Technology Briefing

DVD Technology 2.

Take it from Toshiba

TOSHIBA

Layout and Design
gruppe eins · Cologne

Contents

Setting standards

DVD, a recent development in digital technology, will change the way movie and video information is stored and distributed. Known alternatively as Digital Versatile Disk or Digital Video Disk, it offers an application field that extends from Hollywood to Silicon Valley: DVD-Video for movies and DVD-ROM for computer applications. In fact, DVD has a tremendous role to play wherever digital technology rules. And nowadays, that means everywhere.

The computer world has a lot to do with numbers – a series of 0's and 1's known as the binary code. Information of any kind can be represented by the binary code. Hence, it forms the basis – or alphabet – for electronic computers. To understand fully what this means, it is important to look at the difference between analogue and digital.

The analogue world

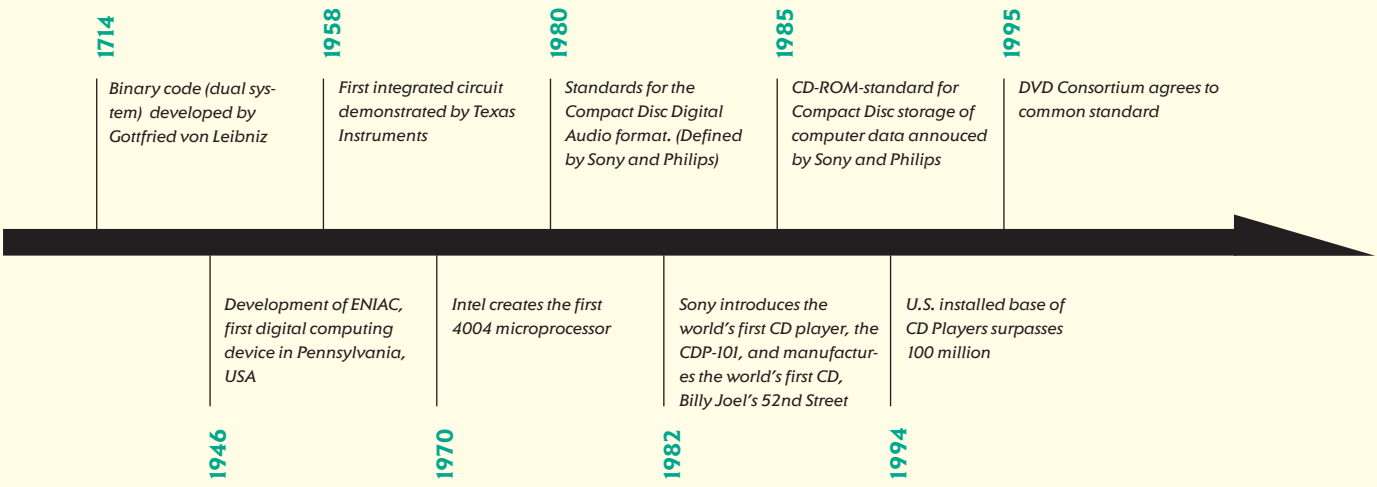
The analogue world is essentially comprised of continuous values. It is a world of air vibrations and light waves. Audio signals that come from nature are continuous signals, i.e. variations in air pressure. Colours are also continuous signals – changing colour hues. The colour of the sky, for example, is not blue or red, but more likely to have elements of both that change continuously.

In the past, analogue information has been stored on a variety of media – video and movies on film and videocassette tapes and music on audio tape and vinyl records. The media itself represents the original vibrations or impulses. On a record, surface changes in the groove represent the analogue information. When the record needle picks up the variations in the groove, it produces audio signals that are amplified into music or sound.

The digital world

The digital world is comprised of discrete values. These values are represented by the binary code, comprised of single "bit" values of "0" or "1". These bits are then combined in 8-digit "bytes" to represent information. The letter "A", for example, is represented by 01000001.

Digital information is created by converting analogue information into the binary code. The process is known as digitisation. Like analogue information, digital information can be stored on a variety of media – ranging from discs and hard drives to CDs and CD-ROMs. However, digital



information separates the contents from the media. That means that the information can be copied from one media to another without a loss in quality. Digital media usually does not involve degeneration – the process by which the media loses quality. A good example of this is a well-worn record and the effects that repeated playing has on sound quality.

Compact Disc

The development of the compact disc (CD) in 1980 was a significant development in digital technology. Defined by Sony and Philips, it was designed to address some of the problems of analogue music. CD had a new small shape – 120 mm in diameter and 1.2 mm thick. Its capacity of 74 minutes was revolutionary at the time and the music quality was superior to analogue records. Moreover, there is virtually no wear and tear to the media itself, which meant that consumers could keep their CDs for years.

With this new technology, audio data was recorded onto the disc in one long spiral. This spiral is comprised of indentations on the surface of the disc called pits. There are two sizes of pits – long and short – representing the binary code. A laser light reads the track of pits and interprets these signals into information, such as audio information, which can be amplified and processed as music.

The CD became the de facto standard in the music industry in less than 10 years. In 1985, a CD version for the computer world, known as CD-ROM, was also introduced. As a storage media, a single CD-ROM offered PC users an unheard of capacity of 650 MB, at a time when hard drives were barely storing 20 MB worth of data.

The development of DVD

In the early 1990s, different companies began working on a further development of CD technology – a disc of similar size but much greater capacity. The two forefathers to DVD were SD (Super density) disc from a consortium lead by Toshiba and Time Warner and MMCD (Multimedia CD) from a consortium lead by Sony and Philips. In developing a new standard, it was extremely important to satisfy the needs of both the computer and the movie industries. Both industries wanted a small disc solution that guaranteed CD compatibility.

Hollywood's wish list

For Hollywood, many factors were of importance, but the amount of capacity was the most significant. The film industry had its heart set on 135 minutes of storage, enough for a whole movie to be viewed without changing to a second disc. This capacity can also accommodate 94% of all movies made today. In addition, various features had to be included, such as superior picture quality comparable to laser discs, superior digital surround sound for dynamic ambience, and dubbing in at least three languages and subtitling in four. These requirements were quite natural, considering that so many movies, whether created in Hollywood or elsewhere, are aimed at the world-wide market.

DVD – more than just a standard for mass storage

DVD in combination with a widescreen television offers high quality home entertainment.

Computer industry

For the development of DVD, technical experts in the computer industry voiced certain demands.

Any new media should be compatible between TV and PC and backward compatible with CD-ROMs in order to protect consumer's assets. It should also use a simple file system for all disc types. There should be no need for a mandatory container such as a caddy or cartridge and the medium should be able to store and retrieve data reliably and accurately. This created a demand for a high-quality data correction system.

The DVD standard

In September 1995, all companies involved agreed to the common set of standards. The DVD consortium could thus avoid a replay of the VHS and Betamax battle that split the analogue video world in the early 1980s.

The results: DVD is one standard for all fields of application. It achieves backward read compatibility with existing compact discs without any significant increase in the cost of a DVD player or drive. Moreover, the DVD format has a single file system for all disc types.

Small media, big capacity

In the quest for fully-fledged multimedia, many companies have recognised the need for more storage capacity. The DVD disc is the fruit of that quest.

The idea behind DVD is simple enough and not that revolutionary – the storing of digitised video information in a consumer-friendly format. DVD has a two-fold meaning. On the one hand, it denotes the unified set of standards for next-generation high-density optical discs. On the other hand, the DVD discs themselves are the storage media.

A DVD disc looks like today's CD. It is a silvery platter, 12 cm in diameter, with a hole in the centre. Like a CD, data is recorded on the disc in a spiral trail of tiny pits, and the discs are read by means of a laser beam. Here is where the similarities essentially stop.

Types of discs

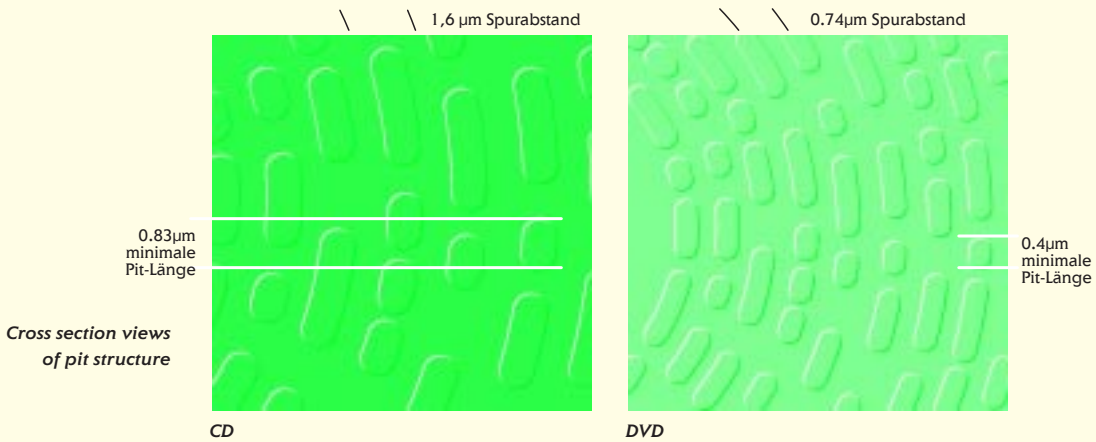
A DVD disc is comprised of two 0.6 mm discs bonded together. Each of these discs has two sides. It is possible to use both sides of a disc for storing information. DVD discs are thus available in four variations:

1. single-sided, single layer with 4.7 GB capacity
2. double-sided, single layer with 8.5 GB capacity
3. single-sided, double layer with 9.4 GB capacity
4. double-sided, double layer with 17 GB

Denser data

The increased capacity of DVD discs is, however, not only a result of more layers. The information on a DVD disc is recorded more densely than on a conventional CD. By narrowing the track pitch – the width of the track which contains the pits – it is possible to fit more data on the disc. In developing DVD technology, the track pitch could be reduced to 0.74 micrometres from 1.6 micrometres of a conventional CD – less than half the previous width.

Equally important was the shortening of the minimum pit length. On CDs, the minimum pit length is slight-



Cross section views of pit structure

ly more than 0.8 micrometres. On DVDs, it is 0.4 micrometres. In short, the three major developments for increasing data capacity are multi-layer capability, a narrower track width and a shorter pit.

Dual-layer structure

The dual-layer structure allows data to be recorded on 2 layers of each disk side. The uppermost layer is semi-transparent, allowing it and the lower fully reflective layer to be read using only one laser pickup. In order to read the lower layer the laser pickup is focused through the semi-transparent upper layer onto the lower layer. To read the data on the upper layer, the laser pickup is simply refocused once more onto the upper layer.

To achieve the maximum storage capacity, two dual layer discs are bonded together. Since both discs can store up to 8.5 GB, a total of 17 GB can be stored.

Dual lens system

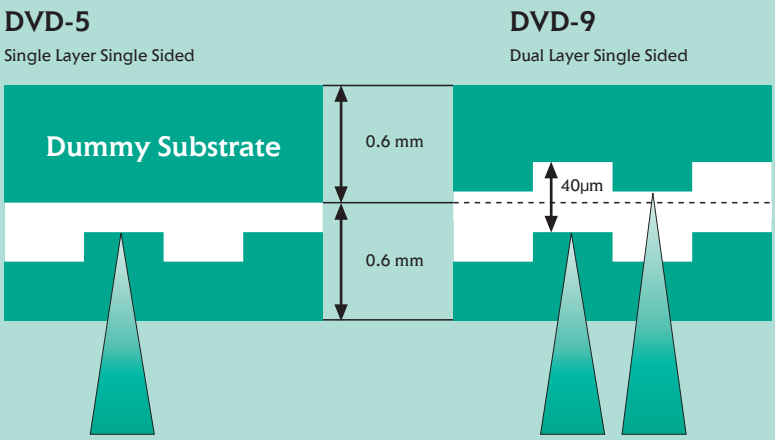
In order to read the tighter track widths on a DVD disc, lasers that produce a shorter wavelength beam of light are required. More accurate aiming and focusing mechanisms are also needed. DVD uses a red-light laser with a wavelength of 640 nanometres, that not only reads the pits but also guides the laser on the pitch track. Conventional CD technology utilises an infrared laser with a wavelength of 780 nanometres.

Backward compatability with CDs means that one device must read and interpret both CDs and DVD discs. In order to solve the problem of reading differing track widths and pit lengths, a dual lens system was developed. Different lenses must be used to achieve the optimum focus characteristics necessary for these different standards. The two lenses are rotated horizontally to read signals for each disc.

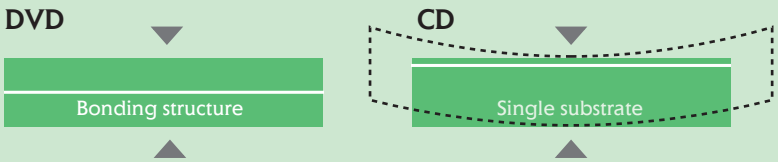
In fact, the focusing mechanism is the technology that allows data to be recorded on two layers. To read the second layer, the reader simply focuses the laser a little deeper into the disc, where the second layer of data is recorded.

Of course, all of this is done automatically when different disc are put in the drives or players. The whole system is electronically controlled for maximum precision.

Dual layer structure

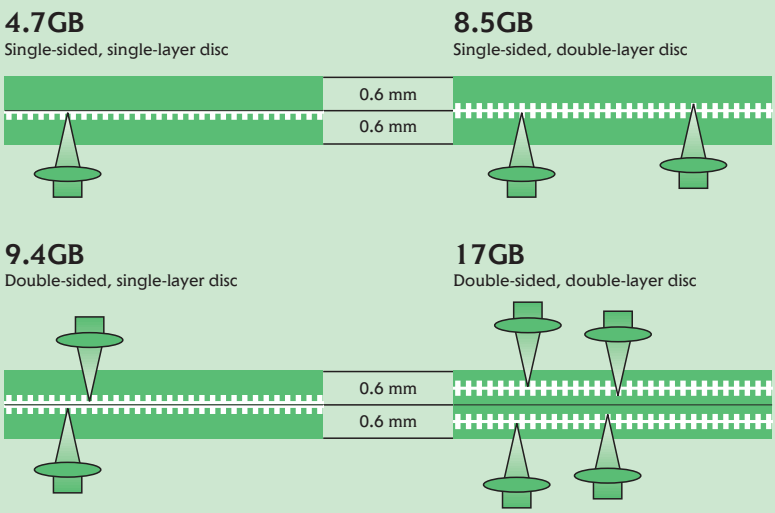


Temperature and humidity changes



DVD has a symmetrical structure which resists from warpage, because the discs are bonded together

Types of DVD discs



Creating an entirely new visual experience

In the initial phases of DVD market acceptance, two products – DVD-Video and DVD-ROM – will undoubtedly receive extra attention. DVD-Video promises to have a major impact on the home entertainment industry.

In terms of capacity, the 4.7 GB of just one side of a DVD-Video disc can store a 133-minute movie in studio quality. This is less than the 135 minutes originally requested by the movie industry. It is, however, enough capacity to store more than 92% of the movies on the market. Part of the DVD specification includes capacity for additional features, including dubbing in eight languages, subtitles in 32 languages and high-quality digital surround sound.

DVD offers an entirely new experience in visual entertainment. Thanks to the adoption of MPEG2 digital image compression technology, it is possible to achieve excellent picture quality comparable to that of a studio master tape. The most visual benefit of DVD is the multi-aspect feature, explained in more detail on the opposite page. Of course, in addition to superior picture and sound quality, various powerful ease of use functions can be implemented with DVD.

DVD player from Toshiba

The angle of your choice

Because a maximum of 9 different pictures recorded simultaneously by multiple cameras can be stored, viewers can select the angle they prefer when watching concerts, sport, movies or any other content. For example, it is possible to watch a rock concert that is edited just like a conventional video. A second time round, viewers might select the close-up of their favourite guitarist's hands, the performance of the drummer, or something else that is not usually displayed at length. If viewers are watching a play, a musical, a dance routine, or any other performance at the theatre, it is often difficult to take in everything that is happening on stage. That difficulty disappears with DVD because it is pos-

sible to switch back and forth between a panoramic view and various cuts.

Main story and sub-story

Many popular movies have sub-stories. Similarly, with DVD technology it is possible to have a multi-story capability.

For example, if the main character and a supporting character part ways in a movie and the story line continues to focus on the main character, an episode about the supporting character can be inserted. With DVD technology, story development can be selected in advance, or on a menu screen at key turning points.

Multiversion

If one movie has several versions, such as the theatre version, uncut version and director's cut, it is possible to store all these versions efficiently on a single disc. A DVD function allows viewers to select the version of their choice from the menu. The selected version is composed automatically by adding the different portions to the common portions and it is played back seamlessly. For movie enthusiasts, this means one disc contains every version of the film.

A DVD Video and storage case

Parental lock function

Parental Lock makes it possible to cut scenes which are deemed unsuitable for children, or to automatically replace them with other materials, and achieve seamless playback.

For example, especially violent or sexually explicit material can be replaced with scenes suitable for children, and which blend in as if they were the original materials. Because 8 different parental levels can be implemented, the rating systems of different countries can be accommodated. Which visuals are to be played back when Parental Lock is used is fixed on the disc.

When adults wish to view the original scenes it will be necessary to input a password, which can be set and changed from the player, on the setting screen.

Multi-aspect format

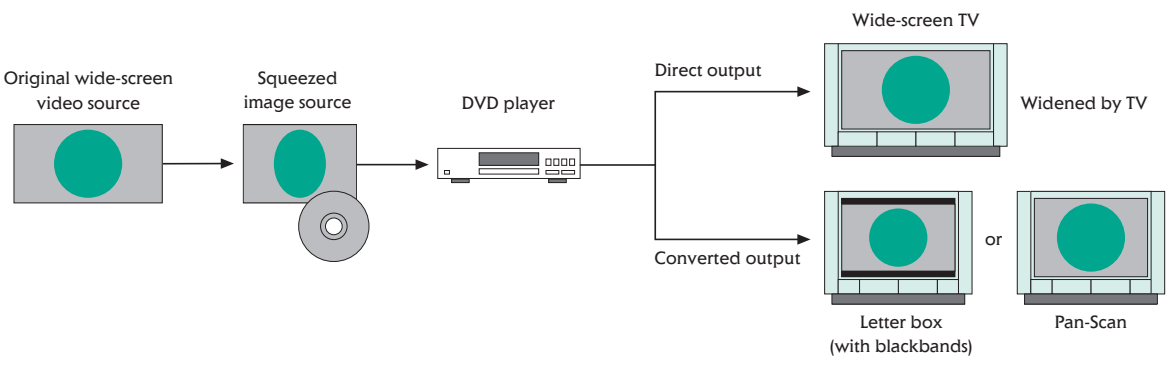
A standard TV usually supports a 4:3 aspect ratio. The aspect ratio is a comparison of the length and the height of the picture. A wide-screen television has a 16:9 aspect ratio, which is more common in cinema versions of movies. A single DVD disc can support both the 16:9 and the conventional 4:3 formats.

In converting a wide-aspect picture, the Squeeze system can be adopted to reduce the picture into a 4:3 aspect ratio by reducing the ratio horizontally.

But picture quality does not deteriorate when the movie is viewed on a wide-aspect TV, because the aspect ratio is restored to the original.

Thanks to adoption of the Squeeze system, wide-aspect pictures can be viewed with the original number of scanning lines.

The chart below shows that DVD can accommodate the different television formats: whether 4:3, 16:9 or Letterbox, which reduces the vertical size of the movie by using black bands on the top and bottom of the screen. This allows users to choose the aspect ratio that best fits their monitor and the video material.



DVD-ROM – More than just enormous data storage

DVD is the first standard designed specifically with the consumer and computer electronic industries in mind. Simply put, not only will consumers be able to enjoy the benefits and enhanced performance of DVD, but PC users can turn their PC into genuine multimedia machines.

The obvious advantage for PC users is the enormously increased capacity that DVD offers. The 4.7 GB capacity offers a great deal of flexibility. More storage-intensive graphics and video sequences can be incorporated into software applications.

For the computer world, the main type of DVD disc used is called the DVD-ROM. This is a read-only disc similar to the CD-ROM. In order to read DVD-ROM discs, PC users will also need a special DVD-ROM drive.

With this equipment, PC users can access any data in standard PC formats or even video in MPEG-1 format. But to take full advantage of the DVD standard, they will also need a MPEG-2 decoding card or expansion board. This is necessary for decoding video information compressed using MPEG-2 video compression.

A PC equipped with the necessary hardware and appropriate playback software can then read DVD-Video discs. Thus, PC users can take advantage of the consumer side of DVD.

With DVD, PCs become genuine multimedia machines

Cross-platform applications

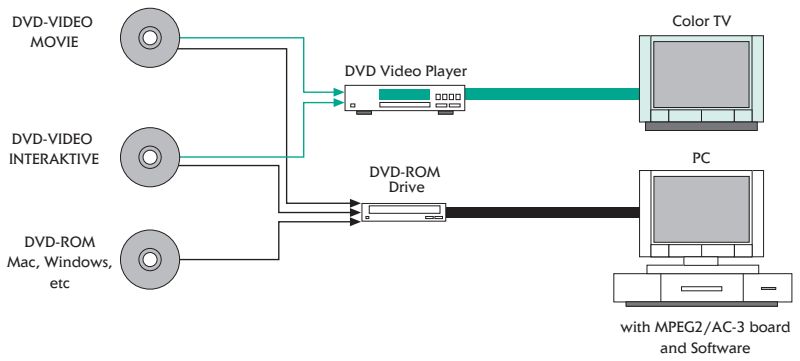
For computer applications, DVD greatly increases the range of possibilities. This includes new games with exceptional video quality, edutainment products (specialised programs designed for educational and entertainment purposes), software libraries, training programs, digitised photo collections and, of course, high-quality interactive encyclopaedias.

DVD-ROM offers much more than just an expansive mode of data storage. Many market experts predict that DVD-ROM will represent DVD's first major area of application. DVD is the realisation of genuine multimedia, which means it is possible to use a PC for cross-platform applications with a wide variety of audio and video material.

An example of a DVD-ROM read-only drive, the SD-M1002 from Toshiba

DVD-ROM drives

DVD-ROM drives are designed to read both CDs and DVD discs. The drives have seek times ranging from 150-200 ms, access time between 200 and 250 ms, and data transfer rates of



Standard file system

The DVD volume and file management architecture uses a UDF/UDF bridge. This allows movie discs to be read by a ROM drive, and a DVD player to read data stored on a rewritable disc.

In addition, the adoption of the Reed-Solomon Product Code, the new error correction scheme, ensures the high data reliability required for computing.

1.2 to 1.4 Mbps with burst transfer rates of up to 17 Mbps. This is the data equivalent of an 8x CD-ROM drive. DVD spin rates are about three times faster than those of single-speed CD-ROM drives. Hence, when reading CD-ROMs, DVD-ROM drives transfer data at 3x speed.

For PC users, upgrading to a DVD-ROM does not involve complicated installation procedures or exotic hardware. Connectivity is similar to CD-ROM drives. DVD-ROM drives are available with standard interfaces – EIDE (ATAPI) and SCSI-2. Audio connections allow playback of audio CDs. Of course, with the correct audio decoding equipment, a PC can produce DVD-audio quality sound. Notebook users can expect to see a mobile version of DVD-ROM drive in early 1998.

DVD-RAM is an efficient rewriteable medium for handling and storing any data that requires a large capacity, such as moving pictures. Because ultra-precise writing is necessary, even a fingerprint left on the disc's recording side before writing would change the optical intensity so that accurate writing could not be achieved. Therefore, a DVD-RAM (rewriteable) disc must be contained in a special cartridge. Although the DVD-RAM standard has been ratified and published by the DVD consortium, DVD-RAM drives will only appear on the market in early 1998.

DVD-RAM – for writing and deleting many times

Another DVD product for PCs is DVD-RAM. These discs and drives have a capacity of 2.6 GB that can be rewritten many times. It includes functions and applications similar to those of floppy discs or MO (magneto-optical) discs.

CD-ROM vs. DVD-ROM

	CD-ROM	DVD-ROM
Diameter	120 mm	120 mm
Thickness	1.2 mm	1.2 mm (0.6 mm per layer)
Track Pitch	1.6 micrometres	0.74 micrometres
Minimum pit length	0.83 micrometres	0.40 micrometres
Laser Wavelength	780 nanometre	640 nanometre
Data Capacity (per layer)	0.65 GB	4.7 GB
Layers	1	1, 2, or 4

A feast for your eyes

By combining the best of video compression technology with the latest in laser reading capability, DVD achieves excellent picture quality comparable to that of a studio master tape.

Although DVD takes advantage of a thinner disc structure and the denser pit structure in order to allow for increased data capacity, it is still not possible to store an entire movie on one side of a 12 cm DVD disc without powerful image-compression technology. Indeed, in its raw state digital video is so voluminous that a feature-length movie would require 40 DVDs at 4.7 billion bytes each.

Video compression

All video sequences are composed of frames. These frames are shown in a series to create the illusion of moving images. NTSC, the standard used throughout North America and Japan, runs at a rate of 30 frames per second. PAL, a common format in many parts of the world, runs at 25 frames per second (fps).

Video sequences are comprised of redundancies and repetition in the form of colours or backgrounds. These can be identified and encoded. Encoding systems recognise the elements that are repeated. The digital information is then recorded once and references are used to retrieve that information for other occurences.

The DVD specifications incorporate the MPEG2 digital image compression standard to encode and decode video sequences. An advantage of this is that a process called variable bit rate encoding allows higher data rates to be used for more complex video sequences. The average data rate for video on a DVD is approximately 3.5 million bits per second. Higher data rates result in higher picture quality.

MPEG-2 supports a resolution of 720 x 480 pixels and 25 or 30 fps, depending on whether the video format is NTSC or PAL. MPEG-2 achieves television broadcast quality at a compression rates of 30:1. A higher degree of compression is possible, but leads to inferior image quality. (Refer to the section “What is MPEG?”.)

Laserdiscs

Over the years, VCR video technology has improved considerably. Industry leaders have introduced equipment with improvements to image quality and functionality. In the early

Regional codes

Creating one global standard also involves commercial aspects. The motion picture industry does not release films simultaneously throughout the world. A movie may come out on video in the US when it is just beginning to reach European cinemas. Therefore, the movie industry required the DVD standard to include codes that can be used to prevent playback of certain discs in certain geographical regions. Players sold in each region will include a built-in code. The player will refuse to play discs that are not intended for that region.

Regional codes are optional and discs without codes will play on any player in any country. The world is divided into 6 regions: Players are identified by the region number superimposed on a map of the world.

If a disc plays in more than one region, it will have more than one number:

1 North America
2 Japan, Europe, Middle East, South Africa
3 Southeast Asia
4 Australia, New Zealand, Central/South America
5 Northwest Asia, North Africa
6 China

days of video another technology came onto the market: laserdiscs. With laserdisc technology the home video industry saw a major introduction of new technology. Laserdisc technology, although it offered improvements in sound and video quality, did not enjoy widespread popularity.

One of the reasons was its unusual size – laserdiscs measure 12 inches in diameter.

DVD – one step further

The development of DVD offers tremendous improvements on the laserdisc technology – in terms of capacity and video quality.

A clear advantage of DVD is capacity. A single-layer DVD disc can hold over 2 hours of high-quality video. Laserdiscs, which only store 1 hour of video information, still have to be flipped when viewing a feature-length film.

In terms of picture quality, the DVD standard again offers advantages over laserdiscs. DVD supports resolution of 720 x 480, compared to a resolution of approximately 567 x 480 supported by laserdiscs. Moreover, for horizontal resolutions, DVD supports roughly 540 lines, laserdisc 425 and standard VHS only 240.

What is MPEG?

MPEG is the acronym for Motion Picture Expert Group. This body of people,which operates under the auspices of the International Standards Organisation, sets standards for digital video and audio compression.

In particular, MPEG standards define a compressed bit stream, which implicitly defines a decompressor. The compression algorithms, however, are up to the individual manufacturers, which is where proprietary advantage is obtained within the scope of a publicly available international standard.

MPEG-1 is a small-picture format mode offering a resolution of 352 x 240 pixels and operating at a rate of 30 frames per second with CD-quality audio.

MPEG-2 operates at a resolution of 720 x 480 pixels. It encompasses several compression ratios. MPEG-1 achieves television broadcast quality at a compression rate of 30:1. MPEG-2 supports compression ratios of as much as 200:1.

With respect to audio quality, the MPEG-1 specification supports two simultaneous channels of sound, while MPEG-2 support multichannels discrete sound signals, comprised of seven separate channels.

Laserdisc suffers from degradation that is inherent in analogue media and in the composite NTSC or PAL video signal.

DVD also provides better audio playback. The standard calls for the integration of fully digital surround sound. Laserdisc, which supports 2 sound tracks – analogue and digital, can achieve surround sound, but must use both channels. This presents a capacity problem and does not leave space on the laserdisc for multiple language or subtitle channels.

Chart comparing Laserdisc and DVD

	Laserdisc	DVD
Size	30 cm	12 cm
Video capacity	60 min (NTSC)	133 min
	64 min (PAL)	
Audio capacity	2 tracks	8 tracks
Audio quality	16 bits at 44 kHz	16, 20 or 24 bits at
		48 or 96 kHz
Video Resolution	567 x 480	720 X 480

Just like in a studio

The excellent video quality of DVD overshadows the equally brilliant sound quality. To many, the audio aspects of DVD get less attention than they deserve. Not only the abundance of audio – in terms of capacity – but also the quality of the sound are of special interest. DVD does not compromise on either capacity or quality.

The DVD consortium has yet to ratify the exact specifications for DVD audio. But the capacity and quality incorporated into the DVD video standard give a clear indication of the coming standard.

Audio information, like video information, can be compressed. Uncompressed digital channels, known as PCM channels, follow the same specifications of today's audio CDs. A sample rate of 44.1 kHz and 16 bits per channel is achieved. A single-sided, single layer DVD disc can store up to 7 times the amount of conventional CDs using the same encoding method. That means roughly 9 hours of music or audio.

That same disc with one surround sound audio stream of MPEG-compressed audio information could accommodate theoretically over 55 hours of music.

Multi-channel sound

DVD-Video has eight sound streams, which means that there are eight routes for digital sounds. It is important to distinguish between a sound stream and a channel. For example, each of the eight streams can carry a full surround sound digital channel. The first stream could be in English, the second in French, the third in Japanese, and so on.

Efficient utilisation of sound streams is the key to making the best use of the disc capacity. The 8-stream capability makes various applications possible, such as dubbing in multiple languages, excellent audio performance, visuals accompanied by the producer's commentary, and storage

DVD Audio, a coming standard, can store up to 7 conventional CDs

of soundtracks. It is possible to switch instantly from stream to stream via the remote control.

Different audio standards

There are two main audio standards for DVD. MPEG2 audio is the standard for audio compression technology. Based on MPEG1, which uses 2 channels, MPEG2 enables a maximum of 7.1 channels of digital surround sound. This means that seven discrete channels are available for storage and playback of sound. They consist of five front channels (LL, LC, CC, RC and RR from left to right) and two rear channels (LS and RS) These channels plus the sub-woofer for heavy bass add up to a total of 7.1 channels.

The second audio standard is Dolby Digital™ (AC-3). This is a 5.1-channel system. It consists of 5-channel surround sound – three front channels and two rear channels – and a sub-woofer bass channel. It is necessary to connect a Dolby digital decoding unit and amplifier and speaker system to a DVD player's digital audio terminals. Without this arrangement, when a DVD player is connected to a stereo system or a TV through its analogue audio terminals, 5.1 channel sound is downmixed to 2-channel stereo with the Dolby Prologic information – this provides backwards compatibility with existing widespread systems used in current home entertainment systems. Downmixing divides the surround sound without losing any information, thereby achieving high-quality audio.

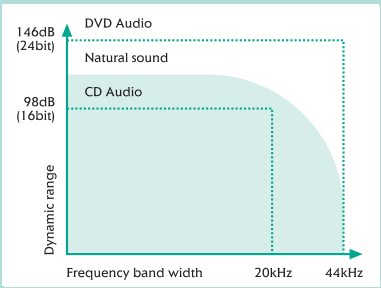
Range of sound

To achieve excellent sound quality, the range of sound is very important. A normal audio CD provides audio sampling at a frequency of 44.1 kHz at 16 bit. DVD supports a sound range from 16-bit/48 kHz stereo sound through 20-bit and 24-bit/48 kHz, to 16-bit, 20-bit, and 24-bit/96 kHz super audio.

Making super digital sound a reality

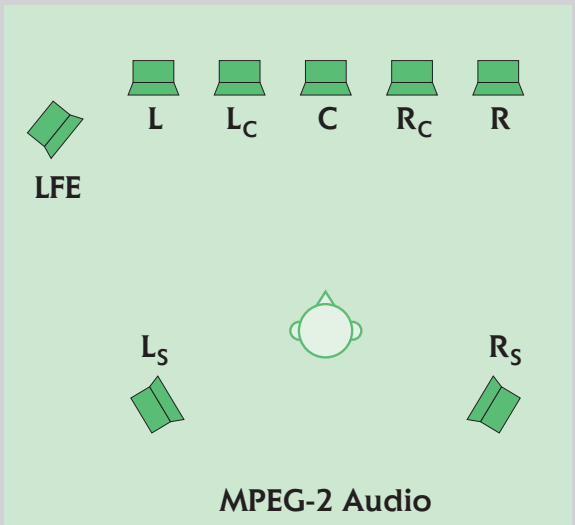
DVD allows a sampling frequency of 96 kHz and a high 24-bit sample, producing super-high-fidelity digital audio recording. CD in comparison only allows a frequency of 44.1 kHz and 16-bit sampling.

Moreover, DVD permits audio recording on a maximum of eight channels each at 48 kHz/16-bit sampling, equivalent to CD audio quality.

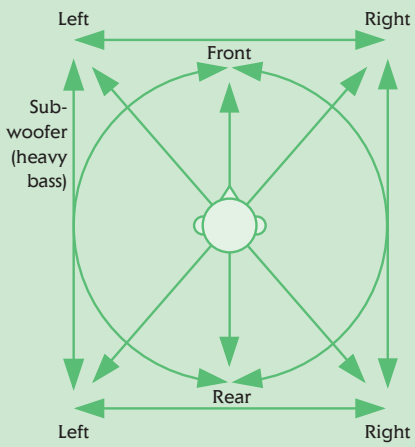


Data recorded at levels other than 16-bit/48 kHz is converted to that level when played back on a regular DVD player.

Digital audio standards



MPEG-2 Audio



Dolby AC-3

DVD – tomorrow's standard

Enthusiastic supporters of DVD see many advantages in this new medium. They also see many factors ensuring the successful proliferation of DVD technology by the turn of the century.

The obvious technical advantages of DVD are enhanced video performance and improved audio output. Combined with the added user-friendly features outlined in the section "The main features of DVD-Video", it is clear that it is not a question of whether the market accepts DVD, but more a question of when. For many experts, DVD will be to the VHS tape what the CD was to the long-playing analogue record.

As a storage medium DVD also offers significant advantages over other methods of storage. Physical storage capacity is its main feature. A dual-layer, double-sided DVD disc can store close to 17 GBytes. That corresponds to 8 hours of studio-quality video, 26 audio CDs or, to put it more graphically, a stack of double-spaced typewritten pages 1.4 kilometres high!

CD production line

It's digital

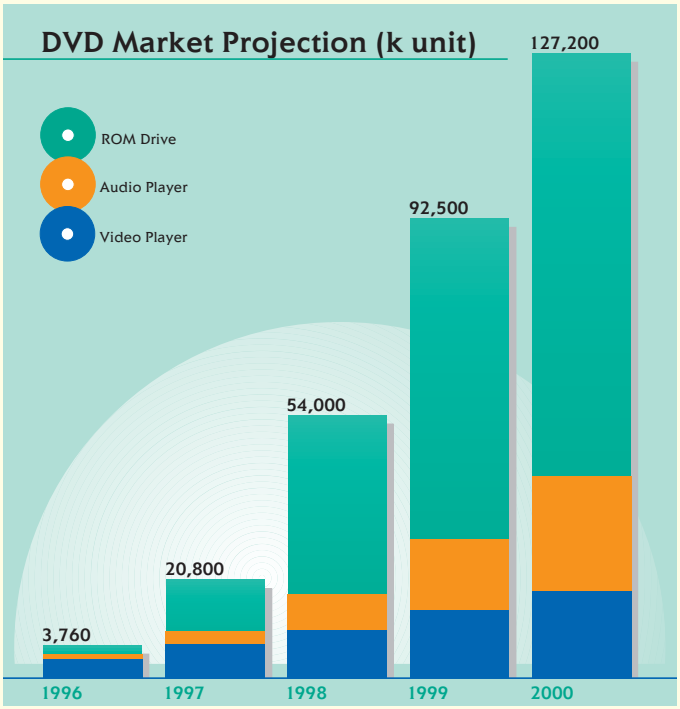
DVD – whether DVD-Video or DVD-ROM – is a digital media. Users can copy and process the information with relative ease. Moreover, it means little to no degeneration – unlike as experienced with well-worn VHS tapes or long-playing records. Consumers are ensured of a high degree of investment protection. A DVD disc bought today will maintain its high quality for years to come.

Similar manufacturing

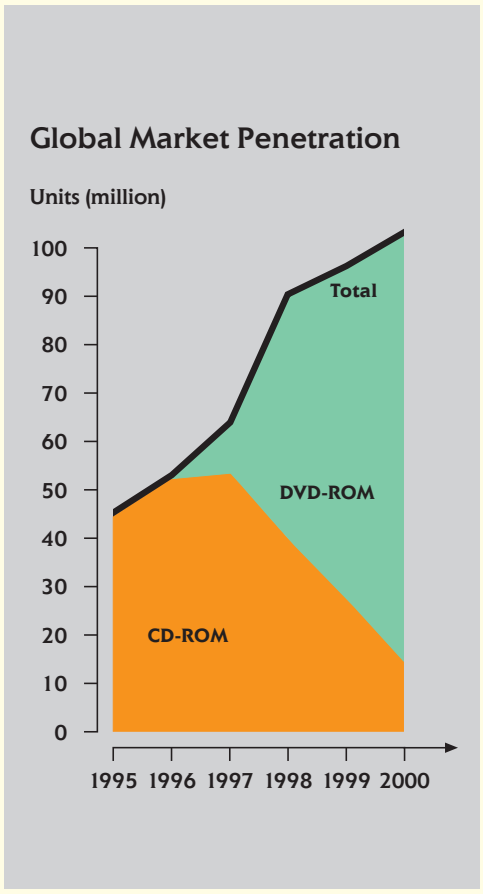
The production of DVDs is slightly different from CD production, but similar enough to allow for an easy transition. There is a one-time investment cost for retooling production lines to produce DVD, but since a CD production line can be easily converted to produce DVD, there is no large financial impediment or risk involved in switching over. The costs involved in actual media production will be slightly higher than current CD levels, but not comparable to the cost structures experienced in the early 80s with CDs and late 1980s with CD-ROMs. It is important to note that actual CD media production costs account for only a fraction of the total costs. Licensing fees, copyright and content costs, etc., comprise the bulk of CD costs. With increasing market acceptance, DVD will see a cost and price structure that is all but identical to CDs.

Market acceptance

With the introduction of CDs and CD-ROMs, it took some time for consumers and PC users to adjust to the new standard and to buy the corresponding equipment. With DVD, this initial introductory period will be shorter. The standard does not re-



quire in-depth consumer education, since most people are familiar with CD technology. DVD, given its familiar shape and size, will not surprise consumers or PC users. Given that DVD players are backward compatible with CD technology and can play conventional CDs, consumers are guaranteed continued enjoyment of existing CD collections.



Developing the home market

By the end of 1997, market experts predict that there will be over 600 DVD-Video titles, with more than 8,000 titles by 2000. Compared to the VHS market-place, these numbers are not that impressive. There are currently about 80 million VCRs in the USA and about 250 million throughout the world. The number of VHS titles is almost limitless.

Clearly, consumers will not be getting rid of VCRs just yet. DVD players will not be recording directly from television for some time. In addition, given the quality advantages, there are concerns about copyrights and illegal copying.

The future

It is important to see how DVD fits into the existing market-place. For purposes of comparison, there are about 600 million audio CD players and 100 million CD-ROM drives worldwide. These figures make it clear clear why backward compatability was a must as far as DVD technology is concerned.

Toshiba experts predict a market penetration of 100 million DVD-ROM drives by the turn of the century. At that time, there is speculation whether the company will also stop producing CD-ROM drives. One thing is certainly clear, DVD will replace CD technology.

The market place also provides a clear indication of the advent of DVD technology. There are currently over 30 major companies, covering the entire computer industry, involved in developing products for DVD technology. These include DVD-ROM drives, decoder chips, playback software and DVD-accelerated audio/video cards.

Who owns DVD

No one really owns DVD. It is a standard that has been approved by a consortium of ten companies. However, from the original concept to this year's product launch Toshiba has been at the centre of DVD developments. Toshiba led both the original DVD alliance (known as SD Disk) and the efforts that resulted in a single, multi-industry-spanning, unified DVD. And Toshiba remains a leader of the present DVD Consortium.

Proof of Toshiba's commitment lies in the fact that 80% of DVD patents are held by Toshiba, including key DVD technologies such as the bonded disc design, chips designs for sound and video decoding, as well as embedded playback control. Moreover, Toshiba's early recognition that Hollywood's film studios had to support DVD ensured that unique features that allow for parental control, multi-camera angles, and multiple story lines, were also integrated into the DVD standard.

Glossary

Aspect Ratios
Aspect ratio refers to the ratio of width to height of a television set. Traditional television sets have a 4:3 aspect ratio. Widescreen television sets have a 16:9 aspect ratio. Traditional television sets are almost square in appearance; widescreen displays are more rectangular.

Decoding
This describes the process which decompresses encoded video and audio information. Separate decoding equipment is required for this process.

Consortium, DVD
This is a group of leading companies responsible for establishing and maintaining DVD standards. The consortium now comprises Hitachi, JVC, Matsushita, Mitsubishi, Philips, Pioneer, Sony, Thomson, Time Warner and Toshiba.

DVD-RAM
A rewriteable DVD disc, also as referred to as "erasable", is a media that allows rewriting many times.

DVD-ROM
This term refers to the use of DVD disc for data storage in the computer world.

DVD-Video
This is the term designated for video information stored on a DVD disc that is intended for playback on a consumer DVD player.

Encoding
A process by which redundant video information, elements that are the same or nearly so, is identified and removed. This can remove over 97 percent of the data required to represent the video without affecting image quality. DVD uses the MPEG-2 digital video encoding standard.

MPEG 1
MPEG-1 is a small-picture format mode offering a resolution of 352 x 240 pixels and operating at a rate of 30 frames per second with CD-quality audio.

MPEG2
MPEG-2 operates at a resolution of 720 x 480 pixels. It encompasseses several compression ratios.

NTSC
NTSC stands for National Television System Committee, which devised the NTSC television broadcast system in 1953. The NTSC standard has a fixed vertical resolution of 525 horizontal lines stacked on top of each other, with varying amounts of "lines" making up the horizontal resolution, depending on the electronics and formats involved. There are 59.94 fields displayed per second. A field is a set of even lines, or odd lines. The odd and even fields are displayed sequentially, thus interlacing the full frame. One full frame, therefore, is made of two interlaced fields, and is displayed about every 1/30 of a second.

PAL
PAL stands for Phase Alternation by Line, and was adopted in 1967. It has 625 horizontal lines making up the vertical resolution. 50 fields are displayed and interlaced per second, making for a 25 frame per second system. An advantage of this system is a more stable and consistent hue (tint).

Parental Control
This is a password-controlled function of DVD-Video that allows parents to control video playback. Scenes that are unsuitable for children viewing can be cut and replaced with other materials to achieve seamless playback.

Pit
The pit is the indention on the disc structure representing the digital binary code "0" and "1".

Surround Sound
Multiple channel sound system to produce an audio ambience similar to the cinema sound experience.

Track Pitch
The track pitch refers to the width of the data track which contains the data pits.

Universal Disk Format
The Universal Disk Format(tm), or UDF ™ specification defines data structures such as volumes, files, blocks, sectors, CRC's, paths, records, allocation tables, partitions, character sets, time stamps, etc.; and methods for reading, writing, and other operations. It is a very flexible, multi-platform, multi-application, multi-language, multi-user oriented format that has been adapted for DVD.

TEG June 1997 Art.-No. 2959095 E

Dealer Stamp

TOSHIBA

TOSHIBA EUROPE GMBH
Marketing Communications
Personal Computers Division Europe
Hammfelddamm 8
D-41460 Neuss, Germany

Telefon: +49/21 31/1 58-01
Telefax: +49/21 31/1 58-5 58
Internet:www.toshiba-teg.com