

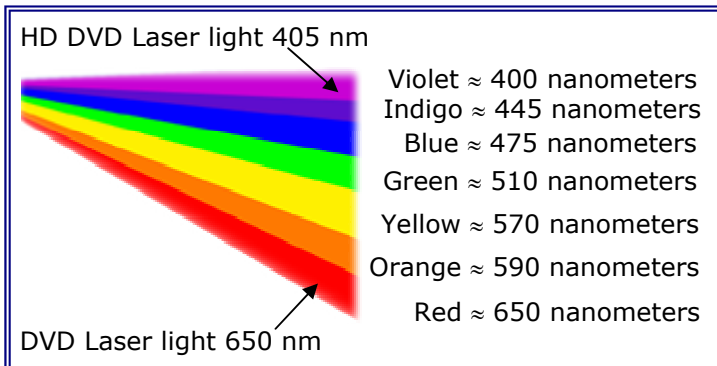
HD DVD – A technical introduction

The increased availability of HDTV broadcasting in North America and Japan, together with the boost that the 2006 Football World Cup will bring to High Definition in Europe and elsewhere in the world, makes the introduction of a corresponding HD DVD format essential. As screen sizes increase, the limitations of standard definition (SD) video become evident and what was acceptable in the past suddenly seems less so. Consumer research shows that perceived picture quality relates directly to viewing distance and screen size. SD video quality assessment tends towards 'poor' as screens increase beyond 36 inches, while HDTV images are still considered 'good' at 60 inches and beyond. HD DVD satisfies the public demand for high quality HDTV content arising from increased availability of large screens at affordable prices. In addition, the spread of broadband and interactive TV has increased expectations of enhanced interactivity in packaged media.

The DVD Forum – the organization that has regulated DVD standards since the birth of the format – has worked with manufacturers and major studios to specify a new disc that is perfectly matched to the needs of the consumer Home Entertainment market as well as PC application. This document summarizes the major technical features of HD DVD; further information may be available from the DVD Forum web site; www.dvdforum.org

HD DVD shares the 12cm diameter and 1.2mm thickness of the current generation of DVD discs, yet is able to deliver eight hours of High Definition video on a dual-layer, single-sided disc. Enhanced interactivity, multi-media functions, secure AACS content protection and the capacity to store ten thousand average MP3 tracks on one disc means that the HD DVD format matches the real-world needs of today's consumer market. For the IT industry, a double-sided HD DVD-R disc can hold up to 30GBytes of data. For replicators, there is the reassurance that today's DVDs can be produced on tomorrow's HD DVD lines.

HD DVD systems play the current generation of red laser DVD discs without problems but part of the secret of their increased data capacity lies in the use of new blue-violet lasers, operating at the other extreme of the visible light spectrum. For comparison with the light wavelengths shown here, a human hair averages around 100,000 nanometers thick.



When the original DVD format was launched in Japan in 1996, MPEG-2 video compression at around eight Mbps was specified. Since then codec efficiencies have improved considerably, though some broadcasters believe that satisfactory reception of High Definition MPEG-2 pictures in the home requires up to 19.3 Mbps. Some videophiles even consider that data rates of 25 Mbps are needed to view HD at the ultimate quality. However, alternative codecs, such as AVC (MPEG-4) and VC-1(Windows Media) are now available that can reduce HD data rates to eight Mbps or even below.

HD DVD discs can deliver HD at any of these bit rates, while still accommodating a full-length feature. The complete 'Gone with the Wind' for example, running 233 minutes, could fit on a single HD DVD disc at 25 Mbps using MPEG-2 HL compression. Using greater bandwidth than the figures proposed by HDTV satellite operators, the new compression strategies allow an hour or more of value-added material to accompany the longest movie: HD DVD is designed from the start to be relevant to the actual needs of content owners and their audience.

Technically, the HD DVD disc builds on the experience gained from the conventional DVD format. There is a choice of three video compression strategies for example: MPEG-2 HL [a higher resolution version of MPEG-2 ML used on existing DVDs]; AVC [MPEG-4] which achieves comparable quality at a significantly lower bit rate and VC-1 [previously known as Windows Media 9 from Microsoft]. The file structure on the disc adopts UDF 2.5.

Audiophiles are well catered for in the new HD DVD format. The existing Dolby Digital [AC-3] and MPEG codecs are joined by Dolby Digital Plus (lossy) and DTS (lossy) as mandatory. Support for 2-channel LPCM, which may be used on current DVDs, is also mandated, along with the 2-channel MLP format that has been adopted for DVD-Audio. DTS HD is adopted as an option for lossless audio.

The table below summarizes the differences between conventional DVD-Video specifications and those of the enhanced HD DVD-Video disc.

		HD DVD-Video		DVD-Video
Disc		HD DVD ROM	3x DVD ROM	DVD ROM
Laser wavelength		405 nanometers		650 nanometers
Numerical aperture		0.65		0.6
Storage capacity (ROM)	Dual layer	30 GB	8.5GB	8.5GB
	Single layer	15 GB	4.7GB	4.7GB
Disc playing time (examples)	Dual layer	HD Video 8 hours	HD Video 2.6 hours	SD video – 3.5 hours
	Single layer	4 hours <i>AVC at 8 Mbps</i>	1.3 hours <i>AVC at 8 Mbps</i>	2 hours <i>MPEG-2 VBR at 5 Mbps</i>
Video Codecs		AVC MPEG-4 / VC-1 MPEG-2		MPEG-2
Audio Codecs	Lossless (mandatory)	Linear PCM / MLP (True HD) [2-ch]		Linear PCM [2-ch]
	Lossless (option)	DTS HD (lossless)		
	Lossy (mandatory)	Dolby Digital Plus / DTS Dolby Digital / MPEG Audio		Dolby Digital MPEG Audio (Europe)
Maximum data transfer rate		36.55 Mbps		11.08 Mbps
Content protection		Advanced Access Content System [AACS] 128-bit		CSS 40-bit
Video Systems		1920x1080 50/60 HDTV		720x480 & 720x576 50/60 SDTV

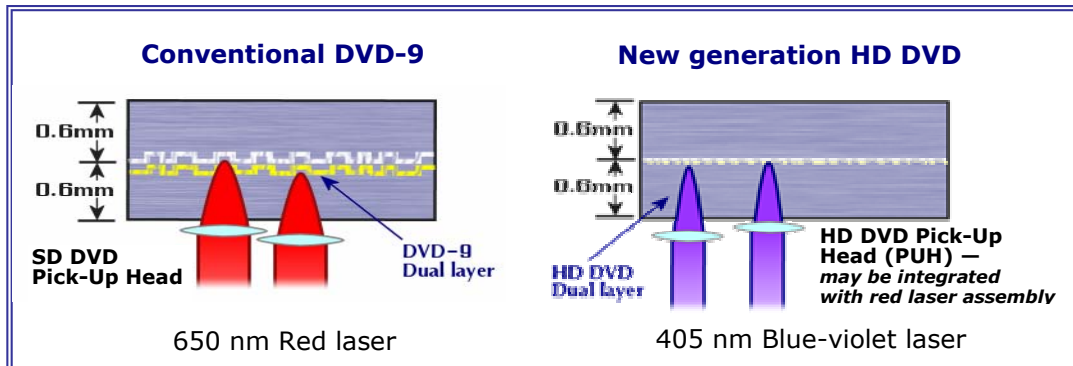
Today's DVD is a widely accepted and very reliable data storage and delivery system. The 1.2mm thick disc has the data placed in the middle of a protective outer layer of transparent plastic. HD DVD has built on this tried and trusted format by adopting the same physical disc parameters.

As a result, the transition is a relatively simple matter for equipment manufacturers and disc replicators alike. In tests, an HD DVD production line has been changed over to conventional DVD replication in under five minutes. No other disc structure could offer such evolutionary compatibility, underscoring the advisability of this approach.

By using a blue-violet laser with a numerical aperture of 0.65 for the lens, the usable spot diameter may be reduced, compared to the current red laser of DVD. As a consequence, the potential data density on the disc is increased. Coupled with higher rotational speed, this allows the maximum data transfer rate to be over three times DVD, at 36.55Mbps.

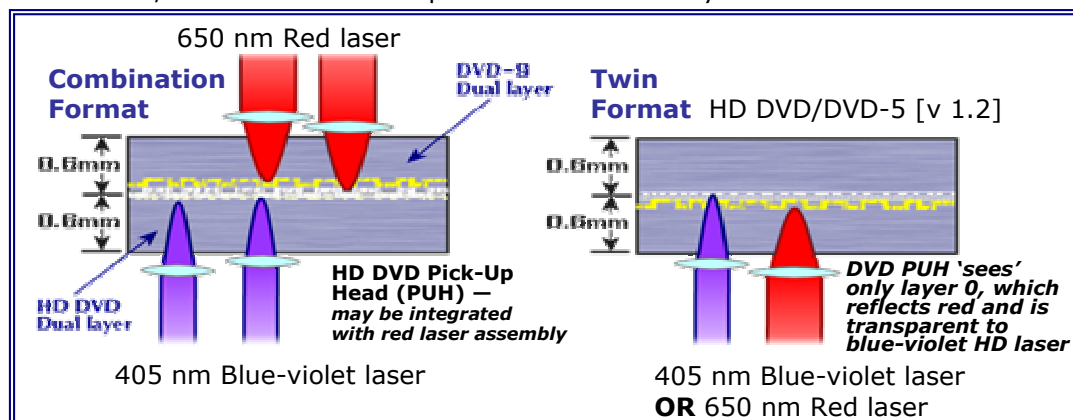
The highest quality HDTV [1920x1080] is supported, along with all recognized subsets through SDTV and down to CIF [320x240]. Additionally, streaming Internet video may be synchronized with pre-recorded content.

Note: In the following illustrations, multiple laser beams are shown for convenience, both above and below the disc. In actual HD DVD drives there is a single laser beam, which illuminates the disc from below.



Although the data density is much greater in HD DVD discs, the structure is very similar to existing DVDs. Discs may be single or double-sided, giving a total storage potential of 60GB on a single disc.

Alternative architectures include the 'Combination' disc, in which one side may be a conventional DVD-9 and the other a dual layer HD DVD. This offers a single inventory product for retailers and a future-proof acquisition for consumers. There is also a technology proposal, approved by the DVD Forum as a format option in HD DVD-ROM version 1.2, for a 'Twin format' disc, in which the layer closest to the pick-up head is reflective to red and transparent to blue-violet light. With this structure, a conventional DVD video player 'sees' the disc as a normal DVD-5, while the blue laser penetrates the first layer to read the HD DVD data behind.



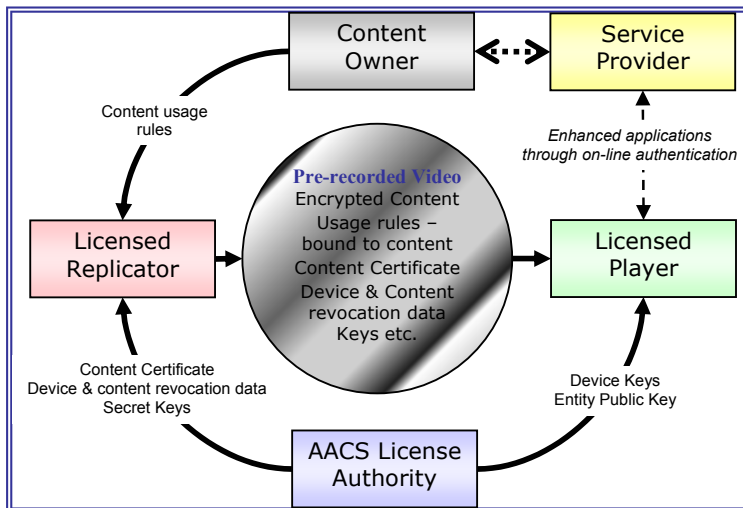
To summarize the family of HD DVD discs:

- **HD DVD-ROM** is a 12cm disc, 1.2mm thick, replicated as either single or dual layer, with a storage capacity of 15GB for a single layer and 30GB for a dual layer disc. Double sided versions increase capacity to 30GB and 60GB respectively.
- **3X DVD-ROM** Brings the higher data rate of HD DVD to the conventional format, enabling 135 minutes of HD content to be placed on a DVD-ROM, using AVC or VC-1 codecs.
- **8 cm mini HD DVD** offers 4.7GB in single layer form and 9.4GB as dual layer. A double-sided disc is part of the standard.
- **HD DVD-R** write once discs can hold 15 GB per side, 30GB total.
- **HD DVD-RW** re-writable discs store 20GB on each side, 40GB total.

AACS Advanced Access Content System is the result of collaboration between the major Studios and the Consumer Electronics and IT industries. Founders of the venture include Toshiba, Microsoft, IBM and Warner Bros. The HD DVD format implements the AACS solutions for digital delivery and consumer access to next generation digital equipment.

AACS is the 128-bit successor to CSS – the Content Scrambling System used in today's DVDs. It takes over where previous content protection leaves off, providing protection for both HD and SD content on HD DVD discs.

As well as inhibiting illegal copying, it enables the management of content transfer to other



devices where permitted, as for example the transfer to the Home Media Server. It is applicable equally to stand-alone, networked and portable consumer devices and also incorporates strategies to protect content from non-digital copying.

The Content owner provides the authored HD DVD data to a licensed replicator, together with the rules for content usage.

The AACS Licensing Authority provides the replicator with secret keys and a Content Certificate,

cryptographically signed, together with data that allows compromised devices and content to be blocked. The replicator then manufactures the HD DVD discs, which carry the encrypted content and the AACS data, and they are shipped to the customers.

AACS LA also supplies Device Keys and the Public Key to licensed player manufacturers, which will allow legally produced discs to play without problems. At the discretion of the Content owner, additional business streams can be created, with Service Providers offering Premium content, synchronized language and subtitle options, and offer other transactional and business links over the Internet.

The HD DVD-Video structure includes extended versions of the conventional DVD-Video object (VOB) and Video navigation. Exclusive to HD DVD-Video is the Advanced Object, encompassing advanced graphics and text that, for example, makes possible user selection of subtitle font and positioning, benefiting both hearing and visually impaired viewers.

Advanced Navigation makes it possible to retrieve and render graphic, video or audio content in real time, synchronized with the locally derived master being viewed and without interruption of the primary audio and video. Streaming objects are also allowed for, with HD DVD player support for IP version 4.

Authoring tools are already available from industry-leading companies, catering for professionals wishing to create complex HD DVD projects and prosumer users.

For more information about HD DVD and the work of the DVD Forum, contact the Office of the Secretary, Daimon Urbanist Bldg 6F, 2-3-6 Shibadaimon, Minato-ku, TOKYO 105-0012 Telephone: +81 3-5777-2881 Fax: +81 3-5777-2882 <http://www.dvdforum.org>