ABSTRACT

Blu-ray Disc is a radically new optical storage medium, jointly developed by ten companies leading in optical disc technology. High-definition video recording may be the starting point for Blu-ray Disc, but it is certainly not the only application that will ultimately leverage its very high storage capacities and high-speed data transfer rates.

With this technology, a Blu-ray disc just 120mm in diameter will be able to hold 23 GB of data, approximately five (5) times more than an average DVD. In addition, the super-fast 36 Mbps transfer rate enables the user to record about two (2) hours of high-definition video in a direct mode. In the long play mode, the disc can handle about 12 hours of recording while offering stable recording and playback.

Blu-ray Disc is not just a technological solution. It has been designed with commercial considerations in mind. The blue laser diodes that it uses are now readily available, while the optical assemblies and servo mechanisms needed are compatible with current high-volume manufacturing techniques. In addition, Blu-ray Discs can be mechanically pressed using the same equipment that is used to produce pre-recorded CDs and DVDs.

Unlike CDs and DVDs, however, where compatibility issues have arisen because of the need to add recordable and re-writable format extensions to an initial read-only concept, Blu-ray Disc takes the re-writable format as the starting point for the entire specification. Utilizing phase-change recording technology Blu-ray Disc also features random access for both reading and writing, enabling high compatibility across PC and consumer product domains and across data and audio/video applications.

The latest development based on Blu-ray technology is the Paper Disc. TOPPAN Printing and Sony Corporation recently announced the successful development of a 25GB paper disc based on Blu-ray Disc technology. Using the disc-structure of Blu-ray Disc technology, the new paper disc has a total weight that is 51% paper. Blu-ray Disc is commonly known for allowing more than 2 hours of high-definition program recording.
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CHAPTER 1

INTRODUCTION
1. INTRODUCTION

Blu-ray Disc (BD) – the next generation of optical discs for storing high-definition movies, photos and other digital content – will have by far the highest capacity of any optical disc storage format ever developed for consumers with disc-making costs that are comparable to those for DVDs when manufactured at mass volumes.

Blu-ray Disc is supported by the Blu-ray Disc Founders, a group of 13 industry giants in the consumer electronics, personal computer, and media manufacturing sectors.

Blu-ray Disc holds 27 gigabytes of data or high definition video on a single-layer disc and 50 gigabytes on a dual-layer disc. The current DVD holds 4.7 gigabytes on single-layer discs and 8.5 gigabytes on dual-layer discs.

While production cost is extremely important to commercial content providers, of equal importance are compatibility with current DVD media and protection of digital content from piracy. In response to these concerns, while no blue-laser disc will be readable using a red-laser, combined blue/red drives and other devices will be perfectly feasible resulting in a full backwards compatibility with DVD. Several leading drive manufacturers have already proven this feasibility with drives for consumer products such as video recorders that can read and write both DVD and BD discs.

The format will also offer a robust, comprehensive content protection system, which includes secure AES 128-bit encryption, enhanced production process controls and secure key management in both CE and PC devices.
The key applications of Blu-ray Disc, with its huge storage capacity, are recording and playback of high definition video. Blu-ray Disc is also suitable for a variety of applications including PC data storage and is the perfect storage medium to enable digital convergence bridging between PC applications and the living room. The performance of Blu-ray Disc will meet the market demand for the coming High Definition TV world and will offer compelling interactive services for consumers.
CHAPTER 2

TECHNOLOGY REAVEALED
2. TECHNOLOGY REVEALED

WHAT IS BLU-RAY?

Blu-ray, also known as Blu-ray Disc (BD) is the name of a next-generation optical disc format. The format was developed to enable recording, rewriting and playback of high-definition television (HDTV). The format is also likely to become a standard for PC data storage and high-definition movies in the future.

WHY THE NAME BLU-RAY?

The name Blu-ray is derived from the underlying technology, which utilizes a blue-violet laser to read and write data. The name is a combination of "Blue" and optical ray "Ray". According to the Blu-ray Disc Founders (BDF), the spelling of "Blu-ray" is not a mistake. The character "e" is intentionally left out because a daily-used term can't be registered as a trademark.

2.1 COMPARISON BETWEEN DIFFERENT COMPACT DISCS

2.1.1 CD

The Compact Disc (CD for short) is been here for over 20 years now. With the help of a 780 nanometer (red) laser the data on the single layer gets read. The first CD’s were meant for audio, and later on the CD-ROM came into place giving us 650/700 MB of space per disc.

2.1.2 DVD (DIGITAL VERSATILE DISC)

The development of DVD (Digital Versatile Disc) introduced an enormous upgrade of capacity, giving enough room (4,7 Gigabytes) for high quality sound and multimedia on a single disc. The throughput is much higher and a 650 nanometer laser is used. Now there are also 2 layers for even more capacity. This gives plenty of room to put an entire movie on a single DVD.
2.1.3 BD (BLU-RAY DISC)

Blu-ray owes its name from the colour of the 405 nanometer used laser (Blue/Violet) to read and write data on the Blu-ray Discs (BD). Blu-ray can contain 27GB, which can be read at 36MB/s on single speed. Blue lasers aren’t new. The first blue laser diode was developed in 1996 by Shuji Nakamura, researcher at Nichia Corp.

Who needs such enormous amounts of data and throughput? What is the purpose behind this? The answer is that the big companies want to sell us HDTV. HDTV is High-resolution Digital Television combined with Dolby Digital surround sound (AC-3). HDTV drives on 3 cornerstones; Bigger, sharper and better than our old TV set. With the help of Blu-ray recording devices it is possible to record up to 2.5 hours of very high quality audio and video on a single BD. It is also possible to put more than 13 hours of VHS quality video on a single BD, making it a nice replacement for our old VCR. Ina perfect environment it takes 25 hours to fill the BD with 27 GB of data.

![Figure 1: The Difference between various forms of Compact Discs](image)
2.2 HOW DATA GETS STORED & READ FROM A BD?

Basically there are two version of recording:

- One time recording: making permanent changes to a disc
- Record many times: the ability to change a disc many times

If we use a CD-R (one time recording) the material on the disc itself is changed forever. There is no way to get the material back into its old state.

If we use a CD-RW (record many times) the material on the disc itself changes, but can be changed back again. You can do this as long as the material doesn’t get worn out. After about a 1000 times the material does not change back to another state anymore.

The materials used to make such a rewritable method possible are special crystals that can go back to their original state. By heating up the crystals, they change form. Now, when we quickly cool them, they stay in that form (which is different from its original form). This is called the *amorphous* state of the crystals. They have changed form and it stays that way. Our CD player can read it.

Now, if we want to erase the CD-RW, we have to make sure that we lose all the data. So we want to get rid of the *amorphous* state. By heating up the material again, but this time using more time and less heat, the material gradually wants to take back its old form again, and thus the info is erased. This state is called the *(poly)* crystalline state.
So, by very quickly heating it and very quickly cool it, give the crystals another state (the amorphous state) which thus contains data and by quite slowly heating it and quite slowly cool it, we can give the crystals their old form back (the crystalline state) which contains no more data. It’s a constant change of phases. And so they called it *phase change recording*.

The crystals that can change back and forth are not scattered over the disc or everywhere. There’s a pattern of lines where this material exists. These patterns are called *grooves*. In the case of CD’s, DVD’s & BD’s the grooves can’t be seen with our naked eye since it is of width in the micron range.
Cross Section of a DVD Re-writable

![Cross Section of a DVD Re-writable](image)

Figure 3: The cross section of a DVD Re-writable (Similar to a BD)

From fig we can see a recording layer based on various elements &
the groove they are in. Also there are some protection layers and the
surface that it all is made on. In the fig it is shown a laser beam that
heathen up the recording layer, changing the phase of the crystals.

Next to the grooves there are lands & they are the borders between
grooves. On DVD & BD the lands and the grooves are not straight. They
have a sinus form. This is called wobbled groove. Grooves hold the data
as small pits and the lands separate all the grooves from each other. This
form of written data is durable as the data is written only on the grooves
and the lands never change. So the laser always knows where to look.
BD uses blue-violet laser of 405 nm with 0.85 numerical aperture of the focusing lens. The data is impressed on to the recording track of the BD as small pits. The different reflectivity of the pits enables the laser pick-up to read information from the disc.

The enormous storage capacity of BD can be achieved by reducing the size of the pits as small as possible and focusing the illuminating laser to a small ‘laser spot’ as shown in figure 5.
A fundamental law of Physics states that the diameter of the laser spot is directly proportional to the wavelength of the laser light and inversely proportional to the numerical aperture of the objective lens. To reduce the size of the laser spot we can therefore use a shorter wavelength laser or increase the numerical aperture of the lens. It is better if we can do both, which is the approach adopted in the case of BD. In the case of BD it is the lowest achievable wavelength and the highest NA that is achievable under industrial conditions.
Use of short wavelength Blue laser with a numerical aperture of 0.85 allows BD to reliably read pits on the disc that are a mere 0.15µm long. Together with the longer recording track achieved by reducing the track pitch from 0.74µm to 0.32µm, this allows single BD to store up to 27GB.

The official Blu-ray Disc specifications show that 1x speed will require a 36Mbps data transfer rate, which means it will take about 1 hour and 40 minutes to record 27GB.

The Blu-ray Disc Founders are currently working on different specification, which will support 2x speed to cut the time it takes to copy content from one disc to another in half. In the future, the data transfer rate is expected and probably will be raised to 8x or more.

2.3 BLU-RAY DISC RECORDING LAYER

For DVD, the recording layer is sandwiched between two 0.6 mm thick layers of plastic—typically polycarbonate. The purpose of this is to shift surface scratches, fingerprints and dust particles to a position in the optical pathway where they have negligible effect—i.e. well away from the point of focus of the laser. However, burying the recording layer 0.6 mm below the surface of the disc also has disadvantages.

Due to the injection molding process used to produce them, disc substrates suffer from stress-induced birefringence, which means that they split the single incident laser light into two separate beams. If this splitting is excessive, the drive cannot read data reliably from the disc. Consequently, the injection molding process has always been a very critical part of CD and DVD production. Another critical manufacturing tolerance, particularly for DVDs, is the flatness of the disc, because the laser beam becomes distorted if the disc surface is not perpendicular to the beam axis—a condition referred to as disc tilt. This distortion increases as the thickness of the cover layer increases and also increases for higher numerical aperture lenses.

To overcome these disadvantages, the recording layer in a Blu-ray Disc sits on the surface of a 1.1-mm thick plastic substrate, protected by a
0.1-mm thick cover layer. With the substrate material no longer in the optical pathway, birefringence problems are eliminated. In addition, the closer proximity of the recording layer to the drive’s objective lens reduces disc tilt sensitivity. This only leaves the problem of surface scratching and fingerprints, which can be prevented by applying a specifically developed, innovative hard-coat on top of the cover layer.

This protective coat is hard enough to prevent accidental abrasions and also allows fingerprints to be removed by wiping the disc with a tissue. Both the cover layer and hard coat can be applied by low-cost manufacturing techniques such as spin-coating.

2.4 DISC MANUFACTURING

Despite the fact that Blu-ray Discs require the application of a cover layer and an optional hard coat, this should have little overall impact on disc manufacturing costs. DVD production currently requires the injection molding of two 0.6-mm discs (one of which must meet stringent birefringence limits), the application of a recording layer to one of the discs, and a gluing operation to bond the two discs together.

Blu-ray Discs only require the injection molding of a single 1.1-mm substrate with non-critical optical characteristics, which reduces injection molding costs. This cost saving offsets the additional cost of applying the cover layer and hard coat, while the techniques used for applying the recording layer remain the same. As a result, the overall cost of manufacturing a Blu-ray Disc will be no more expensive than producing a DVD, while some equipment such as injection molding machines can actually be used more efficiently. Because of the thinness of the cover layer, surface-flatness tolerances become far less stringent, while relative cover-thickness tolerances remain almost the same as for current DVD production.
As with Normal DVDs and CDs, Blu-ray disc founders plan to provide a wide range of formats including:

BD-ROM (for reading only made for pre recorded data.)
BD-R (for recording made for PC data storage)
BD-RW (for rewriting on the same disc for PC data storage)
BD-RE (for rewriting and is a format made for HDTV recordings)

2.5 DRIVE COMPATIBILITY

Although no blue-laser disc will be readable using a red-laser, combined blue/red drives will be perfectly feasible. With respect to Blu-ray Disc, several leading drive manufacturers have already demonstrated drives for consumer products such as video recorders that can read and write DVD and Blu-ray Discs.
CHAPTER 3

FEATURES, ADVANTAGES & DISADVANTAGES
3. FEATURES, ADVANTAGES & DISADVANTAGES

3.1 FEATURES & ADVANTAGES

Blu-ray disc enables the recording, rewriting and play-back of up to 27 GB of data on a single layer 12cm CD/DVD & up to 50 GB on a single side dual layer single disc using 405nm Blue-Violet Laser. This is more than enough for a Bollywood / Hollywood movie. It supports 2.5 hours of HDTV (High Definition Television) and 13 Hours of SDTV! It is a technology platform that can store sound & video while maintaining high quality and also access the stored content in an easy-to-use way.

By employing a short wave length blue violet laser, the Blu-ray disc successfully minimises its beam spot size by making the numerical aperture (NA) 0.85 on a field lens that converges the laser. In addition, by using a disc structure with a 0.1mm optical transmittance protection layer, the Blu-ray Disc diminishes aberration caused by disc tilt.

On BD we can store MPEG movies. The BD technology has a standard compression MPEG-2 Transport Stream (based on the IEC 13818 standards) which can record audio & video at the same time and maintain the same quality it was presented in.

Blu-ray also promises some added security, making ways for copyright protections. Blu-ray discs can have a unique ID written on them to have copyright protection inside the recorded streams. The Recorder Unique Identifier (RID) is a 97-bit code recorded every 100 sectors. It is composed of a brand name identifier, a type number, and a drive serial number.

The latest versions of Blu-ray discs like Paper Discs are environment friendly since the main component of these BD’s is pure Paper!!

Since the Blu-Ray Disc does not require laser light to travel through the substrate, researchers were able to develop this paper disc. By increasing the capacity of the disc, can decrease the amount of raw material used per unit of information.
The Blu-Ray Disc uses a cartridge to protect the optical disc’s surface from dust, scratches, and fingerprints. The cartridge should also make this format more durable.

Since a paper disc can be cut by scissors easily, it is simple to preserve data security when disposing of the disc.

3.2 DISADVANTAGES:

Trustworthiness of Blu-ray technology also hasn’t been proven yet. If archive and backup companies are to invest in Blu-ray as a storage technology, they would like some real evidence that the data stored on a BD will stay intact for a very long time.

The technology is proven, but that's no guarantee of a smooth migration. The technology is yet to be standardized.
CHAPTER 4

CHALLENGES FOR BD
4. CHALLENGES

The major challenge to the Blu-ray disc is the HD-DVD, (High Definition DVD), backed by a group led by Toshiba and NEC. The HD-DVD discs can hold up to 30GBs and are more like an upgrade of current DVD technology.

The consumer has a big DVD library. If the next generation of DVDs is different, then their main fear is that the current DVD library has no meaning. So they are not yet ready to accept the new format. The consumer will appreciate compatibility with current DVDs."

The HD-DVD grouping is up against a powerful consortium of electronics giants, including Sony, Philips, Matsushita and Samsung, who back the incompatible Blu-ray format.

The Blu-ray discs can hold up to 50GBs and are based on blue/violet lasers. The BDF companies are saying that there is a need for a quantum leap in performance.

This holds true for all products. For success the companies had to offer a leap in improvement.

Blu-ray has everything to wow consumers with a high-definition experience and much more. The battle for control of the DVD of the future has only just begun.
Table 1: Differentiates a BD from HD-DVD

<table>
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<th>Blu-ray Disc</th>
<th>HD-DVD</th>
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<tr>
<td>1.</td>
<td>Recording Capacity</td>
<td>27GB and 54GB</td>
<td>20 GB and 32 GB</td>
</tr>
<tr>
<td>2.</td>
<td>Number of Layers</td>
<td>Single / Dual</td>
<td>Single / Dual</td>
</tr>
<tr>
<td>3.</td>
<td>Laser Wavelength</td>
<td>405 nm</td>
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<tr>
<td>4.</td>
<td>Numerical Aperture</td>
<td>0.85</td>
<td>0.65</td>
</tr>
<tr>
<td>5.</td>
<td>Protection Layer</td>
<td>0.1 mm.</td>
<td>0.6 mm.</td>
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<tr>
<td>6.</td>
<td>Data transfer rate</td>
<td>36 Mbps.</td>
<td>36 Mbps.</td>
</tr>
<tr>
<td>7.</td>
<td>Video Compression</td>
<td>MPEG-2</td>
<td>MPEG-4</td>
</tr>
</tbody>
</table>
CHAPTER 5

CONCLUSION
5. CONCLUSION

Think of BD as supervised grandchildren of the CD or as genetically enhanced offspring of the DVD. In a few years, for just a few hundred dollars, consumers will start snapping up next-generation digital recording systems that will employ exotic blue-violet lasers to etch 13 hours of video--more than six full-length movies--onto disks the size of standard music CDs.

With a capacity of about 30 gigabytes of data, compared with 4.7 GB for today's DVDs, the new disks promise a richer-than-ever digital experience. Video games will acquire photorealistic graphics and far more elaborate story lines. And TV viewers will be able to store hours of high-definition TV permanently on low-cost disks. If product-development plans at Japanese electronics companies pan out, the first commercial machines are expected to appear in late 2003. And because all of the new machines will be recorders, not just players, analysts expect consumer adoption to be swift.

The nine companies behind this new and improved medium are Hitachi, LG, Matsushita, Philips, Pioneer, Samsung, Sharp, Sony and Thomson. In addition to actively promoting the new format throughout the industry, the nine plan to begin licensing the new format as soon as specifications are completed. It is hoped that the licensing will begin very soon.

The nine companies involved in the announcement will respectively develop products that take full advantage of Blu-ray disc's large capacity and high-speed data transfer rate.

Blu-ray is very cool technology. It takes the DVD-Technology one step further, basically by just using a smaller laser with a nice colour. It is to be seen whether the world is ready for Blu-ray Discs, Recorders and Players.
REFERENCE
REFERENCE:

1. www.opticaldisc-systems.com
2. Blu-ray.com
3. PC-Quest Magazine October 2003 Issue
4. www.mcmedia.com
APPENDIX 1

A.1. MPEG-2 VIDEO COMPRESSION

MPEG-2 is an extension of the MPEG-1 international standard for digital compression of audio and video signals. MPEG-1 was designed to code progressively scanned video at bit rates up to about 1.5 Mbit/s for applications such as CD-i (compact disc interactive). MPEG-2 is directed at broadcast formats at higher data rates; it provides extra algorithmic 'tools' for efficiently coding interlaced video, supports a wide range of bit rates and provides for multi channel surround sound coding.

A.1.1. INTRODUCTION

MPEG (Moving Picture Experts Group) was started in 1988 as a working group within ISO/IEC with the aim of defining standards for digital compression of audio-visual signals. MPEG's first project, MPEG-1, was published in 1993 as ISO/IEC 11172 [1]. It is a three-part standard defining audio and video compression coding methods and a multiplexing system for interleaving audio and video data so that they can be played back together. MPEG-1 principally supports video coding up to about 1.5 Mbit/s giving quality similar to VHS and stereo audio at 192 bit/s. It is used in the CD-i and Video-CD systems for storing video and audio on CD-ROM.

During 1990, MPEG recognised the need for a second, related standard for coding video for broadcast formats at higher data rates. The MPEG-2 standard [2] is capable of coding standard-definition television at bit rates from about 3-15 Mbit/s and high-definition television at 15-30 Mbit/s. MPEG-2 extends the stereo audio capabilities of MPEG-1 to multi-channel surround sound coding. MPEG-2 decoders will also decode MPEG-1 bit streams.

Drafts of the audio, video and systems specifications were completed in November 1993 and the ISO/IEC approval process was completed in November 1994. The final text was published in 1995.
MPEG-2 aims to be a generic video coding system supporting a diverse range of applications. Different algorithmic 'tools', developed for many applications, have been integrated into the full standard. To implement all the features of the standard in all decoders is unnecessarily complex and a waste of bandwidth, so a small number of subsets of the full standard, known as profiles and levels, have been defined. A profile is a subset of algorithmic tools and a level identifies a set of constraints on parameter values (such as picture size and bit rate). A decoder which supports a particular profile and level is only required to support the corresponding subset of the full standard and set of parameter constraints.

This paper introduces the principles used in MPEG-2 video compression systems, outlines the general structure of a coder and decoder, and describes the profiles and levels defined to date.

A.1.2. VIDEO FUNDAMENTALS

Television services in Europe currently broadcast video at a frame rate of 25 Hz. Each frame consists of two interlaced fields, giving a field rate of 50 Hz. The first field of each frame contains only the odd numbered lines of the frame (numbering the top frame line as line 1). The second field contains only the even numbered lines of the frame and is sampled in the video camera 20 ms after the first field. It is important to note that one interlaced frame contains fields from two instants in time. American television is similarly interlaced but with a frame rate of just under 30 Hz.

In video systems other than television, non-interlaced video is commonplace (for example, most computers output non-interlaced video). In non-interlaced video, all the lines of a frame are sampled at the same instant in time. Non-interlaced video is also termed 'progressively scanned' or 'sequentially scanned' video.

The red, green and blue (RGB) signals coming from a colour television camera can be equivalently expressed as luminance (Y) and chrominance (UV) components. The chrominance bandwidth may be reduced relative to the luminance without significantly affecting the picture quality. For standard definition video, CCIR recommendation 601 [3] defines how the
component (YUV) video signals can be sampled and digitised to form discrete *pixels*. The terms **4:2:2** and **4:2:0** are often used to describe the sampling structure of the digital picture. **4:2:2** means the chrominance is horizontally subsampled by a factor of two relative to the luminance; **4:2:0** means the chrominance is horizontally and vertically subsampled by a factor of two relative to the luminance.

The active region of a digital television frame, sampled according to CCIR recommendation 601, is 720 pixels by 576 lines for a frame rate of 25 Hz. Using 8 bits for each Y, U or V pixel, the uncompressed bit rates for **4:2:2** and **4:2:0** signals are therefore:

- **4:2:2**: \(720 \times 576 \times 25 \times 8 + 360 \times 576 \times 25 \times (8 + 8) = 166 \text{ Mbit/s}\)
- **4:2:0**: \(720 \times 576 \times 25 \times 8 + 360 \times 288 \times 25 \times (8 + 8) = 124 \text{ Mbit/s}\)

MPEG-2 is capable of compressing the bit rate of standard-definition **4:2:0** video down to about 3-15 Mbit/s. At the lower bit rates in this range, the impairments introduced by the MPEG-2 coding and decoding process become increasingly objectionable. For digital terrestrial television broadcasting of standard-definition video, a bit rate of around 6 Mbit/s is thought to be a good compromise between picture quality and transmission bandwidth efficiency.

**A.1.3. BIT RATE REDUCTION PRINCIPLES**

A bit rate reduction system operates by removing redundant information from the signal at the coder prior to transmission and re-inserting it at the decoder. A coder and decoder pair is referred to as a 'codec'. In video signals, two distinct kinds of redundancy can be identified.

**Spatial and temporal redundancy:** Pixel values are not independent, but are correlated with their neighbours both within the same frame and across frames. So, to some extent, the value of a pixel is predictable given the values of neighbouring pixels.

**Psychovisual redundancy:** The human eye has a limited response to fine spatial detail [4], and is less sensitive to detail near object edges or around shot-changes. Consequently, controlled impairments introduced into
the decoded picture by the bit rate reduction process should not be visible to a human observer.

Two key techniques employed in an MPEG codec are intra-frame Discrete Cosine Transform (DCT) coding and motion-compensated inter-frame prediction. These techniques have been successfully applied to video bit rate reduction prior to MPEG, notably for 625-line video contribution standards at 34 Mbit/s [5] and video conference systems at bit rates below 2 Mbit/s [6].
APPENDIX 2

A.2. AC-3 DIGITAL SURROUND SOUND

Surround sound refers to the use of multiple audio tracks to envelop the movie watching or music listening audience, making them feel like they're in the middle of the action or concert. The surround sound movie soundtrack allows the audience to hear sounds coming from all around them, and plays a large part in realizing what movie makers call "suspended disbelief". "Suspended disbelief" is when the audience is completely captivated by the movie experience and is no longer aware of their real-world surroundings.

True surround sound formats rely on dedicated speakers that literally and physically surround the audience. There is one center speaker which carries most of the dialog (since the actors usually speak while making their on-screen appearance), and part of the soundtrack. There are left and right front speakers that carry most of the soundtrack (music and sound effects), and may carry parts of the dialog (when the director wants to intentionally offset the source of the dialog to either side, from its default dead-center screen location). There is a pair of surround sound speakers that is placed to the side (and slightly above) of the audience to provide the surround sound and ambient effects. Finally, a subwoofer can be used to reproduce the low and very low frequency effects (LFE) that come with certain movies (e.g., the foot-stomping bass effects in "Jurassic Park" and "Godzilla").

AC-3 is the name given to an encoding scheme for a digital surround system which is called a 5.1 channel system (five discrete channels plus a subwoofer output). The digital approach permits new ways of dealing with the limited available bandwidth. Since most of the bandwidth of video/audio media must go to the video portion, the audio signals must be squeezed into the remaining limited bandwidth. Squeezing the additional discrete channels into the digitally recorded signal is aided by what is called perceptual encoding, making use of the fact that some sounds are inaudible and others are masked by louder ones; these signals can be simply removed by the encoder to make room for more important sounds.
AC-3 also allocates bits between channels of the discrete system to shift signal-handling capability to the channel with the greatest current demand.

AC-3 was originally developed for HDTV. AC stands for Audio Coding and 3 is the generation of the design. The designation "Dolby digital" is sometimes used as a name for this system.

Dolby Stereo Digital uses a digital data stream running at 320 kilobits per second. The HDTV and laserdisc version of Dolby Surround AC-3 Digital runs at 384 kilobits per second and dynamically allocates the bits to the channel with the most demanding signal. Use is made of perceptual encoding to decide which parts of the audio signal would not be heard and therefore can be eliminated. The system provides a slight delay in the center channel sound to achieve a more realistic experience of the sounds arriving at the listeners’ location from the other speakers.

A.2.1 PERCEPTUAL ENCODING FOR DIGITAL SOUND

Perceptual encoding refers to systems which dynamically determine the number of bits of data given to a given channel of audio information based on judgments of its importance to the sound perceived by the listener. Sounds which are below the audibility threshold for the human ear should not waste bits which could be devoted to a higher fidelity reproduction of an important sound. Also, certain sounds are masked by others, and if it is judged that a certain sound would be masked anyway, why not give those bits to another sound which would be heard?

Perceptual encoders divide the sound into frequency bands and determine which bands contain essential audio information, based on rules for audibility and masking. It can also deal with the signal just before and just after a given point in the recording since the temporal environment also affects human perception of sound. Perceptual encoding is used in the AC-3 system of Digital Surround sound.
APPENDIX 3

HOME PAGES

MITSUBISHI TECHNOLOGY

The first dual-layer DVD+R recording media are set to go on sale in Japan at the end of this month and overseas in June, disc maker Mitsubishi announced. The discs were developed jointly by Mitsubishi, which uses the Verbatim brand-name, and Philips, and offer 8.5GB of recording space compared to the 4.7GB of space available on a standard DVD+R disc.

The Mitsubishi branded Dual-Layer Jewel Case

They will cost around ¥1,500 (around £7.50) per disc in Japan, said a spokeswoman for the company.

As the name suggests, the extra recording capacity is made possible through the addition of a second recording layer inside the disc. To make it possible for a single laser to access both recording layers, one behind the other, the top layer has been made semi-transparent. That allows enough reflectivity for data storage and playback while also allowing light to pass through to the second layer.

A.3.3 http://www.opticaldisc-systems.com/

And that's what Blu-ray is! A laser with a smaller wavelength means a license plate if the car moves away from you or gets closer to you constantly, while you are experiencing an earthquake.

The light gathering capacity of the lens is measured in "Numerical Apertures" or NA for short. The bigger NA (which means the lens can gather more light), the better.

**The History of CD**

**1st Generation**

The Compact Disc (CD for short) is been here for over 20 years now. With the help of a 780 nanometer (red) laser the data on the single layer gets read. The first CD's were meant for audio, and later on the CD-ROM came into place giving us 650/700 Megs of space per disc.

**2nd Generation**

The development of DVD (Digital Versatile Disc)