear. Their use leads to much smaller file sizes than PCM data formats like AIFF. This explains why formats like MP3 and WMA have become more popular than AIFF.

4 Related Formats

4.1 Specification and File Variations:

AIFF-C files have a Format Version chunk that indicates which AIFF-C specification 'version' the file complies with. The version is stored in the form of a date and in practice should always

be 0xA2805140 (2726318400 seconds since January 1, 1904) indicating when version 1 of AIFF-C was published.

5 Summary and Conclusions

AIFF is one of the oldest audio formats still in use today. It is widely supported by audio applications and uses no compression (PCM) on its data (except when in the AIFF-C format). It is not as popular as it once was, and the original specification seems to be only available from third parties and not from Apple itself. Some of the possible successors to the AIFF format are discussed in the rest of this section.

An interesting development in the digital audio world is that there are now a large group of lossless compression algorithms for digital audio like FLAC (flac.sourceforge.net), La (http://www.lossless-audio.com), WavPak (www.wavpack.com), Shorten (http://www.softsound.com/Shorten.html) and Monkey's Audio (http://www.monkeysaudio.com/). The lossless algorithms cannot produce files as small as the lossy compression algorithms used in MP3, WMA, Ogg Vorbis and others, but they can produce smaller files than the PCM formats (AIFF, PCM WAVE, etc). According to [Whittle 2003] lossless compression can produce files 60-70% smaller on pop, rock, techno and other 'loud' musical genres, and 35-65% smaller on less noisy choral and orchestral music. These lossless compression algorithms can be used to produce archival-quality files with smaller file sizes than the PCM data formats. Some of these formats, like FLAC, were designed with preserving data integrity in mind. From the FLAC website:

> *The encoding of audio (PCM) data incurs no loss of information, and the decoded audio is bit-for-bit identical to what went into the encoder. Each frame contains a 16-bit CRC of the frame data for detecting transmission errors. The integrity of the audio data is further insured by storing an MD5 signature of the original unencoded audio data in the file header, which can be compared against later during decoding or testing.*
>
> *...*
>
> *FLAC is an open format, and there is no generation loss if you need to convert your data to another format in the future. In addition to the frame CRCs and MD5 signature, flac has a verify option that decodes the encoded stream in parallel with the encoding process and compares the result to the original, aborting with an error if there is a mismatch.*

The lossless compressed audio formats may be good candidates for a successor to PCM data formats like AIFF. They save on file space, are lossless and some are non-proprietary. However, the popularity of a format must be considered. An archive does not want to use an unpopular and therefore poorly-supported format for master audio files.

Another potential successor to the AIFF format is the BWF format (see the FCLA WAVE Action Plan Background Report). Like the AIFF, it can store its sound data in PCM format, but BWF also supports the inclusion of a core metadata set based on Dublin Core. For

archives that want to store at least some metadata directly in the file, this would be a good choice.

The AIFF format is essentially a container for PCM sound data. Another technological advance to monitor is a successor to the PCM format. Sony and Philips' DSD (Direct Stream Digital) technology is an example of an alternative to PCM. Use of the DSD promises better sound quality [Sony and Philips 1997]. It remains to be seen if it will become popular.

It is a little premature to choose an AIFF successor but the above-mentioned technologies should be monitored.

6 References

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