CHAPTER 16

Multimedia Services

For the past year, the home market has been the fastest-growing segment of the PC business, and multimedia titles have been one of the fastest-growing segments of the software industry. A large and increasing percentage of the PCs purchased for home use include the equipment that makes multimedia applications possible, notably horsepower, CD-ROM drives, sound subsystems, and local-bus video.

In 1993, the installed base of multimedia-capable Windows PCs grew rapidly to become the largest multimedia computing platform in the world (see Figure 107). By Christmas of 1993, more multimedia titles were available for Windows than there were for any other computing platform (see Figure 108 on the following page).

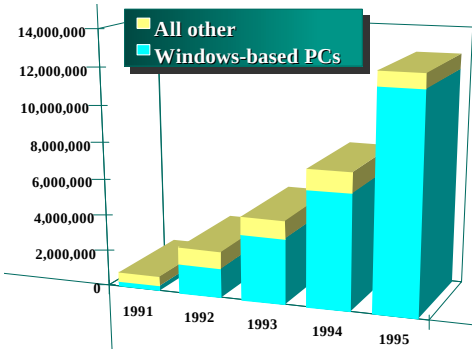

Figure 107. Estimated and forecast sales of multimedia-capable PCs (source: Dataquest)

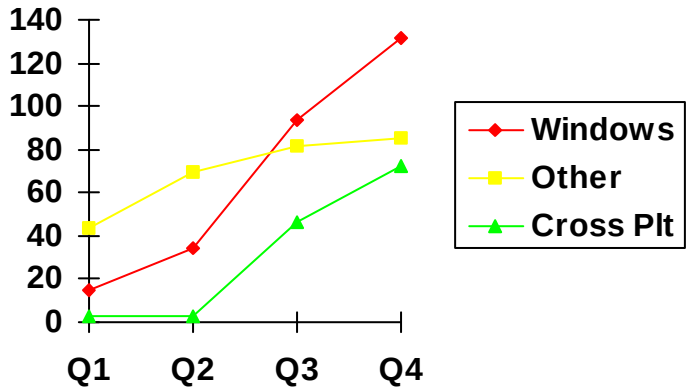

Figure 108. The number of multimedia titles sold by computer software retailers in 1993, by platform and by quarter (source: PC Data)

A Little History

It is worth dwelling for a moment on how far Windows multimedia has come in the last few years. When Microsoft Video for Windows 1.0 was released in 1992, sound cards and CD-ROM drives were relatively rare. Graphics subsystems were universally ISA-based, and software codec (compression/decompression) technology was in its infancy. The standard size for a digital video clip was 160 pixels by 120 pixels—one-sixteenth of a VGA resolution screen. Technologists, who understood the difficulties of this accomplishment, cheered wildly and proclaimed the dawn of the multimedia computing era. Customers shrugged. What was so great about a video clip the size of a "dancing postage stamp"?

In 1993, hardware and software makers began to deliver equipment and technology that offered better-than-postage-stamp performance at reasonable consumer prices. Double-speed CD-ROM drives and local bus video offered more bandwidth to support the massive data requirements of digital video and quality sound. A second generation of software codecs made more effective use of the data available. Prices on 16-bit sound cards dropped into consumer range. With Microsoft Video for Windows 1.1, the size of a digital video clip that a mainstream computer could display reliably increased to 320 pixels by 240 pixels—one-quarter the size of the screen. Critics labeled these digital video clips "dancing credit cards," but consumers found digital video of this size compelling enough that it spurred a virtual tidal wave of multimedia title development. Retail software store shelves are now crowded with multimedia titles and games, and progress marches on.

Installing Windows 95 provides today's multimedia PCs with an overnight upgrade in multimedia capabilities. Based on the capabilities of high-end PCs in 1994, the mainstream PC of 1995 will be able to play digital video segments that are larger, smoother, and better-looking than ever before—even up to 640 pixels by 480 pixels (full screen) and beyond (see Figure 109). We are now able to look forward quite realistically to a time when the amount of data that can be stored on a CD-ROM, rather than the speed of the video subsystem, is the most relevant factor limiting the richness of a consumer's experience with a multimedia title or game.

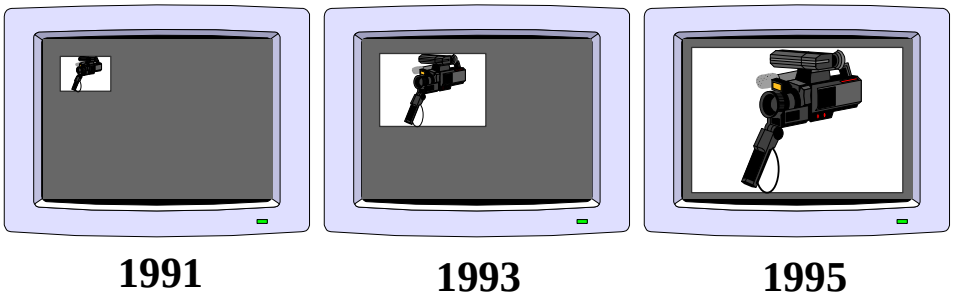

Figure 109. Digital video, evolving through the dancing postage stamp (1991) and dancing credit card (1993) eras to full screen

A New High-Performance Multimedia Platform

Windows 95 delivers a new high-performance platform for PC multimedia. From a "big picture" perspective, the "greatest hits" of what Windows 95 contributes to the world of multimedia computing are as follows:

- For consumers, Windows 95 makes multimedia easier, more engaging, and more fun.
    - **Easier.** Plug and Play makes the successful installation of multimedia devices far easier for consumers. All of the architectural support for digital video, audio, and MIDI is built into Windows 95, so that users are relieved of setup challenges. And Windows 95 is compatible with multimedia titles and tools created for Windows 3.1.
    - **More engaging.** Installing Windows 95 is an immediate multimedia upgrade that allows any PC to become a better, more exciting multimedia playback machine. Authors creating titles and games for Windows 95 can make their products faster and more exciting to play.
    - **More fun.** Windows 95 is a much better platform for computer games than any earlier version of Windows and includes support for fast, intensely graphical games.
- For developers, Windows 95 offers a powerful platform for professional multimedia authoring.
    - **Power.** The new 32-bit architecture in Windows 95 squeezes vastly improved multimedia performance out of PCs, so developers can capture digital video and sound that is bigger and bolder than ever before. The multitasking architecture of Windows 95 makes it a much more convenient working environment for multimedia authors.
    - **Professional quality.** The streamlined architecture of digital video, digital audio, MIDI, and file handling subsystems in Windows 95 enables authors and toolmakers to create high-quality sound, video, and animation effects. Windows 95 is an attractive platform for the professional development of multimedia effects and footage beyond the realm of the PC— for example, TV commercials.
- For hardware makers, Windows 95 offers exciting new opportunities.

- **Graphics.** A display driver technology called Display Control Interface (DCI) offers ways for Windows 95 to take advantage of hardware assistance for several graphical operations, such as image stretching.
- **Sound.** A new technology called Polymessage MIDI offers sound card manufacturers a way to play complex MIDI sequences with virtually no CPU use. Sound cards are improving rapidly, and competition based on features is increasing.

Making Multimedia Easier

Microsoft is committed to making Windows the leading force in multimedia technologies and systems for PCs. This commitment takes many forms, the most important being an ongoing investment in multimedia-related research and development. Some of the results of the last few years of research and development are described in this chapter. Multimedia technologies are evolving rapidly, and Microsoft will continue to press ahead in providing tools and architectural enhancements to enable developers and consumers to take advantage of new innovations.

Plug and Play Support

As multimedia applications, titles, tools, and games have become more and more compelling, consumers have begun buying add-on multimedia components, such as CD-ROM drives and sound cards. Buying these devices has been cheap and easy; installing them has been a different matter. To put it mildly, installing a CD-ROM in a PC has required…patience.

Support of Plug and Play in Windows 95 makes the prospect of adding a new multimedia device to a PC considerably less daunting. Just plug in a Plug and Play–enabled sound card and, literally, it plays. In fact, Windows 95 even makes the prospect of installing *old* multimedia devices less daunting because it includes tools that make identifying and resolving conflicts between legacy devices that are not Plug and Play–enabled vastly easier. To make this process as painless as possible, Windows 95 includes built-in drivers for the most popular sound cards.

It is difficult to overstate the importance of Plug and Play for multimedia. For the multimedia market, Plug and Play will have the following three effects:

- It will allow the base of multimedia-capable PCs to grow through Plug and Play upgrade kits, rather than placing so much of the growth burden on the purchase of new CPUs. Because Windows 95 includes the basic architecture for handling sound, MIDI, and digital video, every PC running Windows 95 can easily be made into a multimedia PC by plugging in a sound card and/or a CD-ROM drive.
- It will substantially decrease the cost of installing and supporting multimedia devices, which will help speed their adoption for business use.
- As multimedia standards, such as CD-ROM speed, continue to improve, Plug and Play will allow consumers to conveniently upgrade multimedia components without replacing their entire PC. Plug and Play support will be vital to the adoption of new multimedia devices, such as MPEG cards.

AutoPlay

In various ways, titles and games that run off a CD-ROM feel different from other applications. First, starting CD-ROM programs differs from starting hard-disk–based applications. First, users have to open a drawer, extract the right disk, and place it in the CD-ROM drive before they can run the program like any other program—assuming, of course, that they can find the icon they created when they first installed the program. A second difference between CD-ROM programs and hard-disk–based applications is that CD-ROM products may be used irregularly.

While watching users run multimedia applications, Microsoft realized that the act of placing a disk in a CD-ROM drive is loaded with information. If the CD-ROM is a program that the user has never run before, the act of putting the CD-ROM in the drive means that the user intends to install the program. If the program has already been installed, the act of putting the CD-ROM in the drive means that the user intends to run the program.

In Windows 95, a feature called AutoPlay allows software developers to make their products easier for users to install and run. When the user puts a disk in a CD-ROM drive, Windows 95 automatically spins it and looks for a file called AUTORUN.INF. If this file exists, Windows 95 opens it and follows the instructions. This new feature makes the setup instructions for a Windows 95–based multimedia game or title almost absurdly easy, reducing them to something like the following:

1. To play this program, insert the disk in your CD-ROM drive.
2. Have a nice day!

Built-In Support for Digital Video

For the past several years, Microsoft has been developing a high-performance architecture for digital video: Microsoft Video for Windows. (For more details, see the section titled “Multimedia Graphics Architecture” later in this chapter.)

In the past, Video for Windows was distributed separately (principally as a Software Developers Kit), but with the release of Windows 95, Video for Windows is now built into every copy of Microsoft Windows, including Windows NT. The widespread ability to play digital video has the following implications:

- Users and ISVs can use the .AVI file format to distribute digital video files with the same confidence that they distribute files of other Windows–supported formats, such as .TXT, .WRI, .BMP, .PCX, and .WAV.
- The barriers to entry for would-be multimedia title and tool developers are further lowered because the issues of licensing and installing Microsoft Video for Windows disappear.

Built-In Support for Sound and MIDI

MIDI is the computer equivalent of sheet music. Using sheet music, an arranger can describe how to play Beethoven’s *Moonlight Sonata* in a few pages, but to actually play the piece, a person who knows how to read sheet music needs a piano. The music performed from the sheet music varies in sound depending on the circumstances—for

example, when played on an expensive grand piano, the sonata sounds better than when played on an old upright.

Similarly, a MIDI file can contain the electronic instructions for playing the *Moonlight Sonata* in just a few kilobytes, but playing the piece requires a device, such as a sound card, that knows how to "read" MIDI instructions and can produce a piano sound. And just as the sound of real pianos varies somewhat, so does the piano sound produced by sound cards.

At the high end, MIDI is used as a development tool for musicians. Virtually all advanced music equipment today supports MIDI, and MIDI offers a convenient way to control the equipment very precisely. At the low end, MIDI is becoming an increasingly popular tool for multimedia product developers because it offers a way to add music to titles and games with a tiny investment of disk space and data rate. The majority of sound cards today have on-board MIDI support built in. Windows 95 includes built-in support for both MIDI and waveform audio (.WAV).

The CD Player

Many people like to play audio CDs in their CD-ROM drives while working, so Windows 95 includes the CD Player. As Figure 110 shows, the controls on this player look just like those on a regular CD player, and the Windows 95 CD Player supports many of the same features found in advanced CD players, such as random play, programmable playback order, and the ability to save programs so that users don't have to re-create their playlists each time they pop in a CD.

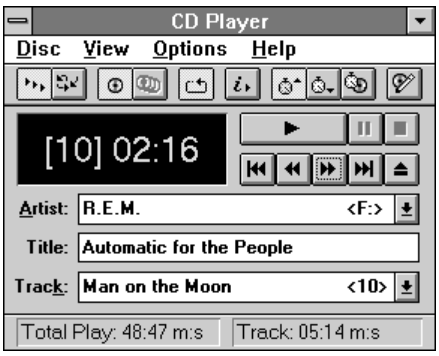

Figure 110. The CD Player, which will play, uninterrupted, in the background

Making Multimedia More Engaging

With Windows 95, users' PCs become a better multimedia machine, so software developers can produce faster and more engaging titles and games.

Built-In Enhanced CD Support

In addition to making it easy for users to play their favorite audio CDs from their current collection, Windows 95 is helping to define a standard for music CDs of the future. Windows 95 is the first operating system to announce support for the new Sony/Phillips Enhanced CD format, which will enable audio CD players and multimedia PCs to easily play the same compact discs. This new format allows both audio and data to be integrated

on the same CD, in a manner conducive to users of both audio CDs and PC–based CD-ROM titles.

The Enhanced CD format uses new technology, called “stamped multisession,” that solves the “track one” problem that has prevented easy use of CD-ROMs in audio CD players. Until now, CD-ROM titles have used the first track of a compact disc for data, thus producing static—and potential speaker damage—when played on audio CD players. Sony and Phillips are implementing stamp multisession under the brand name Enhanced CD. Other music-industry companies can license the Enhanced CD brand from them or create their own implementations of stamp multisession. Microsoft Windows 95 will accommodate all compatible implementations of the technology.

Because data and audio information can be combined on the same CD, the new Enhanced CD format will open up a broad, new category of CD titles that can be enjoyed fully as audio discs and, when inserted into a PC running Windows 95, can also provide digital information in the form of music videos, song lyrics, biographies, and other text, and even promote online exchanges with musicians.

The new format leverages a range of new features being included exclusively in Windows 95 to help make multimedia more engaging. The AutoPlay feature, for example, enables users to insert a compact disc in their CD-ROM drive and have it automatically play. Also, the 32-bit multimedia subsystems in Windows 95 enable unprecedented playback performance. The new CD file system further facilitates multimedia use, while Plug and Play support makes installing and using CD-ROM drives and related hardware simple for consumers.

Bigger, Faster, Better-Looking 32-Bit Digital Video Playback

Displaying digital video involves moving and processing huge streams of data continuously and efficiently. The new digital video implementation in Windows 95 offers some exciting new efficiencies, allowing software developers to confidently create multimedia titles that are more compelling and better-looking than ever before.

Multimedia title and game developers are business people. When they create a product, they do so with the hope of turning a profit. To maximize the number of PCs that can run a title, most developers tend to include lowest-common-denominator digital video. As a result, video windows the size of postage stamps with low frame rates (which make movement look “jerky”) and extreme compression (which makes the video look “blocky”) have tended to be the norm. However, Windows 95 raises the lowest common denominator significantly.

In the past, the process of displaying digital video has relied on a series of 16-bit systems that read data from the disk, decompress the video data, and display it on screen. One key design goal of Windows 95 was to enable this architecture to make the transition to 32 bits, and the difference is eye-popping. For multimedia users, installing Windows 95 is the quickest and cheapest multimedia upgrade available. Without adding any hardware, Windows 95 enables users to display bigger, smoother, more colorful digital video than ever before.

This improvement does not come at the expense of compatibility. Multimedia in Windows 95 is fully compatible with 16-bit multimedia titles. Early testing has shown that the 32-bit improvements in file access speed and stream handling results in performance

improvements even for 16-bit multimedia applications. However, the biggest improvements will obviously be realized in the new generation of fully 32-bit titles that will be designed for Windows 95.

For users who upgrade their PCs to Windows 95, one easy-to-overlook source of performance improvements is the display driver. Many display drivers are updated more or less continuously, whether to fix problems, enhance performance, or incorporate new features such as DCI. Most users, however, don't update drivers on their system unless they are having a problem. Upgrading to Windows 95 ensures that they have the latest and greatest.

Multitasking and Threading

Multimedia applications don't take well to interruption. When watching a video clip or listening to a sound file, users really don't want it to stop in the middle. Because of multitasking, interruption is less likely. The multitasking in Windows 95 is quite different from earlier versions of Windows because it is preemptive. In Windows 95, multiple 32-bit processes can share the CPU at the same time, whether those processes have been initiated by different applications (multitasking) or by one application (threading).

Threading has a very important implication because it allows multimedia titles and games to have a smoother, more finished feel to them. A game might have one thread that plays background music continuously during game play to help smooth out the breaks between scenes while another thread is loading new data.

As applications, tools, and codecs are gradually rewritten to 32 bits, video and other multimedia processes will become less and less likely to be interrupted by other applications. For example, in Windows 95 you can move a video window while it is playing without interrupting it.

Built-In Support for Fast CD-ROMs

The development of faster CD-ROM drives (double and triple speed) has been essential for the growth of multimedia computing because faster reading of CD-ROM data helps make video and audio playback from CD-ROM drives look and sound better.

To get the best possible performance from these new devices, Windows 95 includes a new 32-bit CD-ROM file system (CDFS) for reading files from CD-ROM drives as quickly and efficiently as possible. (The Windows 3.1 system for reading files from CD-ROM drives [MSCDEX.DLL] is also included in Windows 95 for compatibility with products that rely on it.) CDFS is an important component of the overall performance enhancements to multimedia in Windows 95.

Windows 95 also extends its support for CD-ROM to drives that read XA-encoded disks, such as Kodak PhotoCD and video CDs.

Hardware Support for TV-Like Video

Digital video and stereo audio can be squeezed into an incredibly small data stream using a complex codec called MPEG. For example, with MPEG compression most feature movies can fit on two CD-ROMs. Because MPEG is so complex, displaying video from an MPEG file is a calculation-intensive process—so calculation-intensive, in fact, that the

most appealing way to display MPEG video on today's PCs is by using hardware assistance.

Together with the Open PC MPEG Consortium, Microsoft has defined an industry standard for MPEG board and chip manufacturers who want to ship MPEG devices for Windows 95. This standard allows applications to incorporate MPEG video without worrying about precisely which vendor's MPEG device is present to decompress it.

Making Windows More Fun

In 1994, the home market was the fastest-growing segment of the PC business, and more and more users have been demanding games for Windows. Games are already the largest category of multimedia application, but most computer games are designed to run on MS-DOS (see Figure 111). Windows 95 is a much better platform for computer games than any earlier version of Windows because it includes support for fast, intensely graphical games. It also has built-in joystick support, so users don't need to load external drivers.

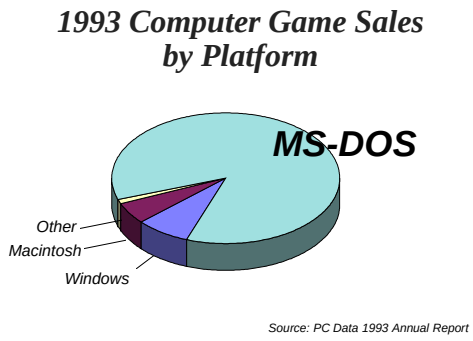

Figure 111. At the end of 1993, computer games were one of the last remaining software categories for which Windows product sales trailed MS-DOS product sales

Fast DIB Drawing

The speed of graphics (or, more accurately, the lack of it) in Windows has been one of the biggest obstacles that prevented game developers from choosing the Windows platform for their games. Windows 95 addresses this issue head-on in a way that provides substantially improved speed while preserving the device independence that makes Windows appealing in the first place.

A new 32-bit call, CreateDIBSection, has been added to the Win32 API for Windows 95 and Windows NT. This new feature allows developers to quickly get bitmaps onto the screen. If nothing fancy (such as clipping or stretching) is involved, the CreateDIBSection call actually allows applications to send DIBs more or less directly to the video frame buffer. (For more information, see the diagram in the section titled "Multimedia Graphics Architecture" later in this chapter.)

Because this kind of graphic speed is critically important to quality games, Microsoft has moved a portion of the CreateDIBSection improvements of Windows 95 into a tool for Windows 3.1 called the WinG (pronounced *Win Gee*; the *G* stands for *games*) libraries. The WinG libraries allow game developers to create fast, graphical games for Windows

3.1 with the assurance that the game will be fast and compatible with Windows 95. Figure 112 shows such a game.

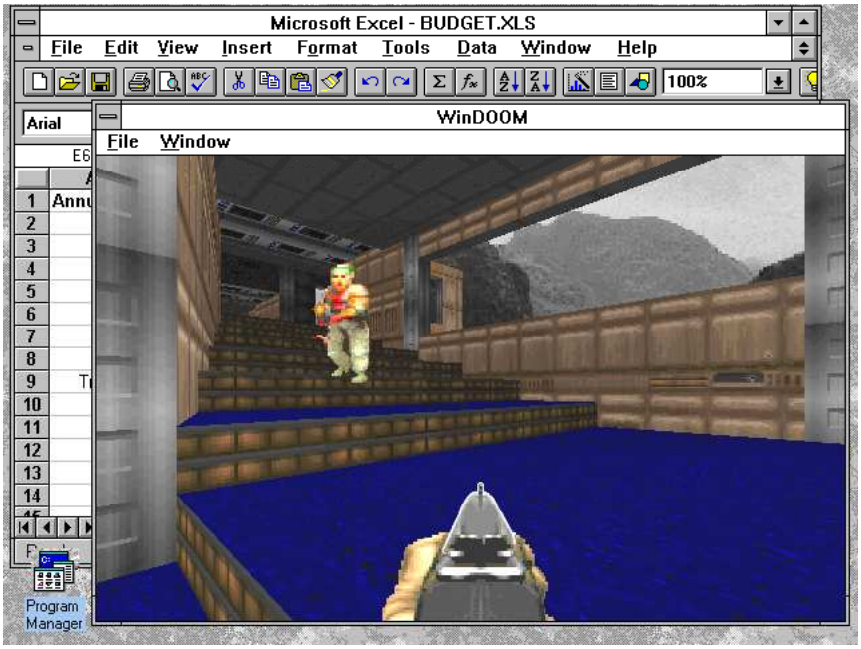

Figure 112. The graphics core of DOOM for Windows (from Id Software) was ported from MS-DOS to the WinG library in two days.

A Powerful Development Environment

Because of its new 32-bit, multitasking architecture, Windows 95 is an attractive platform for the professional development of multimedia titles.

Sound Compression for CD-Quality Sound

Sound can take up a lot of disk space. Full CD-quality, uncompressed stereo audio contains a lot of data—about 176 KB for every second of sound! An entire CD-ROM can contain only a little over an hour of music. Sound can also eat up a fair-sized chunk of the data rate that a CD-ROM drive is capable of sustaining.

To lessen the burden of storing and playing sound from an application, Windows 95 includes a family of sound compression technologies. These codecs can be divided into the following two groups:

- Music-oriented codecs, such as IMADPCM, allow close to CD-quality sound to be compressed to about one-quarter of its original size.
- Voice-oriented codecs, such as TrueSpeech, allow extremely efficient compression of voice data.

This support for compressed sound is two-way: Sound can be played from a compressed sound file, or a sound file can be compressed using the built-in sound recording and editing utility. If users have microphones, they can turn on voice compression when recording so that the file is compressed in real time.

In addition to the codecs that come with Windows 95, the audio architecture of Windows multimedia is designed to be extensible through other installable codecs. (The Windows 95 video architecture can be extended in the same way.)

Polymessage MIDI Support for Better Sound

Windows 95 comes with Microsoft's best-ever implementation of MIDI, including a new technology called "polymessage MIDI support." This enhancement allows Windows 95 to communicate multiple MIDI instructions simultaneously within a single interrupt. As a result, playing MIDI files requires even less computing power than it did before and allows developers to process MIDI instructions alongside graphics and other data even more successfully.

Multitasking

Multitasking makes Windows 95 a much more attractive platform for multimedia authoring. Creating multimedia content is very CPU-intensive work that can take a long time to complete. For example, compressing a digital video file could take hours, depending on the complexity of the file and what type of system is doing the compression. Moreover, digital video files had to be compressed one at a time. As a result, video authors were virtually chained to their desks until their work was done.

Because of the Windows 95 multitasking capabilities, authors retain control of their PCs, even when an enormous compression operation is underway. Digital video authors can initiate several compression operations at once—and then head home.

Professional Quality

The digital video, digital audio, MIDI, and file handling subsystems in Windows 95 make it an ideal platform for developing high-quality video, sound, and animation effects.

Capture and Compression of Bigger Digital Video

The grim reality is that video contains an enormous amount of data. Capturing digital video is even more data-intensive than playing it back, because raw digital video footage is uncompressed. A single frame of full-color video at 640 pixels by 480 pixels contains close to a megabyte of data. At 30 frames per second, you can fill up a 1 GB hard drive with uncompressed video data in less than a minute. This data can be compressed to make storage go further, but for multimedia developers, the rate at which they can write data to disk is still an important concern.

The 32-bit file access of Windows 95 is every bit as important to digital video authors as it is to digital video users. Because data can be written to disk more quickly in Windows 95, authors can capture better-looking video—bigger, more frames per second, and more colorful. After the raw footage is captured, the potentially time-consuming process of compression begins. Both Cinepak and Indeo will be available in 32-bit versions for Windows 95 to make the compression process considerably more efficient.

General MIDI for Specific Sounds

One of the early challenges for MIDI was that it was, in a way, too flexible. Any instrument can be "connected" to any MIDI channel so that a "sequence" (song) written for a piano might accidentally end up being played on a tuba. Windows 95 supports the General MIDI specification, an industry-standard way for MIDI authors to request particular instruments and sounds.

Built-In Support for Multimedia Devices

Windows 95 includes built-in support for common multimedia authoring devices, such as laser disks and VCRs. This support simplifies the process of setting up a system for "step capture," a process in which the author captures digital video data one frame at a time, usually to be compressed later. Step capture is a slow process, but it is the best way to capture the highest quality digital video. Frame-accurate control of the VCR is also important for recording broadcast-quality special effects for use in commercials, movies, television programs, music videos, and so on.

Multimedia PCs for 1995

All things being equal, installing Windows 95 upgrades any PC into a more capable multimedia tool. However, all things are *not* equal. The quality and capability of multimedia PCs and devices varies a great deal.

Microsoft is publishing the *Microsoft PC 95 Hardware Design Guide* to help IHVs and OEMs identify opportunities to take advantage of new capabilities in Windows 95. This guide makes the following five high-level recommendations to OEMs:

- **Balance beats horsepower.** Multimedia playback places heavy demands on many parts of the system, from the CD-ROM (reading) to the hard disk (writing) to the CPU (decompressing) to the video and audio subsystems (playing). A fast CPU does not guarantee a great playback system. In fact, multimedia playback on most high-end PCs is not constrained by the CPU.

- **Local bus video is indispensable.** Even OEMs creating non-multimedia systems should use local bus video because doing so gives consumers the option of using Plug and Play to create a multimedia system later. Without local bus video, a PC cannot keep up with the amount of video data that 1995's consumer multimedia titles and games will want to display continuously.

- **CD-ROM drives must be double-speed or better.** Titles in 1995 will assume double-speed data rates.

- **Displays must be SVGA (800 x 600) or better with 16-bit color**. Why are more than 256 colors required? Because multimedia applications use a lot of colors and tend to compete for access to the system palette. For example, if a multimedia presentation includes a digital video clip of an underwater scene on a slide with a smooth-shaded maroon background, a 256-color palette doesn't have enough colors to make both the slide background and the underwater scene look good.

- **Audio must be 16-bit**. The installed base of sound cards that can interpret MIDI is now large enough to be tempting to game and title developers. Not all sound systems are equal: Some sound great (16-bit with sampled sounds), and some sound like *Star*

Trek reruns. The differences are significant, and consumers will be able to tell the difference.

New Opportunities for Great-Sounding Audio

The quality of audio cards and sound systems varies a great deal. Sound cards have generally been used for their ability to play waveform audio—the equivalent of recorded sound. For some uses, such as voice-overs, recorded waveforms have no realistic alternative. However, recorded sound is very resource-intensive for both the CD-ROM and the CPU.

In Windows 95, enhancements to the handling of MIDI make it an even more appealing alternative to .WAV for playing music within games and multimedia titles. Makers of audio cards and systems can provide the following features to distinguish themselves in the marketplace:

- **Polymessage MIDI support.** This highly efficient new technology is included in Windows 95 to make using MIDI easier for application and game writers. When a sound card supports polymessage MIDI, the CPU use required to play even a very complex song is quite small.
- **16-voice-or-better polyphony.** Polyphony is the ability to play multiple sounds at once. Support for more concurrent sounds means fuller-sounding playback.
- **Sampled sound rather than waveform synthesis.** Waveform synthesis uses a mathematical approximation of a sound such as a piano. Sampled sound is an actual recording of the piano, and it sounds considerably better. Including samples of at least the most common general MIDI instruments helps ensure that music in games and titles doesn’t sound synthetic.

Taking Advantage of New Video Card Features

In the summer of 1994, Microsoft released the new DCI display driver development kit. The DCI technology was developed in partnership with Intel and other makers of advanced video display cards.

DCI is a device driver level interface that allows Windows to take advantage of the following hardware features when they are built into advanced display adapters:

- **Stretching.** Speeds up the rendering of images that are stretched or distorted.
- **Color-space conversion.** Assists in playback of compressed digital video by accepting YUV data instead of requiring RGB.
- **Double buffering.** Allows faster, smoother block transfers (BLTs) of images by providing memory space for off-screen drawing.
- **Chroma key.** Facilitates the merging of video data streams, allowing a particular color to be treated as “transparent” in the merge operation.
- **Overlay.** Speeds display of partly concealed objects.
- **Asynchronous drawing.** Along with double buffering, provides a faster method for “drawing” into offscreen memory space.

Most of these hardware features relate to the fast, efficient decompression and playback of digital video. Applications that use the Microsoft Video for Windows architecture will benefit from these features automatically and substantially.

The Multimedia Architecture

The Multimedia Graphics Architecture

The Windows 95 graphics architecture is illustrated in Figure 113. As the figure shows, an application might want to "draw" the following four kinds of graphics on the screen, and it can use four APIs to do so:

- **"Productivity application" graphics**. Applications that want the system to help them draw scroll bars, fonts, buttons, and so on use GDI, the basic Windows graphics API.
- **Digital video**. Applications that want to play digital video use the Video for Windows API. (More details about the Video for Windows architecture are provided in the next section.)
- **Game graphics**. Games draw their own graphics (in memory) and use WinG when they want bitmaps blasted to the screen as fast as possible. WinG is available for Windows 3.1, and provides many of the same benefits as the CreateDIBSection function in Windows 95, as well as fast access to the frame buffer through DCI.
- **3D engineering graphics**. Applications that want the system to help them draw 3D solids use OpenGL. OpenGL is Microsoft's strategic choice for a 3D application programming interface, and Microsoft has a long-term commitment to deliver an implementation of OpenGL as part of the broader Win32 API. Microsoft's first OpenGL implementation shipped in Windows NT 3.5.

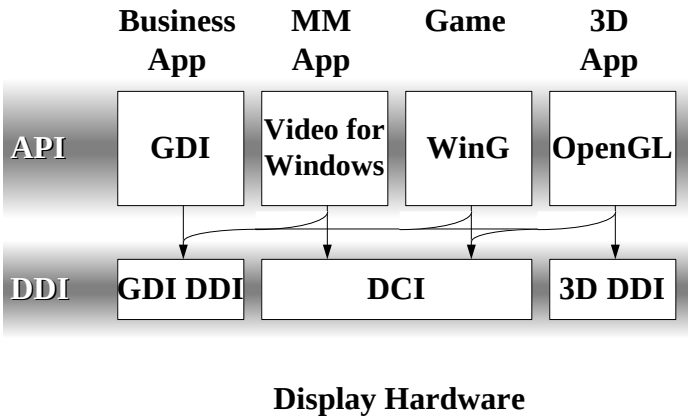

Figure 113. The Windows 95 graphics architecture

The device driver interface in Windows 95 has the following three parts, and the APIs described earlier are designed to take advantage of whichever part provides the best performance:

- **GDI-DDI.** The basic graphics device driver interface for Windows. It is optimized for the flexible graphics requirements described earlier for the GDI API.
- **DCI.** The new device driver interface created jointly by Microsoft and Intel. DCI drivers provide a fast, direct way for games and digital video to write to the video frame buffer. They also enable digital video playback to take advantage of several specific kinds of hardware support included in advanced graphics adapters. For example, stretching hardware can allow users to scale up the size of a digital video clip with virtually no additional strain on the CPU. Color space conversion support in hardware can reduce the amount of work a codec must perform by up to 30 percent, allowing substantially better video playback.
- **3D-DDI.** Enables applications that use OpenGL to take advantage of accelerated 3D support in hardware.

Multimedia Data Routing

The diagram in Figure 114 illustrates (in simplified form) the path that synchronized multimedia data travels from storage to playback.

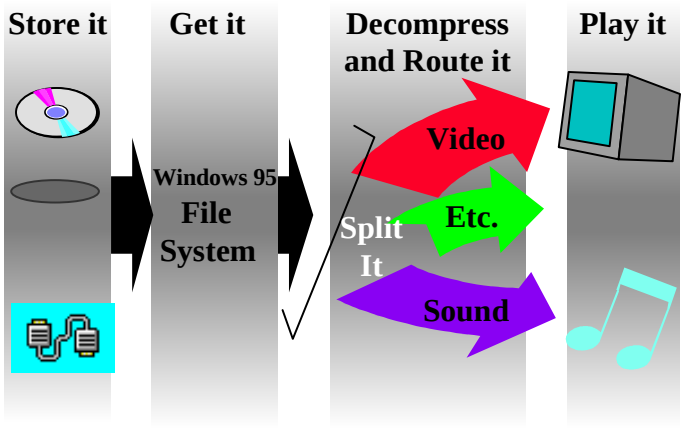

Figure 114. Multimedia data routing

To start with, the data—usually an .AVI file—must be stored somewhere, such as a CD-ROM, a local hard drive, or a network file server. The quality of the eventual playback will be constrained by the amount of data that the storage medium can supply continuously to the file system.

A command—for example, Play—that is usually issued through the Media Control Interface (MCI) causes the relevant part of the file system in Windows 95 to retrieve the stored data. Obtaining this data swiftly and steadily is vital to the success of overall playback performance, and the 32-bit protected-mode enhancements in the new file system (and CDFS) in Windows 95 make a big contribution to the overall performance enhancements of multimedia in Windows 95.

A multimedia data stream, such as an .AVI file, generally contains multiple components, such as digital video data, audio data, text, and perhaps other data such as hot spot information, additional audio tracks, and so forth. As multimedia information comes off the CD-ROM, the first job of the Video for Windows architecture is to figure out what the data stream contains and to separate and route it accordingly.

In most cases, digital video and digital audio are stored in a compressed form, and before it can be seen or heard, it must be decompressed. Frequently, this function is performed in software. However, if hardware support is available on the graphics adapter or sound card for all or part of the decompression work, Video for Windows can tap into it.

Windows 95 ships with a set of useful software-only codecs for both video and audio. However, the Video for Windows architecture has been created in a way that allows additional codecs to be installed. As new codecs become available for particular audio and digital video needs, they can be plugged into the Video for Windows architecture. For example, motion JPEG, which is not included in Windows 95, is a useful codec for multimedia authoring, and capture cards that support JPEG compression and decompression are easily available.