



DVD-ROM: Format & Applications

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Introduction

DVD technology was developed to provide an optical disc format with a much larger capacity than the CD, for a wide range of applications. Pre-recorded DVD discs provide capacities from 4.7 GB to 9.4 GB with 17.1 GB having limited availability. They are capable of supporting a wide range of applications, including DVD-Video, for full-length movies, and DVD-Audio, the very high quality multi-channel audio format.

The term DVD-ROM is used to define both the physical and logical format of pre-recorded DVD discs and also refers to the computer multimedia applications of DVD. DVD-ROM discs, as opposed to DVD-Video or DVD-Audio discs, are being used for games, encyclopaedias and other applications where the large size is needed. In addition DVD-Video and DVD-Audio discs often include a DVD-ROM section with data that runs on a PC, giving additional features such as Internet access.

DVD-ROM Requirements

The **Technical Working Group**, representing the computer industry, listed the following requirements for a DVD-ROM specification for multimedia, games and other computer applications.

- Single format for computer and TV-based applications
- Backward read compatibility with existing CD-ROMs
- Forward compatibility with future R/W and WORM discs
- A single file system for all content and disc media types
- Low cost drives and discs
- No mandatory container
- Reliable data storage and retrieval
- High on-line capacity
- High performance for sequential and non-sequential data

DVD-ROM drives and PCs with DVD capability are now widespread in the USA, Europe and Japan. Generally these also include MPEG-2 decoders either in hardware or software. They are then capable of playing DVD-Video discs as well as DVD-ROM applications.

DVD-ROM Specification

DVD-ROMs are like large CD-ROMs, capable of holding more data for a wide range of applications. Some applications include MPEG-2 video, as used on DVD-Video discs, to give added realism to games and richer content for multimedia applications.

The DVD-ROM specification is actually the physical specification for all DVD read-only discs together with the UDF file system. Like CD-ROM the DVD-ROM specification does not define how the user data is to be formatted and used. That is left to the application. In contrast the DVD-Video and DVD-Audio specifications define precisely how the data is formatted.

A DVD-ROM disc can be any of the physical DVD formats DVD-5, DVD-9, DVD-10 etc.

DVD-ROM vs CD-ROM

CD-ROM discs are specified in the *Yellow Book* and are based on the original *Red Book* Audio CD. A DVD-ROM provides at least 7 times the capacity so can store much more data for complex multimedia applications and games.

The table below gives a comparison of the major differences between a CD-ROM disc and DVD. Note that 1 GB = 1 billion bytes.

	DVD-5	DVD-9	CD-ROM
Capacity (GB)	4.7	8.5	0.7
File Structure used	UDF & ISO 9660		ISO 9660

DVD-ROM supports the application formats DVD-Video, DVD-Audio plus other formats which are not defined in the DVD Books. Unlike CDs, all DVD discs not only have identical physical formats but also use the same logical format and file system. All application data on the disc, whether video, audio, text, graphics or program data, are contained in files.

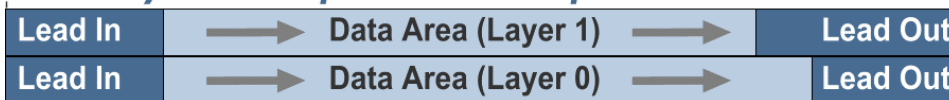
DVD-ROM Disc Layout

Dual layer (DVD-9) DVD-ROM discs will normally be organised as Parallel Track Path discs (see below), with the file system located on layer 0. The two layers therefore represent a single volume. For both single and dual layer discs the data will start at the ID.

Single layer disc



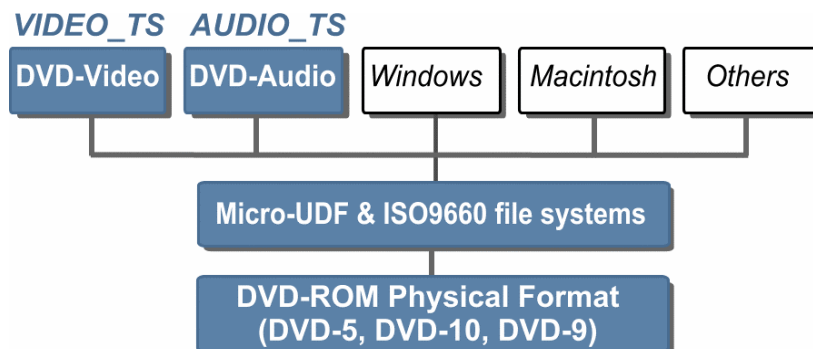
Dual layer disc - parallel track path



For DVD-10 discs the two sides represent two separate volumes.

Directory & File Structure

The following diagram shows the directory and file structure for a typical DVD disc with specified directories (VIDEO_TS and AUDIO_TS) for DVD-Video and DVD-Audio files (if present) and other directories (whose names are not specified in the DVD specifications) containing files for use on computers or games consoles.



- The Universal Disc Format (UDF) file system was developed to support re-writable as well as read-only media. It is the file system chosen for all DVD formats.
- ISO 9660 is included to provide backward compatibility with Windows 95, although Windows 98 supports UDF. MacOS 8.1 and above on DVD-enabled Macintosh computers also supports UDF.

DVD-Video and DVD-Audio players only read UDF, not ISO 9660.

Hybrid titles, with data for more than one application (eg DVD-Video plus a PC game) will include data in two or more of these directories.

DVD-ROM Applications

DVD-ROM applications can take advantage of the increased capacity of DVD discs and, optionally, make use of DVD-Video's high quality MPEG-2 video and multi-channel audio encoding. There is a wide range of applications for DVD-ROM including:

- Bigger and better games allowing current multi-disc CD-ROM games to be distributed on one DVD-ROM disc. DVD allows the content of six or more CD-ROM discs to be stored on a single disc.
- More extensive multimedia applications, such as encyclopaedias, with additional content including higher quality MPEG-2 video and surround sound audio.
- Very large databases and clip-art libraries.
- Hybrid DVD/online titles where the bulk of the data needed (such as video) is stored on the disc and updates are downloaded from the Internet. The Internet can also be used to pay for and unlock software contained on a DVD-ROM disc.
- Interactive DVD-Video titles, which will play on DVD-Video players with limited interactivity and on computers for full interactivity. These include movies with an associated game or multimedia content or web access, which can only be played on a PC or Macintosh.

DVD-ROM Hardware

DVD-ROM titles are designed to play on a specific platform eg PC or Macintosh. These platforms, with appropriate hardware/software, will also play DVD-Video and DVD-Audio discs.

- Most Pentium PCs can be upgraded by adding a DVD-ROM drive and hardware or, for faster processors, software MPEG-2 decoder in order to play DVD discs.
- The latest Apple Macintosh computers can provide DVD playback or can be upgraded with the external Apple DVD-Video kit.
- New Games consoles such as Sony's Playstation2, which incorporates a DVD drive and is capable of playing DVD-Video discs.
- Enhanced DVD-Video players can provide more interactive possibilities. The NUON processor, developed by VM Labs, is designed to turn the DVD-Video player into a multimedia computer, not only for playback of DVD-

Video discs but also high-performance video games, educational and reference applications, with highly sophisticated film quality 3-D graphics.

- New hardware such as Microsoft's X-box has DVD capability.

DVD-ROM Drives

DVD-ROM drives, like CD-ROM drives, are being developed with ever-increasing speeds. Early drives offered 2x speeds, while the latest drives now offer 16x speeds or more. These faster drives are not necessary for DVD-Video titles (which read data at 1x), but allow faster data transfer for multimedia and games applications.

Single speed DVD-ROM drives have a data transfer rate of approximately 11 Mb/s, which is equivalent to a 9x CD-ROM drive. A 5x drive can theoretically transfer data at 55 Mb/s, equivalent to a 45x CD-ROM data rate. However most 4x and faster DVD-ROM drives read CD-ROMs at 32x maximum. This is because a CD must spin faster than a DVD for the same data rate. For the above example, a 1x DVD spins at 3.49 m/s, while the 9x CD spins at 11.7 m/s.

The table below gives a comparison of the major differences between CD-ROM and DVD-ROM drives. Note that the linear velocity is lower for a DVD than for a CD at the same data rate. Unlike DVD-ROM drives, the highest speed CD-ROM drives are not true CLV (constant linear velocity) but the data rate increases from the ID to the OD, where the maximum data rate is achieved.

	DVD-5	DVD-9	CD-ROM
Capacity (GB)	4.7	8.5	0.7
Drive speed	10x		40x
Data transfer rate (Mb/s)	110		2.8 to 6
Linear velocity (m/s)	21	23	up to 52

MPEG-2 Decoders

An MPEG-2 decoder is needed to play DVD-Video titles plus any MPEG video contained on a DVD-ROM disc. Both hardware and software decoders are available.

- **Hardware** decoders allow a slow processor to be used. Many decoders include a video output, which allows your favourite movies to be watched on a TV instead of the computer monitor
- **Software** decoders require a faster processor (which all new PCs have) and a suitable graphics card, but offer a lower cost solution for new PCs.

DVD add-on kits usually comprise a DVD-ROM drive and MPEG-2 decoder board. Software to play DVD-Video discs is also included in the package. Normally this includes an on-screen controller to simulate the remote control of a DVD-Video player.

Microsoft Windows 98 & DirectShow

Microsoft has included DVD capability in Windows 98 (and Windows 2000) for DVD including:

- Reading data sectors from DVD-ROM drives and providing support for the DVD-ROM command set
- UDF file system support
- Support for streaming data such as MPEG-2 video and Dolby Digital audio
- **DirectShow** (formerly ActiveMovie), which improves compatibility by replacing the old MCI (Media Control Interface) with a new standard interface to play Video Object (VOB) files. VOB files contain the audio, video, subpictures, menus and navigation commands defined in the DVD-Video specification. DirectShow allows applications to control the playback of VOB files (including interpreting program instructions and user interactivity) and supports interlaced video and multi-channel audio
- **DirectDraw**, which supports the transfer of decoded video streams from an MPEG-2 decoder to the display card via dedicated buses
- Copy protection and region coding support for both software and hardware decoders to enable authentication between the decoder and the DVD-ROM drive for playing DVD-Video discs.

QuickTime

QuickTime 4 on both Macintosh and Windows platforms is capable of playing back MPEG-2 video including VOB files, using an existing MPEG-2 decoder.

Copy Protection

There is as yet no copy protection available for DVD-ROM discs, but a number of developments are under way. Some existing CD-ROM copy protection methods, such as SafeDisc from Macrovision, are being extended to DVD-ROM. These are intended to prevent the content of discs being copied, pirated or transferred to hard disk for use without the disc itself.

Compatibility Issues

DVD-ROM titles are, as yet, few in number compared with DVD-Video titles, despite the number of PCs with DVD-ROM drives exceeding the number of DVD-Video players in use. The reason is partly that while a DVD-Video player is purchased primarily or only to play DVD-Video discs, a DVD-ROM drive in a PC can be used to play DVD-Video and CD-ROM discs as well as DVD-ROMs.

Another reason is that there have been a number of compatibility problems with certain software/hardware configurations.

Reading Other Discs

All DVD-ROM drives will read all DVD pre-recorded discs (from 4.7 to 17.1 GB capacities), plus CD audio discs and CD-ROM discs. Some early DVD-ROM drives were not able to read CD-R discs, but most now will do so. MultiRead drives are capable of reading most discs, including CD-R and DVD-R. Only the latest DVD-ROM drives will read DVD-RAM and/or CD-RW discs.

The Optical Storage Technology Association has embarked on a programme to extend MultiRead capability to all CD and DVD formats including DVD-RAM and DVD-RW, so in future most drives should play all these formats.

The DVD Forum has announced DVD Multi, which "will set hardware specifications to enable disc compatibility for virtually all formats officially created by the DVD Forum, both for consumer electronics and personal computers."

DVD Multi specifications will ensure compatibility of the following products.

- For computers **DVD-ROM** drives will read DVD-Video and DVD-Audio discs (if they have the relevant decoders) plus DVD-ROM, DVD-RAM, DVD-RW and DVD-R discs.
- **DVD Recorders** attached to PCs will read all the above discs and write to DVD-RAM, DVD-RW and DVD-R discs.
- **DVD Multi Players** will be able to read the DVD-Video and/or DVD-Audio data recorded on DVD-Video, DVD-Audio, DVD-RAM, DVD-RW and DVD-R discs.

Producing DVD-ROM Titles

The production process comprises authoring, pre-mastering and manufacture. Multimedia titles for DVD-ROM can be created using similar tools to those used for CD-ROM titles such as Macromedia Director, Visual Basic or Visual C++. Where MPEG-2 video files are to be incorporated, DVD-Video authoring tools will also be required to encode the audio and video, add navigation and create the VOB files.

Premastering and Testing

The resulting files are then premastered using software that is designed to format the data using the UDF Bridge file system and according to the DVD specification. Where relevant, the DVD-Video, DVD-Audio and/or other files must be contained in the appropriate directories (as described above).

The pre-mastering process will result in a disc image, which can either be written to DLT with the appropriate DDP file, for glass mastering, or be used to write a DVD-R for testing purposes. However, DVD-9 format titles cannot be fully tested until a pressed disc is made.

Several CD-ROM premastering tools now also support DVD and will write data to DVD-R discs as well as CD-R. However there are few that will write to DLT and support DVD-9. One that will is Sonic Solutions' ROM Formatter, a low cost tool for formatting DVD-ROM content and writing to DLT.

Manufacturing DVD-ROM Discs

The manufacturing process is identical to that of a DVD-Video or DVD-Audio disc. The disc can be a DVD-5, DVD-10 or DVD-9 depending on the data size and whether a double-sided disc is acceptable. DVD-9 and DVD-10 discs will require two DLTs, one for each side/layer. Alternatively, for DVD-5 and DVD-10 formats, the title can be mastered from DVD-R disc(s). DVD-9 titles cannot be mastered from DVD-R.

DVD-RAM is generally not suitable for mastering because, unless the data on the disc has been fully erased, or it is a new disc, the files may not be contiguous.

Disctronics

Disctronics is one of the largest independent CD and DVD disc manufacturers, with plants in the USA and Europe offering a total capacity of 1 million CD and 100 thousand DVD discs every day, seven days a week. The company has replication plants in the UK, France, Italy and Texas, plus sales offices in Paris and Los Angeles as well as a rapidly growing fulfilment division in the UK. We offer CD & DVD premastering, mastering, copy protection, on-line order tracking, replication, fulfilment, CD cards, custom CDs and e-commerce services for the music, software and home video industries. Disctronics is ISO 9002 registered, accredited by IRMA, ELSPA and FACT and is a founder member of IODRA.

Disctronics thrives on offering the best service to our customers. In addition to our disc replication and fulfilment services, we also provide information and advice to our customers where and when they need it. This is particularly important for new technologies such as DVD where even the most experienced are still learning.

For more information on CD, CD-ROM and DVD replication email sales@disctronics.com or visit our website www.disctronics.com.

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