Sound Compression and Expansion Saving disk space

One minute of single-channel sound recorded with the fidelity you would expect from a commercial compact disc occupies about 5.3 MB of disk space. One minute of sound digitized by the current low-fidelity digitizing peripherals for the Macintosh occupies more than 1 MB of disk space. Even one minute of telephone-quality speech takes up more than half of a megabyte on a disk. Despite the increased capacities of mass-storage devices, disk space can be a problem if your application incorporates sound. The space problem is particularly acute for multimedia applications. Because a large portion of the space occupied by a multimedia application is likely to be taken up by sound data, the complexity and richness of the application's sound component are limited.

To help remedy this problem, the enhanced **Sound Manager** includes a set of new routines known collectively as **Macintosh Audio Compression and Expansion (MACE).** MACE enables you to provide more audio information in a given amount of storage space by allowing you to compress sound data and then expand it for playback. These enhance-ments are based entirely in software and require no specialized hardware.

The new audio compression and expansion features allow you to enhance your applications by including more audio data. MACE also relieves some distribution problems by reducing the number of disks required for shipping an application that relies heavily on sound. MACE may make some new kinds of applications feasible as well, such as talking dictionaries and language-instruction software.

MACE adds three main kinds of capabilities to those already present in the **Sound Manager**-audio data compression, real-time expansion and playback of compressed audio data, and buffered expansion and playback of compressed audio data.

- **Compression.** The **Sound Manager** can compress a buffer of digital audio data either in the original buffer or in a separate buffer. If a segment of audio data is too large to fit into a single buffer, then your application can make repeated calls to the compression routine.

- **Real-time expansion playback.** The **Sound Manager** can expand compressed audio data contained in a small internal buffer and play it back at the same time. Since the audio data expansion and playback occur at the same time, there is greater CPU loading when using this method of sound expansion rather than buffered expansion.

- **Buffered expansion.** The **Sound Manager** can expand a specified buffer of com-pressed audio data and store the result in a separate buffer. The expanded buffer can then be played back using other **Sound Manager** routines with minimal processor overhead during playback. Applications that require screen updates or user interaction during playback (such as animation or multimedia applications) should use buffered expansion.

MACE provides audio data compression and expansion capabilities in ratios of either 3:1 or 6:1 for all currently supported Macintosh models, from the Macintosh Plus forward. The principal trade off when using MACE is that the expanded audio data suffers a loss of fidelity in comparison to the original data.

A small amount of noise is introduced into a 3:1 compressed sound when it is expanded and played back, and a greater amount of noise for the 6:1 ratio. The 3:1 buffer-to-buffer compression and expansion option is well suited for high-fidelity sounds. The 6:1 buffer-to-buffer compression and expansion option provides greater compression at the expense of lower-fidelity results and is recommended for voice data only. This technique reduces the frequency bandwidth of the audio signal by a factor of two to achieve the higher compression ratio.

The following provides a summary of the available compression and expansion options.

Table Audio compression and expansion options

Computer	3:1 and 6:1 compression	3:1 and 6:1 Stereo expansion and playback	Stereo expansion and playback	Sample-rate conversion
Macintosh Plus	Real-time	Real-time	No	No
Macintosh SE	Real-time	Real-time	No	No
Macintosh Portable	Real-time	Real-time	Yes	Yes
Macintosh II and successors	Real-time	Real-time	Yes	Yes

Note: Macintosh Plus, Macintosh SE, and Macintosh Portable computers play only the right channel of stereo 'snd ' data through the internal speaker. Certain Macintosh II models may play only a single channel through the internal speaker.

Existing applications that use the **Sound Manager**'s **SndPlay** function to play digitized audio signals can play compressed audio signals without modification or recompilation.

TheMACE routines assume that each sample consists of 8 contiguous bits of data. The compression techniques do not, however, depend on a particular sample rate. The compression techniques produce their best quality output when the sample rate is the same as the output rate of the sound hardware of the machine playing the audio data. The output rate used in current Macintosh computers is 22.254 kilohertz (hereafter referred to as the 22 kHz rate). Because of speed limitations, the Macintosh Plus and Macintosh SE cannot perform sample-rate conversion during expansion playback. On those machines, all sounds are played back at a 22 kHz rate. To provide consistent quality in sounds that may be played on different machines, you should record all sounds at a 22 kHz sample rate.

TheMACE algorithms are optimized to provide the best sound quality possible through the internal speaker in real time. However, the user who employs high-quality speakers may notice a high-frequency hiss for some sounds compressed at the 3:1 ratio. This hiss results from a design trade off between maintaining real-time operation on the Macintosh Plus and preserving as much frequency bandwidth of the signal as possible. If you think that your output may be played on high-quality speakers, you may want to filter out the hiss

before compression by passing the audio output through an equalizer that removes frequencies above 10 kHz. When you use the 6:1 compression and expansion ratio, your frequency response is cut in half. For example, when you use the 22 kHz sample rate, the highest frequency possible would normally be 11 kHz; however, after compressing and expanding the data at the 6:1 ratio, the highest frequency you could get would be only 5.5 kHz