Pentium® Processor with MMX™ Technology Platform Integration Guide

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1. INTRODUCTION

The recent rapid growth of personal computer use has given birth to an array of new platform technologies in the consumer PC market. Consequently, system integrators are constantly challenged to stay informed about the latest platform technologies in order to advise their customers. Furthermore, system integrators often face obstacles integrating these new technologies onto the platform. This document's objective is to familiarize readers with the backgrounds of new key technologies as well as their integration- and performance-related issues.

2. ORGANIZATION AND SCOPE OF THIS DOCUMENT

This document will first cover three key technologies that have recently become available to the consumer. The document will then proceed to show a specific implementation example for each of the three technologies discussed. Finally, the document will discuss some of the integration- and performance-related issues of each platform technology.

This document aims to point out generic integration issues and performance expectations related to these new technologies, but does not cover vendor-specific information. For such information, please contact your local representatives for the vendors.

3. KEY PLATFORM TECHNOLOGY OVERVIEW

This section describes three key platform technologies that have recently become available to consumers: DVD/MPEG-2 video playback, Video Phone, and PC imaging. For each of the three new technologies, the document discusses the background, features, performance and implementations.

3.1 DVD/MPEG-2 Video Playback

3.1.1 BACKGROUND

Media-rich applications have become more and more popular among PC users in the last few years. Recently, new forms of media storage and compression standards have started yet another revolution in the PC industry. The Digital Versatile Disc (DVD), is the storage device providing high capacity for media-rich applications. MPEG-2 (Motion Pictures Experts Group) is the compression standard which makes delivery of high-capacity multimedia possible. The combination of DVD storage and MPEG-2 compression can provide video playback superior to both video cassettes and laser discs. The DVD/MPEG-2 combination provides the highest quality of multimedia playback. Not only will DVD/MPEG-2 enable playback of Hollywood movie content, but it will also allow interactive games. With powerful computers available today, DVD/MPEG-2 playback has become a reality. Intel's MMX™ technology was specifically designed for this type of multimedia on the PC. In the coming years, as computers become even more powerful, DVD/MPEG-2 playback will be a standard capability on all computers. The following sections explain how DVD, combined with the MPEG-2 and other coding standards, provides exceptional multimedia playback.

3.1.2 DVD

DVDs are the same size as CDs and the technology is fully backward-compatible with today's CD media. The DVD combines the high storage capacity of consumer laser discs with the manufacturability and reliability of optical CDs. DVD is the media for the next-generation laser disc players and the eventual successor to CDs. Presently, multimedia content is being stored on DVD discs using MPEG-2 compression for video and Dolby* AC-3 compression for audio. Compression is needed because there is a limited bandwidth associated with transferring data from the DVD disc to the computer.

Currently there are three types of DVD drives in the market:

1) DVD-ROM (Read Only Memory)
2) DVD-R (Writeable)
3) DVD-RAM (Random Access Memory)

DVD-ROM drives are commonly available and are priced for the consumers. The ROM designation indicates that these drives are read-only devices and that no data can be written on them by the consumer. DVD-R drives can write data to special writeable DVD media. However, after data is written, it can no longer be modified or deleted from the disc. This drive is very expensive and is used mostly by software developers. Recently, DVD-RAM has been introduced. On a special re-writeable DVD media, the DVD-RAM drive can write and over-write data for as many times as needed. Although DVD-RAM is quite expensive today, the price is expected to eventually come down. In fact, Hitachi recently announced they will be shipping DVD-RAM drives priced as low as $800 by December of 1998. All these drives are backward-compatible with CD-ROM and audio CDs; however, only a few have the capability to read writeable and re-writeable CD media.

DVD discs can store from 4.7 GB to 17 GB of audio and/or video data. There are four types of DVD discs:

1) 4.7 GB, single-sided, single-layer
2) 8.5 GB, single-sided, double-layer
3) 9.4 GB, double-sided, single-layer
4) 17 GB, double-sided, double-layer

CDs, on the other hand, come in just one type and can store only 688 MB. Since a standard two-hour broadcast movie requires at least 4.7 GB of space, CDs are not a viable option. The

high storage capacity of the DVD disc, however, allows for Hollywood movie content as well as various extra features. Support for multiple video and audio tracks, subtitles, multiple languages, parental control mechanisms, and user interactivity are some of the 'movie-like' features defined into the logical format of the disc. The DVD video disc specification allows for a wide variety of audio and video formats. Hollywood movie titles will typically utilize a subset of the available formats based on several standards from the commercial and consumer entertainment industries.

In addition, copyrighted movies can be encrypted on the DVD disc. This capability makes it more difficult to pirate movies. In order to decrypt, a licensed descrambler (software or hardware) must authenticate itself to the DVD drive. Upon successful authentication, the descrambler receives a key to decrypt the data. Since data copying programs cannot pass the authentication process, this technique prevents movies from being copied.

Many popular movie titles are available on DVD-ROM today. Retailer surveys have shown that DVD movies are in high demand. In response, Warner Home Video recently announced that it will begin national title distribution in DVD format this fall. In addition, Universal Studios has committed to a project of converting over 17,000 movie titles into DVD format. Software titles are also going to be available on DVD media by the end of 1998. Since multimedia-rich applications and games can exceed CD-ROM storage capacity, these programs can be stored on the higher capacity DVD discs.

3.1.3 MPEG-2

The MPEG compression market is currently divided into two major camps: MPEG-1 and MPEG-2. Each video compression standard serves a different purpose. The MPEG-1 standard is primarily intended to process video at the SIF (Source Input Format) with a resolution of 352x240 pixels at 30 frames per second (fps). This process is one-fourth the resolution of the broadcast television resolution standard called CCIR 601 (also known as the "Hollywood standard"). The broadcast television standard calls for 720x480 pixels. Since MPEG-1 could not meet this standard, MPEG-2 was created to process video at this resolution.

MPEG-2 has been widely embraced by the television and satellite broadcast industries. It targets increased image quality, support of interlaced video formats, and provisions for multi-resolution scaleability. Like most digital video compression algorithms, it separates pixel data into luminance value (lightness or intensity) and two chrominance values (color). However, unlike MPEG-1 which compresses only spatial information, MPEG-2 compresses both spatial and temporal information that is redundant within the video, thus achieving very high compression ratios. When more compression is achieved, more data can be sent along a line with finite bandwidth. Thus, while MPEG-1 can deliver a bit rate of 1.5 Mbits/s, MPEG-2 can deliver rates up to 9 Mbits/s.

3.1.4 DOLBY* AC-3

The DVD audio content is encoded using Dolby* AC-3 standards. AC-3 is a six-channel "surround sound" digital audio scheme originally developed for theaters. Dolby AC-3 reproduces sound at a higher fidelity than Dolby Prologic. Its high reproduction quality and compression make it well suited for a variety of consumer applications. AC-3 is a six channel audio scheme encoding only those signals with perceived impact upon the user's sound experience. Sounds that lie outside the human auditory range or that are masked out by stronger signals from nearby frequencies are discarded. Each of the five "main" channels (left, right, center, left surround and right surround) is a full-range channel. The sixth channel is designed for low frequency effects (LFE) and carries signals lower than 120 Hz for dramatic "earthshaking" noise effects. This channel requires speakers capable of reproducing sound in the 3 Hz to 120 Hz range, i.e. sub-woofers. The frequency-limited sixth channel gives AC-3 the "5.1 channel" designation.

3.1.5 BREAKDOWN OF DVD PLAYBACK

The process of DVD playback can be divided into seven major parts:

1) Inverse Discrete Cosine Transform (iDCT)
2) Motion Compensation (MC)
3) Variable Length Decoding (VLD)
4) AC-3 decoding
5) Synchronization of audio and video
6) Rendering
7) Decryption (if movie content is copyrighted)

The first three items highlight the features of the MPEG-2 decoding process and are 80% of the whole playback process on the processor. AC-3 decoding and synchronization are each 10% of the process. Rendering is the last step in displaying the image on screen. It involves color-space conversion, gamma correction removal, scaling, alpha blending, and frame buffer writes. Video controllers today can handle most, if not all, of the rendering process; therefore it does not occupy processor time. If the movie is copyrighted, then additional time is needed for the decryption process.

3.1.6 IMPLEMENTATION

There are three ways to implement the installation of DVD/MPEG-2 onto a PC system. The most expensive approach is to use special hardware-dedicated to the playback of DVD content. The dedicated hardware decodes the MPEG-2 and AC-3 and also performs synchronization of audio and video. The advantage to this approach is that it delivers the best performance at full frame rate; however, the disadvantage is that it comes at a higher cost.

The least expensive approach is to have the software decode the MPEG-2 and AC-3 and also perform synchronization. This approach adds a hefty load to the microprocessor and may not perform as well as the full hardware solution. However, many programs implementing the software-dedicated solution utilize Intel's MMX technology to enhance playback. This implementation is the most cost-efficient method of adding DVD playback onto a PC.

A compromise between the two alternatives is to have the software handle one part of the decoding while dedicated hardware handles the other. Specifically, the hardware handles the motion compensation (MC) while the software handles the rest of the decoding (iDCT, VLD, AC-3 decoding) and playback process (synchronization). Motion compensation can consume 20% to 30% of the processor, so having hardware handle it can be very beneficial to performance. This implementation falls in the middle of the price range set by the full hardware and full software implementations. Table 1 summarizes these three different approaches.

Table 1. Implementation Approaches

Hardware-Dedicated		Hardware/Software		Software-Dedicated	
Software Tasks	**Hardware Tasks**	**Software Tasks**	**Hardware Tasks**	**Software Tasks**	**Hardware Tasks**
Rendering*	iDCT	iDCT	MC	iDCT	Rendering*
	MC	VLD	Rendering*	MC	
	VLD	AC-3 decode		VLD	
	AC-3 decode	Decryption		AC-3 decode	
	Decryption	Synchroniza-tion		Decryption	
	Synchroniza-tion	Rendering*		Synchroniza-tion	
	Rendering*			Rendering*	

3.2 Video Phone

3.2.1 WHAT IS VIDEO PHONE?

Video phone is a communication tool similar to today's telephone service, except that users can transmit and receive video as well as audio.

Video phones come in several forms:

- Stand-alone video phones (similar to a regular telephone but with a small viewing screen),
- TV-based video phones, and
- PC-based video phones.

This section discusses video phone technology in general and focuses primarily on PC-based video phones.

3.2.2 BENEFITS AND FEATURES OF VIDEO PHONE

Video phone benefits both the business and home user in several different ways. All of them break down into three key points:

1) By allowing people to engage both visually and through voice, communication is much more personal, establishing a stronger relationship between the two parties.
2) With the ability to easily exchange visual data, video phone enables sharing of data that was not possible before, such as 3-D models or sculptures that are difficult to fully represent in 2-D (e.g. sketches or written description).
3) The added value mentioned above is available at no extra cost compared to today's regular phone service. In some cases, the cost may be even less by utilizing the Internet. Refer to "Main Components of a PC-based Video Phone" for more details on using the Internet for video phone.

3.2.2.1 Business

On the business side, many meetings require participants to interact beyond just talking to each other. There needs to be visual engagement and an exchange of vital visual information. Examples of this are training sessions, prototype design reviews, or sales calls.

Video phone opens the opportunity to have the benefits of these face-to-face meetings without needing to be there in person. This saves travel costs and time.

Here are examples of how video phone would be of tremendous benefit in business situations:

- Training – Companies can use video phone to train employees that are scattered across the country, or even the world, without having to gather them together in one physical location. This saves both time and expenses.
- Product Design – Product designers can now show customers the latest prototype model instead of settling for 2-D sketches or sending the model to the customer physically. This saves time in the design process. Through video phone, the customer can give real-time feedback to the product designer, who can then make adjustments to the design immediately.
- Sales and Inter-department Meetings – Much of business involves relationships. Video phone allows a more personal interaction since both parties can see each other, instead of being faceless voices on the telephone.

Admittedly, video phone cannot completely replace in-person meetings because there will always be those instances where an in-person meeting is essential. But video phone will help reduce the amount of traveling and overhead for many other meetings.

3.2.2.2 Consumer

On the consumer side, the most compelling benefit of video phone is how it enriches our everyday lives. It starts with what people already do today on their telephones, e.g.:

- Keep in touch with distant family members;
- Call home while on the road;
- Chat with friends;
- Build relationships with customers; and
- Communicate and coordinate with co-workers,

and enhances it by involving our visual sense to enrich the interaction and relationship.

For instance, children too young to carry on a conversation can actually "communicate" with distant family members and loved ones through video phone. By actually seeing the warm, smiling faces instead of only hearing distant voices, children can get to know loved ones who live far away. They can keep in touch during those times when a visit is not possible.

Even something as simple as sharing vacation photos becomes a richer experience through video phone. With the snap-shot features of many video phone applications, friends can send photos while talking on the video phone and receive instant narration for the picture.

3.2.2.3 Overall Cost

Best of all, video phone calls do not cost more than normal telephone calls because they use regular telephone lines. With a long distance call, the cost is potentially lower if two video phones are connected across the Internet, since long-distance toll charges are not accrued (assuming local Internet access). Refer to "Main Components of a PC-based Video Phone" for further information on connecting through the Internet.

In short, video phone allows richer, more effective communication at the same cost of a normal telephone call.

3.2.3 MAIN COMPONENTS OF A PC-BASED VIDEO PHONE

The basic hardware components of a PC-based video phone are:

1) A modem (or network card) to connect to Plain Old Telephone Service (POTS) or the Internet
2) A sound card with an input jack
3) A video capture system (analog or digital)

The exact hardware requirements will depend on the specific video phone application itself. Some applications may only support certain modems, sound cards, and video capture devices. Refer to the video phone application's documentation for specific hardware requirements.

3.2.3.1 Modem for POTS or Internet Connection

The first component, the modem (or network card for LAN connections), establishes the connection between video phones for transmitting data back and forth. They can either call each other through the Internet, or they can connect directly across a phone line (POTS).

3.2.3.1.1 Internet Connection

Using the Internet requires both parties to have access to the Internet either through an Internet Service Provider (ISP) or a direct connection (i.e. through a LAN). Another requirement is for both video phones (or more accurately, both video phone applications) to comply with the

International Telecommunications Union (ITU) H.323 standard. (The ITU sets world-wide standards for desktop conferencing and is an agency of the United Nations.) This ensures interoperability between phones from different vendors. In other words, two video phones that both comply with H.323 are guaranteed to be able to talk to each other. Refer to Table 2 for a listing of relevant ITU standards

Most H.323 video phone applications are not dependent on any specific modem, so a regular analog or DSVD[1] modem with a minimum transfer rate of 28.8 Kbps is satisfactory. Use of modems slower than 28.8 Kbps will result in inferior video and audio performance .

Once again, hardware requirements may be different for each video phone application, so check the application's documentation for specific requirements.

3.2.3.1.2 POTS

The other option is to connect directly through a single analog phone line (POTS). The caller dials the recipient via a normal telephone connection. Consequently, the video and audio streams are transmitted directly over the phone line instead of through the Internet. Similar to the H.323 standard, the ITU H.324 standard governs this type of connection and ensures that two compliant video phone applications can communicate with each other.

H.324 not only ensures interoperability but also high-quality video and voice by specifying how digital video and voice compression technologies are used to convert sounds and facial expressions into a digital signal. For instance, with a 28.8 Kbps modem, H.324 specifies that voice data compresses down to approximately 6 Kbps and video uses the rest of the bandwidth. This delivers 4 to 12 frames per second (176x132 resolution), roughly half the frame rate used for television.

Compared to H.323, H.324 video phone applications have more stringent modem requirements. First, *some* video phones only work with a specific modem, as opposed to H.323 video phones which work with *most* modems. But in most of these cases, the software and hardware will ship together as one product. Also, H.324 video phones require that the modem support the V.80 protocol. V.80 is the international protocol between the video phone host (in this case the PC) and the modem. Refer to Table 2 for a listing of ITU standards and modem protocols.

Table 2. ITU Standards and Modem Protocols

H.323	**ITU standard for desktop conferencing for intranets and the Internet**
H.324	**ITU standard for desktop conferencing for regular phone lines (POTS)**
H.263	Video compression algorithm used in H.323 and H.324
G.723	Voice compression algorithm used in H.323 and H.324
H.223/H.245	Multiplexing and control protocol for H.323 and H.324
V.80	**International protocol between video phone host (e.g. PC) and modem**
V.34	**International protocol for connections between modems (max 33.6 Kbps)**

Also, since the connection is across a dedicated phone line (as opposed to the shared Internet), the transfer rate of the modem becomes the limiting factor. Therefore, H.324 video phones will usually come with modems faster than 28.8 Kbps (i.e. 33.6 Kbps or 56.6 Kbps).

[1] DSVD (Digital Simultaneous Voice Data) modems allow the transmission of voice and data at the same time by converting the voice data into digital information, just like any other data coming out of the PC. Then, the entire, combined data stream is sent across a standard analog phone line. However, in order to use the simultaneous voice and data feature, both parties must be using DSVD modems.

3.2.3.1.3 Choosing between POTS and Internet Connections

Selecting which type of connection to use comes down to a trade-off between cost and quality. With the Internet connection (H.323), a long distance call could virtually be free since the only phone call is to a local ISP. However, the trade-off comes with potential bottlenecks on the Internet slowing down the data, hence reducing the quality of service. (Refer to the section, "Factors that Affect Video Phone Performance" for more details.)

On the other hand, a direct call through the phone line (H.324) does not have the Internet congestion problem since the phone line is a dedicated connection, resulting in better quality. However, phone tolls are charged on long distance calls, just like any regular long distance telephone call.

3.2.3.2 Sound Card/Audio Capabilities

The second component, the sound card, captures (with a microphone) and plays back (via speakers) the voice data similar to the hand-set of a regular telephone. A half-duplex sound card is adequate but a full-duplex sound card is recommended. Half-duplex means that the sound card *cannot* capture and play back sound simultaneously. Therefore, one party must wait for the other to finish talking before he/she can reply. A full-duplex sound card *can* capture and play back sound at the same time.

Almost all video phones require no additional audio hardware beside a standard sound card. In fact, plug-in sound cards are probably not needed in most of today's PCs because many manufacturers of motherboards and computers are integrating sound capabilities onto the motherboard. At most, a headset with a built-in microphone may be necessary to help cancel feedback, depending on the acoustics of the PC workspace.

3.2.3.3 Video Capture System

Full function video phone systems must have a camera at each end to capture video data. Either an analog camera with a video capture card or a digital camera that feeds digital video directly into the computer is required. Refer to Table 3 for the requirements for both analog and digital video capture.

Table 3. Video Capture Systems

Analog Capture	Digital Capture
Analog Camera Analog Video Capture Card	Digital Camera USB or 1394 Ports on PC Operating System Support

Analog cameras plug into a video capture card installed in the PC through a composite video or s-video jack. Similar to the case with audio cards, some manufacturers are beginning to integrate video capture capabilities directly onto the motherboard so that an additional capture card is not necessary. The analog camera can either be one built specifically for use with a PC or just a regular analog camcorder.

Some video phone applications only support certain video capture boards. Refer to the application's documentation for specific hardware requirements.

Digital cameras, on the other hand, do not require an analog video capture card because they feed the digital video directly into the computer through digital port protocols such as Universal Serial Bus (USB) and IEEE 1394 (Firewire). These protocols allow digital cameras (and other digital devices) to plug directly into the PC.

The requirements for using a USB or 1394 camera are:

1) Support by the video phone application,
2) Support by the operating system (OS), and
3) Existence of USB or 1394 ports (built-in or on add-in card) on the PC.

Even though USB and 1394 are new technologies to the consumer market, there is already evidence that the above requirements to support them are already taking shape. First, major PC manufacturers (e.g. Compaq, Hewlett Packard) are already shipping systems with USB ports. Also, operating systems are releasing support for USB (Windows 95 OSR 2.1). And finally, consumer electronic manufacturers are building 1394 ports into their devices (e.g. Sony's digital camcorders).

It is still possible for people who do not have a camera and video capture system to experience video phone because many new computers come with a receive-only version of the video phone application pre-installed. This version allows a person to receive a video phone call (video + voice), but only transmit back an audio message (no video since there is no camera). Also, they can only answer a call initiated by someone else with a full version of the video phone application and cannot initiate a call themselves.

3.2.3.4 Sample PC Configurations

Here are sample PC configurations for different types of video phone configurations based on the main components discussed in this section.

H.323 Internet Video Phone #1

- Analog camera
- Analog video capture board
- 33.6 modem
- ISP service for access to Internet
- Plug-in sound card
- Video phone software

H.323 Internet Video Phone #2

- USB camera
- USB port on PC
- OS support for USB
- Video phone software
- 28.8 modem
- ISP service for access to Internet
- On-board sound card

H.324 POTS Video Phone #1

- Analog camera
- Analog video capture board
- Video phone software
- 56.6 modem
- On-board sound card

H.324 POTS Video Phone #2

- USB camera
- USB port on PC
- OS support for USB
- 56.6 modem
- Plug-in sound card
- Video phone software

3.2.4 FACTORS THAT AFFECT VIDEO PHONE PERFORMANCE

In order to get the best performance from video phone, one must understand the factors that affect video phone performance. These factors fall into two main categories:

1) The type of connection between the video phones and
2) The configuration of the computers.

3.2.4.1 Internet vs. POTS Connection

As discussed in the "Modem for POTS or Internet Connection" section, there are two ways for video phones to connect to each other. The first option is through a POTS connection (analog phone line); the other is having the modems connect across the Internet.

Connecting across the Internet usually degrades the performance of video phone because of Internet traffic congestion. During peak Internet hours, the transmission of packets (a technical term for the pieces of data traveling across the Internet) carrying the video and voice data slows down due to Internet traffic congestion. Packets being delayed means longer latency (i.e. video will take longer to reach the other person) causing lower frames per second, worse audio quality, and worse synchronization of video and voice.

Another inherent factor in using the Internet involves the total distance the packets must travel. The farther a packet must travel from source to destination, the greater the chance becomes of running into traffic congestion as well as the unavoidable impact of time required to travel over the greater distance.

In short, the amount of traffic on the Internet combined with the distance the packets must travel (number of hops) dramatically affects video phone performance.

With a POTS connection however, a dedicated line links the two modems (i.e. no one else uses the bandwidth). Therefore, the data traveling across the phone line is always going at the maximum transfer rate of the modems (except in special cases when the telephone system may be overburdened). In general, this dedicated line will achieve much better video phone performance than using the Internet.

3.2.4.2 Internet Service Provider

When using the Internet, the Internet Service Provider (ISP) for both users also plays a crucial role in performance.

- Like the Internet, an ISP may have certain times that it experiences peak load conditions when many of its customers are logged on. During these times, performance will be lower since the ISP has a high number of packets to handle (i.e. high load). Subsequently, each user must share the total available bandwidth of the ISP's connection to the Internet with more customers.
- Also, the user's connection speed to the ISP is important. Even though the ISP may support 28.8 Kbps (or higher) modems, the user may not always be able to connect at the maximum transfer rate due to phone line noise, technical difficulties with the ISP's equipment, etc.

Therefore, selecting an ISP that does not over-extend itself by accepting too many customers, and one who maintains it's hardware regularly, will increase the performance of video phone across the Internet.

3.2.4.3 Microprocessor Performance

Whether using the Internet or a POTS connection, the microprocessor in the user's PC plays a large part in determining performance, because the speed (clock frequency) and availability of

Intel's MMX technology is important for the compression/decompression of the data stream, as well as the PC's overall responsiveness when concurrently running other applications.

Because of the limited bandwidth of today's high speed modems and potential traffic jams on the Internet, video phones must compress data as much as possible. However, if the computer cannot compress and decompress the video and voice data fast enough, the quality of video phone will suffer. In general, the faster your system processor, the better your video phone performance will be. Intel's MMX technology also plays a large role because the compression algorithms can be highly optimized for MMX technology. This provides smoother, clearer video because of the faster compression through the use of the Single Instruction Multiple Data (SIMD) feature of MMX technology.

Better microprocessor performance and MMX technology also benefits the PC's overall responsiveness when running other applications concurrently. Higher processor speeds mean more instructions are executed every second, and MMX technology allows certain instructions to be computed in parallel. Both result in the PC being able to handle more tasks as well as a smoother execution of all applications that are running.

Users who have a slower processor or one without MMX technology should limit the number of applications running concurrently.

3.2.5 EXAMPLES OF PEOPLE/GROUPS USING VIDEO PHONE

With the appeal of being able to see others instead of only hearing their voices, video phone is beginning to be used in many creative ways. Here are a few examples of creative ways people have used one particular video phone application, Intel Video Phone with ProShare technology:

- Scott Adams – creator of "Dilbert" – recently conducted a series of "virtual book signings" at bookstores across the country using Intel Video Phone technology. Right at local book stores, customers were able to chat with Scott via video phone and buy pre-signed copies of his latest book.
- Joining together with Intel, the Portland, Oregon Ronald McDonald House provided children and their parents the ability to interact face-to-face during the child's stay at the hospital. This helped to alleviate the seclusion during treatment, and aided in recovery periods when children are often kept away from home for long periods of time, and visitors are kept to a minimum.
- Many seniors cannot visit their loved ones as often as they would like, especially during those important festive times of the year. Intel and Seniornet, a nationwide network of computer-using seniors, installed ten Seniornet Learning Centers across the U.S. with personal computers equipped with Intel Video Phone. This allowed them to see and talk with their children in distant cities, get a peek at the grandchildren's artwork, and nurture lifetime bonds with old friends.
- Starbucks, with Intel, created a prototype cybercafe equipped with WWW access, e-mail, and video phone. The company also plans to train its employees in the fine art of making cappuccino via an Intel Video Phone in order to help retain it's small business roots through face-to-face relationships with it's employees.

3.3 PC Imaging

3.3.1 BACKGROUND

PC imaging, in the most general sense, is the activity of recording images from the outside world in an electronic format, then importing them into a computer. PC imaging is very important because images are much more useful inside a computer than on paper. Today, there are powerful software programs that can make digital images extremely versatile. Once the images are imported into a computer, these programs can store, manipulate, edit, fax, or copy the digital images. In fact, programs optimized for Intel's MMX technology can work faster than ever to process the images. In addition, Optical Character Recognition (OCR) software can convert printed text to computerized text. Amongst PC imaging devices, a scanner is an important tool for making these benefits possible. Adding a scanner to a PC system could mean adding imaging, fax and copy machine capabilities for the price of one. This section begins with a review of the basic technology behind scanners, then proceeds to consider the various types of scanners available today. Finally, information is provided about the different features and performance trade-offs to educate consumers on purchasing a scanner.

3.3.2 FUNDAMENTALS OF SCANNERS

A scanner collects data from the scanned item using small electronic components known as Charge-Coupled Devices (CCDs). The CCDs are arranged in a row along a scanning 'head'. When an image is passed by the head, the light reflected off the scanned item is recorded. The information is then sent to the computer in binary form. From there, the computer can organize the binary data into a file and use it later in imaging software. Scanners differ primarily in the number of CCDs placed on the scanning head and the amount of information each of them can record. However, other details about the actual scanning process can also be significant.

3.3.3 TYPES OF SCANNERS

The three most common types of scanners available are:

1) Flatbed
2) Sheetfed
3) Handheld

Flatbed scanners look very similar to copy machines. The scanned item rests on a glass plate while the scanning head moves underneath it. These scanners can scan both flat and small three-dimensional objects. Their versatility makes them the most popular of the three types. Sheetfed scanners operate like fax machines in that the scanned item moves past the scanning head. This type of scanner can scan only flat sheets of paper. In addition, the imperfect mechanical motion of the paper can introduce distortions. As a result, sheetfed scanners are not as popular. Handheld scanners are the most inexpensive alternative. They are small devices with a scanning head about six inches wide. These devices have to be moved along the scanned item by hand. If the item is more than six inches wide, they have to be scanned in separate parts and then 'stitched' together by software. Although, the software does the stitching automatically, it can make severe mistakes if each part is not scanned properly. Furthermore, the hand motion introduces distortions. The handheld scanner is appropriate only for those with a limited budget.

3.3.4 FEATURES/PERFORMANCE

Within each type of scanner, the following specifications determine the quality:

- Resolution
- Bit-depth

- Dynamic range
- Scanning method
- Scanning area
- Scanning speed

Typically, a high-end scanner will have better resolution, bit-depth, and dynamic range than a low-end scanner. Since scanning method, area and speed are straightforward, this document will only focus on the first three specifications.

3.3.4.1 Resolution

Resolution is a measure of the number of pixels sampled in an area of one square inch. For instance, a 600x1200 resolution scanner can sample up to 600 pixels per inch in the horizontal direction and 1200 pixels in the vertical direction. Thus, 720,000 pixels can be scanned per square inch. Usually, when indicating resolution, only the horizontal resolution is given since it is the limiting factor. Consequently, in the example given, the resolution would be referred to as 600 dpi (or dots per inch).

Manufacturers have two methods of indicating resolution, namely optical resolution and interpolated resolution. The optical resolution measures the number of pixels the scanner can physically read. A flatbed scanner with an optical resolution of 600x1200 indicates that there are 600 sensors per inch in the horizontal direction (on the scanning head) and that the scanning head moves 1200 times per inch in the vertical direction. On the other hand, the interpolated resolution measures how many pixels the scanner can resolve through intelligent guessing. The software which accompanies a scanner is capable of guessing at the readings between the physically scanned pixels. This gives the appearance of a higher resolution scan, when in fact the image has just been intelligently enhanced by the software. Manufacturers usually specify both the optical resolution and the interpolated resolution.

The amount of resolution needed depends on the application of the scanner. For instance, scans that need to be converted to text will require a higher resolution than scans that will be printed out. Scanning at a resolution higher than actually needed will only waste storage space and take more time to process. Images that will be converted to text should be scanned at a minimum of 300 to 400 dpi. A 300-dpi scan will provide good results; however, a 400-dpi scan can give more accurate results. Desktop laser printers with resolutions of 300 to 600 dpi in the horizontal direction will have line screens of 50 to 100 lpi (or lines per inch) in the vertical direction. Therefore, images that will be printed out on these printers need to be scanned at only 100 to 200 dpi. Since most computer monitors can only display 72 to 80 dpi, images that will be scanned for on-screen viewing require even less resolution. If an image needs to be enlarged, more resolution is needed. For instance, if the image is enlarged to twice its size, twice as much resolution is needed. If, on the other hand, it is reduced down to one half its size, half as much resolution is needed. The table below summarizes the common applications and the corresponding resolution needed.

Table 4. Minimum Resolution Requirements for Popular Applications

Resolution	Popular Applications
72 – 80 dpi	On-screen viewing
100 – 200 dpi	Desktop laser printing
300 – 400 dpi	OCR

3.3.4.2 Bit-Depth

The amount of color information recorded for each pixel is measured by “bit-depth.” On the lowest scale, a 1-bit scanner records only black and white. Usually, bit depth indicates the quality of a color scanner rather than a black and white scanner. A 4-bit scanner, for instance, can record up to 16 colors while an 8-bit scanner can record up to 256 colors. The higher the bit depth, the more accurately the scanner can describe the image. Most color scanners today have what is known as ‘true-color’ scanning. This essentially means that the scanner has a 24-bit depth. Eight bits of information are collected about each of the primary colors — red, green and blue. A 24-bit scanner can capture nearly 16 million different colors. Today, there are many scanners that can scan more than 24 bits. However, there are not many graphics packages which can accept more than 24 bits of information from each pixel. For those graphics packages which can handle more than 24 bits, the extra bits are used to correct for imperfections which occur in the scanning process. Furthermore, not all monitors can handle 24 bits of color. Therefore, poor image quality may be caused by the monitor rather than by the scanner.

3.3.4.3 Dynamic Range

Dynamic range is a specification that measures the range of gray tones a scanner can record. While bit depth indicates the amount of red, green and blue information that can be recorded, dynamic range indicates the scanner’s capability to record the gray shades between black and white. Dynamic range is measured on a scale from 0.0 (perfect white) to 4.0 (perfect black). The higher the number, the more tones the scanner can read. The dynamic range suggests how well the scanner can differentiate between dark and light colors. For common applications, a dynamic range of 2.4 is sufficient.

3.3.5 IMPLEMENTATION

Most handheld and sheetfed scanners simply connect to the parallel port on the back of the computer. Since printers get connected to the parallel port, these devices often come with an adapter which allows the port to be shared by both the scanner and the printer. Desktop scanners are usually higher end and therefore come with a special connector known as a SCSI. These devices come with a low-end SCSI card which fits into one of the expansion slots and connects only to the scanner. These cards may have jumper settings; however, they rarely need to be changed.

4. SYSTEM IMPLEMENTATION EXAMPLES

This section describes four systems that were built according to the implementation recommendations mentioned in the previous sections. The first three platforms show the capabilities of DVD/MPEG-2 video playback, Video Phone, and PC Imaging respectively. The last section describes a system that contains all three technologies. This last section demonstrates that it is technologically possible to integrate all three components, but applications should be run with consideration of processor and system load capacities.

4.1 Platform A: DVD/MPEG-2 Video Playback

4.1.1 OVERVIEW

The hardware-dedicated solution to DVD/MPEG-2 playback was implemented with the Diamond Maximum DVD Kit*. The kit came with a Toshiba DVD drive, a PCI decoder card, sample DVD content, and the necessary software. The software-dedicated and software/ hardware solutions both used the same Toshiba drive provided by the Maximum DVD Kit. The decoder for the software-dedicated solution was implemented with the Zoran SoftDVD* software. For the software/hardware solution, SoftDVD was used in conjunction with the ATI Rage Pro* video card.

4.1.2 FEATURES

The Toshiba DVD drive has a DVD access time of 200 ms and CD access time of 130 ms. Its transfer rate in DVD mode is 1.35 MB/second and in CD mode, it is 1.2 MB/second. All three DVD/MPEG-2 playback solutions contain MPEG-2 and AC-3 decoders. In addition, all three can support multiple formats, screen size, versions, ratings, languages and camera angles.

The PCI decoder card provided with the Maximum DVD Kit has a stereo, AC-3 and S-video output. The software/hardware and software-dedicated solutions cannot deliver S-video outputs but they can provide stereo and AC-3 output via the sound card. In order to receive an AC-3 signal, the sound card must be AC-3 compatible. As of yet, AC-3 sound has not been tested on the Zoran SoftDVD player.

4.1.3 SYSTEM REQUIREMENTS

All three solutions require at least 16 MB of RAM and the Windows 95 operating system. For the software/hardware and software-dedicated solutions, implementing DVD/MPEG-2 playback on processors lower than a 233-MHz Pentium processor with MMX technology will result in inferior quality.

4.1.4 DVD/MPEG-2 EVALUATION

4.1.4.1 System Configuration

The DVD/MPEG-2 solutions were installed on a system with the following configuration:

- Intel Pentium processor with MMX technology 233 MHz
- Intel evaluation motherboard with 430TX chipset
  - On-board audio with Yamaha OPL3-SAx sound system
  - 512K pipeline burst cache
- 32 MB SDRAM
- Quantum Fireball* ST6.4A 6.0 GB hard drive
- Toshiba DVD drive
- Microsoft DirectX 5.0*
- Microsoft Windows* 95 OSR 2.1
- Generic SVGA monitor
- Generic 3.5 inch floppy drive
- Generic PS-2 mouse and keyboard

4.1.4.2 Implementation Issues

Installation of the three playback solutions is fairly straightforward. Each of the respective solutions provides the necessary installation software. The following tips can help optimize DVD/MPEG-2 playback for each of the three implementations.

Tip 1. (Applicable to all three implementations)

To optimize playback performance for all three solutions, the DVD drive must have Direct Memory Access (DMA). Enabling DMA for the DVD drive can result in a 40% improvement to the frame rate. DMA can be turned on by following these instructions:

1) Move the mouse pointer to the "My Computer" icon and click the *right* mouse button
2) Select "Properties"
3) Select the "Device Manager" tab
4) Double click on "CD-ROM"
5) Double click on "TOSHIBA DVD-ROM"
6) Select the "Settings" tab
7) Check the "DMA" box in the "Options" section
8) Select "OK" and then "OK" again

Obtaining the latest version of Microsoft DirectX* API can also be very beneficial to the playback performance. The latest version of DirectX can be found in Microsoft's homepage at http://www.microsoft.com/directx. The latest version available at the time of this evaluation was DirectX 5.0.

Tip 2. (Applicable to software-dedicated implementation)

Once DMA is set and the latest version of DirectX is installed, the Diamond Maximum DVD Kit is ready to play DVD discs. To implement software/hardware or software-dedicated playback on Zoran SoftDVD, an extra step is required. The software-dedicated solution can be implemented as follows:

1) Move the mouse pointer to the "My Computer" icon and click the *right* mouse button
2) Select "Explore"
3) Double click on the "C:" folder
4) Double click on the "Windows" folder
5) Double click on the file "Softpeg.ini"
6) Add these lines at the end of the file:

```
[dci]
fourcc=uyvy
```

7) Save the file

Tip 3. (Applicable to software/hardware implementation)

The software/hardware solution can be implemented as follows:

1) Follow steps 1 through 5 in Tip 2 above
2) Add these lines at the end of the file:

```
[dci]
fourcc=mc12
```

3) Save the file

Once these steps are taken, the software-dedicated or software/hardware solutions are ready to play DVD discs with the Zoran SoftDVD player.

4.1.4.3 Performance of DVD/MPEG-2 Playback

The two movie specimens used for the evaluation were “Batman Forever” and the movie trailer for “Total Recall”. Since “Batman Forever” is an encrypted movie, extra processor time is required to decrypt. This movie is recorded at 24 frames per second (fps); therefore, that is the maximum frame rate achievable. “Total Recall” is an unencrypted movie recorded at 30 fps. Thus, the maximum frame rate achievable for this movie is 30 fps. Table 5 presented below shows the results obtained. It can be seen that the software/hardware implementation results in a 7% to 16% improvement over the software-dedicated implementation.

Table 5. Frame Rate for the Three Playback Solutions on the Pentium® Processor with MMX™ Technology at 233 MHz

	BATMAN FOREVER (Encrypted, 24 fps content)		TOTAL RECALL (Unencrypted, 30 fps content)
Implementation	**Active Scene Only (fps)**	**Entire Movie (fps)**	**Movie Trailer Only (fps)**
Software Only	14.1	17.3	15.5
Software/Hardware Hybrid	16.8	18.6	16.8
Hardware Only	24*	24*	30*

* * Frames per second measurement was obtained from Diamond Multimedia’s specifications.

It can be observed that the active scenes in “Batman Forever” require more processor time than the less active scenes. The active scenes, therefore, have a frame rate lower than the frame rate averaged over the entire move. The “Total Recall” movie trailer is also very active. Thus, when compared to the frame rate in the active scene of “Batman Forever,” it can be observed that the unencrypted “Total Recall” is equal or better.

For comparison, the same movie’s specimens were played with a Pentium II processor in a slightly altered system configuration. Table 6 confirms the general observation from Table 5. It also shows that a Pentium II processor can achieve close to full frame rate with both the software-dedicated and software/hardware solutions.

Table 6. Frame Rate on the Pentium® II Processor 266 MHz

	BATMAN FOREVER (Encrypted, 24 fps content)	TOTAL RECALL (Unencrypted, 30 fps content)
Implementation	**Active Scene Only (fps)**	**Movie Trailer Only (fps)**
Software Only	22.1	24.4
Software/Hardware Hybrid	23.9	27.1
Hardware Only	24*	30*

* Frames per second measurement was obtained from Diamond Multimedia’s specifications.

System Configuration

- Intel Pentium®II Processor 266 MHz
- Intel evaluation motherboard
  - 512KB pipeline burst cache
- 32 MB SDRAM
- Quantum Fireball*ST6.4A 6.0 GB hard drive
- Toshiba DVD drive
- Microsoft DirectX*5.0
- Microsoft Windows*95 OSR2.1
- Generic SVGA monitor
- Generic 3.5 inch floppy drive
- Generic PS-2 mouse and keyboard

4.1.5 SPECIFICATION OF DVD/MPEG-2 SETUP

Obtaining the latest versions of the Zoran SoftDVD player and the ATI Rage Pro drivers can be very beneficial to the performance of the software-dedicated and software/hardware solutions. Obtaining the latest version of Microsoft DirectX is also very important. The version numbers for the pertinent software used are listed below:

- Zoran SoftDVD version 1.0A
- ATI Rage Pro drivers version 4.30C8U
- Microsoft DirectX version 5.0

The ATI Rage Pro was in the PCI card format. Performance on the software/hardware solution can be improved if the Rage Pro is in an Advanced Graphics Port (AGP) card format.

4.2 Platform B: Video Phone

4.2.1 INTEL CREATE AND SHARE PACK OVERVIEW

The Intel Create and Share Pack is an integrated suite of applications that allows users to easily create, manipulate, and share images and photos. One of the applications in the suite is an Internet video phone designed for sharing content created by the Create and Share Pack or any other digital images. The video phone brings people face-to-face with one another through Internet video phone calls and opens up a whole new world for people to see as well as talk with each other while sharing images and photos.

Some of the Intel Create and Share Pack Video Phone's main features include:

- Compliance with the International Telecommunications Union (ITU) H.323 standard for Internet video phone calls
- Hardware independence
- Availability of data sharing tools

Compliance with ITU H.323 ensures interoperability with other H.323 compliant video phone applications. Most video phone applications are compliant since H.323 is the international standard. From a consumer perspective, compliance to the standard is important because it ensures they can use the Create and Share Pack Video Phone with as many other video phones as possible.

Hardware independence means that the video phone does not require any specific hardware from a particular manufacturer, e.g. only modems made by XYZ Corporation. Therefore, the user can use hardware components from a variety of vendors.

Lastly, the Create and Share Pack Video Phone has data sharing tools that allow parties to easily share data and information while using the video phone. Data sharing tools in the video phone include the following:

- Send Files – Send files such as documents, graphics, pictures or spreadsheets to each other. When a file is received, it is automatically placed on the desktop. To send a file, select the file and drag it to the "Guest Video" window.
- Whiteboard – Draw diagrams and charts, or display other graphics in a common window that can be seen and used by both parties. Also, play drawing games, such as Tic-Tac-Toe or Hang Man.
- Text Chat – Write back and forth between the two parties. They can also cut and paste text.
- Share Applications – Share a running application on the local computer with the remote computer. The remote user will be able to see the same information that is on the local computer, but the remote user cannot change the data.

Besides these data sharing tools, the Create and Share Pack Video Phone also allows snapshots from a video camera to be taken and shared. The snapshots taken (or received) are automatically saved in a snapshot album. In the snapshot album, users can view several snapshots at a time at thumbnail size or one at a time at their original size. Pictures that have been scanned in or graphics created in another application can also be sent through the snapshot feature.

4.2.2 SYSTEM REQUIREMENTS

Besides the standard subsystems on most of today's PCs, there are several other system requirements for the Intel Create and Share Pack Video Phone:

- Windows 95

- Video Capture System (analog or USB)
- Audio Capabilities
- Dial-up access to the Internet (or direct access through a network connection)
- v.34 Modem (or network card)

4.2.2.1 Windows* 95

The Intel Create and Share Pack requires Microsoft Windows 95 to run.

4.2.2.2 Video Capture System

The computer system needs to have a video capture subsystem to capture local video. This subsystem can be either analog or digital video capture.

In an analog system, an analog video capture card and analog video camera are required. The Create and Share Pack Video Phone currently supports the Intel Smart Video Recorder III analog video capture card.

The analog video camera can either be a tethered camera built especially for use with the PC or a consumer electronic analog camcorder. Either type of camera will work as long as it has s-video or composite video output jacks, which feed into the video capture card.

In a digital system, a Universal Serial Bus (USB) digital camera is required. No video capture card is necessary because the video is already in digital format and feeds directly into the computer. However, the computer must have USB ports and be running an operating system that supports USB ports. The Intel Create and Share Pack Video Phone supports all USB cameras and runs under Windows 95 OSR 2.1, which support USB.

Table 7 is a summary of requirements for both analog and digital video capture.

Table 7. Video Capture System Requirements

Analog Option	Digital Option
Analog Camera	USB Camera
Analog Video Capture Card	USB ports built on motherboard or on add-in card
	Operating System support for USB

4.2.2.3 Audio Capabilities

Audio capabilities are necessary on a computer with video phone to capture local audio and playback remote audio. Audio systems are common on new PCs and will therefore not be discussed in great detail. If the computer does not have audio capabilities, adding any standard 16-bit sound card that is SoundBlaster*-compatible will satisfy the Create and Share Pack Video Phone's audio capabilities requirement.

A pair of PC speakers and microphone (or integrated headphone set) is also required.

4.2.2.4 Dial-Up Access to Internet (or Direct Internet Access)

The Create and Share Pack Video Phone requires the user to have access to the Internet either through dial-up access on a modem or direct access through a network. Direct access through a network is usually available only to people connecting through company or university networks.

Most users will connect to the Internet by dialing up through a local Internet Service Provider (ISP). The Create and Share Pack Video Phone does not require the user to use any particular Internet Service Provider as long as they offer Point-to-Point (PPP) connections. Refer to Microsoft Windows 95 Help documentation for how to set up an Internet connection through an ISP in Windows 95.

4.2.2.5 Modem (or Network Card)

The Intel Create and Share Pack Video Phone complies with the International Telecommunications Union (ITU) H.323 standard for Internet video phone calls. This guarantees interoperability between video phone applications. The Create and Share Pack Video Phone's implementation for compliance with H.323 is not hardware dependent (i.e. does not require hardware from a specific vendor in order to run) and can therefore use any modem that complies with the v.34 standard. A v.34 modem (28.8 Kbps) is necessary because lower transfer rates would severely degrade video and audio quality. Table 8 describes the international standards governing modems and desktop conferencing.

Table 8. ITU Standards and Modem Protocols

H.323	**ITU standard for desktop conferencing for intranets and the Internet**
H.263	Video compression algorithm used in H.323
G.723	Voice compression algorithm used in H.323
H.223/H.245	Multiplexing and control protocol for H.323
V.34	**International standard for 28.8 Kbps modem connections**

4.2.3 SAMPLE/TEST SYSTEM

This section covers the installation of the Intel Create and Share Pack Video Phone on an actual system. It lists the system configuration, implementation issues encountered while installing video phone, and performance data from test Internet video phone calls (H.323).

4.2.3.1 System Configuration

The Intel Create and Share Pack Video Phone was installed on a system with the following configuration:

- Intel Pentium processor with MMX technology 233 MHz
- Intel AN430TX motherboard
  - On-board video with ATI Rage II+DVD* video chip (2 MB SGRAM)
  - On-board audio with Yamaha OPL3-SAx* sound system
  - 512K pipeline burst cache
- 32 MB Micron Technology SDRAM
- Intel Smart Video Recorder III with Intel C0 Analog Camera
- Lucent Technology Win Modem* 33.6 Kbps
- Quantum Fireball ST6.4A* 6.0 GB hard drive
- Microsoft Windows 95 OSR 2.1
- NEC MultiSync* 17XP monitor
- Generic PC speakers and Telex microphone
- Generic PS-2 mouse and keyboard

The Internet connection for the video phone calls was made through an account from Concentric Network, a local Internet service provider. *Maximum connection speed for the particular Concentric Network dial-up line used was 28.8 Kbps, not 33.6 Kbps.*

4.2.3.2 Implementation Issues

The installation process for the Intel Create and Share Pack Video Phone ran without any problems. In installing the subsystems (i.e. video capture system, modem), the only one that had minor issues was the Intel Smart Video Recorder (ISVR) III.

1) Due to a conflict with the evaluation board, Plug-and-Play support in the BIOS needed to be disabled in order for video capture to work.
2) After each (re)installation of the Create and Share Pack Video Phone, the ISVR drivers needed to be reinstalled. Apparently, a registry entry or file was being altered that caused the ISVR card not to function properly. Reinstalling the ISVR drivers corrected the problem.

No problems or conflicts were encountered with installation of the Lucent Technology modem. Since the audio and video systems were on-board the motherboard, all BIOS settings and drivers were pre-configured. Therefore, all that was necessary was to load the audio drivers when Windows 95 asked for them.

Also, the Create and Share Pack Video Phone can take advantage of DirectDraw* to enable enhanced video display features. Not all versions of DirectDraw are compatible. Version 4.04.00.0068 was found to be compatible and was installed on the test system. Other versions may also be compatible but were not tested in this investigation.

4.2.3.3 Performance of Test Internet Video Phone Calls

Two test Internet video phone calls were made with the Create and Share Pack Video Phone from Santa Clara, CA, to Hillsboro, OR: one on August 14, 1997 at 2:00 PM PST and the other on August 15, 1997 at 8:00 AM PST. Those particular times were selected to establish two test points with varying degrees of overall Internet usage. Performance of the calls was measured against three metrics:

1) Average delay of video and audio (seconds)
2) Percent of video and audio data lost
3) Data transfer rate for video and audio (Kbps)

Refer to Table 9 for performance results of the test Internet video phone calls. All performance data was measured using Intel Connection Advisor. The data for each metric was established by observing the figures during a typical video phone call and estimating a range that captured 85% of the figures.

Overall usage of the processor when running the Create and Share Pack Video Phone ranged from 25% to 35%. (Source: Intel Connection Advisor.)

Table 9. Test Internet Video Phone Call Performance Data

Time of Call	Delay		Data Lost		Data Rate	
	Video	Audio	Video	Audio	Video	Audio
2:00 pm	0.7–1.2 sec	0.4–0.9 sec	0–3%	0%	8.3–19.0 Kbps	4.7–9.8 Kbps
8:00 am	0.6–1.1 Sec	0.4–0.8 Sec	0–2%	0%	8.8–20.7 Kbps	4.9–9.8 Kbps

The above performance figures translated to an average of 3 to 5 frames per second (best estimate by naked eye) and audio quality was comparable to a normal telephone call.

In measuring Internet video phone performance, it is important to remember how dependent performance is on traffic and network conditions on the Internet. The time of day, busyness of the Internet, and overburdened routers are all examples of conditions that can dramatically affect Internet video phone performance.

Refer to the next section, "Specifications of Test Internet Video Phone Calls" for local and remote video phone system configurations and exact details of the test conditions under which the test calls were made.

4.2.3.4 Specifications of Test Internet Video Phone Calls

Test Internet video phone calls on the Create and Share Pack Video Phone were made from Santa Clara, CA to Hillsboro, OR at various times during the day on August 14 and 15, 1997. Both callers connected through local ISPs in their respective areas.

The smoother-video/clearer-image setting on the video phone was set to the default value when the application was started up.

Local Setup:

Location: Santa Clara, CA
Area code and prefix: 408-653-XXXX
Internet Service Provider: Concentric Network
Connection speed: 28.8 Kbps
System configuration: See "System Configuration" section above.

Remote Setup:

Location: Hillsboro, OR
Area code and prefix: 503-264-XXXX
Internet Service Provider: Easy Street
Connection speed: 31.2 Kbps
System configuration:

- Intel Pentium II processor 266 MHz
- Intel PD440FX motherboard
  - On-board audio with Yamaha OPL3-Sax sound system
  - 512K pipeline burst cache
- ATI All-in-Wonder* Video Card (2 MB SGRAM)
- 32 MB SDRAM
- Intel Smart Video Recorder III with Intel M1 Analog Camera
- Lucent Technology Win Modem 33.6
- Western Digital 32500 2.5 GB hard drive
- Microsoft Windows 95 OSR 2.1
- 17 inch monitor
- Labtec PC speakers and Telex microphone
- Generic PS-2 mouse and keyboard

4.2.3.4.1 Typical Path of Data Packets (CA to OR)[2]

```
Tracing route to dial-0053.easystreet.com [206.103.35.53] over a maximum of
30 hops:

1 125 ms 125 ms 123 ms ts022e01.cup-ca.concentric.net [209.31.13.4]
2 120 ms 130 ms 130 ms rt001e0104.cup-ca.concentric.net [209.31.13.1]
3 123 ms 123 ms 130 ms rt002f1101.cup-ca.concentric.net [206.83.90.66]
4 189 ms 192 ms 192 ms bordercore4-hssi1-0.SanFrancisco.mci.net [166.48.19.253]
5 205 ms 198 ms 192 ms core1.Seattle.mci.net [204.70.4.165]
6 205 ms 198 ms 199 ms border4-fddi-0.Seattle.mci.net [204.70.3.147]
7 199 ms 202 ms 206 ms easy-street-online.Seattle.mci.net [204.70.55.18]
8 233 ms 213 ms 206 ms cs01-pdx.easystreet.com [206.26.36.62]
9 333 ms 439 ms 343 ms dial-0053.easystreet.com [206.103.35.53]


Trace complete.
```

4.2.3.4.2 Typical Path of Data Packets (OR to CA)[3]

```
Tracing route to ts031d18.cup-ca.concentric.net [209.31.14.30] over a maximum of
30 hops:

1 153 ms 152 ms 157 ms cs04-pdx.easystreet.com [206.26.36.59]
2 260 ms 164 ms 157 ms e11-pdx01-gw.easystreet.com [206.26.36.33]
3 185 ms 164 ms 178 ms border4-serial2-2.Seattle.mci.net [204.70.55.17]
4 281 ms 329 ms 397 ms core1-fddi-1.Seattle.mci.net [204.70.3.145]
5 498 ms * 270 ms bordercore2-loopback.WillowSprings.mci.net [166.48.22.1]
6 220 ms 247 ms 226 ms concentric-network-c.WillowSprings.mci.net [166.48.23.250]
7 229 ms 233 ms 233 ms concentric-network.SanFrancisco.mci.net [166.48.19.254]
8 243 ms 233 ms 274 ms 206.83.90.70
9 237 ms 268 ms 243 ms ts031e01.cup-ca.concentric.net [209.31.14.3]
10 436 ms 404 ms 411 ms ts031d18.cup-ca.concentric.net [209.31.14.30]


Trace complete.
```

---

[2] Typical path taken by data packets determined with “tracert xxx.xxx.xxx.xxx” command in Windows 95 where the x’s indicate the IP address of the remote user.

[3] Refer to Footnote #2.

4.3 Platform C: PC Imaging

4.3.1 OVERVIEW

The evaluation was performed on two scanners at opposite ends of the typical consumer price range. This section covers the implementation and performance issues associated with the two scanners.

4.3.2 FEATURES

The high-end scanner used in the evaluation was the UMAX Astra 1200S. The Astra 1200S is a flatbed scanner with an optical resolution of 600x1200 dpi and an interpolated resolution of 9600x9600 dpi. This 30-bit scanner features Bit Enhancement Technology (BET). BET is a technology which can improve the accuracy of scanned images. The Astra 1200S has a scanning area of 8.5" x 14". It connects to the computer via a SCSI II adapter which is included with the package.

The entry-class scanner used in the evaluation was the Logitech Scanman 2000. The Scanman 2000 is a handheld scanner with an optical resolution of 400 dpi and a bit depth of 24. It connects to the computer via the parallel port. A port splitter is included with the package so that the parallel port may be shared with any other device having a parallel port connection. The Scanman 2000 features a parallel set of rubber wheels to allow for straight scanning. The included software contains the AutoStitch feature which can automatically stitch the individual strips of the scanned image. Table 10 summarizes the features of each scanner.

Table 10. Comparison of Features

	UMAX Astra 1200S	Logitech Scanman 2000
Optical Resolution	600 x 1200 dpi	400 dpi
Interpolated Resolution	9600 x 9600 dpi	N/A
Bit Depth	30 bits	24 bits
Dynamic Rang	2.8	N/A
Connection	SCSI II	Parallel port
Scanning Area	8.5" x 14"	Unlimited
Misc. Features	Bit enhancement	Straight scanning AutoStitch Parallel port sharing

4.3.3 SYSTEM REQUIREMENTS

The minimum requirements for integrating the two types of scanners are:

- 8 MB of RAM
- Windows 95, 3.1, NT, or Workgroups operating system

4.3.4 SCANNER EVALUATION

This section covers the installation of the Astra 1200S and the Scanman 2000 on an actual system. It lists the system configuration, implementation issues encountered while installing the scanners, and performance data from OCR and resolution tests.

4.3.4.1 System Configuration

The scanners were installed on a system with the following configuration:

- Intel Pentium processor with MMX technology 233 MHz
- Intel evaluation motherboard with 430TX chipset
  - 512K pipeline burst cache
- 32 MB SDRAM
- Quantum Fireball ST6.4A 6.0 GB hard drive
- Pioneer DR-A12X CD-ROM
- Microsoft Windows 95 OSR 2.1
- Generic SVGA monitor
- Generic 3.5 inch floppy drive
- Generic PS-2 mouse and keyboard

4.3.4.2 Implementation Issues

Integrating scanners is a very simple and quick procedure. The Scanman 2000 easily fits into the parallel port and it is ready to scan once the drivers are installed. The Astra 1200S plugs into a SCSI adapter which must be inserted into one of the available ISA slots. For both scanners, a color calibration is required. The respective packages provide a piece of paper which must be scanned to calibrate the scanner. This will ensure that the scanner accurately depicts the scanned images.

4.3.4.3 Performance of Test Scans

In order to benchmark the scanners, Optical Character Recognition (OCR) and resolution tests were performed.

4.3.4.3.1 Optical Character Recognition (OCR) Tests

OCR software relies on the quality of the scanned image to produce accurate conversions to text. Different font types and sizes were scanned. The following tables present the results of the OCR tests. The percent of accuracy was determined by counting the number of incorrectly recognized words and spaces.

In Table 11, the OCR results on the regular Times New Roman font demonstrates that the Astra 1200S performs better than the Scanman 2000. However, since the percent accuracy for all sizes are very high for both scanners, the difference between high-end and entry-class is negligible for the average user.

Table 11. Times New Roman Font, Regular

UMAX Astra 1200S		Logitech Scanman 2000	
Font Size	**Accuracy (%)**	**Font Size**	**Accuracy (%)**
6 point	99.7	6 point	96.9
8 point	100	8 point	96.9
10 point	100	10 point	97.9

With the italicized Times New Roman font, the general remark is that italics do not get recognized as well as regular font. In practice, the OCR results are a function of the scanner's quality as well the quality of the OCR software. For the 8- and 10-point results in Table 12, the

Scanman 2000 actually performs better than the Astra 1200S. This is probably because the OCR software that came with the Scanman 2000 is better equipped to handle italics than the Astra 1200S OCR software. For the 6-point result, however, the Scanman 2000 does not perform better because the quality of the scanned image at such a small font size becomes the greater factor in determining OCR performance.

Table 12. Times New Roman Font, Italic

UMAX Astra 1200S		Logitech Scanman 2000	
Font Size	**Accuracy (%)**	**Font Size**	**Accuracy (%)**
6 point	88.5	6 point	75.1
8 point	91.0	8 point	97.2
10 point	93.1	10 point	97.4

Table 13 shows that the results are high enough that the difference between high-end and entry-class is negligible for the average user.

Table 13. Miscellaneous Fonts at 10 Point

UMAX Astra 1200S		Logitech Scanman 2000	
Font Type	**Accuracy (%)**	**Font Type**	**Accuracy (%)**
Courier, regular	100	Courier, regular	100
Courier, italics	99.7	Courier, italics	100
Arial, regular	100	Arial, regular	100
Arial, italics	99.2	Arial, italics	99.7

Different paper quality and shadings were also tested. Specifically, newspapers were used to characterize the scanner's performance on low quality paper. The Astra 1200S was 98.5% accurate and the Scanman 2000 was 96.9% accurate. In addition, text with varying degrees of background shading were scanned to determine at which point the OCR software could no longer recognize the text. In both cases, the OCR software could not recognize beyond a 10% shading.

4.3.4.3.2 Resolution Tests

The resolution tests were performed on a $20 bill because of the its extremely high resolution print. In fact, the words "THE UNITED STATES OF AMERICA" are microprinted around the oval frame containing the picture of President Andrew Jackson. The images presented below clearly demonstrate the difference between the Astra 1200S and the Scanman 2000.

Figure 1 was scanned at 400 dpi with 24 bits of color using the Scanman 2000. Figure 2 and Figure 3 were both scanned at 600 dpi; however, Figure 2 is 24-bit and Figure 3 is 30-bit. The difference between the Scanman 2000 and the Astra 1200S is shown to be significant when zoomed in to such levels of detail. Also, the color is more accurately represented with the Astra 1200S. The difference between the 24-bit and 30-bit scan is very subtle, however.

Figure 1. Scanman 2000, 400 dpi, 24-bit Portrait[4]

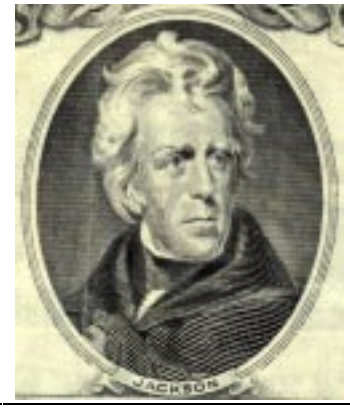

Figure 2. Astra 1200S, 600 dpi, 24-bit Portrait[7]

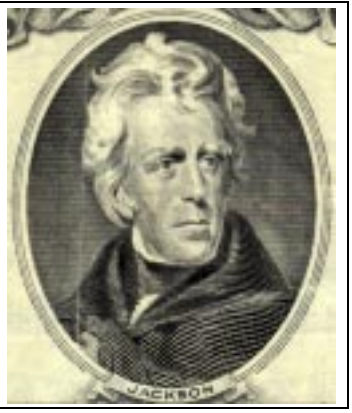

Figure 3. Astra 1200S, 600 dpi, 30-bit Portrait[7]

Figures 4, 5, and 6 were obtained by zooming in to the microprint from Figures 1, 2, and 3, respectively. These two images again demonstrate the significant difference between the quality of the Scanman 2000 and the Astra 1200S. While Figure 4 is blocky and unreadable, Figure 5 is much less blocky and actually readable. The difference between the 24-bit image of Figure 5 and the 30-bit image of Figure 6 is more noticeable here.

Figure 4. Scanman 2000, 400 dpi, 24-bit Microprint[7]

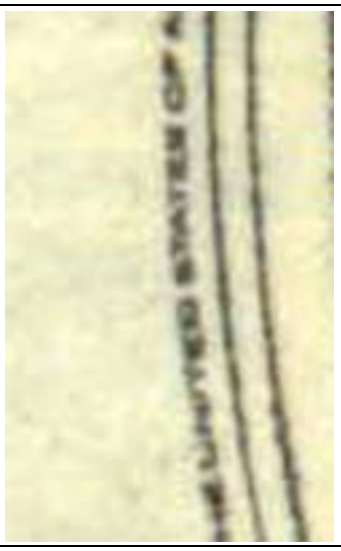

Figure 5. Astra 1200S, 600 dpi, 24-bit Microprint[7]

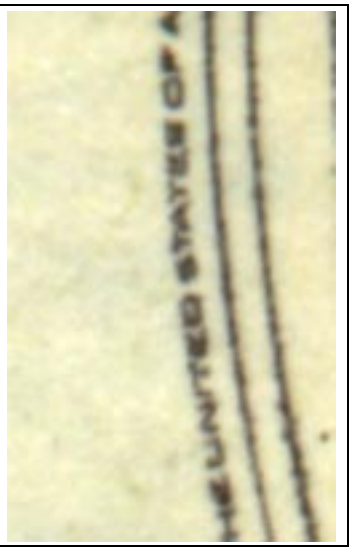

Figure 6. Astra 1200S, 600 dpi, 30-bit Microprint[7]

The enhancements of interpolated resolution are displayed in Figure 7 and Figure 8. The 9600-dpi interpolated image of Figure 7 is much smoother than the raw 600-dpi image of Figure 5. However, the difference between the 24-bit image in Figure 6 and the 30-bit image in Figure 8 is shown to be subtle.

[4] Printing or facsimile of currency may be subject to regulation by the issuing country.

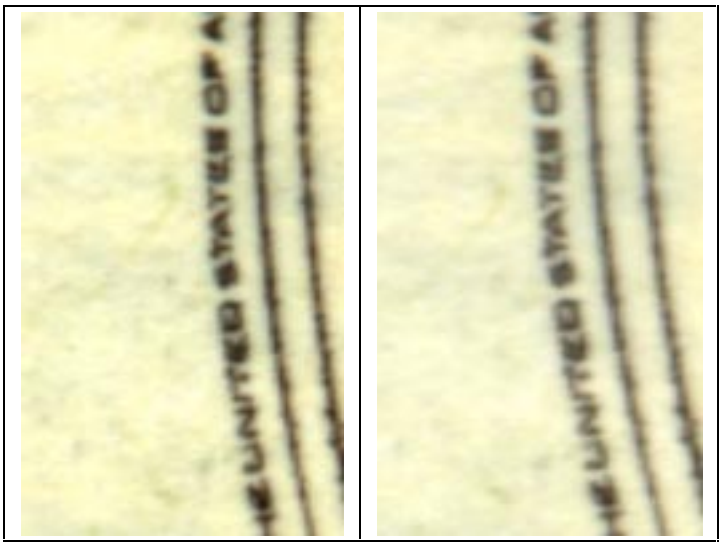

Figure 7. Astra 1200S, 9600 dpi, 24-bit Microprint[7]

Figure 8. Astra 1200S, 9600 dpi, 30-bit Microprint[7]

Adobe Photodeluxe* is an imaging software included with most scanner packages. Once the image is scanned into the computer, Photodeluxe can use its powerful filters to modify and enhance the image. The following graph illustrates how Intel's MMX technology can greatly improve speed performance on the MMX technology-optimized Photodeluxe.

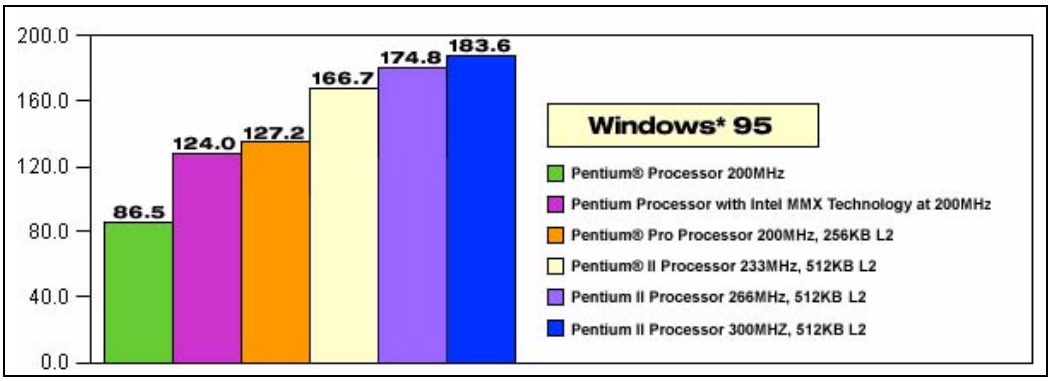

Figure 9. Adobe Photodeluxe* Performance Comparisons
(Benchmark contains Intel MMX™ technology code.)

4.3.4.4 Conditions of Test Scans

All the tests were performed with a standardized method. The specimens used in the first set of OCR tests were printouts on clean white sheets of paper printed from Microsoft Word on an HP LaserJet 4 printer. None of the fonts used were bolded. Both of the scanners were calibrated using the calibration sheet provided by the respective vendor. Since typical OCR software can handle only black and white images, the scans were conducted in black and white mode. With the exception of resolution, all other settings were kept at their default values. The OCR software used were the ones which came with the respective packages. Specifically, Presto Page Manager* came with the UMAX package and Xerox Text Bridge* came with the Logitech package. The percent of accuracy of the OCR results was determined by counting the number of incorrectly recognized words and spaces. The specimen used contained approximately 390 words and spaces.

The Astra 1200S scan was made under the maximum optical resolution of 600 dpi. The Scanman 2000 scan was made at its maximum optical resolution of 400 dpi. Since the Scanman 2000 is handheld, care was taken to perform each scan slowly and without distortion. Since the text on the specimen was wider than the Scanman 2000 scanning head, the document was scanned in two separate strips and then automatically stitched together by the software provided.

All the resolution tests were performed on the same $20 bill. The bill was relatively new and crisp. Both scanners were set to RGB color mode. The imaging software that came with the respective packages were used to conduct the scans. Specifically, Presto Page Manager was used with the Astra 1200S and Adobe Photodeluxe was used with the Scanman 2000. The Scanman 2000 test was conducted at the maximum resolution of 400 dpi. The Astra 1200S was varied from the maximum optical resolution of 600 dpi to the maximum interpolated resolution of 9600 dpi. Since Presto Page Manager was not capable of handling 30 bits of color, Adobe Photodeluxe was used to conduct the 30-bit scans.

4.4 Platform D: DVD/MPEG-2 Video Playback, Video Phone, and PC Imaging

4.4.1 EVALUATION OF INTEGRATED SYSTEM

The standard platform was integrated with the Intel Create and Share Pack Video Phone, the Diamond Maximum DVD Kit, the Zoran SoftDVD, the ATI Rage Pro, the UMAX Astra 1200S, and the Logitech Scanman 2000.

4.4.1.1 System Configuration

- Intel Pentium processor with MMX technology 233 MHz
- Intel evaluation motherboard with 430TX chipset
  - On-board audio with Yamaha OPL3-SAx sound system
  - 512K pipeline burst cache
- 32 MB SDRAM
- Intel Smart Video Recorder III with Intel C0 analog camera
- Lucent Technology Win Modem 33.6 Kbps
- Quantum Fireball ST6.4A 6.0 GB hard drive
- Microsoft Windows 95 OSR 2.1
- Pioneer DR-A12X CD-ROM
- Generic SVGA monitor
- Generic 3.5 inch floppy drive
- Generic PC speakers and Telex microphone
- Generic PS-2 mouse and keyboard

4.4.1.2 Performance of Integrated System

All the devices on the integrated system worked properly. The evaluation consisted of simultaneously running the Create and Share Video Phone, the UMAX Astra 1200S scanner, and each of the three DVD/MPEG-2 playback solutions.

Listed below are processor utilization data gathered when running multiple applications concurrently. Processor utilization was measured using Microsoft WinTop.

- When the video phone and the software/hardware or software-dedicated DVD playback are running together, the video phone consumes 30% of the processor time, while DVD playback consumes 70%.
- When the hardware-dedicated DVD playback is running simultaneously with the video phone, the DVD playback consumes 3% of the processor time while the video phone consumes 90%.
- When the scanner is running, it takes priority over all other tasks, including DVD playback, and utilizes 95% of the processor's time. Once the scanned data is transferred to the PC, the imaging software utilizes much less processor time. Scanning takes up a very heavy load because of the large quantity of data being transferred. Since the PCI bus cannot fully handle both the scanned data and the DVD data, one of the two must take precedence. In this case, the scanner takes precedence because scanning, in general, requires much less time than DVD/MPEG-2 playback.

This test system shows that integrating all the devices on a Pentium processor with MMX technology platform is certainly achievable; however, it is important to keep in mind that

simultaneously running all of them may cause the system to become unstable. Also, quality of all the applications degrades when all three are running at the same time. For instance, frame rate of the DVD playback when running video phone at the same time slows down to <1 frame per second. This is a result of too much data passing through the limited bandwidth of the PCI bus. Also, since both DVD playback and video phone both require the audio resources, conflict occurs and one will override the other depending on how the applications are written.

A potential implementation issue may arise if too many devices are integrated on the system. On a PC system, each device is assigned an interrupt address. In general, systems have four to five free interrupts available for use. If there are more devices than interrupts, some of the devices may not work. One method of overcoming this limitation is to daisy-chain devices when possible, so devices will share interrupts.

5. SUMMARY

In this document, new platform technologies were discussed, and sample platforms based on the Pentium processor with MMX technology were presented. This document addressed mainly the integration and performance issues associated with these platform technologies.

In the first half of this document, three key platform technologies were described: DVD/MPEG2 video playback, video phone, and PC imaging. For each technology, the background, implementation options, and performance trade-offs were discussed. With this generic information, system integrators should be able to educate their customers on these technologies and utilize/optimize them for the latest applications.

In the second half of the document, four sample platforms were presented. The first three reflect each of the three platform technologies introduced in the first half of the document. The last sample platform addresses the integration issues of all three technologies. In general, there are no major roadblocks to integrating any of these three platform technologies, but this document pointed out some possible performance/integration limiters that system integrators should avoid.