**Blu-ray Disc**

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*"Blue ray" redirects here. For the fish, see* [*Neoraja caerulea*](http://en.wikipedia.org/wiki/Neoraja_caerulea)*.*

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| **Blu-ray Disc** | |
| **[Blu-ray Disc.svg](http://en.wikipedia.org/wiki/File:Blu-ray_Disc.svg)** | |
| [Reverse side of a Blu-ray Disc](http://en.wikipedia.org/wiki/File:BluRayDiscBack.png) | |
| **Media type** | High-density [optical disc](http://en.wikipedia.org/wiki/Optical_disc) |
| [**Encoding**](http://en.wikipedia.org/wiki/Content_format) | [MPEG-2](http://en.wikipedia.org/wiki/MPEG-2), [H.264/MPEG-4 AVC](http://en.wikipedia.org/wiki/H.264/MPEG-4_AVC), and [VC-1](http://en.wikipedia.org/wiki/VC-1) |
| **Capacity** | 25 [GB](http://en.wikipedia.org/wiki/GigaByte) (single-layer) 50 [GB](http://en.wikipedia.org/wiki/GigaByte) (dual-layer) 100/128 GB ([BDXL](http://en.wikipedia.org/wiki/Blu-ray_Disc#BDXL)) |
| **Block size** | 64 kb ECC |
| **Read mechanism** | 405 nm laser: 1× @ 36 [Mbit/s](http://en.wikipedia.org/wiki/Megabit_per_second) (4.5 [MByte/s](http://en.wikipedia.org/wiki/Megabyte_per_second)) |
| **Developed by** | [Blu-ray Disc Association](http://en.wikipedia.org/wiki/Blu-ray_Disc_Association)[[1]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-0) |
| **Usage** | Data storage [1080p](http://en.wikipedia.org/wiki/1080p) [High-definition video](http://en.wikipedia.org/wiki/High-definition_video) [High-definition audio](http://en.wikipedia.org/wiki/High-definition_audio) [stereoscopic 3D](http://en.wikipedia.org/wiki/Stereoscopy)  Future possibility: [Quad HD](http://en.wikipedia.org/wiki/Quad_HD) [2160p](http://en.wikipedia.org/wiki/2160p) [Ultra HD](http://en.wikipedia.org/wiki/Super_Hi-Vision) |

**Blu-ray Disc** (official abbreviation **BD**) is an [optical disc](http://en.wikipedia.org/wiki/Optical_disc) [storage](http://en.wikipedia.org/wiki/Data_storage_device) medium designed to supersede the standard [DVD](http://en.wikipedia.org/wiki/DVD) format. Its main uses are for storing [high-definition video](http://en.wikipedia.org/wiki/High-definition_video), [PlayStation 3](http://en.wikipedia.org/wiki/PlayStation_3) video games, and other [data](http://en.wikipedia.org/wiki/Data), with up to 25 GB per single-layered, and 50 GB per dual-layered disc. Although these numbers represent the standard storage for Blu-ray Disc drives, the specification is open-ended, with the upper theoretical storage limit left unclear. The discs have the same physical dimensions as standard [DVDs](http://en.wikipedia.org/wiki/DVD) and [CDs](http://en.wikipedia.org/wiki/CD).

The name *Blu-ray Disc* derives from the "[blue laser](http://en.wikipedia.org/wiki/Blue_laser)" used to read the disc. While a standard DVD uses a 650 [nanometer](http://en.wikipedia.org/wiki/Nanometer) red laser, Blu-ray Disc uses a shorter [wavelength](http://en.wikipedia.org/wiki/Wavelength) 405 nm laser, and allows for over five times more data storage on single-layer and over ten times on double-layer Blu-ray Disc than a standard DVD. The laser color is called "blue," but is [violet](http://en.wikipedia.org/wiki/Violet_(color)) to the eye, and is very close to [ultraviolet](http://en.wikipedia.org/wiki/Ultraviolet) ("blacklight").

During the [high definition optical disc format war](http://en.wikipedia.org/wiki/High_definition_optical_disc_format_war), Blu-ray Disc competed with the [HD DVD](http://en.wikipedia.org/wiki/HD_DVD) format. [Toshiba](http://en.wikipedia.org/wiki/Toshiba), the main company that supported HD DVD, conceded in February 2008, and the [format war](http://en.wikipedia.org/wiki/Format_war) came to an end.[[2]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-1) In late 2009, Toshiba released its own Blu-ray Disc player.[[3]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-2)

Blu-ray Disc was developed by the [Blu-ray Disc Association](http://en.wikipedia.org/wiki/Blu-ray_Disc_Association), a group representing makers of consumer electronics, computer hardware, and motion pictures. As of June 2009, more than 1,500 Blu-ray Disc titles were available in Australia and the United Kingdom, with 2,500 in the United States and Canada,[[4]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-3). In Japan as of July 2010 more than 3,300 titles were released.[[5]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-4)

Blu-Ray Discs can be clustered together in systems such as [optical jukeboxes](http://en.wikipedia.org/wiki/Optical_jukebox) to increase data storage. This increase of storage can span multiple [terabytes](http://en.wikipedia.org/wiki/Terabyte) and utilize hundreds of Blu-Ray Discs. These systems are currently the largest storage units using Blu-Ray technology.

## History

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| |  | | --- | | [**Optical discs**](http://en.wikipedia.org/wiki/Optical_disc) | | * [Optical disc](http://en.wikipedia.org/wiki/Optical_disc) * [Optical disc drive](http://en.wikipedia.org/wiki/Optical_disc_drive) * [Optical disc authoring](http://en.wikipedia.org/wiki/Optical_disc_authoring) * [Authoring software](http://en.wikipedia.org/wiki/Optical_disc_authoring_software) * [Recording technologies](http://en.wikipedia.org/wiki/Optical_disc_recording_technologies)   + [Recording modes](http://en.wikipedia.org/wiki/Optical_disc_recording_modes)   + [Packet writing](http://en.wikipedia.org/wiki/Packet_writing) | | **Optical media types** | | * **Blu-ray Disc** (BD): [BD-R, BD-RE](http://en.wikipedia.org/wiki/Blu-ray_Disc_recordable) * [DVD](http://en.wikipedia.org/wiki/DVD): [DVD-R](http://en.wikipedia.org/wiki/DVD-R), [DVD+R](http://en.wikipedia.org/wiki/DVD%2BR), [DVD-R DL](http://en.wikipedia.org/wiki/DVD-R_DL), [DVD+R DL](http://en.wikipedia.org/wiki/DVD%2BR_DL), [DVD-R DS](http://en.wikipedia.org/wiki/DVD-R_DS), [DVD+R DS](http://en.wikipedia.org/wiki/DVD%2BR_DS), [DVD-RW](http://en.wikipedia.org/wiki/DVD-RW), [DVD+RW](http://en.wikipedia.org/wiki/DVD%2BRW), [DVD-RAM](http://en.wikipedia.org/wiki/DVD-RAM), [DVD-D](http://en.wikipedia.org/wiki/DVD-D), [HVD](http://en.wikipedia.org/wiki/High-Definition_Versatile_Disc), [EcoDisc](http://en.wikipedia.org/wiki/EcoDisc) * [Compact Disc](http://en.wikipedia.org/wiki/Compact_Disc) (CD): [Red Book](http://en.wikipedia.org/wiki/Red_Book_(audio_Compact_Disc_standard)), [CD-ROM](http://en.wikipedia.org/wiki/CD-ROM), [CD-R](http://en.wikipedia.org/wiki/CD-R), [CD-RW](http://en.wikipedia.org/wiki/CD-RW), [5.1 Music Disc](http://en.wikipedia.org/wiki/5.1_Music_Disc), [SACD](http://en.wikipedia.org/wiki/Super_Audio_CD), [PhotoCD](http://en.wikipedia.org/wiki/PhotoCD), [CD Video](http://en.wikipedia.org/wiki/CD_Video) (CDV), [Video CD](http://en.wikipedia.org/wiki/Video_CD) (VCD), [SVCD](http://en.wikipedia.org/wiki/SVCD), [CD+G](http://en.wikipedia.org/wiki/CD%2BG), [CD-Text](http://en.wikipedia.org/wiki/CD-Text), [CD-ROM XA](http://en.wikipedia.org/wiki/CD-ROM_XA), [CD-i](http://en.wikipedia.org/wiki/CD-i) * [Universal Media Disc](http://en.wikipedia.org/wiki/Universal_Media_Disc) (UMD) * [Enhanced Versatile Disc](http://en.wikipedia.org/wiki/Enhanced_Versatile_Disc) (EVD) * [Forward Versatile Disc](http://en.wikipedia.org/wiki/Forward_Versatile_Disc) (FVD) * [Holographic Versatile Disc](http://en.wikipedia.org/wiki/Holographic_Versatile_Disc) (HVD) * [China Blue High-definition Disc](http://en.wikipedia.org/wiki/China_Blue_High-definition_Disc) (CBHD) * [HD DVD](http://en.wikipedia.org/wiki/HD_DVD): [HD DVD-R](http://en.wikipedia.org/wiki/HD_DVD-R), [HD DVD-RW](http://en.wikipedia.org/wiki/HD_DVD-RW), [HD DVD-RAM](http://en.wikipedia.org/wiki/HD_DVD-RAM) * High definition [Versatile Multilayer Disc](http://en.wikipedia.org/wiki/Versatile_Multilayer_Disc) (HD VMD) * [VCDHD](http://en.wikipedia.org/wiki/VCDHD) * [GD-ROM](http://en.wikipedia.org/wiki/GD-ROM) * [MiniDisc](http://en.wikipedia.org/wiki/MiniDisc) (MD) ([Hi-MD](http://en.wikipedia.org/wiki/Hi-MD)) * [Laserdisc](http://en.wikipedia.org/wiki/Laserdisc) (LD) * [Video Single Disc](http://en.wikipedia.org/wiki/Video_Single_Disc) (VSD) * [Ultra Density Optical](http://en.wikipedia.org/wiki/Ultra_Density_Optical) (UDO) * [Stacked Volumetric Optical Disk](http://en.wikipedia.org/wiki/Stacked_Volumetric_Optical_Disk) (SVOD) * [Five dimensional discs](http://en.wikipedia.org/wiki/5D_DVD) (5D DVD) * [Nintendo optical disc](http://en.wikipedia.org/wiki/Nintendo_optical_disc) (NOD) | | **Standards** | | * [Rainbow Books](http://en.wikipedia.org/wiki/Rainbow_Books) * File systems   + [ISO 9660](http://en.wikipedia.org/wiki/ISO_9660)     - [Joliet](http://en.wikipedia.org/wiki/Joliet_(file_system))     - [Rock Ridge](http://en.wikipedia.org/wiki/Rock_Ridge) / SUSP     - [El Torito](http://en.wikipedia.org/wiki/El_Torito_(CD-ROM_standard))     - [Apple ISO 9660 Extensions](http://en.wikipedia.org/wiki/Apple_ISO_9660_Extensions)   + [Universal Disk Format](http://en.wikipedia.org/wiki/Universal_Disk_Format) (UDF)     - [Mount Rainier](http://en.wikipedia.org/wiki/Mount_Rainier_(packet_writing)) | | **See also** | | * [History of optical storage media](http://en.wikipedia.org/wiki/History_of_optical_storage_media) * [High definition optical disc format war](http://en.wikipedia.org/wiki/High_definition_optical_disc_format_war) | | This box: [view](http://en.wikipedia.org/wiki/Template:Optical_disc_authoring) • [talk](http://en.wikipedia.org/wiki/Template_talk:Optical_disc_authoring) • [edit](http://en.wikipedia.org/w/index.php?title=Template:Optical_disc_authoring&action=edit) | |
| [http://upload.wikimedia.org/wikipedia/commons/thumb/a/a3/Blu-ray_disc_%28BD-RE%29.JPG/200px-Blu-ray_disc_%28BD-RE%29.JPG](http://en.wikipedia.org/wiki/File:Blu-ray_disc_(BD-RE).JPG)  [http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Blu-ray_disc_(BD-RE).JPG)  A blank rewritable Blu-ray Disc (BD-RE). |

Commercial [HDTV](http://en.wikipedia.org/wiki/HDTV) sets began to appear in the consumer market around 1998, but there was no commonly accepted, inexpensive way to record or play HD content. In fact, there was no medium with the storage required to accommodate HD [codecs](http://en.wikipedia.org/wiki/CODEC), except for JVC's [Digital VHS](http://en.wikipedia.org/wiki/D-VHS) and Sony's [HDCAM](http://en.wikipedia.org/wiki/HDCAM).[[6]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-5) Nevertheless, it was well known that using lasers with shorter wavelengths would enable optical storage with higher density. [Shuji Nakamura](http://en.wikipedia.org/wiki/Shuji_Nakamura) invented the practical [blue laser diode](http://en.wikipedia.org/wiki/Blue_laser); it was a sensation among the computer storage-medium community, although a lengthy patent lawsuit delayed commercial introduction.[[7]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-6)

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=2)] Origins

[Sony](http://en.wikipedia.org/wiki/Sony)/[Philips](http://en.wikipedia.org/wiki/Philips) started two projects applying the new diodes: [UDO](http://en.wikipedia.org/wiki/Ultra_Density_Optical) (Ultra Density Optical), and DVR Blue (together with [Pioneer](http://en.wikipedia.org/wiki/Pioneer_Corporation)), a format of rewritable discs that would eventually become Blu-ray Disc (more specifically, BD-RE).[[8]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-7) The core technologies of the formats are essentially similar.

The first DVR Blue prototypes were unveiled at the [CEATEC](http://en.wikipedia.org/wiki/CEATEC) exhibition in October 2000.[[9]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-8) On February 19, 2002, the project was officially announced as Blu-ray Disc,[[10]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-9)[[11]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-10) and [Blu-ray Disc Founders](http://en.wikipedia.org/wiki/Blu-ray_Disc_Founders) was founded by the nine initial members.

The first consumer device was in stores on April 10, 2003. This device was the Sony BDZ-S77, a BD-RE recorder that was made available only in Japan. The recommended price was US$3800;[[12]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-11) however, there was no standard for prerecorded video, and no movies were released for this player. The Blu-ray Disc standard was still years away, as a newer, more secure [Digital Rights Management](http://en.wikipedia.org/wiki/Digital_Rights_Management) (DRM) system was needed before Hollywood studios would accept it—not wanting to repeat the failure of the [Content Scramble System](http://en.wikipedia.org/wiki/Content_Scramble_System) used on standard DVDs. On October 4, 2004, the Blu-ray Disc Founders was officially changed to the [Blu-ray Disc Association](http://en.wikipedia.org/wiki/Blu-ray_Disc_Association) (BDA), and [20th Century Fox](http://en.wikipedia.org/wiki/20th_Century_Fox) joined the BDA's Board of Directors.[[13]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-12)

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=3)] Technical problems with Blu-ray laser

Gallium arsenide (GaAs) is a semiconductor that is necessary to meet with a [red laser](http://en.wikipedia.org/wiki/Helium-neon_laser) requirements. It can be produced by methods similar to those developed previously for silicon. Tiles made from this material are the ideal substrate on which, with great precision, atoms can be placed to form the active part of the laser that generates light (from [quantum wells](http://en.wikipedia.org/wiki/Quantum_well)) with a thickness of over a dozen layers of atoms. It is important that the substrate does not have defects, called [dislocations](http://en.wikipedia.org/wiki/Dislocation), and that the distance between atoms making up the ground and those of the [quantum wells](http://en.wikipedia.org/wiki/Quantum_well) are the same.

These conditions are relatively easy to produce in case of red lasers. In the case of blue semiconductor lasers the best ground is another semiconductor - gallium nitride (GaN). The process of producing single crystals of GaN is much harder than GaAs. It is similar to the process of manufacturing synthetic diamonds, since both diamonds and GaN are formed at very high pressures and temperatures. Many technical challenges make it difficult to manufacture GaN, one of which is the need to use high-pressure nitrogen gas.

The process of high-pressure crystallization of GaN seemed to be impractical and since the 1960s attempts to replace the surface of the GaN substrates with readily available [sapphire](http://en.wikipedia.org/wiki/Sapphire) have not worked. Mismatch between sapphires structure and Gallium Nitride created a large number of structural defects (dislocation), which prevented the implementation of efficient blue light-generating devices.

In 1992, the Japanese inventor [Shuji Nakamura](http://en.wikipedia.org/wiki/Shuji_Nakamura) invented the first efficient blue LED, and four years later, the first blue laser. Nakamura used the material deposited on the sapphire substrate, although the number of defects remained high (106-1010/cm2). The presence of defects in the structure of the laser made it difficult to build a high-power laser.

In the early 90s the Institute of High Pressure Physics at the Polish Academy of Sciences in Warsaw ([Poland](http://en.wikipedia.org/wiki/Poland)), under the leadership of Dr. [Sylwester Porowski](http://en.wikipedia.org/wiki/Sylwester_Porowski) was developing technology to create gallium nitride crystals.[[5]](http://www.poland.gov.pl/Sylwester,Porowski,blue,laser,1983.html) Those crystals had very high structural quality and the number of defects did not exceed 100/cm2. It was at least 10 000 times less than in the case of the best material deposit on sapphire.

In 1999, Shuji Nakamura tried to use Polish crystals to see how defects in this crystal affected the properties of lasers. Laser built on Polish crystal have proved repeatedly to be better than previously constructed, both in terms of lifetime and efficiency. The lifetime at a power of 30 mW has increased 10-fold (from 300 to 3 000 hours), and the yield more than twice.

A further development of the technology has led to the launch of the first mass production of the device. Today - blue lasers utilize sapphire surface covered with layer of gallium nitride (this technology is used by Japanese company [Nichia](http://en.wikipedia.org/wiki/Nichia), which has an agreement with [Sony](http://en.wikipedia.org/wiki/Sony)), and blue semiconductor lasers utilize a gallium nitride mono-crystal surface (Polish company [TopGaN](http://en.wikipedia.org/w/index.php?title=TopGaN&action=edit&redlink=1) [[14]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-13)).

After 10 years in Japan it was possible to master the production of a blue laser with 60 mW of power, making them applicable in reading a dense high-speed stream of data from Blu-ray, BD-R, and BD-RE. Polish technology is cheaper than Japanese but has a smaller share of the market. There is one more Polish high-tech company which creates gallium nitride crystal - [Ammono](http://en.wikipedia.org/w/index.php?title=Ammono&action=edit&redlink=1)[[15]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-14)[[16]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-15), but this company does not produce blue lasers.

Nakamura's technological success, which created the basis for a new field of blue-laser utilization in the electronics industry, has been honored with the Millennium Technology Prize awarded in 2006 year. [[6]](http://www.gizmag.com/go/5754/)

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=4)] Blu-ray Disc format finalized

The Blu-ray Disc physical specifications were completed in 2004.[[17]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-16) In January 2005, [TDK](http://en.wikipedia.org/wiki/TDK) announced that they had developed a hard coating polymer for Blu-ray Discs.[[18]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-17) Cartridges, originally used for scratch protection, were no longer necessary and were scrapped. The BD-ROM specifications were finalized in early 2006.[[19]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-18) AACS LA, a consortium founded in 2004,[[20]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-19) had been developing the DRM platform that could be used to securely distribute movies to consumers. However, the final AACS standard was delayed,[[21]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-20) and then delayed again when an important member of the Blu-ray Disc group voiced concerns.[[22]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-21) At the request of the initial hardware manufacturers, including Toshiba, Pioneer, and Samsung, an interim standard was published that did not include some features, such as managed copy.[[23]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-22)

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=5)] Launch and sales developments

The first BD-ROM players were shipped in mid-June 2006, though [HD DVD](http://en.wikipedia.org/wiki/HD_DVD) players beat them to market by a few months.[[24]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-23)[[25]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-24)

The first Blu-ray Disc titles were released on June 20, 2006: [*50 First Dates*](http://en.wikipedia.org/wiki/50_First_Dates), [*The Fifth Element*](http://en.wikipedia.org/wiki/The_Fifth_Element), [*Hitch*](http://en.wikipedia.org/wiki/Hitch_(film)), [*House of Flying Daggers*](http://en.wikipedia.org/wiki/House_of_Flying_Daggers), [*Underworld: Evolution*](http://en.wikipedia.org/wiki/Underworld:_Evolution), [*xXx*](http://en.wikipedia.org/wiki/XXx) (all [Sony](http://en.wikipedia.org/wiki/Sony)), and [MGM](http://en.wikipedia.org/wiki/MGM)'s [*The Terminator*](http://en.wikipedia.org/wiki/The_Terminator).[[26]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-25) The earliest releases used [MPEG-2](http://en.wikipedia.org/wiki/MPEG-2) video compression, the same method used on standard [DVDs](http://en.wikipedia.org/wiki/DVD). The first releases using the newer [VC-1](http://en.wikipedia.org/wiki/VC-1) and [AVC](http://en.wikipedia.org/wiki/H.264/MPEG-4_AVC) [codecs](http://en.wikipedia.org/wiki/Codec) were introduced in September 2006.[[27]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-26) The first movies using 50 GB dual-layer discs were introduced in October 2006.[[28]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-27) The first audio-only release was made in March 2008.[[29]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-28)

The first mass-market Blu-ray Disc rewritable drive for the PC was the BWU-100A, released by [Sony](http://en.wikipedia.org/wiki/Sony) on July 18, 2006.[[30]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-29) It recorded both single and dual-layer BD-Rs as well as BD-REs and had a suggested retail price of US $699.

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=6)] Competition from HD DVD

*Main article:* [*High definition optical disc format war*](http://en.wikipedia.org/wiki/High_definition_optical_disc_format_war)

The [DVD Forum](http://en.wikipedia.org/wiki/DVD_Forum), chaired by [Toshiba](http://en.wikipedia.org/wiki/Toshiba), was deeply split over whether to develop the more expensive blue laser technology or not. In March 2002, the forum voted to approve a proposal endorsed by [Warner Bros.](http://en.wikipedia.org/wiki/Warner_Bros.) and other [motion picture studios](http://en.wikipedia.org/wiki/Film_studio) that involved compressing HD content onto dual-layer standard [DVD-9](http://en.wikipedia.org/wiki/DVD-9) discs.[[31]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-30)[[32]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-31) In spite of this decision, however, the DVD Forum's Steering Committee announced in April that it was pursuing its own blue-laser high-definition solution. In August, Toshiba and NEC announced their competing standard, Advanced Optical Disc.[[33]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-32) It was finally adopted by the DVD Forum and renamed [HD DVD](http://en.wikipedia.org/wiki/HD_DVD) the next year,[[34]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-33) after being voted down twice by DVD Forum members who were also Blu-ray Disc Association members—prompting the U.S. Department of Justice to make preliminary investigations into the situation.[[35]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-34)[[36]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-35)

HD DVD had a head start in the high definition video market, as Blu-ray Disc sales were slow to gain market share. The first Blu-ray Disc player was perceived as expensive and "buggy", and there were few titles available.[[37]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-36) This changed when the [PlayStation 3](http://en.wikipedia.org/wiki/PlayStation_3) was launched, since every PS3 unit also functioned as a Blu-ray Disc player. At [CES 2007](http://en.wikipedia.org/wiki/Consumer_Electronics_Show), Warner proposed [Total Hi Def](http://en.wikipedia.org/wiki/Total_Hi_Def)—a hybrid disc containing Blu-ray on one side and HD DVD on the other—but it was never released. By January 2007, Blu-ray Discs had outsold HD DVDs,[[38]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-37) and during the first three quarters of 2007, BD outsold HD DVDs by about two to one. In a June 28, 2007 press release, Twentieth Century Fox cited Blu-ray Disc's adoption of the BD+ anticopying system as a key factor in their decision to support the Blu-ray Disc format.[[39]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-38)[[40]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-39) In February 2008, Toshiba withdrew its support for the HD DVD format, leaving Blu-ray Disc as the victor.[[41]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-40)

Some analysts believe that Sony's [PlayStation 3](http://en.wikipedia.org/wiki/PlayStation_3) video game console played an important role in the format war, believing that it acted as a catalyst for Blu-ray Disc, as the PlayStation 3 used a Blu-ray Disc drive as its primary information storage medium.[[42]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-41) They also credited Sony's more thorough and influential marketing campaign.[[43]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-42) It is also worth noting that [AVCHD](http://en.wikipedia.org/wiki/AVCHD) camcorders, first appeared in 2006, produce recordings that can be played back on many Blu-ray Disc players without re-encoding, but not on HD DVD players.

## Technical specifications

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| --- | --- | --- | --- |
| **Type** | **Physical size** | **Single layer capacity** | **Dual layer capacity** |
| Standard disc size | 12 cm | 25 [GB](http://en.wikipedia.org/wiki/Gigabyte) / 23866 [MiB](http://en.wikipedia.org/wiki/Mebibyte) / 25025314816 [B](http://en.wikipedia.org/wiki/Byte) | 50 GB / 47732 MiB / 50050629632 B |
| Mini disc size | 8 cm | 7.8 GB / 7430 MiB / 7791181824 B | 15.6 GB / 14860 MiB / 15582363648 B |

High-definition video may be stored on BD-ROMs with up to 1920×1080 pixel resolution at up to 59.94 [fields](http://en.wikipedia.org/wiki/Field_(video)) per second, if interlaced. Alternatively, progressive scan can go up to 1920×1080 pixel resolution at 24 frames per second, or up to 1280x720 at up to 59.94 frames per second:[[59]](http://en.wikipedia.org/wiki/Blu-ray_Disc" \l "cite_note-58)

|  |  |  |  |
| --- | --- | --- | --- |
| **Resolution** | **Frame rate1** | **Aspect ratio** | **Video format restrictions** |
| 1920×1080 | 59.94-i | 16:9 | 2D encodes only |
| 1920×1080 | 50-i | 16:9 | 2D encodes only |
| 1920×1080 | 24-p | 16:9 |  |
| 1920×1080 | 23.976-p | 16:9 |  |
| 1440×1080 | 59.94-i | 16:9 ([anamorphic](http://en.wikipedia.org/wiki/Anamorphic)) | MPEG-4 AVC / SMPTE VC-1 only |
| 1440×1080 | 50-i | 16:9 (anamorphic) | MPEG-4 AVC / SMPTE VC-1 only |
| 1440×1080 | 24-p | 16:9 (anamorphic) | MPEG-4 AVC / SMPTE VC-1 only |
| 1440×1080 | 23.976-p | 16:9 (anamorphic) | MPEG-4 AVC / SMPTE VC-1 only |
| 1280×720 | 59.94-p | 16:9 |  |
| 1280×720 | 50-p | 16:9 |  |
| 1280×720 | 24-p | 16:9 |  |
| 1280×720 | 23.976-p | 16:9 |  |
| 720×480 | 59.94-i | 4:3/16:9 (anamorphic) |  |
| 720×576 | 50-i | 4:3/16:9 (anamorphic) |  |

### Laser and optics

Blu-ray Disc uses a "blue" [laser](http://en.wikipedia.org/wiki/Laser_diode), operating at a [wavelength](http://en.wikipedia.org/wiki/Wavelength) of 405 [nm](http://en.wikipedia.org/wiki/Nanometre), to read and write data. The diodes are [GaN](http://en.wikipedia.org/wiki/Gallium_nitride) (gallium nitride) lasers that produce 405 nm [photons](http://en.wikipedia.org/wiki/Photons) directly, that is, without [frequency doubling](http://en.wikipedia.org/wiki/Frequency_doubling) or other [nonlinear optical](http://en.wikipedia.org/wiki/Nonlinear_optics) mechanisms.[[60]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-59) Conventional [DVDs](http://en.wikipedia.org/wiki/DVD) and [CDs](http://en.wikipedia.org/wiki/Compact_Disc) use red and near-infrared lasers, at 650 nm and 780 nm, respectively.

[](http://en.wikipedia.org/wiki/File:Panasonic_BD-CMBUJ120.jpg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Panasonic_BD-CMBUJ120.jpg)

Panasonic Internal Blu-ray ROM notebook drive

The blue-violet laser's shorter wavelength makes it possible to store more information on a 12 cm CD/DVD-size disc. The minimum "[spot size](http://en.wikipedia.org/wiki/Spatial_resolution)" on which a laser can be focused is limited by [diffraction](http://en.wikipedia.org/wiki/Diffraction), and depends on the wavelength of the light and the [numerical aperture](http://en.wikipedia.org/wiki/Numerical_aperture_(microscopy)) of the [lens](http://en.wikipedia.org/wiki/Lens_(optics)) used to focus it. By decreasing the wavelength, increasing the numerical aperture from 0.60 to 0.85, and making the cover layer thinner to avoid unwanted optical effects, the laser beam can be focused to a smaller spot. This allows more information to be stored in the same area. For Blu-ray Disc, the spot size is 580 [nm](http://en.wikipedia.org/wiki/Nanometre). In addition to the optical improvements, Blu-ray Discs feature improvements in data encoding that further increase the capacity[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]. (See [*Compact Disc*](http://en.wikipedia.org/wiki/Compact_Disc) for information on optical discs' physical structure.)

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=10)] Hard-coating technology

Since the Blu-ray Disc data layer is closer to the surface of the disc compared to the [DVD](http://en.wikipedia.org/wiki/DVD) standard, it was at first more vulnerable to scratches.[[61]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-BDF_general_whitepaper-60) The first discs were housed in [cartridges](http://en.wikipedia.org/wiki/Caddy_(hardware)) for protection, resembling [Professional Discs](http://en.wikipedia.org/wiki/Professional_Disc) introduced by Sony in 2003.

Using a cartridge would increase the price of an already expensive medium, so hard-coating of the pickup surface was chosen instead. [TDK](http://en.wikipedia.org/wiki/TDK_Corporation) was the first company to develop a working scratch-protection coating for Blu-ray Discs. It was named [Durabis](http://en.wikipedia.org/wiki/Durabis). In addition, both Sony and Panasonic's replication methods include proprietary hard-coat technologies. Sony's rewritable media are spin-coated, using a scratch-resistant and antistatic coating. [Verbatim's](http://en.wikipedia.org/wiki/Verbatim_Corporation) recordable and rewritable Blu-ray Discs use their own proprietary hard-coat technology, called ScratchGuard.

Blu-ray Disc specification allows the use of such a layer to meet the required scratch resistance.[[62]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-BDF_physical_format_whitepaper-61) DVD media are not required to be scratch-resistant, but since development of the technology, some companies, such as Verbatim, implemented hard-coating for more expensive lineups of recordable DVDs.

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=11)] Recording speed

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Drive speed** | **Data rate** | | **Theoretical Write time for Blu-ray Disc (minutes)** | |
| [Mbit/s](http://en.wikipedia.org/wiki/Data_rate_units#Megabit_per_second) | [MB/s](http://en.wikipedia.org/wiki/Data_rate_units#Megabyte_per_second) | Single-Layer | Dual-Layer |
| 1× | 36 | 4.5 | 90 | 180 |
| 2× | 72 | 9 | 45 | 90 |
| 4× | 144 | 18 | 22.5 | 45 |
| 6× | 216 | 27 | 15 | 30 |
| 8× | 288 | 36 | 11.25 | 22.5 |
| 10× | 360 | 45 | 9 | 18 |
| 12×[[63]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-62) | 432 | 54 | 7.5 | 15 |

## Software standards

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=14)] Codecs

The [BD-ROM](http://en.wikipedia.org/wiki/BD-ROM) specification mandates certain codec compatibilities for both hardware decoders (players) and movie software (content).[[64]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bda-av-63)[[65]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-64)

#### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=15)] Video

For video, all players are required to support [MPEG-2 Part 2](http://en.wikipedia.org/wiki/MPEG-2_Part_2), [H.264/MPEG-4 AVC](http://en.wikipedia.org/wiki/H.264/MPEG-4_AVC), and [SMPTE](http://en.wikipedia.org/wiki/SMPTE) [VC-1](http://en.wikipedia.org/wiki/VC-1).[[66]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-65) MPEG-2 is the codec used on regular [DVDs](http://en.wikipedia.org/wiki/DVD), which allows [backwards compatibility](http://en.wikipedia.org/wiki/Backwards_compatibility). MPEG-4 AVC was developed by [MPEG](http://en.wikipedia.org/wiki/MPEG), [Sony](http://en.wikipedia.org/wiki/Sony), and [VCEG](http://en.wikipedia.org/wiki/Video_Coding_Experts_Group). VC-1 is a codec that was mainly developed by [Microsoft](http://en.wikipedia.org/wiki/Microsoft). BD-ROM titles with video must store video using one of the three mandatory codecs; multiple codecs on a single title are allowed.

The choice of codecs affects the producer's licensing/royalty costs as well as the title's maximum run time, due to differences in compression efficiency. Discs encoded in MPEG-2 video typically limit content producers to around two hours of high-definition content on a single-layer (25 GB) BD-ROM. The more-advanced video codecs (VC-1 and MPEG-4 AVC) typically achieve a video run time twice that of MPEG-2, with comparable quality.

MPEG-2 was used by many studios (including [Paramount Pictures](http://en.wikipedia.org/wiki/Paramount_Pictures), which initially used the [VC-1](http://en.wikipedia.org/wiki/VC-1) codec for [HD DVD](http://en.wikipedia.org/wiki/HD_DVD) releases) for the first series of Blu-ray Discs, which were launched throughout 2006.[[67]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-66) Modern releases are now often encoded in either MPEG-4 AVC or VC-1, allowing film studios to place all content on one disc, reducing costs and improving ease of use. Using these codecs also frees a lot of space for storage of bonus content in HD ([1080i](http://en.wikipedia.org/wiki/1080i)/[p](http://en.wikipedia.org/wiki/1080p)), as opposed to the [SD](http://en.wikipedia.org/wiki/Standard_Definition) ([480i](http://en.wikipedia.org/wiki/480i)/[p](http://en.wikipedia.org/wiki/480p)) typically used for most titles. Some studios, such as [Warner Bros.](http://en.wikipedia.org/wiki/Warner_Bros.), have released bonus content on discs encoded in a different codec than the main feature title. For example, the Blu-ray Disc release of [*Superman Returns*](http://en.wikipedia.org/wiki/Superman_Returns) uses VC-1 for the feature film and MPEG-2 for bonus content.[[*citation needed*](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed)] Today, Warner and other studios typically provide bonus content in the video codec that matches the feature.

#### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=16)] Audio

For audio, BD-ROM players are required to support [Dolby Digital](http://en.wikipedia.org/wiki/Dolby_Digital) (AC-3), [DTS](http://en.wikipedia.org/wiki/DTS_Coherent_Acoustics), and [linear PCM](http://en.wikipedia.org/wiki/Linear_pulse_code_modulation). Players may optionally support [Dolby Digital Plus](http://en.wikipedia.org/wiki/Dolby_Digital_Plus) and [DTS-HD High Resolution Audio](http://en.wikipedia.org/wiki/Digital_Theater_System#DTS-HD_High_Resolution_Audio) as well as [lossless](http://en.wikipedia.org/wiki/Audio_compression_(data)#Lossless_audio_compression) formats [Dolby TrueHD](http://en.wikipedia.org/wiki/Dolby_TrueHD) and [DTS-HD Master Audio](http://en.wikipedia.org/wiki/DTS-HD_Master_Audio).[[68]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-67) BD-ROM titles must use one of the mandatory schemes for the primary soundtrack. A secondary audiotrack, if present, may use any of the mandatory or optional codecs.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Specification of BD-ROM Primary audio streams:**[[69]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-BDWhite2010-68) | | | | | | | | |
|  | [**LPCM**](http://en.wikipedia.org/wiki/Linear_pulse_code_modulation) | [**Dolby Digital**](http://en.wikipedia.org/wiki/Dolby_Digital) | [**Dolby Digital Plus**](http://en.wikipedia.org/wiki/Dolby_Digital_Plus) | [**Dolby TrueHD**](http://en.wikipedia.org/wiki/Dolby_TrueHD) **(Lossless)** | **DTS digital surround** | [**DTS-HD**](http://en.wikipedia.org/wiki/DTS-HD) **(Lossless)** | [**DRA**](http://en.wikipedia.org/wiki/Dynamic_Resolution_Adaptation) | **DRA Extension** |
| Max. Bitrate | 27.648Mbps | 640kbps | 4.736Mbps | 18.64Mbps | 1.524Mbps | 24.5Mbps | 1.5Mbps | 3.0Mbps |
| Max. Channel | 8(48 kHz, 96 kHz), 6(192 kHz) | 5.1 | 7.1 | 8(48 kHz, 96 kHz), 6(192 kHz) | 5.1 | 8(48 kHz, 96 kHz), 6(192 kHz) | 5.1 | 7.1 |
| Bits/sample | 16, 20, 24 | 16-24 | 16-24 | 16-24 | 16, 20, 24 | 16-24 | 16 | 16 |
| Sample frequency | 48 kHz, 96 kHz, 192 kHz | 48 kHz | 48 kHz | 48 kHz, 96 kHz, 192 kHz | 48 kHz | 48 kHz, 96 kHz, 192 kHz | 48 kHz | 48 kHz, 96 kHz |

#### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=17)] Bit rate

For users recording [digital television](http://en.wikipedia.org/wiki/Digital_television) programming, the recordable Blu-ray Disc standard's initial data rate of 36 Mbit/s is more than adequate to record high-definition broadcasts from any source ([IPTV](http://en.wikipedia.org/wiki/IPTV), cable/satellite, or terrestrial). BD Video movies have a maximum data transfer rate of 54 Mbit/s, a maximum AV bitrate of 48 Mbit/s (for both audio and video data), and a maximum video bit rate of 40 Mbit/s. This compares to HD DVD movies, which have a maximum data transfer rate of 36 Mbit/s, a maximum AV bitrate of 30.24 Mbit/s, and a maximum video bitrate of 29.4 Mbit/s.[[70]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-69)

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=18)] Container format

Audio, video and other streams are [multiplexed](http://en.wikipedia.org/wiki/Multiplexed) and stored on Blu-ray Discs in a [container format](http://en.wikipedia.org/wiki/Container_format_(digital)) based on the [MPEG transport stream](http://en.wikipedia.org/wiki/MPEG_transport_stream). It is also known as [BDAV MPEG-2 transport stream](http://en.wikipedia.org/wiki/MPEG_transport_stream#Modifications_of_transport_stream_specification_for_random-access_media_.28M2TS.29) and can use filename extension [.m2ts](http://en.wikipedia.org/wiki/.m2ts).[[64]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bda-av-63)[[71]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bdav-videohelp-70) Blu-ray Disc titles authored with menu support are in the BDMV (Blu-ray Disc Movie) format and contain audio, video, and other streams in BDAV container.[[72]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bdvm-71)[[73]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bdav-72) There is also the BDAV (Blu-ray Disc Audio/Visual) format, the consumer oriented alternative to the BDMV format used for movie releases. The BDAV format is used on BD-REs and BD-Rs for audio/video recording.[[73]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bdav-72) BDMV format was later defined also for BD-RE and BD-R (in September 2006, in the third revision of BD-RE specification and second revision of BD-R specification).[[74]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-r2-73)[[75]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-re3-74) Blu-ray Disc employs the MPEG transport stream recording method. That enables transport streams of digital broadcasts to be recorded as they are without altering the format.[[76]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bda-bdre-75) It also enables flexible editing of a digital broadcast that is recorded as is and where the data can be edited just by rewriting the playback stream. Although it is quite natural, a function for high-speed and easy-to use retrieval is built in.[[76]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bda-bdre-75)[[77]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bda-76) Blu-ray Disc Video use MPEG transport streams, compared to DVD's [MPEG program streams](http://en.wikipedia.org/wiki/MPEG_program_stream). This allows multiple video programs to be stored in the same file so they can be played back simultaneously (e.g., with "[Picture in picture](http://en.wikipedia.org/wiki/Picture_in_picture)" effect).

### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=19)] Application format

* BDAV or BD-AV (Blu-ray Disc Audio/Visual)[[78]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-77)[[79]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-filesystem-78)[[80]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-books-79)[[81]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-books2010-80) - a consumer-oriented Blu-ray video format used for audio/video recording (defined in 2002)
* BDMV or BD-MV (Blu-ray Disc Movie)[[74]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-r2-73)[[75]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-re3-74)[[79]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-filesystem-78)[[80]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-books-79)[[81]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-books2010-80)[[82]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-dvddemystified-bdmv-81) - a Blu-ray video format with menu support commonly used for movie releases
  + BDMV Recording specification - (defined in September 2006 for BD-RE and BD-R).[[75]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-re3-74)[[83]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-re3-82)
    - RREF - (Realtime Recording and Editing Format) - a subset of BDMV designed for realtime recording and editing applications[[83]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-re3-82)

### Directory and file structure

#### [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=21)] BD-ROM

All BD-ROM application files are stored under a “BDMV” directory.[[71]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bdav-videohelp-70)[[84]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-83)[[85]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-84)[[86]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-aacs-bd-r-85)

### Filesystem

Blu-ray Disc specifies the use of [Universal Disk Format](http://en.wikipedia.org/wiki/Universal_Disk_Format) (UDF) 2.5 as a convergent friendly format for both PC and consumer electronics environments.[[79]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-filesystem-78) It is used in latest specifications of BD-ROM, BD-RE and BD-R.[[74]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-r2-73)[[75]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-re3-74)[[80]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-bd-books-79)

#### BD-ROM Mark

[BD-ROM Mark](http://en.wikipedia.org/wiki/ROM-Mark) is a small amount of cryptographic data that is stored separately from normal Blu-ray Disc data. Bit-by-bit copies that do not replicate the BD-ROM Mark have no known decoding method.[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*] A specially licensed piece of hardware is required to insert the ROM-mark into the media during replication. Through licensing of the special hardware element, the BDA believes that it can eliminate the possibility of mass producing BD-ROMs without authorization.[*[citation needed](http://en.wikipedia.org/wiki/Wikipedia:Citation_needed" \o "Wikipedia:Citation needed)*]

## [[edit](http://en.wikipedia.org/w/index.php?title=Blu-ray_Disc&action=edit&section=29)] Player profiles

The BD-ROM specification defines four Blu-ray Disc player profiles, including an audio-only player profile (BD-Audio) that does not require video decoding or [BD-J](http://en.wikipedia.org/wiki/BD-J). All three of the video-based player profiles (BD-Video) are required to have a full implementation of [BD-J](http://en.wikipedia.org/wiki/BD-J), with varying levels of hardware support.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Feature** | **BD-Audio** | **BD-Video** | | |
| *Grace Period* [[d]](http://en.wikipedia.org/wiki/Blu-ray_Disc#endnote_profiles_table_note_d) | *Bonus View* | *BD-Live*[[e]](http://en.wikipedia.org/wiki/Blu-ray_Disc#endnote_profiles_table_note_e) |
| Profile 3.0 [[c]](http://en.wikipedia.org/wiki/Blu-ray_Disc#endnote_profiles_table_note_c) | Profile 1.0 | Profile 1.1 | Profile 2.0 |
| Built-in persistent memory | No | 64 KB | 64 KB | 64 KB |
| Local storage capability[[a]](http://en.wikipedia.org/wiki/Blu-ray_Disc#endnote_profiles_table_note_a) | No | Optional | 256 MB | 1 GB |
| Secondary video decoder ([PiP](http://en.wikipedia.org/wiki/Picture-in-picture" \o "Picture-in-picture)) | No | Optional | Mandatory | Mandatory |
| Secondary audio decoder[[b]](http://en.wikipedia.org/wiki/Blu-ray_Disc#endnote_profiles_table_note_b) | No | Optional | Mandatory | Mandatory |
| [Virtual file system](http://en.wikipedia.org/wiki/Virtual_file_system) | No | Optional | Mandatory | Mandatory |
| Internet connection capability | No | No | No | Mandatory |

[](http://en.wikipedia.org/wiki/File:Blu-ray_200GB.png)

### 3D Blu-ray Disc

[](http://en.wikipedia.org/wiki/File:Blu-ray_3D.svg)

[http://bits.wikimedia.org/skins-1.5/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Blu-ray_3D.svg)

Blu-ray 3D logo.

The Blu-ray Disc Association created a task force made up of executives from the film industry and the consumer electronics and IT sectors to help define standards for putting [3D film](http://en.wikipedia.org/wiki/3D_film) and [3D television](http://en.wikipedia.org/wiki/3D_television) content on a Blu-ray Disc.[[140]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-139) On Dec. 17, 2009 the BDA officially announced 3D specs for Blu-ray Disc, allowing backward compatibility with current 2D Blu-ray players.[[141]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-140) "The Blu-ray 3D specification calls for encoding 3D video using the "Stereo High" profile defined by [Multiview Video Coding](http://en.wikipedia.org/wiki/Multiview_Video_Coding) (MVC), an extension to the ITU-T H.264 Advanced Video Coding (AVC) codec currently supported by all Blu-ray Disc players. MPEG4-MVC compresses both left and right eye views with a typical 50% overhead compared to equivalent 2D content, and can provide full 1080p resolution backward compatibility with current 2D Blu-ray Disc players."[[142]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-141) This means the MVC (3D) stream is backward compatible with H.264/AVC (2D) stream, allowing older 2D devices and software to decode stereoscopic video streams, ignoring additional information for the second view.

Also, Sony has stated that they will release a firmware upgrade for PlayStation 3 consoles to enable 3D Blu-ray Disc playback before the end of 2010 [[143]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-142), having already released support for 3D gaming content on April 21, 2010 [[144]](http://en.wikipedia.org/wiki/Blu-ray_Disc#cite_note-143) (followed by availability of 3D games).